Catalogue M

MAY 1909

Physical and Chemical Apparatus for Science Laboratories

MANUFACTURED & IMPORTED BY
CENTRAL SCIENTIFIC CO
CHICAGO, U.S.A.

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CENTRAL SCIENTIFIC COMPANY.

May 1, 1909.

PHYSICAL *and* CHEMICAL APPARATUS

MANUFACTURED AND IMPORTED BY

CENTRAL SCIENTIFIC CO.,

14 to 28 MICHIGAN STREET,

CHICAGO

U. S. A.

MAY, 1909

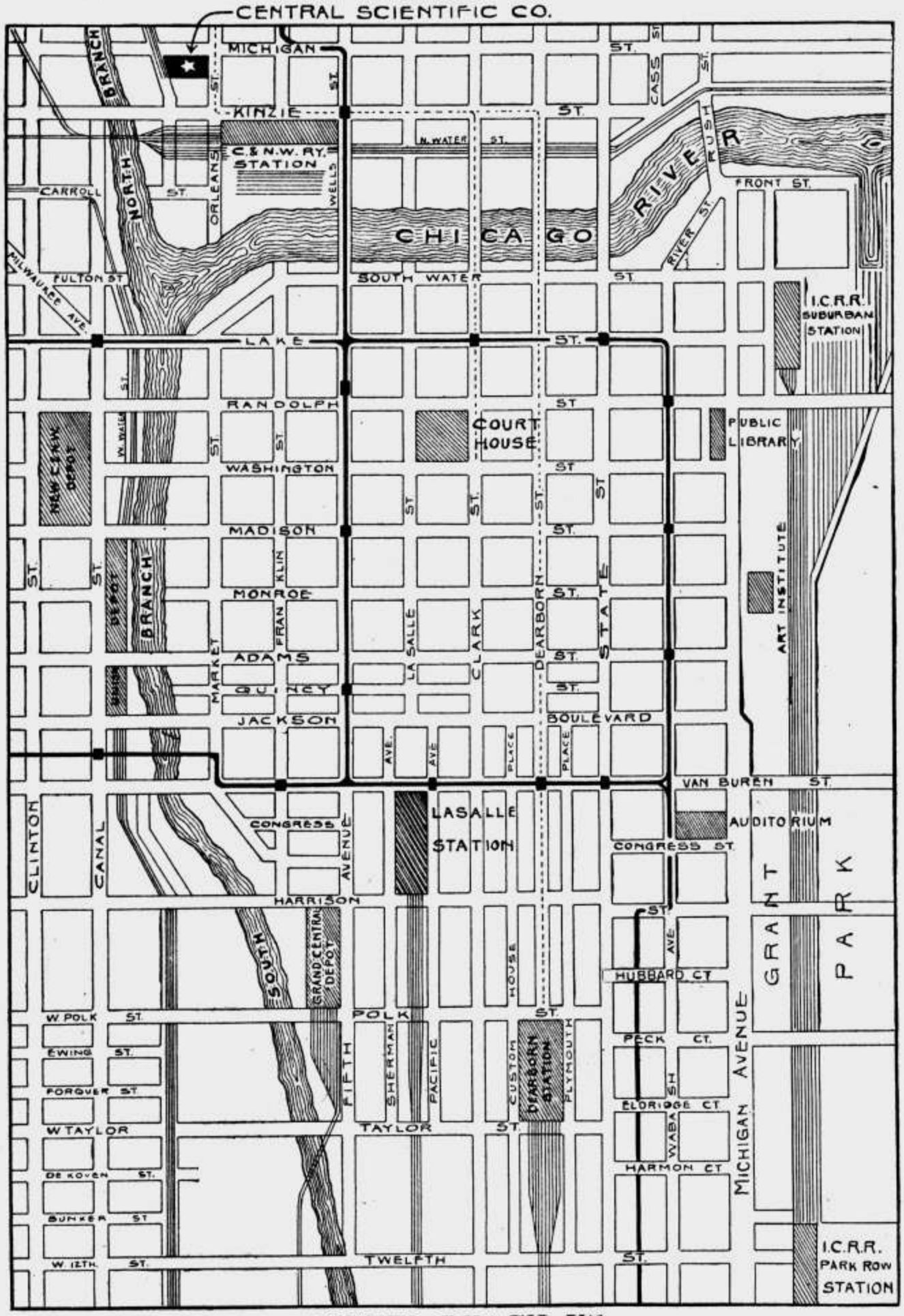
Established 1889

A. H. McCONNELL, Pres.
H. C. ARMS, Vice-Pres.
J. M. ROBERTS, Secy.
A. H. STANDISH, Treas.

Incorporated 1900

CATALOGUE M

Map of Business District of Chicago.



HOW TO REACH US.

Take Sedgwick Street car going north on Dearborn Street (dotted line), get off at Michigan Street and walk 200 feet west.

Take Riverview Park car starting from the Court House (dotted line) get off at Michigan St.

Take Northwestern Elevated train from any station on the loop (heavy black line), get off at Kinzie Street Station (first stop across the river) and walk two blocks west and one block north.

From the Union Depot you can reach us by walking north on Canal Street to the Kinzie Street bridge, then across the bridge one block and north one block.

To the Science Teachers.

We present this catalog to the Science Teachers, believing that it is in many respects superior to any catalog in our line heretofore issued in this country, and with it our assurance on the following important points:—

1. The illustrations represent faithfully the apparatus offered for sale,

2. The descriptions are drawn with all the detail and accuracy that space will permit,

3. The statements as to efficiency, sensibility, etc., of the apparatus are based upon a series of tests made in our own laboratories,and may be relied upon.

We have endeavored to eliminate the obsolete and less efficient types of apparatus, and have made our selections only after a careful study of all the standard Text Books and a thorough examination of the various types of instruments in the market.

A helpful feature of this catalog is the method we have employed to aid the teacher in selecting instruments for demonstrations of a particular nature. To do this we state what the instrument is designed to do, how it is operated and the special structure that makes the attainment of desired results possible. In extension of these helpful features we supplement the brief catalog descriptions by furnishing detailed instructions with each instrument when shipped, where it is considered by us at all helpful and advisable.

CENTRAL SCIENTIFIC COMPANY.

To Our Customers.

We are desirous of avoiding mistakes and misunderstandings in our dealings and, therefore, make the following suggestions, the careful observance of which will be to our mutual advantage.

Correspondence should plainly indicate State, Town, name of School and should be officially signed.

In order to keep pace with the advancement of science and improved laboratory methods, we often find it necessary to **alter** the **details** of **construction** of apparatus from **catalog illustration.** Where such modification does not meet the approval of the purchaser, he is at liberty to return the apparatus.

Suggestions regarding improvements in our apparatus and the making of new and useful instruments are desired at all times.

We are prepared to build **Special Apparatus to order** from original drawings and specifications.

ORDERS and LISTS for QUOTATION.

1. When possible, specify our catalog number, name of article and dimensions. Further specification is not necessary. We furnish conveniently ruled order sheets upon request.

Note: Lists made from catalogs of other dealers will be transposed by us into our own numbers when possible, with our guarantee that the articles will equal in efficiency and finish those originally specified.

2. Specify date when shipment is desired and route and method of shipment, i. e., by express or freight. If goods are to be F. O. B. Chicago, or F. O. B. destination, so specify in order or list.

DUTY FREE IMPORTS, see page 276.

REPAIRS.

Our manufacturing facilities and skilled workmen enable us to repair instruments of any make. Our charge therefor is based upon the actual number of hours consumed. Apparatus for repair or exchange should **be carefully packed and addressed,** and **should have a separate tag attached,** showing **name and address of owner. Letter of advice should be sent us through the mails.**

SHIPMENTS.

Unless otherwise ordered, shipments are made by us **at once,** by such route as will insure earliest delivery. Large shipments by freight and smaller shipments by express or mail, as seems expedient to us. Boxes are charged at cost.

DISCOUNTS.

Prices herein are subject to a discount of **TEN PER CENT,** except on items marked **NET** or **DUTY FREE;** the latter will be quoted upon application. No cash discount for prepayment allowed.

TERMS.

30 days after delivery.

NOTE.—Unless otherwise directed, invoices and statements will be mailed to the person placing the order, **upon whom we rely to O. K. the bills promptly and thus expedite payment.**

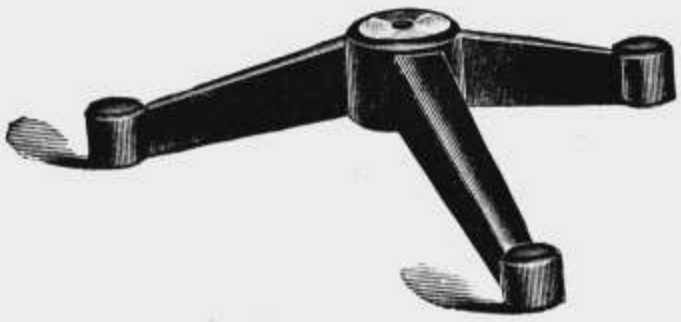
REMITTANCES.

Should be in exchange at par in Chicago, as we are obliged to pay exchange upon all private checks, except from a few of the largest cities.

NOTE.—School Warrants tendered as payment, the funds for which are not immediately available, should if possible, be registered before sending.

CENTRAL SCIENTIFIC COMPANY.

UNIVERSAL PHYSICAL LABORATORY SUPPORTS.



Nos. 1—6.



Nos. 16—18.

A tripod base is the essential part of a system of laboratory supports. It must therefore be very carefully made. We call attention to features which our experience has suggested for improvement over the bases already on the market. Each base is made as heavy as practicable with the center of mass low. In addition, we have made the legs as long as each individual base would allow, which insures stability. Each one of our bases is faced, drilled and threaded by lathe operations and we guarantee that a rod will stand perpendicular to the table or floor. Each base is treated with two coats of japan. The English thread is used, the pitch and the diameter being given below. The round bases are faced top and bottom.

TRIPOD BASES.

1. **Tripod Base,** length of leg 11.5 c. m. Tapped to receive 10 m. m. rod. Diameter of thread ¼ inch. Pitch of thread to inch 20..... $ 35
2. **Tripod Base,** length of leg 14 c. m. Tapped to receive 13 m. m. rod. Diameter of thread ⅜ inch. Pitch of thread to inch 16..... 45
3. **Tripod Base,** length of leg 16.5 c. m. Tapped to receive 13 m. m. rod. Diameter of thread ⅜ inch. Pitch of thread to inch 16..... 70

3a. **Tripod Base,** length of leg 16.5 c. m. Tapped to receive 19 m. m. rod. Diameter of thread ½ inch. Pitch of thread to inch 12..... 70

4. **Tripod Base,** length of leg 19 c. m. Tapped to receive 19 m. m. rod. Diameter of thread ½ inch. Pitch of thread to inch 12..... 1 00
5. **Tripod Base,** length of leg 22 c. m. Tapped to receive 30 m. m. rod. Diameter of thread ¾ inch. Pitch of thread to inch 10..... 2 10
6. **Tripod Base,** length of leg 45 c. m. Tapped to receive 30 m. m. rod. Diameter of thread ¾ inch. Pitch of thread to inch 10..... 5 50
7. **Tripod Base,** No. 1, with three leveling screws..... 1 35
8. **Tripod Base,** No. 2, with three leveling screws..... 1 50
9. **Tripod Base,** No. 3, with three leveling screws..... 2 20
10. **Tripod Base,** No. 3a, with three leveling screws..... 2 20
11. **Tripod Base,** No. 4, with three leveling screws..... 2 50
12. **Tripod Base,** No. 5, with three leveling screws..... 4 50
13. **Tripod Base,** No. 6, with three leveling screws..... 8 00

ROUND BASES.

16. **Round Base,** 8.5 c. m. diameter, tapped to receive 10 m. m. rod..... 25
17. **Round Base,** 11 c. m. diameter, tapped to receive 10 m. m. rod..... 35
18. **Round Base,** 14 c. m. diameter, tapped to receive 13 m. m. rod..... 50

N. B. Any of the above Bases furnished in brass. Prices upon application.



Nos. 20—23.

These rods are made of Bessemer steel, copper plated to prevent rusting, and nickel plated. The shoulders of these rods are made so that they fit the facing of the base closely.

20. **Support Rod.** Diameter 10 m. m. Threaded to fit Nos. 1, 7, 16 and 17 Bases.

Length,	10 c. m.	15 c. m.	20 c. m.	30 c. m.	40 c. m.
Each,	.18	.20	.22	.25	.30

21. **Support Rod.** Diameter 13 m. m. Threaded to fit Nos. 2, 3, 8, 9 and 18 Bases.

Length,	20 c. m.	40 c. m.	60 c. m.	80 c. m.	100 c. m.
Each,	.26	.35	.45	.55	.70

22. **Support Rod.** Diameter 19 m. m. Threaded to fit Nos. 3a, 4, 10 and 11 Bases.

Length,	30 c. m.	40 c. m.	60 c. m.	80 c. m.	100 c. m.	120 c. m.
Each,	.45	.55	.70	.90	1.00	1.20

23. **Support Rod.** Diameter 30 m. m. Threaded to fit Nos. 5, 6, 12 and 13 Bases.

Length,	60 c. m.	80 c. m.	100 c. m.	120 c. m.	160 c. m.
Each,	1.50	1.75	2.00	2.25	2.75

24. **Support Rod.** Diameter 19 m. m. For use as horizontal cross rod in connection with No. 39 Clamp and No. 22 Support Rod. Rounded ends.

Length,	100 c. m.	125 c. m.	185 c. m.
Each,	.90	1.10	1.95

25. **Support Rod,** square. One end is turned to a diameter of 19 m. m. and threading to fit Nos. 3a, 4, 10 and 11 Bases.



No. 25.

Length,	40 c. m.	60 c. m.	80 c. m.	100 c. m.	150 c. m.	200 c. m.
Each,	1.40	1.60	2.00	2.35	3.35	4.35

25A. **Support Rod.** Same as No. 25, but graduated in millimeters.

Length	100 c. m.	200 c. m.
Each	6.65	10.00



No. 26.



No. 26A.



No. 26½.

In all our Clamps with V openings, we have modified the old designs so that the screws are long enough to reach to the apex of the V.

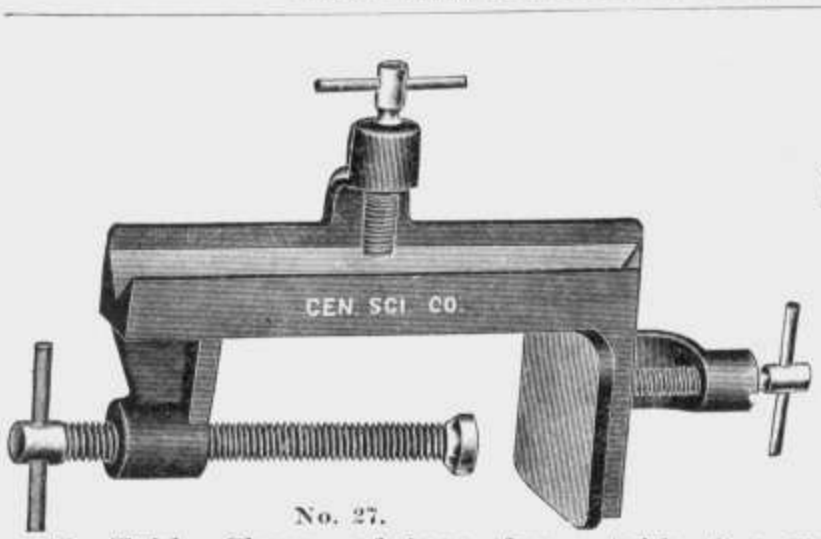
Instead of thumb nuts, we use a nickel plated T, as shown in the illustrations. All V's are accurately milled.

26. **End Support,** for holding rods in a horizontal position (19 m. m. is advised). The increased length of the V in our support is advisable, since it offers a more rigid support in the horizontal plane. The base of the support is milled so that it will stand upright. These clamps are essential in building up the Optical Bench illustrated on pages 227 to 229..... $ 50

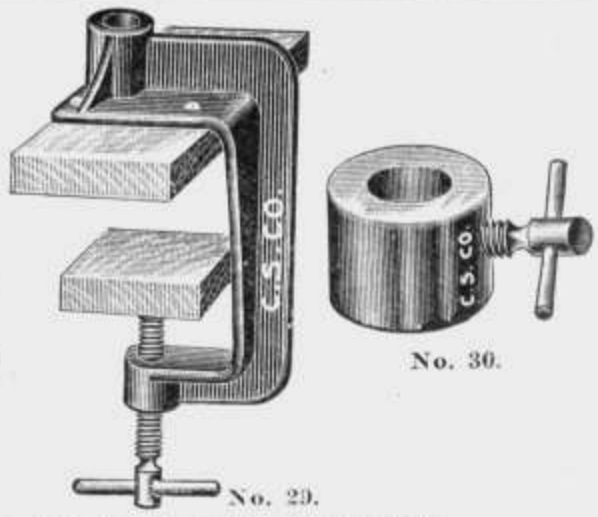
26A. **End Support,** same as above, to hold two rods 75 m. m. apart and 150 m. m. above the supporting base. One supplied with leveling screw. Per pair..... 2 10

26½. **V Support.** Useful for supporting objects of various sizes and forms in a horizontal position, for holding telescope holders, level testers, etc. To clamp on either 10 or 13 m. m. rod..... 60

N. B.—Any of the above clamps furnished in brass. Prices upon application.



No. 27.



No. 29. No. 30.

27. **Table Clamp,** of iron, for a table 6 c. m. thick or less, accurately planed V's at right angles to each other. To be attached to the edge of the table for holding 13 or 19 m. m. round or square rods, either horizontally or vertically. The broad flange is carefully milled and insures stability..... $ 1 50
28. **Table Clamp,** same as No. 27. For a table 11 c. m. thick or less.... 1 75
29. **Table Clamp,** wooden jaws, for a table 9 c. m. thick or less. Designed for use where there is danger of injury to the table top. The large surface of jaws gives increased stability. Tapped to receive 19 m. m. rod..... 1 95
30. **Collar,** with set screw, allowing a clamped rod to rotate freely, at the same time preventing motion along the axis.

For rods	10 m. m.	13 m. m.	19 m. m.	30 m. m.
Each	.40	.50	.60	.80



No. 31.



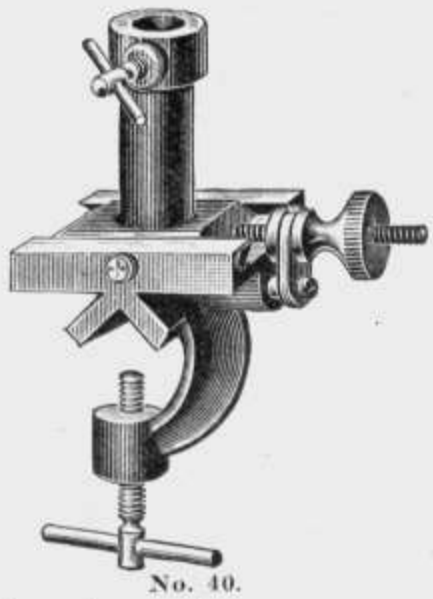
No. 32.



No. 35.



No. 38.



No. 40.

31. **Bridge Clamp,** to be used with optical bench or photometer made up of No. 26A End Supports and a pair of 19 m. m. square rods. The clamp has an index line in the same plane with the vertical hole, for use with the graduated rods. A slight movement of handle is sufficient for firm clamping. Hole 10 m. m. diameter..... 4 50
32. **Right Angle Clamp,** of brass, nickel plated. To hold two 10 m. m. rods accurately at right angles to each other..... 50
35. **Right Angle Clamp,** of iron, neatly japanned. V opening 13 m. m. Hole 10 m. m..... 45
36. **Right Angle Clamp,** same as No. 35, but V opening 19 m. m. Hole 13 m. m..... 60
36A. **Right Angle Clamp,** same as No. 36, with zero line for optical bench accessories 1 00
36B. **Right Angle Clamp,** same as No. 36, except hole is 6 m. m..... 60
37. **Right Angle Clamp,** same as No. 35, but V opening 30 m. m. Hole 19 m. m..... 90
38. **Right Angle Clamp,** of iron, neatly japanned. Two V openings, 13 m. m., at right angles..... 70
39. **Right Angle Clamp,** same as No. 38. V openings 19 m. m..... 80
40. **Right Angle Clamp,** with screw adjustment. This clamp is designed to give a very fine adjustment in the plane perpendicular to the V. Range of adjusting screw, 25 m. m. V opening 19 m. m., hole 10 m. m. 4 50



No. 42.



No. 43.



No. 44.



No. 46.



No. 48.

42. **Right Angle Clamp,** with swivel. Very useful for holding pulleys, mirrors and lens supports where different angular directions are desired. Two 19 m. m. V openings..... $ 1 10

N. B.—For smaller size see No. 4725.

43. **Right Angle Clamp.** One 19 m. m. V opening. Tapped to receive 10 m. m. rod..... 45

44. **Right Angle Clamp,** for lens holders, telescope supports, pulleys, etc. Carefully made so that the rod will be held perpendicular to the V. V opening 19 m. m., hole 10 m. m..... 80

44A. **Right Angle Clamp,** same as No. 44, with zero line for photometer and optical bench accessories..... 1 00

44B. **Right Angle Clamp,** same as No. 44A, with addition of spring. Can be moved along the rod without unlocking the set screw. Convenient for carrying photometer box..... 1 75

45. **Right Angle Clamp,** same as No. 44. V opening 19 m. m., hole 13 m. m. 80

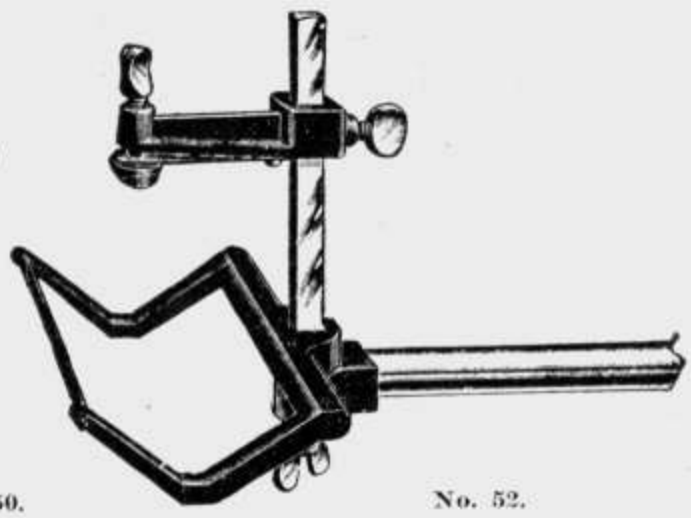
46. **Pulley,** of brass. 45 m. m. diameter. Adjustable, cone bearing, mounted on nickel plated rod 15 c. m. long by 10 m. m. diameter.. 90

48. **Mirror Support,** with mirror 35 m. m. in diameter. Adjustable about a vertical and horizontal axis. Mounted on nickel plated rod 15 c. m. long by 10 m. m. diameter..... 2 40

49. **Mirror Support,** same as No. 48, but 60 m. m. in diameter and mounted on nickel plated rod 10 c. m. long by 10 m. m. diameter..... 3 00



No. 50.



No. 52.

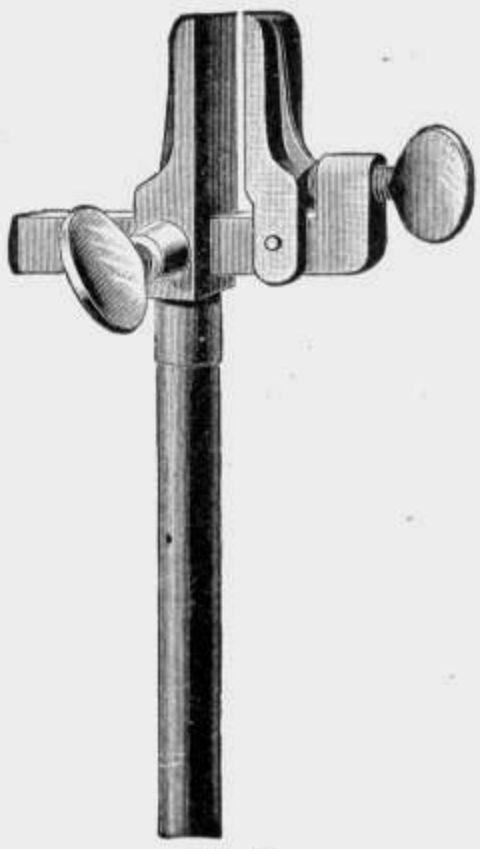
50. **Lens Holder.** This holder has three very important features: The lens is held more securely than in any other holder; the lens is centered in the optical axis and held in a plane perpendicular to the rod. For lenses 25 to 50 m. m. in diameter. Mounted on nickel plated rod 15 c. m. long by 10 m. m. diameter..... 1 00

51. **Lens Holder.** Same as No. 50, for lenses 50 to 100 m. m. in diameter.. 1 35

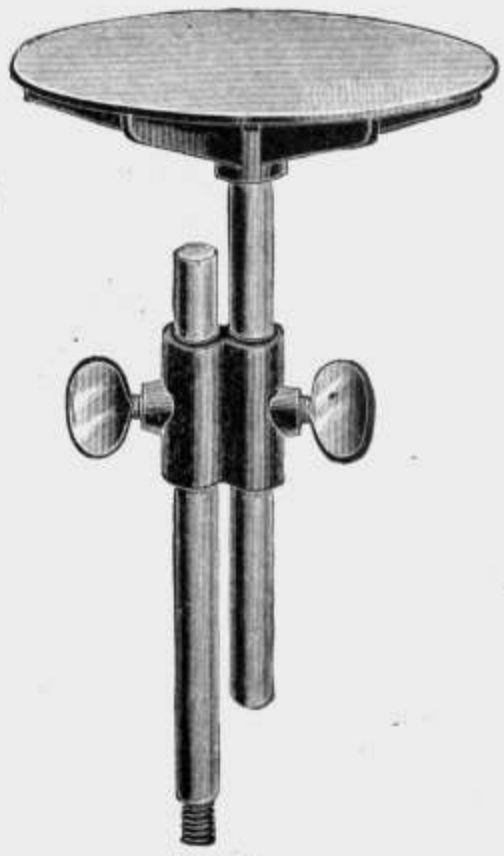
52. **Holder,** for telescopes, lenses and cylinders of any form and size as well as irregular objects up to 8 c. m. in diameter. Rod 13 m. m. in diameter 2 25



No. 53.



No. 58.



No. 60.

53. **Stand Tube,** of brass, nickel plated, used in connection with rods, tripods and stand tops for building up tables or stands. Will fit Bases Nos. 2, 3, 8, 9 and 18 and hold 13 m. m. rod. Length, 20 c. m.. $ 1 20
54. **Stand Tube,** same as No. 53, but 30 c. m. long..... 1 35
55. **Stand Tube,** same as No. 53. Will fit Bases Nos. 3a, 4, 10 and 11 and hold 19 m. m. rod. Length, 30 c. m..... 2 00
56. **Stand Tube,** same as No. 55, but 40 c. m. long..... 2 25
58. **Clamp,** of brass, nickel plated, for holding square objects, mirrors, scales, screens, etc. Jaws open 4 c. m.; rod 20 c. m. long, 10 m. m. diameter 2 00
59. **Clamp,** same as No. 58, but rod 10 c. m. long, 10 m. m. diameter.... 1 90
60. **Extension or Parallel Clamp** (illustrated in connection with two rods and iron table top). For two 10 m. m. rods..... 50
61. **Extension or Parallel Clamp,** same as No. 60, but openings 13 m. m. diameter 60
62. **Extension or Parallel Clamp,** same as No. 60, but openings 19 m. m. diameter 70



No. 66.

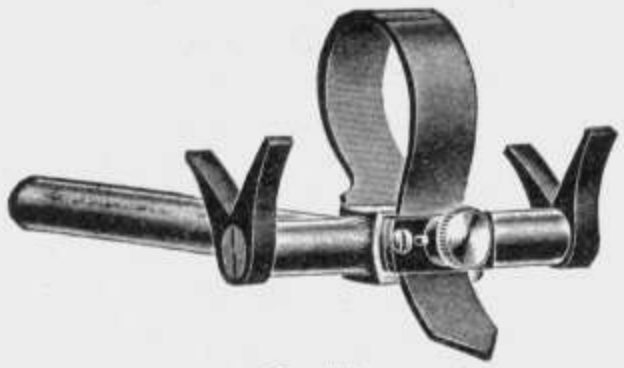


No. 70.

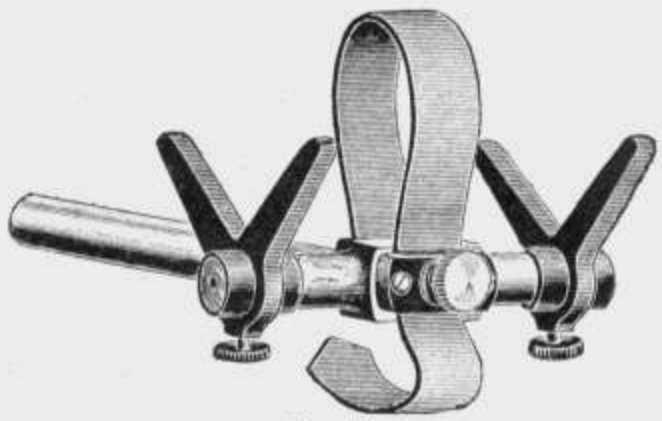
66. **Stand Top,** of well seasoned wood, three-ply to prevent warping. Diameter of top, 15 c. m. Tapped for 13 m. m. rod..... 1 00
66B. **Stand Top,** same as No. 66. Tapped for 10 m. m. rod..... 1 00
66C. **Stand Top,** see page 227.
67. **Stand Top,** same as No. 66, but diameter of top 20 c. m..... 1 50
68. **Stand Top,** same as No. 67. Tapped for 19 m. m. rod..... 1 65
69. **Stand Top,** same as No. 68, but diameter of top 30 c. m..... 1 80

N. B.—Stand Tops of iron planed true on top are designated as Nos. 66a, 67a, 68a and 69a and will be furnished at the above prices. (See illustration in cut No. 60 above.)

70. **Table Platform,** of cast iron. Top surface milled true and at right angles to the opening. Top 6x9 c. m., for 10 m. m. rod..... 60
71. **Table Platform,** same as No. 70. Top 9x13 c. m., for 13 m. m. rod.... 80
72. **Table Platform,** same as No. 70. Top 12x19 c. m., for 19 m. m. rod.. 1 10



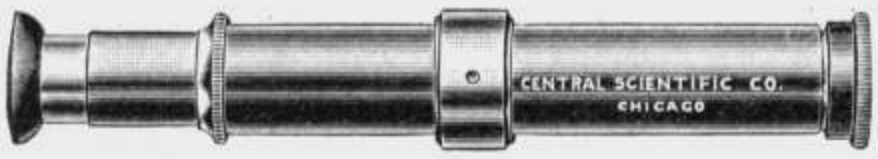
No. 78.



No. 79.

78. **Telescope Clamp,** made of brass. For holding telescopes from 2 to 5 c. m. in diameter. Will hold any round or square object liable to be injured by too great pressure. Illustration shows rod 20 c. m. long by 13 m. m. diameter in usual position, and which is included. Clamp is also tapped at bottom so as to take the rod from below. When desired, a vertical rod 10 m. m. diameter can be attached to carry a scale as illustrated in cut No. 2435..... $ 2 20

79. **Telescope Clamp,** same as No. 78, with movable V's..... 2 75



No. 80.

80. **Reading Telescope,** simple form, without rack and pinion. Eyepiece fitted with cross hairs. Objective 18 m. m. diameter with brass cap. Focus ½ to 1 meter. This Telescope is well made and the objective is achromatic..... 6 00



No. 82.

82. **Reading Telescope,** superior construction, with rack and pinion movement. Eyepiece fitted with cross hairs. Achromatic objective 25 m. m. in diameter with brass cap. Focus 1½ meters up..... 13 30

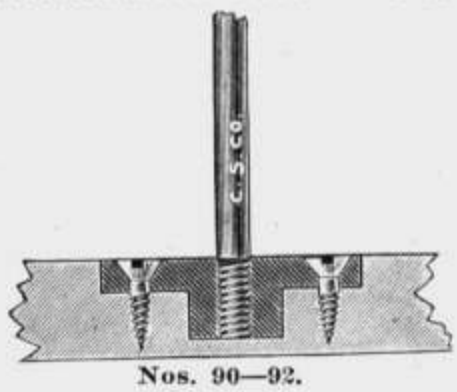
85. **Reading Telescope Scale,** printed on glazed cardboard 50 c. m. long in millimeter divisions, figures inverted and half red and half black. Scale is mounted on hardwood strip with clamp for 10 m. m. rod. (See illustration in cut No. 2435, page 184)..... 1 00

Transparent Glass Scales listed on page 184.

90. **Flush Plate,** of brass, nickel plated, to be fitted into laboratory table flush with the top. Large diameter to secure stability. Tapped for 10 m. m. rod..... 35

91. **Flush Plate,** same as No. 90, tapped for 13 m. m. rod..... 45

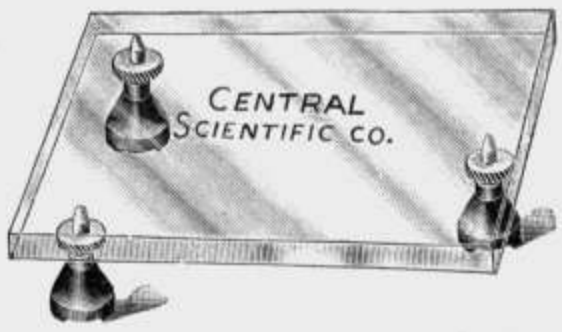
92. **Flush Plate,** same as No. 90, tapped for 19 m. m. rod..... 70



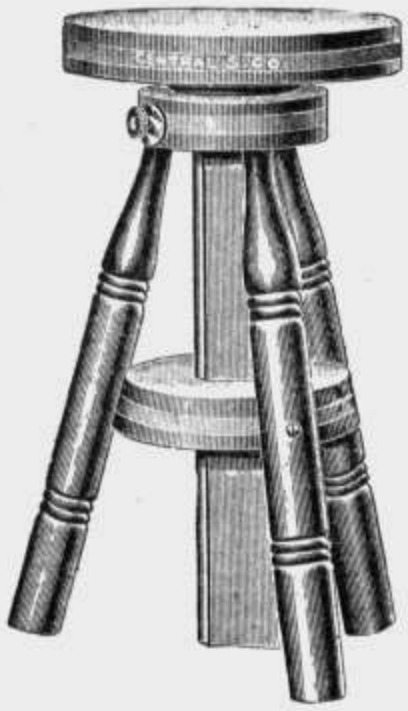
Nos. 90—92.



No. 94.



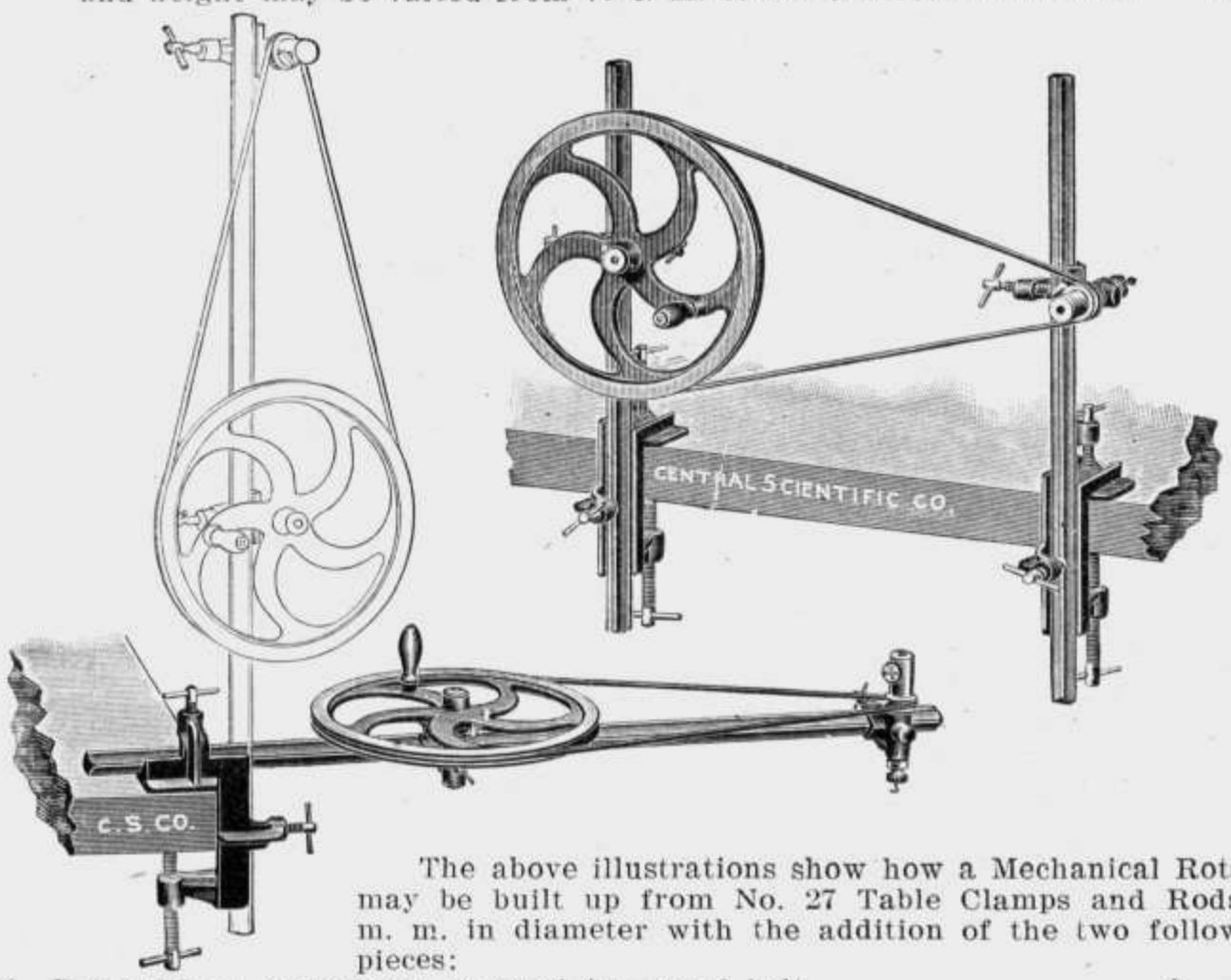
Set of No. 94 with Glass Plate.



No. 95.

94. **Leveling Screws,** in sets of three, permitting the rapid leveling of table as illustrated. Made entirely of metal, the base of which is accurately planed. Height, 75 m. m. Range of adjustment, 13 m. m. Per set..... $ 1 95

95. **Adjustable Wood Stand.** Made from well seasoned hardwood, very heavy and solid. The tops are three-ply to prevent warping. All metal parts are of brass. These stands are useful in supporting telescopes, galvanometers and other laboratory instruments, where a magnetic substance would interfere. Top is 35 c. m. in diameter and height may be varied from 70 c. m. to 115 c. m..... 10 00



The above illustrations show how a Mechanical Rotator may be built up from No. 27 Table Clamps and Rods 19 m. m. in diameter with the addition of the two following pieces:

96. **Drive Wheel and Clamp,** grooved for round belt..... $ 4 50

97. **Spindle and Clamp,** with socket and set screw on one end and a chuck with lock nut and washer on the other, for holding accessories 4 00

If both Nos. 96 and 97 are included in your order we will add the rotator belt free of charge.

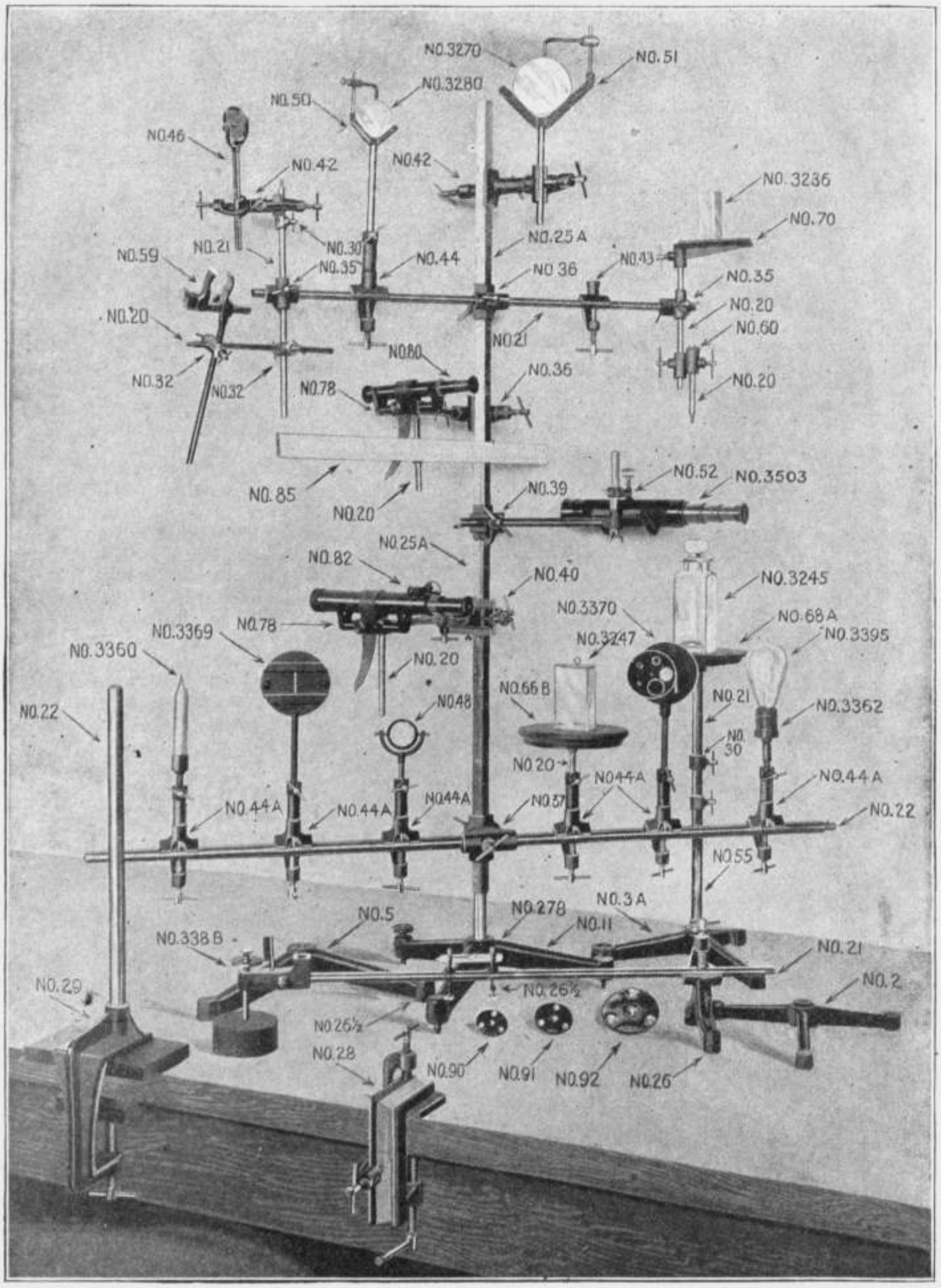


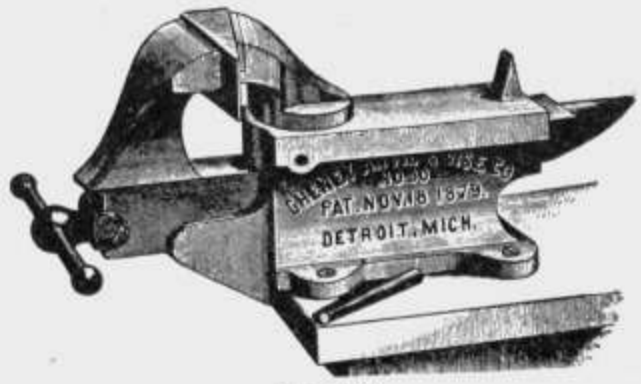
Illustration showing some of the possible combinations that can be made with the **Universal Physical Laboratory Supports** as listed on pages 1 to 7.

TOOLS AND MEASUREMENTS.

ARRANGED ALPHABETICALLY.



No. 101.



No. 102.

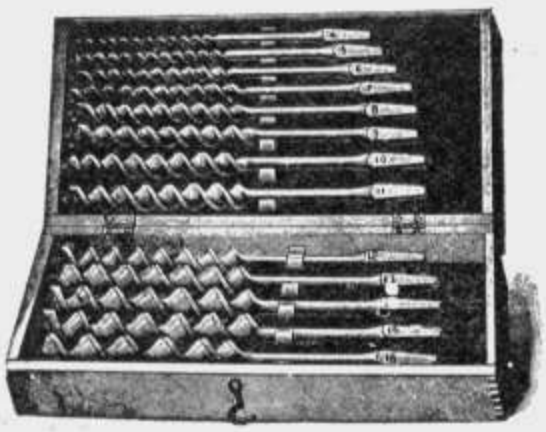
101. **Anvil.** Heavy, regular shape, steel face, two horns, for table use.

Weight in pounds,	5	10	15	20
Length in inches,	4	5	6	6½
Each,	2 00	2 75	3 25	4 00

102. **Anvil Vise,** adjustable jaws, strongly constructed.

Weight in pounds,	9	25	35	50
Width of jaws, inches,	2½	3½	4	4½
Opening in inches,	3	4	5	6
Each,	3 90	5 00	6 10	7 25

See also **Anvil Clamp Vises** on page 45.



No. 103.



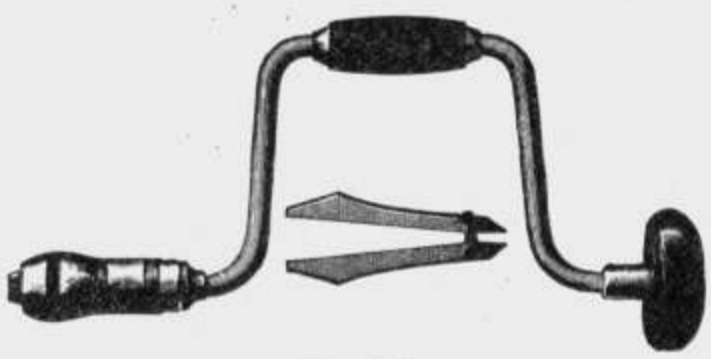
No. 107.

103. **Auger Bits,** set of 13 high grade bits in hardwood case; ¼ to 1 inch by sixteenths of an inch..... $ 5 00

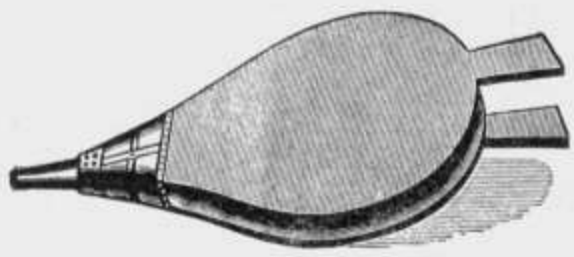
105. **Auger Bit,** good quality.

Size,	3	4	5	6	7	8	9	10	11	12	13	14	15	16-16ths
Each,	.20	.20	.20	.22	.23	.24	.25	.26	.28	.30	.35	.38	.40	.45

107. **Auger Bit,** Clark's adjustable expansion bit, cutting from ½ inch to 1½ inches..... 1 10



No. 109.



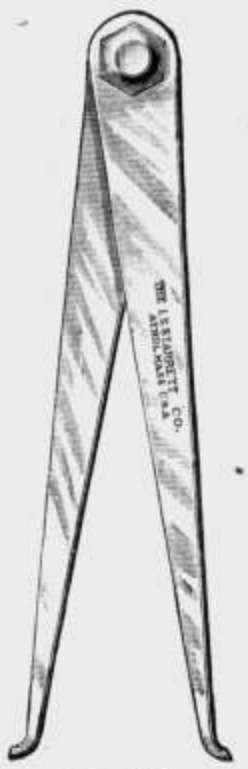
No. 111.

109. **Bit Brace,** steel bow, good quality..... 80

111. **Bellows,** hand, width 7 inches..... 80



No. 113.



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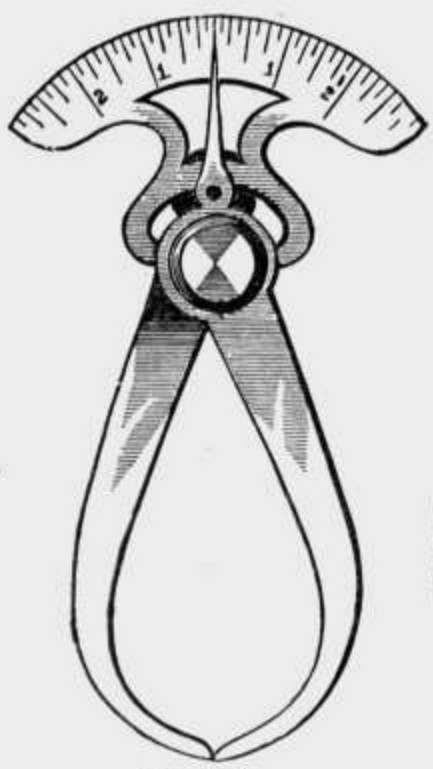

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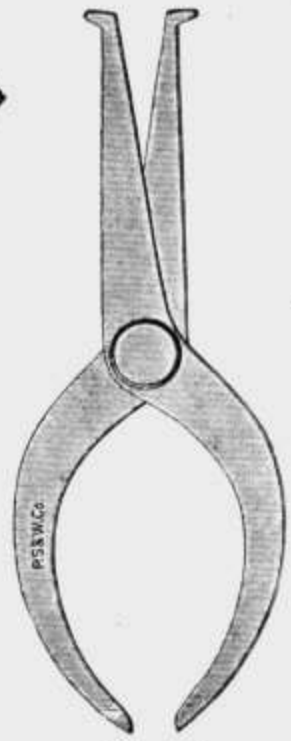
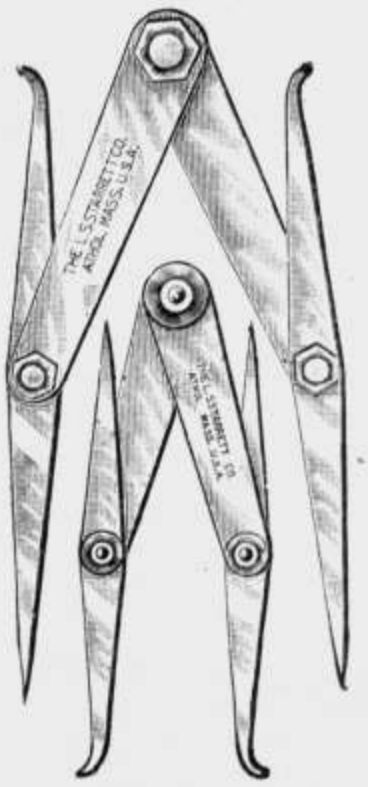
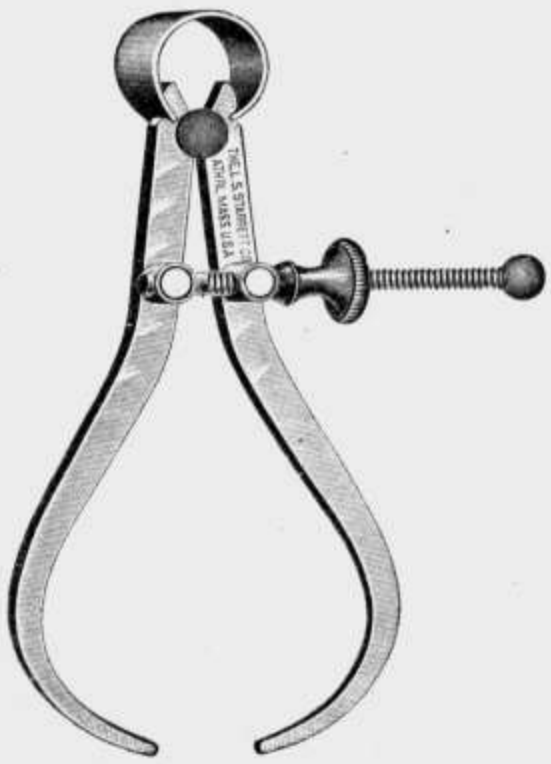


No. 119.

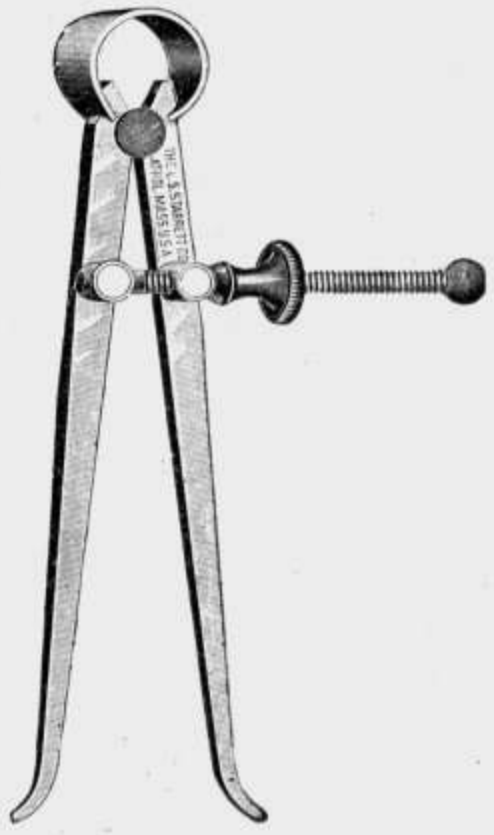
113.	**Caliper, outside.** Length,	4 in.		6 in.
	Each,	.16		.22
115.	**Caliper, inside.** Each,	.16		.22
117.	**Caliper, registering,** nickel plated, 4 inch,		$	1 00
119.	**Caliper, double,** outside and inside. Length,	4 in.		6 in.
	Each,	.20		.25



No. 120.

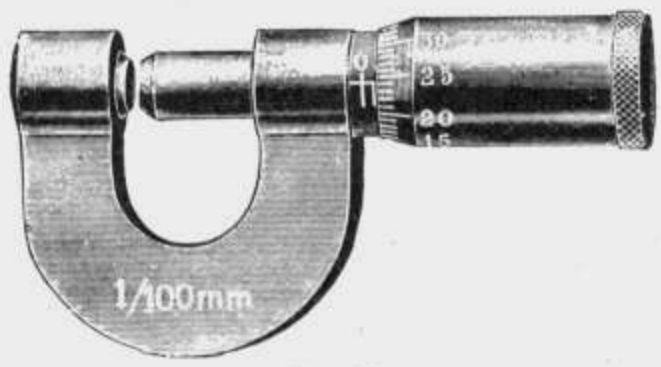


No. 121.



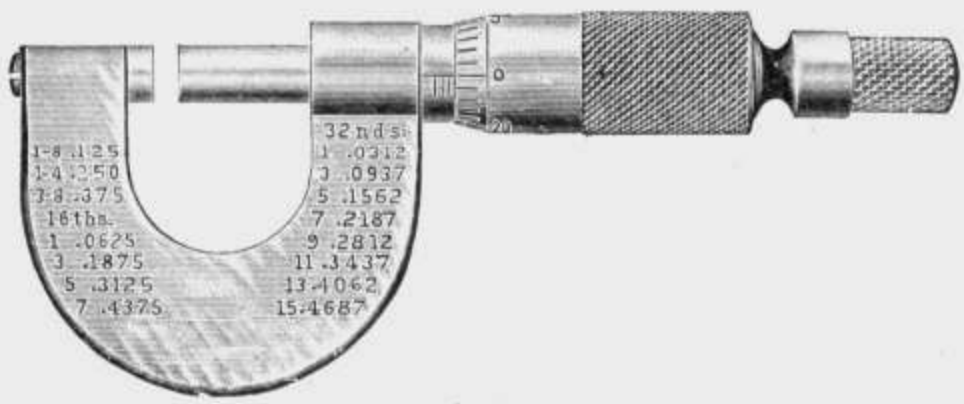
No. 123.

120.	**Caliper, double.** Combined dividers and outside and inside calipers. Firm friction joints. Length,	6 in.		8 in.	
	Each,	$1 40		$1 65	
121.	**Caliper, spring, outside.** Even tension, solid nut. Length,	4 in.	5 in.		
	Each,	.85	.90		
123.	**Caliper, spring, inside.** Even tension, solid nut. Each,	.85	.90		



No. 125.

125. **Caliper, Micrometer.** Metric measure. This caliper will measure all sizes less than 15 m. m. Graduated to read to 1/100 m. m. Provided with friction head which enables all objects measured to be subjected to the same degree of pressure..... $ 3 35



No. 127.

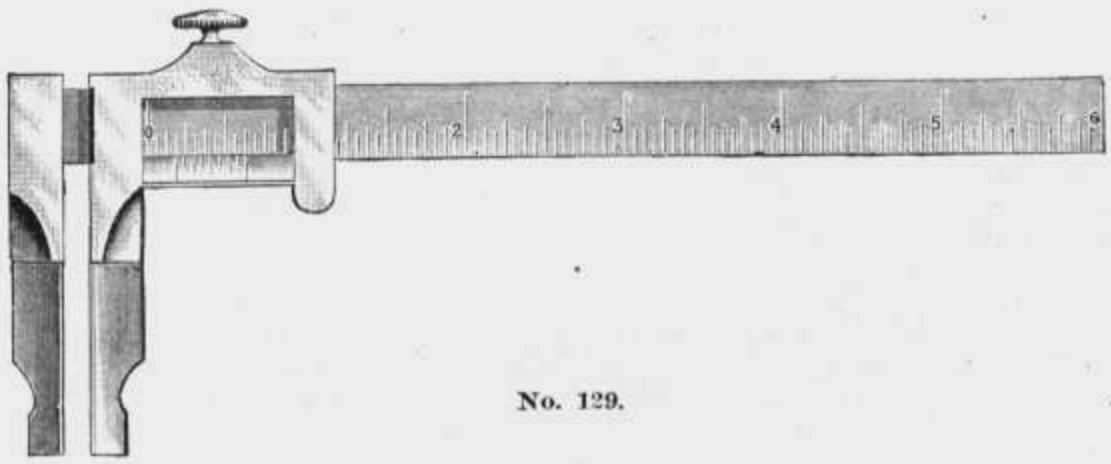
127. **Caliper, Micrometer,** same as No. 125, but provided with ratchet stop, which enables all objects measured to be subjected to the same degree of pressure. If more than a certain degree of pressure is exerted, the ratchet will throw the screw out of action. With ordinary usage the devise can not get out of order and the wear is practically imperceptible 5 00

127A. **Caliper, Micrometer,** same as No. 127, but larger. Will measure all sizes less than 25 m. m. by 1/100 m. m..... 6 60

127B. **Caliper, Micrometer,** same as No. 127A, but without ratchet stop. Will measure all sizes less than 25 m. m. by 1/100 m. m..... 6 00

Morocco cases for any of the above micrometer calipers, extra..... 50

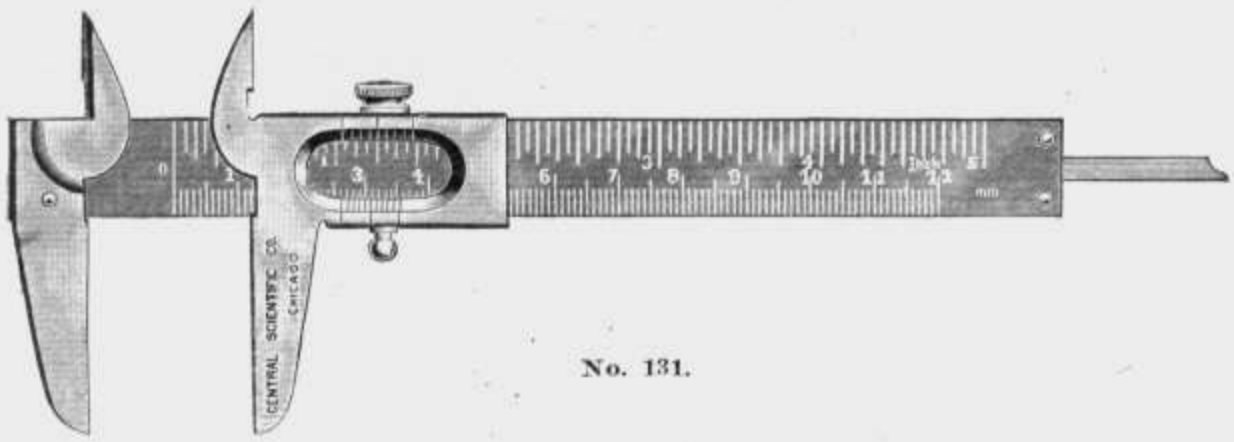
N. B.—We can furnish any size Brown and Sharpe calipers in English or metric graduation, with or without ratchet stop. Prices on application.



No. 129.

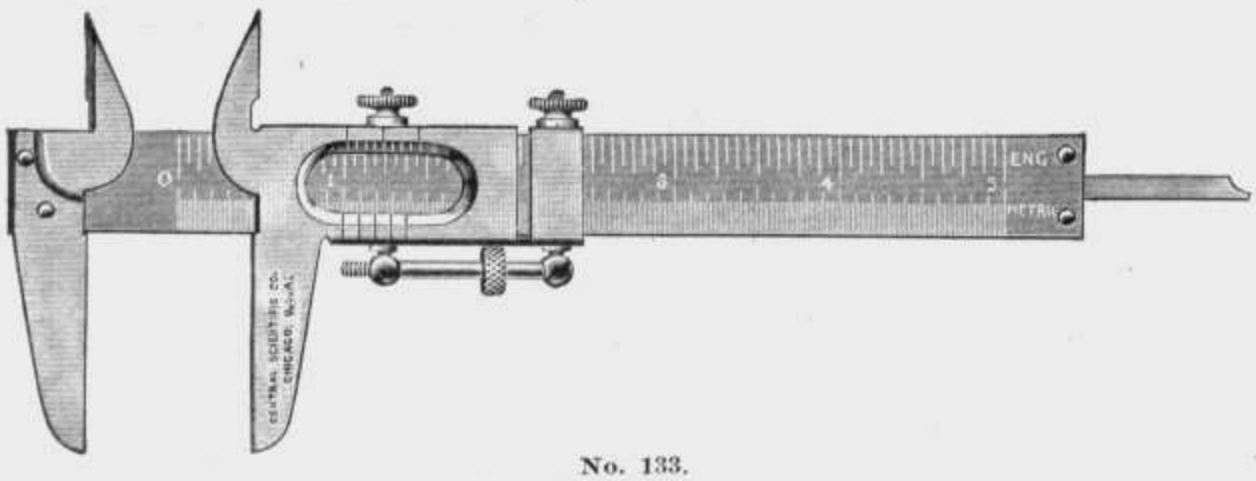
129. **Caliper, Vernier,** of steel, 10 c. m. long, with vernier reading to 1/10th millimeter 1 65

130. **Caliper, Vernier,** Boley's..... 2 00



No. 131.

131. **Caliper, Vernier,** of steel, 16 c. m. long; the most complete Vernier caliper on the market. Inside caliper, outside caliper and depth gauge combined, with both **English** and **Metric scales and Verniers** for each, reading to 1-128 inches and 1-10 millimeters. Thumb attachment for easy operation. Neat, accurate and durable, in neat leather case.... $ 2 50



No. 133.

133. **Caliper, Vernier,** of steel, same as No. 131 with the addition of a micrometer screw adjustment, in neat leather case..... 3 75



No. 137.

137. **Chisel,** extra cast steel, ½-inch, 45c; 1-inch..... 55



No. 139.

139. **Chisel,** gouge, extra cast steel, ½-inch, 50c; 1-inch..... 75



No. 141.

141. **Chisel, cold,** ⅜-inch, 15c; ½-inch..... 22

Wood Turning Chisels, page 46.



No. 145.



No. 146.



No. 149.

145. **Clamp, Standard.** This Clamp is made of malleable iron, neatly japanned, and provided with ball and socket swivel cap on screw.

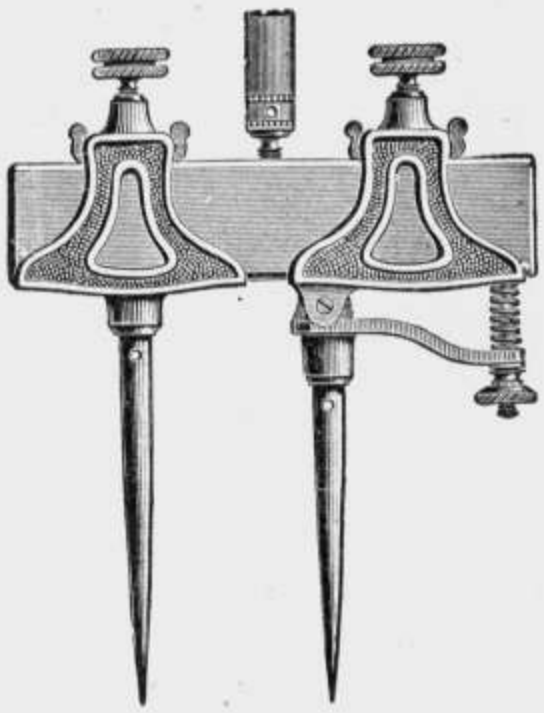
	2 in.	3 in.	4 in.	6 in.
Opens,				
Each,	.20	.28	.40	.50

146. **Clamp, Standard,** adjustable form, quick acting. Made of malleable iron, neatly japanned. By turning the bolt one-quarter turn to the left it can be moved its full length in or out. When turning to the right it operates like any other screw.

	4 in.	6 in.	8 in.
Opens,			
Each,	.65	.90	1.10

149. **Clamp, Hand Screw,** wood, No.

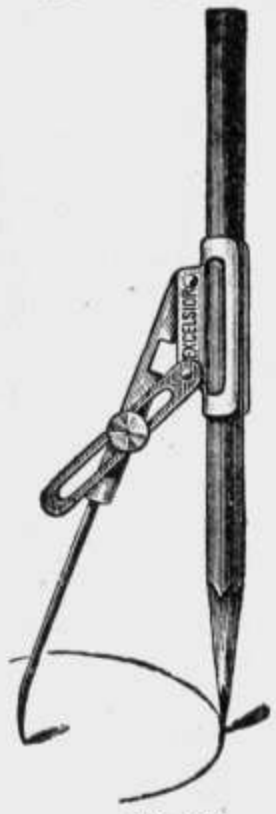
No.	Length of jaws, inches	Opening, inches	Each
15	5	2	.30
14	7	3	.33
13	8	4½	.45
12	10	5½	.50
11	12	7¼	.75
10	12	8½	.90



No. 151.



No. 154.



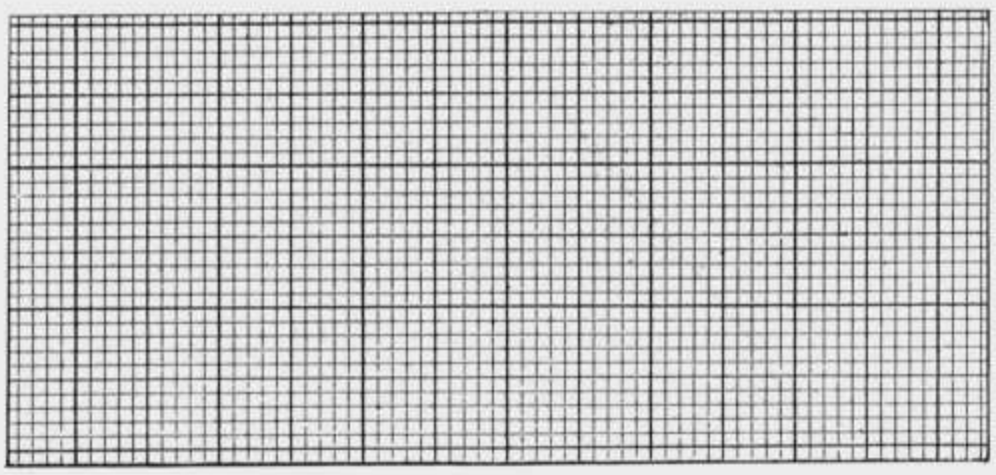
No. 155.

151. **Compass, Beam,** nickel plated, with forged steel points, either point can be removed and the pencil socket accompanying each pair put in its place; adjustable..... $ 3 00

153. **Compass, Beam,** same as No. 151, but not adjustable..... 2 00

154. **Compass, Eagle Pencil.** The most universally used school compass. Pen, pencil, divider and compass combined. Provided with set nut. Each, 20c. Per dozen..... 2 25

155. **Compass, Pencil..** Easily attached to a common pencil. Solid steel leg, durable and accurate. Superior quality. Each 15c. Per dozen.. 1 50



Nos. 157—159.

156. **Cross Section Paper,** one millimeter divisions with heavy centimeter ruiing. In sheets 17x17 c. m. on transparent onion skin paper. Per quire, 40c.

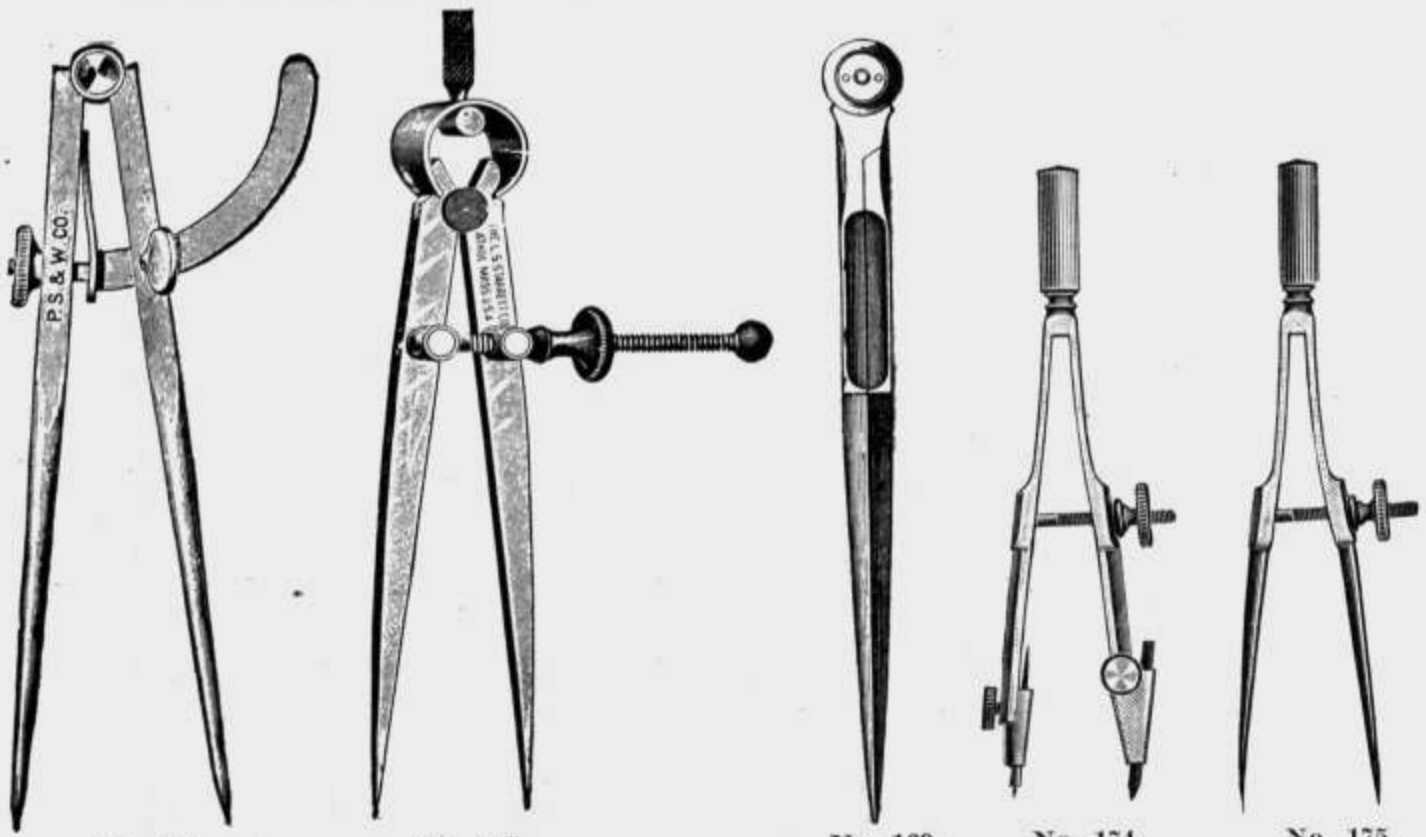
157. **Cross Section Paper,** accurately ruled, printed from an engraved plate. One millimeter divisions with heavier centimeter ruling; size 40x50 c. m. Per sheet, 20c; per quire, $4.00.

159. **Cross Section Paper,** same as above, continuous ruling in 1 millimeter divisions, 50 c. m. wide. Per yard..... 40

161. **Cross Section Paper,** ruled in 1-10th inch divisions, size 16x21 inches. Per sheet ..... .08 Per quire 1 10

Cross Section Paper, 2 m. m. divisions, in tablets. See Page 359.

162. **Polar Co-ordinate Paper,** printed from an engine divided plate, 17 c. m. in diameter. Per quire..... 50



No. 163. No. 167. No. 169. No. 174. No. 175.

163. **Divider,** of steel, sharp points, wing and set screw, 6 inches long..... $ 30

167. **Divider.** The popular "Yankee" spring steel divider, 5 inches long.... 80

169. **Divider,** plain brass. Length, ... 4½ in. 5½ in.
Each, ...25 .30

173. **Drawing Board,** made of selected, narrow and thoroughly seasoned strips of pine, with side ledges clamped.
Size, inches, ... 16x22 20x24½ 23x31
Each, ... 1.10 1.50 2.25

174. **Drawing Compass,** steel spring bow compass. Made of German silver, nickel plated. Steel points, metal handle, length 3½ inches.... 1 00
N. B.—See also **Compasses** on page 13.

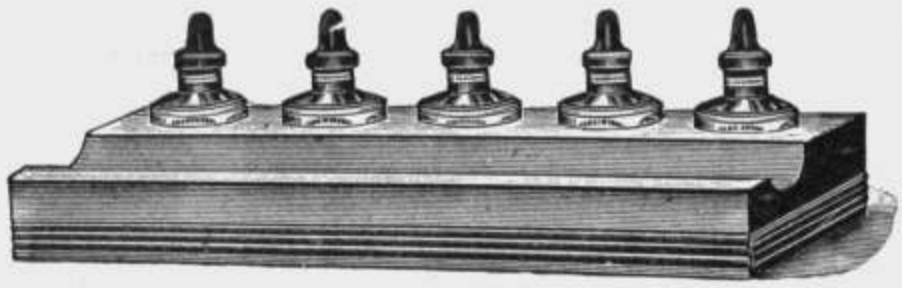
175. **Drawing Divider,** steel spring bow divider. Metal handle, steel points. Length 3¼ inches..... 80

176. **Drawing Eraser,** for pencil..... 10

177. **Drawing Eraser,** for ink..... 10

178. **Drawing Eraser,** for both ink and pencil..... 15

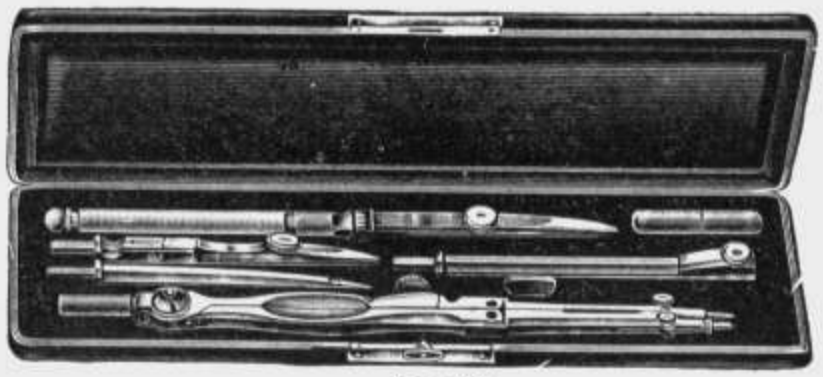
179. **Drawing Sponge Eraser,** for cleaning drawings, 2½x1¾x⅝ inches. Each 40



No. 181.

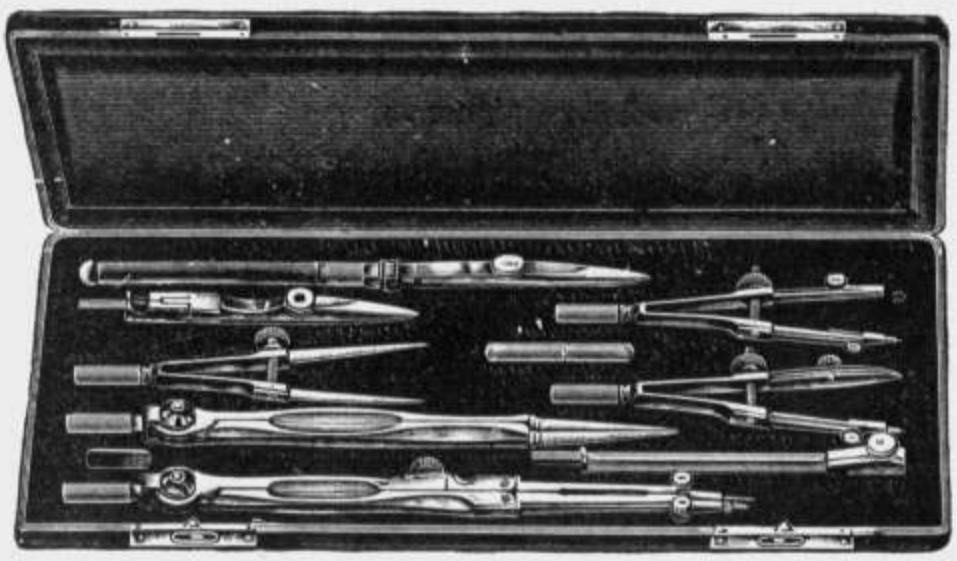
180. **Drawing Inks** in the following colors: Blue, brown, carmine, green, orange, scarlet, vermillion, violet, yellow and waterproof black, per bottle ..... $ 27

181. **Drawing Inks** in nicely finished hardwood tray. Choice of five different colors, selected from list under No. 180..... 1 65



No. 183.

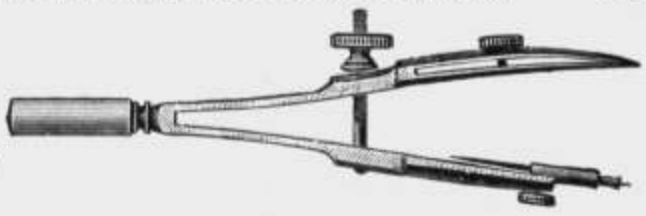
183. **Drawing Instruments.** High grade German silver instruments with steel points, in morocco pocket case, lined with velvet. Contains ruling pen, 5-inch, with joint. Compasses, 6-inch, with fixed needle point, pen, pencil point and lengthening bar. Extra steel divider point and box of leads..... 2 75



No. 187.

187. **Drawing Instruments,** same as No. 183, with the addition of plain dividers, 5½ inches; steel spring bow dividers, bow pencil and bow pen, 3¼ inches, with metal handle..... 5 50

191. **Drawing Pen.** Steel spring bow pen. German silver, with steel points. Metal handle. 3¼ inches..... 1 00

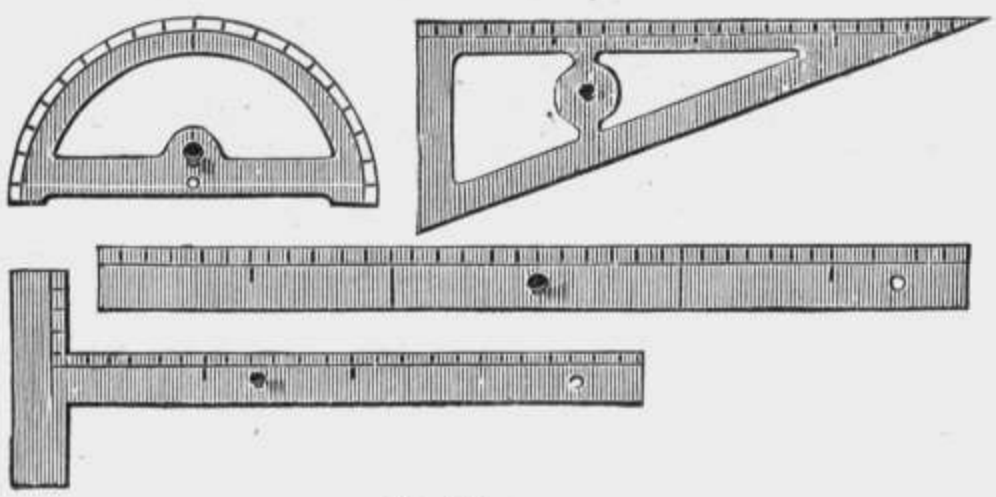


No. 191.



No. 193.

193. **Drawing Pen,** ruling pen, same as used in set No. 183..... 45



No. 195.



No. 197.

195. **Drawing Instruments** for blackboard. Four pieces—24-inch T square, 36-inch Straight Edge, 24-inch Triangle (graduated in inches) and a 15½-inch Protractor. Per set..... $ 4 50

197. **Blackboard Compass,** of wood, 15 inches long, with crayon holder and rubber foot 55

201. **Drawing Paper,** slightly grained surface. Suitable for school use.

Size sheet, inches,	15x20	19x24	22x30	27x40
Per quire, . . .	.55	.95	1.45	2.75



No. 205.

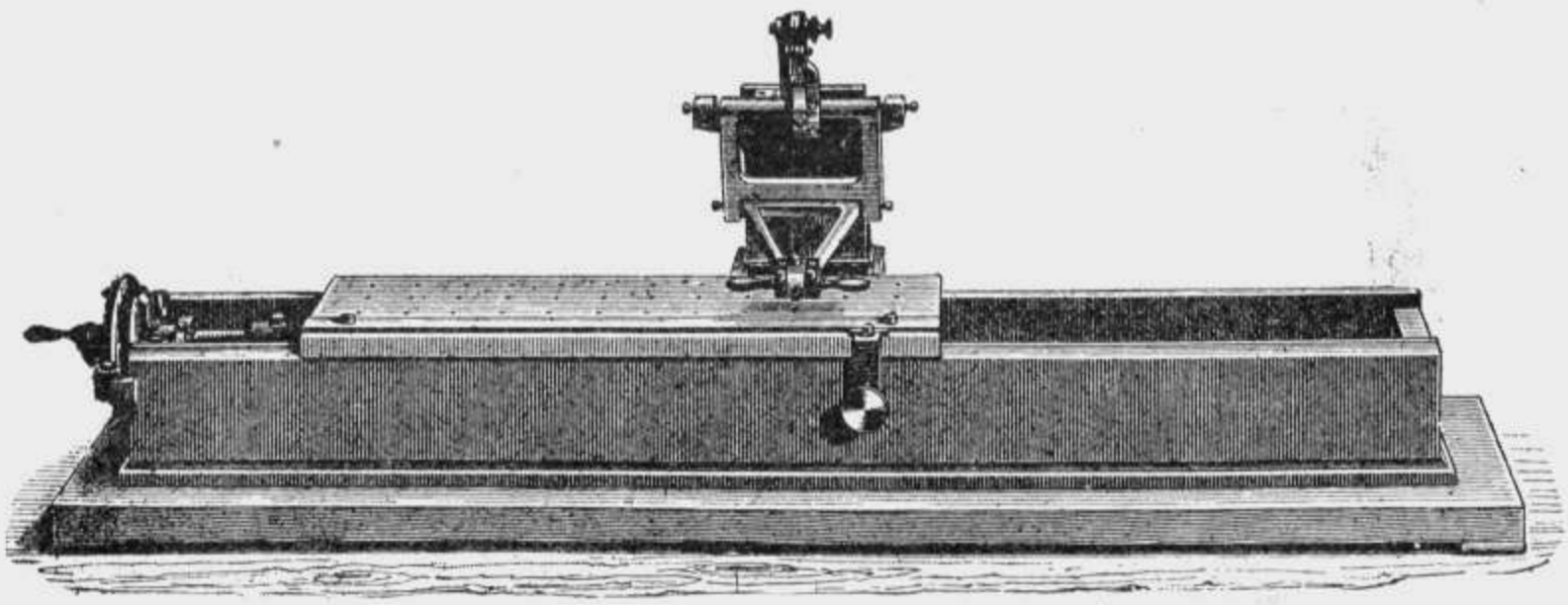
205. **Drawing Pencil,** "Koh-i-noor." These pencils are widely used and, being made of a special compressed lead, are durable and give an even line. Each..... .11 Per dozen..... 1 25

207. **Drawing Pencil,** "Faber's," yellow polished. Each, 7c. Per dozen.... 75



No. 208.

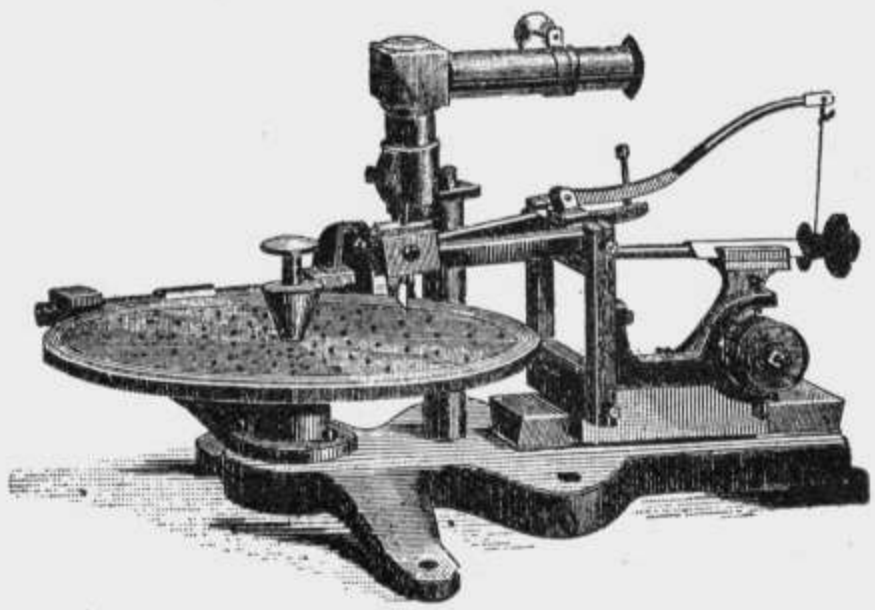
208. **Drawing Table.** Solidly constructed of clear selected stock. Board stands 40 inches above floor when level. Adjustable to any angle either front or back or to almost a perpendicular position. The box attached is for holding tools, rolls of paper, tracing paper, ink, etc. Hardwood ruler is fitted to board by means of cord and brass pulleys, which keeps it in perfect adjustment and renders use of T square unnecessary. An adjustable tray swings on a double-jointed bracket. Size of drawing board, 26x36 inches..... $ 14 50



No. 209.

209. **Linear Dividing Engine.** Laboratory model. The screw has a millimeter thread and divisions as fine as 0.005 m. m. can be made directly by a ratchet wheel. The tracelet is stationary and arranged so that lines of different length are made mechanically. It also permits the tracing of transversals. The object to be divided is moved by a hand screw and the length of the progression corresponding to one division is automatically measured, i. e., the machine stops at the proper place for each division by means of a ratchet wheel and no reading is necessary before tracing a division. A scale 350 m. m. long can be graduated without interruption. The total length of the machine is 85 c. m.....Duty free. $ 160 00

209A. **Linear Dividing Engine,** same as No. 209, but with the addition of two micrometer microscopes which slide along entire length, enabling the machine to be used as a comparator and facilitating the graduation of long scales.....Duty free. 233 00



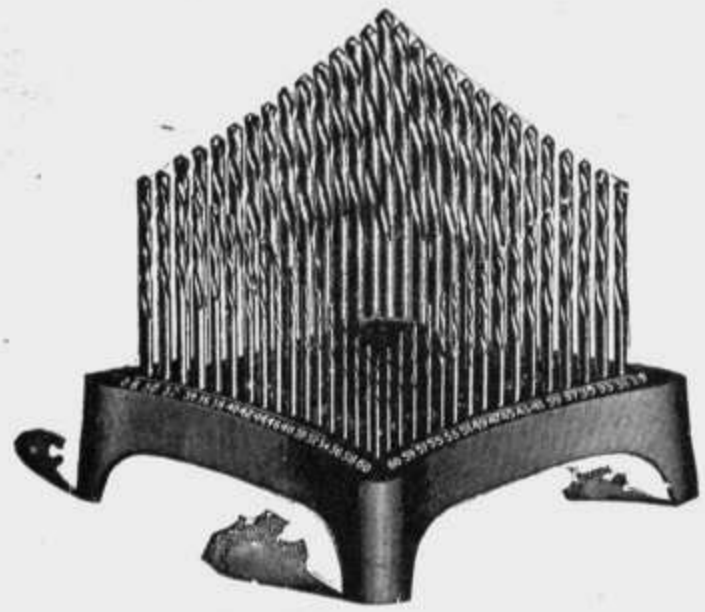
No. 210.

210. **Circular Dividing Engine,** with divisions on silver to one-sixth degrees and divisions for verniers. The machine is provided with a microscope for exact adjustment of divisions. The platform, 25 c. m. in diameter, has a tangent screw with divided head. This screw serves either for rapid execution of regular divisions or to make irregular divisions . . . . . .Duty free. 172 00

210A. **Circular Dividing Engine,** same as No. 210, except that the stop for each division is automatically produced by a special system of ratchet wheels so that no reading is necessary. A great variety of different systems of divisions can be traced with this machine.....
. . . . . .Duty free. 210 00



No. 211.



No. 215.



No. 213.



No. 217.

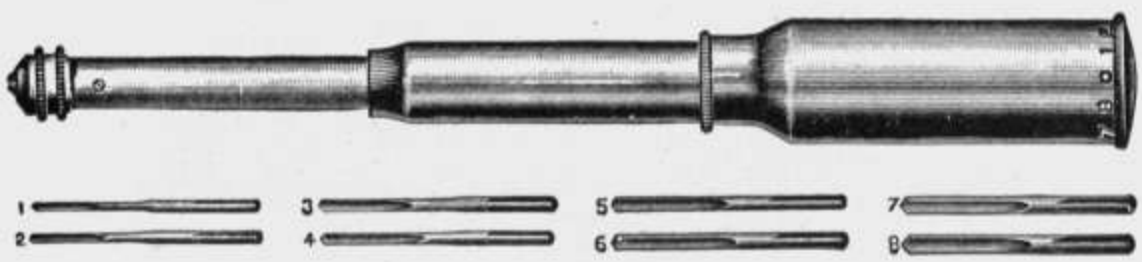
211. **Draw Knife,** extra cast steel, razor blade, 8 inch..... $ 80

213. **Drills,** twist, straight shank, for wood or metal—

Diameter, . .	1-16	⅛	3-16	¼	5-16	⅜	7-16	½ inch
Each, ...	.07	.11	.15	.22	.28	.38	.50	.60
Per doz., . .	.70	1.10	1.50	2.20	2.80	3.80	5.00	6.00

215. **Drills,** twist, straight shank. No. 1 to 60, Stubb's steel wire gauge, mounted on neat nickel plated iron base which can also be used as a **Stubb's steel and wire gauge.** Indispensable for the laboratory shop 6 65

217. **Drill,** hand, single gear, length 12 inches, with six cast steel drills, will hold ⅛ inch round shank drill..... 2 00



No. 219.

219. **Drill,** hand (Automatic Boring Tool), 9½ inches long, nickel plated. Eight steel drills from 1-16 to 3-16 inches, enclosed in the handle in numbered compartments. A very useful tool for boring holes in wood, bone, etc..... 1 95

221. **Extra Drills,** per set..... 65

222. **Drill Gauge,** Brown & Sharpe's Nos. 1 to 60..... 1 65

See also No. 215 for drill gauge and No. 565 for wire gauge.

NOTE.—Any kind or make of drill for drill presses, lathes or bit stocks, breast drills, etc., furnished upon application.



No. 223.

223. **Figures,** of steel, for stamping..Face, 1-16 in. ⅛ in. 3-16 in. ¼ in.
Per set ..... .65 .80 1.00 1.20



No. 225.



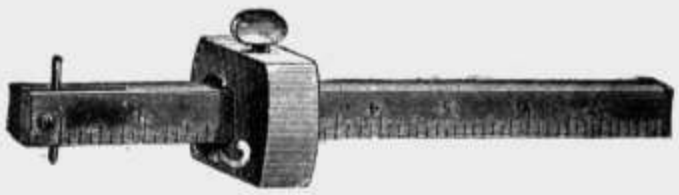
No. 227.



No. 229.

	Size	4 in.	5 in.	6 in.	8 in.
225.	**File,** round (rat tail), second cut. Each.....	.09	.10	.11	.13
227.	**File,** triangular (slim tapers), single cut. Each...	.08	.09	.10	.13
229.	**File,** flat, bastard cut. Each.....	.11	.13	.17	.20
231.	**File,** wood rasp, flat. Each.....	...	...	.15	.20

233. **File Handle** for any of the above..... $ 05



No. 234.

234. **Gauge, Marking,** of boxwood, adjustable, steel point, brass thumb screw and shoe..... 50



No. 235.

235. **Gauge, Tube,** of steel. For measuring the internal diameters of tubing, etc. Divided to 1-10 m. m.

Scale range	1 to 15 m. m.	15 to 30 m. m.
Each	.80	1.20

Drill Gauges, page 18.
Wire Gauges, page 45.

236. **Gimlets,** metal heads, sizes ⅛, 5-32 and 3-16 inch.
Each..... $ .07 Per set of three, 17



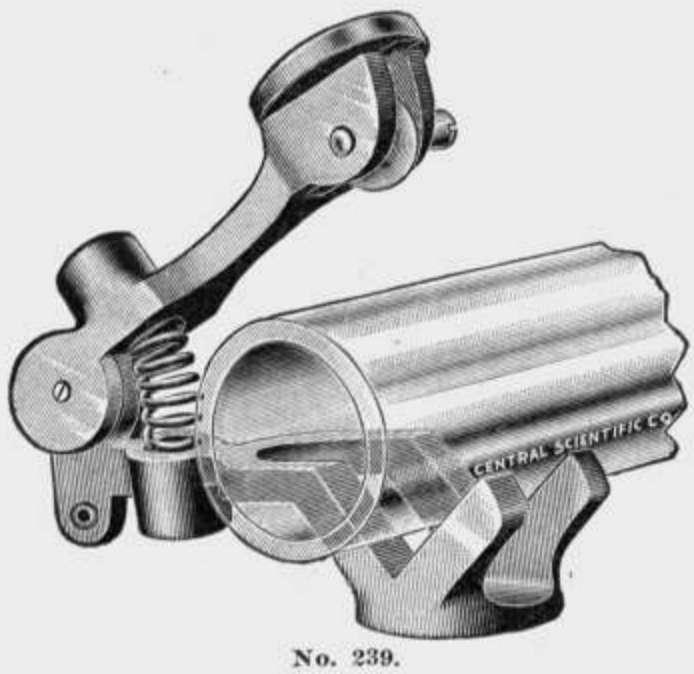
No. 237.

237. **Glass Cutter,** steel wheel, best quality.....$ 11



No. 238.

238. **Glass Cutter.** Glazier's diamond, for cutting or writing on glass. Finished in best manner possible and nickel plated. Diamond is guaranteed to re-set several times and to give entire satisfaction. Cuts "single thick" 6 00



No. 239.



No. 241.

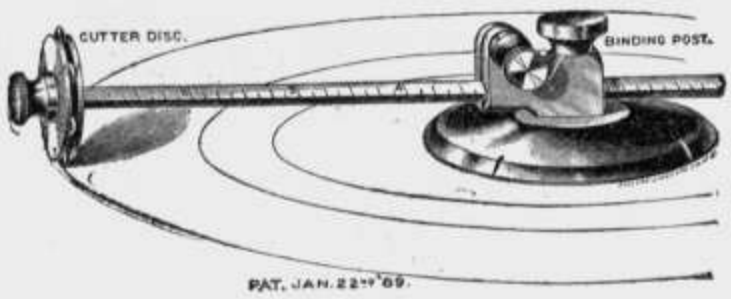
239. **Glass Cutter.** This is the only glass cutter by which the pressure on the cutting wheel may be regulated so as to be firm and even. The cutting wheel may readily be renewed when worn..... 1 10

239A **Extra Cutting Wheel** for No. 239..... 20

239B **Extra Screw** for cutting wheel of No. 239..... 07

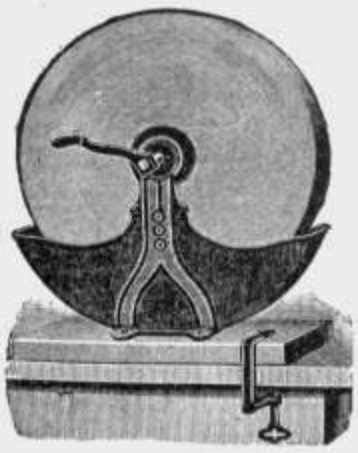
240. **Glass Cutter,** for cutting circles. Cheap form..... 50

241. **Glass Disc Cutting Apparatus.** Finest grade of workmanship. Will cut discs from 1 to 20 c. m. in diameter. The cutter arm is graduated in millimeters and provided with six cutters. The apparatus can also be used for cutting discs of cardboard, metal and other materials. It will be found of universal adaptability and value..... 6 60



No. 242.

242. **Glass Cutter, Rotary Form,** better quality than No. 240. Cutting disc at end of 13 inch graduated arm, carries six steel cutting wheels mounted on heavy brass base with rubber bearings on under side.. 3 30



No. 243.



No. 244.



No. 245.

243. **Grindstone,** so-called "Family Grindstone." Good quality.

Diameter	6 in.	8 in.	10 in.	12 in.
Each	1.25	1.65	2.10	2.50

244. **Hack Saw,** for cutting metals, 8 inch, with one blade..... $ 1 00

245. **Hack Saw,** finest quality, adjustable for 8, 9, 10, 11 and 12 inch blades. Nickel plated, with one blade..... 1 10

246. **Hack Saw Blades,** made of best grade of steel.

Length	8 in.	9 in.	10 in.	11 in.	12 in.
Each	.65	.70	.85	.95	1.05



No. 247.



No. 249.

247. **Hammer,** claw, extra quality cast steel.
7½ oz. ..... 50 16 oz. 60

248. **Hammer,** with wedge shaped end, for breaking ores.

Size	7 oz.	12 oz.	16 oz.
Each	.45	.55	.70

249. **Hammer, "Prospecting Pick."** Finest grade cast steel. Hexagonal head with flat face. Pick point hardened steel. Weight 1½ lbs... 1 50



No. 251.

251. **Knife,** good steel blade 4 inches long. Round wood handle. The most useful form for the laboratory..... 22



No. 252.

252. **Ladle,** of wrought iron, 2½ inch bowl..... 40

LATHES.



No. 255.

255. **Lathe** No. 4. This lathe is designed for turning both wood and iron; for boring, drilling, polishing, etc. It is a desirable tool for small work, and has many important advantages in the construction and arrangement of its parts.

It swings 7 inches, and takes 20 inches between centers. It has a patent velocipede foot power, which is the best power ever applied to a foot-driven lathe. The speed can be varied from 1,000 to 2,000 revolutions per minute, and the motion can be started, stopped or reversed instantly at the will of the operator.

The lathe is made entirely of iron and steel. The bed is solid. The lead screw for the carriage is operated by hand; by it the carriage can be traveled 20 inches, the entire distance between centers. The carriage can be engaged or disengaged instantly from the lead screw. The cross feed way on which the tool post moves can be set at any desired angle for taper turning and boring. The tail stock can be moved and set at any point desired by the simple turning of the hand wheel; or it can be taken off entirely, thus leaving the bed free for face-plate or chuck work. The head stock spindle is hollow; size of hole, 9-32 inch. The head stock spindle has taper bearings, and is capable of very nice adjustment. The tail stock center is self-discharging.

Price, including face plate, 2 pointed centers, 1 spur center, hand rest, wrenches and necessary belting, as shown in cut, f. o. b. factory..Net. $ 50 00

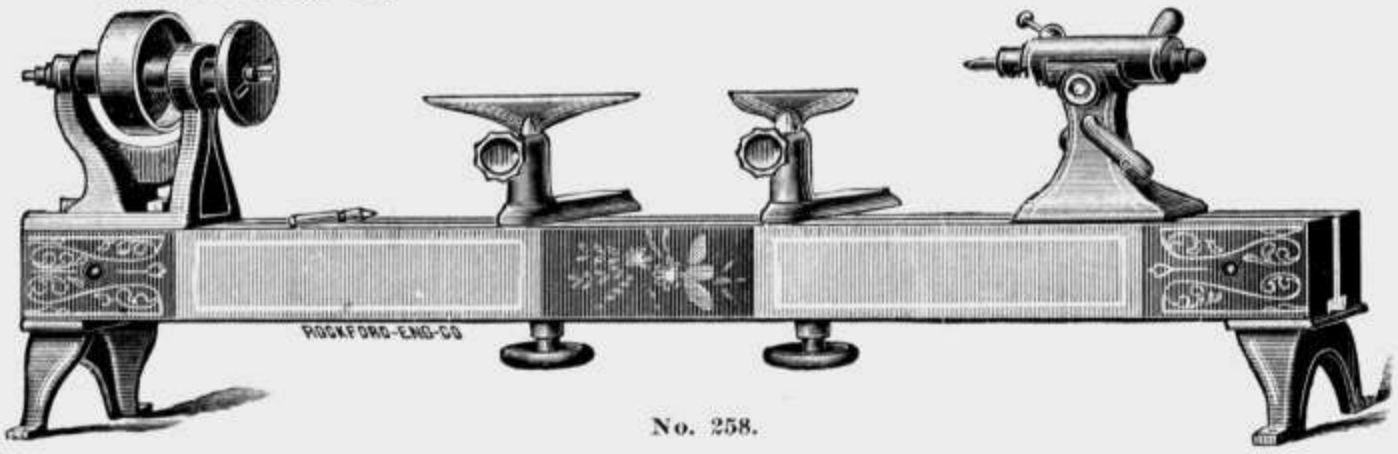
256. **Lathe,** No. 4, same as No. 255, but furnished with a countershaft in place of foot power. The pulleys on countershaft are 7x1½ inches and should be speeded to 250 revolutions.....Net. 50 00

NOTE.—Above prices do not include a chuck, which must be fitted to the lathe at the factory. For prices see next page.

Lathe Accessories, see next page.

Drills, see page 18.

Taps, see page 40.



No. 258.

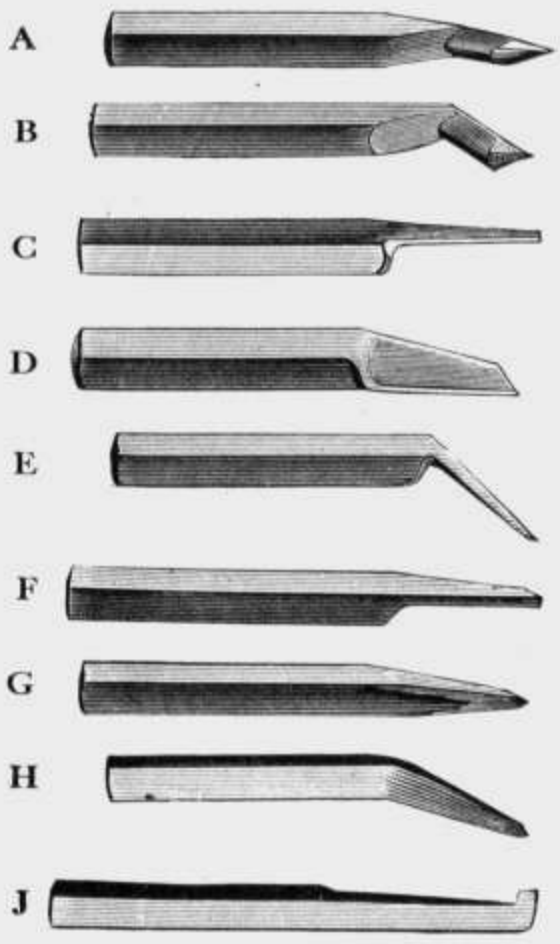
257. **Lathe** No. 3, **for Wood Turning.** Will take in stuff 12 inches in diameter and 3 feet long. Provided with patent movable velocity foot power, as illustrated on No. 255 Lathe. Made entirely of iron and steel, except the bed, which is of wood. Spindle and bearings are of steel and centers are accurately fitted to taper holes. Tail stock, tool rests and sockets adjusted by hand wheels. (Illustration No. 258 shows lathe mounted on bench legs.)

Price, including three centers (one a spur), two tool rests and sockets and one turned face plate.....Net. 40 00

258. **Lathe** No. 3, **for Wood Turning.** Same as No. 257, but with short bench legs . . . . . Net. 25 00

259. **Countershaft** for No. 258 Lathe. Tight and loose pulleys, 6 inch diameter by 2 inch face. Speed of countershaft 500 R. P. M.....Net. 10 00

Wood Turning Tools, see page 46.



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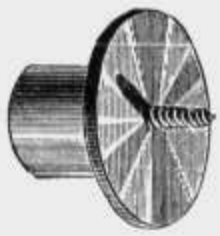


No. 262.



No. 263.



No. 264.



No. 265.



No. 266.



No. 267.

ACCESSORIES FOR No. 255-256 LATHES.

ALL PRICES NET.

260.	**Hand Turning Tools.**	
260A.	**Milling Tool,** with one knurl	$ 1 00
260B.	**Flat Tool,** for brass, ivory, hardwood, etc. ¼ inch	25
260C.	**Side Tool,** right, for brass, ivory, hardwood, etc. ¼ inch	25
260D.	**Side Tool,** left, for brass, ivory, hardwood, etc., ¼ inch	25
260E.	**Point Tool,** for brass, ivory, hardwood, etc. ¼ inch	25
260F.	**Round Pointed Tool,** for brass, ivory, hardwood, etc. ¼ inch	25
260G.	**Square Graver,** for metal. ¼ inch	25
261.	**Lathe Tools,** for metal. Size of steel ¼ x ½ inch. Nine shapes, as follows:	
261A.	**Right Hand Diamond Point**	30
261B.	**Left Hand Diamond Point**	30
261C.	**Right Hand Side Tool**	30
261D.	**Left Hand Side Tool**	30
261E.	**Bent Right Hand Side Tool**	30
261F.	**Cut Off Tool**	30
261G.	**Thread Tool**	30
261H.	**Bent Thread Tool**	30
261J.	**Inside or Boring Tool**	30
262.	**Screw Chuck**	1 50
263.	**Cup Center**	1 50
264.	**Square Center,** for iron	1 50
265.	**Spur Center**	1 50

266. **Common Dogs.**

Size, inch	¼	⅜	¾	1	1¼	1½
Each	.25	.25	.35	.35	.50	.50

267. **Steel Lathe Arbors,** for holding saws, emery wheels, etc., as listed on page 32.

Diameter, inch	½	⅝	¾
Each	1.75	2.50	3.00

268.	**Champion Scroll Chuck.** Diameter 3 inches, with two sets of jaws	6 75
269.	**Champion Scroll Chuck.** Diameter 4 inches, with two sets of jaws	8 00
270.	**Almond Drill Chuck,** to hold 0 to 11-32 inch drills, with taper fitting	5 50
271.	**Almond Drill Chuck,** to hold 0 to 17-32 inch drills, with taper fitting	9 00

N. B.—The above Chucks, mounted and fitted to the lathe at an extra charge of $2.00 each.



No. 274.



No. 275.

274. **Letters,** of steel, for stamping.

Face...	1-16 in.	⅛ in.	3-16 in.	¼ in.
Per set	2.00	2.20	3.00	3.65

275. **Level.** This is the most effective and useful level on the market. The little "Which Way," as it is called, being more sensitive than any other level, is specially adapted for balances and other instruments. Nickel plated ..... $ 85



No. 276.

276. **Level,** pocket, iron japanned..... 13



No. 277.

277. **Level,** hexagonal, nickel plated. Very useful in making apparatus; 2 inches long..... 30



No. 278.

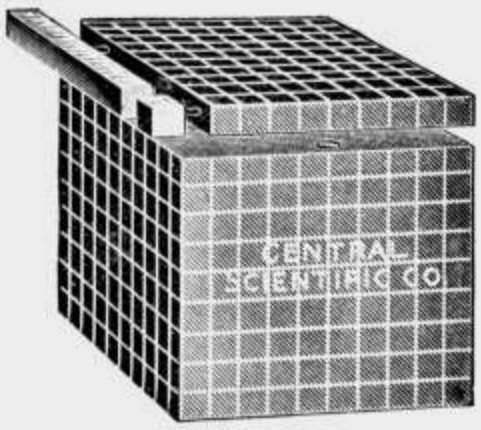
278. **Level Glasses,** for use in level testing. Ungraduated. 3 inches long. Per dozen 1 10



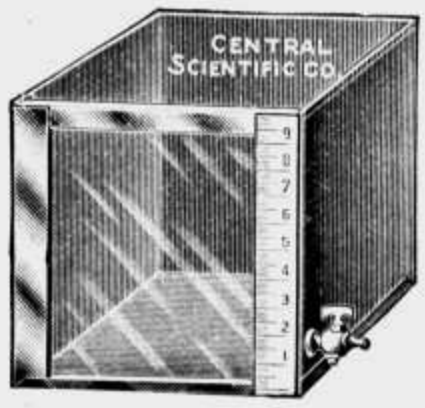
No. 279.

279. **Level.** Ordinary type of wood level. 10 to 18 inches long. Oval top plate, two side views..... 45

Leveling Screws, page 7.



No. 281.



No. 285.



No. 303.

281. **Liter Block.** An important adjunct in teaching density, as well as the metric system. The block is loaded and has a graduated face, showing 100 square centimeters on a side. It is dissectable to 1-10, 1-100 and 1-1000 of its volume, each piece being weighted to the specific gravity of water..... $ 2 85

283. **Liter Block,** plain, neither loaded nor dissected..... 1 00

285. **Liter Case,** to be used in connection with No. 281 Liter Block. It is made of polished copper, one side of which is of glass with a graduated rule and stop cock. The case is especially adapted for specific gravity work and measuring irregular solids. It is the counterpart of the liter block in hollow form. The glass face allows a full inspection of the contents, the stop cock, a nicer adjustment and measurement than is possible in common capacity measures, and the brass rule indicates exact amounts. If this case is put on the balance and its weight exactly balanced, the addition of water shows an increase of 10 grams of water for every millimeter of scale division, which is equal to a centiliter or 10 c. c. of water. Any small solid, of however irregular shape, may be measured in this case and its specific gravity taken with a minimum of trouble..... 3 00



No. 291. No. 289.

No. 295.

289. **Liter Measure,** tin, standard form, one liter piece only..... 40

291. **Liter Measure,** tin, standard form, two liter piece only..... 50

293. **Liter Measures,** tin, standard form, one liter to centiliter, 7 pieces.. 1 85

295. **Liter Measures,** tin, standard form, two liter to centiliter, 8 pieces.. 2 25

NOTE.—"Standard form" is that in which the diameter equals half the height.

303. **Mallet,** round, wood; 3 inch..... 20

304. **Mallet,** rawhide; 5 oz..... 80

305. **Measures, Liquid,** of tin, 1 gallon to ½ pint, 5 pieces..... 1 10

306. **Measures, Dry,** of wood, ½ bushel to 1 quart, 5 pieces..... 1 65

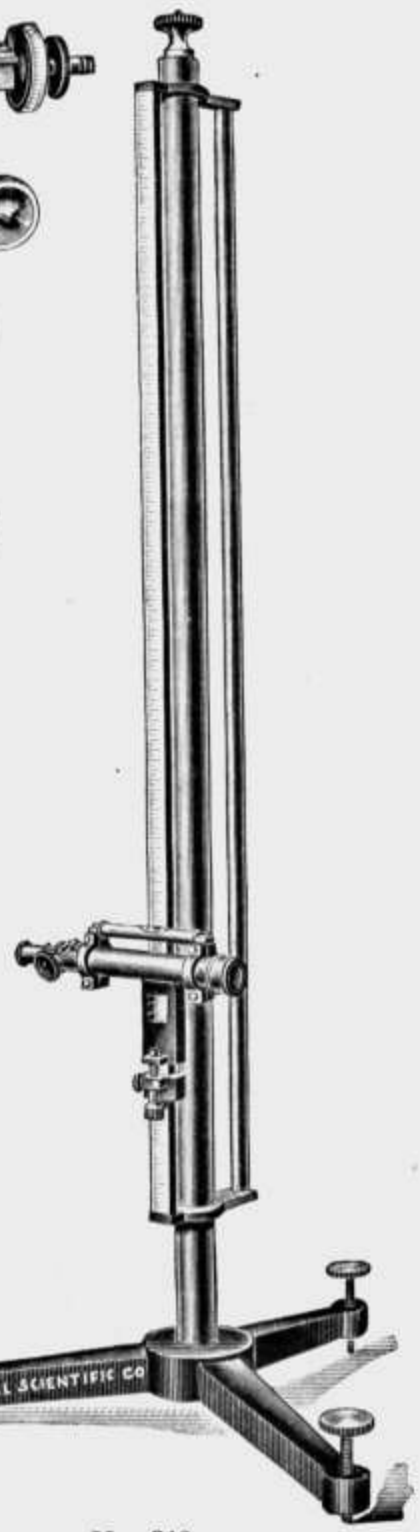


No. 307.



No. 308.

Nos. 309—310.



No. 312.

307. **Measuring Microscope.** A plain microscope without micrometer. Fitted with fixed cross hairs, tube and clamp collar. Diameter of tube, 22 m. m..... 11 00

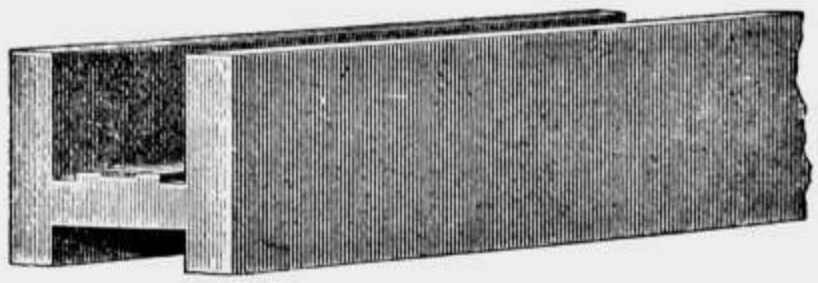
308. **Measuring Microscope,** same as No. 307, with addition of simple micrometer. This micrometer is especially designed as suitable for all but the most accurate work. The screw has a pitch of 0.25 m. m. and a range of 6 m. m. Index reading to 0.005 m. m..... 18 45

309. **Measuring Microscope,** with eyepiece micrometer. This micrometer is of new design and is guaranteed to be of the highest order of workmanship and accuracy. Pitch of screw is 0.25 m. m. and the range is 10 m. m. Reads direct to 0.0025 m. m..... 26 25

310. **Microscope Support.** A heavy, adjustable support for measuring microscopes. The microscope can be held rigidly in any position, as all joints can be tightly clamped. The base is sufficiently heavy to insure the stability required in a microscope used for accurate measurements. The top of the base is machined, so as to enable the attaching of stages or other accessories. The diameter of the horizontal and vertical arms is the same and the microscope may be clamped in a horizontal position, so as to read a vertical scale. Illustration shows Microscope No. 309 used in connection with the support. Support only, without microscope..... 7 50

312. **Cathetometer.** This instrument is suitable for all ordinary work, mounted on heavy tripod base, with leveling screws. Telescope magnifies eight times and is mounted on a vertical steel prism, 1 meter long, with micrometer adjustment and level.....Duty free. 60 00

313. **Cathetometer.** A superior instrument. Column 1.15 meters high, divided into millimeters and furnished with vernier reading to 1-20th m. m. The telescope may be inclined to any angle and is fitted with micrometer screw, movable thread and spirit level. Objective, 27 m. m.....Duty free. 150 00



No. 316.

314. **Measuring Disc,** as used in "Millikan and Gale" Experiment 1 for the determination of *H*..... $ 28

Measuring Cup, as used in "Millikan and Gale" Experiment 2, for the determination of volume listed under No. 1590.....

315. **Metric Chart.** Excellent for comparison of English and Metric Systems of Weights and Measures. Mounted on cloth with roller..... 2 00

316. **Meter Scale.** Standard meter scale, H form. Divided to m. m. on silver, the first and last m. m. being subdivided into tenths. The form of the scale was suggested by the "International Bureau of Weights and Measures" and adopted because the subdivisions are on a surface in the neutral axis of the system, and in consequence will not be affected by flexion. It also offers maximum resistance for minimum mass and maximum surface.....Duty free. 45 00



No. 319.

317. **Meter Stick** (School Meter), of maple, 2 c. m. square. One surface is plain and shows the length of the simple meter; the second face is divided into tenths of meters, or decimeters; the third face is divided into hundredths of meters, or centimeters; and the fourth face is divided into thousandths of meters, or millimeters. The last named face gives divisions also in decimeters and centimeters. This piece is valuable in teaching students the metric system in lengths. 75

319. **Meter Stick,** of maple. One side is divided into decimeters, centimeters and millimeters. The other side into inches and eighths.. 30

321. **Meter Stick,** same as No. 319, but ends tipped with brass..... 35

322. **Meter Stick,** same as No. 321, but two meters long, brass tipped..... 1 35

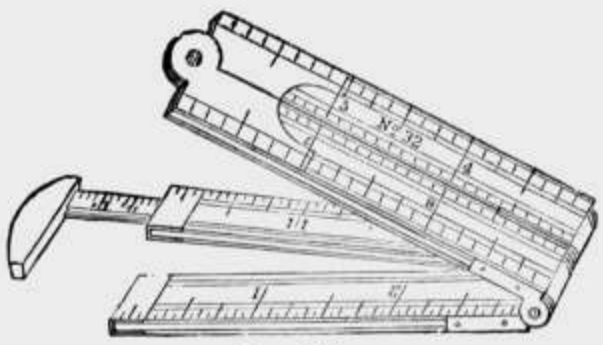
323. **Meter Scale,** of paper, divided into millimeters.
Each..... 10 Per dozen..... 1 00

325. **Metric Rule,** of maple, 12 inches long. Graduated in both English and Metric systems. Double bevel with protractor on back.
Each..... 04 Per dozen..... 40

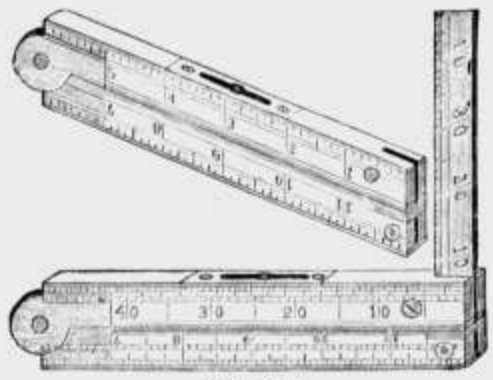
326. **Metric Ruler,** of white celluloid, 6 inches long. One edge divided into m. m., other edge into eighths of an inch. May be easily carried in vest pocket.
Each..... 05 Per 100..... 4 50

327. **Metric Ruler,** of boxwood, 12 inches long, one edge beveled and accurately graduated to m. m., the other side of ruler graduated into eighths of an inch.
Each..... 09 Per dozen..... 1 00

328. **Metric Ruler,** on heavy bond paper. 20 c. m. long, in m. m. divisions.
Per dozen..... 10 Per 100..... 90



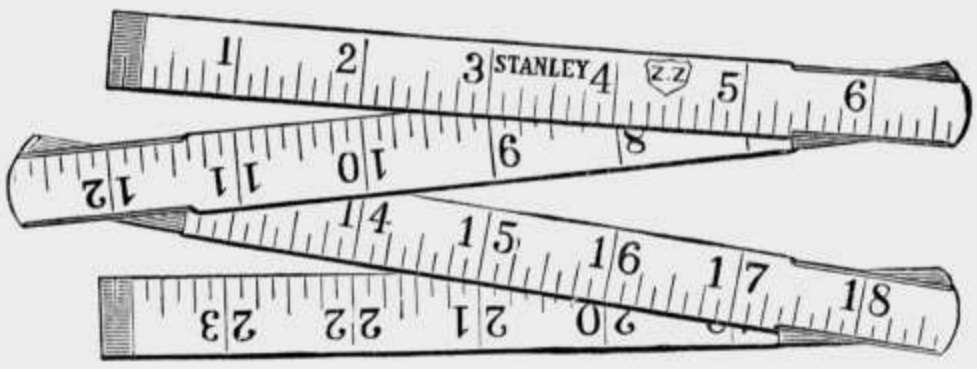
No. 329.



No. 330.

329. **Metric Measure,** boxwood, graduated into millimeters on one side and 1-16 inches on the other. Four fold, solid brass joints, with brass caliper extension for measuring diameters up to 2¾ inch or 70 m. m. Made to carry in the pocket..... $ 55

330. **Metric Measure (Combination Rule).** Made of boxwood, heavy brass binding, one joint. When folded it is 6 inches long, 1⅜ inches wide and ⅜ inches thick. May be used as (1) Spirit Level, (2) Try Square, (3) Level and Plumb, (4) as a Clinometer or Slope Level. Strong, firm and reliable..... 2 25

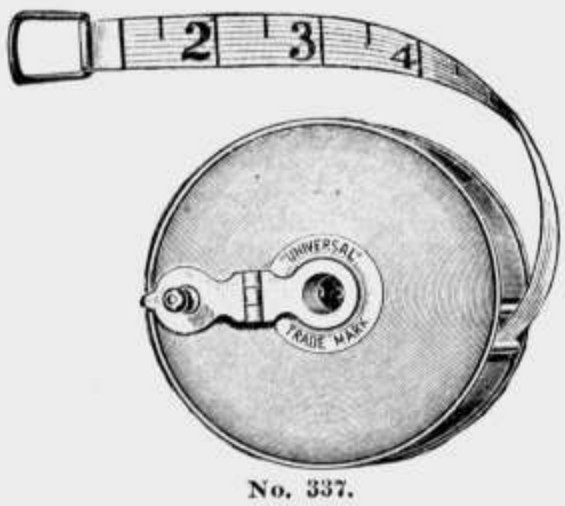


No. 331.

331. **Metric Measure,** light boxwood, 24 inches by 16ths one side, millimeters on the other. Four fold, spring joints, very convenient for comparing English and metric measurements. Made to carry in the vest pocket. 33



No. 335.



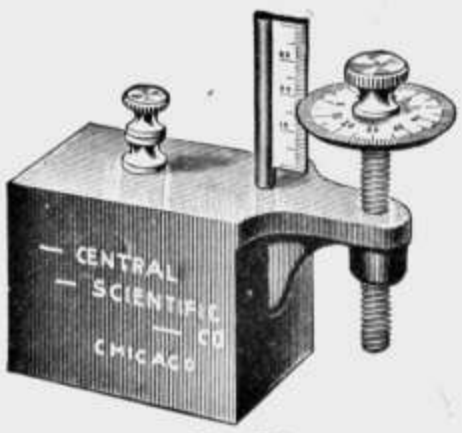
No. 337.

335. **Metric and English Steel Pocket Tape,** in German silver case with spring wind and stop. Divided into millimeters and 16ths of inches.

Length, meters,	1	2	3	5
Each,	1.00	1.50	3.00	4.50

337. **Metric Linen Pocket Tape,** strong linen tape ½ inch wide, brass bound case and folding handle.

Length, meters,	10	15	20	25
Each,	.75	1.00	1.10	1.35



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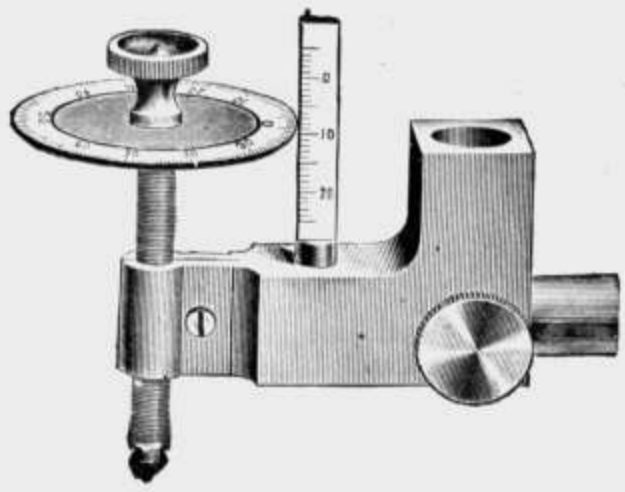


No. 338B.



No. 338C.

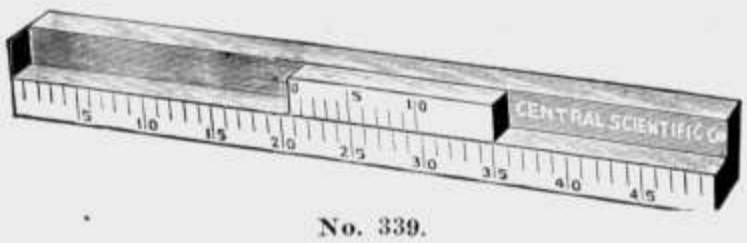
338. **Micrometer Screw.** Mounted on a heavy iron base, milled on two sides so that it may be used in either vertical or horizontal position, the screw moving in an overhanging bracket. Pitch of screw, 1 m. m., length, 6½ c. m. Head is 4 c. m. in diameter and is divided into 100 parts, thus reading to .01 m. m. Binding post for electrical connections. This screw is indispensable for accurate measurements in experiments on the flexure of beams..... $ 3 35

338A. **Micrometer Screw.** Same as No. 338, furnished with platinum contact and with brass stirrup having binding post and platinum contact for beam. 5 50

See cut on page 49, showing use of above.

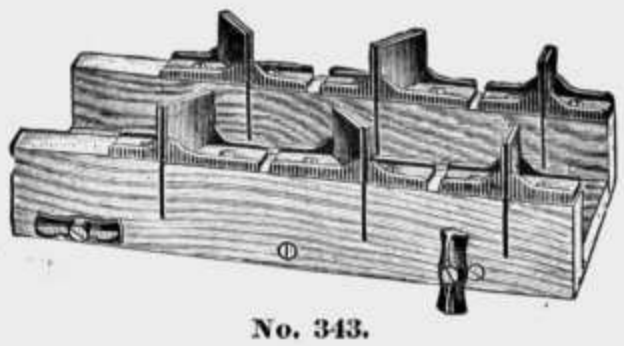
338B. **Micrometer Screw.** Same screw as No. 338, but mounted so as to be used with standard 13 m. m. rods, which permit its use in a variety of ways in building special apparatus. When used with No. 21 Rod, No. 278 Level and No. 26½ V Clamp and end support, it makes a desirable level tester..... 5 00

338C. **Micrometer Screw.** Screw only of No. 338, with nut and index, unmounted. 2 00



No. 339.

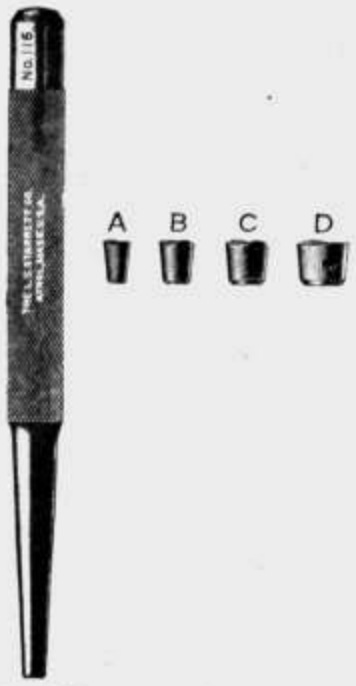
339. **Model of Vernier,** graduated rod, half meter long, with sliding Vernier 2 25



No. 343.

343. **Mitre Box,** Olmsted's. Can be used with ordinary hand saw, which will do perfect work and not cut the frame away. Provided with iron guides for saw. Small size, will cut moulding, etc., 1½ in. x 3 in... 1 65

345. **Mitre Box,** same as No. 343, medium size, will cut moulding 2½x4 in.. 2 20



No. 346.



No. 347.



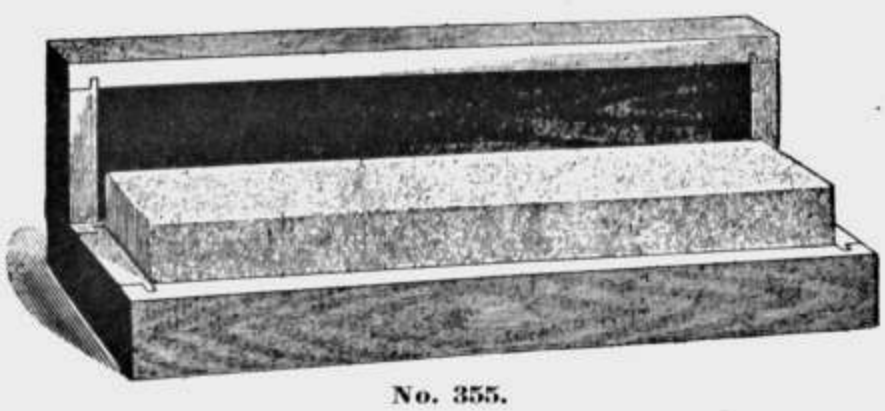
No. 349.

346. **Nail Sets,** made of fine grade steel, both ends hardened, centers nicely knurled, tips concaved, tops oval and the size exact.

Length, inches	4	4	4	4
Diameter at tip	(A) 1-16	(B) 3-32	(C) ⅛	(D) 5-32
Each	.11	.11	.11	.11

347. **Nippers,** end cutting — 5 in. 6 in.
Each — .65 .75

349 **Nippers,** Hall's compound lever cutting nippers, very strong, all parts interchangeable. — 5 in. 7 in.
Each — 1.50 2.25



No. 355.

353. **Oil Stone,** genuine Washita, unmounted.
Length — 5 in. 6 in.
Each — .55 .60

355. **Oil Stone,** same as No. 353, mounted in case — 1.00 1.30

357. **Oil Stone,** Washita slips for gouges and fine tools — 3 in. 4 in.
Each — .20 .30

359. **Oil Can,** zinc, diameter 2 inches — 11



No. 361.

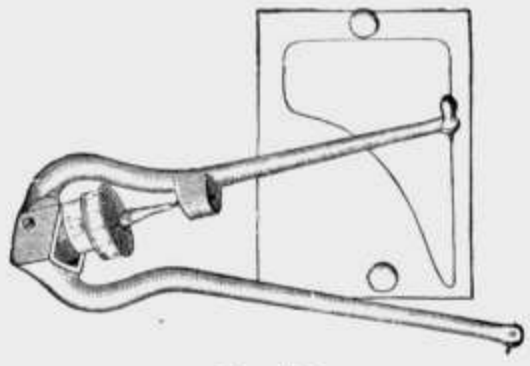


No. 363.

361. **Plane,** iron block, 5½ inches long, 1¼-inch cutter — 45

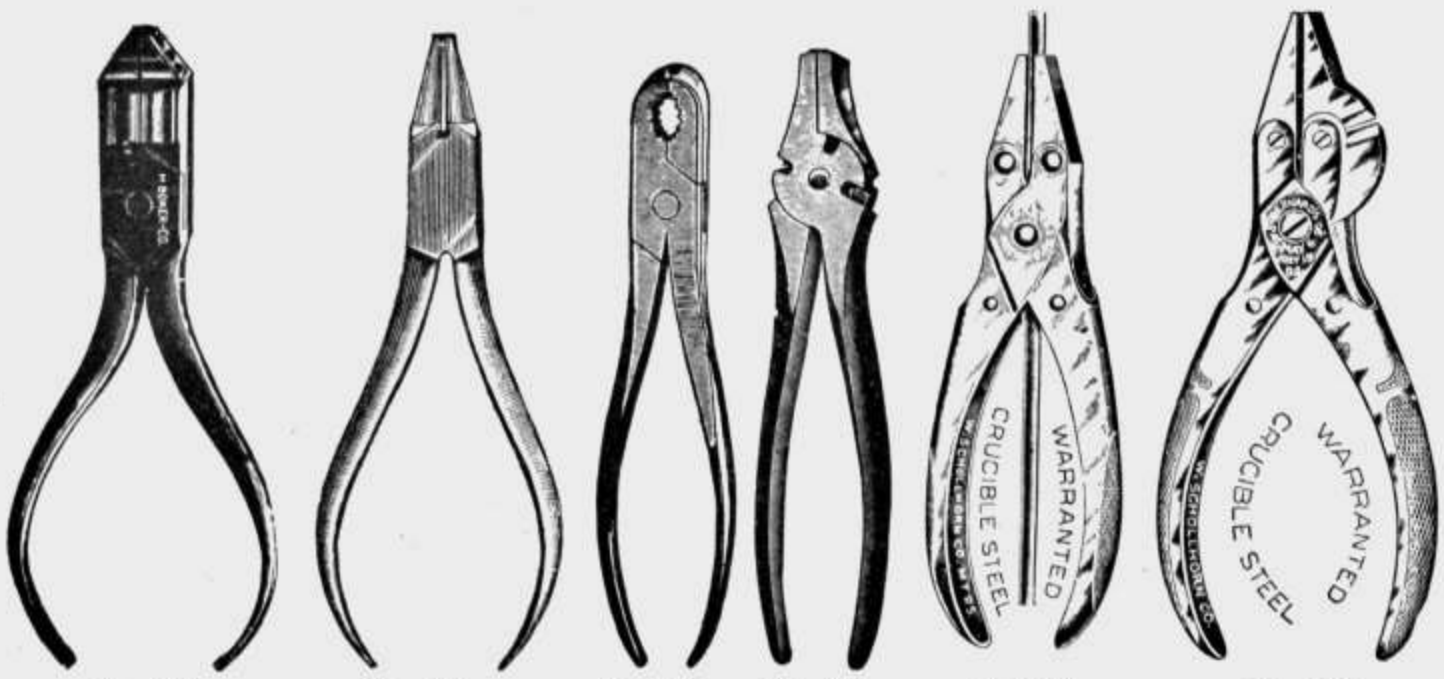
363. **Plane,** double ender, 8 inches long, 1¾-inch cutter. This plane may be used as a block plane, or by reversing the cutter and wedge it can be used to plane close up into corners or other difficult places — 1 00

365. **Plane, Jack** bench plane, 2-inch double iron — 1 10



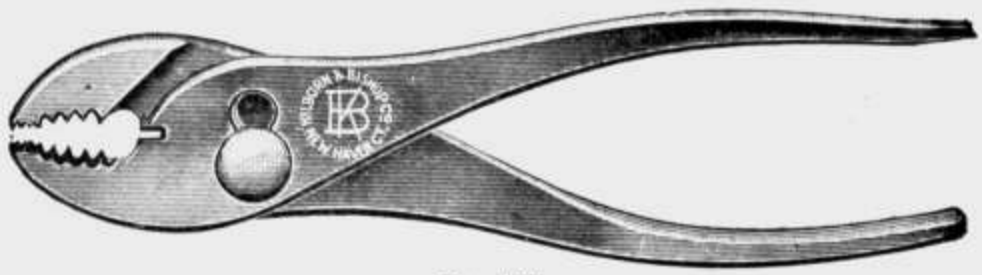
No. 366.

366. **Planimeter,** for measuring the area of diagrams, etc. Enclosed in velvet lined morocco case..... $ 16 65



No. 369. No. 371. No. 373. No. 375. No. 377. No. 379.

367.	**Pliers,** flat nose	.5 inch,	$ .27	6 inch,		40
369.	**Pliers,** flat nose, side cutting	.5 inch,	.55	6 inch,		75
371.	**Pliers,** round nose	.5 inch,	.27	6 inch,		40
373.	**Pliers, Gas,** cast steel, best quality	.6 inch, $ .45	8 inch,	.55	10 inch,	70
375.	**Pliers and Nippers** combined, Button's patent	4½ in.,	.55	6 inch,		65
377.	**Pliers,** Bernard's, flat nose	4½ in.,	.75	5½ in.,		1 00
379.	**Pliers,** Bernard's, cutting	4½ in.,	1.15	5½ in.,		1 40



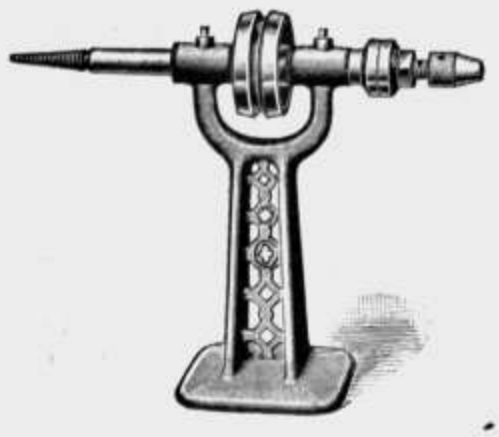
No. 381.

381. **Pliers, Combination;** gas plier, wire cutter, wrench and screw driver combined. Drop forged from high grade tool steel and warranted free from defects. A very useful tool.....6-inch, $1.10 10-inch, 1 40

Wire Nippers, page 30.



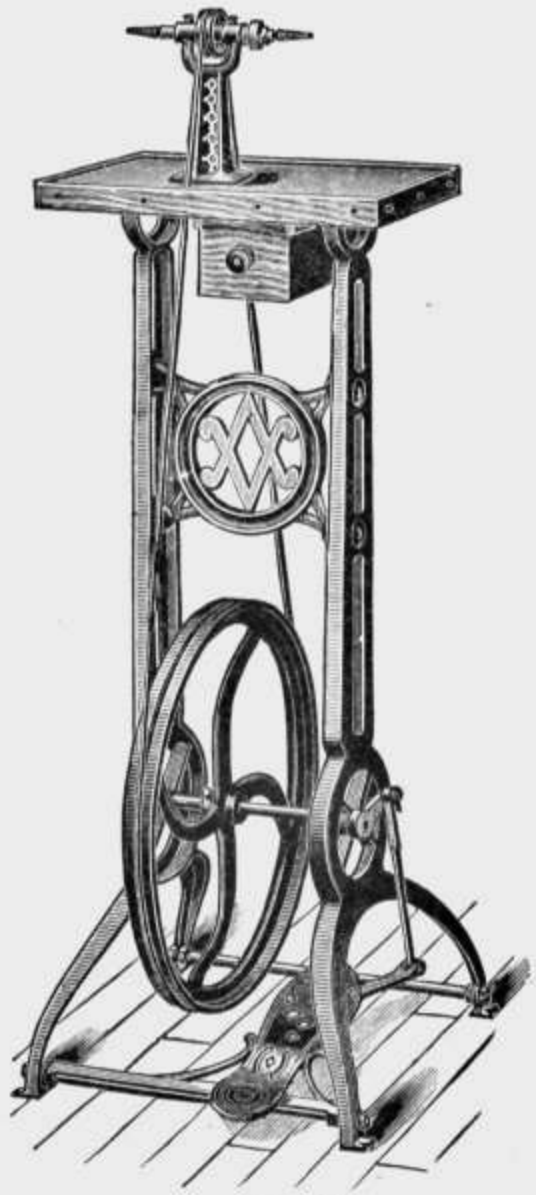
No. 383.



No. 391.



No. 385.



No. 393.

383. **Plumb Bob,** japanned iron, weight 9 oz..... $ 13

385. **Plumb Bob, Mercury.** These plumb bobs are made from solid steel rod, bored out and filled with mercury, which makes them unusually heavy in proportion to their size, and the center of gravity low. The small diameters allow them to be used close to corners and walls. The points are hardened and the bodies and points ground. The plumb bobs are nickel plated and each is furnished with a braided silk line.

		Weight	Length	Diameter	
		3½ oz.	4 in.	½ in.	1 10
387.	**Plumb Bob,** same as above.....	6 oz.	4½ in.	⅝ in.	1 65
389.	**Plumb Bob,** same as above.....	12 oz.	5⅜ in.	⅞ in.	2 20

391. **Polishing Head.** Stand nicely japanned, steel arbor running in adjustable bearings. Fitted to hold emery wheels, circular saws, buffers, etc. Chuck for drills also furnished..... 2 25

393. **Polishing Head,** same as No. 391, operated by foot power..... 11 00

SEE ELECTRIC POLISHING HEAD, PAGE 33.

POLISHING HEAD ACCESSORIES.

395. **Emery Wheel,** extra fine quality, ½ inch thick, ⅜-inch hole.

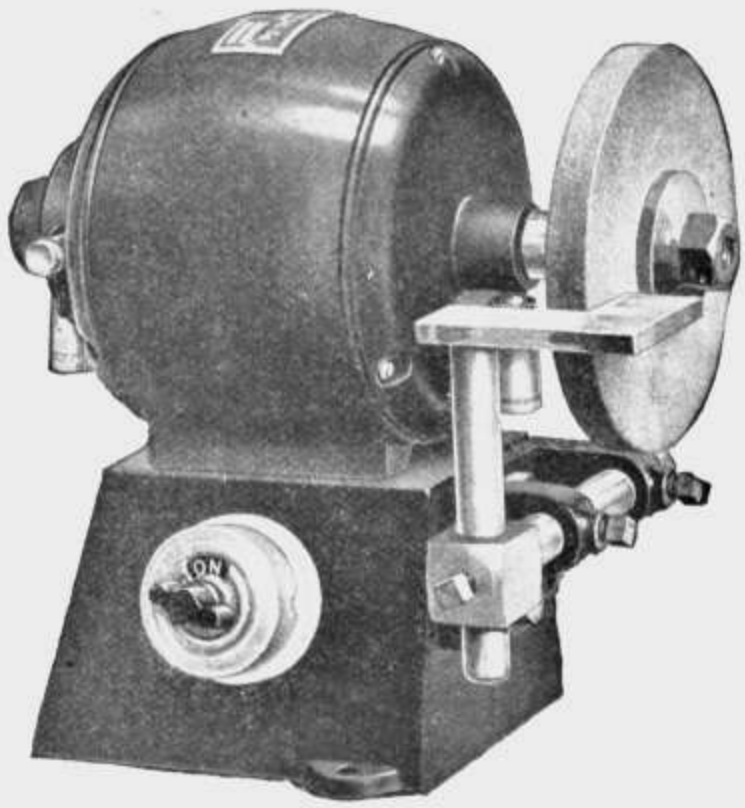
Diameter, inches	2	2½	3
Each	.40	.50	.65

397. **Circular Saw,** good quality steel.

Diameter, inches	2	2½	3
Each	.30	.40	.55

399. **Felt Polishing Wheel,** fine quality felt, 6 inches diameter, 1 inch wide.. 1 55

401. **Muslin Buff Wheel,** 3 inches diameter. 35 pieces heavy muslin strongly stitched together 25



No. 402.

402. **Polishing Head, Electric,** for direct current. Will meet all requirements for light grinding, buffing, etc. Motor enclosed, protecting all working parts from flying dust and dirt. Bearings are made of extra heavy phosphor bronze, steel shaft ½ inch in diameter. Lubrication is automatic by means of feed wick oil cups. Motor practically noiseless in operation. Has a speed of 3,000 R. P. M. and will develop 1-6 H. P. Dimensions: Height over all, 9½ inches; base, 6x5 inches; length of shaft, 9½ inches. Finished in black japan. Buffing attachment to hold small buffs for buffing wheel is furnished extra. Complete with adjustable tool rest, emery wheel 5 inches in diameter, ½ inch face, indicating snap switch, attachment plug and six feet reinforced cord, wound for either 110 or 220 volts direct current. . . . . $ 30 00

403. **Polishing Head, Electric,** same as above, without tool rest. 25 00

404. **Buffing Attachment,** for either of above, extra. 3 00

404A. **Pulley,** to attach to shaft of motor. 1 10

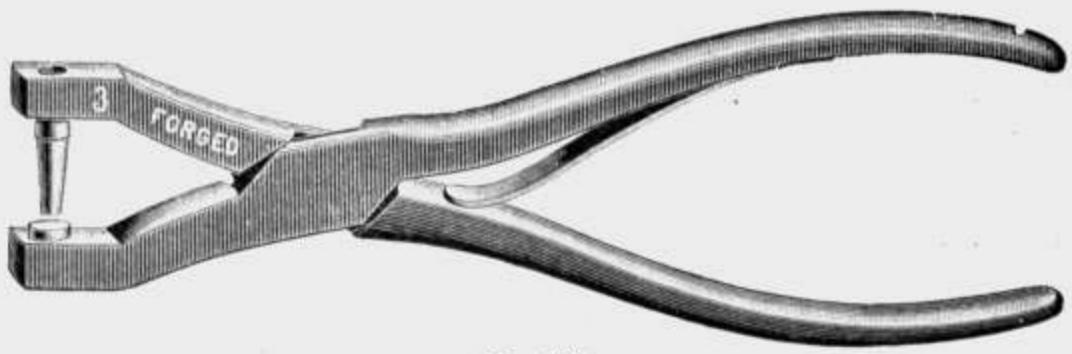
Polishing head accessories as listed on page 32 can be furnished to fit this motor at the same price.



No. 405.

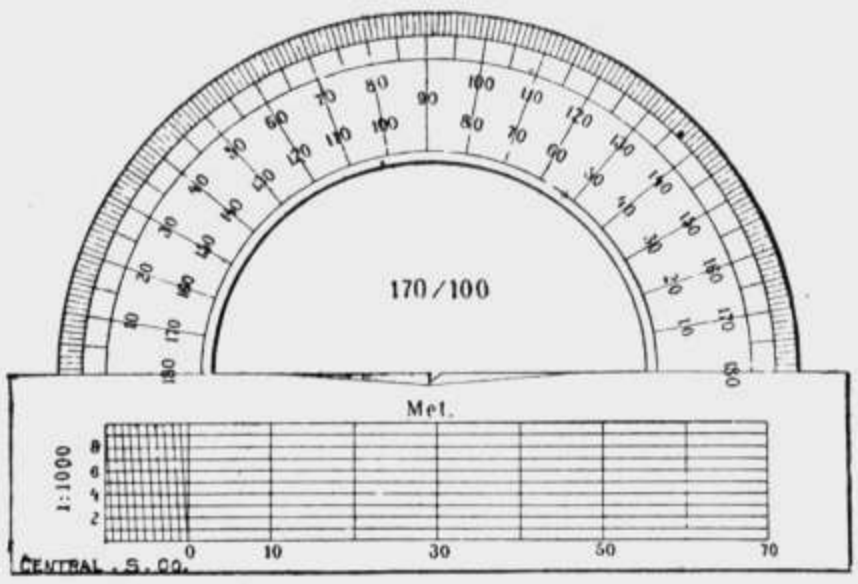
405. **Punch,** hollow cast steel. . . . . ⅛ in. ¼ in. ⅜ in. ½ in.

Each . . . . . .13 .15 .25 .35



No. 407.

407. **Punch,** spring, cast steel, double joint. 55



No. 409.

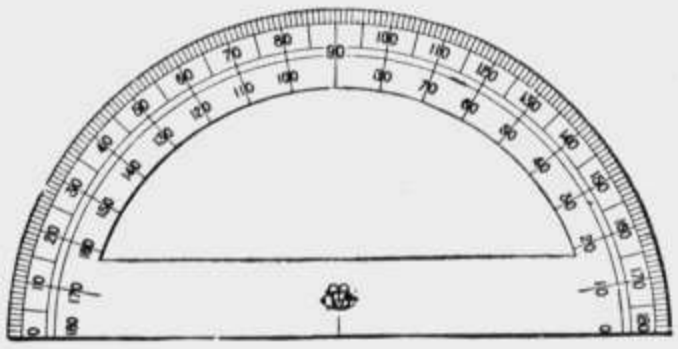
409. **Protractor and Diagonal Scale Combined,** of silvered metal, 5⅛ inches long ..... $ 60

411. **Protractor,** same as No. 409, engraved on bristol board, English and Metric 20



No. 413.

413. **Protractor,** boxwood, 6 inches long, 1¾ inches wide, scales of ¼, ½, ¾ and 1 inch to the foot. Scale of chords and diagonal scales..... 45



No. 419.

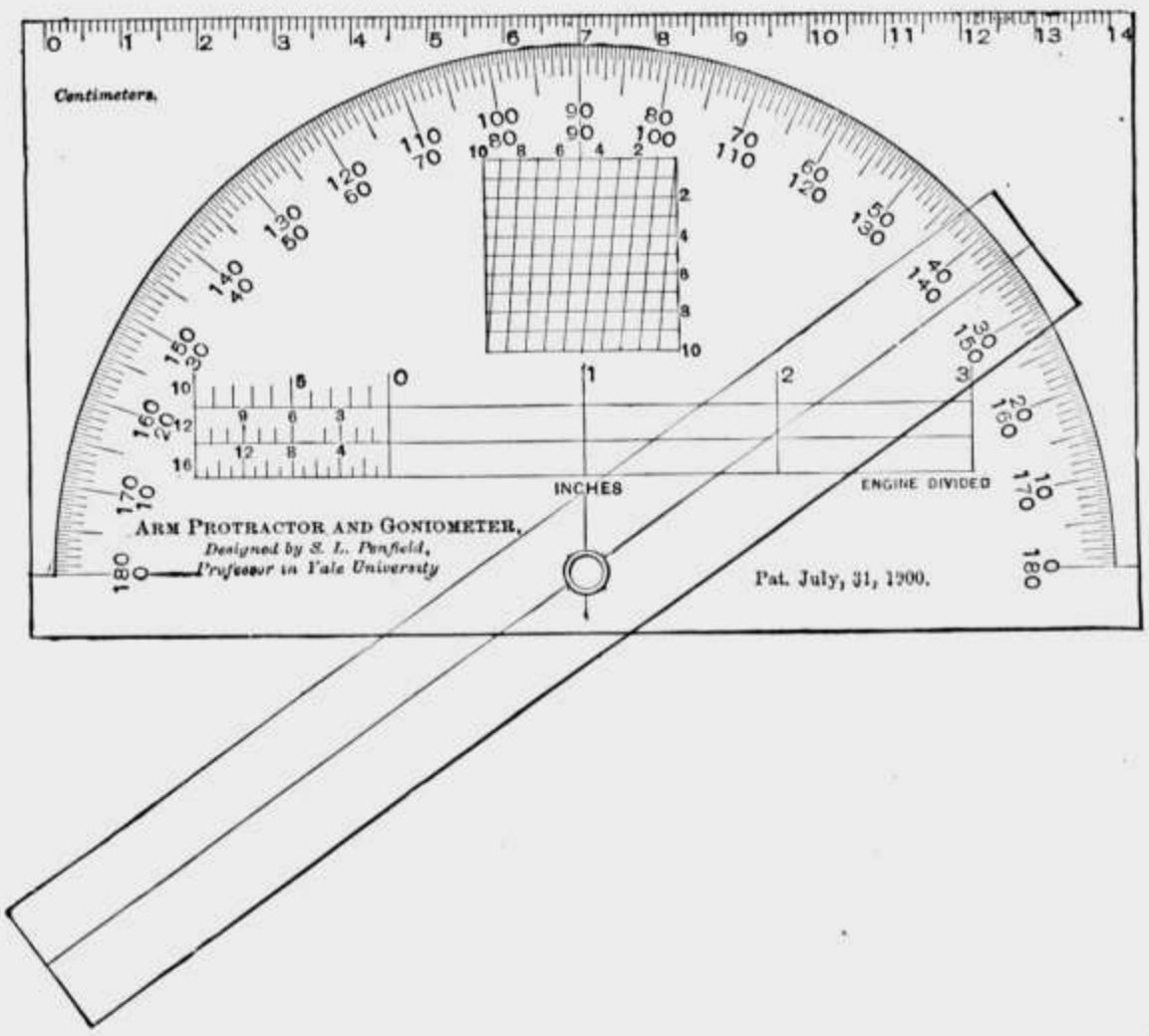
415. **Protractors,** cardboard, 4-inch, per dozen..... 45

417. **Protractors,** celluloid		4¼ in.	5⅛ in.
Each		.20	.40
419. **Protractors,** brass	3½ in.	4¼ in.	5⅛ in.
Each	.11	.22	.50
421. **Protractors,** German silver.....		4¼ in.	5⅛ in.
Each		.50	.80

423. **Protractors,** whole circle, on bristol board, 8 inches in diameter, ½ degree divisions 35

425. **Protractors,** same as No. 423, 14-inch, ¼ degree divisions..... 60

Walter Smith School Square, page 43.



No. 427.

427. **Protractor and Goniometer combined,** designed by the late Prof. S. L. Penfield of Yale University. We are the **sole agents** for this instrument in the West. This instrument consists of a graduated semicircle printed on a heavy card, in combination with an arm of transparent celluloid, swiveled by means of an eyelet at the center of the semicircle. A fine index line, scratched on the under side of the celluloid arm parallel to its edges, indicates by its position with reference to the graduation, the angle which the arm makes with the base-line of the card.

Can be used in connection with a T square if desired.

The scales printed on the card are the ones generally needed.

The decimal one on the upper edge may be used in connection with angles for plotting all kinds of problems in geometry and trigonometry. The diagonal scale is very accurate; by means of it any desired hundredths of an inch may be determined.

In addition to being a protractor, the instrument is also an accurate goniometer for measuring plane angles.

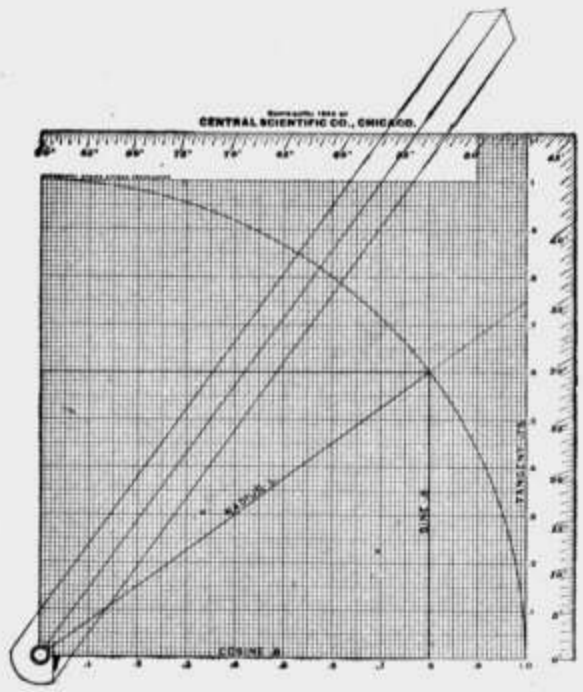
The scales and graduation of the semicircle are all engine divided.

Inexpensive, convenient and exceedingly accurate.

Each instrument placed in a stout manila envelope with complete printed instructions by Prof. Penfield..... $ 80

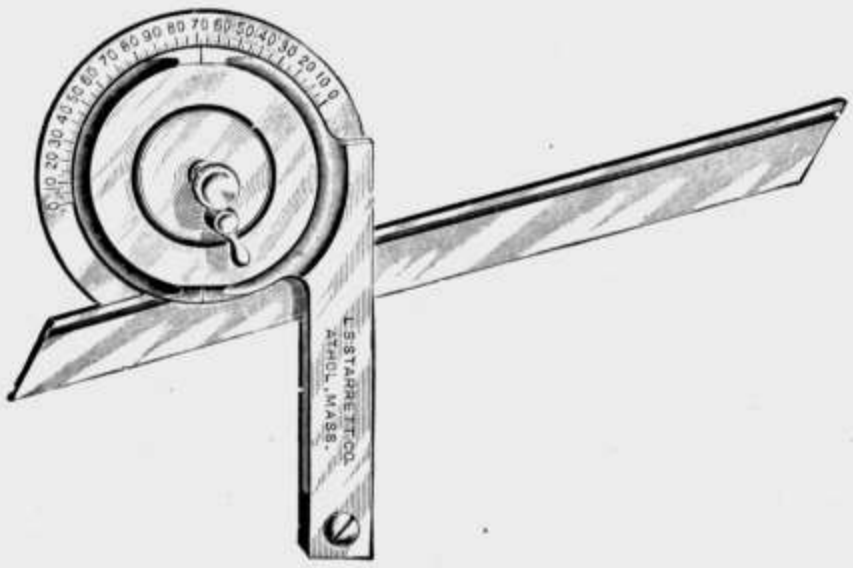
427A. **Contact Goniometer** (Model A). For measuring internal angles and for use where an arm protractor cannot be employed. Consists of two pairs of measuring arms with separate protractor..... 80

427B. **Contact Goniometer** (Model B). As it is difficult to adjust a transparent edge in exact contact with some surfaces, a modified form of No. 427 is made for measuring crystals, having the celluloid arm opaque for a portion of its length..... 80



No. 428.

428. **Protractor or Trigonometer,** engine divided. This protractor reduces the problem of the right angle triangle to the simplest possible terms. All fundamental trigonometrical problems are graphically solved. The instrument takes the place of the tables for angle work. Angles are read to fifteen minutes and functions are readable to .002. The instrument proves an excellent basis for tangible work in physics and trigonometry. In electrical work, the angle of lag, the induction factor, and the power factor can be read direct. Complete instructions are furnished with each instrument.
Printed on strong litho card, 8 inches by 8 inches, with celluloid arm.. $ 35



No. 430.

430. **Protractor, Universal Bevel,** made of the best sheet steel, nicely finished. The disc is graduated in degrees from 0 to 90 each way, and rotates the entire circle on a central stud inside the case. The blade (clamped by an eccentric against the edge of the disc) may be slipped back and forth its full length, or turned at any angle around the circle, and firmly clamped at any point. The most universal and complete protractor of its kind on the market, and also the cheapest;
7-inch blade, in leatherette case..... 6 50



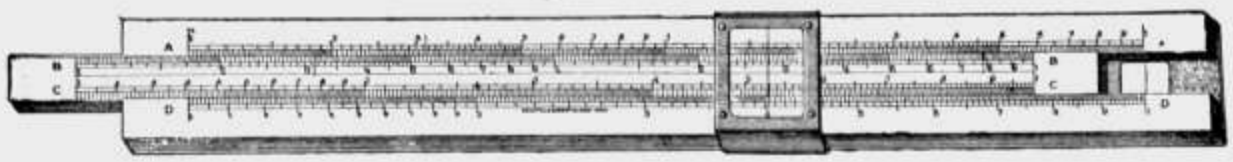
No. 431.

431. **Rule, Parallel,** of ebony; 9-inch, .75; 12-inch..... 1 00



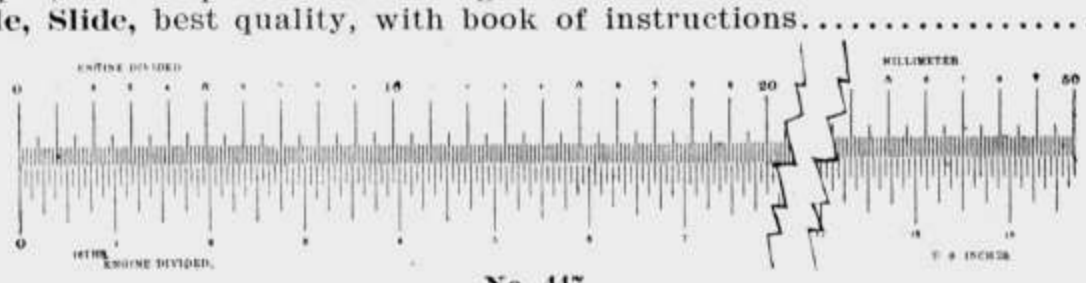
No. 437.

433. **Rule, Steel,** standard improved metric and English measure. First corner graduated to ½ m. m.; second corner to 1 m. m.; third corner to 1-64 inch; fourth corner to 1-100 inch; 5 c. m. long..... $ 30
435. **Rule, Steel,** same as No. 433; 10 c. m. long..... 50
437. **Rule Steel,** standard improved, metric and English measure. First corner, 5 c. m., graduated to ½ m. m.; the remainder of that corner together with second corner, to 1 m. m.; third corner, 2 inches to 1-64, the remainder to 1-16 of an inch; fourth corner, 2 inches to 1-100, the remainder to 1-50 of an inch; 20 c. m. long..... 1 00
439. **Rule, Steel,** same as No. 437, 30 c. m. long..... 1 40
441. **Rule, Steel,** same as No. 437, 50 c. m. long..... 2 20
443. **Rule, Steel,** same as No. 437, 1 meter long..... 7 75



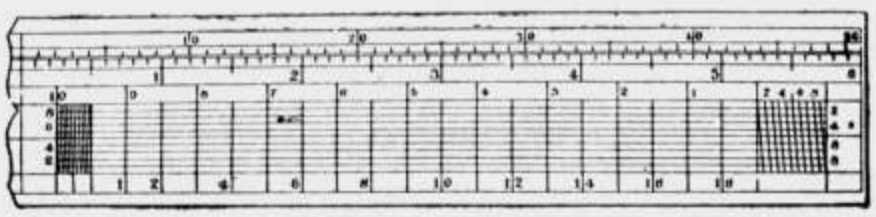
No. 446.

445. **Rule, Slide** [Woodworth], a simple machine for multiplying and dividing. It is engraved on the best **bristol board,** ready for the student to cut and fit together. Recommended by the Central Association of Science and Mathematics Teachers. Each, 11c. Per dozen..... 1 10
446. **Rule, Slide** [Mannheim], boxwood, 10 inches, graduations on white paper, with a protective coating..... 1 40
446½. **Rule, Slide,** best quality, with book of instructions..... 4 00



No. 447.

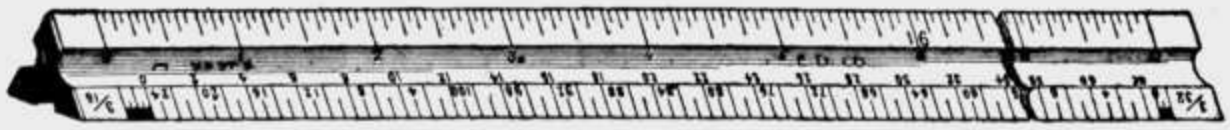
447. **Scale, Comparing Scale,** metric and English. Engine divided, printed on bristol board, ½ meter long..... 35



Nos. 449—450.

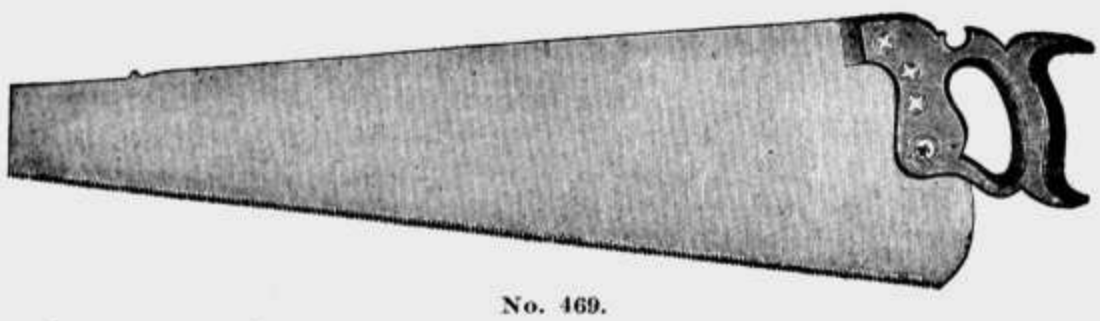
449. **Scale, Diagonal or Plotting,** boxwood, 6-inch, metric..... 10
450. **Scale,** same as No. 449, English..... 10
451. **Scale, Diagonal,** of silvered metal, 7-inch, metric..... 45
452. **Scale, Diagonal,** on best bristol board, 6-inch, metric..... 08
453. **Scale,** same as No. 452, English..... 08
455. **Scales for Galvanometers,** printed on bristol board, 2¾, 3¼ and 5 inches in diameter, in 1 degree divisions, each..... 15
458. **Scale, Mirror,** for Jolly's Balance, half mirror with No. 323 Paper Scale, pasted on back, 65 c. m. long..... 1 65
459. **Scale, Mirror,** for Jolly's Balance and other apparatus, accurately etched on plate glass and finely silvered, ½ meter long in millimeters 4 00
461. **Scale, Mirror,** same as No. 459, 1 meter long..... 6 50
462. **Scale, Mirror,** vertical, 12 centimeters long, graduated in millimeters.. 55
463. **Scale, Paper,** for reading telescopes, 50 c. m. long, divided into m. m. both ways from 0, which is in the center..... 20
323. **Scale, Paper,** 1 meter long, graduated in millimeters..... 10

Reading Telescope Scales, pages 6 and 184.
Other Rules and Scales on pages 27 and 28.



No. 467.

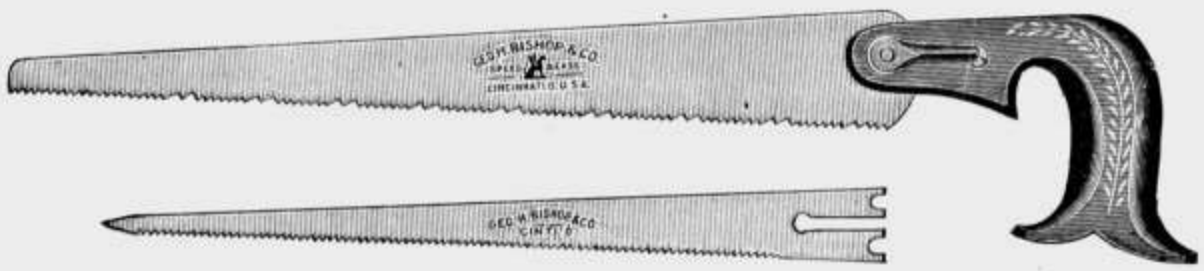
467. **Scale, Triangular Boxwood,** U. S. standard, machine divided, 12 inches long, **divided to** 1-16th **inch,** 10 different scales to the foot..... $ 55



No. 469.

469. **Saw, Crosscut,** good grade steel, hand filed and ready for use; 20-inch, 1.25; 26-inch 1 50

470. **Saw, Rip,** good quality, filed ready for use, 28 inches long..... 1 75



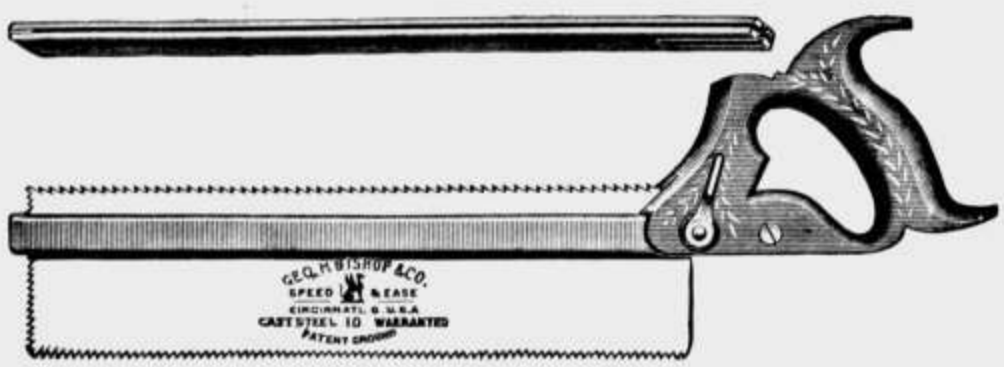
No. 472.

472. **Saw, Keyhole,** adjustable with interchangeable nest of saws. Apple wood handle, polished brass adjusting lever. With set of three blades 1 25



No. 473.

473. **Saw, Keyhole,** cheap..... 30



No. 474.

474. **Saw, Dovetailing,** Rip and Crosscut. The back of this saw constitutes a slot through which the blade slides, enabling the workman to move, space and adjust it to any desired width or distance from edge of back.

Length of blade, inches.....	8	12	18
Each	1.50	1.75	2.35

Hack Saws, page 21.

SCREWS.

Wood and machine screws are put up in packages of one gross. The prices given below are per gross. Packages will not be broken.

475. **Wood Screws,** flat or round head, **iron.**

Length.	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10
¼-inch.....	30	30	30	..	..	..	..	..
⅜-inch.....	30	30	30	30	33	35	40	..
½-inch.....	30	30	30	32	35	40	42	45
⅝-inch.....	30	30	30	33	36	42	44	50
¾-inch.....	..	30	33	35	40	44	47	52
⅞-inch.....	..	30	33	36	42	47	50	55
1-inch.....	..	35	38	42	46	50	54	60

477. **Wood Screws,** flat or round head, **brass.**

Length.	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 10
¼-inch.....	43	45	50	..	..	..	..	..
⅜-inch.....	45	50	51	56	60	68	75	..
½-inch.....	50	53	55	60	65	73	83	1.08
⅝-inch.....	51	55	60	65	70	80	93	1.20
¾-inch.....	56	60	63	70	78	88	1.00	1.33
⅞-inch.....	65	67	80	80	83	95	1.10	1.45
1-inch.....	..	80	85	88	90	1.05	1.23	1.58

479. **Machine Screws,** flat or round head, **iron.**

No.	3-16	¼	5-16	⅜	½	⅝	¾	⅞	1 inch	1½ in.
2....	15	15	15	15	15	17	20	..	..	..
4....	15	15	15	15	15	17	20	24	..	..
6....	15	15	16	16	17	18	22	24	28	50
8....	18	18	20	20	21	23	26	30	35	60

481. **Machine Screws,** flat or round head, **brass.**

No.	3-16	¼	5-16	⅜	½	⅝	¾	⅞	1 inch	1½ in.
2....	20	20	20	22	25	30	..	..	..	..
4....	20	20	20	22	25	30	35	..	..	..
6....	22	22	25	27	30	33	40	50	55	1.10
8....	33	33	35	38	40	45	50	60	65	1.20

483. **Screw Eyes,** of bright wire.

No.	214	210	208	206
Length	¾ in.	1 in.	1¼ in.	1½ in.
Price, per dozen.....	.06	.09	.10	.11

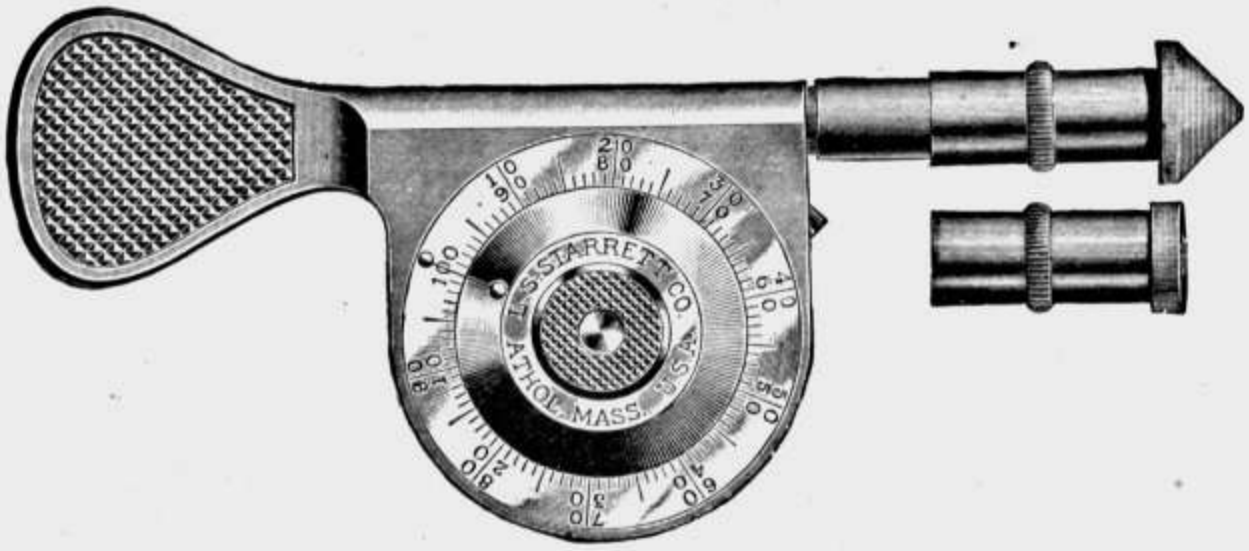
485. **Screw Hooks,** of bright wire.

No.	14	13	11	10
Length	1¼ in.	1½ in.	1¾ in.	2 in.
Price per dozen.....	.06	.09	.10	.11



No. 487.

487. **Screw Drivers,** 4-inch blade, 16c; 6-inch blade, 22c; 8-inch blade..... 30



No. 511.

511. **Speed Indicator,** improved form, may be run at highest speed required without heating; dial plate has two rows of figures reading right or left, with rubber tip for both pointed and centered shafts, which not only remove the jar and run smoothly, but produce a stronger frictional contact with the shaft..... $ 1 10



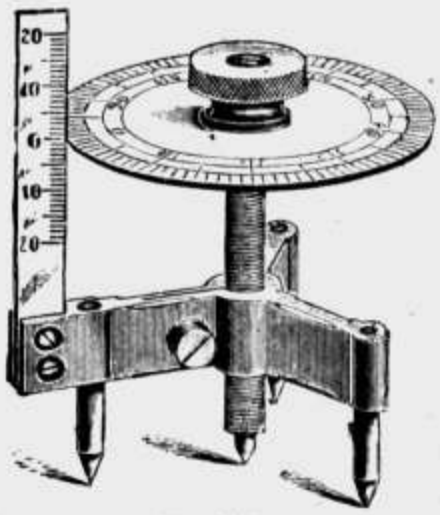
No. 513.

513. **Speed Counter,** suitable for any purpose requiring a small, light and accurate counter. Registers up to 99,999. Cut is full size. Made in a variety of styles 1 50

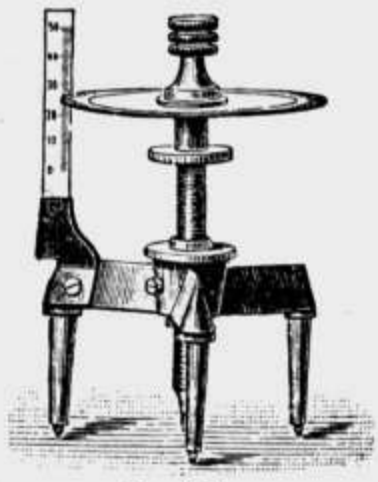


No. 514.

514. **Speed Counter** (iniatitive speed counter). This instrument will register from 0 to 10,000 in either direction and then repeat. It can easily be set back to zero from any number..... 7 00



No. 515.

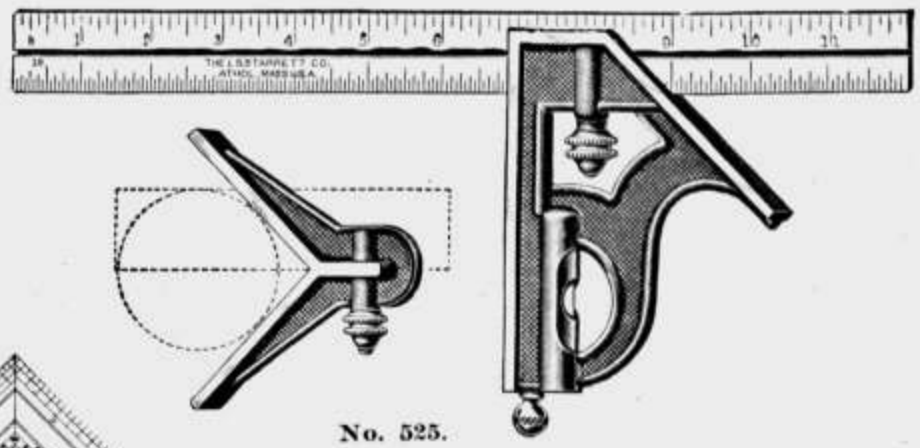


No. 520.

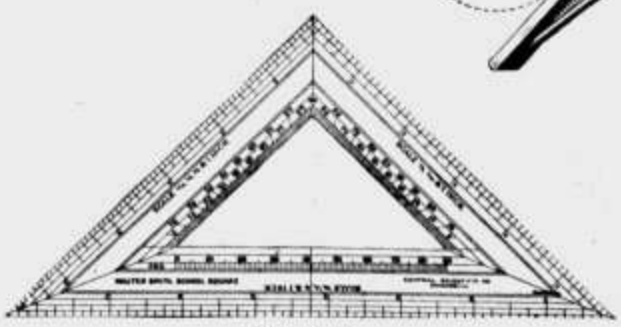
515. **Spherometer,** student form, reading to 1-200th millimeter, with silvered scales. Tripod covers a 2-inch circle..... $ 3.90

519. **Spherometer** (Societé Genevoise). Has double index lever. The thread of the screw is 0.5 m. m, pitch, and the horizontal circle is divided into 500 equal parts, thus reading to 0.001 m. m. With glass plate .....Duty free. 35.00

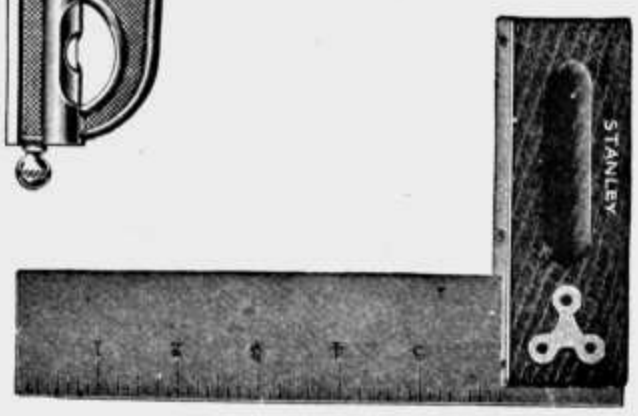
520. **Spherometer,** smaller size than No. 519 and without index lever. .....Duty free 19.50



No. 525.



No. 522.



No. 527.

522. **Square. Walter Smith School Square,** finely lithographed on heavy bristol board. Can be used as a measure, ruler or protractor, small size, length of hypothenuse, 8½ inches, each..... .07

525. **Square, Patent Combination** of new design. Every tool warranted accurate. One of the most convenient and useful tools ever devised for mechanics' use. It is a complete substitute for a whole set of common try squares, and is one of the best gauges made for transferring exact measurements or laying out work. It is also convenient for a depth gauge or to square in a mortise. For a miter it is perfect, while with the auxiliary center head it forms a centering square, both inside and outside, which for convenience and accuracy has no equal. **Six-inch blade,** graduated into 16ths, 32nds, 64ths and 100ths. Complete, with center head and level..... 1.75

526. **Square, Patent Combination,** same as No. 525, graduated in millimeters 1.75

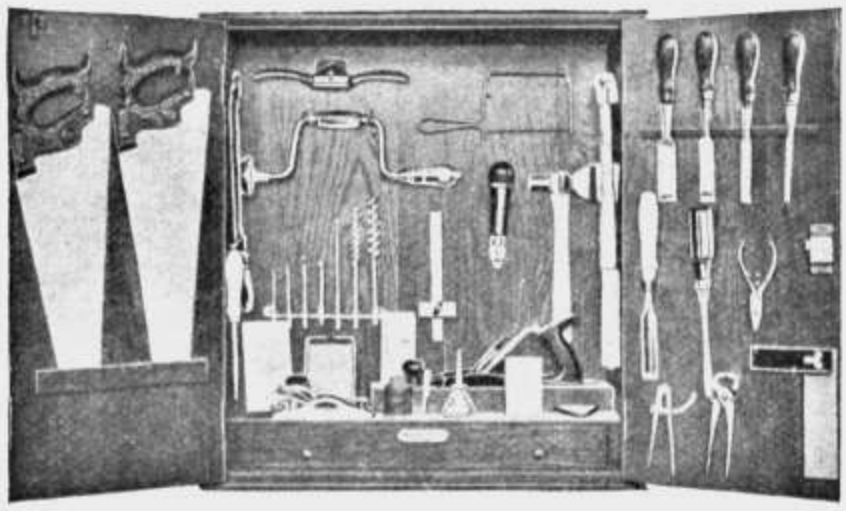
527. **Square, Try,** steel blade and rosewood handle.

Size, inches	3	4½	6
Each	.27	.30	.45

529. **Square,** all steel, length 2 feet, width 2 inches, 8ths, 4ths and Essex's New Board Measure, giving the feet and inches in full..... 1.50



No. 533.



No. 539.

530. **Stencils.** Complete set of letters, 1 inch high, for marking boxes, making signs, charts, etc..... $ 1 00

531. **Stencils.** Complete set of figures, same as above..... 45

533. **Stop Watch.** Stem wind, lever movement, 1-5th second divisions..... 7 25

535. **Straight Edge,** cherry, one edge bevelled.....24 inch, $ .30; 36 inch 50

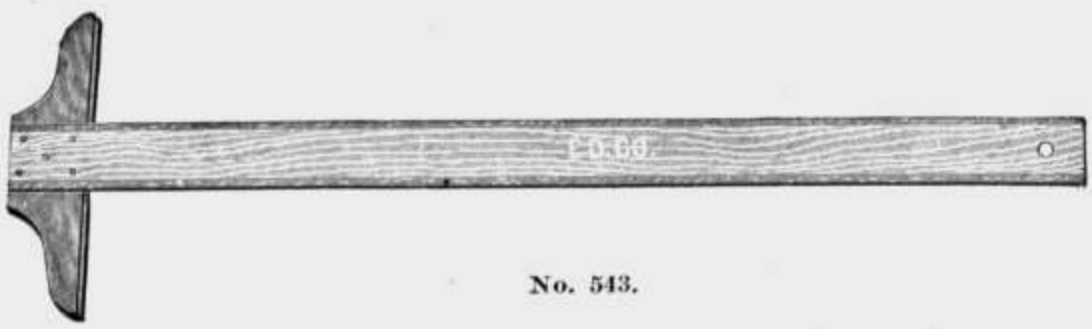
537. **Thumb Tacks,** stamped steel, made of one piece, head 5-16 in., per doz., 10

539. **Tool Chest,** made of chestnut, panelled and nicely finished, containing the following tools of the very best quality:
Panel saw, brace, 3 gimlet bits, 3 auger bits, 3 chisels, 2 screw drivers, hack saw frame, pocket level, countersink, scraper, hammer, tack hammer, tool handle, spoke shave, block plane, jack plane, 2-foot rule, try square, marking gauge, nail sets, wing dividers, gas pliers, flat nose pliers, nippers, saw file, oil stone, oil can, can of glue, and coping saw 19 00



No. 541.

541. **Tool Holder** and ten tools enclosed in handle. A very handy tool.... 55



No. 543.

543. **T Square,** pearwood blade and head, extra quality.

Length	24 inch.	30 inch.	36 inch.
Each	.40	.50	.60



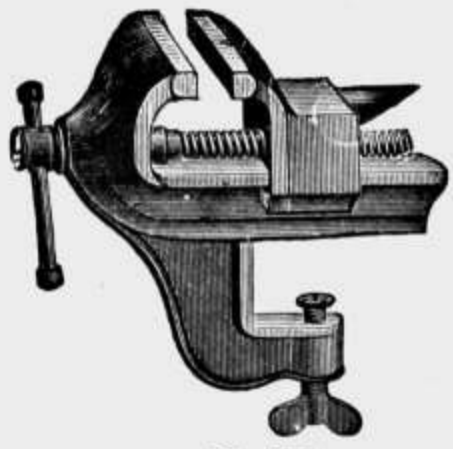
No. 545.



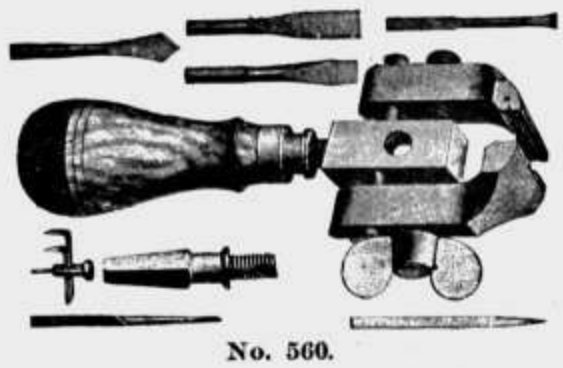
No. 547.



No. 565.



No. 555.



No. 560.

545. **Triangles,** pearwood, framed, 30°x60°..... 8 in. 10 in. 12 in.
Each ..... .20 .27 .35

547. **Triangles,** pearwood, framed, 45°..... 6 in. 8 in. 10 in.
Each ..... .20 .27 .35

549. **Triangles,** hard rubber, 30°x60°..... 6 in. 8 in. 10 in.
Each ..... .30 .40 .50

551. **Triangles,** hard rubber, 45°..... 6 in. 8 in. 10 in.
Each ..... .40 .50 .70

555. **Vise, Anvil Clamp,** 1½ inch jaw, opens 1¾ inches..... 40

557. **Vise, Anvil Clamp,** 2 inch jaw, opens 2¼ inches..... 75

559. **Vise, Anvil Clamp,** 2½ inch jaw, opens 2¾ inches..... 2 00

560. **Vise, Alford's Hand Vise.** The jaws, which are of forged and tempered steel, 1¼ inches wide and open 1⅛ inches, will center and hold tools of any shape. The handle of rosewood, with lignum vitae cap, is hollow and the bit shank and tools shown in the illustration are placed inside. It can be unscrewed from the vise and the bit shank put in its place, to be used with a bit brace for any kind of boring, drilling or in cutting washers. It can also be screwed into vise at right angles with its usual position, which is desirable for many kinds of work. Complete with tools..... 2 25

561. **Vise. Hand,** 4 inch wrought iron, 1⅛ inch jaws..... 45
N. B.—**Standard Vises** listed on page 9.

565. **Wire Gauge,** American standard, sizes 0 to 36..... 3 00

566. **Wire Gauge,** same as No. 565, sizes 5 to 36..... 2 25
Wire Cutters, see **Nippers,** Nos. 347-349, and **Pliers,** Nos. 369-381.



No. 567.

567. **Wrench.** Good quality. 6 inch, $ .55; 8 inch..... $ 65

569. **Wrench.** Cheap pocket monkey wrench..... 20



No. 571.

571. **Wrench, Stillson's Pipe Wrench.** 10 inches long, will take pipe from ⅛ inch to 1 inch..... 1 00



No. 573.

573. **Work Bench.** This bench is 4 feet long, exclusive of vises, or 4½ feet over all. It is 32 inches high and 20 inches wide, with a 13 inch glued up maple top 1¾ inches thick and a 7 inch well for tools. It has holes for stops and is fitted with both front and tail vises with our 1½ inch patent saw cut bench screws. Bench is fitted with both back board and tool rack, as shown in illustration.
Weight packed for shipment, 110 pounds..... 8 40

Wood Turning Tools. Good quality, handled.

Cat. No.	Name of Tool	¼ inch	½ inch	1 inch
590	Turning Chisel	.50	.55	.90
591	Turning Gouge	.60	.65	1.00
592	Parting Tool	..	.50	..

TOOLS OF ALL KINDS QUOTED UPON.

PROPERTIES OF MATTER.



No. 601.



No. 603.



No. 605.



No. 607.



No. 609.

601. **Adhesion Disc,** to show the adhesion between a liquid and glass. Made of glass 3 inches in diameter with ground edges, suspended by three silk cords ..... $ 27

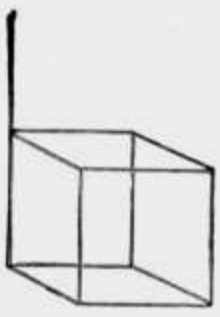
602. **Adhesion Disc.** Glass disc attached to wood cone, with supporting thread. (Millikan and Gale, Fig. 107.)..... 50

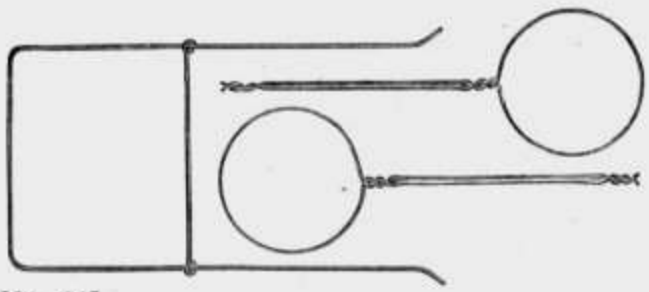
603. **Cohesion Plates,** to show cohesion between two glass plates. Plates are 3 inches square by ¼ inch thick, perfectly plane. Provided with handles 50

605. **Cohesion plates,** to show cohesion between brass plates. T shaped handle and disc in one piece. Faces accurately ground..... 3 00

607. **Cohesion Hemispheres,** to show cohesion between lead surfaces. Faces ground plane..... 40

609. **Prince Rupert Drops.** Per dozen..... 25





No. 613.



No. 615.



No. 616.

613. **Cohesion Figures,** to show phenomena of surface tension and cohesion. Four wire forms as illustrated, for making liquid films, with clay pipe for making bubbles..... 55

615. **Surface Tension Apparatus,** to show surface tension in a water film. The floating ring sinks below surface when tapped and is held under by the water film. Simple and effective..... 50

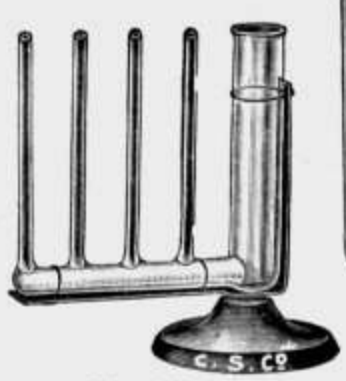
616. **Steel Scale,** 10 centimeters long, divided into millimeters with zero at the tip, for measuring capillary attraction according to Chute..... 2 00



No. 619.



No. 621.



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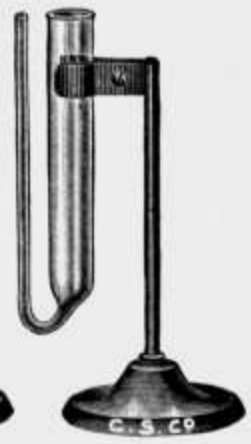

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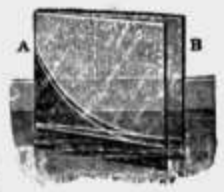


No. 631.

617. **Capillary Tubes,** set of seven..... 33

619. **Capillary Tubes,** set of 7, with nickel plated support, japanned base.. 95

621. **Capillary Tubes,** set of four, in wood bar to rest upon a tumbler..... 45

623. **Capillary Tubes,** set of four, all glass, mounted on support..... 1 25

625. **Capillary Tubes,** glass part only of No. 623..... 80

627. **Capillary Phenomenon,** mounted on support..... 1 00

629. **Capillary Phenomenon,** glass part only of No. 627..... 33

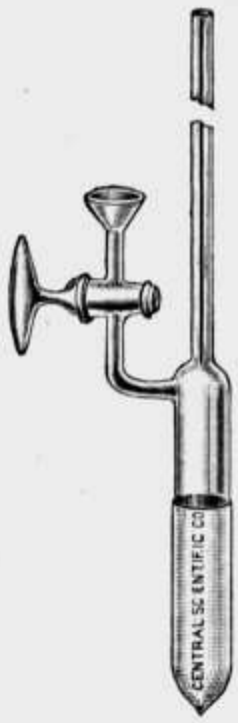
631. **Capillary Plates,** pair with rubber band..... 27



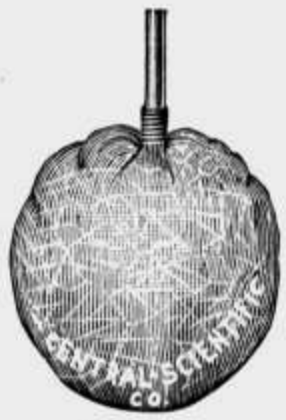
No. 635.



No. 638.



No. 640.



No. 643.



No. 647.

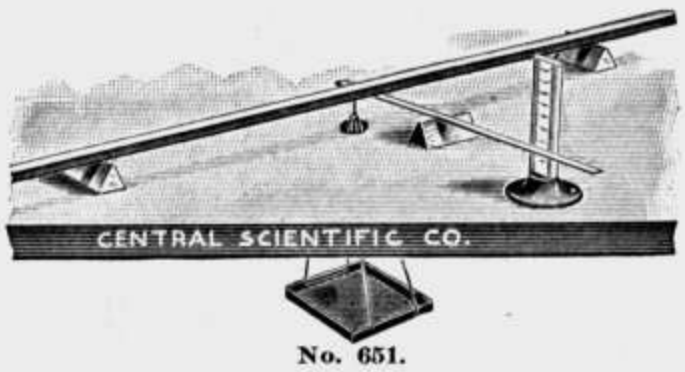
635. **Osmose Apparatus,** to show diffusion of gases. Simple form, two glass bottles connected by a tube..... 60

638. **Osmose Apparatus,** to show diffusion of gases. Glass tube sealed to porous cup 65

640. **Osmotic Pressure Tube,** as used at University of Chicago. Consists of glass tube of small bore 6 feet long, lower end closed by an S. & S. diffusion shell. Colored sugar solution is introduced by means of a stop cock. Very rapid in action, certain in its results, ready for use in an instant. Glass parts only..... 4 00

643. **Osmose Apparatus,** to show diffusion of liquids. Long tube, to which is attached a porous membrane. Tube and membrane to be filled with a glucose solution and membrane placed in water with the tube upright 50

647. **Inertia Apparatus,** with card and ball..... 80



No. 651.

649. **Inertia Balance,** for measuring the mass of a body without measuring its weight. (Crew & Tatnall Ex. 17) 4 00

651. **Elasticity of Flexure Apparatus** (lever method) to observe the laws of bending beams. Parts listed below from A to G (with three F) constitute the complete outfit 70

651A. **Pine Rod,** 102x1x1 c. m..... 08

651B. **Pine Rod,** 102x2x1 c. m..... 10

651C. **Maple Rod,** 102x1x1 c. m..... 08

651D. **Scale** of wood, 10 c. m., on iron base..... 16

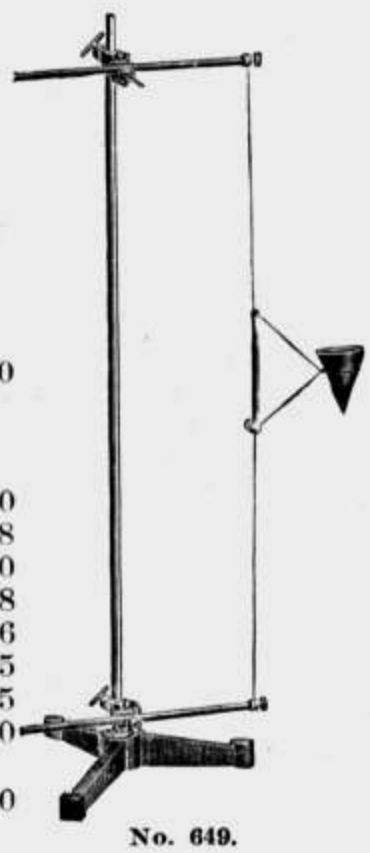
651E. **Indicator,** of light wood..... 05

651F. **Prism,** of hardwood, 50 m. m. long, 25 m. m. wide.. 05

651G. **Scale Pan,** of metal..... 10

651H. **Contact Piece,** brass plate with knife edge and binding post, to be used in Contact Method No. 652.... 1 10

Weights for use with above, listed on pages 270, 271.



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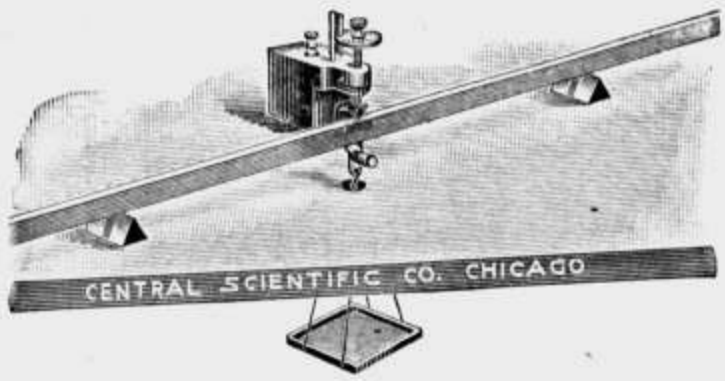


No. 652.



No. 653.

652. **Elasticity of Flexure** (Contact Method). In this method Nos. 651A, B, C, F, G and H are used with the addition of No. 338 Micrometer Screw, complete without battery..... $ 4 90

Weights for use with No. 652 listed on pages 270 and 271.

653. **Clamp with knife edge.** Superior to the wood prism, as it can be clamped to the table. The knife edge extends over the edge of the table and weight pan can be suspended without cutting through the table top 1 10



No. 654.

654. **Testing Machine,** for measuring tensile strength of wires. Convenient form, giving efficient results with a minimum of labor. No danger from recoiling wire after breaking. The indicator of balance is held at breaking point, eliminating possibility of error. Complete with No. 3873 spring balance, 30 pound by 15 kilograms, and full directions..... 6 65

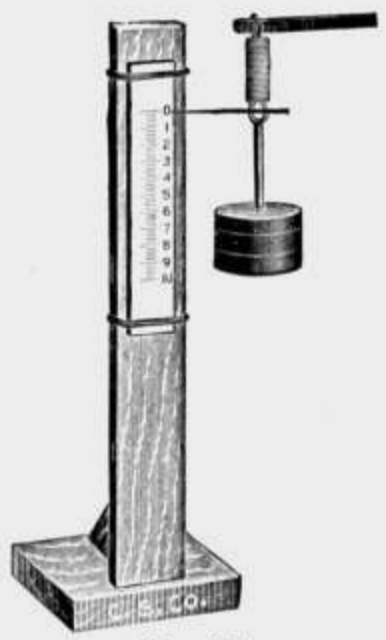


No. 656.

656. **Young's Modulus and Wire Testing Apparatus.** Consists of a fastening clamp, tension clamp and a guard or balance block. This apparatus forms a convenient and inexpensive device for testing the tensile strength of wires and Young's Modulus of Elasticity, and is capable of very accurate results with a minimum of labor. Furnished complete with directions for operating, but without balance of any kind 3 75

658. **Hooke's Law Apparatus,** according to Millikan and Gale Experiment No. 12, consisting of a mirror glass scale graduated in millimeters for 12 centimeters (No. 462), a neat wooden support and a spring and weight holder without weights 1 80

N. B. No. 3939 Weights are best adapted for use with above. See page 270.



No. 658.

661. **Hooke's Law and Young's Modulus Apparatus,** for verifying Hooke's law and determining Young's Modulus, according to Ames and Bliss. Consisting of a bracket supporting two brass wires, one of which is furnished with a metallic millimeter scale and the other with a vernier. Each wire is also furnished with a one kilo weight hanger. Four extra 2 kilo slotted weights complete the apparatus..... 12 00


No. 661.

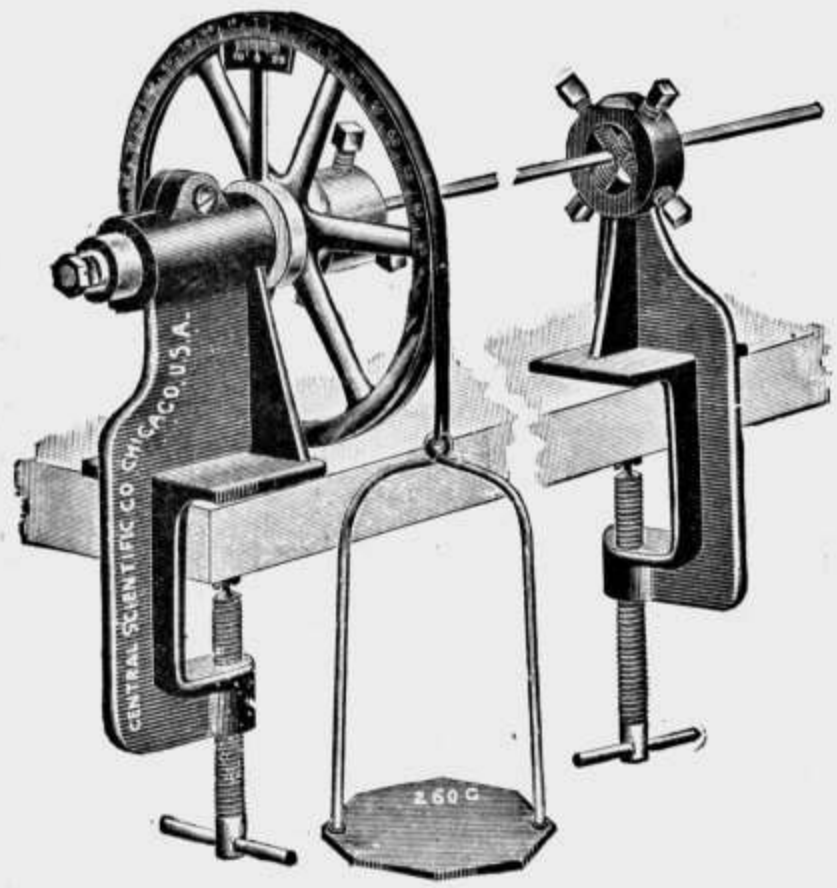
662. **Young's Modulus Apparatus.** The supporting frame consists of two heavy steel rods 90 m. m. high, mounted on tripod with leveling screws and fitted with strong clamps on top of rod for holding the wire. A small bushing is clamped near the end of the wire and on this one leg of the Optical Lever rests. The other two legs rest on an adjustable platform attached to the support rods. The elongation is measured by a telescope and scale. A micrometer microscope clamped to one of the supporting rods may also be used for measuring the elongation of the wire. Complete with Optical Lever and weights..... 25 00



No. 662.

For Wire of all kinds to be used with apparatus listed on this page, see page 350.

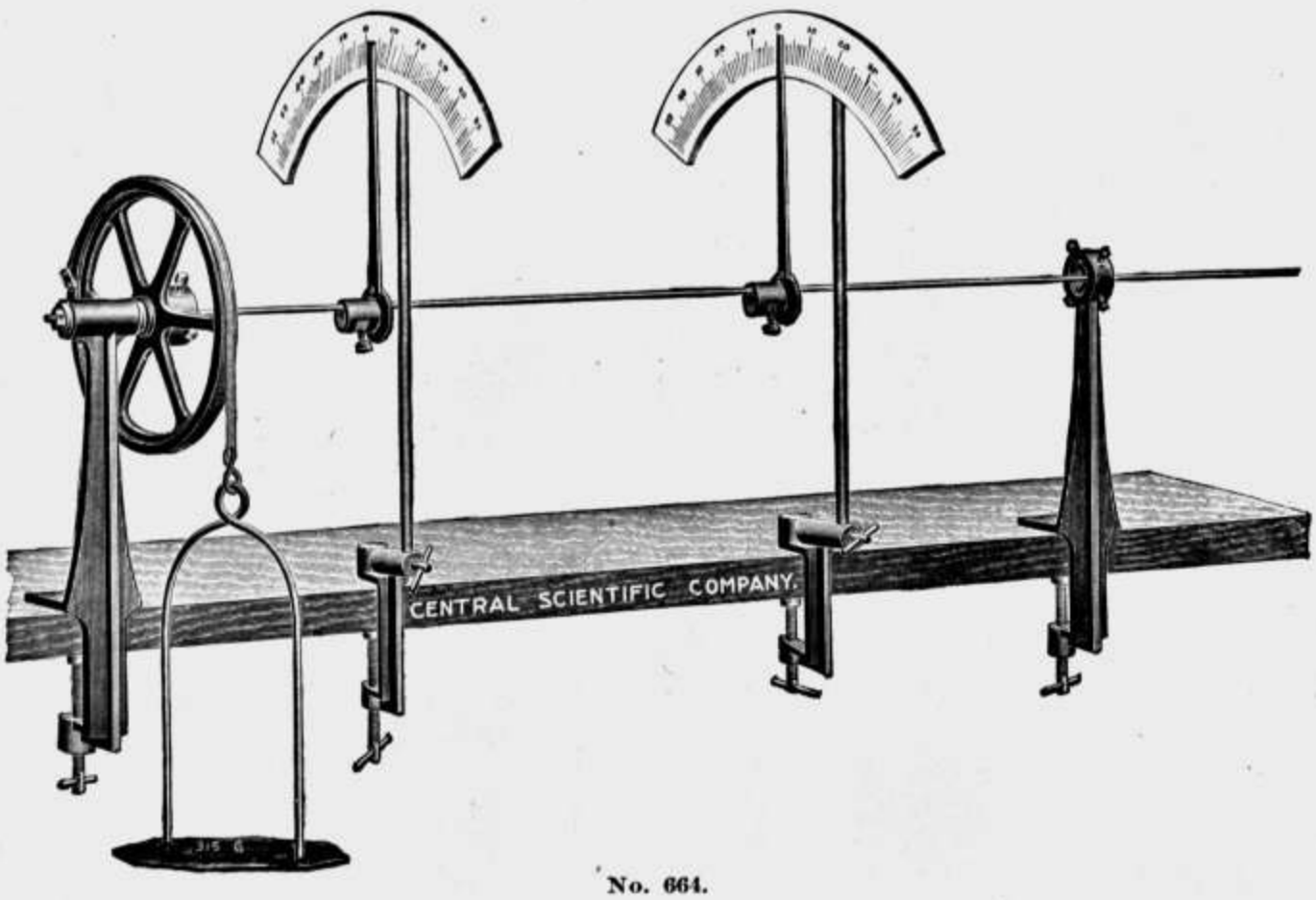
Weights listed on pages 270 and 271.



No. 663.

663. **Torsion Apparatus,** to show that the angle of torsion in a given rod is proportional to its length and the stress applied. The apparatus illustrated is an improved form, recommended wherever used. A heavy table clamp carries a ball bearing hub, to which is attached a wheel 6 inches in diameter, one-half the rim of which is divided into degrees. An adjustable vernier arm fits closely to the scale and is graduated to read in either direction. In the hub is a socket, in which the rod to be tested is centered and rigidly fastened. The other end is held in a similar socket, mounted in another table clamp. The pulley is flat for a steel ribbon band, which holds a scale pan of known weight. Complete with full directions and eight rods, all 110 centimeters long but of different materials and dimensions, as follows: One each brass rod 6 millimeters round and 6 millimeters square, one each steel rod 6 millimeters round and 6 millimeters square, one each maple rod 10 millimeters round and 10 millimeters square, one each whitewood rod 10 millimeters round and 10 millimeters square 13 35

For extra rods, see next page.



No. 664.

664. **Torsion Apparatus, new design.** Errors due to slippage at the point where the rods are clamped are entirely avoided in this new model. The torque is directly measured by the pointers and graduated arcs, which are held in position by set screws, and the length of rod being tested can be varied conveniently while carrying a constant load. The amount of torque is indicated by the difference in reading between the two pointers and may be observed by a large class. The experimental rod is held rigidly at one end by a heavy clamp, while the other end is held by a ball bearing wheel 20 c. m. in diameter, to which is attached a flat steel band carrying a scale pan of known weight. Complete with directions and one each rods Nos. 665, 665A, 667 and 667A..... $ 11 00

EXTRA RODS FOR No. 663 AND No. 664.

665. **Brass Rod,** round, 110 centimeters long, 6 millimeters diameter..... 27

665A. **Brass Rod,** round, 110 centimeters long, 10 millimeters diameter..... 55

666. **Brass Rod,** square, 110 centimeters long, 6 millimeters square..... 40

667. **Steel Rod,** round, 110 centimeters long, 6 millimeters diameter..... 11

667A. **Steel Rod,** round, 110 centimeters long, 10 millimeters diameter..... 22

668. **Steel Rod,** square, 110 centimeters long, 6 millimeters square..... 27

669. **Maple Rod,** round, 110 centimeters long, 10 millimeters diameter..... 12

670. **Maple Rod,** square, 110 centimeters long, 10 millimeters square..... 11

671. **Whitewood Rod,** round, 110 centimeters long, 10 millimeters diam... 12

672. **Whitewood Rod,** square, 110 centimeters long, 10 millimeters square.. 11

Note—Rods of other dimensions upon application.

674. **Pointer and Graduated Arcs,** as used on No. 664 Torsion Apparatus. Set consists of two each arcs mounted on rods, table clamps and pointer as shown in above illustration. These attachments can also be used with No. 663 Torsion Apparatus. Per pair..... 5 50



No. 676.



No. 677.







No. 681.

676. **Geometrical Solids and Surfaces.** Includes 24 solids, 17 surfaces and 3 angles, in strong wooden box..... $ 3 00

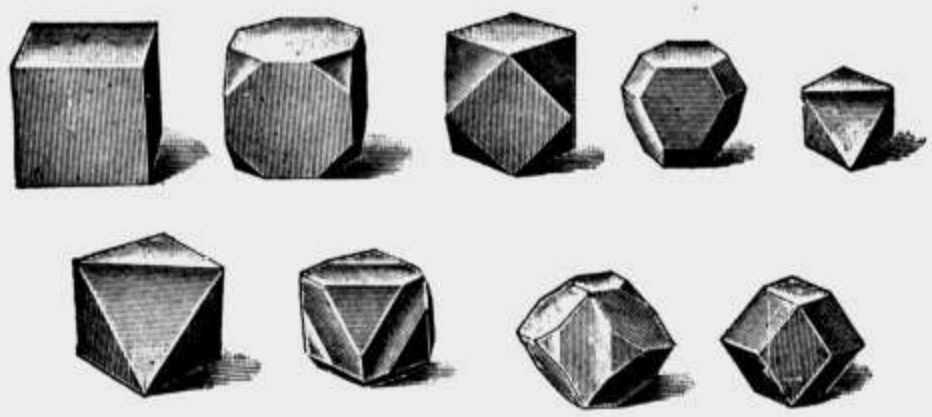
677. **Dissected Cone.** Illustrates conic sections, viz.: the circle, ellipse, parabola and hyperbola. Made of highly polished black walnut, cherry and maple, with heavy pins; easily dissectable. Height 9 inches, base 6 inches in diameter..... 3 35

678. **Plain Cone.** Illustrating stable, unstable and neutral equilibrium. Six inches in diameter, of wood, finely finished..... 1 10

679. **Area of Circle.** Visual demonstration that the area of a circle is equal to the radius multiplied by one-half of the circumference, diameter 8 inches 1 40

680. **Area of Triangle.** Visual demonstration that the area of a triangle is equal to its base multiplied by one-half its altitude..... 1 40

681. **Cone, Sphere and Cylinder.** Actual demonstration shows that the contents of the cone three times filled with water fills the cylinder, and that if the cylinder is filled with water and the ball entirely immersed there will remain in the cylinder just water enough to fill the cone. It follows, therefore, that the contents of the three are as the numbers 1:2:3. The pieces are packed together in a box..... 1 10



No. 683.

683. **Models of Crystals,** of solid Bohemian glass, surfaces ground and polished. Set of 20 models in pasteboard box..... 8 00

685. **Models of Crystals,** same as No. 683, set of 40 models in velvet lined case .....Duty free 20 00

686. **Models of Crystals,** same as No. 683, set of 90 models in velvet lined case .....Duty free 40 00

687. **Models of Crystals,** constructed of glass plates, axes indicated by colored silk threads. Collection of 15 models.....Duty free 25 00

688. **Models of Crystals.** Set of 50 wooden models in neat box. Set contains principal plane forms as well as the various combinations and twin forms. Size, 5 c. m.....Duty free 19 00

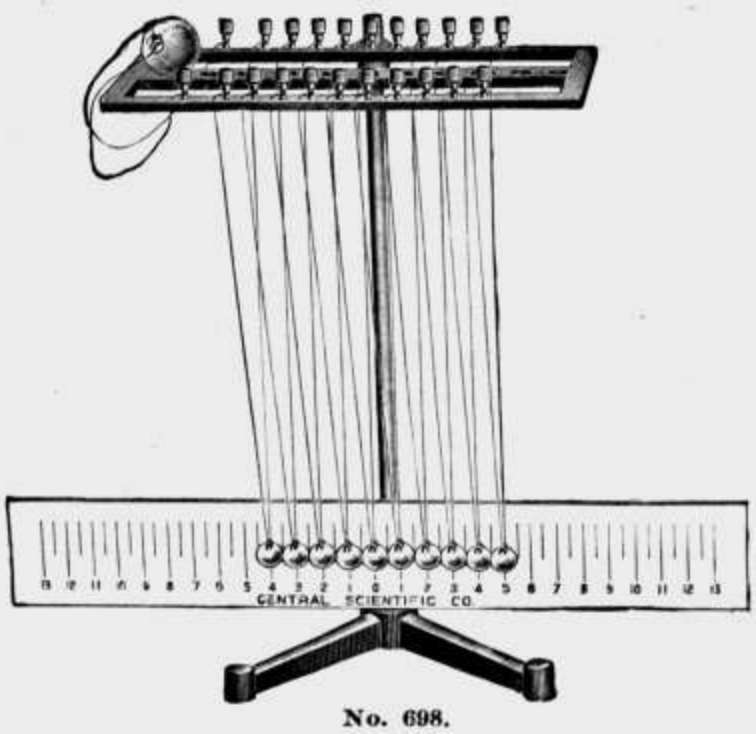
689. **Models of Crystals,** same as above, 80 models.....Duty free 38 00

N. B.—Stereoscopic Slides for showing luster of Crystals, see No. 3493.

MECHANICS OF SOLIDS.



No. 691.



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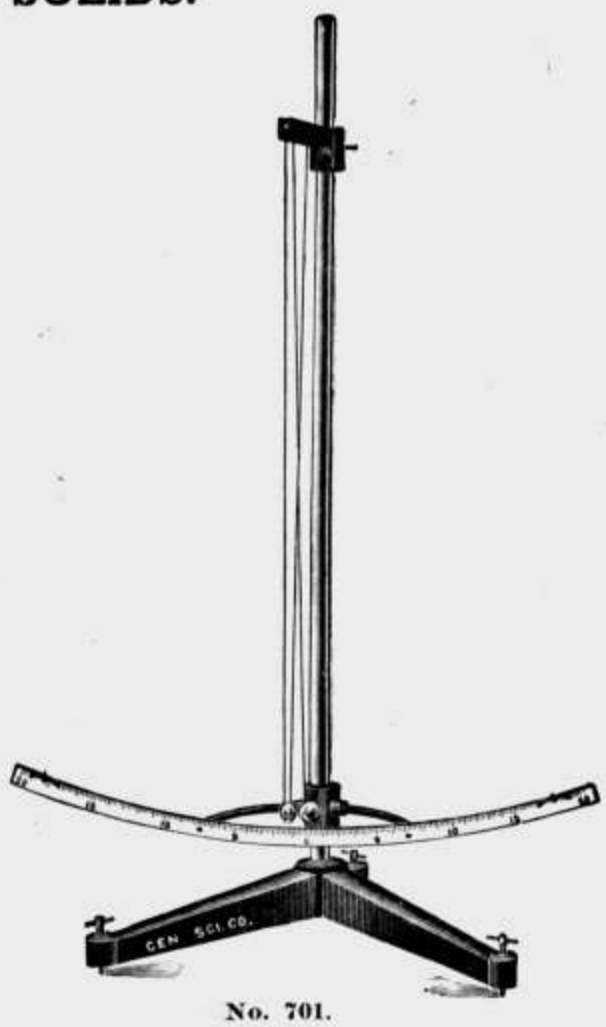


No. 701.

691. **Collision Balls.** Set of seven glass balls, 1½ inches in diameter, with grooved base, 1 meter in length..... 1 50

692. **Collision Balls,** iron frame, with clamp and screw for use with tripod and rod, set of five lignum vitae balls, 1½ inches in diameter, suspended from iron frame by double adjustable cords..... 3 00

693. **Collision Balls,** consisting of No. 692 complete, with tripod base and rod 3 50

694. **Graduated Arc,** on wood, with clamp and screw for use with No. 692. 1 00

696. **Collision Balls.** Consists of a rectangular frame adjustably mounted on tripod support. Ten highly elastic and polished steel balls 1 inch in diameter and one of four times the mass are supported on this frame by double cords, whose adjustment is secured by means of tapered keys. This construction gives a bifilar suspension to each ball, thus affording ease in alignment and provides a directive force to the ball, a great improvement over old designs. When it is desired to place one or more balls out of service it is only necessary to place them in receptacles on the cross bar. A scale (No. 697) for quantitative work may be added if desired..... 10 00

697. **Scale,** on wood, with clamp and screw for use with No. 696..... 1 00

698. **Collision Balls,** same as No. 696, with addition of Scale No. 697..... 11 00

701. **Impact Apparatus,** for the demonstration of Newton's laws of motion and all the laws of impact, both in elastic and non-elastic bodies. Consists of heavy iron base, fitted with leveling screws and supporting a steel frame and graduated arc. Balls are supported by double adjustable cords and are released by burning a thread or by a spring pistol, which is so adjusted on the arc between the balls as to strike both at the same instant with equal force. The spring pistol can be removed if desired. A sliding index on the graduated arc indicates the height to which the body is driven. Can also be used as a ballistic pendulum and for comparison of mass by inertia. The following balls are furnished with the apparatus:

a. Two elastic balls of precisely equal masses.
b. One elastic ball of exactly ½ the mass of each of the former.
c. One elastic ball of exactly ¼ the mass of the same.
d. Two non-elastic balls of exactly equal masses.
e. One non-elastic ball of exactly ½ the mass of each of the former.

Apparatus complete, as above..... 35 00

BALLS.

703. **Brass Balls,** accurately turned and drilled for suspension.

Diam.	¾ in.	1 in.	1½ in.
Each	.22	.33	.72

704. **Brass Balls,** same as No. 703, but not drilled.

Diam.	½ in.	¾ in.	1 in.	1½ in.
Each.	.15	.18	.25	.66

705. **Cast Iron Balls,** accurately ground and polished, similar in appearance and accuracy to No. 717 Steel Balls; drilled for suspension.

Diam.	¾ in.	1 in.	1½ in.
Each	.06	.08	.13

706. **Cast Iron Balls,** not turned, japanned and drilled for suspension.

Diam.	2 in.	3 in.
Each	.30	.50

707. **Copper Balls,** not turned, drilled for suspension.

Diam.	¾ in.	1 in.	1½ in.
Each	.33	.45	.85

708. **Cork Balls,** lathe turned and drilled for suspension.

Diam.	¾ in.	1 in.	1½ in.
Each	.07	.11	.20

709. **Glass Balls** (Marbles).

Diam.	⅝ in.	¾ in.	1 in.	1½ in.
Doz...	.11	.11	.17	.65

711. **Hardwood Balls,** of maple, accurately turned, polished and drilled for suspension.

Diam.	¾ in.	1 in.	1½ in.	2 in.
Each.	.07	.09	.13	.16

713. **Ivory Balls,** guaranteed genuine ivory, accurately turned, polished and drilled for suspension.

Diam.	1 in.	1½ in.	2 in.
Each	1.65	1.95	2.50

715. **Lead Balls,** not turned, drilled for suspension.

Diam.	¾ in.	1 in.	1½ in.
Each	.08	.11	.18

716. **Lignum Vitae Balls,** accurately turned, drilled for suspension. Diameter 1½ inches. Each 27

717. **Steel Balls,** hardened, accurately ground and polished, same as used in ball bearings. Impossible to be drilled.

Diameter	¼ in.	⅜ in.	½ in.	¾ in	1 in.	1½ in.	2 in.
Each	.04	.05	.07	.10	.20	.50	1.65

718. **Steel Ball,** 1 inch in diameter, provided with suspension hook, as used on No. 696 Impact Apparatus..... 55

719. **Set of Balls.** In this set we have included an outfit that has proved very convenient and efficient for all work in impact experiments and in experiments on the pendulum. Each ball is drilled for suspension and the set comprises the following:

A. Four balls, highly elastic, of equal weight, each 1½ inch diameter.

B. One ball, same diameter as A, but one-half the weight.

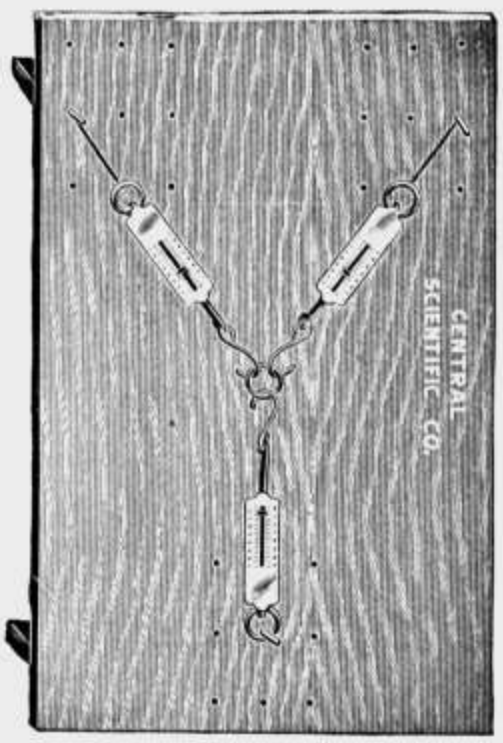
C. One ball, double the weight of A.

D. One iron ball with screw eyes, weight four pounds.

E. One inelastic ball, same diameter as A.

Complete set as listed above..... 2 25

720. **Composition of Force Board,** after specifications of Prof. Millikan. A great improvement over the old checker board type. Easily and quickly set up, ready for use and results more conveniently obtained. Size of board is 58x84 c. m. With rings and pegs, but without balances..... 1 75

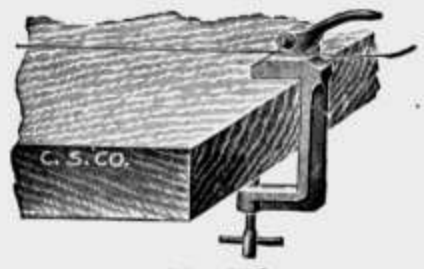


No. 720.

723. **Stone's Tension Clamp,** modified form, for use in composition of forces, tensile strength of wires, sonometer and many other experiments where it is desired to maintain a strain on a wire or cord and enable the individual operator to readily adjust such a tension without the co-operation of a second person.

This clamp is substantially made of cast iron and neatly finished. Will fit any table or board 7 centimeters thick or less. Wires, cords, etc., are securely clamped by an eccentric lever, as shown in the illustration.

Each 50



No. 723.

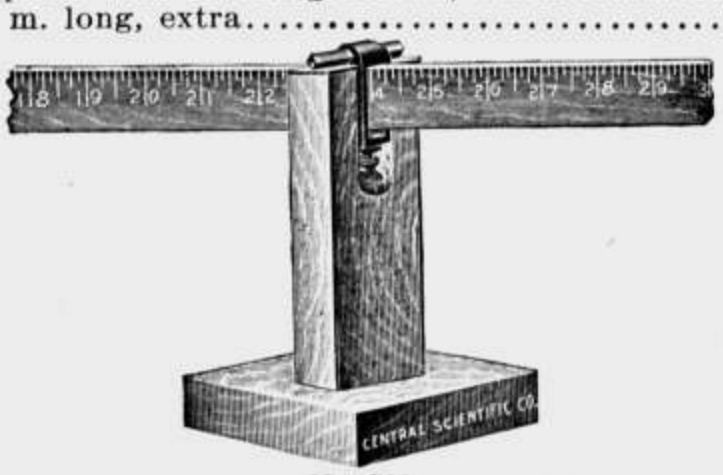
725. **Composition of Force Table,** to demonstrate the laws of the composition and resolution of forces. The table top, 40 c. m. in diameter, is of cast iron, accurately turned. The outer edge is raised and divided into degrees. The vertical rod is 30 m. m. in diameter and mounted on a heavy tripod base. The pulleys are large size, running with very little friction, on cone bearings, and may be clamped to any part of the rim. The cords are attached to a small ring, which can be held in the center of the table by a pin in order to adjust the weights easily. Complete as illustrated, with 4 pulley clamps, weights and 4 weight hangers..... 25 00



No. 725.

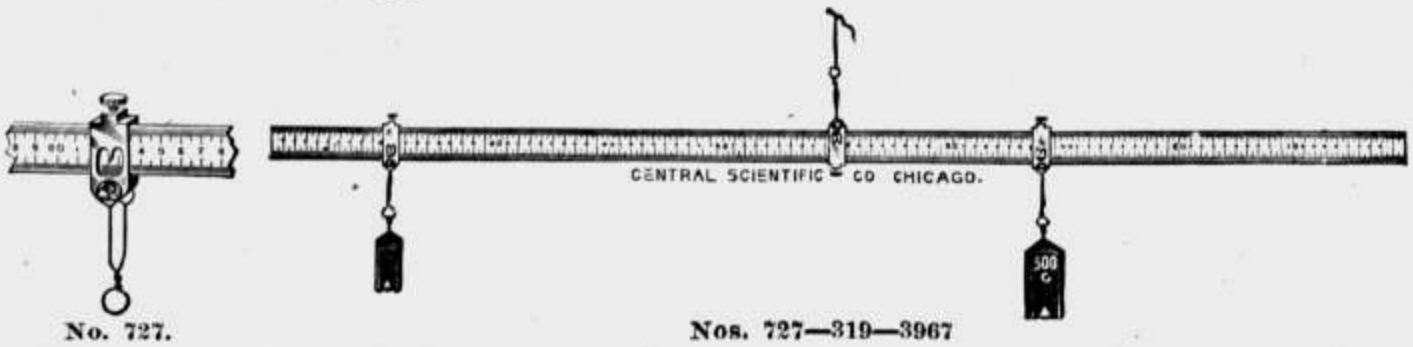
Tripod supplied with levelling screws, extra..... 2.25

Rod 100 c. m. long, extra..... 1.00



No. 726.

726. **Demonstration Balance,** for demonstrating the principle of moments, consisting of a knife edge clamp which will fit a standard meter stick, and a support..... 72



No. 727. Nos. 727—319—3967

727. **Lever Holder,** to demonstrate the principle of balance and laws of levers, made of brass casting to fit standard meter stick. Its durability will be found much greater than those made of sheet metal. The holder is fitted with a steel knife edge and a set screw for clamping the holder to the meter stick. An indicator facilitates the readings. Each..... 30

N. B.—Owing to the inaccuracy and inconvenience of the ordinary forms of levers as have heretofore been sold, we have decided not to advocate a further sale of them. The following combination will do all the work required in the study of levers and moments of forces.

A. Three No. 727 Lever Holders..... 90
B. One set of No. 3967 Weights with Hooks..... 2 00
C. One No. 319 Meter Stick..... 30



No. 728.

728. **Wheel and Axle,** of four diameters, mounted in iron frame with straight rod ½ inch in diameter, for use with clamp holder in connection with system of laboratory supports (see pages 1-7)..... $ 1 25



No. 729.



No. 730.



No. 731.



No. 732.

Pulleys, New Form, a great improvement over the old type brass pulley. The wheels are made of thin pressed steel, 50 m. m. in diameter and, being lighter and having less bearing surface than the old style, turn freely. Each pulley is carefully mounted and runs true. Will give longer service and more efficient results than any other pulley of the same price.

729. **Single Pulley** 26
730. **Double Pulley** 45
731. **Triple Pulley** 60
732. **Quadruple Pulley** 1 00



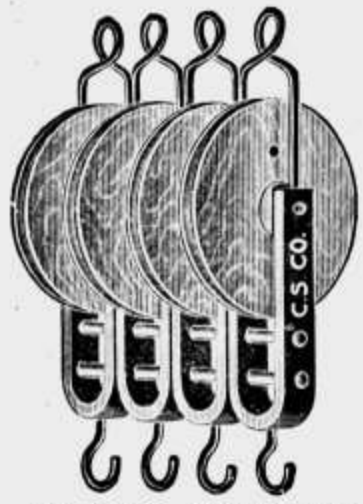
No. 733.

733. **Triple Pulleys** in tandem of varying diameters, largest being 2 inches in diameter. Pulleys are of brass, accurately turned. Per pair.... 2 00

N. B.—**Weights** for use with pulleys listed on pages 270-271.
See also No. 750 Weights listed on page 59.



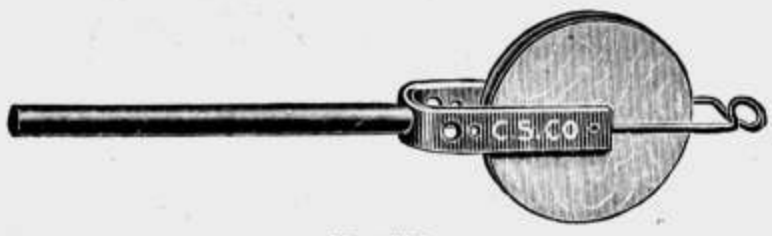
No. 736.



No. 736 in combination.

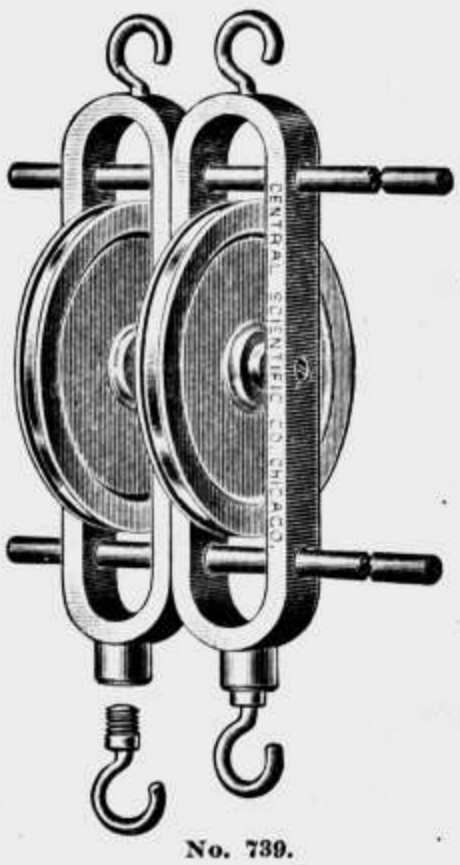
736. **Pulley,** freely running, of hardwood, 2-inch diameter, accurately centered and balanced. The bearings are steel cones, greatly reducing friction. When used in combination, as shown above, the pulleys are held together by two closely fitting steel rods.
Each, 50c; per dozen..... $ 5 50

737. **Rods of Steel,** for combining two, three or four pulleys. Per pair.... 10



No. 738.

738. **Pulley,** of hardwood, with 5/16-inch rod, same construction as No. 736. $ 65



No. 739.

739. **Pulley,** special design after Prof. Harry Chase of Tuft's College. Consists of a brass pulley, lathe turned, 2½ inches diameter, with a square groove for convenience in accurate measurement of diameter. Mounted on hardened steel cone bearings, fitted with inside lock nut, in a heavy brass frame which is provided with two hooks, one of which may be unscrewed and rods 10 m. m. diameter (as listed under No. 20) attached. This permits its use with a clamp in connection with laboratory system of supports. Different combinations may be arranged, as illustrated, by use of a pair of steel rods listed below. This pulley runs so true and free from friction that gyroscopic effects are felt if wheel is rapidly rotated..... 2 25

739A. **Steel Rod,** for use with No. 739 Pulley in making combinations..... 11

Weights for use with pulleys listed on pages 270-271.

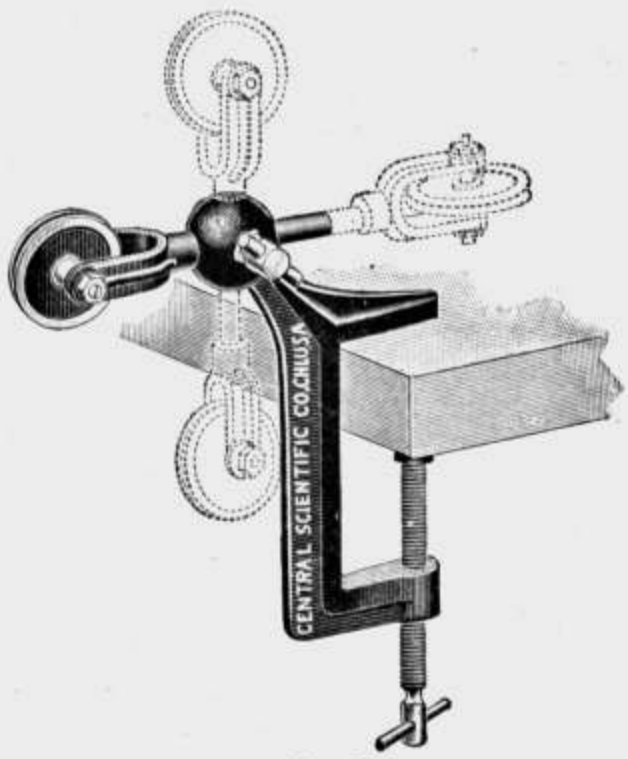
See also No. 750 Weights, page 59.



No. 740.



No. 741.



No. 745.

740. **Pulley, Tackle Block** of wood, commercial type, iron strapped and bushed with steel pin.

	3 inch	4 inch
A. Single Pulley	.40	.50
B. Double Pulley	.75	.90
C. Triple Pulley	1.00	1.25

741. **Pulley, Differential,** one-quarter ton capacity, regular hoist 6 feet, minimum distance between blocks 17 inches. Chain pull of 72 pounds through 18 feet. Commercial type. Net weight, 22 pounds. Complete with chain 18 00

745. **Pulley, Universal,** of brass, 45 m. m. in diameter, mounted on hardened steel cones provided with nuts for locking, thereby reducing friction to a minimum. The ball holding the pulley is drilled and tapped so as to firmly clamp the pulley in any conceivable position. The clamp, which is rigid and neatly finished, has an opening of 6 c. m., enabling it to be clamped to any laboratory table. The pulley being mounted on a detachable stem, is adapted for use with the system of Laboratory Supports 1 65

46. **Pulley,** same as the pulley of No. 745, mounted on 10 m. m. rod, for use with system of Laboratory Supports (see cut, page 4) 90

770. **Pulley,** of brass, 35 m. m. in diameter, mounted on hardened steel cones with lock nuts in frame for attaching to board. (See illustration, page 62) 75

746. **Pure Manila Rope,** best quality, for use with No. 740 and No. 741.

Diameter	⅜ inch	½ inch
Per foot	.05	.05

N. B.—12 feet smallest quantity sold.

747. **Cord,** for use with pulleys and levers, extra fine quality of twisted flax, large balls weighing ½ pound each 55

748. **Fish Line,** braided linen, best quality, 25 yards on card 22

749. **Fish Line,** braided silk, 25 yards on card 40

750. **Weight Hanger,** of brass, for pulley experiments. Capacity, 1,000 grams. Total weight of hanger, 50 grams. Each 50

751. **Pulley Weights,** of brass, accurately adjusted. With slot to fit No. 750 hanger.

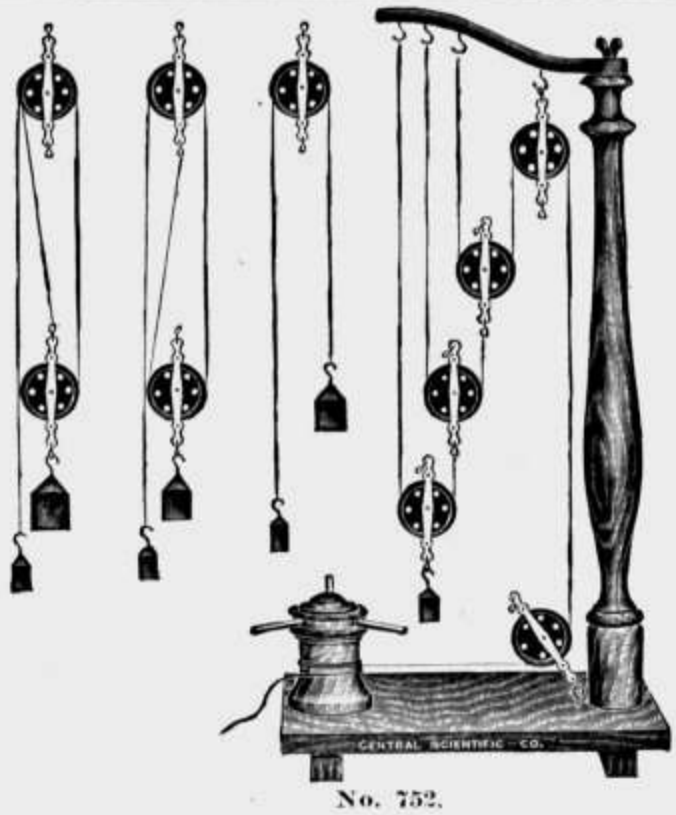
Weight, grams	10	20	50	100	200	500
Each	.30	.35	.40	.50	.60	.90

Weights with Hooks, see page 271.



Nos. 750—751.





No. 752.

752. **Illustration of Pulleys,** base and pillar of hardwood, with screw and nut to hold the iron arms for supporting the different systems, including:

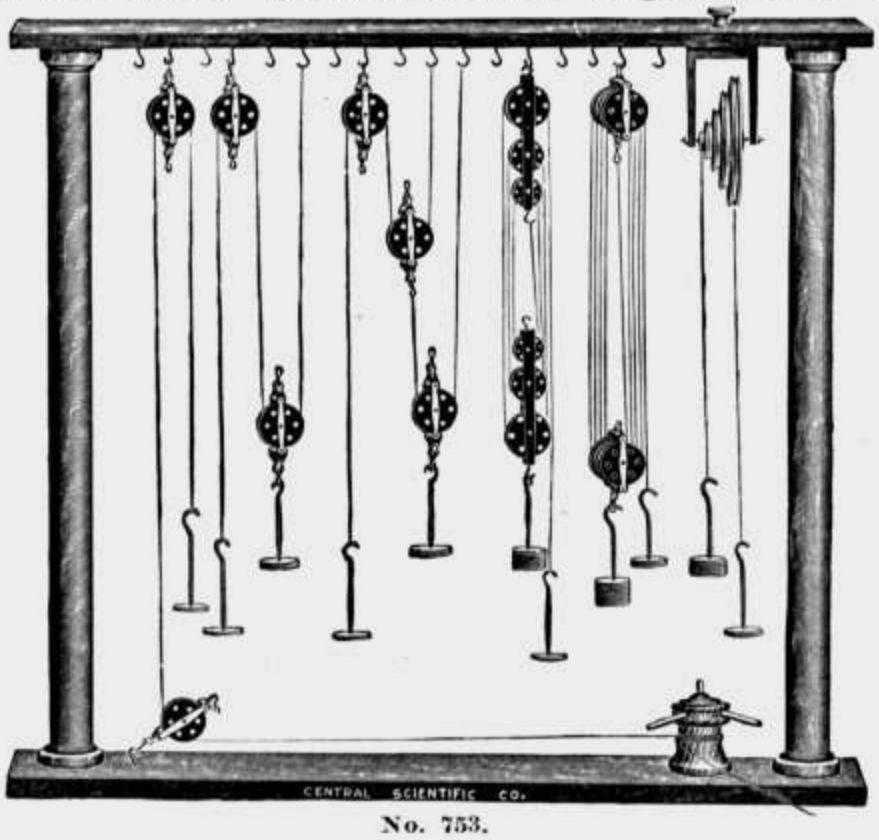
A. Fixed pulleys, power and weight equal.

B. Fixed and movable pulleys, power and weight equal as 1 to 2.

C. Double fixed and movable pulleys, power and weight as 1 to 4.

D. Wheel and Axle with four diameters and cords.

E. Capstan and Levers. Complete set with weights..... 8.00



No. 753.

753. **Illustration of Pulleys,** finely polished hardwood frame, three feet high, easy running pulleys with silk cords, brass weights, etc. Showing the following combinations:

A. Fixed pulleys, power and weight equal.

B. Fixed and movable pulleys, power and weight as 1 to 2.

C. Fixed and two movable pulleys, power and weight as 1 to 2 and 2 to 4.

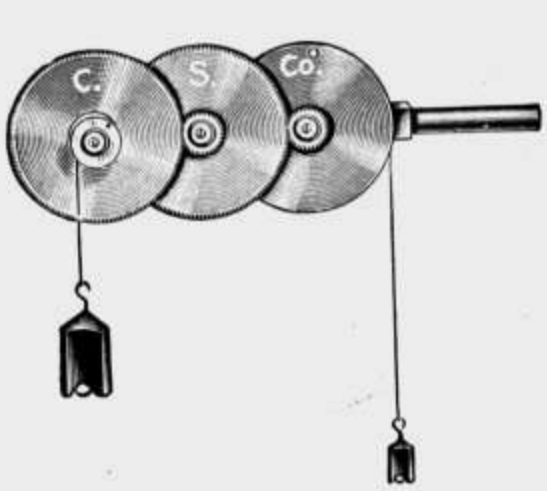
D. Fixed and movable triple tandem pulleys, power and weight as 1 to 6.

E. Fixed and movable quadruple pulleys, power and weight as 1 to 8.

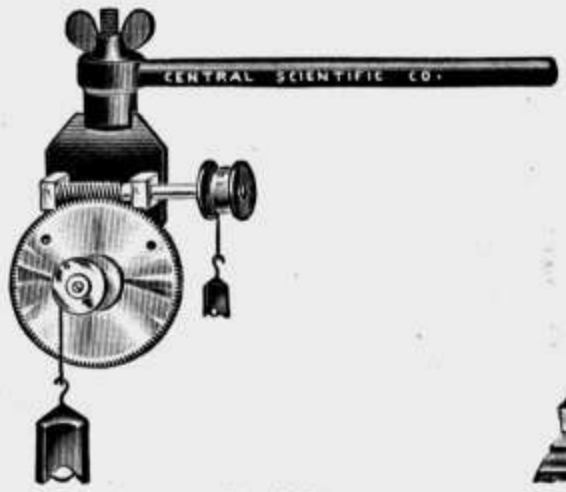
F. Wheel and Axle with four diameters.

G. Capstan and Levers.

Frame furnished with lug and screw cap for holding arms, etc., for pendulum experiments. Complete set..... 20 00



No. 757.



No. 759.



No. 761.

757. **Geared Wheels.** A train of gears consisting of two wheels with pinions one-fourth the diameter of the wheels and a third wheel with drum of the same ratio, giving a mechanical advantage of the ratio as one to sixty-four. Mounted on a rod to be held with a clamp, without weights ..... $ 4 50

759. **Endless Screw,** model of brass, finely finished, without weights, mounted on a rod to be held with a clamp..... 6 65

761. **Screw,** mounted in frame..... 1 65

765. **Jack Screw.** A perfect model, capable of raising 1,000 pounds or more. Diameter at base, 1¼ inches, with a range from 2½ to 3⅝ inches. An auxiliary pointed screw is supplied, to be used in place of the screw with swivel cap in places where it may be preferable. Complete, as shown in cut $ 1 10

765B. **Extension Base,** to fit above, 2 inches high 30

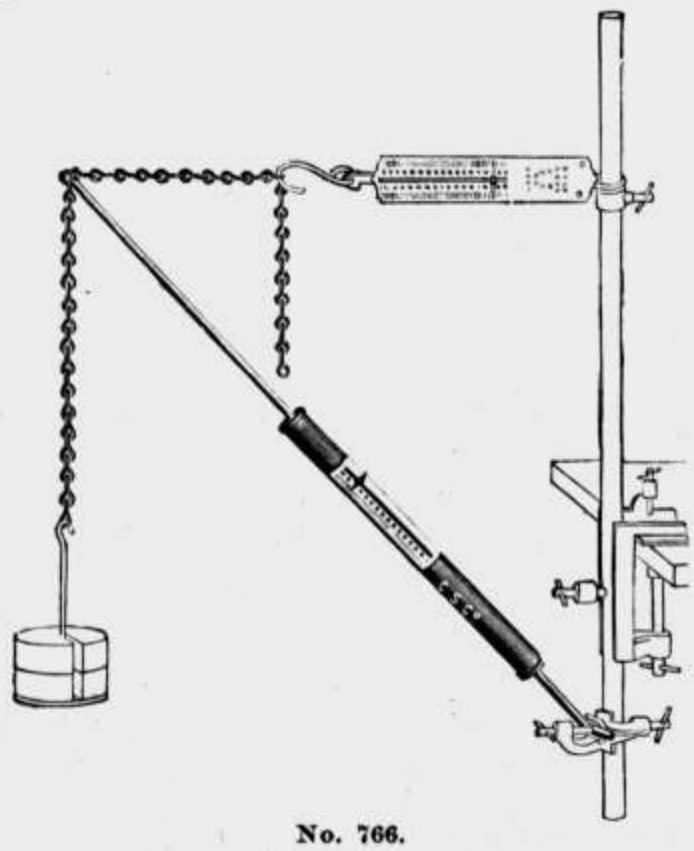
765C. **Extension Base** to fit above, 1 inch high 20



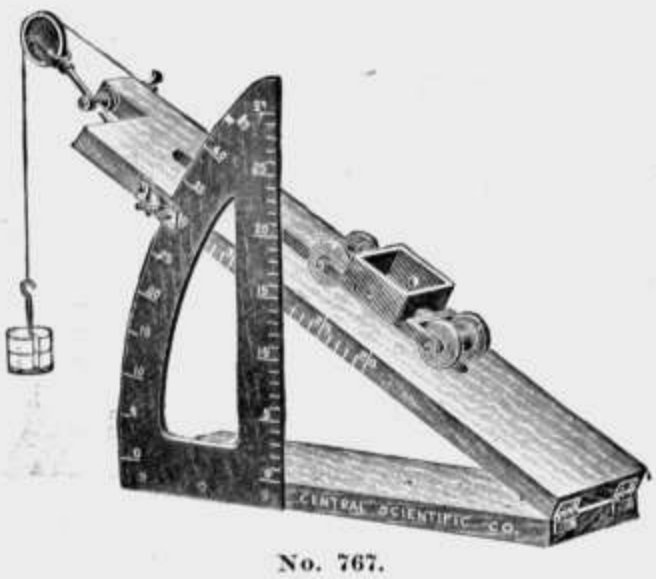
No. 765.

766. **Crane Boom,** for use in observing crane stresses and determining laws of Parallelogram of Forces. The illustration shows a further application of our system of rods and clamps listed on pages 1 to 5, the following numbers being used: No. 27 Table Clamp, No. 22 Support Rod, 100 c. m., No. 39 Right Angle Clamp, and No. 30 Collar. In addition to the Crane Boom, No. 3873 Spring Balance, No. 3062 Weight Hanger and No. 3063 Weights will be needed.

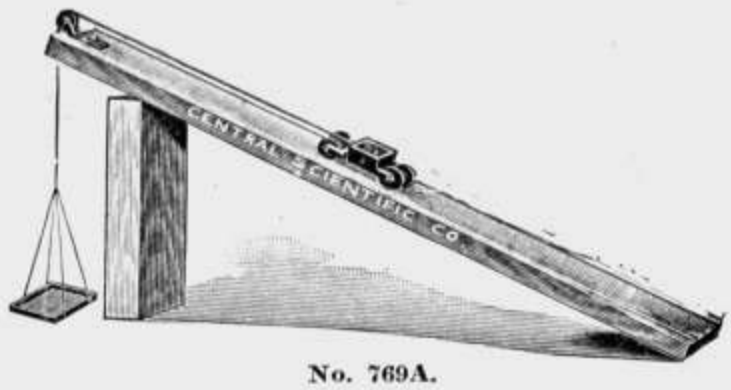
The Crane Boom consists of Compression Spring Balance registering from 0 to 10 kilos in 1-10th divisions with bent rod at one end and rod with hook at other end. It makes a valuable addition to any equipment in study of mechanics. Crane Boom only, with chain..... 7 50



No. 766.

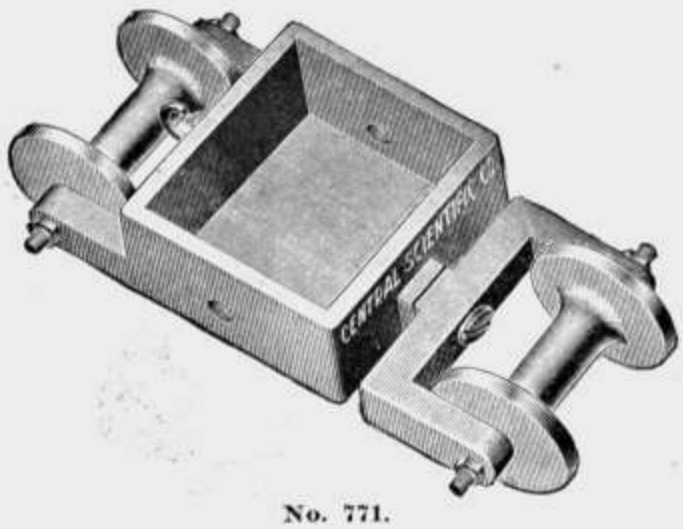


No. 767.



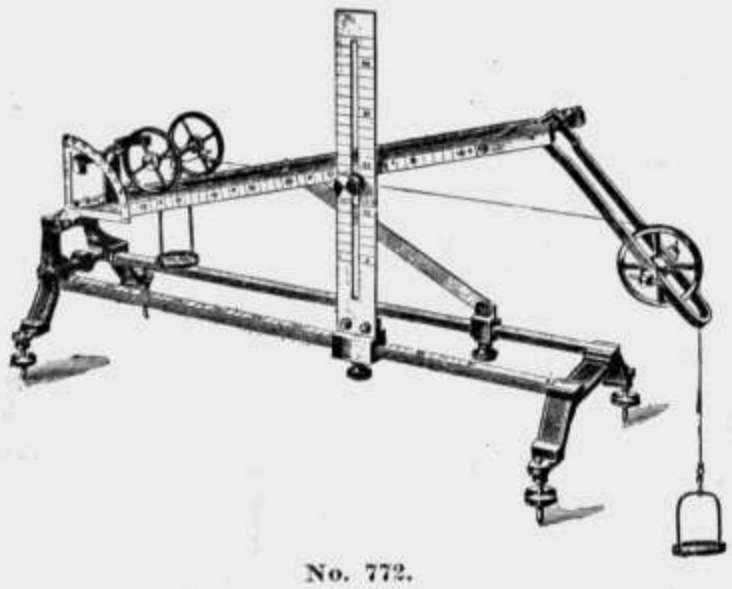
No. 769A.

767. **Inclined Plane,** of hardwood, finely finished, with graduated arc and freely running adjustable pulley..... $ 4 15
769. **Board for Inclined Plane,** of hardwood, smooth surface, length four feet 75
769A. **Board,** No. 769, with No. 770 Pulley..... 1 50
770. **Pulley** for No. 769A, of brass, 35 m. m. in diameter, mounted on hardened steel cones with lock nuts, in frame for attaching to No. 769 or any other board..... 75



No. 771.

771. **Hall's Carriage,** improved form. Made entirely of metal. Each pair of wheels with their axles are of one piece, being lathe turned from solid steel 1½ inches in diameter and are held to truck in cone bearings, thus reducing friction to a minimum. One of the trucks is so mounted that the four wheels will always bear on the plane..... 1 10



No. 772.

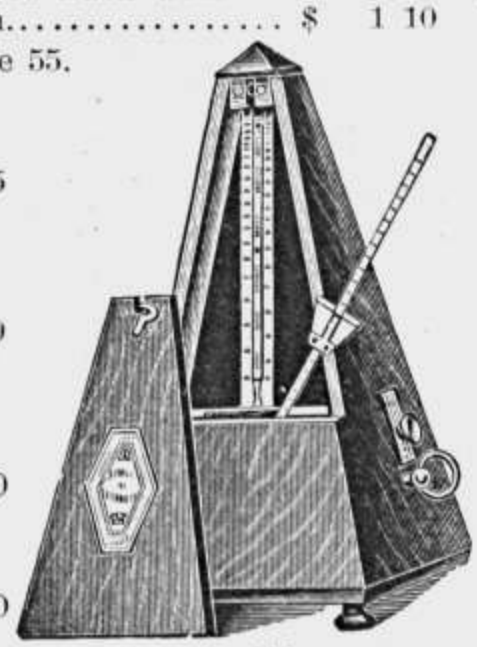
772. **Inclined Plane.** This Plane is made entirely of metal and of the finest workmanship. Length, height and incline are graduated. Wheels of car and the pulley wheel are carefully adjusted so as to be as free from friction as possible. Pulley may be adjusted to any position in the one plane.....Duty free 34 00
722A. **Inclined Plane,** same as No. 772, without incline scale.....Duty free 30 00



No. 773.

773. **Pendulum Clamp.** Can be clamped to any vertical or horizontal support rod. Upon the arm are three removable clamps, each consisting of a flat brass plate with guide pin and held (by means of a thumb screw) against the plain face of the arm and flush with its lower edge. This gives exact points of suspension..... $ 1 10

N. B.—**Balls** for pendulum experiments listed on page 55.



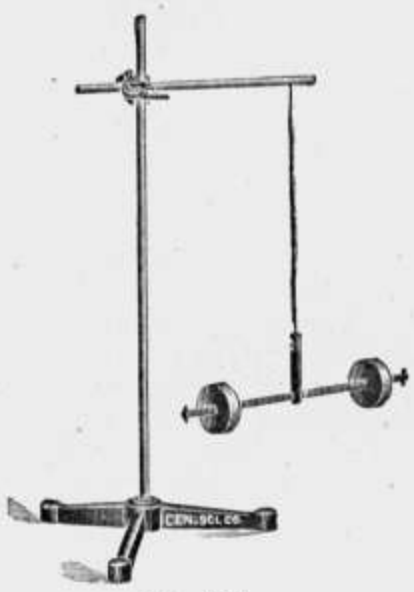
No. 775.

775. **Metronome,** for counting seconds and fractional parts of a second, etc. Best French make, in fine mahogany case..... 3 85

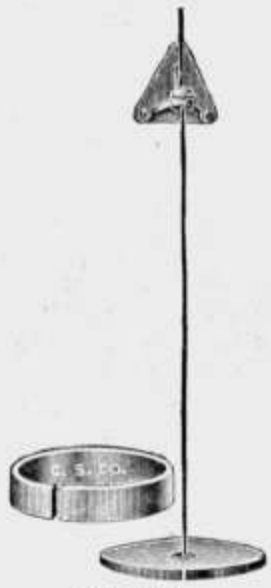
776. **Metronome,** same as No. 775, with adjustable bell attachment, striking every beat, every second beat, or every fourth beat, as desired 5 50

777. **Metronome,** after Kronecker. No. 775 Metronome fitted with mercury cups and binding posts for tracing time on revolving drum in connection with a "Time Marker"..... 11 00

778. **Time Marker,** single, after Pfiel, with stylus and aluminum holder, for use with No. 777 Metronome 11 00



No. 780.



No. 781.



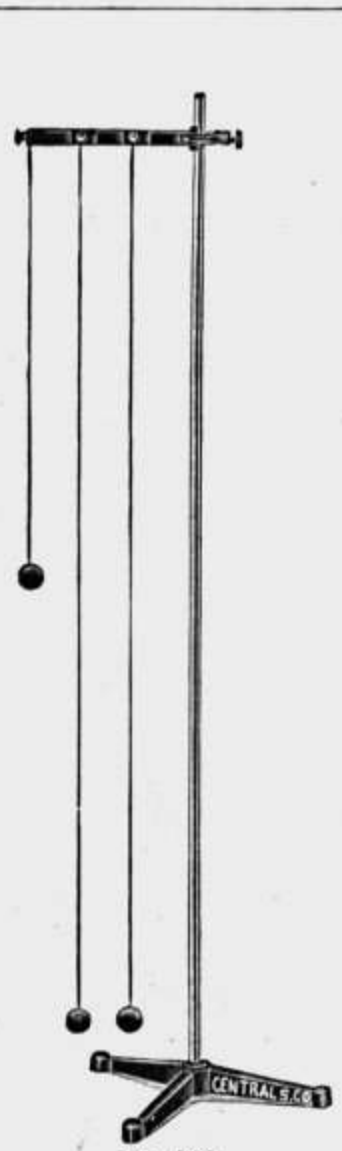
No. 782.

780. **Torsion Pendulum,** to study Rotational Inertia. Consists of tripod support with clamp and rod, to which is fastened a steel wire carrying two adjustable weights..... 3 00

781. **Torsion Pendulum,** for determining the Moment of Torsion. Consists of a metal disc 300 m. m. in diameter and 12 m. m. thick, suspended from a suitable wall bracket. A slotted brass ring of the same diameter and weight is supplied for an additional known Moment of Inertia. Complete with one rod..... 15 00

781A. **Torsion Pendulum,** simple form, a flat disc with pointer and graduated circle, with support..... 3 50

782. **Sand Pendulum.** Two adjustable cords have as a common pendulum bob a weighted funnel carrying fine sand. As the funnel swings it is acted upon by the two forces of the combined cords and leaves a path of sand which is the resultant of the two harmonic motions. Without support 90



No. 783.



No. 785.



No. 786.



No. 791.

783. **Pendulum Illustration.** Apparatus complete for Pendulum experiments. Consists of a heavy tripod base, nickel plated rod, No. 773 pendulum clamp, with set of three balls..... $ 3 30

784. **Compensated Pendulum.** Consists of five alternate bars of brass and steel, mounted on neat wall bracket..... 10 00

785. **Kater's Pendulum** for determining the value of "g." A laboratory instrument of accurate construction. The bar is made of steel, white plated, and knife edges are at fixed distances and so fitted with adjustments as to make them parallel. The weights are of lacquered brass and adjustable along the bar. The wall support is of iron, japanned black, with necessary fittings for easy adjustments. The ends of the pendulum bar are provided with detachable platinum points for mercury contacts..... 24 00

785A. **Kater's Pendulum,** same as No. 785, with slow motion screw for fine adjustments of the small weight..... 30 00

785B. **Adjustable Mercury Contact,** to be used in connection with Nos. 785 and 785A 6 00

786. **Kater's Bar Pendulum,** to find length of equivalent second's pendulum and the value of "g." New and practical design. This is a very serviceable pendulum for student use in laboratory experiments. It is unbreakable, portable and accurate. A screw driver makes all necessary adjustments. Made of steel, 24x1x1 inches, with two hardened steel knife edges, coincidence mirror, wall support and complete directions 4 50

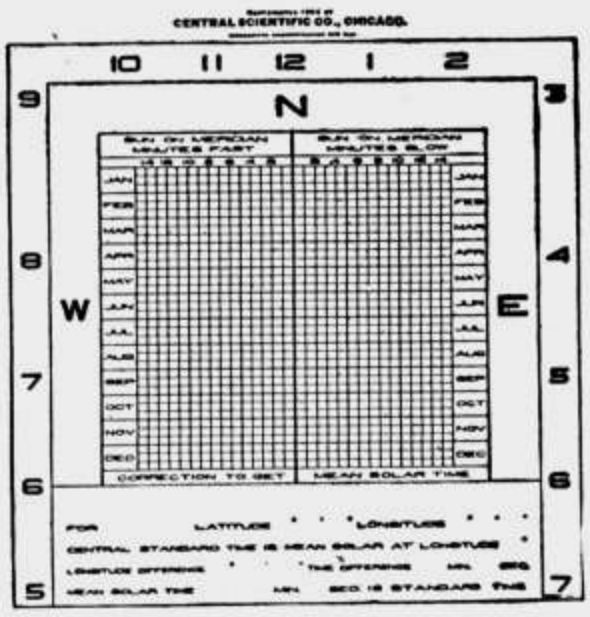
791. **Seconds Pendulum, an** inexpensive instrument to take the place of a more expensive clock for simple experiments. Consists of a lens shaped iron bob six inches in diameter supported at the upper end by a strip of thin steel. The apparatus is mounted on a polished oak board and provided with an improved, adjustable mercury well which exudes a thin knife edge of mercury, giving a sharp contact. Bob is furnished with an adjustable contact tip. Board is provided with binding posts for attaching battery and sounder..... 6 00

Ballistic Pendulum, see No. 701.

Balls for pendulum work listed on page 55.



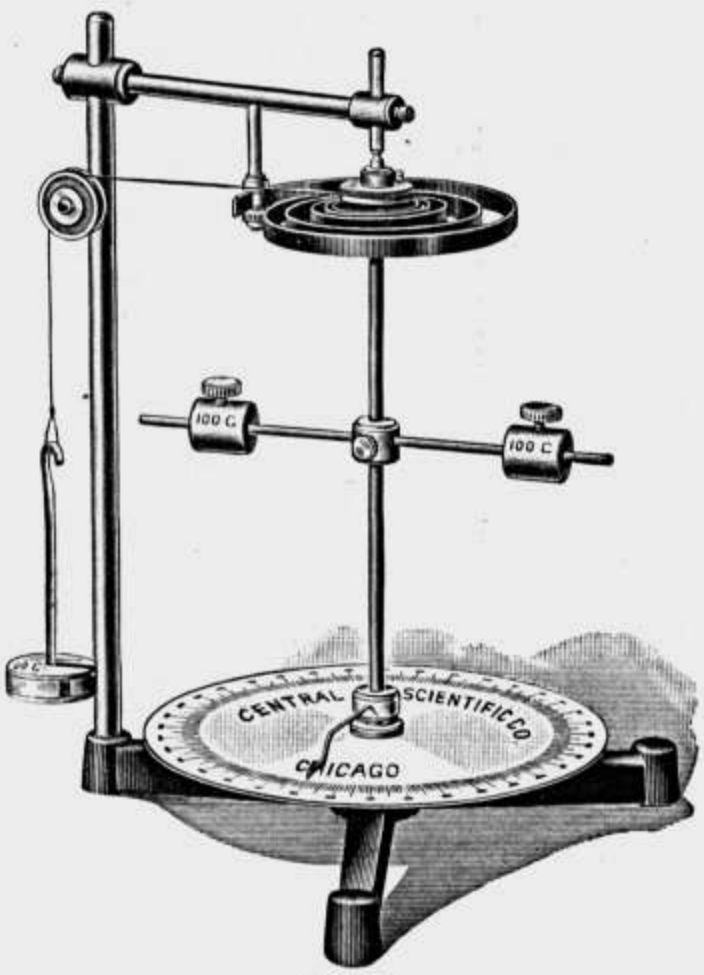
No. 792.



No. 793.

792. **Universal Sun Dial.** The Dial is over 10 inches in diameter, is of substantial construction and can be exposed continuously to the weather. The new feature consists of a spirit level indicating on a graduated circle the correct setting for any latitude, so that the instrument can be used in any locality. We supply with each instrument a correction curve which reads directly the variation between sun time and mean solar (clock) time for every day in the year. With complete instructions..... $ 5 50

793. **Sun Dial, Student Demonstration Form..** This Sun Dial is prepared in a convenient form, on which the student can lay off the hour angles and obtain the relation between sun time, mean solar time and standard time, experiments which hitherto have seldom been attempted. All the necessary data can be obtained from a school geography or almanac. Printed on 8x8 litho board with full instructions for making style, etc. With every order of a dozen or more a copy of a sun dial, worked out for Chicago (for the instructor's use) is included. Per dozen.... 2 00



No. 794.

794. **Harmonic Motion Apparatus** (Ames and Bliss). Consists of a flat coiled spring in a horizontal plane, one end fastened to a fixed support, the other to a vertical axis which rotates freely on ball bearings and to which is attached a horizontal rod carrying sliding weights. Oscillations of the spiral spring may be observed on a divided circle at the base of the instrument. Complete with weights, pulleys and cord..... 18 00

795. **Laboratory Clock.** This is the best clock we can furnish, adaptable to the needs of the average laboratory.

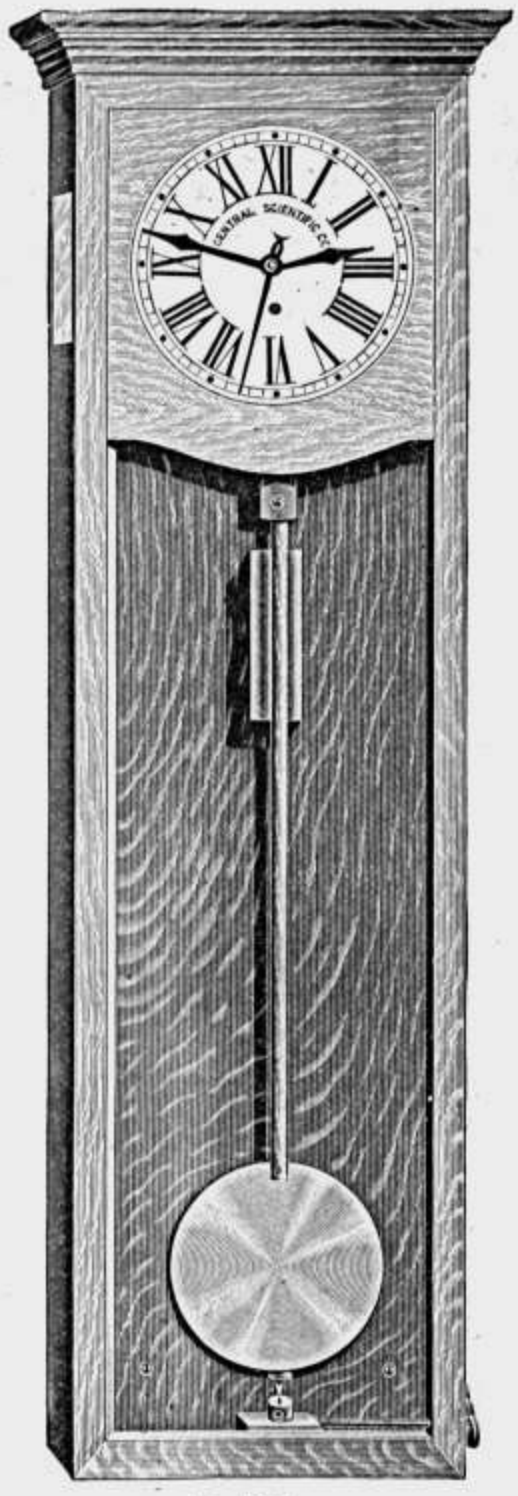
It is a standard make, eight-day movement, weight-driven clock, designed and made for us, and we guarantee it to be a reliable timekeeper.

The dial is 12 inches in diameter with seconds divisions. It is provided with hour and minute hands and a full sweep seconds hand for timing laboratory experiments.

The pendulum is of brass, full seconds length, and provided with an adjustable platinum contact.

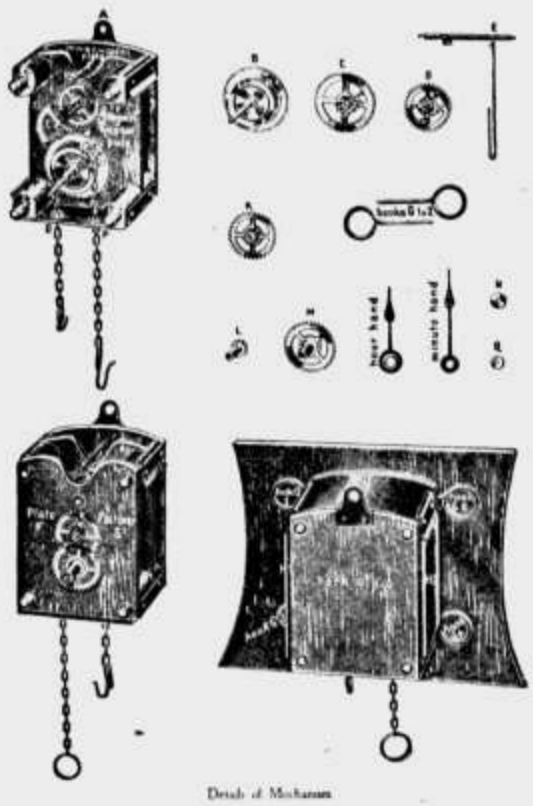
The mercury well is of the latest improved construction, and placed exactly in center of the arc of the pendulum swing. Regulating device for adjusting the height of the mercury in the well is operated from the outside of the clock case. By means of the construction of the mercury well, a thin strip of mercury is exposed, a great improvement, as it provides for a quick, yet sure contact, and with proper adjustment of the sounder, a sharp, clean click can be obtained.

The clock is completely enclosed in a polished oak case, with glass front, glass covered opening in sides, and binding posts on the outside for attaching battery and sounder ..... $ 53.00



No. 795.

SWISS CLOCK.



No. 797 Parts.



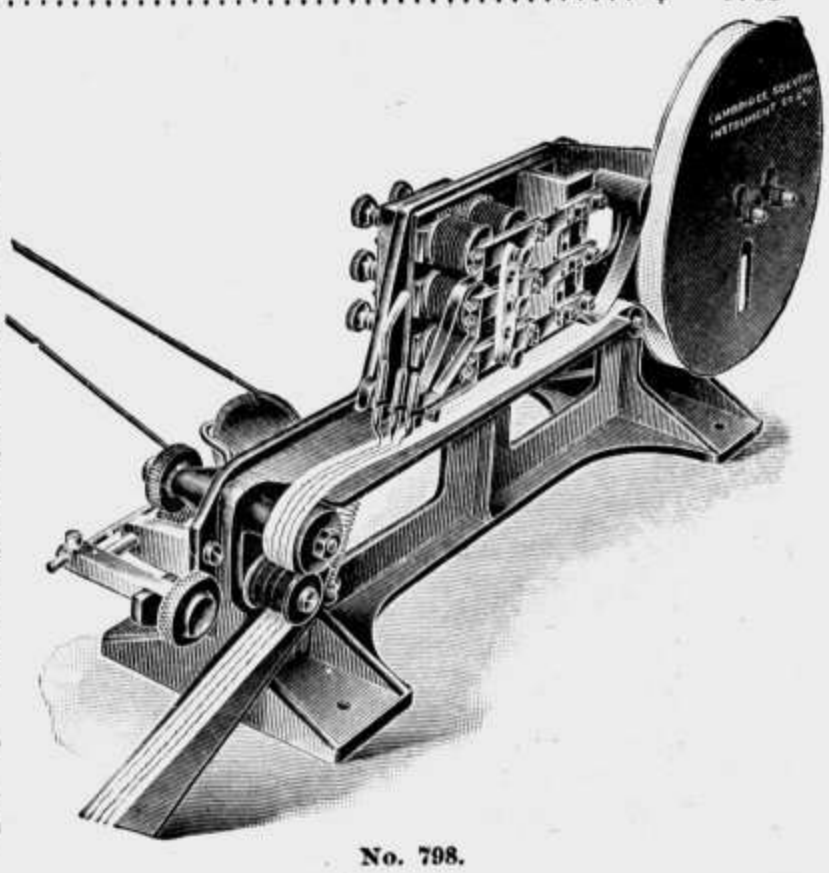
No. 797.

797. **Dissected Clock,** for studying the mechanics of a weight-driven clock. This is a most ingenious and remarkable device, which the student can put together in a few minutes without the use of tools. A complete clock which will keep good time and requires no mechanical skill to assemble.

The works are mounted on a card and are suitably designated by numbers or letters. The weight, pendulum and wooden case are separate. The whole is packed in a neat box, accompanied by full and simple directions. The parts are so exactly and perfectly adjusted that each fits precisely into its proper place. No screws are required, no tools are necessary—the fingers are the only tools needed. The parts are strongly and substantially made and suffer no injury from ordinary handling..... $ 1.65

798. **Chronograph,** for accurate and continuous record of time in laboratory operations. A strip of Morse paper 12.5 m. m. wide is drawn by means of a motor under three pens attached to the armatures of electro magnets. One of these electro magnets may be connected to a clock, tuning fork or time marker recording constant time; the other two being used for recording events under observation. The movement of the paper can be started or stopped while motor is running. Without motor.....
.....Duty free 120 00

798A **Extra Reels Morse Paper,** for No. 798..... 90



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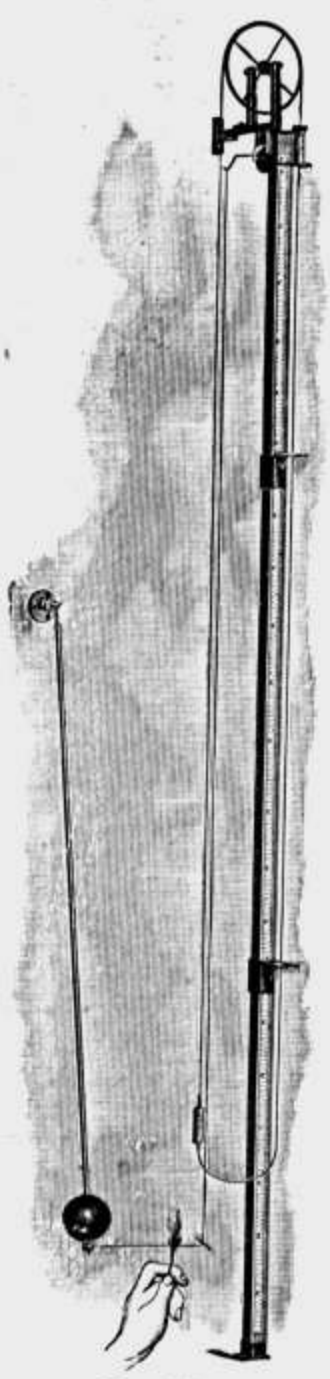
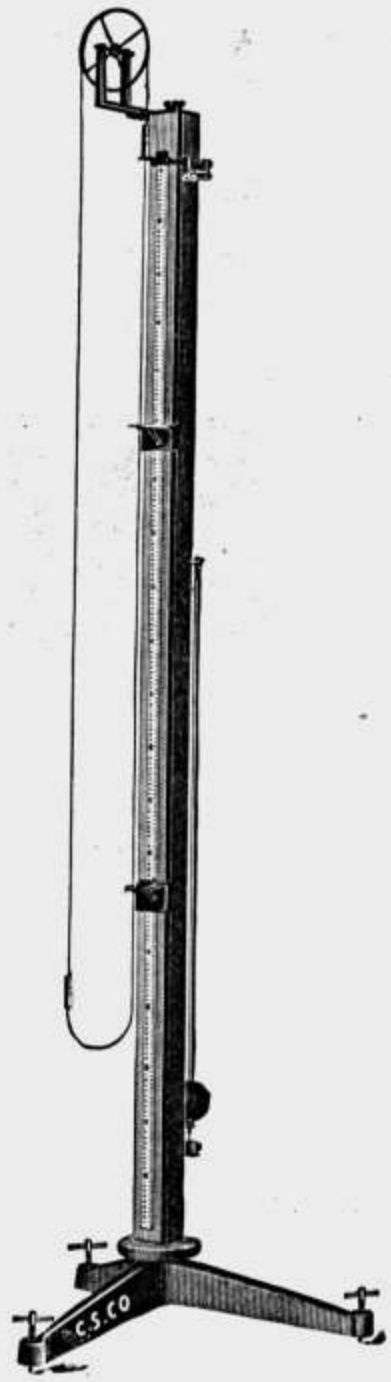


No. 801.



No. 803.

801. **Atwood's Machine,** for the determination of the laws of falling bodies. Simple form, consisting of a japanned iron frame to be attached to the wall, on which is mounted a delicately balanced, cone-bearing brass wheel with adjustment screws; a drop table with detent, sprung by a cord, a hardwood rod 180 c. m. in length, graduated in centimeters, with attachment to the frame and a socket for the lower end to be screwed to the floor, a sliding ring and stop plate; cylindrical compound weight and two impulse riders; a full seconds pendulum with knife edge, to be attached to the wall, complete with directions..... $ 10 50

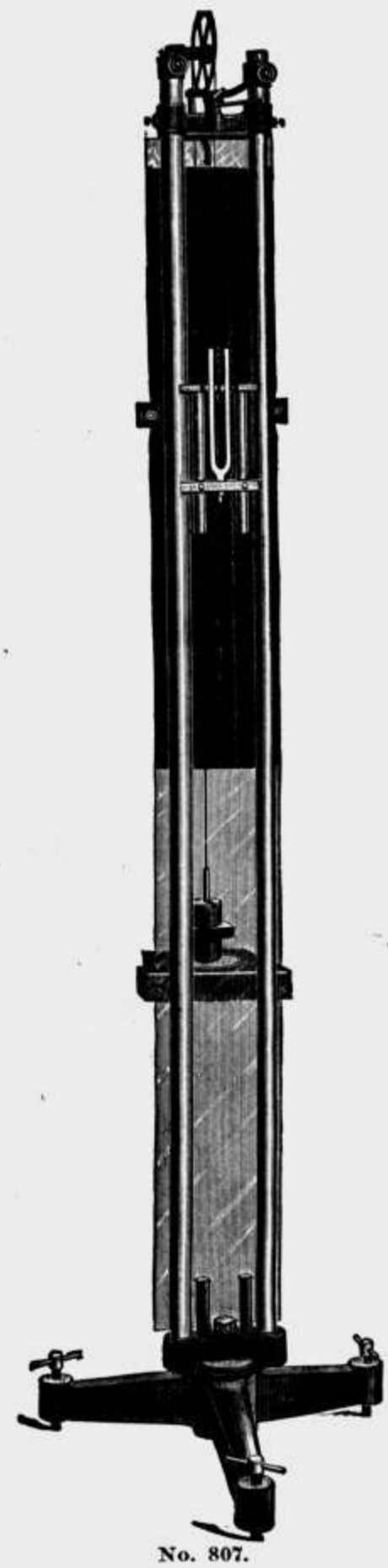
803. **Atwood's Machine,** improved form on heavy japanned iron tripod base with brass leveling screws, polished hardwood pillar with metric graduations, sliding platforms and set screws, large brass wheel delicately balanced on steel pivots, full seconds pendulum with new improved mercury well and automatic drop table which falls the instant the pendulum touches the contact point. The electro magnet clicks at the same instant and with each subsequent stroke of the pendulum, so marking the time. Balance and impulse weights of brass with silk cord and directions..... 25.00

807. **Acceleration Apparatus.** This instrument is used to verify the laws governing acceleration of falling bodies.

The falling piece is very freely guided between two highly polished and nickel plated steel rods, and carries a tuning fork of known rate of vibration. The prongs of the fork are spread slightly apart by means of an eccentric on top of the frame. This eccentric can be drawn up in the frame by turning a lever, and thus the fork is released and set in vibration. A light metal stylus attached to one of the prongs records the vibrations on the smoked glass plate while the fork is falling. The heavy glass plate is held parallel to the rods, and can easily be shifted sidewise, so that a number of curves can be traced with one smoking of the plate. Two dash pots at the base of the instrument catch the falling piece and take up the jar. For measuring the curves on the plate, the same is taken from the frame and laid on a table, and the measurements are made with a pair of dividers, or by directly applying a scale. In using the apparatus as an Atwood machine, a light aluminum wheel is attached to the top of the frame. This wheel runs very free of friction in light ball bearings. The falling piece is attached to a cord passing over this wheel and holding on its other end the counterbalance weight. The counterbalance weights can be picked up from adjustable platforms attached to the back of the glass plate, and are so adjusted that when all weights are in use the falling piece will be exactly counterbalanced and drop without acceleration.

The apparatus stands one and one-half meters high. It is mounted on a heavy tripod with leveling screws, and is provided with a plumb bob for the easy vertical adjustment of the rods. The cut shows the lower part of the smoked glass removed in order that the platforms on the back may be seen.

We have furnished this apparatus to many leading universities and colleges, and have received very satisfactory testimonials in regard to the same. The value of "G" has been obtained with an accuracy of from 1 to 1½ per cent, which error is due to the friction in the rods.



No. 807.

A circular giving information as to setting up and adjusting the apparatus, as well as suggestions as to the experiments for which it is adapted, and methods of smoking the glass and measuring the vibrations, will be sent with the apparatus.

Complete with Atwood attachment as shown in cut..... $ 45.00

809. **Acceleration Apparatus,** same as No. 807, without Atwood attachment 30.00

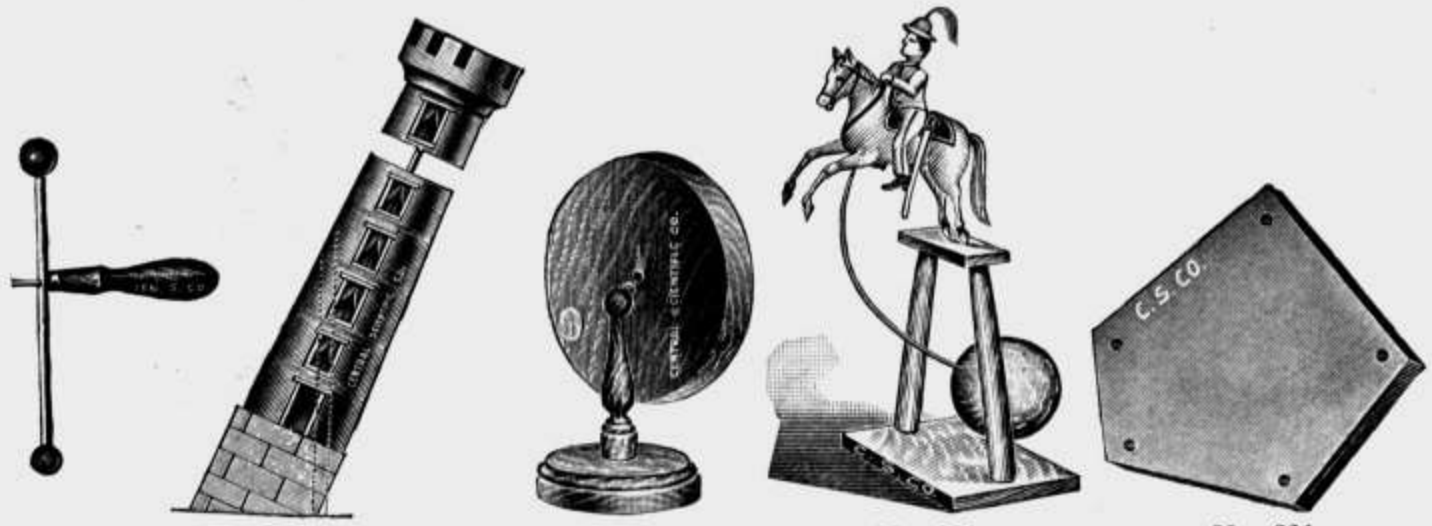
811. **Glass Plate** for above, when ordered separately..... 3.00



No. 814. No. 813.

813. **Falling Body Apparatus (Inclined plane),** according to "Millikan and Gale" for determination of the distance traversed by a body under force of gravity in one, two, three or four seconds with uniformly accelerated motion. Consists of a straight-grained wooden track 16 feet long, which, when inclined, furnishes a slope down which a steel ball may roll. Distances traversed are easily determined by means of a time marker (a Metronome or a Seconds Pendulum) and a block stop. Complete with directions..... $ 5.50

814. **Falling Body Apparatus (Inclined plane),** to be used in connection with No. 813, for measuring velocity acquired per second by a body under force of gravity in uniformly accelerated motion. Consists of a straight-grained wooden track 8 feet long to be placed at a slight inclination (to eliminate friction) at the bottom of the incline No. 813. This frees the rolling ball from force of gravity, and it will move along at the velocity it had at the end of the incline. Full directions for use in connection with No. 813..... 2 50



No. 816. No. 817 No. 818. No. 820. No. 821.

815. **Center of Gravity Apparatus.** Complete set, comprising Nos. 816-821.. $ 4 50

816. **Two Balls of** unequal weight, balanced on handle, showing center of gravity in the system..... .90

817. **Leaning Tower,** in explanation of the leaning tower of Pisa. Shows stability when the center of mass is within the base of tower. With movable top 1.25

818. **Loaded Wheel** with center of gravity marked. Provided with support 1.05

819. **Witch,** cylinder of pith attached to a hemisphere of lead. Very interesting and instructive..... .11

820. **Horse and Rider,** horse seemingly stands on his hind legs in the position as shown in the illustration. Heavy ball changes center of mass so that it is under the point of support of the horse..... 1.00

383. **Plumb Bob** (see page 32)..... .13

821. **Center of Gravity Block,** new form, more positions possible than with old form. Provided with handle and pin..... .33



No. 822.

822. **Gravity Bar** according to "Ames and Bliss," to verify the law of equilibrium. Consists of a heavy brass tube 101 c. m. long by 22 c. m. in diameter, with three adjustable heavy metal bobs, which may be clamped to the tube, with complete directions..... $ 8.00

822A **Gravity Bar** to determine experimentally the center of gravity of a weighted bar. Same as above, but graduated in millimeters the whole of its length..... 12.00



No. 823.



No. 825.

823. **Double Cone and Plane,** cone appears to roll up the plane, the bars of which diverge so that the axis of the cone actually descends.. 1.10

825. **Metal Arc,** with balls and stand, to illustrate law of center of gravity, and the different states of equilibrium..... 1.25

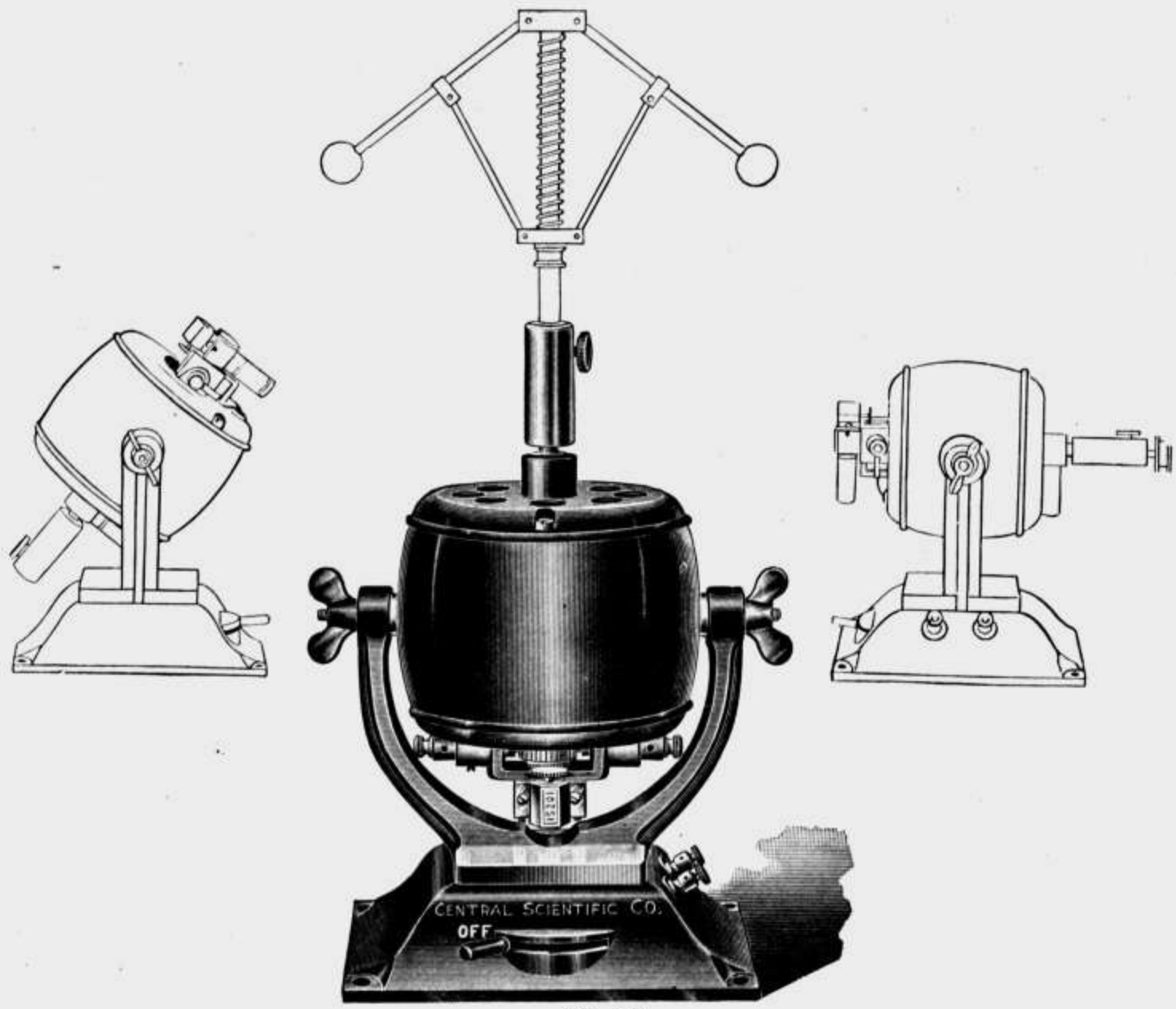
678. **Equilibrium Cone,** listed on page 53..... 1.10



No. 827.

827. **Second Law of Motion Apparatus.** A spring hammer propels one ball and releases the other at the same instant. Both balls reach the floor at the same time, although one reaches it after describing a parabola, while the other drops in a straight line..... 3.30

828. **Second Law of Motion** consists of flexible ash strip, one end of which is fastened securely in a vise and at the other end is attached a right angle head having a notch at each upper end in which are placed small marbles. Apparatus bent to one side and allowed to spring back to position, shoots one marble out horizontally, and at the same instant releases the other ball, which drops in a straight line ..... .50



No. 830.

830. **Motor Rotator.** The Motor Rotator illustrated above is designed to meet the demands of laboratories for an inexpensive, efficient and conveniently operated rotator for demonstration and experimental work. It has the advantage of being small and thus easily portable; as it is well built, it runs true and without noise, and has a high efficiency.

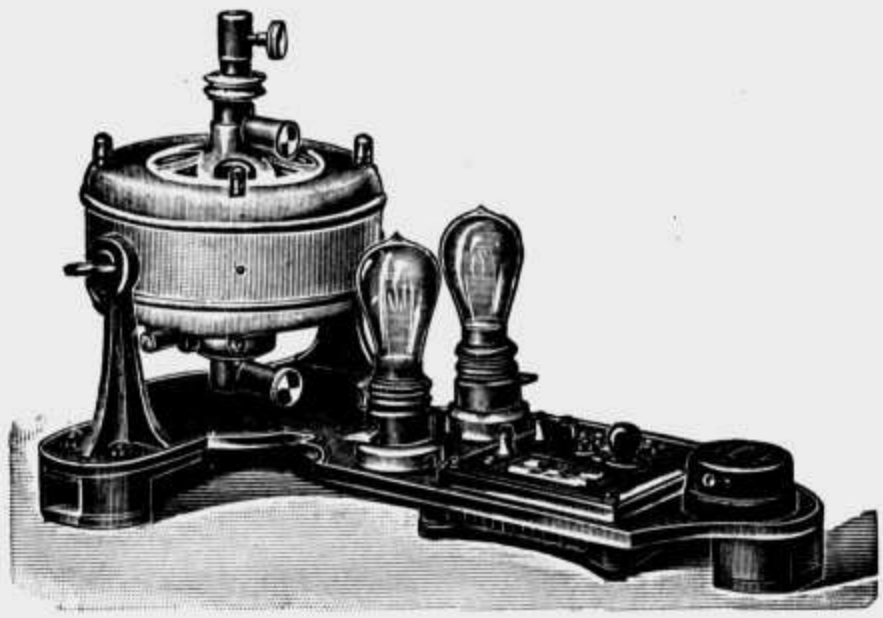
The motor proper is mounted on a trunion so as to give any position of shaft from horizontal to vertical, and can be held rigidly in any such position by tightening the thumb nuts. The bearings are made of hard drawn phosphor bronze and the lubrication is provided by means of self-feeding oil cups which need refilling only once in six months. A speed controller is mounted in the base, giving approximately 200, 800, 1,400 and 2,000 revolutions per minute and is regulated by means of a handle extending out from the base. A speed counter is mounted on the front bearing, registering the revolutions of the shaft.

The dimensions of the motor are: Length of shaft with chucks, 10 inches; base, 6 inches square; height over all (shaft horizontal), 9½ inches (shaft vertical), 13½ inches.

Though this rotator is intended for a portable form, screw holes are provided for the permanent attachment to a table, base board, wall or wherever desired.

The finish and construction of this instrument is of such a quality that it will prove a valuable addition to the laboratory. Finished in black japan with nickle plated trimmings. Provided with socket, set screws and thumb screw for use with any of the rotator accessories listed on pages 74-77. Wound for 6 to 8 volts..... $ 30.00

831. **Motor Rotator,** wound for 110 volts, direct current..... 33.00



No. 832.

832. **Motor Rotator** for main line currents. The apparatus is provided with a starting rheostat, so that it may be connected directly to the lighting circuit. The velocity is regulated by means of this rheostat, and the two incandescent lamps which may be thrown into the circuit. The motor can be clamped in any position, and since it is provided with a pulley, may be used for running other machinery. The R. P. M., depending on the candle power of the lamps and on the rheostat, varies between less than 400 and more than 2,600, speed remaining constant, for the resistance in circuit.

The chuck is the same as on all our rotators and all rotator accessories may be attached.

Wound for 65, 110 or 220 volts direct current. When ordering state exact voltage.....Duty free $ 60.00

833. **Motor Rotator** to be operated by battery currents. (Storage battery recommended.) Similar in design to No. 832, but wound for 16 to 30 volts .....Duty free 60.00

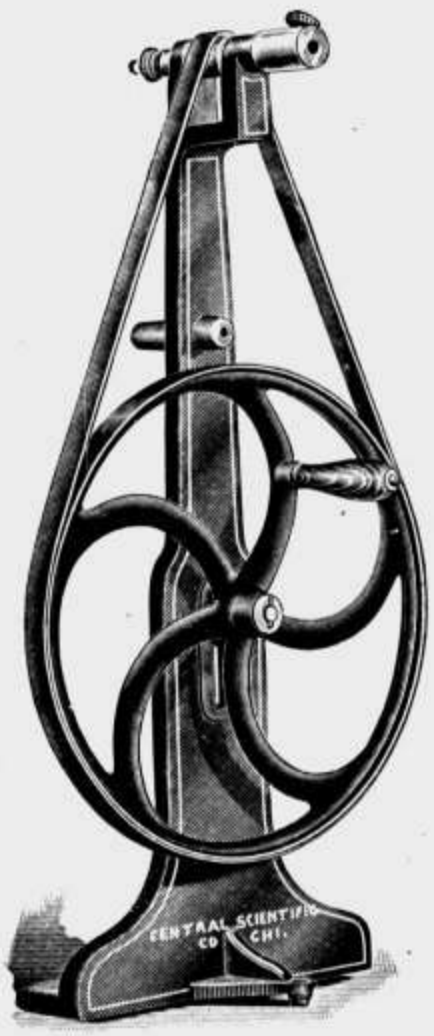
N. B.—No. 832 may be obtained for use on alternating current mains. Specify voltage and number of alternations per second. Prices on application.

834. **Lamps** for use with No. 832 Motor Rotator. Box contains two each of 8, 16 and 32-candlepower lamps and two fuses..... 3.75

837. **Rotator or Whirling Table.** One of the most important pieces of apparatus in the laboratory, constructed entirely of iron and brass in the best and strongest manner; can be used vertically or horizontally as the experiment requires; has a flat belt and tension slide for tightening same. The spindle is of steel with socket and set screw on one end for holding all attachments except discs. This socket is also supplied with a steel chuck, with brass nut and washer having a flat side so that it is impossible for discs to escape while being rotated. The other end of the steel spindle also has a brass nut and flat sided washer for holding discs, the brass nut being further supplied with a hook for "Ring Chain and Cylinder" and other attachments..... $ 6.65

839. **Rotator,** same as No. 837, with addition of improved speed indicator No. 513, operating by means of bevel gears, accurately registering the rate of revolution ..... $ 11 00

145. **Clamp,** 3 inch, for holding rotator to table..... 28



No. 837.

ACCESSORIES FOR ROTATOR.

The following pieces of apparatus are made to fit Rotators Nos. 830, 831, 832, 833, 837, 839 and No. 843 clamp. They cover the entire field of physical demonstration, including mechanics, heat, magnetism, electricity, acoustics and optics.



No. 843.



No. 849.



No. 851.

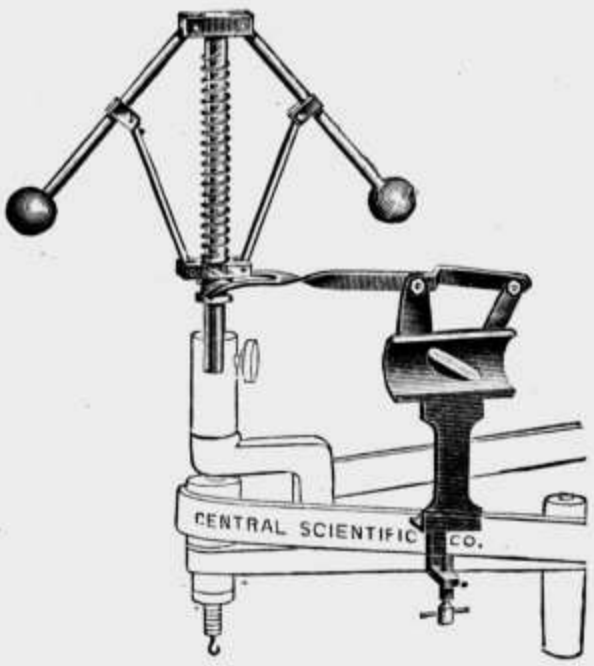
843. **Clamp.** In schools having no rotator it is often desired to illustrate the following experiments. For such we list a table clamp with chuck and brass drum. By use of a cord wound about the drum the different accessories may be rotated by rapidly pulling the cord. This clamp, however, is not recommended for the heavier accessories and is a poor substitute for a rotator..... 2.50

849. **Centrifugal Hoop.** Two brass rings to show the effect of the earth's rotation by the flattening of the poles..... 2.25

851. **Glass Dish,** with three balls of same size but of unequal weight to show the effect of momentum and of specific gravity; the upper edges of dish are inclined inward to prevent escape of balls..... 2 90



No. 859.



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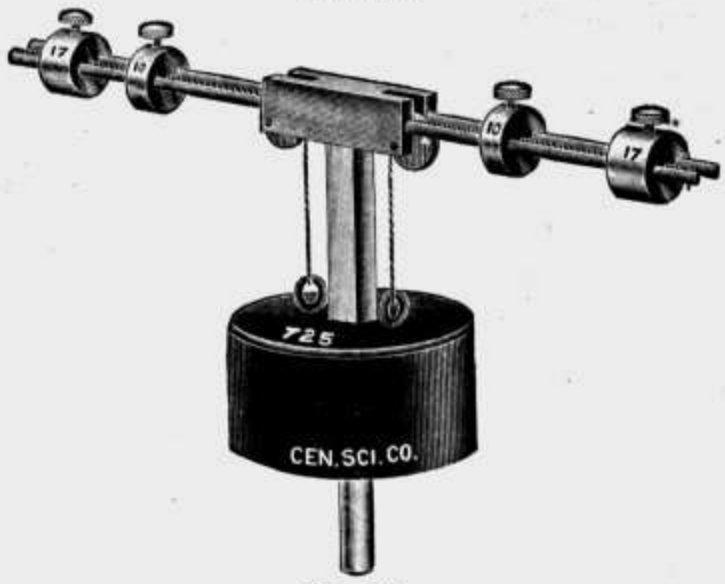


No. 861.

853. **Governor or Watt's Regulator** without valve regulator..... $ 4.15

855. **Governor** with valve regulating gear. As the speed increases it is noted that the valve begins to shut. Essential to explanation of the use of the governor on engine..... 8.50

859. **Centrifugal Force Apparatus,** two balls of unequal weight connected by a cord. Whole mounted on frame..... 2.90

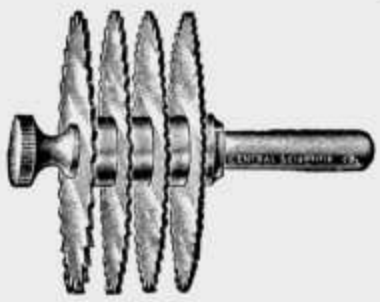
861. **Centrifugal Force Apparatus,** improved form, detachable weights, cone bearing pulleys. The most satisfactory form of apparatus for the determination of centrifugal force yet devised..... 6.00



No. 863.



No. 865.



No. 869.



No. 873.

863. **Centrifugal Separator or Filter,** on rotation, the particles held by the liquid in suspension are thrown to the bottom of the cups..... 3.75

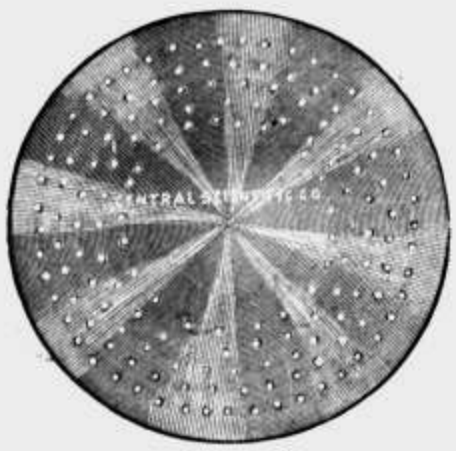
865. **Glass Globe,** for rotating liquids or colored water. When the globe is one-quarter full, on rapid rotation the liquid will rise and show a band at the point of the greatest circumference; when half full and a pith ball inserted, the liquid will fill the globe, and the ball disappear in the lower neck of the globe; when nearly full and corked, it shows an air bubble at center when rapidly rotated.... 2.10

867. **Ring, Chain and Cylinder,** each suspended by silk cords, for showing that the shortest diameter tends to become the axis of rotation. The ring will assume, on rotation, a horizontal position. The cylinder will look like a ball with rays of light stringing from it, and the chain will act like the ring..... 75

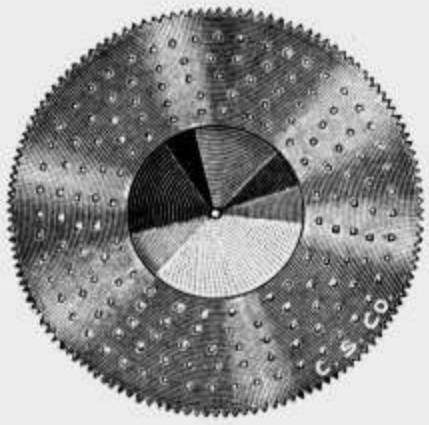
869. **Savart's Toothed Wheel,** consists of four brass wheels on same axle, so that the speed is uniform for each wheel. Will sound the octave when rotated rapidly with a card held to the teeth to cause the impulses..... 3 30

871. **Savart's Toothed Wheel,** a single wheel, 3 inches in diameter. Will sound single note if used as above..... 60

873. **Count Rumford's Experiment,** for boiling ether or alcohol by friction as suggested by Prof. Tyndall. With this apparatus ether or alcohol will in a moment's time boil sufficiently to blow a cork from the tube 2 05



No. 879.



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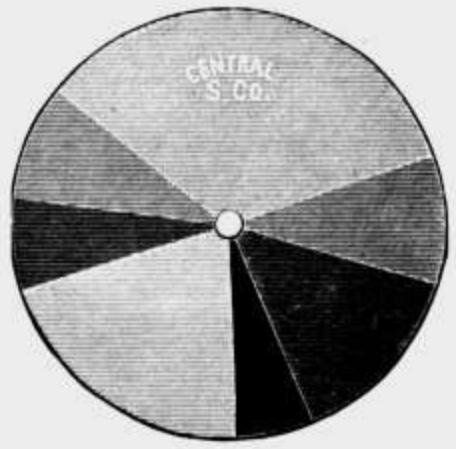


Nos. 885—887.

875. **Crova's Disc,** consists of a thick cardboard 12 inches in diameter, with a series of eccentric circles. When fitted to the rotator and a card with slit (the length of the radius of the disc) is held in front of the rapidly rotated disc it will show the wave effect..... $ 55

877. **Siren Disc,** of metal, one row of holes..... 1 00

879. **Siren Disc,** of metal, with five rows of holes, giving the chord do, me, sol, do. To operate, hold the corner of a card on a row of holes in succession or blow strongly on the holes through a tube with bore slightly smaller than the holes. (See attachment No. 883.) The fifth row of holes is unevenly spaced and does not emit a musical tone, but a "noise"..... 1 65

881. **Combined Acoustic and Color Disc,** combining a Siren, Savart's Wheel and a Newton's Color Disc. The disc is made of heavy metal, which prevents its vibration when being rotated..... 3 00

883. **Attachment,** for use with the Siren Disc for sounding any one or five notes at the same time. Metal air tips, flexible hose and mouthpieces. clamps to rotator..... 2 50

885. **Newton's Color Disc,** made of heavy zinc so as not to warp. The seven primary colors are obtained by using the imported Hering papers (for description see No. 890)..... 1 00

887. **Newton's Color Disc,** of heavy cardboard, covered with same imported papers as on No. 885..... 65

888. **Color Discs,** two sets of eight discs each. Each set has graduated disc for quantitative work in color mixing. Illustrates shading, blending, changing of colors, complimentary, including Maxwell's cut color discs and a variety of others..... 2 25

890. **Hering's Colored Paper Discs.** The colored papers of Prof. Hering are justly celebrated for their purity of color, uniformity and absence of gloss. They were originally produced for experimental work in psychological laboratories, but are especially adapted for all color work in physics. Furnished in discs 20 c. m. in diameter in the following colors: Violet, indigo, blue, green, yellow, orange, red, black and white, per sheet..... 11



No. 897.



No. 899.



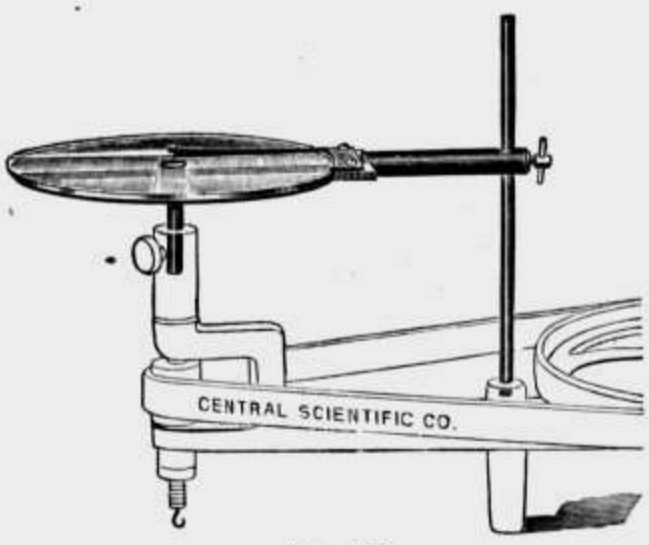
No. 902.

897. **Cubical Mirror** for Manometric Flame Apparatus. Accurately centered, 6 inches on edge..... $ 4 00

899. **Diaphragm or Vibrator** for Manometric Flame Apparatus. Made entirely of metal, with tube and mouthpiece, gas tube and jet. Easy to renew membrane..... 3 75

901. **Stroboscopic Cylinder,** for showing diverse oscillation, with views, to fit rotator 2 75

902. **Stroboscope (Zoetrope),** same as No. 901, to rotate by hand..... 2 35
See also **No. 3498. Improved Stroboscope,** with eighteen views by Prof. Quincke.



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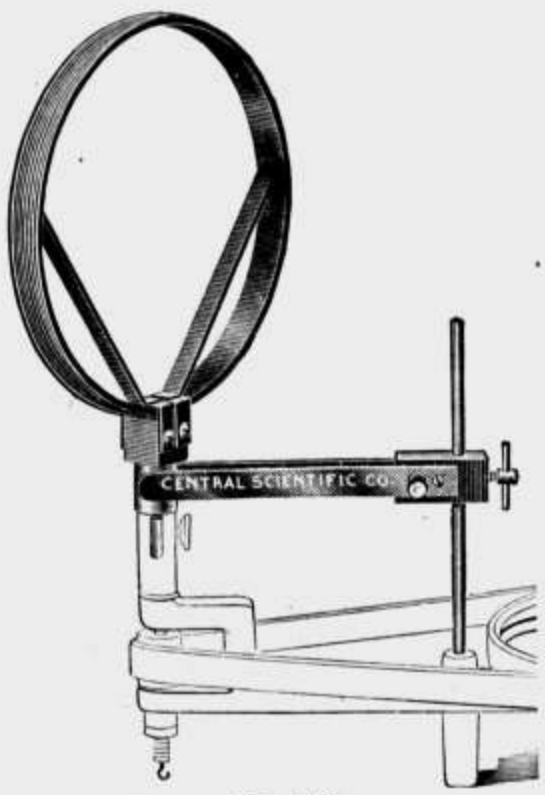


No. 905.

903. **Arago's Magnetic Rotations,** a revolving copper disc over which is placed a stationary glass plate with pivot and delicate magnetic needle. If the disc is moved with a slow and uniform velocity, the needle is deflected in the direction of the motion and stops at an angle from the magnetic meridian according to the velocity of the rotation; but if this velocity increases, the needle is deflected more and more until it is carried along, describes an entire revolution and follows the motion of the disc until it stops. Reversal causes the same result in the opposite way..... 6 50

905. **Earth Induction Apparatus,** with revolving coil and commutator for showing terrestrial induction..... 7 50

N. B.—See also **Earth Induction Apparatus,** on page 129.



No. 913.



No. 915.



No. 917.

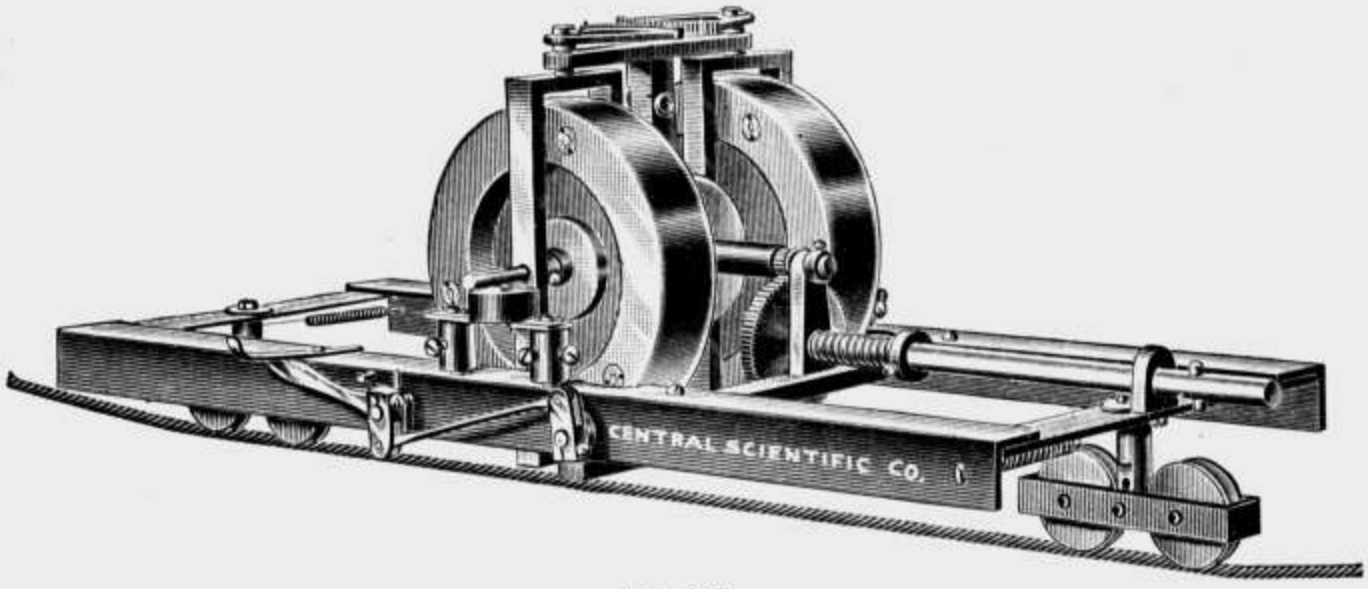
The **Gyroscope** illustrates better than any other piece of apparatus the principle of the composition of forces in rotary motion.

The wheel with ring revolving rapidly around the point of support is a resultant between the force of gravity and the rotary motion of the wheel.

913. **Gyroscope,** simple form, accurately centered wheel two inches in diameter, mounted on pivot and stand..... $ 2 00

915. **Gyroscope,** accurately centered, wheel three inches in diameter, with balance weight and lever supported on upright and base of finely finished brass 5 00

917. **Gyroscope, Bohnenberger's Apparatus.** Consists of a heavy ellipsoidal lead ball accurately turned and balanced about an axis which is supported on steel points in the diameter of a brass ring. This brass ring in turn is supported in a second ring, so as to turn freely on steel pivots placed at 90 degrees from points of support of the ball. This second ring is supported in like manner on a third, on pivots situated at 90 degrees from pivots of the first ring. This construction permits the ellipsoidal ball to revolve in any plane without confining its motion about any axis. The combination is mounted on suitable support. Finished in lacquered brass and japan..... 10 00



No. 950.

MODEL OF BRENNAN'S MONO-RAIL CAR.

This model embodies the gyrostatic arrangement employed by Mr. Brennan for the purpose of balancing a car upon a single rail, when the center of gravity of the car is above the rail. It is described by Prof. Perry in "Nature," for March 12, 1908, page 447. The design which we are placing on the market is that of Profs. Crew and Tatnall of Northwestern University.

Brennan's invention consists substantially of the following features:

(a) Two gyrostats or flywheels are used, mounted side by side, as shown in the cut, and spinning in opposite senses. The precessional couple due to the turning of the car in rounding a curve is equal and opposite for the two gyrostats and the upsetting torque arising from this source is thus eliminated.

(b) The two gyrostats are mounted in separate frames, and each of these frames is provided with bearings at the top and bottom, so that it may rotate slightly about a vertical axis. The frames are, however, geared together in such a way that they are compelled to rotate in opposite senses.

(c) The whole system of gyrostats and supporting frames is carried upon a horizontal axis running lengthwise of the car, i. e., parallel to the track. The center of gravity of the system lies in this supporting axis, so that the system is in neutral equilibrium with regard to gravity.

(d) Attached to the sides of the car itself are four small horizontal plates or "shelves," two on each side. (See diagram in "Nature.") As seen by a person facing either side of the car, one of these shelves extends toward the right from the central or undisturbed position of the projecting end of the gyrostat shaft. The second shelf is lower than the first, and extends toward the left. When the car begins to fall over, so that one side rises, one of two things will always happen. Should the gyrostat on that side be so oriented about its vertical axis that the projecting end of its shaft lies over the upper shelf, this shelf will rise until it touches the rotating shaft. The shaft, on account of friction, then begins to roll along the shelf, thus hurrying on the precession about the vertical axis. The second gyrostat shares this increased precession, but in the opposite sense. The opposite precession of the two oppositely spinning gyrostats thus unite their torques about a fore-and-aft axis, causing the shaft to press down on the shelf, righting the car.

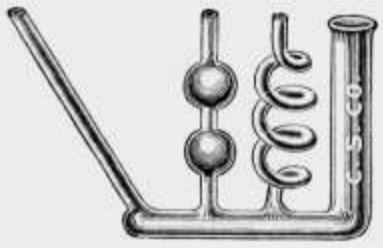
On the other hand, should the orientation of the gyrostats be such that the shaft is not immediately over its shelf, then the lower shelf will rise against an idle roller attached to the gyrostat frame, and the precessional torque thus brought into play will not only prevent the car from tipping farther, but will swing the gyrostats around until the live shaft is again over the upper shelf, when a righting torque is immediately brought into action.

As a result of these processes, taking place first on one side of the car and then on the other, the center of gravity of the whole car is kept oscillating very slightly about a point directly over the rail.

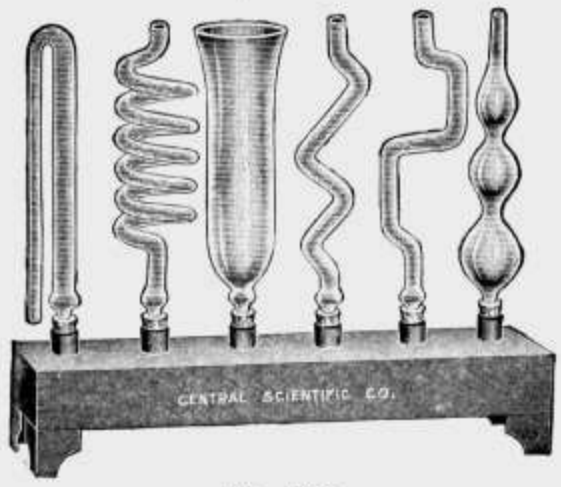
In the model, the gyrostats are speeded up to about 2,500 R. P. M. by means of a geared crank. The energy thus stored is sufficient to balance the car for ten or fifteen minutes. If the car is placed on a short section of track, the latter may be jerked sidewise, or suddenly rotated like a turn-table, without upsetting the car or throwing it off the track. If a load be added to one side of the car, that side will rise, so as to maintain the center of gravity over the track. Curves may be rounded, and the car may be run on a wire rope. Weight, 28 pounds. Diameter of wheels, 5 inches. Length of frame, 20 inches.

Net 100.00

MECHANICS OF FLUIDS.



No. 1001.



No. 1005.

1001. **Equilibrium Tubes.** Consists of four connecting glass tubes of different shapes ..... $ 75

1005. **Equilibrium Tubes.** Set of six tubes of different shapes and sizes mounted on japanned base..... 3 30

1007. **Liquid Pressure Tube.** Consists of two united glass tubes of areas as four to one..... 27

1009. **U Tubes,** of equal areas.

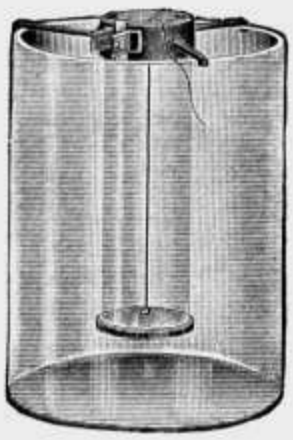
Length	4 in.	5 in.	6 in.
Each	.12	.15	.20





No. 1010.

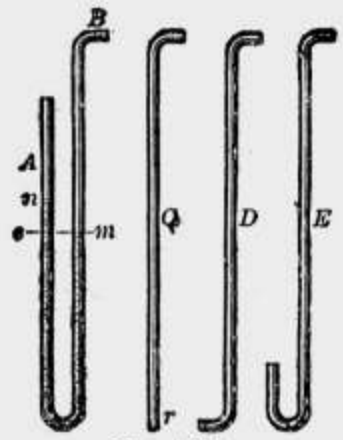
1010. **Graduated Tubes,** of glass, according to "Chute," for verifying the laws of liquid pressure. Tubes are 50 c. m. long and graduated the entire length in millimeters. Per pair of different diameters..... 2 25



No. 1013.



No. 1019.



No. 1021.

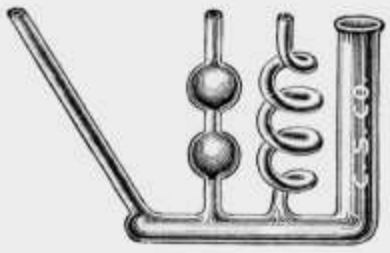
1011. **Pressure Apparatus,** to demonstrate upward and downward pressure. Consists of a glass tube, the bottom of which is ground to fit a brass plate attached to a cord..... 1 25

1013. **Pressure Apparatus,** same as No. 1011, with support and jar complete. 2 05

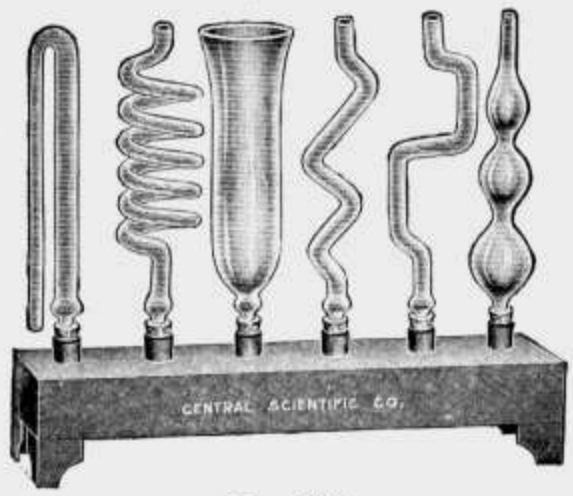
1019. **Pressure Syringe,** all glass, perforated to show that pressure is equal in all directions..... 2 00

1021. **Pressure Tubes.** Consists of four tubes bent in shapes as shown above. 90

MECHANICS OF FLUIDS.



No. 1001.



No. 1005.

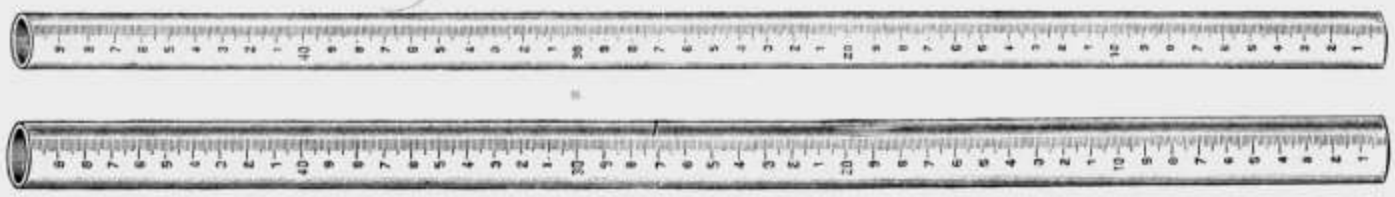
1001. **Equilibrium Tubes.** Consists of four connecting glass tubes of different shapes ..... $ 75

1005. **Equilibrium Tubes.** Set of six tubes of different shapes and sizes mounted on japanned base..... 3 30

1007. **Liquid Pressure Tube.** Consists of two united glass tubes of areas as four to one..... 27

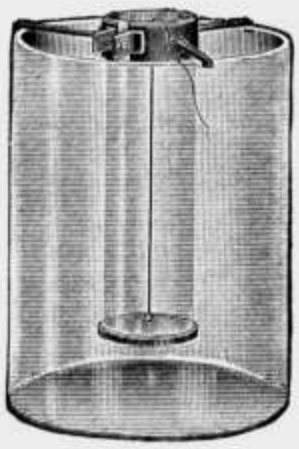
1009. **U Tubes,** of equal areas.

Length	4 in.	5 in.	6 in.
Each	.12	.15	.20



No. 1010.

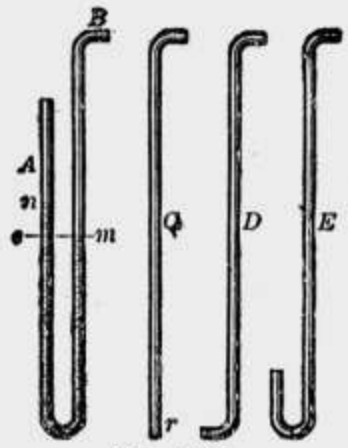
1010. **Graduated Tubes,** of glass, according to "Chute," for verifying the laws of liquid pressure. Tubes are 50 c. m. long and graduated the entire length in millimeters. Per pair of different diameters..... 2 25



No. 1013.



No. 1019.



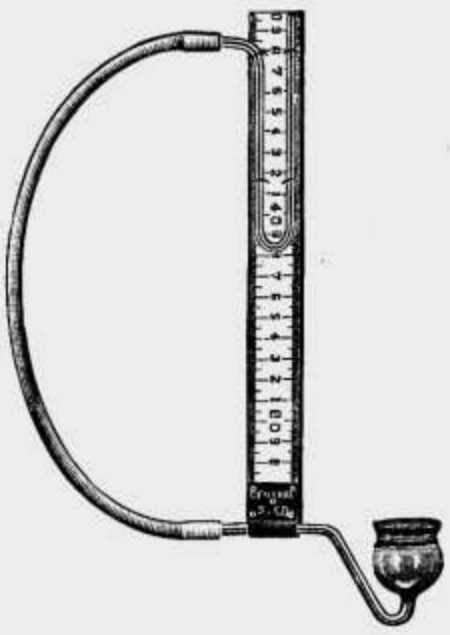
No. 1021.

1011. **Pressure Apparatus,** to demonstrate upward and downward pressure. Consists of a glass tube, the bottom of which is ground to fit a brass plate attached to a cord..... 1 25

1013. **Pressure Apparatus,** same as No. 1011, with support and jar complete. 2 05

1019. **Pressure Syringe,** all glass, perforated to show that pressure is equal in all directions..... 2 00

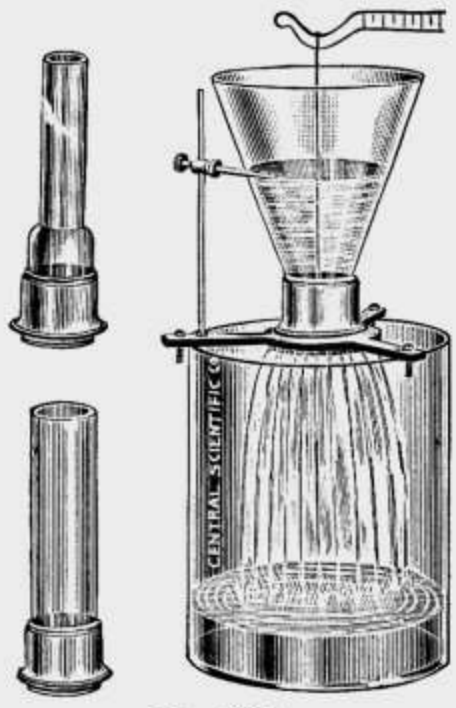
1021. **Pressure Tubes.** Consists of four tubes bent in shapes as shown above. 90



No. 1023.



No. 1025.



No. 1027.

1023. **Liquid Pressure Gauge,** for illustrating the relation between depth and the pressure exerted by a liquid. The indicator is a column of colored liquid held in the manometer tube. Variations of pressure are measured by a scale, to which the tube is attached. The manometer tube is connected to a thistle shaped glass terminal, over which is stretched a rubber membrane..... $ 95

1025. **Bursting Bottle Apparatus.** To demonstrate the incompressibility and elasticity of a liquid. Consists of a bottle with a plunger held in a frame. The plunger forced into bottle when filled with water causes it to break. Complete with two extra bottles..... 1 50

1027. **Pascal's Vases or Masson's Apparatus,** to show that pressure is independent of the shape of the containing vessel and the mass of liquid. Consists of three different shaped glass vessels with caps to be fastened to a metallic frame. An upright rod carries an index pointer to indicate water level. Complete with ground brass disc and jar 7 75

1028. **Pascal's Vases,** consist of three glass vessels of the same form as in No. 1027, with ground glass disc; no support..... 2 50

1031. **Cartesion Diver,** to show successively the phenomena of floating, sinking and rising. The diver is so weighted that it will just float when the upper part is filled with air at atmospheric pressure. A finger pressed on the rubber diaphragm over the top of the jar will transmit pressure to the water in the jar, which in turn will cause water to enter the interior of the diver, and it will sink, owing to its increased weight. On releasing the pressure the air compressed within the diver will expel the excess of water and it rises to the surface. As the outlet in diver is horizontal, the reaction produced causes the diver to rotate during its ascent. By regulating the pressure on the rubber diaphragm very interesting and amusing antics will be observed. Diver only 20

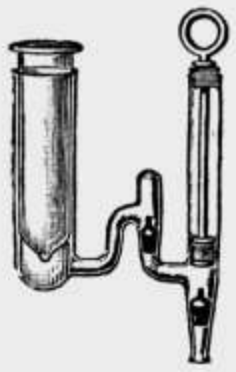


No. 1033.

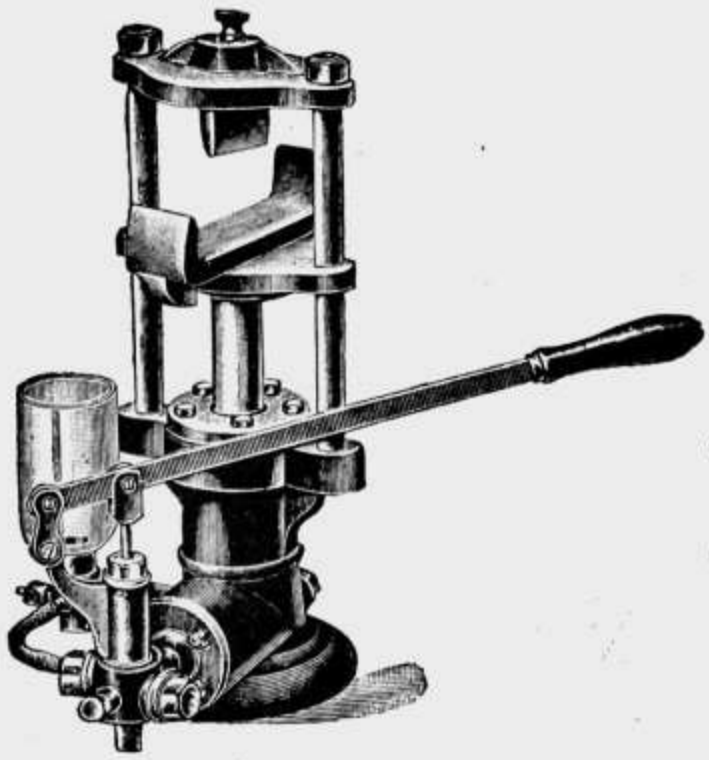
1033. **Cartesion Diver,** with jar and diaphragm complete..... 80

1035. **Cartesion Diver,** same as No. 1031, but larger..... 45

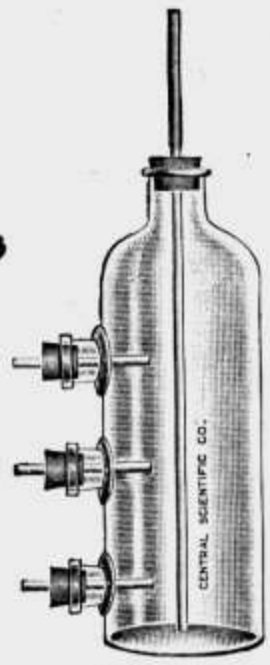
Hydrometer Jars, page 87.



No. 1037.



No. 1039.



No. 1043.

1037. **Hydraulic Press.** Made wholly of glass with visible valves. This is a perfect working model and will explain to a class the fundamental principle of the commercial machine..... 1 65

1039. **Hydraulic Press.** This instrument is a model capable of doing work. Will break bars of cast iron and wood very easily. It is mounted on a heavy iron standard containing an oil cistern and the press proper. Large cylinder has an internal diameter of 1½ inches, the small cylinder of the force pump 5-16ths of an inch. The instrument is finished in brass and steel and all iron parts are japanned. Plunger of large cylinder carries a movable attachment for different breaking tests 40 00

1043. **Mariotte's Bottle,** improved form, capacity one gallon. A study of the phenomena presented by this piece of apparatus furnishes excellent practice in applying the principle of hydrostatics; with fittings and rubber stoppers complete..... 3 75



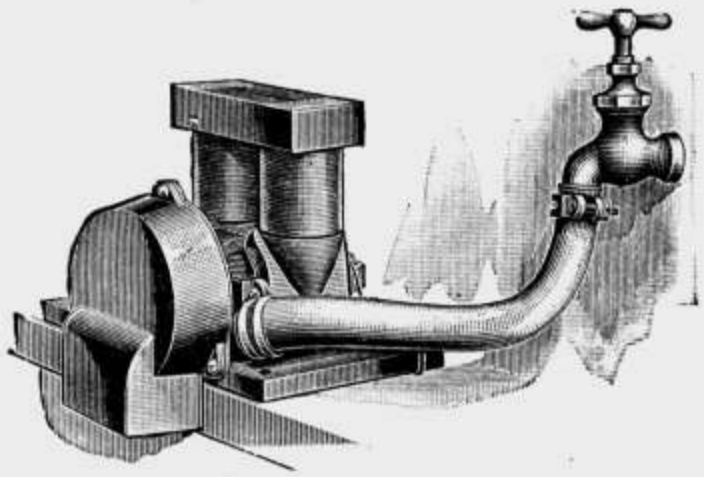
No. 1417.

1417. **Seven in One Apparatus (Spirometer).** A brass cylinder 6 inches in diameter with a tight fitting piston, with packing to make it air and water tight. A recent improvement does away with the sticking of the piston. Detachable handle in piston head, stop cock, rubber tube and funnel..... 8 30

N. B.—The illustrations show this apparatus in use as **hydraulic press, upward pressure apparatus and pneumatic lift.**

For other experiments to be performed with this apparatus, see "**Pneumatics,**" page 107.

1047. **Tripod Support,** to be used with No. 1417, as shown in illustration... 30

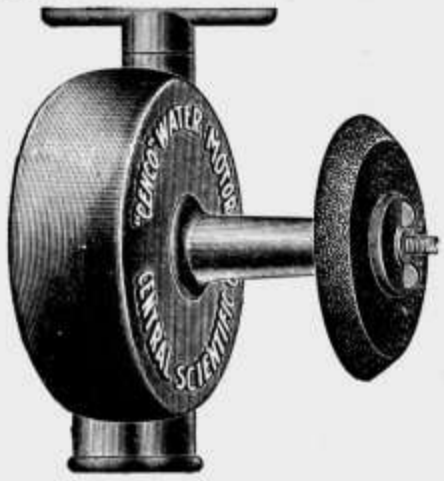


No. 1048.

1048. **Complete Water Power Plant, Water Motor and Dynamo.** Wherever water of 50 pounds pressure or over is available we recommend the use of one of these little machines to supply electric current for operating small motors, incandescent lamps, etc. Electricity may be obtained at actually no expense, the amount of water used being so small that it costs nothing. It can be attached to any household faucet by means of the rubber hose and clamps furnished with it. With 50 pounds water pressure enough current is obtained to light a four candle power 10 volt incandescent lamp. The output is 8 to 10 volts and 1 ampere. With greater pressure more current can be obtained 13 30



No. 1049.



No. 1050.

1049. **Water Turbine.** Improved form, having the outlet opposite the inlet, whereas all other forms have them on the same side, causing the water to go clear around. In the above form the water goes but half way around, eliminating clogging and giving better results and with less water. Diameter of wheel, 60 millimeters; 4,000 R. P. M.; 4 to 5 liters of water per hour..... 3 00

The Cenco Water Motor, a reliable motor made for us by one of the largest manufacturers of water motors and fully guaranteed. These motors will be found useful as a source of power, grinding, buffing and as a test of efficiency in the laboratory, also in connection with bottle washing brushes, for the rapid cleaning of bottles, flasks, etc.

1050. **Cenco Motor,** diameter 4 inches, weight 5 pounds. With 80 pounds water pressure will develop ⅛ H. P. when connected with ½ inch house pipe. The motor complete with 4 inch beveled face emery wheel, one cloth buffing wheel for brass, one stick of brass polish, one grooved wood pulley..... 5 00

1050A. **Cenco Motor,** diameter 6 inches, weight 7 pounds. With 80 pounds water pressure will develop ¼ H. P. when connected with ½ inch house pipe. Complete with grooved wheel..... 8 00

1050B. **Universal Coupling,** for plain faucet (state size)..... 44

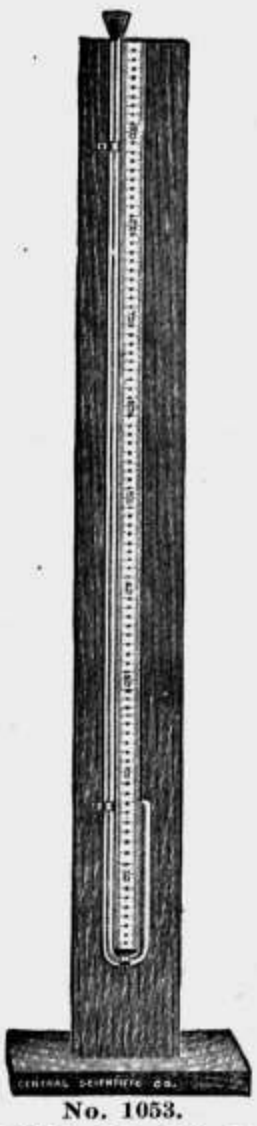
1050C. **Extra Rubber** for same..... 17

1050D. **Quart Bottle Washers**..... 80

1050E. **Pint Bottle Washers**..... 80

1050F. **Steel Polish** 17

Universal Couplings, page 104.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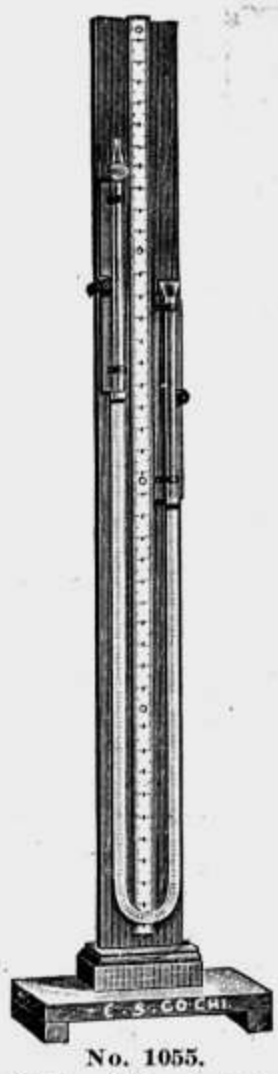
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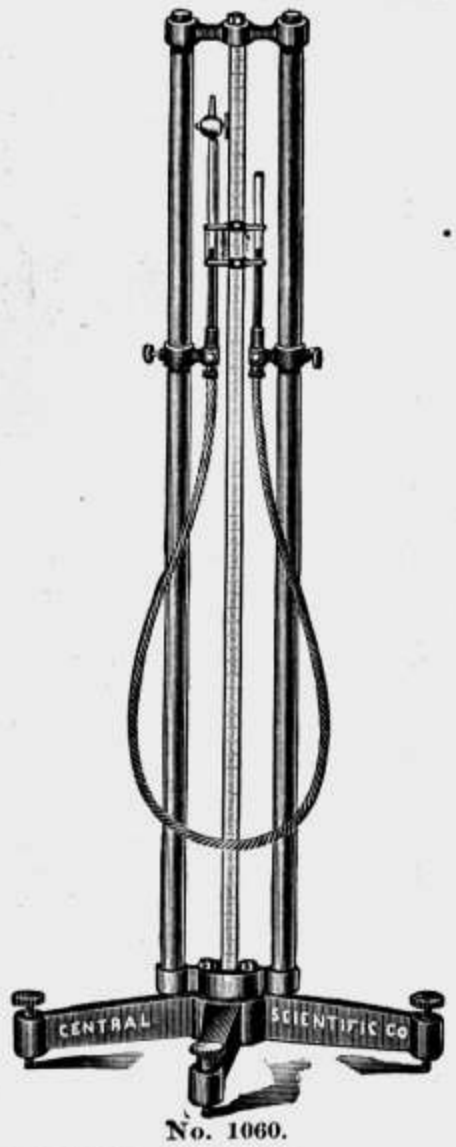
No. 1057.



No. 1060.

1051. **Boyle's Law Tube (Mariotte's Law)** to show that the volume of a gas, if temperature remains constant, varies inversely as the pressure to which it is subjected. Glass tube only, short end sealed..... $ 75

1053. **Boyle's Law Apparatus.** Glass Tube No. 1051 mounted on support having both English and Metric scales..... 3 50

1055. **Boyle's Law Apparatus,** new form, consisting of an open funnel end tube and a tube closed by a glass stop cock, each mounted upon a slide which can be clamped at any height on the standard, and connected by a heavy rubber tube. Metric and English scales. Mounted on a finely finished hardwood support..... 5 25

1057. **Boyle's Law Apparatus,** improved form, as used at Northwestern University and the University of Chicago. Adapted for any pressure from one-half to two atmospheres. Sold complete with pump. This is a convenient form, as there is no handling of mercury after the cistern is once filled. Full directions for performing the experiment furnished with each instrument..... 5 00

1059. **Boyle's Law Apparatus,** for pressure of less than one atmosphere. Consists of an iron mercury well mounted upon heavy base and a barometer tube with adjustable clamp..... 4 25

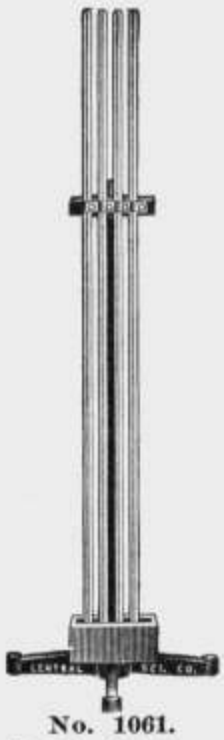
1059A. **Boyle's Law Apparatus,** cistern only of No. 1059..... 3 00

1059B. **Boyle's Law Apparatus,** same as No. 1059, but with graduated Barometer Tube No. 1161 in place of plain barometer tube..... 6 40

1060. **Boyle's Law Apparatus.** Height 150 c. m., mounted on heavy tripod, fitted with leveling screws. Middle rod is square and provided with scale 130 c. m. in length divided to m. m. Vernier reads to 1-10 m. m. A mirror behind the glass tubes assists in reading the height of the meniscus without parallax. The two glass tubes are connected by steel couplings and heavy rubber tubing. The closed tube is graduated to m. m. and fitted with stop cock on top. This tube can be removed and No. 1060A Air Thermometer attachment substituted. All steel parts are nickel plated..... 30 75

1060A. **Air Thermometer Attachment** for No. 1060, with steel socket and platinum point for reading the mercury meniscus (see page 111)... 3 25

1060B. **Air Thermometer Attachment** with three way stop cock, steel coupling and platinum point for reading mercury meniscus..... 5 50



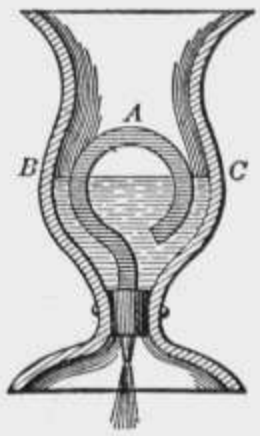
No. 1061.



No. 1065.



No. 1067.



No. 1069.



No. 1071.

1061. **Pressure of Saturated Vapor Apparatus.** Consists of a support with four tubes, one end of each closed, mercury well and pipette..... $ 5 00

1065. **Siphon,** plain form of glass..... 22

1067. **Siphon,** with suction tube, of glass, 12 inch..... 33

1069. **Tantalus Cup,** illustrating intermittent springs..... 70

1071. **Hero's Fountain,** to demonstrate the raising of water by the elastic force of air..... 2 75



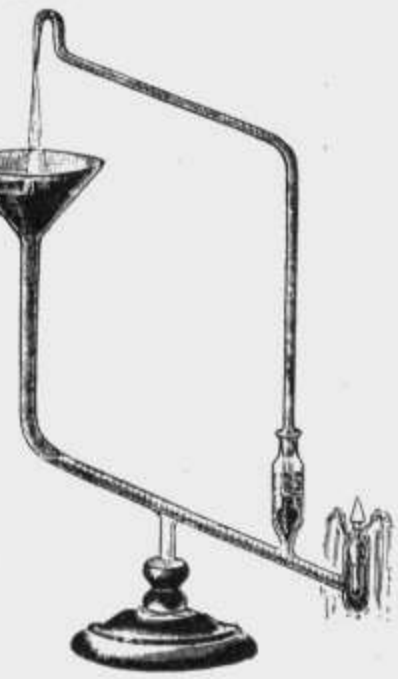
No. 1073.



No. 1081.



No. 1083.



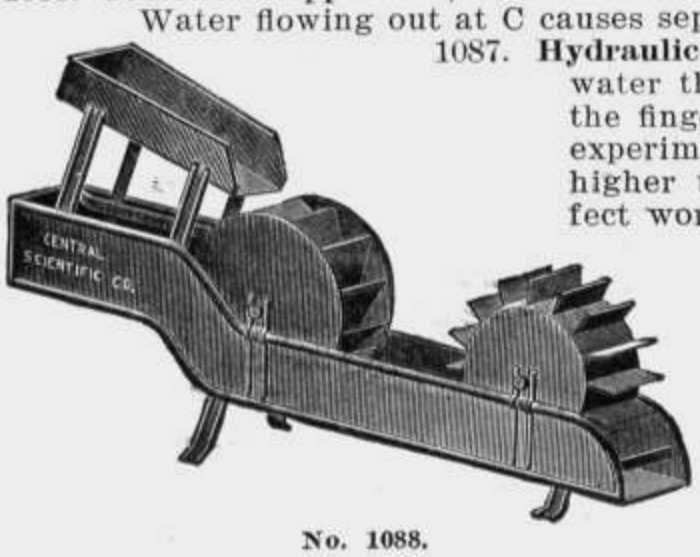
No. 1087.

1073. **Barker's Mill,** made entirely of metal, much superior to other models. Water running from the nozzle tips causes the mill to rotate owing to the water reaction..... 4 50

1081. **Reaction Wheel,** illustrating Third Law of Motion. Can also be used as Hero's Engine..... 1 75

1083. **Reaction Apparatus,** also demonstrates the Third Law of Motion. Water flowing out at C causes separation of the points as illustrated 1 00

1087. **Hydraulic Ram.** After the funnel has been filled with water the valve is pushed down once or twice with the finger until the apparatus plays of itself. This experiment illustrates how water may be raised higher than the source of supply. This is a perfect working model, all of glass, showing the valve operating as the water flows 3 30



No. 1088.

1088. **Water Wheel Model,** illustrating "breast," "overshot" and "undershot" water wheels. Made of sheet metal, neatly japanned 6 00



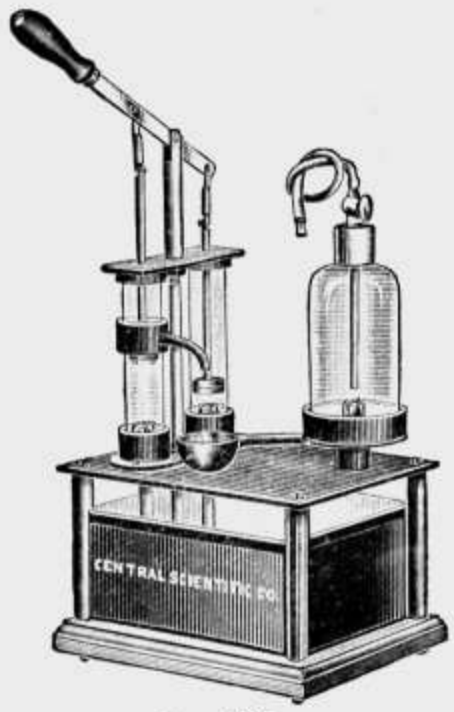
No. 1089.



No. 1091.



No. 1093.



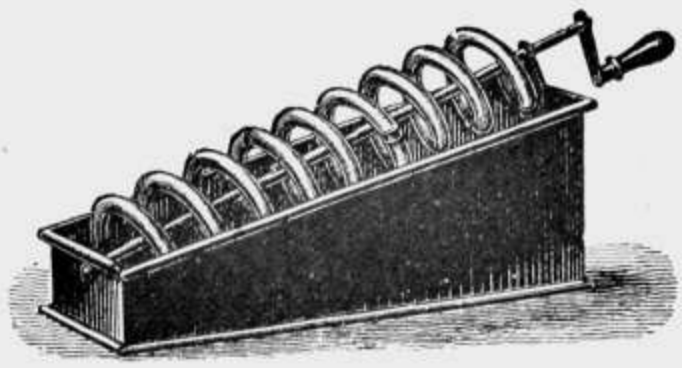
No. 1095.

1089. **Archimedes' Principle,** a brass cylindrical cup with handle and hook beneath, a brass cylinder (with hook) exactly fills the cup..... $ 1 65

1091. **Lift Pump,** a complete working model in glass..... 1 65

1093. **Force Pump,** a complete working model in glass..... 2 00

1095. **Lift and Force Pump,** mounted on finely polished hardwood stand, with japanned tin water tank. The barrels are of glass with brass mountings and brass pistons, valves being in plain sight..... 20 00



No. 1099.

1099. **Archimedes' Pump.** Consists of a tin vessel with glass worm attached to a crank. By turning the crank, water is caused to flow upward through the worm. Works on principle illustrated in Hero's Fountain 4 45



No. 1101.

1101. **Specific Gravity Bottles,** unadjusted, perforated stopper for student adjustment.

	25 c. c.	50 c. c.
Approximate capacity		
Price each	.35	.45

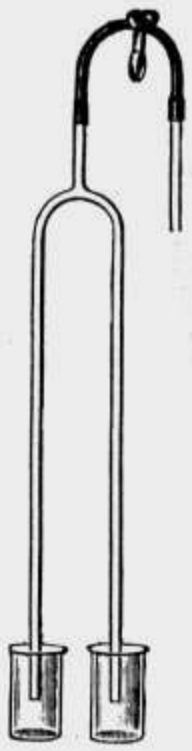
1103. **Specific Gravity Bottles,** very accurately adjusted.

	25 c. c.	50 c. c.
Exact capacity at 15°C.....		
Price each	.75	1.00

1105. **Specific Gravity Bottles, Geissler's,** with thermometer ground in central neck and a capillary stopper ground in side neck. Capacity, 25 c. c..... 2 50

1105A. **Specific Gravity Bottle,** same as No. 1105, capacity 50 c. c. 2 75

Specific Gravity Balances, pages 262-264.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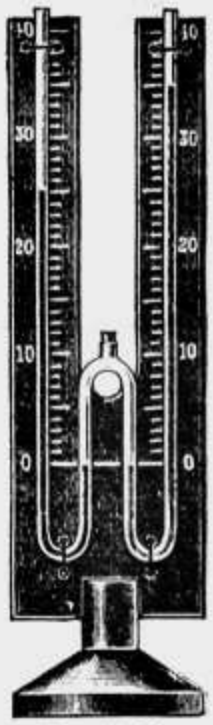

No. 1109.

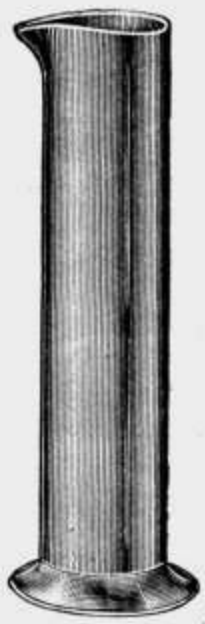

No. 1111.


No. 1113.



No. 1114.


No. 1115.


No. 1125.

1106. **Hare's Balancing Column Apparatus,** for determination of specific gravity of a liquid by balancing a column of the liquid with a column of water. Consists of two glass tubes, connected at the upper end by a lead Y tube. Lower ends of these tubes extend into two glass tumblers. Apparatus is complete with rubber connections and pinch cock..... $ 90

1107. **Balancing Column Tube,** for use when two liquids do not mix. U tube 30 c. m. long..... 25

1108. **Balancing Column Tube,** for use with two liquids of any kind. U tube 100 c. m. long, 5 m. m. bore..... 80

1109. **Density U Tube,** a double U tube mounted on a stand with millimeter scale for determining specific gravity of liquids of different densities. 5 50

1110. **Hydrometer Tube, Constant Weight,** for finding density of a liquid by the principle of flotation. For use with shot..... 44

NOTE: For above tube graduated in millimeters, see No. 1010.

1111. **Hydrometer Tube, Constant Volume,** for finding density of a liquid by principle of flotation and comparison of accuracy with No. 1110 Tube. For use with shot..... 33

1113. **Hydrometer, Demonstration,** of wood, paraffined, weighted at one end, 1 c. m. square, graduated in millimeters..... 25

1114. **Hydrometer, Nicholson's** [constant volume]..... 1 65

1115. **Hydrometer** [constant weight], for light liquids with Baumé's scale 70-10, and specific gravity scale 0.7000 to 1.000..... 45

1117. **Hydrometer** [constant weight], for heavy liquids with Baumé's scale 0-70, and specific gravity scale 1000 to 2000..... 45

1119. **Hydrometer, Universal,** standard, weighted with mercury, for both light and heavy liquids, combining Nos. 1115 and 1117..... 1 35

1120. **Hydrometer,** ungraduated, for student graduation, similar to Nos. 1115 and 1117..... 33

1123. **Hydrometers, Normal,** Jena glass, guaranteed accuracy. Set of six with range 0.700 to 2.000, for small quantities of liquids to be tested. With thermometer and cylinder, in case.....Duty free 6 00

1124. **Hydrometers, Normal,** as above, but with thermometer in each spindle. Set in case with cylinder.....Duty free 9 50

1125. **Hydrometer Jar,** with lip.

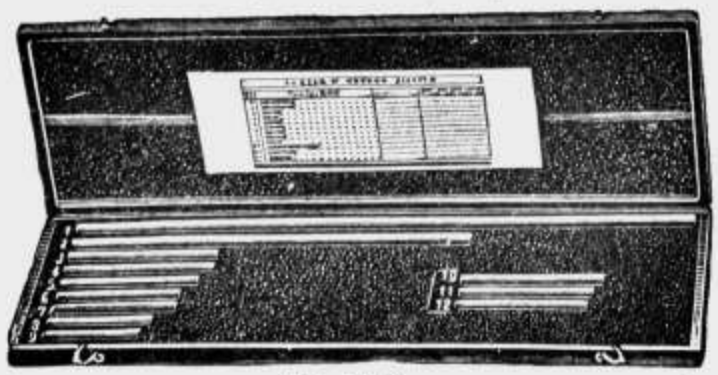
Size, inches	10x2	12x2½	15x2½	15x3	18x3
Each	.40	.50	.65	.80	1.10

1127. **Hydrometer Jar,** with flange, same sizes and prices as No. 1125.

Hydrometers of all kinds, for acid, alcohol, alkali, gasoline, Twadell's, etc., can be furnished. Prices upon application.



No. 1132.



No. 1133.

1129. **Specific Gravity Specimens.** Set of ten different substances of irregular shape, for student use in density experiments. Enclosed in pasteboard box ..... $ 55

1130. **Specific Gravity Specimens.** Solid metal rods ½ inch in diameter and 2 inches long, ends squared accurately.

1130A. Aluminum Rod 25

1130B. Brass Rod 25

1130C. Steel Rod 22

1132. **Specific Gravity Specimens.** Set of twelve different metals in form of cubes, exactly 1 cubic centimeter. Set comprises magnesium, aluminum, zinc, tin, iron, copper, nickel, lead, silver and alloys of copper and zinc, copper and aluminum, and copper and tin. The weight in grams gives the specific gravity of the metal. Set is enclosed with table in velvet lined case.....Duty free 10 00

1133. **Specific Gravity Specimens.** Set of twelve metals as listed under No. 1132. These metals are in form of cylindrical rods, each rod is exactly 5 m. m. in diameter and weighs 10 grams and shows that the lengths are inversely proportional to the specific gravities. Set is enclosed with table in velvet lined case.....Duty free 11 00



No. 1139. No. 1140.



No. 1142.



No. 1143.

1134. **Waterproof Wooden Cylinder,** loaded, 4.5x8 c. m..... 28

1135. **Waterproof Wooden Block,** loaded, weighs 225 grams, 7x4.5x4.5 c. m. 22

1137. **Waterproof Cherry Block,** 7.5x7.5x3.8 c. m..... 16

1139. **Overflow Can,** brass, nickel plated, 7x14 c. m..... 50

1140. **Catch Bucket,** brass, nickel plated, capacity 175 c. c..... 33

1142. **Aluminum Cylinder,** with hook..... 44

1143. **Lead Sinker,** weight about 175 grams, with hook..... 13

1145. **Waterproof Wooden Cylinder,** 1x20 c. m..... 06

1146. **Brass Holder,** for keeping No. 1145 upright in jar. (Use 6x8 jar)..... 15

8088. **Glass Jars,** clear white glass of good quality.

Height, inches	4	5	6	9
Diameter, inches	5	7	8	12
Each	.30	.40	.55	1.35

For cheap battery jars see Nos. 2121E and 2123E, page 143.

Specific Gravity Balances, pages 262-264.

METEOROLOGICAL INSTRUMENTS.

1151. **Barometer Tubing,** heavy large bore, per meter ..... $ 20

1153. **Barometer Tube, large** bore, thick walled, one end sealed, 80 c. m. long 33

1155. **Barometer Tube, cup** and **pipette,** complete 55

1157. **Barometer Tube,** with bend and bulb..... 45

1161. **Barometer Tube,** same as No. 1153, graduated in millimeters. 2 00

1162. **Mercury Well,** iron.. 33



No. 1153.



No. 1157.



No. 1161.

1165. **IMPROVED MERCURIAL BAROMETER. FORTIN PRINCIPLE. Patented Nov. 28, 1905.**

A **Barometer** without provision for the adjustment of the mercury level (zero point) is of no practical value in scientific work. For this reason we have ceased to carry the "old line" instruments.

This **New Barometer** embodies all of the important features and operates on the same principle as the U. S. Weather Bureau Standard Barometer.

The **glass tube** is straight and of heavy wall and uniform bore. This is much stronger than the bent or "U" shaped tubes commonly used.

The **mercury cistern** (C) is constructed of glass, sealed to the tube. A flexible and air-tight piece of leather forms the lower part of the cistern, and by means of the adjustment screw (B) the mercury level can be raised or lowered to coincide with the zero point. This zero point consists of a piece of colored glass (A) drawn to a sharp point, and extending from the outer wall of the tube. The zero level of the mercury is readily obtained, and with no error due to parallax. This form is far superior to the "line" zero used on most low cost barometers.

The **height of the mercury column** is observed by means of a special device attached to the vernier, which overcomes any error of parallax.

The **Barometer Scale** is fixed to the board and the distance between the scale divisions and zero is absolute and constant. This is superior to other forms constructed with a metal rod connecting the movable scale and zero, as this rod contracts or expands with changes in temperature, which destroys the accuracy of the graduations on the scale.

The **Barometer Scale** is graduated in Metric and English readings by means of a vernier to $\frac{1}{10}$ m. m. and 1-200 inch. The vernier slides in an accurately cut slot and moves freely and independently of the glass tube. The graduations are placed on a beveled surface, bringing them close to the scale. A lens front thermometer with Centigrade and Fahrenheit scale is attached to the mounting. $16 65

1165A. **Improved Mercurial Barometer,** same as No. 1165, with a scale reading down to 20 inches for use in high altitudes ..... $ 19 00

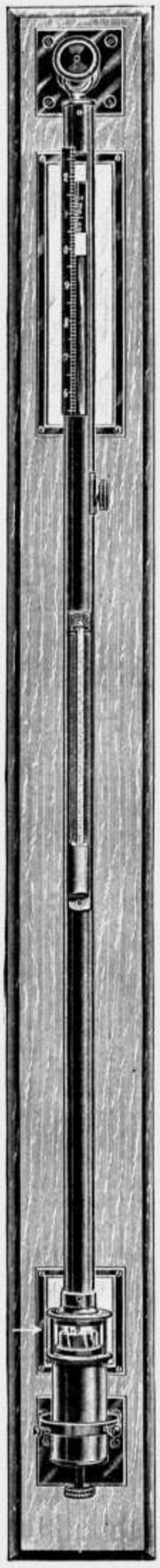
1166. **Improved Mercurial Barometer.** Same as No. 1165, with addition of rack and pinion adjustment for the vernier and a certificate of error..... 22 25



No. 1165.

1169. **Standard Barometer, United States Weather Bureau Type,** Fortin Principle. This barometer is of the highest type of excellence, indorsed by the United States Weather Bureau and fully warranted by the manufacturer. The mercury tube is inclosed in a bronze-brass body, having at its upper end two vertical openings, in which the vernier works, the latter operated by a rack and pinion movement. The readings are taken through these openings, aided by light reflected from a white opaque glass reflector attached to the mahogany board behind. The scale is divided on one side into inches and 10ths, and on the other centimeters and millimeters, the vernier enabling a reading to be taken, in each case respectively, of 1-100th of an inch and 1-10th of a millimeter. The attached thermometer consists of a well seasoned tube with both Centigrade and Fahrenheit scales, with the figures etched on the stem. It is so mounted that it can be easily removed for testing, etc. Corrections for the thermometer accompany each instrument. No correction for capillary action or instrumental error is given with these barometers, as the scale has been adjusted until readings are identical with the standard compared with that of the Kew Observatory, England. The barometer may be used without the board by suspending it by the ring at the top, but the board (No. 1171), as shown in the illustration, possesses many advantages. Without board..... $ 45 00

1171. **Mahogany Back** for above, to which is attached a brass bracket to receive the ring in the top of the barometer, a ring with steadying screws to clamp about the cistern, and white opaque glass reflectors forming a translucent background for reading the instrument..... 5 50



No. 1169-71.

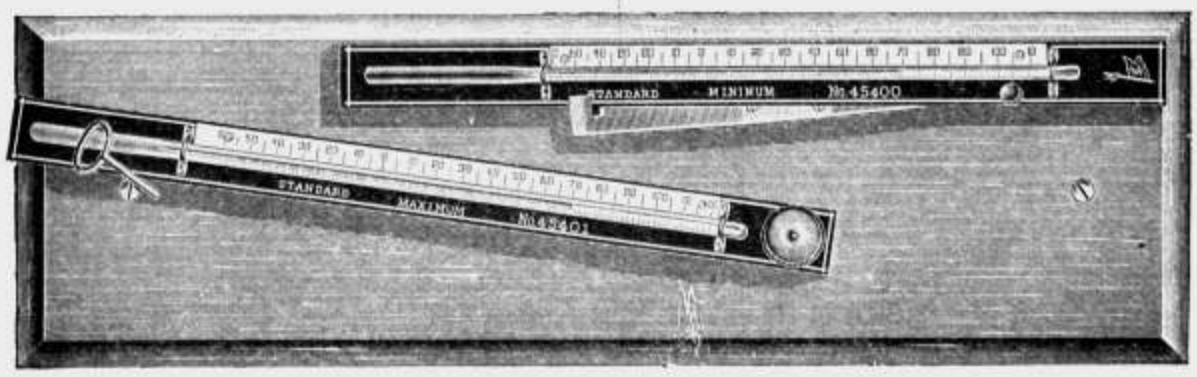


No. 1185.

1181. **Standard Thermometer,** 12 inch, latest Weather Bureau pattern, cylindrical bulb, graduation etched on tube, with raised metal strip at side of the tube on which are marked the figures and every fifth line of the scale. Furnished with support and binding screws. Certificate with each thermometer..... $ 5 50

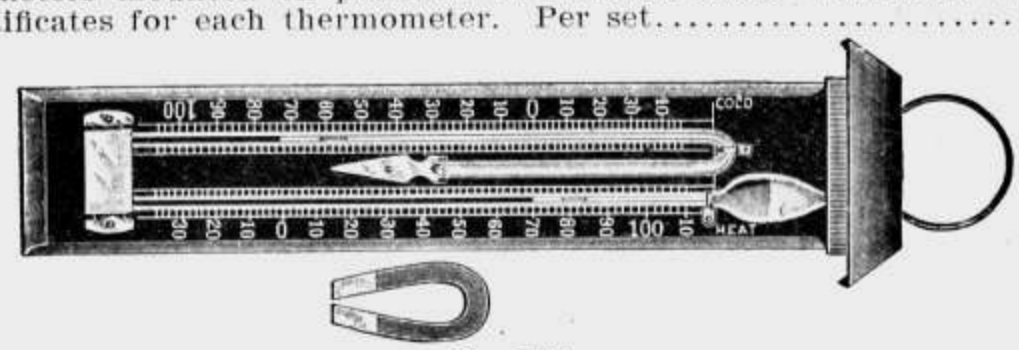
1183. **Standard Minimum Registering Thermometer,** same pattern and description as No. 1181. Certified..... 6 00

1185. **Standard Maximum Registering Thermometer,** same pattern and description as No. 1181. Certified..... 6 50



No. 1189.

1189. **U. S. Weather Bureau Set of Maximum and Minimum Registering Thermometers,** latest pattern, consisting of Nos. 1183 and 1185 Thermometers mounted on polished oil finished back. Furnished with certificates for each thermometer. Per set..... 12 00



No. 1190.

1190. **Six's Self-Registering Maximum and Minimum Thermometer.** Eight inch black japanned tin case, silvered metal scale with magnet..... 3 65



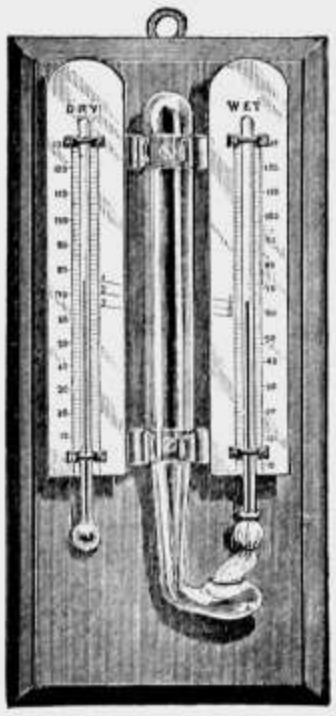
No. 1191.

1191. **Soil Thermometer,** for work in physical geography. Ten inches in length, paper scale, in cylindrical tube with brass point..... 1 25

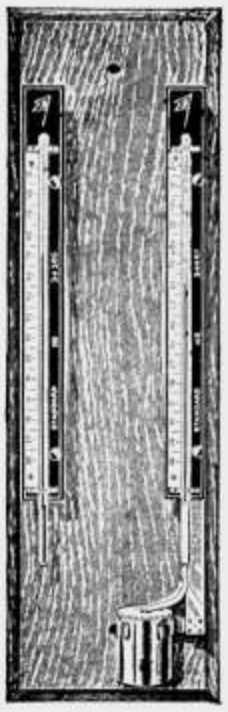
1194. **Spiral Hygrometer,** scale denoting the humidity of the air without reference to tables. In spun brass nickel plated case, 3 inch dial.... 2 20



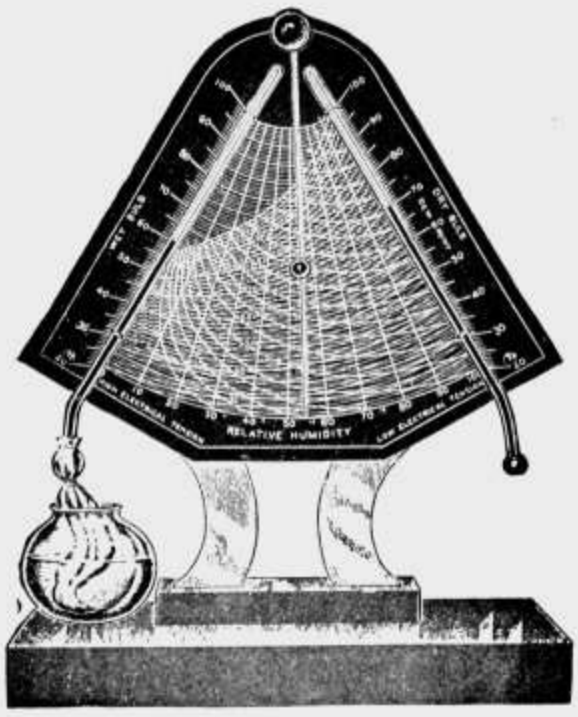
No. 1194.



No. 1195.



No. 1199.



No. 1203.

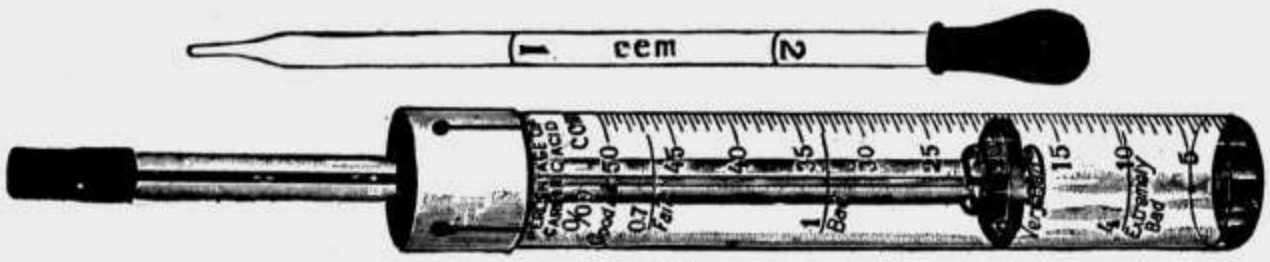
1195. **Mason's Hygrometer,** with lines drawn on the scale for convenience of maintaining a humidity of 50 degrees at normal temperatures, mounted on polished hardwood frame, 10½ x 4¾ inches, scale raised from frame by insulating strips, complete with glass cistern and tables for determining dew point and humidity..... $ 5 00

1197. **Mason's Hygrometer,** cheaper form, thermometers not raised, mounted on polished hardwood frame..... 2 50

1199. **U. S. Weather Bureau Hygrometer,** consisting of two standard thermometers, No. 1181, extending below the finely polished hardwood back, metal cistern with wick, and certificate for each thermometer 12 00

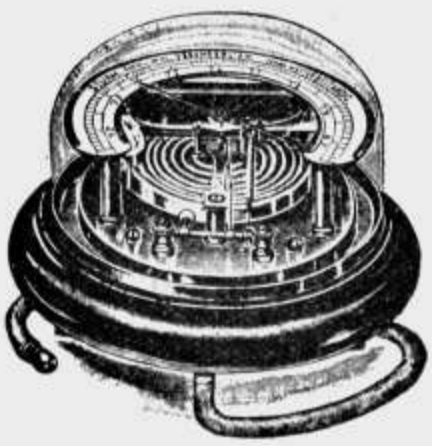
1203. **Hygrodeik,** an improved form of the Mason's Hygrometer. Consists of two thermometers, wet and dry bulbs, mounted upon the outer edge of a chart which has been plotted from new and corrected tables prepared under the direction of the U. S. Weather Bureau. This chart, while complicated in appearance, is very simple and obviates entirely the use of tables for temperatures between 20 and 100 degrees Fahrenheit. Full directions furnished with each instrument..... 10 00

1205. **"Sling" Psychrometer or Hygrometer,** designed for the purpose of obtaining quick and more accurate results than are possible with the stationary wet and dry bulb instrument. Two paper-scale thermometers, No. 1525, carefully selected, mounted upon an oxydized brass plate with wooden handle and swivel, student form..... 2 50



No. 1209.

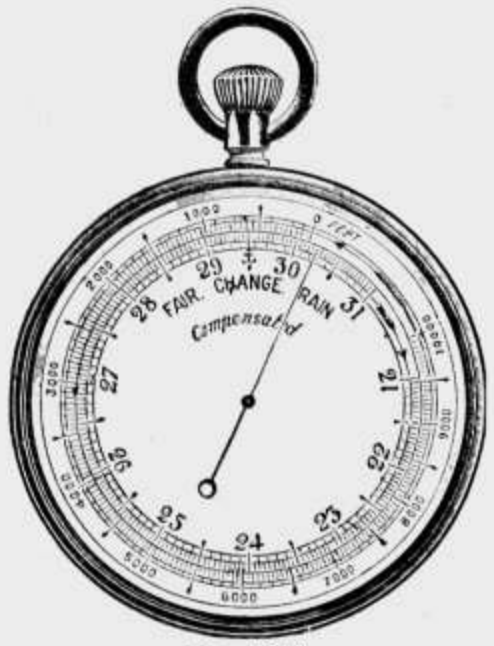
1209. **Wolpert's Air Tester (Carbacidometer),** for obtaining the amount of carbonic acid gas in a room by direct readings from the graduations etched on the glass, thus doing away with all computations and tables as in the old forms. Another advantage of this form is that the air of a room may be secretly tested, if desired. Directions and full set of test solutions furnished with each instrument..... 3 75



No. 1210.



No. 1212.



No. 1217.

1210. **Aneroid Barometer, Demonstration Form.** This is a very desirable and useful instrument that should be in every laboratory. By simply blowing in or drawing out the air by means of a rubber tube the effect of the atmospheric pressure upon a barometer is clearly demonstrated. This barometer is handsomely mounted and finished and makes a very accurate instrument to hang up in the schoolroom for daily barometric observations..... $ 13 35

1212. **Aneroid Barometer,** 5 inch brass case, with closed porcelain dial. A most valuable instrument. As an improvement over all other types of Aneroids, a patent adjustable altitude hand is provided, which shows without computations at any latitude (1) the U. S. government sea level reading; (2) fair, rainy and stormy weather indications; and (3) high or low atmospheric pressure..... 8 00

1212A. **Aneroid Barometer,** same as No. 1212, but with scale reading down to 22 inches. Weather indications arranged for an approximate altitude of 6,400 feet. With patent adjustable altitude hand..... 9 50

1213. **Aneroid Barometer,** 4 inches in diameter. The mechanism is mounted in a highly polished copper case and is in full view. The graduations read in both English and Metric systems..... 7 50

1214. **Aneroid Barometer,** 4 inch card dial, open face, nickel plated case. Graduations in both English and Metric systems..... 4 00

N. B.—None of the above aneroids, with the exception of No. 1212A, are suitable for altitudes over 3,000 feet.

1215. **Aneroid Barometer,** pocket mountain type, watch case form, 1¾ inches in diameter, first quality, compensated for temperature, silvered metal dial, revolving altitude scale, 3,000 feet, in gilt case. Inclosed in neat morocco case..... 16 75

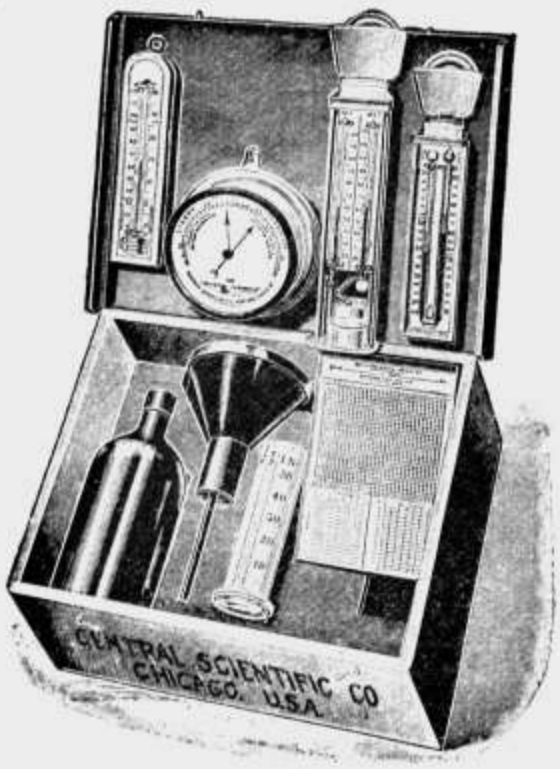
1217. **Aneroid Barometer,** same as No. 1215, reading to 10,000 feet..... 16 50

1218. **Aneroid Barometer,** same as No. 1215, reading to 16,000 feet..... 19 50

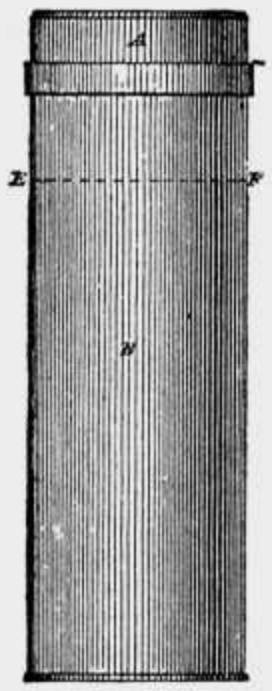
1219. **Surveying Aneroid,** especially designed and constructed for the purpose of readily ascertaining slight variations in gradients, levels, etc. Besides extreme sensitiveness, the specialty claimed for this instrument is an arrangement of the scale of altitudes which admits of subdivisions by a vernier. Compensated for temperature changes and reads to single feet of altitude scale. 3 inch bronze metal case, silvered metal dial, with vernier scale moved by rackwork motion, reading lens arranged to traverse the entire circle, altitude scale 6,000 feet, in solid leather sling case. .....Duty free 40 00



No. 1219.



No. 1220.



No. 1222.

1220. **Universal Meteorological Set,** a complete set of meteorological instruments suitable for a beginner, and of such a quality as to give entire satisfaction. The set comprises a 5 inch metal case aneroid barometer, 8 inch boxwood thermometer with F. and C. scales, 8 inch maximum and minimum (Six's) thermometer with boxwood scale and magnet, 8 inch Mason's wet and dry bulb hygrometer with boxwood scale, 5 inch Howard rain gauge, and a calendar for keeping a record of the instruments in the set. Packed in neatly stained box.... $ 16 65

1221. **Weather Forecast Chart, or Key to Barometer Reading, and Chart for Aneroid Barometer,** by J. Benj. F. Rawson, late of the Weather Bureau. This chart is intended as an aid in the intelligent interpretation of barometer readings and in forecasting weather for twenty-four hours. By a comparison of outside air temperature and the direction of the wind at 30 inch readings, with temperature and wind reference given on the chart, one can know the nature of a coming change of weather, also the general location of centers of areas of high and low pressure and the rapidity with which the pressure areas travel, which will be indicated by the rate of change of the barometer. High pressure areas read above, while low pressures read below, 30 inches. This chart will be found quite accurate and most useful in any science laboratory. Full directions on each chart. Each 50

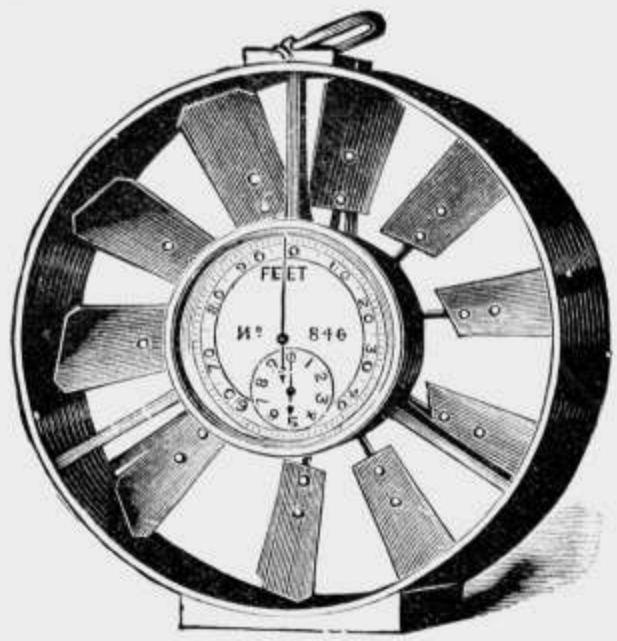
1221A. **"Weather and Weather Instruments."** Many teachers have written us for information regarding the management and use of weather instruments. This book contains the most complete information of any book or books of which we have knowledge. It describes the mechanism of the many instruments and in addition gives in concrete and simplified form the practical uses of the different instruments. The tables of classified data recommend it particularly to teachers. Pasteboard covers..... 50

1221B. **"Weather and Weather Instruments,"** same as above, cloth covers... 1 00

1222. **Rain Gauge,** United States Weather Bureau type, 3 inches in diameter, with overflow and measuring stick..... 2 75



No. 1223.



No. 1225.

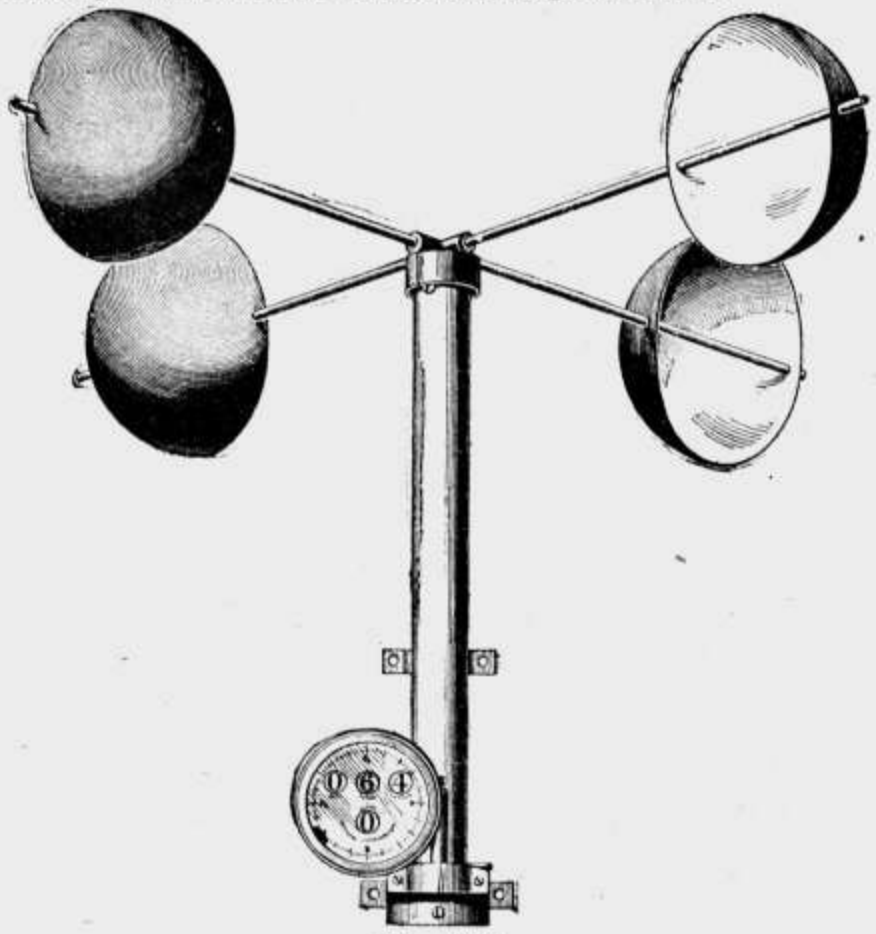
1223. **Anemometer,** portable form, for measuring velocities of air currents in buildings, etc. Indications are obtained by means of a delicately poised fan wheel 2¾ inches in diameter. The long hand indicates on the outer circumference of the main dial the passage of 100 feet or less of air. The readings are continued up to 100,100 feet by a series of smaller dials, as shown in the illustration. Complete with jointed socket holder, zero setting device and disconnector, in mahogany case ..... $ 22 50

1225. **Anemometer, Biram's,** 4 inches in diameter, four dials reading to 100,-100 feet, complete with zero setting device and disconnector, in mahogany case 21 50

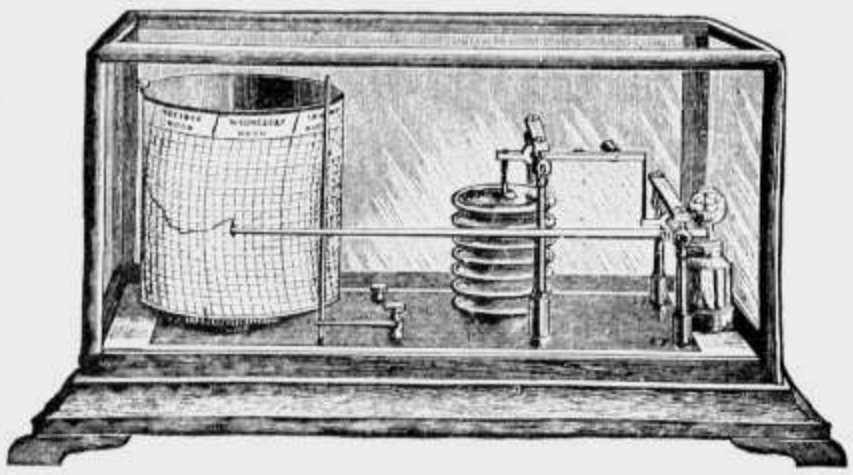
1227. **Wind Gauge or Anemometer.** This simple device for indicating the velocity of the wind in miles consists of a vertical shaft, to the upper end of which are fastened four arms, each carrying a Robinson hemispherical copper cup. These cups turn in one direction, regardless of the direction of the wind, and at a ratio determined by experiment. To the lower end of the shaft is rigidly fastened a plate carrying two small roller bearings, which, as the shaft revolves, actuate a wheel, which in turn meshes into a series of other wheels; thus the miles are indicated on the registering dial. The dial is so divided as to show velocities from one hundredth of a mile to 10,000 miles, and then it repeats, commencing at zero.

This instrument is carefully made and requires no care or attention, save a little oiling, say once a month. All parts are interchangeable.

Each instrument is standardized and fully warranted; weight, 3½ lbs. ..... $ 22 00



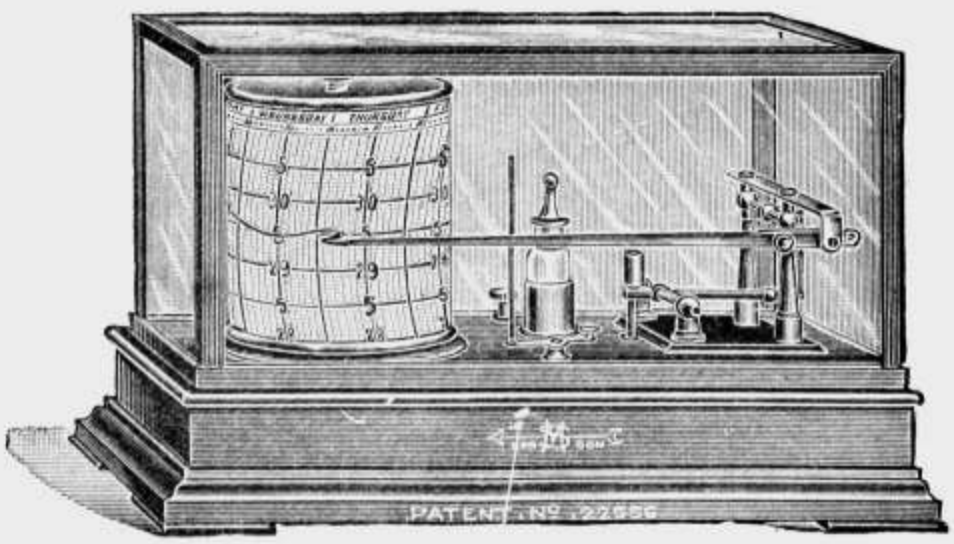
No. 1227.



No. 1229.

1229. **Barograph (Recording Barometer),** a most interesting instrument to those who take note of atmospheric variations, as a complete record is given by a pen upon a printed chart for an entire week, and, by its form, the exact barometric reading can be seen at any moment, as well as the varying line traced by the pen for the time preceding. The charts, which are changed at the beginning of each week, can be retained as a record for the entire year. The mechanism consists of a series of vacuum chambers, eight in number, joined to each other. The movement of pen is magnified by a series of levers. Chart reading 28 to 31 inches is held on a drum driven by eight day clock movement. Mahogany frame with glass case. Complete with full directions for use, charts for a year, pen and ink.....Duty free $ 30 00

1229A. **Barograph,** same as No. 1229, but in copper case, glass front and end, with handle. Cover hinged at end. Complete with directions for use, charts for a year, pen and ink.....Duty free 34 50



No. 1230.

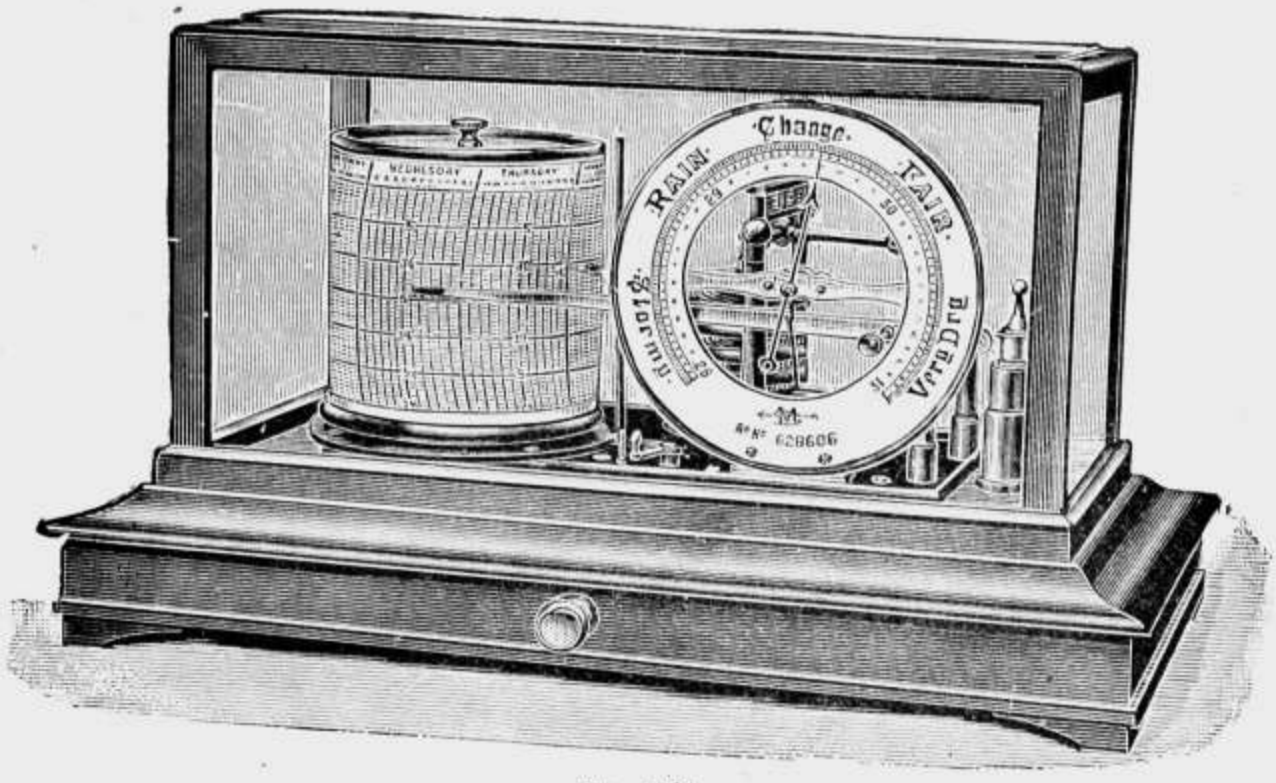
1230. **Barograph,** same as No. 1229, but of new design. The movement is concealed in the base of the instrument and is worked by a large vacuum pan. In fumed oak case, glass top and sides. Complete with full directions for use, charts for a year, pen and ink. Duty free 25 00

N. B.—**High Altitude Barographs.** Barographs Nos. 1229 and 1229 A may be so modified as to read to altitudes of 6,000 feet. A special high drum is substituted, with special charts marked in feet.
Extra charge .....Duty free 13 60

Certificate from Kew Observatory, extra..... 10 00

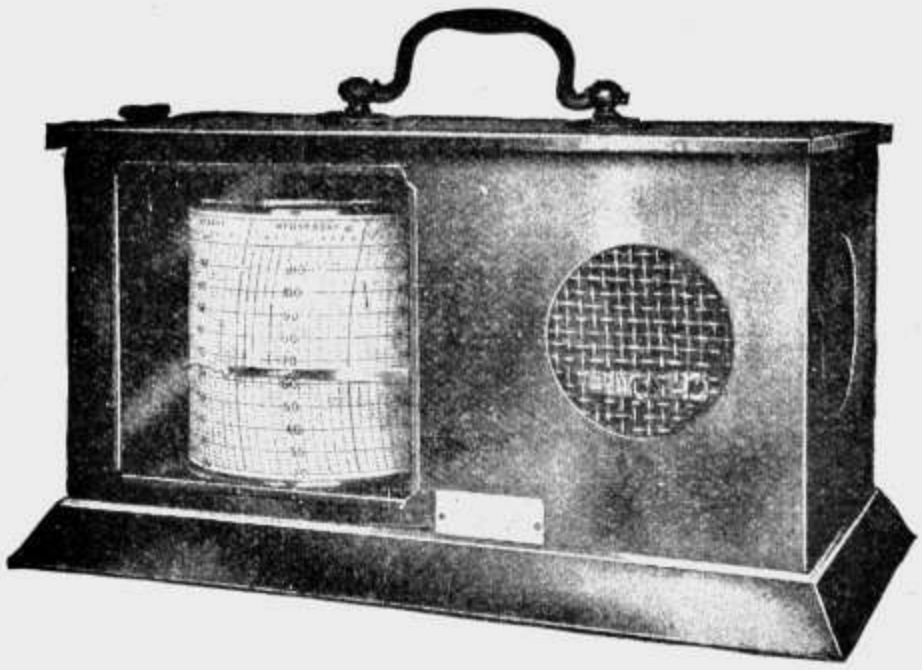
1230A. **Barograph Charts,** for barographs reading 28 to 31 inches. Per box containing one year's supply..... 2 00

1230B. **Barograph Charts,** for use with barographs with "special high drums." Per box containing one year's supply..... 2 50



No. 1231.

1231. **Barograph.** The illustrated instrument shows No. 1229 Barograph (with drawer) with metal dial aneroid attachment. For range and description of movement see No. 1229.....Duty free $ 37 50

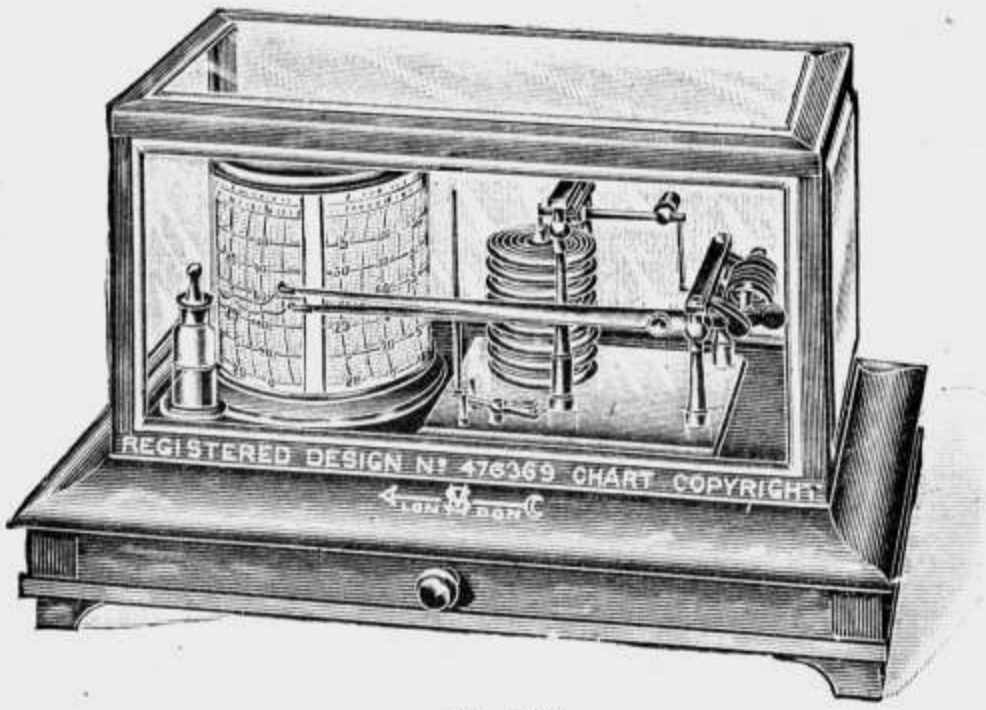


No. 1232.

1232. **Thermograph (Recording Thermometer).** A most accurate thermometer which will not vary its standard for years. A complete record is given by a pen upon a printed chart for an entire week, and by its form an exact thermometric reading can be seen at any moment, as well as the varying line traced by the pen for the time preceding. The charts are changed at the beginning of each week and can be retained as a record for the entire year. Mechanism consists of a spiral lamina of non-rusting material, which is exposed to the atmosphere at the end of the case. It is extremely sensitive and, having no levers in its construction, is very rigid. In copper case, with glass front and screened openings on three sides about the lamina. With handle. Ranges —50 to 120 degrees F. Complete with full directions for use, charts for one year, pen and ink.....Duty free 30 00

Certificate from Kew Observatory, extra..... 10 00

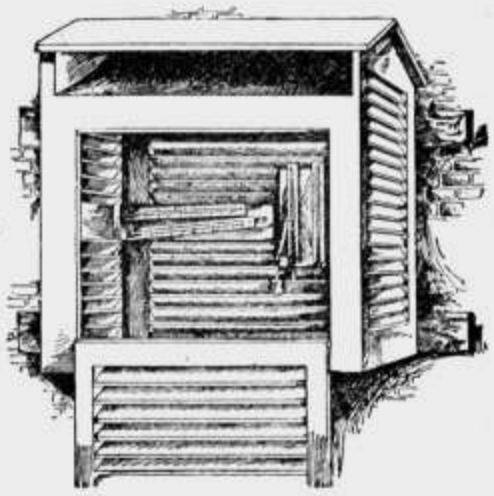
1232A. **Thermograph Charts,** for use with No. 1232, per box containing a year's supply 2 50



No. 1234.

1234. **Baro-Thermograph (Recording Barometer and Thermometer Combined),** a recent improvement whereby both barometric and thermometric tracings are made on the same chart, records being made by two pens in different colored inks (blue for the barograph and green for the thermograph). Range of the barograph is from 28 to 31 inches, while the thermograph shows a range of 0 to 120 degrees F. in 2 degree lines. In copper case, glass front and end, with handle. Cover hinged at end.....Duty free $ 50 00

1234A. **Baro-Thermograph Charts,** for use with No. 1234, per box containing one year's supply..... 2 50



No. 1235.

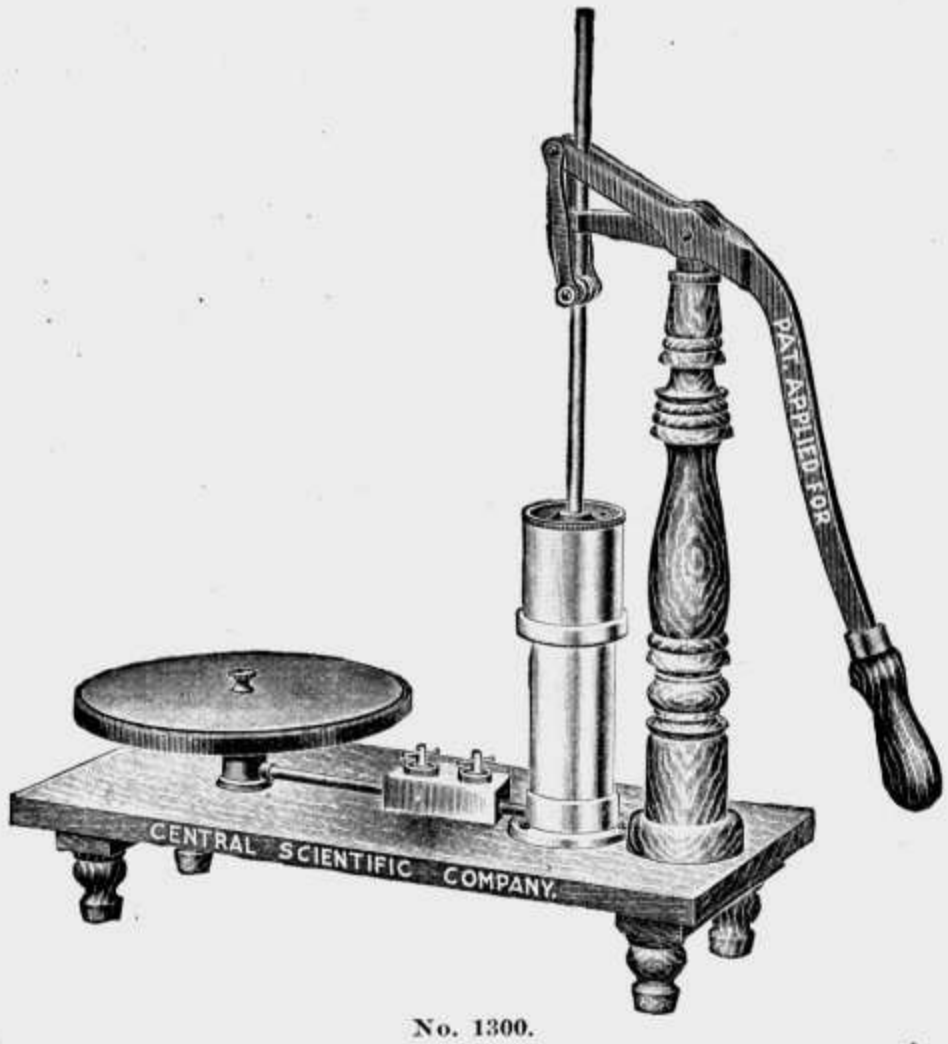


No. 1236.

1235. **Shelter.** The latest pattern Weather Bureau Instrument Shelter. Sufficiently large to hold Barograph or Thermograph and the two instruments shown in the cut. Made of best quality white pine wood, painted three coats lead paint, swing door provided with lock and key. Complete with screws for mounting..... 20 00

1236. **Sunshine Recorder.** This instrument records the duration and intensity of sunshine for twenty-four hours on a specially prepared photographic chart, which merely requires washing in cold water to become permanent. The chart being divided into hours, an exact record is thus obtained with the minimum of trouble. Complete with divided arc for adjustment of instrument to any latitude, with 100 charts and directions for use..... 16 65

1236A. **Extra Charts for Above,** per 100..... 3 30



No. 1300.

1300. **Air Pump, Automatic and Oil Sealed.** This laboratory air pump embodies the necessary features of a highly efficient pump; namely, automatic valve action and oil sealed connections and valves.

Automatic Valve. The automatic valve action is dependent wholly upon the mechanical operation of the lever and not on the receding air, which is incapable of opening the valve after a partial vacuum is secured.

Oil Sealed. Metal air cock and solder joints are not absolutely air tight, but become so when entirely surrounded with heavy oil. On this pump all joints, where leakage might occur, are sealed with oil.

Quick Action. The cylinder is 2½ inches diameter with 6 inch strokes, securing exhaustion much quicker than the Geryk and other pumps with small cylinders.

Plate. The pump plate consists of a heavy iron casting, to which is securely sealed a ground glass plate with a smooth working surface of full 10 inches diameter, large enough for all bell jars.

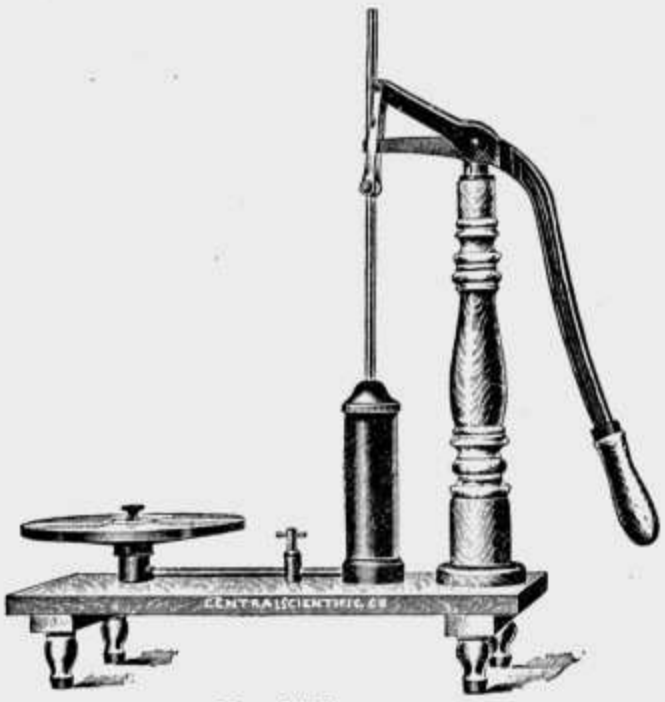
Vacuum. We guarantee this pump to produce a vacuum within 1 to 2 m. m. of perfect..... $ 33 30

1302. **Vacuum Wax.** The best preparation on the market for using on apparatus in connection with the Air Pump, especially where high vacua is desired. Will not injure the pump plate or apparatus. Will not harden and can therefore be easily removed. Superior to vaseline, tallow or heavy oil. Put up in 4 oz. jars. Each..... 40

1303. **Oil Can,** filled with fine sperm oil..... 25

1303½. **Pump Oil,** a high grade oil specially adapted for lubricating air pump cylinders and for use on oil sealed pumps such as No. 1300 above and the Geryk. Put up in ½ pint screw cap cans..... 30

1304. **Leather Washers,** as used on Air Pumps. Per dozen..... 11



No. 1305.



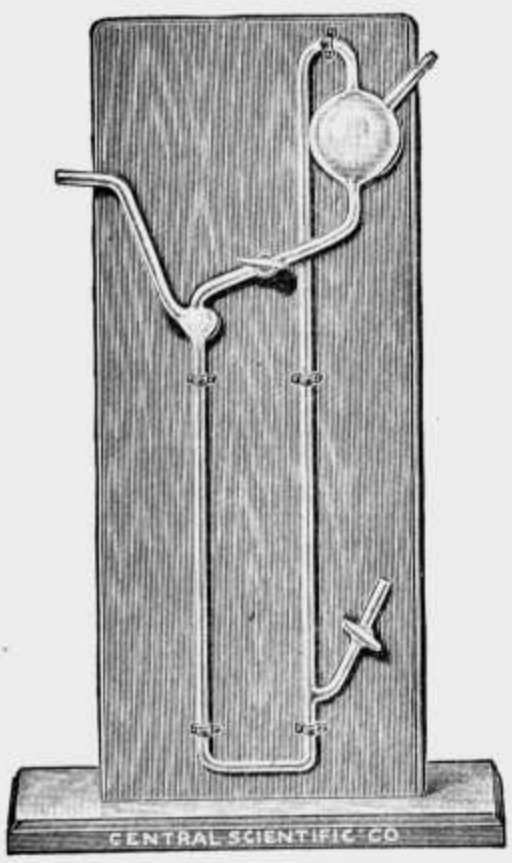
No. 1307.

No. 1309.

1305. **Air Pump,** lever action; cylinder 6½ inches long, 2¼ inches diameter, with two valves, air pump plate 10 inches in diameter of glass, ground plane and resting in a cast iron mold, with guard plug and vent screw; base and pillar of polished hardwood..... $ 22 25

1307. **Air Pump,** exhaustion and compression cylinder. Useful in elementary work in the laboratory and where only a partial vacuum is desired. Cylinder is 11 inches long by 1 inch in diameter. Nickel plated and mounted on tripod base..... 4 00

1309. **Pump Plate** for No. 1307, of cast iron, 8 inches in diameter. Ground plane and provided with brass stopcock and connecting tube. Mounted on substantial iron tripod base..... 5 00



No. 1312.

1309A. **Pump Plate,** of heavy plate glass, 10 inches in diameter ground plane and provided with brass stopcock and brass connecting tube with oil sealed taps for inlet of air and for manometer. Finest workmanship throughout..... 10 00

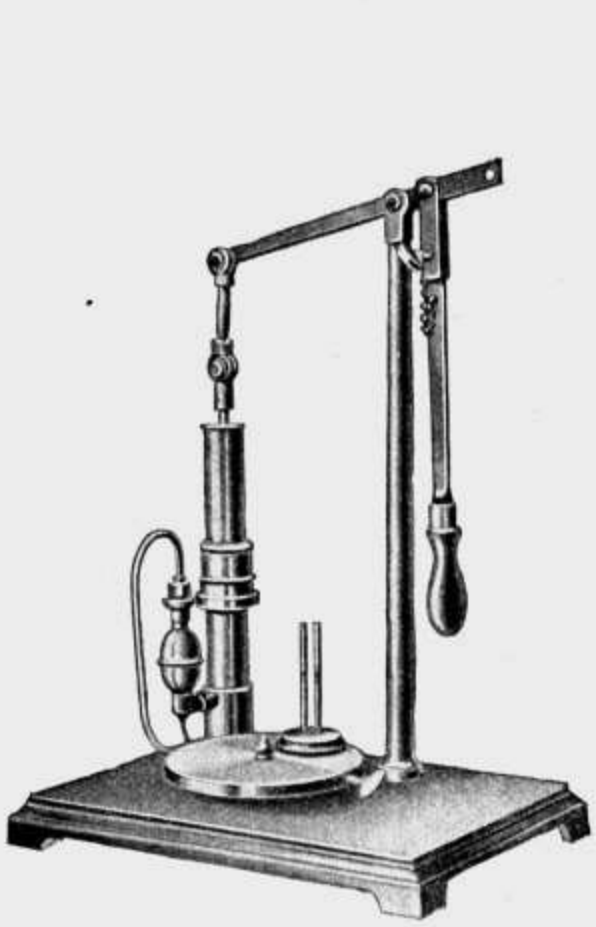
1309B. **Pump Plate,** same as No. 1309A, but without stopcock, specially adapted for use with Geryk Pump..... 9 00

1312. **Mercury Pump,** modified form of Boltwood Pump. The pump is automatic and is operated continuously by a small aspirator (filter pump). It uses only a small amount of mercury and will exhaust a flask of liter capacity, efficient for any ordinary work, in half an hour. Pump complete, mounted on hardwood supporting stand ... 13 50

1313. **Condensing Chamber** of heavy copper, with dome and sockets, without stopcocks..... 4 50



No. 1313.



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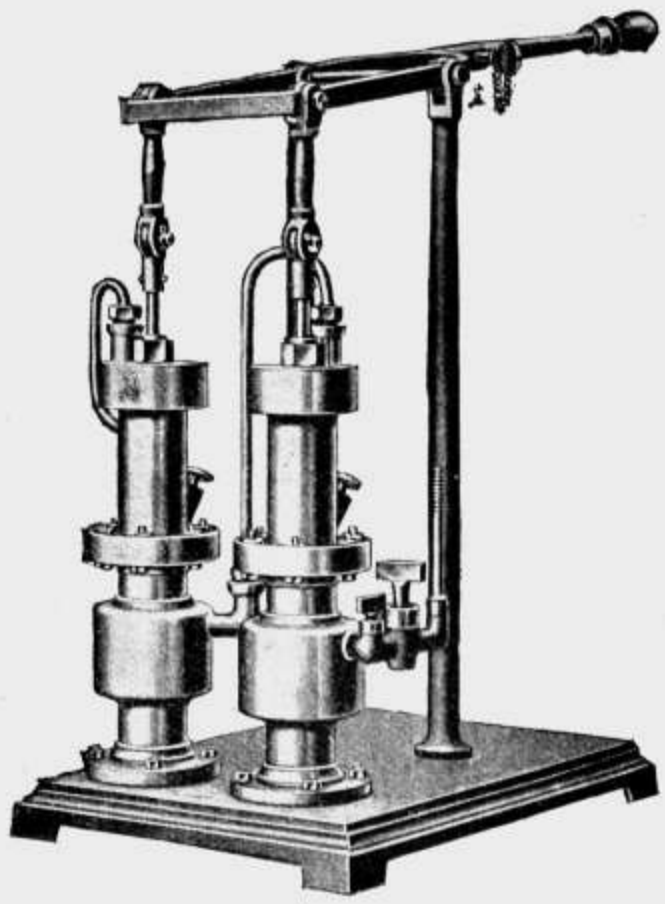


No. 1320.

"THE GERYK" MECHANICAL AIR PUMP FOR HIGH VACUA.

This is an English pump (Fleuss' patents) and is a strictly mechanical device with no valves in the usual sense of the word; the pistons work in oil, which continually follows and seals the inlets and outlets, so that leakage is impossible. There are no inside working parts to wear out, replace or adjust.

POINTS OF SUPERIORITY.

Vacuum. Equal to the Sprengel or Geissler pump.

Efficiency. Will hold its vacuum for any length of time—hence, may be worked as slowly as desired; the quantity of air removed at each stroke is positive.

Ease of Operation. There being practically no friction, very little power is required.

Rapidity. At least fifty fold that of the mercury pumps and in largest sizes one hundred to five hundred fold.

Reliability. Always ready for immediate use, even after months of idleness.

Simplicity. Nothing to go wrong; all working parts practically frictionless and immersed in oil.

1315. **Geryk Pump No. 0.** Furnished with 7 inch plate and vacuum gauge. With this pump all the ordinary phenomena can be produced. Guaranteed vacuum of 0.3 of a millimeter.....Duty free $ 30 00

1316. **Geryk Pump No. 1.** For hard laboratory service. Has larger cylinder than No. 0 and hence is more rapid. Guaranteed vacuum of 0.14 of a millimeter.....Duty free 33 50

1317. **Geryk Pump No. 1,** with vacuum plate 8 inches in diameter.Duty free 40 00

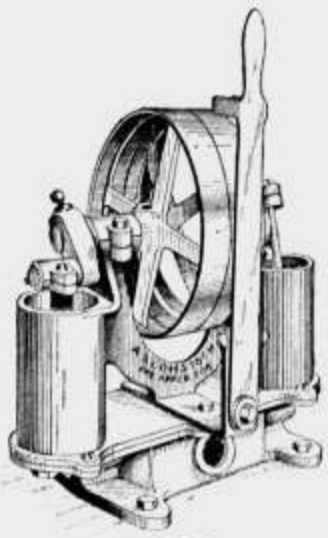
1318. **Geryk Pump No. 2,** same as No. 1, but larger.....Duty free 48 60

1319. **Geryk Pump No. 2,** with vacuum plate 9 inches in diameter..Duty free 58 60

1320. **Geryk Pump, Duplex No. 1.** For research and industrial laboratories. Two 2 inch cylinders with 5 inch stroke.....Duty free 96 50

1321. **Geryk Pump, Duplex A,** same as Duplex No. 1, but with walking beam and connecting rod driven by flywheel, to be operated by motor. ..... Duty free 125 40

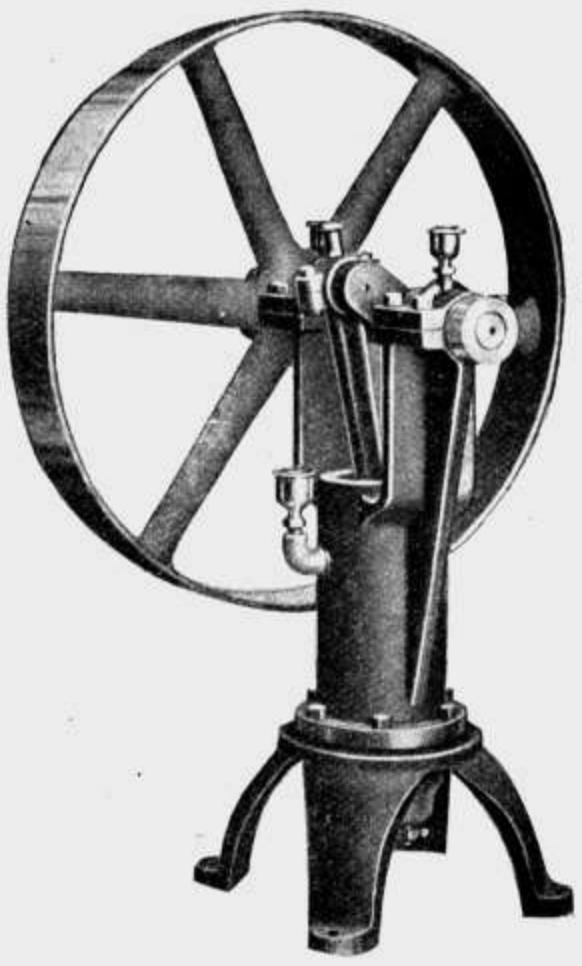
1309B. **Pump Plate** of heavy plate glass, 10 inches in diameter, ground perfectly plane and provided with brass connecting tube, with oil sealed taps for inlet of air and for manometer. Specially adapted for Geryk Pump where the use of stopcocks is not advisable..... 9 00



No. 1323.

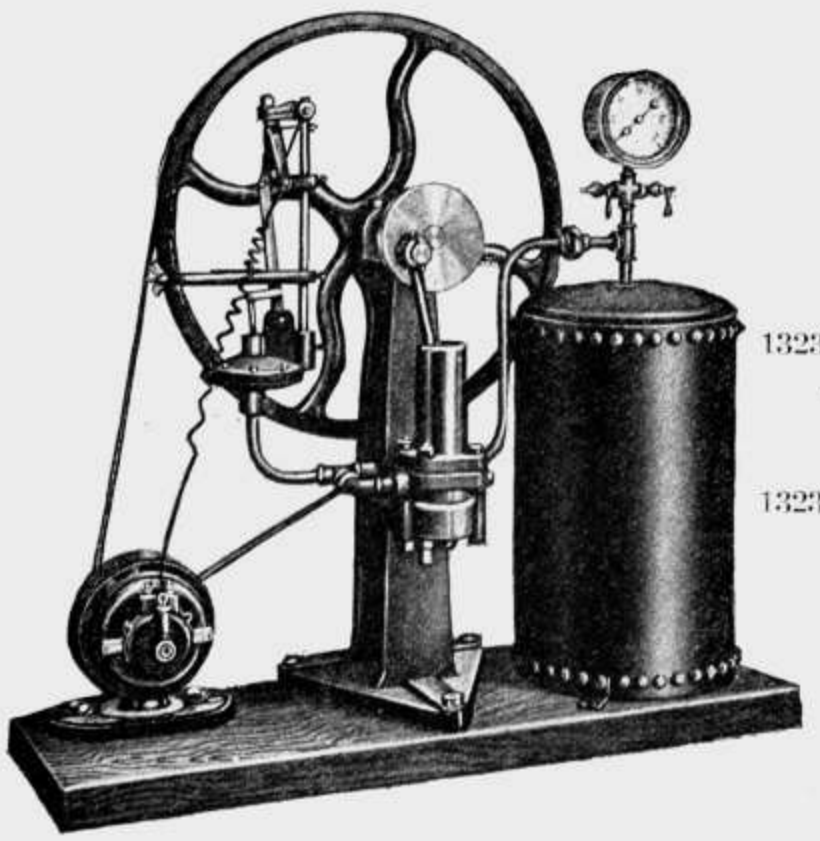
1323. **Twin Cylinder Air Pump,** for power. Bore of cylinder 2½ inches, stroke 2 inches. Efficiency claimed, 30 per cent above that of rotary blowers. Designed for fastening to floor. May be mounted on shelf if desired. Furnished with shift lever to rapidly start or stop the apparatus.... $ 16 65

1323A. **Tank,** of 12 gallon capacity. With pressure gauge..... 11 00



No. 1323B.

1323B. **Exhaust and Compression Pump Combined.** Bore of cylinder, 3¼ inches, stroke 4 inches. Capacity 3.8 cubic feet at 200 R. P. M. against a pressure of 125 pounds. Pulley 20 inches in diameter, 3 inches wide. Height of pump over all, 28½ inches; weight 86 pounds. This will be found an excellent pump for any laboratory.. 50 00



No. 1323C.

1323C. **Electric Air Compressor.** Outfit for pressures up to 40 pounds. Provided with automatic switch to start and stop the motor at variation of pressure. Complete with one gallon tank, 110 volt, series wound D. C. ⅛ H. P. motor and with all necessary accessories, mounted on base board 10x30 in.....63 50

1323D. **Automatic Electric Air Compressor.** Same as No. 1323C, but with 220 volt, series wound D. C. ⅛ H. P. motor..... 65 50

1323E. **Automatic Electric Air Compressor.** Same as No. 1323C, but with 110-115 volt 60 cycle A. C. 1-6 H. P. motor complete with centrifugal clutch pulley and self-starting up to 25 lbs. pressure.... 93 75

1324. **Blast Apparatus, Richards',** modified, for exhausting and compressing air where hydrant pressure is available; desirable for quick filtering or for blast lamps. With one Aspirator No. 1335..... $ 8 50

1324A. **Blast Apparatus.** Same as No. 1324, with two Aspirators No. 1335..... 11 00

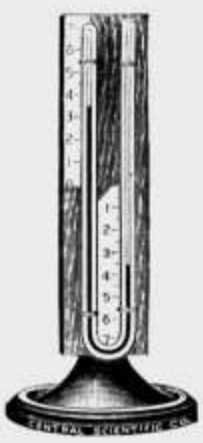
1324B. **Blast Apparatus.** Same as No. 1324, with one large Aspirator No. 1336..... 14 00



No. 1324.



No. 1325.



No. 1326.



No. 1327A.

1325. **Vacuum Gauge (Manometer),** for measuring the degree of exhaustion. Enclosed in glass tube with oxidized scale graduated in millimeters. Filled with mercury, ready to attach to pump..... 6 25

1326. **Vacuum Gauge.** To be used under a bell jar. Tube is mounted on a base with millimeter scale. Filled with mercury, ready for use..... 1 75

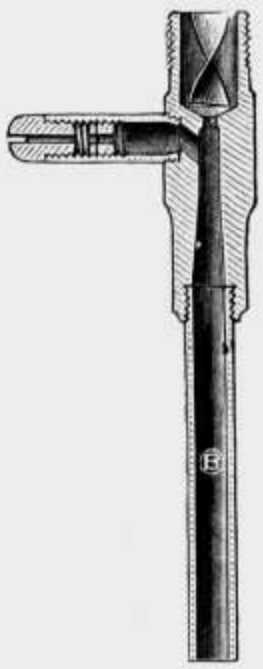
1327. **Pressure Gauge,** commercial type, improved single spring form, for air, steam or water pressure; iron case with nickel plated trimming, 3½ inch dial, range 0 to 30 lbs. per square inch..... 3 30

1327A. **Vacuum Gauge,** same type and description as No. 1327, range 0 to 30 inches 3 30

1327B. **Compound Pressure and Vacuum Gauge,** showing both pressure and vacuum on one dial, combining Nos. 1327 and 1327A, 3½ inch dial, in iron case with nickel trimmings..... 6 75

1327C. **Combination Pressure and Altitude Gauge,** especially valuable for work in hydraulics, for indicating the height and pounds pressure per square inch of water in pipe or reservoir.
To raise a column of mercury 2.04 inches or to raise a column of water 27.67 inches requires one pound pressure.
Iron case with nickel trimming, 4½ in. dial, 0 to 30 lbs. and 0 to 70 ft. 6 00

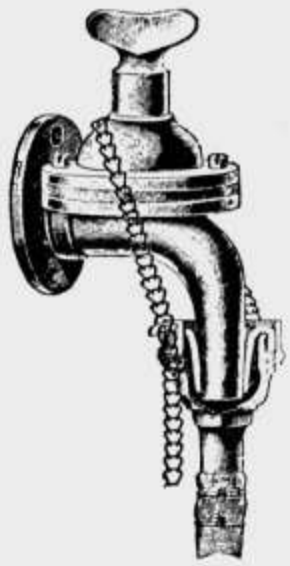
Unless otherwise specified the above gauges are furnished with back connection so as to be used with No. 1332 Coupling.
Other gauges than these listed can be supplied.



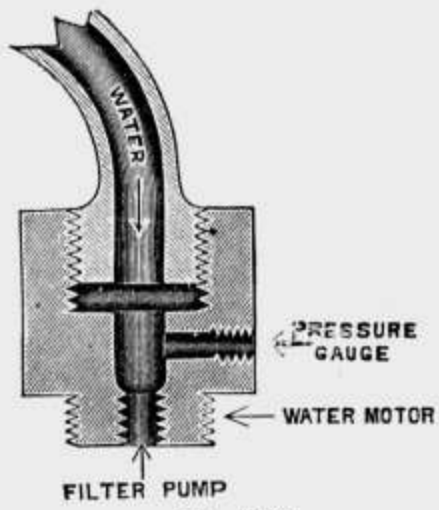
No. 1328.



No. 1328A. No. 1328B.



No. 1330.



No. 1332.



No. 1335.

1328. **Filter Pump (Aspirator).** New design. Constructed of brass on an entirely new idea and will produce a higher vacuum in less time and using one-third less water than any other pump made. Small size $ 1 25

1328A. **Coupling,** to connect No. 1328 with threaded faucet..... 33

1328B. **Coupling,** to connect No. 1328 with smooth faucet..... 50

1329. **Filter Pump,** same as No. 1328, large size..... 2 00

1329A. **Coupling,** to connect No. 1329 with threaded faucet..... 33

1329B. **Coupling,** to connect No. 1329 with smooth faucet..... 50

1330. **Coupling, Universal.** This coupling is not threaded, but merely slipped on a faucet and fastened with a chain. Can be attached to any water faucet in a minute. The best and simplest device for attaching filter pumps, stills, water motors, turbines and centrifuges to a common faucet. It is practical, self-tightening and air tight..... 2 00

1332. **Coupling,** new improved style, for attaching filter pumps, water motors, etc., to a common faucet and using a pressure gauge in connection with it. For threaded faucet..... 2 00

1333. **Filter Pump,** Prof. Richards', of brass, small..... 1 35

1333A. **Coupling,** to connect No. 1333 with threaded faucet..... 33

1333B. **Coupling,** to connect No. 1333 with smooth faucet..... 50

1335. **Filter Pump,** Prof. Richards', of brass, large..... 1 80

1335A. **Coupling,** to connect No. 1335 with threaded faucet..... 33

1335B. **Coupling,** to connect No. 1335 with smooth faucet..... 50

1336. **Filter Pump,** Prof. Richards', of brass, extra large..... 7 00

1336A. **Coupling,** to connect No. 1336 with threaded faucet..... 33

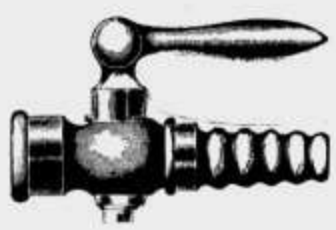
1336B. **Coupling,** to connect No. 1336 with smooth faucet..... 50

1340. **Gas Cock,** of brass, with hose end, male thread for attaching to gas pipe.

Diameter of gas pipe...	¼ in.	⅜ in.	½ in.
Each	.50	.55	.65

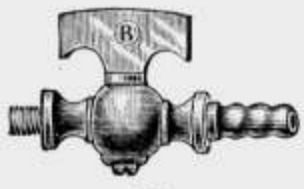
1341. **Gas Cock,** same as No. 1340, but with female thread.

Diameter of gas pipe...	¼ in.	⅜ in.	½ in.
Each	.65	.70	.80



No. 1341.

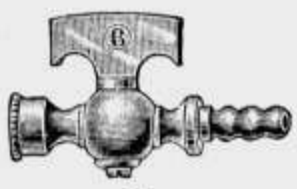

A


B


C


No. 1343.


D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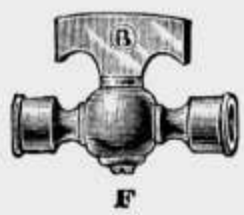

F


No. 1344.

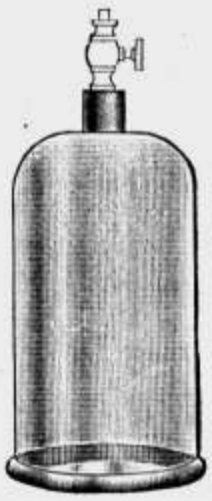
No. 1342.

STOP COCKS.

Our stop cocks are accurately made of brass and in order that they may be capable of the greatest service in the laboratory we have used the same threads as are used on all our Air Pump plates and Air Pump accessories (7-16 inch in diameter and 16 threads to the inch). Stop cocks, style A to F, are ⅛ inch bore.

1342A. **Stop Cock,** double male screw..... $ 55
1342B. **Stop Cock,** one end for tubing, the other with male screw..... 55
1342C. **Stop Cock,** both ends for tubing..... 55
1342D. **Stop Cock,** one male and one female screw..... 70
1342E. **Stop Cock,** one end for tubing, the other with female screw..... 70
1342F. **Stop Cock,** both ends with female screws..... 70
1342G. **Stop Cock,** with connector for gas bags..... 80
1343. **Nipple,** of brass, female screw..... 20
1344. **Nipple,** of brass, male screw..... 20

Glass Stop Cocks, see page 328.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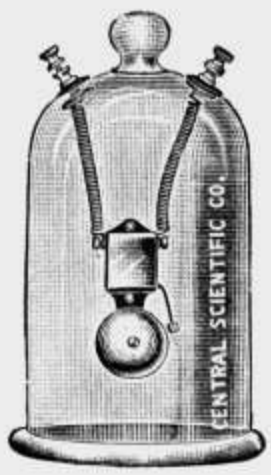

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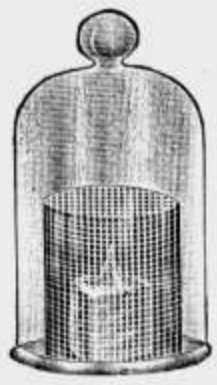
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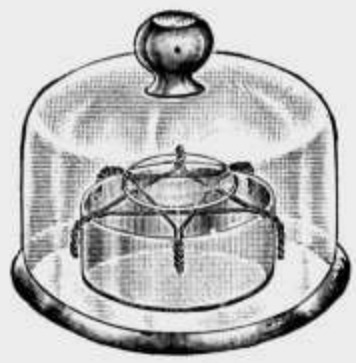

No. 1350.

1345. **Bell Glass, with Brass Cap,** to receive stop cock or sliding rod. Sold without stop cock or rod. Capacity 1 gallon..... 2 10
1346. **Sliding Rod,** with ball, hook and packing screw, for use with No. 1345. 1 10
1347. **Bell in Vacuo,** bell glass, ½ gallon capacity, with electric bell suspended by springs and brass connectors on the outside..... 3 00
1348. **Bursting Squares,** to illustrate crushing effect of atmospheric pressure. Imported German glass, 3 inches square. Per dozen..... 2 50
1349. **Wire Guard,** for use with No. 1348 to protect bell jar..... 50
1350. **Freezing Apparatus,** illustrating freezing by the rapid evaporation of ether. Complete with bell glass..... 1 40
1351. **Freezing Apparatus,** same as No. 1350, without bell glass..... 50



Nos. 1355-1360.



Nos. 1361-1364.



No. 1365.



Nos. 1367-1369.

Bell Glasses, white glass, straight form with knob top, flange ground and tested.

Number	1355	1357	1359	1360
Diameter inside	5 in.	6 in.	7 in.	8½ in.
Height inside	9 in.	11 in.	15 in.	15 in.
Capacity	½ gal.	1 gal.	2 gal.	3 gal.
Each	.90	1.10	1.65	2.25

Bell Glasses, swelled form of clear white glass, knob top, flange ground and tested.

Number	1361	1363	1364
Diameter inside	5 in.	6 in.	7 in.
Height inside	8 in.	10 in.	12 in.
Capacity	½ gal.	1 gal.	2 gal.
Each	.90	1.10	1.65

1365. **Bell Glass,** straight form, clear white glass, top for cork stopper, flange ground and tested. Capacity 1 gallon. Inside diameter 6½ inches, height 11 inches..... $ 1 10

1367. **Bell Glass,** straight form, clear white glass, ground glass stopper, flange ground and tested. Capacity ½ gallon. Inside diameter 5 inches, height 8 inches..... 1 25

1369. **Bell Glass,** same as No. 1367. Capacity 1 gallon. Inside diameter 6 inches, height 10 inches..... 1 65

1371. **Bell Glass,** straight form, extra tall, flange ground and tested. Height 22 inches, diameter 5 inches..... 3 50



Nos. 1373-1377.



Nos. 1379-1383.



No. 1385.

Bell Glasses, clear white glass, swelled form, open top, flange ground and tested.

Number	1373	1375	1377
Diameter inside	5 in.	6 in.	7 in.
Height inside	8 in.	10 in.	12 in.
Capacity	½ gal.	1 gal.	2 gal.
Each	.90	1.10	1.65

Bell Glasses, clear white glass, low form, knob top, flange ground and tested.

Number	1379	1381	1383
Diameter inside	4 in.	6 in.	8 in.
Height inside	2¼ in.	4 in.	5 in.
Each	.60	.90	1.35

1385. **Hand and Bladder Glass,** both flanges ground, medium size..... 1 00

1387. **Glass Plate,** ground to fit open top Bell Glasses above..... 11

1389. **Rubber Dam,** pure gum, per square foot..... 28

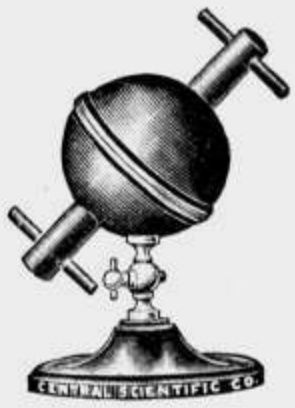
1391. **Parchment Paper,** vegetable, per sheet..... 11

1392. **Parchment Paper,** genuine animal product, 17x22 inches, per sheet.. 1 00

1393. **Bladder,** prepared and clean for bursting and covering bladder glasses. 16



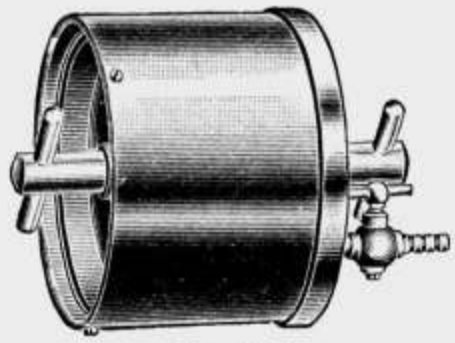
No. 1403.



No. 1413.



No. 1415.



No. 1417.

1403. **Mercury Shower,** for illustrating the porosity of wood. Mercury is poured into a funnel, which is placed over a bladder glass as illustrated. Air pressure being removed from the bladder glass, mercury speedily seeks its way through invisible pores and drops into the glass cup. Without bladder glass or cup..... $ 85

1413. **Magdeburg Hemispheres,** japanned iron, 4 inch, with detachable handles and stop cock, mounted on tripod for protection when not in use. 4 55

1415. **Bacchus Illustration.** Two bottles connected by a tube. Air may be exhausted from one bottle, which causes the water in the other to be transferred, owing to the reduction of the atmospheric pressure. 50

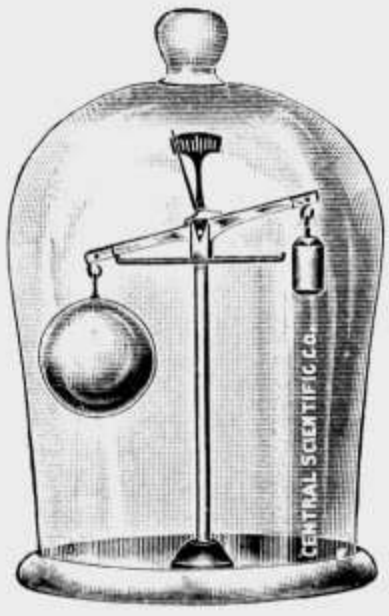
1417. **Spirometer (Seven-in-One Apparatus).** Cylinder is made of heavy, seamless brass tubing. Can be used as Magdeburg Hemispheres, Hydraulic Press, Hydrostatic Bellows, Weight Lifter, Upward Pressure Apparatus, etc. (See further description on page 82)..... 8 30



No. 1420.



No. 1423.



No. 1424.

1420. **Globe for Determining Weight of a Gas.** Air may be exhausted from globe by air pump and gas then introduced through tube connection and stop cock. Most convenient and practical form. Capacity of globe, about 1 liter..... 5 50

1421. **Weight of Air Globe,** of brass, 4 inches in diameter, with stop cock and hook 2 90

1423. **Weight of Air Globe,** of glass, 6 inches in diameter, with brass stop cock and hook..... 2 50

1424. **Baroscope,** same as No. 1421, with counterpoise, sensitive beam balance, brass support and stand with Bell Glass..... 8 90

1425. **Baroscope,** same as No. 1424, without Bell Glass..... 7 25



No. 1426.



No. 1427.



No. 1429.

1426. **Demonstration Incandescent Lamp,** according to Prof. Hans Hartl, a heavy glass globe carefully ground to fit air pump plate, with two binding posts hermetically sealed into the sides, connected with two springs which hold a piece of ebony, to which are attached two steel mercury cups; one dozen carbon filaments for 4-6 volts, which fit into the mercury cups, are included..... $ 3 30

N. B. **Carbon Filaments** for 110 volts, to fit No. 1426 Lamp, furnished if desired.

1427. **Water Hammer,** all glass, one bulb, length 25 centimeters. Illustrating that water enclosed in vacuum falls as if solid, striking the bottom of the glass tube, emitting a click as if glass was struck with a solid substance 70

1429. **Water Hammer,** two bulb, extra quality. In addition to click emitted by No. 1427, will emit musical tones..... 2 25



No. 1435.

1435. **Guinea and Feather Tube.** Aurora Tube and Fountain in Vacuo Tube combined. 110 c. m. long with removable brass caps, so that tube may easily be cleaned. Provided with brass stop cock with male end. Can be used as follows:

(1) **Guinea and Feather Tube.** Attach tube to exhaust pump. Open cock and exhaust tube. Close cock and detach tube from pump. By rapidly inverting the tube it is possible to cause both metal disc and feather to drop at the same instant. It may readily be observed that the two fall together. If the cock is opened and the air admitted, it is observed that the metal disc reaches the bottom first.

(2) **Aurora Tube.** Exhaust as before and connect metal knob and stop cock to the two terminals of a static machine or an induction coil. Generate a spark and very beautiful effects may be noticed if the room is slightly darkened.

(3) **Fountain in Vacuo.** Exhaust as in previous cases and dip end having stop cock under water. Open cock and water will rush violently into tube and stream will rise the whole length of the tube.

Complete with metal disc, feather and tripod support..... 6 65

1437. **Rubber Balloon,** small, pure gum..... 11

1439. **Rubber Balloon,** large, pure gum..... 1 10

1441. **Collodion Balloon,** for hydrogen, 1 liter capacity..... 1 10

Reaction Wheel, for use with Air Pump, page 85.



No. 1497. No. 1498.



No. 1495L. No. 1499.

HYPSOMETER. NEW DESIGN.

Experience has shown us that of the hypsometers in use among schools today, the truly high grade instruments are much beyond the resources of many teachers who desire to do work for which high grade apparatus is necessary and the lower priced instruments do not give satisfactory results.

In this design we submit an instrument capable of accurate results and recommended for the utility of its component parts.

The hypsometer consists of the boiler A (1 liter capacity), made of heavy spun copper and designed to be used as a calorimeter, and also as a boiler in heating solids for specific heat experiments in connection with the spun copper cap (E) and dipper (D). The steam jacket (B) is double walled to prevent radiation, the inner jacket receiving the steam from the boiler. The thermometer suspended in this jacket is subjected to the live steam, which then passes to the outer jacket, the part not condensed passing through the upright tube into the air, the condensed portion being drained through another tube back into the boiler.

In testing the boiling point of a thermometer this upright tube should be removed from the apparatus. This tube is to be used only when it is desired to increase the pressure in the steam chamber.

A simple mercury gauge is attached to the apparatus, as illustrated.

By adding an inner calorimeter (K) with fiber ring (H) a double walled calorimeter is secured. The wood cap (L) may be used to advantage as a cover for the double calorimeter. A stirrer (M) is alsc designed to fit this combination.

1495. **Hypsometer,** parts, as follows:

A	**Boiler**	$ 1 45
B	**Steam Jacket with Pressure Gauge**	9 00
C	**Tripod Support**	55
D	**Dipper**	1 25
E	**Metal Cover**	1 75
H	**Fiber Ring**	30
K	**Inner Calorimeter**	1 00
L	**Wood Cover,** with holes for thermometer and stirrer	25
M	**Stirrer**	50

In a complete outfit we recommend the purchase of two boiler calorimeters (A.)

1496. **Hypsometer,** complete outfit consisting of two boilers (A) and one each of parts B, C, D, E, H, K, L and M 17 50

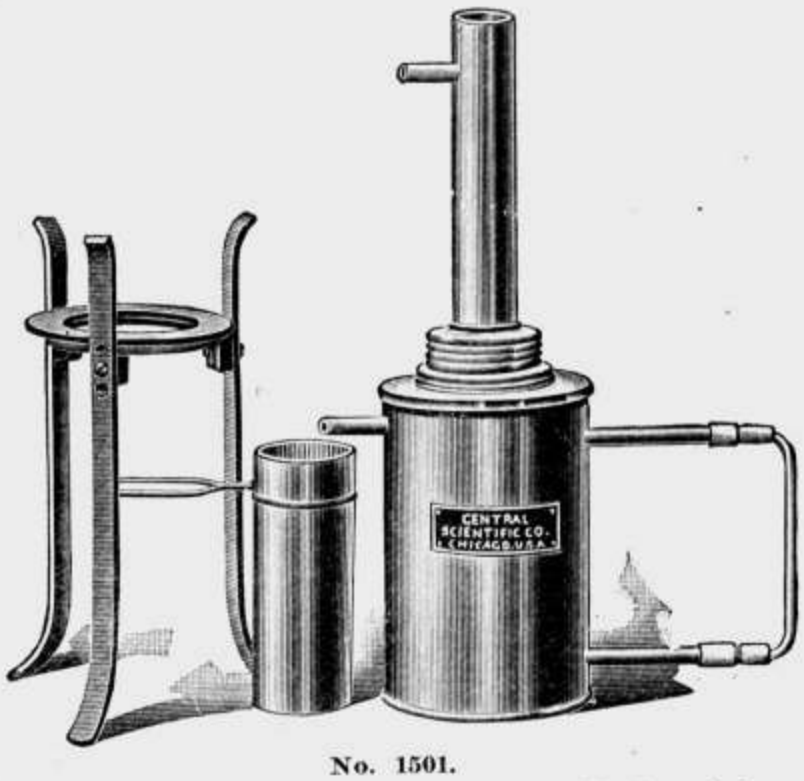
1497. **Hypsometer,** to test the boiling point of a thermometer. Consists of one each of parts A, B and C 11 00

1498. **Specific Heat Apparatus,** consisting of one each of parts A, D and E 4 45

1499. **Double Walled Calorimeter,** consisting of one each of parts A, H and K 2 75



No. 1503.



No. 1501.

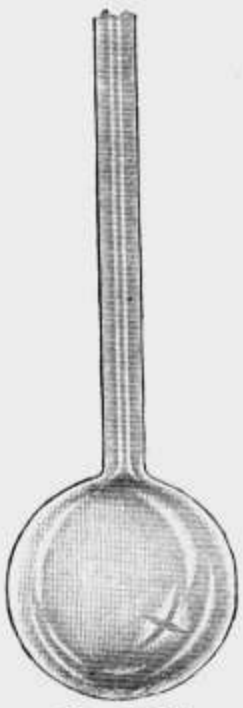


No. 1505.

1501. **Apparatus A (Hypsometer) Improved Form.** Made of heavy copper with durable water-tight joints and seams. The bottom of the boiler is concave to retain the flame, and is double seamed. The brass tubes are securely attached and will not break away from the boiler. This new model is superior to others in both construction and design. Invaluable in heat experiments, such as calorimetry, specific heat, thermometry, expansion, etc. Complete apparatus consists of boiler, thermometer tube, copper dipper, screw cap, water gauge and separate tripod..... $ 2 50

1503. **Mercury Gauge,** for steam pressure, to be used with No. 1501. Without mercury 27

1505. **Water Trap,** of glass, to catch condensation. For use with No. 1501.. 27



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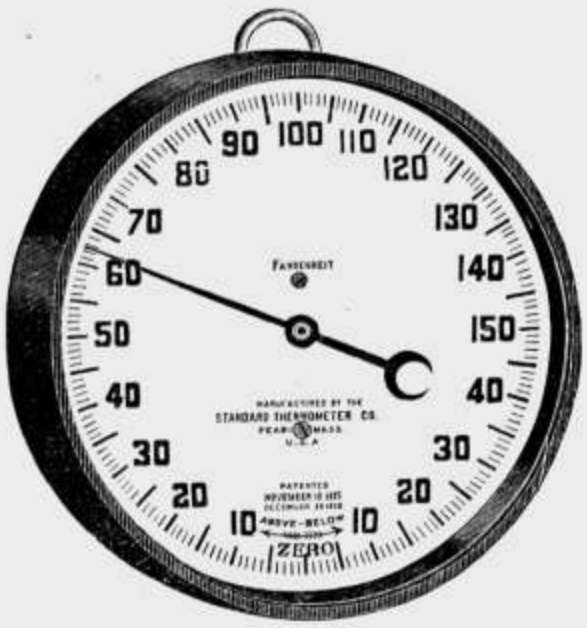


No. 1513.



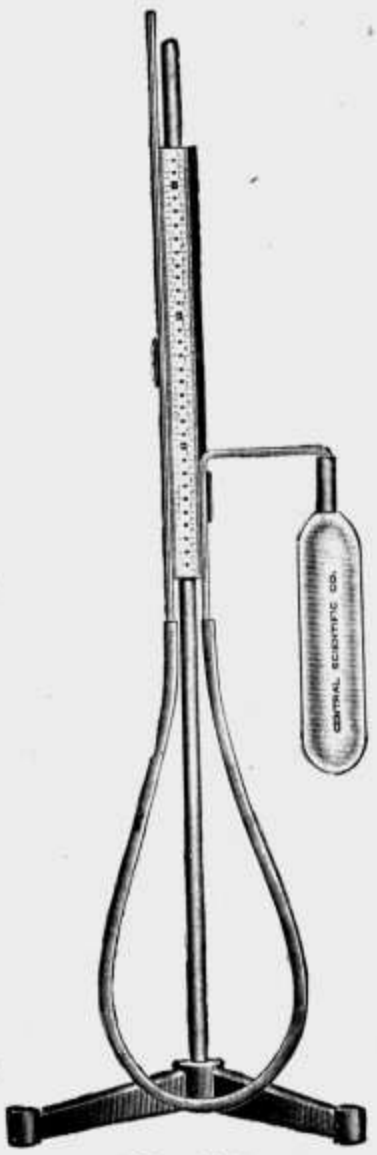
No. 1514.

1509. **Air Thermometer,** of glass, 2 inch bulb..... 17

1511. **Air Thermometer,** same as No. 1509, with capillary tube 25

1513. **Metallic Thermometer, Demonstration Form,** with glass back to show the internal mechanism, which consists of a strip of two metals soldered together and connected with an index hand by a multiplying lever. Diameter 6 inches. Range, —50 to 150 degrees F.... 4 45

1514. **Weight Thermometer** (according to Ames and Bliss), for the determination of temperature by the weight of the mercury overflow. Unfilled..... 33



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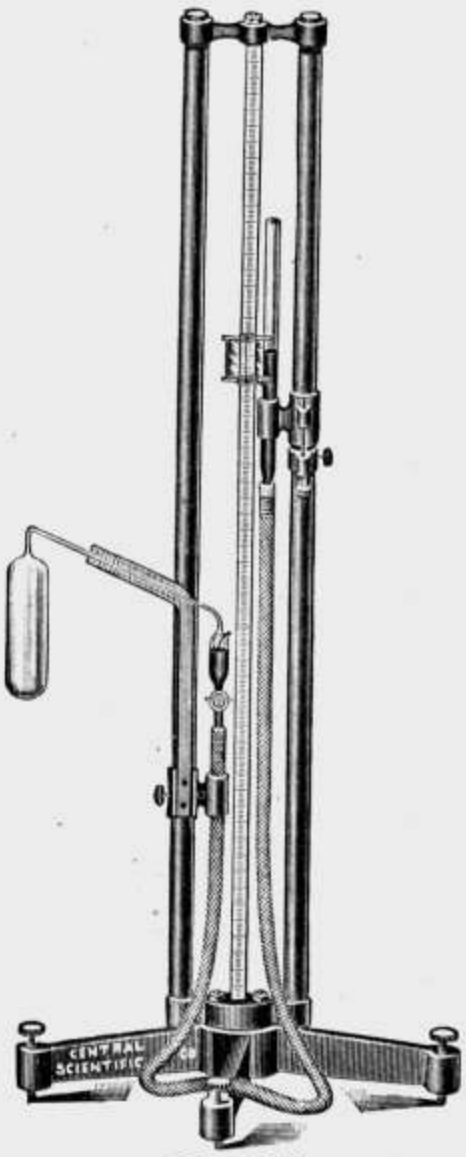


No. 1516.

1515. **Air Thermometer,** to show expansion of air or a gas and to prove the laws governing the expansion. Mounted as illustrated. Complete with full directions for operating..... $ 3 35

1516. **Air Thermometer,** height 150 c. m., mounted on heavy tripod fitted with leveling screws. Middle rod is square and provided with scale 130 m. m. in length divided to m. m. Vernier reads to 1-10th m. m. A mirror is attached behind the glass tubes which assists in reading the height of the meniscus without parallax. The two glass tubes are connected by means of steel couplings and heavy rubber tubing. Bulb is furnished with three-way stopcock and the right arm of the apparatus is provided with a fine adjustment.

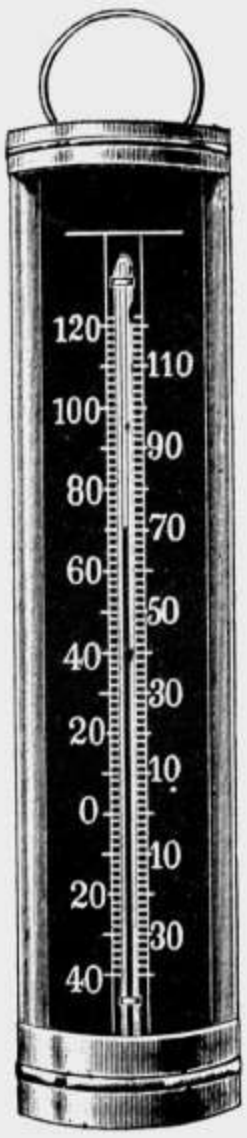
Air thermometer bulb may be taken off and a Boyle's Law Tube graduated to m. m. may be substituted (see No. 1060).

Air thermometer, with full directions..... 32 50

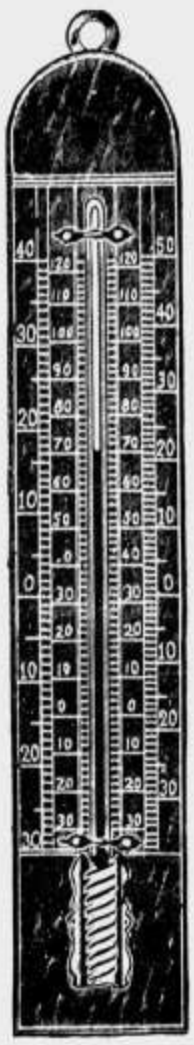
1516A. **Boyle's Law Attachment,** for No. 1516. Graduated to m. m., with stopcock and steel coupling..... 2 75

N. B.—For **Boyle's Law Apparatus with Air Thermometer Attachment** see page 84.

THERMOMETERS.



No. 1517.



No. 1521.

1517. **House Thermometer,** standard grade, 10 inch, heavy japanned tin case, accurately tested..... $ 1 10

1519. **House Thermometer,** 8 inch, metal scale, maple back, oval edge, with brass guard over bulb.... 65

1521. **Three Scale Thermometer,** boxwood, F. R. and C. scales..... 80

1523. **Ungraduated Thermometer,** for student use in thermometry. Same as No. 1533 Thermometer, 100 degree C. stem scale, filled with mercury, but with no graduations. Per dozen... 5 00

Our **Chemical Thermometers,** Nos. 1527 to 1547, are of standard quality from the best German manufacturers, and made of Jena glass 16III, which is much superior to Thuringen glass in that the latter is liable to alter in course of time. The accuracy of the described thermometers is guaranteed. We also furnish wooden cases for these thermometers, as it avoids breakage in the laboratory.

1525. **Chemical Thermometer,** enclosed paper scale, tube 200 x 7 millimeters; graduated to 110 degrees C. 40

1527. **Chemical Thermometer,** enclosed hand written scale, tube 325 x 7 millimeters, in wood case.

Centigrade scale	—10 to 110°	—10 to 210°
Price each	.60	1.00

1529. **Chemical Thermometer,** same as No. 1527, but with

Fahrenheit scale	17 to 220°	17 to 400°
Price each	.60	1.00

1531. **Chemical Thermometer,** same as No. 1527, with double scale; —10 to 110° C. and 17 to 220° F..... .90

1533. **Chemical Thermometer,** scale engraved on stem, white enameled back, tube 325 x 7 millimeters.

Centigrade scale	—10 to 110°	—10 to 210°	—10 to 360°
Price each	1.00	1.10	1.50

1535. **Chemical Thermometer,** same as No. 1533, but with

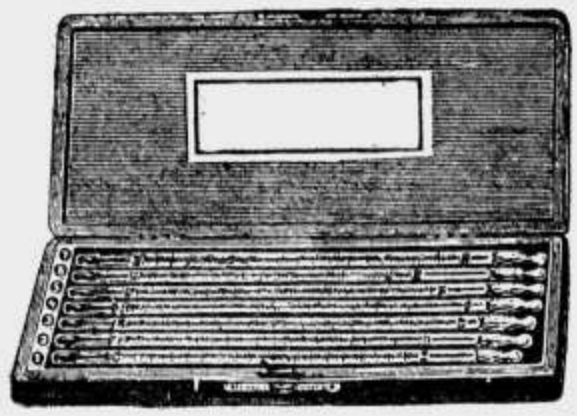
Fahrenheit scale	17 to 220°	17 to 400°	17 to 600°
Price each	1.00	1.10	1.50

1537. **Chemical Thermometer,** same as No. 1533, with double scale—10 to 110° C. and 17 to 220° F..... $ 1 50

1539. **Chemical Thermometer,** enclosed porcelain scale, tube 325x7 m. m.

Centigrade scale ....—10 to 110°	—10 to 210°	—10 to 360°	
Price, each	1.00	1.10	1.50





No. 1546.

1541. **Chemical Thermometer, standard,** scale engraved on stem, white back.

Tube	550 x 8 m. m.	660 x 8 m. m.
Centigrade scale	100° in 1-5°	100° in 1-10°
Price, each	3.35	3.60

1543. **Chemical Thermometer,** stem scale, similar to No. 1533, with white glass back, accurately graduated and furnished **with certificate.**

Centigrade scale	—10 to 100°	—10 to 200°	—10 to 320°
Price, each	2.00	2.50	3.00

1545. **Chemical Thermometer,** scale engraved on stem, the whole enclosed in a Jena glass tube, so-called "insulated thermometers," indelible, invaluable for work in acids. 110° C., 2.00; 300° C..... 2 50

1546. **Normal Thermometers,** finest grade of thermometers for special research work in laboratory, fractional distillation, etc. Opal glass scale, very small mercury bulb. Instruments No. 5, 6 and 7 are filled with nitrogen to guard against a distillation of mercury.

No. 1.....— 15 to 55° C.	No. 2..... 45 to 105° C.
No. 3..... 95 to 160° C.	No. 4.....140 to 220° C.
No. 5..... 195 to 260° C.	No. 6.....250 to 310° C.
No. 7.....295 to 350° C.	

Set of seven, each about 6 m. m. in diameter and 16 c. m. long, divided in fifths of degrees.....Duty free 15 00

1547. **Normal Thermometer,** same as No. 1546, but graduated in tenths of degrees and about 27 c. m. long.....Duty free 18 50

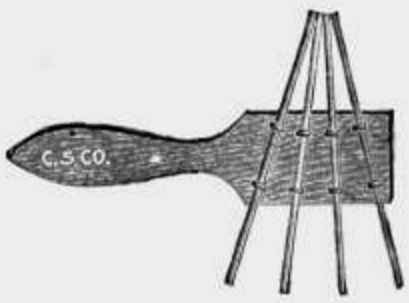
NOTE—The above sets will be furnished with Reichsanstalt certificate at an extra charge.

Beckman's Thermometers, page 346.

Pentane Thermometers, page 346.

U. S. Weather Bureau Thermometers, etc., page 91.

Leslie's Differential Thermometers, page 120.



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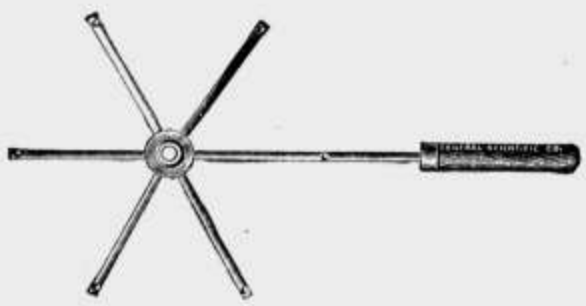

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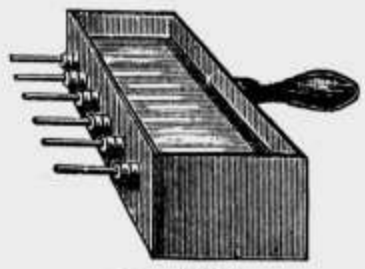


No. 1550.

1548. **Conductometer,** four wires of different metals fastened to a board.... $ 35

1549. **Conductometer,** brass hexagon, with stem and wooden handle, and five rods maxing six different metals, cavities on the end of each rod for phosphorus 1 65

1550. **Conductometer,** after Ingenhaus, copper tank 3 x 12 inches and 2 inches deep, with six rods of different metals, with cavities on the end of each to hold phosphorus..... 3 00



No. 1551.



No. 1553.

1551. **Ball and Ring,** illustrating expansion of metals with application of heat. Ball heated will not pass through ring. Made of brass with hardwood handles 1 10

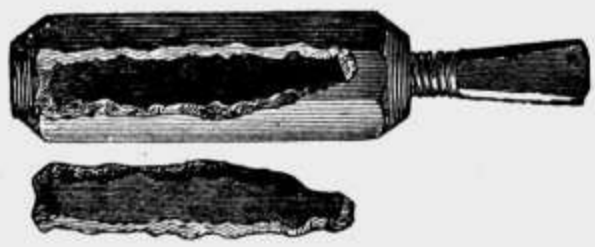
1553. **Compound Bar,** illustrating unequal expansion of metals.' Made of brass and iron riveted together, hardwood handle..... 95



No. 1555.



No. 1557.



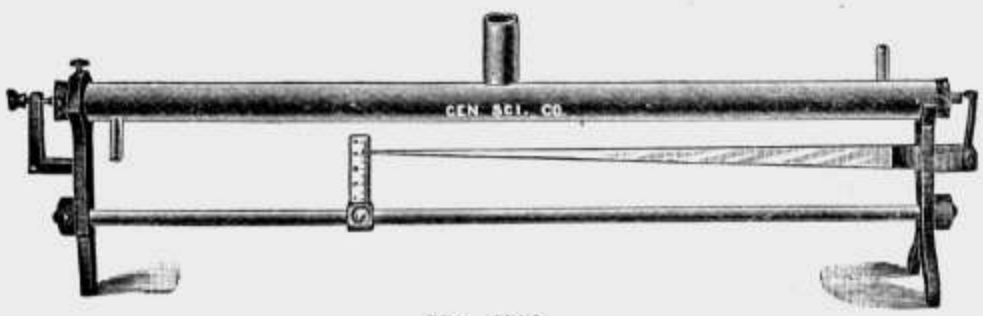
No. 1556.

1555. **Pulse or Palm Glass,** two glass bulbs holding colored liquid in partial vacuum. One bulb warmed in palm of hand will transmit heat to the contained air and force the liquid into the other bulb..... 45

1556. **Ice Bomb,** bottle form. Made of iron with tight-fitting screw plug. When filled with water and put in freezing mixture, water freezes and expands causing the bomb to burst open..... 1 50

1557. **Cryophorus,** illustrating principle of freezing by rapid evaporation.. 1 65

1558. **Candle Bomb.** Consists of glass bulb filled with water and sealed. Upon application of heat, steam is formed which fills more space than water and causes the bomb to burst. Per dozen..... 40



No. 1559.

1559. **Linear Expansion Apparatus.** Improved design, made entirely of metal. Nickle-plated brass tube for steam jacket and Bessemer steel rod. Superior over other forms made with wooden base which warps and bends with every humidity change in the laboratory, or when in contact with the moisture from escaping steam during experiment $ 2 65



No. 1561.

1561. **Linear Expansion Apparatus,** same as No. 1559, but better workmanship and with the addition of micrometer screw reading to .01 m. m. and binding posts for electrical connections..... 4 00
1563. **Aluminum Rod,** for No. 1559 or No. 1561..... 30
1564. **Copper Rod,** for No. 1559 or No. 1561..... 45
1565. **Brass Rod,** for No. 1559 or No. 1561..... 30
1566. **Nickel-Alloy Rod,** expansion coefficient practically nil, for No. 1559 or No. 1561..... 1 25

Apparatus A, for use with above, listed on Page 110.



No. 1568.



No. 1570.

1568. **Cubical Expansion Apparatus,** for liquids. Consists of bulb of known volume, provided with capillary neck of known diameter. The rise of the liquid in the neck is observed for a given rise in temperature 2 00
1570. **Expansion Apparatus,** for fluids. Brass cylinder closed at both ends, one end provided with outlet tube, the other end with three openings, for inlet tube, thermometer and a tube closed at one end for receiving liquid to be tested, without thermometer..... 3 00
1572. **Cubical Expansion Apparatus,** for liquids. Same as No. 1570, but closed tube graduated in millimeters..... 3 75



No. 1573.



No. 1574.

1573. **Junker Calorimeter,** Mann's modification for determining the heat units of a burner from a given amount of gas consumed. Consists of a double walled copper vessel provided with a number of tubes or flues so arranged as to receive the heat from a Bunsen flame. These tubes coming in contact with water which is running continuously through the Calorimeter give up their heat. A thermometer placed in the orifice at the top registers the temperature of water at entrance, a second thermometer placed in orifice at the bottom registers the temperature at delivery. Any convenient gas measuring apparatus will give the amount of gas supplied the burner. A vessel placed to catch water delivered, gives amount of water passing through the Calorimeter. Complete with tripod support, but without gas meter or thermometers ..... $ 11 00

1574. **Thorpe Gauge,** a convenient form of measuring both the pressure and the rate of flow of gas.

When the gas supply is attached to the inlet and the cap is screwed down over the outlet at top, the index reads on left hand scale the pressure in inches of water.

When the cap is removed from outlet and the gas is allowed to flow through the instrument (e. g.) testing the rate of consumption of a burner, the indicator registers on the right hand scale the rate of flow in cubic feet per hour..... 12 00



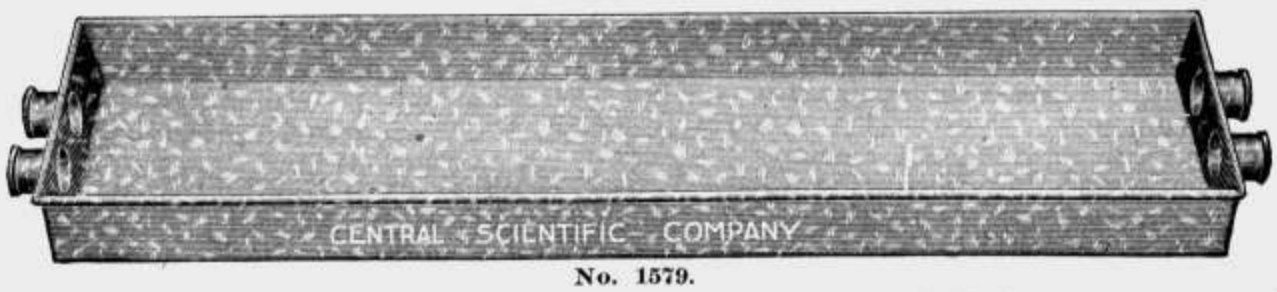
No. 1576.



No. 1577.

1576. **Ice Chipper,** for use in quickly chipping ice to small bits of a size convenient for calorimetric determinations. Tinned iron frame, wood handle. Each..... 80

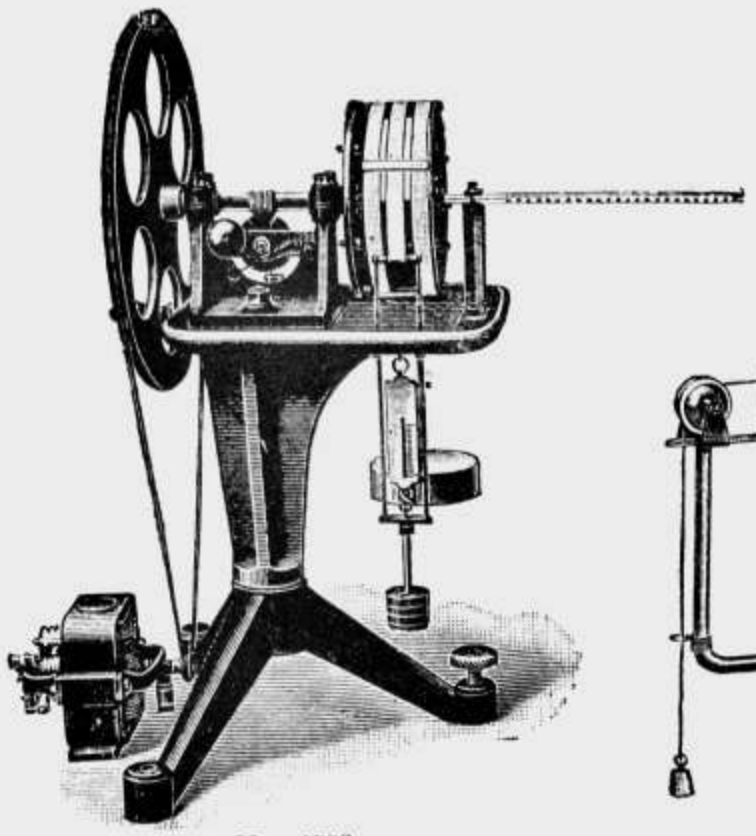
1577. **Ice Shredder,** for shaving ice, coarse or fine, as may be desired, of tinned iron with removable steel cutter, self-emptying. Each..... 65



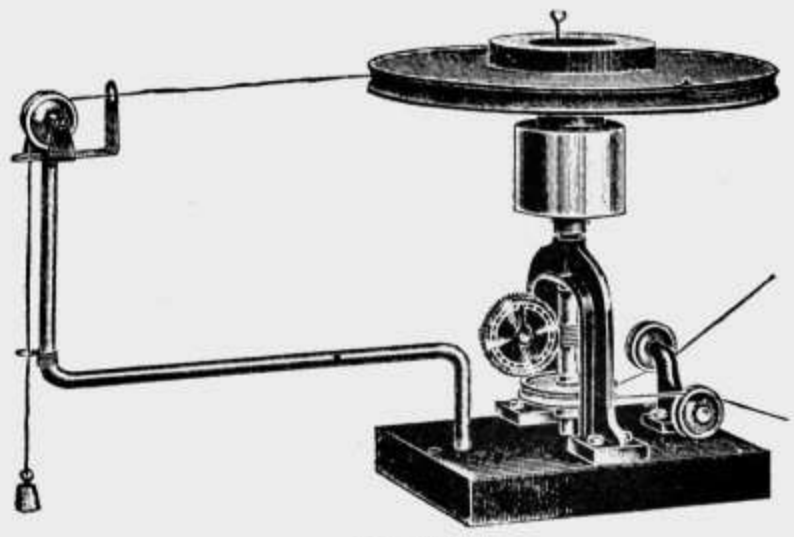
No. 1579.

1579. **Ice Tray,** of galvanized iron with four tubulatures 60x15x5 c. m..... 1 65

1580. **Ice Bag,** of canvas, for breaking ice..... 22



No. 1583.



No. 1584.

1583. **Mechanical Equivalent of Heat, Callender's Apparatus.** Consists of a cylindrical calorimeter of thin brass, whose axis is horizontal, containing a known quantity of water. This cylinder is rotated at a moderate speed either by hand or by means of a water or an electric motor. The equal weights are suspended from the ends of a silk belt slung over the cylinder, and so arranged as to make one and one-half complete turns around the cylinder. Stability of equilibrium is secured by the addition of a light spring balance, which acts in direct opposition to lighter weight. Since this spring balance contributes only a small positive term to the effective difference of load at the two ends of the belt, small errors in its reading are relatively unimportant. The weights are adjusted by trial to suit approximately the friction of the belt, the final adjustment being effected automatically by the spring balance. A counter registers the number of turns, while the rise of temperature is read by means of a bent thermometer inserted through a central opening in the front end of the cylinder.

With this apparatus a lecturer can obtain, in about ten minutes, in the presence of a class of students, a value of "J" correct to ½ per cent.

Complete with thermometer, but without motor.....Duty free $ 90 00

1584. **Mechanical Equivalent of Heat Apparatus.** Consists of a mounted vertical spindle rotated by means of a driving pulley. Two brass truncated cones fit closely one within the other and are held in a brass cup lined with cork. The inner vessel is fitted to a horizontal wooden wheel and turns with it. A weight of about 250 grams is attached to a cord which passes around the edge of the wooden wheel. When spindle is rotated friction is caused between the two cups, which heats a known quantity of water placed inside the inner cup. A counter shows the number of revolutions made and a thermometer inserted in the water gives the rise in temperature; from these data the mechanical equivalent of heat may readily be determined .....Duty free 30 00

1584A. **Hand Wheel** on bracket, for driving No. 1584.....Duty free 5 00

1585. **Tube for Mechanical Equivalent of Heat** (Millikan and Gale, Exp. 20). Consists of a tube 1 meter long made up of a number of layers of heavy brown paper securely fastened together. The rise in temperature is secured by allowing shot to fall a number of times through the length of the tube..... 72



No. 1589.



No. 1590.



No. 1592.



No. 1595.



No. 1599

1589. **Calorimeter,** of thin brass, nickle-plated and finely polished. Three inches in diameter, 5 inches high..... $ 50

1590. **Calorimeter,** of heavy copper with accurate internal dimensions. Capacity about 125 c. c. May also be used in "measurement experiments" 44

1592. **Calorimeter,** double walled of heavy spun copper, nickle-plated, outer vessel 1 liter capacity, inner vessel suspended by fibre ring, complete with wood cover (No. 1495L) and stirrer (No. 1495M) see page 109 ..... 3 50

1593. **Calorimeter,** same as No. 1592, without cover and stirrer. This is the most popular Calorimeter for laboratory work..... 2 75

1595. **Ice Calorimeter,** after Bunsen. Glass part only. For determination of specific heat of solids or liquids where only a small portion of the substance is available 1 25

1599. **Calorimeter** for determining the heating effect of the electric current and Joule's law, simple form, after Gage, including thermometer 3 35

1602. **Electric Calorimeter,** after Millikan, for determining the calories of heat developed in a wire, and to test the calibration of a voltmeter by the absolute determination of the P. D. Consists of two heavy copper vessels, the inner having a capacity of about 350 c. c., which is supported and insulated from the outer by a fibre ring. A coil of fine platinum wire wound on an insulating ring is connected to two brass rods which support the coil to the fibre cover, and connect it to the binding post terminals. Provided with improved stirrer with insulated handle, neatly finished and nickle-plated, without thermometer 12 00



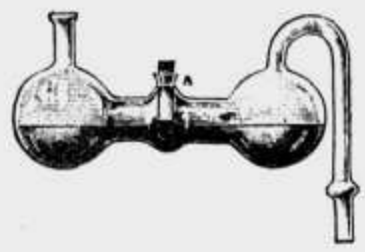
No. 1602.

Temperature Coils and Continuous Flow Calorimeter, page 192.

1608. **Lead Shot,** for use in specific heat experiments.....Per pound $ 16
1609. **Copper Shot,** for use in specific heat experiments.....Per pound 45
1610. **Glass Beads,** for use in specific heat experiments.....Per pound 1 10
1611. **Aluminum Shot,** for use in specific heat experiments.....Per pound 1 10
1612. **Steel Shot,** for use in specific heat experiments.....Per pound 33



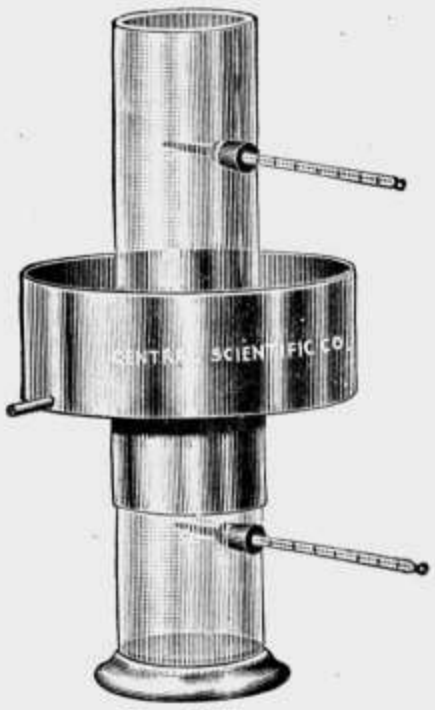
No. 1613.



No. 1614.

1613. **Tyndall's Specific Heat Apparatus,** complete with plate, paraffine cake, support and five balls of different metals. Balls are held on support and heated, when dropped on paraffine cake they will melt their way through the cake at different rates, depending on their specific heats 2 00

1614. **Ice Machine,** after Carré. Small fused in test tube is half filled with ether and the apparatus one-third filled with sulphuric acid (C. P.). The projecting neck tube is fitted air tight to a flask filled one-third with water to be frozen, the other tube is connected air tight to an aspirator or air pump by means of a stopper and tubing. Air exhausted from apparatus causes rapid evaporation of the water in the flask, freezing it and the absorption of the water vapor by the sulphuric acid generates heat sufficient to boil the ether, blowing out the stopper 2 50



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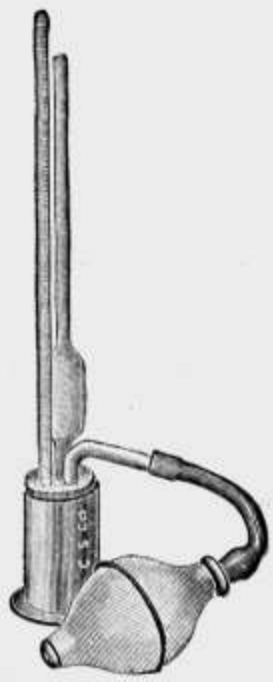


No. 1617.

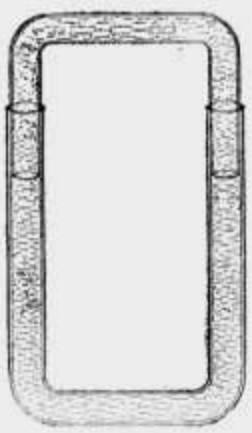


No. 1618A.

1615. **Maximum Density of Water Apparatus,** glass jar with copper reservoir, for freezing mixture, without thermometers..... 5 00
1616. **Dew Point Tube,** nickle-plated brass tube..... 55
1617. **Dew Point Apparatus,** (Millikan). Consisting of a nickle-plated vessel with rubber bulb, cork and glass tubing, but without thermometer, to be used with ether..... 1 22

N. B.—See also No. 1350. **Freezing Apparatus,** page 105.

1618. **Fire Syringe,** brass cylinder with piston and piece of tinder. Illustrating generation of heat due to compression of a gas..... 1 65
1618A **Fire Syringe, Glass Cylinder.** This type of Fire Syringe has a heavy glass cylindrical barrel 1¼ in. x 8 in. with a ½-in. piston. Sure results are possible with this instrument and the phenomenon is entirely visible 6 65



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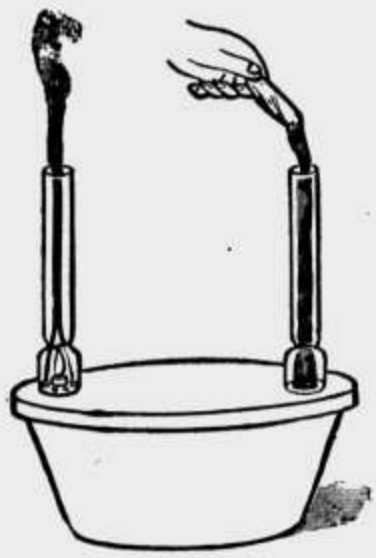

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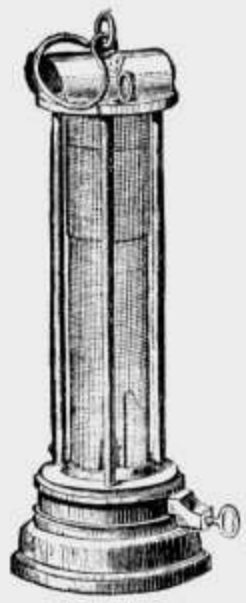


No. 1625.

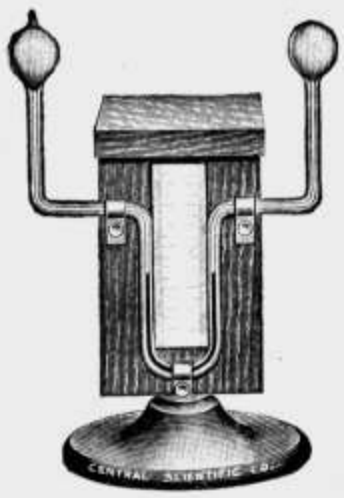
1619. **Circulation Apparatus (convection of liquids),** improved form..... 1 20

1621. **Convection Apparatus (convection of gases).** A closed tin vessel, with holes to surround a candle near one edge, a hole on the opposite edge. Two student lamp chimneys, complete..... 1 05

1623. **Ventilation Apparatus,** a glass cylinder (contracting at the top), to place over a short candle, a tin partition, for upward and downward currents 1 65

1624. **Touch Paper,** per sheet..... 11

1625. **Davy's Safety Lamp,** as used in mines..... 2 50



No. 1630.



No. 1633.



No. 1636.

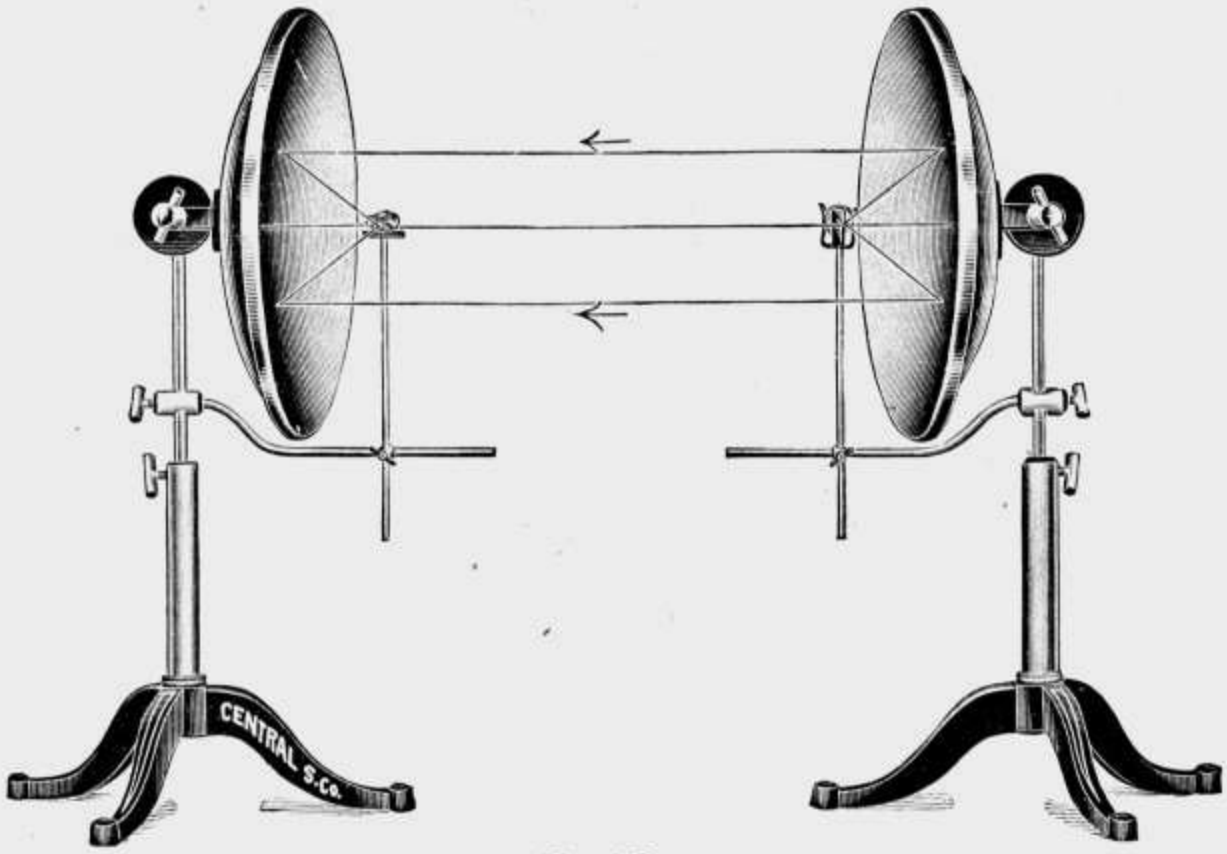
1630. **Differential Thermometer,** for showing differences of temperature between two neighboring positions. This form, designed for the convenient manipulation of Leslie's cubes, the platform being provided especially for the purpose, may also be used in all experiments where Leslie's thermometers are used..... 3 30

1631. **Differential Thermometer,** (Leslie's), on stand with scale, German form 2 00

1633. **Leslie's Cube or Radiator.** Consists of four polished faces of different metals 1 65

1635. **Leslie's Radiating Cube,** painted in four different colors with three-sided protecting case. Complete with one-hole rubber stopper for thermometer. Without thermometer..... 1 65

1636. **Radiometer,** illustrating many interesting phenomena of radiant heat. Mounted on glass base..... 2 00



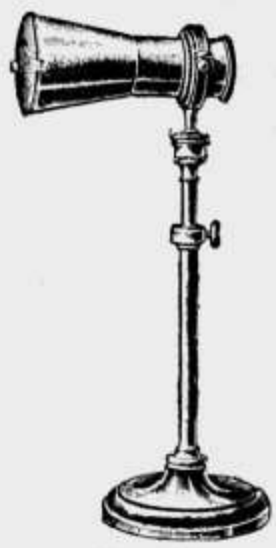
No. 1639.

1637. **Parabolic Reflectors,** a pair 10 inches in diameter mounted on tripod stands. The backs of our reflectors are not fastened by a clamp, but held by the rims by a special spring device. This arrangement obviates all danger of destroying the parabolic surfaces by any strain at the back or by accidentally dropping the reflectors. Highly polished surfaces, accurately constructed 6 00

1639. **Parabolic Reflectors,** a pair of same general construction as No. 1637, but 12 inches in diameter and provided with ball and phosphorus holder, completely adjustable 13 50



No. 1647.



No. 1651.

1645. **Thermo-Electric Pair,** simple pair, brass and German silver..... 50

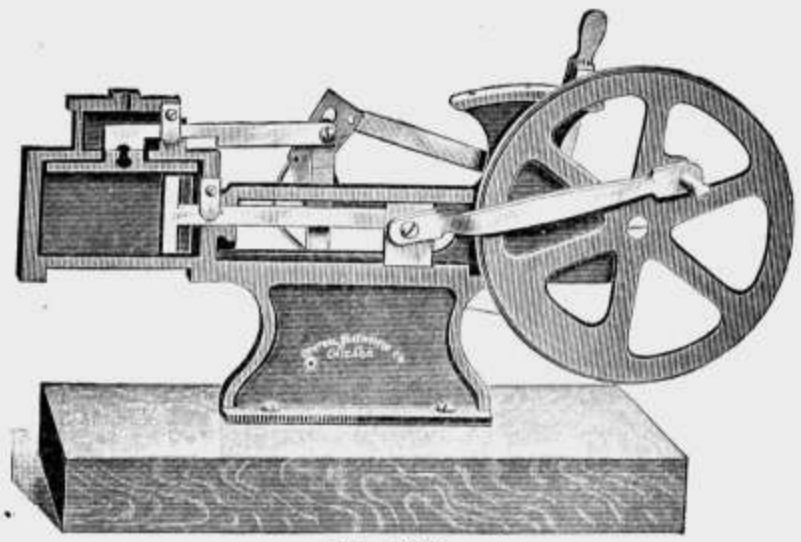
1647. **Thermo-Electric Pair,** of German silver and copper, on brass stand, with agate cap astatic needle..... 3 00

1649. **Thermo-Multiplier,** five pairs, German silver and brass with mica insulation and connecting wires..... 2 50

1651. **Thermo-Multiplier,** twenty-four pairs of bismuth and antimony, on adjustable brass stand with two brass cones.....Duty free 16 00

1653. **Thermo-Multiplier,** same as No. 1651, but sixty pairs.....Duty free 30 00

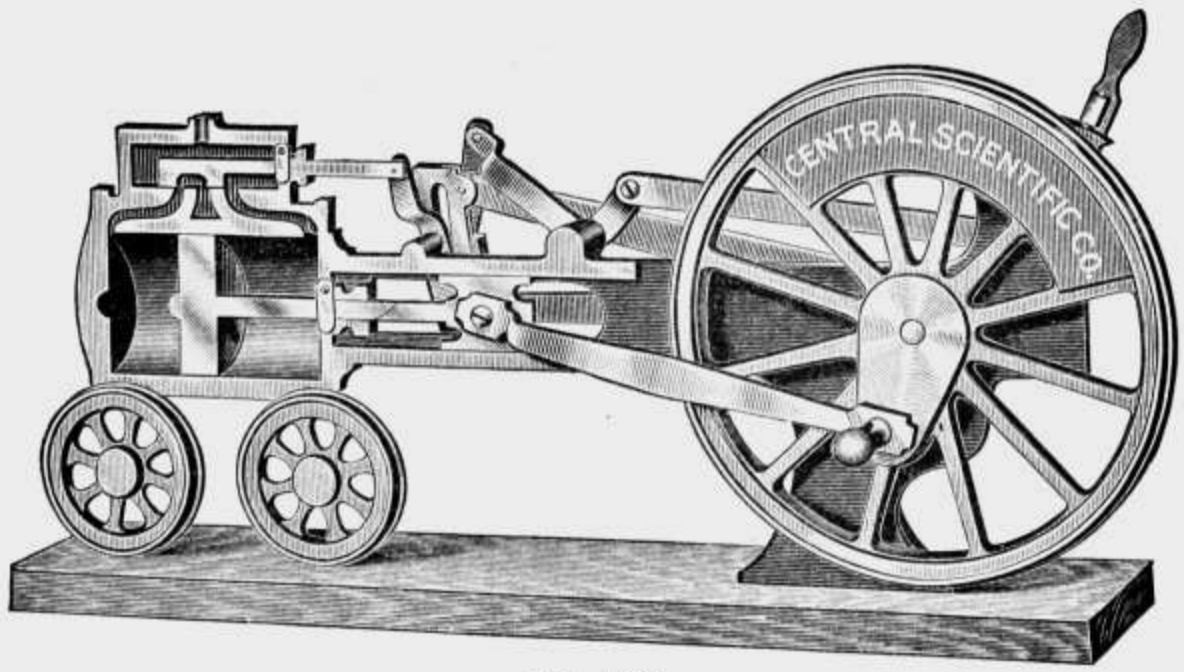
Radio-Micrometer, page 179.



No. 1661.

1661. **Sectional Model of Steam Engine.** This model clearly shows the workings of all the various parts, such as piston, slide valve, crank, etc., reversible ..... $ 3 30

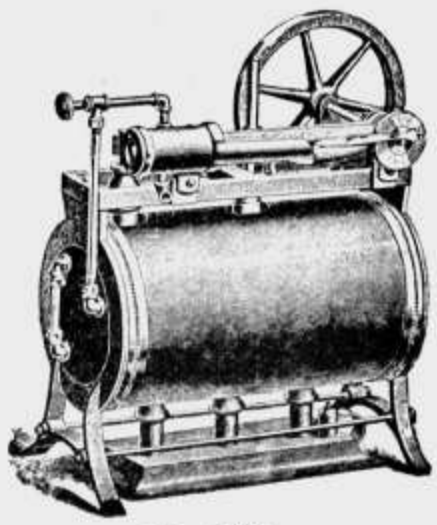
1662. **Wollaston's Steam Engine,** model of the low pressure engine, glass cylinder and bulb, piston and wooden handle..... 2 25



No. 1663.

1663. **Steam Engine Model** (large size). A complete model of the locomotive engine showing a section through the steam chest with the piston and valve connected to their proper parts. Excellent illustration of link motion. The eccentric is so connected that it may be adjusted to show the movement of slide valves in steam chest in relation to the piston. Model stands 7½ inches high and is 15 inches long. Each part is carefully made and adjusted 6 65

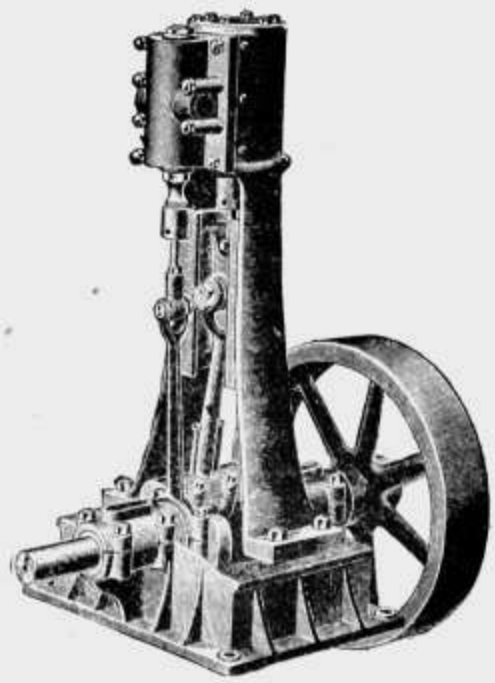
1665. **Horizontal Steam Engine and Boiler.** A perfect working model, exceptionally well built, containing all the essential parts of an engine and boiler. It is more than a toy and the best thing of its kind we have ever seen. Height, seven and one-half inches; length, nine inches; weight, four and one-half pounds 7 50



No. 1665.

STEAM ENGINES.

The engines listed below are of the famous **Sipp** make, and are without doubt the best small engines on the market. They are of the latest and most approved designs, complete in all their parts and made of the same materials as a large engine. They are compact and light, yet strong and substantial, and capable of heavy duty, being provided with large bearings, adjustable for wear, and excellent provision for oiling. Prices are for the complete finished engine, f. o. b. factory.



No. 1670.

Catalogue No.	Type.	H. P.	Bed, inches.	Cylinder, inches.	Flywheel, inches.	Price.
1667	Horizontal.	¼	7 x12	1⅛x2	6	$ 25.00
1668	Horizontal.	½	13½x23½	1¾x3	10	55.75
1669	Vertical.	¼	10 x12	1½x2	8	40.00
1670	Vertical.	1	8 x10	2 x2¾	10	67.50
1671	Vertical.	2	18 x20	3 x4½	16	135.00

BOILERS.

These boilers are of the same make as the above engines. They are of the vertical tubular type, having ¾-inch, seamless, drawn brass tubes, with a water firebox. The shell is of wrought iron, lap welded; the casing and stack are of Russia iron. Each boiler is tested to 250 pounds, cold water pressure, and is safe to run at 100 pounds steam pressure.

The **Steam Gauge** is of the very best.

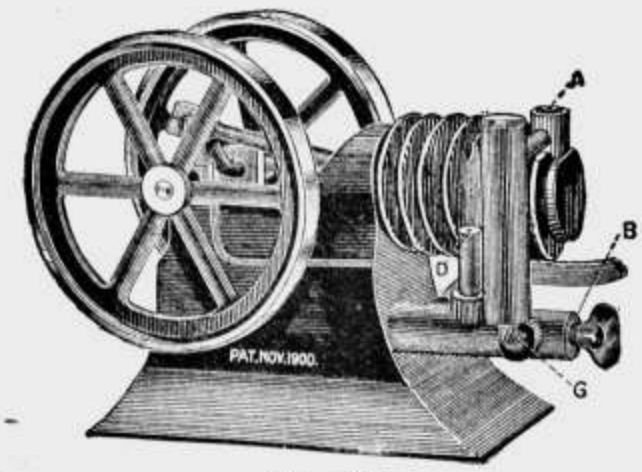
The **Safety Valve** is made of the best steam metal, and will not rust or corrode tight.

There is also a **Water Gauge** and three **Gauge Cocks,** all of steam metal, and **Steam** and **Water Pipes** with **Valves.**

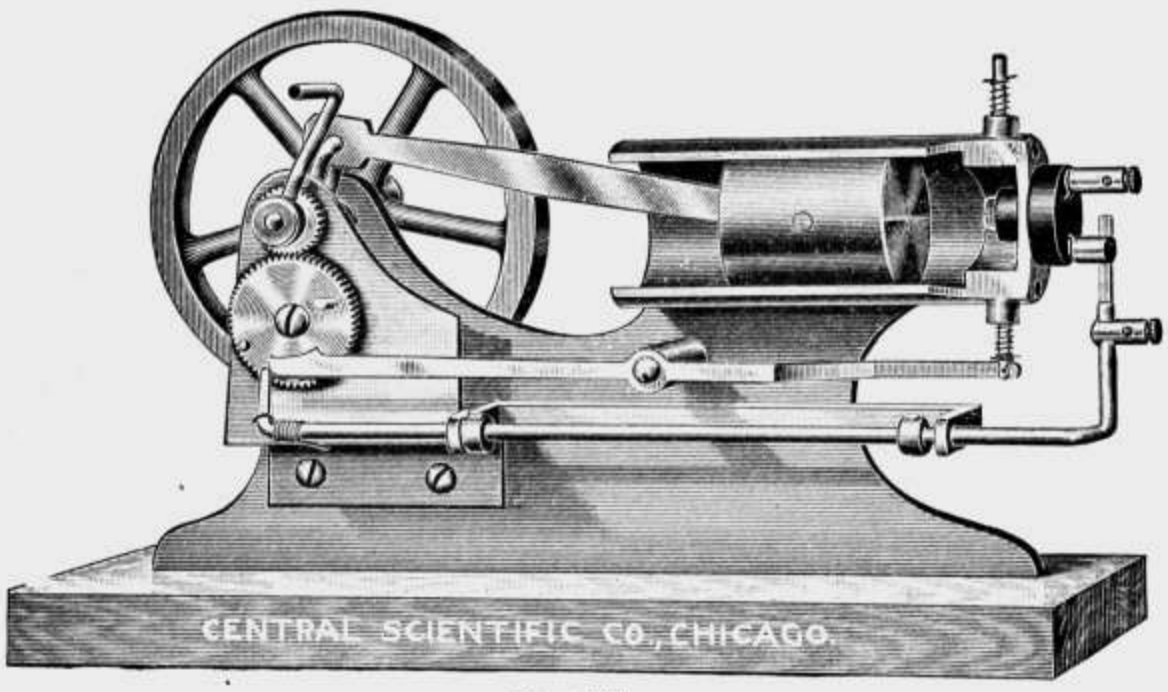
These boilers can be fired with hard coal, charcoal, gas or gasoline.

Catalogue No.	H. P.	Tubes.		Shell.	Price, F. O. B., with Grate.
		Number.	Length, inches.	Thickness, inches.	
1675	¼	20	10½	⅛	$31.50
1676	½	40	26	¼	48.50

1678. **Gas Engine,** working model for illuminating gas only. Made of iron and brass, enameled and nickle plated, six inches long, three inches wide, weight three pounds. Runs with an explosion at each revolution. Speed varies from 200 to 700 R. P. M. This engine makes an excellent demonstration model and is fully guaranteed. Easily operated and perfectly safe. With directions 3 00



No. 1678.



No. 1680.

1680. **Gas Engine Model.** This model is an exact reproduction, in section, of the commercial types of gas engines, (2 cycle). All parts are adjusted to their proper position in the engine. Exhaust and intake valves, piston head, spark plug are all shown to their best advantage. By a succession of gears it is easily demonstrated how compression and exhaustion is accomplished, and if the secondary of a Ruhmkorff's coil is connected in series with the spark plug the spark may be shown at the proper time of compression..... $ 7 50

1683. **Gas Engine** to run all kinds of light machinery. Operates on four-cycle principle. Speed may be varied from 100 to 1,000 R. P. M. by regulating governor and gas mixture (500 to 600 R. P. M. advised). Cylinder and engine frame are cast in one piece and cylinder is water jacketed. Cylinder has 2½-inch bore by 2½-inch stroke, shaft ¾-inch steel. Floor space required 11x17 inches, weight 50 pounds. Develops ¼ horsepower.
Shipped complete with spark coil and battery ready for use..... 62 50

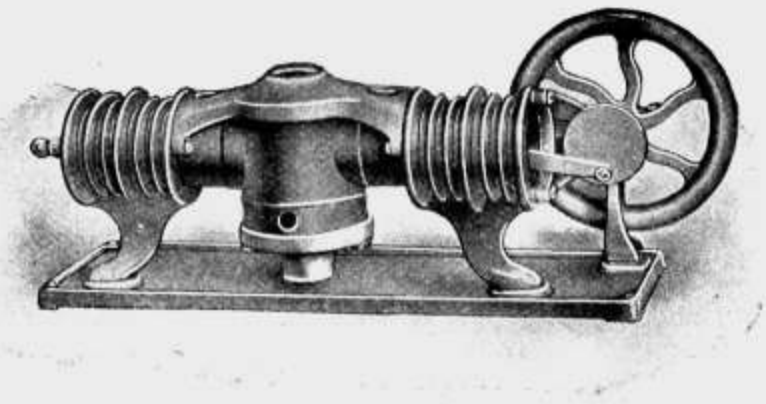
1684. **Gasoline Engine.** Same description and specifications as No. 1683. The special mixing valve of the gas engine is omitted and a special vaporizer furnished in its place. Complete, f. o. b. factory..... 65 00

Gas and Gasoline Engines to be operated with any grade gasoline, kerosene, distillate, a good grade of crude oil, coal gas or producer gas. Material used is the best that can be produced. **Crank Shafts** are of forged steel, **Boxes** of brass and babbitt lined; **Valves** direct acting, poppet valves which need no lubrication or cleaning whatever and air cooled; **Cylinder and Water Jacket** comprises one casting, consequently no packing to be renewed; **Generator** so arranged that every drop of fuel is vaporized as it is drawn into the cylinder; **Governor** of centrifugal type, is extremely sensitive, durable and easily adjusted; **Ignition,** electric, easily removed and replaced, time of ignition may be changed while engine is in operation.

All engines are shipped with written guarantee by the manufacturers.

Each engine complete, including circulating tank, gasoline tank, exhaust muffler and set of Edison type R. R. cells or Gordon battery.

Cat. No.	Actual H. P.	Floor Space ins	Shipping Weight lbs.	Speed. R. P. M.	Driving Pulley ins.	Price F. O. B. Factory
1685	2	40x30	600	350	10x 6	$134.50
1686	4	44x35	900	320	12x 6	197.50
1687	6	50x37	1500	300	14x10	250.00
1688	8	58x40	2000	245	16x10	300.00



No. 1690.



No. 1694-1696.

HOT AIR ENGINES.

These engines are operated by the alternate heating and cooling of the same volume of air contained in the cylinder. There are no valves to get out of order, no inlet to become clogged and no noisy exhaust. The air is heated by means of a small flame of gas or alcohol in a special burner under the center of the cylinder, and the engine will continue to run as long as the heat is supplied.

These engines will be found invaluable in the laboratory for demonstrations, running machinery, mixers, stirrers, revolving tables and clinostats, as they are always ready, require little attention and will run indefinitely at a very small cost.

1690. **Hot Air Engine,** has a speed of 400-500 R. P. M., is about 1/40 H. P. It weighs 14 pounds, base 6x8 inches. The fly wheel is 6 inches in diameter and has two belt pulleys 1¼ and 2 inches in diameter. Consumes 3 cubic feet of gas per hour..... $ 11 00

1691. **Hot Air Engine,** consists of two No. 1690 coupled together and connected to one shaft and fly wheel and has double the power. The base is 9x18 inches, weighs 25 pounds, has three belt pulleys 1¼, 2 and 3 inches in diameter. Other dimensions are the same as No. 1690 ..... 20 00

1692. **Hot Air Engine** is a simplified form of No. 1690 of about the same size and power 8 30

The above engines have air cooled cylinders and are supplied with gas burner, unless otherwise specified. Alcohol burner will be substituted if desired at no change in price.

1693. **Fan,** 10 inches in diameter to fit above engines..... 1 00

VERTICAL TYPE.

These engines are of the same general description as Nos. 1690-1692, but are vertical and much more powerful. The cylinders are water cooled and no piping for water is needed, as a special small tank is supplied with each engine. No. 1694 will run a sewing machine, scroll saw, small dynamo for experimental purposes, etc. No. 1695 has twice and No. 1696 four times the power of No. 1694; supplied with gas burner.

Cat. No.	H. P.	Speed R. P. M.	Weight, Pounds.	Height.	Gas, per hour.	Each.
1694	1-16	500	35	18 ins.	4 ft.	$ 27 80
1695	1-8	375	65	26 ins.	6 ft.	44 45
1696	1-4	250	110	33 ins.	8 ft.	66 60

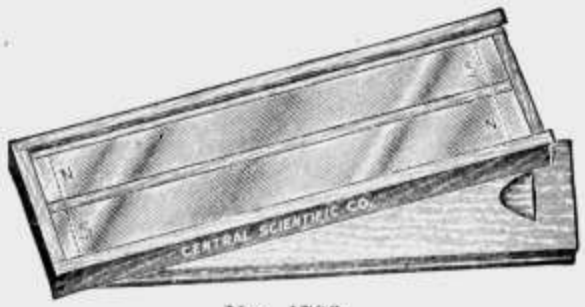
1698. **Countershaft,** for illustration and also as a speed reducer. Shaft is ¼ inch in diameter and 12 inches long; four pulleys are furnished, 1, 2, 3 and 4 inches in diameter..... 1 40



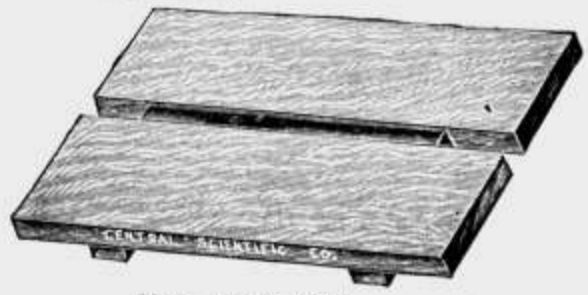
No. 1701.



No. 1704.



No. 1706.



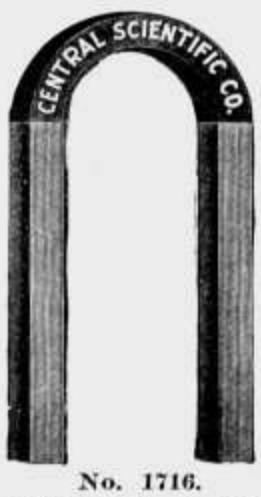
Nos. 1707-1708.

1701. **Lodestone or Natural Magnet**..... $ 40
1702. **Soft Iron Rod** of Norway Iron, 6x½ inch..... 22
1703. **Magnet,** small, 2x¼x¼ inch..... 17
1704. **Bar Magnet,** 6x¾x¼ inch..... 22
1705. **Bar Magnet,** 8x1x¼ inch..... 33
1706. **Bar Magnets,** pair of 6-inch in box with keepers..... 65
1707. **Bar Magnet,** 6x⅜x⅜ inch, for use with No. 1708 board..... 33
1708. **Board** of finely finished hardwood, 12x8½ inches, with groove for No. 1707 Magnet, for plotting magnetic lines of force in connection with No. 1729 Iron Filings, No. 1730 Shaker and No. 1731 Blue Print Paper 45
1709. **Stirrup** of heavy wire, for suspending bar magnets, friction rods, etc. 10

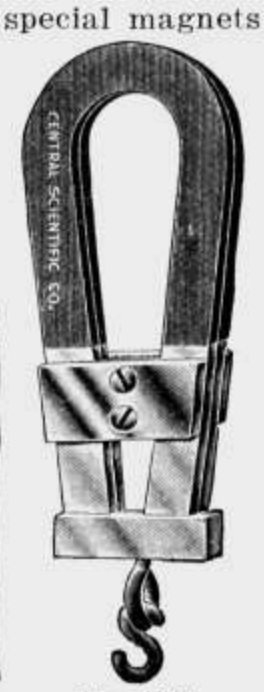
N. B.—Under **Raw Material** will be found a list of magnet steels. We are prepared to make special magnets from sizes found in this list.



No. 1713.



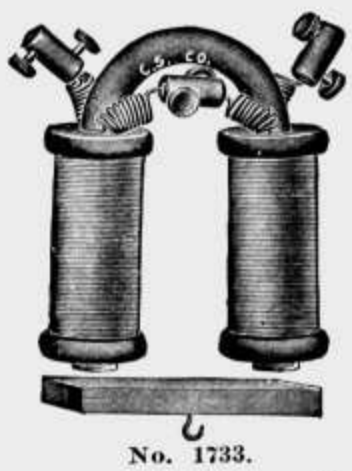
No. 1716.



No. 1717.



No. 1730.



No. 1733.

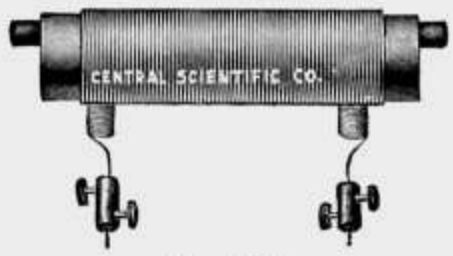
1710. **Horseshoe Magnet,** 3 inches long..... 11
1711. **Horseshoe Magnet,** 4 inches long..... 20
1713. **Horseshoe Magnet,** 6 inches long..... 50
1715. **Horseshoe Magnet,** 8 inches long..... 1 00
1716. **U Magnet,** 5½ inches long, poles ¾x½ inch; 2 inches between poles 35
1717. **Horseshoe Magnet, Compound,** consists of two 6-inch magnets..... 1 75
1719. **Horseshoe Magnet, Compound,** consists of four 8-inch magnets..... 6 65
1720. **Darning Needles,** large, 20 in paper, per paper..... 07
1722. **Knitting Needles,** per dozen..... 10
1723. **Breaking Magnet,** notched for four pieces..... 22
1725. **Floating Magnets,** set of six..... 25
1727. **Magnetized Steel Disc**..... 75
1729. **Iron Filings,** fine, per ¼-pound carton..... 11
1730. **Shaker,** japanned tin with removable top. For sprinkling iron filings 27
1731. **Blue Print Paper,** for taking prints of the magnetic field. Two dozen sheets, 4x5; in light proof package..... 25

N. B.—For other sizes see No. 6263 under Miscellaneous Supplies.

1733. **Electro-Magnet,** 3 inches long with removable helices..... $ 1 50
For illustration of No. 1733, see page 126.
1735. **Electro-Magnet,** 4 inches long with removable helices..... 2 00
1738. **Electro-Magnet,** 5 ohm resistance, for instrument making..... 65
Electro-Magnet, large, for demonstration, see page 373.



No. 1739.



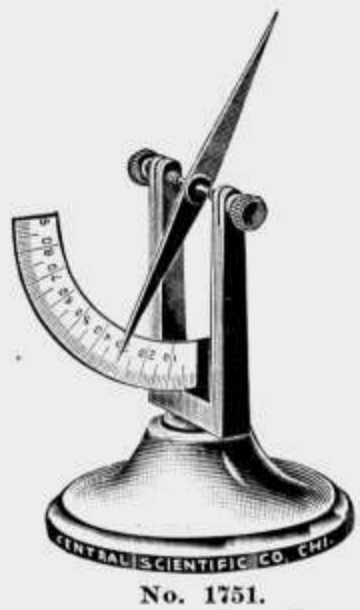
No. 1741.


No. 1743.

1739. **Helix and Ring or Magic Circle.** Consists of two semi-circles of soft iron with brass handles and helix of insulated copper wire..... $ 2 00
1741. **Helix or Solenoid,** with movable core and connectors, unmounted 1 10
1743. **Helix,** mounted on stand..... 2 50


No. 1745.


No. 1749.



No. 1751.

1745. **Magnetic Needle,** 6-inch brass cap, on stand..... 65
1747. **Magnetic Needle,** 6-inch, agate cap, on stand..... 1 20
1749. **Astatic Needle,** 6-inch, brass caps, on stand..... 2 00
1751. **Dipping Needle,** 3-inch, on brass stand with graduated arc..... 3 30
N. B.—High-Grade **Dip Needle,** see page 128.



No. 1761.



No. 1763.



No. 1765.

1761. **Compass,** brass case, card dial, beveled glass, with ring.

Diameter. .	10 m. m.	25 m. m.	40 m. m.	50 m. m.
Each	.11	.17	.25	.33

1763. **Compass,** brass case, brass dial, agate cap needle, beveled glass with cover, full circle divisions.

Diameter	40 m. m.	50 m. m.
Each	1.10	1.20

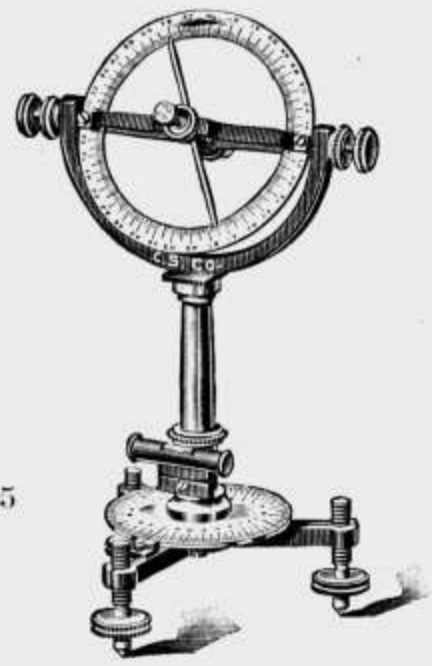
1765. **Compass,** brass case, raised metal dial with full circle divisions, agate cap needle with 37 m. m. aluminum pointer, stop for needle. Useful in building apparatus. Diameter 50 m. m..... 1 50

N. B.—**Ampere's Frame, Oersted's Law Apparatus,** etc., page 151.



No. 1767.

1767. **Sight Compass,** watch case form, 55 m. m. diameter, with raised dial and full circle divisions. Bar needle 30 m. m. long, with agate cap. Sights and spring cover..... $ 6 65



No. 1769.

1769. **Declination and Inclination Needle,** consisting of metal disc 80 m. m. in diameter, graduated in degrees, mounted upon a tripod fitted with leveling screws. Above this and supported by a brass column is a circle 115 m. m. in diameter, also graduated in degrees. Within this circle is a magnetic needle 85 m. m. long and delicately mounted in agate bearings. The graduated circle may be rotated on both its vertical and horizontal axis, so that the needle may be brought into any conceivable plane. Supplied with plumb bob .....Duty free 16 65

1771. **Magnetoscope,** small jar form..... 1 15



No. 1773.

1773. **Magnetometer,** for measuring relative strength of a magnet. Compass No. 1765, mounted in mahogany frame, with meter scale and bar magnet 4 00



No. 1774.

1774. **Magnetometer,** to determine the ration **M:H** Consists of a cylindrical housing mounted on a heavy tripod with leveling screws so as to turn around the vertical axis. This housing can be removed without disturbing the suspension.

The suspension system consists of five small magnets, upon which is mounted a light plane mirror, hanging from a graduated torsion head by means of an unspun silk fiber. Complete with magnet for observation..... 18 00

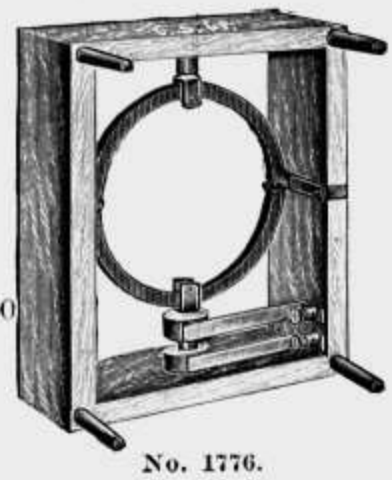
1774A. **Magnetometer System** to be used in connection with No. 1774 to determine the value of **H.** Consists of a suspension magnet, stirrup for magnet and inertia ring. This system may be readily placed in No. 1774 and does not necessitate an extra instrument..... 4 00

1774B. **Support for Meter Stick** to be used in connection with No. 1774 Magnetometer. Consists of two wooden supports with spring brass clamps for holding magnets. Per pair..... 1 00

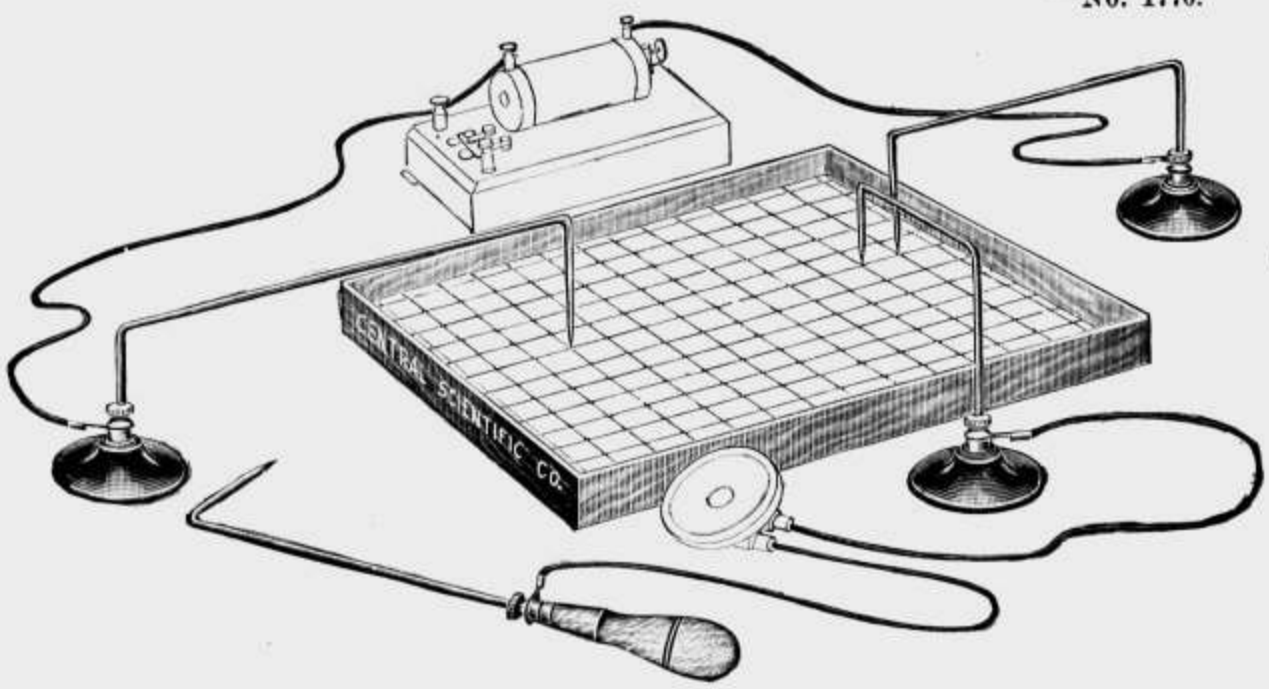
For Reading Telescope and Scale, non-magnetic, see No. 2437.

1776. **Earth Induction Apparatus.** Consists of a large coil of 1,000 turns of insulated copper wire so mounted in a hardwood frame that it may be rotated suddenly through 180 degrees by spring action. The coil may be placed in a vertical or horizontal plane..... $ 17 50

N. B.—See also No. 905 **Earth Induction Apparatus.**



No. 1776.



No. 1778 A to C.

APPARATUS FOR MAPPING ELECTRICAL FIELDS OF FORCE.

1778A. **Field Tray,** consists of a tray with clear glass bottom 11x16 inches, covered with co-ordinate paper for fine determination of accurate positions of no sound points or points of equipotential. Each.... 4 00

1778B. **Potential Points** with arm, weighted support and binding post. Three needed in experiment. Per set of three..... 1 50

1778C. **Equipotential Seeker,** with insulating handle. Each..... 50

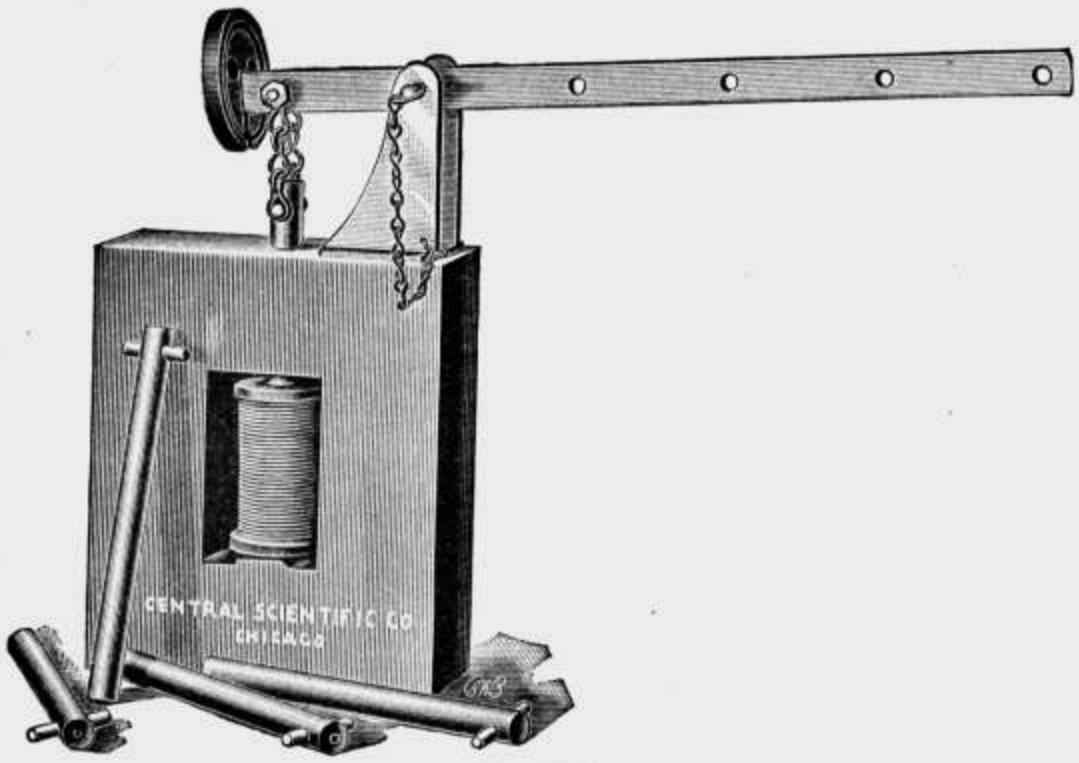
1778D. **Induction Coil,** with light hammer, for use with above..... 4 00

Telephone Receivers, see page 173.



No. 1779.

1779. **Rowland's Apparatus for Distribution of Magnetism** (Millikan and Mills, Exp. 128). Consists of a graduated nickeled brass tube, holding a bar magnet. Upon the tube is mounted a small exploring coil with adjustable stops. This is a very convenient form for measuring the distribution of magnetism and locating the poles of a magnet 10 00



No. 1780.

PERMEAMETER or MAGNETIC IRON TESTER.

for testing the magnetic properties of iron and steel.

This apparatus is constructed after the Westinghouse specifications. The yoke is made of soft iron and has a magnetic cross section of 78 square centimeters. The test bars are 16 m. m. in diameter. The magnetizing coil will carry about 20 amperes, the exact number of turns of wire being stamped on each coil.

A few cells of a primary or storage battery, or a city current, reduced by our No. 2453 Rheostat are sufficient. From observations of the force required to detach the test bar, the magnetic flux and permeability are easily determined.

A secondary snap coil (not shown in cut) is also included with each instrument. By means of this coil the hysteresis curves, one of the most essential principles in electrical engineering, may be plotted.

The test set includes 10 accurately fitted and labeled test bars of the best known varieties of iron and steel. A complete laboratory report of the Permeameter, including the **B-H** curves, the permeability and the hysteresis curves are furnished with each instrument.

1780. **Permeameter,** including secondary snap coil..... $ 27 75

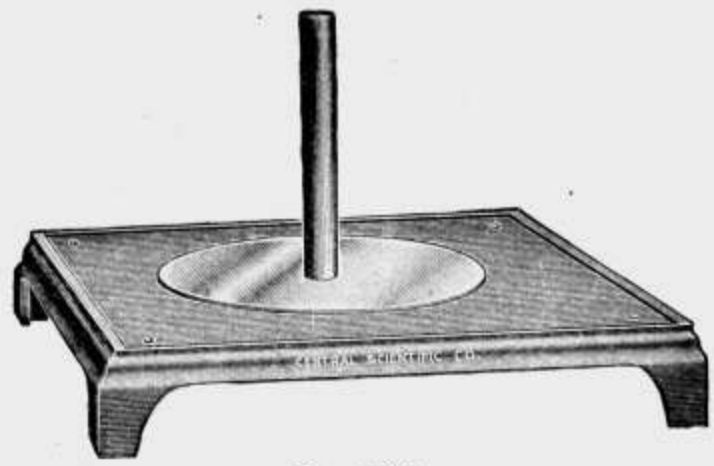
1780A. **Students' Technical Report Forms,** iron test (B) induction, 100 sheets in tablet, each..... 1 10

1780B. **Students' Technical Report Forms, B-H** curves, 100 sheets in tablet, each 1 10

ELECTROSTATICS.



No. 1797.



No. 1799.

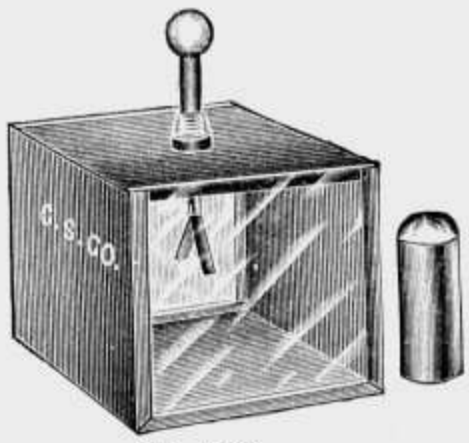
1781. **Friction Rod,** of glass..... $ 17
1782. **Friction Rod,** solid glass, one end ground, other polished. Will show positive charge on one end and negative on other when rubbed..... 55
1783. **Friction Rod,** of wax..... 11
1785. **Friction Rod,** of vulcanite..... 50
1787. **Silk Pad,** for exciting..... 40
1789. **Flannel Pad,** for exciting..... 25
1791. **Cat Skin** (half skin), for exciting..... 60
1792. **Cat Skin** (whole skin), for exciting..... 1 15
1793. **Pith Balls,** colored, very fine, per dozen..... 25
1794. **Pith Balls,** with silk cords, each..... 08
1795. **Pith Balls,** covered with tin foil, very sensitive, each..... 15
1796. **Pith Images,** per pair..... 50
1797. **Electrophorus,** cheap form, mounted rubber plate, with brass disc.... 1 65
1799. **Electrophorus,** large rubber plate, mounted on a metal base, nickel plated brass disc with rubber handle..... 4 15



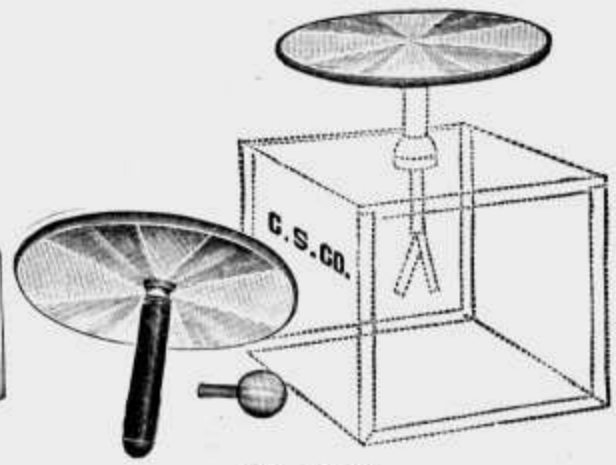
No. 1801.



No. 1805.

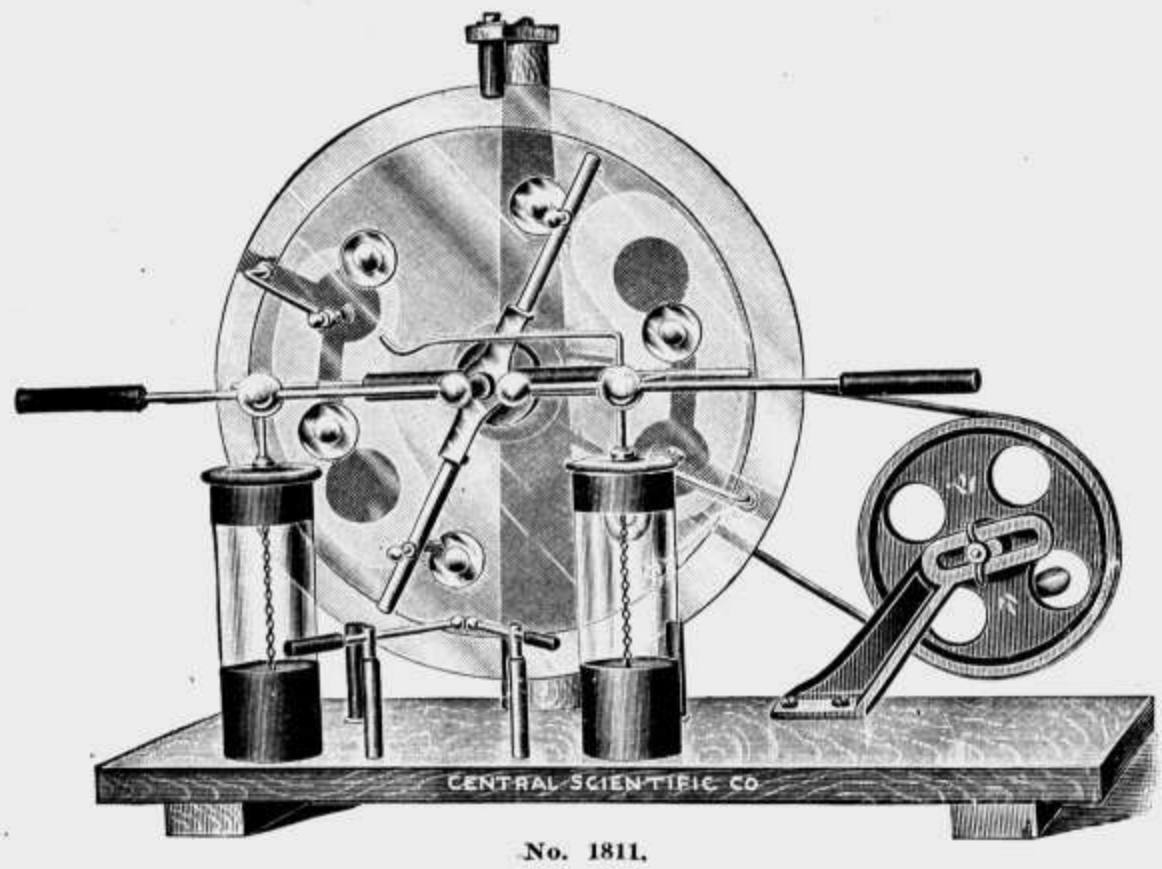


No. 1808.



No. 1808A.

1801. **Electrical Pendulum.** Consists of a pair of pith balls, mounted on stand 60
1805. **Electroscope,** flask form, aluminum leaves, nickel plated rod and knob 70
1808. **Electroscope, Box Form.** Consists of a metal box 6x6 inches with removable glass front and back. The brass rod carrying the strips of gold foil is insulated by pure amber, giving the best insulation possible. To obviate radio-active influences, a metal cap is provided to fit over the collar on top of the box and enclose the projecting rod. This knob may be easily removed and No. 1808A Plates attached.
Insulation and design of this Electroscope is such that it will retain its charge for from 6 to 8 days..... 3 50
1808A. **Plate Attachment** for No. 1808 Electroscope, for demonstating that the plates of a galvanic cell are statically charged. Consists of two heavy brass plates, one of which is provided with insulating handle, other with rod for attaching to the Electroscope. By use of these plates it may be easily shown to a large class that the positive charge is always found in the copper element and the negative in the zinc element 2 25



No. 1811.

1811. **"Mars" Toepler-Holtz Static Machine, improved form.** This machine is the result of long experience and we firmly believe it to be the best Induction Machine on the market.

The **essential features** of this machine are: Simplicity in construction, certainty of operation, rapidity of discharge and length of spark. These have been combined in a very satisfactory manner.

The **construction** is so simple that there can be no trouble in putting it together; all parts are interchangeable.

The **driving wheel** is equipped with our improved belt tightener, and the machine works very easily and without noise.

The **brushes** are made of tinsel, which has been found to be much superior to wire.

The **condensers** are blown from the best Leyden jar glass and their size accurately determined so as to give the greatest efficiency.

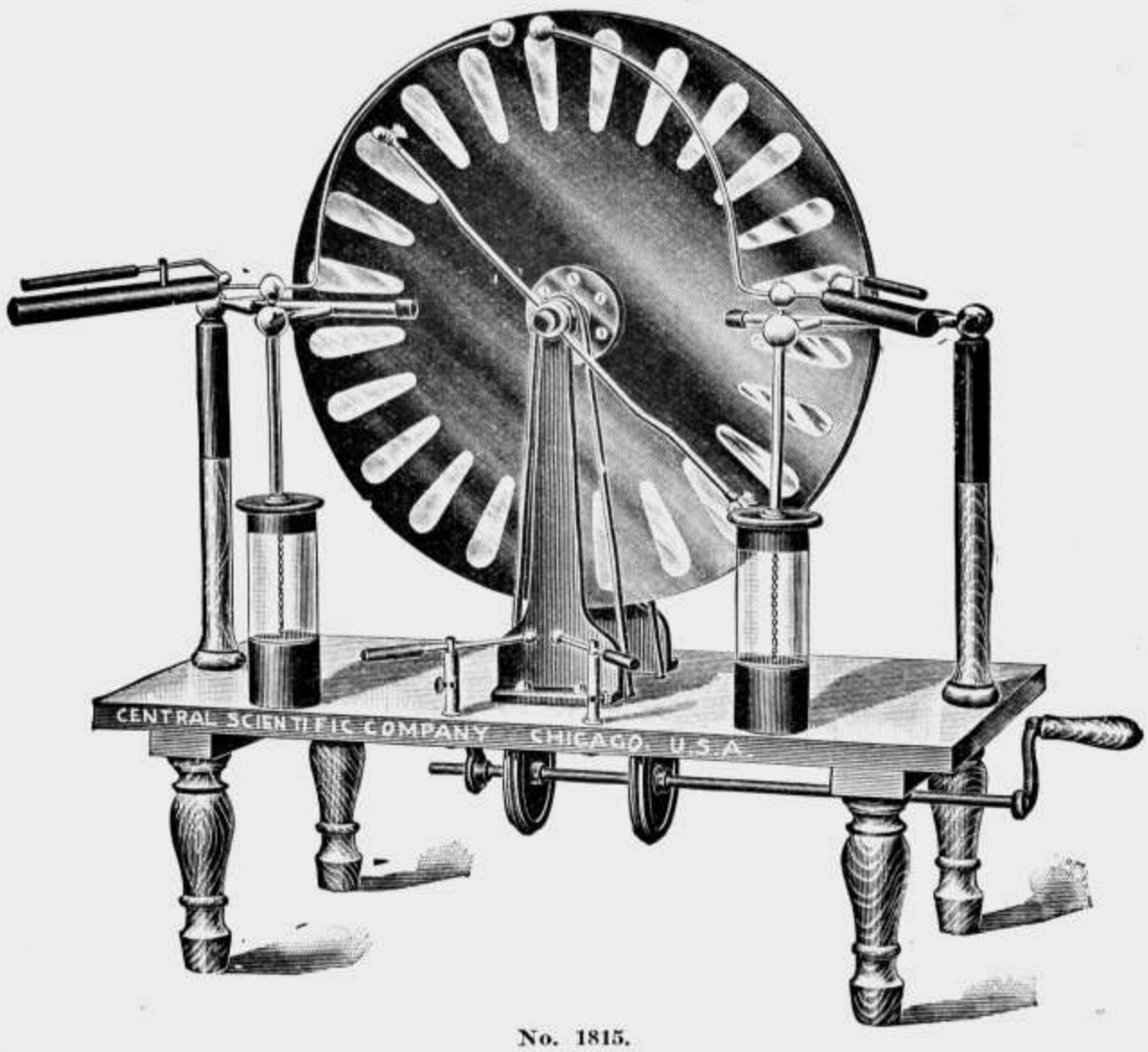
The **plates** are made from the best crystal plate and treated in the most approved manner to exclude all moisture and imperfections.

The **base** and **pillar** are of polished hardwood, the driving wheel of japanned iron, the brass parts are all nickel plated and the insulation is of pure vulcanite, higly polished.

The machine is equipped with a **current breaker** which admits of varying the intensity and rate of discharge; a pair of nickel plated shocking handles and cords and an attachment for holding accessories, such as bell chimes, image plates, etc.

Will give a **spark** of from 4 to 6 inches, depending upon weather conditions. Revolving plate 12-inch, stationary plate 14-inch..... $ 24 00

Repairs for Electric Machine, page 138.



No. 1815.

1815. **Wimshurst Self-Charging Static Machine, improved form.** This type of machine is regarded by leading scientists both in Europe and America as a considerable advance over all forms of static generators now in general use.

The Wimshurst type is not affected by moisture or atmospheric changes and works entirely **without pole changes.** Better results are thus obtained than follow the use of any instrument where every discharge may mean a reversal of the poles. For this reason the machine is much better adapted for X-Ray work than the Toepler-Holtz type.

The machine is provided with a **current breaker,** by means of which the Leyden jars may be thrown in or out of circuit, thus allowing the discharge to be taken off by means of electrodes.

The machine is also provided with a **Spark Gap Attachment,** especially adapting it for **X-Ray work.**

It **generates** quickly and **discharges** rapidly, giving **sparks** from 1-3 to 1-2 the plate's diameter.

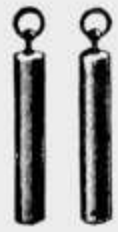
In **construction** it is mechanically perfect, being built of the best materials, mahogany base, japanned iron supports, nickel plated brass parts and pure rubber insulation.

The **plates** are made of **pure vulcanite** and are 16 inches in diameter.. $ 48 00

1817. **Wimshurst Self-Charging Static Machine,** same as No. 1815, with 20-inch vulcanite plates..... 58 00

X-Ray Apparatus, page 141.

X-Ray Tube No. 2035 is best adapted for above machines.



No. 1821.



No. 1827.



No. 1831.



No. 1835.

1821. **Handles** for shocking, nickel plated..... $ 60

1823. **Brass Chains,** with hook and snap for connecting accessories to static machine 25

1825. **Brass Chain,** per yard..... 06

1827. **Insulated Stool,** hardwood, with glass legs..... 2 50

1829. **Leyden Jar,** special glass, hardwood top, nickel plated brass rod and ball, capacity 1 pint..... 1 25

1831. **Leyden Jar,** same as No. 1829, capacity 1 quart..... 1 65

1833. **Leyden Jar,** same as No. 1829, capacity 2 quarts..... 2 05

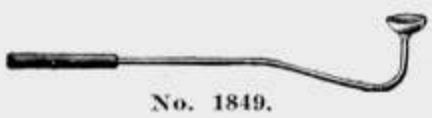
1835. **Leyden Jar,** with movable coatings, capacity 3 pints..... 3 30

1837. **Leyden Jar Battery,** four 1-quart Leyden jars No. 1831, in finely finished wood case, with connections and sliding rod for discharge... 12 00

1839. **Leyden Jar Battery,** same as No. 1837, with six 1-quart jars..... 16 65



No. 1845.



No. 1849.



No. 1851.



No. 1861.



No. 1865.

1843. **Discharger,** rubber handle, plain form..... 1 00

1845. **Discharger,** jointed, rubber handle..... 2 00

1849. **Ether Spoon** 60

1851. **Powder Bomb,** of wood..... 1 25

1855. **Egg Shell,** covered with tin foil and suspended by a silk thread..... 25

1859. **Image Plates,** nickel plated, 150 m. m. in diameter, one with handle the other with support for attaching to the static machine. When pith images are placed between the charged plates the images commence to dance. Without images..... 1 25

1861. **Image Plates,** on adjustable stand, without images..... 2 50

N. B.—For **Pith Images** see No. 1796.

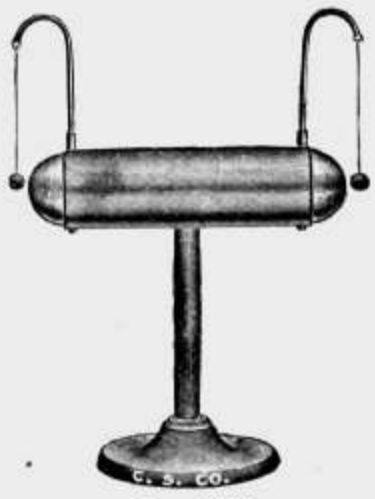
1865. **Faraday's Wire Cylinder,** on insulated stand. For protecting objects from any outside electrical disturbance..... 3 00



No. 1867.



No. 1871.



No. 1873.



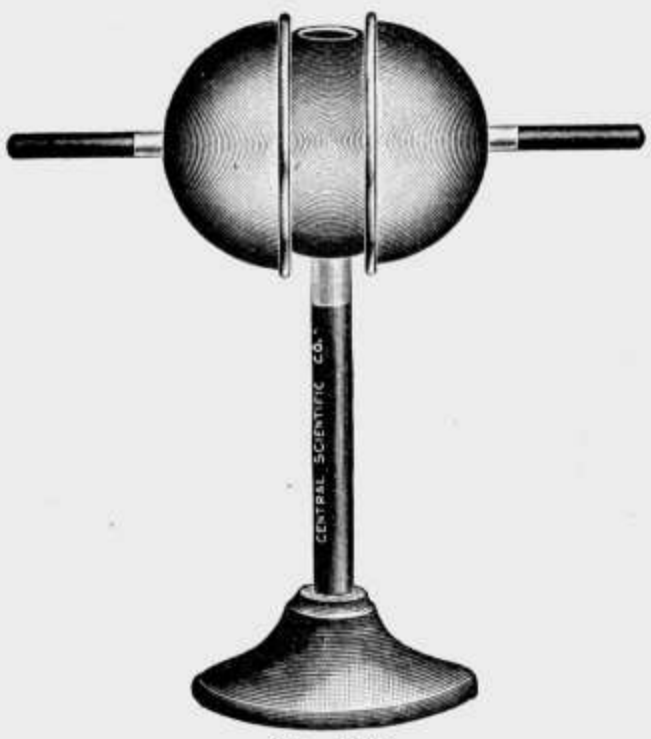
No. 1875.

1867. **Faraday's Bag..** When the bag is charged and pulled inside out the static charge always remains on the outside. On insulated stand.... $ 1 65

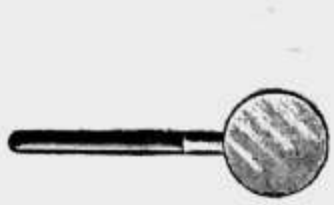
1871. **Hollow Cylinder,** brass, nickel plated, on an insulated stand, with pith balls, showing that electricity resides only on the surface of bodies.. 2 75

1873. **Induction Cylinder,** brass, nickel plated, on insulated stand, with movable pith ball holders..... 3 00

1875. **Ellipsoidal Conductor,** brass, nickel plated, on insulated stand, showing unequal distribution 4 50



No. 1879.



No. 1881.



No. 1883.



No. 1886.



No. 1887.

1877. **Hollow Globe,** of brass, nickel plated, mounted on insulated stand, with hole at top for insertion of proof plane, showing that a charge resides only on the outside..... 2 75

1879. **Biot's Hemispheres,** same as No. 1877, with addition of a pair of thin nickel plated brass hemispheres with rubber handles. Charge on outside of globe may be removed by placing hemispheres about it 5 00

1881. **Proof Plane or Test Needle,** a metal disc on vulcanite handle for transporting a charge from one body to another..... 30

1883. **Electrical Chime,** two bells. To suspend from the static machine attachment. Illustrating the attraction and repulsion of charges.. 90

1886. **Universal Support,** for holding electrostatic accessories. Consists of hard rubber rod mounted on japanned iron base..... 1 00

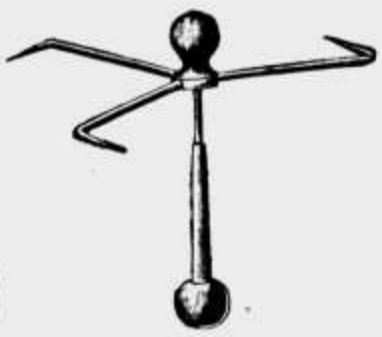
1887. **Electrical Chimes,** five bells. Illustrating attraction and repulsion of charges. Designed to fit No. 1886 Support..... 2 75



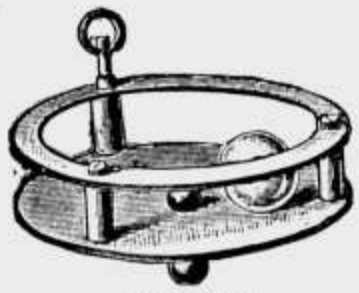
No. 1891.



No. 1893.



No. 1897.



No. 1899.



No. 1901.

1891. **Volta's Hail Storm or Dancing Balls.** Disc charged from static machine causes balls to dance rapidly. Designed to fit No. 1886 Support..... $ 2 75

1893. **Smoke Condenser.** The glass shade is filled with smoke from a punk candle, which is condensed upon the glass, when a charge from a static machine is applied. Including three smoke candles, designed to fit No. 1886 Support..... 2 75

1895. **Smoke Candles,** three in tin box, for use with No. 1893..... 11

1897. **Electrical Whirl or Flier.**. When the whirl receives a charge, it discharges it into the air from the points, causing the whirl to rotate. Designed to fit No. 1886 Support..... 70

1898. **Electrical Whirl or Flier,** complete with stand, simple form..... 1 10

1899. **Electrical Circus or Racing Ball.** When connected with a static machine the glass ball will race around the plate. Designed to fit No. 1886 Support 1 65

1901. **Electrical Plume,** of paper, illustrating repulsion. When attached to a static machine the strips of paper will arrange themselves like a plume. Designed to fit No. 1886 Support..... 60

1903. **Holder** for Geissler tubes and lightning plate. Designed to fit No. 1886 Support .... .50

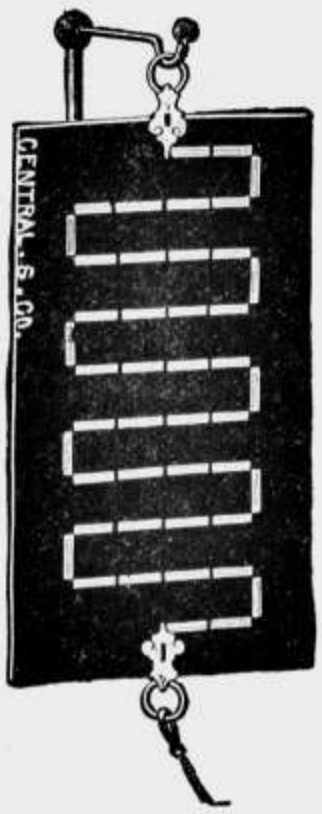
1905. **Lightning Plate,** of vulcanite. A charge sent across the plate through the foil, in which are several air gaps, will spark across the gaps. Designed to fit No. 1886 Support 1.20

1906. **Spiral Tube.** A charge sent through the tube will show beautiful effects as it crosses the gaps. Designed to fit No. 1886 Support. 1.65

Brass Connecting Chains for the above apparatus, page 134.



No. 1903.



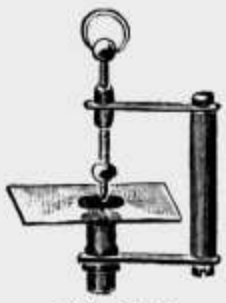
No. 1905.



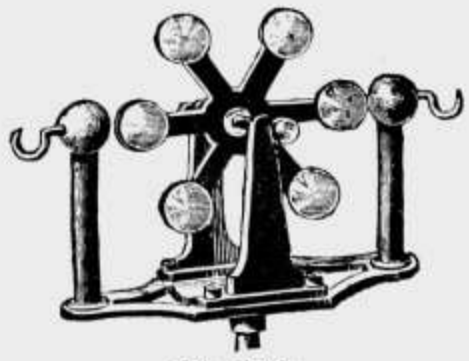
No. 1906.



No. 1907.



No. 1911.

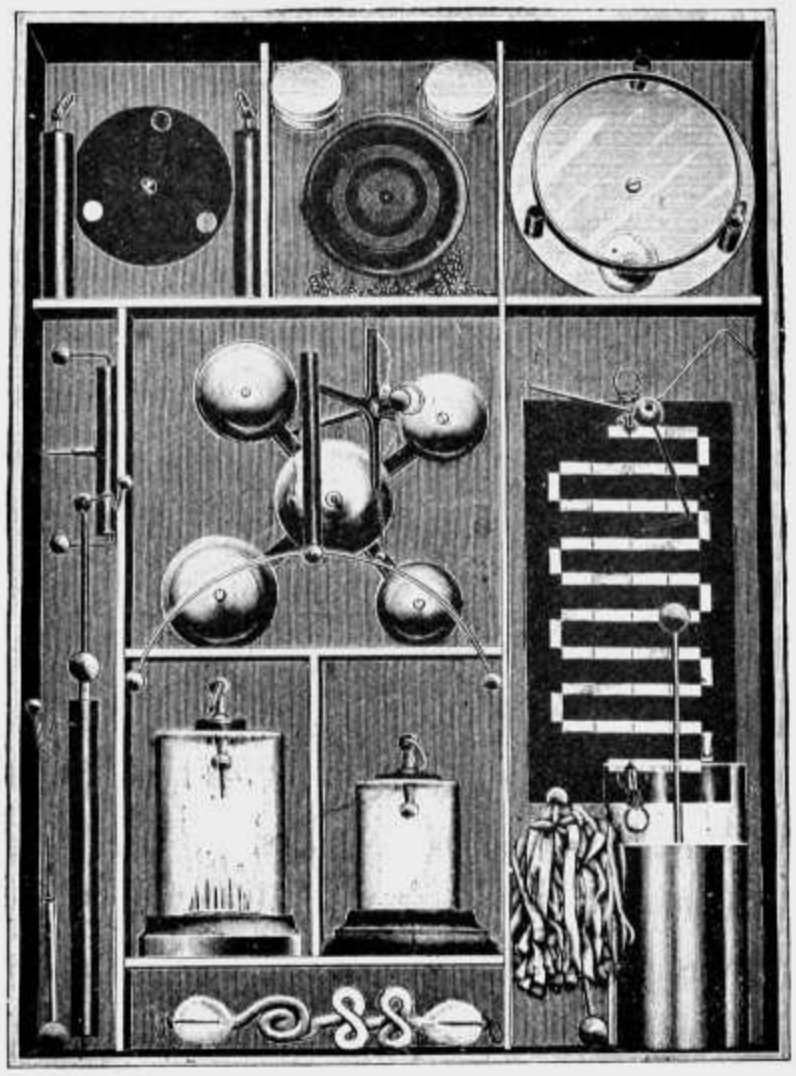


No. 1913.

1907. **Rotating Disc.** Will rotate rapidly when connected to static machine. Designed to fit No. 1886 Support..... $ 1 20

1911. **Glass Boring Apparatus.** Will pierce glass and reproduce the faces of coins on glass. Designed to fit No. 1886 Support..... 3 35

1913. **Electrostatic Motor.** Will rotate at high speed when connected to static machine. Designed to fit No. 1886 Support..... 5 50



No. 1915.

1915. **Electrostatic Demonstration Outfit,** consisting of Universal Support No. 1886 and the accessory apparatus Nos. 1887, 1891, 1893, 1895, 1897, 1899, 1901, 1903, 1905, 1907 and also 6-inch Geissler Tube No. 2001, Brass Chains No. 1823, Leyden Jar No. 1829, Discharger No. 1843 and Handles No. 1821. Put up in a strong cardboard compartment box, with full instructions. This set, together with a Static Machine, forms a very complete outfit, covering Static Electricity..... 16 65

REPAIRS FOR STATIC MACHINES, ETC.

The list includes such essentials as are used in our own factory and in it will be found any necessary repairs.

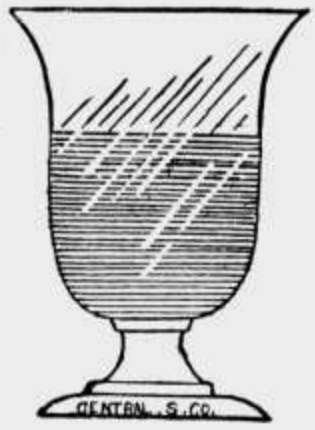
1921. **Revolving Glass Plate** for No. 1811, 12-inch, finished..... 2 50
1923. **Stationary Glass Plate** for No. 1811, 14-inch, finished..... 2 75
1925. **Revolving Glass Plate,** 10½-inch, finished..... 2 00
1927. **Stationary Glass Plate,** 12-inch, finished..... 2 25
1929. **Revolving Glass Plate,** 14-inch, finished..... 3 35
1931. **Stationary Glass Plate,** 16-inch, finished..... 3 65
1933. **Rubber Plate** for No. 1815, 16-inch, finished, ready to attach to the hubs 7 00
1935. **Rubber Plate** for No. 1817, 20-inch, finished, ready to attach to the hubs 9 00
1937. **Leyden Jar** for No. 1811, tin foiled, each..... 50
1939. **Leyden Jar** for Nos. 1815 or 1817, tin foiled, each..... 75
1942. **Brush Arm** with washer and rubber nut to fasten on No. 1923 Stationary Plate 35
1943. **Brush Holder with Brush** for No. 1811..... 45
1945. **Brush,** refilling only..... 10
1947. **Disc and Button,** one piece, of metal, for Revolving Plates, each..... 11
1949. **Gold Leaf (pure)** for Electroscopes, per book..... 80
1950. **Dutch Metal** (imitation gold leaf), per book..... 20
1951. **Aluminum Leaf** for Electroscopes, per book..... 25
1953. **Tin Foil (pure)** for coatings, per sq. ft., .10; per lb..... 1 00
1955. **Leather Belting,** ¼-inch, round, per ft..... 10
1959. **Amalgam,** per bottle..... 30



No. 1991.



No. 1993.



No. 1995.

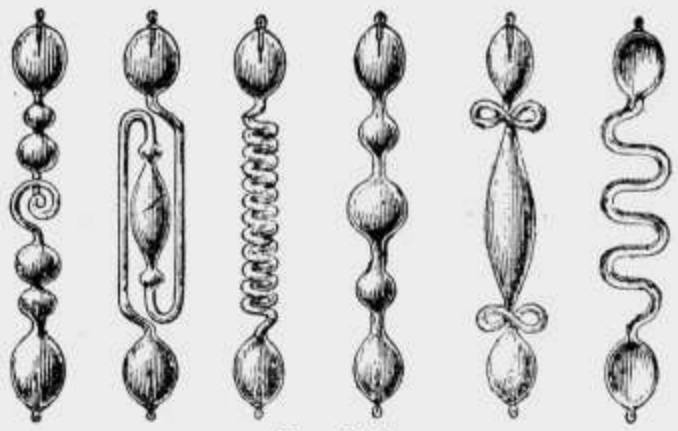
1991. **Electrical Egg,** 12 inches high, sliding rod and packing screw. If the egg is partially exhausted, a spark from a static machine will produce a luminous appearance within the egg..... 7 00

1993. **Aurora Tube,** 12 inches long, with platinum electrode. When a spark is passed through tube a beautiful colored glow is observed..... 2 00

N. B.—**Guinea** and **Feather Tube** and **Aurora Tube** combined see No. 1435.

1994. **Vacuum Tube** for exhausting. In shape similar to No. 1993..... 1 50

1995. **Gassiott's Cascade** for showing the effect of atmospheric pressure on an electrical discharge..... 90



No. 2003.

2001. **Geissler Tube,** six-inch..... $ 50
2003. **Geissler Tubes,** six-inch, set of six assorted in box..... 3 00
2005. **Geissler Tube,** eight-inch 80
2007. **Geissler Tubes,** eight-inch, set of six assorted in box..... 4 75

Note—The above tubes are filled with highly attenuated air and are made in a variety of designs of uranium, iron and lead glass, showing both the effect of design in illumination and the effect on the kind of glass. The glass has a fluorescense as follows.

Uranium—Yellow. Iron—Green. Lead—Blue.



No. 2009



No. 2017.



No. 2018A.



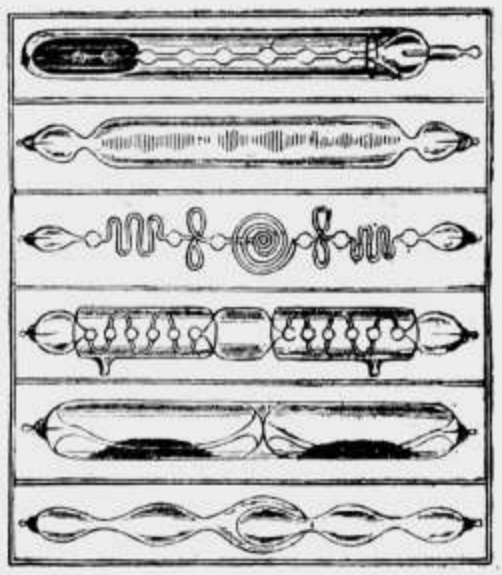
No. 2018B.



No. 2018C.

2009. **Geissler Tube, Demonstration Form,** 11 inches high, with uranium spiral in bulb, complete with leaded base..... 2 50
2017. **Fluorescent Tube,** eight inches long. These are double tubes, the inner one being of a variety of shapes of uranium glass, the outer being filled with a fluorescent liquid such as eosine, quinine, kerosene, aesculine and uranine. Each..... 1 25
2018. **Geissler Tubes.** The illustration represents the newest types in Geissler Tubes. They are made entirely of glass and are very attractive in design. The tubes are filled with various colored fluorescent liquids, such as eosine, quinine, aesculine and uranine.
2018A. **Geissler Tube.** Is oval in shape, six inches high, mounted on glass foot 1 65
2018B. **Geissler Tube.** Consists of four vertical tubes of various designs, five inches high, mounted on glass foot..... 1 95
2018C. **Geissler Tube.** Consists of two vertical tubes of different designs, seven inches high, mounted on glass foot..... 1 65
2019. **Phosphorescent Tube,** eight inches long. These tubes contain crystalline salts (sulphides) which phosphoresce under the action of an electrical discharge, showing how radiant matter may produce visible light. Each..... 1 50
2021. **Phosphorescent Mercury Tube,** eight-inch, with which no static machine or coil is needed, the friction resulting from mercury falling on globules of glass, producing a beautiful phosphorescent glow..... 2 25

2023. **Lecture Set of Tubes, ten-inch.** .A set of six tubes, one double Induction Tube containing oxygen and nitrogen, one Phosphorescent Tube, one Fluorescent Tube, one Nitrogen Scroll Tube, one Hydrogen Stratification Tube and one Mercury Tube, complete, in a neat compartment box ..... $ 11 00



No. 2023.



No. 2025.

2025. **Spectrum Tube,** for spectrum analysis, 10 inches long, filled with **oxygen gas,** emitting pale purple color..... 1 65

2025A. **Spectrum Tube,** same as No. 2025, filled with **Hydrogen Gas,** emitting cream yellow color..... 1 65

2025B. **Spectrum Tube,** same as No. 2025, filled with **Nitrogen Gas,** emitting deep pink color..... 1 65

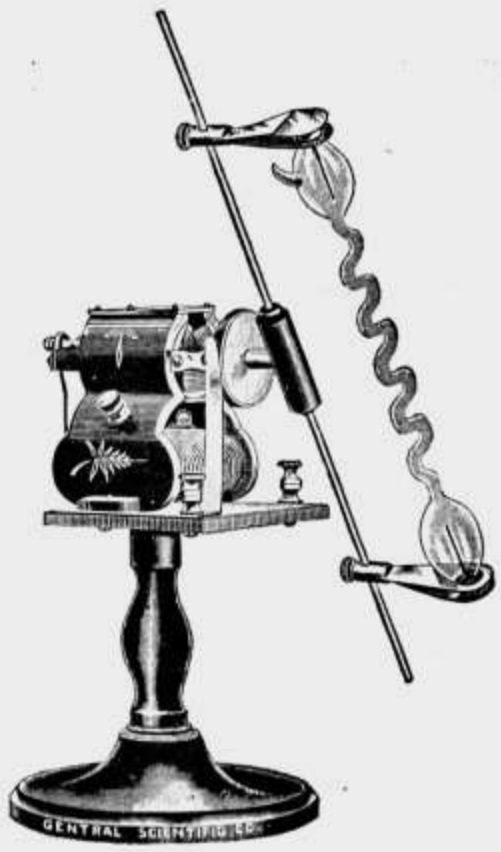
2025C. **Spectrum Tube,** same as No. 2025, filled with **Carbonic Acid Gas,** emitting green color..... 1 65

2025D. **Spectrum Tube,** same as No. 2025, filled with **Water Vapor,** emitting light pink color..... 1 65

2027. **Geissler Tube Rotator..** A standard Porter motor, No. 2, 1-16 H. P., mounted upon a heavy iron standard, with binding posts, etc., for illuminating the tube. Will carry any tube listed in this catalogue, and requires very little battery power, a one-quart Grenet cell being sufficient to operate the motor.

This Rotator may also be used to rotate color discs, siren discs, etc., and an attachment for holding discs is included. Complete..... 12 50

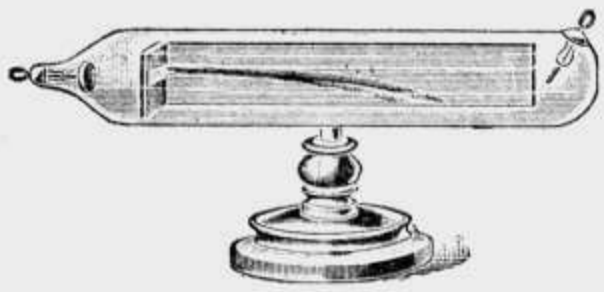
2029. **Rotating Attachment** for Geissler Tubes to be attached to No. 837 Rotator, holding any tube listed.. 4 50



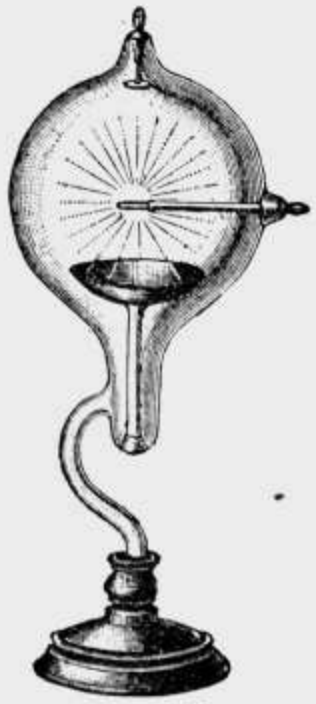
No. 2027.



No. 2035.



No. 2044.



No. 2043.

These tubes are of the celebrated Gundelach make and tested for the Static Machine or Induction Coil as listed. It is necessary in ordering a tube to specify the kind of a machine and the spark length, in order that you may receive the correct vacuum.

2035. **X-Ray Tube,** adjusted for Static Machine, giving spark from 8 to 10 c. m. ..... $ 5 00
2036. **X-Ray Tube,** same as No. 2035, with Osmium Regenerating device..... 7 75
2037. **X-Ray Tube,** adjusted for Static Machine, giving spark from 10 to 15 c. m. 6 60
2038. **X-Ray Tube,** same as No. 2037, with Osmium Regenerating device..... 8 85
2039. **X-Ray Tube,** adjusted for Static Machine, giving spark from 15 to 20 c. m. 8 00
2040. **X-Ray Tube,** same as No. 2039, with Osmium Regenerating device... 10 25
2041. **X-Ray Tube,** adjusted for Induction Coil, giving six-inch spark..... 7 50
2042. **X-Ray Tube,** universal self-regulating tube, for six-inch coil..... 15 00
2043. **Tube Showing Heating Effect of Cathode Ray.** Negative electrode is concave and a piece of platinum foil is placed at the center of a sphere of which the cathode is a section. Rays come to a focus upon the small part of the foil and heat it white hot, showing that the rays travel in straight lines at right angles to the surface of the cathode 7 75
2044. **Tube Showing Deflection of Cathode Ray.** Inside of an exhausted tube is placed a screen coated with a substance which fluoresces brilliantly when the cathode rays fall upon it. A mica strip with slit crosses the tube at one end, absorbing all cathode rays except those that pass through the slit. The path of the ray is traced by the fluorescence as it grazes the screen. If a magnet is held to the tube this ray will be deflected in the same way as if they were negatively charged particles 7 00
2045. **Fluoroscope,** with removable Platinum Barium Cyanide Screen, 4x5 9 00
2047. **Fluoroscope,** with removable Platinum Barium Cyanide Screen, 5x7..... 12 50

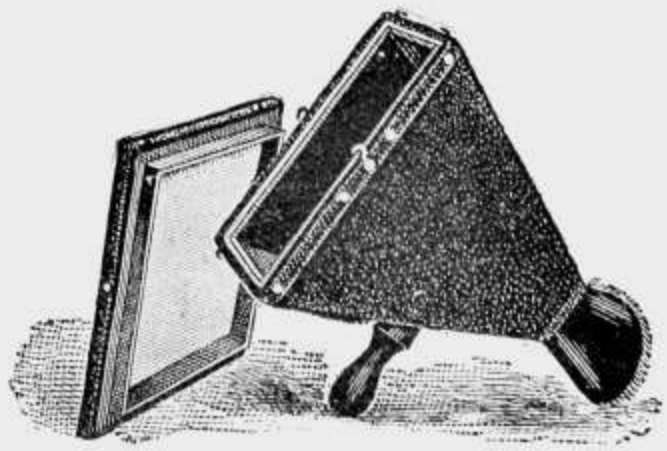
For Tube Stand use No. 5345.

2053. **Cramer X-Ray Plates for Radiographs,** recognized as the best plate for this purpose on the market.

5x7.....Per dozen	1 50
6x8½.....Per dozen	2 25
8x10.....Per dozen	3 25

Static Machines for X-Ray work, page 133.

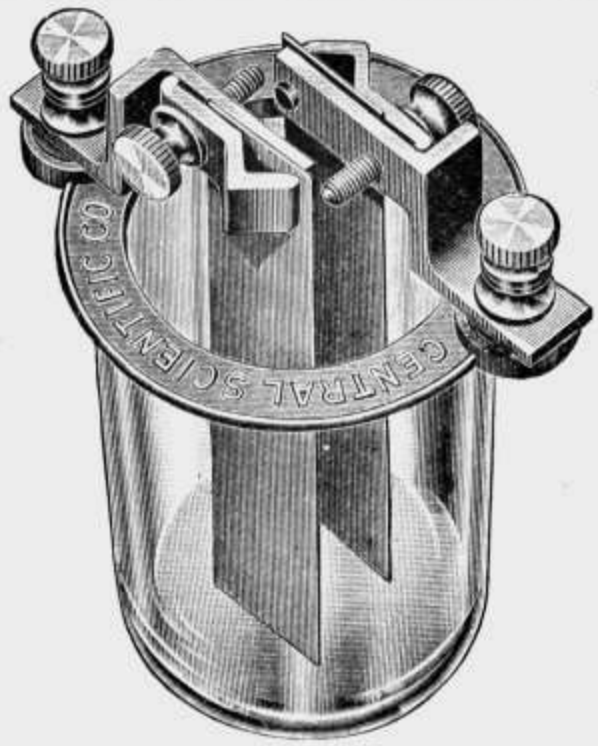
Induction Coils for X-Ray work, page 155.



Nos. 2045-2047.



No. 2100..



No. 2110.



No. 2111.

2099. **Pole-Indicating Paper.** When two electrical leads are placed close together upon a piece of the moistened paper, the negative pole shows a red stain. Per sheet, .05; Per book of 25 strips..... 33

2100. **Simple Element,** Copper Strip, 12.5 c. m. long, with wire attached.... $ 06

2101. **Simple Element, Zinc Strip,** 12.5 c. m. long, with wire attached..... 06

2102. **Tumbler,** for simple cell, each, .06. Per dozen..... 60

2105. **Zinc Element,** 10x2.5x.6 c. m., with wire attached..... 15

2106. **Copper Element,** 10x10 c. m., with wire attached..... 11

2110. **Student's Demonstration Battery.** An excellent battery for studying the laws of the voltaic cell, such as internal resistance, effects of amalgamated zinc, use of various solutions, etc.

With a complete set of elements, the various forms of batteries in common use are readily assembled, namely: Simple Voltaic, Bunsen, Daniell, Grenet, Gravity and LeClanche.

The cap which fits the glass jar is made of an acid proof alloy, making it strong and durable. This is an improvement over the old wooden form, which warps and looks badly after use with the acid solutions.

The clamps will hold either flat or round elements and, as they are attached to the cap by a swivel joint, the distance between the elements can be varied at will.

The clamps are insulated from each other and prevent a short circuit between the elements. The elements can be removed without disconnecting the lead wires.

Cell, including cap, tumbler and flat zinc and copper elements..... 80

2110½. **Student's Demonstration Battery,** complete, with tumbler, cap and all the elements listed from A to K. With this outfit a very complete **Electromotive Series** may be easily determined..... 1 45

2110A. **Porous Cup,** 3x7.5 c. m. inside..... 12

2110B. **Zinc Pencil,** 14x1x1 c. m..... 06

2110C. **Carbon Pencil,** 14x.6 c. m..... 11

2110D. **Zinc Element,** flat, 12.5x2 c. m..... 05

2110E. **Copper Element,** flat, 12.5x2 c. m..... 05

2110F. **Lead Element,** flat, 12.5x2 c. m..... 05

2110G. **Iron Element,** flat, 12.5x2 c. m..... 05

2110H. **Aluminum Element,** flat, 12.5x2 c. m..... 05

2110J. **Carbon Element,** flat, 12.5x2 c. m..... 11

2110K. **Tin Element,** flat, of pure block tin, 12.5x2 c. m..... 11

2111. **Dry Battery, "Columbia."** The best dry cell on the market. Prof. F. R. Nichols of the Richard T. Crane Manual Training High School of Chicago has made a thorough test of all the dry cells on the market, and the Columbia gave the best results. E. M. F. on open circuit, 1.35; internal resistance, 0.10; E. M. F. after delivering ½ ampere for thirty minutes, 1.26..... 33

2112. **Water Battery,** 50 small cells, with zinc and copper elements, mounted on a hardwood base, for demonstrating the relation between static and galvanic electricity..... 6 00



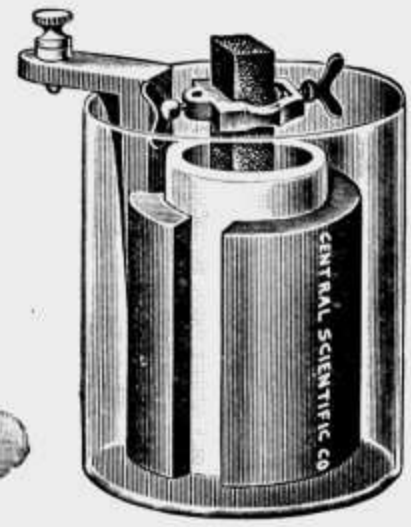
No. 2113.



No. 2115.



No. 2119.



No 2121.

2113. **Carbon Cylinder Battery** for "open circuit work." Well adapted for all telephone and bell service. E. M. F. about 1.4 volts. Cell complete $ 50

2113A. **Carbon** for No. 2113 33

2113B. **Jar** for No. 2113 16

2115. **Le Clanche Battery** for "open circuit work," as in No. 2113, with practically the same E. M. F. Cell complete 50

2115A. **Porous Cup,** sealed, for No. 2115 33

2115B. **Jar** for No. 2115 16

2116. **Zinc Rod** with binding screw for either Nos. 2113 or 2115 06

2117. **Samson Battery,** No. 1, The most popular battery for "open circuit" work. It is the best, most durable and effective of all cells of the carbon cylinder type. Recuperates very quickly. E. M. F. 1.44; internal resistance about .14. Cell complete 1 25

2117A. **Zinc Cylinder** for No. 2117 27

2117B. **Corrugated Carbon Cylinder** for No. 2117 80

2117C. **Jar** for No. 2117 20

2119. **Samson Battery,** No. 2. Larger than No. 2117. E. M. F. 1.47; internal resistance .11 ohm. Cell complete 1 50

2119A. **Zinc Cylinder** for No. 2119 30

2119B. **Corrugated Carbon Cylinder** for No. 2119 ..... 1 00

2119C. **Jar** for No. 2119 22

2121. **Bunsen Battery** for "open circuit" work. A powerful two-fluid cell of about 1.9 volts E. M. F. and 1.86 ohms internal resistance. An excellent cell for operating induction coils, motors, etc., and for electrolysis of water. Quart size, complete 1 40

2121A. **Zinc Cylinder** with binding post for No. 2121 75

2121B. **Carbon** for No. 2121 17

2121C. **Clamp** for Carbon No. 2121B 35

2121D. **Porous Cup,** 2x4 inches, for No. 2121 15

2121E. **Jar,** 4x5 inches, for No. 2121 20

2123. **Bunsen Battery,** gallon size, complete 3 30

2123A. **Zinc Cylinder** with binding post for No. 2123 ..... 1 50

2123B. **Carbon** for No. 2123 55

2123C. **Clamp** for Carbon No. 2123B 85

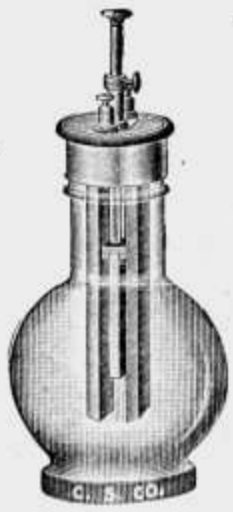
2123D. **Porous Cup,** 4x8 inches, for No. 2123 35

2123E. **Jar,** 6x8 inches, for No. 2123 33

2125. **Grove Battery** for "open circuit" work. This cell is similar to No. 2121, but the carbon element is displaced by a platinum element. Voltage about 1.9, internal resistance 1.85 ohms. Quart size complete 3 30



No. 2128.



No. 2129



No. 2133.

2127. **Daniell Battery,** quart size. Consists of No. 2105 Zinc, No. 2106 Copper, No. 2121D Porous Cup and No. 2121E Jar. An excellent battery for student use with constant E. M. F. of about 1.08 volts. Complete $ 55

2128. **Daniell Battery,** gallon size. This has been the standard cell for many year for "open" or "closed circuit" work. The best of all laboratory work is electrical measurements. Next to the standard cells, it gives the most constant E. M. F., about 1.08 volts, which remains the same during the life of the cell. With new form riveted copper pocket for holding copper sulphate crystals. Complete..... 1 65

2128A. **Zinc,** amalgamated, weight two pounds, with binding screw attached, for No. 2128..... 50

2128B. **Copper, New Form,** with riveted copper pocket, for No. 2128..... 65

2128C. **Porous Cup,** 3x7 inches, for No. 2128..... 22

2123E. **Jar,** 6x8 inches, for No. 2128..... 33

2129. **Grenet Battery (French Type).** Most convenient form for use on lecture table, giving very powerful current for a short time. The E. M. F. is 2 volts at the start. Small internal resistance. Height of cell 8 inches, capacity 1 pint. Complete..... 1 65

2129A. **Zinc** for No. 2129..... 15

2129B. **Carbon** for No. 2129..... 22

2129C. **Jar** for No. 2129..... 60

2130. **Grenet Battery (French Type),** 10 inches high, capacity one quart.... 2 25

2130A. **Zinc** for No. 2130..... 17

2130B. **Carbon** for No. 2130..... 33

2130C. **Jar** for No. 2130..... 80

2131. **Grenet Battery (French Type),** 12 inches high, capacity two quarts.. 3 35

2131A. **Zinc** for No. 2131..... 25

2131B. **Carbon** for No. 2131..... 40

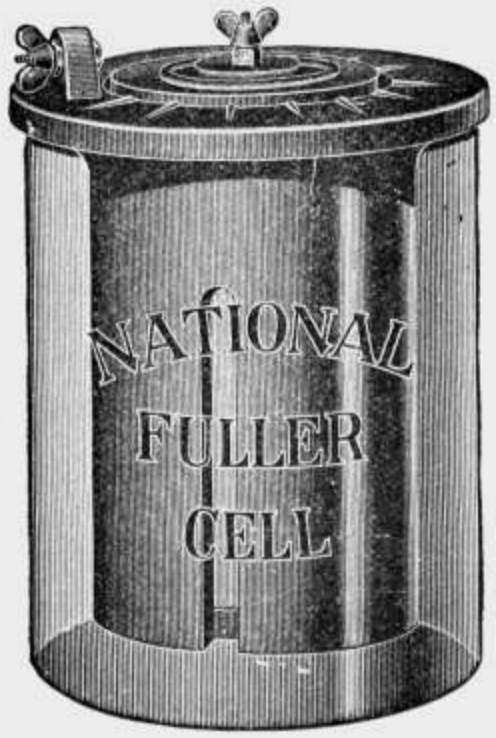
2131C. **Jar** for No. 2131..... 1 00

2133. **Gravity Battery (Crowfoot Type),** especially adapted for "closed circuit" work. Standard type for telegraph companies. E. M. F. about 1.1 volts, internal resistance from 1 to 5 ohms. Gallon size complete 90

2133A. **Crowfoot Zinc,** with connector for No. 2133..... 45

2133B. **Copper** for No. 2133..... 20

2123E. **Jar,** 6x8 inches, for No. 2133..... 33



No. 2135.

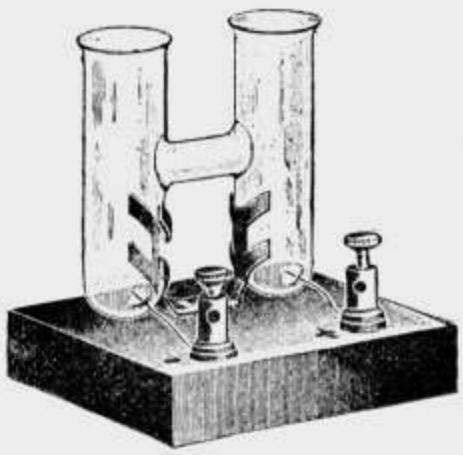
2135. **Fuller Battery, Improved Form,** for "open" or "closed circuit" work. Generally adopted in the Chicago High Schools. The high voltage of 2.4 volts, with an internal resistance of 0.40 ohms makes it desirable for exacting service. Gallon size complete..... $ 1 50

2135A. **Carbon Cylinder** for No. 2135..... 65

2135B. **Zinc** for No. 2135 (same as No. 2128A)..... 50

2135C. **Porous Cup** for No. 2135 (same as No. 2128C)..... 22

2123E. **Jar,** 6x8 inches, for No. 2135..... 33



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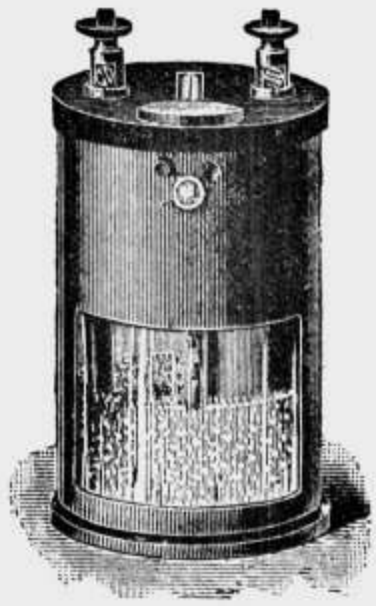


No. 2140.

2136. **Standard Cell, Glass Part with Platinum Wires only,** for schools desiring to make their own standard cells. This is the standard H form and may be used to make any of the ordinary form of standards. Each 1 10

2137. **Standard Cell,** same as No. 2136, on stand as illustrated..... 1 65

2140. **Clark Standard Cell.** E. M. F. of one volt at normal temperature and a temperature co-efficient of 0.039 per cent. per degree centigrade. Mounted in brass case with thermometer and graphite resistance to prevent short circuiting. Both cell and thermometer are furnished with certificate of accuracy from the Germain Reichsanstalt. Duty free..... 12 50

The Edison Primary Battery, formerly known as the **Edison Lalande.**

This battery is designed for closed circuit work, in which field it has no equal. It uses an alkali solution.

The chief points of superiority are:

Constant E. M. F. (.667 volts).

No chemical action and consequent loss of energy while the cell is idle.

Extremely low internal resistance (.025).

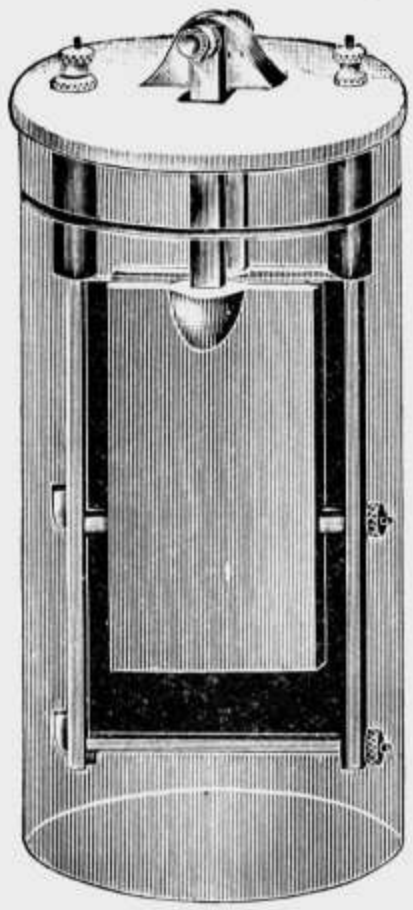
Cheap renewals.

No polarization.

Will not freeze at lowest temperature.

Convenience of form and freedom from noxious fumes and chemical deposits.

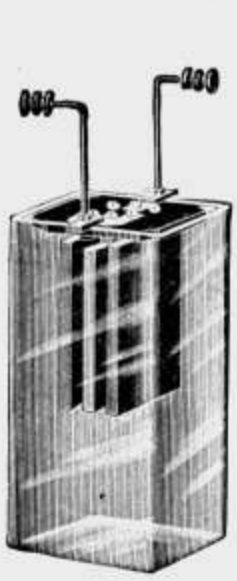
Type S is recommended as the best type for laboratory work.



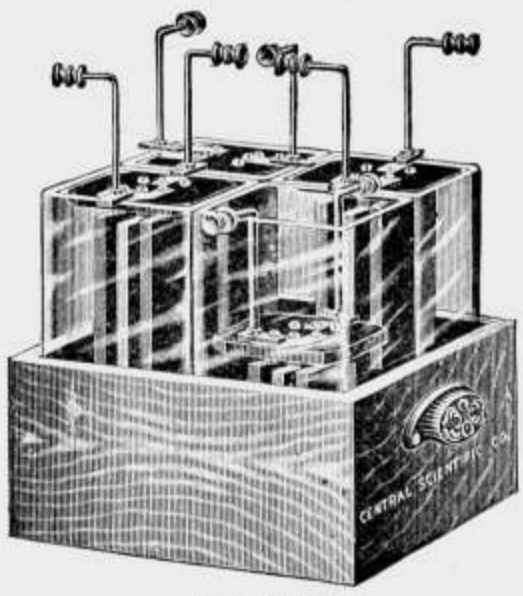
No. 2147.

Prices Net.

2145.	**Edison Primary Battery, Type BB,** 100 ampere-hour capacity	$ 1 50
2145A.	**Charge of Copper Oxide** (1 plate) for Type BB	24
2145B.	**Charge of Zinc** (1 plate) for Type BB	28
2145C.	**Charge of Caustic Soda** for Type BB	15
2145D.	**Charge of heavy oil** for Type BB	05
2146.	**Edison Primary Battery, Type Q,** 150 ampere-hour capacity	2 20
2146A.	**Charge of Copper Oxide** (1 plate) for Type Q	31
2146B.	**Charge of Zinc** (2 plates) for Type Q	28
2146C.	**Charge of Caustic Soda** for Type Q	17
2146D.	**Charge of heavy oil** for Type Q	06
2147.	**Edison Primary Battery, Type S,** 300 ampere-hour capacity	3 00
2147A.	**Charge of Copper Oxide** (2 plates) for Type S	62
2147B.	**Charge of Zinc** (2 plates) for Type S	50
2147C.	**Charge of Caustic Soda** for Type S	28
2147D.	**Charge of heavy oil** for Type S	06
2148.	**Edison Primary Battery, Type W,** 600 ampere-hour capacity	4 85
2148A.	**Charge of Copper Oxide** (2 plates) for Type W	1 10
2148B.	**Charge of Zinc** (2 plates) for Type W	87
2148C.	**Charge of Caustic Soda** for Type W	52
2148D.	**Charge of heavy oil** for Type W	08



No. 2150.

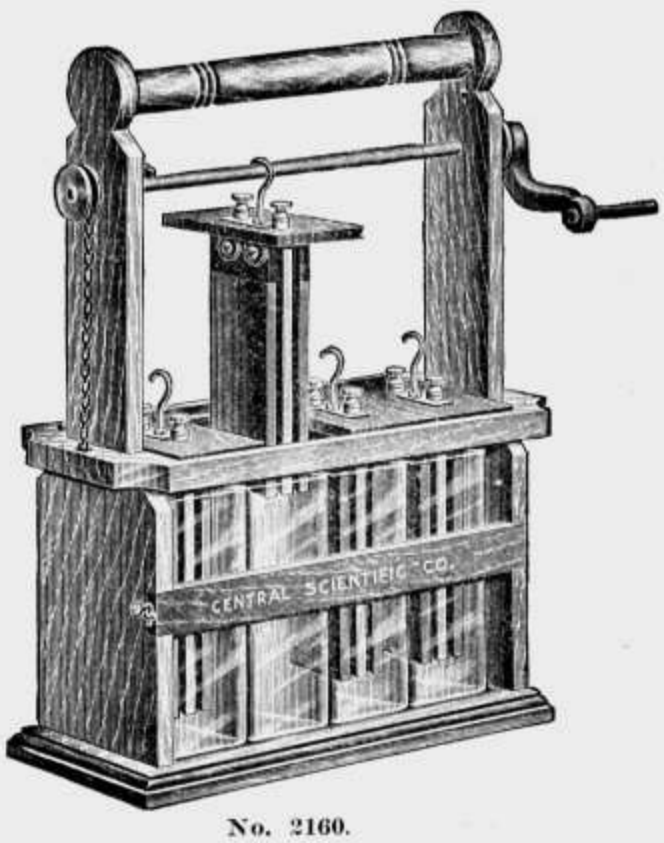


No. 2152.

THE CENTRAL PLUNGE BATTERY.

A powerful, compact form of the bichromate battery, expressly designed for laboratory and lecture table work. Elements can quickly be lifted out of the solution when not in use. Vulcanite top, with nickel plated brass trimmings. Large zinc and carbon elements placed close together, reducing the internal resistance to a minimum and producing a large E. M. F.

2150.	**Central Plunge Battery, single cell**	$ 2 50
2151.	**Central Plunge Battery, two cells,** in case with handles	5 00
2152.	**Central Plunge Battery, four cells,** in case with handles	10 00
2153.	**Central Plunge Battery, six cells,** in case with handles	15 00
2154.	**Zinc Plate** for Central Plunge Battery, 4⅛x3x¼ inches, each	27
2155.	**Carbon Plate** for Central Plunge Battery, 4x3x¼ inches, each	22
2156.	**Glass Jar** for Central Plunge Battery, 4x4x8, each	33



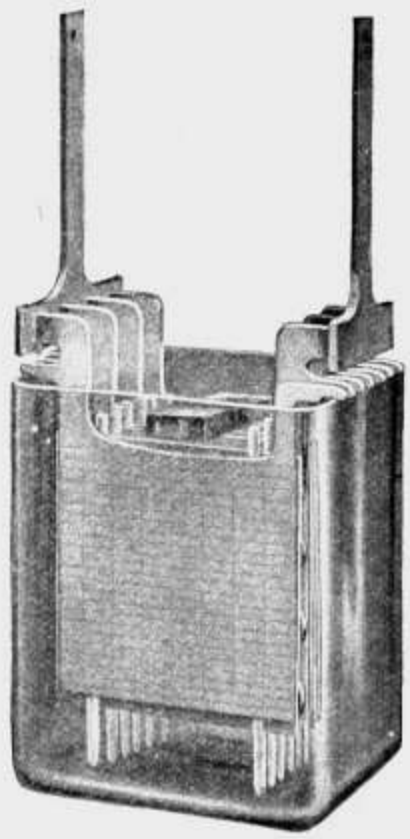
No. 2160.

HIGH SCHOOL PLUNGE BATTERY.

Similar in construction to the Central Plunge Battery described above, the essential difference being in the elements, which are larger, and the case, which has an easy lifting motion, with a deadfall catch not liable to slip. The elements are quickly removed from the solution. Each cell may be used singly, two or more in series, or in parallel. Any cell which is not required for use can be suspended by the hook from the axle. All parts are interchangeable. Unquestionably the best battery for the lecture table.

2160.	**High School Plunge Battery, four cells,** complete, with case	$ 13 35
2161.	**High School Plunge Battery, six cells,** complete, with case	18 00
2162.	**Zinc Plate** for High School Plunge Battery, 6¼x2½x¼ inches, each	27
2163.	**Carbon Plate** for High School Plunge Battery, 6½x2½x¼ inches, each	25
2165.	**Glass Jar** for High School Plunge Battery, 2½x4¼x7 inches, each	35
2166.	**Elements Complete,** with fiber top, binding post and hook	2 00

CHLORIDE ACCUMULATORS.



These Batteries are more extensively used than any other type in scientific laboratories, both in this country and Europe. We guarantee them to give good service at the capacities designated.

The voltage of each cell of all capacities is slightly above two volts on open circuit and during discharge at the eight-hour rate varies from that point at the beginning to 1.75 volts at the end.

We have selected types that are adapted to the various laboratory demands. Other sizes will be quoted upon application.

As will be noticed, a number of cells are connected by means of the lead straps and bolts.

The prices given include the electrolyte.

CELLS COMPLETE IN GLASS OR RUBBER JARS—NOT CHARGED.

Cat. No.	Type	No. of Plates	Size of Plates	Normal Charging Rate in Amperes	Normal Rate of Discharge for			Dimensions of Glass Jar			Dimensions of Rubber Jar			Complete in Glass Jar	Complete in Rubber Jar
					8 Hours	5 Hours	3 Hours	Length	Width	Height	Length	Width	Height		
2170A	LT	2	3½x1	⅕	⅕	¼	⅖	1⅝	1¾	6⅝	..	..	..	1.00	...
2170B	BT	2	4 x3	¾	¾	1	1½	1¾	1¾	6¾	1½	3¾	6½	1.50	2.00
2170C	CT	2	5 x5	1½	1½	2	3	2¼	6¼	8	2	5⅝	8	2.75	3.50
2170D	PT	2	8¾x5	3	3	4¼	6	2½	6	12	2	5⅝	12¼	4.25	5.30
2170E	ET	2	7¾x7¾	4½	4½	6½	9	2¼	8¾	11	2	8½	11	5.40	6.60
2171A	D	7	6 x6	7½	7½	10½	15	6½	7⅞	9½	3⅜	6½	9	9.70	11.10
2171B	D	9	6 x6	10	10	14	20	8¾	8	9½	5	6½	9	12.20	14.40
2172A	E	5	7¾x7¾	10	10	14	20	5½	9⅛	11⅜	2⅞	8½	11	12.00	14.00
2172B	E	7	7¾x7¾	15	15	21	30	6¾	9⅛	11⅜	3⅜	8½	11	15.75	18.75
2172C	E	9	7¾x7¾	20	20	28	40	8	9⅛	11⅜	5	8½	11	20.00	24.00

2174. Connecting Bolts, each..... 25

PORTABLE CELLS, CHARGED.

At the normal rate given below the cells will be completely charged in 9 hours and discharged in 8 hours.

Cat. No.	Number of Cells in Case	Type	Number of Plates in Cell	Normal Charge and Discharge Rate	Dimensions			Weight Pounds	Price Complete
					Length	Width	Height		
2175A	1	C	3	1¼	3	5½	10½	8	6.10
2175B	2	C	3	1¼	4¾	5½	10½	14	10.55
2176A	1	D	3	2½	3¼	7¾	12½	15	7.70
2176B	2	D	3	2½	5¼	7¾	12½	26	14.00
2177A	1	D	5	5	4¼	7¾	12½	24	11.90
2177B	2	D	5	5	7½	7¾	12½	43	20.75
2178A	1	D	7	7½	5¼	7¾	12½	33	14.00
2178B	2	D	7	7½	9¼	7¾	12½	58	25.00



No. 2188C.

CENCO DRY STORAGE BATTERY.

This is a **guaranteed battery** of portable form, low maximum discharge rate and high efficiency. Being a **dry storage battery,** it may be used in all positions without injury. May be used equally well on all ignition work and lighting.

Each battery is **guaranteed** for **two years** from date of sale. This guarantee covers everything except abuse and disregard of well known directions for the care of storage batteries. It is further guaranteed to retain its output efficiency for the same period.

Each battery is shipped "charged." In recharging, the metal cap at top is unscrewed and about a tablespoonful of water poured into the interior. After being charged the battery is turned up to pour off the water and the cap is then screwed into place. In charging, **never use more current than the "maximum discharge"** as specified.

Cat. No.	Type	Volts	Amp. Hours	Max. Discharge	Net
2188A	D2	2	20	2	7.50
2188B	D4	2	60	4	10.80
2188C	D6	6	70	4	30.00
2188D	D8	8	70	4	41.70
2188E	D7	6	100	7-10	50.00

Note—In our Nos. 2188C and 2188E four binding posts are furnished, and in our Nos. 2188D, five. Thus each or all cells may be used as desired.

BATTERY DIRECTIONS.

Amalgamating. A good method for amalgamating the zinc element is to dip it into acid, then pour a few drops of mercury on the surface and rub in with a piece of cloth attached to a stick. This is perhaps the best and quickest method although the most expensive.

Amalgamating Fluid. Two-ounces mercury, 1 ounce aqua regia, 10 ounces water. Dip zinc into solution and then wash with water. No need of brush or rag.

Le Clanche Cell. Place 6 ounces Ammonium Chloride into jar and fill with water to two-thirds its capacity. Stir well until the salt is entirely dissolved. Place elements with zinc outside porus cup as illustrated.

Carbon Cylinder Cell. Directions furnished under Le Clanche cell apply to this type of cell, except that zinc rod is placed inside carbon cylinder.

Samson Cell. Directions furnished under carbon cylinder cell apply to this type of cell.

Grove Cell. Outer cell contains amalgamated zinc plate dipping into dilute sulphuric acid (by weight 10 parts water to 1 part acid). In inner porous cup, a piece of platinum dips into nitric acid of full strength. Obnoxious nitrogen oxide fumes may be suppressed in a large measure by the addition of a small quantity of Potassium Dichromate.

Bunsen Cell. This cell is merely a modification of the Grove cell, in which the expensive platinum is replaced by an electrode of gas carbon.

In Both the Grove and Bunsen Cells the Nitric Acid May Be Replaced by a Chromic Acid Solution.

Grenet Cell. In this cell, the zinc plate between two carbon plates dips into a chromic acid solution. (See below.) When this cell is exhausted, the rich reddish color of chromic acid will be replaced by a muddy dark green color.

Chromic Acid Solution. There are many different formulae, but the most convenient method of making a generally useful acid is by simply dissolving prepared chromic acid salt in water.

A useful formula is, 30 parts Sodium Dichromate, 100 parts water and 23 parts sulphuric acid (sp. gr. 1.845); all by weight.

Plunge Battery. Elements and directions under Grenet type apply to this type of battery.

Daniell Battery. The zinc element is placed in a porous cup containing sulphuric acid (1 part acid to 20 parts water, by weight). The copper element encircles a porous cup and dips into saturated solution copper sulphate, kept continually saturated by the addition of an excess of copper sulphate crystals on bottom of jar. Solution is more effective by addition of few cubic centimeters sulphuric acid.

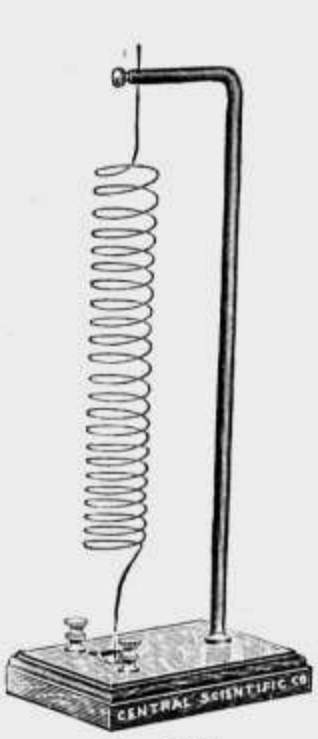
(In our No. 2128 a pocket is provided for holding excess crystals of copper sulphate.)

Gravity Battery. This type of battery is merely a form of Daniell cell, where the two solutions are kept separate by their difference in gravity. Place 2 pounds copper sulphate crystals in bottom of jar with copper element. Add clear water to fill the jar when elements are in position. Allow to stand for 2 hours, unless desired for use at once, in which case add 1 ounce zinc sulphate to solution and suspend zinc over edge of jar when liquids are sufficiently separated.

Fuller Cell. Fill glass jar half full of chromic acid solution, place 1 teaspoonful mercury and 2 tablespoons full of common salt in the porous cup and fill with water to 1½ inches of top. The carbon element containing the porous cup is then placed in the glass jar, the zinc is placed in the glass jar and the cover over it. The solution should fill the glass jar to within an inch of the top.

Edison Cell. Dissolve contents of can of caustic soda in jar filled with water to mark. Insert the elements, taking care that the copper oxide plate is at least 1 inch below the surface of the liquid. Carefully pour contents of bottle of oil on surface of solution. Oil excludes all air and keeps salts from forming.

Storage Cells. These cells make the most convenient source of electrical supply, providing the laboratory is equipped for charging. Full directions for use and for charging accompany each cell.



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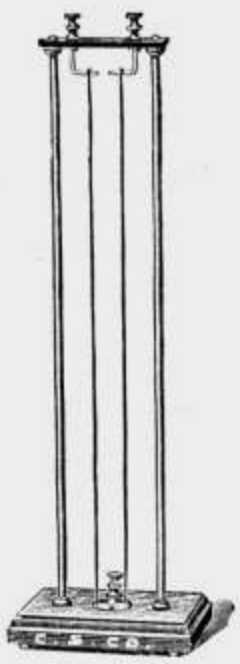

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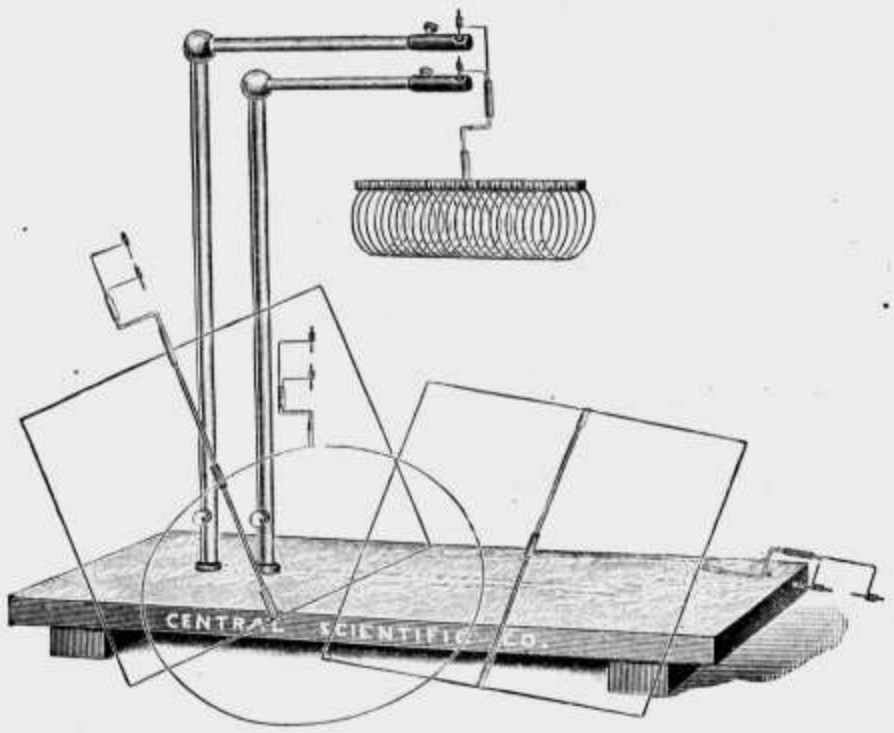
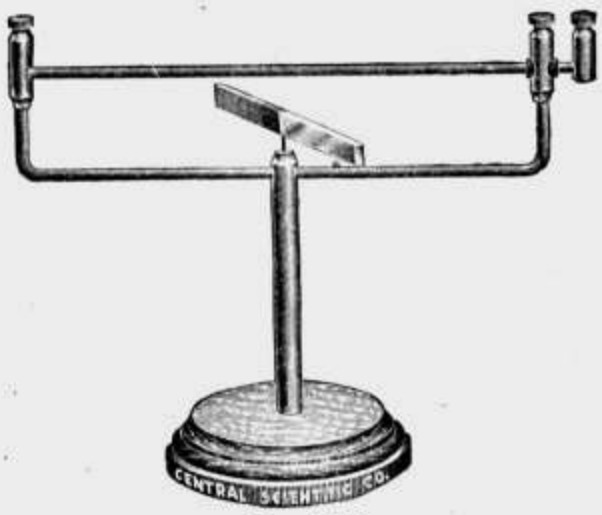


No. 2205.

2201. **Contracting Helix,** improved form, as illustrated. The current passing through the spiral causes a contraction owing to attraction between spirals. This will break the current and the spirals again become normal. A contraction is caused as soon as the circuit is made again ..... $ 2 25

2203. **Parallel Current Apparatus,** mounted on base and support as shown. To demonstrate laws of parallel currents..... 1 75

2205. **Ampere's Frame,** consists of a hardwood base, brass pillars and arms, with steel mercury cups, a set of five forms of aluminum wire, to illustrate the effect of magnets and solenoids upon the currents; the action of terrestrial magnetism; and the action of currents upon currents. This piece is guaranteed to work, complete with directions..... 11 00



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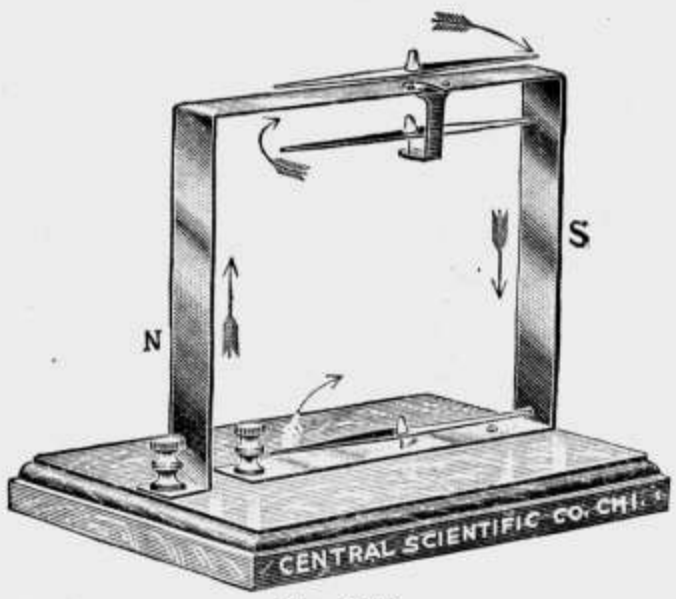
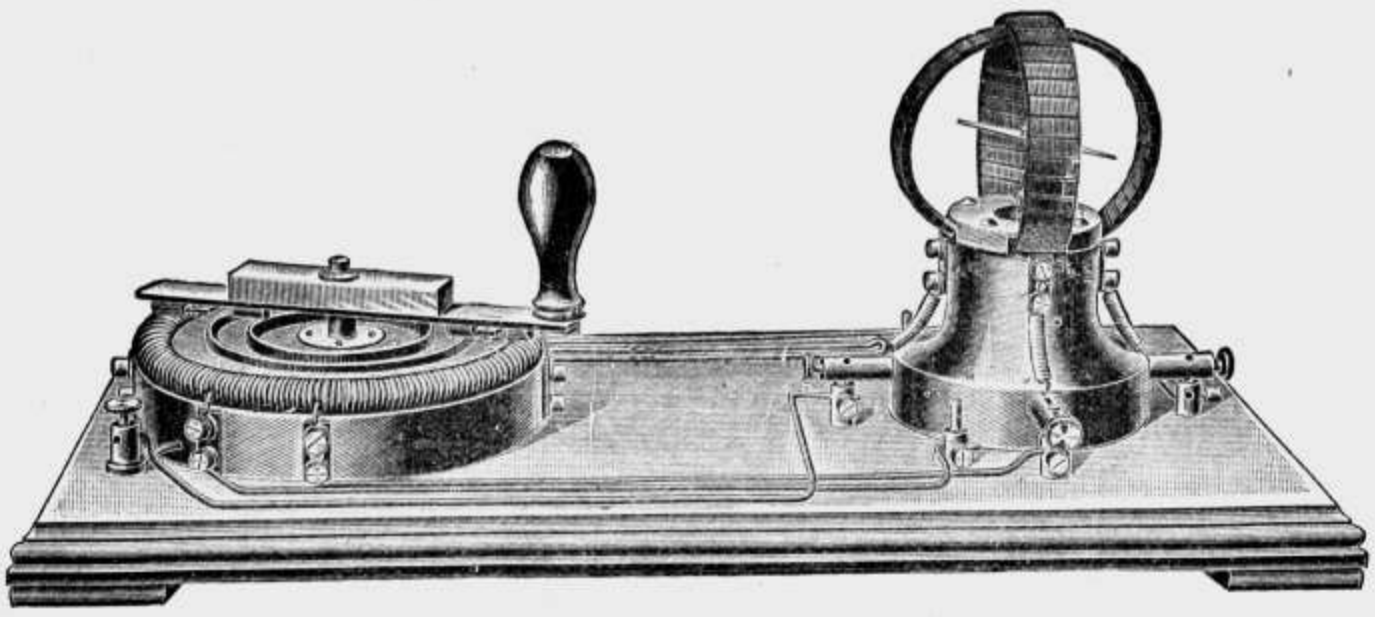


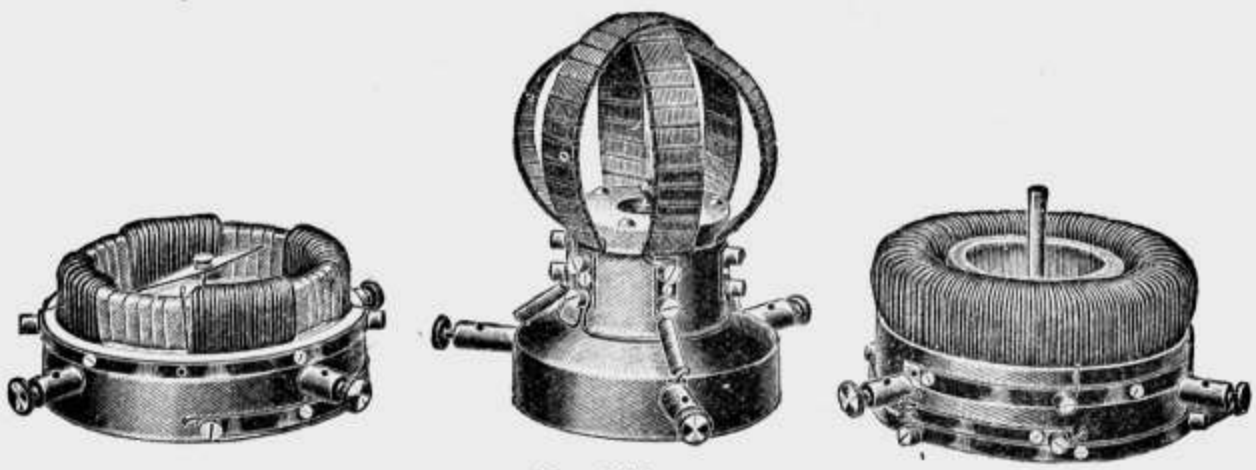
No. 2209.

2207. **Oersted's Law Apparatus,** simple form with 6-inch bar magnet. Illustrates effect of electric current upon a magnetic needle, thus showing Oersted's law..... 3 00

2209. **Oersted's Law Apparatus,** a convenient form with 3 needles. Rules of direction of currents are easily deduced with this instrument. Very valuable and instructive..... 5 00

Note—Compasses, Magnetic Needles, Helices, Etc., page 127.





No. 2215.

2215. Alternating Current Demonstration Apparatus.

This is a simple set of apparatus for showing the essential principles of an induction or alternating current motor, for either two-phase or three-phase currents. It demonstrates very clearly and simply the rotating magnetic field, which is the fundamental principle of such motors. The study of such apparatus is of great value, inasmuch as the alternating current is in almost universal use for the long distance transmission of electrical power.

The current of two dry cells is passed into a transformer representing the A. C. generator of a power plant. Here the direct current of the cells, by a simple device, is divided into either two-phase or three-phase alternating currents of essentially the same phase relations as the currents from a two-phase or three phase commercial generator.

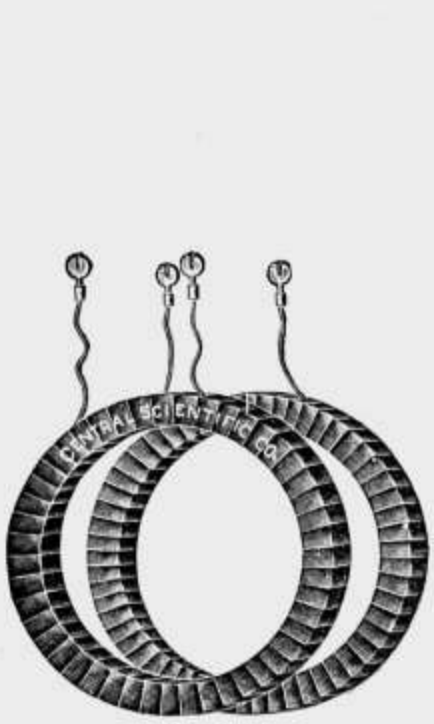
This current passes through the proper windings of the coils representing the field coils of the motor. The rotating magnetic field produced by these coils may be a glass plate and iron filings, a mounted magnetic needle, a metal disc and a closed circuit armature. The disc, needle and core will rotate synchronously with the rotation of the "generator" by hand.

The rotating parts are mounted with agate caps and steel bearing points, and all wiring is plainly indicated by different colors and by placing the connections on top of the base. Complete with full directions ..... Duty free $ 40 00

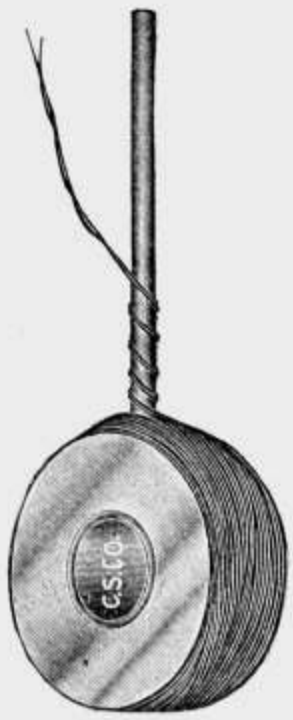
Transformers, page 166.

Arc Lamps, page 167.

Electro Dynamic Charts, page 205.



No. 2217.



No. 2219.



No. 2221.



No. 2221½.

2217. **Coil for Current Induction.** A form wound coil 10 inches in diameter with flexible leads and connectors. A pair of coils will be found useful for work in induced currents. When a single coil is connected in series with our No. 2420 or other sensitive galvanometers interesting experiments showing the earth's magnetic field and other induction phenomena may be made.....Each 8 00

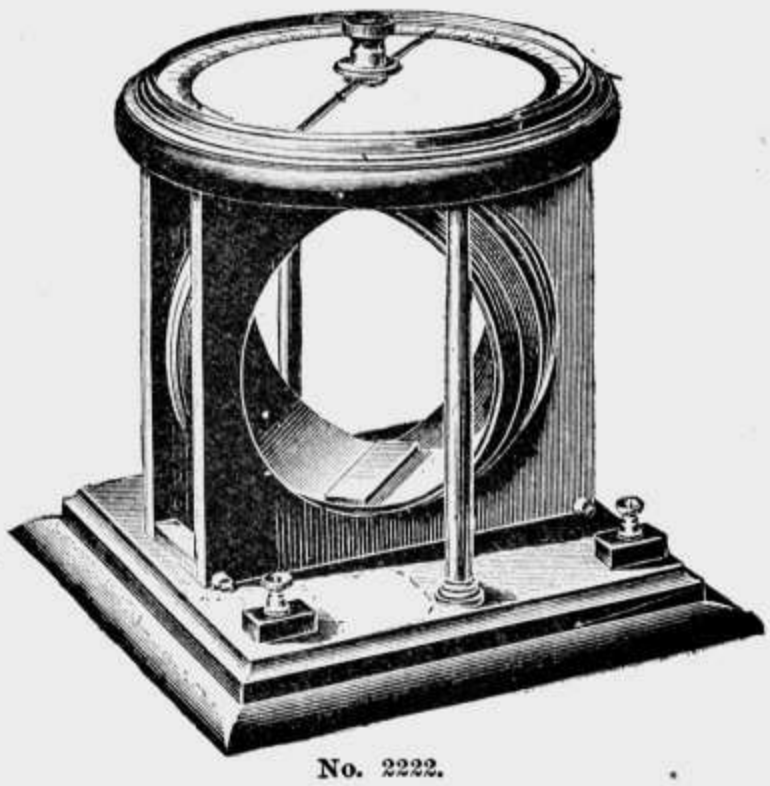
2219. **Induction Coil.** A simple coil wound on brass spool. Illustrates conveniently and in the simplest manner the current induced in the coil by proximity to the other carrying the current.....Each 1 10

2221. **Primary and Secondary Coil,** mounted on hardwood spools and base, wound with silk insulated wire, provided with soft iron core..... 6 25

2221½. **Interrupting Wheel** for making and breaking an entire circuit. This consists of a brass wheel whose periphery is provided with a number of teeth and mounted so that when it is revolved by the crank, the spring contact makes and breaks the circuit, the wheel and spring being provided with electric connections.

In use this device is connected in series with a battery and coil, in which the interrupted current is desired. In use with No. 2221 primary and secondary coil it serves as a vibrator in illustrating an induction coil 3 00

2222. **Variable Standard of Self-Induction,** after Ayrton and Perry, consists of two coils connected in series, the smaller revolves within the other, so that it may be placed at any angle with it, and the self-induction may be varied from a minimum to a maximum value. The coils, in shape, are parts of concentric spheres, so that the inner is very close to the outer and yet free to revolve within it, and a wide range of values is thus secured. The scale reads directly in millihenrys from 4 to 40. The wire is of copper, so that the resistance may be as low as possible for a given value of the self-induction. The instrument is made of ebonite, since wood will not stand the variations of climatic conditions. Duty free $150 00

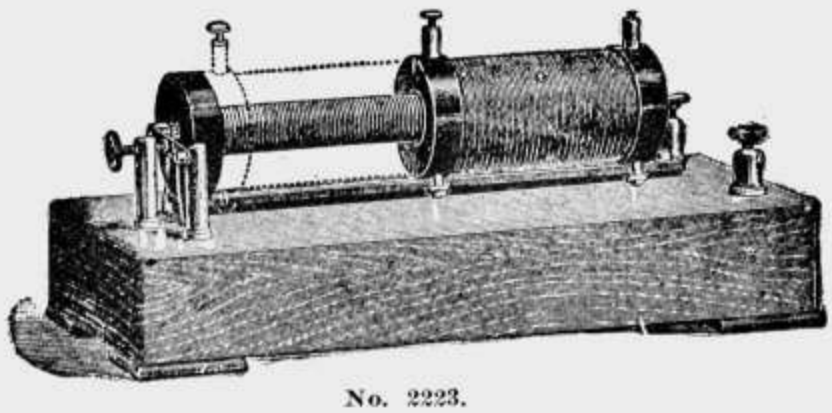


No. 2222.

2222A **Variable Standard of Self-Induction,** flat, round form, made of ebonite. This instrument reads direct in millihenrys from 5 to 25..Duty free 45 00

2222B **Standard of Self-Induction,** same as above. For purpose of comparison. Capacity 1 Henry (109 c. m.).....Duty free 20 00

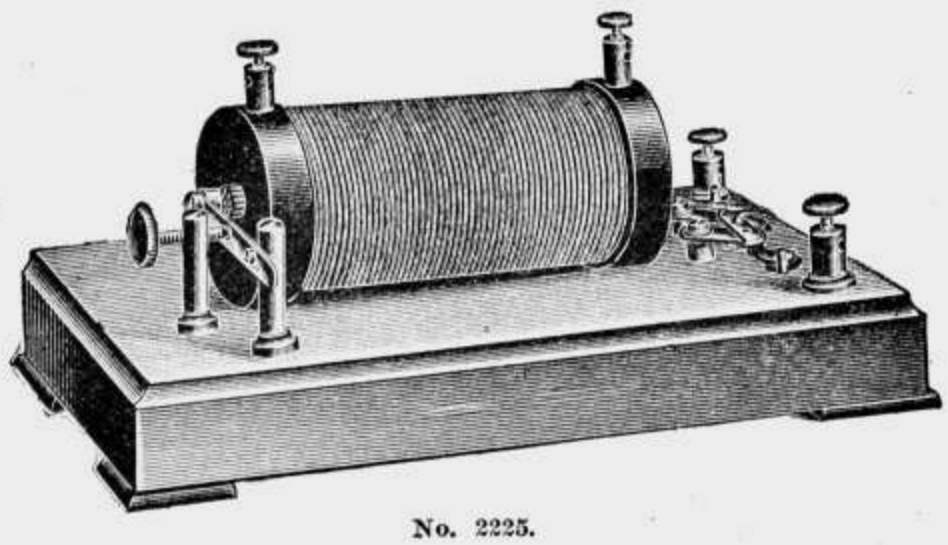
2222C. **Self-Induction Coils,** (Millikan and Mills, Exp. 14). Ten centimeters high, 8 centimeters diameter, mounted on hardwood base with binding posts 3 00



No. 2223.

2223. **Induction Coil, Demonstration Form,** with sliding secondary, mounted on polished mahogany box with condenser, 6 m. m. spark..... $ 5 00

2224. **Induction Coil, Demonstration Form,** 10 m. m. spark..... 8 35



No. 2225.

2225. **Induction Coil,** with adjustable vibrator or interruptor, commutator and condenser, mounted on finely polished mahogany box, 6 m. m. spark 5 00

2226. **Induction Coil,** same as No. 2225, 10 m. m. spark..... 7 50

2227. **Induction Coil,** same as No. 2225, 13 m. m. spark..... 10 00

2228. **Induction Coil,** same as No. 2225, 18 m. m. spark..... 15 00

2229. **Induction Coil,** same as No. 2225, 25 m. m. spark..... 19 50

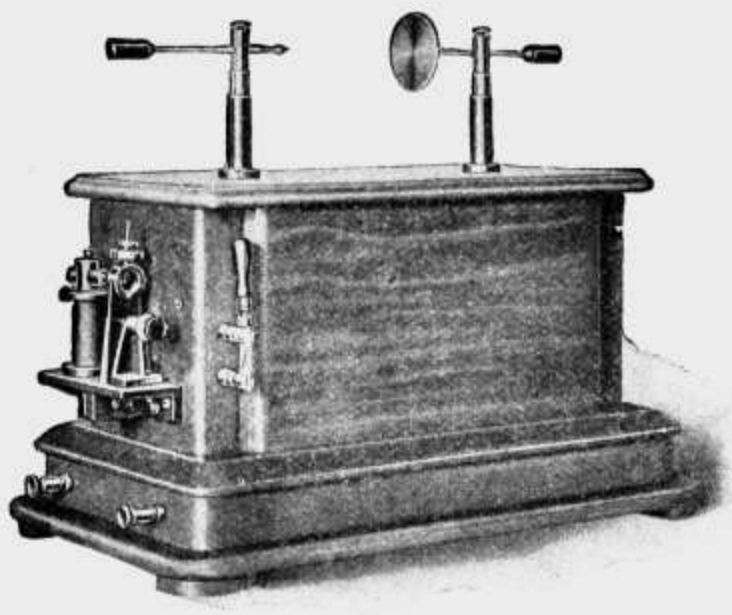
2230. **Induction Coil,** same as No. 2225, 50 m. m. spark.....Duty free 22 00

2231. **Induction Coil,** same as No. 2225, 75 m. m. spark.....Duty free 33 00

2232. **Induction Coil,** same as No. 2225, 100 m. m. spark.....Duty free 45 00

X-RAY COILS.

We are selling agents for the Standard Scheidel Coil. A high grade coil offering many desirable features in mechanical and electrical construction. The primary windings are divided into sections. The secondary windings are subdivided into a number of sections, embedded in a flexible insulating compound. Being wound with wire of ample cross section, its internal resistance is very low in proportion to the high potential obtained. The structural advantages of this coil consists in the independent support of both windings, permitting the interchanging of each without interference. The ends of the primary are covered with protective housings, thus maintaining the finished appearance for which this coil has no equal. Each instrument is sold under a guarantee. Only very best material is used in the construction; adjustment is perfect, and workmanship and finish are of the highest quality. Coil is entirely inclosed in a handsome mahogany case. (See next page.)



No. 2240.

2240. **Induction Coil,** operating on a 4 cell storage battery to give a 6 inch spark. Supplied with vibrator, all necessary adjustments, and provided with platinum iridium contact points. The condenser is built into the base of the instrument.....Net $ 75 00

2241. **Induction Coil,** operating on a 6 cell storage battery to give an 8 inch spark. This coil may be supplied with a vibrator and condenser as in No. 2240, but it is advised that an electrolytic interrupter, No. 2244, be used. Without vibrator and condenser or interrupter..Net 100 00

2242. **Induction Coil,** operating on 8 cell storage battery to give a 10 inch spark. Otherwise same as No. 2241.....Net 125 00

2243. **Induction Coil,** operating on 8 cell storage battery to give a 12 inch spark. Otherwise same as No. 2241.....Net 150 00

Vibrator and Condenser Attachment to Nos. 2241, 2242, 2243, extra.Net 25 00

For use on 110 or 220 volt, direct current, these coils must be built with a **variable inductance.** In addition an electrolytic interrupter or mercury turbine and rheostat must be used. When a coil is used in this manner, if it has a vibrator, the platinum points are screwed tight together to complete the circuit to prevent interrupting. The interrupter is then connected in series with the coil, rheostat and line in the usual manner. Extra charge for variable inductance ..... Net 25 00

N. B. For use on alternating current of any voltage a current rectifier must be used (see our No. 2270) in addition to above accessories.

For the convenience of those who desire a complete self-contained outfit, the illustration No. 2243A, B and C shows a most popular combination. It consists of No. 2243 coil with variable inductance. The interrupter usually supplied with this style of apparatus is a standard mercury turbine interrupter driven by a 1-10 H. P. direct current motor, but the apparatus may be equipped at any time with an additional electrolytic interrupter without changing the coil, as the inductance of the primary is quickly varied to suit the different kinds of interrupters.

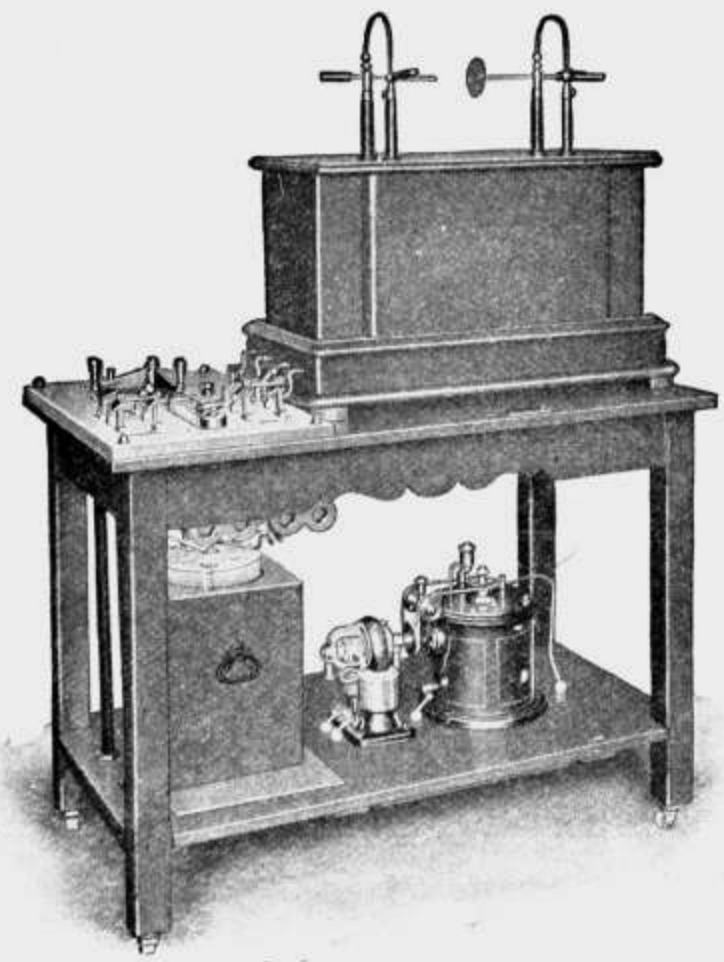
On the left end of the table is the controlling rheostat, built into the table in the most permanent and compact manner. The main switch controlling the current supply for the whole equipment serves also as pole changer and is placed on top of the table, together with the switch and speed regulating rheostat for the interrupter motor.

This outfit is entirely self-contained, can be readily connected through binding posts in the rear of the table to circuits of normal carrying capacity, as found commonly in buildings.

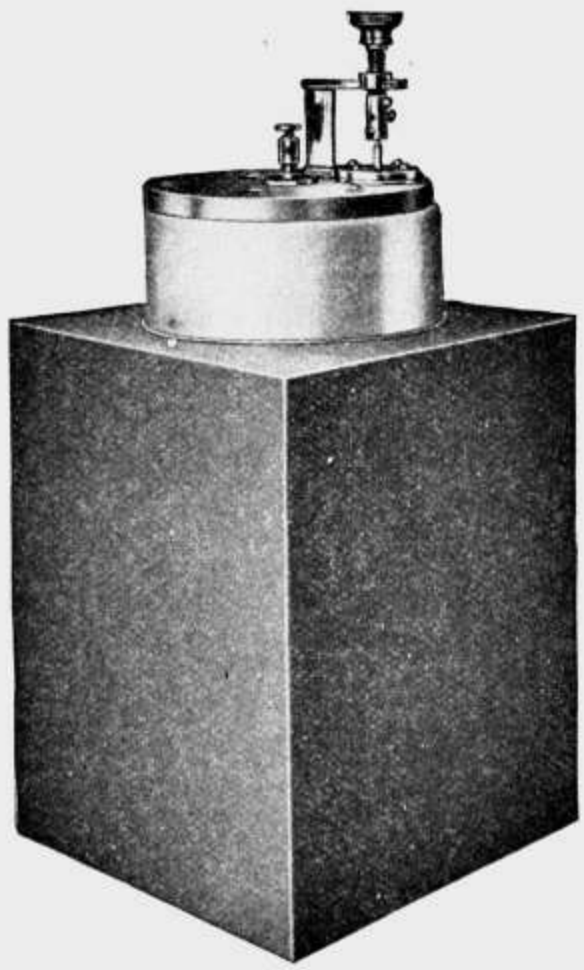
The table itself is mounted on casters of liberal proportions and therefore readily removable.

A full set of instructions, illustrated properly by connection diagrams and drawings, accompanies each apparatus, enabling anybody to install and operate the instrument without previous knowledge in this line of work.

Each apparatus is subjected to a series of most severe tests, of which complete records are kept.



No. 2243 A, B and C.



No. 2244.

2243A. **Induction Coil,** 12 inches, with variable inductance.....Net $ 175 00

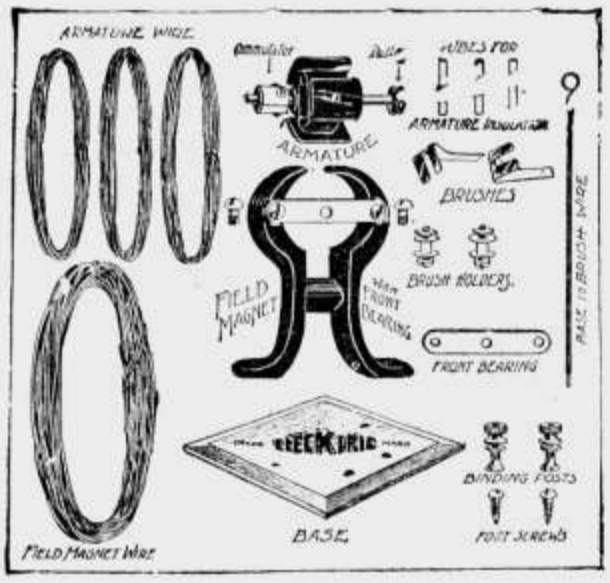
2243B. **Mercury Turbine Interrupter**.....Net 75 00

2243C. **Table Cabinet,** with rheostat, switches, etc.....Net 50 00

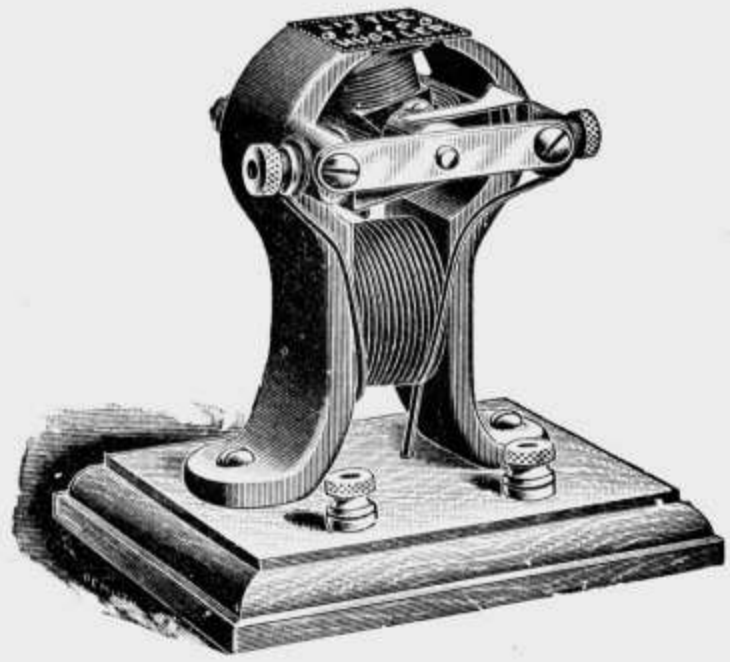
2244. **Electrolytic Interrupter.** Built in the most substantial and compact manner, provided with platinum points of liberal proportions, which have been determined under actual working conditions. It is provided with water cooling jacket, thus insuring immunity from noise and all disturbances arising from overheating.

When ordering, it is necessary to state the type of coil with which the interrupter is to be used, as well as the properties of the electric current, so that the proper type of interrupter, with correct instructions, diagrams, etc., can be selected.....Net 25 00

N. B.—**Electrolytic Rectifier** (Nodon Valve), see page 164.



No. 2245.



No. 2246.

2245. **"Little Hustler" Dissected Motor.** Among the apparatus for the revised requirements for college admission is a dissected motor, by means of which the student may, in a practical way, demonstrate the principles he has studied, by constructing his own motor. The "Little Hustler" will prove satisfactory if the instructions which accompany it are carefully followed.

The armature has three poles, causing the motor to start without assistance when the current is applied and will drive a 5 inch fan at a high rate of speed. It is also fitted with pulley for running toys, etc. One cell of any standard type of battery will run the motor.

Diagrammatic instructions for winding and assembling accompany each instrument..... $ 1 10

N. B.—If sent by mail, remit 15 cents postage additional.

2246. **Little Hustler Finished Motor.** Consists of above parts put together and mounted ready for use..... 1 40

N. B.—If sent by mail, remit 15 cents postage additional.

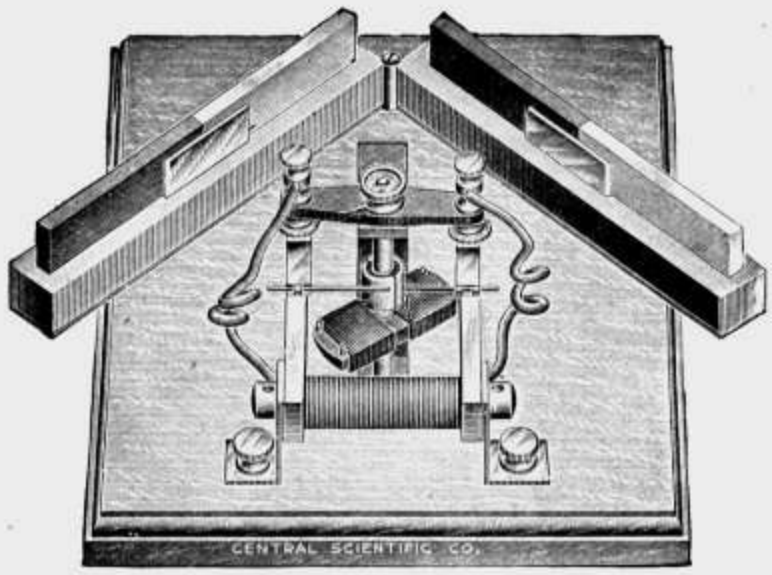
2247. **Little Hustler Fan**..... 30

2248. **Little Hustler Complete Outfit,** consisting of No. 2246 Finished Motor, No. 2247 Fan, Battery and Wire, complete..... 2 35

N. B.—This outfit cannot be sent by mail.

2249. **Motor Parts, Large Size.** In accordance with a number of requests for a dissected motor larger than the "Little Hustler," we have made a motor similar in design to No. 2246, but 5 inches high, weighing 2 lbs. The iron parts are japanned and with all machine work done; all screws, washers, bearings, etc., are nickel plated. Complete, ready for assembling, with the exception of wire and wooden base..... 1 65

2249A **Wooden Base** for No. 2249, with sufficient wire for winding field and armature..... 27



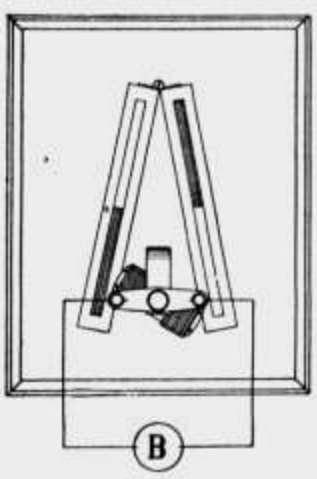
No. 2250-2250A.

St. Louis Motor. This apparatus is a dissectable motor that may also be operated as a dynamo. The model was suggested by the physics teachers of the St. Louis High Schools and is now marketed after two years' experimentation in the shop and laboratory. The salient features are:

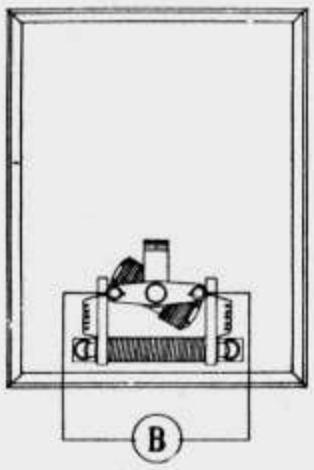
1. **Dissectability.** Parts are of good construction and go together accurately and rigidly. Not easily put out of adjustment.

2. **All parts are plainly visible** when at rest and in motion.

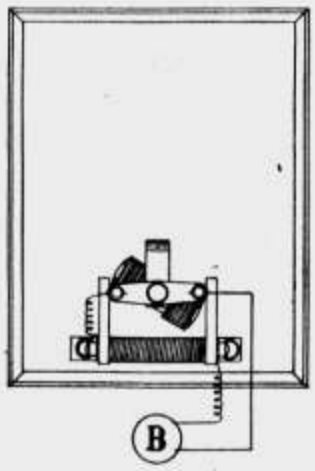
3. **Individual laboratory work** on motor and dynamo.



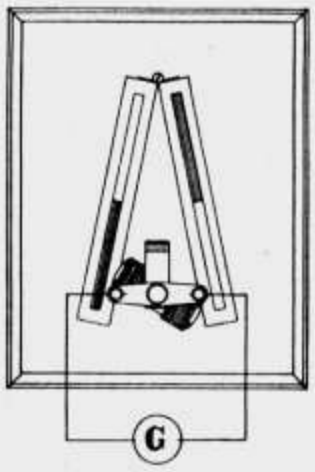
No. 1.
Motor Bar Magnet Fields.



No. 2.
Shunt Motor Electro Magnet Fields.



No. 3.
Series Motor Electro Magnet Fields.



No. 4.
Dynamo Bar Magnet Fields.

The following points may be studied with a test needle.

I. **Field Magnets (permanent).** See illustration 1.
   A. Strength of **bar magnet field** at different distances from armature.
   B. Effect of two like poles, etc.

II. **Electro Magnet Field** in shunt or series connection. See illustrations 2 and 3.

III. **Polarity** of armature at different points in its revolution.
Polarity of field.

IV. **Direction of Current** in armature and field.

V. **Commutation,** position of armature, commutator and brushes.

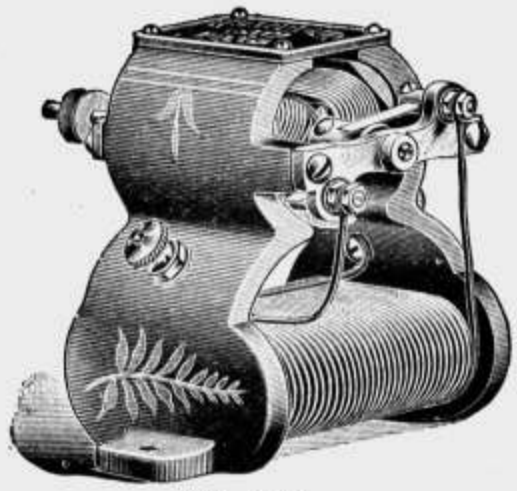
VI. **Motor** characteristics, operated by one dry cell.

VII. **Dynamo** characteristics, turned by hand. See illustration 4.

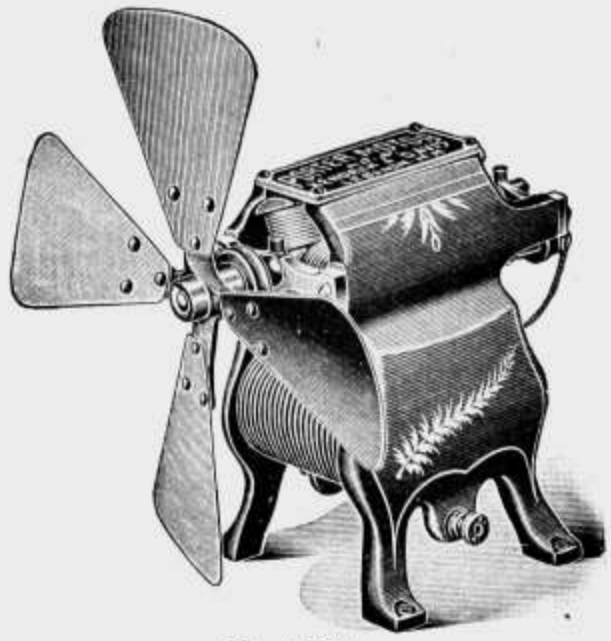
2250. **St. Louis Motor,** mounted on base with two 6 inch bar magnets..... $ 2 25

2250A. **Electro-Magnet Attachment,** for use with No. 2250..... 75

Special prices for quantity quoted upon application.



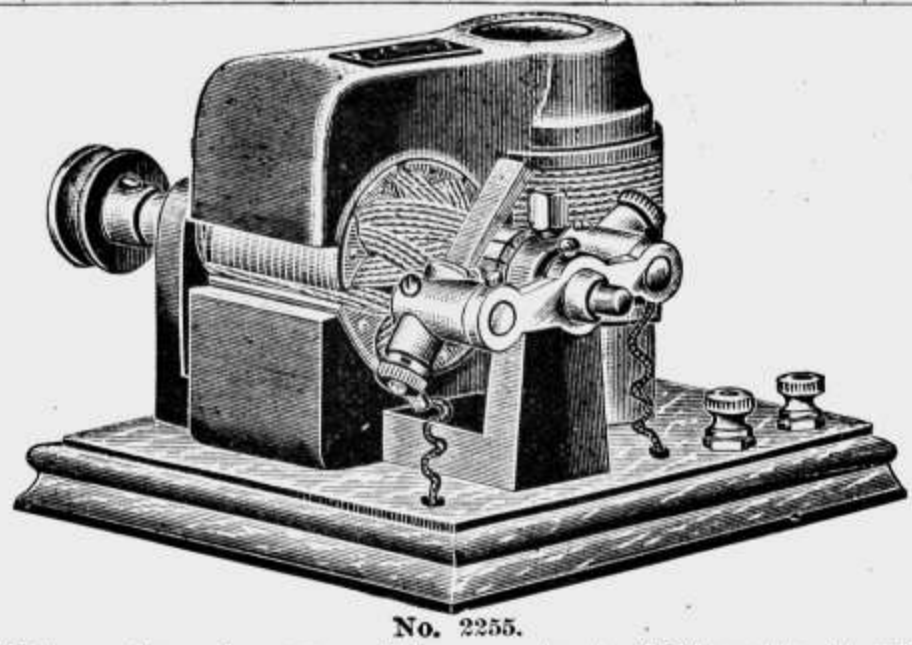
No. 2251.



No. 2254.

Porter Battery Motors. These motors have a well-earned reputation and are recognized as standard articles. They are perfect in every detail of design and construction and accurately made. These motors are finished in black enamel, handsomely decorated, with nickel plated trimmings, without fan.

Catalog No.	Motor No.	H. P.	Volts.	Amperes.	R. P. M.	Size of fan, in.	Height, in.	Weight, lbs.	Price.
2251.	1	1-32	2	1.5	2,200	4¾	3½	1½	$ 3.35
2252.	2	1-16	4	2.5	2,800	5½	4	2¾	5.60
2253.	3	1-12	6	1.6	1,800	8	5½	6½	10.00
2254.	4	1-8	6	1.6	1,800	10	6	8	13.50



No. 2255.

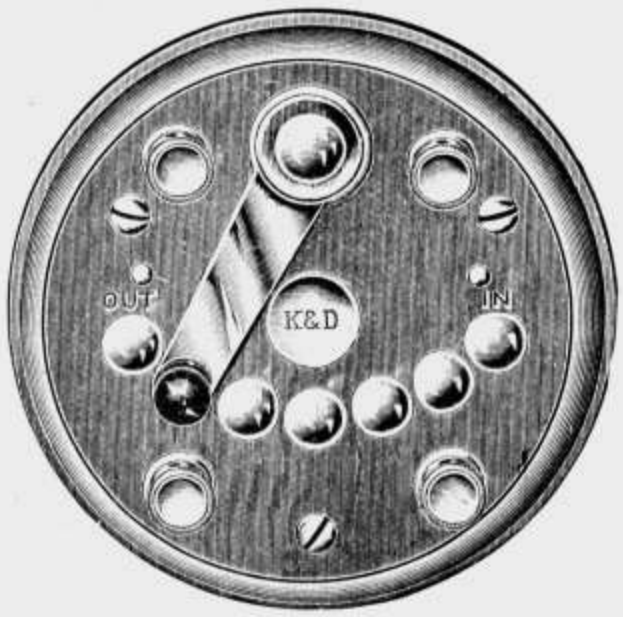
2255. **Dynamo-Motor.** As a dynamo with an output of 24 watts, it will light lamps, run motors, explode gas, decompose water, etc. As a motor it can be run with any number of cells, according to the power and speed desired. A wonderful achievement in a miniature generator, outclassing all similar machines of equal size and efficiency. Frame and field poles are cast in one piece. Armature is of the eight section laminated type. Output about 40 watts. Will light from eight to twelve 4 V. to 6 V. miniature lamps. As a motor it can be run with 4 to 6 V. cells, giving very strong power. A feature of this machine is the rocker arm brush holder, by means of which any voltage can be obtained, ranging at 3,000 R. P. M. from 6 V.-1¼ A. to 14 V.-3 A., and at 2,200 R. P. M. from 5 V.-1 A. to 8 V.-1½ A. It has brass bearings, steel shaft, laminated type armature, eight section commutator and phosphor bronze brushes. It is finished in black enamel, mounted on polished base, size 4½x5½ inches, height 4 inches. Grooved pulley 1 inch diameter. Weight 4¾ lbs. Shipping weight 7 lbs..... $ 7 75

Motor Rotators, pages 72 and 140.

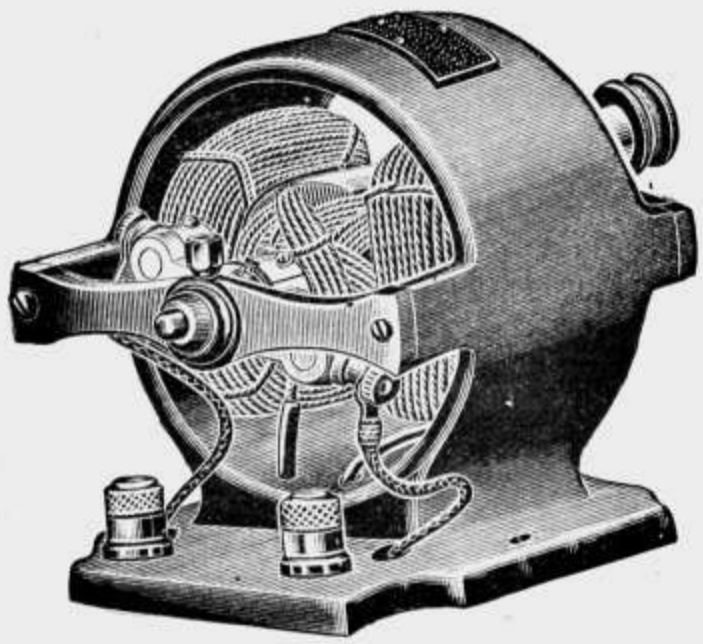
2256. **Dynamo and Motor,** of simple construction for demonstrating the complete transformation of energy, the motor being run on two cells, to furnish power which will operate the dynamo, thereby giving a current which is indicated by the galvanometer..... $ 3 35

2257. **Fans**..... 4¾ in. 5½ in. 8 in.
Each ..... .33 .75 1.50

2258. **Battery Rheostat,** for regulating the speed of small motors, as listed on page 159, and also for use with miniature battery lamps. This rheostat fills a long felt want, is nicely finished with nickel trimmings and rubber handle. Resistance, 0 to 5 ohms..... 1 10



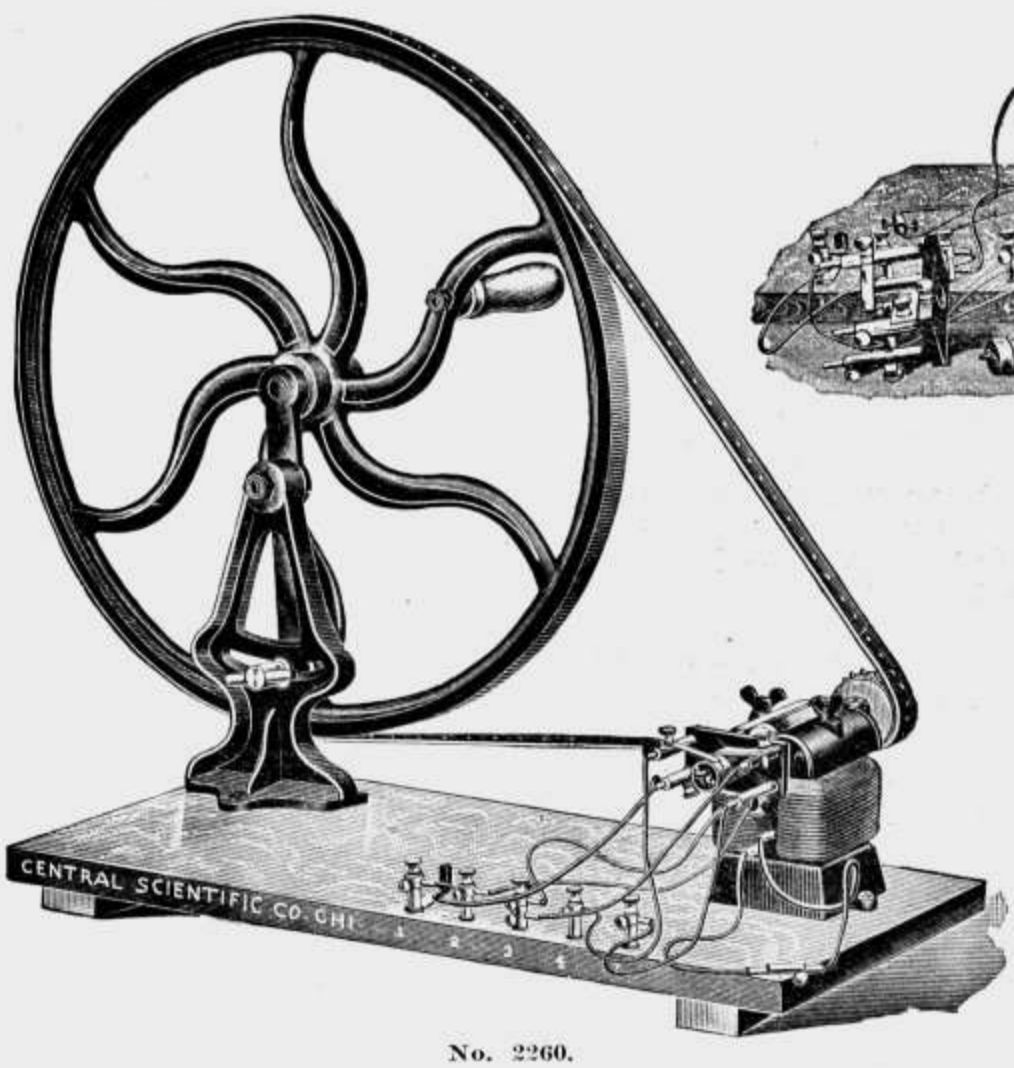
No. 2258


No. 2259.

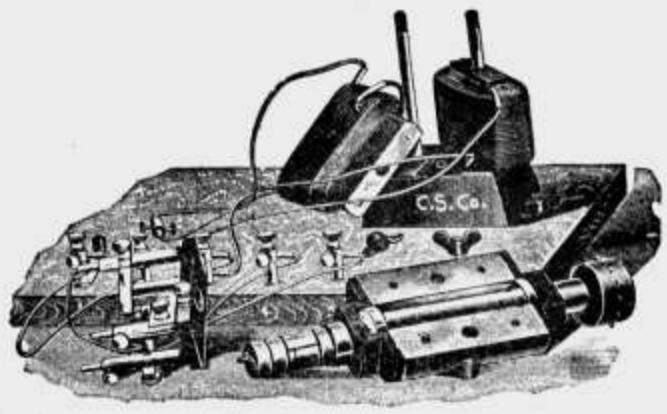
2259. **Dynamo.** This instrument imitates closely the patterns of heavy commercial generators in practical use of proved efficiency. The field is cast in one solid piece with two poles. The armature is of the six section pattern and both field and armature are wound to produce the highest efficiency. It has adjustable rocker arm brush holder to control the voltage output and flat compressed woven wire brushes.

This generator is well adapted for experimental purposes, operating motors, sparking gas or gasoline engines and for supplying current in an electro-plating tank up to 5 gallon capacity.

It will light from 12 to 16-6 volt 2 candle-power lamps. Gives 6 volts, 6 amperes at 1,800 R. P. M. Finished in black enamel with nickeled trimmings. Furnished with grooved pulley. Base 4½x4⅝ inches. Height 5 inches. Weight 8 lbs..... 10 75



No. 2260.



2260. **DISSECTABLE DYNAMO.** Is especially adapted to the needs of the student in high school and college. It is a real application, exactly suited to the natural youthful interest. Not only is there a fascination about things that go and work, but in all physics there is no greater triumph of engineering skill than the modern dynamo. Undoubtedly the dynamo should be placed first in importance in the electrical equipment of any laboratory. **What is wanted is a dynamo capable of demonstrating in a simple way all the important laws of dynamo electric machinery.** For this reason, and with the advice of qualified teachers, we continue the manufacture of this ideal simple dynamo with Siemens shuttle armature. A few minutes with this dynamo will give a student information that he cannot comprehend in the more complicated dynamos. The machine can be depended upon to do any of the work which any dynamo of its capacity may reasonably be called upon to do. The illustration is self-explanatory, every part of the dynamo is open for inspection, and the number of turns of wire, resistance of the wire and the quality of iron are furnished with each machine.

BRIEF SPECIFICATIONS.

The **fields** are high grade electro magnets. When used separately will demonstrate the laws of magnetic traction and exhibit the magnetic lines.

The **armature** is perfectly balanced, has a large shaft and small clearance. The dynamo delivers **direct current** and is also provided with slip rings to deliver **alternating current** to operate induction coils, polarized bells, etc.

As a **separately excited dynamo** the machine develops 15 to 20 volts on open circuit and 5 to 7 amperes on short circuit, or 15 volts at 5 amperes at terminals.

As a **series dynamo** the output is 12 volts at 5 amperes.

As a **shunt dynamo** the output is 15 volts at 5 amperes. The field rheostat is fastened in the base between posts No. 1 and No. 2.

As a **series motor** will develop the variable speed street railway motor characteristics.

As a **shunt motor** will carry considerable load without appreciable variation in speed.

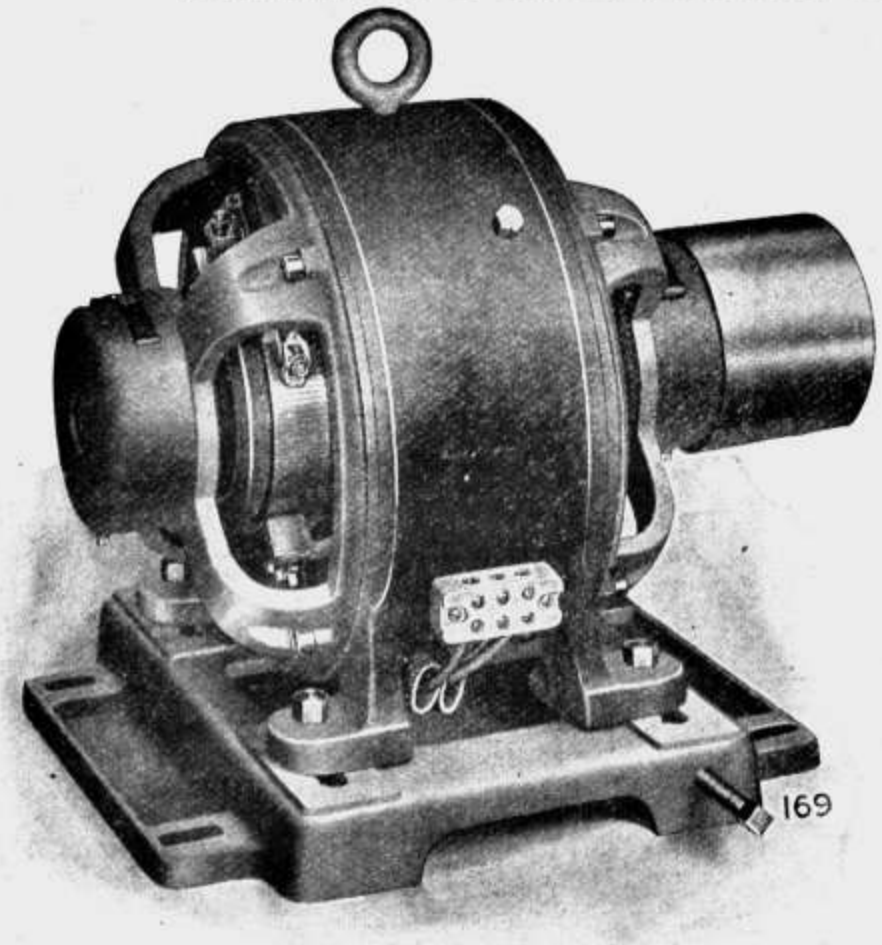
In **water electrolysis** the machine will liberate 17.38 c. c. of hydrogen and oxygen gas in approximately three minutes.

A complete **laboratory report** accompanies each machine, gives size of wire, number of turns of wire and the resistance of each part. Test also includes records of output developed and armature speed required.

Price, with complete directions and blue print showing now to use the dynamo in various ways, and with the different connections..... $ 33 30

2261. **Dynamo,** same as No. 2260, mounted on base without driving wheel, but supplied with belt for use with motor, which may be attached to same base 30 00

DYNAMOS FOR ELECTRIC LIGHTING.



No. 2263.

In designing these machines the object was to bring out a dynamo which would prove adaptable for all kinds of electric lighting, charging storage batteries, etc. There are hundreds of these generators in use today, giving satisfactory service, and we unhesitatingly guarantee them against any inherent defects, mechanically or electrically, for a term of one year. The prices given below are for 110 and 220 volt machines, f. o. b. Chicago, and include a **dynamo, field rheostat, sliding base and standard pulley.**

Catalog No.	K. W.	No. 16 c. p. lamps.	Speed R. P. M.	Pulley diam. face.	Shipping weight.	Each.
2263A.	1/4	4½	2,750	2½ x 3¾	59	$ 40.00
2263B.	1/3	6	1,750	3 x 2¼	95	60.00
2263C.	½	9	2,300	3 x 2¼	95	60.00
2263D.	⅔	12	1,250	4 x 3	155	80.00
2263E.	⅞	16	1,650	4 x 3	155	80.00
2263F.	1⅓	25	2,150	4 x 3	155	80.00
2263G.	1⅓	25	1,125	5 x 4	200	110.65
2263H.	1¾	32	1,400	5 x 4	200	110.65
2263J.	2½	45	1,100	6 x 4½	258	141.30
2263K.	3	55	1,300	6 x 4½	258	141.30

STANDARD SPEED MOTORS.

Nos. 2264A, B, C are series wound; Nos. 2264D, E, F, G, H are shunt wound. These motors are of the same design as above cut and are provided with **automatic release starting box, sliding base and standard pulley.**

Catalog No.	H. P.	Speed R. P. M.	Pulley diam. face.	Shipping weight.	Each.	
					110 Volts.	220 Volts.
2264A.	1-20	1,800		30	$ 12.50	$ 13.00
2264B.	1-16	2,000		30	13.50	14.00
2264C.	1-12	2,200		35	14.50	15.00
2264D.	1-8	1,800		40	17.50	18.00
2264E.	1-8	750	2½ x 1¾	60	40.00	40.00
2264F.	1-4	1,650	2½ x 1¾	60	40.00	40.00
2264G.	1-2	1,550	3 x 2¼	95	60.00	60.00
2264H.	1	1,200	4 x 3	155	80.00	80.00

Battery Motors on page 159. **Hot Air Motors** on page 125. **Water Motors** on page 83.

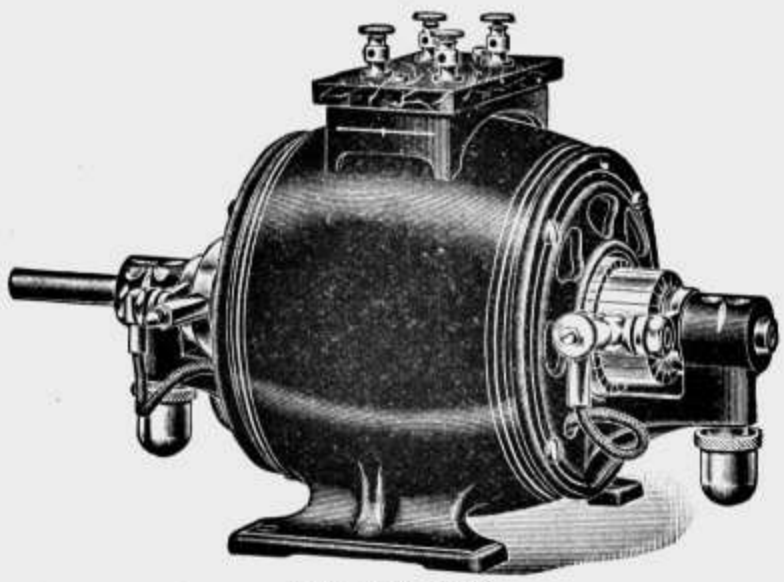
ALTERNATING CURRENT MOTORS.

Single Phase, 110 Volts.

Catalog No.	H. P.	Speed R. P. M.	Frequency cycles per sec.	Pulley.		Price.
				Diam.	Face.	
2265A.	1/8	1,800	60	1½	1¼	$ 31.00
2265B.	1/8	1,200	60	1½	1¼	31.00
2265C.	1/8	1,800	125	1½	1¼	31.00
2265D.	1/8	1,200	125	1½	1¼	31.00
2265E.	1/6	1,800	60	1½	1¼	40.00
2265F.	1/6	1,200	60	1½	1¼	40.00
2265G.	1/6	1,800	125	1½	1¼	40.00
2265H.	1/6	1,200	125	1½	1¼	40.00
2265J.	¼	1,800	60	2	2	60.00
2265K.	¼	1,200	60	2	2	60.00
2265L.	¼	1,800	125	2	2	60.00
2265M.	¼	1,200	125	2	2	60.00
2265N.	½	1,200	60	3	2	85.00
2265P.	½	1,200	125	3	2	85.00
2265Q.	1	1,200	60	4	3	138.00
2265R.	1	1,200	125	4	3	138.00
2265S.	2	1,200	60	4	3	165.00
2265T.	2	1,200	125	4	3	165.00

For 220 volt machines, add 10 per cent to above prices.

ROTARY CONVERTERS.

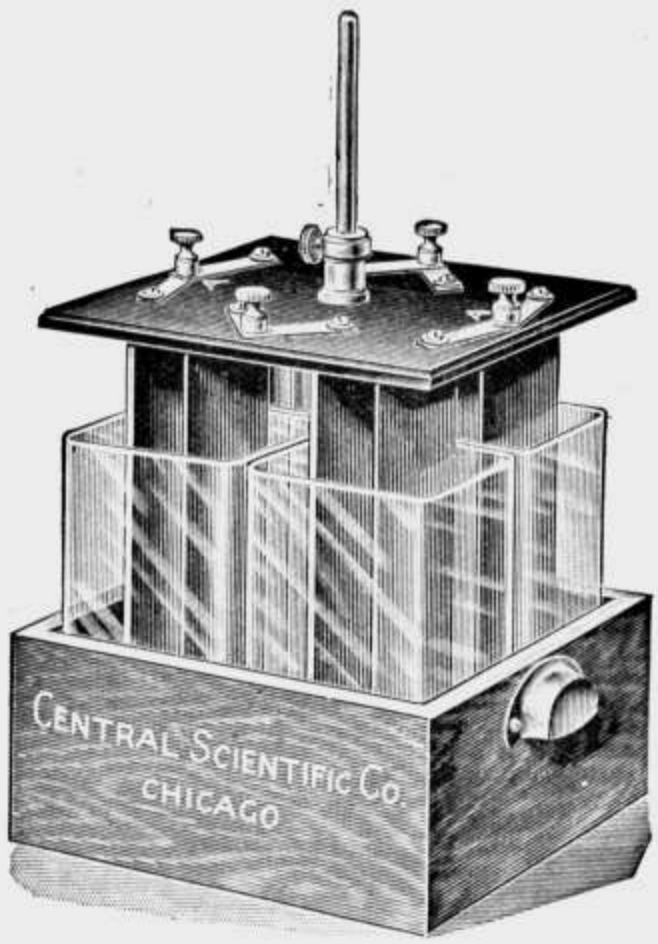


Nos. 2267-2269.

2267. **Rotary Converter.** This machine converts the direct to an alternating current. The motor can be used for furnishing power for any purpose not requiring more than 1-6 h. p. Complete for 110 or 220 volt current, f. o. b. Chicago..... $ 33 00

2268. **Rotary Converter.** Same as No. 2267; ¼ h. p. for 110 volt current. Motor can be used to operate a static machine and should then be used in connection with a rheostat ($6.50 extra). Complete, f. o. b. Chicago..... 50 00

2269. **Rotary Converter.** Same as No. 2268, for 220 volt current; f. o. b. Chicago..... 52 00



No. 2270.

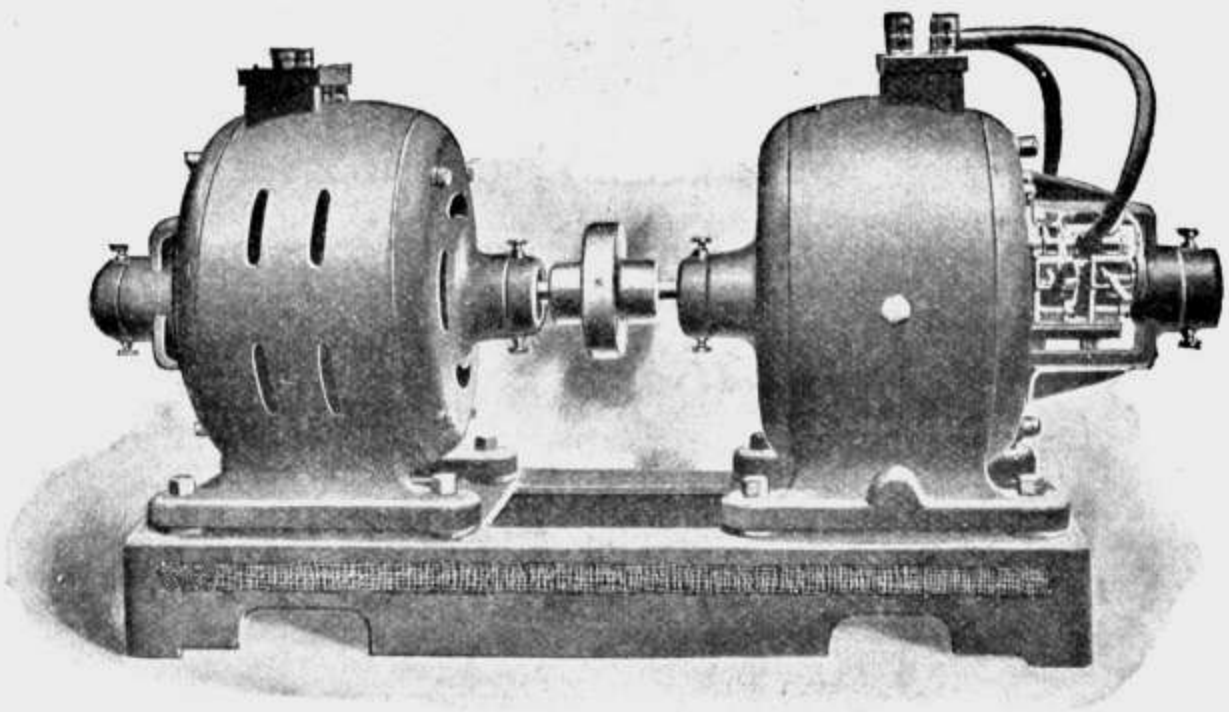
2270. **Electrolytic Rectifier or Nodon Valve.** Electrolytic rectifiers have been on the market for a number of years. They have for the most part, however, changed but one alternation of the alternating current. Our No. 2270 changes both alternations, giving practically a uniformly steady direct current.

Alternating current leads are attached to binding posts marked A. C. with some lamps, connected in parallel, in circuit. (Our No. 2453 Lamp Rheostat is excellent for this purpose.) The direct current is taken directly from posts marked D. C. If it is desired, a resistance may also be used in the direct current circuit.

This valve, though not as efficient as Motor Generators, may adequately take their place in any science laboratory. They may be used on either 110 or 220 volts alternating circuit giving a moderately high efficiency depending upon use. Current sufficient to operate a lantern requiring 15-25 amperes may readily be obtained. For charging storage batteries it excels the motor generator, as the current is more pliable. In electrolysis experiments, running small motors, and induction coils, etc., it is most convenient, being always ready for use. Many teachers have run connections from the rectifier to each student's desk, thus obviating the use of all primary batteries for ordinary physical and chemical experiments. Those teachers who have been dependent upon primary batteries with their inconvenience, annoyance and expense, and who have only an alternating current at their disposal, will find this rectifier an economy in every respect.

From a theoretical standpoint this valve presents many interesting problems, but practically it is so easily set up and cared for that even inexperienced students may use it with impunity. We furnish full directions for mixing solution, methods of operating and connecting to secure the highest efficiency for different experiments and whatever data advisable. Complete with chemicals, porcelain jars and slate top.....Net $ 15 00

MOTOR GENERATORS.

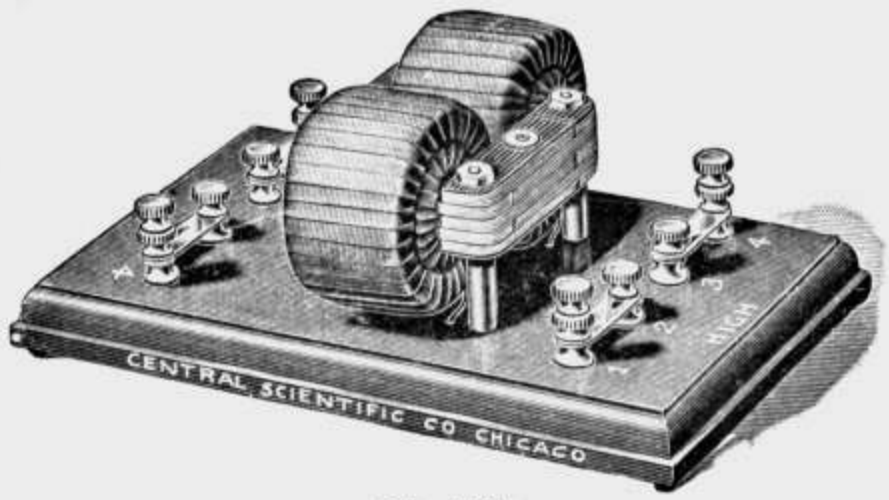


No. 2271.

A great many school laboratories have available 60 to 125 cycle alternating current at 110 or 220 volts. For such schools the motor generator is the most satisfactory machine for producing the proper direct current for laboratory work. These sets consist of an alternating current motor coupled to a direct current generator, as shown in cut. Motor Generators Nos. 2271A or 2271B with a 10 volt direct current generator are especially recommended for school work. The outfit will give 6 amperes and can be used to charge storage batteries, do electro chemical work, operate induction coils, electro magnets, small motors, etc. A driving pulley can be placed on the driving shaft next to the coupling without extra charge.

Catalogue No.	Motor A. C. H. P.	Generator Watts	Voltage		Net F. O. B. Factory
			Motor A. C.	Generator D. C.	
2271A	1/6	60	110	6-125	84.60
2271B	1/6	60	220	6-125	86.40
2271C	1/4	120	110	6-125	99.00
2271D	1/4	120	220	6-125	102.00
2271E	1/2	175	110	6-125	144.00
2271F	1/2	175	220	6-125	148.20
2271G	1/2	250	110	6-125	170.40
2271H	1/2	250	220	6-125	174.60
2271J	1	500	110	6-125	225.00
2271K	1	500	220	6-125	231.60

Field Rheostat for Nos. 2271A to 2271D, extra..... 10 00
Field Rheostat included with Nos. 2271E to 2271K at no extra charge.
Starting Box not necessary with Nos. 2271A to 2271H.
Starting Box included with Nos. 2271J and 2271K at no extra charge.



No. 2272.

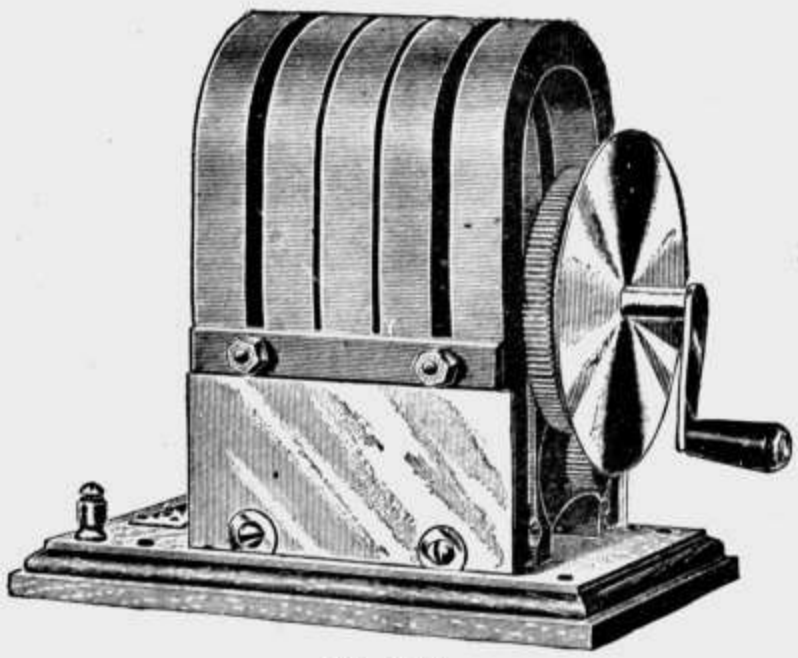
2272. **Model Transformer.** A working model of one of the most important pieces of electrical apparatus used in modern electrical engineering. In the design of this transformer care has been taken to give proper proportion to each part. The separate parts, laminated core, primary and secondary coils, all coil terminals and the connecting bars for changing ratios are in plain sight, making possible the tracing of both magnetic and electrical circuits.

The magnetic circuit is of the core type, with dovetail magnetic joints, making the core and the whole transformer dissectable. The quality and quantity of iron used is such that when firmly clamped at the corners there is produced an excellent closed magnetic circuit.

The primary and secondary windings are separately wound and placed on opposite sides of the square formed by the core. The low windings consist of 160 turns each. The high windings, often called the primary, consist of 640 turns in each coil, and are slipped over the low windings.

As in the commercial transformer, all coil terminals are brought out separately. The transformer can be used as a "Step up" (changing low voltage to higher) or a "Step down" (changing high voltage to lower), or as an auto transformer (either up or down by divided windings).

Since the number of turns on the high winding is four times that of the low winding, the ratio of the voltage transformation will be as 4 to 1. Construction is such that connections may be made in either series or parallel. These transformers are tested to stand over 15 volts on each low winding or 30 volts total, and over 60 volts on each high winding, or 120 volts total. Safe carrying capacity, 3 to 5 amperes. Complete laboratory report and directions for use furnished with each instrument..... $ 8 00

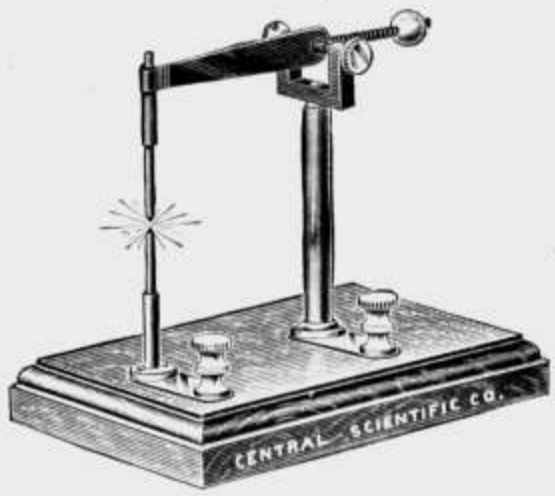


No. 2277.

2273. **Two 6 C. P. Lamps,** one of 5 volts and one of 15 volts, for visible proofs of transformation 1 25

2275. **Magneto Electric Generator,** mounted on base with incandescent lamp, which can be lighted by the current generated 6 00

2277. **Magneto Electric Generator,** same as No. 2275, wound for producing a high E. M. F., giving a strong physiological effect 6 00



No. 2279.

2279. **Arc Lamp,** with counterpoise adjustment, can be operated by No. 2260 Dynamo or Plunge Battery.... $ 3 30

2283. **Model Arc Lamp.** This lamp has been designed to meet the demands for a working model arc lamp, illustrating the operation and principles of the commercial arc lamp. It is equipped with automatic feed, consisting of a series magnetic coil and adjustable ring clutch. When used on a battery about 30 volts will be required, and the lamp will take from 1 to 1.25 amperes. If used on a 110 to 125 or 220 volt direct current circuit, an outside resistance must be connected in series with the lamp. No. 2453 Lamp Rheostat is the most convenient form for use.



No. 2283.

When used in connection with No. 2260 Dynamo a transformer must be employed to secure the necessary voltage. No. 2272 is designed for such use.

One of the features of this lamp is the ease with which the different parts may be reached. Through an opening in the magnetic iron case the series coil and other working parts may readily be seen. Complete with full directions..... 10 00



No. 2285-2290.



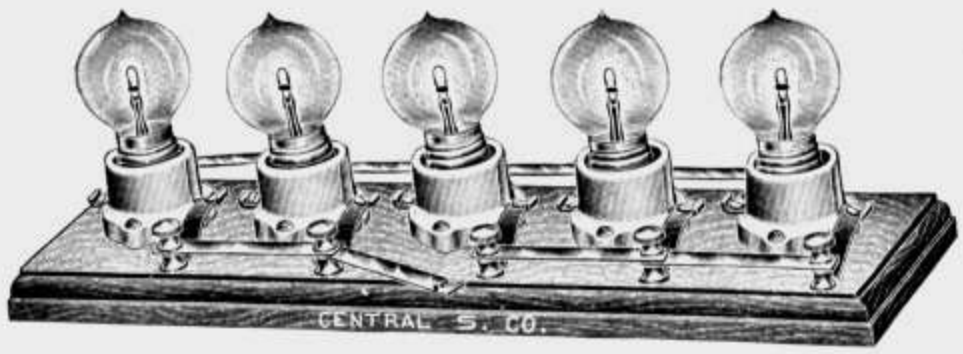
No. 2297.



No. 2291-2295.

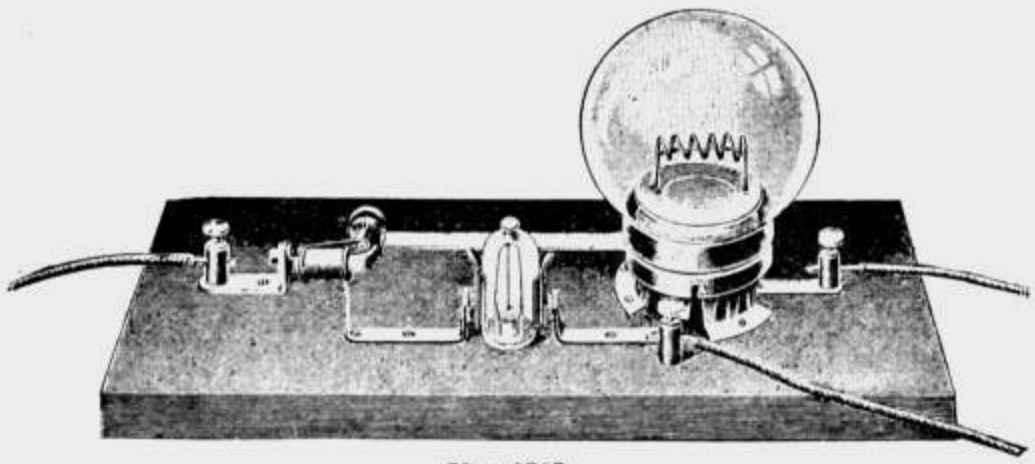
2285. **Miniature Incandescent Lamp,** ½ c. p. requires 2 to 3 volts..... 55
2286. **Miniature Incandescent Lamp,** 1 c. p., requires 3 to 4 volts..... 55
2287. **Miniature Incandescent Lamp,** 2 c. p., requires 4 to 5 volts..... 55
2288. **Miniature Incandescent Lamp,** 3 c. p., requires 4 to 6 volts..... 55
2289. **Miniature Incandescent Lamp,** 4 c. p., requires 6 to 8 volts..... 55
2290. **Miniature Incandescent Lamp,** 6 c. p., requires 8 to 10 volts..... 55
2291. **Miniature Incandescent Lamp,** with screw base, 1 c. p..... 55
2292. **Miniature Incandescent Lamp,** with screw base, 2 c. p..... 55
2293. **Miniature Incandescent Lamp,** with screw base, 3 c. p..... 55
2294. **Miniature Incandescent Lamp,** with screw base, 4 c. p..... 65
2295. **Miniature Incandescent Lamp,** with screw base, 6 c. p..... 65
2297. **Porcelain Receptacle or Base,** for Nos. 2291 to 2295..... 15
2298. **Miniature Incandescent Lamp,** with Edison base, 3 c. p., 8 volts..... 80
2299. **Miniature Incandescent Lamp,** 6 c. p., 6 volts, same as used on No. 2301 Lamp System..... 90

Demonstration Model of Incandescent Lamp No. 1426, page 108.



No. 2301.

2301. **Lamp System,** consisting of five 6 c. p., 6 volt lamps mounted upon a hardwood base, furnished with connections so that the lamps can be used either in series or multiple. This system is especially adapted for use with No. 2260 Dynamo. (Extra lamps, see No. 2299)..... $ 8 60



No. 2303.

2303. **Model Nernst Lamp,** for demonstration. Shows the principle involved and the parts of the regular commercial lamp. In ordering state kind of current to be used and the voltage. In case of alternating current, also state the frequency of the alternations. Complete with full directions..... 10 00

2304. **Nernst Lamp,** commercial type. Lamps for even voltages from 200 to 240 volts direct current may be obtained. Specify exact voltage. A one glower lamp with horizontal glower, 4 inch clear ball shade and oxidized copper finish..... 6 00

2305. **Nernst Lamp,** commercial type, for voltages from 100 to 120, alternating current, otherwise same as above..... 6 00

2307. **Cooper-Hewitt Lamps.** Each lamp is sent complete and entirely self-contained, and can be installed as readily as an arc lamp. Nos. 2307B, 2307D and 2307E have an automatic tilting device, which obviates the necessity of hand tilting, a great convenience when a lamp is installed out of easy reaching distance. Only No. 2307E may be used for alternating current (either 110 or 220 volt, 60 cycle) and is sold with automatic tilting device.

Catalogue No.	Type	Length of Tube.	Voltage	Candle Power	Watts per C. P.	Net
2307A	H	20¾ in.	110 D. C.	300	.64	$30.00
2307B	H Automatic	20¾ in.	110 D. C.	300	.64	34.00
2307C	K	45 in.	110 D. C.	700	.55	44.00
2307D	P Automatic	50 in.	110 D. C.	800	.48	50.00
2307E	F Automatic	50 in.	110 or 220 A. C. 60 cycle	800	.48	50.00

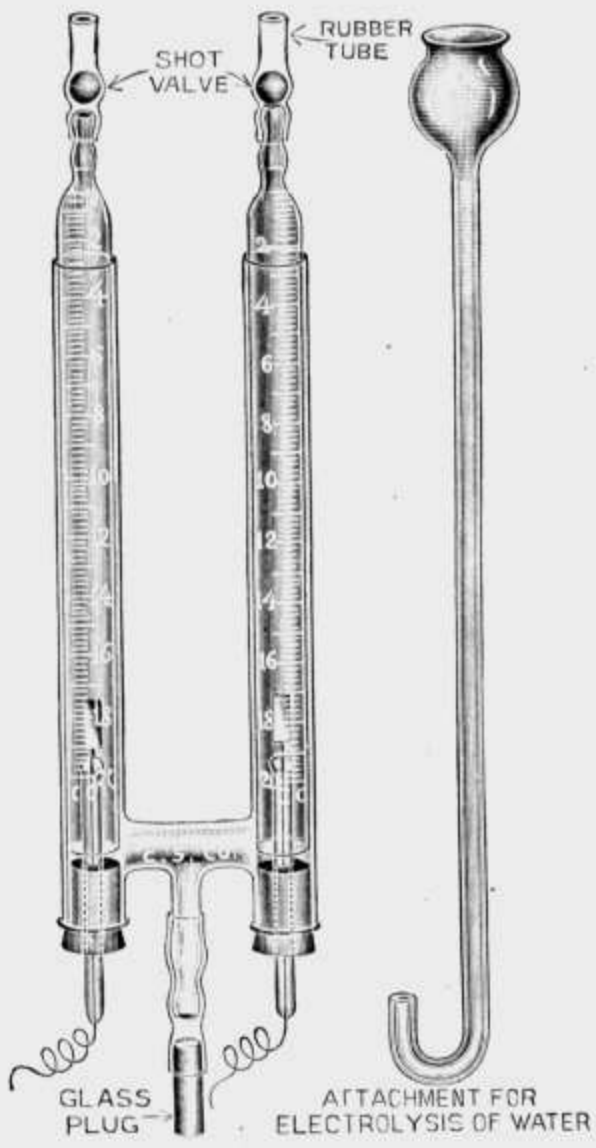
On 220 volt circuits it is necessary to use four No. 2307A or two No. 2307B lamps connected in series, and two No. 2307C lamps in series. No. 2307D cannot be used on 220 volt circuit. In ordering state exact voltage.



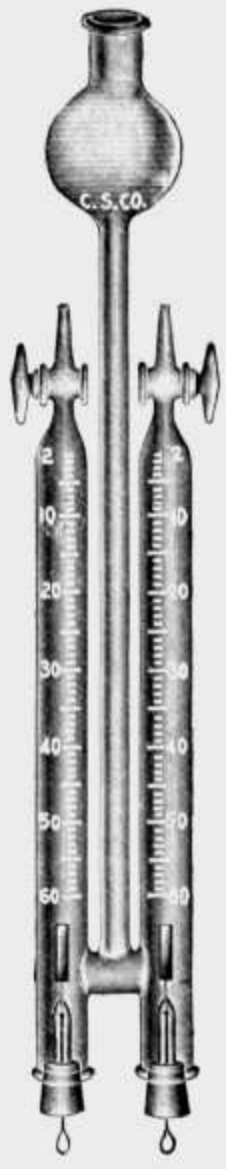
No. 2309.



No. 2311.



No. 2312.



No. 2313.

2309. **Electrolysis of Water,** simple form with sliding graduated tubes and platinum electrodes ..... $ 1 25

2311. **Electrolysis of Water,** improved form with platinum electrodes that may easily be replaced by carbon electrodes for electrolysis of hydrochloric acid 2 20

2312. **Electrolysis Apparatus** (Osborne Form), for study of conductivity of liquids, ionization, electro plating and electrolysis of water. This apparatus has been constructed to supply the urgent demand for a simple, substantial form of electrolytic apparatus that can be used to demonstrate the principles involved in the new theory of electrolytic dissociation. It consists of an outer U tube with graduated sliding tubes, shot valves, glass plug and platinum electrodes, which are easily replaced by carbon or copper electrodes. It allows immediate change of liquids, permits the introduction of litmus, methyl orange, cloth for bleaching or any other indicator, is readily cleaned, requires least amount of liquid to fill it. Complete as illustrated, with instructions for use..... 5 00

2313. **Electrolysis of Water Apparatus,** Hoffman's improved form with graduated tubes, glass stop cocks and removable platinum electrodes... 7 50

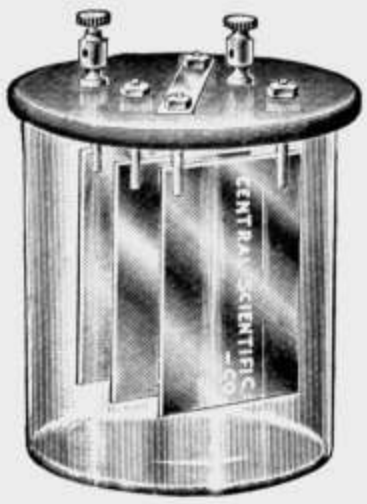
2314. **Electrolysis of Water Apparatus,** same as No. 2313, but without glass stop cocks 5 65

2315. **Support** for Nos. 2311 to 2314, including binding posts..... 1 65

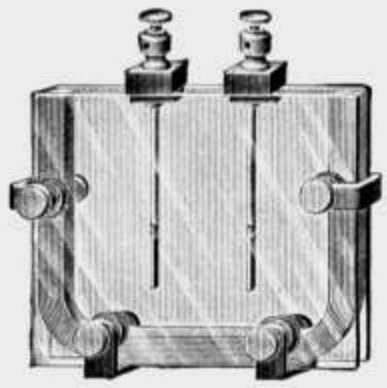
2316. **Carbon Electrodes,** two rubber stoppers fitted with carbon electrodes and connectors, adapted to Nos. 2311 to 2314, inclusive..... 55

2317. **Copper Electrodes,** two rubber stoppers fitted with copper electrodes and connectors adapted to Nos. 2311 to 2314, inclusive..... 55

2318. **Platinum Electrodes,** two rubber stoppers with platinum electrode and connector, adapted to Nos. 2311 to 2314, inclusive..... 1 10



No. 2319.



No. 3726.

2319. **Copper Voltameter,** consisting of glass jar in which are suspended three copper plates, two loss plates and one gain plate, 2x3 inches. These plates are held in spring clips so as to be easily removed for weighing and drying..... $ 5 00

2320. **Silver Voltameter,** same construction as No. 2319, with detachable silver plates 8 00

Gas Voltameters, see page 169.

3726. **Voltameter.** Consists of a cell fitted with platinum electrodes and binding posts for the demonstration of electrolytic analysis, chemical action, crystallization. Excellent for lantern projection..... 3 75



No. 2323.

2321. **Electro-Plating Outfit, for copper plating,** consisting of a square glass jar with brass rods and binding posts for supporting anode, complete with chemicals and full directions..... 1 65

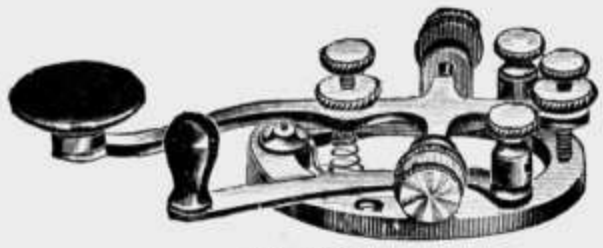
2322. **Electro-Plating Outfit, for nickel plating,** same as No. 2321, with pure nickel anode, chemicals and full directions..... 3 30

2323. **Electro-Plating Outfit, for silver plating,** same as No. 2321, with pure silver anode, chemicals and full directions..... 5 50

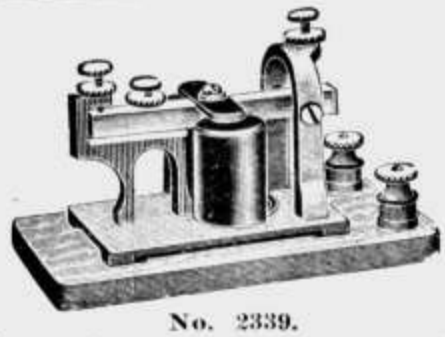
Copper, nickel, silver or gold anodes of various sizes, and chemicals for making solutions quoted upon application.

Electro-Plating Dynamo, see No. 2259.

See our new Cenco Water Motors with buffing accessories, page 83. Also **Polishing Heads** and accessories, pages 32 and 33.

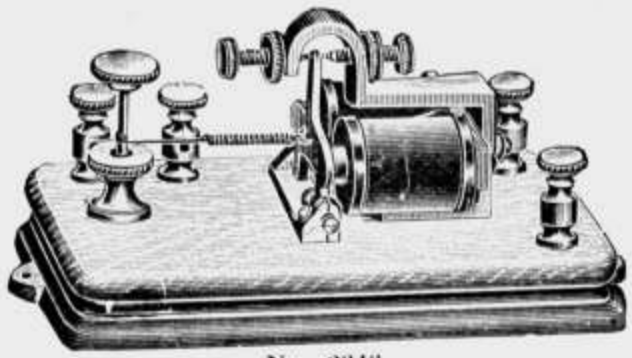


No. 2335.

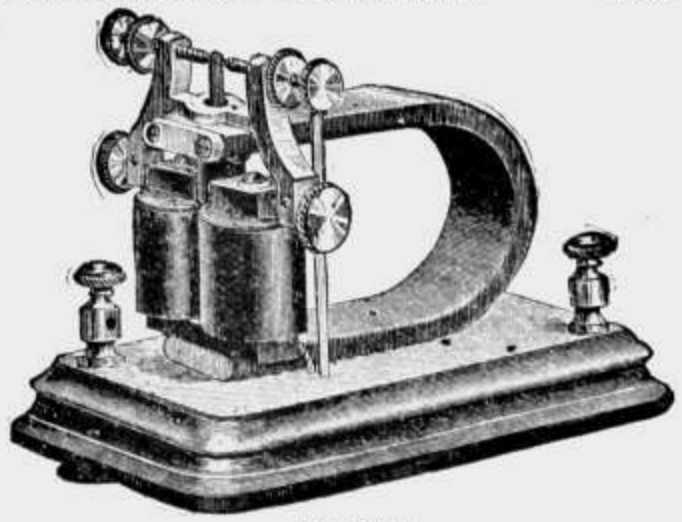


No. 2339.

2335. **Telegraph Key,** standard form of brass, without legs..... $ 2 00
2335A **Telegraph Key,** dissected, for assembling by students..... 1 10
2336. **Telegraph Key,** cheap form, mounted on wooden base..... 1 10
2337. **Telegraph Key,** of brass, with legs..... 1 85
2339. **Telegraph Sounder,** unequalled for quick action, loudness and clear tone. Its proportions are scientifically correct. Resistance 5 ohms 2 60
2339A **Electro Magnet,** for above. Resistance 5 ohms..... 65
2339B **Telegraph Sounder,** dissected for assembling by students..... 1 80
2341. **Telegraph Sounder,** same as No. 2339 with resistance of 20 ohms.... 3 00
2342. **Telegraph Sounder,** cheap form 1 80

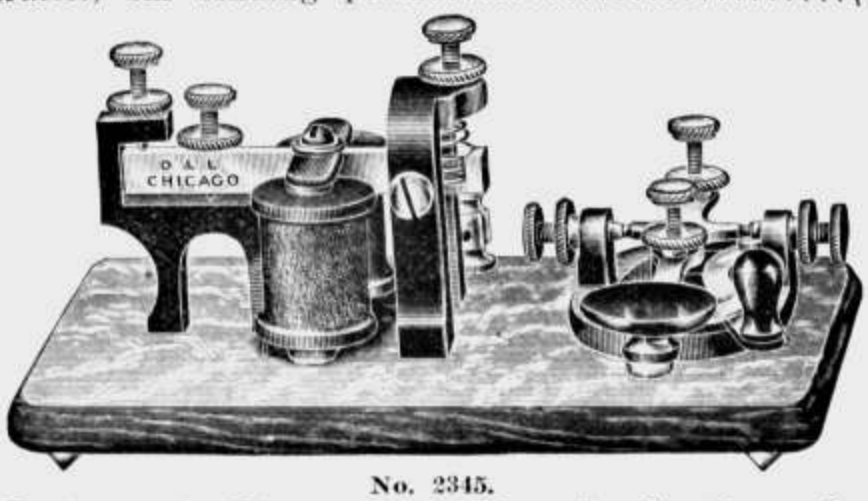


No. 2343.



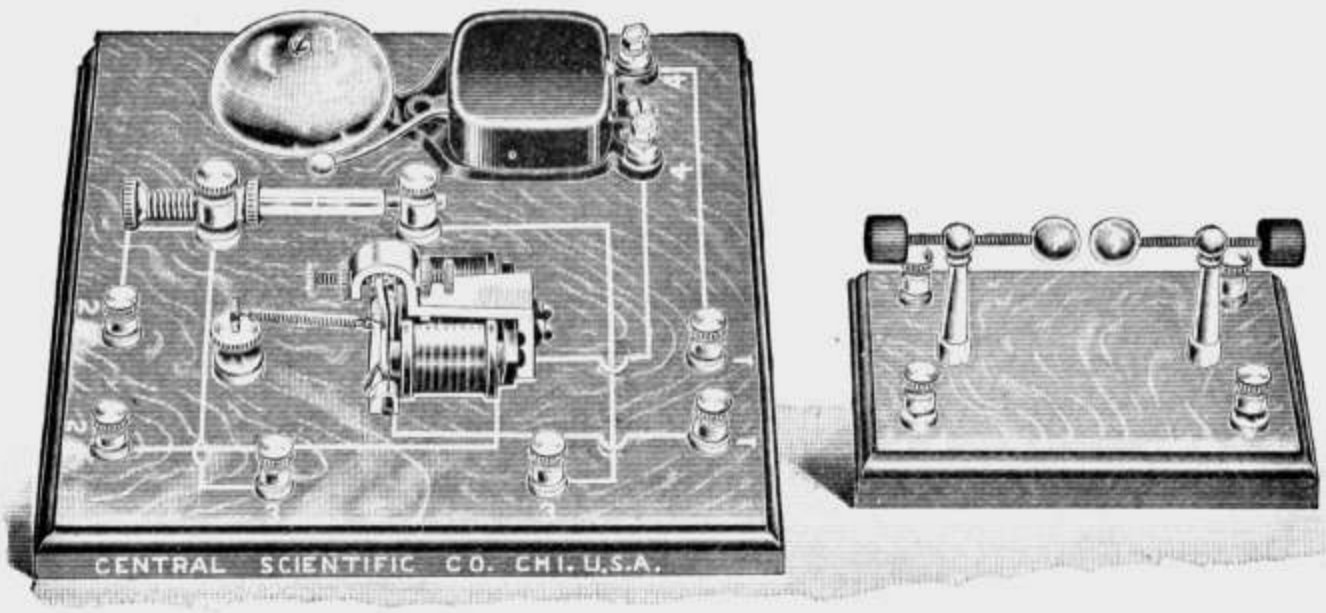
No. 2344.

2343. **Telegraph Pony Relay,** standard. Its use will enable work on short lines up to 20 miles in length to be done with perfect ease. Resistance 20 ohms..... 3 50
2344. **Polarized Relay.** This form is much more sensitive than the regular types and is especially desirable for long distance telegraphy.
A very strong, permanent magnet, has the electro-magnet spools mounted on one pole. This makes the polarity of each core the same. A finely balanced armature is hung between the two spools, but never touches the poles of the same. By means of set screws the armature is set so that it is exactly in the center between the poles. This balances the relay. A minute current passing through the electro-magnet will disturb this balance and move the armature. Resistance 50 ohms..... 9 00
2344A **Polarized Relay, Quadruple,** resistance 500 ohms, differentially wound so that each spool may be connected separately, crosswise, in series or in parallel, six binding posts..... 27 00



No. 2345.

2345. **Telegraph Instrument, Key and Sounder Combined on One Base,** for use of beginners. Resistance 5 ohms..... 2 50



No. 2349. No. 2351.

WIRELESS TELEGRAPH APPARATUS.

Commercial Wireless Telegraph Instruments are high in cost and thus beyond the resources of the majority of schools. We are therefore concerned with apparatus demonstrating the fundamental principles involved, i. e., the propagation of electro-magnetic waves through space.

To start these waves we use the Hertz Oscillator slightly modified. As a Detector, we employ the Lodge Coherer. Instead, however, of his Galvanometer Indicator, we use in circuit a relay which operates a bell answering the double purpose of Sounder and Decoherer. By connecting No. 2339 Sounder to the Decoherer, the Morse alphabet may be easily transmitted. To further enhance the effective decoherence, we are now using high resistance shunts in the bell and relay circuits which counterbalance the self induction in these circuits, obviating the sparking at the "make" and "break," which is detrimental to perfect decoherence.

With two of our No. 2351 Hertzian Oscillators one may demonstrate the Hertz Spark Gap Resonator and determine the length of the electro-magnetic waves.

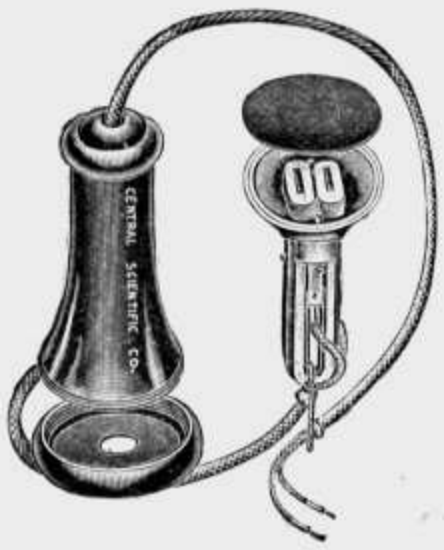
Our instruments are all tested at 40 feet distance between sending and receiving stations with a ¼-inch spark Induction Coil and the Coherers are all adjusted for this distance. With a ¾-inch spark Induction Coil frequent tests have shown transmission to distances of 150 feet and more.

2349. **Receiving Station,** complete with plates, Coherer, Decoherer and blue print showing in detail the different circuits and full directions for making connections and adjusting..... $ 13 30

2351. **Hertzian Oscillator,** complete with plates..... 3 30

N. B.—The above **No. 2349 Receiver** and **No. 2351 Transmitter,** forms a complete Wireless Telegraphy outfit with the exception of the necessary batteries and an Induction Coil with which most laboratories are equipped. A Telegraph Key connected with the oscillator in connection with a sounder attached to the receiver, forms a complete outfit for sending Marconigrams.

For **Induction Coils** see page 155.



No. 2355.



No. 2357.



No. 2359.

2355. **Telephone Receiver, Demonstration Form.** The above receiver in addition to being readily dissected for demonstration purposes, can be used on any line and for any distance, as it is the standard commercial form of the latest type and is very generally used in modern telephone systems. It is of the two pole variety..... 1 45

2357. **Telephone Receiver, Watch Case Form.** This receiver has short magnets and is the form frequently used on inside telephone systems and also for instrument use and testing in the laboratory..... 1 00

2359. **Telephone Transmitter, Chicago Solid Back Type.** The transmitter used on most commercial phones, especially long distance lines.... 2 00

2361. **Acoustic Telephone,** with 100 feet of wire, complete system..... 1 25

2362. **Carbon Diaphragms,** each 20

2363. **Carbon Backs** for carbon balls, each..... 25

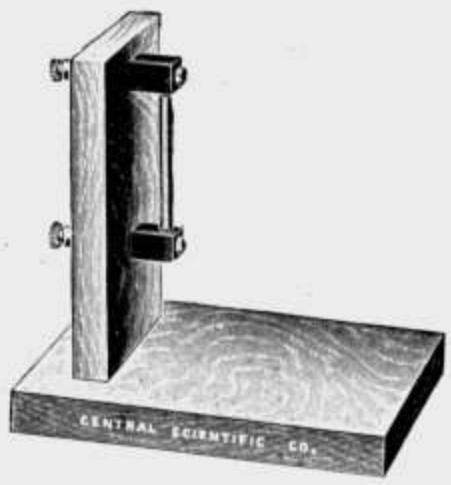
2363A **Carbon Balls,** ¼-inch diameter, per doz..... 55

2364. **Carbon Backs,** for grain carbon, each..... 25

2364A **Carbon,** granulated, domestic, per ounce..... 50



No. 2365.



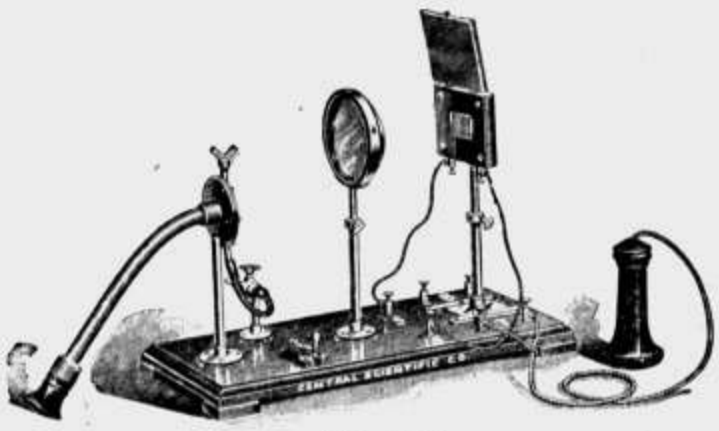
No. 2369.

2365. **Battery Call Telephone.** An attractive, high grade instrument, especially designed for inside work, very useful for connecting principal's office with the janitor or other practical school work. Price for each station, with complete directions..... 5 00

2369. **Microphone,** simple form, on resonating base for demonstration,.... 2 50

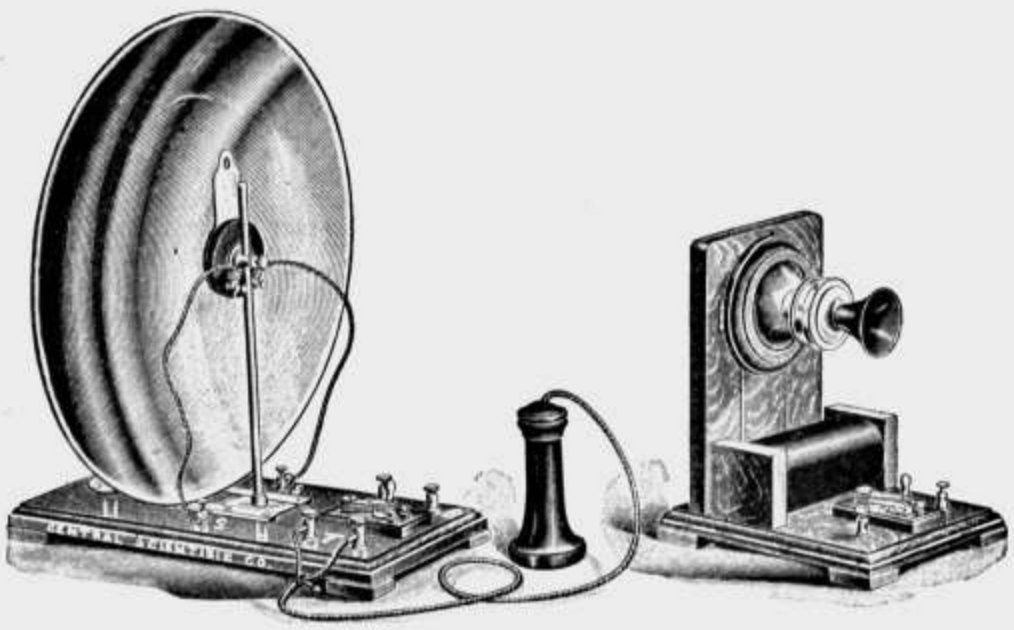
2370. **Microphone or Loud Speaking Telephone,** consisting of transmitter and receiver handsomely mounted in polished walnut case, receiver is fitted with horn, so that an audience in large lecture room may easily hear the transmitted sound.....Duty free 30 00

Magnetos, page 166. **Telephone Cord,** page 351.



No. 2371.

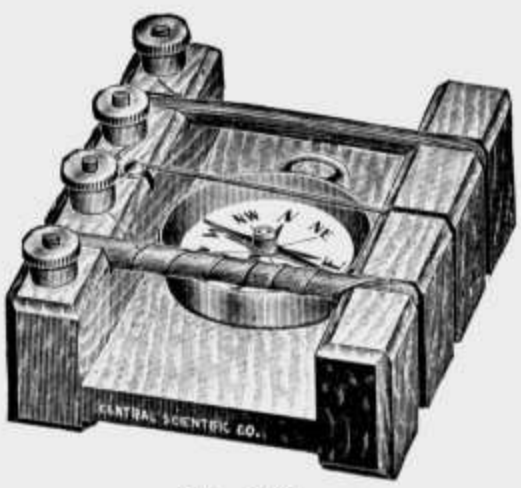
2371. **Wireless Telephone Outfit,** for acetylene light. Consists of a gas flame manometer with gas cock and rubber mouthpiece, condensing lens adjustable vertically, a selenium cell adjustable vertically and horizontally, switches and binding posts, all mounted on mahogany base with telephone receiver. Receiving station requires 36 dry batteries. Complete without batteries, including full directions for operating. ..... Duty free 40 00



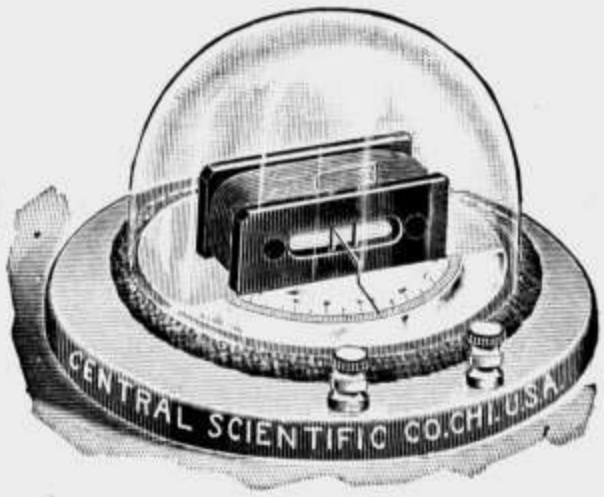
No. 2373.

2373. **Wireless Telephone Apparatus,** for arc lamp. Sending station consists of a loud speaking microphone with interchangeable carbon grains, an arc lamp transformer with binding posts and switches, mounted on a mahogany base. In addition there is also included on separate base a hand feed arc lamp not shown in the illustration. The receiving station consists of a silvered parabolic mirror 40 c. m. in diameter and a high grade Selenium Cell No. 2375 adjustable vertically on a movable base with switches and binding posts mounted on a mahogany base, telephone receiver and 36 dry batteries. Complete with full directions.....Duty free 70 00

2375. **Selenium Cell,** for wireless telephone experiments and general work in light. Consists of a round, hard rubber case with aperture which may be closed light proof by means of a slide (shown in illustration No. 2373). The two binding posts are connected with the selenium, which consists of a rectangular tablet of insulating material upon which the sensitive selenium is spread. Diameter of working surface, 30 m. m.....Duty free 14 50



No. 2401.



No. 2403.



No. 2405.

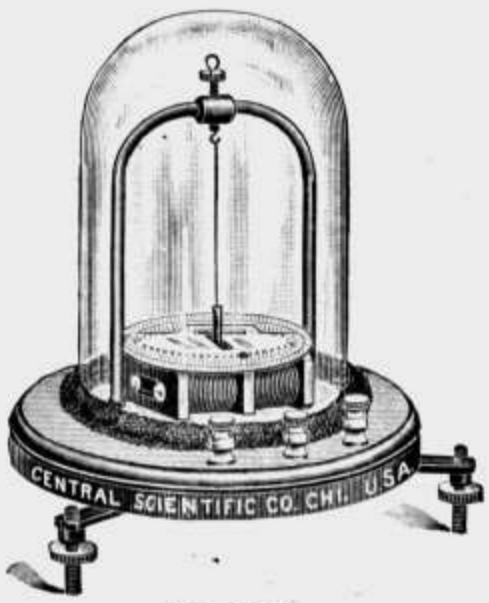
2401. **Galvanoscope,** simple form, with three separate circuits for light and heavy currents. This form has the advantage over others in that the number of turns can be readily changed, also that the distance of the needle can be varied from the current bearing coil, thus changing the sensibility of the instrument to any desired amount. Without compass ..... $ 1 50

1765. **Compass,** delicate and good quality, for use with No. 2401..... 1 50

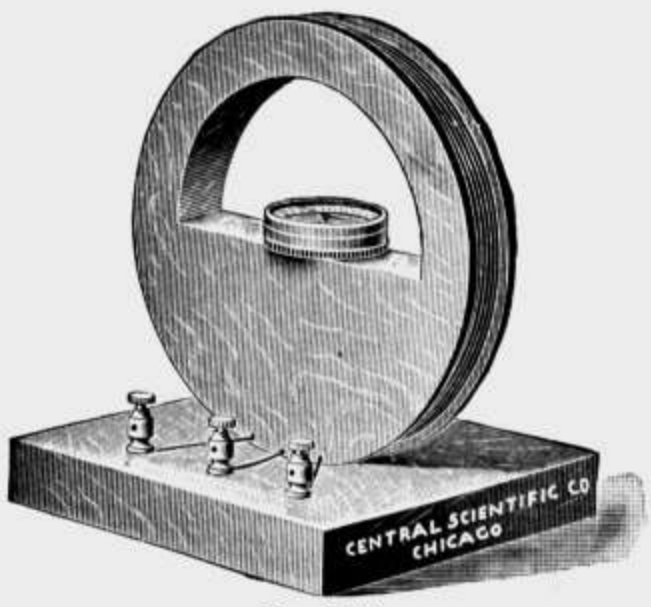
N. B.—For cheaper **Compasses** as illustrated with No. 2401, see page 127.

2403. **Galvanometer.** A delicately balanced agate cap needle, with stop attachment to prevent the violent oscillation of the needle and to bring it to rest. The slightest currents are detected and indicated by this instrument. Excellent for use in Wheatstone Bridge experiments. Mounted on hardwood base with glass shade..... 5 00

2405. **Galvanometer, Elementary Astatic Form,** improved form of Dr. Hall's design. Neatly and substantially constructed, fiber suspension and leveling screws 3 75



No. 2407.



No. 2409.

2407. **Galvanometer, Astatic,** supplied with an astatic pair of needles, fiber suspension and aluminum pointer, with two coils wound for strong and weak currents. Mounted on hardwood base with leveling screws. 6 65

2409. **Galvanometer, Tangent, Elementary Form,** after Dr. Hall. Body and base of finished wood. Three coils of wire, 5, 10 or 15 turns may be used when ends are connected to the binding posts. Complete with compass. This instrument is substantially made and is superior to the old forms with coils wound on frail metal frames..... 2 10

Commutators and Contact Keys, pages 200 and 201.



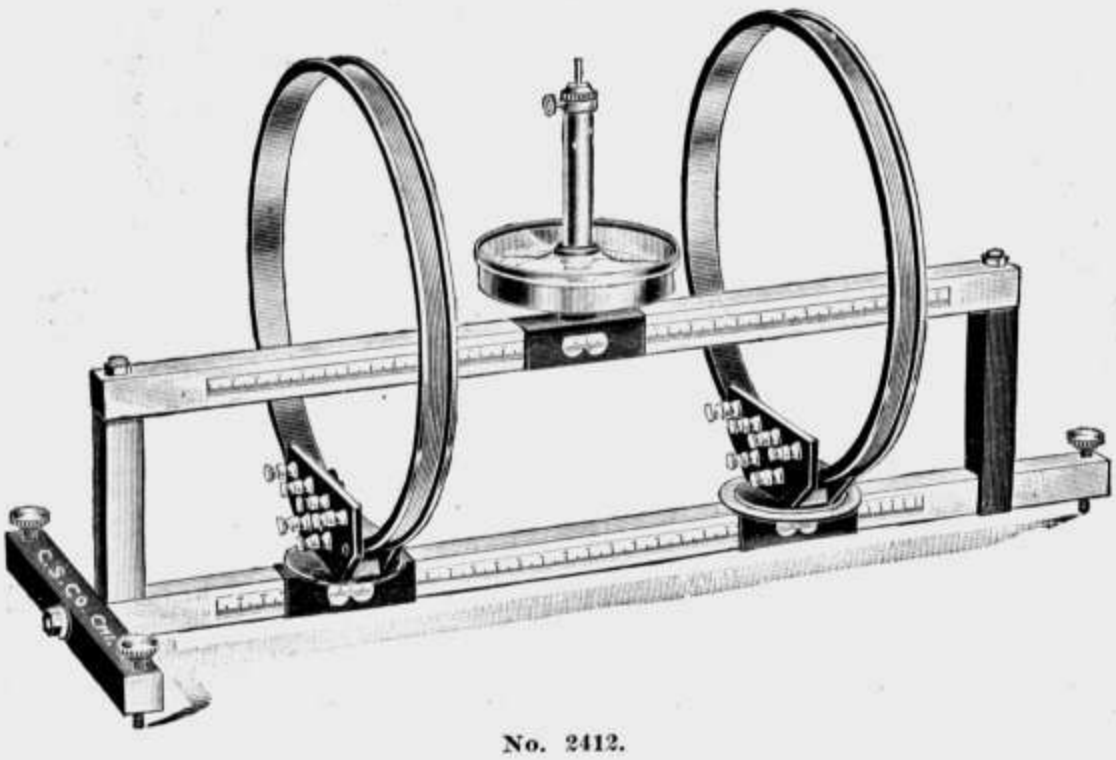
No. 2411.



No. 2413.

2411. **Galvanometer, Tangent.** A brass ring eight inches in diameter, mounted on mahogany base, with leveling screws. The needle, ¾ inch long, has an agate cap, aluminum indicator and stop, and is mounted in a brass cup with glass cover. Winding is two coils of 5 and 10 turns, No. 20 silk covered magnet wire, brought to three binding posts, so that either 5, 10 or 15 turns may be used..... $ 7 25

2413. **Galvanometer, Tangent.** Solid brass ring nine inches in diameter, mounted on a mahogany base which rotates on a heavy brass tripod provided with leveling screws. The needle is proportional to the diameter of the ring and has jeweled bearing with aluminum pointer. The card dial is engine divided with mirror to avoid parallax. The winding consists of 300 turns of magnet wire so connected to the plugs in front that 20, 40, 80 or 160 turns or any combination of these numbers may be used. For heavy currents the brass ring alone is used by connecting to the extra pair of binding posts in the rear of the instrument. The constant K of a Tangent Galvanometer cannot be satisfactorily determined on an instrument having less than 300 turns..... 16 65



No. 2412.

For description see next page.

2412. **Galvanometer, Universal Tangent,** may be used as a Tangent, Gaugain, Helmholtz-Gaugain, Sine, Cosine, Wideman or Detector Galvanometer. The coils, sliding on a rod parallel to the one carrying the needle box, are double wound of 48 turns, each connected to separate binding posts on solid brass rings 12 inches in diameter. The coils and needle box are provided with an indicator for reading the scale. The needle box is swivelled and removable and one coil may be rotated about its vertical axis and position read on a disc graduated in degrees. Currents ranging from .000002 ampere to 100 amperes may be measured. Made entirely of metal and fitted with leveling screws 50 00

D'ARSONVAL GALVANOMETERS.

This type of galvanometer is independent of the earth's magnetic field and is not affected by surrounding magnetic bodies, so that they can be used in many places where other galvanometers can not. For this reason, they have become more universally used than any other form, and we have given considerable attention to the development of a series of model instruments.

There are a number of important practical points to be taken into consideration in the selection of a galvanometer, and the greatest number of desirable features should be embodied in one instrument.

Our D'Arsonval Galvanometers have the following salient features:

Magnet—An important consideration, is strength and permanency, so that when the Constant is once determined, it will remain practically the same. The **Magnets** of all our D'Arsonval instruments are cast, as recent investigations indicate that the Cast Magnets are more permanent, and this construction also enables us to secure the proportions so as to concentrate the greatest intensity of the magnetic field between the poles and thus through the coil.

Suspensions—The elasticity of the suspending wires controls the movement of the coil and tends to bring it back to its initial position. From observations and tests, we have adopted a steel ribbon for the upper suspension. While this does not give as high a sensibility as the Phosphor bronze, the "set" is practically "zero," and as steel possesses the greater tensile strength, the suspension is not so easily broken; at the same time the sensibility will be found within the requirements desired, as we have increased the length. The suspensions are so attached that they may be easily replaced.

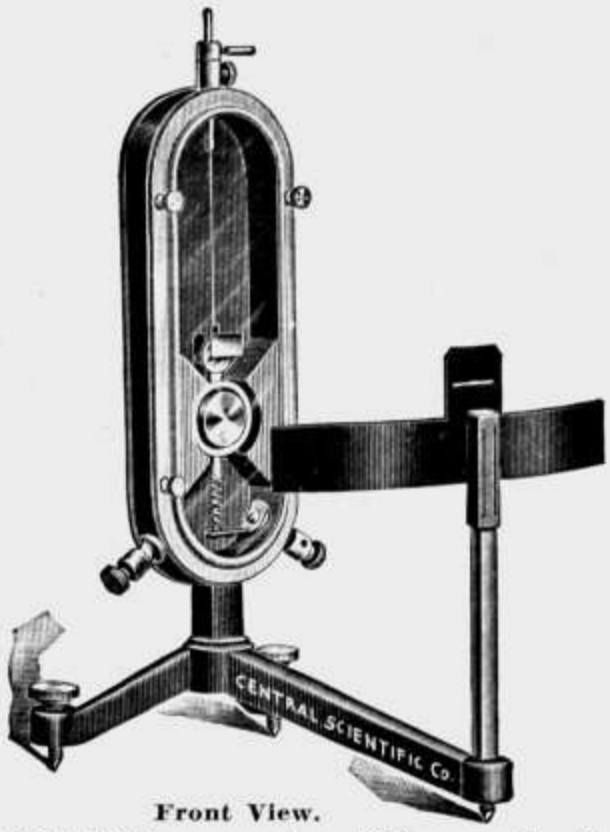
Coil System—In our "ballistic" types, damping, if desired, is secured by means of small copper rectangles placed about the coil. In the "dead beat" coils, damping is secured by the use of a pure copper bobbin on which the coil is wound. The "coil clearance" is ample, so that the instrument is easily leveled, and there is no danger of its movements being hindered by a foreign body, such as lint, etc. **Reflecting Mirrors** used are tested optically plane.

Reading Device—On our Nos. 2414 and 2415 we use a sight and scale. With this device, quicker adjustment is possible for inexperienced students. We have also improved it by abolishing the former minute "peep hole," substituting a slit 20x3 millimeters. On account of the position of the slit in reference to the scale all parallax is obviated, regardless of the point from which the reading is taken. No. 2417, which is intended for the better grade of work, is supplied with a reading telescope with achromatic lens mounted with an adjustable bichrome scale.

METHODS OF SPECIFYING SENSIBILITY.

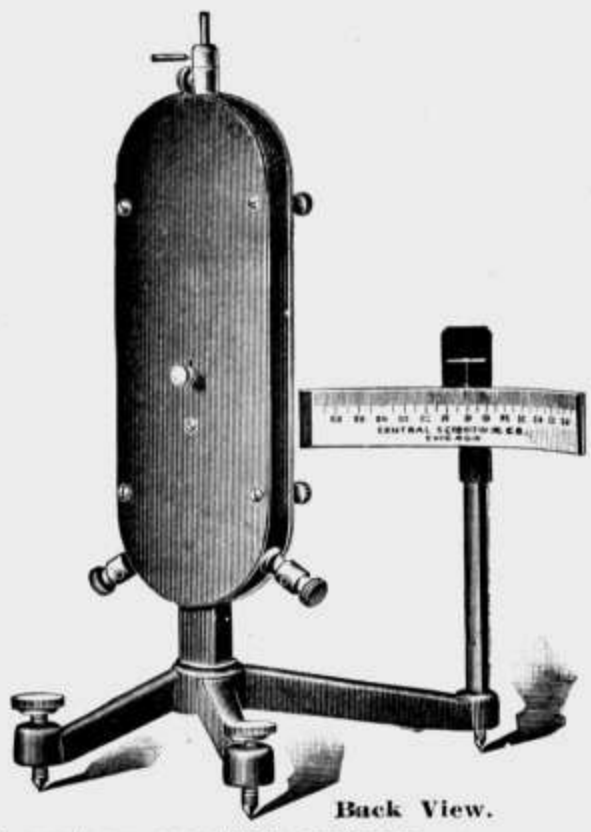
The three methods of specifying sensibility, Micro-Amperes per m. m., Micro-Volts per m. m. and "Megohms" are equivalent to each other. When one has determined the current per division, then this can by Ohm's Law be immediately changed to volts per division, as soon as the resistance of the galvanometer is known. The sensibility in megohms means the number of megohms through which one volt will produce a deflection of one division, and this can be calculated from the current per division, if the resistance is known. There is a slight advantage in favor of "megohms" in the fact that the number of megohms is directly proportional to the sensibility, while the other quantities are inversely proportional to the sensibility.

Repairs for Galvanometers, page 182.



Front View.

No. 2414.



Back View.

2414.' **Galvanometer, D'Arsonval.** For general laboratory use this galvanometer is recommended to the majority of teachers, as it possesses these commendable features:

The **magnet** is cast and carefully aged, forming the framework of the instrument. The poles are so proportioned as to give a strong magnetic field through the coil.

The **coil** is circular, giving maximum strength and area at a minimum weight. This, on account of the shape of the poles and core, greatly increases the sensibility. The clearance is ample to insure quick adjustment. The suspension is a phosphor bronze ribbon of medium weight to prevent excessive breakage. The coil may be raised or lowered or set to zero by means of the screw adjustment at the top of the instrument. The coil may also be locked to protect the suspension when not in use.

The **sight and scale attachment** has recently been improved and a slot substituted for the former minute peephole. The position of the slot and its zero line in reference to scale is such that all parallax is avoided, regardless from what point on the slot the reading is taken. This direct reading gives a good, clear image which cannot be obtained in the mirror scale devices, on account of loss of light by reflection, and will be appreciated by those having imperfect eyesight. The scale is a segment of the circumference of a circle whose radius is its distance from the coil mirror, which gives proportional readings. It is mounted directly on the tripod supporting the instrument, preventing vibrations by the stability thus secured.

To **renew suspensions,** when broken, it is only necessary to remove the glass window, laying open for easy access all parts of the coil system.

Working Period, on short circuit, coil comes to rest in four seconds, and is absolutely dead-beat. On open circuit, coil makes about six half swings before coming to rest, and the period of one complete swing is about four seconds. Hence, on open circuit the working time is about 12 seconds.

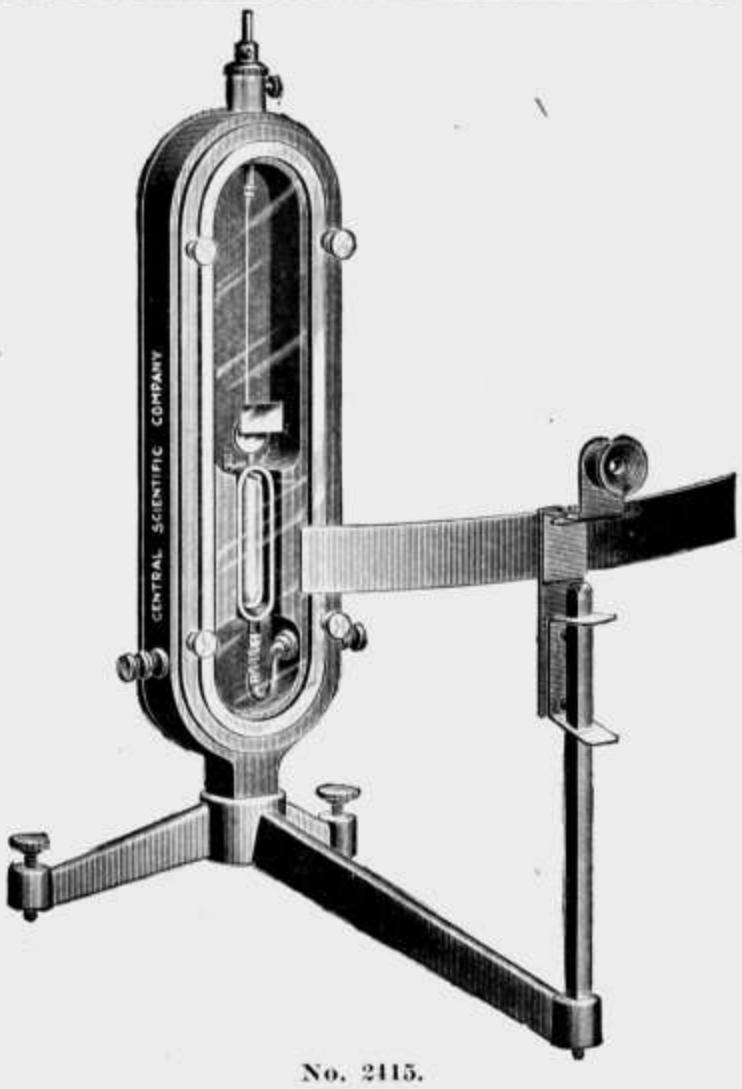
Sensibility. From the mean of a number of readings, in which a known but variable difference in potential was applied to the galvanometer terminals, the sensibility was found to be as follows:

	At Working Distance.	At 1 Meter.
Micro-amperes per m. m.....	0.37	0.054
Micro-volts per m. m.....	63.0	9.2
"Megohms"	2.7	18.5

We claim that this is the best D'Arsonval Galvanometer offered to the laboratories of this country for a reasonable price. This assertion is confirmed by the large number sold since its introduction. One large state university placed twenty at one time in their laboratories.... 6 65

Commutators and Contact Keys, pages 200 and 201.

Reading Telescopes and Scales, page 184.



No. 2415.



Front View of Scale.

2415. **D'Arsonval Galvanometer.** We are manufacturing this instrument to meet the demand for an instrument better in quality than our No. 2414, and less in cost than our No. 2417. Though similar in appearance to No. 2414, the workmanship is fully equal to that of No. 2417. It stands over all 16 inches (No. 2414, 11 inches), and other parts are proportionately larger than No. 2414.

The **Magnet** is heavy, with pole area made in correct ratio to the yoke, is carefully hardened and aged, thus securing a strong magnetic field in which the coil swings.

The **Coil** is rectangular in shape, and swings freely with a minimum air gap between the pole faces. Coil supplied has a resistance of 250 ohms. Coils of higher or lower resistance can be easily substituted. The upper suspension is a fine steel ribbon which has practically no zero variation. The lower suspension is of copper in form of a coil.

Suspensions when broken are easily renewed by removing the glass front.

The **Reading Device** on this Galvanometer is like that of No. 2414, with the addition of an adjustable zero line, enabling the operator to quickly secure exact coincidence.

Construction. All parts of this Galvanometer are made with great care, and the instrument is finished in dead black and lacquer, with the exception of the tripod, which is japanned.

Sensibility. From the mean of a number of readings in which a known but variable difference in potential was applied to the galvanometer terminals, the sensibility at working distance (25 centimeters) was found to be 30.3 megohms. Complete with 250 ohm "Dead Beat" coil ..... $ 15 00

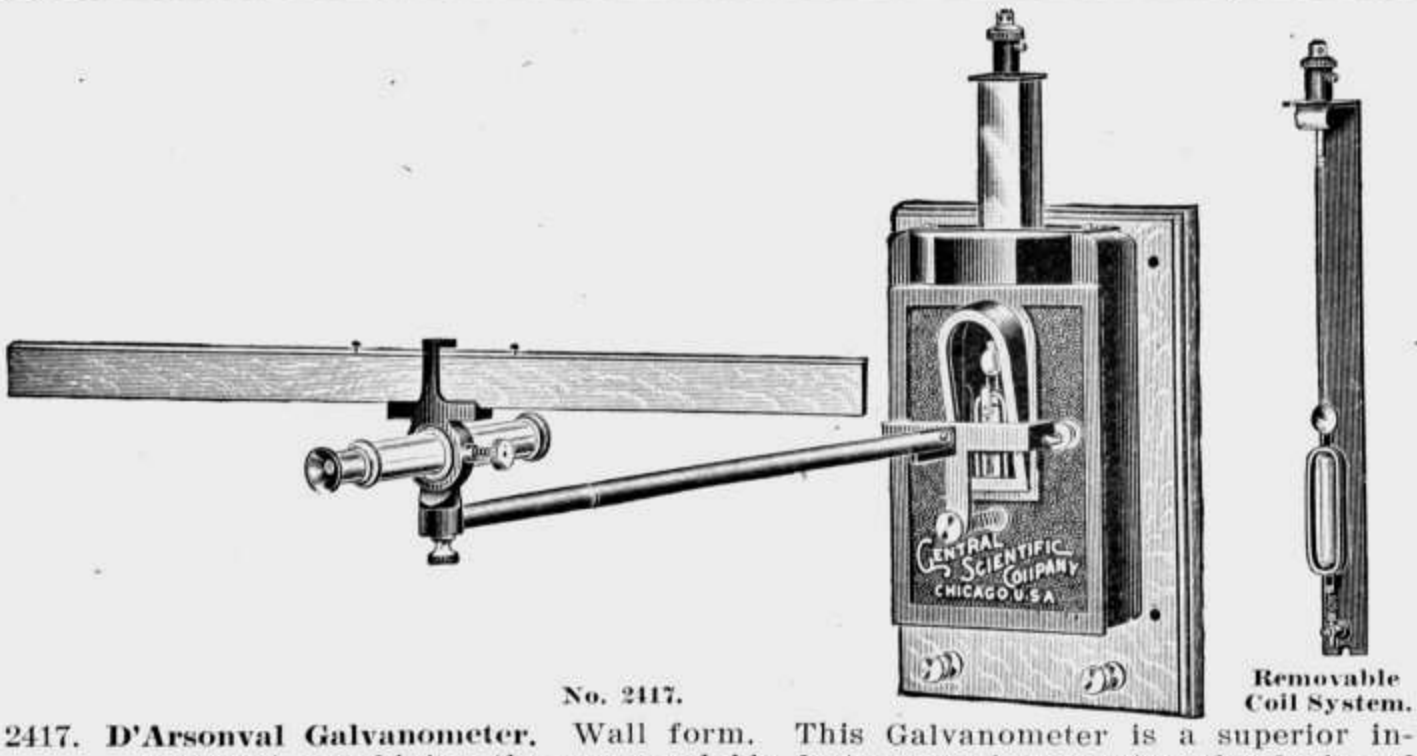
2415A. **Extra Coil,** "Dead Beat," 5 ohms..... 4 00

2415B. **Extra Coil,** "Dead Beat," 250 ohms..... 4 00

2415C. **Extra Coil,** "Dead Beat," 500 ohms..... 4 00

2415D. **Extra Coil,** Ballistic, 500 ohms 5 00

2416. **Radio-Micrometer.** This instrument can be used with our D'Arsonval Galvanometers Nos. 2415 and 2417 by removing the galvanometer coil and substituting the Radio-Micrometer system. A deflection of 3 m. m. can be obtained with a candle placed about 35 feet from the instrument. The radiation is received on a piece of blackened copper foil to which is attached two bars of strongly thermo-electric alloys. The other ends of the bars are connected by a copper loop with mirror attached, thus forming a complete electrical circuit. Complete with instructions 7 50



No. 2417. Removable Coil System.

2417. **D'Arsonval Galvanometer.** Wall form. This Galvanometer is a superior instrument, combining the commendable features and correcting the faults of those equally priced. It is compact in design, and well finished in every detail.

The Magnet is cast, strongly magnetized, aged and very heavy, weighing approximately 6 kilos. The proportion between the yoke area and area of poles has been accurately determined by experts to give the greatest intensity of the magnetic field through the coil. This field is further concentrated by a soft iron core.

Coil System. As noticed from the illustration, one of the principal features of this Galvanometer is its **Removable Coil System.** The coil is suspended in a frame and forms with it a **Unit** which slides into place by means of guides into a good electrical contact. It is therefore possible, by securing any number of coil systems, to have a universal instrument with only the additional cost of the extra systems. Also, if any adjustments or repairs are to be made on the suspension system, the frame can be removed and laid flat on the table.

Each Galvanometer is supplied with a 240 ohm **"Dead Beat"** Coil, with an optically plane mirror ⅝-inch diameter. Extra Coils, Dead Beat and Ballistic, are listed below.

The Suspension. The upper suspension, unless otherwise requested, is a steel ribbon which has a high tensile strength and a "zero set" of less than a millimeter. The sensibility can be increased from three to four times by the substitution of phosphor-bronze suspension.

The Reading Device consists of a telescope with achromatic objective and a bichrome scale mounted upon an adjustable arm, which may be either swung up to a vertical position, or entirely removed when not in use.

The Housing. The front plate is detachable by loosening two thumb screws, giving easy access to the interior. A large window is provided for viewing the moving system. This window is placed at an angle found to obviate the blur of the scale image due to the diffusion of light caused by reflection and refraction.

For Mounting and Leveling we furnish two adjustable screws fastened to the back board, so that the instrument may be leveled rapidly and accurately on the wall. A jeweler's screw driver is furnished with each instrument.

SENSIBILITY.

From the mean of a number of readings, in which a known but variable difference of potential was applied to the galvanometer terminals, the sensibility was found to be as follows:

At working distance..... 53.4 megohms.
At one meter distance.....101.1 megohms.

The working period is 15 seconds on open circuit, and is dead beat.

Complete with 250 ohm "Dead Beat" coil..... $ 25 00

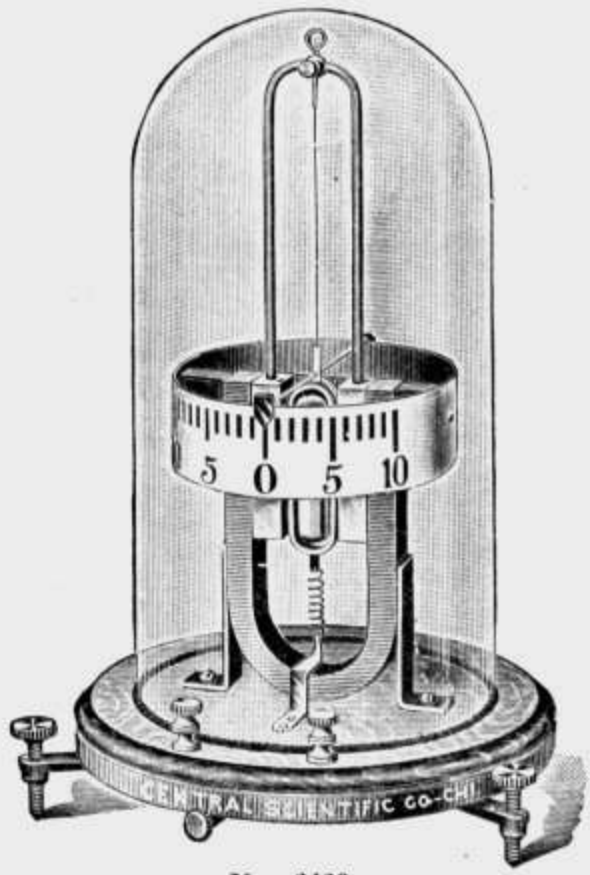
2417A. **"Dead Beat" Coil System,** with 5 ohm coil..... 7 50
2417B. **"Dead Beat" Coil System,** with 250 ohm coil..... 7 50
2417C. **"Dead Beat" Coil System,** with 500 ohm coil..... 7 50
2417D. **Ballistic Coil System,** with 500 ohm coil..... 7 50
2417E. **Ballistic Coil System,** with 1000 ohm coil..... 7 50

2419. **Galvanometer,** made on D'Arsonval principle, same type as used in commercial testing sets, and is built for hard service.

Gives 1 scale division deflection with 1 volt through about 80,000 ohms..... 14 00



No. 2419.



No. 2420.

2420. **Lecture Table Galvanometer** after specifications by Prof. Millikan. This galvanometer is especially suited to demonstrations of induction experiments. Thus a single No. 2217 Coil 10 inches diameter turned through 180 degrees in the earth's magnetic field produces a deflection of 20 degrees or 3.5 scale divisions.

The current induced in a secondary coil placed on a 12 m. m. rod, by the making and breaking of a current in a primary coil on the same rod 25 to 50 m. m. distant, using a single dry cell, throws the index through 27 degrees (4.3 scale divisions).

By rotating a small coil of 600 or 700 turns of No. 28 wire (No. 2219) between the poles of a U shaped magnet, the direction and relative strength of the current induced in a dynamo armature, as it revolves, can be demonstrated before a large class.

With a single copper-iron junction, thermo-electromotive forces and thermo-electric reversals can be strikingly shown, the maximum deflection produced by heating a single copper-iron junction being about 20 degrees or 3.5 scale divisions.

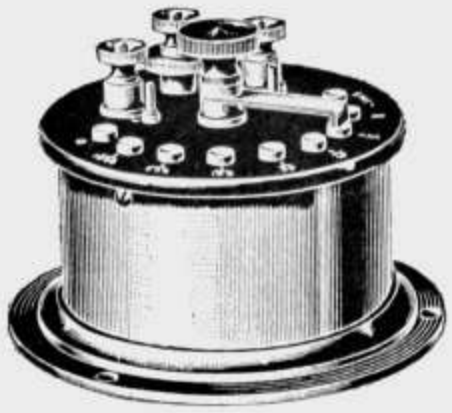
Resistance of galvanometer coil, about 20 ohms.

Sensibility, a deflection of 1 scale division 7 m. m. on the circular scale, 7 c. m. from the axis of the coil, is produced by a current of .000022 ampere. In other words, the figure of merit is 11-6, that is, a mirror galvanometer of the same sensibility would have produced in it a deflection of 1 m. m. on a scale 1 meter distance when it was in series with a 1 volt cell and 9 megohms resistance.

The advantages which this galvanometer possesses over a mirror lecture table galvanometer are:

(1) It is more convenient and easier to manipulate, since it is always ready at a moment's notice for any sort of experiment.

(2) It is easier to understand, since there is no optical intricacies to bewilder the pupil and divert his attention from the electrical principles to be elucidated..... $ 15 00



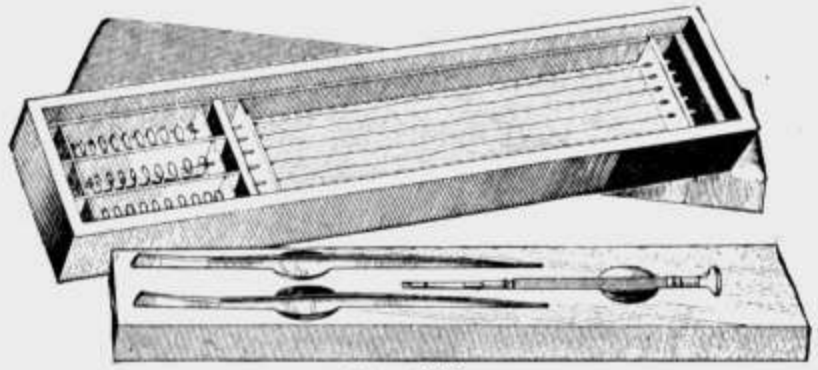
No. 2421.

2421. **Universal Shunt, Ayrton-Mather.** Adjustment to each galvanometer is not required as is the case with the ordinary shunt, but can be applied to any regardless of its resistance. It is not advisable, however, to have the resistance of the shunt too disproportionate to that of the galvanometer on account of loss of sensitiveness. This form is made with a switch instead of plug, which is more convenient to work and equally accurate, allowing of a wider range of values. The great advantage of this shunt is that it may be used for ballistic work, as the damping remains constant whatever the resistance used.

It also forms a very convenient form of **Potentiometer,** giving 1-3, 1-10, 1-30, etc., of the total volts of the terminals.

Wound to about 10,000 ohms for galvanometers whose resistance is of 1,000 to 6,000 ohms.....Duty free $ 25 00

2422. **Universal Shunt, Ayrton-Mather,** same as No. 2421, wound to 1,000 ohms, for use with galvanometers of low resistance.....Duty free 25 00



No. 2423.

2423. **D'Arsonval Repair Kit.** Consists of a neat wooden box containing two pairs of forceps for handling suspensions, a watchmaker's screw driver, suitable for small screws on any galvanometer, 6 upper steel suspensions and 3 lower phosphor bronze suspensions, all conveniently accessible. (We will supply the upper suspensions of phosphor bronze if desired.) Complete outfit..... 4 00

455. **Galvanometer Dial or Scale,** printed on bristol board, 2¾, 3¼ and 5 inches in diameter, in 1 degree divisions. Each..... 15

2424. **Galvanometer Mirror,** optically plane, ½ inch diameter..... 80

2424A. **Galvanometer Mirror,** optically plane, ⅝ inch diameter..... 1 00

2424B. **Galvanometer Mirror,** concave, 1 meter focus, ½ inch diameter..... 1 00

2424C. **Galvanometer Mirror,** concave, 2 meter focus ½ inch diameter..... 1 25

2425. **Galvanometer Shades** of clear white glass.

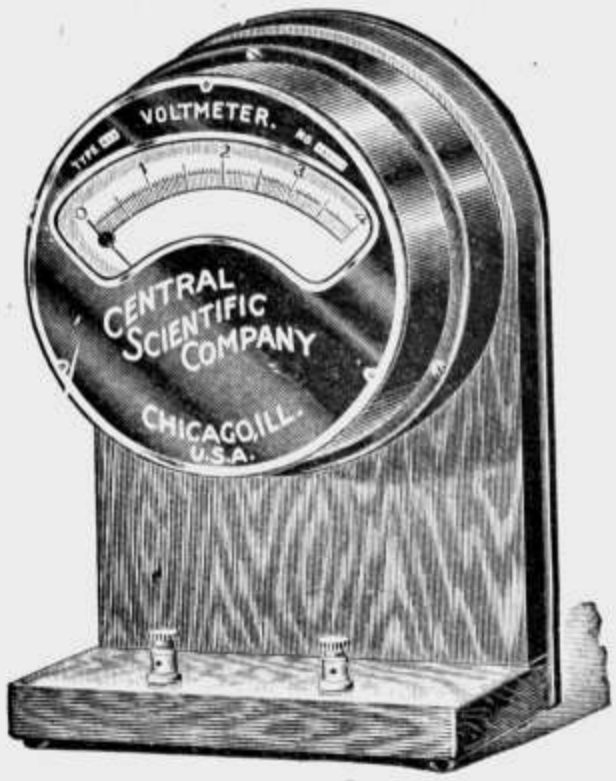
Height	9.5 c. m.	14.5 c. m.	18 c. m.	30 c. m.
Diameter	11.5 c. m.	8.9 c. m.	11.5 c. m.	15.2 c. m.
For Galvanometers Nos.....	2403	2405	2407	2420
Each	.45	.55	.75	1.50

2426. **Galvanometer Suspension Fiber,** of unspun silk, best quality. Five yards wound on card. Per card..... 15

2427. **Galvanometer Suspension Ribbon,** of phosphor bronze, 0.001x0.014 inches. Per foot..... 10

2427A. **Galvanometer Suspension Ribbon,** of steel, 0.0008x0.005 inches. Per foot 15

2428. **Agate Caps** for mounting needles, etc. Each..... 30



No. 2431.

These meters are a standard make and guaranteed in every respect. They are mounted vertically in a dust-proof case so that they may be used in demonstration work. They are extremely sensitive, have no suspensions, mirrors or adjustments, hence are always ready for use. The reading is quick and positive and is guaranteed within 1 per cent. External shunts and coils are all interchangeable.

2429. **Galvano-Volt-Ammeter.** Consists of a milli-voltmeter with the zero in the center, reading 0 to 25 milli-volts in ½ milli-volt divisions. As the instrument has a resistance of one ohm between the terminals, the graduations can be read to indicate either milli-volts or milli-amperes. This instrument used as a Galvanometer gives readings in practical electrical units. A coil mounted on a nickel plated brass case with rubber top is also furnished, which when connected in series with the instrument makes it read from 0 to 25 volts in ½ volt divisions.

A shunt to make the instrument read from 0 to 25 amperes in ½ ampere divisions is also furnished.

As may readily be seen from the above, this combination includes five instruments in one at the price of one. It is used as Galvanometer, Milli-voltmeter, Milli-ammeter, Voltammeter and Ammeter.

The instrument can be used as follows:

The **Measurement of Voltage, Amperage and Resistance of Batteries.**

The **Determination of Resistance, Conductivity,** etc., of the various metals.

The **Measurement of Thermo-Electric Effects** of different metals.

As a **Current Indicator in Wheatstone Bridge Work.**

As a **Lecture Table Galvanometer.**

Complete 33 00

2429A. **Extra Shunt,** to make No. 2429 read from 0 to 5 amperes in 1-10 ampere divisions 4 50

2429B. **Extra Coil,** to make No. 2429 read from 0 to 125 volts by 2½ volt divisions 7 50

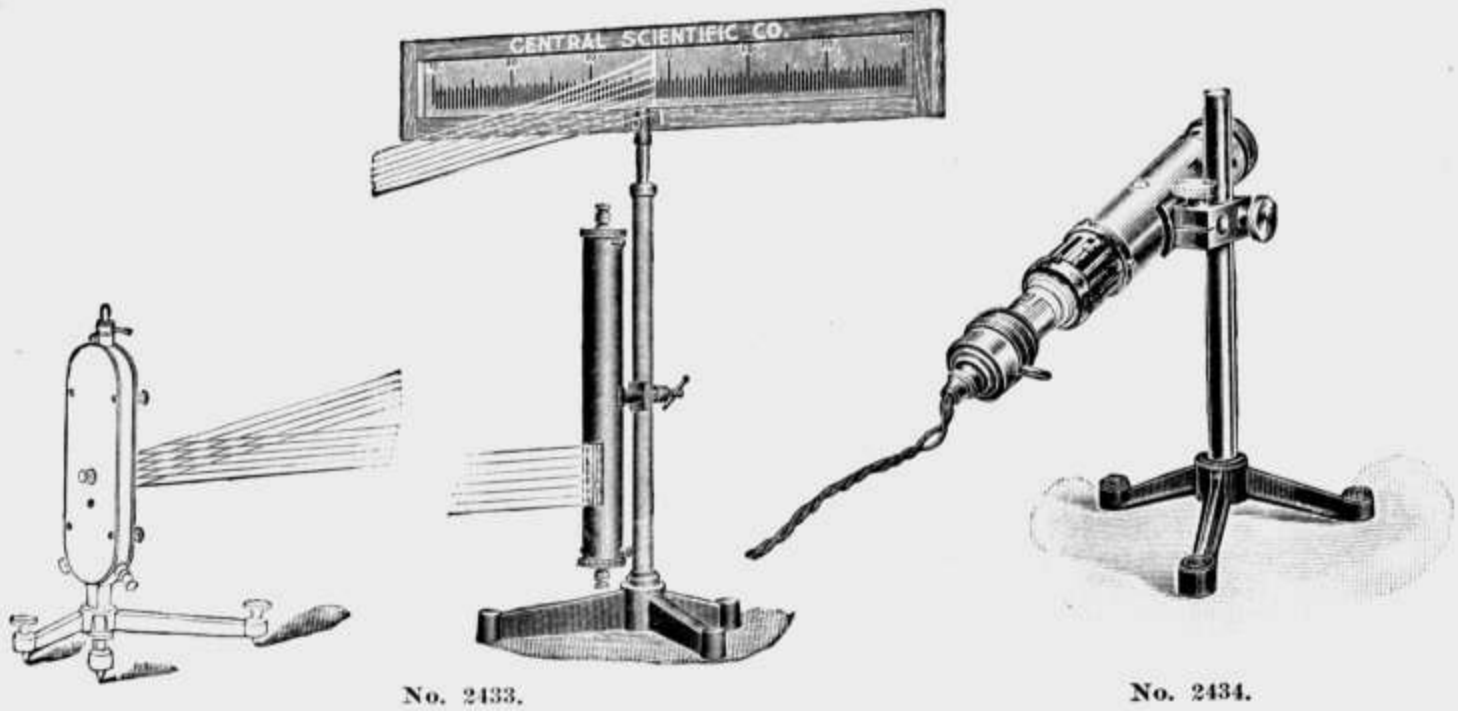
N. B.—**The above Three Numbers Give Seven Standard Instruments.**

2431. **Voltmeter,** with zero at left of scale. Range 0 to 4 volts in 1-20 volt divisions. Mounted vertically as No. 2429..... 25 00

2431A. **Extra Coil,** to make No. 2431 read from 0 to 120 volts in 1 volt divisions 7 50

2432. **Ammeter,** with zero at left of scale. Range 0 to 1 ampere in 1-100 ampere divisions. Mounted vertically as above..... 25 00

2432A. **Extra Shunt,** to make No. 2432 read 0 to 10 amperes in 1-10 ampere divisions 4 50



No. 2433. No. 2434.

2433. **Lamp and Scale** for individual use. The scale is etched on a ground glass strip 6 centimeters wide by 60 centimeters long with long centimeter divisions and shorter millimeter divisions the entire length, reading both ways from zero in the center. It is mounted in adjustable wooden frame.

A straight filament lamp (110 volts) is enclosed in a metal hood japanned black to cut out all reflected light. This form of filament makes a single brilliant line of the scale, enabling closer readings than the "spot of light." The lamp hood can be adjusted to any desired height on the support rod. Complete with lamp, support and scale . . . . . $ 11 00

2433A **Lamp and Scale,** for class room. The scale is on cardboard mounted on a wooden strip. A mirror mounted in wooden frame as long as the scale, is placed above and in front of it, and the scale is viewed by reflection from the mirror, which may be tilted to suit the convenience of the observers. In other features No. 2433A is similar to No. 2433. Complete 16 65

2433B **Single Filament Incandescent Lamp** (110 volts), in hood, japanned black and mounted on clamp..... 5 00

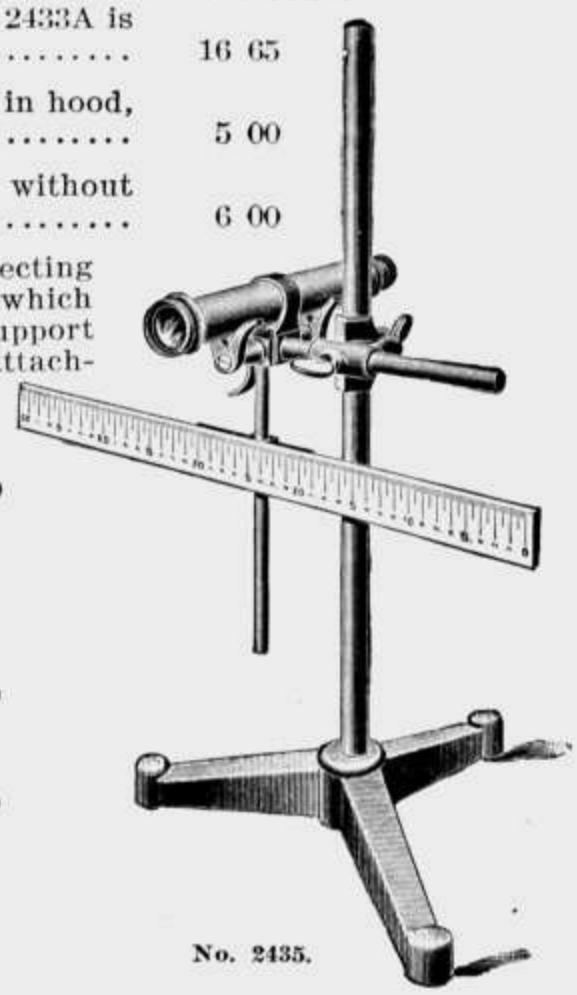
2433C **Scale and Support,** same as described in No. 2433 without lamp of any kind 6 00

2434. **Nernst Projection Lamp,** for use with any reflecting instrument. The lamp is enclosed in a tube which is provided with clamp for attaching to support rods. Lamp complete with flexible leads for attaching to any 110-volt direct current circuit. This lamp gives a very powerful light, suitable for demonstration purposes . . . . . Duty free 15 00

2435. **Reading Telescope.** This is built up from our laboratory support pieces (see pages 1-6). This support allows adjustment of the telescope and scale in every direction. Complete with No. 80 Telescope and No. 85 Scale... 11 00

2436. **Reading Telescope.** Same as No. 2435, but fitted with No. 82 Telescope in place of No. 80..... 18 00

2437. **Reading Telescope,** same as No. 2436, but made entirely of brass, so as to be non-magnetic, to be used with magnetometers 30 00



No. 2435.

RESISTANCE BOXES.

In the selection of a resistance box a number of points should be taken into consideration, as a poor, unreliable box is expensive at any price, since it will render doubtful any results obtained in electrical measurements.

We use high grade rubber plates for the tops, of sufficient thickness to insure a firm anchorage for the brass bars.

We use only imported Manganin Wire, which is the same as advised by the German Physkalisch Technischen Reichsanstalt for all standard resistances. This wire has a neglible temperature coefficient amounting to only .00001 of the total, per degree C. Besides, it does not change its qualities after use. The variation in six years being only one part in 30,000.

All coils are wound bifilar in uniform layers and are practically free from inductance and capacity so that any of the boxes may be used in conductivity experiments with alternating currents. The coils are securely fastened to the top, so that there is no danger of the spools breaking loose and destroying the connections.

One important part of the box is the plug. Our plugs are provided with knurled hard rubber tops moulded on, which prevents removal. The taper part of the plug fits below the upper surface of the blocks so that rings will not be worn into the taper, forming a shoulder which prevents the plug from fitting properly. The plugs are carefully fitted, giving good contacts, and are placed sufficiently far apart to insure easy manipulation. The brass blocks are heavy and separated so that the insulation between may be cleaned.

We guarantee, without reservation, all our boxes to be accurate within the per cent. claimed, and any boxes will be replaced that show faulty construction or do not come up to the guaranteed accuracy when compared with reliable standards.



No. 2441.

2441. **Resistance Box.** The standard design for individual student use. We believe this box will be found to be superior to any sold at equal price.

The total resistance is 111 ohms, divided as follows: 0.1, 0.2, 0.3, 0.4, 1, 2, 3, 4, 5, 10, 20, 30 and 40 ohms. The coils are guaranteed accurate to ½ of 1 per cent.

For detailed description of construction see above..... $ 8 35

2441A. **Resistance Box,** same as No. 2441, guaranteed accuracy 1-5 of 1 per cent. 11 10

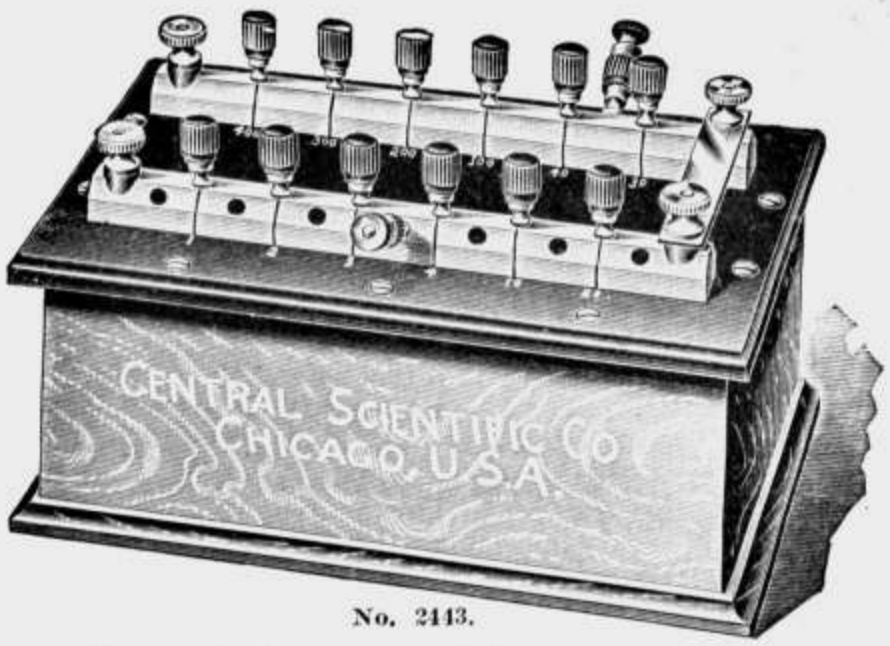
2441B. **Resistance Box,** same as No. 2441, but with following coils: 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, 400 ohms guaranteed accuracy, 1-5 of 1 per cent..... 13 90

Standard Ohm, page 192.



No. 2442.

2442. **Resistance Box,** new design, with Spring Contacts. The greatest objection to the plug form resistance box when used by inexperienced students is the unreliability of the contacts, caused either by the loosening of the adjoining plugs when one is withdrawn or to a loose fit, caused either by exchange or failure to properly insert the plugs. As will be noticed by the above illustration, these dangers have been obviated by the use of the spring contact, which on account of the taper fits tightly all points of the plug, causing no irregular wear. The external resistance of the box has not been materially increased. The capacity and coils are the same as in No. 2441. Wound non-inductively with Manganin wire. The only box of equal price wound with this wire guaranteed within 1 per cent. ..... $ 6 65



No. 2443.

2443. **Resistance Box,** traveling plug form. Extra heavy brass blocks, rubber top, ⅜ inch thick.

The total resistance is 1,110 ohms, divided as follows: 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300 and 400 ohms. The box is supplied with two traveling plugs, which add greatly to the usefulness of the instrument, making it available for the comparison of the E. M. F. of batteries and other tests by the potentiometer method. For detailed description of construction see page 185.

Guaranteed accuracy, 1-5 of 1 per cent..... 25 00

2444. **Resistance Box,** similar to No. 2443, but with greater capacity and heavier blocks. Total resistance of 11,110 ohms, as follows: 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, 400, 1,000, 2,000, 3,000 and 4,000 ohms. For detailed description of construction see page 185.

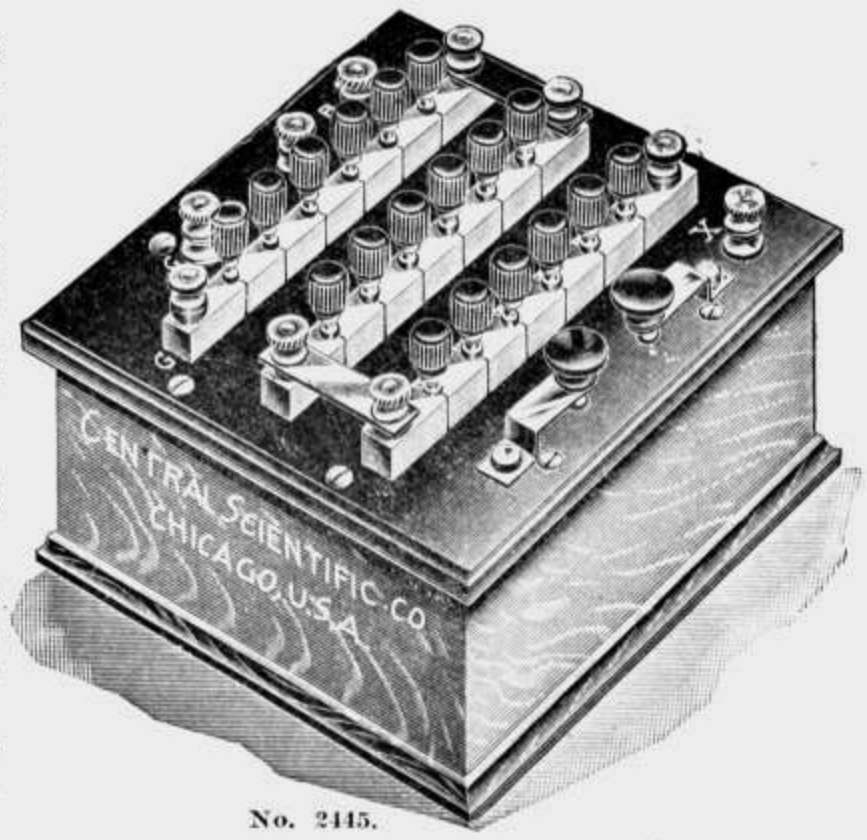
Guaranteed accuracy, 1-5 of 1 per cent..... 30 00

2445. **Resistance Box and Bridge Combined.** Polished mahogany box with pure rubber top ⅜ inch thick. Heavy brass blocks and rubber topped plugs, carefully ground. The coils are all non-inductively wound with "Manganin" wire, carefully tested and then embedded in paraffine.

The bridge coils are six in number, 1, 10 and 100 ohms on each side.

The rheostat coils are twelve in number, viz.: 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, 400 ohms.

The total range of measurement is therefore from .01 to 111,000 ohms.

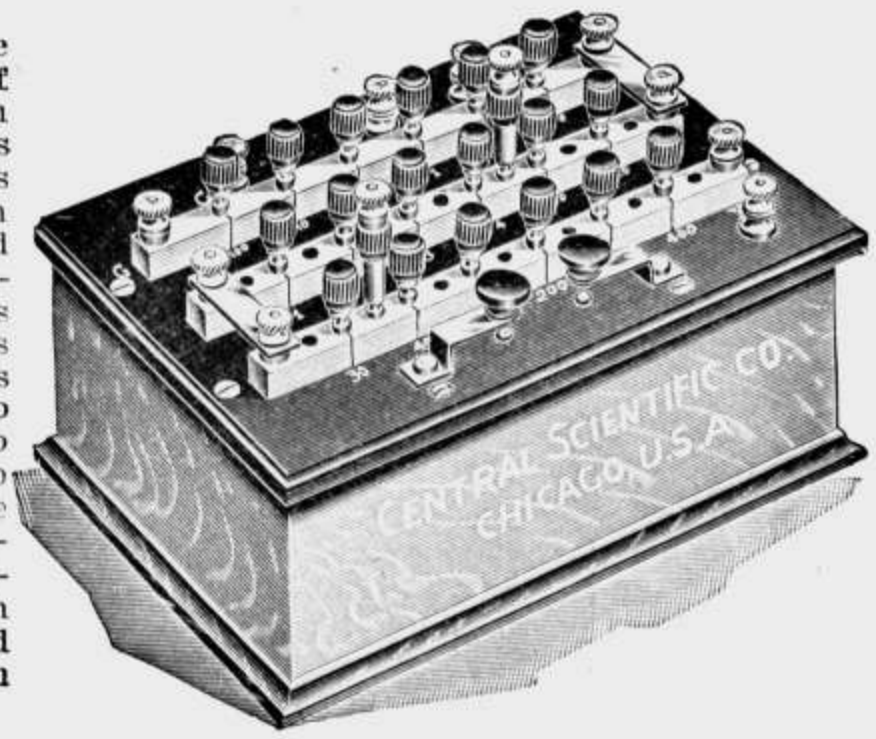


No. 2445.

The binding posts for Battery and Galvanometer are placed at the rear so as to keep the connecting wires out of the way of the operator and also to prevent short circuiting. Keys with platinum contacts are conveniently placed on the front of the box for Battery and Galvanometer. Blue Print showing connections and method of operating is included with every box. For detailed description of construction see page 185.

Guaranteed accuracy, 1-5 of 1 per cent..... $ 25 00

2446. **Resistance Box and Bridge Combined.** This box is of the same general design and the same capacity as No. 2445. The brass blocks, however, are much heavier and longer, and each has a hole in its center to receive the plugs when using the coils, thus always keeping the plugs on the instrument. Two traveling plugs are also furnished which fit into the same holes. Blue print showing connections and method of construction is included with every box. For detailed description of construction see page 185.



No. 2446.

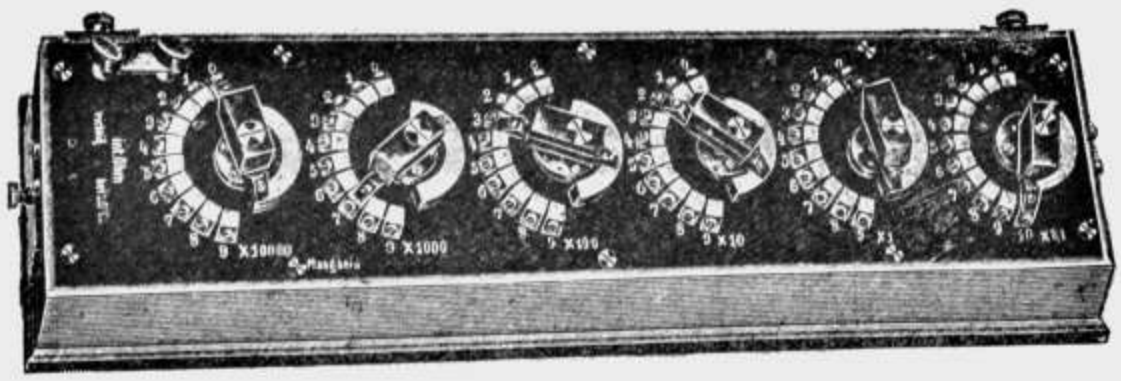
Guaranteed acuracy, 1-10 of 1 per cent..... 40 00

2446A. **Resistance Box and Bridge Combined.** Same general design as above, but without traveling plugs, and with the following coils in the rheostat: 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, 400, 1,000, 2,000. 3,000, 4,000; total, 11,110 ohms.

The ratio of coils of the bridge are as follows in each arm: 1, 10, 100 and 1,000 ohms.

The rheostat coils are guaranteed to 1-5 of 1 per cent, the bridge coils to 1-10 of 1 per cent..... 45 00

For detailed description of construction see page 185.



No. 2447.

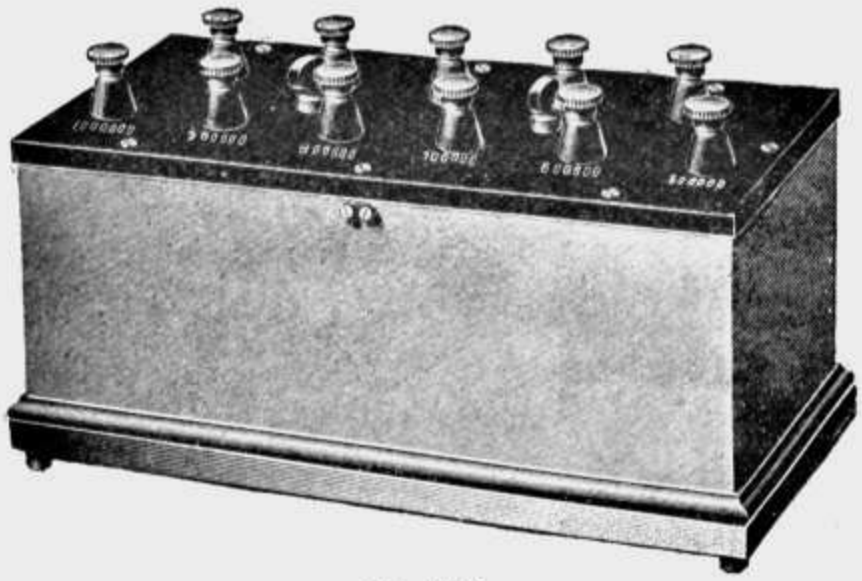
2447. **Resistance Box in Decades.** The sliding contacts have advantage over the plug type in rapid and convenient manipulation when care is taken that these contacts are reliable.

The spindle serves as a support for the massive lever, with its brushes resting on the contact blocks on one side and on the other resting on a segment from which the current is taken. A spiral spring within the ebonite handle of the sliding contact gives the necessary contact force.

Each contact piece is provided with a terminal screw, which admits of comparing the resistance of the single decades with each other, exclusive of the constant resistances. In a similar manner the resistances are adjusted so that the smallest resistance of 0.1 ohm can be adjusted with accuracy.

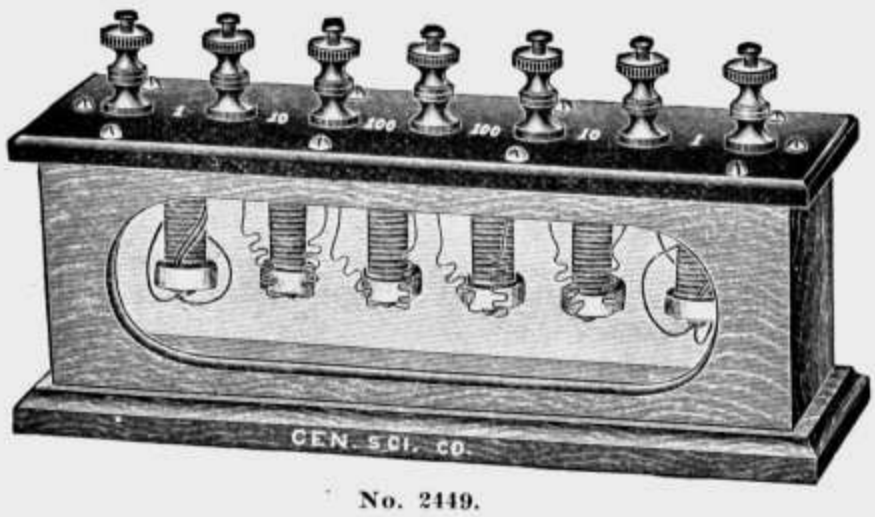
The box is provided with a removable cover, protecting it from dust and light when not in use. The terminals are arranged on the side of the box, so that the cover may be replaced without removing the connecting wires. The standard type of box is arranged so that each decade consists of 9 resistances, except the lowest decade, which contains 10 resistance coils. The smallest is 0.1 ohm.

Catalogue No.	2447A	2447B	2447C	2447D
No. of Decades.....	3	4	5	6
Duty free	90.00	120.00	142.50	165.00



No. 2448.

2448. **Megohm Box.** Consists of 10 resistances of 100,000 ohms each. A single resistance consists of 4 coils of 25,000 ohms each, mounted in series. The ends of each resistance are connected to contact pins mounted on conic pillars of ebonite, provided with screws with ebonite heads, to which the current wires are connected direct....Duty free 90 00



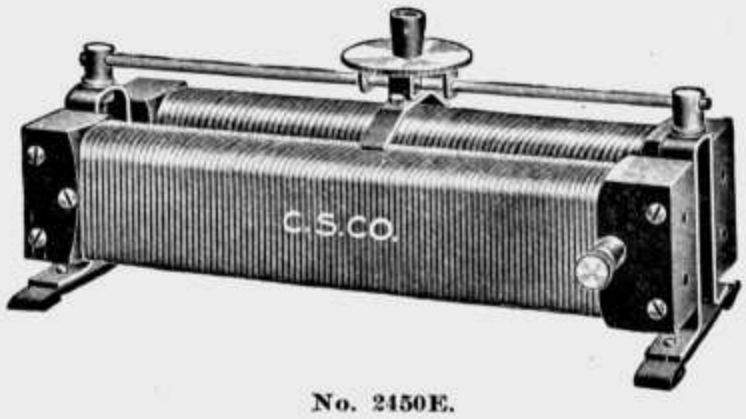
No. 2449.



No. 2449½.

2449. **Ratio Box,** for use as Ratio Arms in Wheatstone Bridge work. Coils non-inductively wound of Manganin Resistance wire and accurately adjusted to 1-5 of 1 per cent, as follows: 1, 10, 100, 100, 10 and 1 ohm. The six coils give nine different working ratios and accuracy of each coil makes possible the use of the box for a standard resistance of 222 ohms ..... $ 11 00

2449½. **Brass Plug,** with knurled rubber top, as used on Resistance Boxes. Ea. 20



No. 2450E.

Slide Resistances (single) of constantin wire wound in grooves on slate blocks.

Cat. No.	Dimensions of Slate.	Max. Current.	Approx. Resist.	Duty Free.
2450A	300x50x25 m. m.	1 amp.	300 ohms.	5 15
2450B	300x50x25 m. m.	3 amp.	45 ohms.	5 25
2450C	200x50x20 m. m.	1 amp.	150 ohms.	4 50
2450D	200x50x20 m. m.	5 amp.	8 ohms.	4 75

Slide Resistances (double), same as above, with two blocks.

Cat. No.	Dimensions of Slate.	Max. Current.	Approx. Resist.	Duty Free.
2450E	300x50x35 m. m.	7 amp.	20 ohms.	9 70
2450F	300x60x35 m. m.	3 amp.	110 ohms.	9 30
2450G	300x60x35 m. m.	1 amp.	700 ohms.	9 30

Universal Rheostats. Consists of two mounted slate blocks. One is wound with a stout constantin wire with a resistance of .5 to 245 ohms, the other with a fine one with a resistance of 5 to 2,450 ohms. The contact is a sliding one with five springs. By different connections we may obtain (1) a reduction of the potential to any amount. (2) A minute regulation of the resistance. (3) May be used at same time on different resistances.

Cat. No.	Volt.	Max. Current.	Resistance.	Dimen. of Slate.	Duty Free.
2451A	110	.45 amp.	800 ohms.		
		2.00 amp.	70 ohms.	200x50x20 m. m.	10 50
2451B	110	.3 amp.	1,200 ohms.		
		3. amp.	45 ohms.	200x80x20 m. m.	10 50
2451C	110	.45 amp.	800 ohms.		
		5. amp.	15 ohms.	200x50x20 m. m.	10 50
2451D	250	.45 amp.	950 ohms.		
		2. amp.	90 ohms.	300x60x35 m. m.	12 50
2451E	250	.3 amp.	1,500 ohms.		
		3. amp.	55 ohms.	300x60x35 m. m.	12 50
2451F	250	.45 amp.	950 ohms.		
		5. amp.	18 ohms.	300x60x35 m. m.	12 50

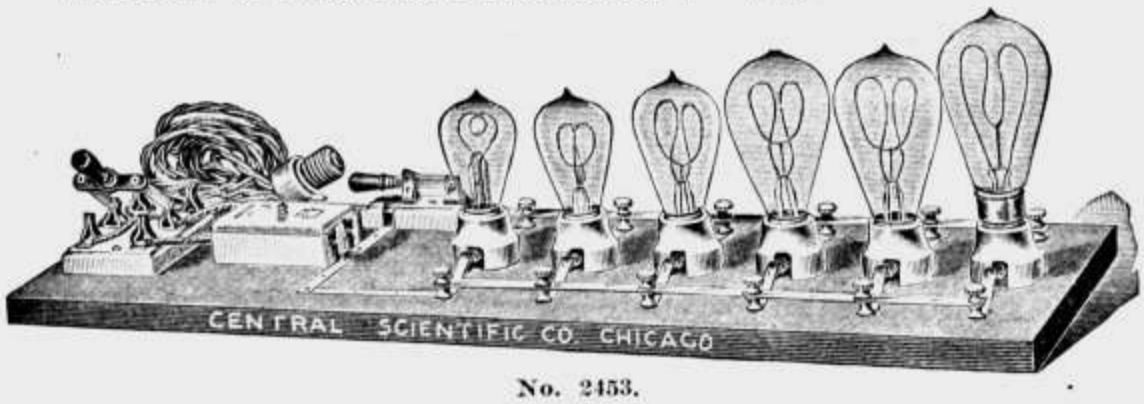
2452. **Battery Rheostat,** for fine adjustment of current strength. Made of a special composition of wire of very high resistance, and at the same time of such strength as to reduce danger from overheating and accidental breakage to a minimum. The resistance scale allows uniform graduations as small as may be desired. It is also made in such a manner as to reduce the wear on the contacts.

This instrument is wired in shunt and when used in connection with 110-volt circuit a lamp must be placed in series with the supply binding posts.

Mounted on polished oak base, fitted with four binding posts..... $ 8 50



No. 2452.



No. 2453.

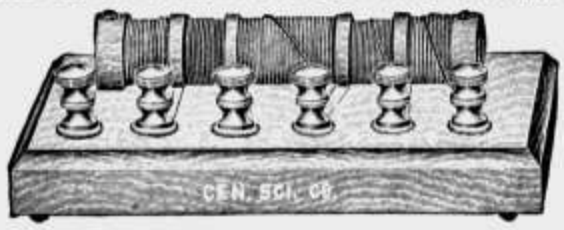
2453. **Lamp Rheostat.** Practical working form for controlling incandescent lighting circuits, suggested by Prof. Parsons, of Colorado College. All connections are in plain sight for series, multiple or combination connections. A single throw knife switch is also provided to permit the introduction of ammeters, tangent galvanometers, magnet coils, permeameters, electrolysis and similar apparatus. The current is controllable from .06 amperes when in series to 5.05 amperes when in multiple.

The following report shows a few of the possible combinations:

Lamp No.	1	2	3	4	5	6	Total
Candle Power	4	8	16	32	32	50	132
Current at 110 V.	.2	.38	.53	1.12	1.12	1.70	5.05
Resistance, hot	550	289.3	207.5	98.2	98.2	64.7	21.7
Resistance, 20° Centigrade	1125	607	452	221	222	136	48

Resistance in series at 110 volts.....1833
Resistance in series at 20° Centigrade.....2764
Current when connected in series at 110 volts.....06 amp.
Price ..... $ 11 00

2454. **Lamp Rheostat,** same as No. 2453 for 220-volt circuit..... 12 00



No. 2455.

2455. **Resistance Spools,** set of five spools of unknown resistance. Mounted on polished hardwood base, with binding screws so that each spool may be separately or collectively measured. This form of resistance spools is the most durable for rough usage and makes a neat looking piece of apparatus for the laboratory. Consists of the following spools:

No. 1. 10 Meters No. 22 Copper Wire.
No. 2. 10 Meters No. 28 Copper Wire.
No. 3. 20 Meters No. 22 Copper Wire.
No. 4. 20 Meters No. 28 Copper Wire.
No. 5. 10 Meters No. 22 German Silver Wire. Per set..... 3 35

2456. **Resistance Board,** originally designed in 1904 by C. H. Andrews of the South High school, Worcester, Mass., and made from recent specifications furnished us. It consists of four coils of wire with the following possible combinations:

1. Two coils of the same length and material, but of different diameters.
2. Two coils of the same length and diameter, but of different material.
3. Two coils of the same diameter and material, but of different lengths.

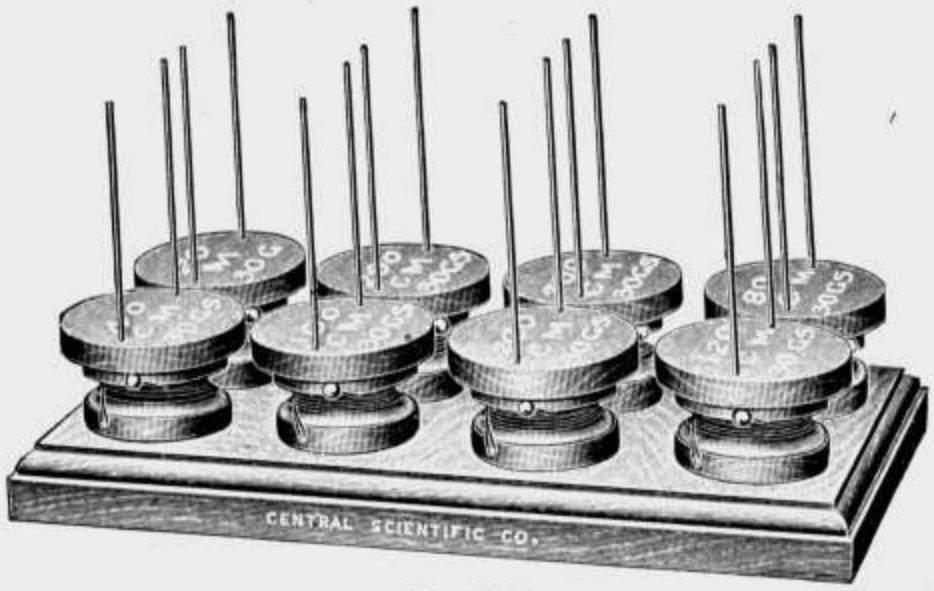


No. 2456.

Care has been taken to select wires whose diameters and resistances have convenient ratios to each other, and are therefore best suited for use in parallel.

The coils are so connected to the brass blocks that the different combinations may be secured by the plugs, connecting any of the coils either in series or parallel.

Mounted on finished hardwood base with hard rubber top plugs..... $ 4 50



No. 2457.


No. 2458



No. 2459

2457. **Resistance Spools.** Set of eight for use with Wheatstone's Bridge. The wood base is fitted with pegs to hold the spools when not in use. As an improvement, we fasten each lead wire to the spool itself and solder it to the resistance wires wound on the spools. This prevents the wires from breaking and makes the coils, in consequence, more durable. Set consists of the following spools:

2 Spools wound with 200 c. m. No. 30 bare German silver wire.
1 Spool wound with 160 c. m. No. 30 bare German silver wire.
1 Spool wound with 120 c. m. No. 30 bare German silver wire.
1 Spool wound with 80 c. m. No. 30 bare German silver wire.
1 Spool wound with 40 c. m. No. 30 bare German silver wire.
1 Spool wound with 200 c. m. No. 28 bare German silver wire.
1 Spool wound with 2,000 c. m. No. 30 silk covered copper wire. Per set $ 3 35

2458. **Resistances** on spools. These resistances are the same as used in our Resistance Boxes and are guaranteed to be of the best workmanship. Wound bifilar with Manganin wire on wooden spools, the ends soldered to heavy copper terminals. Accurate to 1-5th of 1 per cent.

Resistance in ohms.	1	2	5	10	25	50	100	200	500	1000	5000
Each	.55	.55	.55	.60	.60	.70	.80	.90	1.00	1.50	2.25

2459. **Resistance Coil,** mounted in brass case, rubber top, with two binding posts and rubber top brass taper plug for throwing the coil in circuit. Coils wound bifilar of Manganin wire and guaranteed to an accuracy of 1-10th of 1 per cent.

Resistance in ohms.	1	2	5	10	25	50	100	200	500	1000	5000
Each	5.50	5.50	5.50	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.50

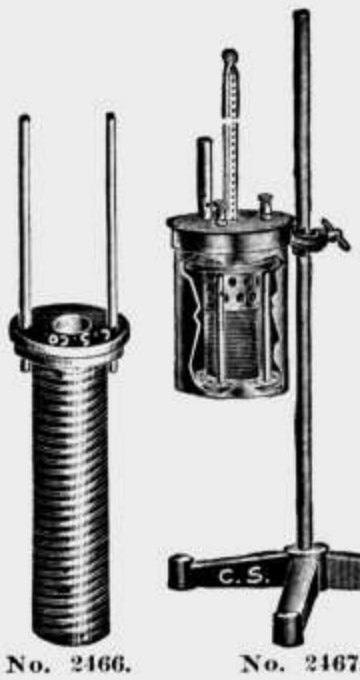
2460. **Standard Ohm,** adjusted so as not to vary more than .01 per cent from a standard. Furnished with certificate from the Reichsanstalt .....Duty free $ 12 50

2463. **Graphite Rods,** for resistance work. Any size of resistance can be furnished. Prices upon application.

Graphite Rods, ½x10 inches, with a resistance of 200 ohms, carried in stock. Price each..... 1 35

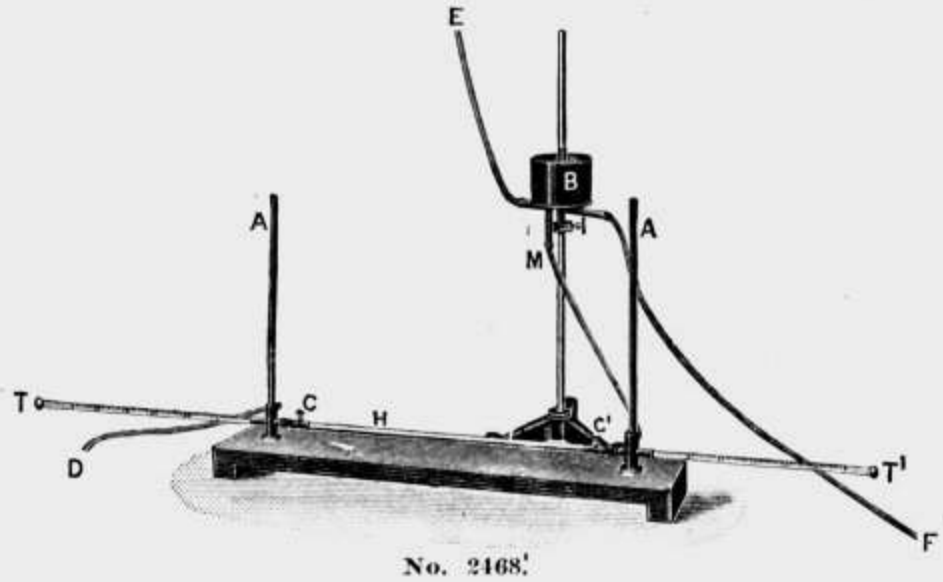


No. 2460.



No. 2466.

No. 2467.



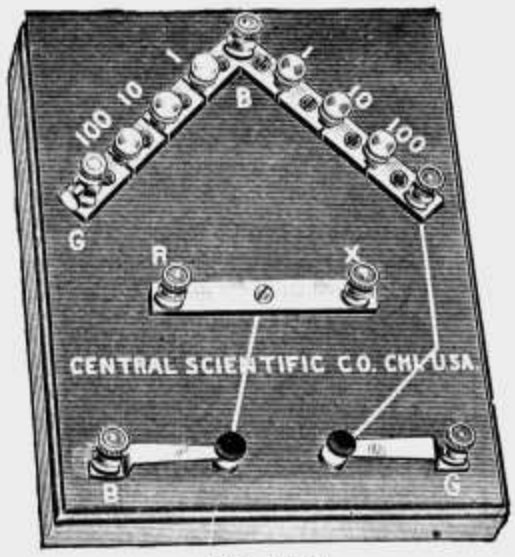
No. 2468.

2466. **Temperature Coil,** for use with Wheatstone Slide Wire Bridge in studying the effects of temperature on resistance..... 1 25

2467. **Temperature Coil,** Cornell University design, for the measurement of the specific resistance of a copper conductor. Fine copper wire (double silk covered) is wound bifilar in spiral grooves on a thin copper cylinder, which is perforated for the free circulation of oil about the coiled wire. This cylinder is also used as a stirrer and is supported by a fiber cap, which fits loosely in the top of the heavy nickel plated copper calorimeter.
Complete, but without thermometer and support..... 10 00

2468. **Temperature Co-efficient Apparatus. (Continuous Flow Calorimeter.)** This instrument has been designed by Profs. Callender and Barnes for the rapid and fairly accurate determination of the Heat Equivalent of Electric Energy. A current of water passes through the tube H, 44 c. m. long, through which a silk-covered Manganin wire is wound in the form of a helix. The temperature of the water at the inlet and outlet is taken by means of the mercury thermometers T and Knowing the electrical energy dissipated in the wire and the volume of water passed through the tube, it is easy to determine the Heat Equivalent of the Electrical Energy. A small cistern B, with an overflow arrangement is provided in order that the flow of water through the tube may be kept constant; the head of water being varied by altering the height of the cistern on the stand. Complete with two mercury thermometers reading from 0 to 50 degrees C. by 1-10 degree..... 30 00

Electric Calorimeter, page 118.



No. 2471.

2471. **Wheatstone's Bridge,** demonstration form, convenient for determining resistance. Furnished with three coils of 1, 10 and 100 ohms for each proportional arm. This form follows Wheatstone's diagram given in every text book..... $ 5 50

2473. **Wheatstone's Bridge,** standard slide wire form, simplest construction, easily manipulated. German silver wire one meter long. Metric scale. Sliding knife edge contact..... 3 35



No. 2475.

2475. **Wheatstone's Slide Wire Bridge, Standard Meter Form.** Heavy brass strips in one piece with no soldered joints, mounted on polished hardwood base, meter scale, platinoid wire and improved sliding contact. 6 00



No. 2476.

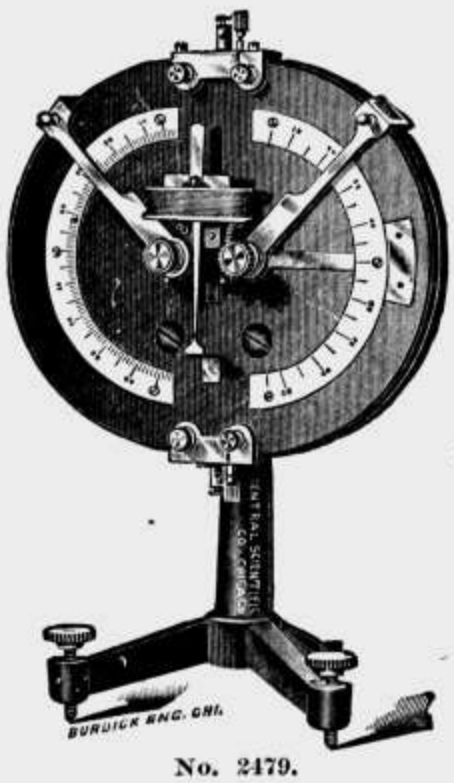
2476. **Half Meter Bridge.** (Simple Carey-Foster Type.) For calibration of a bridge wire or measurements in resistances: by short circuiting the two end gaps, it may be used also as an ordinary Wheatstone Bridge. This bridge is well made and neatly finished and binding posts for all necessary connections are furnished. We call attention to the improved contact key. It is of the knife edge type and moves easily along a brass tube with which it makes good electrical contact. Advantages of this key will readily present themselves to the buyer. The galvanometer wires do not get tangled or interfere with easy movement of key, knife edge always makes contact at right angles to the wire, contact is sure and adjustments can be made very minute 9 00



No. 2477.

2477. **Wheatstone's Standard Slide Wire Meter Bridge.** In this bridge we use extra heavy copper strips, and connections are made in such a manner as to obviate use of soldered joints. Provided with four gaps and scale one meter long, divided to millimeters. Manganin wire and improved form of key..... 15 00

Commutators and Contact Keys, pages 200 and 201.



No. 2479.

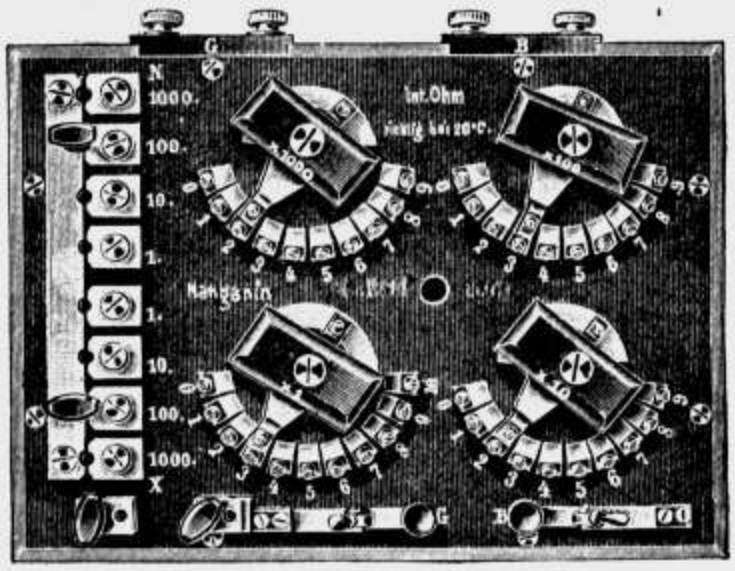
2479. **Wheatstone's Bridge, Demonstration Model and Lecture Table Instrument.** This apparatus consists of a plate of slate with two semi-circular scales graduated in 100 parts. On the outer edge of the plate are two Manganin wires (0.4 and 0.6 m. m.) stretched and connected between the brass pieces at the top and bottom.

The current enters at the top and passes out at the bottom. These two brass pieces, also the brass piece on the right, are equipped with thumb screws. In the middle of the plate is placed a sensitive vertical galvanoscope which is connected with two brass rulers, provided with spring contacts which slide on the Manganin wire.

When both brass rulers are on corresponding points of the scales, no current passes through the galvanometer, the needle remains stationary, and Wheatstone's law is clearly demonstrated and the proportion of resistances easily shown. By moving one of the rulers forward or backward the proportion of resistance is changed and the galvanoscope shows a deflection either to the right or left.

When the law of the bridge has been verified, this apparatus may be used for measuring resistances. For this purpose the right hand ruler is unscrewed, the known resistance is placed between the top brass plate and the one at the right. The resistance to be measured is placed between this plate and the bottom plate and the Manganin wire thrown out by means of the plugs. The position of the ruler then has to be changed until there is no deflection of the needle. One 5 ohm resistance coil is included..... $ 22 50

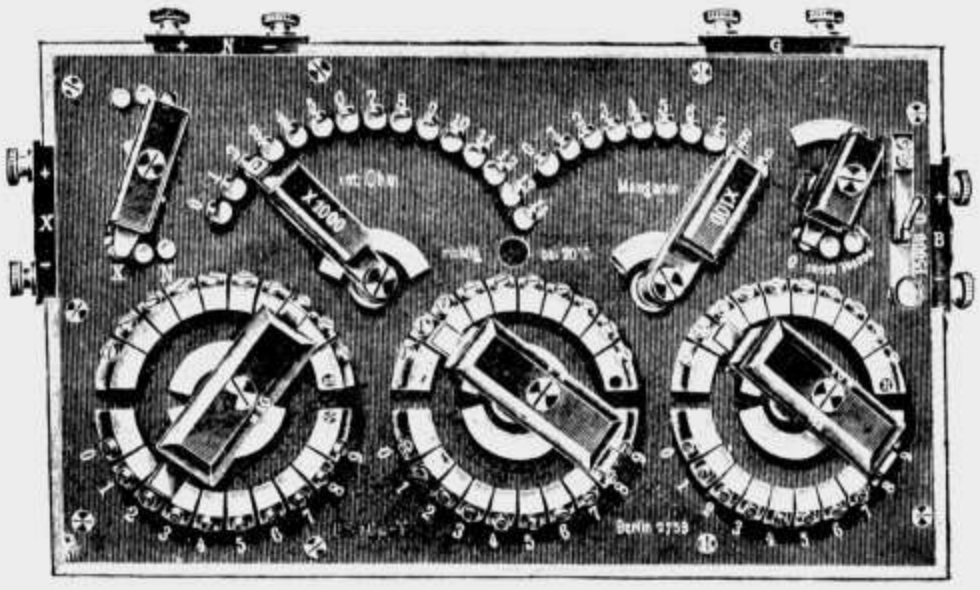
Extra Resistance Coils Furnished if Desired.



No. 2480.

2480. **Wheatstone's Bridge with Four Decades,** with sliding contacts, as described in No. 2447. Four pair of ratio resistances of 1, 10, 100, 1,000 ohm or 10, 100, 1000, 10,000 ohms. Four decades of comparison resistances, 9x1000, 9x100, 9x10, 10x1 ohm or 9x100, 9x10, 9x1, 10x0.1 ohm. Battery and galvanometer keys, a pair of ordinary terminals for connecting the resistances to be measured. Provided with wooden lid to keep out light and dust when not in use. .....Duty Free 142 50

N. B.—Prices of Bridges with 5 and 6 decades furnished on request.



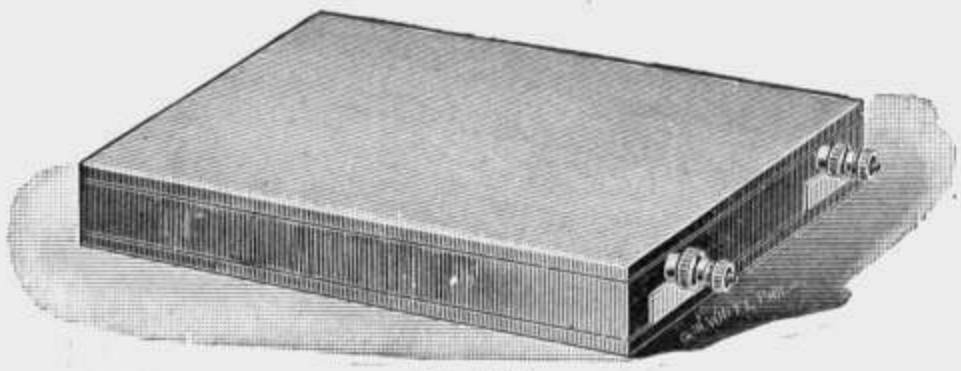
No. 2481.

2481. **Potentiometer,** after Dr. Fuessner. For measuring electromotive force and currents, the latter by the fall of potential on the ends of the standard resistances. Provided with sliding contact connection and fitted with 77 resistance coils with an aggregate resistance of 15,000 ohms. In this high resistance the unavoidable connection and contact resistances are of little influence; and smaller fractions of the potentials can be measured without the danger of having too small resistance. The limit is 15 volts; if the fall of potential is 1 volt on 1000 ohms, the potential can be measured to .0001 volt, as 0.1 ohm is the smallest resistance; and to 1.5 volt, if the fall of potential is 1 volt on 10,000, then .00001 volt can be measured. Higher potentials can be measured by connecting them in place of an auxiliary battery to the +B terminals, after having inserted sufficient resistance, and compensating with the standard cell.

For measuring higher potentials it is recommended that the multiplier No. 2483 be used. This is connected the same as the potentials less than 15 volts to the +X—terminals. Then only one cell of about 2 volts is needed as an auxiliary battery and a rheostat of about 5000 ohms. The high potential to be measured is connected to the main terminals of the multiplier. The potential read on the potentiometer is then multiplied by the respective figure of the multiplier and measured accurately to the fifth decimal.....Duty free 180 00

2482. **Potentiometer and Wheatstone's Bridge.** This apparatus is an extension of No. 2481. It serves not only for the same accurate measuring processes, but also for measuring resistance according to the Wheatstone method. It contains, in addition, a double pole switch for the battery and four pairs of ratio resistances (85 resistance coils in all), which can be interchanged by means of two plugs. For measuring resistances a pair of terminals is provided. As comparison resistances the three decades of the potentiometer are used. Auxiliary battery with rheostat and galvanometer are used for both purposes. .....Duty free 225 00

2483. **Multiplier,** with three ranges. The apparatus can be used for potentials up to 1500 volts. The total resistance is 100,000 ohms, and is composed of a number of single coils for better insulation and cooling. The resistances are arranged in a box made of perforated sheet metal with a wooden bottom.....Duty free 52 50



No. 2484.

Paper Condensers, for experimental purposes. These condensers will meet the demand for an inexpensive type which is reliable in its electrical characteristics. They are thoroughly recommended for use with a potential of 500 volts or less. The following sizes are carried in stock:

2484. **Paper Condenser,** capacity 1 M. F., size 4½x¾x1 5/16..... $ 1 30

2484A. **Paper Condenser,** capacity 2 M. F., size 4½x1¾x1⅝..... 2 15

2485. **Paper Condenser,** in hardwood case. The box contains two commercial condensers capable of standing 120 volts. Each condenser has a capacity of approximately 1 micro-farad. Three Cenco binding posts are provided so that the condensers may be used or measured singly, in series or parallel..... 5 50

Standard Paper Condensers, in mahogany case with plug connections mounted on ebonite.

2486. **Paper Condenser,** capacity .5 M. F. in 5 subdivisions (.05, .05, .1, .1, .2 M. F.) .....Duty free 25 00

2486A **Paper Condenser,** capacity 1 M. F. in 2 subdivisions (.5, .5, M. F.) .....Duty free 24 00



No. 2487.



No. 2487C.

Standard Mica Condensers, accurately adjusted and fully guaranteed.

2487. **Mica Condenser,** mounted between ebonite plates with two substantial terminals .....Duty free 16 00

2487A **Mica Condenser,** in mahogany case with ebonite top plug connections and short circuiting position. Capacity .5 M. F.....Duty free 40 00

2487B **Mica Condenser,** mounted as above, capacity .5 M. F., in 3 subdivisions (.1, .2, .2 M. F.) .....Duty free 52 00

2487C **Mica Condenser,** mounted as above, capacity 1 M. F., in 4 subdivisions (.1, .2, .5 M. F.) .....Duty free 64 00

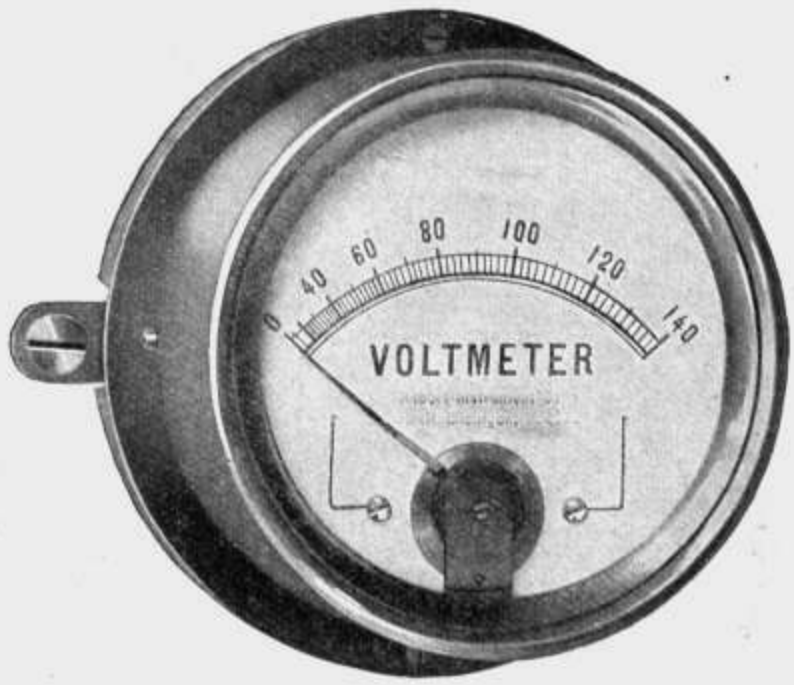
Reichsanstalt Certificates will be furnished for condensers Nos. 2487A, B and C at an additional cost, depending upon the capacity.

2488. **Mica Condenser,** a good condenser mounted in a neat hardwood case, 6x4x3 inches. The terminal binding posts are secured in rubber bushings. A copper strap is furnished to short circuit the terminals. Capacity 1 M. F. adjusted approximately to 1 per cent.... 7 00

2489. **Air Condenser:** Two accurately planed brass plates 6 inches diameter, nickel plated with hard rubber handles, mounted on insulated support with one mica plate 8 inches square, capacity 1-20 M. F..... 12 00



No. 2492.



No. 2500.

POCKET METERS.

These meters are especially useful for the rapid testing of the voltage and amperage of batteries. A leather case is furnished with every instrument. Illustration is actual size.

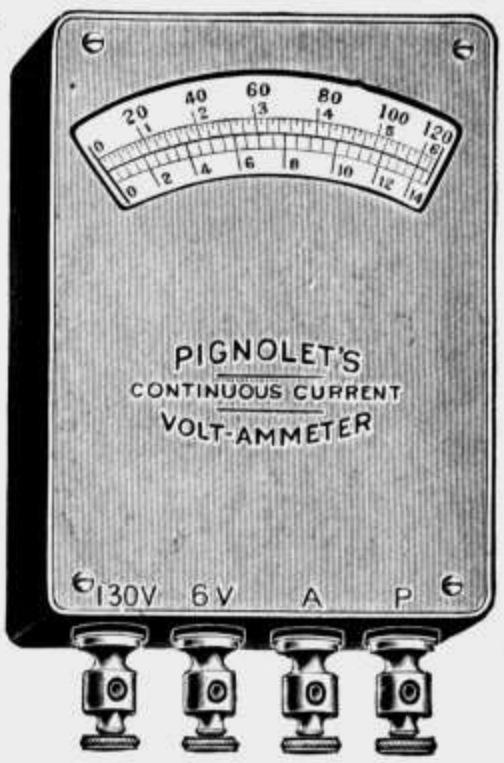
2490.	**Pocket Voltmeter,** range 0— 3 volts	$ 4 00
2491.	**Pocket Voltmeter,** range 0—10 volts	4 00
2492.	**Pocket Ammeter,** range 0—30 amperes	4 00
2493.	**Pocket Volt-Ammeter,** range 0— 3 volts and 0—30 amperes	6 00
2494.	**Pocket Volt-Ammeter,** range 0—12 volts and 0—30 amperes	6 00

SWITCHBOARD METERS.

These meters are of the electro-magnetic type for either direct or alternating current. The instruments are 3¾ inches in diameter, accurately calibrated with a distinct scale.

2495.	**Ammeter,** range 0- 5 ampere	12 00
2496.	**Ammeter,** range 0-15 ampere	12 00
2497.	**Ammeter,** range 0-25 ampere	12 00
2498.	**Voltmeter,** range 0- 6 volts	12 00
2499.	**Voltmeter,** range 0- 25 volts	12 00
2500.	**Voltmeter,** range 0-140 volts	14 00

N. B.—See our **vertically mounted meters,** page 183.



Nos. 2503-2509.



No. 2512.

2503. **Voltmeter.** This instrument is of the permanent magnet type and has the high accuracy and equal scale divisions of this form. Large enough for practical use and reliability, yet small enough to be carried in the pocket. (Cut is half size.) Guaranteed against defects and made in a thorough manner, the same as the best standard instruments. Pivots are jeweled bearings. The scales are hand made, and each instrument is carefully adjusted. Range 0 to 10 volts in one-fifth volt divisions..... $ 10 00

2504. **Voltmeter**, same as No. 2503, range 0 to 50 by single volt divisions.... 11 00

2505. **Voltmeter,** same as No. 2503, especially designed for testing storage batteries, with dead beat attachment. Range 0 to 3 volts by one-twentieth volts 10 00

2506. **Ammeter,** same as No. 2503, range 0 to 10 amp. by ¼ amp..... 10 00

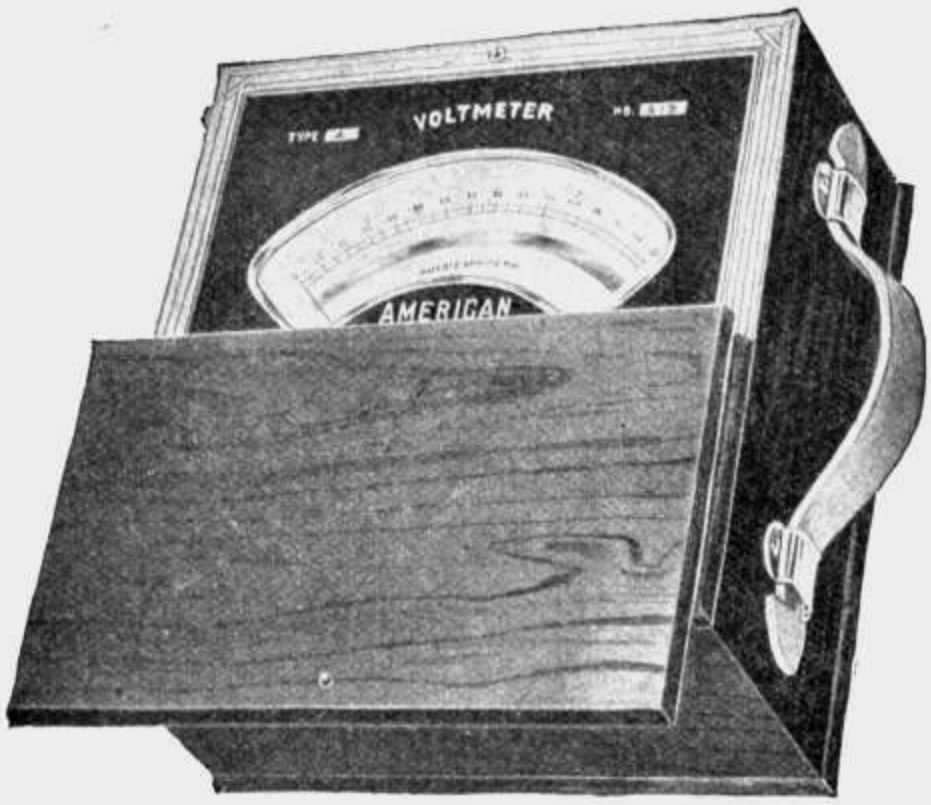
2507. **Ammeter,** same as No. 2503, range 0 to 30 amp. by 1 amp. divisions.. 10 00

2508. **Volt-Ammeter**, same as No. 2503, range 0 to 10 volts and 0 to 30 amp. (combination of Nos. 2503 and 2507)..... 12 25

2509. **Volt-Ammeter,** same as No. 2503, range 0 to 50 volts and 0 to 30 amp. (combination of Nos. 2504 and 2507)..... 13 35

N. B. Dead Beat Attachment fitted to any instrument, extra..... 1 10

2512. **Volt-Ammeter.** Instrument illustrated above is entirely new design and will meet the demands for a dependable electrical measuring instrument at a reasonable price. It is a direct current instrument made on the D'Arsonval Galvanometer principle with a rectangular coil of wire rotating in a small annular gap between a core and pole pieces. This gap is traversed by a concentrated uniform field produced by a powerful permanent magnet carefully aged. The current is carried into and out of the coil by means of non-magnetic springs. The moving element is so perfectly balanced between two highly polished jewels that scale divisions are nearly uniform even to the highest readings. The throw of the coil is stopped by the coil striking its support. This prevents the bending of the pointer and the destroying of the calibration of the instrument. The large window directly over the moving system shows to the student the essential parts of the instrument. The meter is enclosed in a dust proof aluminum case mounted on a polished mahogany base. Leads are brought to three of our Cenco binding posts, which are recommended for their convenient size and from the fact that their construction will not allow the knurled nuts to be lost. Scale has a range of 10 volts by 1/10 divisions and 10 amperes by 1/10 ampere divisions. Calibration guaranteed to 1% of the full scale..... 11 00



No. 2526.

AMERICAN VOLTMETERS AND AMMETERS.

These instruments are of the D'Arsonval (moving coil) type, which is recognized as the best for accurate direct current measurements. The voltmeters have uniform resistance of 100 ohms per volt and the ammeters have interchangeable external shunts, so that several shunts can be used with one instrument if desired. Scale divisions are equal throughout and all instruments are strictly "dead beat," so that indications may be read very quickly. For laboratory use there are instruments, mounted in portable cases to be carried from place to place; and also instruments for more stationary use with what are commercially styled "switchboard" mountings. We list below a few of the most popular instruments. Others quoted upon application.

SWITCHBOARD METERS.

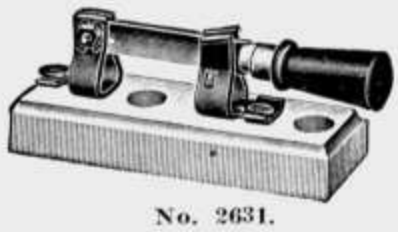
2515.	**Voltmeter,** 0-10 volts, in .1 volt divisions.....Net $	16 00
2516.	**Voltmeter,** 0-120 volts, in 1. volt divisions.....Net	16 50
2518.	**Ammeter,** 0-10 amperes, in .1 ampere divisions.....Net	15 00
2519.	**Ammeter,** 0-50 amperes, in .5 ampere divisions.....Net	15 75

PORTABLE METERS (SHIELDED).

2522.	**Voltmeter,** 0-15 volts, in .1 volt divisions.....Net	25 00
2523.	**Voltmeter,** 0-50 volts, in .5 volt divisions.....Net	26 50
2524.	**Voltmeter,** 0-150 volts, in 1. volt divisions.....Net	29 50
2526.	**Voltmeter, Double Scale,** supplied with "Multiple Scale Switch" to thoroughly protect instrument from injury due to accidental wrong connections. 0-15 volts and 0-150 volts.....Net	34 50
2528.	**Ammeter,** 0-15 amperes, in .1 ampere divisions.....Net	25 00
2530.	**Ammeter,** 0-50 amperes, in .5 ampere divisions.....Net	25 50
2531.	**Ammeter,** 0-100 amperes, in 1. ampere divisions.....Net	26 50
2534.	**Milli-Voltmeter,** 0-50 milli-volts.....Net	25 00
2535.	**Milli-Ammeter,** 0-100 milli-amperes.....Net	25 00

N. B.—The above instruments are shipped direct from the factory.

See also our **Vertically Mounted Meters,** page 183.



No. 2631.



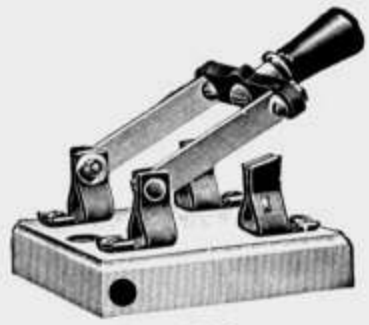
No. 2632.



No. 2616.

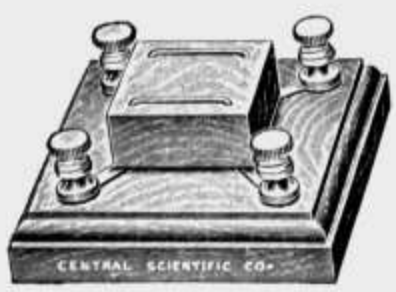


No. 2621.



No. 2633.

2615. **Switch, Wood Base,** 2½ inches diameter, 1 point..... $ 17
2616. **Switch, Wood Base,** 2½ inches diameter, 2 point..... 20
2617. **Switch, Wood Base,** 2½ inches diameter, 3 point..... 22
2618. **Switch, Wood Base,** 2½ inches diameter, 4 point..... 25
2621. **Switch, Rubber Base,** with binding posts, 1 point..... 65
2622. **Switch, Rubber Base,** with binding posts, 2 point..... 80
2623. **Switch, Rubber Base,** with binding posts, 3 point..... 1 00
2624. **Switch, Rubber Base,** with binding posts, 4 point..... 1 25
2631. **Switch, Knife,** slate base, single pole, single throw, 15 amperes..... 45
2632. **Switch, Knife,** slate base, single pole, double throw, 15 amperes..... 65
2633. **Switch, Knife,** slate base, double pole, single throw, 15 amperes..... 55
2634. **Switch, Knife,** slate base, double pole, double throw, 15 amperes..... 1 00



No. 2641.



No. 2643.

2641. **Commutator or Pole Changer,** simple form, four binding posts and mercury cups. Contact parts are made of steel..... 65
2643. **Commutator or Pole Changer,** new form, mounted on polished wood base. Heavy phosphor bronze spring clips, giving an excellent contact. This is a convenient and desirable form, since there is no spilled mercury or corrosion of contacts..... 1 65

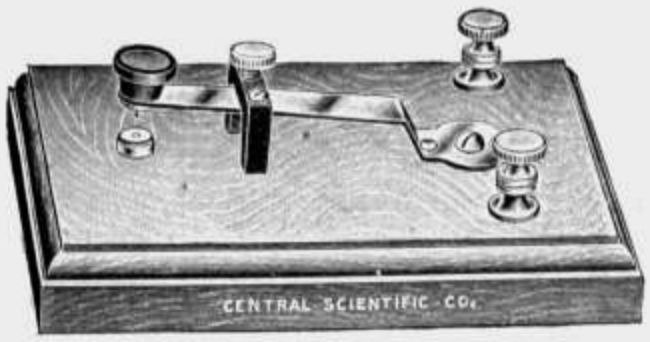


No. 2645.

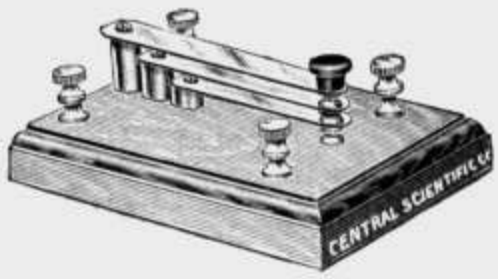


No. 2647.

2645. **Commutator or Pole Changer (Pohl's).** This is the familiar, popular form in use for so many years. Mounted on polished hardwood base 2 50
2647. **Commutator or Pole Changer,** knife switch form, mounted upon a slate base sufficiently heavy to insure stability; all connections visible, hence easy to understand. No mercury to spill. Will carry 15 amperes. The simplest and most durable commutator yet designed 1 25

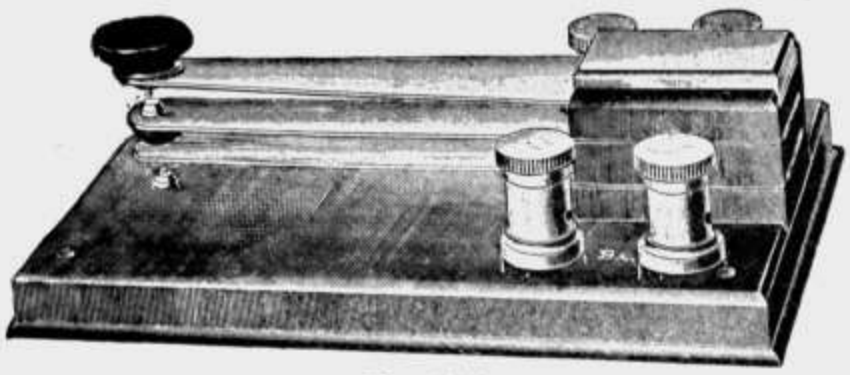


No. 2653.

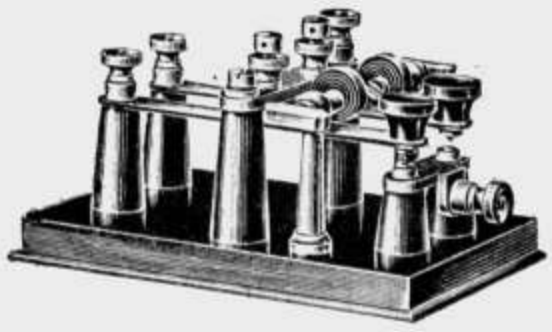


No. 2655.

2651. **Contact Key,** simple form..... $ 1 00
2653. **Contact Key,** single contact, with platinum points..... 1 50
2655. **Contact Key,** double contact, with platinum points..... 3 35



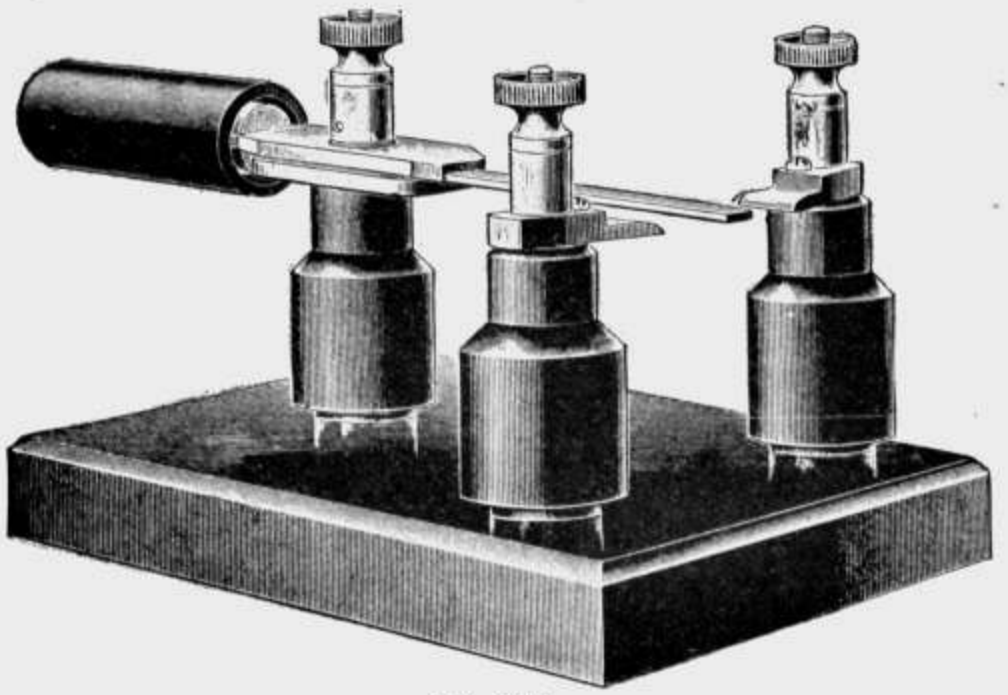
No. 2657.



No. 2659.

2657. **Double Contact Key.** High insulation pattern. This key may be used in any experiment where a double contact key of the highest or lowest insulation is needed. This is a high grade key with rubber blocks and base and the best workmanship throughout. Heavy platinum contacts 11 00

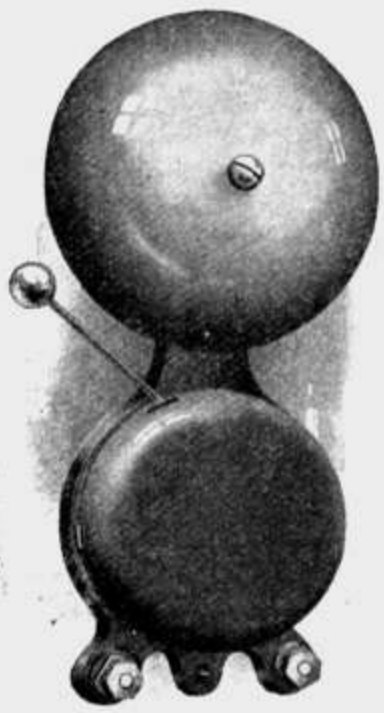
2659. **Reversing Key.** High insulation pattern. This key is of substantial construction, with heavy platinum contacts. Ebonite is of best quality. Finely finished and polished.....Duty free 27 00



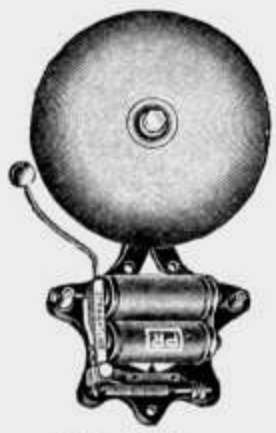
No. 2661.

2661. **Charge and Discharge Key.** This key is admirably adapted to charging and discharging condensers of small or large capacity. The insulation is of the highest, so that none of the charge can be lost by leakage. The insulated handle enables the key to be used without insulating the body. Finely polished and finished..... 19 50

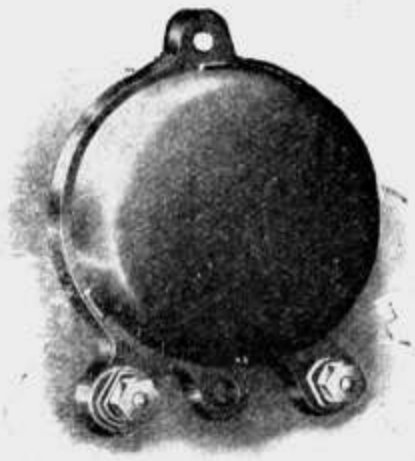
2663. **Damping and Discharge Key,** combined, new design, insulated for high voltages and well finished. Adapted for best work..... 27 75



No. 2672.

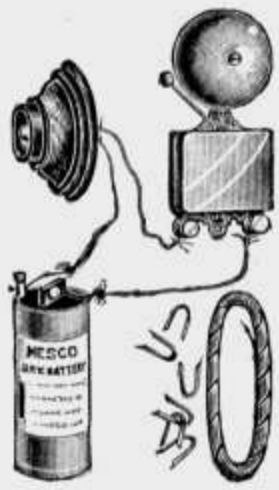


No. 2684.



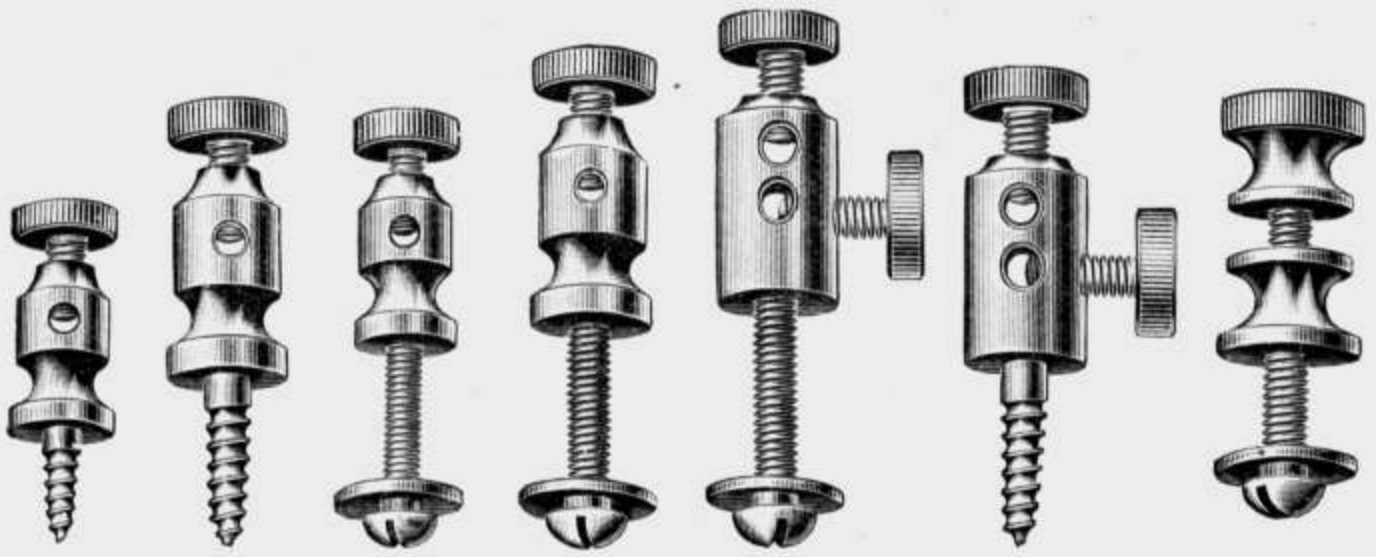
No. 2695.

2672. **Bell, Electric,** latest improved design, iron box, pivoted armature, 2½ inch nickel plated gong..... $ 45
2673. **Bell, Electric,** same as No. 2672, 3 inch gong..... 60
2674. **Bell, Electric,** same as No. 2672, 4 inch gong..... 75
2681. **Bell, Electric, Pony Size,** all nickeled, 1 inch gong..... 1 00
2682. **Bell, Electric,** same as No. 2681, 2 inch gong..... 90
2684. **Bell, Electric, Skeleton Type,** pivoted armature, superior workmanship, 4 inch nickel plated gong, giving clear, penetrating tone..... 2 00
2685. **Bell, Electric,** same as No. 2684, 5 inch gong..... 2 50
2686. **Bell, Electric,** same as No. 2684, 6 inch gong..... 3 00
2687. **Bell, Electric,** same as No. 2684, 7 inch gong..... 4 50
2688. **Bell, Electric,** same as No. 2684, 8 inch gong..... 5 00
2690. **Bell, Electric,** same as No. 2684, 10 inch gong..... 8 00
2695. **Buzzer,** iron box 45

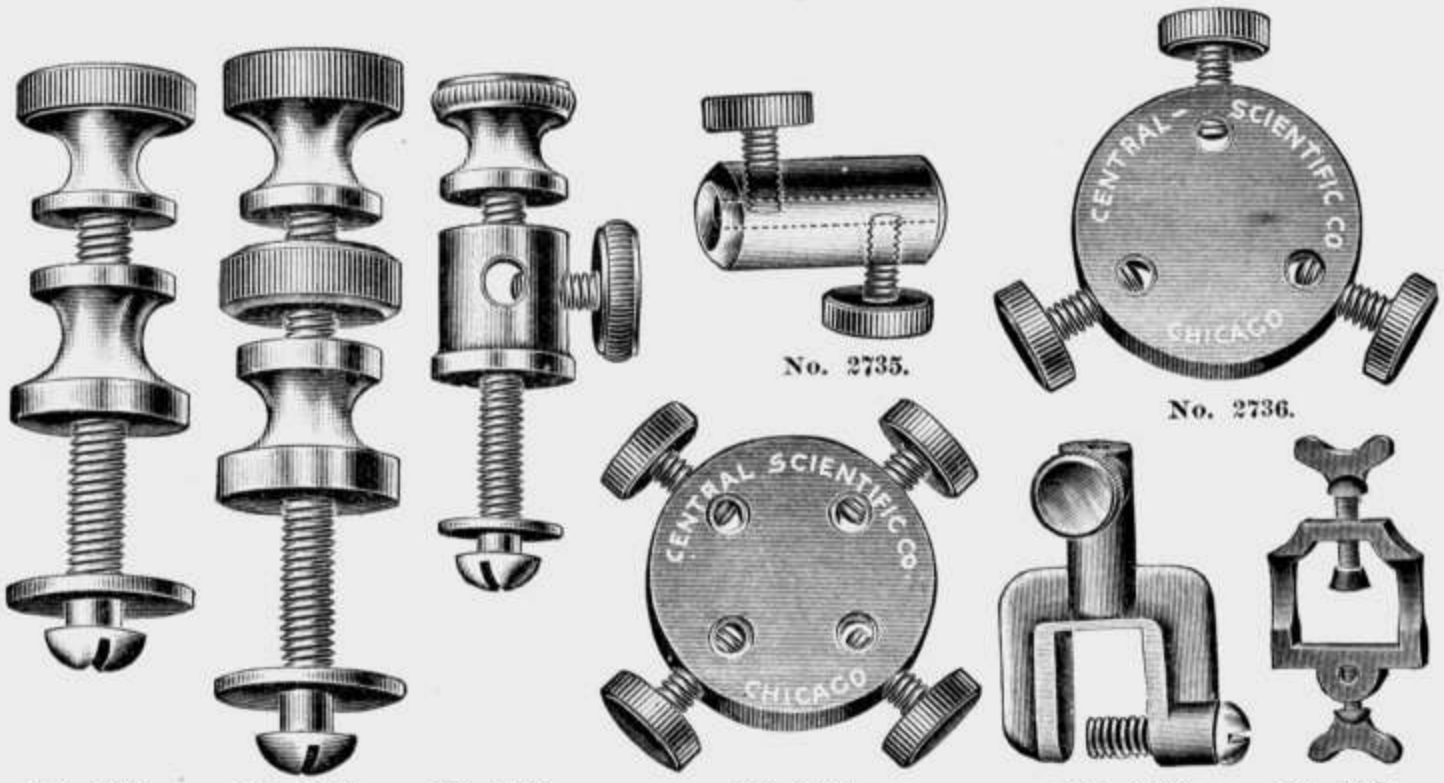


No. 2699.

2699. **Electric Bell Outfit,** consisting of No. 2672 Bell, No. 2111 Dry Battery, No. 2756 Push Button, No. 2807 Tape, 1 lb. (150 feet) annunciator wire and staples for putting up..... 1 65



No. 2721. No. 2722. No. 2723. No. 2724. No. 2725. No. 2726. No. 2727.



No. 2728. No. 2729. No. 2730. No. 2735. No. 2736.

No. 2737. No. 2738. No. 2739.

Illustrations are full size.

2721.	**Binding Post, American form,** with wood screw, small	$ 09
2722.	**Binding Post, American form,** with wood screw, large	11
2723.	**Binding Post, American form,** with machine screw, small	09
2724.	**Binding Post, American form,** with machine screw, large	11
2725.	**Binding Post, American form,** with machine screw, double	17
2726.	**Binding Post, American form,** with wood screw, double	17
2727.	**Binding Post, English form,** with machine screw, small	11
2728.	**Binding Post, English form,** with machine screw, large	20
2729.	**Binding Post, English form,** with machine screw, double	33
2730.	**Binding Post,** combination English and American form, with machine screw	20
2735.	**Connector, double**	11
2736.	**Connector, triple**	18
2737.	**Connector, quadruple**	20
2738.	**Connector, for zinc**	20
2739.	**Connector, for carbon**	30

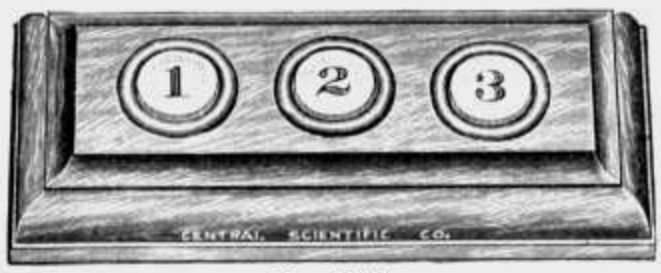


No. 2755.



No. 2756.

2755. **Push Button, bronze,** with screw cap..... $ 45
2756. **Push Button, hardwood,** with screw cap..... 11



No. 2793.

2792. **Push Button, compound,** with 2 numbered buttons..... 1 10
2793. **Push Button, compound,** with 3 numbered buttons..... 1 65
2794. **Push Button, compound,** with 4 numbered buttons..... 2 00
2795. **Push Button, compound,** with 5 numbered buttons..... 2 50
2796. **Push Button, compound,** with 6 numbered buttons..... 3 00
2798. **Push Button, compound,** with 8 numbered buttons..... 3 50
2799. **Push Button, compound,** with 10 numbered buttons..... 4 00

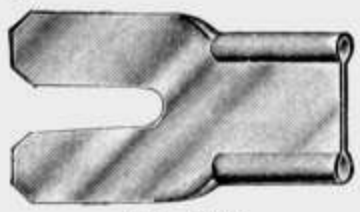
Above Are Furnished in Either Oak, Mahogany or Cherry.



No. 2800.



No. 2801.



No. 2802.



No. 2803.

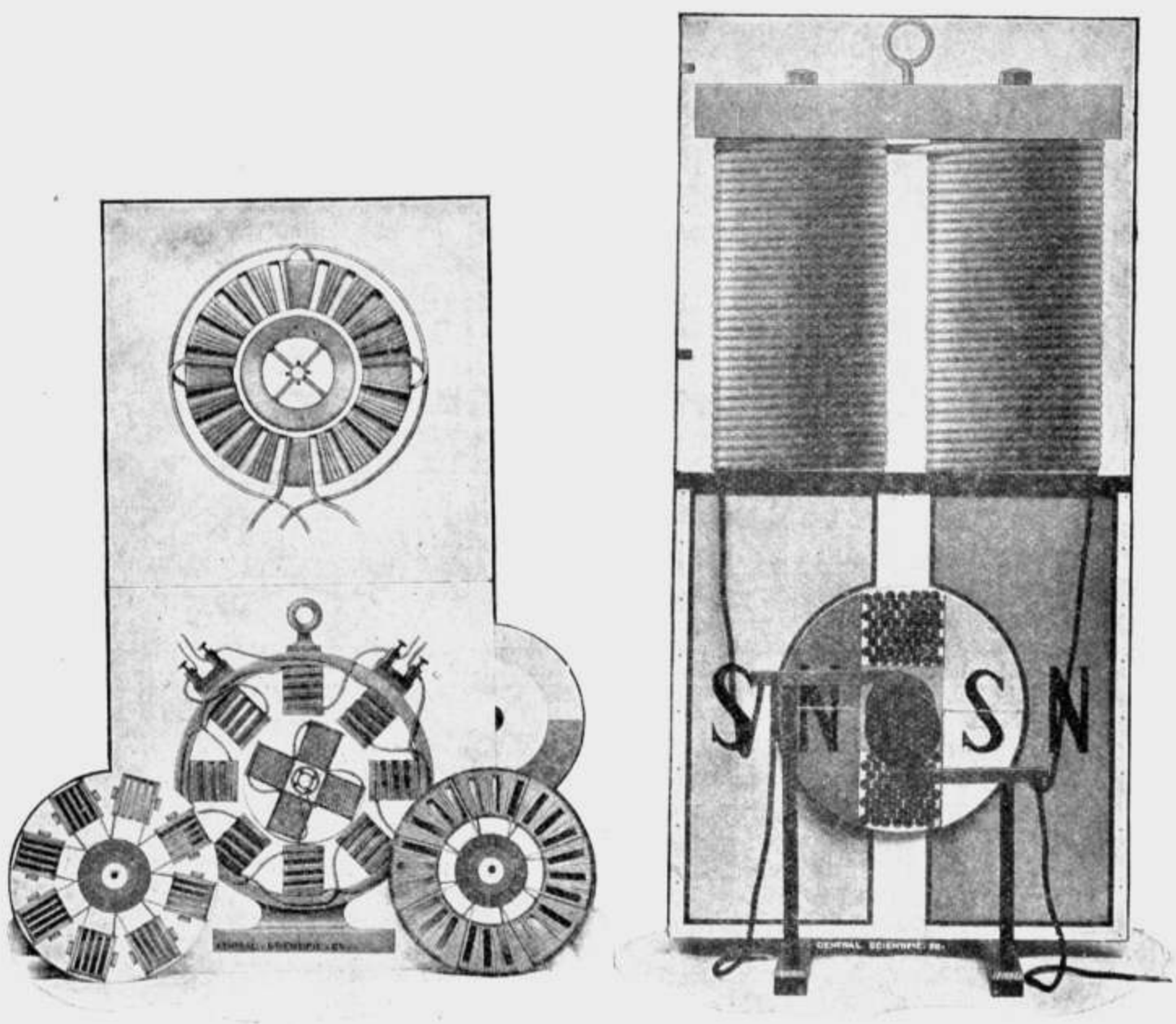


No. 2804.

2800. **Connector Tip,** for use in making connections with American binding posts; may also be used with English binding posts in conjunction with No. 2802.....Each 07
2801. **Connector Tip,** for use in connecting to English binding posts. To be soldered to cord.....Each 05
2802. **Binding Post Attachment,** for use with Nos. 2800 or 2803 connectors in making single or two-way connections. Will fit any English binding posts. .....Each 15
2803. **Connector,** consists of two No. 2800 connector tips attached to 3 feet flexible silk cord.....Each 20
2804. **Connector,** consists of two No. 2801 connector tips soldered to ends of 3 feet flexible silk cord.....Each 15
2805. **Staples, Wire,** square or round top, ⅜-inch, for inside wiring. In 4-oz. packages, per package..... 10
2807. **Insulating Tape,** cloth base, ¾-inch wide, black. Per ¼-lb. roll..... 17

Wire, all kinds, listed on page 350.

Batteries, pages 142 to 150.



No. 2821.

2821. **Electro-Dynamic Charts.** These charts, finely lithographed in eight colors and mounted on heavy cardboard, are used to demonstrate the principles of the electric generator and motor and the 3 phase current machine.

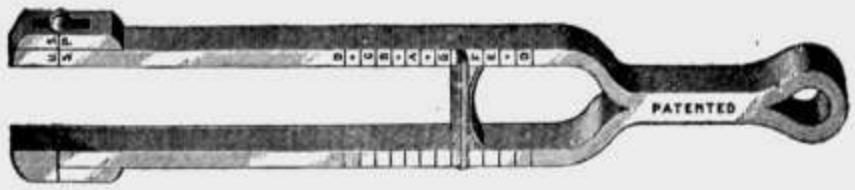
The charts are 28x30 inches, and can easily be seen across the largest lecture room. The complex mechanism of the dynamo, motor and alternating current are more clearly shown by means of these charts than is possible by any other means. The different windings, connections and armatures are all plainly indicated. The charts can be mounted on a frame, as shown in the above illustration, and the armature revolved by means of a crank, operated from the rear. The change of poles in the armature is automatically shown by different colors, red for the north pole and blue for the south pole, which change as the armature is revolved. The set includes 8 charts, as follows:

Magnetic Electric Machine, 2 pole armature, direct current.
Magnetic Electric Machine, 2 pole armature, alternating current.
Dynamo, 2 pole armature.
Dynamo, Gramme ring.
Motor, Gramme ring.
Motor, 2 pole armature, direct current.
Alternating current generator (2 phase).
Alternating current motor (3 phase).
Commutator, connecting cords, cranks, brushes and frame, complete.. $ 12 50

Alternating Current Apparatus, page 152.

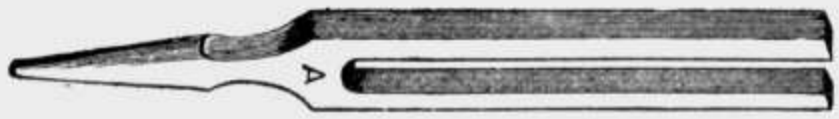
A. C. Motors, page 163.

SOUND.



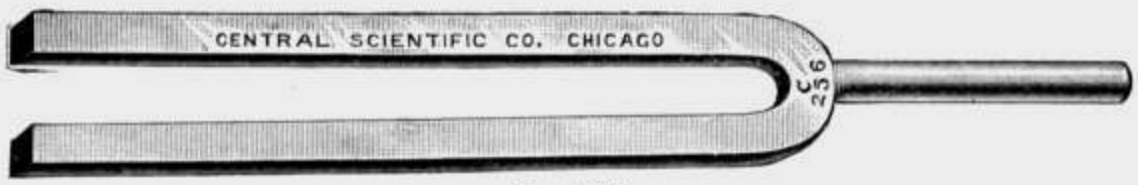
No. 3001.

3001. **Tuning Fork, adjustable**..... $ 1 20



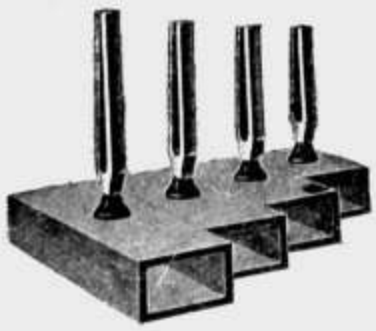
No. 3003.

3003. **Tuning Fork,** small, A..... 17
3004. **Tuning Fork,** small, C..... 17



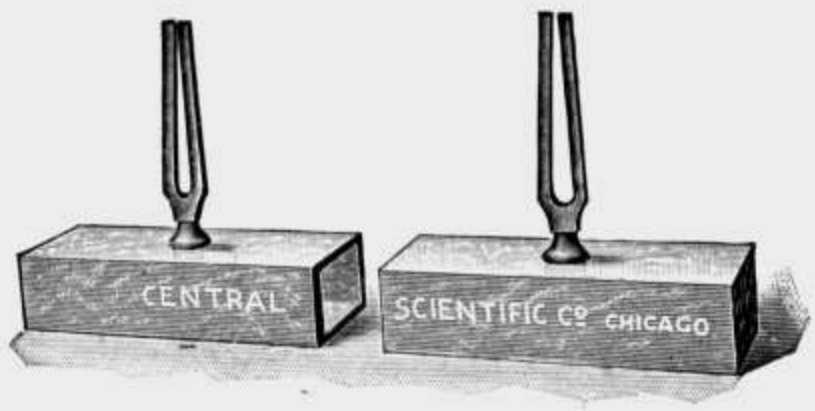
No. 3012.

3011. **Tuning Fork,** C, 128 Vibrations Physical pitch, 10 in. long..... 3 00
3012. **Tuning Fork,** C^1, 256 Vibrations Physical pitch, 7¼ in. long..... 1 25
3013. **Tuning Fork,** D, 288 Vibrations Physical pitch, 7 in. long..... 1 50
3014. **Tuning Fork,** E, 320 Vibrations Physical pitch, 6⅞ in. long..... 1 50
3015. **Tuning Fork,** F, 341⅓ Vibrations Physical pitch, 6¾ in. long..... 1 40
3016. **Tuning Fork,** G, 384 Vibrations Physical pitch, 6½ in. long..... 1 40
3017. **Tuning Fork,** A, 426⅔ Vibrations Physical pitch, 6¼ in. long..... 1 25
3018. **Tuning Fork,** B, 480 Vibrations Physical pitch, 6 in. long..... 1 25
3019. **Tuning Fork,** C^2, 512 Vibrations Physical pitch, 5⅞ in. long..... 1 00
3019½. **Stylus,** for tracing vibrations with special wax for use on any of the above forks..... 22
3020. **Tuning Forks,** set of 4, C^1, E, G, & C^2, giving chord..... 5 00
3020A. **Tuning Forks,** set of 8, Nos. 3012-3019, giving full octave..... 10 00



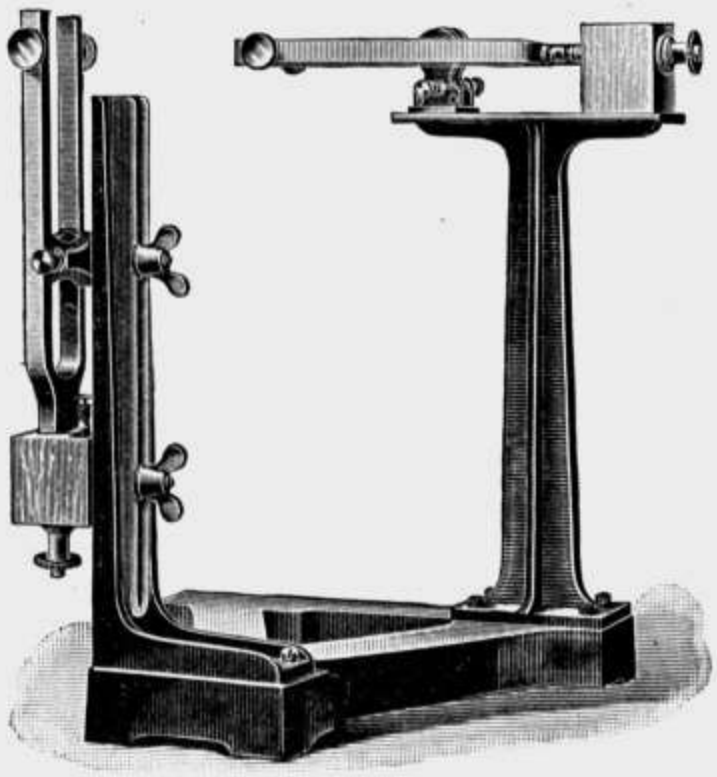
No. 3021-3024.

3021. **Tuning Fork,** No. 3012 C^1 Fork, mounted on a resonant case with hammer..... 3 35
3022. **Tuning Fork,** No. 3014 E Fork, mounted on resonant case with hammer 3 60
3023. **Tuning Fork,** No. 3016 G Fork, mounted on resonant case with hammer 3 50
3024. **Tuning Fork,** No. 3019 C^2 Fork, mounted on resonant case with hammer 3 10
3027. **Tuning Forks,** Made and tested by Dr. M. Th. Edelmann. A complete set of eight forks, giving the octave from $C^1$256 to $C^2$512, of recognized standard and of the greatest accuracy. Adapted for the highest scientific work. Each mounted upon a fine resonant case and carefully synchronized. Complete set with rubber hammer. Duty free 54 50
3028. **Tuning Fork.** Any fork of set No. 3027, separate.....Duty free 7 50



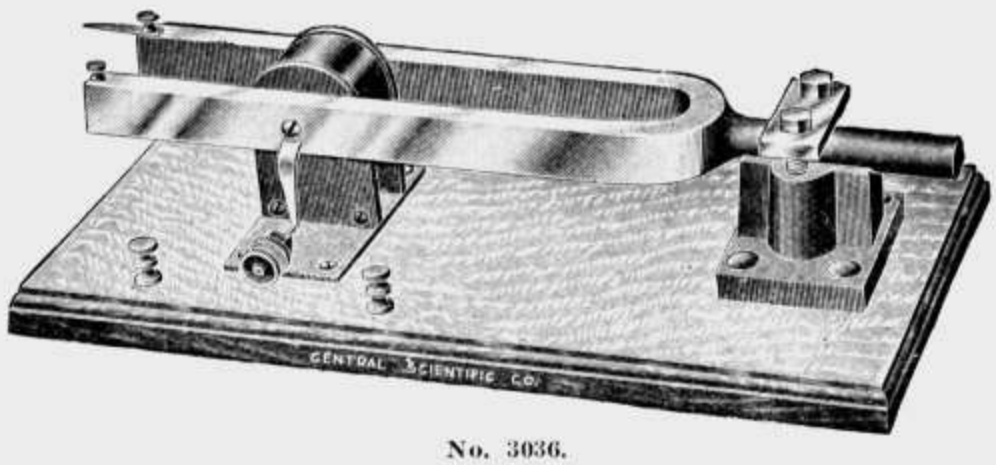
No. 3030.

3029. **Tuning Fork,** C 64 vibrations, extra heavy, 18 in. long. Duty free $ 4 25
3029A **Tuning Fork,** C 128 vibrations, extra heavy, 14 in. long. Duty free 3 75
3029B **Tuning Fork,** C^1 256 vibrations, extra heavy, 11 in. long. Duty free 3 25
3029C **Tuning Fork,** C^2 512 vibrations, extra heavy, 9 in. long. Duty free 2 75
3029D **Tuning Fork,** C^3 1024 vibrations, extra heavy, 7 in. long. Duty free 2 25
3029E **Tuning Fork,** C^4 2048 vibrations, extra heavy, 6 in. long. Duty free 2 00
3029F **Tuning Fork,** C^5 4096 vibrations, extra heavy, 5 in. long. Duty free 1 75
3030. **Sympathetic Forks.** A pair of extra heavy diapasons of polished steel, C^1 256 vibrations, tuned in unison so that either will respond to vibrations set up in one of the forks. Mounted on heavy resonant cases; also in perfect synchrony. Excellent for showing transmission of sound waves. Complete, with large rubber hammer.... 11 00
3031. **Sympathetic Forks.** An extra heavy pair of the finest made tuning forks especially forged for sympathetic work, mounted on resonant cases. Will audibly transmit sound waves a distance of 15 meters and at this distance will cause the pendulum listed below to vibrate sufficiently to strike the bell.....Duty free 13 50
3032. **Pendulum and Glass Bell,** mounted on stand, for use with Sympathetic Forks No. 3031.....Duty free 2 50
3033. **Rubber Hammer,** small, with flexible handle..... 11
3033A **Rubber Hammer,** large, for heavy forks, with flexible handle..... 16



No. 3035.

3035. **Apparatus for Lissajous' Figures.** Consists of two tuning forks, one horizontal and the other vertical, both carrying small mirrors. The forks are mounted as shown in the illustration and are maintained in vibration by means of electro-magnets. Complete with two calibrated forks of frequencies as 1:2 carrying mirrors.Duty free 60 00



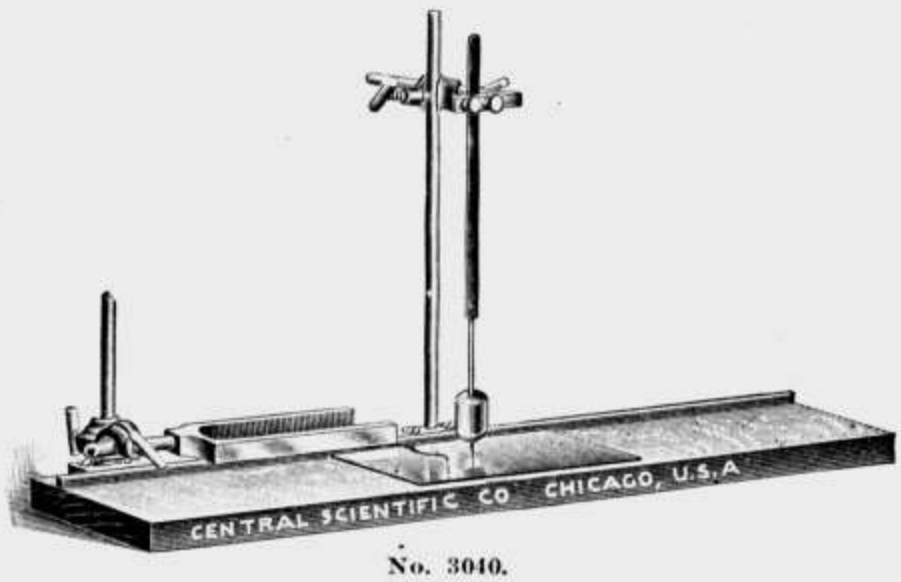
No. 3036.

3036. **Tuning Fork, electrically maintained.** The fork is adjustably mounted on a heavy, polished, hardwood base. Prongs measure ½x1 inch, are 12 inches long and nickle plated. Each prong is provided with binding screws for attaching cords, and a steel stylus is included. The prongs are also tapped on the end to receive mirrors.

This apparatus will be found invaluable for many experiments, especially for the projection of Lissajous curves, Melde's method of studying transverse waves in stretched strings and other phenomena due to sound vibration..... 15 00

3038. **Mirrors.** A pair of optically plane ½-inch mirrors mounted in a light brass spinning, threaded to fit No. 3036 Tuning Fork, for Lissajoys experiments.....Per pair 2 25

3039 **Acoustical Chart.** A reproduction of the piano keyboard, showing the relation between the Orchestra, Philharmonic, International and Physical Pitch 25

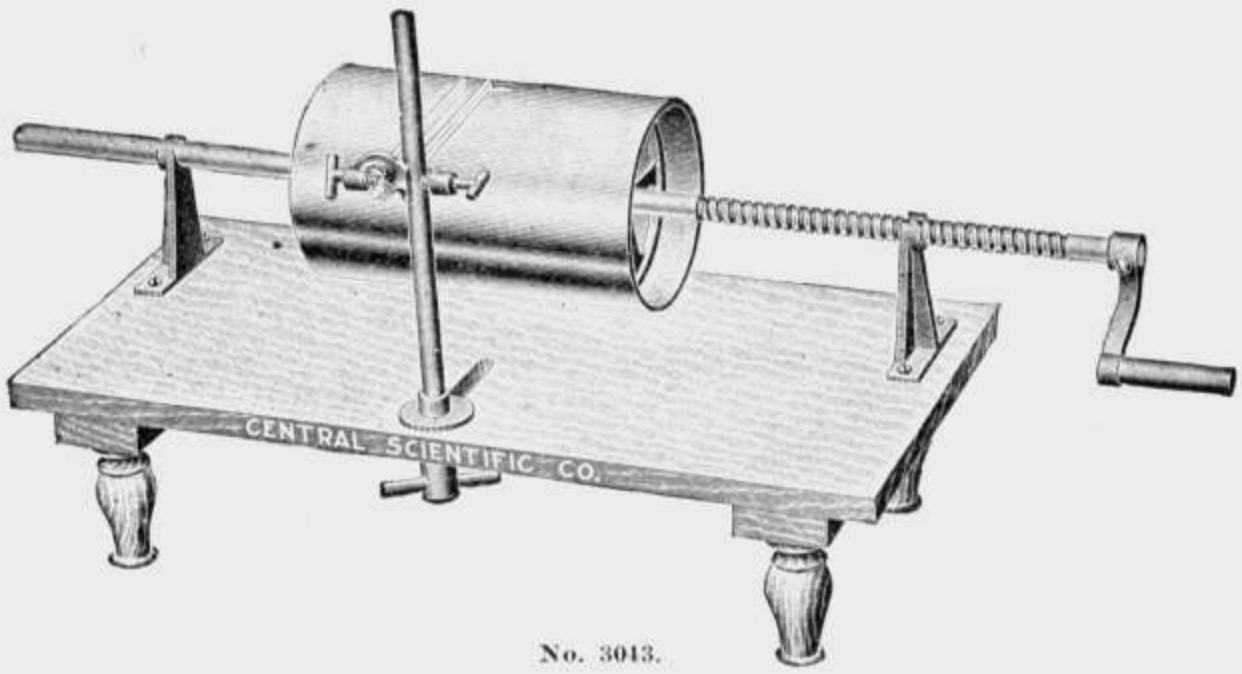


No. 3040.

3040. **Vibrograph,** for recording the vibrations of a tuning fork. Consists of a base and support, with an adjustable pendulum and needle, slide for smoked glass and glass plate, adjustable clamp for tuning fork, but without fork..... 4 00

3041. **Tuning Fork.** Especially designed for the Vibograph, of low pitch and large amplitude of vibration..... 1 65

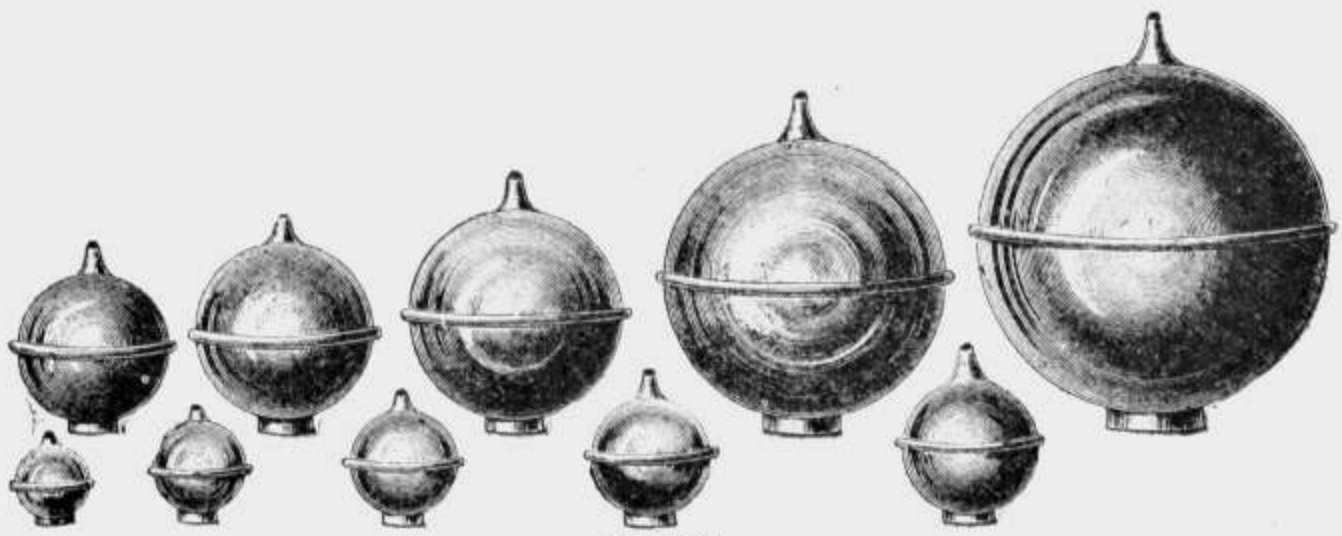
3042. **Extra Glass Plates** for use with No. 3040.....Each 11



No. 3043.

3043. **Recording Drum,** for recording vibrations of tuning forks. Consists of an accurately turned brass cylinder, 10x6 inches, mounted on a steel shaft, with a lateral movement of one centimeter for each revolution of the drum, the whole mounted on a japanned iron base..... $ 25 00

Time Marker, see page 63.



No. 3045.

3045. **Resonators,** after Helmholtz, spherical, for use with reed pipe. Guaranteed accurate in tone. Much superior to cheaper but larger sets heretofore offered. Consists of set of 10 resonators, commencing C128 .....Duty free 35 00



No. 3052.

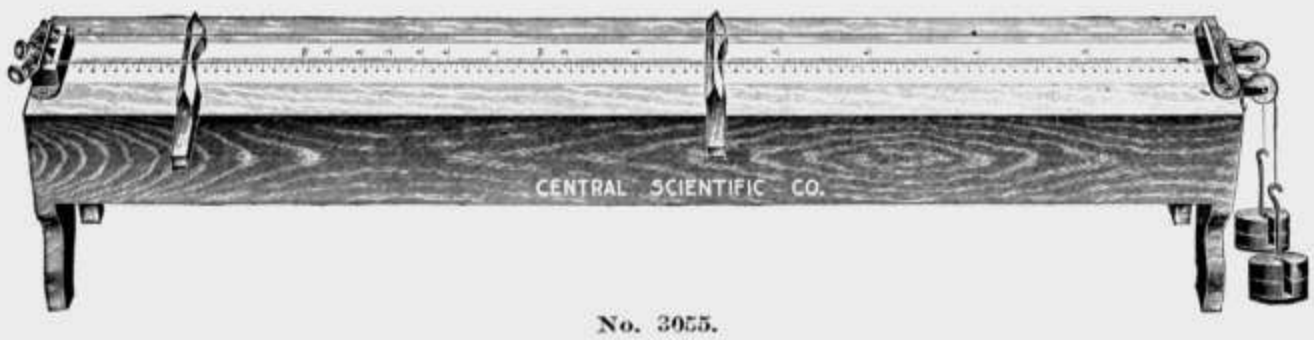
3051. **Sonometer,** for illustrating laws of vibrating strings. Consists of a resonant case with millimeter scale one meter long; one wire, tension key and bridge..... 4 00

3052. **Sonometer,** same as No. 3051, but fitted with two wires, tension keys and bridges 5 00

3053. **Sonometer,** same case as No. 3052, but fitted with pulleys and provided with stout canvas bags for holding weights..... 5 50

3054. **Sonometer,** same as No. 3053, but with two No. 3062 weight hangers for slotted weights, in place of canvas bags..... 6 00

Weights for Sonometers, see page 211.



No. 3055.

3055. **Sonometer,** the resonant case is made of the best kiln dried birch with a spruce sounding board and is mounted on legs. Two scales are supplied, a millimeter scale and diatonic and harmonic scales with two weight hangers for slotted weights and two 2-kilo weights, one 5-kilo weight and two bridges..... $ 15 00

3056. **Sonometer, Vertical Wall Form.** This sonometer is two meters long and fastened to the wall by means of two brackets. The deadening effect of the wall is prevented by means of rubber pads. The case is made of the best quality of seasoned wood, well finished. The bridges are in the form of clamps which may be fastened at any point of the scale. The tension of the wires is effected by means of weights attached to the lower end. This tension may be held by means of screw clamps.

The advantages of this instrument over the horizontal forms are:

First: Can be used for demonstration.

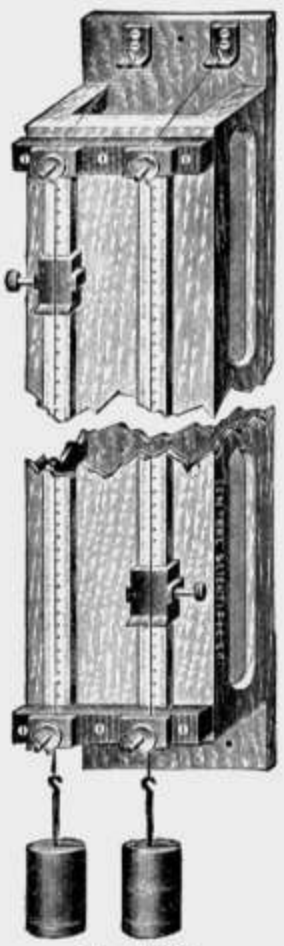
Second: The pull or tension is supplied direct, hence no loss through friction.

Third: The greater length allows a greater range..

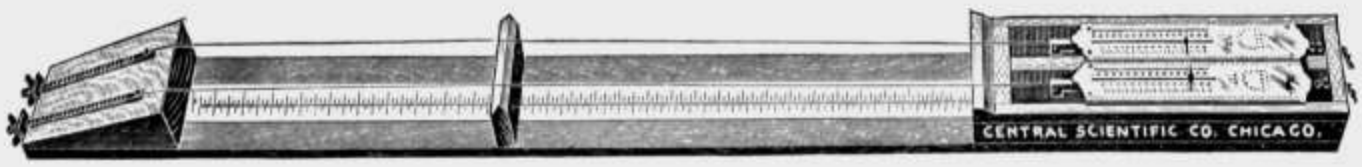
Fourth. Is out of the way at all times.

Complete with two wires, two bridges, but without weight hangers or weights 20 00

For **Hangers and Weigh'ts,** see page 211.



No. 3056.



No. 3057.

3057. **Sonometer,** consists of a heavy wooden frame supporting two No. 3873 spring balances by which the tension is measured. The balance is firmly clamped at one end and tension is secured on the wire by a screw device which displaces the old style of tension keys. Complete with three wires, bridges and metric and chromatic scales.. 7 50



No. 3062-3063.



No. 3065.



No. 3067.

3061. **Sonometer Wires.** A pair of the best music wire strings, diameters of .014 and .028, with loops ready to attach, per pair..... $ 22

3125 **Music Wire on Spools.**

Music gauge No.....	00	0	1	2	3	4	5	6	7	8
Nearest B. & S. No.....	32	31	30	29	28	28	27	26	25	24
Approximate feet on spool.....	15	15	14	12	12	12	10	10	8	8
Per spool	.07	.07	.06	.06	.06	.06	.06	.06	.06	.06

N. B.—For other Wire see page 350.

3062. **Weight Hanger,** for use with Sonometers, for carrying slotted weights. Made of iron with hook. Weight, one kilogram..... 70

3063. **Weights,** of iron, with slots for No. 3062 Weight Hangers.

Weight	500G	1K	2K	5K
Each	.50	.55	.75	1.50

3065. **Violin Bow,** for light work..... 80

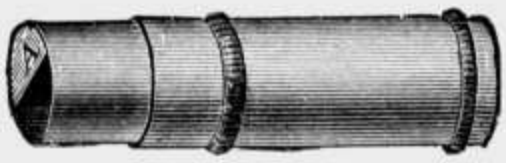
3066. **Violincello Bow,** for general work except the heaviest..... 1 10

3067. **Double Bass Bow,** for heaviest work..... 1 50

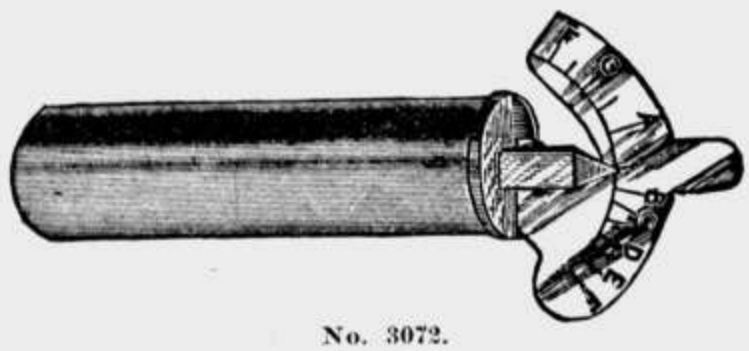


No. 3068.

3068. **Rosin, French,** best quality, for use on bows and rods..... 10



No. 3070.

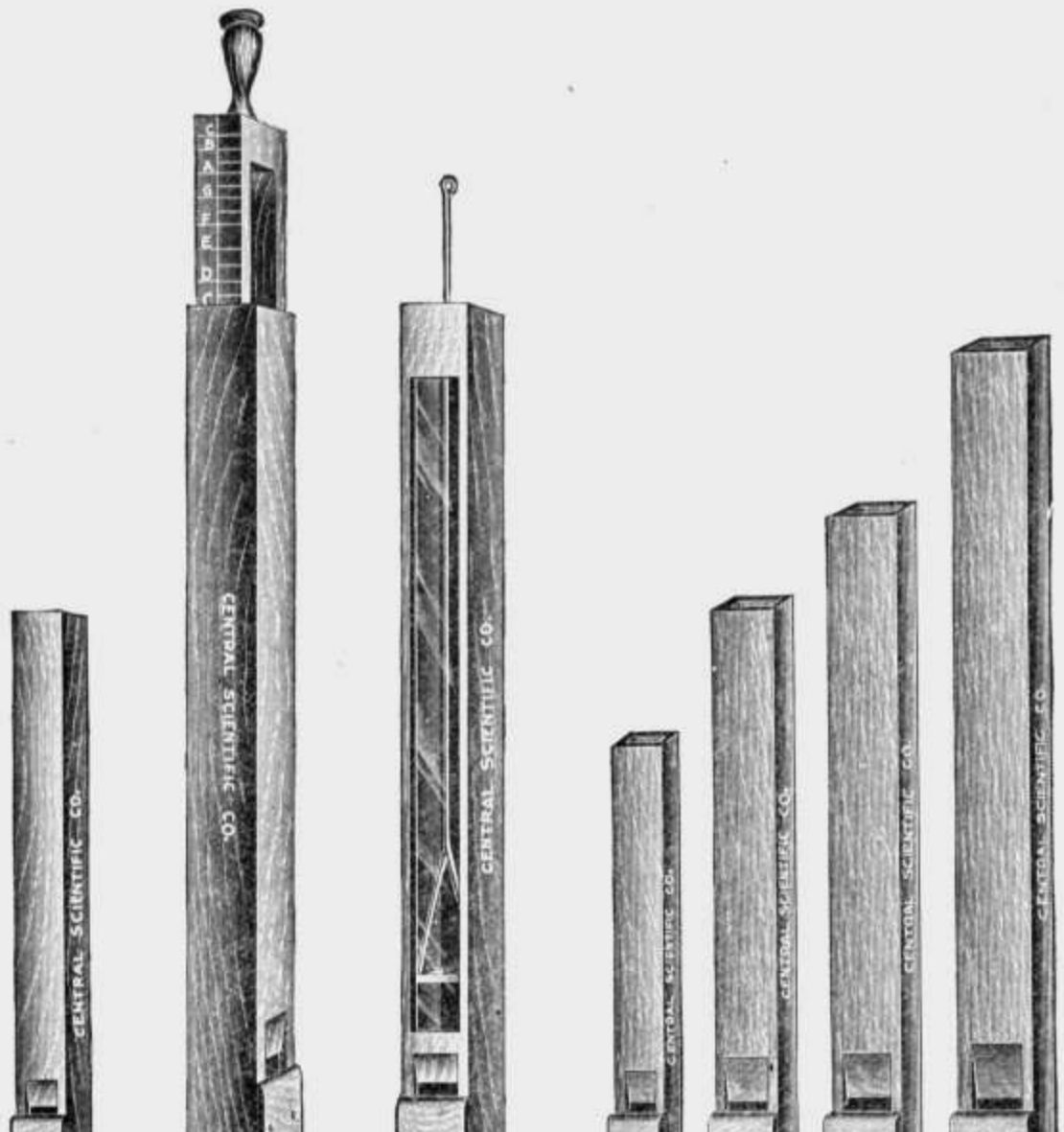


No. 3072.

3070. **Pitch Pipe,** key of A & C combined, in metal box..... 16

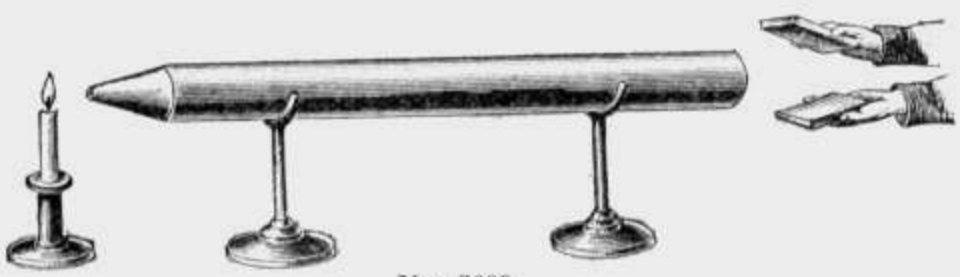
3071. **Pitch Pipe,** key of C & G combined, in metal box..... 16

3072. **Pitch Pipe, chromatic,** with sliding rod, giving octave..... 1 40



No. 3081. No. 3082. No. 3083. No. 3084.

3081. **Organ Pipe,** plain pipe of wood..... $ 1 65
3082. **Organ Pipe,** with sliding piston, sounding two octaves, with tones and semi-tones marked on the piston..... 4 50
3083. **Organ Pipe,** one set of glass, with membrane on sliding frame..... 4 20
3084. **Organ Pipes,** set of four open pipes, sounding chord C^1, E, G, and C^2 6 65
3085. **Organ Pipes,** set of eight open pipes, sounding the octave C^1 to C^2.... 13 35

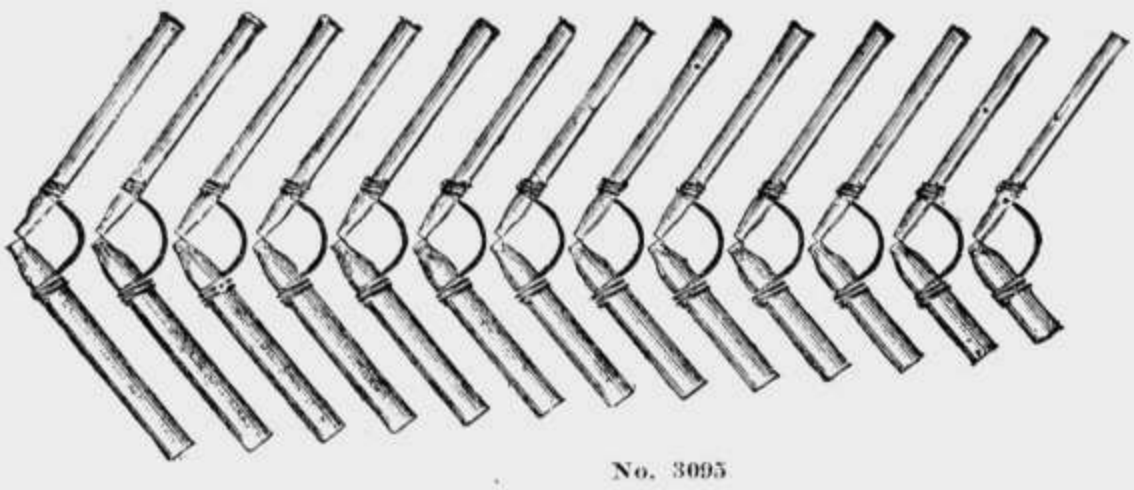


No. 3089.

3089. **Tin Tube,** with cone, for illustrating wave motion in air, 10 feet long, in 3 sections, without support.... 2 75
3091. **Sensitive Flame,** on stand to attach to gas burner.. 2 50
3093. **Singing Flame or Hydrogen Tones (Philosopher's Lamp).** Set of 3 glass tubes of varying lengths and diameters, complete with hydrogen jet of glass 1 00



No. 3091.

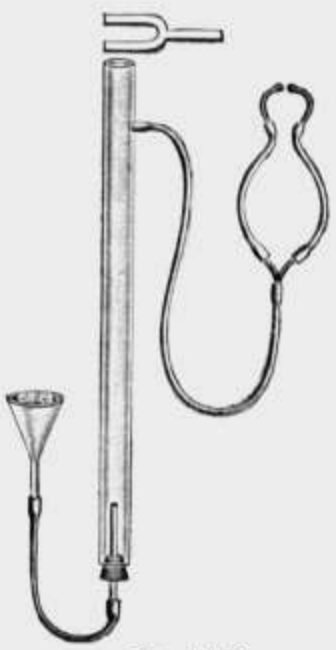


No. 3095



No. 3096.

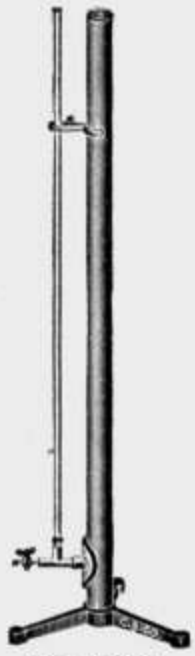
3095. **Acoustic Tubes,** after Prof. Quincke. Set of thirteen, illustrating the effects of different sizes and lengths of tube upon pitch. Also illustrates interference ..... $ 2 50
3096. **Whistle,** of glass, with sliding piston..... 1 00
3097. **Rose Burner and Tube,** for use with No. 3093. For either gas or hydrogen 1 45



No. 3098.

3098. **Resonance Tube,** after "Ames and Bliss," for determining the velocity of sound in air and the wave length of a tuning fork. Tube is 150 c. m. long by 4 c. m. diameter, furnished complete with rubber inlet tube, funnel and double ear piece.... 3 35
3099. **Resonance Tube,** simple form with support and piston. Tube 4 feet long 2 00
3099A. **Glass Tubes,** with annealed ends, for use in resonance experiments....

Size	3x120 c. m.	4x45 c. m.	4x110 c. m.
Each	.75	.85	1.50



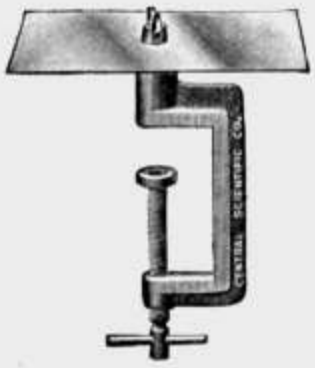
No. 3100.

3100. **Resonance Tube.** This design combines the features of existing forms with the addition of durability. It consists of an upright metal tube, 5 feet high, supported on a heavy tripod; at the lower end of this tube is an outlet or inlet tube, as may be desired. A glass tube connected to the inlet tube serves as an indicator of the height of water in the Resonant Tube. The inlet tube is provided with stop cock for regulating height of water..... 6 50
For Resonance Jars use Hydrometer Jars, page 87.
3101. **Rods,** for longitudinal vibrations. Consists of set of three; steel, pine and hardwood, each 100 c. m. long, 6 m. m. diameter. Per set.... 1 00
3102. **Ear Trumpet,** for demonstrating the concentration of sound waves 2 50

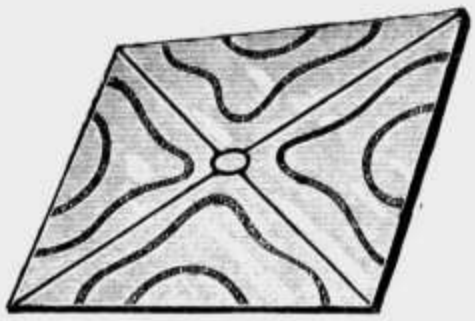


No. 3103.

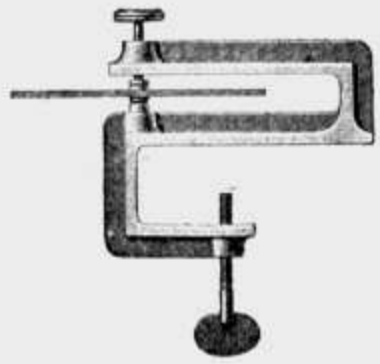
3103. **Kundt's Apparatus,** for determining velocity of longitudinal vibrations in brass. Consists of a resonant tube on support, with piston to vary length of vibrating column of air, brass rod and vise for the rod 3 75
3104. **Kundt's Apparatus,** for determining the velocity of longitudinal vibrations of a brass rod in gases. Designed with fittings to fill the resonance tube with any gas. Best workmanship, complete ready for use .....Duty free 11 00



No. 3105.



No. 3111.



No. 3107.

3105. **Chladni's Plate Apparatus,** for showing position of nodes and antinodes in a vibrating body. Fine white sand or lycopodium powder sprinkled over plate will arrange itself in peculiar figures, sand or powder massing itself at nodes when the plate is bowed. Apparatus consists of one each round and square plate 6 inches diameter, of brass, with table clamp..... $ 2 50

3106. **Clamp.** Clamp only of No. 3105, for use with metal Chladni's plates up to 10 inches in diameter. Clamp attaches to table..... 1 00

3107. **Clamp,** a substantial plate holder for glass or metal plates up to 12 inches in diameter. Can be securely clamped to the laboratory table 2 75

3109. **Chladni's Plates,** set of five glass plates of different diameters and shapes to be used with No. 3107 clamp..... 1 65

3112. **Chladni's Plate,** of brass, 10 inches in diameter..... 1 40

3114. **Chladni's Plate,** of brass, 10 inches square..... 1 40

3116. **Lycopodium Powder,** put up in 4-ounce cartons. This powder usually must be dried first before using to give best results. For use with Kundt's tubes and Chladni's plates. Per carton..... 45

3117. **Sand.** Best quality fine sand carefully sifted. For use on Chladni's plates. Per 8-ounce carton..... 27



No. 3120.

3120. **Trevelyan's Rocker,** consisting of a lead prism and grooved brass rocker, with rod and counterbalance. When the rocker is heated and placed upon the lead prism, as shown above, it will vibrate rapidly and produce a musical tone..... 2 10



No. 3126.

3126. **Xylophone,** twelve bars of steel, sounding one and one-half octave. Mounted and labeled. Complete with wooden hammer..... 2 50

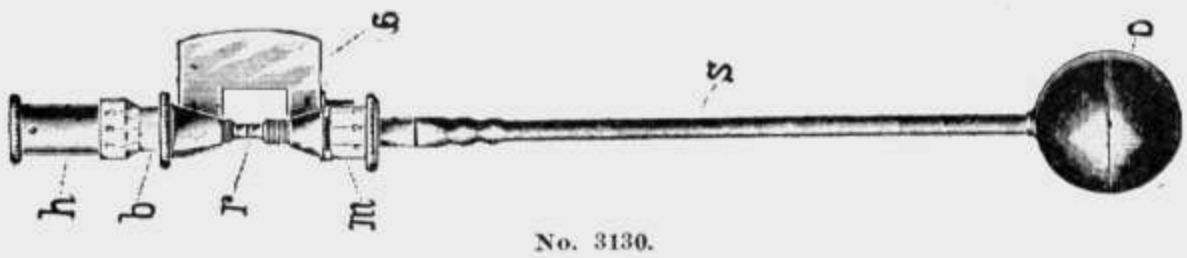
3127. **Xylophone,** eight pieces of wood, sounding the octave.. Wooden pieces rest on cords. Complete with wooden hammer..... 1 25

3128. **Gamut Bells.** These bells are twenty-five in number. Made of the finest tool steel and tuned true, giving two chromatic octaves, from and including A below middle C, to the first A above treble staff. The tones are pure, clear and mellow. Especially intended for teachers in demonstrating the exact sound belonging to each letter or note in the chromatic scale. A large number are in use in the Chicago schools..... 11 00



No. 3129.

3129. **Galton's Whistle,** for measurement of the highest audible note. The divisions indicating the length of the column of air vibrating in the whistle for the different positions in the piston in 1/10 m. m..... 8 90



No. 3130.

3130. **Galton's Whistle.** This whistle is an improved form by Dr. M. Th. Edelmann, having two adjustable lengths of column and large throat. Finely finished and accurate. In leather case with descriptive pamphlet .....Duty free 16 65

3131. **Attachment for Galton's Whistle** No. 3130, consisting of glass tubes of various lengths and diameters, with lycopodium powder. For sound experiments .....Duty free 3 35

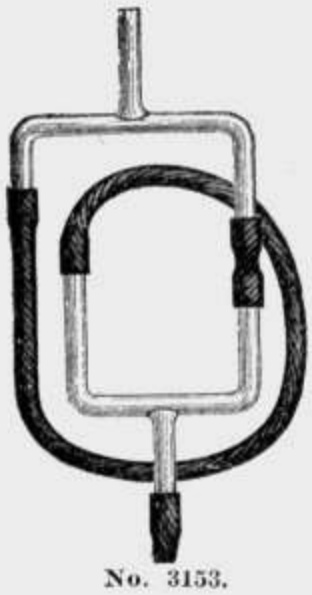


No. 3140.

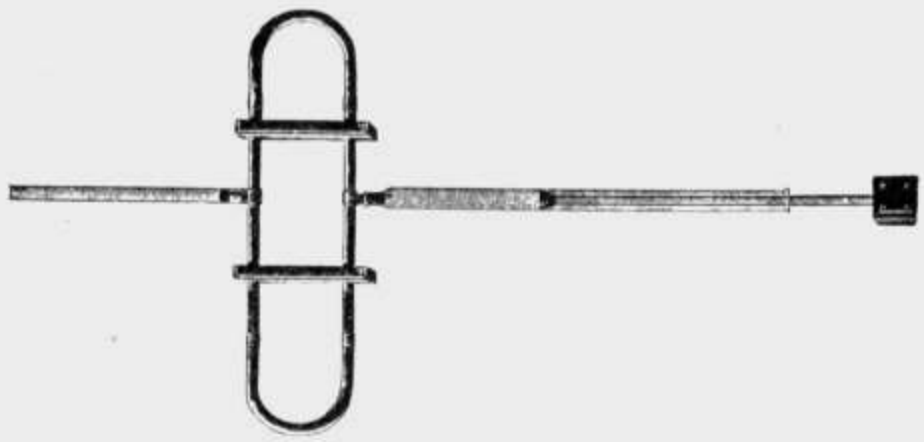
3139. **Siren, Cagniard-Latour's.** Simple form, without indicators, for the determination of the number of vibrations per second for any pitch. Consists of a wheel on a vertical spindle, which revolves over the head of the cylinder, both pierced with diagonal holes. The current of air causes the wheel to revolve, thus opening and closing the air exits, and produce a musical tone (vibration in the air) which rises as the revolutions increase. Made of brass and nicely finished. .....Duty free 9 00

3140. **Siren, Cagniard-Latour's,** same as No. 3139, but furnished with dials, by which the number of vibrations are determined.....Duty free 15 00

Siren Disc, page 76.



No. 3153.



No. 3154.

3153. **Interference Tube,** after Prof. Quincke. Of glass, with rubber connections for varying the length of the arms. If the lengths of the two arms are the same there will be no interference. If not, there will be discord. By manipulation a number of interesting phenomena may be shown..... $ 1 40

3154. **Interference Tube,** after Kundt. This instrument consists of two telescoping brass tubes, the adjusting tube being graduated in millimeters. By withdrawing the inner tube the length of the sound course on one side is varied, causing interference.

A glass tube is attached for giving visual demonstration of the locaton of the nodes and internodes. A resonator may also be attached for reinforcing the sound.....Duty free 15 00



No. 3155.



No. 3160.





No. 3165.

3155. **Oscillograph.** Will produce Lissajous' figures, the only accessory being a beam of direct sunlight. A mirror mounted on a sensitive diaphragm is made to vibrate by talking or singing. Any word, letter or note produces a definite figure..... 55

3160. **Sound Lens,** a rubber lens 15 inches in diameter. When inflated shows refraction of sound. Neatly mounted on iron stand..... 10 00

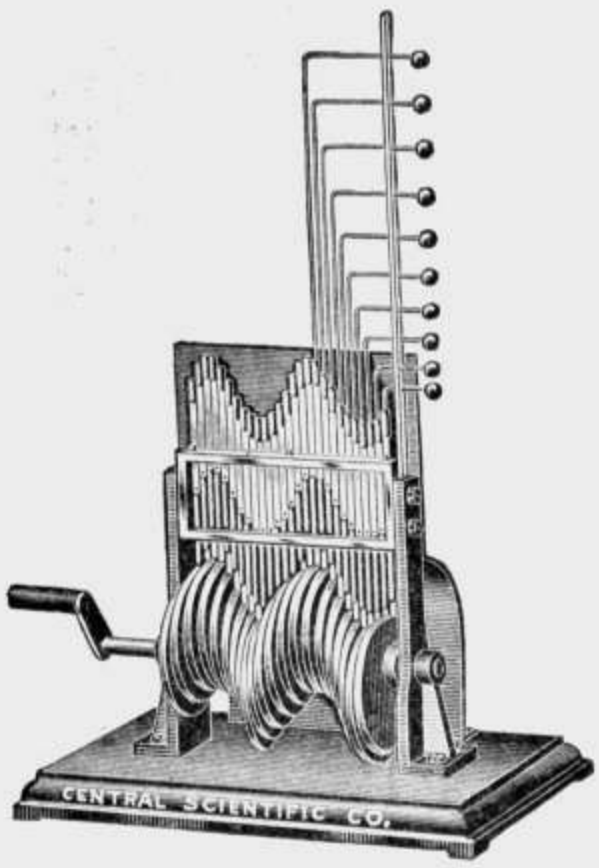
3165. **Manometric Flame Apparatus,** for the analysis of sound waves. Consists of No. 897 Cubical Mirror and No. 899 Vibrator. May be used with any Rotator..... 7 75



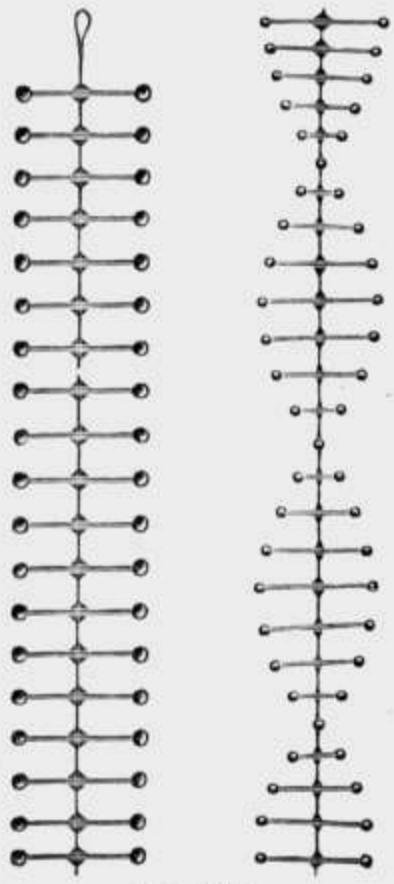
No. 3170.

3170. **Spiral of Brass Wire.** A helix of spring brass wire, three meters long, for illustrating progressive wave motion..... 2 00

3171. **Rubber Cord,** three meters long, for showing wave motion..... 80



No. 3175.

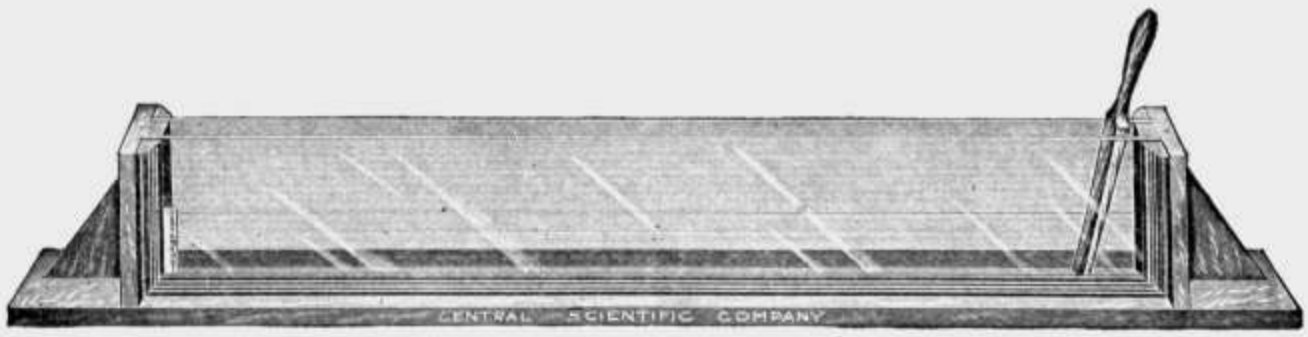


No. 3176.

3175. **Wave Apparatus.** This model is adapted for the study of transverse and longitudinal wave forms, made entirely of metal. Both forms of waves are shown in direct comparison, as both may be seen at the same time. Well adapted for use in lantern projection $ 20 00

3176. **Wave Apparatus** (Ames and Bliss). This model illustrates the propagation of both transverse and longitudinal waves. It consists of a steel wire 13 feet long, to which are attached at regular intervals metal rods carrying balls at each end. The steel wire is attached by a large screw eye to the ceiling and the transverse waves may be shown by giving the lowest cross bar a tortional movement, which is communicated to the entire length and in turn is reflected back to the upper support.

Longitudinal waves may be propagated by depressing in a vertical direction one end of the lowest cross bar. The motion thus originated is transmitted throughout the entire length..... 11 00



No. 3177.

3177. **Wave Trough,** as described in "Nichol's, Smith and Turton's Manual." Consists of a heavy rectangular oak case with plate glass sides 2½-inches by 10 inches by 5 feet long. Open at top with millimeter scale and black line on glass 10 c. m. from bottom. For demonstration of water waves, etc. Complete with paddle..... 12 50

3179. **Ripple Trough,** described in "Nichol's, Smith and Turton's Manual." Consists of a rectangular oak box 17x25x1¾ inches with a glass bottom and open at top. With No. 3177 and this Ripple Trough the teacher has all that is needed for a complete study of formation and propagation of forms, crests and troughs, and a thorough study of waves 5 00

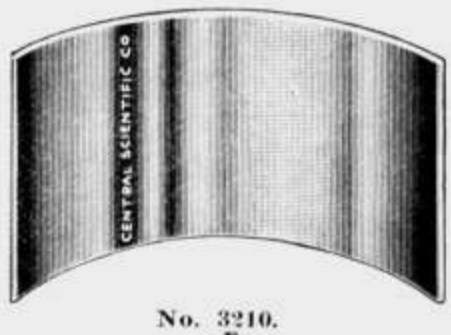
LIGHT.



No. 3204.



No. 3206.



No. 3210.



No. 3211.

3201. **Mirror,** best German glass, 4x15 c. m..... $ 11

3203. **Mirrors,** of thick plate glass, 10x15 c. m., for double image reflection, each 22

3204. **Fresnel's Mirror,** two black mirrors, 30x40 m. m., placed at an angle slightly less than 180 degrees, to demonstrate interference of light. Mirrors mounted on stand, one with micrometer screw adjustment. Mirror frame mounted on a 10 m. m. rod for use with optical benches, etc. .....Duty free 12 00

3205. **Mirror, Concave and Convex,** of heavily nickeled brass, 75 m. m. in diameter. Carefully made and true..... 50

3206. **Mirror, Concave and Convex,** of glass, 12 c. m. in diameter, mounted in one frame..... 2 25

3208. **Mirror, Convex,** of glass, 40 m. m. in diameter, 25 c. m. focus..... 85

3209. **Mirror, Concave,** of glass, 40 m. m. in diameter, 25 c. m. focus..... 85

3210. **Mirror, Cylindrical,** of heavily nickeled brass..... 50
See also **Mirrors** on page 228.

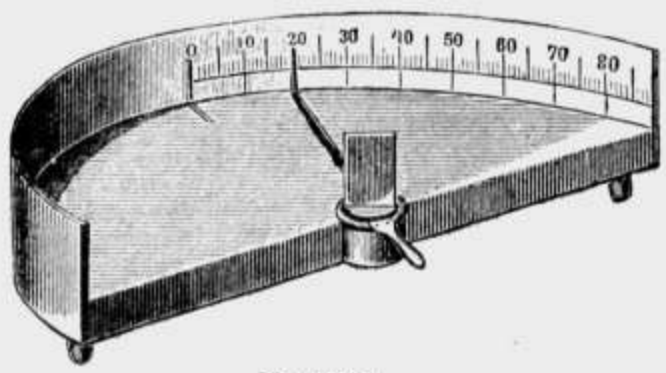
3211. **Multiple Image Apparatus.** Consists of two hinged mirrors on base, with graduated arc for illustrating multiple reflections..... 5 50

3212. **Multiple Image Apparatus,** according to Hall and Bergen. Consists of a board on which is a circle with holes set at equal distances in the circumference, two hinged mirrors and pegs to fit the holes.. 1 65

3213. **Kaleidoscope,** showing images formed of pieces of colored glass, metal case 55



No. 3215.



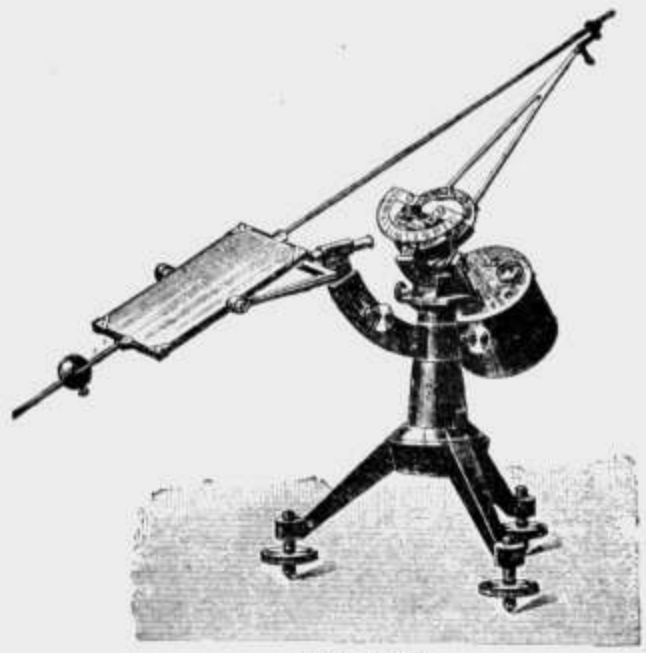
No. 3217.

3215. **Incidence and Reflection Apparatus,** new design. Simple method of proving law of reflection. Angle of incidence very easily read from graduated scale and proved equal to angle of reflection..... 2 25

3217. **Incidence and Reflection Apparatus,** a semi-circular brass case with graduations on one quarter and holes on the other quarter to correspond; with movable mirror and indicator..... 6 65



No. 3221.



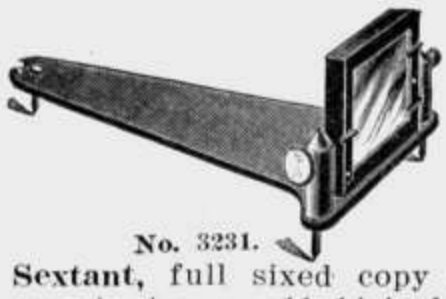
No. 3223.

3221. **Heliostat,** simple form, consisting of a clock movement mounted on a heavy base with mirror. A separate mirror mounted on adjustable stand is also included with each instrument. In ordering, state latitude of laboratory, so that the instrument may be adjusted before shipment.....Duty free $ 30 00

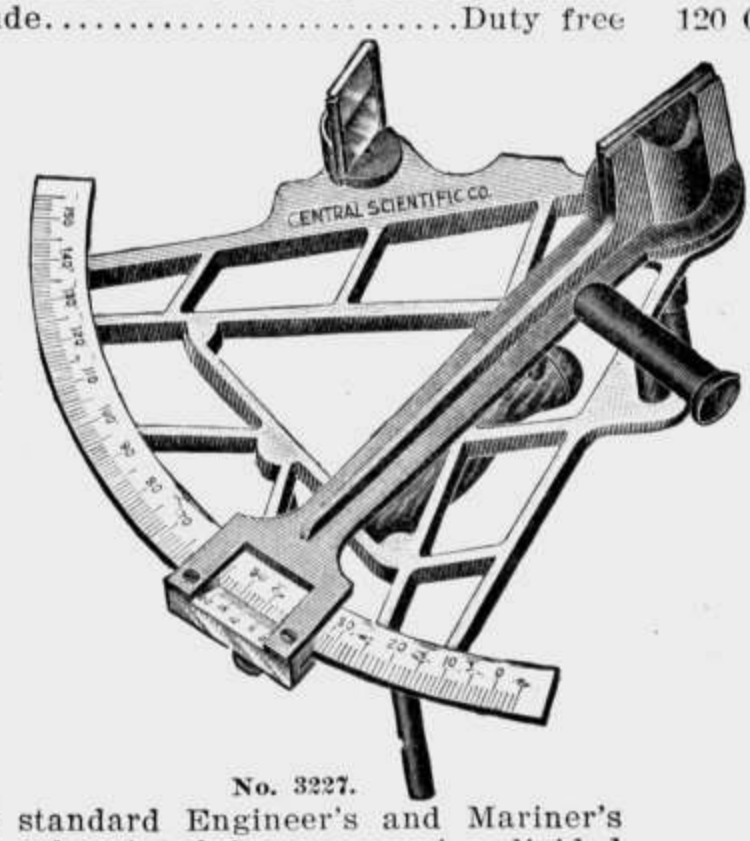
3223. **Heliostat,** optically plane mirror, 85x200 m. m., driven by a strong clock work with escapement and compensation balance, slit and diaphragm adjustment. The whole mounted on heavy base with leveling screws. A high grade instrument of the best workmanship, adjustable for any latitude.....Duty free 120 00



No. 3226.



No. 3231.



No. 3227.

3225. **Sextant,** full sixed copy of the standard Engineer's and Mariner's sextant, on a 11x14 inch cardboard, printed from an engine divided plate. The adjustment of the correct position of the mirrors and sight are easily made. Full directions for making parts, assembling and using the sextant are furnished. Cardboard print and vernier with directions. Per dozen..... 3 50

3226. **Sextant,** same as above, with addition of hardwood block for handle, mirrors, mirror holders and sight, complete, ready for assembling, as shown in the illustration, with directions..... 1 65

3227. **Sextant,** good quality, brass base with handle, mirror mountings and vernier arm, scale graduated on silver, with telescope, assembled ready for use. The main scale is divided to read to 20 minutes, and the vernier on the index arm to read to 30 seconds. Accurately made 16 50

3229. **Opthalmoscope, Lorings',** consists of 7 lenses, with tilted mirror, in morocco case 5 50

3231. **Optical Lever,** plane mirror, 25 m. m. square, length of lever 75 m. m. A very useful little instrument for any well equipped laboratory.. 4 00



No. 3236.



No. 3237.



No. 3238.

3236. **Prisms, Flint Glass,** wide face, square ends, equilateral.

Length, inches	3	4	6
Each	.25	.33	.50

3236½. **Prism, Flint Glass,** extra quality, 60 degree, optically true surfaces 1½x2 inches ..... $ 11 00

3237. **Prism, Flint Glass,** right angled, for total reflection, angles of 45 and 90 degrees.

Size, inches	1½x1	1½x2
Each	.40	.50

3238. **Prism, Flint Glass,** thin edge, with refracting angle of 20 degrees. Dimensions, 27x50 m. m..... 50

3239. **Prism, Crown Glass,** wide face, square ends, equilateral.

Size, inches	1x1½	1x2
Each	.55	.75



No. 3241.



No. 3243.

3241. **Prism,** 4 inches long, square ends, mounted on an adjustable frame. Prism can be rotated about either its horizontal or vertical axis, adjustable vertically 2 10

3242. **Prism,** 6 inch, square ends, mounted as No. 3241..... 2 50

3243. **Prism, Achromatic,** of crown and flint glass, accurately ground, with 40 m. m. faces. Mounted on adjustable elevating stand, arranged so that the two prisms may be used separately or together..... 12 00

3244. **Fresnel's Bi-Prism,** of extra quality quartz, which is much superior to glass.....Duty free 10 00

N. B. Cheaper Bi-Prisms of glass of domestic manufacture will be quoted upon application.

Spectral Prisms, page 238.

Eaton's Prism, something new, for use with lantern, see page 253.



No. 3245.



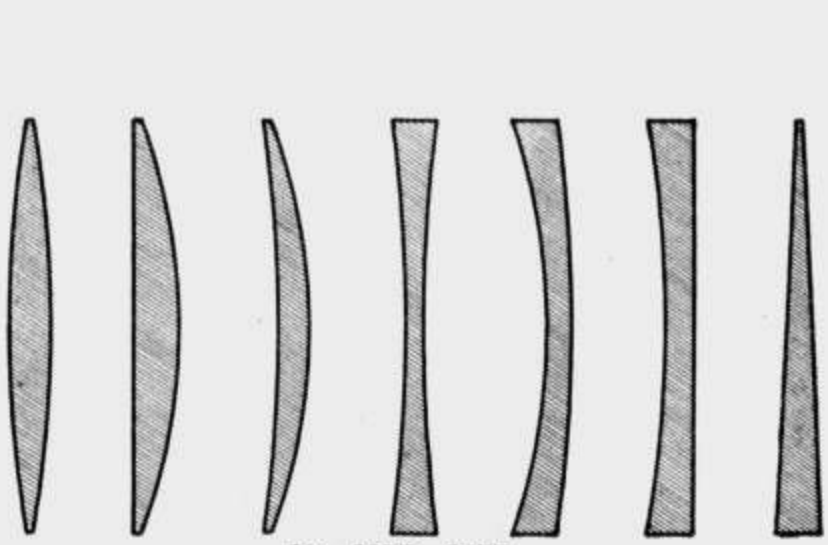
No. 3247.

3245. **Prism, Hollow,** for carbon bisulphide, made of one piece of glass, with ground glass stopper..... $ 2 00

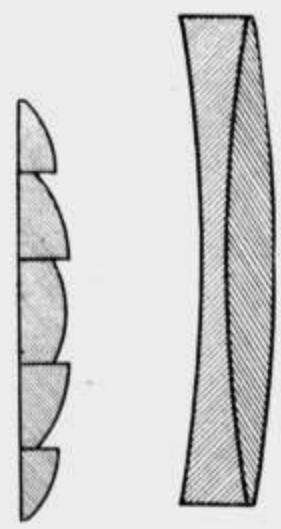
3247. **Prism, Hollow,** for carbon bisulphide, triangular, all glass, with two plane polished glass plates. Faces 60 m. m. wide by 90 m. m. high, best quality 6 65

3249. **Polyprism, or Multiplying Glass,** mounted in copper tube..... 40

Nicols' Prisms, page 240.



No. 3255—3257.



No. 3258. No. 3259-60.

3255. **Lenses, Demonstration Set,** consists of six lenses with ground edges, double convex, double concave, plano convex, plano concave, periscopic convex, periscopic concave, each 1½ inches in diameter, in box 1 25

3256. **Lenses, Demonstration Set,** set of six lenses as above listed, but two inches in diameter and of superior quality and construction, in wooden case 2 50

3257. **Lenses, Demonstration Set.** Ten lenses 1½ inches in diameter, consisting of cylindrical convex, cylindrical concave, sphero-cylindrical and sphero-prismatic, in addition to the six lenses of set No. 3255, complete in box..... 3 35

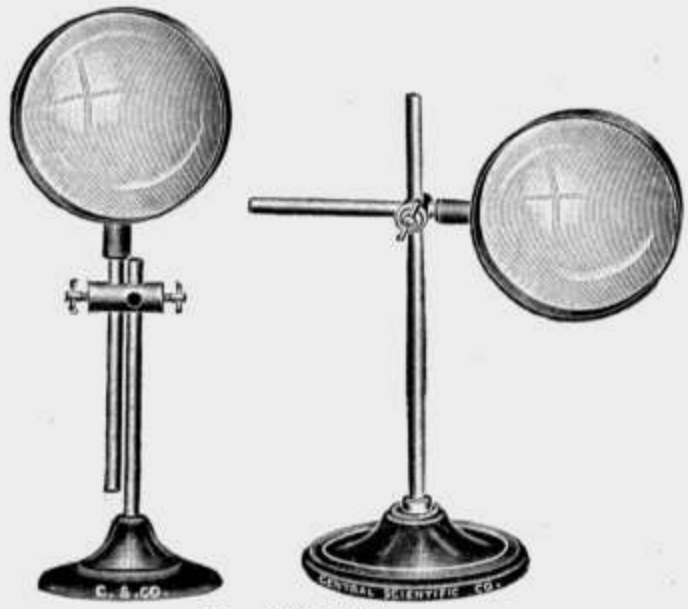
3258. **Fresnel's Lens,** a highly polished glass casting, 3 inches in diameter. Shows construction of lenses used in lighthouses, semaphores, etc., and the advantages of the use of same..... 55

3259. **Achromatic Lens, demonstration form.** A concave and convex lens, ground to fit each other, 1½ inches in diameter..... 75

3260. **Achromatic Lens.** A high grade lens, consisting of a diverging concavo-convex flint glass lens and a double convex crown glass lens, perfectly fitted and accurately ground. Diameter 2 inches, focus 8 inches 9 00



No. 3261-3263.



No. 3265-3267.

3261. **Lens, Condensing,** plano-convex, 4 inch diameter, 6½ inch focus.... $ 1 35

3760. **Lens, Condensing,** plano-convex, 4½ inch diameter, 6½ inch focus.... 1 75

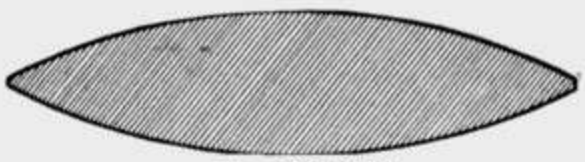
3761. **Lens, Condensing,** plano-convex, 4½ inch diameter, 7½ inch focus.... 1 35

3762. **Lens, Condensing,** plano-convex, 4½ inch diameter, 10 inch focus.... 1 35

3263. **Lens, Condensing,** plano-convex, 5 inch diameter, 8 inch focus..... 2 00

3265. **Lens, Condensing,** plano-convex, No. 3263, mounted on adjustable stand of new and improved design. Lens and mounting can be raised or lowered to any desired height or inclined to any angle..... 5 50

3267. **Lens, Double Convex,** No. 3274, mounted on adjustable stand, in design same as No. 3265..... 6 00



No. 3268-3274.



No. 3276-3278.

LENSES, DOUBLE CONVEX, ground edges, first quality.

Cat. No.	3268	3269	3270	3271	3272	3273	3274
Diameter, inches	1½	1½	2	2½	3	4	5
Focus, inches	4	6	5	6	7	10	14
Each	.45	.45	.55	.70	1.00	1.50	2.50

3276. **Lens, Double Concave,** ground edges, first quality. Diameter 1½ inches, focus 6 inches..... 45

3278. **Lens, Double Concave,** same as No. 3276, 2 inch diameter, focus 8 inch. 65

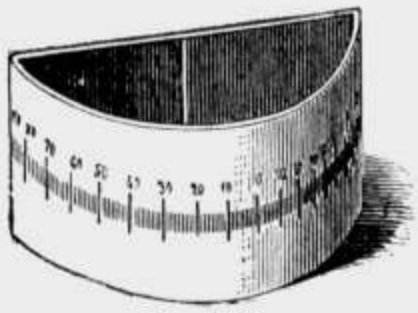
3279. **Lens, Double Concave,** rough edges, diameter 1½ inch, focus 6 inch... 25

3280. **Lens, Double Convex,** rough edges, suitable for student use. Diameter 4 c. m., focus 10 c. m..... 17

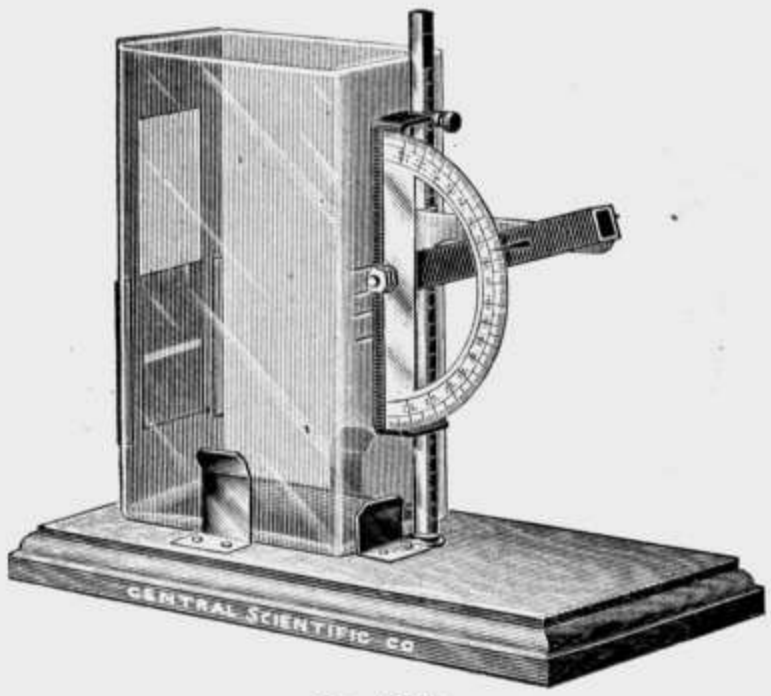
3281. **Lens, Double Convex,** same quality as No. 3280. Diameter 4 c. m., focus 15 c. m..... 09

Reading Glasses and Magnifiers, see Catalogue "N."

Optical Disc for demonstrating all laws of lenses, page 224.



No. 3299.



No. 3300.

3297. **Refraction Bottle,** with adjustable slit..... $ 1 10

3299. **Refraction Tank.** Semi-circular glass tank, made of one piece of glass, convex surface graduated into degrees; plane surface blackened with slit for admission of a ray of light..... 8 00

3300. **Universal Index of Refraction Apparatus.** An instrument that can be easily and intelligently manipulated by secondary students so as to give accurate and conclusive results. It is correct from a scientific standpoint and allows great latitude in manipulation. It is simple to operate and from the measurements obtained easy to deduce the required results. Any colorless liquid, alkali, acid or water, may be used without injury to the instrument, as none of the metal parts come in contact with the liquid.

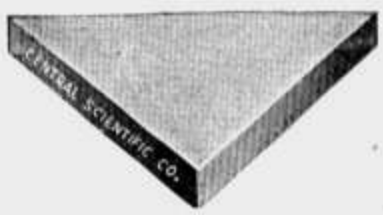
A sight tube with an index is used to denote the direction of line of sight. Angles of incidence and refraction are read directly from the graduated arc and their sines may be obtained from any table of trigonometric functions and the Index of Refraction readily computed.

A simpler method would be to construct the sines of the angles in the ordinary way and from their lengths compute the Index of Refraction. The lengths of the sines may, however, be read directly by means of the graduated upright.

Complete directions and modes of operation are included with each instrument 4 50



No. 3302-3303.



No. 3306.

3301. **Index of Refraction** (after Dr. Hall). Heavy glass plate 7 c. m. by 7 c. m. Edges ground, two opposite edges also polished. Simple yet effective plate for Index of Refraction of glass..... 28

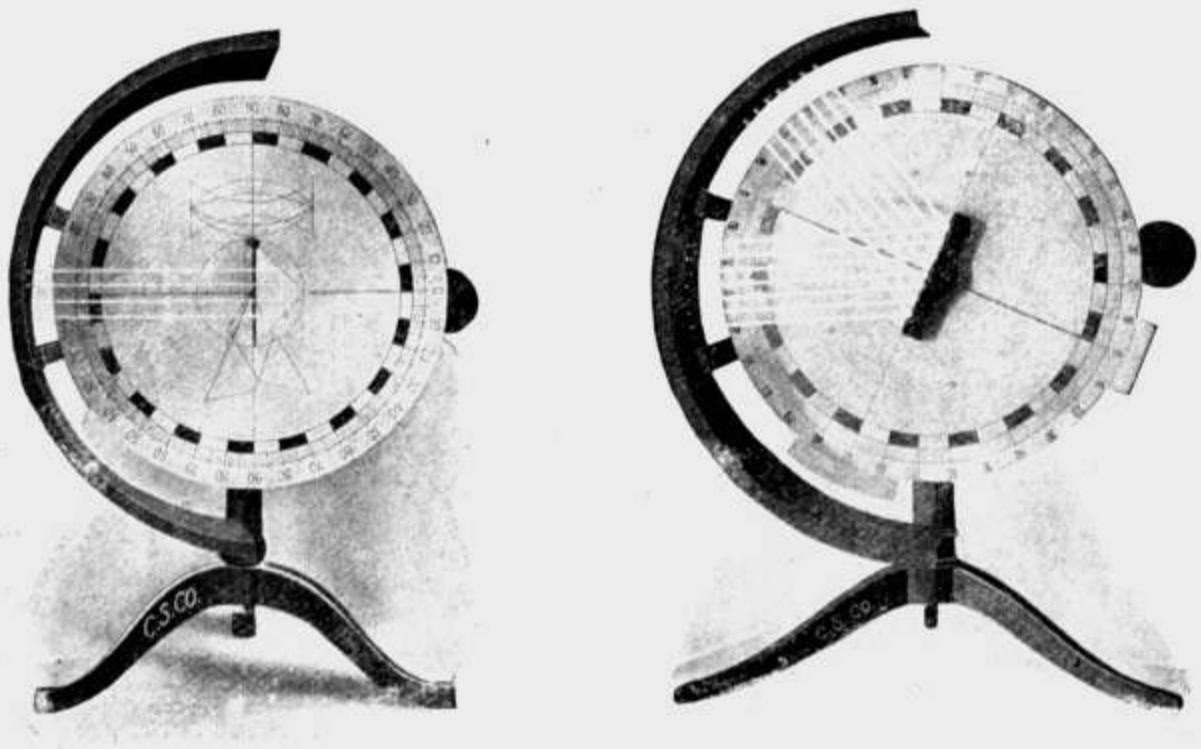
3302. **Glass Cube,** for Index of Refraction Experiments, 30 m. m. edge..... 40

3303. **Glass Cube,** for Index of Refraction Experiments, 50 m. m. edge..... 80

3306. **Equilateral Prism** (Millikan and Gale, Exp. 43), 75 millimeter face, 9 millimeters thick, for determining the Index of Refraction of glass 1 10

3310. **Index of Refraction of Water Board,** new design of the Gilley Board. 60

Iceland Spar, page 240.



No. 3320.

HARTL OPTICAL DISC.

AS DESIGNED BY PROF. HANS HARTL, REICHENBERG, AUSTRIA.

Manufactured and sold exclusively by us. The several accessories as designed by Prof. Hartl can be used only with the "Hartl Optical Disc."

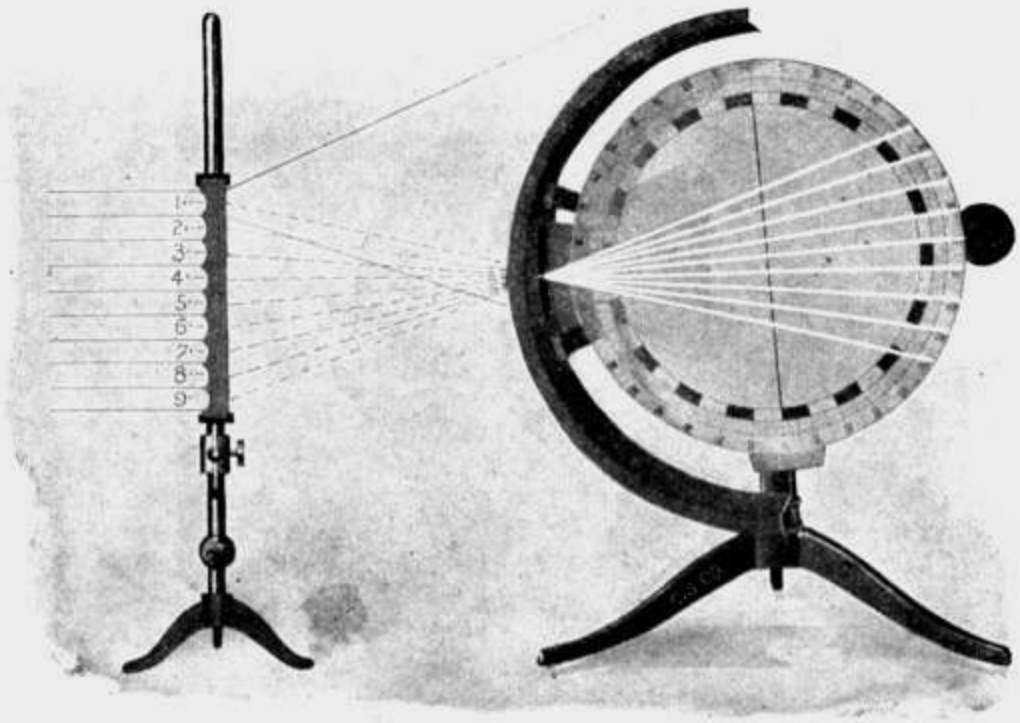
This apparatus is designed to illustrate in a simple and perfect way the fundamental laws of optics. The sunlight is utilized either directly as it falls into the room through a partly shaded window or reflected by means of a simple mirror. It is not necessary or desirable to use a darkened room. The paths of the light rays upon the graduated disc, the lenses and mirrors, can be seen at once by the entire class. **The Hartl design permits the use of the optical disc in either vertical or horizontal position.** A great variety of optical experiments may be performed with this apparatus, two of which are illustrated above. These experiments with a single or several parallel rays include the following:

Total reflection.
Angle of reflection.
Angle of refraction.
Refraction through lenses.
Caustic of lenses.
Newtonian Telescope.
Critical angle.
Refraction through a prism.
Refraction through a parallel plate.
Perre's prism system.
Stereo binocular.
Principle rays.
Dispersion showing spectrum.
Critical angle shown by different colored lights.
Principle focus of lenses.
Theory of the rainbow, formation of primary and secondary bow.
Measurement of the angle of a prism, etc., etc.

A complete pamphlet is furnished with each set, describing and illustrating all of these experiments and many others.

3320. **Hartl Optical Disc** complete, with—

1 set of four concave and convex lenses.
2 prisms, 3 mirrors (plane, concave and convex).
2 slotted plates with sliders for using a single or several rays.
1 set of colored screens.....Net $ 17 50

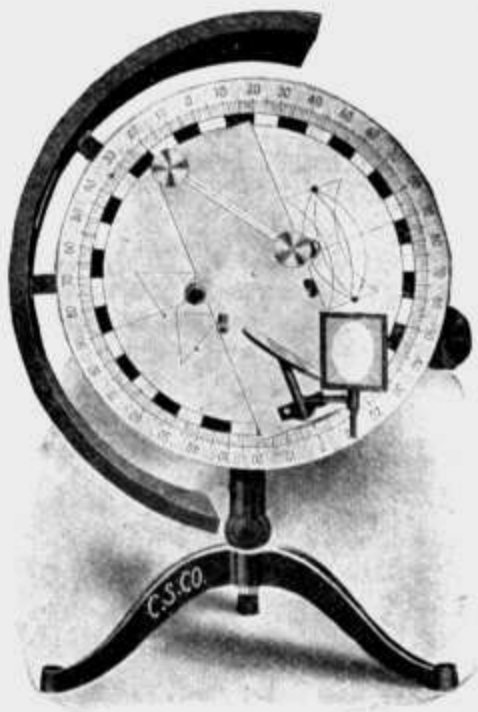


No. 3322 (In connection with Hartl Optical Disc).

3322. **Diverging Ray Attachment,** for the Hartl Optical Disc. A corrugated glass plate forming a series of parallel cylindrical lenses to illustrate the action of lenses and mirrors upon diverging rays. It is mounted on an adjustable stand with counterpoise. Short focus lens with metal screen included..... $ 5 50



No. 3324 (Attached to Disc).



No. 3328 (Attached to Disc).

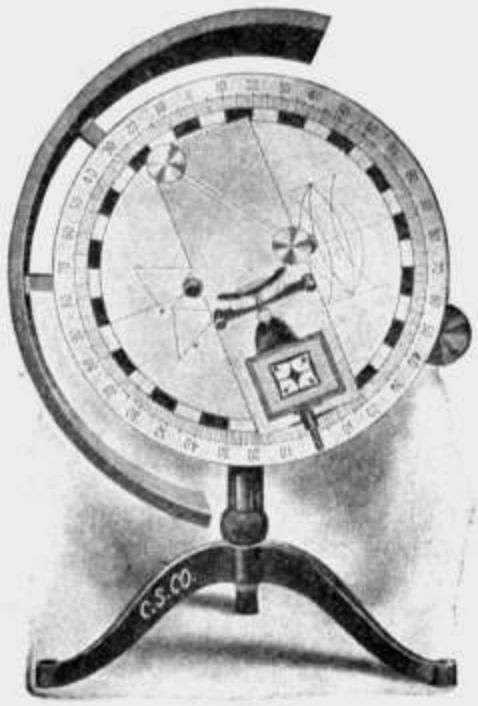
3324. **Refraction Tank,** for determining the Index of Refraction of any transparent liquid. To be attached to the face of the disc, with clamp for holding plane mirror to edge of disc for reflecting ray of light into the tank 4 50

3326. **Diffraction Attachment.** Consists of a Wallace Replica of Rowland Grating (Grade D), suitably mounted for attaching to face of disc.... 4 00

3328. **Polarized Light Attachment.** Prof. Hartl has arranged this attachment to show to a class the phenomena of polarized light with as great ease and simplicity as the ordinary phenomena of optics. Easily attached to Optical Disc..... 8 35

3330. **Condensing Lens and Slide Carrier,** with one specimen of Potassium Nitrate (optically biaxial) and one specimen of Sodium Nitrate (optically uniaxial). To be used with No. 3328..... 5 00

Preparations to be used with **Polarized Light Attachment,** page 226.



No. 3328.

(Attached to face of Hartl Optical Disc) showing No. 3336 on stage.

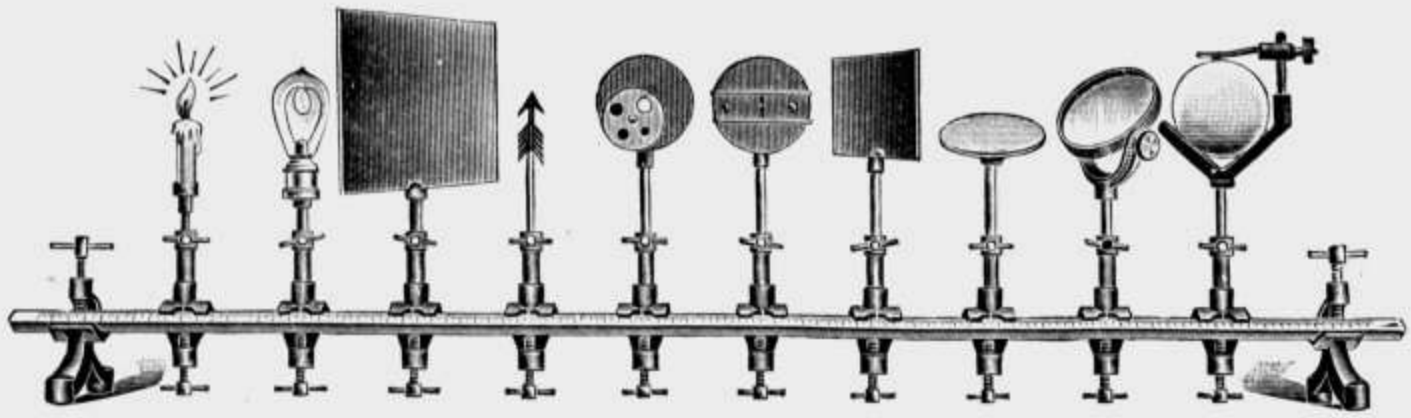
Polariscope Preparations for Use With No. 3328.

3331.	**Gypsum Figure,** plain, 4 strips, 4 colors	$ 2 20
3331A.	**Gypsum Figure,** cube in 3 colors	2 75
3331B.	**Gypsum Figure,** octahedron in 4 colors	3 50
3331C.	**Gypsum Figure,** star in 6 colors	5 00
3332.	**Holder,** for compressing No. 3333 annealed glass blocks to show same effect as the unannealed plate	2 00
3333.	**Annealed Glass,** rectangular block to fit No. 3332 Holder	1 40
3335.	**Selenite Films (Gypsum),** after Mueller. Set of eight different colors	6 50
3336.	**Unannealed Glass Plate,** square	1 65
3337.	**Unannealed Glass Plate,** rectangular	1 65
3338.	**Unannealed Glass Plate,** round	1 65
3339.	**Unannealed Glass Plate,** triangular	1 65
3341.	**Mica Plate,** square, large, quarter undulations	2 50
3342.	**Mica Plate,** round, medium, quarter undulations	1 65
3343.	**Mica Plate,** round, small, quarter undulations	1 00
3344.	**Mica Plate,** round, small, half undulations	1 00



No. 3350.

3350.	**Elementary Optical Bench.** A simple, effective working bench for elementary work. Complete with No. 319 Meter Stick and Nos. 3351 to 3355, as listed below	80
3351.	**Support Blocks,** for meter stick, per pair	14
3352.	**Lens Support,** of brass; will hold 4 c. m. lenses	17
3353.	**Screen Support,** of brass, for meter stick	10
3354.	**Screen,** of best bristol board, 8 c. m. square	05
3355.	**Pin Support,** of brass, for meter stick	10
3356.	**Lens or Mirror Support,** similar to No. 3352, for objects 75 m. m. diameter; will hold No. 3205 Mirror or No. 3272 Lens	22
319.	**Meter Stick,** of maple, one side graduated in m. m., other in ⅛ inch	30



ACCESSORIES FOR BUILDING PHOTOMETER AND OPTICAL BENCHES.

It has been our intention in cataloging the following accessories to give the teacher as much latitude in selection as possible. Very excellent Laboratory Optical Benches or Photometers may be made up from these accessories. As a suggestive Photometer we list one on page 229 that has been in actual use in many schools and has given perfect satisfaction.

25. **Rod,** not graduated, 19 m. m. square; 1 meter, $2.35; 2 meters..... $ 4 35
25A. **Graduated Rod,** 19 m. m. square and graduated in millimeters; 1 meter, $6.65; 2 meters..... 10 00
26. **End Supports,** with extra long "V," accurately milled, for holding graduated rods, forming a solid bed, each..... 50
26A. **End Support,** similar to above, but to hold two 19 m. m. square rods 75 m. m. apart and 150 m. m. above the table. One support is provided with leveling screw. Per pair..... 2 10
31. **Clamp,** double, for use on double rod bed. Hole is 10 m. m. diameter. (See illustration, page 3)..... 4 50
36A. **Clamp,** with zero line, designed to hold No. 3363 Universal Holder, "V" opening 19 m. m., hole 13 m. m..... 1 00
36B. **Clamp,** designed to hold No. 3366 Eye Shades, "V" opening 19 m. m., hole 6 m. m..... 60
44A. **Clamp,** with zero line, designed to hold all accessories, except as specified under No. 36A, 36B and 44B Clamps. "V" opening 19 m. m., hole 10 m. m..... 1 00
44B. **Clamp,** with zero line, same as No. 44A, with addition of spring, which permits adjustment along the rod without unlocking the set screw. Designed to carry the comparison screens, Nos. 3400-3404.. 1 75
3359. **Rotator,** for rotating unknown (incandescent lamp) to obtain mean horizontal candle power..... 6 60
50. **Lens Holder,** for lenses 25 to 50 m. m. diameter, mounted on rod to fit No. 44A Clamp..... 1 00
51. **Lens Holder,** for lenses 50 to 100 m. m. diameter, mounted on rod to fit No. 44A Clamp..... 1 35
66C. **Table Top,** of three ply wood, 15 c. m. diameter, mounted on rod to fit No. 44A Clamp..... 1 25
3360. **Candle Holder,** for one candle, mounted on rod to fit No. 44A Clamp.. 75
3361. **Candle Holder,** for four candles, mounted on rod to fit No. 44A Clamp 1 25
3362. **Lamp Socket,** for holding incandescent lamps, mounted on rod to fit No. 44A Clamp..... 1 25
3363. **Universal Holder,** for holding the "unknown" lamp, with graduated disc, adjustable arm and lamp socket, to fit No. 36A Clamp..... 7 50
3364. **Image,** arrow shaped, mounted on rod to fit No. 44A Clamp..... 75
3365. **Scale,** cardboard, 5 c. m. long, in m. m. divisions, mounted on rod to fit No. 44A Clamp..... 75
3366. **Eye Shades,** pair of black cloth shades, mounted to fit No. 36B Clamp, per pair 1 50
3367. **Screen,** 10 c. m. square, finished dead black, mounted on rod to fit No. 44A Clamp..... 1 00
3368. **Screen,** opalescent, 20 c. m. square, ground glass plate in frame, mounted on rod to fit No. 44A Clamp..... 2 25
3369. **Screen,** with adjustable, vertical slit, mounted on rod to fit No. 44A Clamp 3 35
3370. **Screen,** with apertures of different size, mounted on rod to fit No. 44A Clamp 3 35
3371. **Screen Holder,** for holding cardboard, sheet gauze, etc., mounted on rod to fit No. 44A Clamp..... 50

48. **Mirror,** plane, 35 m. m. diameter, adjustable about a vertical and horizontal axis, mounted on rod 15 c. m. long by 10 m. m. diameter, to fit No. 44A Clamp..... $ 2 40

3372. **Mirror,** plane, same as No. 48, but not mounted, to be used with No. 50 Lens holder 75

3373. **Mirror,** convex, 40 m. m. diameter, 250 m. m. focus, mounted same as No. 48, on rod to fit No. 44A Clamp..... 3 00

3208. **Mirror,** convex, same as No. 3373, but not mounted, to be used with No. 50 Lens holder 85

3374. **Mirror,** concave, 40 m. m. diameter, 250 m. m. focus, mounted same as No. 48, on rod to fit No. 44A Clamp..... 3 00

3209. **Mirror,** concave, same as No. 3374, but not mounted, to be used with No. 50 Lens holder 85

3375. **Mirror,** concave and convex, in one frame, diameter 90 m. m., focus convex, 9 c. m., concave, 35 c. m., mounted on rod to fit 44A Clamp. 2 50

3377. **Prism,** flint glass, 4 inches long, mounted on rod to fit 44A Clamp. 1 50

3378. **Prism,** Nicol's, 8 m. m. face, for polarization, mounted on rod to fit No. 44A Clamp..... 7 50

Larger sizes of Nicol's Prisms listed on page 240. Mounted to order.

Prisms, carbon bisulphide, to be carried on No. 66C, Table Top. See page 221.

Prism, achromatic, see page 220.

Prism, Fresnel's, see page 220.

Lenses, unmounted, to be carried on No. 50 and 51 lens holders. See page 222.

3380. **Candle,** paraffine, twelve to the pound.....Per dozen 22

3381. **Candle,** paraffine, six to the pound.....Per dozen 33

3382. **Candle Standard,** sperm, six to the pound, will burn 120 grains (7.776 grams) of wax per hour. Imported. Each..... 33

3383. **Candle,** Christmas wax, twenty-four in box.....per box 20

3385. **Kerosene Lamp,** small, of brass, with wick and chimney, to be used with No. 66C Table Top..... 30

3386. **Asbestos Shade,** with pin hole, for use with No. 3385 Clamp..... 10

3387. **Kerosene Lamp,** with adjustable screen in front of flame, as used for secondary standard. To be carred on No. 66C Table Top..... 5 00

3389. **Gas Burner,** with 4, 6 or 9-foot tips, mounted on rod to fit No. 44A Clamp 75

3390. **Welsbach Gas Burner,** complete, mounted on rod to fit No. 44A Clamp 2 00

3391. **Pentane Lamp,** Harcourt's 10-candlepower, generally accepted as a standard for illuminating gas. Complete with British Board of Trade certificate.....Duty free 65 00



No. 3392.

3392. **Hefner Lamp,** German standard, recommended by the Imperial Institute as a photometric standard. To be carried on No. 66C Table Top.....Duty free 13 50

3392A. **Hefner Lamp,** same as No. 3392, with Reichsanstalt certificate of accuracy. To be carried on No. 66C Table Top.....Duty free 15 75

Amyl Acetate, C. P., for use with Hefner lamp. Lb. 1 50

3393. **Electric Arc Lamp,** right angle, same as our No. 3636, mounted on 10 m. m. rod, to fit No. 44A Clamp.... 9 50

3395. **Standard Incandescent Lamps,** stated percentage of accuracy refers to the voltage and current consumption at their rated candlepower. To be used with No. 3362 socket.

Candlepower.	Voltage.	¼% Rotating Accuracy.	1-10% Rotating Accuracy.	¼% Station'y Accuracy.	1-10% Station'y Accuracy.
2 to 20	100 to 125	$2.25	$4.00	$2.70	$4.40
24 to 32	100 to 125	3.00	4.80	3.60	5.20
50	100 to 125	5.00	6.40	5.40	6.80

N. B.—We carry in stock **Stationary Standard Lamp** of 16-candlepower, 110 volts, accuracy ¼%, which we will supply, unless otherwise specified.



No. 3401.



No. 3402.

3400. **Bunsen Photometer Box**, mounted on rod to fit No. 44B Clamp. Each ..... $ 3 50

3401. **Dibdin's Modification of Bunsen Photometer Box.** In the Bunsen Box the grease spot and its surrounding media do not transmit light equally, and in consequence the grease spot is never entirely lost, even when equal illumination is on either side. We have therefore modified the Bunsen form, according to Dibdin, and use a star of paper through which light may pass. Mounted to fit No. 44B Clamp..... 4 50

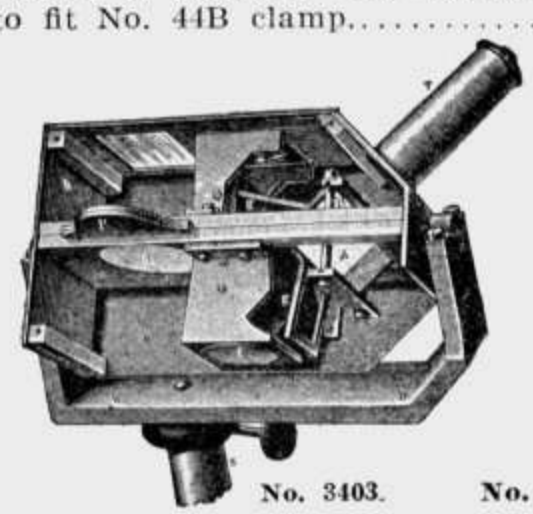
3402. **Flicker Photometer,** after Simmance-Abady. The principle of the Flicker Photometer is a departure from that of the grease spot and optical effect familiar to the majority of experimentalists.

The field of comparison is a revolving screen, which is observed through an eyepiece. When the lights are unequal, a flickering or throbbing effect is apparent. When they are equal the flickering vanishes, and all the observer sees is an apparently motionless disc of light. Thus personal error is avoided. For horizontal testing only. Mounted on rod to fit No. 44B clamp.....Duty free 50 00

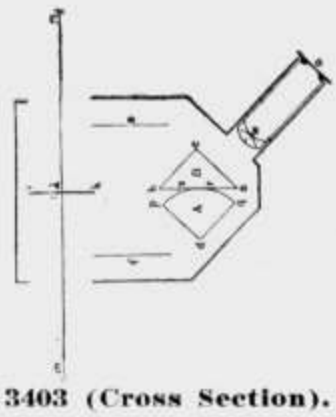
3402A. **Flicker Photometer,** same as No. 3402, for both angle and horizontal testing. Mounted on rod to fit No. 44B Clamp. Duty free 70 00

3403. **Lummer-Brodhun Photometer Box,** mounted on rod to fit No. 44B Clamp. Duty free 40 00

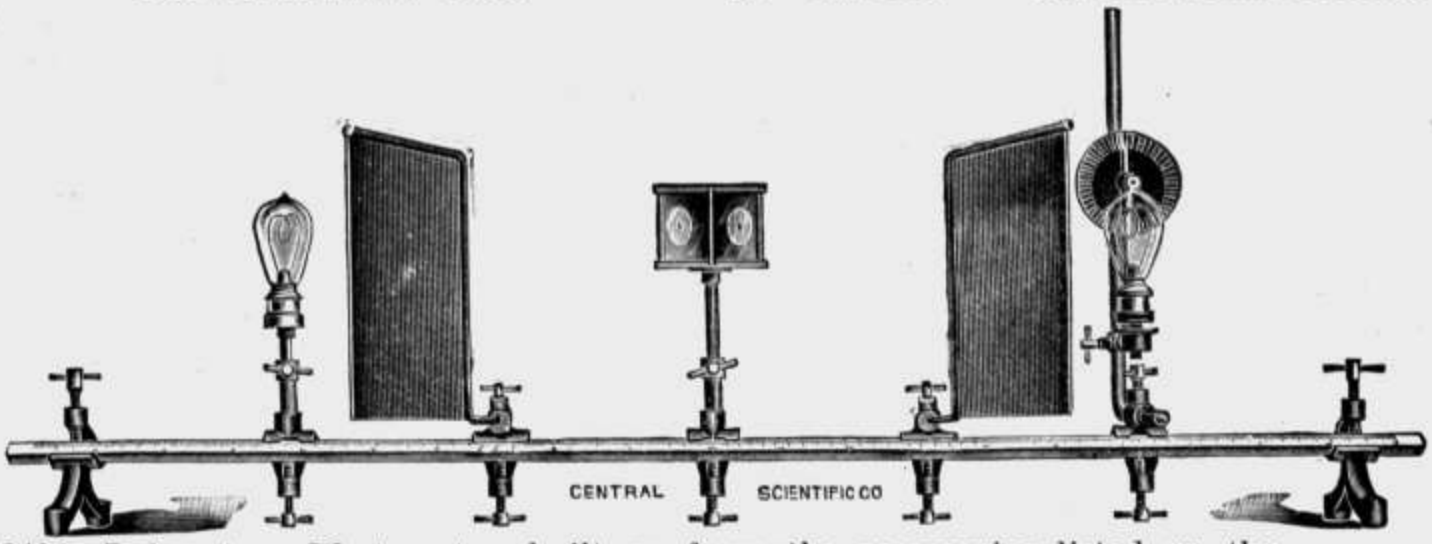
3404. **Joly's Diffusion Paraffine Photometer Box,** mounted on rod to fit No. 44B Clamp. Duty free 13 30



No. 3403.



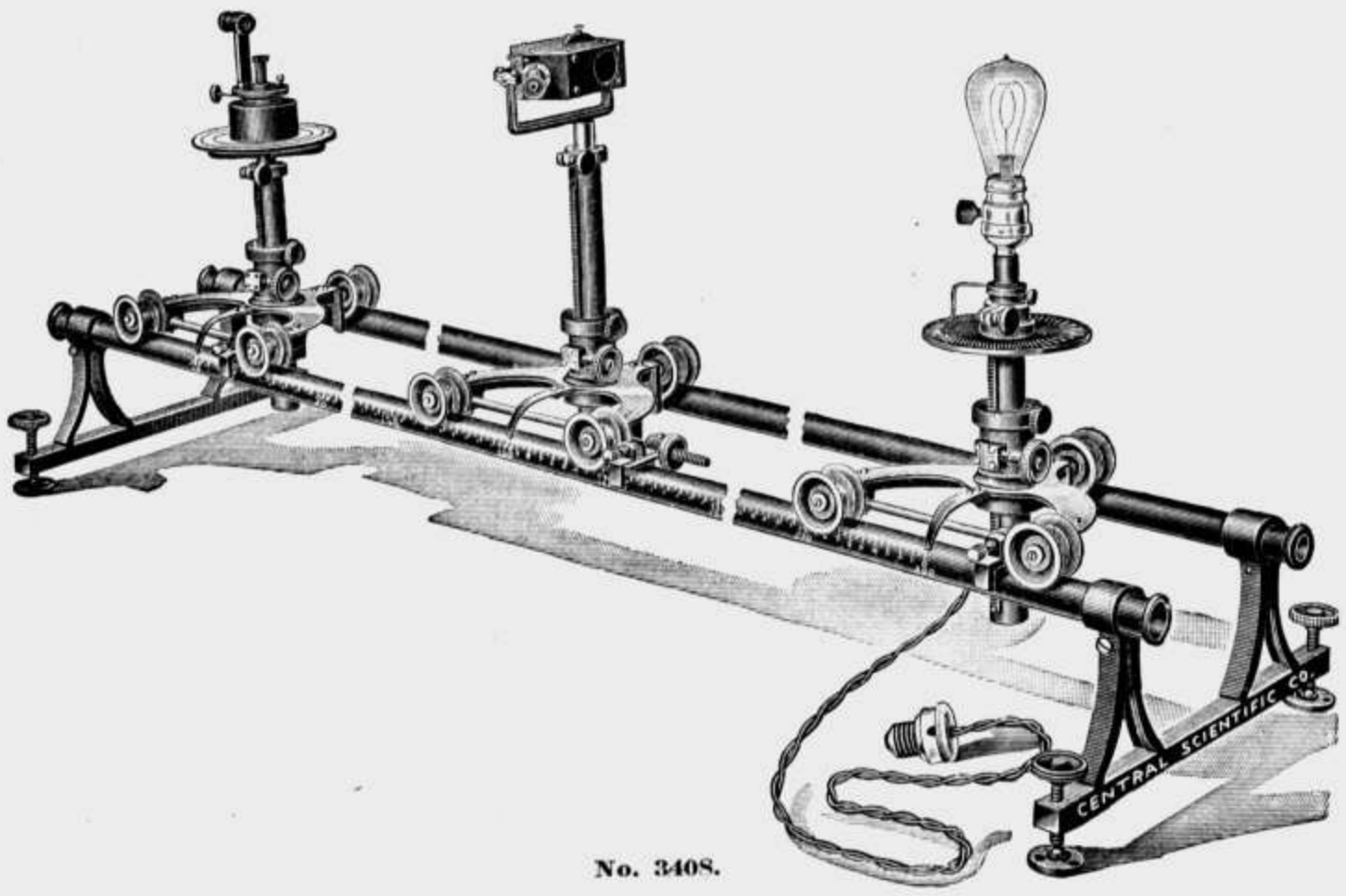
No. 3403 (Cross Section).



3406. **Laboratory Photometer,** built up from the accessories listed on the preceding pages. This outfit embodies the essential features of the high priced and elaborate photometers used in commercial work. It has been tested by actual use in a prominent technical school, where accurate work was done with oil, gas and electrical illuminants. The outfit is complete with light standard for the determination of maximum candlepower (vertical or horizontal distribution) and mean spherical candlepower of incandescent lamps..... 30 00

Complete Set as Follows:

25A. **1 Steel Rod,** 2 meters long.
26. **2 End Supports.**
3395. **1 Standard Incandescent Lamp.**
3362. **1 Lamp Socket.**
3363. **1 Universal Holder.**
3400. **1 Bunsen Photometer Box.**
3366. **2 Eye Shades.**
36B. **2 Clamps** for No. 3366 Eye Shades.
44A. **1 Clamp** for No. 3362 Socket.
36A. **1 Clamp** for No. 3363 **Universal** Holder.
44B. **1 Clamp** for No. 3400 Box.



No. 3408.

3408. **Precision Photometer, Reichsanstalt Pattern.** This instrument is designed for exact photometric work and is arranged so that it may be used with a large number of accessories, thus meeting the requirements of laboratories that are doing work in photometric measurements.

The bed consists of two large brass tracks parallel to one another and carried on supports provided with brass leveling screws, each fitted with a socket to be screwed to the bench. The graduations on the track read in both directions from 0 to 300 c. m. in millimeter divisions and show white on a black background.

The scale may also be divided in inverse squares at an additional cost.

The carriages are of solid construction and of sufficient weight to insure stability. They are provided with rack and pinion for vertical adjustment, with a clamping collar to avoid slipping. Guards prevent the carriages from being accidentally knocked from the track and legs are provided to support the carriages, when placed upon a flat surface. The position of the carriage is determined by a pointer extending down to the graduations on the track and carrying a white line which indicates the center of support. A clamping device is provided for holding the carriages at any point desired.

The observing carriage has in addition a slow motion screw for careful horizontal adjustment.

The carriages are constructed to take accessories provided with a 19 m. m. rod. When desired, we can supply a collar (No. 3409) to carry accessories mounted on a 10 m. m. rod.

We have endeavored to list this photometer so that any desired combination may be easily selected. We recommend the use of the No. 3410 Universal Compound Rotator for the unknown. When this is purchased, only one end carriage is needed. This apparatus will also be found to make an excellent optical bench.

For prices, see next page.

Note.—Illustration above shows, in addition to Nos. 3408A-F, listed on next page, No. 3392 Hefner Lamp, No. 3395 Standard Incandescent Lamp and No. 3403 Comparison Screen.

3408A. **Bed,** 3 meters between light, graduated to millimeters..... $ 70 00

3408B. **End Carriage,** for "Standard" or "Unknown" luminant..... 27 75

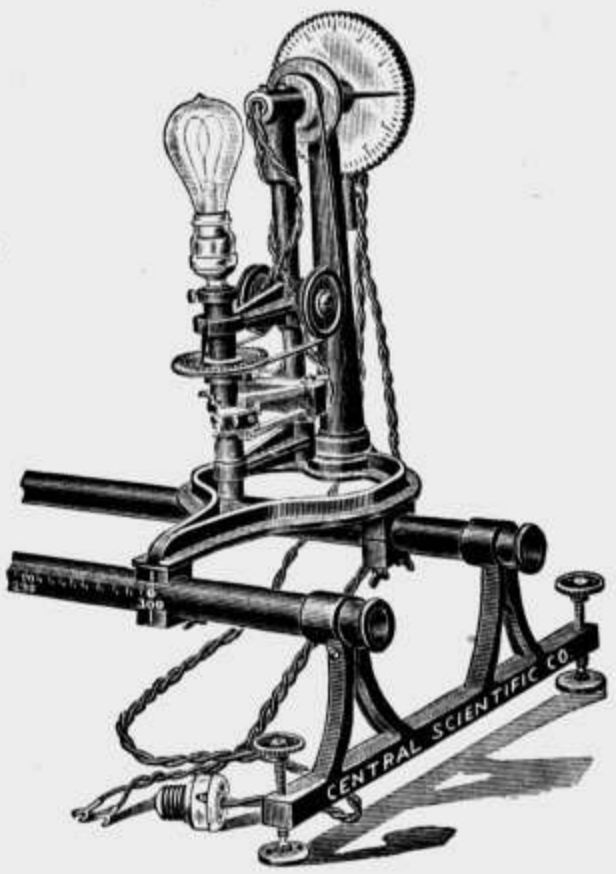
3408C. **Observing Carriage,** for comparison screen..... 35 00

3408D. **Socket,** with cord and plug, for incandescent lamp, with 19 m. m. rod 2 25

3408E. **Platform,** for amyl acetate lamp with 19 m. m. rod..... 2 00

3408F. **Graduated Disc,** to be used on end carriage with incandescent lamp to secure mean horizontal power of lamp..... 3 35

3409. **Collar,** for use on No, 3408B or C when it is desired to use an accessory having a rod 10 m. m. in diameter..... 1 00



No. 3410.

3410. **Universal Compound Rotator,** for obtaining the mean spherical candle power. It consists of a heavy frame that can be clamped to the photometer track. The lamp socket is attached to a shaft mounted on ball bearings so as to reduce the friction to a minimum. This shaft may be adjusted through any vertical angle of five degrees so as to bring all parts of the filament in line with the photometer box. This is held to the desired angle by a pin fitting into a slot in the perephery of an accurately graduated disc.

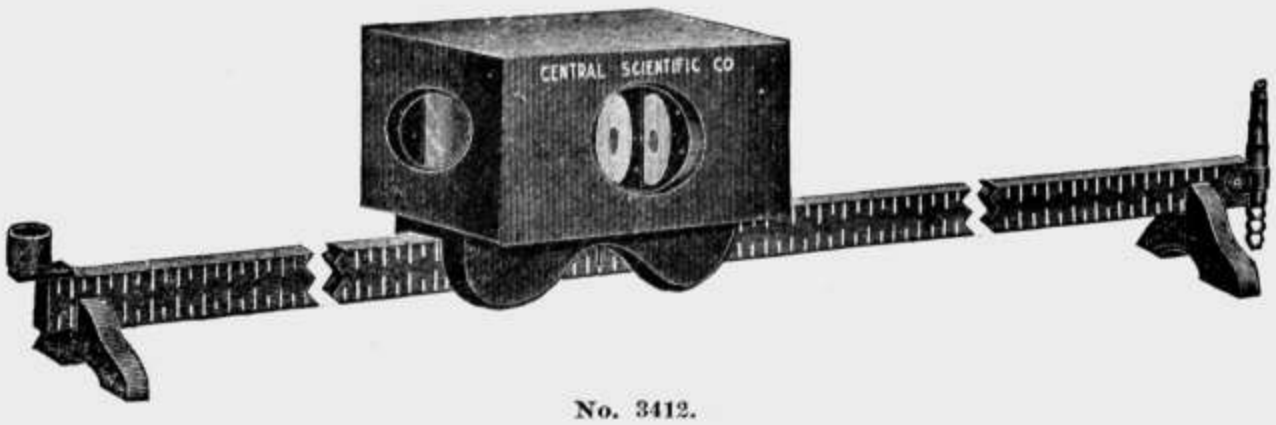
The horizontal rotation of the lamp is read by another graduated circle.

The rotator is provided with two sets of brushes, one for delivering the lighting current to the lamp, the other for leads to the electrical measuring instruments.

The rotator is provided with all necessary pulleys and belt and may be driven by any 1-12 h. p. motor.

This will be found to be the best built and most convenient rotator of unknowns yet designed..... 83 35

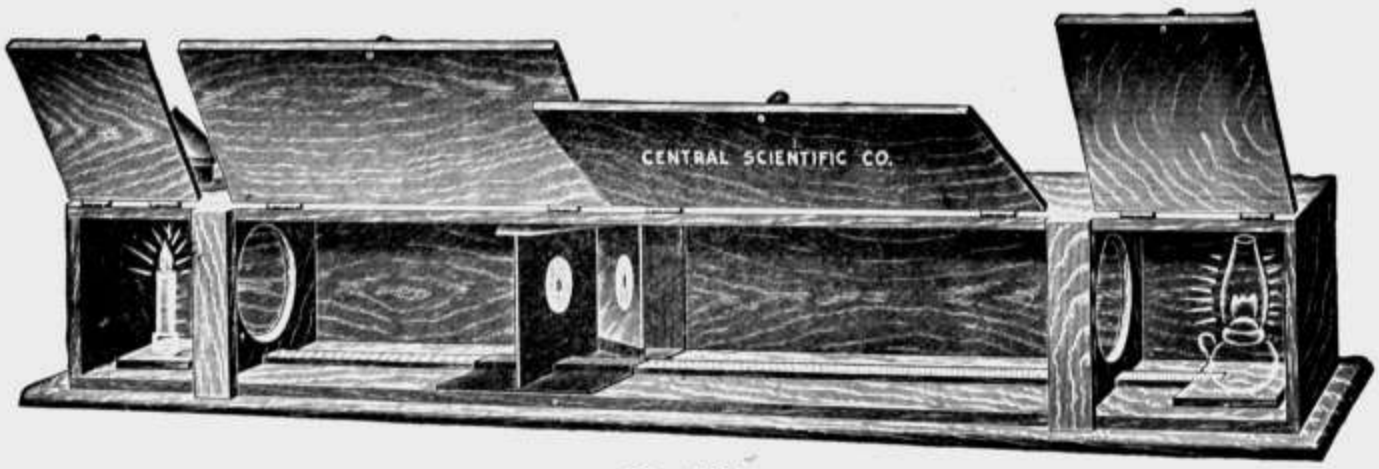
For Comparison Screens, Standard Illuminants and other accessories, see pages 227-229.



No. 3412.

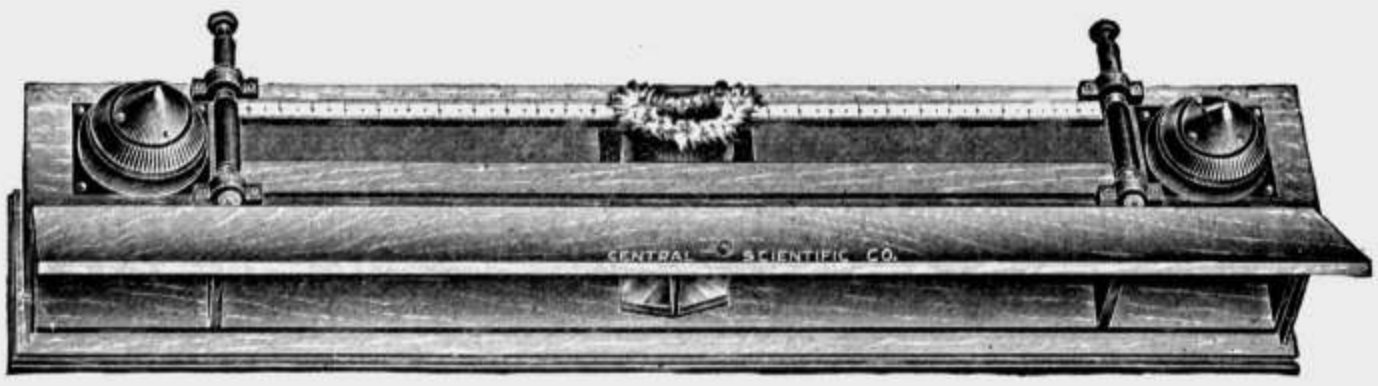
3412. **Photometer, Student's, Bunsen Form.** A simple and convenient form for individual work. Consists of a meter stick mounted on two supports bearing a gas jet at one end and a candle holder at the other. A box painted dead black, so as to avoid any reflection, slides upon this meter stick, and contains a Bunsen screen with two mirrors at right angles for viewing both sides of screen at the same time. Box is provided with indicator..... $ 3 50

3413. **Photometer,** same as above, with paraffine blocks, after Joly..... 4 50



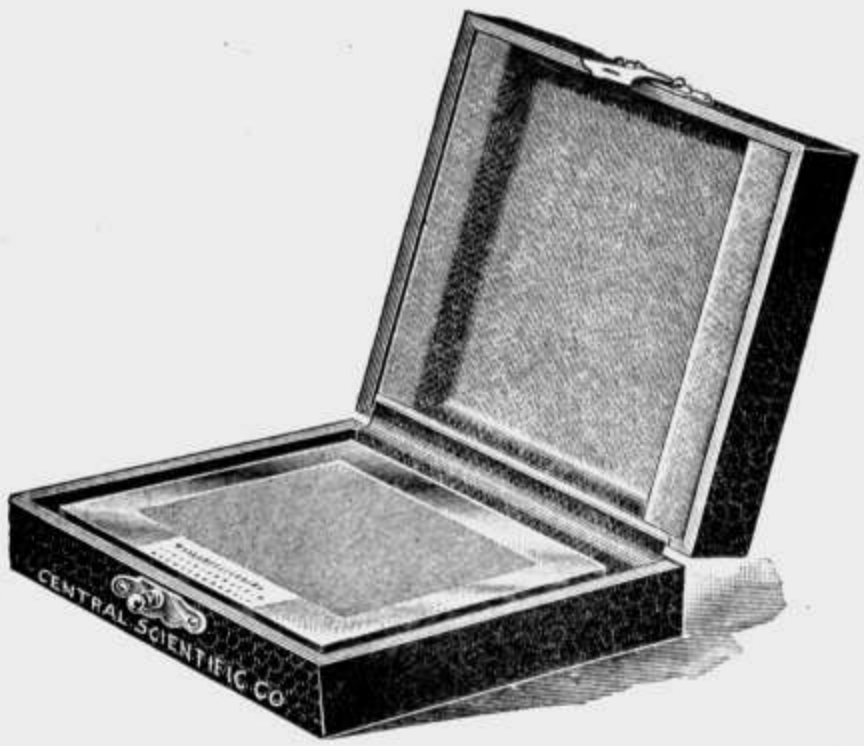
No. 3414.

3414. **Photometer, Bunsen's,** with separate doors for lamp and candle, and a door opening on each side of the screen. Complete, with screen, mirrors, scale and hoods..... 8 00



No. 3415.

3415. **Photometer, Bunsen's, New Design.** This photometer is designed for rapid work in a light room. The Bunsen screen is viewed through a shaded slit mounted upon a strip of light proof canvas fitted into grooves upon the top of the box. This canvas passes over rollers and is attached to the screen directly under the viewing slit. By turning the rollers, the screen may be moved to any point of the scale between the lamps. The relative distance between the lamp and the illuminants is indicated upon a scale mounted on the top of the box. The lights may be reached through a light proof door, which remains closed through the experiment. This is the only form which may be used in an ordinary laboratory..... 11 00



WALLACE REPLICAS OF ROWLAND'S PLANE DIFFRACTION GRATINGS.

Made by R. James Wallace, formerly Photo-Physicist of the Yerkes Observatory.

We take pleasure in announcing that we have become exclusive agents for Dr. Wallace's famed diffraction grating replicas and accessory instruments. These replicas during the eight years they have been on the market have become so well and favorably known that further words seem almost unnecessary; but, since the publication by Dr. Wallace of his method of manufacture, important modifications in the process have been effected, which result in the production of a replica grating of the very highest point of practical perfection.

All Wallace gratings bear the signature of Dr. Wallace, together with the grade and date when tested, engraved in the glass, and this constitutes an absolute guarantee of quality.

Grade A. These gratings are guaranteed to possess the finest resolving power and definition, showing clean, sharp black lines in sunlight "condensed" upon the slit, and in an instrument of aperture as indicated. With a sufficiently high power eye-piece to render the separation visible, they will show the clear resolution of the triple $\left\{\begin{matrix} \text{A}5226.707 \\ 5227.043 \\ 5227.362 \end{matrix}\right\}$ in the second order, a resolving power equal to 19 times that necessary to separate the D lines,— $\left\{\begin{matrix} \text{D1—}5886.155 \\ \text{D2—}5890.186 \end{matrix}\right.$

Grade B. Gratings of this grade are guaranteed to resolve the double at $\left\{\begin{matrix} \text{A}5262.419 \\ 5261.876 \end{matrix}\right.$ a power of eleven times that necessary to resolve the D lines, in the second order spectrum, and, while not giving quite as perfect definition as those of Grade A, are yet for all but the most critical work a very perfect article, and one which is recommended for general class instruction.

Grade C. These are grating replicas, which through error in the mounting do not define as well as Grade B, and are not entirely free from "ghosts" caused by distortion of the lines. They are guaranteed to show the Ni line between the D's very clearly; the D lines themselves being widely separated.

Grade D. For projection purposes, and use in the chemical laboratory, dark room, etc. Gratings of this grade are bound between thin glass plates, lantern-slide fashion, and when simply held in the hand close before the eye are extremely useful in the flame test for the detection of K in the presence of Na—the study of dichroism—general absorption, estimation of transmission of dark room light, etc., etc. In projecting the spectrum with the optical lantern, they are simply held in front of and against the lens nozzle, while an opaque slide with a slit cut in it is placed in the stage. These gratings are not intended for use in the spectroscope, as the definition of the Fraunhofer lines is not sufficiently good.

All Grade A and Grade B gratings are enclosed in leather covered velvet lined case. Price list on next page.

NET PRICE LIST OF WALLACE GRATINGS.

No.	Size of ruled Surface	Grade				No. of Lines to 1 inch.
		A	B	C	D	
3420	28x20 m. m.	$5.00	$4.00	$3.00	$2.00	14,438
3421	25x21 m. m.	5.00	4.00	3.00	2.00	15,000
3422	28x20 m. m.	5.00	4.00	3.00	2.00	20,000
3423	47x35 m. m.	8.00	7.00	5.00	3.00	15,000
3424	46x32 m. m.	8.00	7.00	5.00	3.00	20,000

CROSSED GRATINGS FOR DIRECT OBSERVATION AND LANTERN PROJECTION.

When a point of light is observed with the grating held close to the eye, eight radiating brilliant spectra of the first order and sixteen second order spectra are seen at once in the field of view, or when held in front of the optical lantern nozzle are projected upon the screen. A very effective piece of class room apparatus.

3425. Ruled space ¾ in. square.....Net, $ 2 50
3426. Ruled space 1⅜ in. square.....Net, 3 50



No. 3428.

3428. **Spectroscope, Wallace's Direct Vision Diffraction**, pocket form. This instrument is modeled somewhat on the lines of that of Thorp of England, but has been much improved and rendered more adaptable for general use. The dispersion piece consists of a 15,000 line replica which is mounted upon a 30° prism of light crown. The only object served by the prism is to deviate the direct image of the slit, which is thus thrown to one side out of the field of view, while the brilliant spectrum of the first order is seen in direct line of sight. By directing the vision at a small angle and when using a sufficiently bright light the spectrum of the second order is readily available, which with its greatly increased dispersion is more suited for some observations.

The collimating lens is of high quality and strictly achromatic, thus enabling the Fraunhofer lines to be defined sharply throughout a greater area in the spectrum than would be possible with a simple uncorrected lens, which would bring the lines in each color to a focus at a different plane.

The slit mechanism is of the form usually supplied on much higher grade of European instruments and is exceedingly ingenious in pattern. It is adjustable by means of a screw with milled head, which gives a smooth and even motion to the movable jaw. With direct sunlight (or electric arc) the D lines are shown well and clearly resolved in the spectrum of the second order, and with critical focusing, even in the first order..... $ 11 00

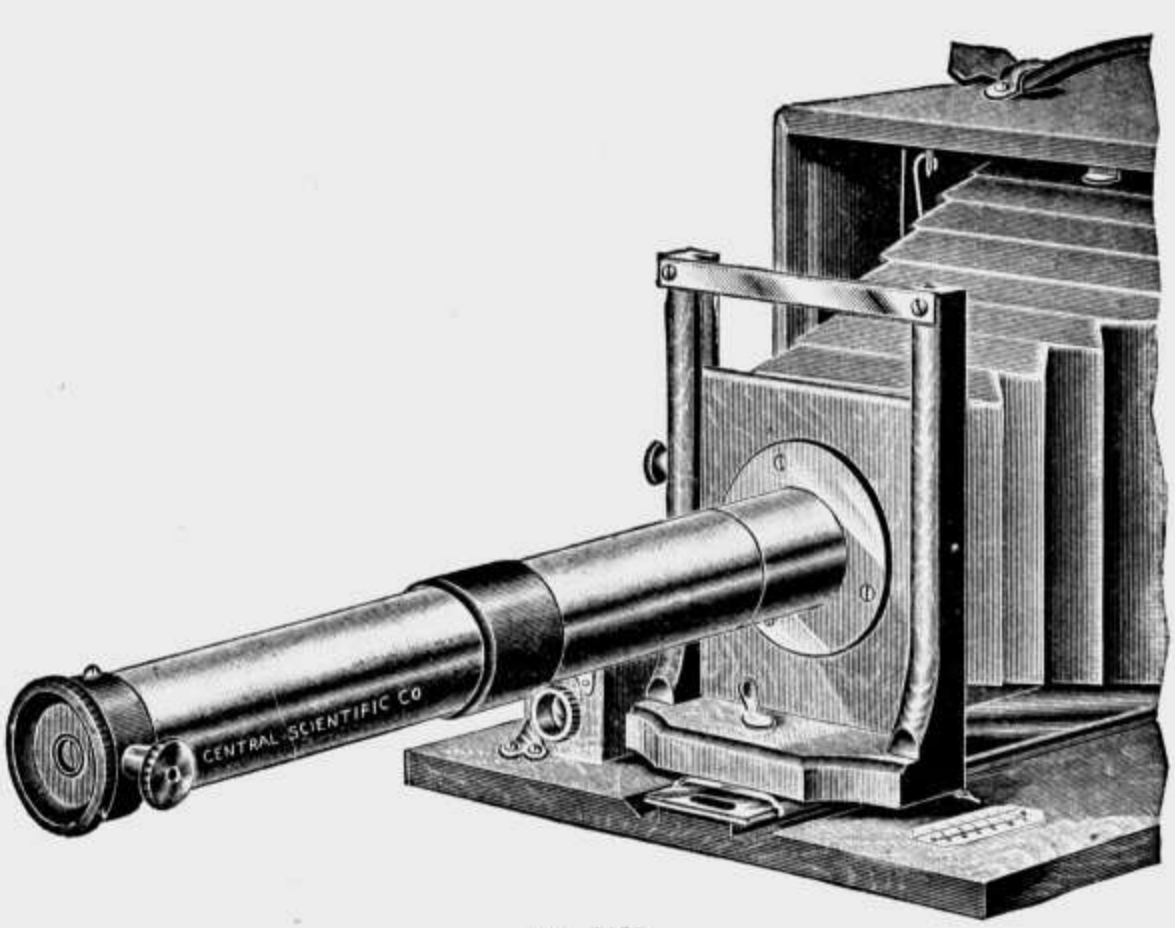
Send for complete pamphlet of Wallace's Replicas and Accessories, also suggestions for use of gratings.



No. 3429.

3429. **Micro-Spectroscope, Wallace's.** The instrument fits over the ordinary eye-piece of the microscope and is instantly attached or removed without trouble. High dispersion, with direct vision, is secured by means of a Wallace grating prism of 15,000 lines to the inch, which gives a practically "normal" spectrum of much brilliancy. By an exceedingly simple and ingenious arrangement varying widths of slit diaphragms may be made use of—three of which are provided with each instrument.

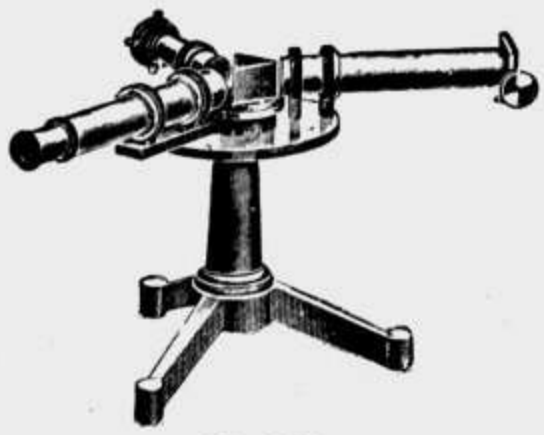
Merely held in the hand close before the eye, this spectroscope eye-piece will be found an exceedingly "handy" piece of apparatus for the observation of colored flames in the chemical laboratory, etc. The instrument is manufactured of brass, handsomely finished..... $ 8 35



No. 3430.

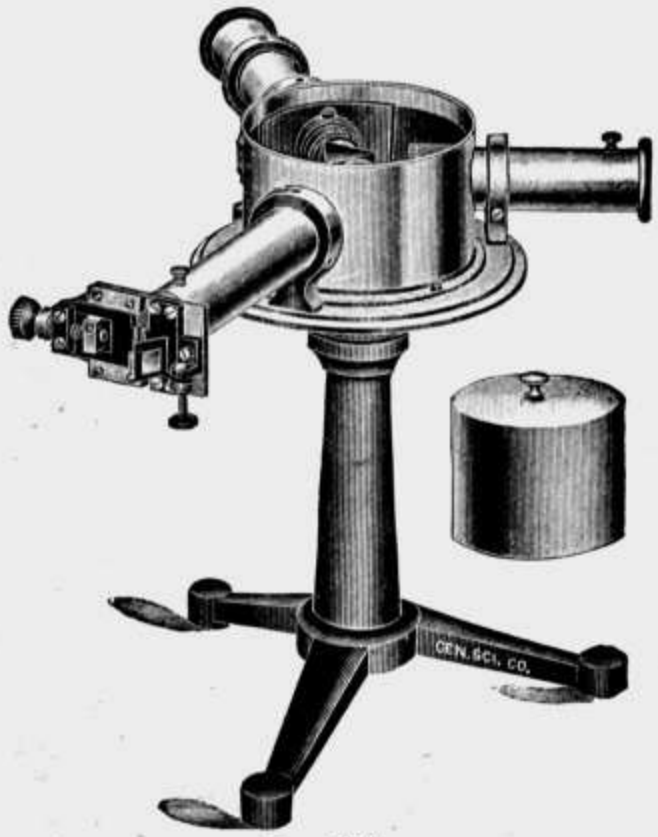
Spectroscope Assembled and in Use as a Spectrograph.

3430. **Spectrograph, Wallace's.** By a clearly devised arrangement of supplementary tubes and a flange, which fit the instrument, Spectroscope No. 3428 is instantly adjusted for spectrum photography with **any ordinary camera,** the flange screwing on the front board in place of the ordinary lens. The instrument has been designed of sufficient length of adjustment to accommodate any of the various makes or forms of cameras—from "short" to "long focus"..... 13 50



No. 3432.

3432. **Spectroscope,** High School pattern. Furnished with 60° flint glass prism of medium density, and a dispersion of 4°. Telescope is adjustable, has an aperture of 20 millimeters and a focal length of 140 millimeters. The collimator has the same dimensions and is provided with a comparison prism and a micrometer adjustable slit. A separate tube contains the scale. Mounted on neat tripod base, with provision for adjusting to any position.....Duty free $ 30 00

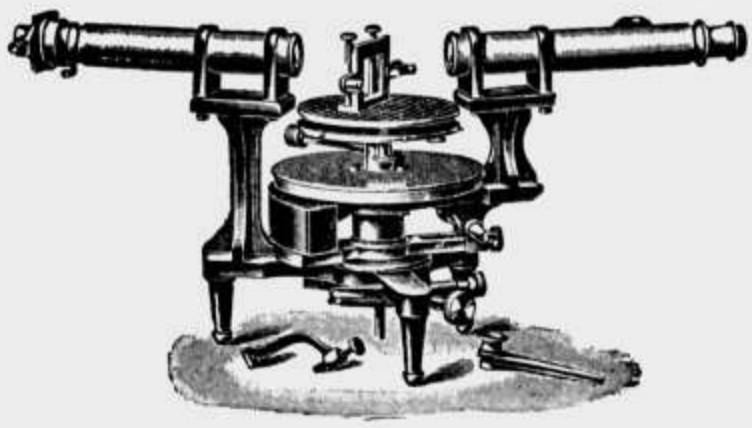


No. 3433.

3433. **Spectroscope,** adapted for physical and chemical laboratories for work in spectrum analysis. The telescope has an aperture of 20 m. m., a focal length of 122 m. m., magnification of 6 diameters, and can be adjusted so that any part of the spectrum may be thrown in the center of the field.

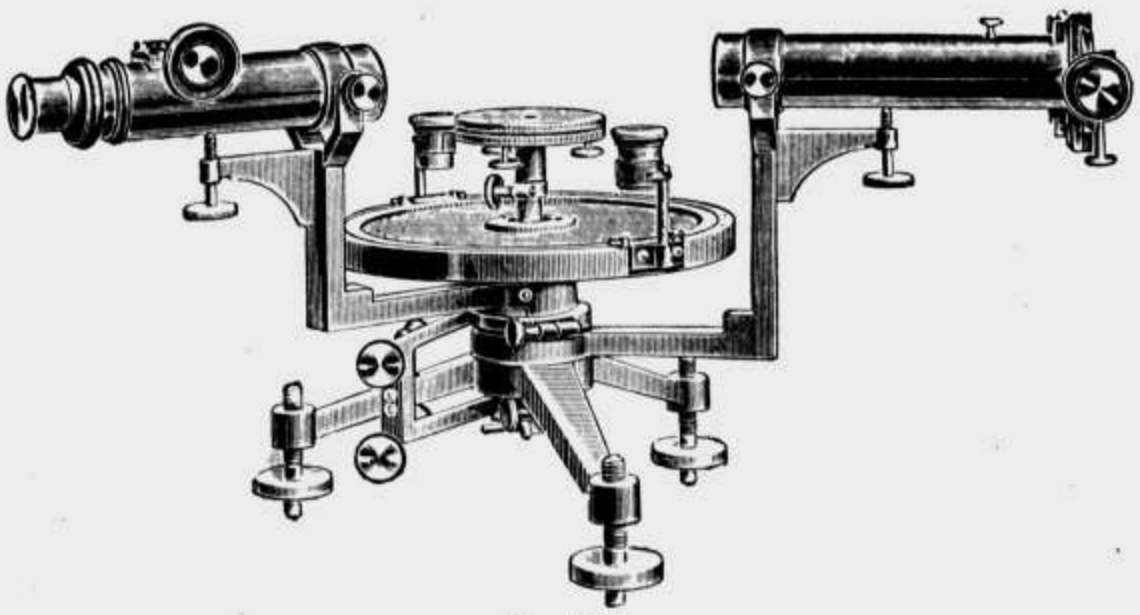
The collimator of the same dimensions is provided with a comparison prism and the slit is adjustable by means of a fine screw. A separate tube contains the scale, which is reflected into position over the spectrum.

A 60° dense flint glass prism with 30 m. m. aperture is enclosed in a brass case, light tight. Its specific gravity is 3.87. Refractive index for D 1.65, angle of dispersion C-F 1°50′; the apparent separation of the D lines 6′.....Duty free 40 00



No. 3435.

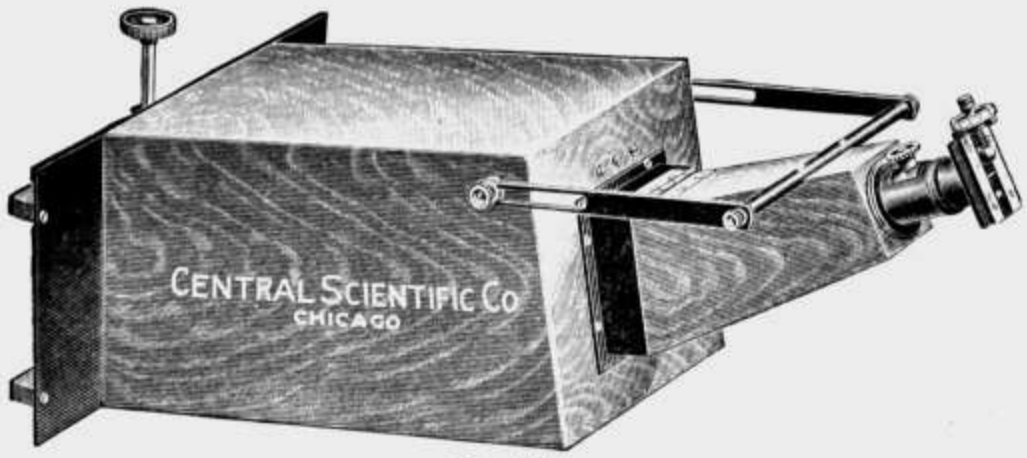
3435. **Spectrometer,** of the celebrated Wilson make, well adapted for the physical laboratory; the circle is graduated to half degrees, 125 m. m. in diameter, and provided with two verniers reading to minutes. The telescope is fitted with rack and pinion and the ocular with cross wires. Both telescope and prism table have fine adjustment, the latter also having leveling screws. The telescope and collimator have an aperture of 24 m. m., and the collimator is provided with an adjustable slit. Complete with prism and grating holders in wood carrying case.....Duty free $ 43 50



No. 3436.

3436. **Spectrometer,** after von Lang. The circle is 120 m. m. in diameter, graduated on silver to ½ degrees. It is fitted with two verniers with magnifiers reading to 60 seconds. The telescope has an aperture of 20 m. m. and is provided with a rack and pinion adjustment, and may be rotated about the vertical axis of the instrument. The collimator is of the same diameter as the telescope and is equipped with a slit with micrometer screw adjustment, the width of opening being indicated on a graduated drum. All adjustments are practically universal.....Duty free $ 67 50

Spectral prisms, page 238.



No. 3438.

3438. **Photo-Spectroscope,** designed by Dr. Wm. L. Dudley of Vanderbilt University. This instrument is made with a Wallace replica grating so arranged that the whole spectrum can be photographed at once. It is provided with a plate holder and rack and pinion motion, so that 12 spectra can be photographed on the same plate. This instrument is in thorough adjustment and is very light and compact. The plate holder carries a 3¼x4 inch plate. By means of a small comparator the special lines can be measured with great accuracy. This instrument has proven of great service in chemical work..... $ 85 00

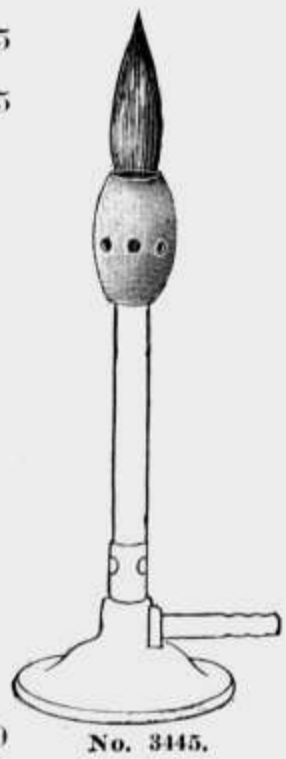
SPECTRAL PRISMS.

Flint Glass Prisms, 60°. Refractive index for D=1.61 to 1.65. Angle of dispersion, C-F=1° 30′ to 1° 56′. Deviation for D 48°-52°.

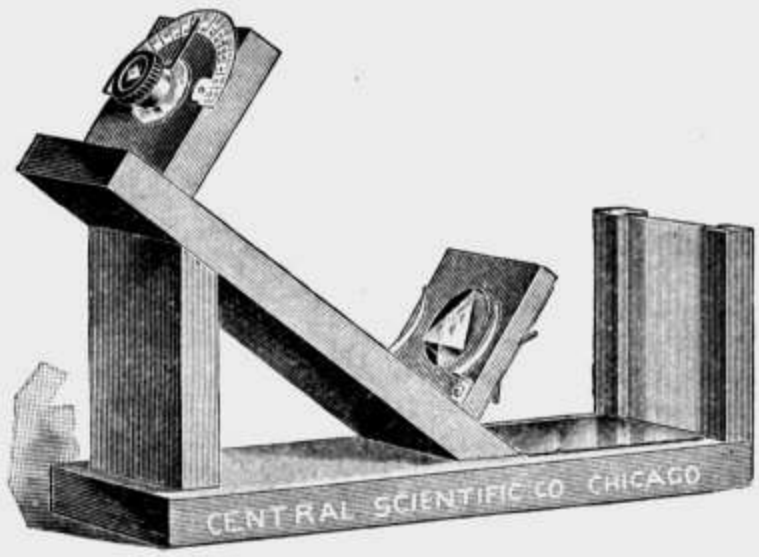
3439A. **Prism,** 25 millimeter face.....Duty free $ 4 50
3439B. **Prism,** same as No. 3439A, furnished from stock..... 6 00
3439C. **Prism,** 30 millimeter face.....Duty free 5 00
3439D. **Prism,** 35 millimeter face.....Duty free 7 00
3439E. **Prism,** 40 millimeter face.....Duty free 8 50
3440. **Prism,** Rutherford's, consisting of a flint glass prism cemented between two crown glass prisms, 20 m. m. high.....Duty free 12 00
3440A. **Prism,** same as No. 3440, but 30 m. m. high.....Duty free 16 50
3440B. **Prism,** same as No. 3440, but 40 m. m. high.....Duty free 24 00
3441. **Spectrum Chart.** Prang's Standard Prismatic..... 1 10
3441B. **Spectrum Chart,** same as No. 3441, with black wood frame close to color band 3 25
3442. **Spectrum Chart,** mounted on linen back with common rollers and containing the following spectrums (size of each spectrum 5.5 c. m. wide, 52 c. m. long); K, Rb, Cs, Tl, Na, Li, Ca, Sr, Ba 3 75
3442A. **Spectrum Chart,** same as No. 3442, with the following spectrums: In, C, Bo, Mn, Pb, Cu, Co, Ni, Fe.. 3 75

Spectrum Tubes, page 140.

3445. **Monochromatic Flame Burner.** This burner is the invention of Mr. H. G. Dorsey of Cornell University and will be found of great service in all forms of experimental work where a continuous monochromatic flame is desired. The burner tip is composed of a porous refractory substance molded into an approved shape and impregnated with a compound of salts of sodium in definite proportions. It is placed upon the tube of an ordinary Bunsen burner and, after warming gently, is soon heated to redness and then produces without any attention a steady sodium flame of great volume and intensity. It may be used continuously for days or occasionally for an almost indefinite period. It obviates the disagreeable features of the usual method, which ruins the burner and has the further advantage of being cleanly. Tip only to fit standard Bunsen burner (tube diameter 7-16 inch). **Each** 1 00



No. 3445.



No. 3450.

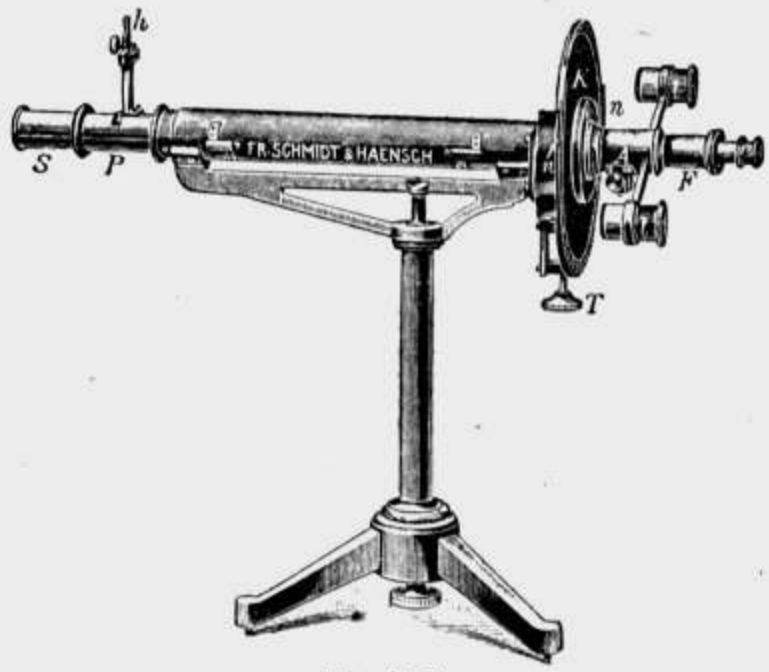
3450. **Polariscope,** improved simple form. Polarizing mirror covers stage. Opening is 1½ inches in diameter. Convenient stage supports for both cubes and films. A light proof hood is supplied, which permits clear film demonstrations and beautiful color effects with unannealed glass plates (Nos. 3336 to 3339) in ordinary daylight or with lamp light. With 6 m. m. Nicol prism mounted in brass tube, with pointer and graduated arc..... $ 8 35

3450A. **Polariscope,** same as No. 3450, with 7 m. m. prism..... 9 50

3450B. **Polariscope,** same as No. 3450, with 8 m. m. prism..... 10 00

3451. **Magnifier,** for either of the above, as shown in the illustration, extra. 1 35

Polariscope Preparations, page 240.



No. 3452.

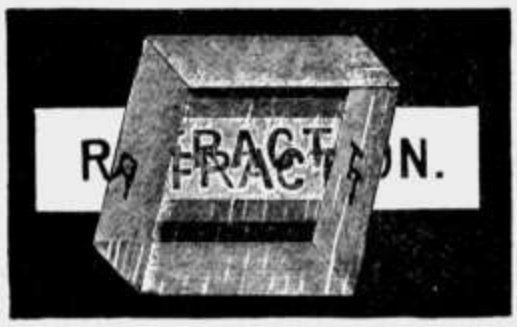
3452. **Polariscope.** Schmidt & Haensch, half shadow, Laurent's, with single wedge compensation, latest construction, including new arrangement for reading scales and dust protection cap for analyzer. Complete on stand with tripod base, including one each 100 and 200 m. m. tubes in mahogany case.....Duty free 145 00

3452A. **Polariscope.** Same as above, but with three tubes, 100, 200 and 400 m. m.....Duty free 160 00

3452B. **Polariscope.** Half shadow, with double wedge compensation. Lippich Polarizer and two tubes, 100 and 200 m. m.....Duty free 205 00

3452C. **Polariscope.** For urine analysis, reading to 0.1%, with three observation tubes and lamp, in mahogany case.....Duty free 80 00

3452D. **Polariscope.** Mitscherlich, simple form with one 200 m. m. tube. .....Duty free 30 00



No. 3465-3467.



No. 3469.

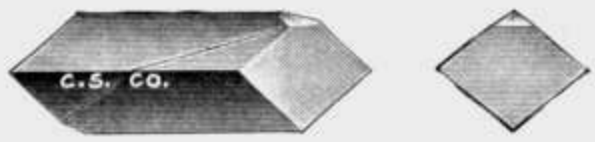
POLARISCOPE PREPARATIONS AND ACCESSORIES.

3331. **Gypsum Figure**, plain, 4 strips, 4 colors..... $ 2 20
3331A. **Gypsum Figure,** cube in 3 colors..... 2 75
3331B. **Gypsum Figure,** octahedron, in 4 colors..... 3 50
3331C. **Gypsum Figure,** star in 6 colors..... 5 00
3332. **Holder,** for compressing glass blocks..... 2 00
3333. **Annealed Glass,** rectangular block, to fit No. 3332 Holder..... 1 40
3335. **Selinite Films (Gypsum),** after Mueller. Set of eight different colors 6 50
3336. **Unannealed Glass Plate,** square..... 1 65
3337. **Unannealed Glass Plate**, rectangular..... 1 65
3338. **Unannealed Glass Plate,** round..... 1 65
3339. **Unannealed Glass Plate,** triangular..... 1 65
3341. **Mica Plate,** square, large, quarter undulations..... 2 50
3342. **Mica Plate,** round, medium, quarter undulations..... 1 65
3343. **Mica Plate,** round, small, quarter undulations..... 1 00
3344. **Mica Plate,** round, small, half undulations..... 1 00

3460. **Black Mirror,** in mahogany frame.

Size	10x20 c. m.	15x30 c. m.	20x40 c. m.
Duty free	3.50	6.30	10.50

3204. **Fresnel's Mirror,** two black mirrors 30x40 m. m. placed at an angle of slightly less than 180 degrees, one of which has an easy screw motion. Mounted on stand. Mirror frame held in 10 m. m. rod for convenience in using on Optical Benches and Photometers in connection with No. 44A Clamp.....Duty free.... 12 00
3465. **Iceland Spar,** showing double refraction, ordinary..... 45
3466. **Iceland Spar,** medium..... 60
3467. **Iceland Spar,** best..... 1 10
3469. **Tourmaline Tongs** 2 50
3470. **Tourmaline Tongs,** superior quality, large size tourmaline plates of the same degree of density.....Duty free 11 00



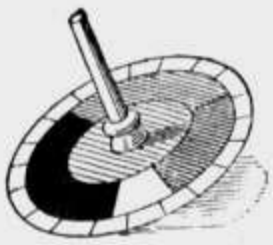
No. 3473-3474.

3473. **Nicol's Prisms,** for polarization, diagonal face, rhomboidal section.

Face in millimeters.....	6	7	8
Each	3.00	4.00	4.50

3474. **Nicol's Prisms,** same as No. 3473.

Face in millimeters.....	15	20	25
Each .....Duty free	10.50	25.50	50.00



No. 3487.



No. 3489.

3476. **Glass Plate,** of best "pot glass" color, 10 c. m. square, Violet..... $ 13

3477. **Glass Plate,** same as No. 3476, Indigo..... 13

3478. **Glass Plate,** same as No. 3476, Blue..... 13

3479. **Glass Plate,** same as No. 3476, Green..... 13

3480. **Glass Plate,** same as No. 3476, Yellow..... 13

3481. **Glass Plate,** same as No. 3476, Orange..... 13

3482. **Glass Plate,** same as No. 3476, Red..... 13

3485. **Gelatine Films, Imported,** all colors, 8x10 inches. Per sheet..... 20

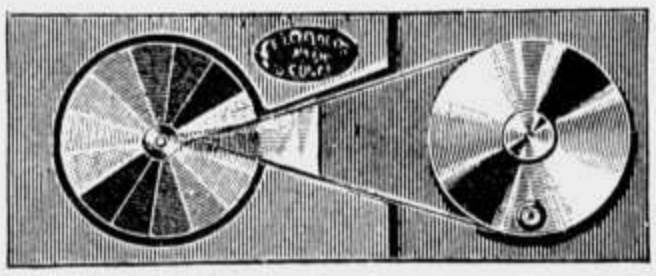
3487. **Color Top,** for student use in the study of colors and their complements, etc. Complete, with 8 discs 1½ inch, 8 discs ¾ inch, and graduated disc. Per dozen..... 90

Color Discs and Newton's Discs, page 76.

3489. **Newton's Rings.** A pair of lenses 1½ inches in diameter, one plane, the other plano-convex, mounted in brass frames, with three compression screws which also act as legs, showing interference of light. 1 50

3491. **Stereoscope,** hardwood, neatly finished, with handle..... 1 50

3493. **Stereoscope Slides.** Martius Matxdorff, to show luster of crystals. Set includes 12 slides. Per set..... 1 65



No. 3495.

3495. **Mechanical Slide,** for color mixing, after Newton, for projection. The wooden frame with the painted glass discs and the rotating apparatus are placed in the front of the condenser of a projecting lantern in place of the usual slide carrier.....Duty free 6 60



No. 3497.

3497. **Spinthariscope,** for **demonstrating Radium Energy,** pocket form, consisting of a tube 1½ inches long, with a fluorescent screen at one end, a movable pointer carrying the radium placed over it, and a powerful magnifier in adjustable tube at the other.

The invention of Sir William Crookes to demonstrate the extraordinary physical properties of radium.

A small quantity of radium is placed in front of a fluorescent screen, and by aid of a high magnifying power the scintillations produced by the constantly emanating rays or atoms as they strike the screen, are made visible in the most marvelous manner. In order to observe this phenomenon in the day time, the observer should remain in a darkened room for five minutes, so that the eye may become sufficiently sensitive. The screen should then be carefully focused by pulling out the lens end of the instrument..... 9 00



No. 3498.

3498. **Stroboscopic Cylinder and new views by Prof. Quincke.**

This instrument is made by ourselves and is much superior to the cheap German toy usually sold. It is 28 c. m. in diameter, with 22 slits. The **views** which accompany this stroboscope are 18 in number and are the latest designs by **Prof. Quincke** for illustrating oscillation and vibration, as follows:

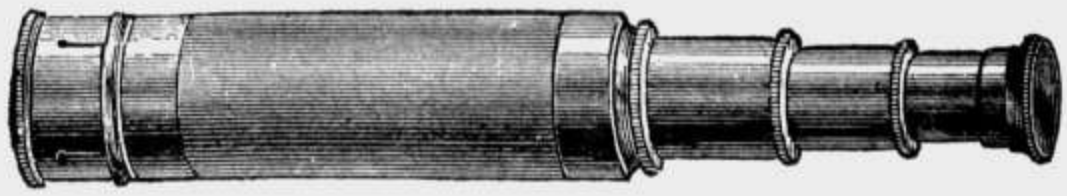
1. Oscillations of a pendulum.
2. Longitudinal oscillations with large amplitude (also horizontal transversal oscillations or linear polarized light).
3. Longitudinal oscillations with small amplitude.
4. Longitudinal oscillations with equal amplitude and different period of oscillation (fundamental tone and octave).
5. Transversal oscillations (linear polarized light in the azimuth 0° vertical).
6. Vibration of ether particles for one ray of linear polarized light in the azimuth of 30°.
7. Oscillation of ether particles of an elliptically polarized ray of light.
8. Oscillation of ether particles for circular polarized light.
9. Reflection of rope waves on the free end of same (elevation reflected as elevation).
10. Reflection of rope waves on the fixed end of same (elevation reflected as depression).
11. Vibrations of a string by a single tone.
12. Vibrations of a plucked string (one third length).
13. Motion of the air in a closed pipe.
14. Pressure of the air for the vibrations in a closed pipe.
15. Production of vibration and combination tones by rapid rotation of the stroboscope. (Transversal vibrations.)
16. Vibration of liquid particles in different depths of a wave trough.
17. Vibration of liquid particles in different depths of a wave trough (in running water) in the case of open tracks.
18. Progressive transversal waves with rectilinear track of the swinging particles.

Price, complete, on stand for rotating by hand with views, as above... $ 6 50

3498A. **Stroboscope,** same as No. 3498, complete with views, as described above, except without tripod; designed to be rotated by Nos. 830, 832 or 837 Rotators..... 6 00

3499. **Camera Obscura,** student's form of wood, according to Hall and Bergen. Consists of two telescoping boxes, one with pin hole, the other with ground glass plate. Excellent for showing principle of photographic camera and formation of images..... 65

Photographic Cameras quoted upon application.



Telescopes, with metal body, covered with morocco, polished brass draw tubes, achromatic objective with cap and sliding eye piece cover.

Cat. No.	Number of draws.	Full length inches.	Closed length inches.	Diam. of objective glass.	Power times.	Range miles.	Price.
3501	3	14¾	5¼	¾	10	5	$ 2 50
3502	3	16½	6	1	15	6	3 00
3503	3	23	8	1½	25	9	5 00
3504	3	29	10	1¾	30	10	7 50
3505	4	36	11	1⅞	35	14	10 50
3506	4	42	11½	2⅛	40	18	16 75

ASTRONOMICAL TELESCOPES.



No. 3521.

3521. **Telescope, Astronomical,** brass body, 40 inches long, achromatic objective 3 inches in diameter, in which the spherical and chromatic aberrations are well corrected. One terrestrial eyepiece, power 50 times, and one celestial eyepiece, power 125 times, with sunshade. Rack and pinion for focusing. Mounted on iron tripod with adjustment for both vertical and horizontal movements. Complete, in strong hardwood case.....Duty free $ 38 50

3522. **Telescope, Astronomical,** same as No. 3521, with addition of a fine achromatic finder with cross wires.....Duty free $ 48 00

3523. **Telescope, Astronomical,** same as No. 3521, but mounted on a strong hardwood tripod .....Duty free 44 00

3524. **Telescope, Astronomical,** same as No. 3523, with the addition of a fine achromatic finder with cross wires.....Duty free 54 00

3525. **Telescope, Astronomical,** finely finished brass body with rack and pinion movement for adjustment of focus, very smooth and steady altitude and azimuth movements. Mounted upon a heavy mahogany tripod, giving the instrument great steadiness. A crank movement with rack and pinion raises the body to any desired height, so that observations may be taken either sitting or standing. Achromatic objective 3 in. in diameter; 2 terrestrial eye pieces, 50 and 75 powers; 2 celestial eye pieces, 75 and 125 powers; achromatic finder with cross wires. Complete, in hardwood case with carrying handles and lock and key. .....Duty free 124 00

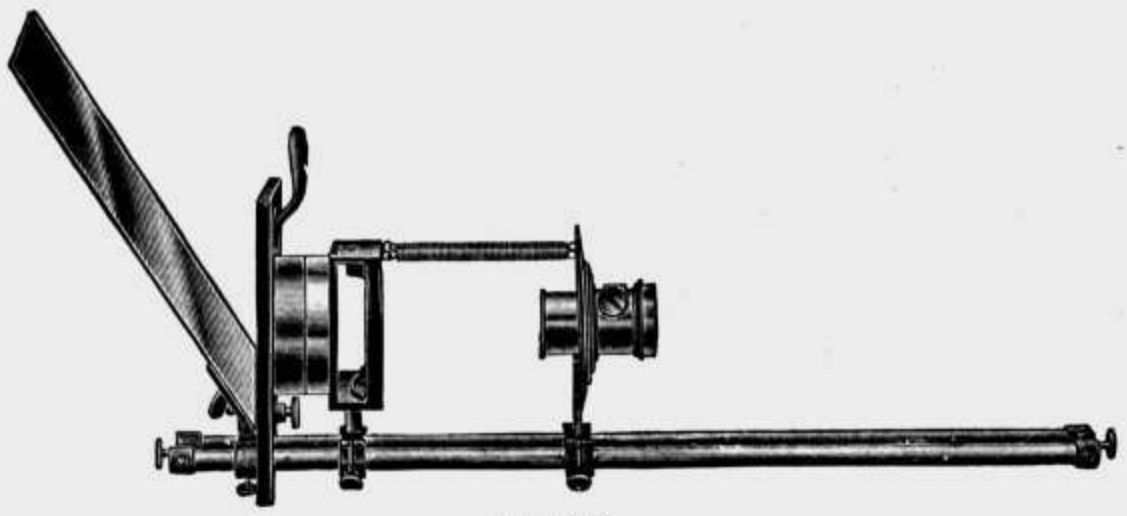
3527. **Telescope, Astronomical,** same as No. 3525, with achromatic objective 4 in. in diameter; 2 terrestrial eye pieces, 65 and 85 powers; 3 celestial eye pieces, 85, 150 and 250 powers, with finder, case, etc..... ..... Duty free 200 00



No. 3525-3527.

Telescopes of higher powers quoted upon application.

PROJECTION.



No. 3601.

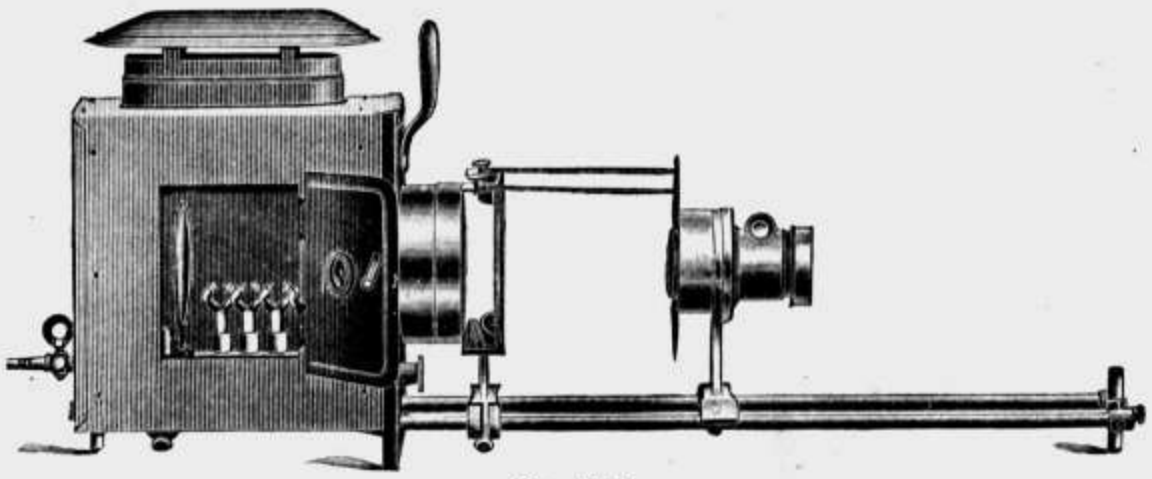
THE HELIOPTICON is a projecting instrument which can be used with sunlight or with artificial illuminants, by the addition of special parts and changes in its adjustment. The instrument arranged for sunlight is shown in the above cut and consists of a square metal plate in which is fitted a large flat ring, upon which is fastened a long mirror, by special patent hinge, capable of adjustment to any angle with the plate by a large screw, which passes through the lower portion of the ring. The ring also carries a condensing lens, in cell, and a metal handle, by which the ring and its attachments are turned in a vertical plane. The combination of movements enables the mirror to be adjusted to reflect a beam of sunlight in one direction and keeps it in position with but slight attention. Two parallel tubes of seamless steel pierce the metal plate below the ring and are held firmly by clamping screws. This tube track forms a light and rigid bench for the slide cell and objective support, and is of sufficient length for use as an optical bench, upon which can be supported various lantern attachments used in demonstrating experiments in physics and chemistry. The slide cell and objective hood are connected by spiral springs, which form an adjustable support for a small black cloth, which can be used to confine the light, and admirably takes the place of bellows or draw-tube.

3601. **Heliopticon,** arranged for sunlight only, as above, including compound achromatic ¼ size objective, one 4½ inch condensing lens and slide carrier..... $ 25 00

The heliopticon can quickly be changed to a lantern, for use on table, by replacing the mirror (held in place by hinge pin) with a Russia iron body which hooks over iron plate, and by pushing the long rod through the plate to give support to electric lamp or other illuminant.. The addition of a leg rod at each end of the tube bench and an extra condensing lens, complete the change, the lantern then tilting on the edge of the metal plate as a fulcrum, and held rigid by the adjustment of front and rear legs, as shown in the cut on opposite page. This enables the heliopticon to be used either for sunlight or artificial light, a feature which, we feel sure, will be greatly appreciated.

3603. **Extra parts,** as given above, necessary to change heliopticon into a stereopticon..... 7 00

3604. **Light Shield,** when above is to be used with arc lamp..... 2 00



No. 3617.

Heliopticon arranged for artificial light, showing acetylene burner (no longer recommended, as alcolite is superior).

3605. **Heliopticon,** arranged for artificial light only, without light apparatus of any kind in body..... $ 30 00

3607. **Mirror Attachment,** for sunlight, when ordered with combination of any artificial light..... 2 00

3609. **Mirror Attachment,** when ordered separately..... 5 00

3611. **Body,** of Russia iron..... 4 50

3613. **Leg Rods and Screw,** per pair..... 1 00

Condensing Lenses on page 255.

3615. **Heliopticon,** same as No. 3605, with No. 3638 Hand Feed Arc Lamp, No. 3644 Rheostat and No. 3648 Switch, Fuse Block, etc., complete.. 44 00

3618. **Heliopticon,** same as No. 3605, with No. 3656 Alcolite burner, complete 40 00

3619. **Polarizing Mirror,** to be placed on glass mirror..... 1 00

3620. **Polariscope Attachment,** consisting of an 8 millimeter Nicol prism, mounted in a brass tube which fits the society screw of the microscope attachment 7 00

Accessories of all kinds for use with the Heliopticon, on pages 252-253.

FULL DIRECTIONS ACCOMPANY EACH INSTRUMENT.

IMPROVED COLLEGE BENCH LANTERN.

Our **Improved College Bench Lantern** is the result of careful study as to the varied requirements of a lantern used as an educational medium.

Not only must such a lantern be capable of projecting ordinary lantern slides or transparencies, but must be quickly and easily adapted for **scientific projection** covering experiments in acoustics, optics, microscopy, physics or chemistry.

This lantern has for its foundation long nickel plated brass tubes, rigidly held a few inches apart and above a baseboard by three supporting brackets, forming a track or bench, which holds a series of interchangeable sliding supports or bridge pieces, on which may be secured the various parts necessary for the particular kind of projection work in hand.

The sliding Y shaped bridge pieces are so constructed that they can be either securely locked to the bench or swung over out of the way on one or the other of the track tubes as desired. This hinge-like movement of the supports is of great convenience, since it enables one to change quickly from one kind of projection work to another.

Illustration No. 3626 shows the lantern with the cooling tank and projection microscope in position ready for use, but should the teacher desire to project lantern slides the supports carrying the cooling tank and projection microscope are swung over toward the operator, and the supports containing the slide stage and the regular objective (both partially shown in the cut) brought forward into optical line with the condensing lenses and illuminant.

All sorts of apparatus suitable for projection can be used on the bridge pieces, such as slot and diaphragm attachments, prism support, mirrors, lenses, chemical tanks, polariscopes and crystal stages.

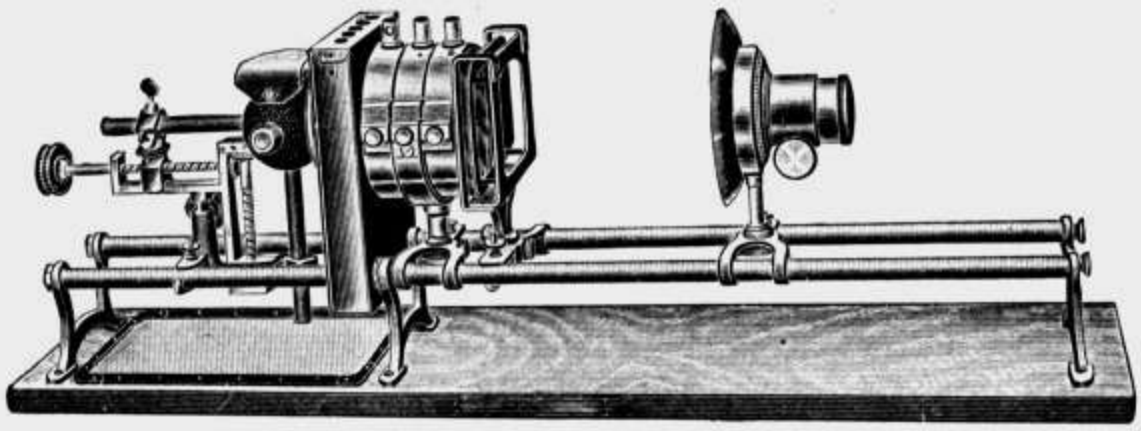
A lantern having a condensing lens of fixed focal length is incapable of producing the best results when used with objectives having a great variation in focal length; for instance, an objective of long focus used with lantern slides, and a high power microscope objective of extreme short focus; to make it possible for the operator to easily and quickly substitute one condensing lens for another, even after the lenses have become heated, we have adopted a new method of mounting, each lens being contained in a separate brass ring so arranged that it can be easily slipped into place and fastened securely in but a few seconds of time.

The **advantages** of this construction are:

First—That the equivalent focus of the condensing lens system can be changed at will by substituting one lens for another of different focal length, thus giving the operator power to use the combination of lenses which exactly suits the condition under which they are to be used.

Second—The distance between the condensing lenses can be varied at will, which is an important feature, especially when using high power microscope objectives, since a slight variation in the distance of separation will often increase the illumination on the screen.

Third—By our method of mounting, the extra condensing lens can be reversed, secured to a support and used to advantage as a projection lens in some experiments. The metal parts of the instrument are nearly all made of an aluminum alloy, which greatly reduces the weight of the entire instrument. The different accessories sold to use with this instrument are all interchangeable in the Y supports.

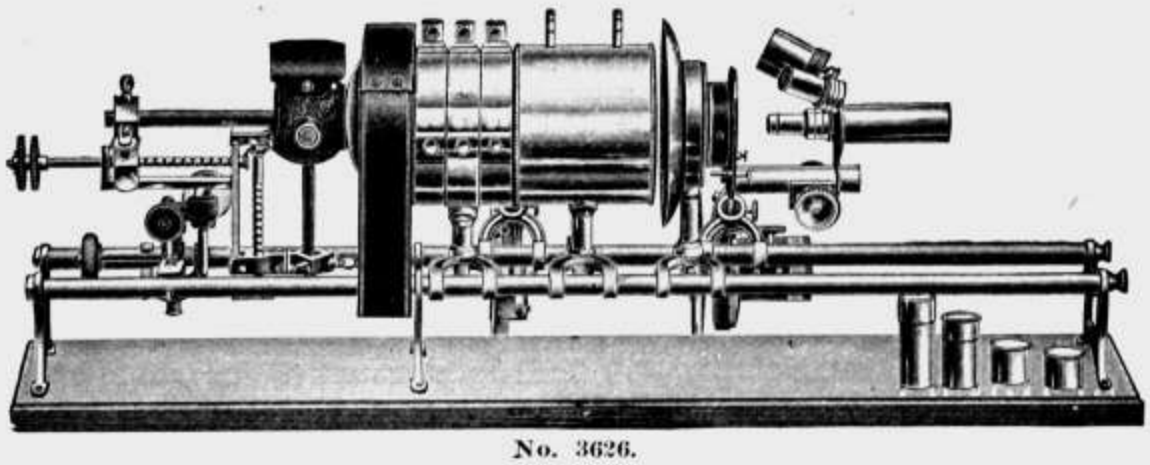


No. 3622.

3621. **College Bench Lantern,** without illuminant, consisting of baseboard with bench, Y support for illuminant, steel light shield, one pair regular focus condensing lenses separately mounted, one mounting without lens (used as a light shield), special supporting frame for condensing lenses, steel slide stage, slide carrier, ¼ size objective with double adapting ring support, three Y bridge pieces for the above parts, and wooden case..... $ 35 00

3622. **College Bench Lantern,** complete for lantern slide projection, same as No. 3621, with the addition of No. 3636 Hand Feed Arc Lamp, No. 3638 Ball Hood, No. 3644 Rheostat and No. 3648 Switch, Fuse Block, etc..... 50 00

3624. **College Bench Lantern,** complete for lantern slide projection, same as No. 3621, with the addition of No. 3656 Alcolite Burner..... 45 00



No. 3626.

3626. **College Bench Lantern,** for projecting both lantern and microscopical slides, and quickly interchangeable. Consists of No. 3622, with the addition of No. 3642 Fine Adjustment Support, No. 3686 Projection Microscope (without objective or nosepiece), No. 3706 Double Adapting Ring and No. 3713 Y Bridge Piece for holding microscope, thereby providing an immediate change from lantern slide projection to microscopic projection, and vice versa; No. 3710 Cooling Tank and No. 3712 Y Bridge Piece for supporting the same, and No. 3627 Set of Extra Condensing Lenses..... 87 25

N. B.—The illustration represents the lantern as described above, with the addition of triple nosepiece, three microscope objectives and two amplifying lenses.

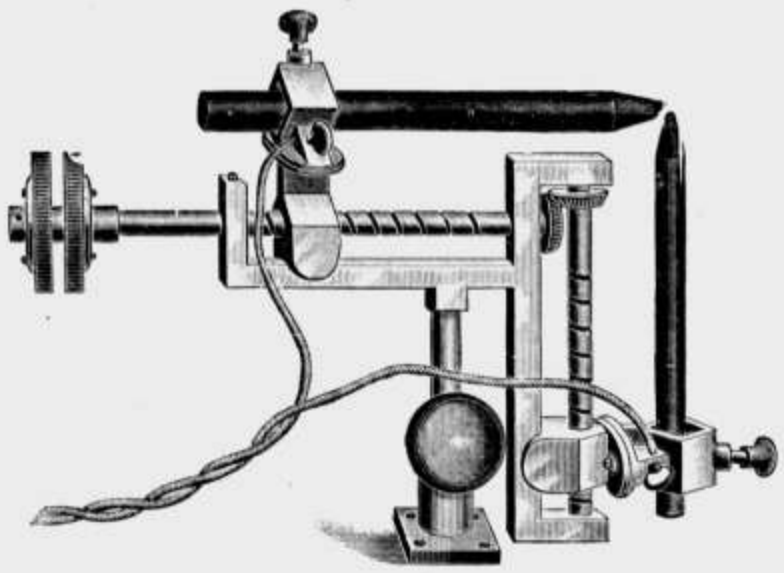
3627. **Two Condensing Lenses** (long and short focus), with special mounting, for No. 3621..... 5 00

Note.—No. 3627 is necessary for changing the equivalent focus of the condensing lens by substituting one lens for another, as per description on page 247.

3629. **Pin Support,** for holding condensing lenses in their mounting..... 25

3630. **Gap Attachment,** for the College Bench Lantern. This consists of a sliding base with the bench rods cut so as to give a gap for the use of apparatus too large to attach to base or by insertion of extra rods to lengthen the base. The rod on the right hand side is graduated to facilitate the location of any point desired.

Gap Attachment, including sliding base and graduated rods, add extra to lantern..... 12 00



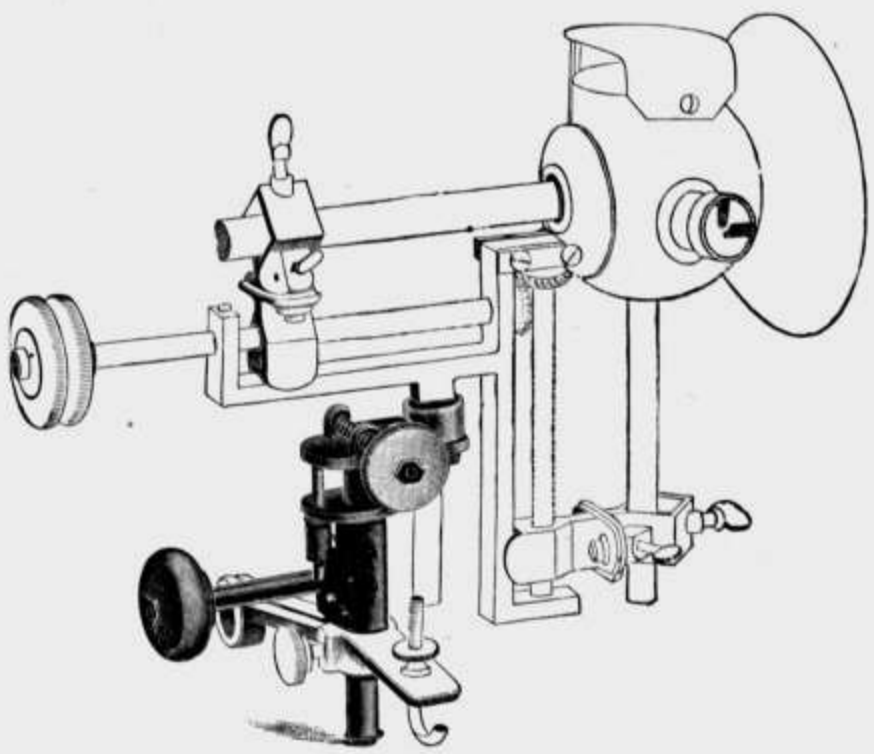
No. 3636.

3636. **Arc Lamp, 90° Hand Feed.** The 90° or Right Angle Arc Lamp has one advantage over the regular upright form, since the arc can be kept nearer in line with the center of the lenses for a greater length of time without readjusting the carbons in the holders, than with the upright form, since the horizontal carbon is placed in line with the optical axis and is fed directly towards the center of the condensing lens, the point of the carbon being the source of light. The carbons can each be fed separately or together, depending on how one grasps the feeding wheels. Operated on direct current, a ⅜ inch solid vertical and a ½ inch cored horizontal carbon are necessary; if upon alternating currents, both carbons should be ½ inch cored..... $ 8 00

3638. **Ball Hood and Shield,** with ground mica disc, giving a perfect reduced, inverted image of the carbon points, indicating to the operator their exact position and how to feed the carbons to produce the best results on the screen (see cut below)..... 1 00

3640. **Y Bridge Piece,** for No. 3636 (included when arc lamp is ordered with lantern)..... 1 00

3642. **Fine Adjustment Support.** The cut shows the support (shaded portion) in position, clamped to a Y bridge piece and holding No. 3636 Arc Lamp with No. 3638 Ball Hood. By the use of this support the arc is kept in perfect alignment with the center of the lenses by means of two screws, one (at the back) moving the entire lamp up and down, the other (at the side) giving a lateral swinging motion. This support is particularly recommended where a projecting microscope is to be used..... 5 00



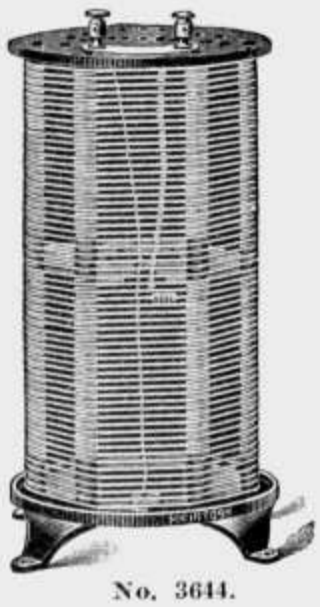
No. 3642.

3644. **Rheostat,** for either direct or alternating currents, capacity 15 amperes on currents from 110 to 115 volts pressure. Height 10½ inches. Diameter 6 inches..... $ 5 00

Note.—Although this rheostat has a fixed resistance for currents from 110 to 115 volts pressure, the resistance can easily be adjusted by attaching one of our special "Jumper wires," so that currents from 52 to 104 volts can also be used.

3646. **Rheostat,** new adjustable form, similar to No. 3644, but covered with gauze to prevent contact with the hot wire and furnished with a sliding contact for varying amount of resistance (see illustration under No. 3748)..... 10 00

3648. **Switch, Fuse Block** and plugs, and 15 feet flexible wire cable for above..... 2 10



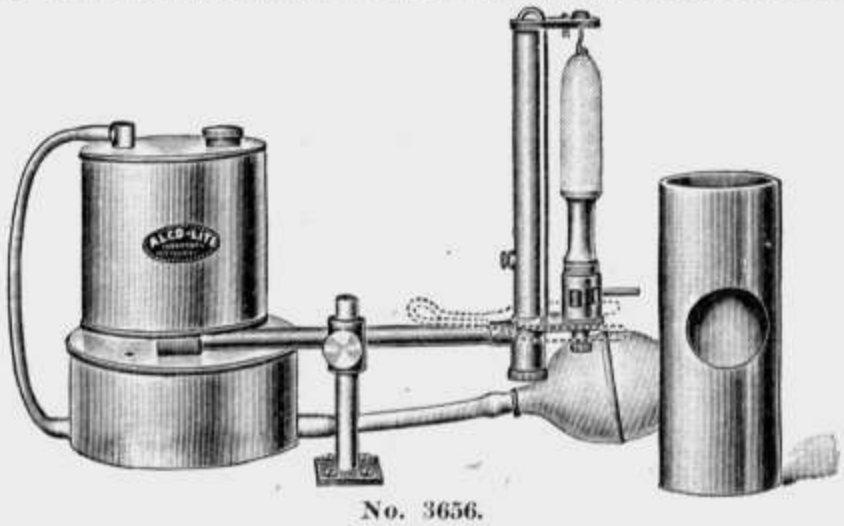
No. 3644.

For **other Rheostats,** see pages 189-190.

3650. **Carbons,** direct current, "uppers," ½x7½ inches cored, per dozen..... 70

3652. **Carbons,** direct current, "lowers," ⅜x6 inches solid, per dozen..... 55

3654. **Carbons,** alternating current, upper or lower, ½x7½ inches cored, per dozen..... 70



No. 3656.

3656. **Alcolite Burner,** the new projection lamp using a mantle and burning denatured alcohol. Grain alcohol can also be used with equally good results. The lamp consumes but five ounces per hour. The tank holds ten ounces, or enough for a two hour run.

The light produced is next in brilliancy to calcium light and will make a good, clear, satisfactory picture up to ten feet square. It has many points of excellence to recommend it to our customers who, from force of circumstances cannot use electric or calcium light:

It is very compact and light in weight.

It costs but little to operate.

It is perfectly clean, smokeless, gives off no disagreeable odor, and does not require cleaning after being used.

It is so simple that a child can learn to operate it.

It is perfectly safe.

It can be used with almost any kind of a single lantern using standard size lantern slides.

It is sold at a very reasonable price.

Note.—Illustration shows plain chimney and plate base when alcolite burner is sold separately.

Complete with rubber bulb, pressure regulator, mantle, funnel shield for use with No. 3621, and instructions for operating..... 10 00

3658. **Mantles,** for alcolite burner, in any quantity less than 1 dozen, each.. 20

3659. **Mantles,** for alcolite burner, per dozen..... 1 75

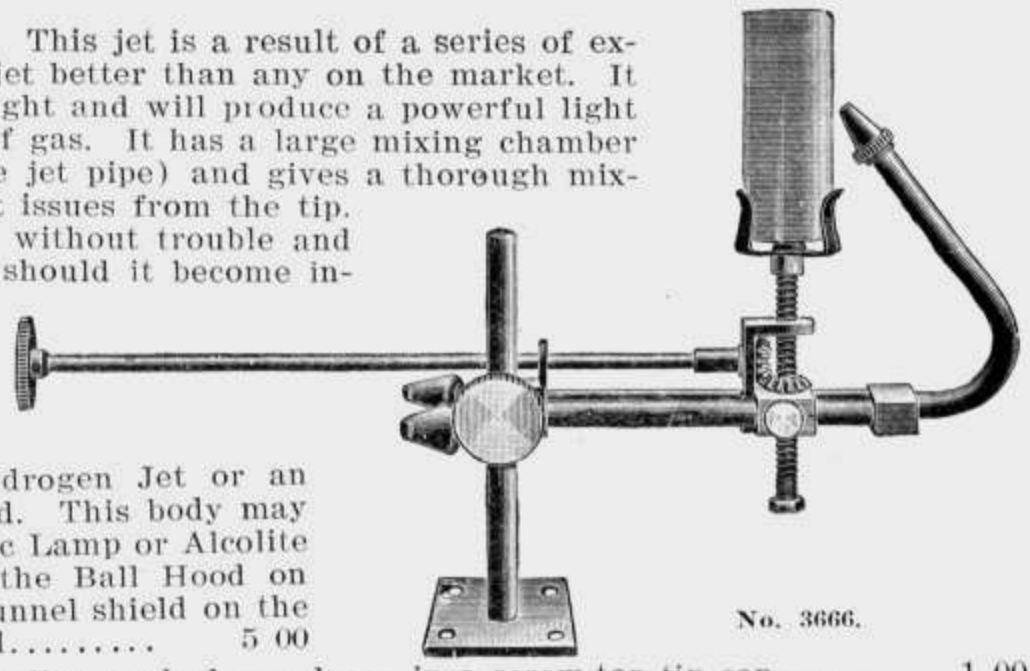
3660. **Calcium Carbide,** ¼ inch size, in 10 pound screw top cans, each..... 1 00

N. B.—We do not recommend acetylene for an illuminant, as the alcolite burner surpasses it in candle power, cleanliness and cost.

See **Table of Relative Candle Power of Different Illuminants** on page 251.

3666. **Oxy-Hydrogen Jet.** This jet is a result of a series of experiments to produce a jet better than any on the market. It is small and light in weight and will produce a powerful light without noise or waste of gas. It has a large mixing chamber (the entire length of the jet pipe) and gives a thorough mixture of the gas before it issues from the tip. The tip can be removed without trouble and with but slight expense should it become injured by the hot lime resting against it. Price ..... $ 10 00

3668. **Lantern Body,** of sheet steel, to fit No. 3621, when Oxy-Hydrogen Jet or an Acetylene Burner is used. This body may also be used with the Arc Lamp or Alcolite Burner, in which case the Ball Hood on the Arc Lamp and the funnel shield on the Alcolite may be omitted..... 5 00



No. 3666.

3670. **Limes,** superior quality, packed one dozen in a screw-top tin can..... 1 00

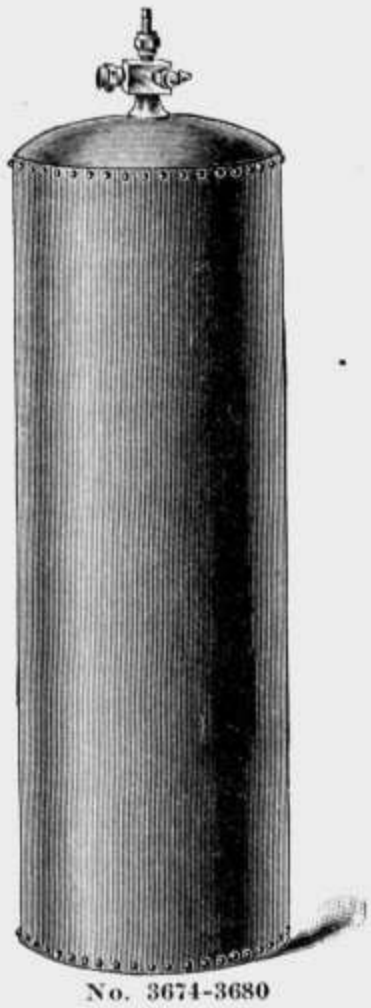
3672. **Limes,** same as No. 3670, sealed in glass tubes. Each.. .15. Per dozen 1 50

Steel Gas Cylinders, made from the best open hearth steel, selected for this particular use. Each cylinder is tested to 600 pounds hydrostatic test and is unqualifiedly guaranteed. The capacity is figured at the standard pressure of 225 pounds to the square inch. Price includes brass nameplate engraved with name of school and address. The MacLahlan Patent Double Needle Valve is also included with each cylinder.

Cat. No.	Capacity, Feet.	Size, inches.	Weight, each.	Price, per pair.
3674.....	25	10x34	62	41.50
3676.....	35	12x36	75	44.50
3678.....	40	12x42	85	47.25
3680.....	50	12x48	95	50.00

Cylinders filled, either oxygen or hydrogen, per cubic foot..... 15

3682. **Pressure Gauge.** Indispensable to users of oxy-hydrogen, for measuring the amount of gas in a tank. Indicates both cubic feet and pounds pressure 5 50



No. 3674-3680

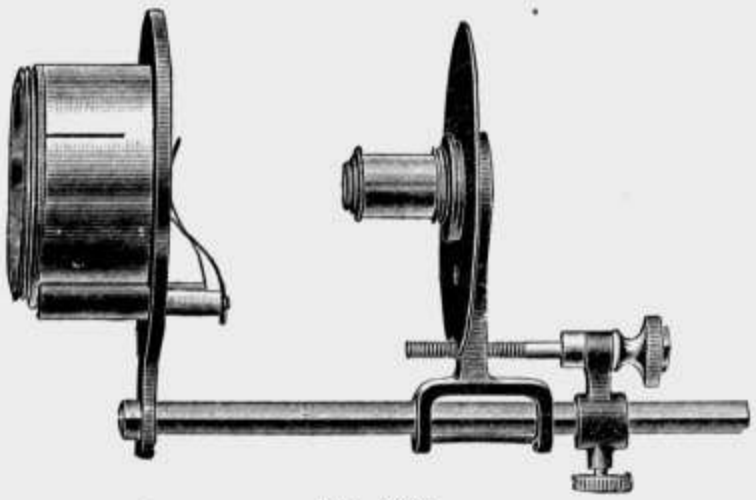
Relative Candle Power of Different Illuminants.

Brilliancy is not the only requisite for a first class light for projection purposes. A perfect light should come from a point, but as this is practically impossible, it follows that the smaller the area from which the light emanates, the more perfectly the light will focus and the clearer and more sharply defined the picture on the screen will be, the brilliancy remaining the same. The following table shows the brilliancy **at the screen,** and not for general illumination outside the lantern:

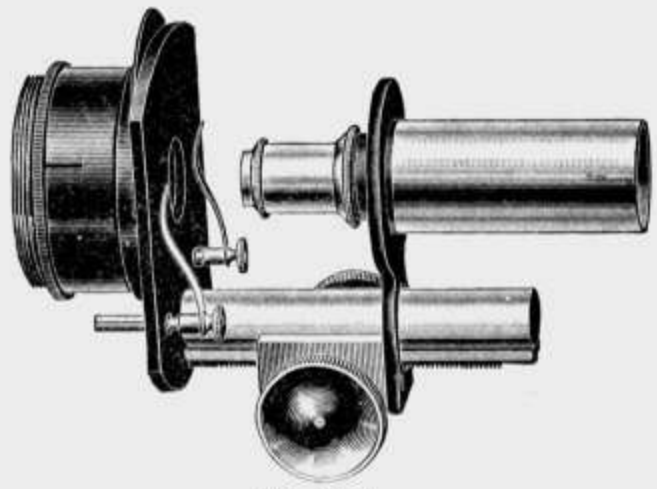
Oil Lamp	100 c. p.
Welsbach Gas Burner.....	110 c. p.
Incandescent Lamp	125 c. p.
Acetylene Burner	250 c. p.
Alcolite Burner	350 c. p.
Lime Light (Oxy-hydrogen Jet)...	800 c. p.
Arc Light	2,000 c. p.

ACCESSORIES.

FOR HELIOPTICON OR COLLEGE BENCH LANTERN.



No. 3684.



No. 3686.

3684. **Projection Microscope,** simple form, without objective..... $ 11 00

3686. **Projection Microscope,** a superior instrument, embodying all the latest improvements. Diagonal rack and pinion movement, supplied with revolving diaphragm and sleeve support for sub-stage condensing lens, which is necessary for high power work. The rack bar can be turned around to any desired position after the instrument is screwed fast to the lantern front, without objective..... 22 25

3688. **Micrometer Stage,** fine adjustment, for No. 3686..... 3 00

3690. **Sub-stage Condensing Lens,** necessary with ¾ inch or higher objectives 4 00

3692. **Double Nosepiece** 5 00

3694. **Triple Nosepiece** 7 50

3696. **Amplifying Lenses,** medium or high power, to be used in place of eye-piece for giving higher magnification with low power objectives..... 2 00

3698. **Projection Objective,** 12 millimeters focus..... 8 00

3700. **Projection Objective,** 16 millimeters focus..... 4 50

3702. **Projection Objective,** 32 millimeters focus..... 4 50

3704. **Projection Objective,** 40 millimeters focus..... 4 50

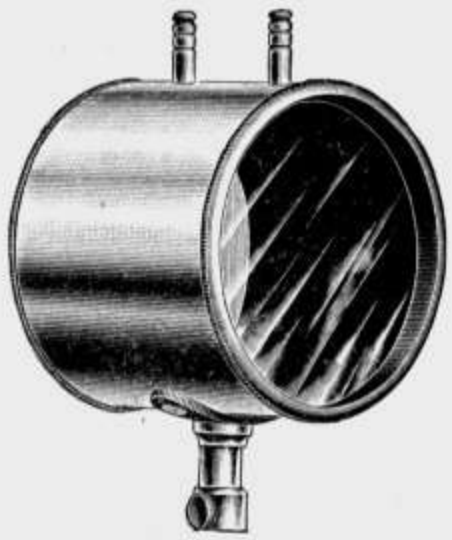
3706. **Double Adapting Ring Support**..... 2 00

3708. **Y Bridge Piece**..... 1 00

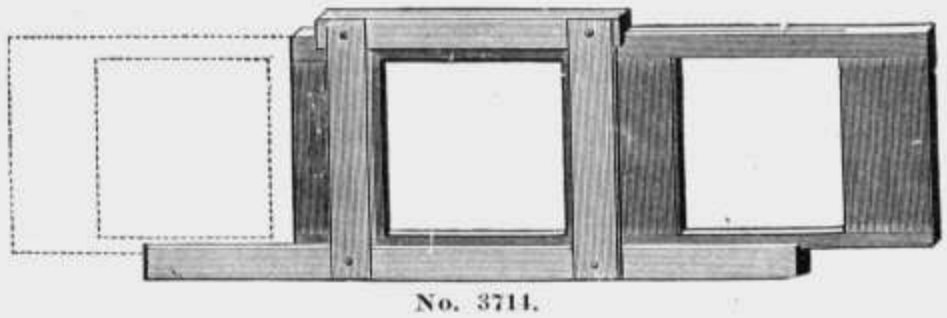
Note.—Nos. 3706 and 3708 are necessary with microscope if quick change from lantern to microscope slide is desired.

3710. **Cooling Tank,** of the latest design; holds about a quart, is of nickel plated brass, polished, and guaranteed water tight. the glass plates are easily removable. A cooling tank is a necessity when a projection microscope is used. The distilled water (alum solution not necessary) with which it is intended to be filled, absorbing much of the heat of the focused beam of light, lessening the danger of injury to the specimen under examination..... 6 00

3712. **Y Bridge Piece,** for tank, necessary when quick change is desired..... 1 00

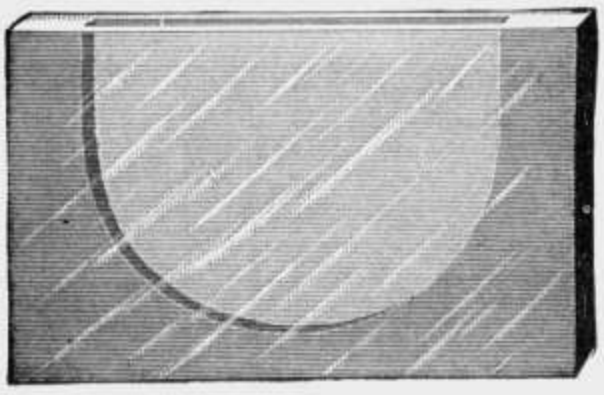


No. 3710.



No. 3714.

3714. **Slide Carrier,** "Rapid," of wood ..... $ 55
3716. **Adjustable Slit,** for the analysis of light 3 50
3718. **Pencil Ray Attachment,** with diaphragm and lens for rendering rays parallel 3 50
3720. **Pencil Ray Attachment,** with diaphragm only 2 00



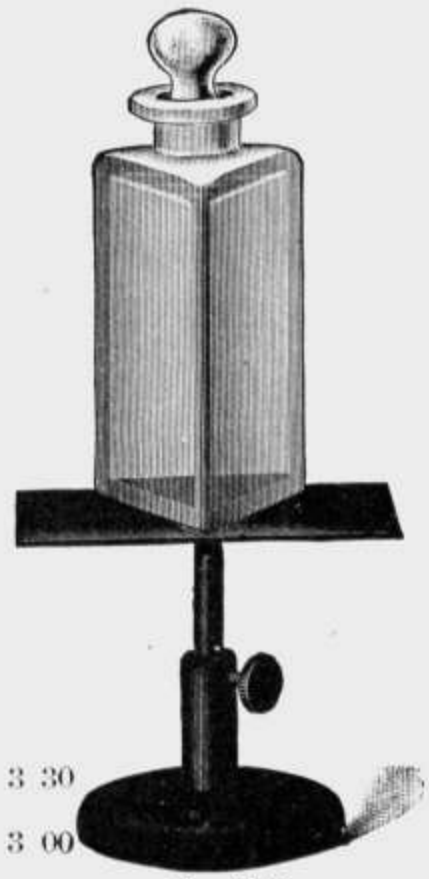
No. 3722.

3722. **Cell,** of glass, 4 inches high and 5 inches long. Will fit into the slide stage of any lantern using standard size slides. It can be used dry to hold insects, or filled with water, showing live specimens from river and pond, such as small fish, leeches, water worms, amoeba, etc. Also useful for illustrating capillary action, specific gravity of liquids, chemical action, etc. Not affected by acid, alkali or alcohol 3 30
3724. **Cell,** two glass plates with rubber packing and brass clamps 3 00
3726. **Cell,** same as No. 3724, fitted with platinum electrodes and binding posts, for the demonstration of electrolytical analysis, chemical action, crystallization, etc. 4 00



No. 3730.

3728. **Animalculae Cage,** on a glass slip 1x3 ..... 1 10
3730. **Eaton's Direct Vision Prism,** for the projection of spectra on a screen. It consists of a combination of dense glass and carbon bisulphide prisms of accurately calculated angles and indices of refraction, so as to give a "direct vision" spectrum of large diffusion. At a distance of 20 feet from screen we secure a clear spectrum band 6 feet long by 2 feet wide. We wish to state that this is the only moderate priced prism, to our knowledge, capable of such results. Mounted on a rod 10 m. m. in diameter, and may be used on the bed of a lantern, or, as illustrated, on a stand. The spectrum of any intense illuminant may be readily obtained. For the spectra of metals we recommend the use of Mann's Metal Spectra Apparatus. Complete with support 27 75
3731. **Mann's Metal Spectra Apparatus,** for the projection of six different metals consecutively on the screen. The attachment in use displaces the negative (or lower) carbon in an ordinary arc lamp. In conjunction with our No. 3730 Eaton's Direct Vision Prism, very clear spectrum bands may be easily produced. For use with 90 degree arc lamp 15 00
3732. **Elevating Stand, Adjustable,** for holding prisms and other apparatus in front of the objective, without bottle 75

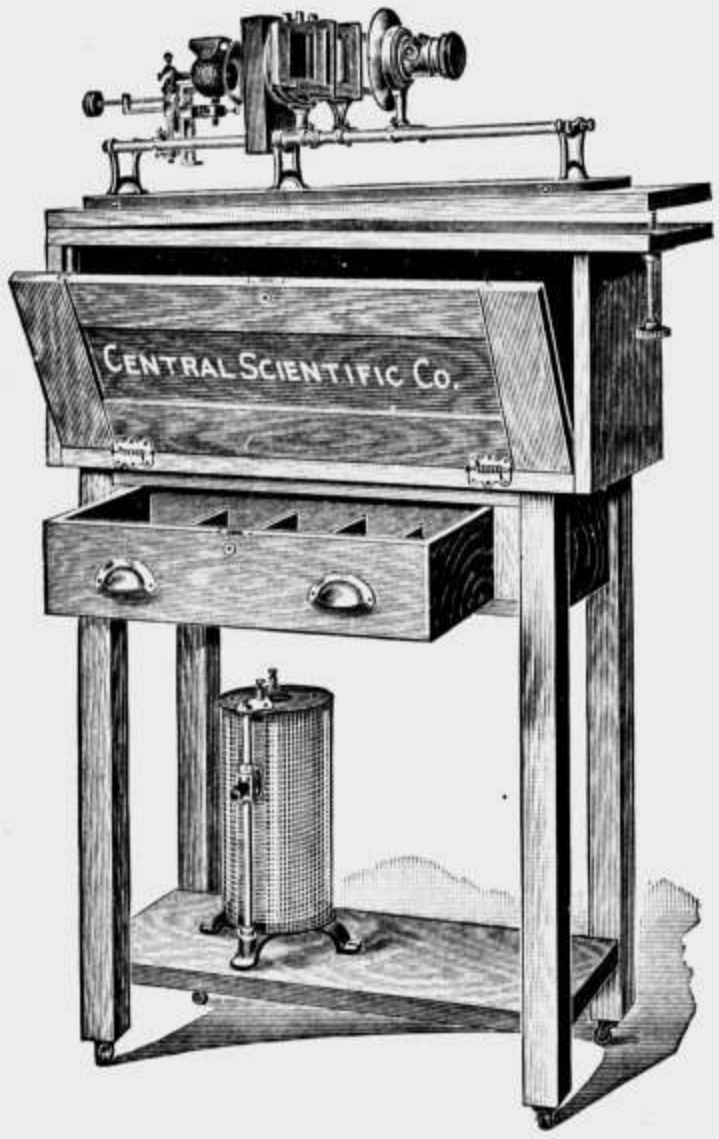


No. 3732.

Bottle Prisms, page 221.



No. 3740



No. 3748.

3740. **Vertical Attachment.** This attachment can be used on the College Bench Lantern and on the Heliopticon for solar projection, which for microscopic projection affords a method superior to any hitherto used. This apparatus is designed expressly for the illustration and exhibition of the various phenomena attending the scientific experiments relating to heat, light, sound, electricity, magnetism, cohesive figures and crystallization, and is useful in many experiments where the object projected must be kept in a horizontal position. No prisms are used, but the finest thin German mirror glass, which materially lessens the cost of the apparatus and avoids double reflection to a large extent. Without condensers or objective..... **10 00**

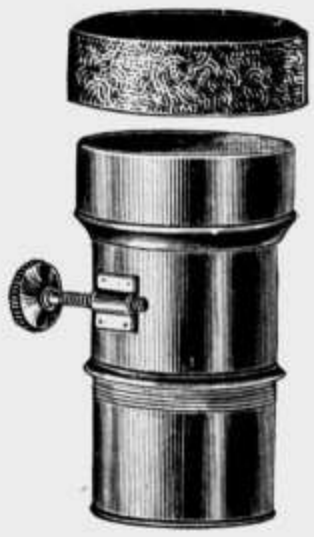
3742. **Vertical Attachment,** same as No. 3740, with condensing lenses in mirror box **14 00**

3748. **Lantern Table.** This table is made of polished hardwood. Provided with drawer, lock and key and compartments for holding lantern slides of the standard size. A cupboard is furnished, with a spring hinged drop door with lock, to hold lantern and lantern accessories. Lantern board has slow movement screw for angle adjustment. Legs are provided with casters to facilitate movement of table from one room to another. Shelf for holding rheostat.

Dimensions over all—height, 4 feet 2 inches; width, 15¼ inches; length, 3 feet 3 inches; inside measurement of cupboard, 13⅞ inches x 2 feet 10 inches x 34 inches. Capacity of drawer, 500 slides **27 75**

Achromatic Projection Objectives. The objectives listed below are manufactured especially for us and are guaranteed to be superior to the imported objectives.

Catalog No.	Size of Lens.	Focus, in.	Back Focus, in.	Price.
3750	¼	6	4½	6.00
3751	¼	10	7	6.00
3752	¼	12	8½	6.00
3754	½	10	7	14.45
3755	⅔	12	8½	21.00
3756	¾	15	10½	26.00



NOTE—The size of the picture at a given distance from the screen depends entirely upon the equivalent focus.

Approximate sizes of pictures made by achromatic objectives at different distances from the screen:

Size of Lenses	10 feet.	20 feet.	30 feet.	40 feet.	50 feet.	60 feet.	70 feet.	80 feet.	90 feet.	100 feet.	110 feet.	120 feet.
1-4 size	5	10	15	20	..	..	..	..	..	..	..	..
1-3 size	4	8	12	16	20	24	..	..	..	..	..	..
1-2 size	..	6	9	12	15	18	21	24	..	..	..	..
2-3 size	..	..	7	10	13	16	19	22	23½	25	..	..
4-4 size	..	..	6	8	10	12	14	16	18	20	21	24

CONDENSING LENSES.

3760. **Condensing Lens,** 4½ inch diameter, 6½ inch focus..... $ 1 75
3761. **Condensing Lens,** 4½ inch diameter, 7½ inch focus..... 1 35
3762. **Condensing Lens,** 4½ inch diameter, 10 inch focus..... 1 35

SCREENS.

Made of the best quality bleached muslin, double corners, edges bound with non-elastic webbing, double tapes or rings at the corners and tapes or rings for stretching ropes every two feet around the edge.

3765. **Muslin Screen,** 6 feet square..... 3 00
3766. **Muslin Screen,** 8 feet square..... 4 00
3767. **Muslin Screen,** 10 feet square..... 4 50
3768. **Muslin Screen,** 12 feet square..... 7 00
3769. **Muslin Screen,** 15 feet square..... 10 00

OPAQUE SCREENS ON SPRING ROLLERS.

Perfectly opaque and of dead white finish.

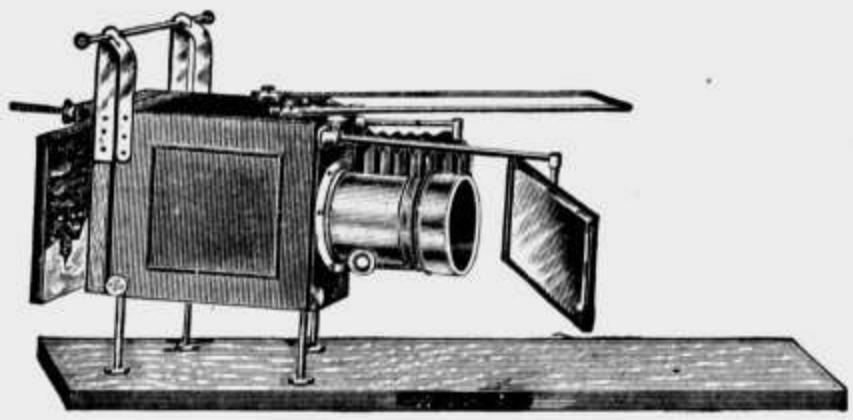
3771. **Enameled Muslin Screen** on spring roller, 6 feet square..... 4 45
3772. **Enameled Muslin Screen** on spring roller, 8 feet square..... 8 35
3773. **Enameled Muslin Screen** on spring roller, 10 feet square..... 16 50
3774. **Enameled Muslin Screen** on spring roller, 12 feet square..... 22 00

BOOKS ON PROJECTION.

"Art of Projecting," Dolbear.....Net 1 80

"Manual of Biological Projection and Anesthesia of Animals." A practical guide in the selection and operation of projection apparatus, the methods of preparing live animals and plants for projection, the anesthesia of animals, and the little knacks in manipulation which insure success in projecting vivographs. By Aaron Hodgman Cole, A.M., instructor in biology and projection in the Chicago Normal School. Two hundred pages, 29 illustrations, over 1,200 time saving references in "Index," "Ready Reference Table" and text. Bound in substantial cloth boards. Price, $1.50 net; by mail, postpaid..... 1 60

OPAQUE ATTACHMENT.



No. 3777.

3777. **Opaque Attachment,** designed to project paper prints of all kinds, sketches, lithographs, photographs, the page of a book or any opaque object not larger than 5 inches square. It can be used with any standard lantern which is equipped with an electric arc lamp as the illuminant, if not placed more than 30 feet from the screen. It is intended to supplement the optical lantern in classroom work, but cannot take its place.

The principle on which it operates is very simple, since it is only necessary to fix an objective at the proper focal distance from the object, which must be very brilliantly illuminated (the more brilliantly the better) and an image is at once projected on the screen by reflected light. The image is reversed by the lens (as in a mirror reflection), and in order to have it appear correctly on the screen it is necessary either to reflect the light from the objective by means of a mirror or use the instrument back of a translucent screen. All reflections cut down the illumination, and some instruments on the market use two mirrors, which greatly decreases the comparatively small amount of available light.

Before the general introduction of the electric arc lamp as a projection medium, opaque projectors were interesting, but not practicable, for classroom work because of the indistinctness of the image from lack of light, but there is now a marked revival of interest in the subject.

There are six requirements for successful opaque projection: First, a very brilliant illumination of the object; second, a very large objective; third; but one mirror reflection; fourth, a small screen image; fifth, a dark room; sixth, a good opaque screen.

Our opaque attachment has but one mirror reflection and includes a large objective, in fact the largest and best obtainable, producing a picture one foot in diameter for every yard distant from the screen. Complete with baseboard and leg rods as illustrated, including special book holder for use with any lantern using the electric arc lamp $ 50 00

3778. **Opaque Attachment,** same as above, without baseboard or leg rods, but with clamps for attaching to No. 3621 College Bench Lantern.. 48 00



No. 3779.

3779. **Opaque Projector,** capable of projecting a magnified image,

First, of any flat opaque surface in its natural form and color, such as photographs, lithographs and prints of all kinds; leather, cloth, marble or stone, wood showing grain, coins, etc.

Second, it will project objects, the surfaces of which are not flat, such as bone, surgical instruments, fruit and flowers, minerals, jewelry, shells, etc. It will project objects in motion (such as the works of a watch), as well as at rest, its only limitation being one of size. Any approximately flat object measuring eight inches square or less and not thicker than two inches comes within the limit.

An object eight inches long produces an image fifty-four inches long on a translucent screen at a ten or eleven foot range, and the smaller objects project in like proportion.

Very satisfactory images can, however, be projected on a ten foot opaque screen, but in this case the image will be reversed as in a mirror reflection.

Successful results largely depend upon the brilliancy of light thrown upon the object projected. We use two 90° hand feed arc lamps, the light from which is thrown upon the object directly without being reflected to change its direction and illuminates the object from two different directions, thus avoiding deep shadows.

We provide with each projector a translucent screen 4½ feet square, mounted on spring roller and supported on a neat hardwood frame.

Complete with rheostats, switches, fuse blocks, two picture frames, adjustable shelf support and mounted screen with frame..... $ 177 50

3779A. **One pair Cooling Tanks and Supports,** for above..... 17 00

LANTERN SLIDES.

Our lists of lantern slides are so extensive that we will only mention them in this place and refer to **Catalog "Q,"** and other special pamphlets listed below.

The different series are selected by specialists in the particular subject, and in most of the series prepared by them. All are of the finest quality, the negatives having been taken only from such illustrations that would give good results. In the majority of slides listed the negatives used were made from the object itself.

The **Regular Series** contained in **Catalog "Q"** embraces the following subjects. Geography, physiography, geology, botany, natural history, anatomy, physiology, astronomy, history, architecture, engineering, psychology, histoiogy, pathology, bacteriology, mining, ornithology, portraits, radium and radiographs.

The **Special Series** comprises the following:

"Atwood and Cook Series." 560 slides selected by Prof. W. M. Atwood of the University of Chicago and Mrs. Jane Perry Cook of the Chicago Normal School, with special reference to an intelligent study of physical geography. A description of each slide, edited by Prof. Ridgely of the Normal University at Normal, Illinois, is furnished.

"Meteorological Series." 268 slides selected by **"The Geographical Society of Chicago,"** with special reference to covering the most important features in meteorological study.

"Land Series" of Mounted Micro-Preparations of Laboratory Materials. 670 slides selected to give a comprehensive study of modern botany from the viewpoint of morphology, anatomy, physiology and ecology.

"Derr Series," for physics. 506 slides selected and prepared by Prof. Louis Derr of the Massachusetts Institute of Technology to aid the teachers by diagrams and illustrations of instruments and their arrangement in certain experiments in tracing for his pupils the development of scientific work in the physical line.

"Dubois Series." 325 slides selected and prepared by Dr. Norman A. Dubois of Case School of Applied Science, showing in detail the principal chemical processes and the various forms of manufacturing equipments for making commercial chemical compounds. A brief description is furnished with each slide.

Catalog "Q" and **Special Lists** will be mailed to those interested upon receipt of request.

LANTERN SLIDE ACCESSORIES.



No. 3780.

3780. **Slide Cabinet,** strongly made of hardwood, neatly finished and highly polished. Nickel plated clasps, lock and key, leather handle. Apartments for 50 slides. Will hold 75..... $ 2 75

3781. **Slide Cabinet,** for 120 slides. Inside of cover padded and plush lined. Leather covered. Better and more expensive construction than above 5 00

3782. **Slide Binding,** dense black, heavily gummed, strong rope paper. Per roll of 12 yards 9-16 inch wide..... 11

3783. **Slide Binding,** strips cut exact size of standard lantern slides. Binders' black cloth heavily gummed on one side with a special gum. Per 100 strips, packed in long carton box..... 20

3784. **Slide Cover Glass,** uniform in thickness and warranted entirely free from rust. Per dozen..... 20

3785. **Slide Mats,** Olmsted's special. Cross section ruled and circled for cut out purposes. Per package of 25..... 40

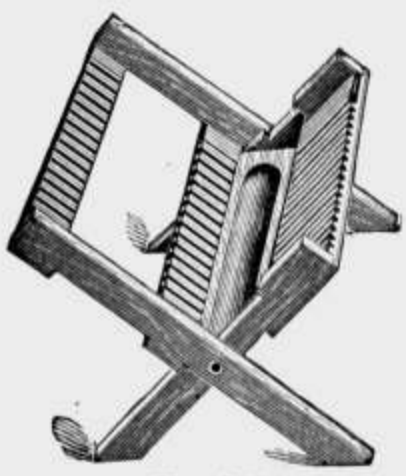
3786. **Slide Numbers,** gummed on back. 1—10,000 Range, 200 numbers on a sheet. Per sheet..... 30

Slide Plates, in sealed packages of 12 plates, 3½x4 inches.

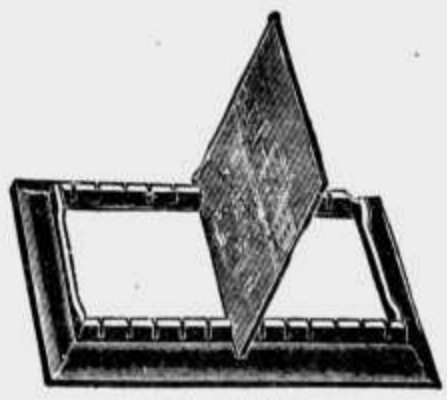
3787. **Carbutt's.** Per package 55

3788. **Seed's.** Per package 55

3789. **Cramer's.** Per package 55



No. 3791.



No. 3793.



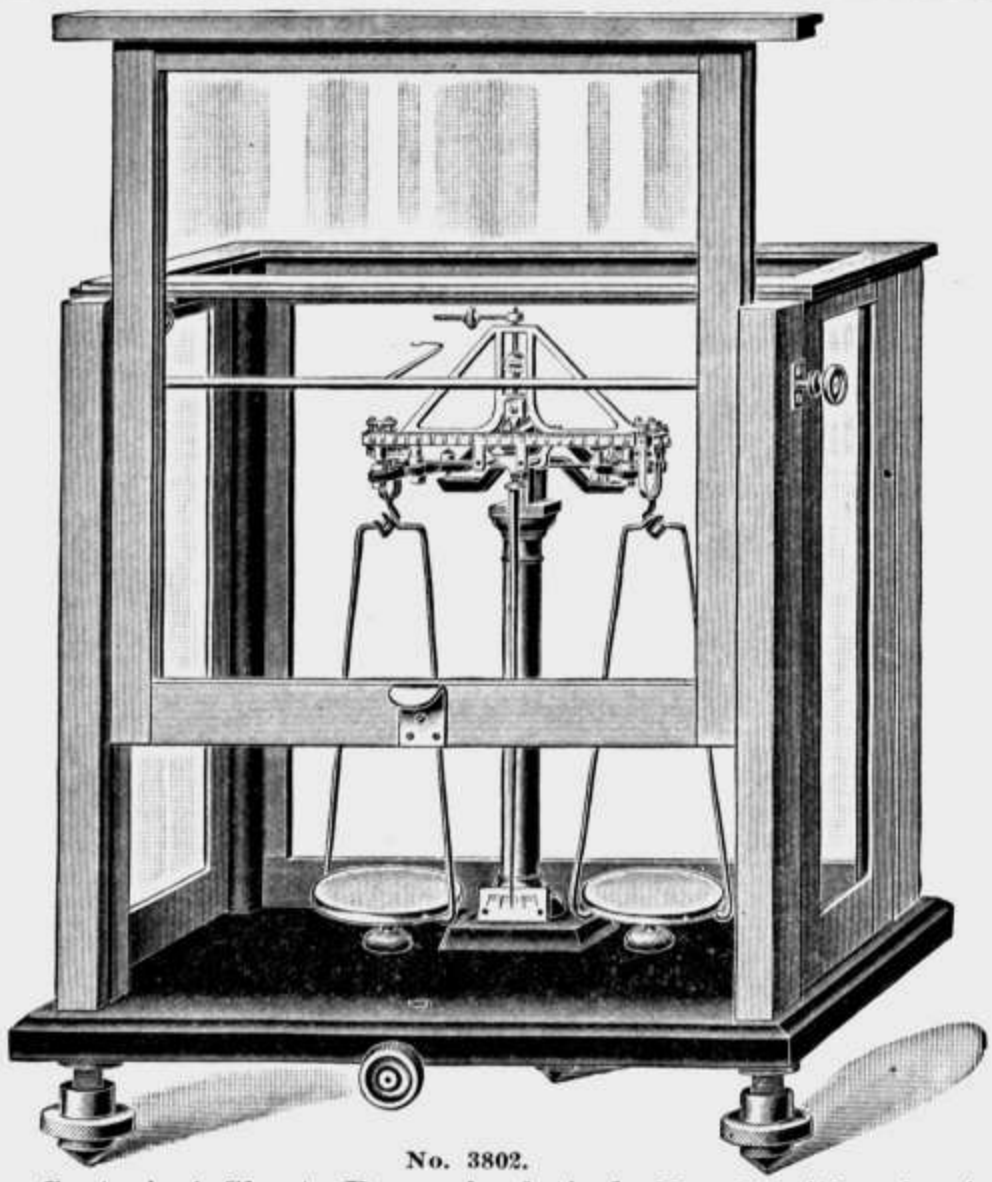
No. 3794.

3791. **Negative Rack.** Folding rack of wood, 24 slides..... 25

3792. **Negative Rack.** Same as No. 3791, for 12 slides..... 20

3793. **Negative Rack.** Black enameled iron, suitable for plates up to 8x10 inches. Each 30

3794. **Slide Vise.** By this device the mat is held in close contact with the lantern slide and cover glass, thus leaving both hands free to manipulate the binding strips. When slide is clamped between the rubber discs it may then be easily revolved to facilitate binding. Each 65



No. 3802.

3800. **Balance, Sartorius' Short Beam Analytical,** No. 2, with aluminum beam, adjustable end knife edges and compensating hangers, agate knife edges and planes and platinum plated pans. Provided with a finely finished aluminum case, fitted with counterpoised front sliding door and mounted on a black glass plate with leveling screws. Length of beam, 14 centimeters; capacity, 200 grams; sensibility with full load, 1 milligram.....Duty free 160 00

3800A. **Balance, Sartorius' Short Beam Analytical,** No. 2. Capacity, 100 grams; sensibility with full load, .05 milligram; length of beam, 12 centimeters .....Duty free 160 00

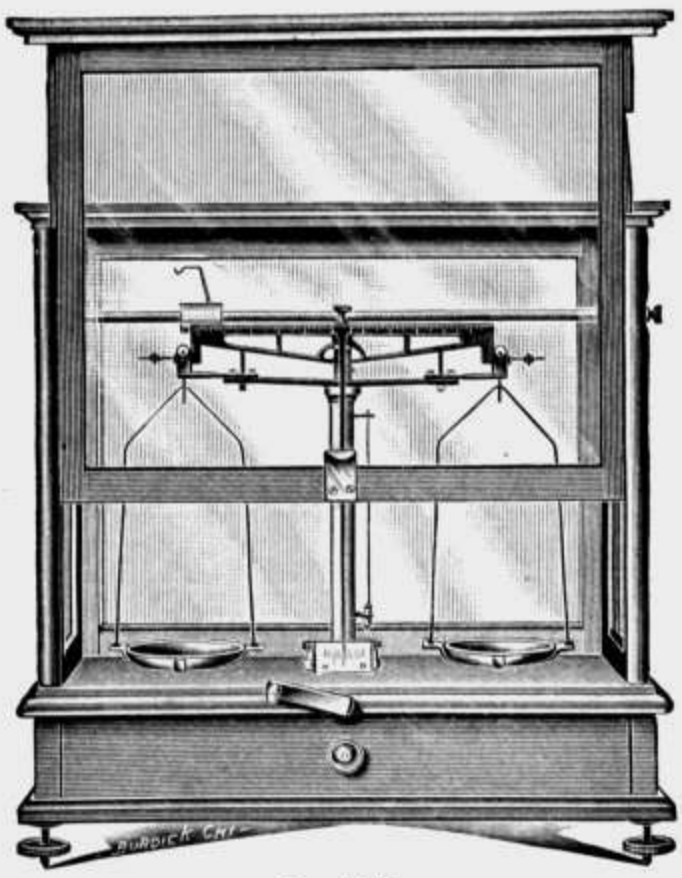
3801. **Balance, Sartorius' Short Beam Analytical,** No. 6, with straight beam of phosphor bronze, which likewise serves as a rider slide. Simple design with green bronze pillar, simple rider displacement and circular arrests. Pans are platinum plated. The knife edges and planes are agate. The base is of black plate glass, provided with leveling screws. This balance is very rapid and largely used in universities. Length of beam, 22 centimeters; capacity, 200 grams; sensibility with full load, .1 milligram.....Duty free 64 00

3801A. **Balance, Sartorius',** same as No. 3801, with length of beam 18 centimeters; capacity, 500 grams; sensibility with full load, .15 milligram .....Duty free 84 00

3801B. **Balance, Sartorius',** same as No. 3801, with length of beam 22 centimeters; capacity, 1,000 grams; sensibility with full load, .2 milligram .....Duty free 130 00

3802. **Balance, Sartorius' Analytical, New Model "America,"** especially designed for American educational institutions. The compensating hangers are made in one piece, which prevents their falling apart and being suspended on three points, they allow for uneven balancing. Short beam of magnalium metal, rider arrangement, agate knife edges and planes, platinum plated pans mounted on black glass plate, provided with leveling screws. Length of beam, 14 centimeters; capacity, 200 grams; sensibility with full load, .1 milligram .....Duty free 38 50

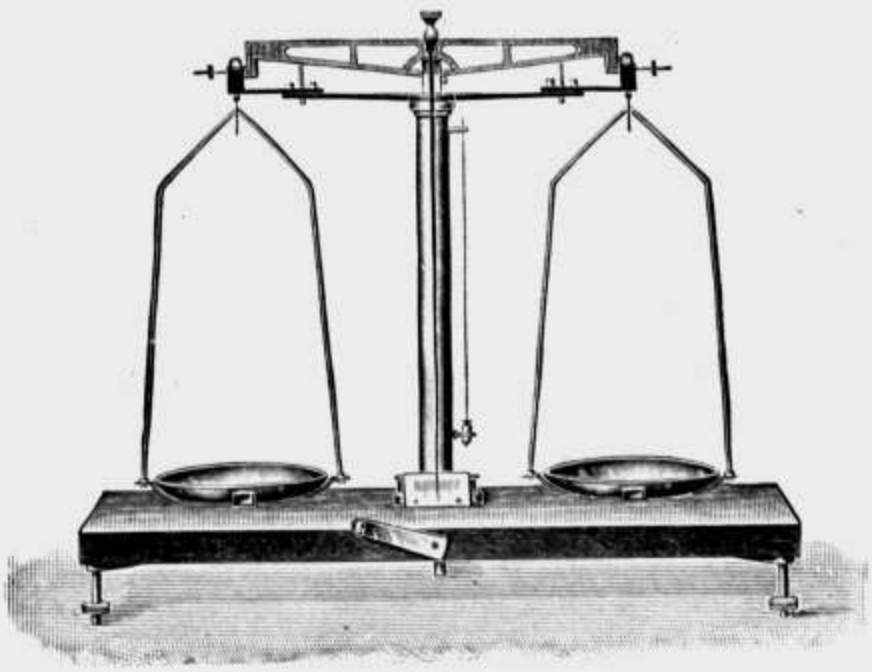
3802A. **Balance, Sartorius' "America," furnished from stock**..... 58 00



No. 3804.

3804. **Balance,** open beam, agate knife edges and planes, arrests for the hangers, beam support, plumb bob and leveling screws, hangers fitted with double hooks for specific gravity experiments. Mounted in mahogany case with glass slides and top and fitted with sliding front and drawer. Length of beam, 21 centimeters; diameter of pans, 8 centimeters; capacity, 100 grams; sensibility, 1 milligram .....Duty free 25 00

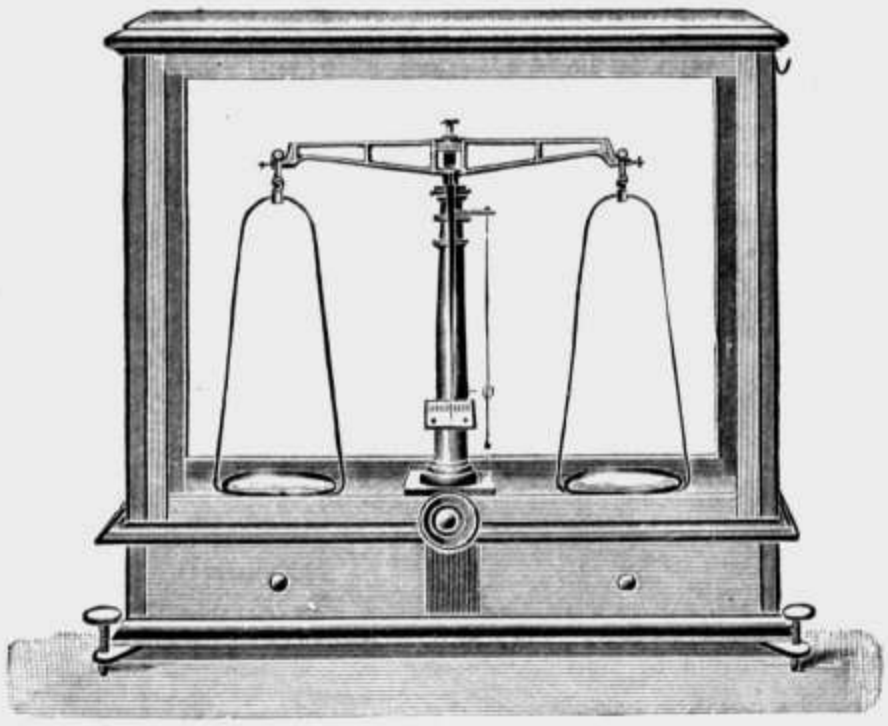
3804A. **Balance,** same as No. 3804, furnished from stock..... 35 00



No. 3806.

3806. **Balance,** same as No. 3804, mounted on polished mahogany board, fitted with leveling screws.....Duty free 11 50

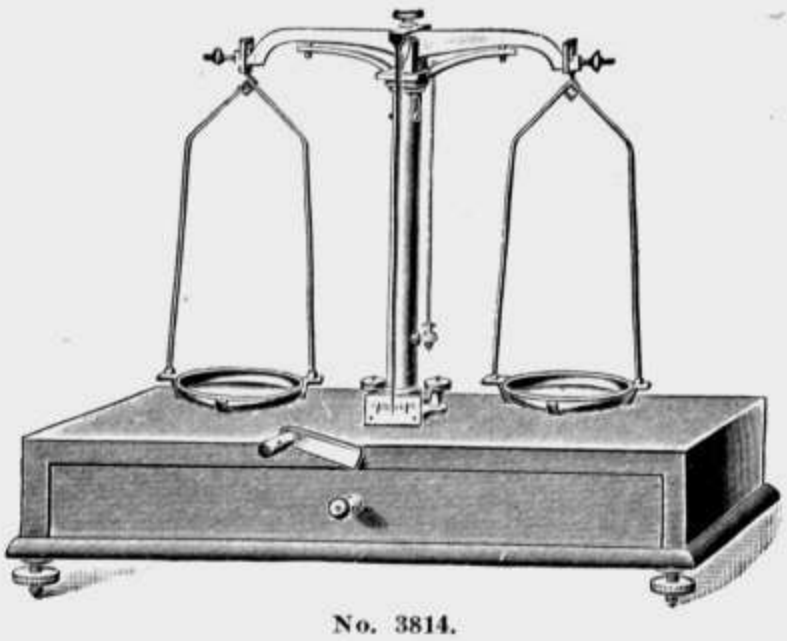
3806A. **Balance,** same as No. 3806, furnished from stock..... 16 60



No. 3813.

3813. **Balance,** with prismatic steel bearings, beam arrest, eccentric for raising or lowering, plumb bob and leveling screws. Mounted in mahogany case with glass sides and top, and fitted with sliding front and two drawers. Length of beam, 21 centimeters; diameter of pans, 7 centimeters; capacity, 60 grams; sensibility, 1 milligram. From stock..... $ 19 50

3813A. **Balance,** same as above.....Duty free 15 00



No. 3814.



No. 3815.

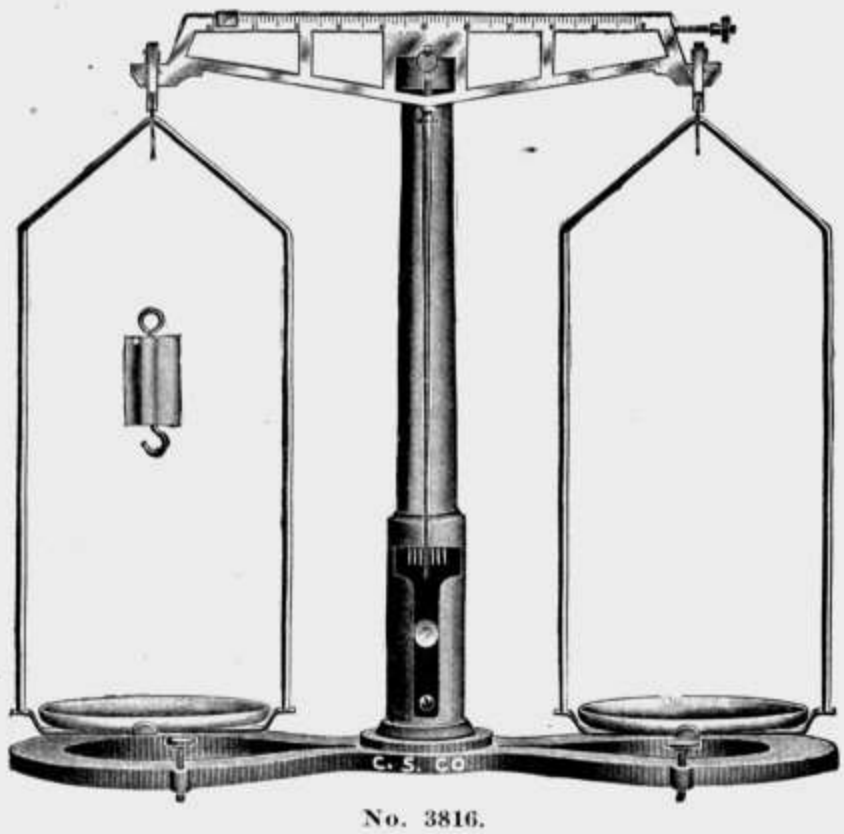
3814. **Balance,** with prismatic steel bearings, beam arrest, eccentric for raising or lowering, removable pans nickel plated, and plumb bob. Mounted on mahogany box provided with leveling screws. Length of beam, 19 centimeters; diameter of pans, 7 centimeters; capacity, 60 grams; sensibility, 1 milligram..... 13 35

3815. **Specific Gravity Balance, Westphal.** This is the latest, handiest and most improved form for exact and quick determination of the density of liquids. In polished hardwood box, with Reimann's patent thermometer sinker. This balance overcomes all trouble with incorrect hydrometers and forms an easy means for standardizing hydrometers 13 35

3815A. **Extra Weights** for No. 3815 Balance. Per set..... 1 10

3815B. **Extra Thermometer,** 15°, for No. 3815 Balance..... 2 65

3816. **Laboratory Balance.** Designed for schools desiring a more sensitive and convenient form of balance than the Harvard Trip Scale, at a slightly additional cost.



No. 3816.

Capacity, 2 kilos.

Sensibility. Loads up to 2 kilos can be accurately weighed within 0.01 gram or 1 c. g. Sensibility on light loads 5 mg.

Beam, open construction. No small weights to handle. A rider upon beam indicates all amounts up to 10 grams by 1 centigram divisions, each division being 2.5 m. m. long.

Damping Device, positive in action, brings balance quickly to rest.

Bearings, high grade steel prisms, carefully polished and adjusted.

Hangers of new design, eliminating friction and wear.

Pan Arrest. The base serves as an arrest, enabling operator to safely move balance while loaded.

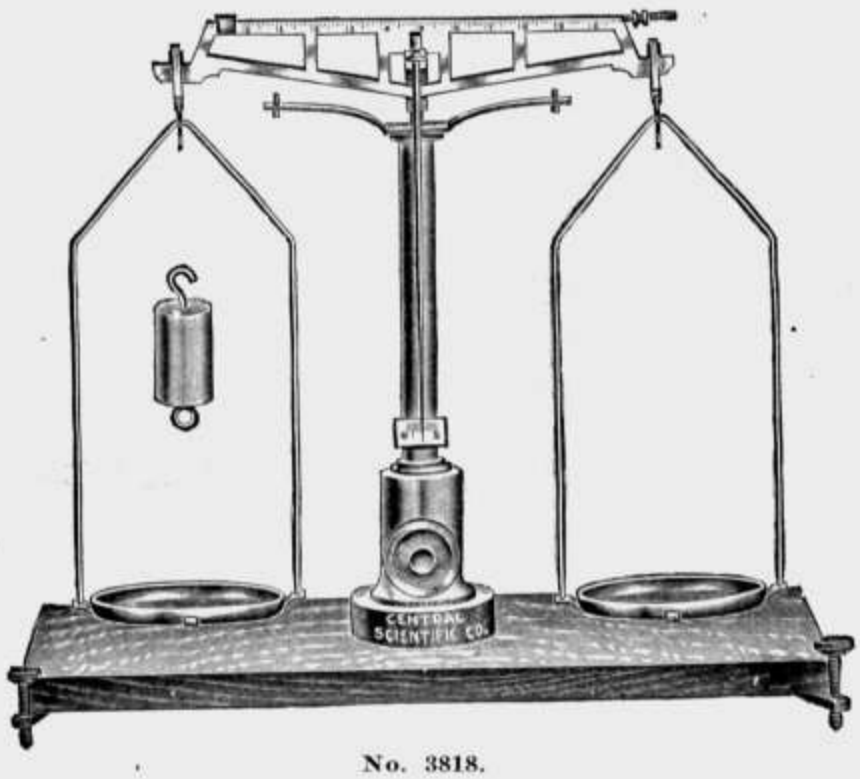
Leveling Screws are supplied, insuring greater sensitiveness.

Dimensions, beam, 34 c. m. long. Length of graduations, 25 c. m. by 2.5 m. m. divisions.

Pans, nickel plated, 15 c. m. in diameter. Height of balance, 45 c. m.

Counterpoise weight included 13 35

3816A. **Laboratory Balance,** with addition of level accurately adjusted and attached 14 45

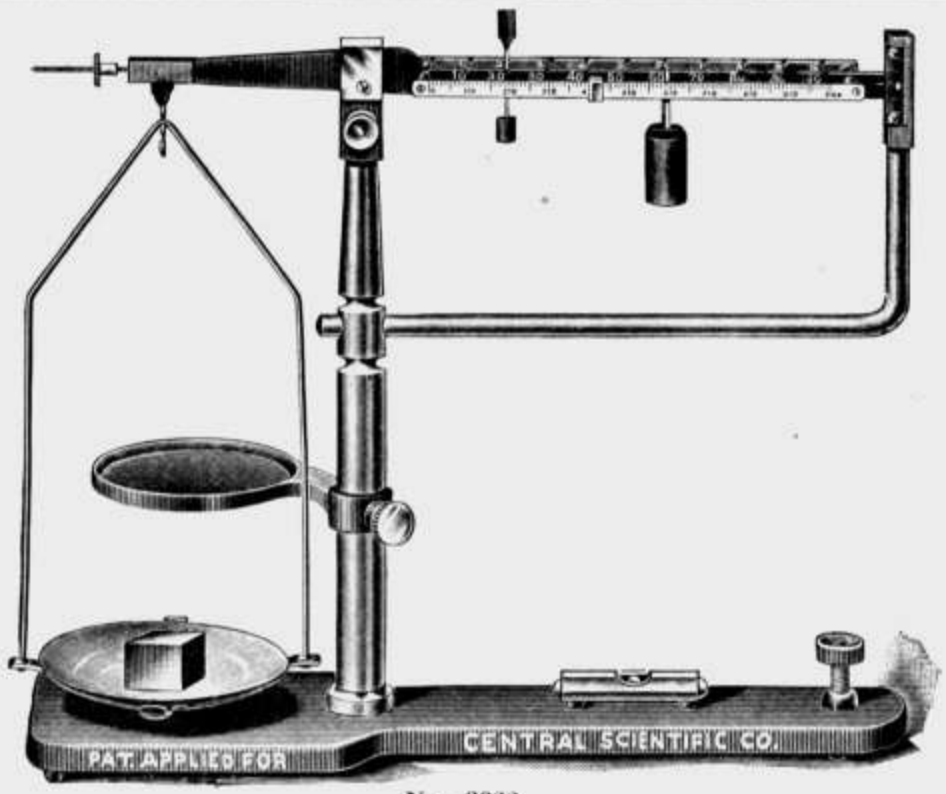


No. 3818.

3818. **Laboratory Balance,** similar to No. 3816, but more sensitive and of better finish and construction. Mounted on polished mahogany base provided with leveling screws. Sliding rider on graduated beam indicates weight up to 10 grams in 1-10 gram divisions. Prismatic steel bearings and supports. An eccentric movement operated by knurled head raises beam from beam arrest. Counterpoise for specific gravity work. Made of lacquered brass throughout and pans nickel plated.

Height of balance, 48 c. m.; diameter of pans, 15 c. m.; length of beam (between knife edges), 30 c. m.

Capacity 2,000 grams. Sensibility with full load 40 milligrams, which is increased with smaller loads..... 22 00



No. 3822.

3822. **Balance, Cenco Triple Beam,** for physical and chemical laboratories. The three beams are placed in the same horizontal plane, thus conforming to scientific principles involved, which is not true of other styles of triple beam balances. Weighings are obtained by movement of the riders along the beams. These riders are easily handled and quickly placed in the notches, but cannot be removed from the beams. An adjustable support is provided for a jar or other receptacle for experiments in specific gravity. Provided with stable base neatly japanned, and with sensitive spirit level and leveling screws. Balance neatly finished in nickel plate and japan. Capacity of middle beam, 100 grams by 10 gram divisions; back beam, 10 grams by 1 gram divisions; front beam, 100 centigrams by 1 centigram divisions. Total capacity, 110 grams; sensibility, with or without full load, guaranteed to 1 centigram. Actual tests, however, give a sensibility of from 4 to 8 milligrams. Features easily recognized are: Rapid weighing, constant sensibility, accuracy, freedom from loss of weights, no interference or breaking of weights..... $ 16 65

3822½. **Extra Weight,** for use with No. 3822, for weighing over 110 grams, but not to exceed 210 grams. Weight is placed on the 100 gram notch of the middle beam..... 1 65

3823. **Balance, Hydrostatic.** Excellent for work in specific gravity experiments. Prismatic steel knife edges, adjustable rod supporting beam and beam arrest. Beam can be so elevated that hook under short pan is 30 centimeters from the table. Mounted on neatly japanned iron base. Length of beam, 25 centimeters; diameter of pans, 10 centimeters; capacity, 200 grams; sensibility, 1 centigram..... 5 75

3824. **Balance, Hydrostatic.** Same as No. 3823, but larger and with adjustable beam arrest. Length of beam, 35 centimeters; diameter of pans, 13 centimeters; capacity, 500 grams; sensibility, 1 centigram 9 00



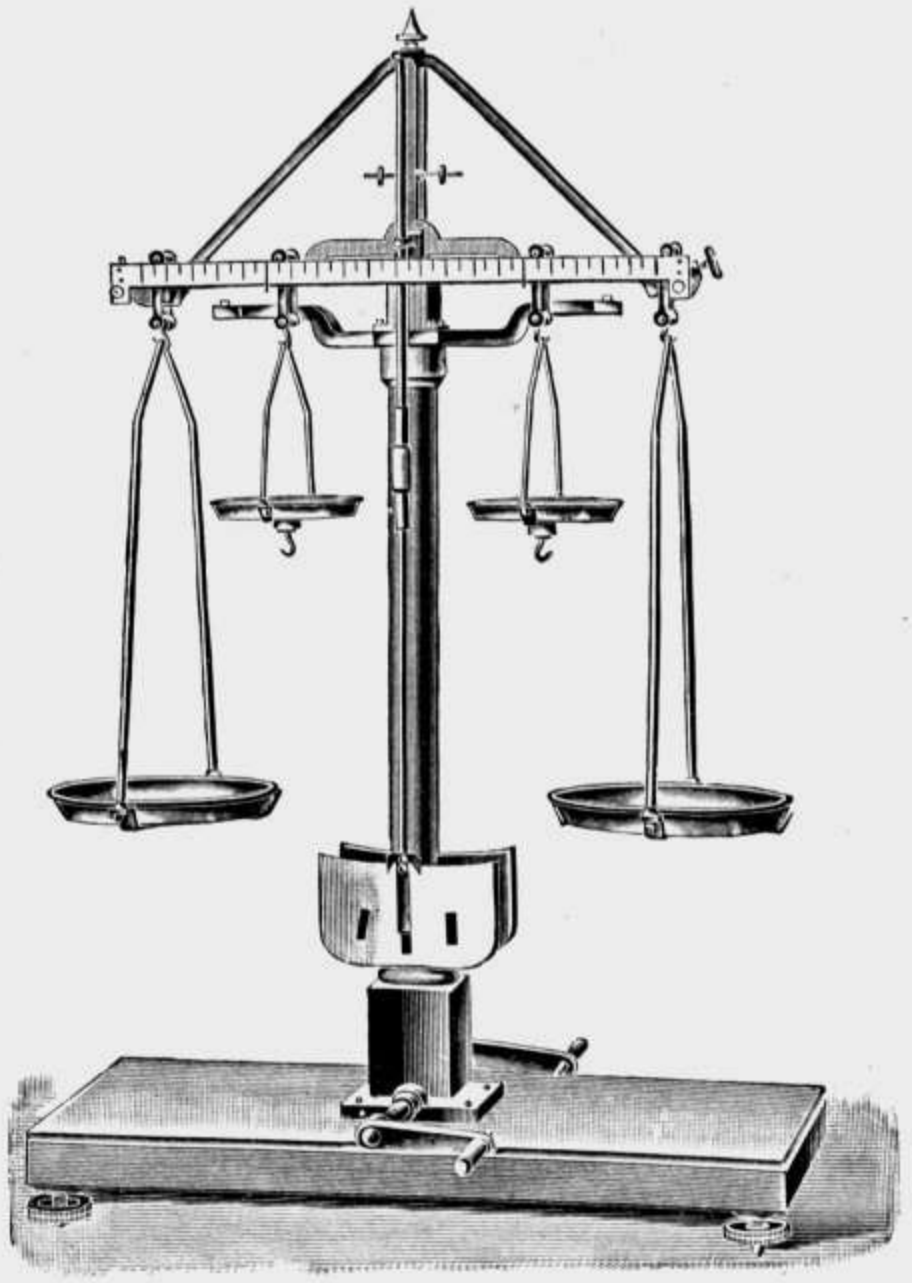
No. 3823.

3826. **Balance, Torsion,** suitable for all kinds of laboratory work. No knife edges, but built on the torsion principle. High poise, indicator and arrest. Slide beam reading to 5 grams by 1-20th gram divisions. Flat nickel plated pans 6 inches in diameter. Capacity, 1 kilo..... $ 20 00

3827. **Balance, Torsion**, same as above, for heavy weighing. Slide beam reading to 300 grams by 2½ gram divisions. Flat nickel plated pans 9 inches in diameter. Capacity, 10 kilos 20 00

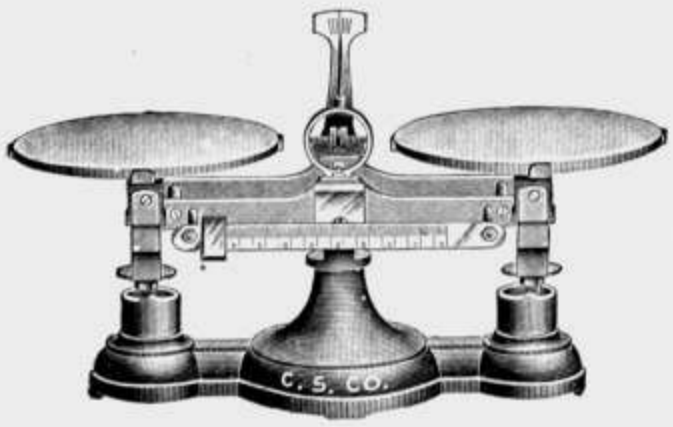


No. 3826.

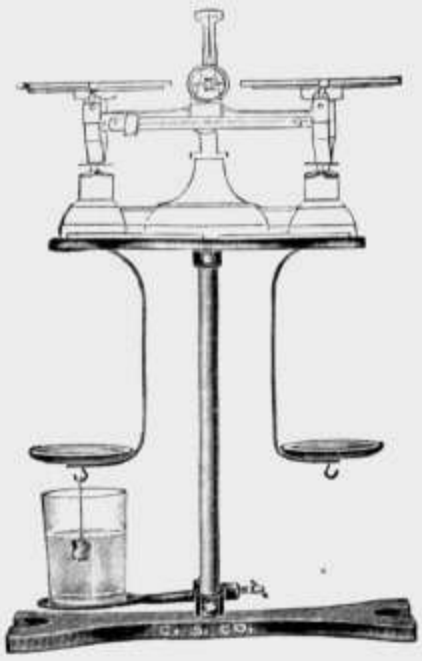


No. 3828.

3828. **Lecture Table Balance.** A universally useful balance for the lecture table, for ordinary weighing, specific gravity work and hydrostatic work in general. Can also be used in the physical laboratory to demonstrate the laws of the lever. Carrying power, 5 kilograms; sensibility, 10 milligrams. Provided with long and short bails and pans arranged on the beam as 1:2 for proportional weighing. Divided beam with eccentric arrestment, worked from either side; two pointers, the one facing the class, the other the lecturer. Handsomely finished in polished brass, carefully lacquered. The most popular lecture table balance on the market.....Duty free 54 00



No. 3830.



No. 3831.

3830. **"Cenco" Agate Bearing Trip Scale,** Harvard design. The Harvard Trip Scale has, for years, been used for rough weighing and the inacuracies due to crude construction (imperfect bearings particularly) are familiar to all users.

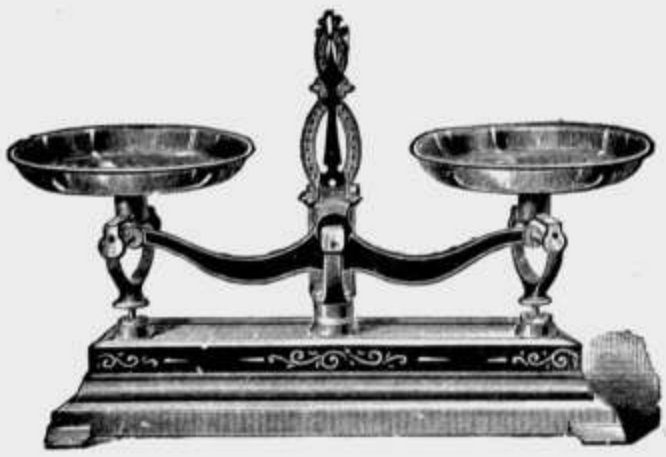
In our **"Cenco" Trip Scale** we have discarded the rough cast and forged iron parts, employing in place parts of brass and steel neatly formed by elaborate tools and machinery. All parts are, therefore, uniformly accurate and assemble with a degree of rigidity not possible heretofore.

The bearings consist of hardened steel prisms resting on six agate shelvès of large dimensions.

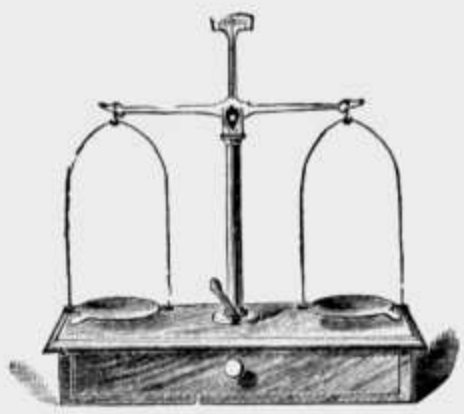
The graduated beam has a range of 10 grams in 1-10 gram divisions. Capacity is 2,000 grams.

Sensibility, after continued use, is guaranteed to be 1-10 gram. Actual tests show sensibility to be greater than 1 centigram..... $ 6 65

3831. **"Cenco" Trip Balance Support.** A convenient support which increases the utility of No. 3830. Illustration shows common use in Specific Gravity experiments. Made entirely of metal, neatly finished in nickel plate and japan. Complete with hanger, scale pans and adjustable platform for tumbler..... 2 90



No. 3833.



No. 3839.

3833. **Robervahl Balance.** This is the genuine imported Robervahl balance and is only adapted for coarse weighing.
Removable scale pans 4¾ inches in diameter, capacity ½ kilo..... 3 10

3835. **Robervahl Balance.** Same as No. 3833. Pans 5 inch, capacity 1 kilo.. 3 50

3837. **Robervahl Balance.** Same as No. 3833. Pans 5½ inch, capacity 2 kilos 4 00

3839. **Army Prescription Balance.** Nicely constructed of brass, nickel plated, mounted on a box with drawer, 6-inch beam lifted by a lever..... 3 00



No. 3845.



No. 3847-3848.



No. 3851.

3845. **Hand Balance,** 5 inch brass beam with brass pans and set of brass weights 1 to 10 gram (grade of No. 3909) and German silver weights 10 to 500 m. g. Superior to the cheap apothecary weights furnished by other dealers. Complete in box..... $ 1 00

3847. **Hand Balance,** 6 inch brass beam, with horn pans..... 1 65

3848. **Hand Balance,** 7½ inch brass beam, with horn pans..... 2 00

3851. **Balance,** of iron with tin scoop and set of iron weights, 2 pounds down to ¼ ounce, for coarse weighing only..... 1 65

3855. **Jolly's Spiral Spring Balance.** This is an improved form, being made entirely of metal and handsomely finished throughout. The upright is a nickel plated rod 100 centimeters long, supported by a heavy japanned iron tripod base, fitted with leveling screws.

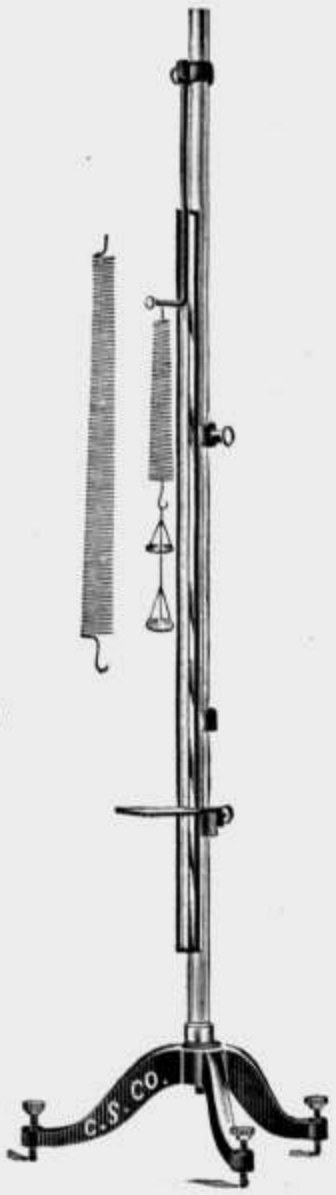
The platform is of oxidized brass, sliding on the rod and can be clamped in any position.

The spring support is also adjustable and can be inverted for light loads or heavier springs, allowing of a large range. The mirror scale is graduated into millimeters and can also be adjusted and clamped in any position. Lower pan is glass with platinum wires. The springs are especially made for this purpose of the best steel, tempered in oil and are conical in form. Two springs, a high and a low tension, are supplied with the balance..... 9 00

3856. **Jolly's Spiral Spring Balance.** Less elaborate in construction, but with all the features of No. 3855 Balance. The upright is metal, 100 centimeters long, supported by a heavy japanned iron tripod base. The mirror scale is graduated into millimeters. The spring is especially constructed for Jolly's Balance and is supported on an adjustable hanger. The pans are of aluminum and the platform is adjustable 6 00

3858. **Spring for Jolly's Balance,** light..... 75

3858A **Spring for Jolly's Balance,** heavy..... 75



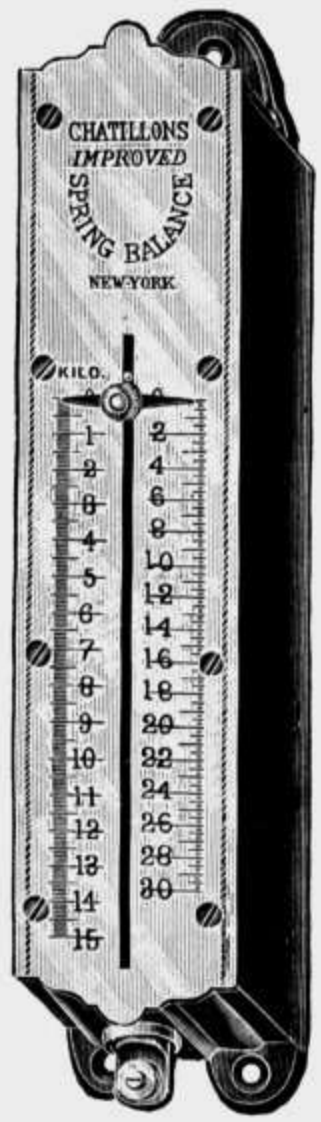
No. 3855.



No. 3865.



No. 3871.



No. 3878.

SPRING BALANCES.

These are the genuine Chatillon Spring Balances, the only standard make in this country.

3861. **Spring Balance,** 25 lbs. in 8 oz. divisions..... $ 16

3863. **Spring Balance,** 50 lbs. in 1 lb. divisions..... 33

3865. **Spring Balance,** English and Metric, 8 oz. in ½ oz. divisions, and 250 grams in 10 gram divisions..... 80

3867. **Spring Balance,** same as No. 3865, with flat back and broad pointer, for either perpendicular or horizontal reading..... 95

3869. **Spring Balance,** English and Metric, 64 oz. in 1 oz. divisions, and 2,000 grams in 25 gram divisions..... 40

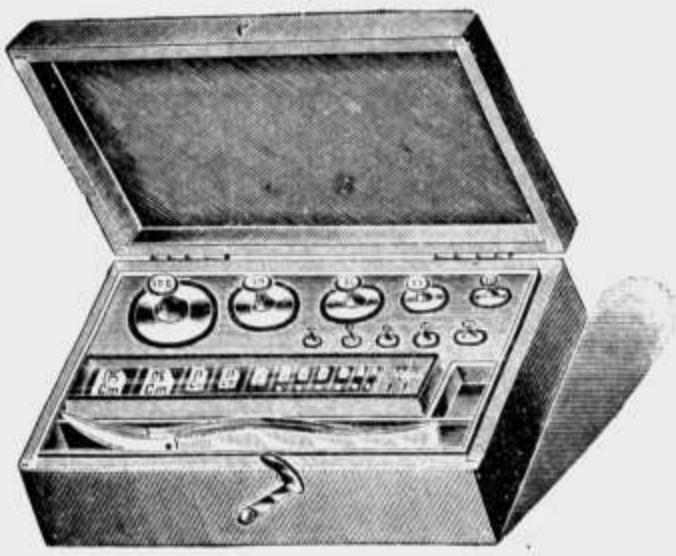
3871. **Spring Balance,** same as No. 3869, with flat back and broad pointer, for either perpendicular or horizontal reading..... 55

3873. **Spring Balance,** English and Metric, 30 lbs. in ¼ lb. divisions, and 15 kilos in 100 gram divisions..... 1 65

3875. **Spring Balance,** same as No. 3873, with flat back..... 1 80

3878. **Spring Balance.** In iron case with sliding index recorder. Especially designed for experiments in tensile strength, the indicator remaining at the breaking strain, instead of going back to zero when the strain is released, as in the case of the regular spring balances. English and Metric scales. 30 lbs. in ¼ divisions, and 15 kilos in 100 gram divisions..... 5 60

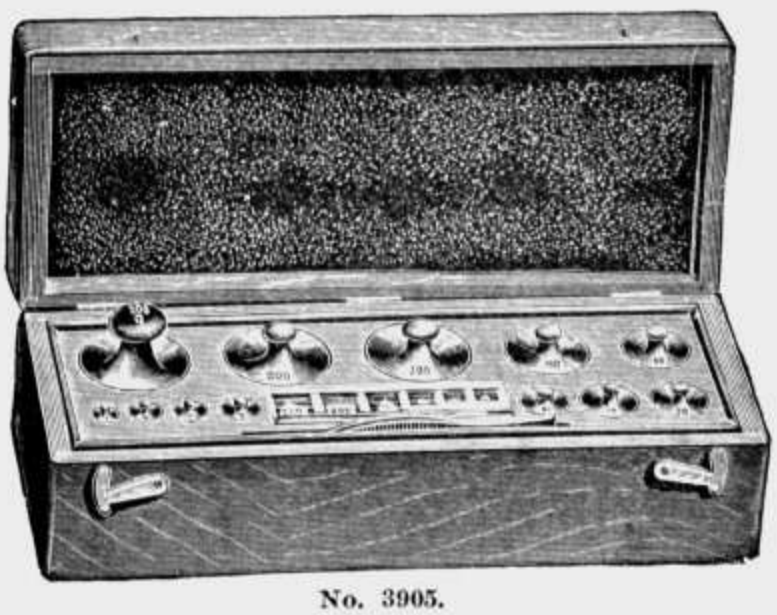
3879. **Spring Balance,** cylindrical pocket form, arranged to obviate the zero error. 15 lbs. in 4 oz. divisions..... 45



Nos. 3901-3903.

3901. **Weights of Precision (Sartorius). Gold plated.** Brass weights, heavily plated with gold, fractional weights of solid platinum, including two riders. Put up in mahogany, velvet lined case, with ivory tipped forceps; 100 grams to 1 milligram.....Duty free $ 10 00

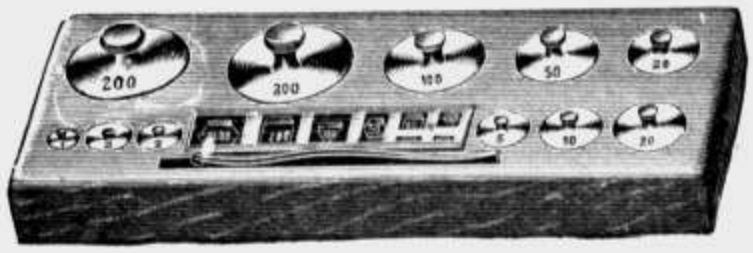
3903. **Weights of Precision (Sartorius).** Same as No. 3901, 50 grams to 1 milligram.....Duty free 9 00



No. 3905.

3905. **Weights. Good grade.** Brass weights, well protected by heavy gold lacquer, superior to the lacquered weights. Fractional weights of German silver. In fine mahogany box with brass forceps.

1 milligram to.....	20 G	50 G	100 G	200 G	500 G
Each	3.00	3.30	4.45	5.90	7.25



No. 3907.

3907. **Weights. Good grade.** Same as No. 3905, but in polished hardwood block instead of box. With brass forceps.

1 milligram to.....	20 G	50 G	100 G	200 G	500 G
Each	1.95	2.20	2.50	3.55	5.30

3909. **Weights.** Separate weights for No. 3905 or 3907.

Grams	1	2	5	10	20
Each	.11	.12	.15	.17	.20



No. 3921.



No. 3929.

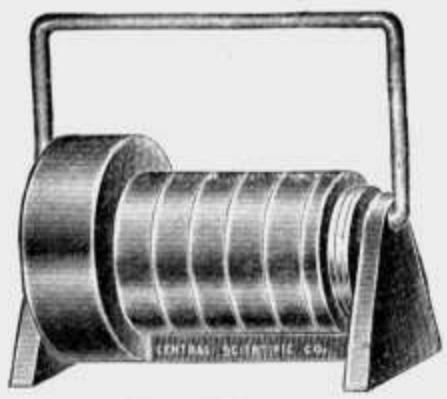
3915. **Weights,** brass, in block, 20 grams to 1 centigram..... $ 55
3917. **Weights,** brass, in block, 50 grams to 1 centigram..... 85
3919. **Weights,** brass, in block, 100 grams to 1 centigram..... 1 30
3921. **Weights,** brass, in block, 500 grams to 1 gram..... 2 25
3923. **Weights,** brass, in block, 1,000 grams to 1 gram..... 3 50
3925. **Weights,** brass, single weights, same style as in above sets.

Grams	1	2	5	10	20	50	100	500	1,000
Each	.07	.08	.10	.13	.15	.18	.25	.75	1.25

3927. **Weights,** brass, in block, 1 lb. to ¼ oz..... 3 00
3929. **Weights,** brass, in block, 2 lb. to ¼ oz..... 4 25



No. 3933.



No. 3939.



No. 3062-3063.



No. 3943.

3933. **Weights,** iron, in nest, 1 kilo to 5 grams (duplicates of 20 and 200 grams)..... 1 20
3934. **Weights,** iron, in nest, 2 kilos to 5 grams (duplicates of 20 and 200 grams)..... 1 95
3935. **Weights,** iron, in nest, 5 kilos to 5 grams (duplicates of 20, 200 and 2,000 grams)..... 4 95
3937. **Weights,** iron, single weights, same style as No. 3933-3935.

Kilos	1	2	5
Each	.55	.75	1.50

3938. **Weights,** iron, in nest, 1 lb. to ½ oz..... 1 25
3939. **Weights,** iron, slotted, 1-500, 5-100, 1-50, 2-20 and 1-10 gram weight, with holder. These weights fit No. 750 Weight Hanger listed below. 1 75
3062. **Weight Hanger,** for attaching to pulleys, levers, sonometers, etc., for carrying slotted weights. Made of iron with hook, weight 1 kilo.... 70
3063. **Weights of Iron, with slot,** for No. 3062 hanger.

Weight	500G	1 kilo	2 kilo	5 kilo
Each	.50	.55	.75	1.50

750. **Weight Hanger,** same as No. 3062, but made of brass, weight 50 grams. 50
751. **Weights,** of brass, accurately adjusted with slot to fit No. 750 Hanger.

Weight, grams	10	20	50	100	500
Each	.30	.35	.40	.50	.90

3942. **Weights,** iron, safety valve, 4 lb., .50; 8 lb..... 85
3943. **Weights,** iron, with ring handle.

Pounds	1	2	4	10	14
Each	.70	.75	1.40	2.00	2.50



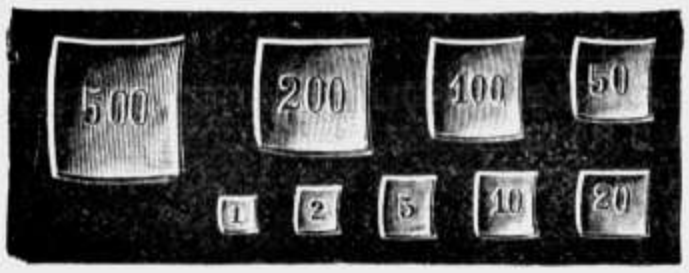
No. 3945.



No. 3947.

3945. **Weights,** aluminum, square, made concave so they can be picked up readily, 10 grains to ½ grain, in pasteboard box..... $ 50

3947. **Weights,** aluminum, 5 grains to ½ grain, in pasteboard box..... 30



No. 3951-3957.



No. 3959.

3951. **Weights,** German silver, fractional parts of a gram, put up in sets, 500 mg. to 1 mg., with duplicates of the 2, 20 and 200 milligram pieces, 12 in all, in pasteboard box 50

3953. **Weights,** German silver, fractional parts of a gram, same as No. 3951; 1, 2, 5, 10, 20, 50, 100, 200, 500 milligram. Each 06

3955. **Weights,** platinum, fractional parts of a gram, put up in sets, 500 mg. to 1 mg., with duplicates of the 2, 20 and 200 milligram pieces, 12 in all, in pasteboard box..... 5 00

3857. **Weights,** platinum, fractional parts of a gram, same as No. 3955.

Mg.	1	2	5	10	20	50	100	200	500
Each	.22	.22	.22	.25	.33	.45	.70	.85	1.10

3959. **Riders,** of platinum.

Mg.	1	2	5	6	10	12
Each	.45	.45	.25	.25	.25	.25

3961. **Weights of Rock Crystal.** Absolute standards of precision. These weights are made with the greatest care, are invariable, non-corrosive, and are not subject to wear or abrasion. Superior to gold or platinum weights. Every high grade laboratory should have a set for their standard. Set comprises one each, 50, 20, 10, 5, 3, 2, 1, 0.5, 0.2, 0.1 grams in velvet lined case with ivory tipped forceps and certificate from the Reichsanstalt .....Duty free 35 00

3967. **Weights, Universal.** These weights are made of cast iron, neatly japanned, with the denomination in raised figures. They are invaluable for general physical laboratory experiments with levers, pulleys, etc., and also for general weighing, as they can be stood upright on a platform balance and the error is considerably less than in the iron nest weights so commonly used with the trip scale. The set comprises nine weights ranging from 10 grams to 1 kilo, with duplicates of the 20 and 200 gram pieces..... 2 00

3968. **Block** of hardwood, with holes to fit No. 3967 set of weights 55

3969. **Weights,** same as No. 3967.

Grams	10	20	50	100	200	500	1000	2000
Each	.15	.20	.25	.30	.35	.45	.60	.85



No. 3967.



No. 3971.



No. 3973

3971. **Forceps,** ivory tipped, for handling weights..... 80

3973. **Forceps,** brass, curved points, plain..... 16

Camel's Hair Brush, for scale pans, see No. 4606.

APPARATUS FOR

"A LABORATORY COURSE IN ELEMENTARY PHYSICS"

by

MILLIKAN AND GALE.

NOTE.—Apparatus previously listed in this catalogue is referred to in this list by its original number. Apparatus not previously mentioned is numbered according to the experiment with a prefex H(H501, H601, etc.).

WRITE FOR COMPLETE ILLUSTRATED CATALOGUE OF SPECIAL APPARATUS FOR MILLIKAN AND GALE'S "A LABORATORY COURSE IN PHYSICS" AND "A FIRST COURSE IN PHYSICS."

M. & G. Exp.	Cat. No.		
1	319	**Meter Stick**	$ 30
1	314	**Brass Disc**	28
2	1590A	**Hollow Brass Cylinder** with glass cover	44
2	3816	**Balance**	13 30
2	3939	**Set of Slotted Iron Weights** with holder	1 75
2	131	**Vernier Caliper**	2 50
3	127A.	**Micrometer Caliper**	6 60
3	127B	**Micrometer Caliper**	6 00
3	717	**Steel Sphere,** ¾-inch diameter	10
4	3871	Three **Spring Balances** (each .55)	1 65
4	720	**Board** for mounting Balances	1 75
5	H501	**Glass Tube,** 110cmx4cm, ends annealed, rubber stoppers	1 95
5	H502	**Glass Manometer Tube** (unmounted)	33
6	H601	**Jar** with two Manometers, Inlet Tube, Pinch Cock	1 65
6	H602	**Manometer Tube**	55
6	4547	**Bottle** with glass stopper, 8 oz	20
7	1142	**Aluminum Cylinder**	44
8	1110	**Constant Weight Hydrometer Tube**	44
8	1111	**Constant Volume Hydrometer Tube**	33
9	2123E	**Battery Jar**	33
9	1137	**Wooden Block**	16
9	1143	**Sinker**	13
10	H1001	°**Boyle's Law Tube,** 110cm long, 1mm bore, filled	1 40
10	H1001A	**Boyle's Law Tube,** 110cm long, 1mm bore unfilled	33
10	H1002	**Set Supports** (Tripod, Rod, Clamp, Burette holder)	1 95
11	1617	**Dew Point Apparatus**	1 22
11	1525	**Thermometer,** 110°C	40
11	4543	Three **Bottles,** 125 c. c. (each .05)	10
11	4847	Three **Evaporating Dishes,** No. 9, 2½ inch diam. (each .11)	33
12	658	**Mirror Scale** with support	1 40
12		**Spring** for **Hooke's Law** and **Weight Holder**	40
12	H1203	**Steel Rod** and two **Wooden Support Blocks**	83
13	H1301	**Pressure Coefficient Apparatus** without support	1 95
13	H1302	°**Volume Coefficient Tube,** filled	1 40
13	H1302A	**Volume Coefficient Tube,** unfilled	17
14	1501	**Steam Generator**	2 50
14	H1402	**Brass Tube** and **Pointer**	83
15	726	**Demonstration Balance**	72
16	769A	**Inclined Plane** with pulley	1 50
16	771	**Carriage**	1 10
17	H1701	**Clamp**	40
18	1593	**Calorimeter**	2 75
19	H1901	100 grams **Aluminum Pellets**	33
20	1585	**Tube** for Mechanical Equivalent	72
21		Apparatus already listed	
22	H2201	**Stirrer**	11
23	H2301	**Glass U Tube** not filled	33
24		Apparatus already listed	

°We find it extremely difficult to ship these tubes in a filled condition, and cannot guarantee safe delivery.

APPARATUS FOR MILLIKAN AND GALE (Concluded).

25	1707	**Bar Magnet,** special	33
25	1708	**Board** for Magnet	45
25	1711	**Horseshoe Magnet** with armature	20
26	1765	**Compass**	1 50
27	1805	**Electroscope**	70
27	H2702	Pair **Condenser Plates,** mounted	27
28	2401	**Galvanometer,** without compass	1 50
28	2110	**Cell, Simple Voltaic**	80
28	2110A	**Porous Cup**	12
29	2641	**Commutator**	65
29	1761	**Compass,** 25mm	17
30	H3001	**D'Arsonval Galvanometer**	2 45
30	H3002	**Soft Iron Horseshoe Core**	11
31	H3101	**Resistance Coil,** 1000 ohms	33
31	2110	**Zinc** (D), **Copper** (E), **Lead** (F), **Iron** (G), **and Aluminum** (H) **Elements,** each	05
31	2110J	**Carbon Element**	11
32	H3201	**Wheatstone's Bridge** with Potentiometer attachment	2 45
32	2111	Two **Dry Cells** (each .33)	66
33	H3301	**Resistance Coil,** one ohm	45
34		Apparatus alrealy listed	
35	2110F	**Lead Strips,** per dozen	60
36	2219	Two **Coils for Induction** (each $1.10)	2 20
37	2672	**Electric Bell**	45
37	2756	Two **Push Buttons** (each .11)	22
37	2246	**Dissectable Electric Motor,** mounted	1 40
38	533	Two **Stop Watches** (each $7.25)	14 50
38	H3802	Two **Revolvers** (each $2.50)	5 00
39	3040A	**Tuning Fork Rating Apparatus** with one glass plate and Fork	4 75
39	3042	**Glass Tracing Plate**	11
40	3012	**Tuning Fork,** 256 vibrations	1 25
40	3016	**Tuning Fork,** 384 vibrations	1 40
40	3019	**Tuning Fork,** 512 vibrations	1 00
41	H4101	**Sonometer Attachment,** bridge and wire only, casting is included with incline plane	20
42	H4201	**Piece of Glass,** lacquered black on back	06
42	419	**Protractor,** 4¼ inches	22
43	3306	Two **Prisms** (each $1.10)	2 20
45	3205	**Concave Mirror**	50
46	H4601	**Convex Lens** with mounting and wire screen	50
47	7538	Two **Linen Testers** (each .24)	48
48		Apparatus already listed	
49	H4901	**Tube and Scale**	22
50		**Apparatus already listed**	

APPARATUS
for
"TEXT BOOK OF PHYSICS"
by
HALL AND BERGEN.

NOTE.—Apparatus previously listed in this catalog is referred to in this list by its original number. Apparatus not previously mentioned is numbered from 6601 up.

Student's Outfit for Part I.

All the articles in the first list here given should be furnished to each member of the laboratory section.

Hall and Bergen's Number	Our Catalogue Number		
1	6601	**Metric Measure,** 10 c. m. long, millimeter divisions	$ 06
2	319	**Meter Stick**	30
3	327	**Metric Rule**	09
4	1134	**Waterproof Wooden Cylinder,** 4.5x8 c. m. loaded	28
5	1139	**Overflow Can**	50
6	1140	**Catch Bucket**	33
7	3867	**Spring Balance,** 250 grams and 8 oz. flat back	95

APPARATUS FOR HALL AND BERGEN—Continued.

Hall and Bergen's Number	Our Catalogue Number		
8	1135	**Waterproof Wooden Block,** 7x4.5x4.5 c. m. loaded	22
9	1137	**Waterproof Cherry Block,** 7.5x7.5x3.8 c. m	16
10	2123E.	**Battery Jar,** 6x8	33
11	6613.	**Sulphur Roll,** 175 to 200 grams	05
12	1143.	**Lead Sinker**	13
13	1145.	**Waterproof Wooden Cylinder,** 1x20 c. m	06
14	1146.	**Holder,** for keeping No. 13 upright in water	15
15	2121E.	**Battery Jar,** 4x5	20
16	6621.	**Glass Stoppered Bottle**	10
17	6623.	**Lever and Supporting Bar**	38
18	6625.	**Scale Pans,** brass, 6.5 c. m. square, each weighing with supporting threads 1 oz., per pair	27
19	6627.	**Set of Iron Weights,** 8, 4, 2 and two 1 oz	1 00
20	6629.	**Friction Board,** selected pine, 15x50x2 c. m	33
21	6631.	**Cubical Block,** 3.7 c. m. on each edge, slotted to fit upon a meter stick with a transverse slot on its upper surface	15
22	6688.	**Cradle,** for spring balance. Unnecessary, as a flat backed spring balance is furnished	55
23	3201.	**Mirror**	11
24	6635.	**Rulers, of White Pine,** 5x30x1 c. m., per pair	14
25	6637.	**Cubical Block,** 3.7 c. m. on each edge. One side painted white with a vertical mark	11
26	522.	**Walter Smith School Square,** medium	07
27	3210.	**Cylindrical Mirror**	50
28	3301.	**Plate Glass,** for index of refraction	28
29	6641.	**Brass Partition,** to fit Jar No. 15	16
30	6643.	**Brass Index,** to clasp side of Jar No. 15	08
31	3281.	**Double Convex Lens**	09
31a	3352.	**Lens Holder**	17
32	3354.	**Screen**	05
32a	3353.	**Screen Holder**	10
33	3385.	**Kerosene Lamp**	30
	3386.	**Asbestos Shade**	10
34	6647.	**Right Angle Brass Wire,** to fit Block No. 21	04

Student's Outfit for Part II.

Most of the articles in this list should be furnished to every student who is to perform all of the exercises.

50	3873.	**Spring Balance,** 30 lbs. and 15 kilos	1 65
51	6682.	**Guard Block,** of metal	30
52	6684.	**Balance Spool**	10
53	6686.	**Fastening Spool**	05
54	125.	**Micrometer Caliper**	3 35
55a	651A.	**Pine Rod,** 41x½x½ inches	08
55b	651B.	**Pine Rod,** 41x1x½ inches	10
56	651F.	**Hardwood Prisms,** set of three	15
57	651E.	**Indicator,** of light wood	05
58	651D.	**Scale,** 10 c. m. long, on iron base	16
59	651G.	**Scale Pan,** 12 c. m. square, with cords attached	10
60	3933.	**Set of Iron Weights,** 1 kilo to 5 grams	1 20
60a	3934.	**Set of Iron Weights,** 2 kilos to 5 grams	1 95
61	6693.	**Ash Rod,** 1 meter long, 1 c. m. square	10
62	6694.	**Ash Rod,** 1 meter long, 2 c. m. square	11
62a	6697.	**Combination Base Lever,** fitting either No. 61 or 62	50
63	6699.	**Card,** with quarter circle divided into degrees for use with No. 62a	13
64	2102.	**Tumblers,** small, per pair	12
65	1106.	**Balancing Column Apparatus** (Hare's apparatus)	90
66	6705.	**Wooden Support,** with meter stick, for No. 65	1 05
67	1051.	**Boyle's Law Tube**	75
67a	1055.	**Boyle's Law Tube,** mounted	5 25
68	1165.	**Barometer, Adjustable**	16 65
69	6707.	**Baroscope Bottle,** capacity 2 liters, complete with rubber stopper, glass tubes, rubber connections and pinch cock	72

APPARATUS FOR HALL AND BERGEN—Concluded.

Hall and Bergen's Number	Our Catalogue Number		
70	1108.	**Glass U Tube,** 1 meter long	80
71	3830.	**Harvard Trip Balance**	6 65
72	1307.	**Air Pump**	4 00
73	5473.	**Lead Y Tube** (included in apparatus No. 65).	
74	720.	**Composition of Forces**	1 75
75	6688.	**Cradle,** for holding Balance No. 50 in a horizontal position	55
76	771.	**Hall's Carriage**	1 10
76a	6711.	**Rubber Tubing,** pure gum. Two pieces 50 c. m. long for use with No. 76 Carriage	35
77	769.	**Inclined Plane,** board 4 feet long	75
78	6627.	**Weights,** for use with No. 76 Carriage (same as No. 19)	1 00
79a	6713.	**Two Ivory Balls,** one about 50 grams, the other about 150 grams, with holes for suspension	4 50
79b	6715.	**Suspension Block,** for No. 79a	25
79c	6106.	**Copper Wire,** bare, No. 30, 4 oz. spool	55
79d	6719.	**Baseboard,** with meter sticks and adjustable sight and release blocks	1 35
80 81	1501.	**Apparatus A**	2 50
80a	1503.	**Mercury Gauge**	27
82	1525.	**Chemical Thermometer**	40
83	4627.	**Bunsen Burner**	20
84 85 86	1559.	**Linear Expansion Apparatus**	2 65
87	6721.	**Glass Tube,** containing dry air, confined by a column of mercury	1 65
88	1579.	**Galvanized Iron Ice Tray**	1 65
89	1589.	**Calorimeter**	50
90	1608.	**Lead Shot,** per pound	16
91	1580.	**Ice Bag,** of canvas	22
92	1505.	**Glass Steam Trap**	27
93	3501.	**Telescope or Spy Glass**	2 50
94	3099.	**Resonance Tube**	2 00
95	3012.	**Tuning Fork**	1 25
96	3040.	**Vibrograph**	4 00
97	1704.	**Bar Magnet,** 6 inch	22
98	1761.	**Compass,** 10 m. m	11
99	6723.	**Single Fluid Cell,** consisting of Nos. 2100 and 2101, elements and tumbler	18
100	2409.	**Galvanoscope**	2 10
101	2127.	**Daniell Cell,** quart size	55
102	2641.	**Commutator**	65
103a 103b 103c	2457.	**Resistance Coils**	3 35
104	2735.	**Binding Post, Double Connector**	11
105	6725.	**Binding Post,** triple	25
106	2473.	**Wheatstone's Slide Wire Meter Bridge**	3 35
107	2405.	**Astatic Galvanometer**	3 75
108	2442.	**Resistance Box**	6 65
109	2466.	**Temperature Coil**	1 25
110	2345.	**Telegraph Key and Sounder**	2 50
111 112	2256.	**Electric Motor and Dynamo**	3 35

CHEMICAL LABORATORY GLASSWARE AND APPARATUS.

Arranged Alphabetically.

DUTY FREE IMPORTATIONS.

Schools, Colleges, Universities and Scientific Institutions are permitted, by act of Congress, to import apparatus free of duty, when they are intended for the institution's use and not for resale or exchange.

The growth of our import business during the past few years and our extended foreign connections, enable us to handle duty free business to the entire satisfaction of our customers.

We wish to state, however, that it is only of advantage to import on this basis when large quantities are ordered, since the expense of shipping, custom house fees, etc., on small lots is proportionately much higher than on large quantities, thus making cost about as high as if bought "from stock," nor would the small difference compensate for the delay of three or four months—the usual time it takes for goods to arrive from abroad after placing your order.

Small instruments, or any goods that can be packed so as to bring the gross weight under 5 kilos, may be imported by parcels post in from six to eight weeks time.

Price of articles marked "duty free" is approximate. Net prices quoted upon application.

We are always glad to quote prices "duty free" on quantity lots, and can assure our customers that such orders will receive our most careful and prompt attention.

RESISTANCE GLASS.

Should you desire a superior Resistance Glass at a moderate cost, we would recommend our Improved Resistance Glass.

This glass is designed to take the place of the expensive Jena Glassware. The following qualities are fully guaranteed:

(1) The color test gives absolutely no indication of solution.

(2) Will stand, as a rule, a sudden change of temperature of 200 deg. C. from heat to cold and of 600 to 800 deg. C. cold to heat.

(3) Solutions can be boiled over a naked Bunsen flame.

(4) Increased security from accidental breakage.

(5) Faultless appearance.

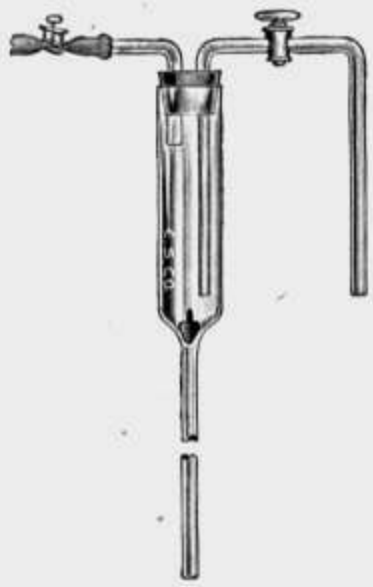
(6) Moderate cost.

We would be pleased to quote special prices on the above for duty free importation.

Catalog of this glassware sent upon application.



No. 4195.



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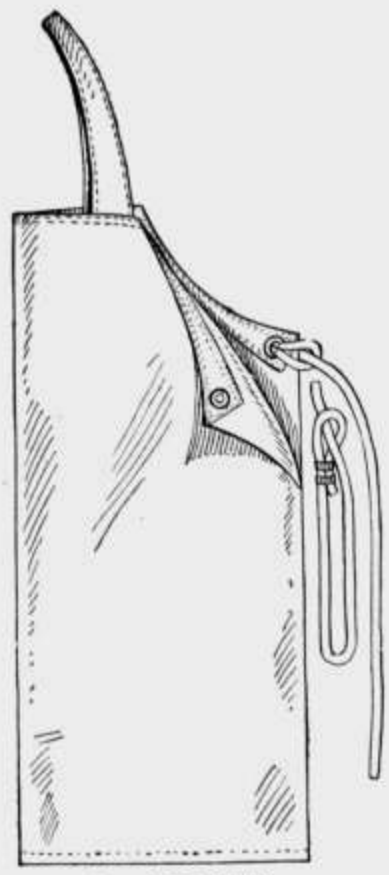


No. 4201-4203.



No. 4205.

Acid Basins, see Dessicator, Acid Dish, page 304.

4195. **Acid Pitcher,** of stoneware, with lip and handle.

Capacity, pints	1	2	4
Each	.30	.35	.40

4197. **Acid Pitcher,** of stoneware, with lip and two handles. Capacity one gallon ..... $ 65

4199. **Acid Pump (Syphon),** of glass. Positive and rapid in action, cleanly and easily operated. Will reach to bottom of standard carboy..... 2 75

Albuminometer, see "Urine Analysis Apparatus," page 335.

Alkalimeter, see "Carbonic Acid Apparatus," page 295.

Aprons and Sleeves for chemical laboratory use. Acid ruins a suit of clothes and there is also danger of severe burns if it comes in contact with the skin. Our aprons and sleeves are made of rubber with a drill or muslin cloth backing. They are **light, pliable, durable** and **acid proof. SAVE YOUR CLOTHES BY USING THEM.**

4201. **Apron,** heavy-weight rubber, with drill cloth backing; width, 36 inches; length, 50 inches. Each..... 80

4203. **Apron,** light-weight, with muslin cloth backing; width, 36 inches; length, 50 inches. Each..... 65

N. B.—If the above aprons are too long they can easily be cut off to the required length.

4205. **Over-Sleeves,** rubber acid proof cloth, per pair..... 40

Aquaria, see Catalogue N.

Arsenic Plates, see **"Streak Plates,"** page 283.

Arsenic Tubes, see **"Tubes,"** page 333.

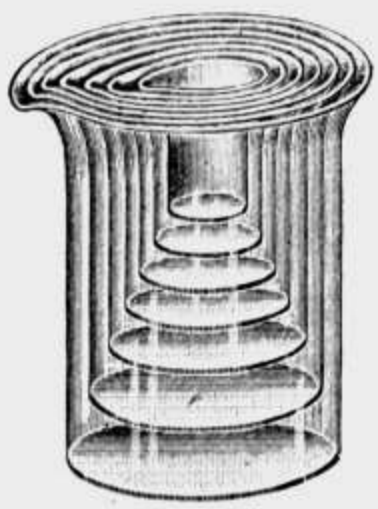
Aspirators, see **"Filter Pumps,"** page 104.

1441. **Balloon,** of collodion, for hydrogen. Capacity, 750 c. c..... 1 10

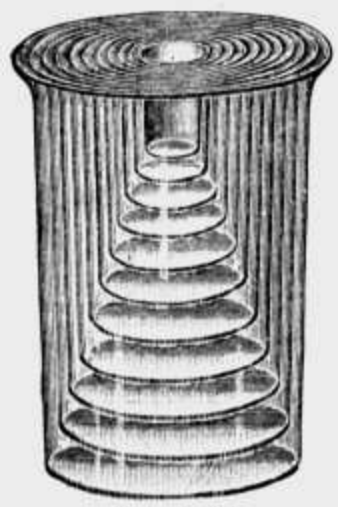
4213. **Balloon,** of glass, Dumas', for determining specific gravity of vapors. Capacity, 50 c. c..... 28

4214. **Balloon,** of very thin glass, for weighing gases, with two tubes..... 83

4214A. **Balloon,** same as No. 4214, but with two glass stopcocks..... 2 10



No. 4215.



No. 4223.

4215. **Beaker, Griffin form,** lipped; of best annealed Bohemian glass.

No.	000	00	0	1	2	3	4	5	6	7
Capacity, c. c.	30	50	75	130	230	350	550	750	1000	1400
Each	.06	.08	.09	.10	.15	.21	.25	.33	.41	.50

Beakers, same as No. 4215, nested.

4227.	Nos. 000-0; 3 in nest.	Per nest	$ 23
4228.	Nos. 0-2; 3 in nest.	Per nest	34
4229.	Nos. 1-4; 4 in nest.	Per nest	71
4230.	Nos. 0-4; 5 in nest.	Per nest	80
4231.	Nos. 0-5; 6 in nest.	Per nest	1 13
4232.	Nos. 0-7; 8 in nest.	Per nest	2 04

4233. **Beaker, usual form,** without lip; of best Bohemian glass.

No.	000	00	0	1	2	3	4
Capacity, c. c.	25	45	70	100	180	270	400
Each	.06	.07	.08	.09	.11	.16	.21



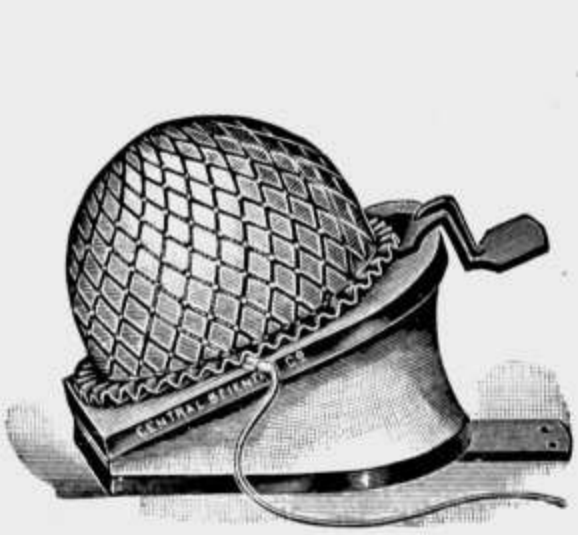
No. 4235-4237.

4235. **Beaker,** copper, Griffin form, with lip.

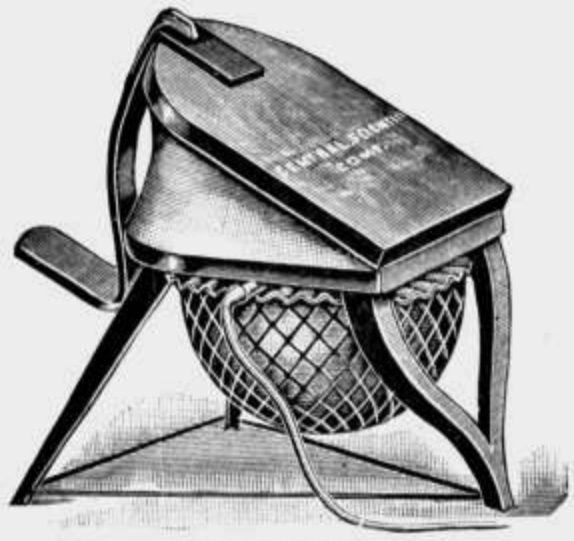
Capacity, ounces	4	8	16	32
Each	.55	.75	1.10	1.35

4237. **Beaker,** aluminum, Griffin form, with lip.

Capacity, ounces	4	8	16	32
Each	.55	.75	1.00	1.65



No. 4241-4243.



No. 4244-4246.

Bellows, for blast lamps, blow pipes, etc. There are cheaper bellows on the market, but there are no better and none more reasonable in cost than the ones listed below.

Catalog No.	4241	4242	4243
Trade No.	9	9A	9B
Each	4.50	5.55	7.75

Bellows, improved pattern, doing away with injury to rubber disc. More convenient to operate.

Catalog No.	4244	4245	4246
Trade No.	10	10A	10B
Each	5.55	6.65	8.90

Rubber Disc for above Bellows.

Catalog No.	4247	4248	4249
Adapted for Nos	9 and 10	9A and 10A	9B and 10B
Diameter, inches	11	14	16½
Each	.55	.85	1.10

4250. **Nets** for any size of above Bellows, each 45



No. 4440.



No. 4441.

4440. **Blast Lamp, Alcohol,** of copper; upright blast. 2 25

4441. **Blast Lamp, Bunsen's;** the oldest and best blast lamp made 3 30

1324. **Blast Apparatus.** Prof. Richards' modified form, for exhausting and compressing air where hydrant pressure is available. Desirable for quick filtering or blower for blast lamps. The larger size can be used simultaneously with lamp and filter flasks. With one Aspirator No. 1335..... 8 50

1324A. **Blast Apparatus,** same as No. 1324, with two Aspirators No. 1335..... 11 00

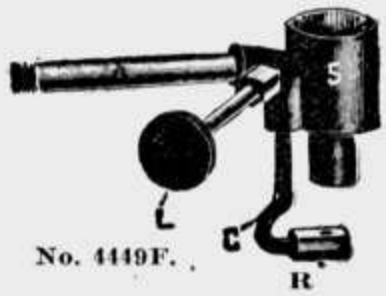
1324B. **Blast Apparatus,** same as No. 1324, with one large Aspirator No. 1336..... 14 00



No. 1324.



No. 4449.



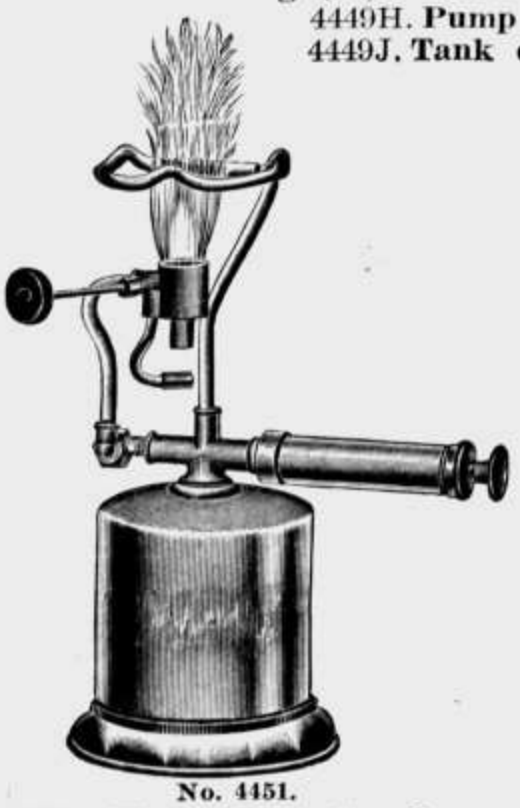
No. 4449F.



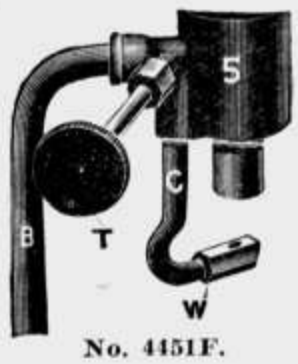
No. 4449G. and 4449H.

4449. **Blast Lamp, Gasoline,** of brass. This Gasoline Blast is recommended where the laboratory is not equipped for gas, or where a portable flame is desired. It is safe in its operation and produces a hot and powerful flame. The temperature and size of the flame is under the control of the operator and may be perfectly adjusted. Very simple in construction and gas may be generated with a match. Capacity of tank, ½ pint.....net $ 2 75

4449A. **Supply Tube** (A)..... 70
4449B. **Generating Tube** (C)..... 25
4449C. **Tip** (R)..... 25
4449D. **Burner Body** (5)..... 80
4449E. **Shut-off Screw** (L)..... 30
4449F. **Burner Complete**..... 2 00
4449G. **Filler Plug** (K) and **Inside Feed Tube**..... 1 00
4449H. **Pump Complete** (M)..... 1 00
4449J. **Tank only**..... 1 50



No. 4451.



No. 4451F.



No. 4451G.



No. 4451H.



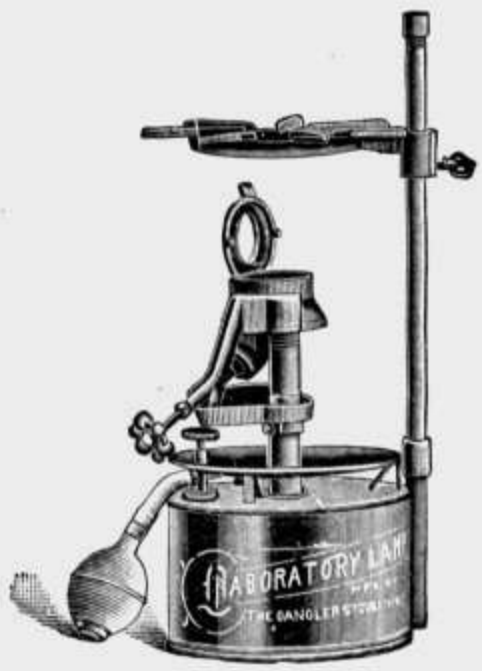
No. 4451J.



No. 4451K.

4451. **Blast Lamp,** Gasoline; same as No. 4449, but larger and more powerful. Capacity, 1 pint; consumption, one-quarter pint per hour. Burner, which generates a clear, blue flame, is swiveled in such a manner that the flame can be raised or lowered, or pointed in almost any direction. Tripod support is removable.....net 4 75

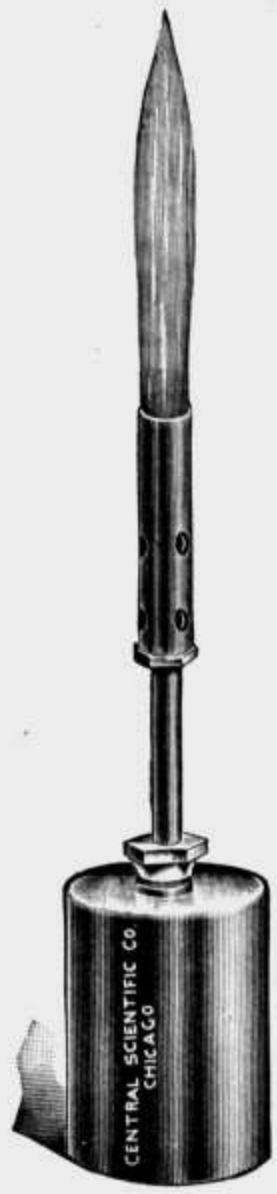
4451A. **Supply Tube** (B)..... 70
4451B. **Generating Tube** (C)..... 25
4451C. **Tip** (W)..... 25
4451D. **Burner Body** (5)..... 80
4451E. **Shut-off Screw** (T)..... 30
4451F. **Burner Complete**..... 2 00
4451G. **Filler Plug** and **Feed Tube** (S)..... 1 20
4451H. **Pump Complete** (U) and (V)..... 1 00
4451J. **Swivel** (X)..... 80
4451K. **Tripod** (Y)..... 40
4451L. **Tank only**..... 2 00



No. 4453.

4453. **Blast Lamp, Gasoline, "Dangler's Lamp."** An excellent substitute for gas, giving a high or low flame. $ 6 10

4455. **Blast Lamp, "Baby" Gasoline Torch.** Smallest torch made giving good results. Fits the hand and can be used in contracted places and corners. Burns equally well in all positions. Perfectly automatic, has no cocks or valves to get out of order or clog, is self-feeding, requires no pumping of air and is always ready for use, and lights with a match. It burns about two hours with one filling..... 1 65

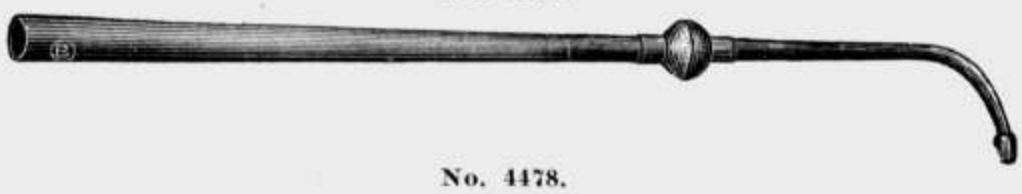


No. 4455.

BLOW PIPE APPARATUS.



No. 4477.



No. 4478.



No. 4479.



No. 4480.

4476. **Anvil,** Plattner's steel, 1½x1½ inches..... 40

4477. **Blow Pipe,** brass, plain.

Length, inches	8	10	12
Each	.09	.10	.13

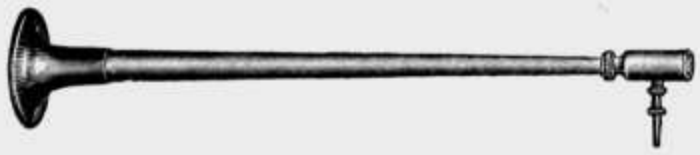
4478. **Blow Pipe,** brass, with bulb.

Length, inches	8	10	12
Each	.20	.22	.25

4478½. **Mouth Piece,** of wood, for No. 4477 or 4478. Each $ 20; per dozen 2 00

4479. **Blow Pipe, Black's,** japanned tin, removable brass tip..... 22

4480. **Blow Pipe, Black's,** new form, brass, with removable tip and wooden mouthpiece..... 60



No. 4481.



No. 4482.



No. 4483.

4481. **Blow Pipe, Plattner's,** of brass, nickel plated, with removable platinum tip and hard rubber mouthpiece..... $ 2 75

4482. **Blow Pipe,** brass, hot blast..... 85

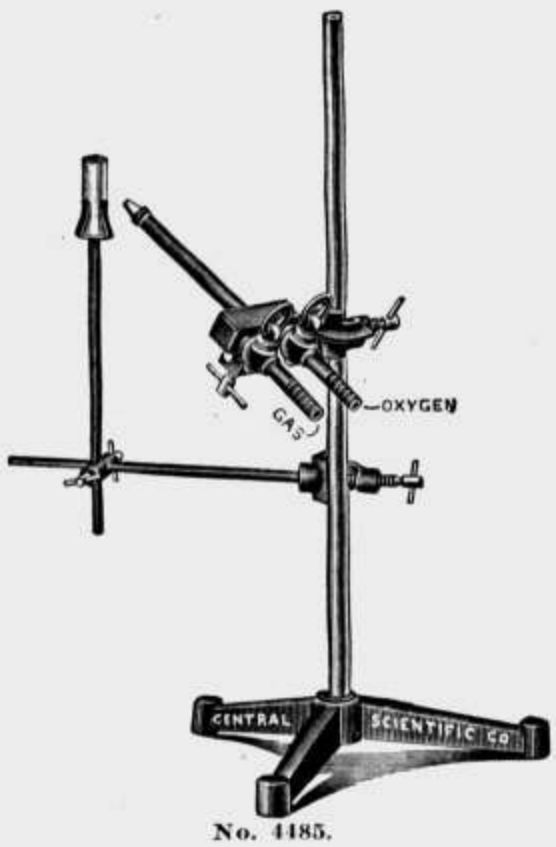
4483. **Blow Pipe, Brazing,** quick in operation and of great heating power, requiring ⅜ inch gas supply..... 2 25



No. 4484.

4484. **Blow Pipe,** for alcohol. This blow pipe burns wood or denatured alcohol and produces a needle pointed flame of remarkably high temperature. The double jet construction of the burner generates the maximum degree of heat from the fuel (over 3,000° F.). The flame is perfectly clean and non-oxidizing. The burner is swiveled so that it can be turned in any position.

Capacity, one pint; consumption, one-quarter pint per hour.....net 5 00



No. 4485.

4485. **Blow Pipe, Oxy-Hydrogen,** all brass, on stand, with movable lime cylinder holder and two stop cocks..... 6 65

4487. **Blow Pipe Lamp,** of brass, nickel plated..... 1 65

4488. **Bunsen Burner,** with blow pipe tip..... 50

4489. **Button Brush** 50

4490. **Carbon Block,** moulded 40

4491. **Carbon Block Holder** 40

4492. **Carbon Cylinder,** moulded, 1¼x3 inches..... 22

4493. **Charcoal Borer,** club shape 90

4494. **Charcoal Borer,** four cornered 40

4495. **Charcoal Borer,** with spatula 50

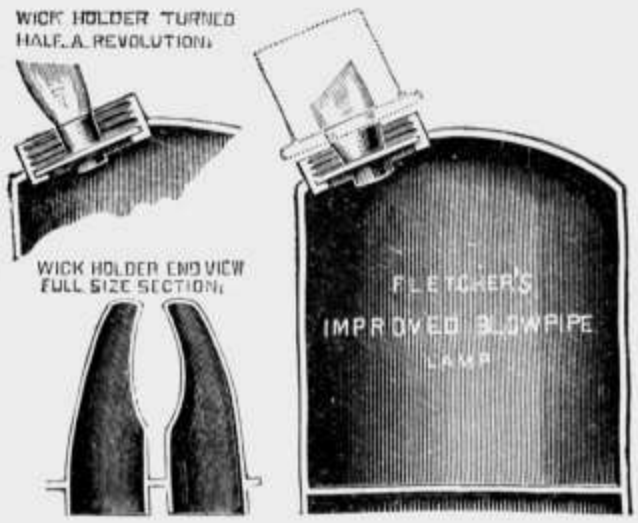
4497. **Charcoal Crucibles.** Per dozen..... 30

4498. **Charcoal Holder,** with platinum wire and shield..... 2 50

4500. **Charcoal Sticks,** natural willow wood, 1x1x3. Per dozen..... 50

4501. **Charcoal Squares,** with covers, for charcoal holder. Per dozen..... 2 25

See illustrations of Nos. 4487 and 4493, on next page.



No. 4487.



No. 4507.



No. 4523.

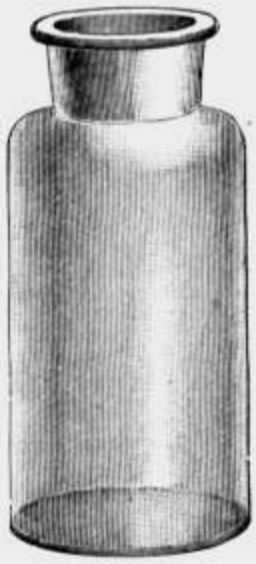


No. 4493.

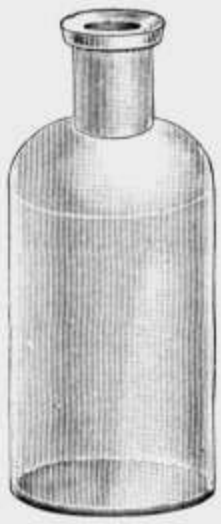


No. 4508.

4502. **Charcoal Saw** ..... $ 45
4503. **Clay Capsules,** per dozen..... 30
4504. **Clay Crucibles,** per dozen..... 30
4505. **Cupels,** bone ash, 1¼ inch, per dozen..... 27
4506. **Cupels,** bone ash, 1½ inch, per dozen..... 50
4507. **Cupel Holder,** with two moulds and one stamp..... 1 90
4508. **Forceps, Plattner's,** with platinum tips.....net 4 40
4509. **Forceps, French Form,** with platinum tips.....net 4 40
For other **Forceps** see Index and Biological catalogue.
4510. **Hammer, Plattner's,** wooden handle..... 55
4512. **Ivory Spoon** 30
Lamps, alcohol, see page 316.
Magnets and **Magnifiers,** see Index.
4515. **Mattrasses,** German glass, flask shape, per dozen..... 35
4517. **Mattrass Holder** 35
4519. **Minerals for Blow Pipe,** 25 specimens, small size, each in box..... 1 65
4520. **Minerals for Blow Pipe,** 50 specimens, small size, each in glass tube.. 3 00
4521. **Minerals for Blow Pipe,** 100 specimens, put up in boxes with glass covers and index..... 8 75
4522. **Minerals for Blow Pipe,** 100 specimens, Plattner's, put up in bottles, in box with catalog..... 11 50
Minerals, per pound, see Catalog R.
Mortars, see page 319.
4523. **Mould,** of boxwood, for clay capsules..... 75
4524. **Mould,** of boxwood, for clay crucibles..... 1 25
4525. **Platinum Wire,** with solid glass handle, for borax beads, etc., each.. 33
Platinum Goods, see page 321.
4526. **Pliers,** for assay buttons..... 55
4529. **Reagents,** set of 14 1-ounce reagent bottles filled with chemically pure blow pipe reagents, according to Fresenius..... 5 00
4530. **Scale,** Plattner's, of ivory, for silver beads..... 3 65
4531. **Scale of Hardness,** without diamond, 9 specimens..... 2 25
4532. **Silver Foil,** per ounce..... 1 65
4533. **Soda Papers,** per box..... 22
4535. **Streak Plate,** porcelain..... 20
4537. **Test Lead Measure** 50
4538. **Test Lead Sieve** 1 00
Test Tubes, see page 331.
4539. **Tubes,** hard glass, 4x¼, open at both ends. Per dozen..... 50
4540. **Tubes,** hard glass, 4x¼, closed at one end. Per dozen..... 75
Tubes for Arsenic Reduction, see page 333.



No. 4541.



No. 4543.



No. 4545.



No. 4547.

4541. **Bottle,** round flint "prescriptions," wide mouth for corks.

Capacity, ounces	1	2	4	6	8	12	16	32
Per dozen	.26	.30	.40	.45	.52	.73	.90	1.33

4542. **Bottle,** round green glass "prescriptions," wide mouth for corks.

Capacity, gallons	½	1	2
Each	.25	.35	.75

4543. **Bottle,** round flint glass "prescriptions," narrow mouth for corks.

Capacity, ounces	1	2	4	6	8	12	16	32
Per dozen	.25	.28	.38	.42	.50	.70	.85	1.25

4544. **Bottle,** round green glass "prescriptions," narrow mouth for corks.

Capacity, gallons	½	1	2
Each	.25	.35	.75

4545. **Bottle,** round flint "tinctures," mushroom stopper.

Capacity, ounces	1	2	4	8	16	32
Per dozen	.80	1.00	1.30	1.60	2.20	3.10

4546. **Bottle, Acid,** ground glass stopper.

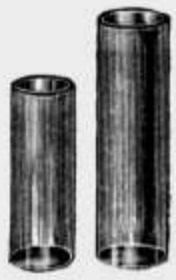
Capacity	Pint.	Quart.	½ Gal.
Each	.18	.25	.33

4547. **Bottle,** round flint glass "salt mouth," mushroom stopper.

Capacity, ounces	1	2	4	8	16	32
Per dozen	1.00	1.15	1.40	1.75	2.25	3.20



No. 4549.



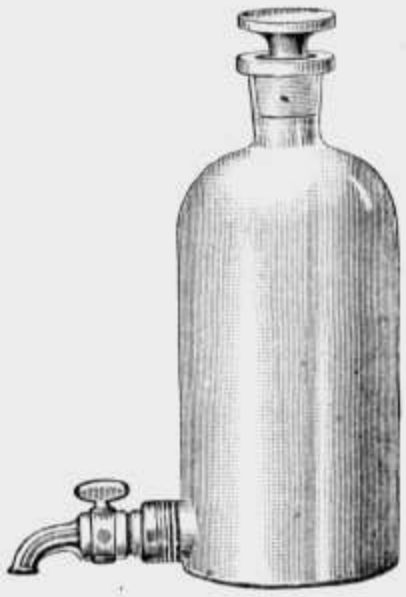
No. 8065.

4549. **Bottle, Homeopathic Vial.**

Capacity in drams	1	2	3	4	6	8
Per gross	.95	1.10	1.50	2.20	3.00	3.35

8065. **Bottle, Shell Vial,** round, straight wall.

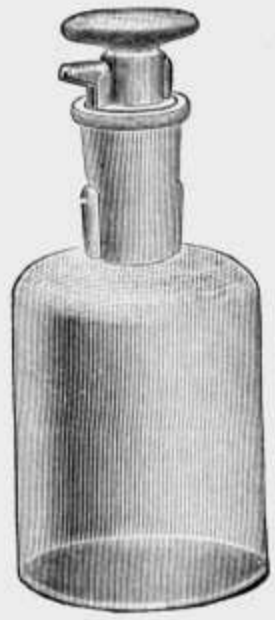
No.	1	2	3	4	5
Height, m. m	50	60	70	80	75
Diameter, m. m	12	13	15	16	25
Capacity, c. c	4	7	11	14	34
Per dozen	.20	.24	.30	.35	.60



No. 4551.



No. 4555.



No. 4558.

4551. **Bottle, Aspirator,** with glass stopper and stop cock.

Capacity	½ gal.	1 gal.	2 gal.
Each	2.20	3.35	5.00

4553. **Bottle, Aspirator,** same as No. 4551, tubulature at bottom, but without glass stopper and stop cock.

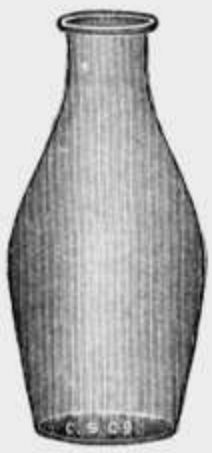
Capacity	1 qt.	½ gal.	1 gal.	2 gal.
Each	.60	.83	1.30	2.40

4555. **Bottle, Dropping,** Schuster's, plain..... 15

4557. **Bottle, Dropping,** Schuster's, glass stoppered..... 22

4558. **Bottle, Dropping.** A groove on one side of the neck of the bottle and a vent on the other connect with two grooves in the peg of the stopper and allow the contents to flow out drop by drop. A quarter turn of the stopper closes the bottle tightly. Capacity, 1 ounce..... 27

Note—For other **Dropping Bottles** see Biological catalog N.



No. 4559.



No. 4561.



No. 4566.

4559. **Bottle, Gas,** plain.

Capacity, pints	½	1	2	4
Each	.17	.22	.30	.50

4561. **Bottle, Gas Generating** or **Evolution Flask,** same as No. 4559, fitted with rubber stopper, funnel and delivery tubes.

Capacity, pints	½	1	2	4
Each	.45	.60	.72	1.00

4563. **Bottle, Gas Washing,** same as 4559, with rubber stopper and fittings.

Capacity, pints	½	1	2
Each	.40	.55	.63

4566. **Bottle, Inverted Show.**

Capacity, pints	1	2	4
Each	.25	.35	.60

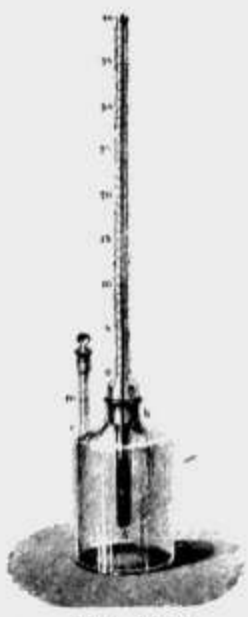
Balsam, Collecting and **Insect Bottles,** see Catalog N.



No. 1101.



No. 1103.



No. 1105.



No. 4567.



No. 4569.



No. 4570.

1101. **Bottle, Specific Gravity,** unadjusted, perforated stopper, for student adjustment.

	25 c. c.	50 c. c.
Approximate capacity		
Each	.35	.45

1103. **Bottle, Specific Gravity,** very accurately adjusted.

	25 c. c.	50 c. c.
Exact capacity at 15° C.		
Each	.75	1.00

1105. **Bottle, Specific Gravity,** Geissler's, with thermometer ground in central neck and a capillary stopper ground in side neck. Capacity, 25 c. c.. $ 2 50

1105A. **Bottle, Specific Gravity,** same as No. 1105. Capacity, 50 c. c..... 2 75

4567. **Bottle, Washing,** with rubber stopper and flexible delivery tube.

Capacity, ounces	8	12	16	24	32
Each	.35	.42	.45	.55	.65

4569. **Bottle, Washing,** all glass, with tubes ground in the neck.

Capacity, ounces	8	16
Each	.90	1.10

4570. **Wash Bottle,** Drechsel's, with tubes ground into the neck, high form.

Capacity, c. c.	125	250	500
Each	.65	.80	1.05



No. 4571.



No. 4573.



No. 4581.

4571. **Bottle, Weighing,** conical form, very light, glass stoppered.

Capacity, ounce	½	1	2
Each	.30	.35	.45

4573. **Bottle, Weighing,** tubular form, flat bottom, glass stoppered.

Height, m. m.	60	80	90
Width, m. m.	10	12	18
Each	.17	.21	.25

Bottle, Woulff's.

Cat. No.	4575	4576	4577	4578	4579	4580	4581	4582
Necks	2	2	2	2	3	3	3	3
Capac'y, pints	¼	½	1	2	¼	½	1	2
Each	.35	.40	.45	.70	.40	.45	.60	83



No. 4587.



No. 4593.



No. 4589.

CHEMICAL REAGENT BOTTLES.

The labels on these bottles are of raised letters blown in the glass, the surface of each letter being ground so as to render it perfectly distinct. The letter is therefore indestructible. The following list will be found to contain the names of all the test solutions referred to in the United States Pharmacopaeia.

No bottle **with other labels** in this type of bottle is manufactured. If, however, any name not in the list is especially desired, it may be engraved on blank bottles at an additional charge of 15c per bottle.

4585.	**Bottles, Reagent,** 1 ounce, per dozen	1 40
4586.	**Bottles, Reagent,** 1 ounce, wide mouth, per dozen	1 50
4587.	**Bottles, Reagent,** 4 ounce, per dozen	1 95
4589.	**Bottles, Reagent,** 4 ounce, wide mouth, per dozen	2 20
4590.	**Bottles, Reagent,** 8 ounce, per dozen	2 50
4591.	**Bottles, Reagent,** 1 pint, per dozen	3 60
4592.	**Bottles, Reagent,** 1 quart, per dozen	4 45
4593.	**Caps,** for reagent bottles. Will fit Nos. 4585-4586, per dozen	65
4594.	**Caps,** for reagent bottles. Will fit Nos. 4587-4590, per dozen	75
4595.	**Caps,** for reagent bottles. Will fit No. 4591, per dozen	90

PLEASE ORDER BY BOTTLE NUMBER.

4585. Reagent Bottles. 1 oz., Height 3⅝ Inches.

No.		No.	
325.	Silver Nitrate (Amber) $AgNO_3$	336.	Gold Chloride $AuCl_3$
326.	Cobaltous Nitrate $Co(NO_3)_2$	341.	Blank.
327.	Platinic Chloride $PtCl_4$		

4586. Reagent Bottles. Wide Mouth, 1 oz., Height 3⅛ Inches.

No.		No.	
350.	Sodium Carbonate Na_2CO_3	367.	Potassium Chlorate $KClO_3$
351.	Borax $Na_2B_4O_7$	368.	Potass. Ferricyanide $K_3Fe(CN)_6$
353.	Sodium Acetate $NaC_2H_3O_2$	369.	Sodium Bitartrate $NaHC_4H_4O_6$
354.	Potassium Nitrate KNO_3	370.	Sodium Nitrate $NaNO_3$
358.	Potassium Cyanide KCN	371.	Starch.
361.	Am. Sod. Phosphate $NaNH_4HPO_4$	372.	Test Paper.
364.	Copper Cu	373.	Zinc.
365.	Ferrous Sulphate $FeSO_4$	374.	Ammon. Phosphate $(NH_4)_2HPO_4$
366.	Ferrous Sulphide FeS	375.	Blank.

4587. Reagent Bottles, 4 oz., Height 5¼ Inches.

No.			No.	
1.	Hydrogen Sulph. (Amber)	H_2S	36.	Cupric Sulphate ..... $CuSO_4$
2.	Hydrochloric Acid	HCl	37.	Platinic Chloride ..... $PtCl_4$
3.	Acetic Acid	$HC_2H_3O_2$	38, 39, 40.	Blank.
4.	Sulphuric Acid	H_2SO_4	58.	Fehling's Solution.
5.	Nitric Acid	HNO_3	59.	Sodium Carbonate ..... Na_2CO_3
6.	Potassium Ferrocyanide....	$K_4Fe(CN)_6$	60.	Sodium Acetate ..... $NaC_2H_3O_2$
7.	Potassium Sulphocyanide...	$KCNS$	61.	Sodium Hydroxide ..... $NaOH$
8.	Potassium Carbonate	K_2CO_3	81.	Stannous Chloride ..... $SnCl_2$
9.	Potassium Sulphate	K_2SO_4	82.	Ammon. Molybdate ..... $(NH_4)_2MoO_4$
10.	Potassium Iodide	KI	83.	Carbon Disulphide ..... CS_2
11.	Potassium Ferricyanide....	$K_3Fe(CN)_6$	86.	Mercurous Nitrate ..... $Hg_2(NO_3)_2$
12.	Potassium Hydroxide	KOH	87.	Indigo Solution.
13.	Potassium Dichromate	$K_2Cr_2O_7$	88.	Nessler's Solution.
14.	Sodium Phosphate	Na_2HPO_4	90.	Magnesia Mixture.
15.	Ammonium Hydroxide.....	NH_4OH	93.	Oxalic Acid ..... $H_2C_2O_4$
16.	Ammonium Sul. (Amber)..	$(NH_4)_2S$	94.	Picric Acid ..... $C_6H_2OH(NO_2)_3$
17.	Ammonium Chloride	NH_4Cl	96.	Potassium Chromate ..... K_2CrO_4
18.	Ammonium Carbonate	$(NH_4)_2CO_3$	97.	Ammon. Sulphydrate ..... NH_4HS
19.	Ammonium Oxalate	$(NH_4)_2C_2O_4$	100.	Mercuric Potassium Iodide.
20.	Barium Chloride	$BaCl_2$	401.	Barium Nitrate ..... $Ba(NO_3)_2$
21.	Calcium Chloride	$CaCl_2$	404.	Silver Sulphate ..... Ag_2SO_4
22.	Calcium Sulphate	$CaSO_4$	406.	Bromine Water.
23.	Calcium Hydroxide	$Ca(OH)_2$	407.	Chloroform ..... $CHCl_3$
24.	Magnesium Sulphate	$MgSO_4$	408.	Cochineal.
25.	Mercuric Chloride	$HgCl_2$	409.	Coralline.
26.	Silver Nitrate (Amber)....	$AgNO_3$	410.	Litmus.
27.	Lead Acetate	$Pb(C_2H_3O_2)_2$	411.	Methyl-Orange.
28.	Ferrous Sulphate	$FeSO_4$	412.	Phenolphtalein.
29.	Ferric Chloride	Fe_2Cl_6	413.	Turmeric.
30.	Alcohol	C_2H_5OH	414.	Iodine Solution ..... $I+KI$
31.	Ammon. Sulphocyanide.....	NH_4CNS	415.	Methyl Alcohol ..... CH_3OH
32.	Barium Hydroxide	$Ba(OH)_2$	416.	Sodium Cobaltic Nitrite.
33.	Barium Carbonate	$BaCO_3$	417.	Sodium Hyposulphite..... $Na_2S_2O_3$
35.	Ether	$(C_2H_5)_2O$		

4588. **Reagent Bottles.** Set of 40 of the above bottles (No. 4587), including the most common names used in the chemical laboratory. Includes Bottles No. 1 to 36, inclusive, and Nos. 38, 39, 40, 59 and 61. Complete set in box..... $ 6 50

4588A. **Reagent Bottles,** 4 oz., set of 24 according to Fresenius. Includes Nos. 2, 3, 4, 5, 6, 7, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 25, 26, 27, 29, 32, 36, 59 and 61. Per set..... 3 90

4588B. **Reagent Bottles,** 4 oz., set of 12, consisting of Nos. 1, 2, 3, 4, 5, 15, 16, 20, 23, 26, 27 and 61. Per set..... 1 95

4589. Reagent Bottles, Wide Mouth, 4 oz., Height 4⅞ Inches.

301.	Sodium Carbonate	Na_2CO_3	305.	Ferrous Sulphate ..... $FeSO_4$
302.	Potassium Nitrate	KNO_3	307.	Blank.
303.	Potassium Cyanide	KCN	312.	Test Paper.
304.	Borax	$Na_2B_4O_7$		

4590. Reagent Bottles, 8 oz., Height 6½ Inches.

101.	Sulphuric Acid, Con.....	H_2SO_4	114.	Barium Chloride ..... $BaCl_2$
102.	Sulphuric Acid, Dil.....	H_2SO_4	116.	Blank.
103	Nitric Acid, Con.....	HNO_3	122.	Ammon. Sulph. (Amber)... $(NH_4)_2S$
104.	Nitric Acid, Dil.....	HNO_3	126.	Alcohol ..... C_2H_5OH
105.	Hydrochloric Acid, Con....	HCl	129.	Sodium Phosphate ..... Na_2HPO_4
106.	Hydrochloric Acid, Dil.....	HCl	130.	Ammonium Oxalate ..... $(NH_4)_2C_2O_4$
107.	Hydrogen Sulp. (Amber)...	H_2S	131.	Acetic Acid ..... $HC_2H_3O_2$
108.	Ammonium Hydroxide.....	NH_4OH	145.	Silver Nitrate (Amber)..... $AgNO_3$
109.	Ammonium Chloride.....	NH_4Cl	150.	Potassium Hydroxide ..... KOH
110.	Ammonium Carbonate.....	$(NH_4)_2CO_3$	151.	Calcium Hydroxide ..... $Ca(OH)_2$
111.	Sodium Hydroxide	$NaOH$	152.	Lead Acetate ..... $Pb(C_2H_3O_2)_2$
112.	Sodium Carbonate	Na_2CO_3		

4591. Reagent Bottles, 16 oz. (Pint), Height 7¾ Inches.

204.	Ammonium Hydroxide.....	NH_4OH	216.	Nitric Acid ..... HNO_3
211.	Blank.		217.	Hydrochloric Acid ..... HCl
215.	Sulphuric Acid	H_2SO_4		

4592. Reagent Bottles, 32 oz. (Quart), Height 9½ Inches.

501.	Sulphuric Acid, Con.....	H_2SO_4	505.	Hydrochloric Acid, Con.... HCl
502.	Sulphuric Acid, Dil.....	H_2SO_4	506.	Hydrochloric Acid, Dil..... HCl
503.	Nitric Acid, Con.....	HNO_3	511.	Blank.
504.	Nitric Acid, Dil.....	HNO_3		



No. 4598.



No. 4599.



No. 4600.



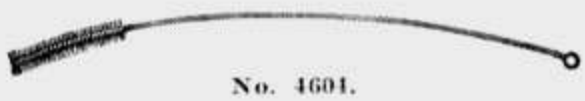
No. 4601.



No. 4603.



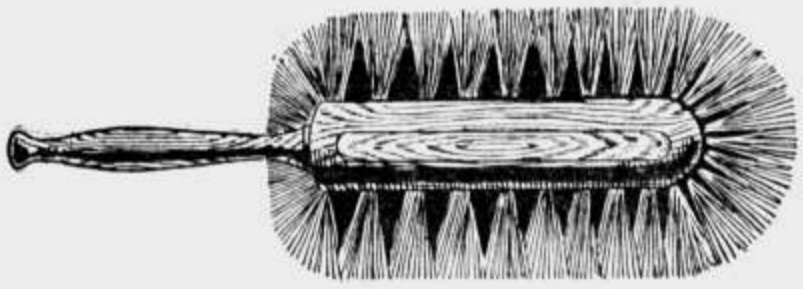
No. 4602.



No. 4604.



No. 4605.



No. 4607.



No. 4606

4598. **Brush, Test Tube,** bristle end. Per dozen..... $ 50

4599. **Brush, Test Tube,** plain. Per dozen..... 40

4600. **Brush, Test Tube,** brass wire and sponge end. Per dozen..... 80

4601. **Brush, Beaker,** bristle with bristle end, wood handle..... 22

4602. **Brush, Burette,** and **Long Tube,** bristle on tinned iron wire..... 17

4603. **Brush, Funnel, bristle,** taper end, wood handle..... 28

4604. **Brush, Small Tube,** bristle on tinned iron wire. Per dozen..... 17

4605. **Brush, Pencil,** of camel hair.

Size	Small.	Medium.	Large.
Per dozen	.18	.22	.30

4606. **Brush,** camel hair, for cleaning scale pans, instruments, etc. Flat, with wood handle.

Width, inches	½	1	1½	2
Each	.17	.20	.30	.40

4607. **Brush,** "Counter Brush." All pure bristles, white outside. A laboratory necessity. Each..... 45



No. 4619.



No. 4620.



No. 4615.



No. 4617.

4609. **Bulb, Rubber,** for pipettes, etc.

Capacity	2 cc.	5 cc.	25 cc.	50 cc.
Each	.05	.06	.20	.25

4611. **Bulb, Rubber,** with hard rubber valves for exhaust or pressure, 50 cc..... $ 45

4613. **Bulb, Rubber,** double, one with net for constant blast 1 50

4615. **Burette, Mohr's,** for use with pinchcock.

Capacity..	25 cc. $\frac{1}{10}$	50 cc. $\frac{1}{10}$	100 cc. $\frac{1}{10}$
Each.....	.66	1.10	1.80

4617. **Burette, Mohr's,** with glass stopcock.

Capacity...	25 cc. $\frac{1}{10}$	50 cc. $\frac{1}{10}$	100 cc. $\frac{1}{10}$
Each	1.35	1.75	2.20

4619. **Burette Float, Erdmann's**..... 30

4620. **Burette Float, Erdmann's,** with points to prevent adherence to the side of the burette 45



No. 4621A.



No. 4621B.



No. 4621C



No. 4621D.



No. 4621E.



No. 4621F.



No. 4621G.



No. 4621H.

BURNER ATTACHMENTS.

For Burner With 7-16 Inch Tube.

4621A. **Blow Pipe Tube,** for yellow flame..... 15

4621B. **Blow Pipe Tip,** with rest..... .17

4621C. **Wing Top** 18

4621D. **Crown Top,** giving round flame..... 38

4621E. **Tripod**..... 18

4621F. **Gauze Top** 25

4621G. **Chimney**..... 17

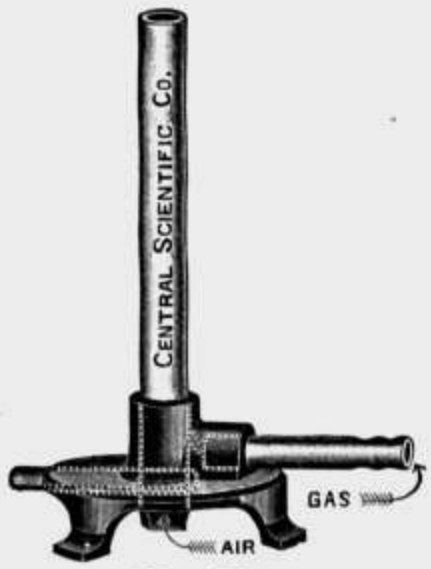
4621H. **Star,** for supporting chimney..... 22

3445. **Monochromatic Flame Burner,** see cut and description, page 238.

4623. **Burner Guard,** of vitrified earthenware. Protects the flame from drafts and affords a rigid and convenient support. Stands 9 inches high; diameter at base 8 inches, at top 5 inches. Each..... 40



No. 4625.



No. 4629.



No. 4631.

4625. **Burner, Bunsen's,** with air regulator..... $ 25

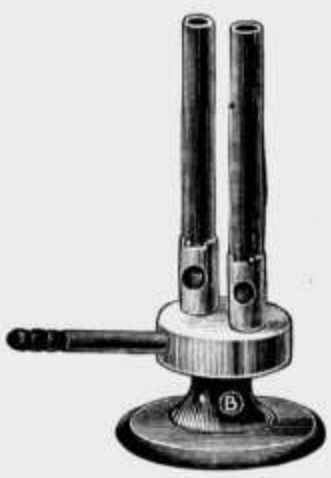
4627. **Burner, New Central Draft Burner.** A new departure for students' use. Consists of only three pieces. No tip to clog up. Substances accidentally dropped into the tube will fall clear through to the table. Perfect combustion, long lived, inexpensive; each, .20, per doz.. 2 00

4629. **Burner, Bunsen's,** same as No. 4627, fitted with air damper. Each, 25 cents, per dozen..... 2 50

4631. **Burner, Bunsen's,** low form, with air regulator. Each..... 41

N. B.—Quantity prices quoted on above burners upon application.

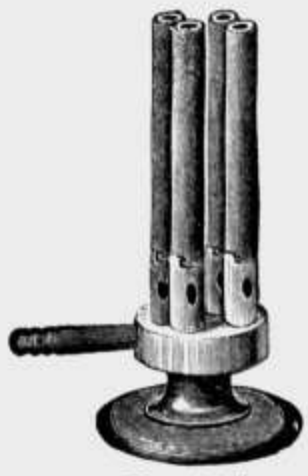
4632. **Burner, Bunsen's,** for acetylene gas, with air regulator..... 1 25



No. 4633.



No. 4635.



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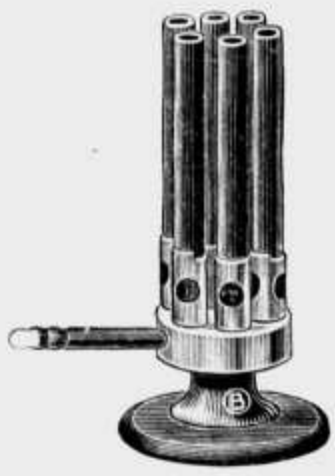


No. 4639.

4633. **Burner, Bunsen's,** 2 tubes, with air regulators..... 1 05

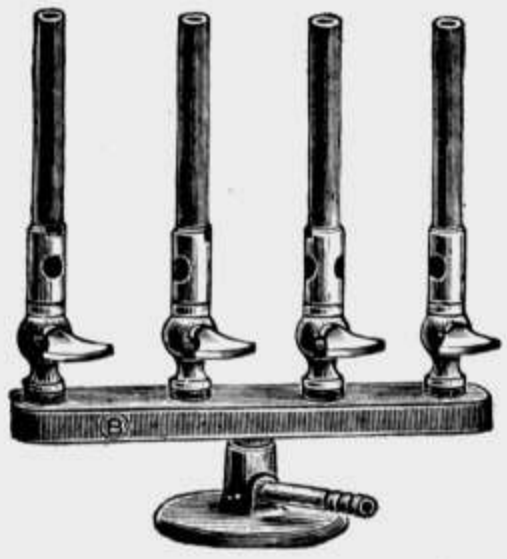
4635. **Burner, Bunsen's,** 3 tubes, with air regulators..... 1 25

4637. **Burner, Bunsen's,** 4 tubes, with air regulators..... 1 65

4639. **Burner, Bunsen's,** 6 tubes, with air regulators..... 2 50

4641. **Burner, Bunsen's,** 4 tubes in one row, with air regulators 3 35

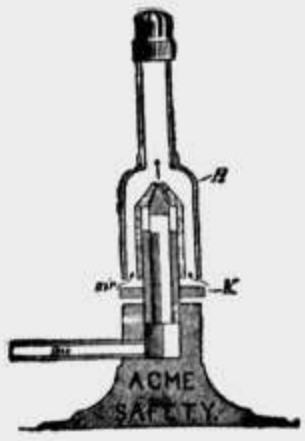
4643. **Burner, Bunsen's,** 4 tubes in one row, with stop cock and air regulator for each tube 4 50



No. 4643.



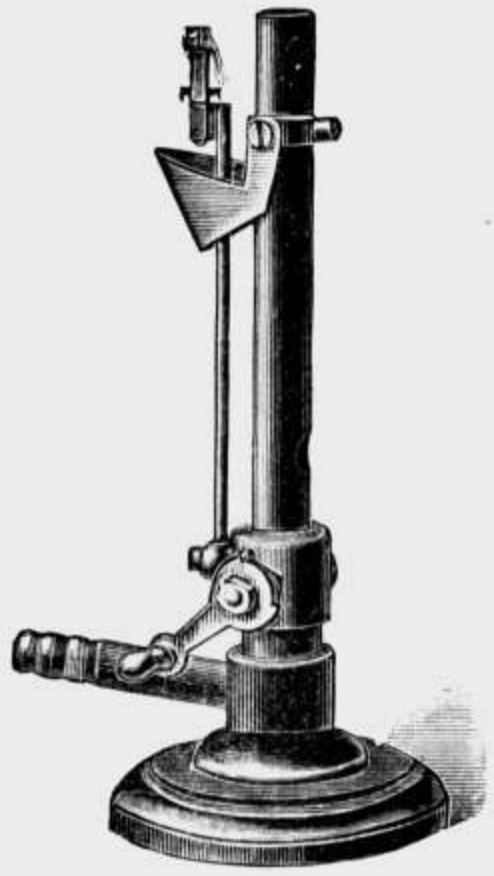
No. 4645.



No. 4647.

4645. **Burner, Boyce's Adjustable,** improved regulator. Burns either coal gas or gasoline gas. The best low priced burner on the market, and the **only adjustable burner** made whose tube is **stationary,** whereby all attachments can be used with it to perfection ..... $ 75

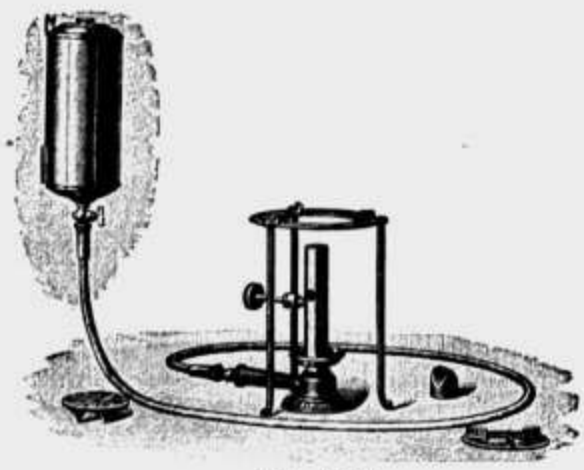
4647. **Burner, Boyce's "Acme."** Considered by all who have used it to be the most perfect burner made. Burns either coal gas or gasoline gas, with regulator for both gas and air. **Flame cannot strike back.** Perfect combustion with either a high or low flame..... 1 35



No. 4651.

4648. **Burner, Boyce's,** same as No. 4647, without base. This is the only make of adjustable burner that can be mounted on a supply tube in any number for constructing different forms of heating apparatus for the chemist..... 1 10

4651. **Burner, New Self-Lighting Bunsen.** This burner is especially adapted for the lecture table, as it does not require a match to light. Simply turning the gascock admits the gas and ignites it at the same instant by means of a platinum and magnesium pellet. These igniting pellets last for years and improve by frequent use. They have a protective shield, shown dropped down in the illustration. Flame is regulated by stopcock. Full instructions accompany each burner... 2 75



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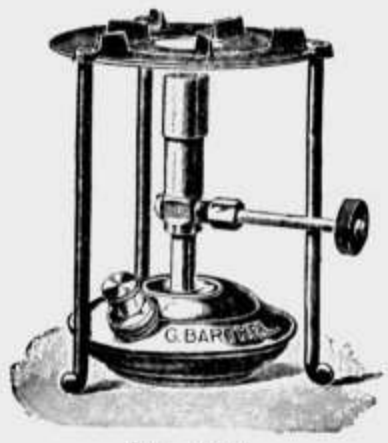
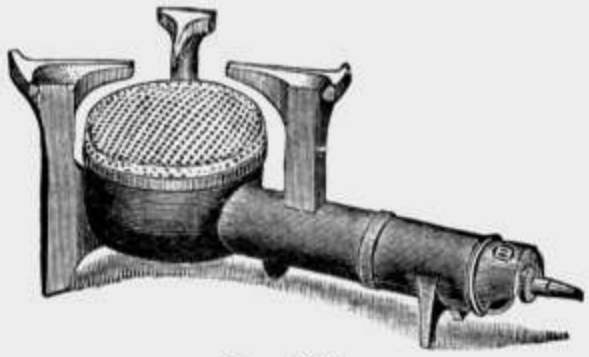


No. 4657.

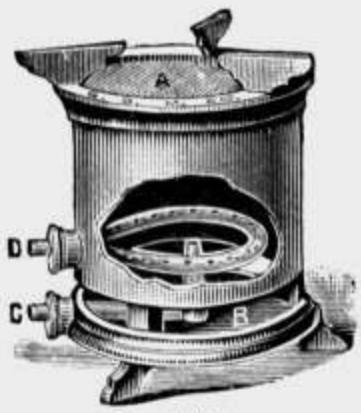
4653. **Burner, Barthel's, for Alcohol,** requires no wick, very powerful. Complete with 1½ meters flexible metallic tubing and reservoir of 1 liter capacity. Without tripod..... 7 50

4655. **Burner, Barthel's,** same as No. 4653, but without tubing..... 5 50

4657. **Burner, Barthel's, for Gasoline,** more powerful than the ordinary Bunsen Burner, for which it is an excellent substitute. Requires no wick. Without tripod..... 5 50



No. 4661.



No. 4665.

4661. **Burner, Solid Flame.** Gas consumption, 35 feet per hour. This burner will boil ½ gallon of water in 5 minutes and melt six pounds of lead or solder in an iron ladle in 7 minutes..... $ 2 00

4663. **Burner,** same as No. 4661, for gasoline gas, with wheel valve..... 3 50

4665. **Burner, Low Temperature.** This burner gives a complete range of temperature, from a gentle current of warm air to a clear, red heat and is perfectly under control. For very low temperature the ring must be lighted through the opening B. For boiling, etc., the light must be applied on the surface of the gauze, thereby providing a large body of blue flame, which can be urged by the blast pipe C... 2 60

4667. **Burner, Low Temperature,** without blast pipe C..... 2 25



No. 4669.



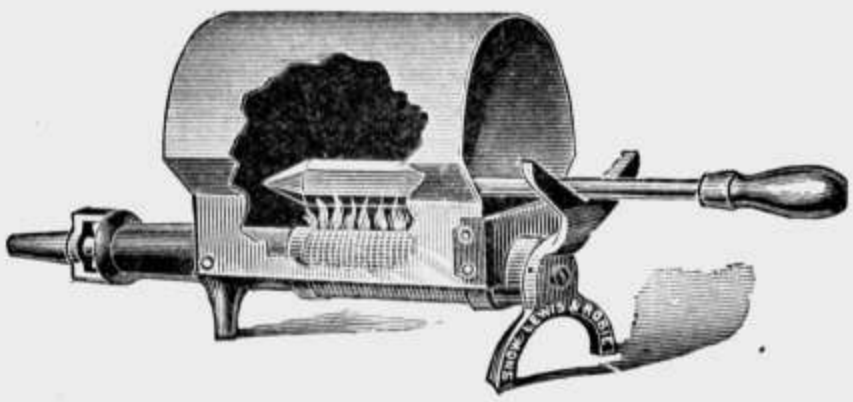
No. 4671.

4669. **Burner, Fletcher's Evaporating,** of copper.....

	4 in.	5 in.	6½ in.
Each	2.25	2.75	3.35

4671. **Burner, Ring Form,** to be attached to support with a right angle clamp.

Diameter	3 in.	4 in.	5 in.	6 in.
Each	1.10	1.35	1.55	1.80



No. 4672.



No. 4673.

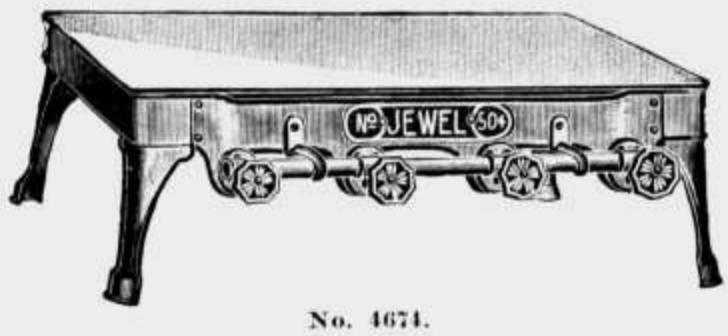
4672. **Burner, Soldering Iron Heater.** Simple construction, superior make, standard design, without soldering iron..... 1 40

N. B.—Soldering Coppers and Soldering Sets listed on page 41.

4673. **Burner, Gas.** A portable gas table stove with cast iron top and base and Russia iron body. A steel drip pan is under the burner and the top is raised. Diameter, 9 inches; height, 4½ inches. Very useful in the laboratory..... 1 25

4673A. **Burner, Gasoline,** same as No. 4673, furnished with valve and air regulator for burning gasoline gas..... 2 25

4673B. **Burner, Gas.** Cast iron, neatly japanned. Extreme length, 12½ inches; height, 4½ inches..... 75

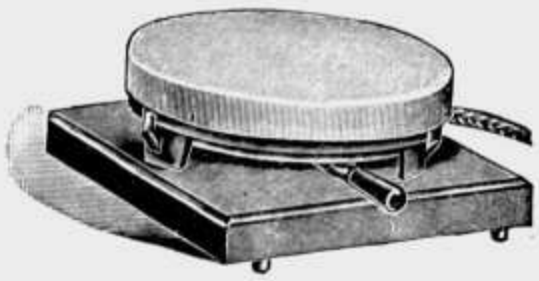


No. 4674.

4674. **Burner, Hot Plate or Drying Table,** for use with gas. The top is of one piece of steel, 18½x25½ inches, with polished surface. The legs and frame are of cast iron. Flame easily regulated. Gives an even temperature. Complete with four burners.....Net $ 16 00

4674A. **Burner, Hot Plate or Drying Table,** same as No. 4674, equipped with two burners. Top surface, 14½x18½ inches.....Net 10 00

4674B. **Burner, Hot Plate or Drying Table,** same as No. 4674, equipped with one burner. Top surface, 10x18½ inches.....Net 7 00



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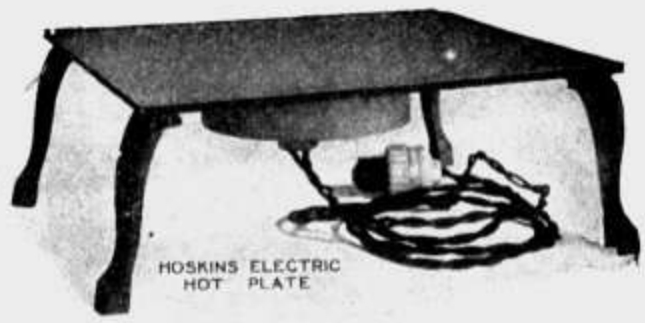


No. 4677.

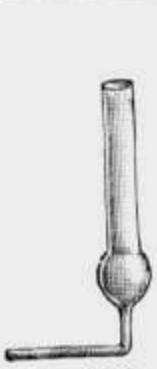
THE ELECTRIC HOT PLATES.

The Electric Hot Plate is free from all odor and soot and can be used without danger of fire, and does not heat up the room. All stoves are mounted on enameled slate base and furnished with six feet of cord and lamp socket plug. May be used on either direct or alternating circuits.

Catalog No.	No. of Heats.	Diameter, in.	Consumption, Watts.		Price.
4675A.	1	4½	220		$4.00
4675B.	1	6	440		6.00
4675C.	1	8	735		9.00
4675D.	1	10	1100		12.00
4675E.	1	12	1300		15.00
			Min.	Max.	
4676A.	3	4½	55	220	6.00
4676B.	3	6	110	440	8.00
4676C.	3	8	185	735	11.00
4676D.	3	10	275	1100	15.00
4676E.	3	12	325	1300	18.00

N. B.—In ordering please state voltage.

4677. **Hot Plate, Electric.** Guaranteed for one year on either alternating or direct circuits. Size of plate, 12x12 inches. Requires only 5 amperes at 110 volts and 2½ at 220 volts. Heated at center, covering 5 inches in diameter. Will boil water in center and evaporate to dryness, contents of breakers placed around the edges..... 15 00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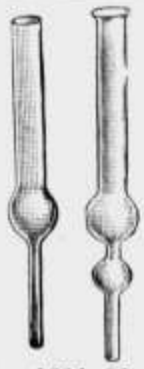
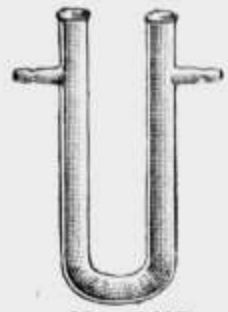

No. 4681. No. 4682.


No. 4683.


No. 4684.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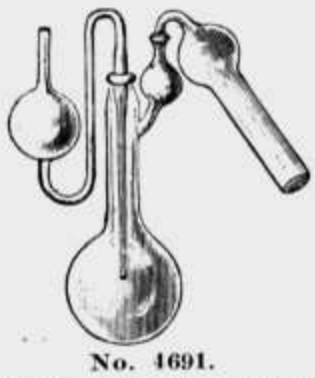
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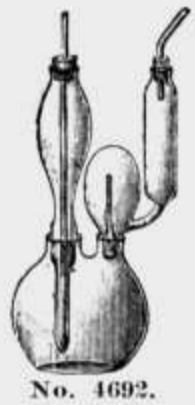

No. 4692.


No. 4693.


No. 4689.

4680. **Calcium Chloride Tube,** one bulb, bent delivery tube.

Length, inches	6	8
Each	.15	.18

4681. **Calcium Chloride Tube,** one bulb, straight delivery tube.

Length, inches	6	8
Each	.10	.12

4682. **Calcium Chloride Tube,** two bulbs, straight delivery tube.

Length, inches	6	8
Each	.12	.15

4683. **Calcium Chloride Tube,** Marchands.

Length, inches	4	6
Each	.25	.33

4684. **Calcium Chloride Tube,** U form.

Length, inches	4	5	6
Each	.11	.15	.17

4685. **Calcium Chloride Tube,** U form, with side neck.

Length, inches	6	8
Each	.25	.30

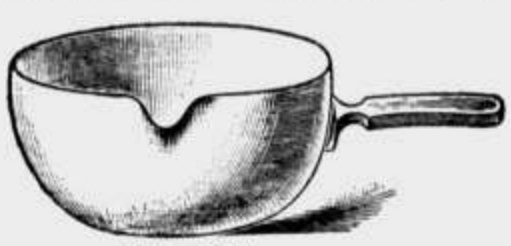
4689. **Calcium Chloride Jar (Drying Tower).**

Height, inches	8	10
Each	.40	.50

4691. **Carbonic Acid Apparatus (Alkalimeter),** Bunsen's ..... $ 1 35

4692. **Carbonic Acid Apparatus (Alkalimeter),** Geissler's, new form 1 55

4693. **Carbonic Acid Apparatus (Alkalimeter),** Schroetter's 1 65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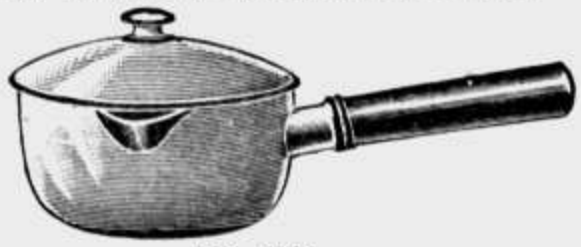

No. 4701.

4700. **Casserole,** of Royal Berlin Porcelain, with porcelain handle, No. cover.

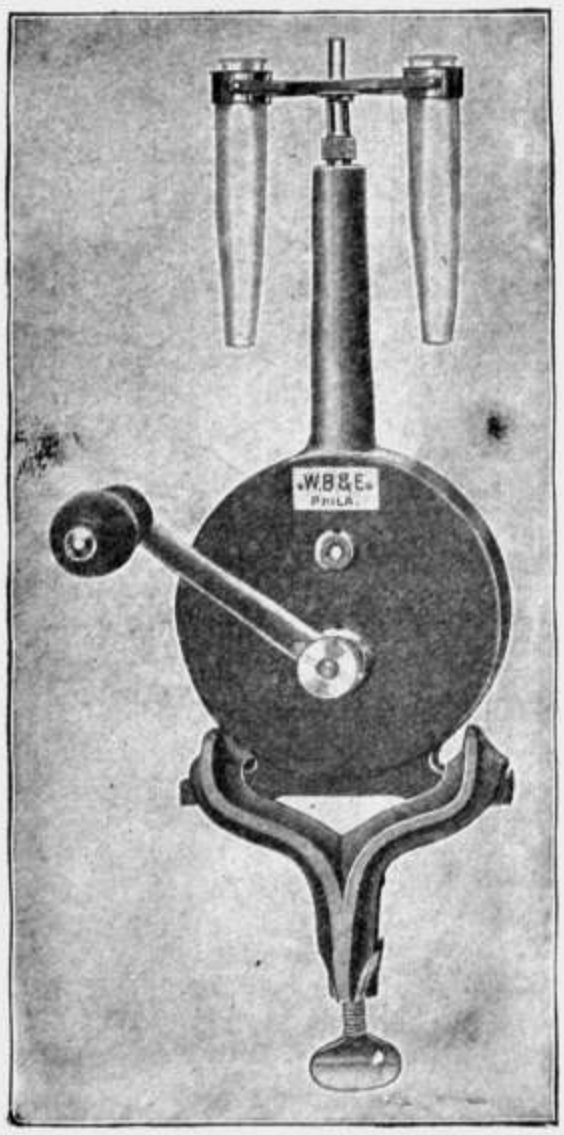
No.	2	3	3a	4
Capacity, ounces	2½	5	7	12½
Diameter, inches	2¾	3¼	3¾	4¼
Each	.40	.50	.65	.85

4701. **Casserole,** German porcelain, with lip, cover and wooden handle.

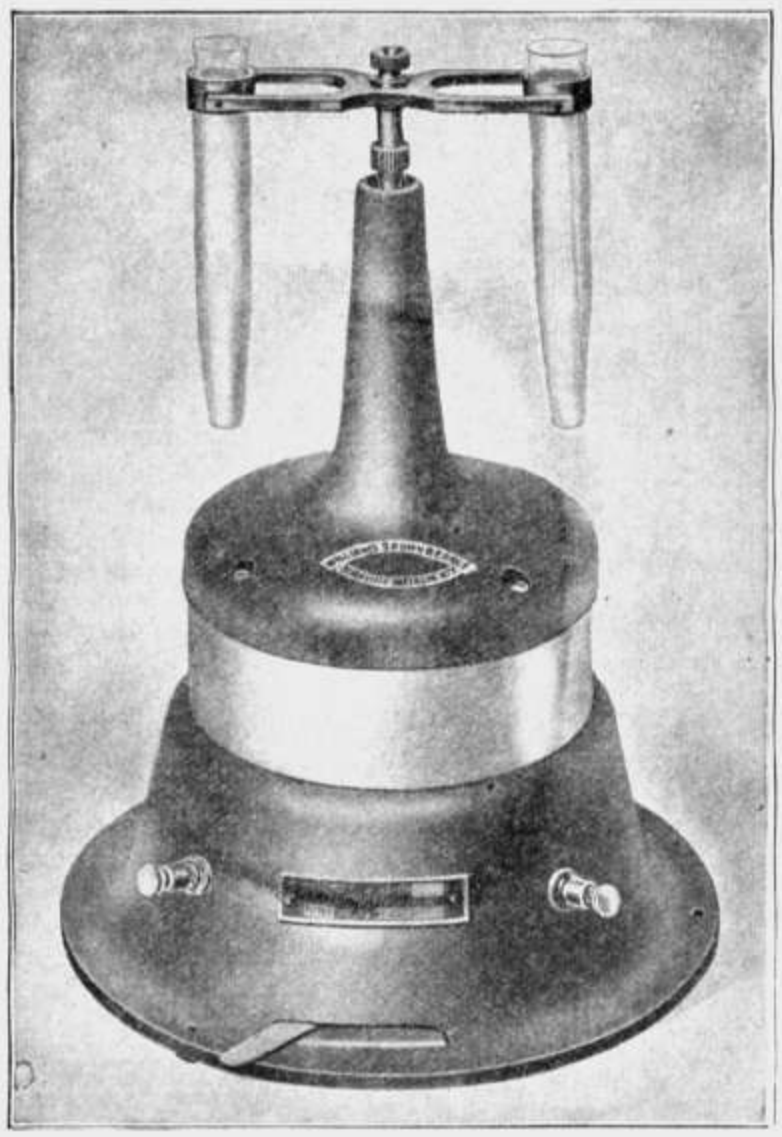
No.	1	2	4
Capacity, ounces	4	8	16
Diameter, inches	3½	4	5
Each	.50	.55	.80

4703. **Casserole,** of agateware.

Capacity, ounces	16	32	64
Each	.22	.33	.45



No. 4704.



No. 4705.

Centrifuges, hand driven. High speed, giving from 1,000 to 3,000 revolutions per minute, for the rapid and accurate analysis of urine, sputum, blood, pus, milk and the precipitation of solids in any liquid. The case is of iron, well finished, the bearings accurate, the gear wheels cut by special machinery, and the pitch so calculated as to render the machine almost noiseless. It can be supplied with arms that will carry two or four tubes and the haematocrit.

4704. **Centrifuge,** for the examination of urine, arranged to carry two tubes, with two aluminum shields, one plain and one graduated glass tube.... $ 10 00

4704A. **Centrifuge,** same as No. 4704, but with arm for holding four tubes, with four aluminum shields, two graduated and two plain tubes. This machine is capable of doing the work of two ordinary centrifuges..... 15 00

4704B. **Centrifuge,** same as No. 4704, with two tubes for the examination of urine and haematocrit for the examination of blood and sputum.... 16 00

4704C. **Centrifuge,** same as No. 4704, with four tubes for the examination of urine and with haematocrit for the examination of blood and sputum 20 00

Purdy Electric Centrifuge, mounted upon a heavy iron base to insure the rigidity essential for accurate work. They are made for either 110 volt direct or 110 volt, 60 cycle alternating current, and can be used on the incandescent lighting circuit, as there is a controlling lever mounted in base to regulate the speed.

Note.—When ordering, give voltage of the current, whether direct or alternating 60 cycles. If your current is 220 volts, add $11.00 to the list price given below.

4705. **Purdy Electric Centrifuge,** for examination of urine, with urine arm carrying two tubes, two plain glass sediment tubes and two graduated percentage tubes 35 00

4705A. **Purdy Electric Centrifuge,** same as No. 4705, with addition of Haematocrit arm for examination of blood and sputum..... $ 41 00
4705B. **Purdy Electric Centrifuge,** same as No. 4705, with addition of precipitating arm for manipulation of micro-organisms..... 41 00
4705C. **Purdy Electric Centrifuge,** same as No. 4705, with addition of both Haematocrit and precipitating arms..... 47 00
4706. **Dome Protector** for Purdy Electric Centrifuges. To protect the operator from flying particles or liquids and to avoid contact with the rapidly moving arms. It also lessens the air resistance and proportionately increases the speed. Supplied with Centrifuges Nos. 4705-4705C..... 10 00
4707. **Graduated Urine Tube,** designed by Dr. Charles W. Purdy for use with the Purdy Electric Centrifuge, and wherever his methods are employed. This tube is fully graduated to 15 c. c., with very tapering tip for the measurement of very small quantities of sediment..... 90
4707A. **Plain Ungraduated Tube,** same size as No. 4707..... 50
4707B. **Aluminum Shield,** to carry tubes Nos. 4707 and 4707A..... 33

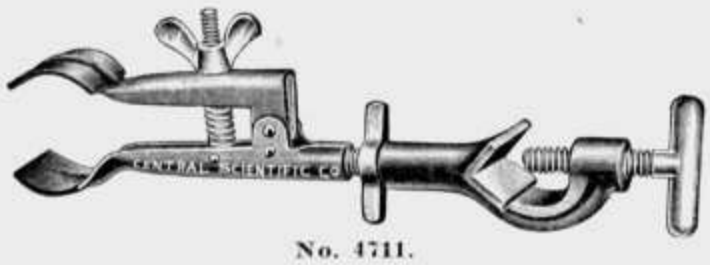
CENTRIFUGE ATTACHMENTS.

WILL FIT ALL CENTRIFUGES Nos. 4704 TO 4705C.

4708. **Arm,** with two metal tube shields and two 50 c. c. cement tubes for testing cement and for use when the percentage of sediment to be measured is very small..... 11 10
4708A. **Arm,** with two metal tube shields and two Goetz tubes for phosphorus determination with graduated tips..... 16 00
4708B. **Graduated Tube.** Length 4⅛ inches, outside diameter 11-16 inches, graduated to 10 c. c..... 40
4708C. **Plain Tube, Ungraduated.** Length of tubes 4⅛ inches, outside diameter 11-16 inches..... 20
4708D. **Aluminum Shield,** for carrying tubes Nos. 4708B and 4708C..... 25
4708E. **Haematocrit,** with two graduated blood tubes and two plain sputum tubes..... 5 00
4708F. **Precipitating Arm,** with two tapering tubes for the manipulation of micro-organisms..... 5 50
4708G. **Goetz Tube,** for phosphorus determination, with graduated tip..... 90
4708H. **Metal Shield,** for carrying No. 4708G Goetz Tube..... 1 10
4708J. **Cement Tube,** with 50 c. c. graduation, with tip graduated to 1-50 c. c. for cement testing and for use where the proportion of sediment is extremely small..... 1 50
4708K. **Metal Shield,** for carrying No. 4708J Cement Tube..... 1 10
4708L. **Percentage Tube,** for blood analysis, for use with Haematocrit..... 85
4708M. **Plain Sputum Tube,** for use with Haematocrit..... .33
4708N. **Precipitating Tube,** with plug and six washers, for the manipulation of micro-organisms..... 60
4708P. **Tube for Milk Analysis.** To obtain absolutely reliable test of either breast or cow's milk, we have devised the graduated milk tube. It will give results accurate to within 1-5 of 1% of fat..... 55
4708Q. **Dropper,** new construction, for filling the blood tubes..... 25
4708R. **Lancet,** spear point, for pocket..... 1 10
4709. **Chart, Atomic Weight.** Compiled by Dr. F. W. Clarke and reported to the American Chemical Society. Corrected up to 1909. Size 42x62 inches. Mounted on common rollers..... 1 35
4709½. **Chart, Periodic System.** The periodic arrangement of the elements according to Mendelejeff, on the basis of O—16. Revised and corrected up to 1909 by Dr. F. W. Clarke; American Nomenclature. Size 42x62 inches. Mounted on common rollers..... 1 50
3442. **Spectrum Chart, Large,** mounted on linen back, size of each spectrum 52 c. m. long, 5.5 c. m. wide. Includes the spectra: K, Rb, Cs, Tl, Na, Li, Ca, Sr and Ba..... 3 90
3442A. **Spectrum Chart,** same as No. 3442, with the following spectra: In, C, Bo, Mn, Pb, Cu, Co, Ni and Fe..... 3 90
4710. **Chlorine Absorption Apparatus,** Bunsen and Fresenius'..... 75



No. 4710.

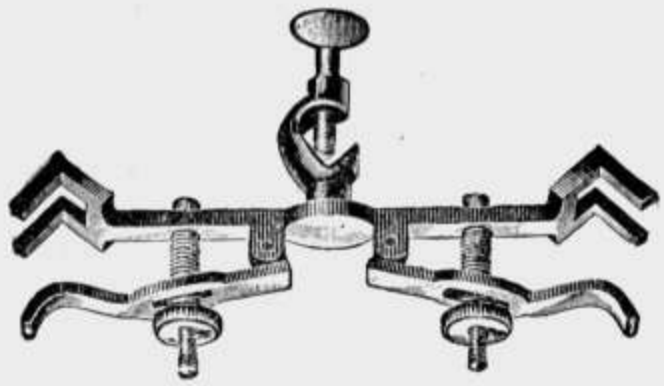


No. 4711.

4711. **Clamp, Burette,** with check nut to adjust to position; to attach to retort stand. An excellent clamp for general use..... $ 40



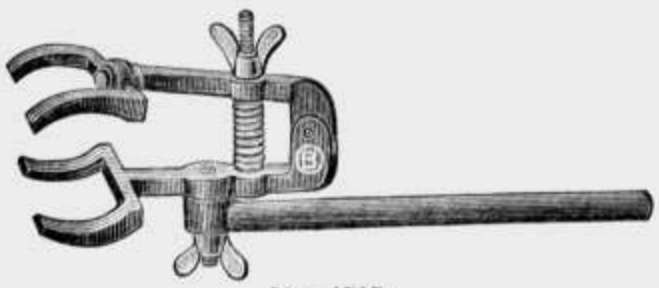
No. 4712.



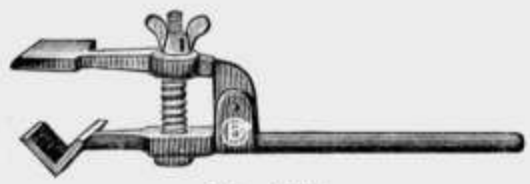
No. 4714.

4712. **Clamp, Burette,** for two burettes, designed by Prof. Lincoln of University of Illinois. Burettes are held perpendicular and are easily removed. This is a very convenient and rigid clamp and nicely made. 1 00

4714. **Clamp,** Hoffman's double, to hold burettes or other tube apparatus... 80



No. 4715.



No. 4717.

4715. **Clamp, Universal Condenser,** with swivel jaws adapting themselves to irregular shapes..... 65

4716. **Clamp, Universal Condenser,** same as No. 4715, large size..... 1 10

4717. **Clamp, Condenser,** of iron, small size..... 50

4719. **Clamp, Condenser,** of iron, same as No. 4717, large size..... 65



No. 4723.



No. 4725.

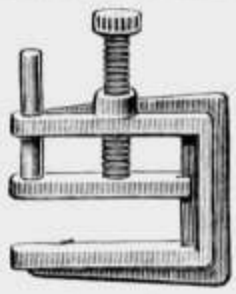
4723. **Clamp Holder,** iron, for fastening clamps to rod of support..... 22

4725. **Clamp Holder,** same as No. 4723, with universal swivel movement.... 45



No. 4727.

4727. **Clamp, Stoddard's Dish,** for holding evaporating dishes and other dishes up to 4½ inches in diameter. Made of brass, white plated... 11



No. 4729.

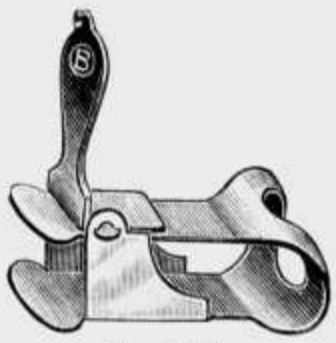


No. 4732.



No. 4735.

4729. **Clamp, Screw Compressor,** new form, of brass, nickel plated; can be placed upon tubing without disconnecting apparatus; small..... $ 22
4730. **Clamp,** same as No. 4729; large..... 2.
4732. **Clamp, Mohr's,** of brass, nickel plated, for burettes, etc.; small..... 09
4733. **Clamp, Mohr's,** same as No 4732; medium..... 13
4734. **Clamp, Mohr's,** same as No. 4732; large..... 17
4735. **Clamp, Screw Compressor, Hofmann's;** small..... 17
4736. **Clamp, Hofmann's,** same as No. 4735; large..... 22



No. 4737.

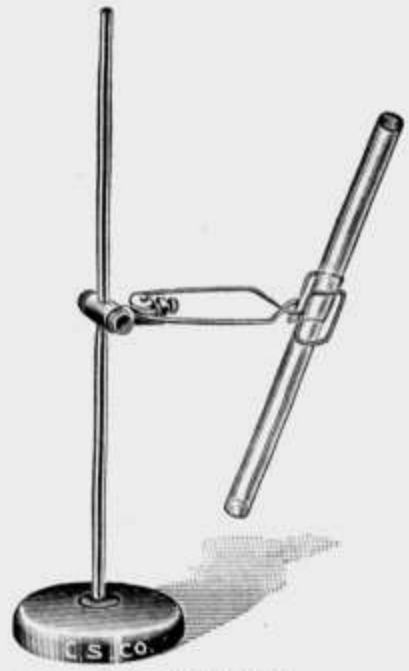


No. 4740.



No. 4741.

4737. **Clamp, Cut-off,** of brass, nickel plated; small, per dozen 50
4738. **Clamp, Cut-off,** same as No. 4737; large, per dozen..... 80
4740. **Clamp, Test Tube,** of wood, improved form, with brass spring..... 11
4741. **Clamp, Test Tube, Stoddard's,** of spring brass wire..... 10



Nos. 4742-4743.

4742. **Clamp Holder, Stoddard's,** an ingenious device for rigidly holding Stoddard Wire Test Tube Holder (No. 4741) in any position. Provides for vertical and horizontal adjustment to any angle and will adapt itself to a great many uses in the laboratory. Made of brass, nickel plated. Clamp holder only, without base and rod or test tube holder..... 75
4743. **Base and Rod,** for use with No. 4742, as shown in illustration. Base is heavy and stable, even with excessive load..... 35

Stoddard's Funnel Holders, page 330.

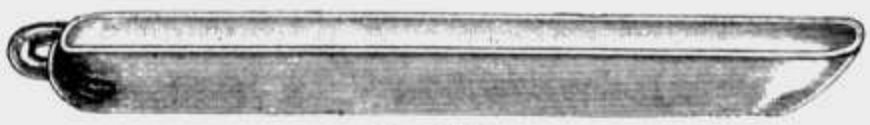


No. 4745.



No. 4746.

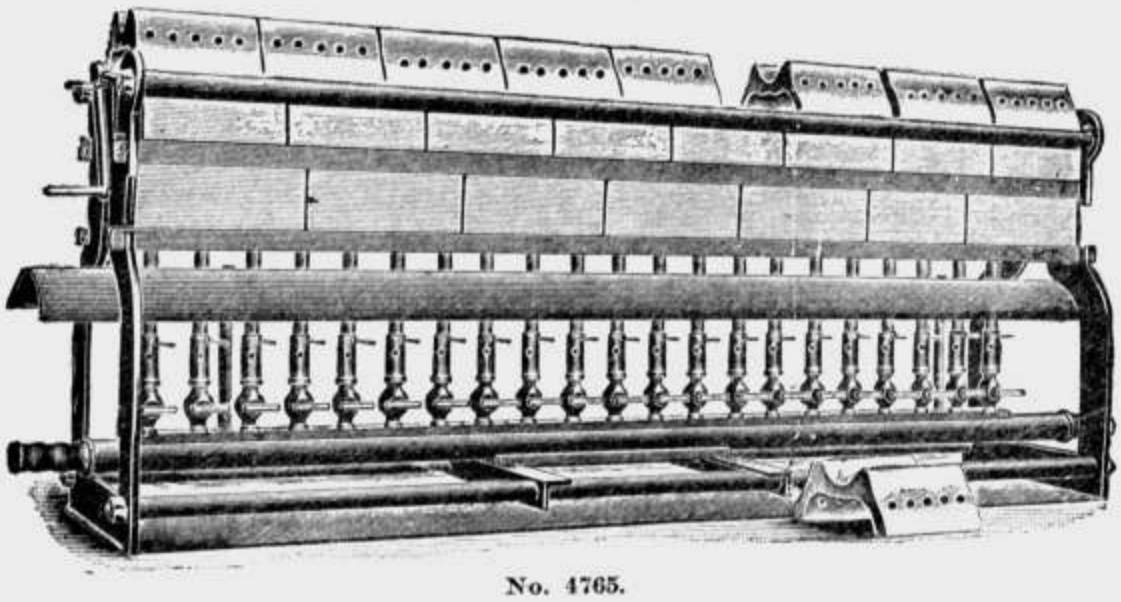
4745. **Clamp, Watch Glass,** of brass, for 2 to 2½ inch glasses..... 11
4746. **Clamp, Watch Glass,** of brass, for 2½ inch glasses..... 15



No. 4755.

4755. **Combustion Boat,** of porcelain.

Length, m. m.....	60	75	75	100
Width, m. m.....	10	11	15	18
Each	.22	.22	.22	.27

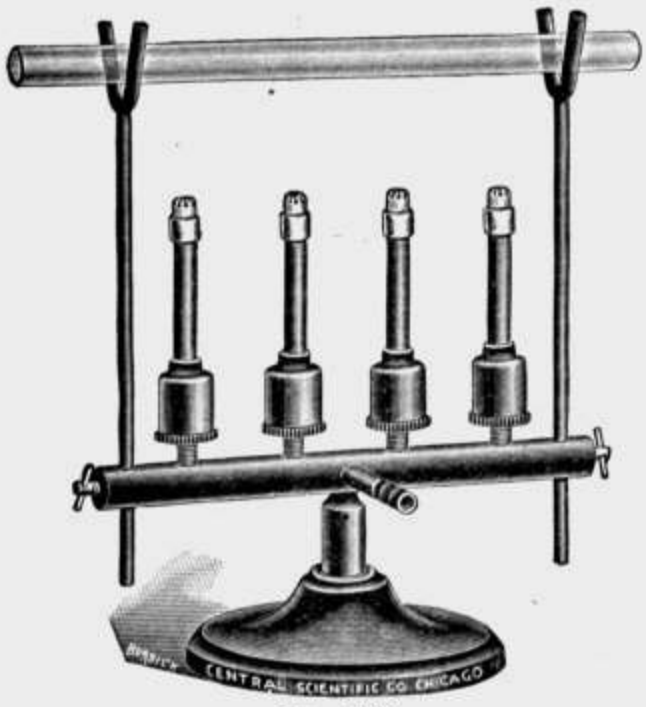


No. 4765.

4765. **Combustion Furnace**, Glazer's, modified by Anschuetz and Kekule. Provided with mica plates for watching the flame during combustion. The row of burners is movable in a furrow, the burners are provided with spring stopcocks and nickel plated air regulators. Complete, with top plates of clay.

Number of burners.....	10	16	21	26
Each, complete	30.00	33.00	41.65	50.00

4766. **Extra Top Bricks** for above, each 25 cents; per dozen..... $ 3 00



No. 4768.



No. 4770.

4768. **Combustion Furnace, Simple Form.** Consists of four adjustable burners having regulators for both gas and air and burning either coal gas or gasoline gas, mounted on gas supply tube with adjustable forks for holding combustion tubes. An inexpensive combustion furnace suitable for all elementary work..... 9 00

4770. **Combustion Furnace, Electric.** The tube is 1 inch inside diameter and 12 inches long; 10 inches of this length is uniformly heated to a constant temperature of 1,000 degrees C. Operates equally well on direct or alternating circuits and is made for 110 or 220 volts; other voltages made to order. Requires 6 amperes at 110 volts and 3 amperes at 220 volts. This makes an excellent furnace for rapid determinations and is very cheaply repaired. For determining carbon contents of steel it is unexcelled. In ordering state voltage of your circuit ..... Net 40 00



No. 4772.

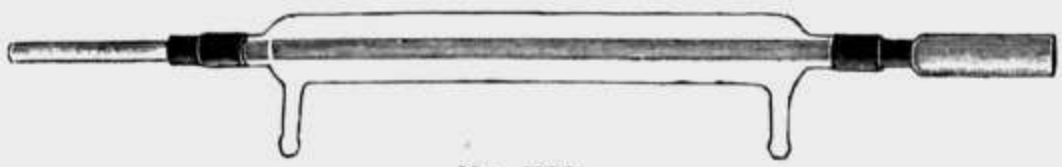
4771. **Combustion Tube (Reduction Tube),** of Bohemian glass, with bulb on end. Length 6 inches. Each..... $ 18

4771A. **Combustion Tube (Reduction Tube),** of Bohemian glass, with bulb in center. Length 6 inches. Each..... 20

4772. **Combustion Tube,** of porcelain, glazed inside.

Length, c. m.....	30	45	60
Diameter, inside, m. m.....	15	15	15
Each.....	.42	.80	1.40

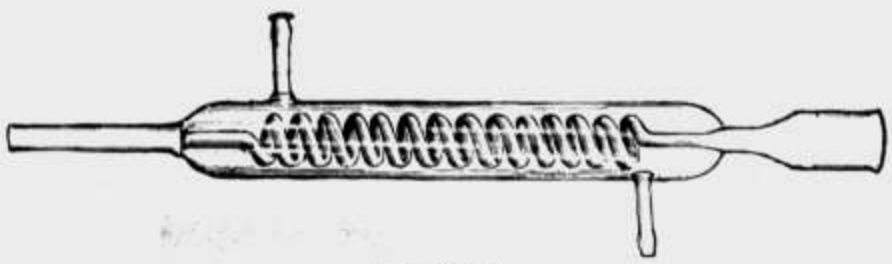
Combustion Tubing, see **"Glass Tubing."**



No. 4773.

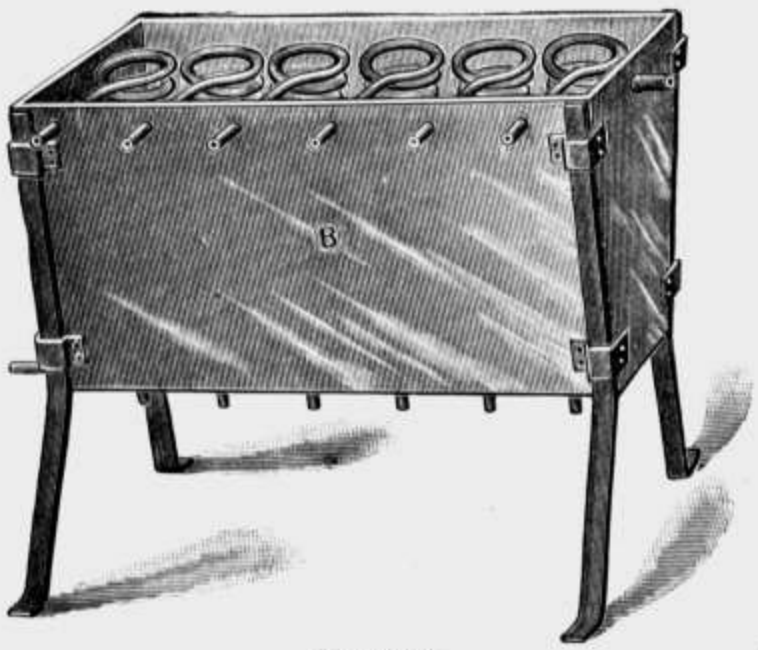
4773. **Condenser,** Liebig's, glass, with rubber connections.

Length, inches.....	15	20	24
Each.....	.95	1.10	1.55



No. 4773 A.

4773A. **Condenser, Liebig's,** of glass, with condensing tube in form of coil sealed in water jacket. Body 8x2 inches..... 2 00



No. 4774.



No. 4774 B.

4774. **Condenser** (Kjeldahl's), copper, tin lined, with six coils of pure block tin tubing. Size of apparatus 24 inches long, 6½ inches wide, 14 inches deep; height, including legs, 24 inches..... 22 00

4774A. **Condenser** (Kjeldahl's), same as No. 4774, but with 10 coils. Size of apparatus, 40 inches long, 6½ inches wide, 14 inches deep; height, including legs, 24 inches..... 35 50

4774B. **Condenser Bulb Tubes**..... 45

Condenser, Metal, see **Stills,** page 326.

Condenser, Soxhlet's, see **"Extraction Apparatus."**



No. 4775.

4775. **Corks, Regular Length,** XX quality. Diameters given are for the large end.

No.	0	1	2	3	4	5	6	7	8	9	10
Diam., inches	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
Per dozen	.03	.03	.03	.03	.03	.04	.05	.06	.07	.08	.09
Per gross	.20	.20	.20	.22	.25	.30	.35	.45	.55	.65	.80

No.	11	12	13	14	15	16	18	20	22	24	26
Diam., in.	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2
Per dozen	.10	.11	.12	.14	.16	.18	.22	.30	.35	.45	.55
Per gross	.90	1.00	1.05	1.20	1.35	1.65	1.95	2.20	2.75	3.50	4.50

4776. **Corks,** same as No. 4775. No. 0 to No. 11, assorted, in gross packages only ..... $ 65

Corks, Rubber, see **Rubber Stoppers,** page 324.

4778. **Corks, Flat** (Specie Corks), XX quality. Diameters given are for large end.

Diam., in.	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/2	4
Length, in.	1/2	1/2	1/2	1/2	1/2	1/2	5/8	5/8	5/8	5/8	3/4
Per dozen	.08	.11	.15	.20	.22	.28	.40	.48	.60	1.00	1.40



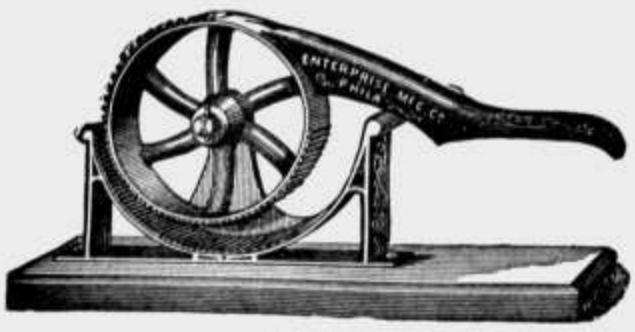
No. 4781.

4779. **Cork Borer,** smallest size, (3/16 inch), with punch 22
4780. **Cork Borer,** brass, with punch, set 1-3 60
4781. **Cork Borer,** brass, with punch, set 1-6 ..... 1 00
4782. **Cork Borer,** brass, with punch, set 1-9 ..... 1 50
4783. **Cork Borer,** brass, with punch, set 1-12 ..... 2 05
4784. **Cork Borer,** brass, with punch, set 1-15 ..... 3 35



No. 4785.

4785. **Cork Borer Sharpener.** Steel cone with knife 1 00
4787. **Cork Knife.** Same as No. 251 Knife (see illustration, page 21) 22



No. 4789.



No. 4791.



No. 4793.

4789. **Cork Press,** wheel form 60
4791. **Cork Press,** flat form, cast iron 25
4793. **Corkscrew,** wood handle 11
4795. **Corkscrew,** twisted wire, per dozen 11



No. 4800.



No. 4807.

4800. **Crucible, Hessian, Sand,** round form. Dimensions are outside measurements.

No.	A	B	C	D	E
Height, inches	2⅝	3	3½	4	4½
Diameter, inches	1⅝	1⅞	2¼	2⅜	2⅞
Each	.03	.04	.05	.06	.07
Per dozen	.20	.27	.35	.40	.55

4807. **Crucible, Royal Berlin Porcelain,** glazed inside and outside, with cover.

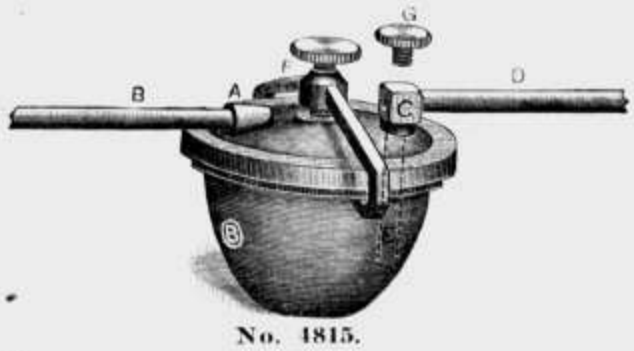
No.	000	00	0	1	2	3	4	5
Diameter, m. m.	26	30	35	41	52	62	72	87
Height, m. m.	19	25	27	35	43	50	59	72
Capacity, c. c.	5	10	15	30	57	95	155	280
Each	.12	.16	.22	.25	.33	.41	.50	.60



No. 4809.



No. 4810-4811.



No. 4815.

4809. **Crucible, Wrought Iron, Light,** with cover.

Diameter, m. m.	37	52	63	78
Height, m. m.	31	37	50	60
Capacity, c. c.	15	30	60	120
Each	.25	.30	.40	.50

4810. **Crucible, Nickel,** spun from pure sheet nickel, with cover.

Diameter, inches	1½	1¾	2⅜
Height, inches	1⅜	2	2½
Capacity, c. c.	20	50	100
Each	.65	.90	1.35

4811. **Crucible, Copper,** with cover.

No.	1	2	3
Diameter, m. m.	50	60	85
Height, m. m.	40	47	70
Capacity, c. c.	50	100	250
Each	.80	1.00	1.65

4815 **Crucible, Normal School,** devised by Prof. S. T. Skidmore, of the Philadelphia Normal School. This is a spun iron crucible for the individual use of the laboratory student, or for general experimenting. It may be used equally well as an open crucible, a closed crucible, or a retort; and, being of thin metal, is easily brought to a red heat in the flame of an ordinary burner. All parts interchangeable. Capacity, about 1½ ounces 1 05



No. 4817.



No. 4819.

4817. **Crucible, Rose's,** of porcelain, with cover and tube.

Capacity, c. c.	15	30
Each	.45	.65

4819. **Crucible, Gooch's,** of porcelain, with perforated bottom; 15 c. c. 35

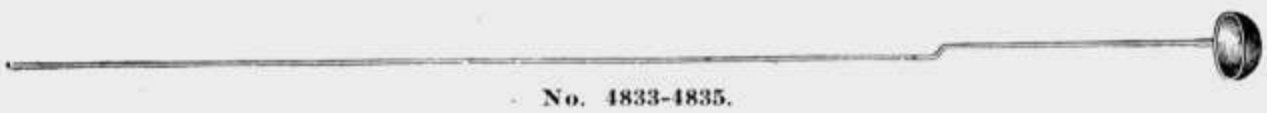


No. 4823.

4823. **Crucible, Black Lead,** Dixon's genuine.

No.	1	2	3	4	5	6
Capacity, ounces	4¼	6½	11	16	20	28
Each	.33	.40	.45	.50	.55	.65

Platinum Crucibles, see page 321. **Crucible Tongs,** see page 332.
Cylinders, graduated, see graduates; **plain,** see jars.



No. 4833-4835.



No. 4831-4831 A.

4831. **Deflagration Globe,** for combustions in oxygen. Diameter of globe, 12 inches; diameter of opening, 2 inches. Globe only..... $ 1 50

4831A. **Support and Cup** for above..... 75

4833. **Deflagration Spoon,** of iron, ¾ inch cup..... 09

4835. **Deflagration Spoon,** of brass, ¾ inch cup..... 13



No. 4840.



No. 4836.



No. 4837.



No. 4839.

4836. **Dessicator, or Acid Dish,** of porcelain, 12 c. m..... 90

4837. **Dessicator,** glass, Scheibler's, knob top, cover ground air tight; diameter, 4 inches..... 60

4838. **Dessicator,** Scheibler's, same as No. 4837, but 6 inches diameter..... 1 00

4839. **Dessicator,** Scheibler's, same as No. 4838, with stop cock ground air tight in cover..... 3 00

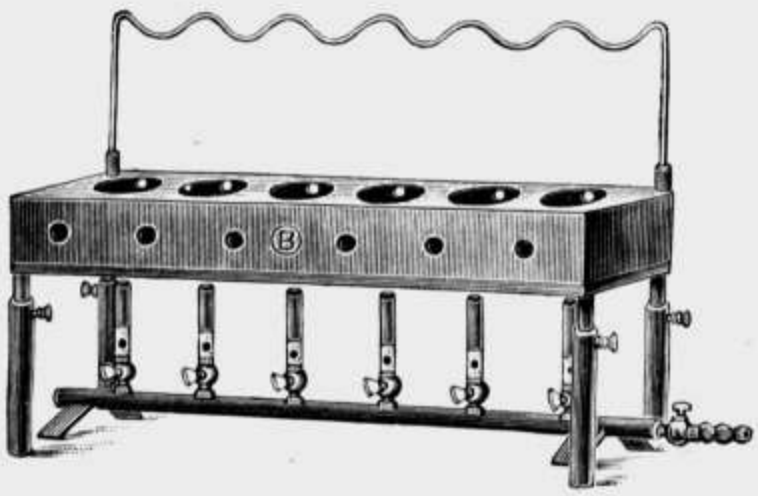
4840. **Porcelain Plate,** for above. 4 inch, 65c; 6 inch..... 1 10

4841. **Dialyzer,** bell glass form, with parchment and jar complete.

Diameter of bell glass, c. m.....	11	15
Each	1.25	1.65

For Parchment Paper see **Paper.**

4842. **Diffusion Shell,** S. & S. No. 579, 100x16 m. m. Each, 25c; per box of 25.. 4 50



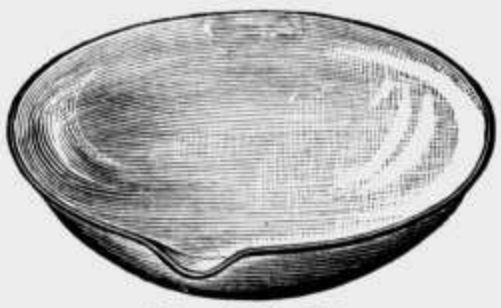
No. 4843.

4843. **Digesting Shelf** (Kjeldahl's), oblong form, made of sheet iron, with rod to support flasks. The shelf is supported on adjustable legs. Six burners in a row with stop cocks. Size of apparatus, 24 inches long, 5½ inches wide, 9½ inches high..... 15 00

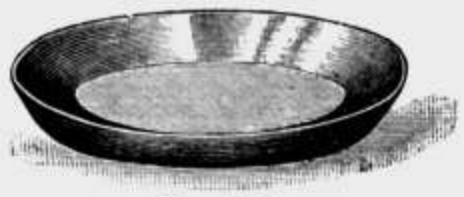
4843A. **Digesting Shelf** (Kjeldahl's), same as above, with 10 burners. Size of apparatus, 40 inches long, 5½ inches wide, 9½ inches high..... 20 00



No. 4845.



Nos. 4847-4849.



No. 4851.

4845. **Dish, Crystallizing,** of light glass, with flat bottom and straight sides.

Diameter, inches..	2	3	4	5	6	8	10
Each	.11	.15	.25	.33	.40	.75	1.00

4847. **Dish, Evaporating,** of German porcelain, glazed inside.

No.	9	8	7	6	5	4	3	2	1
Diameter, inches....	2½	3	3½	4	4½	5	5½	6	6¼
Capacity, ounces.....	1	2	2½	3½	6	7½	10	13	16
Each	.11	.13	.17	.20	.22	.27	.33	.40	.50

4848. **Dish, Evaporating,** of German porcelain, same as No. 4847, but larger, with heavy rim.

No.	6	5	4	3	2	1	0
Diameter, inches	7¾	8¼	9½	10½	11¼	12½	14½
Capacity, ounces.....	28	38	50	75	92	120	200
Each	.60	.65	.75	1.10	1.35	1.65	2.65

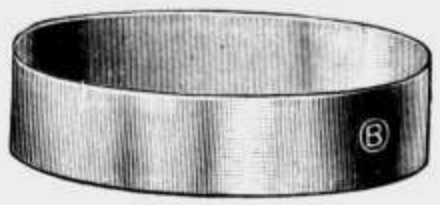
4849. **Dish, Evaporating,** of Royal Berlin porcelain, glazed inside and outside.

No.	00	0	1	2	3	4	5	6	7	8
Diameter, in...	2¼	3	3¼	3½	4	4¼	4¾	6	7	8¾
Capacity, oz....	2	3	3½	4½	6½	8	10	16	28	48
Each	.15	.18	.27	.30	.33	.41	.52	.63	.83	1.10

4851. **Dish, Lead.** Diameter, inches..... 2 3 4
Each ..... .11 .17 .22

4853. **Dish, Milk, of aluminum,** flat bottom, straight sides.

Diameter, inches..	2	3	4
Height, inches.....	½	¾	1
Each	.25	.40	.50



No. 4853.

Dishes, Iron, see **Sand Baths,** page 325.

Dishes, Platinum, page 321.

Distillation Apparatus, see **Stills,** page 326.

4855. **Drying Oven,** of heavy planished copper, with tubulations for thermometer and gas regulator, on separate iron support, provided with false bottom of sheet iron to protect the copper. Single wall. Outside measurement, 6x8 inches..... 5 00

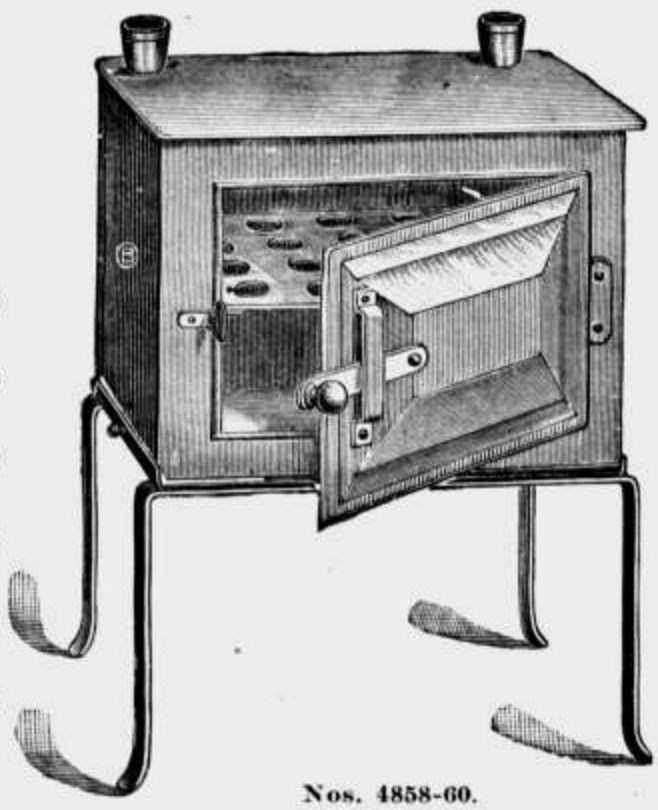
4856. **Drying Oven,** same as No. 4855, 8x10 inches..... 6 75

4857. **Drying Oven,** same as No. 4855, 10x12 inches..... 8 50

4858. **Drying Oven,** same as No. 4855, double wall, 6x8 inches..... 7 00

4859. **Drying Oven,** same as No. 4858, 8x10 inches..... 9 50

4860. **Drying Oven,** same as No. 4858, 10x12 inches..... 12 25



Nos. 4858-60.

Drying Tubes, see Calcium Chloride Tubes, page 295.



No. 4861.

ELECTRIC OVENS.

The Electric Oven is the only device for laboratory work that gives the same measured amount of heat every time, distributes that heat evenly and is absolutely free from drafts. The double walls are packed with asbestos to conserve the heat, and when the door is closed it becomes an air-tight box. Within, at the top and the bottom of the oven, are the two heating plates. As soon as the current is turned on, these at once become hot throughout their whole area and give a steady, measured heat to every part of the oven, a heat that comes from above as well as below; a heat that is the same every time with the same position of the switch, and the effect can be measured by the clock. The electric oven can be placed where it is most convenient to reach without stooping. In use it will not affect the temperature of the room.

		Watts.	Price.
4861.	**Electric Oven.** Inside dimensions, 12″ wide, 12″ deep, 14″ high. Weighs 30 lbs. Three heats. Four feet cord and plug switch....	1100	20 00
4861A.	**Electric Oven.** Inside dimensions, 19″ wide, 12″ deep, 13″ high. Weighs 60 lbs. Three heats. Four feet cord and plug switch....	1600	25 00
4861B.	**Electric Oven.** Inside dimensions, 15″ wide, 18″ deep, 11½″ high. Weighs 75 lbs. Three heats. Four feet cord and indicating snap switch on front	1600	40 00
4861C.	**Electric Oven.** Inside dimensions, 15″ wide, 18″ deep, 11½″ high. Weighs 76 lbs. Same style as No. 4861B, with thermometer. Three heats. Four feet cord and indicating snap switch on front	1600	45 00
4861D.	**Electric Oven.** Dimensions, 21½″ wide, 19″ deep, 13″ high. Weighs 115 lbs. Three heats. Four feet cord and indicating snap switch on front.....	2400	60 00
	Any of the above ovens may be furnished with a thermostat for automatically controlling the temperature to within four degrees Fahrenheit between 200° and 400°. Ovens may also be furnished with double windows in the door. Extra .....net		7 00
	N. B. In ordering, please state voltage.		
4863.	**Extraction Apparatus.** Soxhlet's, complete, consisting of flask, extractor and plain condenser. Length of extractor, 6¼ inches; diameter, 1¼ inches; capacity to top of syphon, 70 c. c.....		2 25
4864.	**Extraction Apparatus,** same as No. 4863, but larger. Length of extractor, 8½ inches; diameter, 2 inches; capacity, 210 c. c.....		3 50
4865.	**Extractor** only, of No. 4863, small.....		1 15
4866.	**Extractor** only, of No. 4864, large.....		2 00
4869.	**Extraction Shells,** S. & S. No. 603. Can be used repeatedly. 80x33 m. m. Each, 15c. Per box of 25.....		2 00
	Extraction Flasks, see No. 4907.		



No. 4863.



No. 4872.



No. 4873.

4871.	**Eudiometer, Bunsen's,** capacity 50 c. c. in 1-5ths.....			$ 1 75
4872.	**Eudiometer, Bunsen's,** graduated into millimeters.			
	Millimeters.....	300	500	
	Each.....	2.10	2.50	
4873.	**Eudiometer, Ure's,** U form, graduated in c. c.....			2 00



No. 4881.



No. 4883-4884.

225. **Files,** round (rat tail), second cut.

Length, inches	4	5	6	8
Each	.09	.10	.11	.13

227. **Files,** triangular (slim taper), single cut.

Length, inches	4	5	6	8
Each	.08	.09	.10	.13

4881. **Filter Paper.** A pure white paper of superior quality, strong and rapid. For qualitative work. Cut in round filters, 100 in a package.

Diameter, c. m	7.5	10	12.5	15	20	25	33
Per package	.10	.12	.15	.20	.33	.46	.70

4882. **Filter Paper,** same quality as No. 4881, in sheets 48x48 c. m. Per quire, 40 cents; per ream ..... $ 6 80

4883. **Filter Paper, J. T. Baker's.** Finest quality Swedish hand-made paper, carefully selected and washed. Put up in boxes holding 100 filters. Perfectly "ashless." Washed in hydrochloric and hydrofluoric acids.

Diameter, c. m	5.5	7	9	11	12.5	15
Per box	.45	.55	.65	.83	1.10	1.25

4884. **Filter Paper, J. T. Baker's, "Washed."** Same as No. 4883, but washed in hydrochloric acid only.

Diameter, c. m	5.5	7	9	11	12.5	15
Per box	.17	.28	.45	.55	.65	.88

4885. **Filter Paper, Munktell's Swedish, No. 1F,** for quantitative work. The most perfect filters made. Of best linen material, cut round, 100 filters in a package, five packages inclosed in a birch-bark box.

Diameter, c. m	5.5	7	9	11	12.5	15	18.5
Per package	.11	.16	.25	.30	.40	.50	.75

4886. **Filter Paper, Munktell's Swedish, No. 0,** same as No. 4885. Washed with hydrochloric acid, removing traces of iron, alumina, lime, etc. Adapted to the most precise requirements of analytical work.

Diameter, c. m	5.5	7	9	11	12.5	15	18.5
Per package	.20	.27	.42	.55	.63	.85	1.25

4887. **Filter Paper, Munktell's Swedish, No. 00,** same as No. 4885. Washed with hydrofluoric and hydrochloric acids.

Diameter, c. m	5.5	7	9	11	12.5	15
Per package	.50	.55	.80	1.00	1.10	1.25

4890. **Filter Paper, Schleicher & Schuell's, No. 595.**

Diameter, c. m	5.5	7	9	11	12.5	15	18.5
Per package	.12	.15	.20	.23	.25	.30	.40

4891. **Filter Paper, Schleicher & Schuell's, No. 575.** A thin, hard paper, specially adapted for use with the filter pump, and retaining the finest precipitates. Useful in filtering caustic liquids and strong acids.

Diameter, c. m	5.5	7	9	11	12.5	15
Per package	.70	.75	1.00	1.10	1.25	1.50

Filter Pumps, see page 104.



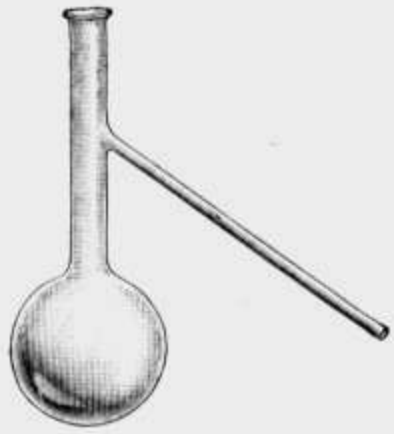
No. 4901.



No. 4902.



No. 4903.



No. 4904.

4901. **Flasks,** best German glass, **flat bottom.**

Capacity, ounces	2	4	6	8	12	16	24	32	64
Each	.08	.10	.12	.14	.16	.20	.24	.27	.45

4901A. **Flasks,** best German glass, flat bottom, **ring neck.**

Capacity, ounces	4	8	16
Each	.10	.14	.20

4902. **Flasks,** best German glass, **round bottom.**

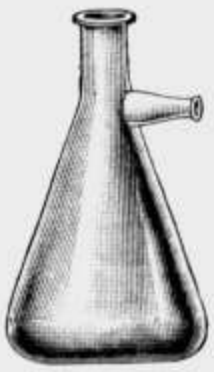
Capacity, ounces	2	4	6	8	12	16	24	32	64
Each	.08	.10	.12	.14	.16	.20	.24	.27	.45

4903. **Flasks,** best German glass, **Erlenmeyer's form.**

Capacity, ounces	2	4	6	8	12	16	32
Each	.08	.11	.15	.16	.20	.23	.35

4904. **Flasks,** best German glass, side neck for **fractional distillation.**

Capacity, ounces	2	4	8	16
Each	.18	.22	.30	.40



No. 4905.



No. 4906.



No. 4907.



No. 4909.



No. 4910.

4905. **Flasks,** best German glass, Erlenmeyer's side neck, for **filtering.**

Capacity, ounces	8	16	32
Each	.30	.40	.53

4906. **Flasks, Kjeldahl's,** digesting, pear shaped. Bohemian glass.

Capacity, c. c.	250	500
Each	.30	.43

4907. **Flasks, Carbonic Acid,** light, low form, with extra wide mouth for carbonic acid apparatus.

Capacity, ounces	1	2	4
Each	.09	.11	.13

4909. **Flasks, Volumetric,** or liter flasks, volume fixed with one mark on the neck, very accurate.

Capacity, c. c.	100	250	500	1,000
Each	.25	.33	.50	.63

4910. **Flasks, Volumetric,** same as No. 4909, with ground glass stopper.

Capacity, c. c.	100	250	500	1,000
Each	.30	.48	.60	.75



No. 4915.



No. 4917.

4915. **Forceps, Steel,** heavy, for general laboratory work.

Length, inches	4	5	6
Each	.10	.13	.18

4917. **Forceps, Platinum Tipped,** for general laboratory work. Each..... $ 5 00

For other Forceps see Index.



No. 4921.



No. 4922.



No. 4923.



No. 4924.



No. 4926.



No. 4927.



No. 4928.

4921. **Funnel,** glass, angle of 60°, stem ground to a point.

Diameter, inches	2	2½	3	3½	4	5	6	8
Each	.08	.10	.12	.15	.16	.21	.25	.41

4922. **Funnel, Separatory,** ordinary shape, 60°.

Diameter, inches	4	6
Each	1.25	1.65

4923. **Funnel, Separatory,** light glass, globe shape, with glass stopper, stopcock and long stem.

Capacity, ounces	2	4	6	8
Each	.90	1.10	1.30	1.65

4924. **Funnel, Separatory,** cylindrical: capacity, 50 c. c. 90

4926. **Funnel Tube,** thistle top, straight stem..... 10

4927. **Funnel Tube,** thistle top, bent safety stem.. 18

4928. **Funnel Tube,** thistle top, one bulb safety stem 22

4933. **Funnel, Agateware.**

Capacity.....	½ pint.	1 pint.	1 quart.
Each.....	.33	.40	.50

4934. **Funnel, Hot Water,** of tin, double wall..... 2 25

4935. **Funnel,** same as No. 4934, but made of heavy polished copper 3 50

4936. **Funnel, Hot Water,** of heavy polished copper, single wall, on three legs..... 3 30

4938. **Funnel, Porcelain, Hirsch's,** with permanent perforated porcelain plate for pressure filtration.

Diameter, inches	2½	3	3½
Each	.55	.65	.75

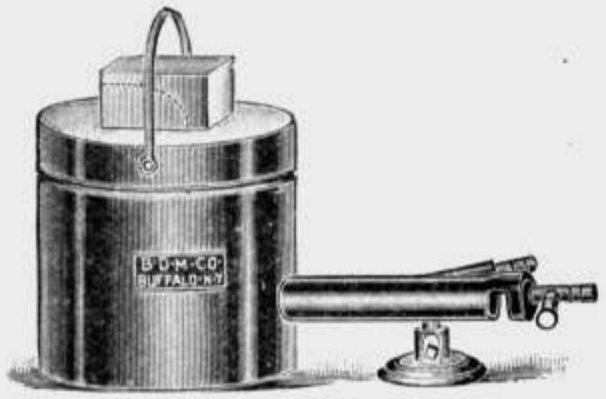


No. 4936.

Funnel Holders, page 329.



No. 4939.



No. 4940.

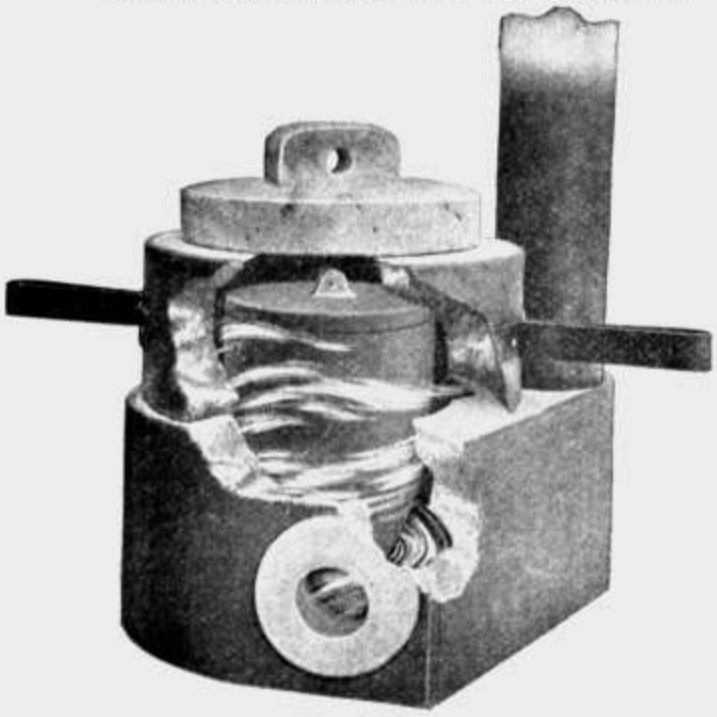
4939. **Furnace, Fletcher's Crucible.** The simplest gas furnace ever constructed, consisting of a simple pot for holding the crucible, with a lid and a blowpipe, all mounted on a suitable cast iron base. Gas from a ⅜ inch supply pipe will work the furnace efficiently; about 10 cubic feet of gas per hour is sufficient. The crucible will hold about 10 ounces. No. 9A or 10A Foot Blower (see page 279) will operate the furnace satisfactorily. Complete, with crucible..... $ 3 35

4939A. **Extra Crucibles** (plumbago), each..... 30

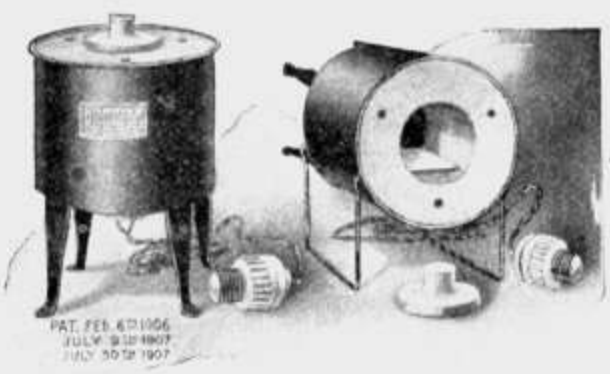
4940. **Furnace, Fletcher's Perfected Injector,** for gas. Complete, with crucible holding two pounds..... 5 00

4940A. **Extra Crucibles,** each..... 40

Furnace, Combustion, see page 300.



No. 4941.



No. 4942.

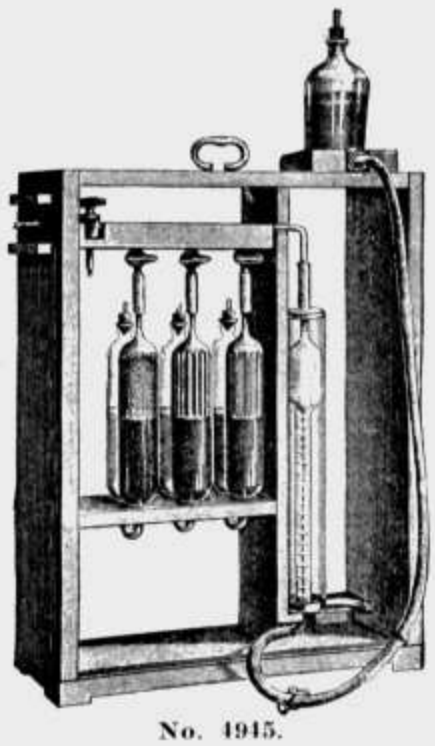
4941. **Furnace, Case Melting.** For use with gasoline or oil. Flame blow-in is located so that the flame blows in on a tangent and does not hit the crucible until there is a complete combustion. The hot gases circle around the crucible, thereby preventing loss of crucible by cracking. Made in three sections, and will take No. 7 Black Lead Crucible. Net weight, 40 pounds..... 8 00

4941A. **Tank.** To operate No. 4941 Furnace it is necessary to have a blowpipe tank and burner. Tanks are of pressed steel and built to stand 300 pounds pressure. Fitted with large, substantial pump with 10 feet of ¼ inch pipe, elbow, etc. Capacity, 2 gallons. Complete...Net 14 00

4941B. **Hydro-Carbon Burner,** for use with above tank.....Net 6 00

4942. **Furnace, Electric, Combination Crucible and Muffle.** Size of chamber, 2⅛x2½ inches. Requires but 3½ amperes at 110 volts and is perfectly safe at any voltage from 100 to 125 volts, either alternating or direct circuit. With 115 volts it will give a temperature of 1,100° C., the melting point of gold. Requires no special wiring, as furnace may be connected directly with the lamp socket. Guaranteed against a "burn out" up to 1,000° C. Should however, through carelessness, a "burn out" occur, renewable heating elements may be obtained at low cost.....Net 25 00

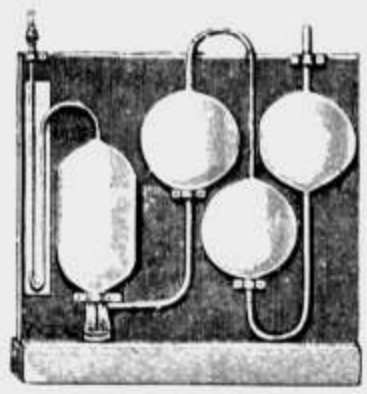
Electric Pyrometer, page 322.



No. 4945.



No. 4946.



No. 4947.

4945. **Gas Analysis Apparatus,** after Orsat, modified by Muencke, for the analysis of CO^2, CO and O, especially adapted for furnace and flue gases. Consists of three absorption pipettes, stop cock tube with three stop cocks, burette with jacket and sedimentation flask. Complete in lacquered wooden case..... $ 25 00

4946. **Gas Absorption Pipette,** single, for solid and liquids reagents..... 2 75

4946A. **Gas Absorption Pipette,** same as above, glass parts only..... 1 50

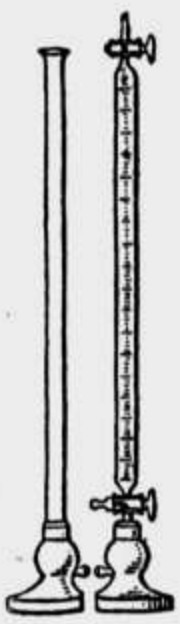
4947. **Gas Absorption Pipette,** double, for solid and liquid reagents..... 3 75

4947A. **Gas Absorption Pipette,** same as No. 4947, glass parts only..... 2 25

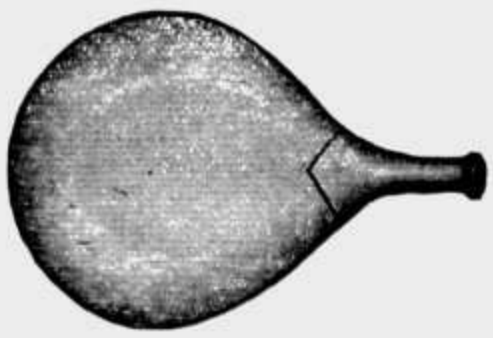
4948. **Gas Absorption Pipette,** for **Explosions**..... 6 25

4948A. **Gas Absorption Pipette,** same as No. 4948, glass parts only..... 3 75

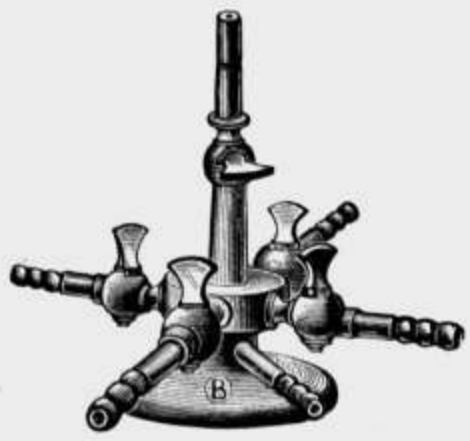
4949. **Palladium Tube** for absorption of hydrogen, filled..... 1 90



No. 4953.



No. 4951.



No. 4954.

4951. **Gas Bags,** pure rubber, oval form.

Capacity	1 gal.	2 gal.	3 gal.	5 gal.
Each	1.75	2.30	3.10	4.00

4952. **Gas Bags,** same as No. 4951, with brass stop cock.

Capacity	1 gal.	2 gal.	3 gal.	5 gal.
Each	2.75	3.30	4.10	5.00

4953. **Gas Burette,** with stop cocks and leveling tube, both mounted on base 6 65

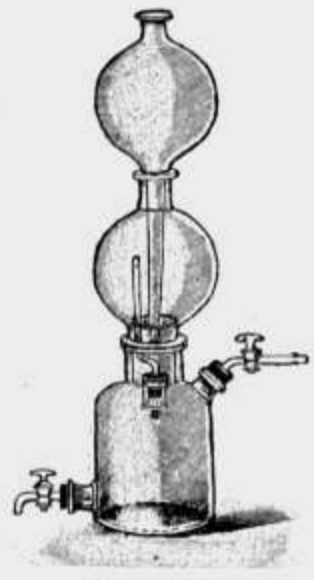
4954. **Gas Distributor,** with four side tubes and center burner, all with stop cocks 5 00



No. 4955.



No. 4957.



No. 4958.

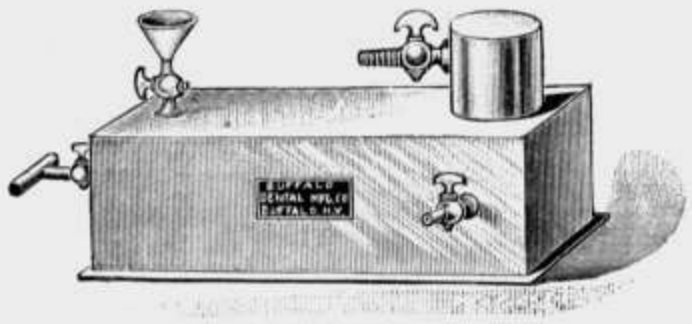
4955. **Gas Generator, Dropping,** after Prof. Freas, of Kent Chemical Laboratory, University of Chicago. An effective, cleanly, economical method of obtaining any gas desired for use. Substance acted upon is placed in flask and if possible in form of a paste. The agent is placed in the funnel and is allowed to drop into the flask and react with the contents. The gas generated passes out through the delivery tube or through the side tube, to increase the pressure in the funnel.... $ 4 50

4957. **Gas Generator, Kipp's Apparatus.**

	Pint.	Quart.	½ Gallon.
Capacity			
Each	3.35	4.45	5.95

4958. **Gas Generator, McCoy's.** Arranged to deliver the acid in drops, thus producing a steady and constant current of gas. There is no waste of chemicals and the spent acid is removed at the lower stop cock. The generator can be emptied and refilled without being taken apart.

	1 Quart.	½ Gallon.
Capacity		
Each	6.65	8.35



No. 4959.

4959. **Gas Generator for Gasoline Gas.** A cheap and efficient means of utilizing the vapor of gasoline for laboratory work. To be used in connection with No. 4645 or No. 4647 burner and foot blower or other air pressure. Size 4x4x10 inches, supplying two burners. Capacity, about one quart of gasoline..... 6 65

4960. **Gas Generator for Gasoline Gas,** same as No. 4959. Size 10x10x8 inches, supplying five burners; capacity, about one and a half gallons of gasoline 16 65

Gas Generating Flasks or Bottles, see page 285.

Gas Washing Bottles, see page 285.

4963. **Gasometer, Berzelius'** (gas holder), improved form, made of zinc, capacity 5 gallons ..... $ 15 00

4964. **Gasometer,** same as No. 4963, capacity 10 gallons 17 75

4965. **Gasometer,** same as No. 4963, of copper, capacity 5 gallons..... 18 50

4966. **Gasometer,** same as No. 4965, capacity 10 gallons 22 00



Nos. 4963-4966.

4971. **Gasometer Tube.**

Capacity	25 c.c. 1-5	50 c.c 1-5	100 c.c 1-5
Each.....	.80	1.10	1.25

4972. **Gasometer Tube,** with glass stop cock, capacity 50 c. c. in 1-10th..... 2 25

4973. **Gauze, Wire, Iron,** to put under dishes.

Size	4x4	5x5	6x6	sq. ft.
Each	.05	.07	.08	.30

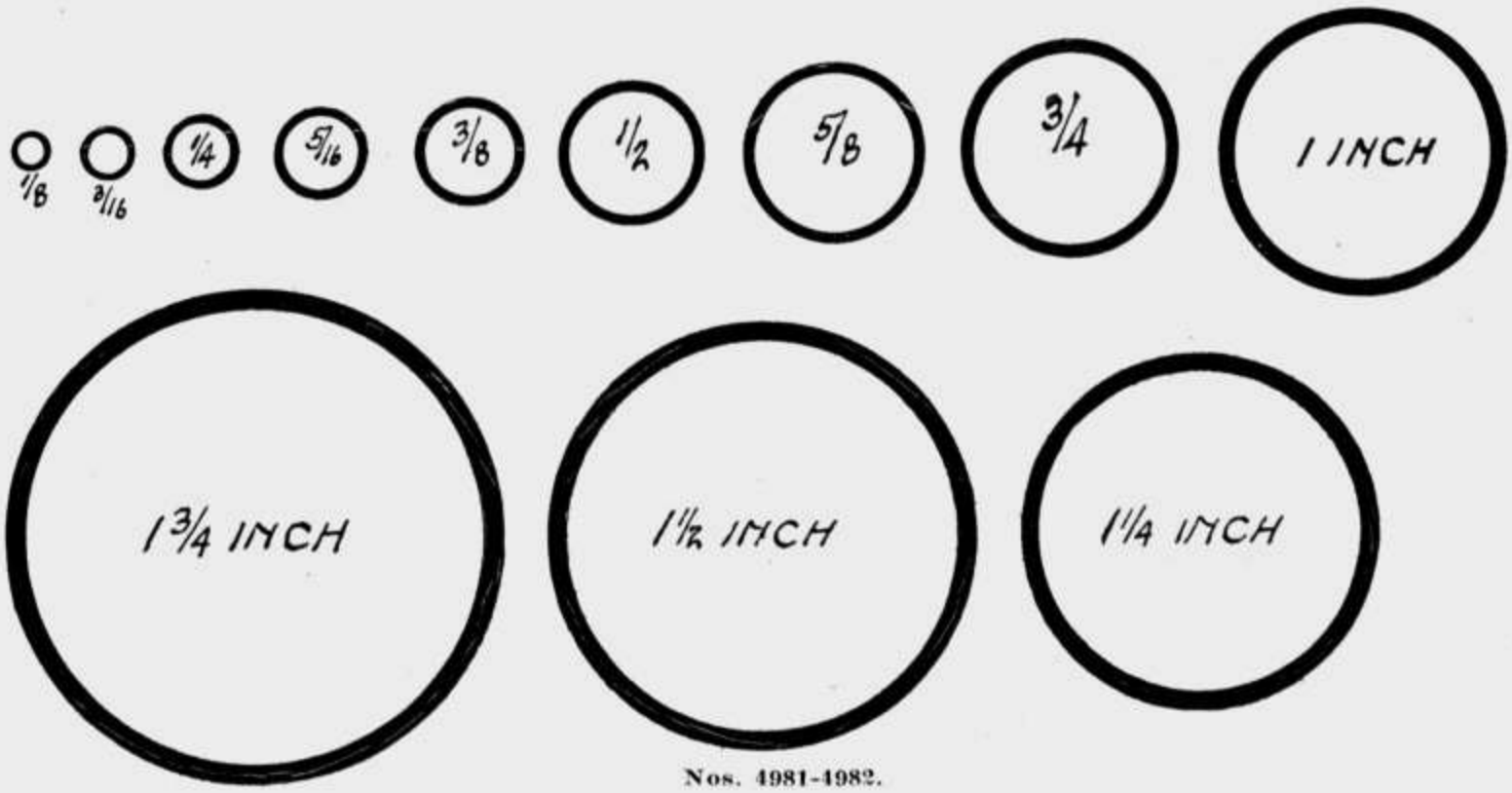
4974. **Gauze, Wire, Iron,** 5x5 inches, with asbestos center 13

4975. **Gauze, Wire, Brass,** to put under dishes.

Size	4x4	5x5	6x6	sq. ft.
Each	.10	.15	.18	.60

4977. **Gauze, Wire, Copper,** for combustion, etc.

Mesh	40	60	80	100
Per sq. ft.....	.80	.85	1.35	1.80



Nos. 4981-4982.

GLASS TUBING IS LISTED BY OUTSIDE DIAMETERS.

4981. **Glass Tubing,** best German soft glass, in five foot lengths, sizes ⅛ to ⅞ inch, per lb..... 44

4982. **Glass Tubing,** best German soft glass, sizes 1, 1¼, 1⅜, 1½, 1¾ and 2 inches, per lb..... 60

4983. **Glass Rod,** best German glass, in five foot lengths from ⅛ to ¾ inch, per lb. 44

4984. **Glass Stirring Rods,** with rounded ends.

Size	5x⅛	8x¼	10x¼
Per dozen	.16	.40	.50

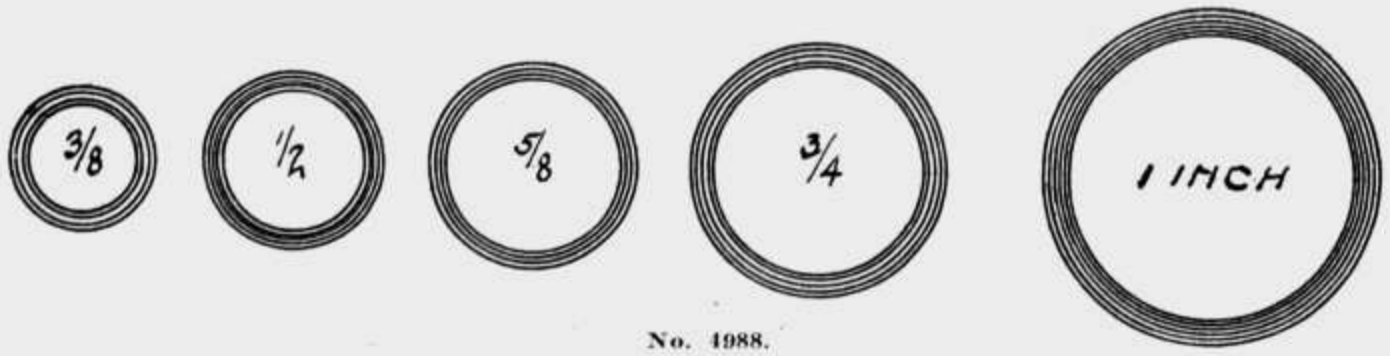
4985. **Glass Rod,** with rubber tip, so-called "policemen," for scraping precipitates from walls of beakers, etc. Each..... 09



No. 4986.

CAPILLARY TUBING IS LISTED BY INSIDE BORE.

4986. **Glass Tubing, Capillary,** 6-7 m. m. diameter, ¼, ½, ¾, 1, 1¼, 1½, 1¾ millimeter bore, per lb..... $ 75



No. 4988.

COMBUSTION TUBING IS LISTED BY INSIDE DIAMETERS.

4988. **Glass Tubing, Combustion,** best Bohemian hard glass, from ⅜ to 1 inch inside diameter, per lb..... 83

Combustion Boats, page 299.

4990. **Glass Tubing, Thermometer Tubing,** with white back, per lb..... 1 10

4993. **Glass Ink, "Diamond Ink,"** for writing on glass, in one ounce gutta percha bottles. Each..... 55

4995. **Glass Wool,** best imported, per oz..... .90. Domestic, per oz..... 55

4997. **Glass Beads,** used to create a large surface in tubes for absorption of gases, per lb..... 1 45

Glass Cutters, see page 20.

Glass Plates, see **Plates.**

4999. **Gold Beaters' Skin,** six inches square..... 22

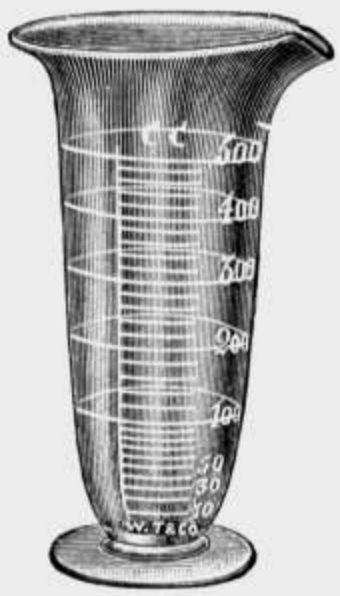
5000. **Goggles,** for protecting the eyes, **Colored Glass.** Per pair..... 27



No. 5001.



No. 5003.



No. 5007.

5001. **Graduate, Cylindrical,** German. Double graduation, so that the divisions may be read up or down.

Capacity, c. c.....	10	25	50	100	200	250	500	1,000
Each	.30	.40	.45	.65	.80	1.00	1.25	2.20

5003. **Graduate, Cylindrical,** same as No. 5001, with glass stopper.

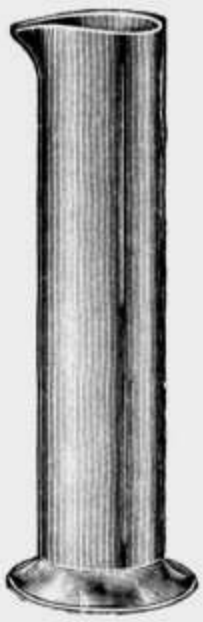
Capacity, c. c.	50	100	250	500	1,000
Each	.60	.90	1.25	1.65	2.50

5007. **Graduate,** glass, cone shape, metric measure.

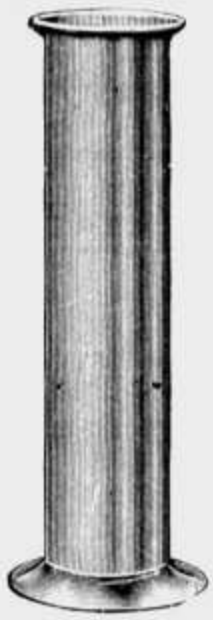
Capacity, c. c.	30	60	100	200	250	500
Each	.25	.30	.33	.42	.55	.83

5009. **Graduate,** glass, cone shape, metric and English measure, double graduation. Capacity, ounces..... 1 2 3 6 8 16

Capacity, c. c.....	30	60	100	200	250	500
Each	.30	.37	.45	.55	.65	1.10



No. 1125.



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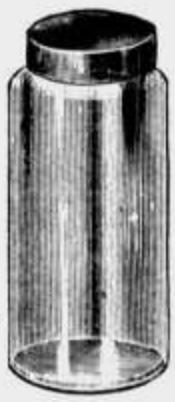

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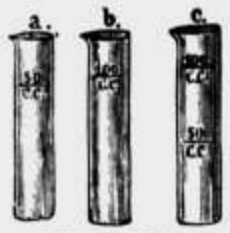
No. 5021.



No. 5023.

1125. **Jar, Hydrometer,** with lip. Height, inches.. 10 12 15 15 18
Diameter, inches 2 2½ 2½ 3 3
Each ..... .40 .50 .65 .80 1.10

1127. **Jar, Hydrometer,** with flange, same sizes and prices as No. 1125.

5019. **Jar, Specie,** for collecting gases. Capacity, quarts..... 1 2 4
Each ..... .22 .30 .45

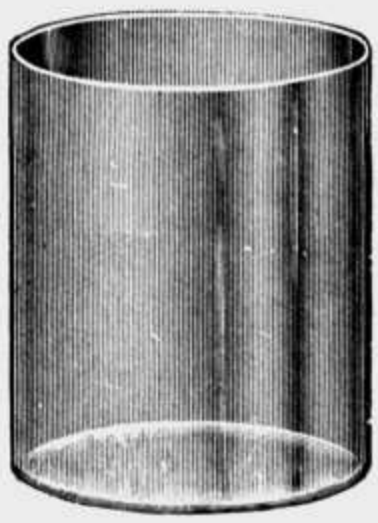
5021. **Jar, Precipitating.** Capacity, pints..... ½ 1 2
Each ..... .30 .37 .55

5023. **Jar, Nessler's,** for ammonia tests in water analysis.

Graduated	50 c. c.	100 c. c.	50 and 100 c. c.
Each	.40	.50	.60



No. 5025.



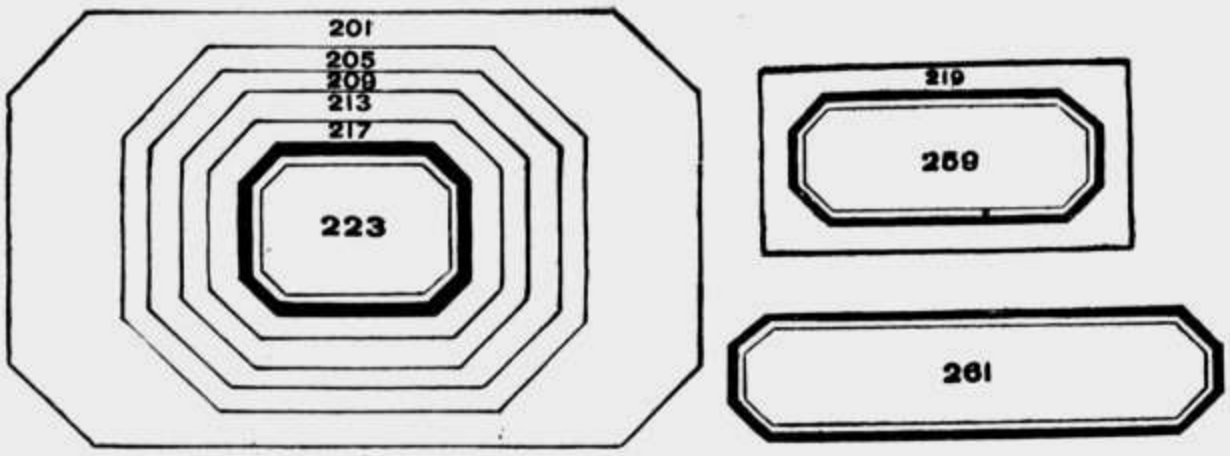
No. 5027.

5025. **Jar, Waste,** stoneware. These jars have handles and covers, and are preferable to a galvanized iron can for the refuse from the chemical laboratory.
Capacity, gallons..... 2 4 6 8
Each ..... .65 1.10 1.45 2.00

5027. **Jars, Battery,** round form, straight sides.
Diameter, inches 4 5 6
Height, inches 5 7 8
Each ..... .22 .27 .33

For **Specimen Jars** of all kinds see Catalog N.

5029. **Kettle,** Royal granite ware, tin cover.
Capacity, quarts 2 4 8
Each ..... .40 .50 .75



No. 5035.

5035. **Labels,** red border, gummed, put up in boxes of 100 each.

Number	223	217	213	209	205	201	261	259	219
Per box	.09	.09	.09	.09	.09	.09	.09	.09	.09

Note—Nos. 201, 205, 209, 213, 217 and 223 are shown full size in cut. No. 219 measures 18x40 m. m., No. 259 measures 14x33 m. m., No. 261 measures 15x50 m. m.

5036. **Labels,** red border, gummed, oval shape.

Number	241	239	229
Size, inches	½x¾	¾x1⅛	1¼x1¾
Per box	.09	.09	.09

5037. **Labels,** red border, gummed, rectangular.

Number	2001	2002	2003	2004	2005	2006	2007
Size, inches	1½x3⅞	1x3⅞	2x4¾	1x2¾	1⅞x4	1⅝x4	1⅝x2⅞
Per box	.27	.22	.45	.18	.35	.33	.22

5039. **Labels, Chemical,** gummed and perforated, per book..... $ 50

Litmus Paper, see **Test Paper.**

Litmus Pencils, see **Pencils.**



No. 5045.



No. 5047.



No. 5049.



No. 5055.

5045. **Lamp, Alcohol,** Bohemian glass, with ground cap, wick and wick holder.

Size, ounces	4	8
Each	.27	.40

5047. **Lamps, Alcohol,** Bohemian glass, with side tubulation glass stoppered, ground cap, wick and wick holder.

Size, ounces	4	8
Each	.40	.50

5049. **Lamp, Alcohol,** brass, with cap, wick and wick lift.

Size, ounces	2	4
Each	.45	.50

5051. **Lamp Wicks,** for alcohol lamps. Per dozen..... 08

5052. **Lamp Wick Holders,** brass, for Nos. 5045 and 5047. Per dozen..... 20

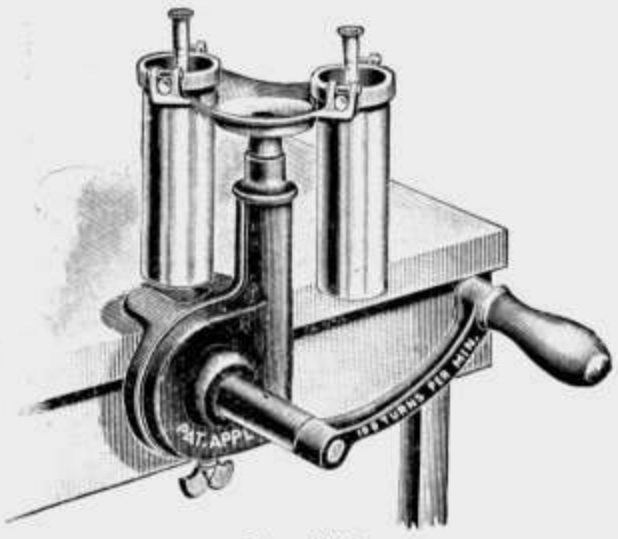
5053. **Lamp Caps,** glass, for No. 5045 or No. 5047, 4 oz. size. Per dozen..... 60

5053A. **Lamp Caps,** glass, for No. 5045 or No. 5047, 8 oz. size. Per dozen..... 60

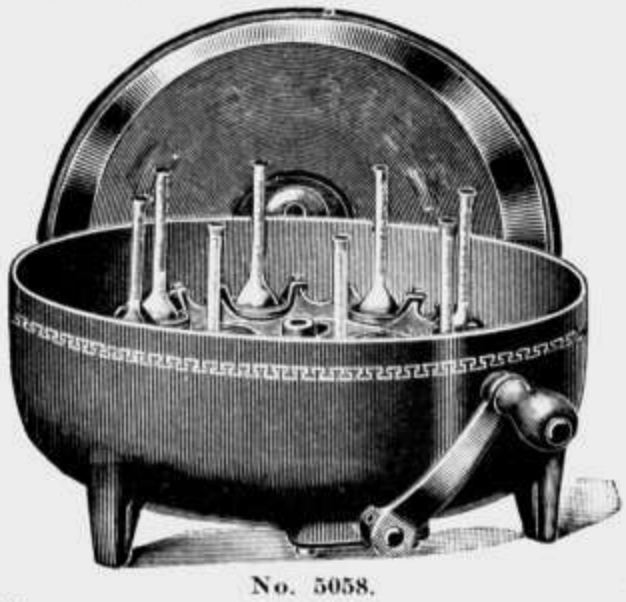
5055. **Lamp, Illuminating,** for laboratory tables; height, 12 inches..... 83

Lamps, Blast, page 279.

MILK ANALYSIS APPARATUS.



No. 5056.



No. 5058.

5056. **Babcock Milk Tester,** for hand power. Turns very easily, without vibration or jar, and can be readily attached for operation to any bench or table. Deep seamless brass swinging pockets are provided with pivots so constructed that they may be rotated with all speeds without danger of them flying off. Complete with full set of glassware, consisting of test bottles, pipette and acid measure, test bottle brush, bottle of acid and full directions for use. Two-bottle machine complete for testing milk.....Net $ 4 00

5056A. **Babcock Milk and Cream Tester,** same as No. 5056, with addition of two cream test bottles and combined pipette for cream testing. Complete .....Net 4 50

5057. **Babcock Milk and Cream Tester,** same as No. 5056A, but four-bottle size. With extra glassware complete.....Net 5 50

N. B.—Any of the above **Babcock Testers** may be obtained to carry the nine-inch test bottle. Extra price to above, $1.00 net.

5058. **Babcock Milk Tester,** Improved Iron Frame. Handsome iron case and cover, cut spur and worm gearing, pressed bottle carriers, seamless brass detachable swinging pockets for holding test bottles, enclosed gearings. Bottles perfectly horizontal when rotating. Turns easily and runs smoothly and noiselessly at very high speed. Prices include full set glassware, comprising test bottles, pipette and acid measure, test bottle brush, bottle of acid and full directions for tests.

Number of bottles.....	6	8	10	12
Each, net	9.00	10.00	12.00	14.00



No. 5060 A.



No. 5060 B.



No. 5060 F.

5060A. **Milk Test Bottle,** 10 per cent. graduated to 1-5 per cent..... 17

5060B. **Cream Test Bottle,** 30 per cent. graduated to ½ per cent..... 22

5060C. **Cream Test Bottle,** 40 per cent. graduated to 1 per cent..... 25

5060D. **Cream Test Bottle,** 50 per cent. graduated to 1 per cent..... 27

5060E. **Cream Test Bottle,** 50 per cent. 9 gram bottle, graduated to ½ per cent. 30

5060F. **"Perfect" Skim Milk Bottle,** graduated to 1-20 per cent..... 75

5060G. **Cream Test Bottle,** 30 per cent. 9 inch, graduated to 1-5 per cent..... 33

5060H. **Cream Test Bottle,** 50 per cent. 9 inch, graduated to ½ per cent..... 33

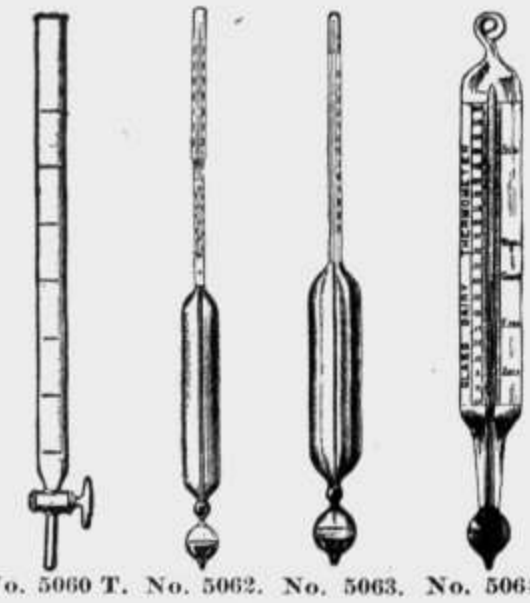
5060J. **Cream Test Bottle,** 55 per cent. 9 inch, graduated to ½ per cent..... 33

5060K. **Cream Test Bottle,** 100 per cent. 9 inch, graduated to 1 per cent..... 45

Milk Dish, of Aluminum, see No. 4853.



No. 5060 S.



No. 5060 T. No. 5062. No. 5063. No. 5064.



No. 5065.

5060L. **Pipettes,** 17.6 c. c. ..... $ 20
5060M. **Pipettes,** 18 c. c. 20
5060N. **Pipettes,** 17.6-18 c. c. combined 25
5060P. **Pipettes,** 9 c. c. 20
5060Q. **Pipettes,** 8.8 c. c. 20
5060R. **Acid Dippers** (Nafis' Style), 17.5 c. c. 12
5060S. **Acid Dippers** (Nafis' Style), 8.8 c. c. 12
5060T. **Acid Burettes.**

Number of charges	3	6	12	25
Each	2.25	2.50	3.30	4.45

5060V. **Cream Test Tubes,** plain, 9x¾ inches. Per dozen 85
5060W. **Cream Test Tubes,** with line five inches from bottom. Per dozen 1 00
5061. **Lactometer,** common, graduated 0 to 100 30
5062. **Lactometer,** Quevennes' combined lactometer with thermometer 1 60
5063. **Lactometer,** N. Y. State Board of Health Pattern, with thermometer. 1 65
5064. **Thermometer** for dairy use; 8 inches long, weighted to float upright 35
5065. **Aluminum Screw Cap Bottles** for holding samples of cream. With cork washer. One ounce capacity. Per dozen 1 10

Corrosive Sublimate Tablets for keeping milk samples sweet. Used in making composite tests. Made in two sizes. Small size will keep samples sweet for two weeks, large size for four weeks.

5066A. **Small Size,** per box of 50 tablets 25
5066B. **Large Size,** per box of 50 tablets 40



No. 5068.

5068. **Refractometer for Butter Examination.** Although primarily intended for refractometric examination of butter, may be used also for testing fats, food oils, etc. Ocular scale gives values between Nd = 1.42 and Nd = 1.49. Furnished with micrometer screw for measuring one-tenth scale divisions, accuracy of ¼ of 1 per cent. Furnished complete with bottle of standard liquid for verifying the adjustment of the ocular scale, table for transposing scale divisions in refractive indices and reverse, full directions for use and a common thermometer with thread for attaching to Refractometer divided in ½ degree from 0 to 50 degrees C. .....Duty free 68 50

5068A. **Thermometer, Special,** after **Wollny,** with separate scale for butter and lard. This thermometer gives the highest allowable refractometer count between 30 and 40 degrees C. Furnished with thread for attaching to instrument .....Duty free 1 90



No. 5071.



Nos. 5073-5075.



No. 5077.

5071. **Mortar, Iron,** vase shape, heavy, with pestle.

Capacity, pints	1	2	4	8
Each	.45	.65	1.10	1.65

5073. **Mortar, Porcelain,** shallow form, with pestle.

No.	6	5	4	3	2	1
Diameter, inches	2¾	3¼	4	4½	5½	6
Each	.33	.42	.48	.63	.75	1.00

5075. **Mortar, Wedgewood,** acid proof, with pestle.

No.	0000	000	00	0	1	2	3	4	5	6
Diameter, in.	2¾	3	3½	3¾	4½	5	5½	6	6½	7
Each	.33	.44	.52	.60	.66	.75	.92	1.10	1.30	1.65

5077. **Mortar, Glass,** with pestle.

Capacity, ounces	2	4	8	16
Each	.18	.25	.33	.50



No. 5079.



No. 5081.



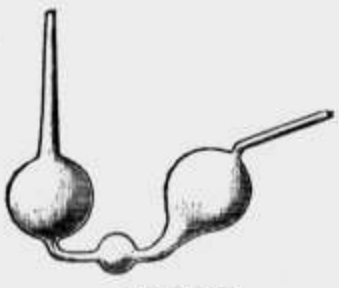
No. 5083.

5079. **Mortar, Agate,** superior quality, with pestle.

Diameter, inches	1½	2	2½	3
Each	1.45	1.90	3.10	4.50

5081. **Mortar, Diamond,** Plattner's form, of hardest steel 3 35

5083. **Mortar, Diamond,** Leed's form 1 75



No. 5085.



No. 5087.



No. 5089.



No. 5091.

5085. **Nitrogen Determination Apparatus,** Will-Varentrapp, 3 bulbs, pear shaped 35

5087. **Nitrogen Determination Apparatus,** Fresenius' 50

5089. **Nitrogen Determination Apparatus,** Volhard 50

5091. **Nitrogen Determination Apparatus,** Schiff (Nitrometer) 6 00

5093. **Paper, Glazed,** white, black or yellow, for collecting filter ashes, etc.; cut in sheets 10x12 inches. Per quire 20

Paper, Litmus, see **Test Paper,** page 331.

Paper, Parchment, see No. 1391-1392.



No. 5109.



No. 5111.



No. 5113.



No. 5117.



No. 5121.



No. 5123.

5105. **Pencil Litmus.** Chemically pure litmus, made like an ordinary lead pencil, one end blue, the other end red. Each ..... $ 27

5107. **Pencil, Blue,** for writing on glass. Each..... 17

5109. **Percolator,** heavy glass, conical shape.

Capacity	1 Pint	1 Quart
Each	.33	.40

5111. **Pipettes, Medicine Droppers, rubber bulb.** Per dozen..... 33

5113. **Pipette,** round bulb..... 11

5117. **Pipette,** long bulb, small..... 11

5119. **Pipette,** long bulb, large..... 17

5121. **Pipette, Volumetric,** accurately graduated.

Capacity, c c..	1	5	10	12	15	20	25	30	50	75	100	200
Each	.11	.13	.16	.20	.21	.22	.27	.30	.33	.42	.50	.65

5123. **Pipette, Mohr's,** accurately graduated into 1-10 c. c.

Capacity, c. c.....	1	2	5	10	20	25	50
Each	.22	.27	.37	.44	.66	.75	1.10

Pipette Support, listed under **Supports.**

5125. **Plate, Bisque** (porous clay), for quickly drying precipitate and crystals; diameter, 8 inches; shape of dinner plate. Each..... 17

5127. **Plate, Glass,** of blue cobalt glass.

Size, inches	2x2	2x3	3x3	3x4	4x4
Each	.06	.08	.09	.11	.13

5130. **Plates, Glass,** for covering beakers, etc.

Size, inches	4x4	6x6
Per dozen	.50	.80

5131. **Plate, Glass,** ground on one side, for covering jars, etc.

Size, inches....	2x2	3x3	4x4	6x6	8x8	10x10
Each	.05	.06	.07	.10	.17	.25

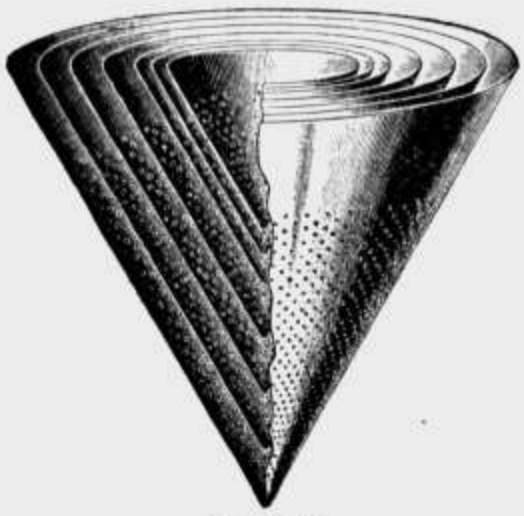
Plates, Glass, all colors, page 241.

Plate, Hot, see under **Burners,** page 294.

5133. **Plate, Porcelain,** with 6 cavities, for color reaction. Each..... 40

4535. **Plate, Streak,** for mineralogists. Each..... 20

Physical-Chemical Apparatus, according to Ostwald, Luther, Arrhenius, Kohlrausch, McCoy and others, will be found listed on pages 338-345. For Resistances, Galvanometers, Wheatstone Bridges, etc., see the Physical section. Other apparatus for this subject will be imported upon request.



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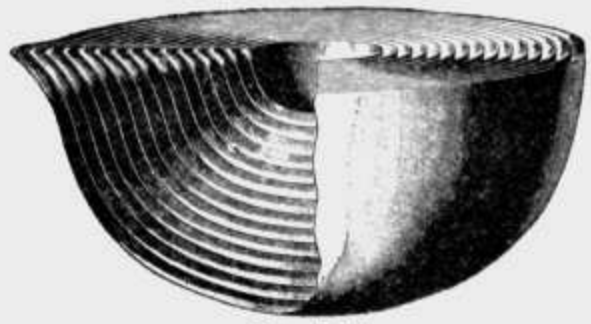
No. 5157.



No. 5161.

PLATINUM WARE.

Our platinum ware is from the celebrated works of Baker & Co., and is warranted pure and of the most approved shapes. Dishes and crucibles are all hammered and thoroughly tested after being finished. Special apparatus made to order. Old or scrap platinum bought at the highest market price. Weights given below are approximate only. **Prices are subject to market fluctuations.**

5151. **Platinum Blow Pipe Tip,** for Plattner's blow pipe. Each..... $ 1 20

5153. **Platinum Combustion Boat and Tube** quoted upon application.

5155. **Platinum Cone,** seamless filter cones, 60°, profusely perforated.

Diameter, inches	¾	1	1¼	1½
Each	3.00	3.50	5.00	8.00

5157. **Platinum Crucible,** with cover. Crucible and cover weigh about as many grams as they hold cubic centimeters.

Capacity, c. c	8	10	15	20	25	30

Per gram 1 10

5159. **Platinum Crucible, Gooch's,** with perforated bottom, cover and cap for bottom.

Capacity, c. c	10	15	20	25
Weight, grams	13	18	22	29

Per gram 1 25

5161. **Platinum Dish,** round bottom, with lip.

Diameter, m. m	38	42	44	48	56
Capacity, c. c	15	20	25	35	50
Weight, grams	5	6	8	12	17

Per gram 1 10

5163. **Platinum Foil.**

Size	Light.	Medium.	Heavy.
Thickness	.001	.002	.004
Grams per square inch	0.353	0.705	1.411
Per gram	1.00	1.00	1.00

Platinum Forceps, with platinum tips, see pages 283 and 309.

5165. **Platinum Gauze.**

45 mesh, No. 31 wire, 1.500 grams per square inch. Per gram..... 1 75

52 mesh, No. 38 wire, 0.543 grams per square inch. Per gram..... 1 75

Platinum Spatulas and **Spoons** quoted upon application.

5169. **Platinum Sponge.** Each 50

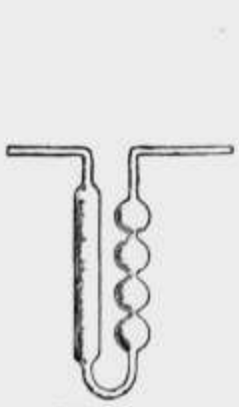
Platinum Tongs, with solid platinum tips, see page 332.

5171. **Platinum Wire,** per gram..... 1 00

B. & S. Gauge.	Grams per foot.	B. & S. Gauge.	Grams per foot.
18	5.37	27	0.65
20	3.41	28	0.48
22	2.08	29	0.41
23	1.61	30	0.33
24	1.33	32	0.21
25	1.08	34	0.12
26	0.85	36	0.08

Platinum Weights and **Riders,** see page 271.

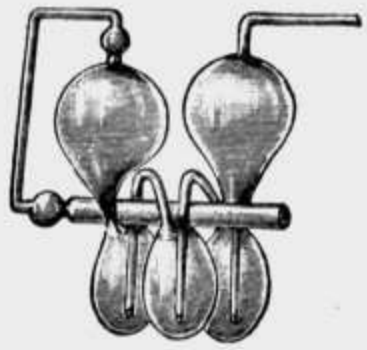
Polariscopes, page 239.



No. 5173.



No. 5175.



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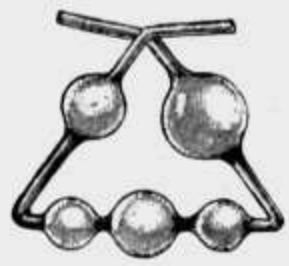


No. 5179.

5173. **Potash Apparatus,** Mitscherlich's ..... $ .45
5175. **Potash Apparatus,** Mohr's, improved by Geissler..... .75
5177. **Potash Apparatus,** Mohr-Geissler, with calcium chloride tube ground on. 1.22
5179. **Potash Apparatus,** Liebig's ..... .50



No. 5180.

5180. **Pyrometer** or **Standard Heat Gauge.** This outfit consists of a mounted thermo-couple. On account of the metals of which this couple is made it is durable and safe to use in molten metals, such as bronze, lead, brass and zinc, and does not need a protective tube, and consequently one may obtain quick and accurate readings. These couples may be supplied any length, but standard length of 36 inches is supplied unless otherwise ordered. For each additional foot over 36 inches an extra price of $1.50 is charged in addition to the cost of the Thermo-couple. The connection between Thermo-couple and Temperature Indicator is made by flexible copper cable 20 feet long. The Indicator is a portable instrument enclosed in a dustproof hardwood case. It is strong and serviceable and guaranteed accurate up to temperatures of 1,200° C. (2,192° F.) for continuous use, and occasionally may be used at 1,400° C. (2,550° F). Indicator for either Centigrade or Fahrenheit readings may be obtained. In Fahrenheit scale the value of each division is equal to 25 degrees; in the Centigrade the value of a scale division is equal to 20 degrees. Unless otherwise ordered, Indicator with the Centigrade scale will be sent.

Complete with a 36 inch Thermo-couple with hardwood handle and 20 feet copper leads .....Net 50.00

5180A. **Extra Thermo-Couples** up to 36 inches long.....Net 5.00



No. 5183.



No. 5187.



No. 5189.

No. 5191.

5181. **Receiver, Glass,** with tubulature only.

Capacity, ounces	4	8	16	32
Each	.20	.25	.33	.45

5183. **Receiver, Glass,** tubulated and glass stoppered.

Capacity, ounces	4	8	16	32
Each	.30	.37	.45	.70

5185. **Retort, Glass,** plain.

Capacity, ounces	4	8	16	32	64
Each	.15	.20	.25	.33	.45

5187. **Retort, Glass,** glass stoppered.

Capacity, ounces	4	8	16	32	64
Each	.22	.30	.42	.55	.75

5189. **Retort, Iron,** for distilling mercury, etc.; cover removable, fastened by screw clamp, delivery tube reaching through the cover.

Capacity, pints	½	1	2	4	8
Each	2.25	2.75	3.00	4.00	5.50

5191. **Retort, Copper,** for making oxygen; flask shape, with iron clamp and delivery tube.

Capacity, pints	½	1	2	4
Each	2.25	2.50	2.75	3.35

5193. **Retort Adapter,** for connecting retorts with receivers; straight.

Diameter, inches, large end	½	1	1½	2
Each	.15	.18	.25	.40

5195. **Retort Adapter,** same as No. 5193; bent.... .15 .18 .25 .40

Retort and Crucible Combined, Skidmore's, see No. 4815.

Reduction Tubes, see No. 4771.



No. 5201.



No. 5203.

5201. **Ring, iron,** for attaching to retort stands; with improved $\frac{5}{16}$-in. screw.

Diameter, inches	3	4	5	6	7
Each	.13	.16	.17	.18	.20

5203. **Ring, iron,** for extension, for fastening to retort stand with Clamp Holders Nos. 4723 and 4725.

Diameter, inches	3	4	5	6	7
Each	.10	.11	.12	.13	.15



No. 5209.

Rubber Bags, see **Gas Bags.**

Rubber Bulbs, see **Bulbs.**

5209. **Rubber Caps,** for test tubes.

Diameter, inches...	¾	1
Per dozen.....	.33	.40



No. 5210.

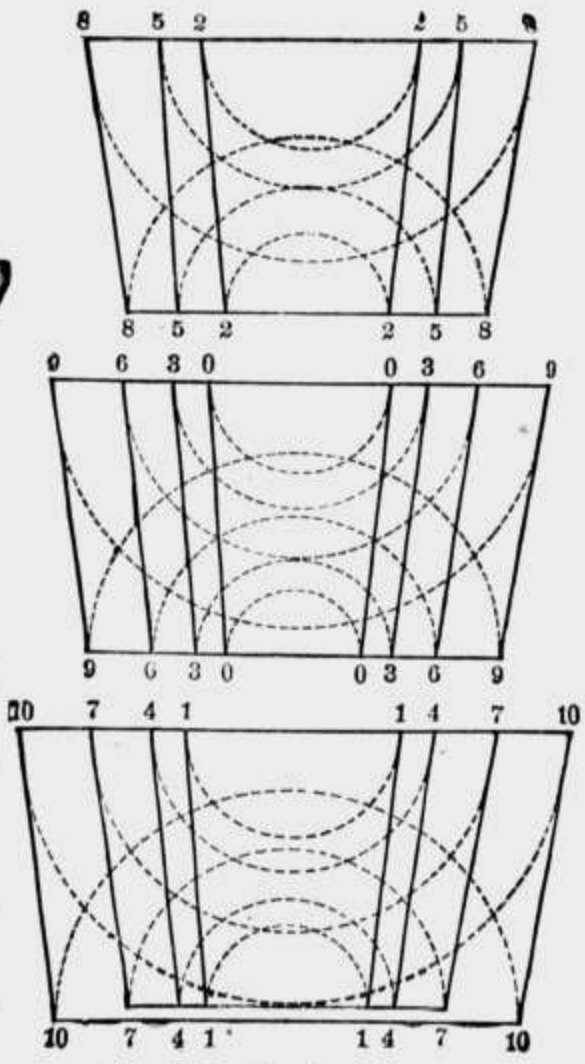
5210. **Rubber Gloves, Acid Gloves,** heavy gauntleted form.

Sizes for women, 6 to 9. Per pair	2 50
Sizes for men, 10 to 12. Per pair	2 50

5212. **Rubber Sheeting,** white, 36 inches wide. Per yard..... 80

Rubber Sheet (Rubber Dam), see No. 1389.

5213. **Rubber Stoppers,** made from best quality of rubber, especially for chemical laboratory use, and will not harden from age. Each size furnished in three styles—solid, one hole or two holes. Per pound. 2 25



No. 5213 Showing Sizes.

Table Showing Approximate Number of Rubber Stoppers in One Pound.

Number		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Diameter large end, m. m.....		17	18	20	23	25	27	32	37	41	45	50	56	65	72
Diameter small end, m. m.....		12	15	16	18	20	23	26	30	33	37	42	50	59	68
Approximate Number in One Pound	Solid	76	58	53	40	32	26	20	15	12	11	8	6	5	4
	1 hole	82	60	55	42	33	27	21	15	12	11	8	6	5	4
	2 hole	85	63	58	44	34	28	22	16	13	12	9	6	5	4

5215. **Rubber Tubing, White,** best quality, hand made, in 12 foot lengths.

Inside diameter, inches...	⅛	3/16	¼	5/16	⅜	½
Per foot	.05	.07	.10	.11	.14	.24

5219. **Rubber Tubing, Red,** Antimony rubber, in 12 foot lengths.

Inside diameter, inches...	⅛	3/16	¼	5/16	⅜	½
Per foot	.06	.10	.12	.15	.20	.27

5220. **Rubber Tubing, Red,** same as No. 5219, but heavy wall.

Inside diameter, inches.....	3/16	¼	5/16	⅜	½
Per foot	.13	.20	.23	.35	.45

5221. **Rubber Tubing, Black,** pure gum, steam cured, seamless.

Inside diameter, inches..	⅛	3/16	¼	5/16	⅜	½
Per foot	.07	.10	.12	.15	.20	.27

5223. **Rubber Tubing, Band,** pure gum, for Gooch's crucibles, etc.

Diameter, inches	1	1¼	1½
Per foot	.13	.18	.22

5225. **Rubber Tubing, White,** cloth insertion, for air pumps, vacua work, etc.

Inside diameter, inches.....	3/16	¼	5/16	⅜
Per foot	.10	.12	.18	.22



No. 5237.



No. 5239.

5237. **Sand Bath.** Best Russia sheet iron, shallow form.

Diameter, inches	3	4	5	6
Each	.08	.10	.12	.17

5239. **Sand Bath.** Best Russia sheet iron, hemispherical form.

Diameter, inches	3	4	5	6
Each	.11	.15	.18	.22

5241. **Sand Bath, Hot Plate.** Of best Russia sheet iron, 8x10 inches, on support ..... $ 2 00

Hot Plate, for use with gas, page 294.



No. 5245.



No. 5247.

5245. **Scoop, Horn,** flat and wide, for ordinary use; square ends.

Bowl, inches	2x3	3x3½
Each	.20	.25

5247. **Scoop, Agateware,** 3x5½ inches..... 20



Nos. 5249-5251.



No. 5263.



No. 5265.

5249. **Sieve,** seamless brass frame, brass gauze with pan bottom, 5 inches diameter.

Mesh	10	20	40	60	80	100
Each	1.10	1.10	1.20	1.35	1.45	1.55

5251. **Sieve,** same as No. 5249; 8 inches diameter.

Mesh	10	20	40	60	80	100
Each	1.55	1.65	1.75	1.90	2.00	2.35

5253. **Sieves,** same as No. 5249; in sets of five, with one bottom and cover.
Per set 6 65

5255. **Sieves,** same as No. 5251; in sets of five, with one bottom and cover.
Per set 10 00

5257. **Cover,** for above sieves.

Diameter, inches	5	8
Each	.33	.55

5258. **Sieve,** wooden frame, brass gauze, diameter 6 inches.

Mesh	20	40	60	80	100
Each	.45	.50	.60	.75	.90

5261. **Spatula, Glass,** 6 inch..... 12

5263. **Spatula, Horn,** double end.

Length, inches	4	6
Each	.10	.17

5265. **Spatula, Steel,** wooden handle.

Length of blade, inches	3	4	5	6
Each	.22	.27	.30	.42



No. 5271.



No. 5273.

5271. **Spoon, Horn,** superior quality, with spatula end.

Length, inches	4	6
Each	.11	.18

5273. **Spoon, Glass,** teaspoon 20

5273A. **Spoon, Glass,** tablespoon 45



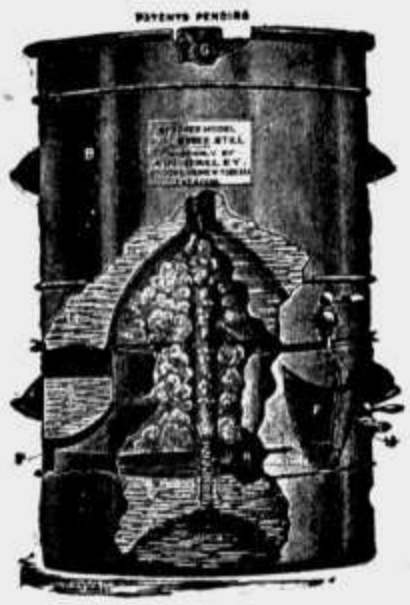
No. 5275.

5275. **Spoon, Sodium,** of brass gauze, wooden handle 33

Stands, see **Supports,** page 328.



No. 5285.



No. 5287.

5285. **Still,** copper retort, tin lined with movable head, connected with pure block tin condensing worm, enclosed in zinc vessel, with proper inlets and outlets.

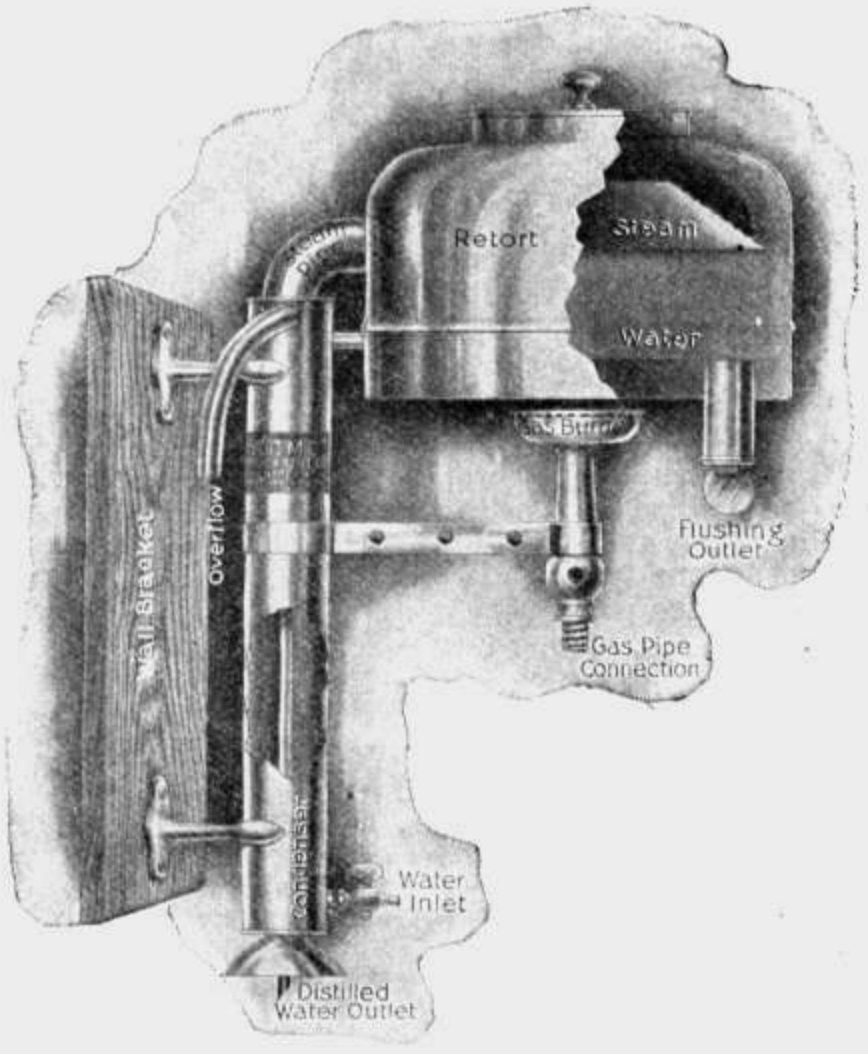
Capacity, gallons.....	½	1	2	3	5
Complete, each.....	8.00	10.50	12.50	16.00	22.00

N. B —Either Still or Condenser of No. 5285 sold separately. Prices upon application.

5287. **Still, Ralston's New Process.** This still may be used on any stove and does not require water under pressure for its operation. The storage of the distilled water within the still avoids the reabsorption of gases which may be in the water to be distilled. Although this still is not entirely automatic in its action, it is so constructed that it cannot boil dry; it requires little care or attention. It is well made, of copper and pure tin. Capacity, from 1 to 3 quarts per hour, depending on the amount of heat used. Weight, 7 lbs.; diameter, 9 inches; height, 14 inches.....net $ 10 00

5292. **Still, Acme Automatic Water Still.** Made to hang on wall and can be placed wherever gas and water connections may be most conveniently made with pipes or rubber tubing. Occupies space 12x4 inches on the wall, projecting only 14 inches in its widest part. To operate still it is only necessary to turn on the water and light the gas under the retort. Water boils in only a few moments, and distilled, pure, aerated water flows out into receptacle. Fitted with removable cover to permit inspection if desired, though it is really unnecessary. Cannot get out of order, absolutely automatic, and everything so arranged as to secure maximum amount of water for the minimum consumption of gas. Made of copper and brass, tin lined and nickel plated, and of the best workmanship throughout. Capacity, one gallon per hour and one-half. Furnished with gas burner.....net 25 00

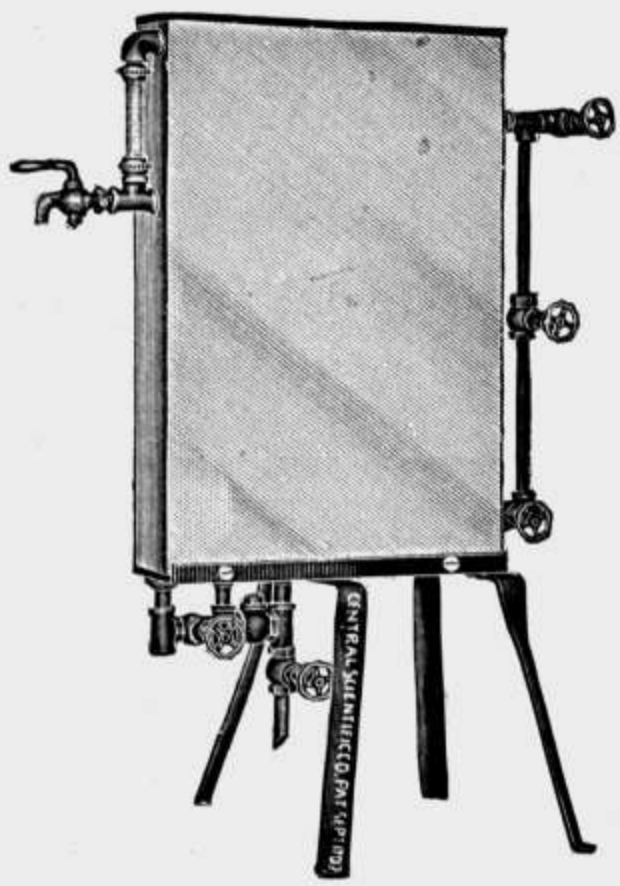
For illustration of No. 5292, see page 327.



No. 5292, Acme Still.

(For description see page 326.)

5298. **Maxson Combination Still and Water Heater.** This is a new departure in the line of Stills and Heaters. It is connected with the radiator and cold water supply, and will condense from **three to four gallons** of water **per hour** or heat **cold water to the boiling point** in **three minutes.** The manipulation of the valves does everything, filling the jacket with cold water, bringing the steam to the condenser, flushing the condenser or draining the jacket when through using. It occupies but little space and there is absolutely no cost in operation. An almost unlimited supply of hot water may be had and an amount of distilled water equivalent to five or six times the capacity of any still now on the market which is sold at the same price. Made of heavy copper, complete with stand, as shown in illustration. 22 00



No. 5298.



No. 5301.



No. 5303.



No. 5305.



No. 5307.



No. 5309.

5301. **Stop Cock, Glass, straight;** bore, m. m..... 2 3 4
Each ..... .80 1.00 1.45

5303. **Stop Cock, Glass, three way,** bore, 2 m. m..... $ 1 30

5305. **Stop Cock, Glass, three way,** with three tubes, bore, 2 m. m..... 1 30

5307. **Stop Cock, Glass,** one end bent, bore, 4 m. m., heavy Bohemian glass. 90

5309. **Stop Cock, Glass, four way,** with four tubes, bore, 2 m. m..... 1 45

Stop Cocks, Brass, see page 105.

5312. **"Suberite"** (Compressed Cork) **Rings,** for supporting flasks, etc. These rings are highly recommended as a substitute for straw rings.

Inside diameter, c. m.....	3	6	9	12
Each	.25	.35	.45	.55

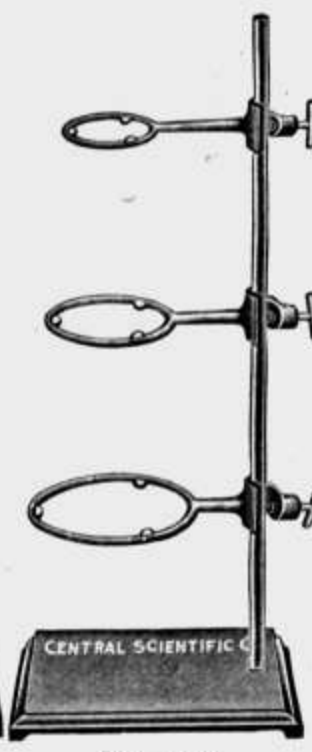
5313. **"Suberite"** (Compressed Cork) **Mats,** for supporting beakers, etc. Diameter, 12 c. m.; thickness, 1 c. m. Each..... 25



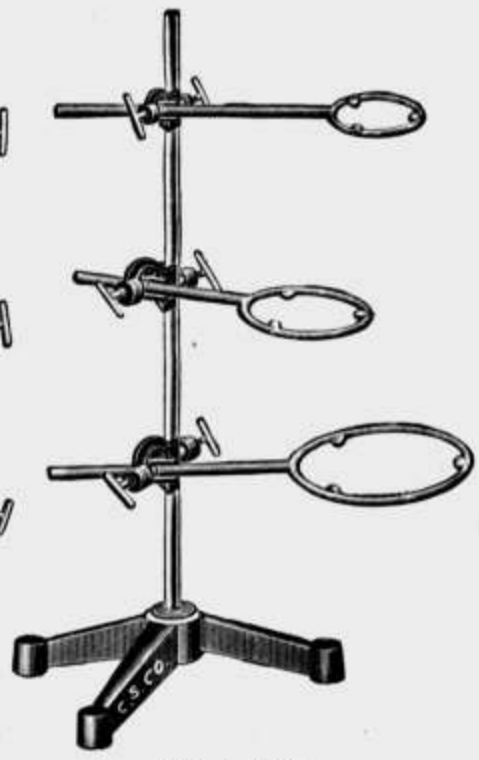
No. 5325.



No. 5327.



No. 5329.



No. 5329 A.

Supports, iron base and coppered steel rod.

Cat. No.	Size of Rod		18x $\frac{5}{16}$	20x⅜	24x½	36x½
5325	Tripod Base, size		Small	Medium	Large	Extra Large
	Price with Rod		.33	.40	.65	1.00
5327	Rect. Base, size		No. 1 (5x8)	No. 2 (5x8)	No. 3 (5½x9)	No. 4 (6x11)
	Price with Rod		.27	.35	.60	1.00
5329	Rect. Base with Rod & Rings	Rings	3 & 4 inch	3, 4 & 5 in.	3, 4, 5 & 6 in.	3, 4, 5 & 7 in.
		Price	.50	.60	1.00	1.55

Extra Rings listed on page 323.

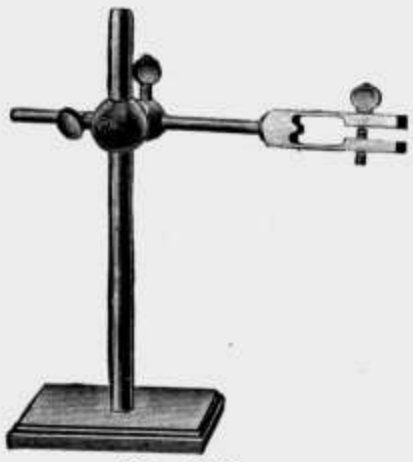
5329A. **Illustration** shows No. 5325 Support with No. 5203 Extension Rings in connection with No. 4723 Clamp Holders.



Nos. 5331-5333.



No. 5341.



No. 5343.



No. 5345.

5331. **Platform,** of iron, 3½ inches in diameter, with heavy screw for clamping on supports or tripods. Useful for supporting burners, etc., in connection with No. 5333 Concentric Rings.... $ 30

5333. **Rings, Concentric,** six inches in diameter, with two removable rings, with heavy screw for clamping on supports for supporting water baths, sand baths, flasks, etc..... 50

5341. **Support, Hardwood, Gay Lussac's.** Cork lined, movable in three ways. 1 33

5343. **Support, Hardwood.** Improved form of Gay Lussac's, with extension rod 22 inches long..... 1 65

5344. **Wooden Clamp** with ½-inch rod, same as in No. 5343, for use with clamp holders, etc., in connection with iron supports. Clamp only.. 75

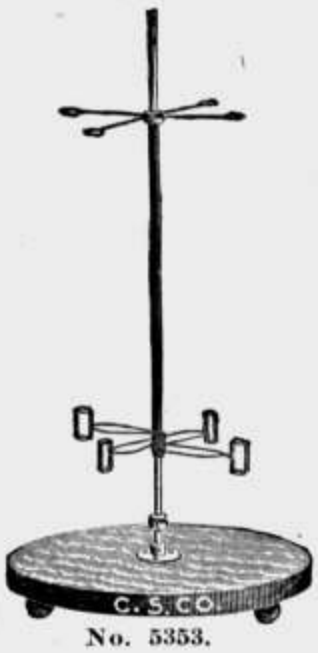
5345. **Support, Hardwood, Schellbach's.** Cork lined, universal movement.... 1 50



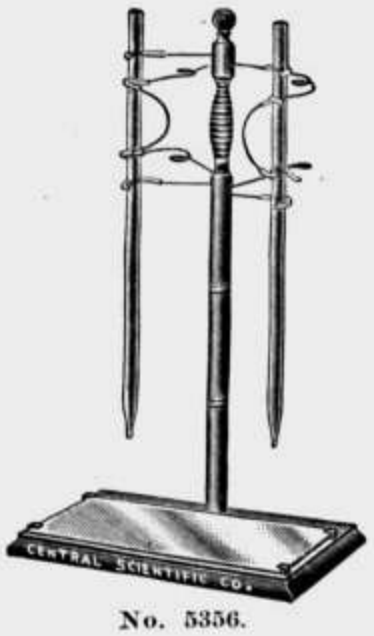
No. 5347.



No. 5349.



No. 5353.



No. 5356.

5347. **Support, Burette,** of hardwood, for two burettes, cork lined..... 1 10

5349. **Support, Burette,** iron tripod and rod with hardwood arm, cork lined, for two burettes..... 1 65

5353. **Support, Burette,** round hardwood base with nickel plated steel rod and revolving spring clamps for four burettes. The best burette support on the market..... 3 35

5353A. **Support, Burette,** same as No. 5353, but with round porcelain base in place of the wooden base..... 6 35

5354. **Support, Burette,** same as No. 5353, for two burettes..... 2 65

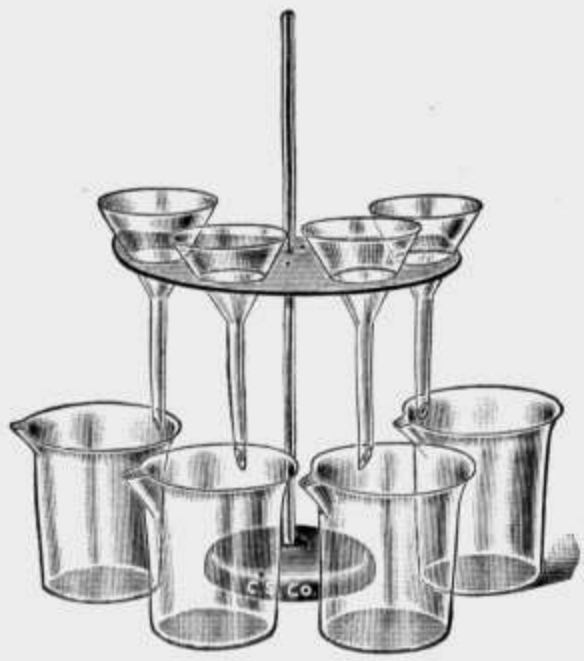
5354A. **Support, Burette,** same as No. 5354, but with round porcelain base in place of the wooden base..... 5 65

5355. **Support, Burette, Chaddock's.** The rod and base are of polished hardwood. Inlaid into the base is a circular piece of white glass. Clamp is of spring wire, Chaddock's patent, lined with rubber. The burette is readily placed in position or removed by simply springing back the wire. For one burette..... 1 65

5356. **Support, Burette, Chaddock's.** Same as No. 5355, for two burettes..... 2 50



No. 5357.



No. 5358.

5357. **Funnel Holder,** for use with supports. Made of hardwood with four beveled openings for 60° funnels. Will center over rings. Without support ..... $ 45

5358. **Funnel Holder,** designed by Prof. John T. Stoddard, of Smith College. Made of aluminum to hold four two-inch funnels. Provided with strong set screw for use with No. 4743 Base and Rod. Without support 75

5358A. **Funnel Holder,** same as No. 5358, to hold four 2½-inch funnels. Without support 85

4743. **Base and Rod,** for use with above funnel holders. Base is heavy and entirely stable with excessive load in funnels..... 35



No. 5359.



No. 5361.



No. 5363.



No. 5365.

5359. **Support, Funnel,** of hardwood, for one funnel..... 60

5361. **Support, Funnel,** of hardwood, for two funnels..... 75

5363. **Support, Funnel,** of hardwood, for four funnels..... 80

5365. **Support, Pipette,** of hardwood, revolving, for 12 pipettes..... 2 25

5367. **Support Table,** of hardwood, with leaded base. Height closed, 7 inches; height when drawn out, 10 inches. Each..... 1 10

5369. **Support Table,** same as No. 5367. Height closed, 9 inches; height when drawn out, 15 inches. Each..... 1 25



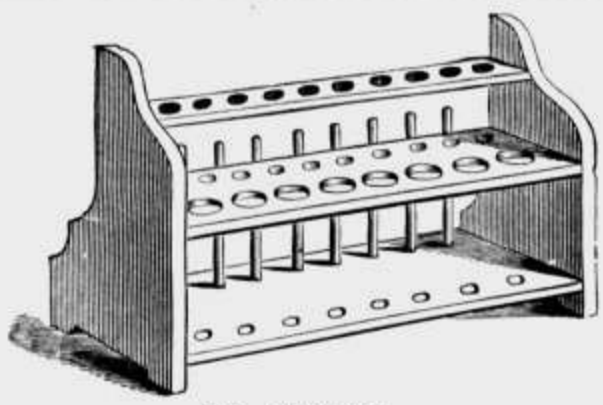
No. 5367.



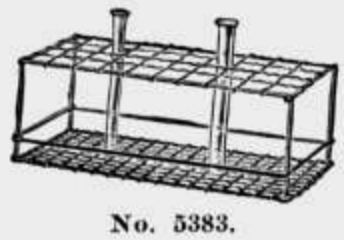
No. 5375.



No. 5377.



No. 5379-5381.

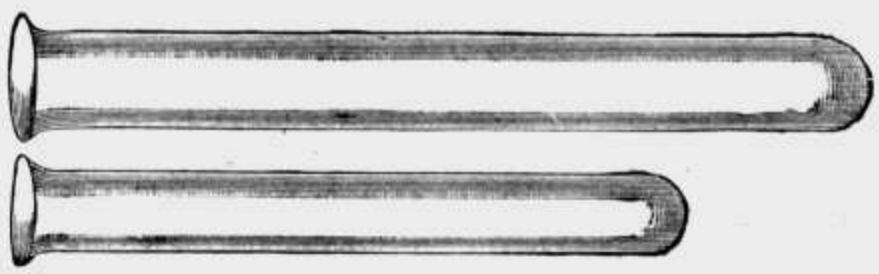


No. 5383.

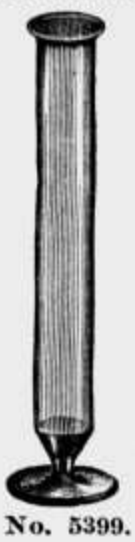
5375. **Support, Test Tube,** for 6 tubes. Heavy base with drying pins..... $ 27
5377. **Support, Test Tube,** for 10 tubes. Heavy base with drying pins..... 35
5379. **Support, Test Tube,** for 13 tubes. Two rows of holes with drying pins 45
5381. **Support, Test Tube,** for 25 tubes. As used at the University of Chicago. Two rows of holes with drying pins..... 65
5383. **Support, Test Tube,** of wire. Will hold 40 tubes. Size 9½ inches long by 4½ inches wide by 3½ inches high..... 35



No. 5385.



No. 5395.



No. 5399.



No. 5401.

5385. **Test Glass,** conical, with lip (urine sedimentation glass).

Capacity	1 oz.	2 oz.	4 oz.	6 oz.
Each	.11	.15	.18	.22

5387. **Test Paper, Litmus,** blue, per sheet, .04; per quire..... 72
5388. **Test Paper, Litmus,** blue, per book..... 06
5389. **Test Paper, Litmus,** red, per sheet, .04; per quire..... 72
5390. **Test Paper, Litmus,** red, per book..... 06
Litmus Pencils, see No. 5105.
5391. **Test Paper, Turmeric,** per sheet, .05; per quire..... 90
5392. **Test Paper, Logwood,** per sheet, .05; per quire..... 90
5393. **Test Paper, Congo Red,** per sheet, .05; per quire..... 90
Test Paper, Pole Indicating Paper, see page 142.
5395. **Test Tubes,** well annealed, teasted and guaranteed.

Size, inches	3x⅜	4x½	5x½	5x⅝	6x⅝
Per dozen	.15	.20	.22	.25	.28
Per gross	1.55	2.00	2.25	2.50	2.85
Size, inches	6x¾	7x⅞	8x1	10x1	12x1
Per dozen	.30	.40	.50	.90	1.50
Per gross	3.00	4.00	5.20	10.00	16.00

5397. **Test Tubes,** assorted sizes, from 3 to 7 inch, per dozen..... 26
5398. **Test Tube,** graduated in cubic centimeters.

Capacity	.5 c.c. in 1-10.	10 c.c in 1-10.	20 c.c. in 1-5.	25 c.c. in ½.
Each	.40	.45	.55	.65

5399. **Test Tubes,** on foot; size, inches.... 4 5 6 8 10
Per dozen..... .60 .75 .85 1.25 1.65
5401. **Test Tubes,** side neck; size, inches..... 5 6 8 10
Per dozen..... .65 .85 1.25 1.65
5403. **Test Tubes,** Bohemian hard glass; size, m. m. 100x14 130x16 160x20
Per dozen..... .75 .90 1.50
5405. **Test Tubes,** heavy hard glass (Ignition Tubes).

Size	4 in.	5 in.	6 in.
Per dozen	.45	.65	.85

Test Tube Brushes, see Brushes. **Test Tube Holders,** see Clamps.



No. 5411.

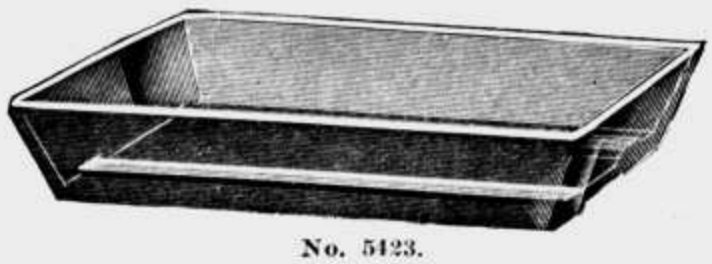
5411. **Tongs, Crucible, Steel.** Double bend, 9-inch..... $ 30

5413. **Tongs, Crucible, Steel.** Double bend, 9-inch, nickel plated..... 45

5415. **Tongs, Crucible, Brass.** Double bend, 9-inch..... 40

5417. **Tongs, Crucible, Brass.** Double bend, 9-inch, nickel plated..... 50

5419. **Tongs, Crucible, Platinum.** Double bend, 9-inch, steel, nickel plated tongs of superior construction, with solid platinum tips..... 8 00



No. 5423.

5421. **Tray,** photographic, of metal, wire bound and coated with acid proof japan.

Size, inches	5x8½	7x9	8x10	10x12	16x20
Each	.25	.30	.35	.50	1.65

5423. **Tray,** photographic, of white or amber glass.

Size, inches	4½x5½	5½x8½	8½x10½
Each	.25	.35	.75

5425. **Tray,** heavy glass, 6x8 inches, 1½ inches deep..... 20



No. 5431.



No. 5433.



No. 5435.



No. 5437.

5431. **Triangle,** plain iron wire.

Size	No. 1	No. 2	No. 3
Each	.04	.04	.05
Per dozen	.40	.40	.45

5433. **Triangle,** iron wire, covered with pipe stems.

Size	No. 1	No. 2	No. 3	No. 4
Holds R. B. Crucible No..	000 or 00	00 or 1	2	3
Each	.07	.08	.08	.09
Per dozen....	.65	.70	.75	.80

5435. **Triangle,** iron wire, covered with pipe stems, having a raised center so that the crucible rests on these points. Each, 11c; per dozen..... 1 00

5437. **Triangle Holder.** Will hold platinum triangles firmly in place; it prevents the wire from bending down when heated; it will accommodate any size triangle for holding crucibles up to 100 c. c. Without platinum triangle 83



No. 5439.



No. 5440.

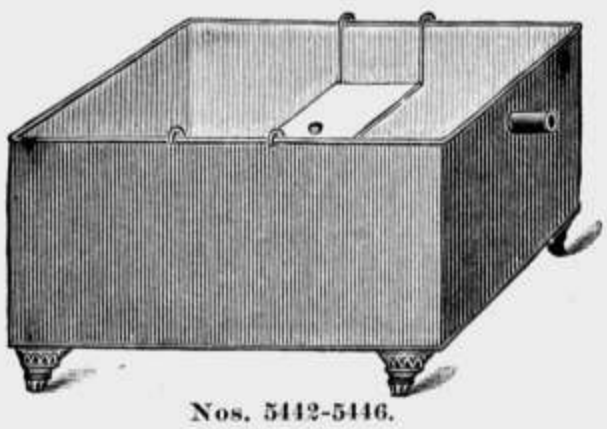
5438. **Tripod,** iron, small, for spirit lamps..... $ 22

5439. **Tripod,** iron, for Bunsen burners, single ring.

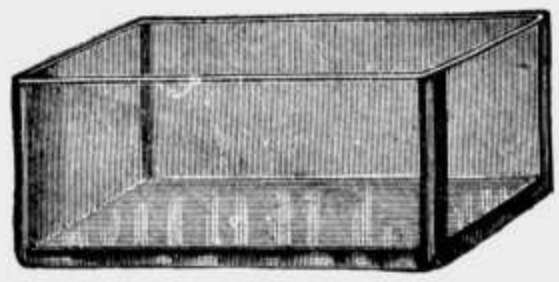
Diameter, inches	5	6	8	10	12
Each	.25	.30	.42	.55	.75

5440. **Tripod,** iron, malleable, same as No. 5439, with concentric rings.

Diameter, inches	5	6	8	10	12
Number of rings	2	3	4	5	6
Each	.33	.50	.65	1.00	1.35



Nos. 5442-5446.



Nos. 5447-5450.

5442. **Pneumatic Trough,** of japanned tin with sliding shelf and overflow; students' size, 4½x6½x10 inches..... 65

5444. **Pneumatic Trough,** of heavy japanned tin with sliding shelf and overflow, 6x11x16 inches..... 1 75

5446. **Pneumatic Trough,** heavy galvanized iron with sliding shelf and overflow, 5x9x12 inches..... 1 10

5447. **Pneumatic Trough, Bohemian Glass,** 20x10x10 c. m..... 1 65

5448. **Pneumatic Trough, Bohemian Glass,** 24x12x12 c. m..... 2 25

5449. **Pneumatic Trough, Bohemian Glass,** 30x15x15 c. m..... 4 50

5450. **Pneumatic Trough, Bohemian Glass,** 36x18x18 c. m..... 6 65



No. 5451.



No. 5453.



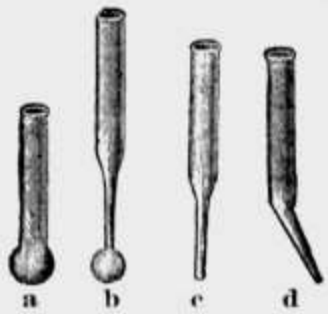
Nos. 5455-5456.

5451. **Beehive,** of zinc, for use with troughs in collecting gases..... 33

5453. **Trough, Mercury,** porcelain, cross shape, holding 3 kilos..... 80

5455. **Trough, Mercury,** porcelain, usual form, holding 4 kilos..... 1 15

5456. **Trough, Mercury,** porcelain, usual form, holding 5 kilos..... 1 35

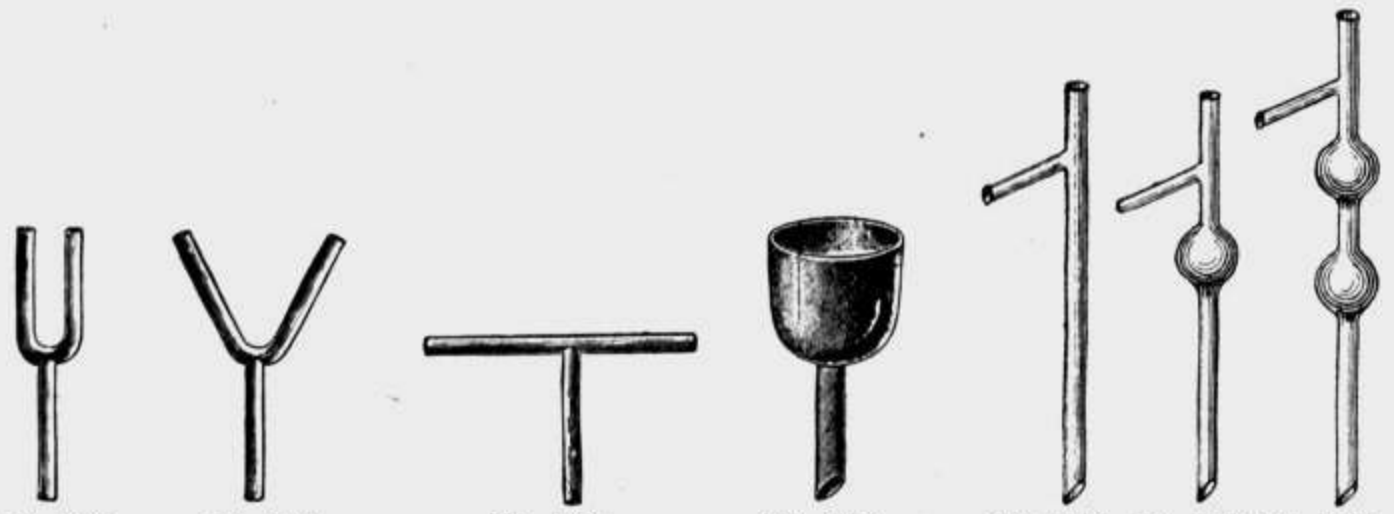


No. 5461.

5461. **Tubes, Arsenic,** of hard Bohemian glass; per set of four..... 22

Arsenic Tubes, separate, either a, b, c or d; per dozen..... 65

5462. **Tube, Arsenic, Marsh Test,** glass part only..... 33



No. 5463. No. 5465. No. 5467. No. 5475. No. 5477. No. 5479. No. 5481.

5463. **Tube, Connecting,** U shape, of glass.

Size, inches	¼	⅜	½
Each	.09	.15	.25

5465. **Tube, Connecting,** Y shape, of glass.

Size, inches	¼	⅜	½
Each	.09	.15	.25

5467. **Tube, Connecting,** T shape, of glass.

Size, inches	¼	⅜	½
Each	.09	.15	.25

5469. **Tube, Connecting,** Y shape, of brass.

Size, inches	¼	⅜	½
Each	.30	.33	.40

5471. **Tube, Connecting,** T shape, of brass.

Size, inches	¼	⅜	½
Each	.30	.33	.40

5473. **Tube, Connecting,** Y shape, of lead, ¼ inch. Each..... $ 22

5474. **Tube, Connecting,** Y shape, of hard rubber, ¼ inch. Each..... 11

Tube, Calcium Chloride, see page 295.

Tube, Combustion, see page 301.

5475. **Tube, Filter.**

Diameter at top, inches...	1⅛	1¼	1½
Each	.22	.27	.35

5477. **Tube, Fractional Distillation** 22

5479. **Tube, Fractional Distillation,** one bulb... 30

5481. **Tube, Fractional Distillation,** two bulbs.. 35



No. 5483.

Tubes, Funnel, see page 309.

Tubes, Gasometer, see page 313.

Tubes, Ignition, see page 331.

Tubes, Reduction, see page 301.

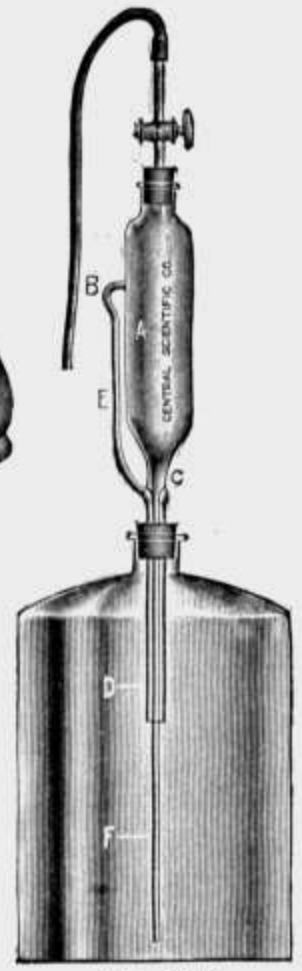
Tubes, Test, see page 331.

Tubes, Weighing, see page 286.

Tubing, Glass, see page 313; **Rubber,** see page 324.

5483. **Tube and Bulb Expander**..... 55

5485. **Dissolving Tube,** after Freas, of the Kent Chemical Laboratory, designed for dissolving solids which are difficultly soluble without the aid of heat or mechanical agitation and filtering the solution at the same time. The crystals are placed in A upon the plug of asbestos or cotton. Suction is applied at B, which is then closed, and a circulation starts upward through D and E down through C and F on account of the different densities of the liquids. This will continue until the entire solution is of the same density. **Without bottle** 4 50



No. 5485.

URINARY ANALYSIS.



No. 5490.



No. 5491.



No. 5492.





No. 5496.

5490. **Albuminometer, Esbach's.** For the quantitative determination of albumin in urine, graduated to read grams of albumin per liter of urine. Complete with directions in wooden case..... $ 65

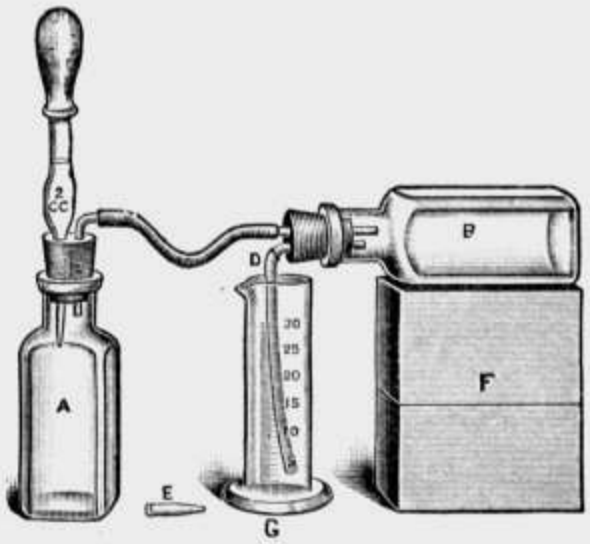
5491. **Horismascope (Albumoscope).** For the detection of albumin in urine with nitric acid. With this instrument the nitric acid comes in contact with the urine in full strength, thus rendering the test much more delicate than ordinarily, 1-60 per cent. of albumin being detectible. Complete with directions for use..... 1 25

5492. **Fermentation Tubes.** Medium size, ungraduated. Each..... 30

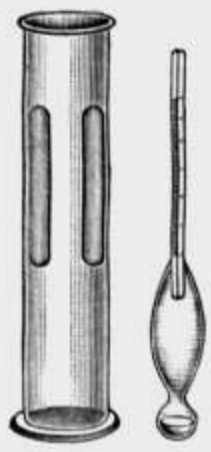
5496. **Saccharometer, Einhorn's Fermentation.** For the estimation of sugar in urine. Consists of a graduated fermentation tube and a graduated test tube. The percentage of sugar is read directly on the tube. 65



No. 5503.



No. 5505.



No. 5507.

Sedimentation Glass, conical, ungraduated, see **Test Glasses.**

5501. **Ureometer, Doremus'.** For the rapid, quantitative determination of urea in urine by the hypobromate method. Consists of a graduated pipette and a fermentation tube graduated to read to 1-10 per cent. Complete with directions for use..... 90

5503. **Ureometer, Doremus',** same as No. 5501, on glass foot..... 1 00

5505. **Ureometer, Squibb's,** for quantitative determination of urea in urine by displacement. Furnished with 50 c. c. bottle of reagent, vials, graduated pipette, graduated cylinder, complete with directions... 3 00

5507. **Urinometer, Squibb's.** For determination of the specific gravity of urine. Graduated from 1.000 to 1.060. Guaranteed accurate for temperatures of 77° F. In case with cylinder and directions, without thermometer 1 00

5509. **Urinometer, Squibb's.** Complete as No. 5507, with thermometer and certificate of corrections..... 1 65

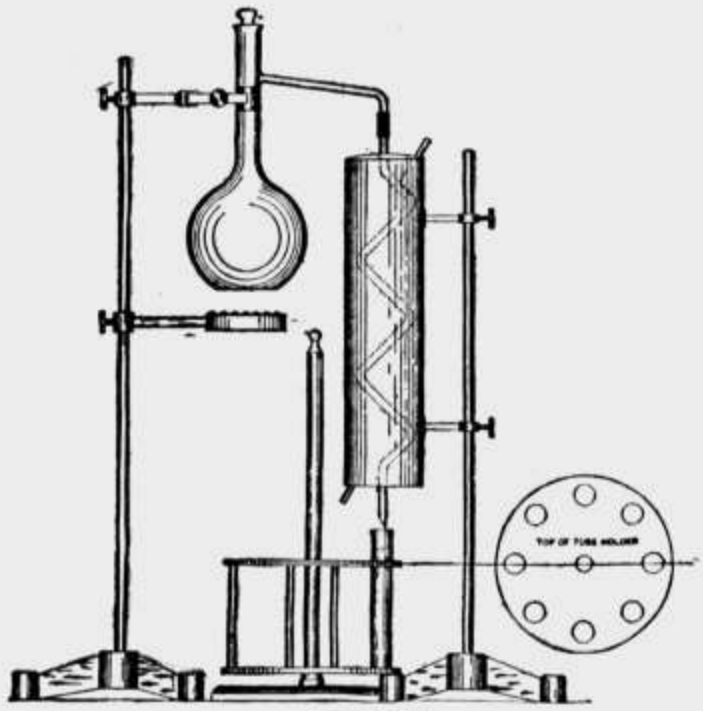
Centrifuges, page 296.



No. 5575.



No. 5585.



No. 5590.

5575. **Vapor Density Apparatus, Victor Meyer's** improved form, complete.. $ 2 50
5576. **Inner Tube** only, for No. 5575..... 1 25
5577. **Outer Tube** only, for No. 5575..... 1 25
5578. **Bottles,** small, glass stoppered, for No. 5575. Per dozen..... 2 25
5585. **Watch Glasses,** best imported glass, well annealed, edges ground, used for covering breakers, etc.

Diameter, inches..	1½	2	2½	3	3½	4	5	6
Per dozen	.22	.30	.60	.83	1.00	1.25	1.65	2.50

5587. **Watch Glasses,** counterpoised, for use on analytical balances; 2, 2½ or 3 inch. Per pair..... 90
Watch Glasses, for staining, see Biological catalogue N.
Watch Glass Clips and Springs, see Clamps, page 299.
5589. **Watch Springs,** for burning in oxygen. Per dozen..... 33
5590. **Water Analysis Apparatus,** for the determination of ammonia in water, as used by the Department of Health of New York City, consisting of a metal condenser with block tin condenser tube and support, eight Nessler cylinders graduated at 50 and 100 c. c. in revolving support, flask, burner and support for same..... 15 00



No. 5591.



No. 5593.

5591. **Water Bath,** polished copper, tin lined, concentric copper rings and cover, handles and steam escape.

Diameter, inches	4	5	6	8
Number of rings.....	3	4	5	6
Each	.95	1.15	1.35	2.25

5593. **Water Bath,** polished copper same as No. 5591, with constant water level.

Diameter, inches	4	5	6	8
Number of rings.....	3	4	5	6
Each	1.50	1.70	1.90	2.80



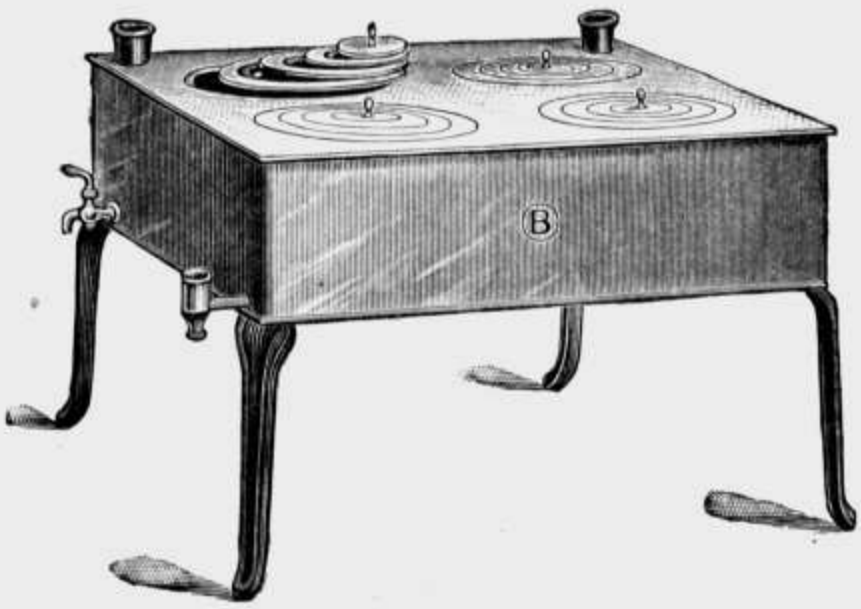
No. 5595.



No. 5596.

5595. **Water Bath,** polished copper, tin lined, with five concentric rings and Kekule's constant water level attachment, on detachable iron support. Adopted by the University of Chicago. Diameter, 6 inches; complete ..... $ 3 85

5596. **Water Bath,** Victor Meyer's, funnel shape, of polished copper, tin lined, with concentric rings, cover and constant water level with tripod 8 inches high. Diameter, 6 inches..... 4 00



No. 5601.



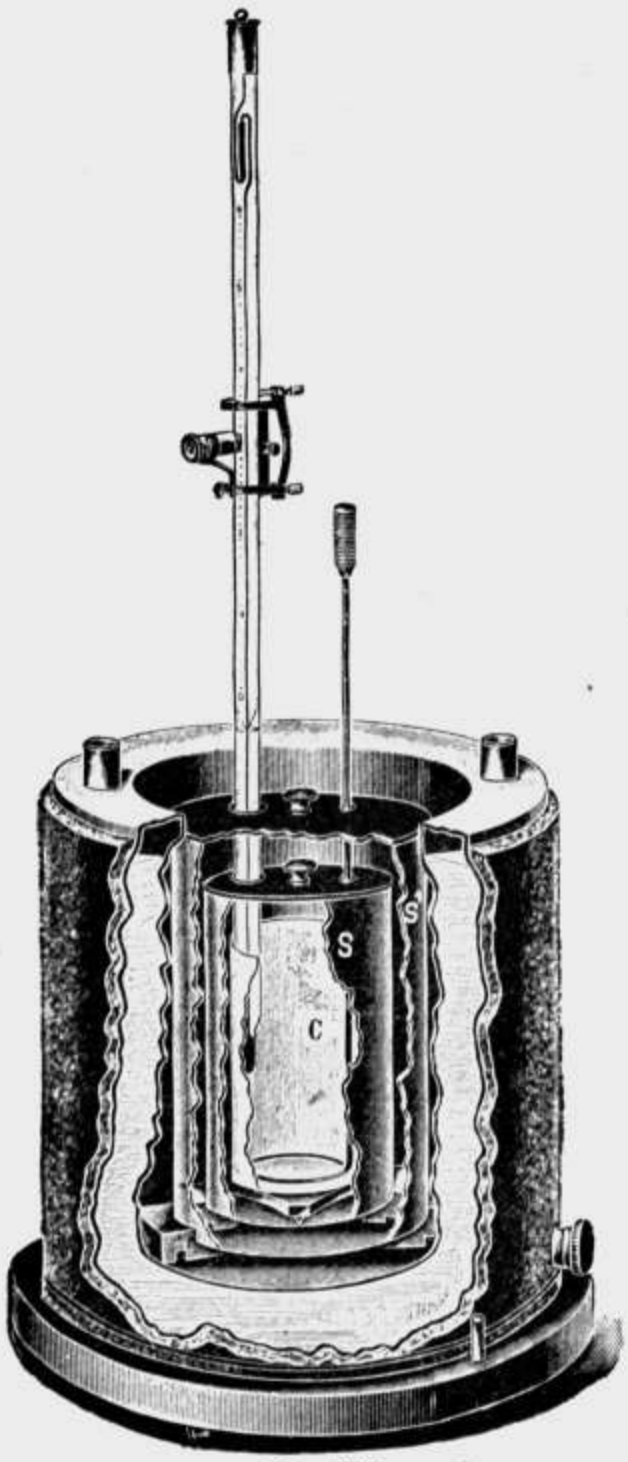
No. 5605.

5601. **Water Bath,** of heavy polished copper, tin lined. Provided with a stop cock to draw off the water and with Kekule's water level regulator with extra sheet iron bottom and supported by four detachable legs, 14 inches square, 5 inches deep, with four openings 5 inches in diameter, with rings and cover..... 13 35

5605. **Water Heater, Instantaneous.** Gives hot water in three seconds after the gas is lighted, and will give sufficient hot water for washing hands in one minute. Illustration shows the heater on No. 4661 burner. Heater complete, without burner..... 4 50

5607. **Water Heater, Instantaneous,** same as No. 5605, with burner..... 6 65

PHYSICAL CHEMISTRY.



No. 5701.

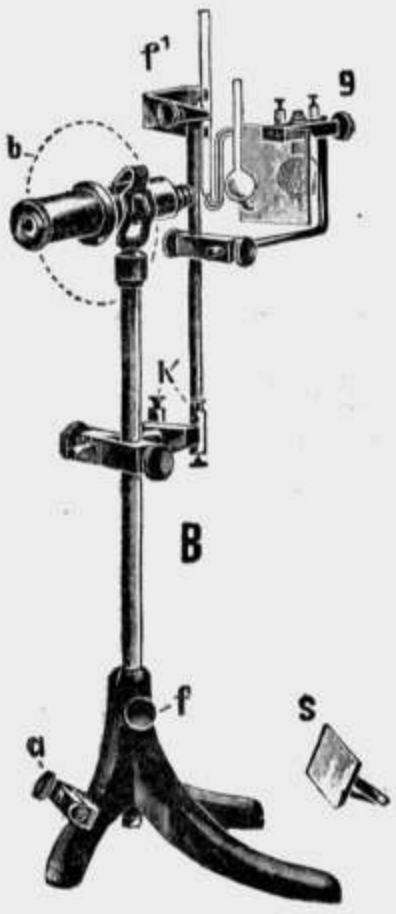


No. 5703.

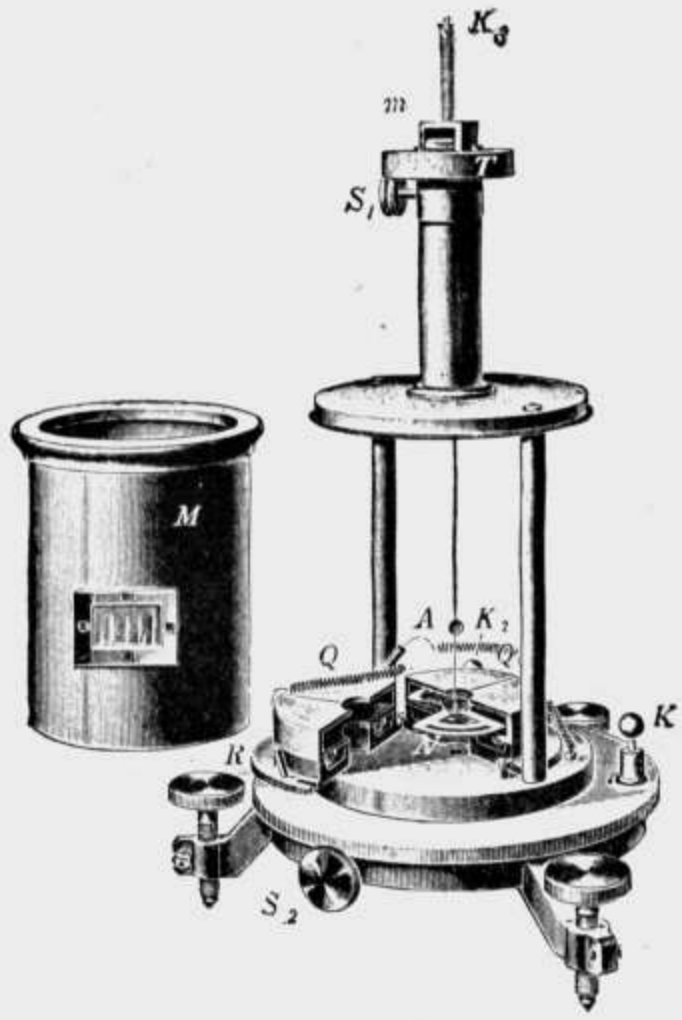
5701. **Calorimeter,** after Ostwald. Consists of Calorimeter C of silver, gold lined inside, capacity 500 cubic centimeters. Enclosing this are two other cylinders insulated from each other and from C. by hard rubber and each provided with hard rubber covers with holes for stirrer and thermometer. The whole is surrounded by water jacket, which in turn is covered with heavy coating of felt. Complete on hard rubber base, stirrer of nickel, but without reading attachment and thermometer.....Duty free $ 40 00

5703. **Mixing Cell** for use with No. 5701 Calorimeter. Consists of Erlenmeyer Flask with insulating handle, supported on hard rubber rest. Inside insulating cylinders, protected by heavy coating of felt. .....,Duty free 9 75

Beckman Thermometer for use with above, see page 346.
Reading Attachment as above illustrated, see No. 5797.



No. 5705.



No. 5707.

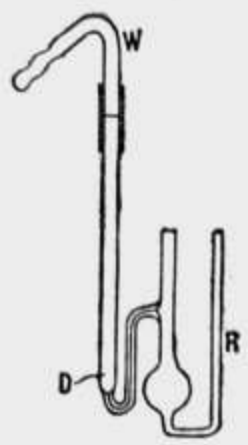
5705. **Capillary Electrometer, Ostwald,** new model. Sensibility about 10 scale divisions for .001 volt. Furnished with universally adjustable mirror, incandescent lamp holder, translucent screen, one four-volt incandescent lamp, one reserve incandescent lamp and two extra capillary tubes and switch for illuminating currents (attached to tripod).

This electrometer is carefully made and completely provided for all adjustments for microscope, tubes and screen. Ocular has micrometer divided into 1-10 m. m.....Duty free $ 14 50

5707. **Thompson's Quadrant Electrometer,** after Dolezalek-Nernst. Sensibility may be varied by interchangeable systems. Lightest system gives 1 m. m. deflection at one meter working distance and 10-5 volt sensibility. Completely aperiodic. Complete with one system.....Duty free 55 00

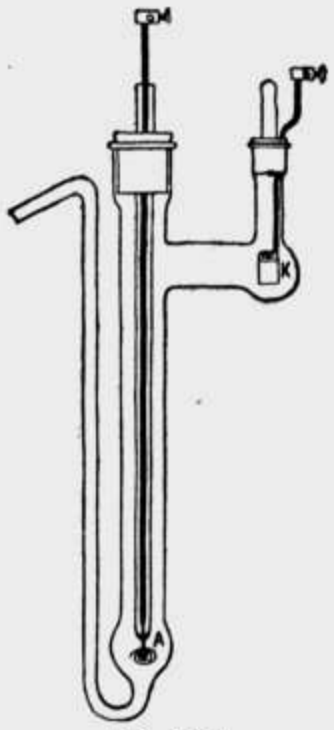
5708. **Additional System for Above,** with attachment for facilitating interchange.....Duty free 13 75

5709. **Capillary Electrometer Tube,** oval form, with sealed in platinum wires.....Duty free 50



No. 5711.

5711. **Capillary Electrometer Tube** with connection tube (W), upright tube (R), and fused in wire (D) .....Duty free 60



No. 5713.

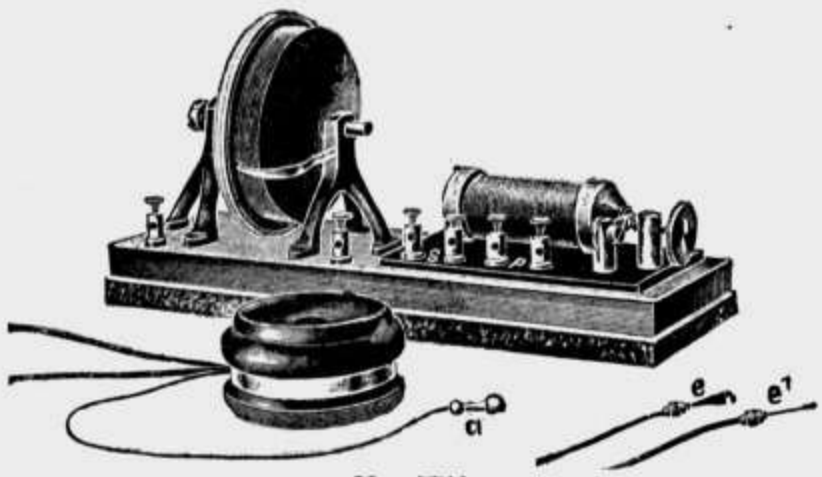


No. 5717.

5713. **Apparatus for Determining the Mobility of Ions in a Silver Salt,** after Loeb and Nernst. Cathode K in the short limb consists of a piece of silver foil connected to the battery wire by a piece of silver wire. The anode A in the long arm consists of a coil of silver wire in form of flat spiral connected to battery by means of platinum wire fused in a capillary tube, which runs entire length of long limb.....Duty free $ 4 00

5715. **Holder** for above, for supporting in thermostat.....Duty free 1 45

5717. **Ionization Cell,** after Smith and Hale. Electrodes consist of two glass rods with platinum wires fused in at bottom. Ends of platinum wires are fastened to side of cell. Battery connection secured by means of copper wires welded to the platinum and running through the glass tubes. Per pair, complete with rubber stoppers and mounted in well paraffined hardwood block..... 4 40

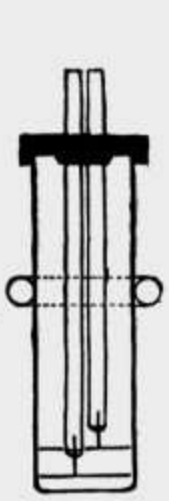


No. 5719.

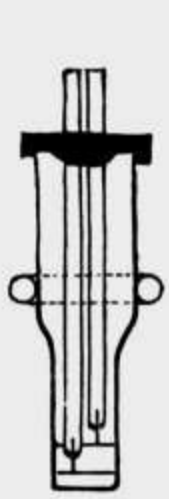
5719. **Inductorium for Conductivity Experiments,** after Ostwald, of superior workmanship. Special device for vibrator to deaden the noise of vibration. Mounted with Kohlrausch spiral bridge on neatly finished hard rubber base. Provided with conveniently placed binding posts for electrical connections. Without receiver.....Duty free 10 00

5721. **Induction Coil,** small, simple form, after Walker..... 4 00

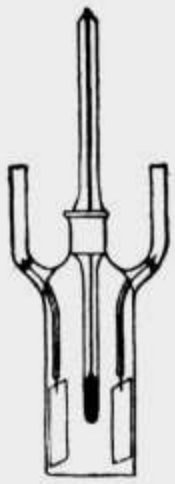
Telephone Receivers, page 173.
Switches, page 200.
Slide Wire Bridge, see No. 2476.



No. 5723.



No. 5725.



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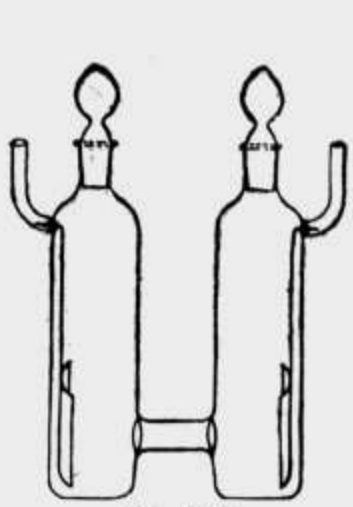


No. 5729.

5723. **Conductivity Cell,** after Ostwald, for poor conducting fluids. Consists of a glass cylinder of Jena glass with hard rubber cap, through which pass two glass tubes with fused in platinum electrodes. .....Duty free $ 7 25

5724. **Reserve Glass Cylinders** for above.....Duty free 45

5725. **Conductivity Cell,** after Arrhenius, for poor conducting fluids, construction similar to No. 5723.....Duty free 13 00

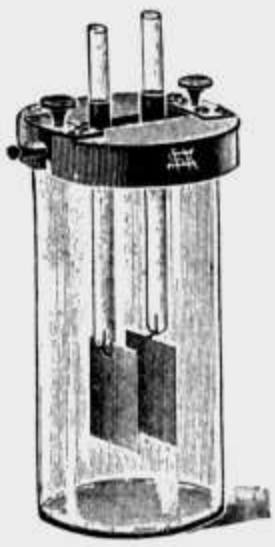
5726. **Reserve Glass Cylinder** for above.....Duty free 40

N. B. Either of above cells may be furnished with ground in glass cap at extra charge to prices above of.....Duty free 3 25

5727. **Conductivity Cell,** after Kohlrausch, for poor conducting fluids. Closed container with fused in electrodes so constructed as to obviate vibrations .....Duty free 12 10

5728. **Conductivity Cell,** same as above, with thermometer.....Duty free 13 70

5729. **Conductivity Cell,** after Kohlrausch, for good conducting fluids. .....Duty free 16 00



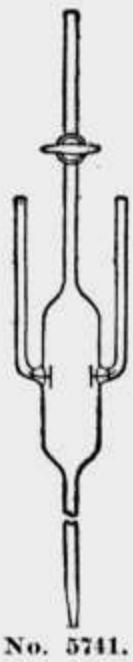
No. 5731.



No. 5737.



No. 5739.



No. 5741.

5731. **Conductivity Cell** of changeable capacity. The vertical electrodes are so supported that the distances apart may be changed....Duty free 16 25

5733. **Conductivity Cell,** same as above, with thermometer.....Duty free 17 50

5735. **Conductivity Cell,** after Kohlrausch, with three glass cells of different cross section, the smallest to hold one cubic centimeter of the fluid to be tested.....Duty free 4 85

5737. **Dipping Electrode** for immersion of poor conductors in fluids to be tested .....Duty free 4 85

5739. **Dipping Electrode,** same as above, for good conductors.....Duty free 4 10

5741. **Pipette Electrode,** for measuring solutions affected by the air and also for measuring aqueous solutions at 100 degrees C. For poor conductors .....Duty free 13 00



No. 5743.



No. 5747.



No. 5749.

5743. **Molecular Weight Determination Apparatus,** freezing method, after Beckman. Complete apparatus consists of Nos. 5744, 5745, 5790 and 5797.

5744. **Freezing Cell** with cover provided with special clips to fasten securely to jar, stirrer for freezing mixture, 4 air jackets, 4 freezing tubes, 3 filling pipettes, 1 "Impfstift," 1 rubber stopper.....Duty free $ 6 00

5745. **Stirrer,** glass stem, with platinum ring.....Duty free, about 7 00

5790. **Beckman Thermometer** (see page 346 for description).....Duty free 6 50

5797. **Reading Attachment for Thermometer** (see page 346 for description) .....Duty free 4 50

5746. **Low Temperature Thermometer,** from —20° to 40° C. in single degrees, with long stem.....Duty free 1 00

5747. **Molecular Weight Determination Apparatus.** This is the latest improved form by Prof. McCoy. Graduated inner vessel and jacket only. Inner vessel makes ground joint connection with the jacket.. 3 00

5749. **Molecular Weight Determination Apparatus,** boiling method, after Beckman (especially for boiling points of about 100 degrees C.) The boiling tube and thermometer, stirrer, cooler, etc., rest upon the asbestos plate, in turn resting upon the iron ring r and held upright by means of the two clamps f and f^1, and all adjustable. Tripod also supports adjustable micro burner. Complete outfit consists of Nos. 5791, 5797, 5750, 5751, 5752 and 5753.

5791. **Beckman Thermometer** (see page 346 for description).....Duty free 6 50

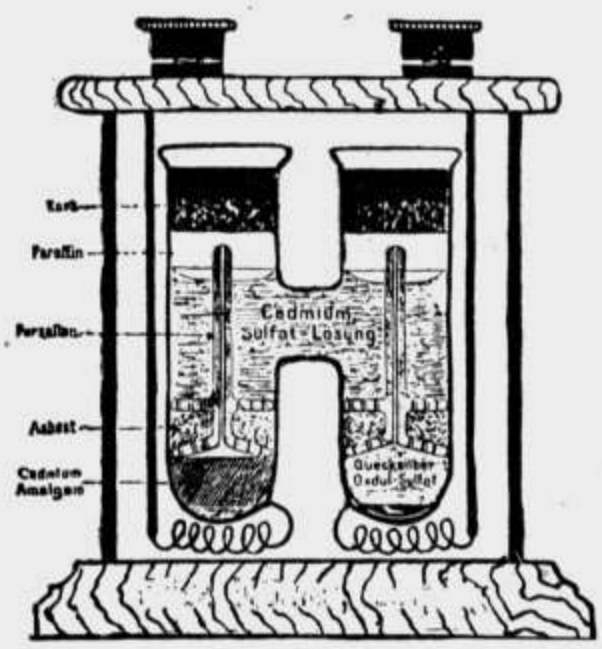
5797. **Reading Attachment** (see page 346 for description).....Duty free 4 50

5750. **Boiling Tube,** with inner cooler and ground in stopper, jacketed cylinder, mica plate and asbestos board.....Duty free 3 50

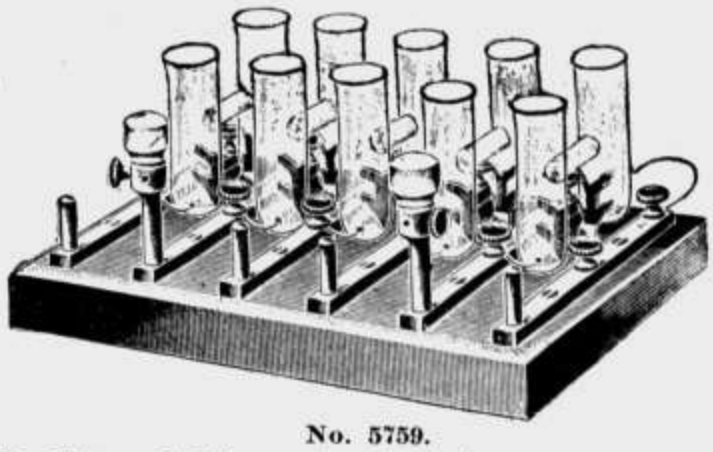
5751. **Platinum "Tetrahedra,"** weight about 5 grams, with equal amount of glass beads.....Duty free, about 6 80

5752. **Support,** for above..... 1 75

5753. **Micro Burner** 3 60



No. 5755.



No. 5759.

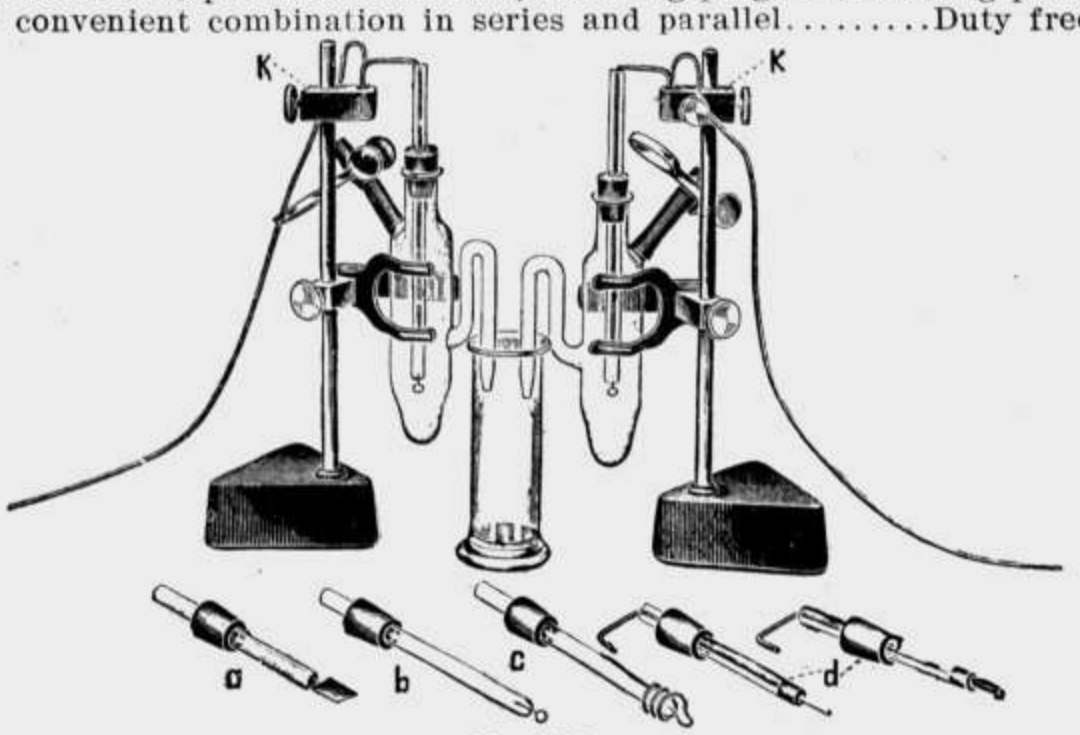
5755. **Normal Element, Cadmium**—portable. Very carefully made and only the purest chemicals used. Internal resistance about 160 ohms, without temperature coefficient.....Duty free $ 18 00

5756. **Normal Element,** same as No. 5755, with Reichsanstalt certificate. .....Duty free 19 50

Note—Nos. 5755 and 5756 Normal Elements should deliver current only for short intervals, and then only through a resistance of at least 50,000 ohms.

2137. **Normal Element,** H form, with two fused in platinum wires, conveniently mounted on support and base with binding screws. (For cut see page 145)..... 1 65

5759. **Battery of five Normal Elements.** Five H cells mounted on supports and base provided with bars, traveling plugs and binding posts for convenient combination in series and parallel.....Duty free 10 50



No. 5761.

5761. **Half Elements.** Cells mounted on movable stands provided with adjustable clamp, insulated binding posts and adjustable mercury well, K, as show in illustration, for connecting electrodes to circuit. With electrodes A to D, inclusive.....Duty free 10 75

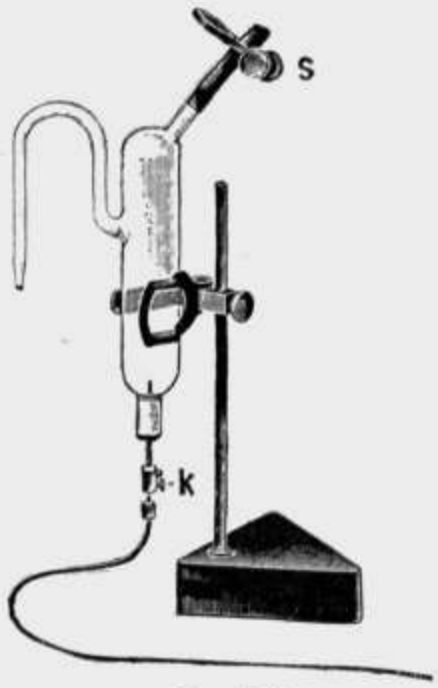
5763. **Half Elements,** with cylinder and stands, but without electrodes of any kind.....Duty free 4 80

5763A. **Platinum Electrodes,** a pair. Complete with rubber stopper. .....Duty free, about 2 75

5763B. **Platinum Electrodes,** a pair made of fused in platinum wire, the ends of which are turned into a ring. Complete with rubber stopper.....Duty free, about 90

5763C. **Silver Electrodes,** set of three. Electrodes are silver spirals connected with fused in platinum wires. Set of three, complete with rubber stoppers .....Duty free, about 3 00

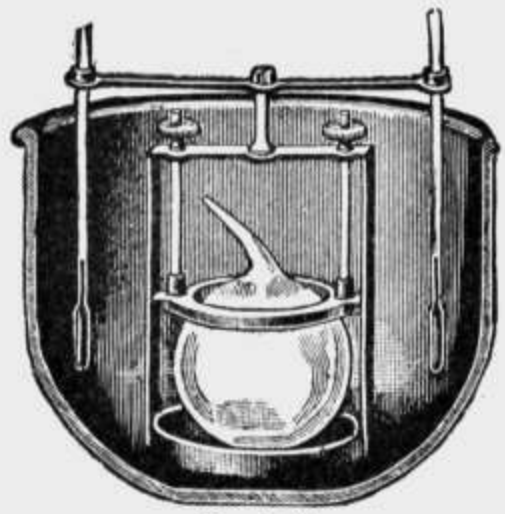
5763D. **Electrodes,** one zinc and one copper electrode, complete with rubber stoppers.....Duty free, about 45



No. 5765.



No. 5767.



No. 5769.

5765. **Calomel Normal Electrode.** Mounted adjustably on stand. With fused in platinum wire and copper rod terminal.....Duty free $ 3 25

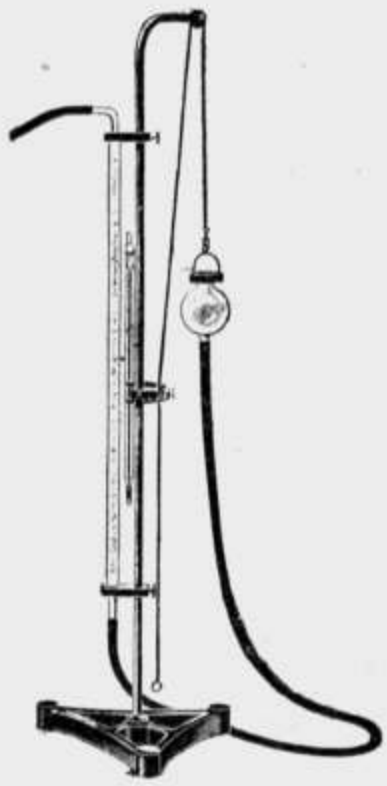
5767. **Tensimeter,** reading accurately in oil to 0.1 m. m. Glass part with manometer and scale.....Duty free 4 50

5769. **Vapor Density Apparatus,** latest modified form, complete as illustrated with bulb support and kettle, but without thermometers..... 16 00

Bulbs only listed under No. 4213.



No. 5575.



No. 5773.



No. 5775.

5575. **Vapor Density Apparatus,** after Victor Meyer. Complete..... 2 50

5576. **Inner Tube** only for No. 5575..... 1 25

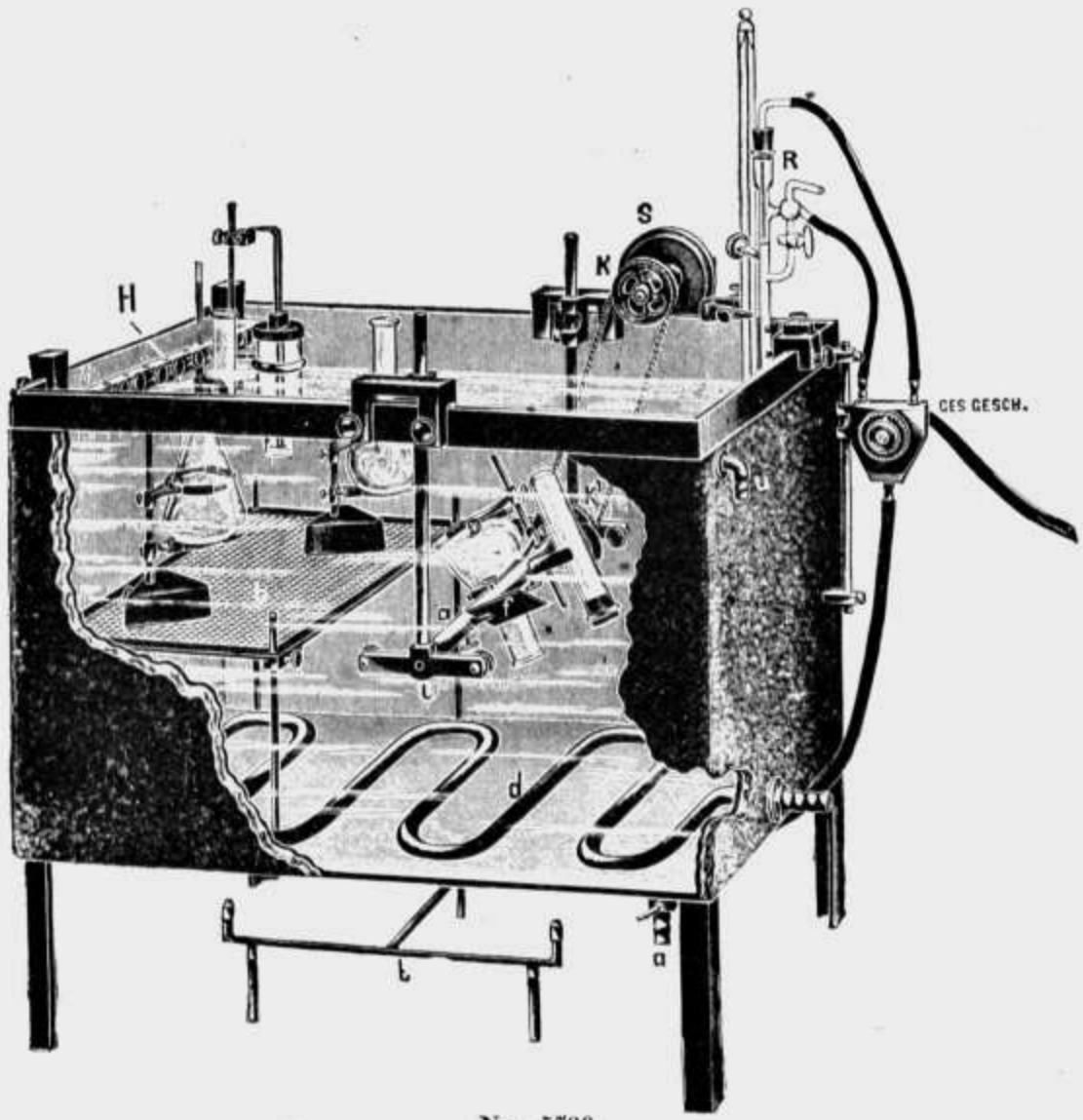
5577. **Outer Bath** only for No. 5575..... 1 25

5771. **Outer Bath** only of copper, McCoy's modification..... 5 50

5578. **Vials,** small, for use with No. 5575. Per dozen..... 2 25

5773. **Gas Measuring Tube and Water Level Attachment,** complete with tripod base and stand, necessary clamps, rubber tubing, etc. .....Duty free 10 00

5775. **Viscosity Pipette,** after Ostwald. Emptied in 80 to 100 seconds. .....Duty free 60



No. 5780.

5777. **Thermostat,** as used in Ostwald's Institute. Temperature range within 0.1° C. Consists of insulated rectangular box of sheet steel 55 c. m. long, 35 c. m. deep and 25 c. m. wide, capacity 58 liters up to overflow. Nickel plated inside and supplied with drainage cock and overflow tube. Furnished complete with axle and bearing, together with transmission pulley, two stirrers, one double burner and thermostat, toluol regulator with holder, two reserve regulators, adjustable nickel plated brass wire shelf, special device H for clamping conductivity cells, jars, etc. Complete chain transmission for use with belt to motor and holder for thermometer, but without any glassware, supporting stands or holders for conductivity cells. Designed for use at room temperature and temperatures up to 100° C. Complete as above.....Duty free $ 48 00

5778. **Thermostat,** same as above. Designed for temperature of tap water and temperature up to 100° C. Tap water is run through the copper tube d as shown in the illustration.....Duty free 55 00

5780. **Thermostat,** for use at room temperature, or with tap water, or with ice water and up to 100° C.....Duty free 58 00

5781. **Universal Holder** (shown holding flasks in illustration), nickel plated brass, spring clamp, all contact points covered with rubber, mounted on substantial foot.....Duty free 1 55

5782. **Universal Holder** (shown holding the flask on axle in illustration), same as No. 5781, without foot.....Duty free 1 25

5783. **Tube Holder** (shown holding test tube on axle in illustration), of nickel plated brass with spring clamp. For use with tubes 5-30 m. m. diameter.....Duty free 50

5785. **Thermostat Thermometer,** 0-60° C., divided to tenths.....Duty free 2 50

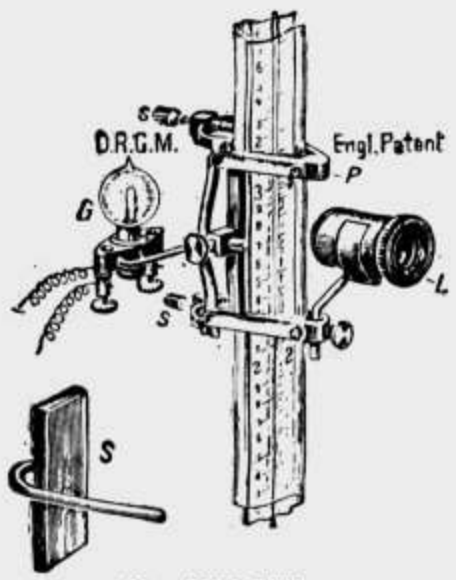
5786. **Thermostat Thermometer,** 50-105° C., divided to tenths.....Duty free 3 25



No. 5790-91.



No. 5792.



No. 5797-5798.

Beckman's Thermometers. These are delicate thermometers, fitted with an auxiliary bulb at the top. By allowing more or less of the mercury to flow into this bulb and then detaching it from the rest of the mercury column, we can so adjust matters that when the bulb is at the freezing point of the solvent being examined, the top of the mercury column is near the top of the thermometer scale. In adjusting the mercury in the thermometer, the bulb of the thermometer is placed in some water heated to a temperature of 1 to 2 degrees above the freezing point of the solvent, and when the thermometer has had time to acquire the temperature of the water the mercury column is caused to break at the top of the bulb by a sudden jerk. The thermometer is then cooled to the melting point of the solvent, and if the end of the mercury column is within about one degree of the top of the scale the adjustment is complete. If not, the operation must be repeated. The mercury in the bulb may be made to join up with the rest of the mercury by heating the bulb till the mercury reaches the top and then inverting the thermometer so that the mercury at the bottom joins on to that at the end of the column.

5790. **Beckman's Thermometer** for freezing point determinations..Duty free $ 6 50

5791. **Beckman's Thermometer** for boiling point determinations...Duty free 6 50

5792. **Beckman's Thermometer,** new form, with Kühn's auxiliary division at the reservoir. This permits any desired interval of temperature to be conveniently and exactly set on any scale divided into 1-100 of a degree. Besides, it can be determined at any time at what degree the thermometer was set when last used, consequently it can at once be seen if mercury must be added to or taken from the reservoir. Duty free 9 50

5794. **Normal Pentane Thermometer,** after the specifications of the German Reichsanstalt, for very low temperatures to —200° C. With milk glass scale .....Duty free 10 50

5795. **Normal Thermometer** for low temperatures, from 10° to —35° C., by 1-10°; 40 centimeters long. With milk glass scale.....Duty free 2 50

5797. **Reading Attachment** for thermometers 6 to 20 m. m. in diameter. All parts adjustable. Complete with clamps, magnifier with cross hair and reflecting mirror for use in daylight.....Duty free 4 50

5798. **Incandescent Lamp** for use as illustrated when light is dim or room is dark. E. M. F. two volts.....Duty free 1 25

N. B.—When desired, we will furnish 4 or 6 volt lamps at same price.

RAW MATERIAL.

The following material has been selected with special reference to the physical laboratory shop. The prices are based on ordinary quantities and include cost of cutting. Special prices will be quoted on large orders.

All prices are subject to market fluctuations.

For convenience in shipping, certain items—rods, tubing, etc.—are cut in about 3 foot lengths, unless specially ordered in longer pieces.

Castings in all metals supplied at market prices.

Comparison Tables, see pages 360-361.

ALUMINUM.

6001. **Aluminum Rod,** full lengths 8 to 10 feet.

Diam., in.	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
Lbs. per ft.	.032	.057	.089	.128	.174	.227	.356	.516	.697	.911
Price per ft.	.06	.07	.10	.14	.20	.27	.44	.60	.75	1.00

6002. **Aluminum Sheet,** full sheets 12 inches wide, 5 to 6 feet long.

Thickness, B. & S., No.	8	12	14	16	18	20	22	24	26	28	30
Lbs. per sq. ft.	1.8	1.13	.89	.71	.56	.45	.36	.28	.23	.18	.14
Price per sq. ft.	2.00	1.25	1.00	.80	.60	.50	.40	.30	.25	.20	.16

6003. **Aluminum Tubing,** seamless. Thickness of Wall, B. & S. gauge, No. 20.

Diameter, outside, 1/4 to 1/2 inch, per foot	$ 40
Diameter, outside, 1/2 to 3/4 inch, per foot	50
Diameter, outside, 3/4 to 1 inch, per foot	60

Aluminum Wire, see page 350.

ASBESTOS.

6008. **Asbestos Cloth,** 25 inches wide, per yard 4 00

6009. **Asbestos Fiber,**

	Common.	Extra Long.
Per pound	.22	1.50

6011. **Asbestos Paper,** 1/32 inch thick, per sheet, 40x40 inches, .33; per lb. 15

6013. **Asbestos Sheet,** full sheets 40x40 inches.

Thickness, inches	1/16	1/8	3/16	1/4
Per sq. ft.	.10	.15	.18	.22
Per sheet	.65	1.30	1.95	2.60

6014. **Asbestos,** cut in squares, 4x4x1/16, per dozen 30

6015. **Asbestos Twine,** 1/8 inch diameter, in pound balls, each 45

6016. **Asbestos Slate,** acid proof, for protecting table tops, etc.; can be cut with ordinary saw. Full sheets measure 42x48 and 42x96 inches.

Thickness, inches	1/8	3/16	1/4	3/8	1/2
Per sheet, 42x48 inches	2.10	2.80	3.50	4.90	6.30
Per sheet, 42x96 inches	4.00	5.50	6.80	9.60	12.20

Note.—Special sizes cut to order, add 2 cents per square foot.

6016A. **Asbestos Slate,** cut 12x12x1/8, superior to asbestos pads, each 22

BRASS.

6017. **Brass Rod,** round, full lengths 12 feet; shipped in 3 foot lengths, or less (see notice above).

Diam., in.	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/2
Lbs. per ft.	.045	.100	.18	.28	.40	.55	.72	1.13	1.63	2.21	2.89	6.51
Price per ft.	.05	.05	.08	.12	.18	.24	.33	.50	.75	.95	1.25	2.90

6018. **Brass Rod,** square, full lengths 10 to 12 feet (see notice above).

Size, inches	1/4	3/8	1/2	5/8	3/4
Lbs. per ft.	.23	.51	.92	1.44	2.07
Price per ft.	.15	.30	.60	.85	1.10

6019. **Brass Sheet,** full sheets 12 inches wide, about 6 feet long.

Thickness B. & S. No.	8	10	12	14	16	18	20	22	24	26	28	30
Lbs. per sq. ft.	5.69	4.51	3.57	2.83	2.25	1.78	1.41	1.12	.89	.70	.55	.44
Price per sq. ft.	1.95	1.65	1.33	1.10	.83	.65	.55	.45	.33	.25	.20	.17

6020. **Brass Strip,** full lengths 10 to 12 feet.

Width, inches	3/8	3/8	1/2	1/2	5/8	5/8	1	1
Thickness, inches	1/16	1/8	1/16	1/8	1/8	3/16	3/16	1/4
Lbs. per ft.	.085	.17	.115	.23	.29	.435	.69	.92
Price per ft.	.07	.11	.11	.15	.20	.28	.35	.60

6021. **Brass Tubing,** brazed, full lengths 12 feet; price per foot:

	Diameter, Outside, Inches													
	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	1 3/4	2
Wall, B. & S.														
No. 12	...	...	...	...	...	...	...	...	...	.55	.70	.85	1.00	1.15
No. 14	...	...	...	...	...	.25	.30	.35	.40	.50	.60	.70	.85	1.00
No. 16	...	...	...	...	.16	.21	.25	.30	.35	.40	.50	.55	.65	.80
No. 18	...	...	.12	.11	.13	.17	.20	.25	.30	.35	.40	.45	.50	.60
No. 20	.10	.11	.11	.10	...	...	...	...	...	...	...	...	...	...

Brass Wire, 1/16 inch and smaller, see page 350.

Brass Balls, see page 55.

CARBON.

6023. **Carbon, Granulated,** for experimental purposes, per lb..... $ .20

6025. **Carbon Rods,** plain, 12 inches long.

Diam., inches	1/8	3/16	1/4	3/8	1/2	5/8
Each	.10	.10	.10	.11	.11	.12

Carbons, for arc lamps, see page 250.

6027. **Carbon Sheet,** full sheets 12x12 inches.

Thickness, inches	1/8	3/16	1/4	5/16	3/8	1/2
Price, per sheet	1.40	1.50	1.65	1.75	1.85	2.00

Special sizes, cut to order, quoted on application.

Carbons, for batteries, see pages 142-147.

COPPER.

6028. **Copper Rods,** full lengths, 10 to 12 feet.

Diam., inches	1/8	3/16	1/4	3/8	1/2	5/8	3/4	1
Lbs. per ft	.047	.106	.189	.426	.757	1.18	1.70	3.03
Price per ft	.05	.09	.16	.35	.60	1.00	1.40	2.50

6029. **Copper Sheet,** plain, full sheets, 30x60 inches.

Thickness, B. & S. No.	14	16	18	20	22	24	26	28	30
Lbs. per sq. ft.	2.90	2.30	1.83	1.45	1.15	.91	.72	.57	.46
Price per sq. ft.	2.50	2.00	1.60	1.25	1.00	.75	.60	.50	.40

6032. **Copper Sheet, Foil,** No. 30 B. & S., per sq. ft., .55; No. 36, per sq. ft.. .50

6033. **Copper Tubing,** 1/16 inch wall.

Diameter, outside, inches	1/4	3/8	1/2
Price per foot	.27	.27	.30

Copper Balls, see page 55.

Copper Wire, see page 350.

FERROTYPE.

6035. **Ferrotype,** plates 10x14 inches, each..... .50

FIBER.

6037. **Fiber Rod,** black, full lengths, about 30 inches.

Diam., inches	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
Price per foot	.17	.17	.17	.18	.20	.30	.40	.55	.83

6039. **Fiber Sheet,** black, full sheets, about 24x34 inches.

Thickness, inches	1/8	3/16	1/4	5/16	3/8	1/2
Price per sq. ft.	.35	.85	1.15	1.45	1.70	2.30

6041. **Fiber Tubing,** black, thickness of wall, 1/16 inch; full length, 2 to 3 feet.

Diam., inside, inches	1/4	3/8	1/2	5/8	3/4	1
Price per ft	.20	.22	.24	.28	.32	.40

IRON.

6043. **Iron Rod,** Norway, soft, for electro-magnets.

Diam., inches	1/4	3/8	1/2	5/8	3/4	1
Lbs. per ft	.16	.37	.67	1.04	1.51	2.68
Price per ft	.05	.05	.08	.13	.20	.36

6044. **Iron Sheet,** tinned. Common tin plate, size 20x28 inches.

No	1C	X	XX	XXX
Thickness B. & S. No	28	26	25	24
Price per sheet	.30	.33	.37	.42

6045. **Iron, Sheet,** Russia, .021 inch thick, per square foot..... 16

Iron Balls, see page 55.

Iron Wire, see page 351.

LEAD.

6047. **Lead Sheet.**

Thickness, inches	1-64	1/32	1/16	1/8	3/16	1/4
Lbs. per sq. ft.	1	2	4	8	12	16
Price per sq. ft.	.27	.33	.66	1.33	2.00	2.65

6048. **Lead Tubing,** medium size wall.

Diam., inside, inches	1/4	3/8	1/2	5/8	3/4
Lbs. per ft	.375	1.0	1.25	2.0	2.25
Price per ft	.10	.16	.20	.33	.38

Lead Shot, see page 119.

Lead Wire, see page 351.

MICA.

6050. **Mica Sheet.**

Size, inches	2x4½	4x5	4x6	5x8
Price per sheet	.06	.09	.15	.16

NICKEL ALLOY.

Nickel-Steel Rod, see No. 1566.

PHOSPHOR BRONZE.

6051. **Phosphor Bronze Sheet,** full sheets, 6 inches wide, 4 to 6 feet long.

Thickness, B. & S. No.	22	24	26	30
Price per sq. ft.	1.35	1.00	.90	.80

Phosphor Bronze Ribbon, for galvanometer suspensions, see page 182.

PLATINUM.

Platinum Sheet and Wire, see page 321.

RUBBER.

6052. **Rubber Rod,** hard polished, full lengths, 30 inches.

Diam., in.	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
Lbs. per ft.	.015	.027	.04	.063	.08	.10	.16	.23	.29	.42
Price per ft.	.09	.12	.17	.30	.32	.38	.55	.80	1.00	1.50

6055. **Rubber Sheet,** hard, polished, full sheets, 20x48 inches.

Thickness, inches	1/16	1/8	3/16	1/4	5/16	3/8	1/2
Lbs. per sq. ft.	.38	.76	1.14	1.52	1.90	2.28	3.04
Price per sq. ft.	.85	1.65	2.50	3.40	4.25	5.05	6.75

Rubber Sheet, soft, see page 324.

6057. **Rubber Tubing,** hard, not polished, 1/8 inch wall.

Diameter, outside, inches	3/8	1/2	5/8	3/4
Price per ft.	.11	.16	.22	.27

Rubber Tubing, soft, see page 324.

STEEL.

6058. **Steel Rod, Bessemer,** 4 foot lengths.

Diam., inches	1/8	3/16	1/4	5/16	3/8	7/16	1/2
Lbs. per ft.	.05	.10	.17	.27	.39	.52	.67
Price per ft.	.05	.05	.05	.10	.10	.10	.11

6059. **Steel, Drill Rod,** high tempered, for tool making.

Diam., inches	1/8 to 3/16	1/4 to 7/16	1/2 to 3/4
Price per ft.	.27	.55	1.00

6060. **Steel, Magnet,** round and square, imported, best grade.

Size, inches	1/4	3/8	1/2	5/8	3/4
6060A. Round, per ft.	.27	.40	.75	1.00	1.50
6060B. Square, per ft.	.40	.50	1.00	1.35	2.00

Hardening and magnetizing quoted upon application.

6062A. **Steel,** cold rolled, round, 8 to 10 feet, full lengths.

Size, inches	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
Lbs. per ft.	.17	.27	.39	.67	1.1	1.5	2.1	2.7
Price per ft.	.05	.10	.10	.11	.13	.20	.27	.33

6062B. **Steel,** cold rolled, square, 8 to 10 feet, full lengths.

Size, inches	1/4	3/8	1/2	3/4	1
Lbs. per ft.	.213	.478	.851	1.94	3.4
Price per ft.	.06	.11	.13	.25	.38

6062C. **Steel,** cold rolled, rectangular, 6 to 8 feet, full lengths.

Size, inches	1/16x1/2	1/8x1/2	1/4x1	1/2x3/4	3/4x1
Lbs. per ft.	.106	.212	.85	1.28	2.55
Price per ft.	.05	.08	.13	.17	.30

Steel Balls, see page 55.

Steel Wire, see page 351.

Steel Ribbon, for suspension, see page 182.

TIN.

Tin, Sheet, see **Iron Sheet,** tinned.

6064. **Tin, Sheet,** pure block tin, 12 inches wide, per square foot ..... $ 1 00

6065. **Tin,** pure block tubing.

Diameter, inside, inches	3/16	1/4	5/16	3/8	1/2	3/4
Lbs. per ft.	.25	.31	.375	.50	.50	.75
Price per ft.	.25	.30	.38	.50	.50	.75

Tin Foil, see page 138.

ZINC.

6067. **Zinc, Foil.** B. & S. gauge No. 30. Per square foot ..... .11

6068. **Zinc, Sheet.**

Thickness, inches	1/32	1/16	1/8	3/16	1/4	5/16
Lbs. per sq. ft.	1.15	2.30	4.60	6.90	9.20	11.50
Price per sq. ft.	.23	.46	.92	1.38	1.84	2.30

Zinc Wire, see page 351.

WIRE.

6101. **Aluminum Wire,** bare.

B. & S. gauge No...	14	16	18	20	22	24	26	27	28	30	36
Per 1 oz. spool.....	...	...	...	...	...	...	...	...	.50	.66	.85
Per 4 oz. spool.....	...	...	...	...	...	.80	1.10	1.15	1.25	1.60	...
Per 1 lb. spool.....	.85	.85	1.00	1.00	1.20	2.30	...	...	...	...	...

6103. **Annunciator Wire,** copper wire, double cotton covered and paraffined; assorted colors—blue, red, yellow and variegated; blue furnished unless otherwise specified.

B. & S. gauge No.....	14	16	18	20	22	24
Feet per pound.....	65	106	157	230	350	580
Price per pound.....	.56	.64	.64	.72	.80	.88

6105. **Brass Spring Wire,** on 4 ounce spools.

Stubbs gauge No.....	16	18	20	22	24	26	27	28	30
Feet per spool.....	20	33	68	108	170	270	340	430	550
Price per spool.....	.20	.20	.20	.22	.27	.30	.33	.33	.35

6106. **Copper Wire,** soft, bare, on 4 ounce spools.

Stubbs gauge No.....	16	18	20	22	24	26	27	28	30
Feet per spool.....	20	32	66	102	160	260	325	410	510
Price per spool.....	.20	.20	.20	.22	.27	.30	.33	.33	.35

6106A. **Copper Wire,** soft, bare, on 1 pound spools.

Stubbs gauge No.....	16	18	20	22	24	26	27	28	30
Price per spool.....	.45	.45	.45	.50	.55	.60	.65	.70	.80

6107. **Copper Magnet Wire.**

	B. & S. Gauge No.....	10	12	14	16	18	20	22	24	26	27	28	30	32	34	36	40
BARE	Per 1 oz. spool.....												.18	.20	.22	.25	Single Silk Only
	Per 4 oz. spool.....											.25	.27	.30	.33	.35	
	Per 8 oz. spool.....										.30	.35	.40	.45	.50	.50	
	Per 1 lb. spool.....	.45	.45	.45	.50	.50	.50	.55	.55	.55	.55	.60	.70	.75	.80	.85	
D. C. C.	Per 1 oz. spool.....									.24	.26	.28	.30	.33	.40	.50	
	Per 4 oz. spool.....						.35	.39	.42	.48	.52	.55	.63	.72	.90	1.20	
	Per 8 oz. spool.....					.45	.50	.60	.65	.75	.85	.90	1.00	1.20	1.50	2.00	
	Per 1 lb. spool.....	.55	.60	.65	.68	.72	.77	.90	1.00	1.25	1.32	1.44	1.70	1.97	2.64	3.60	
D. S. C.	Per 1 oz. spool.....									.30	.32	.35	.44	.55	.70	.85	1.60
	Per 4 oz. spool.....						.50	.52	.56	.68	.74	.80	1.10	1.40	1.85	2.35	
	Per 8 oz. spool.....					.72	.75	.78	.87	1.05	1.15	1.30	1.75	2.20	3.00	3.65	
	Per 1 lb. spool.....				1.10	1.15	1.25	1.30	1.46	1.80	2.00	2.20	3.08	4.08	5.52	6.72	

6108. **Fuse Wire.**

Amperes.....	½	1	2	3	5	6	10	12	15
Size of spools.....	2 oz.	4 oz.	8 oz.	8 oz.	1 lb.	1 lb.	1 lb.	1 lb.	1 lb.
Feet per spool.....	200	250	340	220	168	145	82	66	53
Price per spool.....	.65	.35	.70	.70	1.35	1.10	1.10	1.10	1.10

6109. **German Silver Wire,** 18% alloy, on 4 ounce spools.

Stubbs gauge No.....	16	18	20	22	24	26	27	28	30
Feet per spool.....	20	33	68	108	170	270	340	430	550
Price per spool.....	.33	.33	.35	.40	.44	.48	.50	.55	.60

6110. **German Silver Resistance Wire,** 18% alloy.

	B. & S. Gauge No.....	16	18	20	22	24	26	27	28	30	32	34	36
Bare	Per 8 oz. spool.....		.50	.55	.60	.65	.70	.80	.90	1.00			1.75
	Per 1 lb. spool.....	.85	.90	1.00	1.10	1.15	1.30	1.40	1.50	1.80			3.00
D. C. C.	Per 1 oz. spool.....						.35	.40	.45	.50	.55	.65	.90
	Per 4 oz. spool.....			.78	.80	.85	.95	1.05	1.20	1.30	1.45	1.80	2.45
	Per 8 oz. spool.....		1.10	1.20	1.30	1.40	1.60	1.75	1.90	2.05	2.35	2.90	4.00
	Per 1 lb. spool.....	1.50	1.60	1.70	1.80	2.00	2.40	2.50	2.70	3.00	3.50	4.35	6.20
D. S. C.	Per 1 oz. spool.....						.50	.55	.60	.70	.80	.95	1.45
	Per 4 oz. spool.....			.95	1.05	1.20	1.40	1.50	1.60	1.95	2.40	3.00	4.20
	Per 8 oz. spool.....		1.45	1.50	1.65	1.95	2.20	2.35	2.60	3.15	4.00	5.10	7.00
	Per 1 lb. spool.....	2.25	2.30	2.35	2.60	3.00	3.50	3.75	4.00	5.00	6.35	8.00	11.20

Tables of Different Wire Gauges on page 361.

6111. **Gutta Percha Covered Copper Wire.**

B. & S. gauge No.	12	14	16
Price per ft.	.05	.04	.03

Iron Wire, see No. 6131 Annealed Steel Wire.

6115. **Lamp Cord,** composed of fine wires insulated with rubber and braided cotton; two conductors twisted.

B. & S. No.	16	18	20	22
Price per yard	.25	.22	.22	.22

6119. **Lead Wire,** diameter ⅛ inch, per foot ..... $ 06

6121. **Magnesium Wire,** in 1 ounce rolls, approximately 150 feet to the ounce; per ounce 80

6123. **Manganin Resistance Wire.** This is an imported wire and is an alloy of mangan, nickel and copper. It is recommended by the "Physikalisch Technischen Reichsanstalt" as the best wire on the market for high grade measuring instruments. Temperature coefficient is .00001. Nos. 18 and 20 are double cotton covered. The remaining numbers are double silk covered.

B. & S. No.	18	20	22	24	26	28	30	32	36	38
Price per lb.	3.00	3.30	4.80	5.20	6.60	7.30	9.50	....	....	....
Price per oz.	.40	.50	.60	.70	.80	.90	1.00	1.25	1.65	2.15

6124. **Nickel Wire,** pure.

B. & S. No.	16	24	28
Price per oz.	.22	.27	.33

6125. **Piano Wire,** on spools.

Music gauge No.	00	0	1	2	3	4	5	6	7	8
Nearest B. & S. No.	32	31	30	29	28	28	27	26	25	24
Approx. feet on spool	15	15	14	12	12	12	10	10	8	8
Price per spool	.07	.07	.06	.06	.06	.06	.06	.06	.06	.06

6126. **Piano Wire,** best imported steel piano wire, in ¼ pound rolls.

Music gauge No.	1	2	4	5	6	7	8	9
Nearest B. & S. No.	30	29	28	27	26	25	24	23
Price per ¼ lb. roll	1.65	1.50	1.00	.80	.80	.80	.50	.50
Music gauge No.			10	11	14	18	23	26
Nearest B. & S. No.			22	21	20	18	16	14
Price per ¼ lb. roll			.50	.40	.40	.40	.40	.40

6127. **Picture Wire,** steel. No. 0 1 2

Per package of 15 yards ..... .10 .11 .12

Platinum Wire, see page 321.

6129. **Platinoid Resistance Wire,** bare, temperature coefficient .000286.

B. & S. No.	20	24	28	30
Price per oz.	.45	.50	.55	.60

6131. **Steel Wire,** annealed, soft, on 4 ounce spools.

Stubbs gauge No.	16	18	20	22	24	26	27	28	30
Price per spool	.13	.14	.15	.16	.16	.17	.18	.19	.20

6132. **Tinsel Wire,** not insulated, per yard 11

6134. **Tinsel Wire, Conducting Cord.** One conductor. Tinsel wire covered with red or green twisted braid, per yard 10

6135. **Tinsel Wire, Conducting Cord.** Two conductors. One covered with blue and the other with red; the whole covered with blue and red worsted braid, per yard 16

6137. **Zinc Wire,** diameter ⅛ inch, per foot 06

6140. **Black Enameled Magnet Wire.** The enamel insulation is an elastic yet resistant and firmly adhering film. This insulation is exceedingly inert toward the ordinary agencies met in practice, which cause silk or cotton insulation to rapidly deteriorate and lose their value as insulating mediums. Impervious to moisture. Requires less winding space. Positive dialectric strength. More feet to the pound.

B. & S. No.	26	28	30	36	40
Feet per oz.	80	128	200	800	2000
Price per oz.	.33	.40	.50	.90	1.95

Comparison Tables, pages 360-361.

MISCELLANEOUS SUPPLIES.

6201. **Asbestos Plates or Pads,** iron bound edges, diameter 8 inches, each.... $ 06

Blue Print Paper, see Paper.

Brushes, camel's hair, page 289.

Brushes, lacquer, see below.

6203. **Blocks,** hardwood, sandpapered, for blocking up apparatus, etc.

Size, inches	1/8x4x4	1/4x4x4	1/2x4x4	3/4x4x4
Each	.10	.10	.10	.10
Size, inches	1x4x4	2x4x4	3x4x4	4x4x4
Each	.12	.15	.20	.25

6205. **Cheese Cloth,** best quality, per yard..... 09

6207. **Clay Pipes,** per dozen..... 16

Candles, see page 228.

6209. **Chamois Skins,** for cleaning instruments, etc.

Size, inches	6x8	9x11	10x13	14x18
Each	.11	.17	.27	.45

6211. **Chimneys,** student's lamp, per dozen..... 75

6213. **Chimneys,** Argand, straight, 2x7, per dozen..... 75

6215. **Cloth,** emery. All numbers, per sheet, .06; per quire..... 1 20

6217. **Cloth,** Turkey red, per yard..... 16

6219. **Cord.** Mason's chalk line, 1/16 inch, per hank of 20 feet..... 06

6221. **Cord.** Clothes line, No. 8, per 100 feet..... 1 10

6223. **Cord.** Window cord, per 100 feet..... 1 20

6225. **Cord.** White cotton cord, 1/8 inch, per hank of 50 feet..... 27

6227. **Flannel.** Best woolen flannel, per yard..... 80

6229. **Flannel.** Best cotton flannel, per yard..... 20

Fish Line, see page 59.

6239. **Foil,** silver, per book..... 20

For **Aluminum Leaf, Gold Leaf** and **Dutch Metal,** see page 138.

6241. **Glue,** LePage's.

	Bottle		Can			
Size	Small.	Large.	2 oz.	4 oz.	8 oz.	1 lb.
Each	.15	.20	.20	.30	.40	.65

6243. **Glue,** marine, waterproof, for projection cells, etc., per ounce bottle.. 27

6245. **Lava Tips,** 4 foot, per dozen..... 20

Leaf, see Foil, above.

6247. **Library Paste,** Sanford's best.

Style	Large Collapsible Tube.	4 Oz. Screw Cap Jar.
Each	.15	.17

6249. **Lacquer,** colorless, for preserving polished metal surfaces, per ounce bottle..... 35

6251. **Lacquer,** gold, per ounce bottle..... 45

6253. **Lacquer Brush,** best camel's hair, 1/2 inch wide..... 20

6255. **Mailing Tubes,** heavy pasteboard, 1 1/2x12 inches, per dozen..... 20

6256. **Matches, Swedish Safety,** in cartons of 12 boxes, per carton..... 11

6261. **Paper,** blue print, 30 inches wide, per 10 yard roll..... 1 10

6263. **Paper,** blue print, in light-proof packages of 24 sheets.

Size, inches	4x5	5x7	5x8	8x10
Per package	.25	.40	.45	.85

6265. **Paper, emery.** All numbers, per quire..... 45

Paper, glazed, see page 319.

6267. **Paper,** paraffine, per quire..... 11

Paper, parchment, see page 106.

6271. **Paper,** sand. All numbers, per quire..... 30

MISCELLANEOUS SUPPLIES—Concluded.

6272. **Rubber Bands,** assorted, in ¼ pound boxes..... $ 85
6273. **Rubber Cement,** for cementing rubber joints, rubber, etc., per ounce bottle..... 15
6275. **Sealing Wax,** best red, four sticks to the pound, per pound..... 44
Shot, see page 119.
6279. **Silk,** best quality heavy black silk, per yard..... 1 00
6281. **Silk,** good quality of same, per yard..... 65
6282. **Silk, Oiled,** per sheet 12x14 inches, in box..... 35
Solder, see page 41.
6289. **Splints,** 100 in package, per package..... 06
6291. **Sponges,** for cleaning purposes, 16 to a pound, per pound..... 1 95
6293. **Tags, Brass,** ¾ inch diameter, numbered, per dozen..... 60
6295. **Thread,** white cotton, No. 70, per dozen..... 75
6296. **Thread,** black silk, per spool..... 08
6297. **Thread,** black linen (200 yards), per spool..... 12
6299. **Wax Tapers,** per box..... 11
6300. **First Aid Cabinet.** A neat hardwood case, 8x12x3¼ inches deep, containing the following:

1 Gauze Bandage, 1 inch.
2 Gauze Bandages, 2 inch.
1 Cotton Bandage, 2 inch.
1 can Mustard (specially prepared for emetics).
2 packages Absorbent Cotton.
1 package Styptic Gauze (medicated, to stop bleeding).
1 package Surgical Gauze (plain, for pads and compresses).
1 Tourniquet (to stop arterial bleeding).
1 can Powdered Antiseptic Soap (for washing hands and wounds).
1 can Recrosco Ointment (for burns, scalds, cuts, etc.).
1 can Kapsikar Embrocation (for use as counter-irritant, for sprains, strains, congestion, etc.)
1 package Court Plaster.
3 Safety Pins.
1 envelope Hooks and Eyes (to hang case on wall).

An excellent cabinet to have about the laboratory for treating cuts and burns.....Net 2 50

MINERAL COLLECTIONS.

These collections are imported from Dr. F. Krantz, the well known mineral dealer of Bonn, Germany, and are furnished in wooden cases with covers, each specimen being in a paper box with a label giving the name and locality. List of minerals in each set furnished upon request.

6502. **Mineral Collection,** consisting of 100 specimens 5x6 c. m..... $ 27 50
6504. **Mineral Collection,** consisting of 100 specimens 3x4 c. m..... 16 65
6506. **Mineral Collection,** same as No. 6504, but in pasteboard box instead of wooden box..... 13 00
6507. **Washington School Collection.** Contains 20 minerals and 20 rocks, good size, each labeled and placed in a separate tray. The whole in a neat cloth covered case with descriptive catalogue and a set of unlabeled duplicates (Set No. 6508) for student..... 2 50
6508. **Student's Collection,** consisting of smaller duplicate unlabeled specimens of Set No. 6507 for student classification..... 45

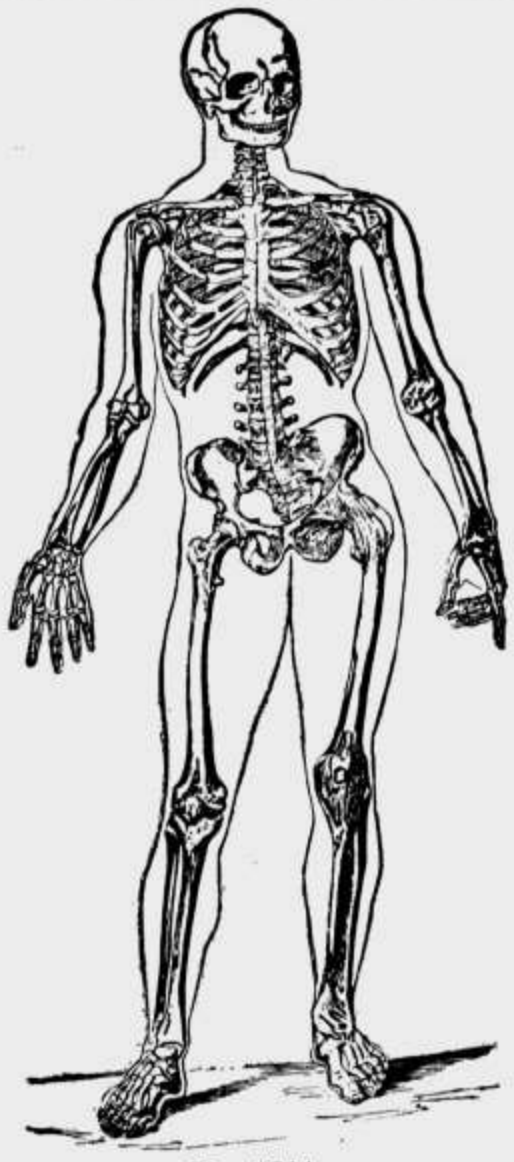
Collections to Illustrate Physical Mineralogy; structure and form, cleavage, fracture, tenacity, hardness, density, luster, color and fusibility. Prices furnished upon application.

Blowpipe Minerals listed on page 283.

See also **Pound List of Rocks and Minerals** in Catalogue R.

Rocks, Minerals, Soils, etc., and **Mineral Sets** are also listed in Catalogue X of Physiography Apparatus and Supplies.

6601. Numbers in the 6600 and 6700 series will be found on pages 273 to 275.



No. 6801.

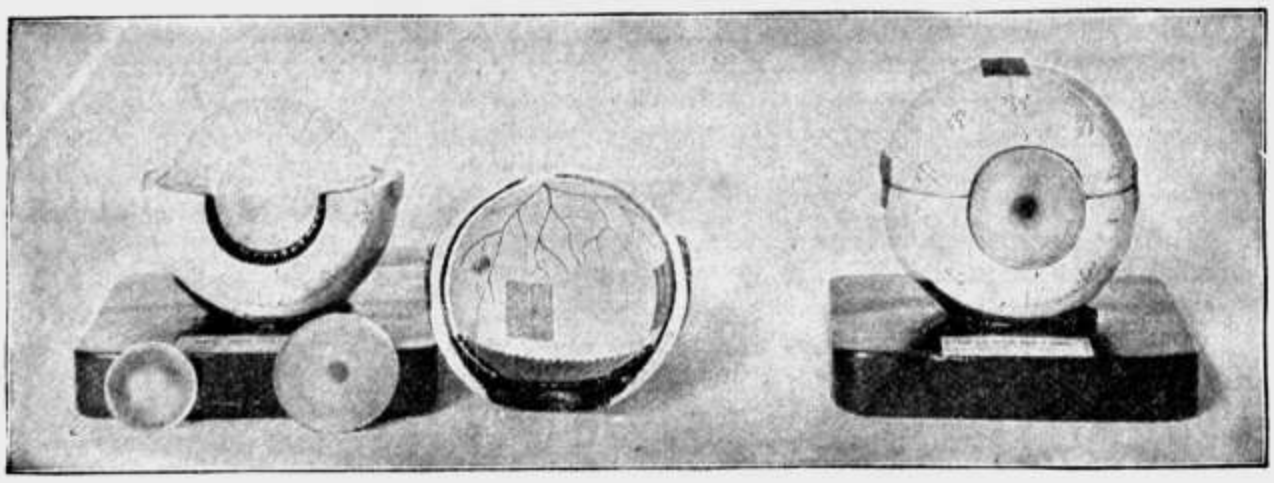
6801. **Human Skeleton.** Best grade, carefully selected, finely developed, perfectly cleansed and prepared, substantially articulated, with ring for suspension at top..... $ 43 00

6805. **Case for Skeleton.** Finely finished hardwood, glass door and sides, lock and key 22 00

ANATOMICAL MODELS.

The unsurpassed usefulness of these models as a means of instruction in Anatomy and Physiology has been universally acknowledged. They are made of a hard composition, after the models of Dr. Bock and other physiologists, are mounted on stands and **painted in natural colors.**

EACH MODEL PACKED IN A SEPARATE BOX.



No. 6808.

Price list on next page.

ANATOMICAL MODELS—Continued.

PRICE LIST.

MODELS—ENLARGED SIZE.

6807. **Human Heart,** No. 1. The anterior wall may be removed, exposing the four cavities of the heart and their openings and valves..... $ 7 10

6808. **Human Eye,** No. 2. The upper portion, containing a microscopical representation of the layers of the retina, can be removed, when the cornea and the iris, the lens and the vitreous body may be taken out 5 80

6809. **Human Ear,** No. 3. Separates into parts, showing the membrana tympani, the ossicles of the tympanum, the labyrinth and the half opened cochlea..... 6 20

6810. **Human Skin,** No. 4. Transverse section, showing the organs of perspiration, a hair and its follicles, the pulp, sebaceous glands and tactile corpuscles 3 10

6811. **Human Teeth,** No. 5. The anterior portion of the left maxillary bone is removed to show the development and structure of the teeth.... 3 10

MODELS—NATURAL SIZE.

Human Brain, No. 6. Four views.

6812A. View of upper portion..... 2 90
6812B. View of the lower portion (basis of cerebral nerves)..... 2 90
6812C. View of perpendicular section along the median line..... 2 90
6812D. View of transverse section of the head, showing the cavities..... 2 90

Human Head, No. 7. Three views.

6813A. Head with muscles, nerves and blood vessels of one side..... 4 90
6814B. Cavities of skull and eye, upper and lower jaw..... 4 90
6814C. View of perpendicular section of the head, showing the brain, cavities of the mouth and nose, and the larynx and pharynx divided along the median line..... 4 90

Human Lungs, No. 8. With the heart in normal position.

6815A. Anterior view of the lungs and heart. The pericardium opens and the anterior portion of the left lung may be removed, showing the bronchial ramifications, aveoli, etc..... 4 00

6815B. Posterior view of the lungs and heart, with a representation of the bronchial ramifications, air cells, blood vessels and lobuli..... 4 00

6816. **Organs of Respiration, Air Passages, Lungs and Heart,** No. 9. The anterior part of both lungs and heart removes, laying open the lungs and showing the ramifications of the windpipe, and the connection of the pulmonary blood vessels with the heart..... 9 75

Human Larynx, No. 10. Anterior and posterior views.

6817A. Is an anterior aspect, showing base of tongue, hyoid bone, thyroid gland, etc. 2 45

6817B. Posterior aspect, showing the glottis and vocal cords..... 2 45

6817C. Larynx in connection with the tongue and pharynx; the latter is opened from behind, and parts showing mucous membrane..... 2 90

Human Joints, No. 11. Partially opened, showing their bones and ligaments.

6818A. Arm joint of the shoulder, opened..... 2 20
6818B. Elbow joint, **a,** anterior view..... 1 80
6818C. Elbow joint, **b,** lateral view..... 1 80
6818D. Wrist joint and hand..... 2 45
6818E. Hip joint 2 20
6818F. Knee joint 2 20
6818G. Ankle joints and foot..... 3 10

6819. **Human Trunk** (Torso), No. 12, with viscera of the chest and abdomen laid open 29 00

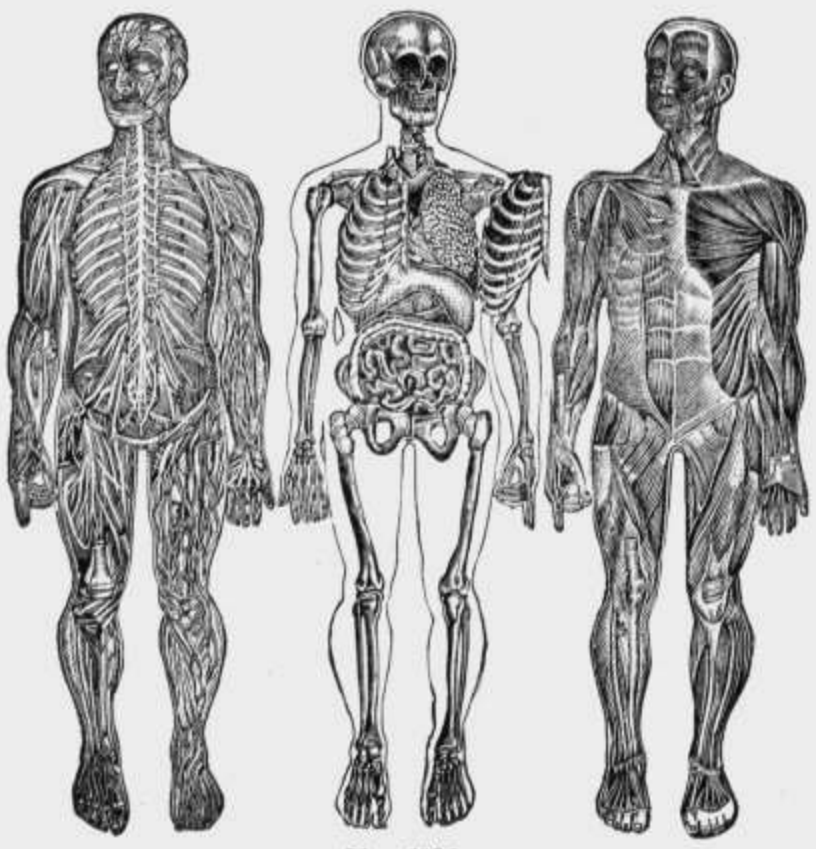
6820. **Human Skull and Brains,** No. 13, the various parts of which can be taken out 9 75

6821. **Larynx Phantom,** No. 14, mask of the face with mouth open..... 8 50

6823. **Complete Set** of 28 Anatomical Models, as above enumerated..... 110 00

6824. **Complete Set** of 28 Anatomical Models, as above enumerated, with case 137 00

ANATOMICAL MANIKINS.



No. 6830.

A manikin is the only complete, practical reproduction of the human body. It hangs upon your wall closed, occupying the space of a picture. Open it, and fold after fold you turn just as you would turn the pages of a large book. So you pass from the skin to the skeleton. You see in its natural colors, life size, exact position, every vein, nerve, muscle, organ and bone in the body. The name of any one of these can be learned in a second by referring to the little volume which goes with every manikin and in which the 455 parts shown are numbered. A simple, fascinating, valuable study.

The Pilz manikin is the result of years of study and work on the part of the best scientists of Germany. Physicians agree that the only perfect manikins come from Germany. The German physiologists are famous, and many of them have given their best work to a graphic illustration of their life study—man—in the form of a manikin. It is important that you get the best manikin.

THE PILZ MANIKIN.

5 Feet 5 Inches High.

A life size figure of the human body, lithographed in natural colors on indestructible heavy linen cardboard. There are thirty large folds—455 parts shown. No part is detached, so that there is no trouble putting on and taking off, and there are no small parts to lose. It shows the blood vessels, nerves, muscles, internal organs and the skeleton in their proper position and relative dimensions, as follows.

Part I. The muscles of the anterior surface of the body. On the right side the superficial muscles are partially removed in order to bring the deeper layers into view. This section shows and designates 85 different muscles.

Part II. The muscles of the posterior surface of the body. On this plate also some of the superficial muscles are partially removed, so that the deeper layers may be recognized. At the occiput a portion of the cranium is removed, showing the brain in the cavity of the skull. There are 71 muscles shown in this section.

Part III. The circulation of the blood. The course of the arterial blood is marked in red, that of the venous blood in blue. This plate shows 61 different veins.

Part IV. The nervous system. The posterior portion of the cranium is shown removed longitudinally so as to bring into view the skull contents. This plate shows 76 nerves.

Part V. The skeleton. In this plate 101 parts of the skeleton and 60 parts of the viscera are shown in actual size and colors.

6830. **Pilz Life Size Sexless Manikin** ..... $ 13 50
6831. **Pilz Life Size Male Manikin** 13 50

THE MINDER MANIKIN.

20 Inches High.

A great many people realize their need of a manikin, yet do not feel like paying the price of a life size figure. Among these are students at colleges and schools, young people interested in physiology or in physical development, and many men who appreciate the value of having in their homes the most valuable text book made.

For these people the Minder manikin is published. This is the same as the large one, except in size, and in the quality of paper. There are the same number of parts, with the exception of the posterior muscles, which are not shown on the smaller manikin. A key, with all the parts named and numbered, is furnished. The folding plan is the same, the colors the same.

6832. **Minder Miniature Sexless Manikin** 2 75
6833. **Minder Miniature Female Manikin** 3 50

PORTRAITS.

"NATURE" SERIES.

We have finally completed our series of **"Scientific Worthies,"** a list of which will be found below. These portraits differ from many that are advertised in that they are made from nearly perfect **steel engravings,** with a few necessary exceptions, which are excellent **photogravures.**

Portraits are 6x8 inches and have a large border, taking frame 10x13 inches. Portrait without frame.....Net $ 2 50

We can also furnish above portraits in a straight grained, dark stained oak frame under glass. Same are designated as 6850A, 6870A, etc. Each.....Net 4 25

STEEL ENGRAVINGS.

6850. Michael Faraday.
6851. Thomas Henry Huxley.
6852. Charles Darwin.
6853. John Tyndall.
6854. Sir Charles Wheatstone.
6855. Sir Wyville Thomson.
6856. Robert Wilhelm Bunsen.
6857. Lord Kelvin.
6858. Hermann L. F. Helmholtz.
6859. J. Louis R. Agassiz.
6860. James Prescott Joule.
6861. Sir C. W. Siemens.
6862. Dmitri Ivanowitsh Mendelejeff.
6863. Louis Pasteur.
6864. William Harvey.
6865. Jean Baptiste Andre Dumas.
6866. James Clerk Maxwell.

PHOTOGRAVURES.

6870. Sir Archibald Geikie.
6871. Simon Newcomb.
6872. Lord Rayleigh.
6873. Sir William Crookes.

"SCIENCE" SERIES.

The following portraits of scientific men are printed in photogravure, on plate paper, 7x10. Portrait measures 3x4. Each.....Net 50

6880. John Tyndall.
6881. Heinrich Hertz.
6882. Herman von Helmholtz.
6883. August Kundt.
6884. Alfred M. Mayer.
6885. William A. Rogers.
6886. Gustav Wiedemann.
6887. Robert Bunsen.
6888. Thomas Preston.
6889. George F. Fitzgerald.
6890. Henry A. Rowland.
6891. Franz E. Melde.

THE ATLAS SERIES OF

SCIENCE TABLETS

FOR

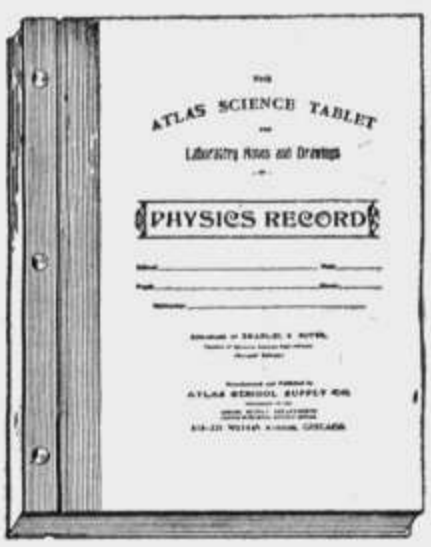
LABORATORY NOTES AND DRAWINGS.

These tablets consist of several tablets and covers, uniform in size (7¾x9¾) and perforated, specially arranged for laboratory use.

Points of Superiority of Atlas Tablets.

These tablets are much more convenient than drawing and note paper, either in bound form or detached sheets, for the following reasons:

1. They render the use of the drawing boards and thumb tacks unnecessary.
2. They afford a convenient form for keeping the paper in good condition for ready use.
3. They enable the instructor to take up completed drawings and descriptions, to be inspected at his leisure, without interrupting the regular work of the pupil.
4. They render it easy to discard unsatisfactory work, which the pupil may be required to perform a second time.
5. They enable the pupil to remove sheets and thus avoid the danger of injuring work already completed.
6. The covers and fastenings afford a convenient way of collecting and temporarily binding work which has been approved and returned by the instructor.
7. Work completed and temporarily bound is easily available for classification and arrangement and for permanent binding if desirable.



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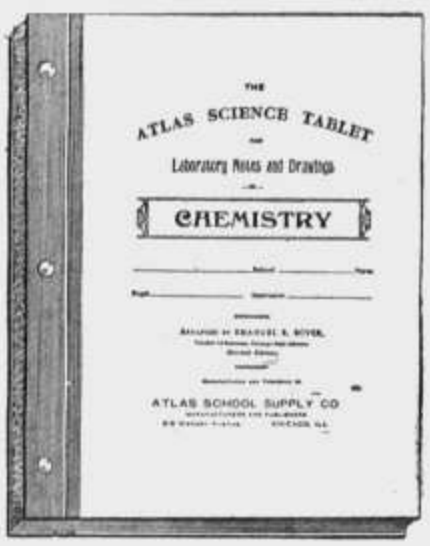
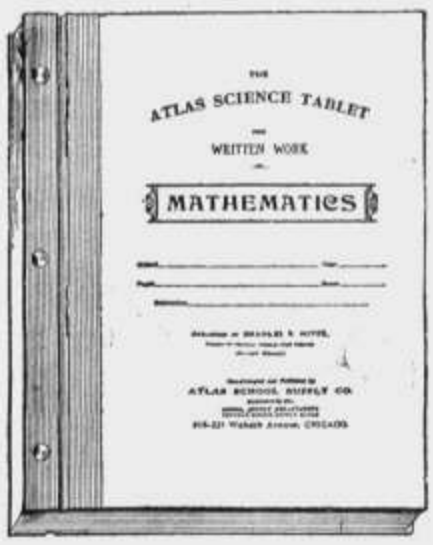
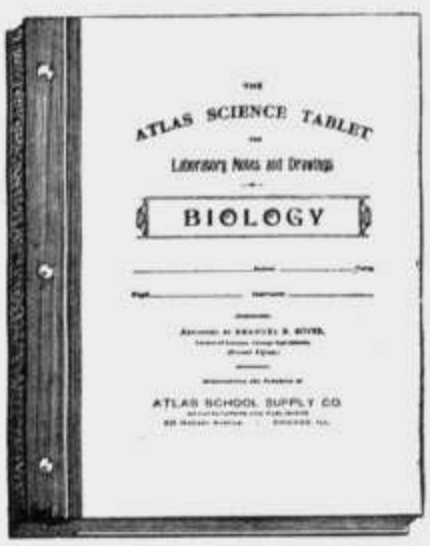


No. 6916.



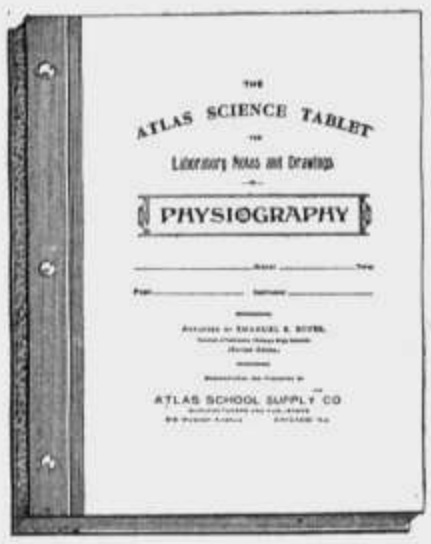
No. 6917.



No. 6925.



No. 6930.



No. 6940.

PRICE LIST ON NEXT PAGE.

"ATLAS SERIES" SCIENCE TABLETS.

NET PRICE LIST.

6911. **Tablet,** containing 75 sheets of metrically cross ruled paper (having note ruling and marginal line on opposite side). The co-ordinately ruled paper permits and facilitates making diagrams to scale. It is **accurately ruled,** being printed from an engraved plate (in non-actinic color), the heavy lines inclosing a square centimeter and the light lines a space of two millimeters square..... $ 17½

6912. **Covers.** Set for binding above, including front and back boards, with flexible cloth eyeletted hinge, lace fasteners, laboratory instructions and table of constants..... 07

N. B.—In ordering covers separately, specify whether for No. 6915, 6916 or 6917.

Note.—The following tablets are uniform in make-up, consisting of a set of covers (No. 6912) and tablet (No. 6911).

6915. **Physics Tablet,** complete..... 21

6916. **Chemistry Tablet,** complete..... 21

6917. **Mathematics Tablet,** complete..... 21

6920. **Drawing Tablet,** containing 30 sheets of specially prepared, high grade drawing paper, with perforations and marginal ruling..... 14

6921. **Note Tablet,** containing 30 sheets of extra quality ruled paper, with perforations and marginal ruling..... 10½

6922. **Covers.** Set for binding, including front and back cover boards and cloth hinge, perforated, lace fasteners; with instructions..... 07

N. B.—In ordering covers separately, specify what tablet they are for (No. 6925-6930).

Note.—The following tablets are uniform in make-up, consisting of a set of covers (No. 6922) and one each drawing tablet (No. 6920) and note tablet (No. 6921).

6925. **Biology Tablet,** complete..... 28

6926. **Botany Tablet,** complete..... 28

6927. **Zoology Tablet,** complete..... 28

6928. **Physiology Tablet,** complete..... 28

6929. **Geology Tablet,** complete..... 28

6930. **Astronomy Tablet,** complete..... 28

Note.—We can also supply the following **Special Tablets,** which can be substituted for Nos. 6920 or 6921, if desired.

6935. **Drawing Tablet,** containing 30 sheets of high grade **ledger** paper for pen and ink drawing, with marginal ruling, perforated to fit covers. 14

6936. **Note Tablet,** containing 30 sheets of extra quality unruled paper, perforated to fit covers..... 10½

6940. **Physiography Tablet,** arranged by Charles Emerson Peet and Ralph E. Blount, consisting of a careful assortment of blank weather maps, astronomical observation blanks, weather observation blanks, drawing paper, ruled note paper and co-ordinate ruled paper, uniform in size with the other tablets listed above, with set of covers, complete 28

6950. **Herbarium.** This is made in two sizes, 7¾x9¾ and 11x17, uniform in design with the Atlas Science Tablets.

The portfolio form permits the specimens to be mounted scientifically according to the genus and species to which they belong. The plan also permits adding to or removing from the collection at any time.

Hints on collecting, pressing and mounting specimens are found on inside cover pages. Each sheet contains a legend for classification.

For 50 specimens, 7¾x9¾, with index..... 28

6950A. **Covers** only, per set..... 10

6950B. **Mounting Sheets** only, per 100..... 50

6951. **Herbarium,** same as No. 6950, size 11x17, for 50 specimens, with index 52

6951A. **Covers** only, per set..... 20

6951B. **Mounting Sheets** only, per 100..... 1 00

TABLES.

APPROXIMATE WEIGHT IN POUNDS OF RODS ONE FOOT LONG.

Diameter.	Aluminum.	Brass.	Copper.	Iron or Steel.
1/16	.0034	.011	.012	.010
1/8	.0144	.045	.048	.041
3/16	.032	.100	.106	.092
1/4	.057	.175	.190	.166
5/16	.089	.275	.296	.260
3/8	.128	.395	.426	.372
7/16	.174	.540	.579	.508
1/2	.227	.710	.757	.664
9/16	.288	.900	.958	.842
5/8	.356	1.100	1.182	1.034
3/4	.511	1.66	1.703	1.501
7/8	.696	2.15	2.318	2.014
1	.910	2.85	3.03	2.660

APPROXIMATE WEIGHT IN POUNDS OF ALUMINUM, BRASS, COPPER, IRON, STEEL AND ZINC PER SQUARE FOOT.

B. & S. gauge.	Size, inches.	Fraction.	Aluminum.	Brass.	Copper.	Iron or Steel.	Zinc.
1	.2893	..	4.029	12.382	13.105	10.993	10.746
2	.2576	1/4	3.588	11.027	11.671	9.790	9.337
3	.2294	7/32	3.195	9.819	10.393	8.718	8.522
4	.2043	..	2.845	8.744	9.255	7.763	7.589
5	.1819	3/16	2.534	7.787	8.242	6.914	6.658
6	.1620	5/32	2.256	6.934	7.339	6.157	6.018
7	.1443	..	2.009	6.175	6.536	5.482	5.354
8	.1285	1/8	1.789	5.499	5.821	4.882	4.773
9	.1144	..	1.594	4.898	5.184	4.348	4.251
10	.1019	..	1.418	4.361	4.615	3.871	3.756
11	.0907	3/32	1.264	3.884	4.110	3.448	3.37
12	.0808	..	1.126	3.458	3.661	3.071	3.00
13	.0719	..	1.002	3.080	3.260	2.734	2.62
14	.0641	1/16	.892	2.743	2.903	2.435	2.32
15	.0571	..	.795	2.442	2.585	2.168	2.06
16	.0508	..	.708	2.175	2.302	1.931	1.87
17	.0452	3-64	.630	1.937	2.050	1.720	1.68
18	.0403	..	.561	1.725	1.826	1.531	1.50
19	.0359	..	.500	1.536	1.626	1.364	1.35
20	.0319	1/32	.435	1.368	1.448	1.214	1.20
21	.0284	..	.396	1.218	1.289	1.081	1.05
22	.0253	..	.353	1.085	1.148	.963	.95
23	.0226	..	.314	.966	1.022	.858	.85
24	.0201	..	.280	.860	.910	.764	.75
25	.0179	..	.249	.766	.811	.716	.67
26	.0159	1-64	.222	.682	.722	.636	.60
27	.0142	..	.197	.607	.643	.568	.52
28	.0126	..	.176	.541	.573	.504	.45
29	.0112	..	.157	.482	.510	.452	.40
30	.0100	..	.140	.429	.454	.400	.37

APPROXIMATE FEET PER POUND OF MAGNET AND RESISTANCE WIRES.

Sizes larger than No. 14, see table of weight of rods on page 360.

Size B. & S.	Aluminum Wire.	Brass or G. S. Wire.	Copper Wire.			Iron or Steel Wire.
			Bare.	D. C. C.	D. S. C.	
14	268	85	80	.....	.....	88
15	334	107	102	.....	.....	108
16	417	132	128	.....	.....	139
17	526	171	162	.....	.....	178
18	667	215	204	.....	.....	226
19	847	272	264	.....	.....	279
20	1,063	343	324	298	312	353
21	1,346	431	408	370	389	446
22	1,695	549	515	461	493	565
23	2,123	684	650	584	631	714
24	2,680	869	819	745	779	909
25	3,389	1,086	1,033	903	966	1,124
26	4,291	1,388	1,302	1,118	1,202	1,428
27	5,405	1,754	1,642	1,422	1,542	2,000
28	6,849	2,222	2,071	1,759	1,917	2,273
29	8,620	2,777	2,611	2,207	2,485	2,857
30	10,869	3,448	3,294	2,534	2,909	3,623
31	.....	4,347	4,152	2,768	3,683	4,566
32	.....	5,555	5,236	3,737	4,654	5,649
33	.....	7,142	6,602	4,697	5,689	7,194
34	.....	9,090	8,328	6,168	7,111	9,090
35	.....	11,111	10,501	6,737	8,534	11,493
36	.....	14,084	13,238	7,877	10,039	14,493
37	.....	.....	16,691	9,309	10,666	.....
38	.....	.....	20,854	10,666	14,222	.....
39	.....	.....	26,302	11,907	16,516	.....
40	.....	.....	33,176	14,222	21,333	.....

COMPARISON OF WIRE GAUGES.

Brown & Sharp's Gauge No...	8	9	10	11	12	13	14	15	16	17	18	19				
Nearest Stubb's Gauge No.....	10	11	12	13	14	15	16	17	18	19	19	20				
Nearest Music Gauge No.....		..	34	33	30	28	26	25	23	20	18	16				
Fractional Part of an Inch.....	1/8	7/64	..	3/32	5/64	..	1/16	..	..	3/64	..	..				
B. & S. No.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Stubbs No...	21	22	23	24	25	26	27	28	29 or 30	31	31 or 32	32	33	34	34	35	35
Music No...	14	12	10	9	8	7	6	5	3	2	1	0	00	..	..	..	..
Inch	1/32	..	..	..	..	..	1/64	..	..	..	..	..	..	..	..	..	..

COMPARATIVE RESISTANCES OF VARIOUS METALS, with Copper as the unit.

Aluminum	1.80	Nickel	7.80
Copper	1.00	Platinum	5.67
German Silver	13.10	Platinoid	24.00
Gold	1.28	Silver	1.02
Iron	6.11	Tin	8.27
Lead	12.28	Zinc	3.20
Manganin	24.00		

Other information concerning resistance and temperature coefficient furnished upon application.

CONVERSION OF THERMOMETER DEGREES.

Degrees C $\times 1.8 + 32 =$ Degrees F.

Degrees $\frac{F-32}{1.8} =$ Degrees C.

Degrees $\frac{R \times 9}{4} + 32 =$ Degrees F.

Degrees $\frac{(F-32)4}{9} =$ Degrees R.

Degrees $\frac{R \times 5}{4} =$ Degrees C.

Degrees $\frac{C \times 4}{5} =$ Degrees R.

PHYSICAL APPARATUS IN SETS.

Our experience has shown us that it is often desirable for a science teacher to order a complete set of Physical Apparatus for the laboratory, the amount depending on the size of his school. For the purpose of aiding the teacher in such cases, we have selected apparatus for the following sets, designed for schools of varying sizes.

The instruments are from our regular stock, and every set forms a good basis for additional apparatus, as the school grows.

The prices quoted do not include cabinets for containing the apparatus. Description thereof and price will be found on page 370.

PHYSICAL SET No. 1; PRICE, $80.00.

Properties of Matter.

319.	Meter Stick	$ 30
601.	Adhesion Disc	27
609.	Prince Rupert Drops	25
621.	Capillary Tubes	45
647.	Inertia Apparatus	80
		2 07

Mechanics.

693.	Collision Balls	3 50
849.	Centrifugal Hoop	2 25
1001.	Equilibrium Tubes	75
1033.	Bottle Imp and Jar	80
1065.	Siphon	22
1091.	Lift Pump	1 65
1093.	Force Pump	2 00
1117.	Hydrometer	45
1155.	Barometer Tube, Cup and Pipette	55
		12 17

Pneumatics.

1305.	Air Pump	22 25
1357.	Bell Glass, 1 gallon	1 10
1385.	Hand and Bladder Glass	1 00
1389.	Sheet Rubber, 1 square foot	28
1413.	Magdeburg Hemispheres	4 55
1435.	Guinea and Feather Tube	6 65
		35 83

Heat.

1509.	Air Thermometer	17
1553.	Compound Bar	95
1555.	Palm Glass	45
1548.	Conductometer	35
5045.	Alcohol Lamp, 4 ounce	27
5438.	Tripod for same	22
		2 41

Magnetism.

1704.	Bar Magnet	$ 22
1729.	Iron Turnings	11
1745.	Magnetic Needle	65
1761.	Compass, 40 m. m	25
		1 23

Electricity.

1783.	Friction Rod, wax	11
1793.	Pith Balls, 1 dozen	25
1805.	Electroscope	70
1811.	Toepler-Holtz Electric Machine, with attachment and shocking handles and brass chains	24 00
1829.	Leyden Jar, pint	1 25
1843.	Discharger	1 00
2100-2.	Simple Cell	18
		27 49

Sound.

3004.	Tuning Fork	17
3051.	Sonometer	4 00
3065.	Violin Bow	80
		4 97

Light

3205.	Concave and Convex Mirror	50
3213.	Kaleidoscope	55
3236.	Prism, 3 inch	25
3255.	Demonstration Set Lenses	1 25
3487.	Color Tops, 1 dozen	90
3465.	Iceland Spar, small	45
		3 90

SUMMARY.

Properties of Matter	**$ 2 07**
Mechanics	**12 17**
Pneumatics	**35 83**
Heat	**2 41**
Magnetism	**1 23**
Electricity	**27 49**
Sound	**4 97**
Light	**3 90**
	90 07
Less 10% discount	**9 01**
	81 06
Boxing	**2 25**
Total	**83 31**

Complete Set, as above, F. O. B. Chicago, $80.00.

PHYSICAL SET No. 2; PRICE, $137.50.

This set is much more complete than Set No. 1, and includes apparatus in all branches of elementary physics. We recommend this set to be complete enough for all ordinary high schools and academies, and guarantee it to be the best set on the market for the money.

	Tools.	
125.	Micrometer Caliper	$ 3 35
129.	Vernier Caliper	1 65
319.	Meter Stick	30
	Properties of Matter.	5 30
601.	Adhesion Disc	27
603.	Cohesion Plates	50
609.	Prince Rupert Drops	25
621.	Capillary Tubes	45
647.	Inertia Apparatus	80
	Mechanics.	2 27
693.	Collision Balls	3 50
720.	Composition of Forces	1 75
849.	Centrifugal Hoop	2 25
843.	Clamp and Drum	2 50
913.	Gyroscope	2 00
1001.	Equilibrium Tubes	75
1023.	Hall's Pressure Gauge	95
1033.	Bottle Imp and Jar	80
1065.	Siphon	22
1091.	Lift Pump	1 65
1093.	Force Pump	2 00
1113.	Demonstration Hydrometer	25
1117.	Hydrometer	45
1125.	Hydrometer Jar, 12x2½	50
1155.	Barometer Tube, Cup and Pipette	55
3871.	Three Spring Balances for use with No. 720	1 65
	Pneumatics.	21 77
1305.	Air Pump	22 25
1348.	Three Bursting Squares	75
1357.	Bell Glass, 1 gallon	1 10
1385.	Hand and Bladder Glass	1 00
1389.	Sheet Rubber, 1 square foot	28
1403.	Mercury Shower	85
1413.	Magdeburg Hemispheres	4 55
1415.	Bacchus Illustration	50
1427.	Water Hammer	70
1435.	Guinea and Feather, Fountain in Vacuo and Aurora Tube combined	6 65
	Heat.	38 63
1509.	Air Thermometer	17
1525.	Chemical Thermometer	40
1548.	Conductometer	35
1551.	Ball and Ring	1 10
1553.	Compound Bar	95
1555.	Palm Glass	45
1559.	Linear Expansion Apparatus	2 65
1589.	Calorimeter	50
1618.	Fire Syringe	1 65
1636.	Radiometer	2 00
5045.	Alcohol Lamp, 8 ounce	40
5438.	Tripod for same	22
		10 84

	Magnetism.	
1704.	Bar Magnet	$ 22
1711.	Horseshoe Magnet	20
1729.	Iron Turnings	11
1733.	Electro Magnet	1 50
1745.	Magnetic Needle	65
1761.	Compass, 40 m. m	25
	Electricity.	2 93
1783.	Friction Rod, wax	11
1793.	Pith Balls, 1 dozen	25
1796.	Pith Images	50
1805.	Electroscope	70
1811.	Toepler-Holtz Electric Machine, with attachment and shocking handles	24 00
1823.	Brass Chains with hook and snap	25
1831.	Leyden Jar, quart	1 65
1843.	Discharger	1 00
1859.	Image Plates	1 25
1873.	Induction Cylinder	3 00
1877.	Hollow Globe	2 75
1881.	Proof Plane	30
1883.	Bell Chimes	90
2001.	Geissler Tube	50
2150.	Plunge Battery, quart	2 50
2225.	Induction Coil	5 00
2309.	Decomposition of Water	1 25
2409.	Galvanometer	2 10
6107.	One-half pound Magnet Wire for connections	35
	Sound.	48 36
877.	Siren Disc	1 00
3012.	Tuning Fork	1 25
3051.	Sonometer	4 00
3065.	Violin Bow	80
3081.	Organ Pipe	1 65
3105.	Chladni Plates and Clamp	2 50
	Light.	11 20
887.	Newton's Disc	65
3203.	Pair Plate Mirrors for double image reflection	22
3206.	Concave and Convex Mirrors, glass in frame	2 25
3213.	Kaleidoscope	55
3215.	Incidence and Reflection	2 25
3236.	Equilateral Prism, 4 inch	33
3255.	Set Demonstration Lenses	1 25
3280.	Lens, 10 c. m. focus	17
3281.	Lens, 15 c. m. focus	09
3351.	Blocks for supporting Meter Stick	14
3352.	Lens Support	17
3353.	Screen Support	10
3354.	Screen	05
3355.	Pin Support	10
3466.	Iceland Spar, medium	60
3487.	Color Tops, 1 dozen	90
3489.	Newton's Rings	1 50
		11 32

SUMMARY.

Tools	**$ 5 30**
Properties of Matter	**2 27**
Mechanics	**21 77**
Pneumatics	**38 63**
Heat	**10 84**
Magnetism	**2 93**
Electricity	**48 36**
Sound	**11 20**
Light	**11 32**
	152 62
Less 10% discount	**15 26**
	137 36
Boxing	**2 80**
Total	**140 16**

Complete Set, as above, F. O. B. Chicago, $137.50.

PHYSICAL SET No. 3; PRICE, $230.00.

This set of apparatus is designed to meet the demand for a more complete collection of apparatus than Sets Nos. 1 and 2. Every department of physics as taught in the leading preparatory and high schools is comprehensively covered.

	Tools and Measurements.	
125.	Micrometer Caliper	$ 3 35
131.	Vernier Caliper (new design)	2 50
321.	Meter Stick, brass tipped	35
369.	Wire Cutting Pliers, 5 inch	55
449.	Metric Diagonal Scale	10
566.	Wire Gauge	2 25
	Properties of Matter.	
601.	Adhesion Disc	27
603.	Cohesion Plates	50
609.	Prince Rupert Drops	25
619.	Capillary Tubes and Support	95
643.	Osmose Apparatus	50
647.	Inertia Apparatus	80
651.	Elasticity of Flexure Apparatus	70
656.	Breaking Strength of Wire Apparatus	3 75
	Mechanics of Solids.	
693.	Collision Balls with No. 694 Arc	4 50
720.	Composition of Forces	1 75
727.	Lever Holders (3)	90
729.	Pulley, single, 2 hook	26
730.	Pulley, double, 2 hook	45
767.	Inclined Plane with Arc	4 15
771.	Hall's Carriage	1 10
815.	Center of Gravity Apparatus	4 50
827.	Second Law of Motion Apparatus	3 30
837.	Rotator (whirling table)	6 65
849.	Centrifugal Hoop	2 25
859.	Two Balls on rod, for rotator	2 90
867.	Ring, Chain and Cylinder	75
913.	Gyroscope	2 00
3871.	Three Spring Balances, Met. and Eng., flat back	1 65
	Mechanics of Fluids.	
1005.	Equilibrium Tubes	3 30
1023.	Hall's Pressure Gauge	95
1033.	Bottle Imp and Jar	80
1037.	Hydraulic Press	1 65
1051.	Boyle's Law Tube	75
1065.	Siphon	22
1069.	Tantalus Cup	70
1089.	Archimedes Principle	1 65
1091.	Lift Pump	1 65
1093.	Force Pump	2 00
1113.	Demonstration Hydrometer	25
1117.	Hydrometer for heavy liquids	45
1125.	Hydrometer Jar, 12x2½	50
1155.	Barometer Tube, Cup and Pipette	55
	Pneumatics.	
1300.	Oil Sealed Air Pump	33 30
1302.	Vacuum Wax	40
1326.	Vacuum Gauge	1 75
1347.	Bell in Vacuo	3 00
1348.	Three Bursting Squares	75
1350.	Freezing Apparatus	1 40
1357.	Bell Glass, 1 gallon	1 10
1385.	Hand and Bladder Glass	1 00
1389.	Sheet Rubber, 1 square foot	28
1403.	Mercury Shower	85
1413.	Magdeburg Hemispheres	4 55
1415.	Bacchus Illustration	50
1417.	Spirometer (Seven-in-One)	8 30
1427.	Water Hammer	70
1435.	Guinea and Feather Tube, Fountain in Vacuo and Aurora Tube combined	6 65
	Heat.	
1501.	Copper Boiler (Apparatus A)	2 50
1509.	Air Thermometer	17
1531.	Chemical Thermometer	90
1549.	Conductometer	1 65
1551.	Ball and Ring	1 10
1553.	Compound Bar	95
1555.	Palm Glass	45
1559.	Linear Expansion Apparatus	2 65
1593.	Calorimeter	2 75
1613.	Tyndall's Specific Heat Apparatus	2 00
1618.	Fire Syringe	1 65
1621.	Convection Apparatus	1 05
	Carried forward	151 70
	Carried forward	$151 70
1636.	Radiometer	2 00
1661.	Sectional Model of Steam Engine	3 30
5045.	Alcohol Lamp, 8 ounce (Bunsen Burner substituted if desired.)	40
5438.	Tripod for same	22
	Magnetism.	
1701.	Lodestone	40
1704.	Bar Magnet, 6 inch	22
1713.	Horseshoe Magnet, 6 inch	50
1729.	Iron Turnings	11
1733.	Electro Magnet	1 50
1745.	Magnetic Needle	65
1761.	Compass, 40 m. m	25
	Electricity.	
1783.	Friction Rod, wax	11
1785.	Friction Rod, vulcanite	50
1791.	Catskin	60
1793.	Pith Balls, 1 dozen	25
1796.	Pith Images, pair	50
1801.	Electrical Pendulum	60
1805.	Electroscope	70
1811.	Toepler-Holtz Electric Machine, with attachment and shocking handles	24 00
1823.	Brass Chains with hook and snap	25
1831.	Leyden Jar, quart	1 65
1843.	Discharger	1 00
1859.	Image Plates	1 25
1877.	Hollow Globe	2 75
1881.	Proof Plane	30
1883.	Bell Chimes	90
1886.	Universal Support	1 00
1891.	Volta's Hail Storm	2 75
1897.	Electric Flier	70
1903.	Holder for Tubes, etc	50
2005.	Geissler Tube, 8 inch	80
2151.	Plunge Battery, 2 cell	5 00
2223.	Demonstration Coil	5 00
2246.	Electric Motor	1 40
2309.	Decomposition of Water	1 25
2403.	Galvanometer	5 00
6107.	One pound Magnet Wire for connections	65
	Sound.	
871.	Savart's Wheel	60
879.	Siren Disc	1 65
3012.	Tuning Fork	1 25
3021.	Tuning Fork on Resonant Case	3 35
3052.	Sonometer	5 00
3066.	Violincello Bow	1 10
3082.	Organ Pipe	4 50
3105.	Chladni Plates and Clamp	2 50
3155.	Oscillograph	55
	Wave Motion.	
875.	Crova's Disc	55
3170.	Spiral of Brass Wire	2 00
	Light.	
887.	Newton's Disc	65
3206.	Concave and Convex Mirrors	2 25
3212.	Multiple Image Apparatus	1 65
3215.	Incidence and Reflection App	2 25
3226.	Sextant	1 65
3236.	Equilateral Prism, 4 inch	33
3256.	Demonstration Lenses, 2 inch	2 50
3280.	Lens, 10 c. m. focus	17
3281.	Lens, 15 c. m. focus	09
3301.	Index of Refraction	28
3351.	Blocks for supporting Meter Stick	14
3352.	Lens Support	17
3353.	Screen Support	10
3354.	Screen	05
3355.	Pin Support	10
3466.	Iceland Spar, medium	60
3489.	Newton's Rings	1 50
		258 19
	Less 10% discount	25 82
		232 37
	Boxing	3 35
	Total	235 72

Complete Set, F. O. B. Chicago, $230.00.

PHYSICAL SET No. 4; PRICE, $503.50.

This set is the same as **Set No. 3,** with the addition of a number of important pieces of apparatus, as given below, the principal ones being the Atwood's Machine, Barometer, Dynamo and an Electrical Testing Outfit. We have also in a number of cases substituted higher grade apparatus for that given in Set No. 3.

	Tools and Measurements.	
515.	Spherometer	$ 3 90
281.	Liter Block	2 85
285.	Liter Case	3 00
	Set No. 3	9 10
		18 85
	Properties of Matter.	
607.	Cohesion Hemispheres	40
678.	Equilibrium Cone	1 10
	Set No. 3	7 72
		9 22
	Mechanics of Solids.	
728.	Wheel and Axle	1 25
786.	Kater's Bar Pendulum	4 50
782.	Sand Pendulum	90
803.	Atwood's Machine	25 00
823.	Double Cone and Plane	1 10
851.	Dish for Rotator	2 90
873.	Count Rumford's Experiment	2 05
897. 899.	Manometric Flame Apparatus complete	7 75
3830.	Harvard Trip Scale	6 65
3921.	Brass Weights, 500g-1g	2 25
	Set No. 3	37 11
		91 46
	Mechanics of Fluids.	
1011.	Pressure Apparatus	1 25
1019.	Pressure Syringe	2 00
1027.	Pascal's Vases	7 75
1055.	Boyle's Law Apparatus	5 25
1081.	Reaction Wheel (3d Law of Motion)	1 75
1087.	Hydraulic Ram	3 30
1114.	Nicholson's Hydrometer	1 65
1115.	Hydrometer for light liquids	45
1165.	Adjustable Mercurial Barometer	16 65
1197.	Mason's Hygrometer	2 50
1214.	Aneroid Barometer	4 00
3823.	Specific Gravity Balance	5 75
3917.	Set of Weights, 50 g. to 1 c. g.	85
	Set No. 3	15 42
		68 57
	Pneumatics.	
1364.	Bell Glass, swelled, 2 gallon	1 65
1423.	Weight of Air Globe	2 50
1325.	Vacuum Gauge, substituted for No. 1343	6 25
	Set No. 3	64 53
		74 93
1326.	Vacuum Gauge, omitted	1 75
		73 18
	Heat.	
1521.	Three Scale Thermometer	80
1561.	Linear Expansion Apparatus	4 00
1631.	Leslie's Differential Thermometer	2 00
1633.	Leslie's Radiating Cube	1 65
1637.	Parabolic Reflectors	6 00
1649.	Thermo Multiplier	2 50
	Set No. 3	23 74
		40 69
1559.	Linear Expansion App., omitted	2 65
		38 04
	Magnetism.	
1741.	Helix	1 10
1771.	Magnetoscope	1 15
	Set No. 3	3 63
		5 88

	Electricity.	
1799.	Electrophorus	$ 4 15
1873.	Induction Cylinder	3 00
1887.	Bell Chime, substituted for 1883	2 75
2003.	Geissler Tube, substituted for 2005	3 00
2160.	High School Plunge Battery, 4 cell	13 35
2207.	Oersted's Law Apparatus	3 00
2251.	Porter Motor No: 1, substituted for No. 2246	3 35
2260.	Dissectible Hand Power Dynamo	33 30
2279.	Arc Lamp	3 30
2301.	Lamp System	8 00
2311.	Electrolysis of Water	2 20
2345.	Telegraph Key and Sounder	2 50
2355.	Telephone Receiver	1 45
2411.	Tangent Galvanometer	7 25
2441.	Resistance Box	8 35
2455.	Resistance Spools	3 35
2466.	Temperature Coil	1 25
2475.	Wheatstone's Slide Wire Bridge	6 00
2512.	Voltammeter	11 00
2641.	Mercury Commutator	65
2651.	Contact Key	1 00
	Set No. 3	59 41
		181 61
1883.	Bell Chime, omitted 90	
2005.	Geissler Tube, omitted 80	
2151.	Plunge Battery, omitted 5 00	
2246.	Electric Motor, omitted 1 40	
2309.	Decomp. of Water, omitted 1 25	
		9 35
		172.26
	Sound.	
3040.	Vibrograph	4 00
3041.	Fork for same	1 65
3103.	Kundt's Apparatus	3 75
3120.	Trevelyan's Rocker	2 10
	Set No. 3	20 50
		32 00
	Wave Motion.	
	Same as Set No. 3	2 55
	Light.	
3299.	Refraction Tank	8 00
3428.	Spectroscope, Direct Vision	11 00
3412.	Photometer	3 50
3450.	Polariscope	8 35
	Set No. 3	14 48
		45 33
	Miscellaneous.	
145.	Clamp, 4 inch	40
225.	Two Round Files, 5 inch	20
227.	Two Triangular Files, 5 inch	18
748.	Twenty-five yards Fish Line	22
2735.	Two Double Connectors	22
3380.	One dozen Candles, 12s	22
4215.	Two Beakers, No. 1	20
4711.	Clamp	40
4723.	Two Clamp Holders	44
4776.	One gross Assorted Corks	65
4901.	Two Flasks, 8 ounce, with 1 hole, rubber stoppers	50
4921.	Funnel, 3 inch	12
5329.	Ring Stand, medium	60
6241.	Can LePage's Glue, 4 ounce	30
	2 pounds Chromic Acid and Jar	80
	One pint Alcohol, 95 per cent	65
	One pound Mercury and Bottle	1 00
		7 10

SUMMARY.

Tools and Measurements	$18 85
Properties of Matter	9 22
Mechanics of Solids	91 46
Mechanics of Fluids	68 57
Pneumatics	73 18
Heat	38 04
Magnetism	5 88
Electricity	172 26
Sound	32 00
Wave Motion	2 55
Light	45 33
Miscellaneous	7 10
Total	564 44
Less 10% discount	56 44
	508 00
Boxing	5 85
Total	513 85

Complete Set, F. O. B. Chicago, $503.50.

CHEMICALS AND APPARATUS IN SETS.

The following Chemical Sets have been arranged by a prominent professor of chemistry according to the latest and best text books. They are up-to-date in every particular. The chemicals are all **placed in bottles.**

Chemical Set. No. 1, F. O. B. Chicago, $13.50.

4 oz. Acid Acetic.
1 lb. Acid Hydrochloric.
1 lb. Acid Nitric.
2 lbs. Acid Sulphuric.
1 oz. Acid Oxalic.
1 oz. Acid Tartaric.
2 oz. Ammonium Chloride.
8 oz. Ammonium Hydrate.
1 oz. Ammonium Nitrate.
1 oz. Ammonium Sulphide.
1 oz. Animal Charcoal.
1 oz. Antimony.
1 oz. Arsenic Trioxide.
1 oz. Alum.
8 oz. Alcohol Methyl.
1 oz. Barium Chloride.
1 oz. Barium Nitrate.
2 oz. Calcium Carbonate (marble).
2 oz. Calcium Fluoride.
4 oz. Calcium Sulphate.
1 oz. Carbon Bisulphide.
1 oz. Charcoal (lumps).
2 oz. Copper Sulphate.
2 oz. Ether.
8 oz. Ferrous Sulphide.
2 oz. Ferrous Sulphate.
½ oz. Gall Nuts (powdered).
⅛ oz. Gun Cotton.
¼ oz. Iodine.
2 oz. Galena.
1 oz. Lead Acetate.
1 oz. Lead Oxide (red).
½ oz. Litmus Cubes.
4 oz. Mercury.
12 in. Magnesium Ribbon.
2 oz. Magnesium Sulphate.
1 lb. Manganese Dioxide (powdered).
6 in. Platinum Wire.
½ oz. Phosphorus.
⅛ oz. Potassium (metallic).
2 oz. Potassium Bichromate.
1 oz. Potassium Bromide.
2 oz. Potassium Chlorate.
2 oz. Potassium Ferrocyanide.
1 oz. Potassium Hydrate (sticks).
1 oz. Potassium Nitrate.
1 oz. Strontium Nitrate.
4 oz. Sulphur Roll.
⅛ oz. Silver Nitrate.
⅛ oz. Sodium (metallic).
1 oz. Sodium Biborate.
2 oz. Sodium Carbonate.
2 oz. Sodium Sulphate.
8 oz. Zinc for making Hydrogen.

Beakers, nest of 3 (3 to 8 oz.).
Blow Pipe, plain, 8 inch.
Bottle, W. M., 4 oz.
Bottle, W. M., 8 oz.
Corks, 1 dozen, assorted.
Crucibles, Hessian, nest, small 5s.
Deflagrating Spoon, iron, ½ inch.
Dish, Evaporating, 2 oz.
Dish, Lead, 3 inch.
File, Triangular, 4 inch.
Filter Paper, 1 pkg., 4 inch.
Flask, F. B., 4 oz.
Flask, F. B., 8 oz.
Funnel, glass, 2½ inch.
Jar, Specie, for deflagration, qt.
Gas Generating Flask, pint.
Glass Tubing, ¼ lb., ¼ inch.
Graduate, conical, 60 c. c.
Lamp, Alcohol, 4 oz.
Mortar, Wedgewood, 2¾ inch.
Pipette, long bulb, small.
Retort, glass, plain, 4 oz.
Rubber Tubing, 6 ft., 3-16 inch.
Sand Bath, 4 inch.
Test Tubes, 1 dozen, assorted.
Test Tube Brush, sponge end.
Test Tube Holder, wood.

Chemical Set. No. 2, F. O. B. Chicago, $25.00.

½ lb. Acetic Acid.
1 lb. Hydrochloric Acid.
1 lb. Nitric Acid.
1 oz. Oxalic Acid.
2 lbs. Sulphuric Acid.
1 oz. Tartaric Acid.
1 oz. Ammonium Carbonate.
2 oz. Ammonium Chloride.
½ lb. Ammonium Hydrate.
1 oz. Ammonium Nitrate.
1 oz. Ammonium Sulphide.
½ pt. Alcohol Methyl.
2 oz. Alum.
2 oz. Animal Charcoal.
1 oz. Antimony.
1 oz. Arsenic Trioxide.
1 oz. Barium Chloride.
1 oz. Barium Nitrate.
1 oz. Borax.
¼ lb. Calcium Carbonate (marble).
2 oz. Calcium Chloride.
2 oz. Calcium Fluoride.
¼ lb. Calcium Sulphate.
1 oz. Carbon Bisulphide.
1 oz. Cobalt Nitrate.
4 oz. Copper Sulphate.
2 oz. Ether.
2 oz. Ferrous Sulphate.
8 oz. Ferrous Sulphide.
½ oz. Gall Nuts (powdered).
⅛ oz. Gun Cotton.
¼ oz. Iodine.
2 oz. Galena.
1 oz. Lead Acetate.
4 oz. Lead Oxide (red).
4 oz. Lead Monoxide.
½ oz. Litmus (best cubes).
12 in. Magnesium Ribbon.
4 oz. Magnesium Sulphate.
1 lb. Manganese Dioxide (powdered).
4 oz. Mercury.
½ oz. Mercuric Chloride.
½ oz. Mercuric Oxide.
12 in. Platinum Wire.
½ oz. Phosphorus.
⅛ oz. Potassium (metallic).
½ lb. Potassium Bichromate.
1 oz. Potassium Bromide.
2 oz. Potassium Carbonate.
½ lb. Potassium Chlorate.
1 oz. Potassium Chromate.
½ oz. Potassium Cyanide.
2 oz. Potassium Ferricyanide.
2 oz. Potassium Ferrocyanide.
1 oz. Potassium Hydrate (sticks).
¼ oz. Potassium Iodide.
2 oz. Potassium Nitrate.
½ oz. Potassium Permanganate.
1 oz. Potassium Sulphate.
⅛ oz. Silver Nitrate.
¼ oz. Sodium (metallic).
1 oz. Sodium Acetate.
4 oz. Sodium Carbonate.
2 oz. Sodium Hydrate (sticks).
2 oz. Sodium Hyposulphite.
2 oz. Sodium Sulphate.
1 oz. Sodium Phosphate.
1 oz. Strontium Nitrate.
½ lb. Sulphur Roll.
½ lb. Zinc for making Hydrogen.

Continued on page 367.

Chemical Set No. 2 Concluded.

Beakers, nest of 4 (3 to 12 oz.).
Blow Pipe, plain, 8 inch.
Bottles, W. M., two 8 oz.
Bottles, N. M., two 8 oz.
Corks, 1 dozen, assorted.
Crucibles, Hessian, nest, large 5s.
Deflagrating Spoon, iron, ½ inch.
Dish, Evaporating, 3½ oz.
Dish, Lead, 3 inch.
File, Triangular, 4 inch.
Filter Paper, 1 pkg., 4 inch.
Flask, F. B., 4 oz.
Flask, F. B., 8 oz.
Flask, F. B., 16 oz.
Funnel, 2½ inch.
Funnel, 3½ inch.
Gas Bag with stopcock, 1 gallon.
Gas Generating Flask, pint.
Glass Tubing, ½ lbs. 3-16 to ¼.
Graduate, conical, 60 c. c.
Hand Balance, 5 inch beam with weights, in case.
Jar, Specie, for deflagration, ½ gallon.
Lamp, Alcohol, 4 oz.
Mortar, Wedgewood, 3 inch.
Pipette, long bulb, large.
Pneumatic Trough, student's.
Retort, glass, plain, 4 oz.
Retort Stand, 3 ring.
Rubber Tubing, 6 feet, 3-16 inch.
Sand Bath, 4 inch.
Test Tubes, 1 dozen, assorted.
Test Tubes, 1 dozen, 6x⅝.
Test Tube Brush, sponge end.
Test Tube Holder, wire.
Thistle Tube.
U Tube, 6 inch.
Watch Glass, 2½ inch.
Wire Gauze, 4x4.

Chemical Set No. 3, F. O. B. Chicago, $50.00.

For those desiring a complete chemical laboratory outfit we recommend the following set:

1 lb. Acid Acetic.
½ lb. Acid Boracic.
2 oz. Acid Citric.
2 lbs. Acid Hydrochloric.
2 lbs. Acid Nitric.
1 lb. Acid Oxalic.
1 oz. Acid Phosphoric.
4 lbs. Acid Sulphuric.
½ lb. Acid Tartaric.
1 qt. Alcohol Methyl.
1 lb. Alum.
½ lb. Ammonium Carbonate.
1 lb. Ammonium Chloride.
1 lb. Ammonium Hydrate.
1 oz. Ammonium Molybdate.
½ lb. Ammonium Nitrate.
1 oz. Ammonium Oxalate.
1 lb. Ammonium Sulphate.
4 oz. Ammonium Sulphide.
⅛ oz. Aniline.
1 lb. Animal Charcoal.
1 oz. Antimony (metallic).
2 oz. Antimony Sulphide.
1 oz. Arsenic (metallic).
¼ lb. Arsenic Trioxide.
1 oz. Asbestos.
2 oz. Barium Carbonate.
½ lb. Barium Chloride.
½ lb. Barium Nitrate.
1 lb. Barium Sulphate.
½ oz. Bismuth.
½ lb. Bone Ash.
1 lb. Calcium Carbonate (marble).
1 lb. Calcium Chloride.
1 lb. Calcium Fluoride.
1 lb. Calcium Sulphate.
2 oz. Carbon Bisulphide.
1 lb. Charcoal Wood (lump).
1 oz. Cobalt Chloride.
1 oz. Cobalt Nitrate.
4 oz. Copper Turnings.
1 oz. Copper Nitrate.
1 lb. Copper Sulphate.
¼ lb. Ether.
2 oz. Ferric Chloride.
1 lb. Ferrous Sulphate.
1 lb. Ferrous Sulphide.
1 oz. Gall Nuts (powdered).
¼ oz. Gun Cotton.
1 oz. Indigo.
1 lb. Iron Filings.
2 oz. Galena.
¼ lb. Lead Acetate.
1 lb. Lead Oxide (red).
¼ lb. Lead Nitrate.
1 lb. Lead Protoxide.
1 oz. Litmus (best cubes).
4 oz. Logwood.
4 ft. Magnesium Ribbon.
2 oz. Magnesium Chloride.
1 lb. Magnesium Sulphate.
2 lbs. Manganese Dioxide (powdered).
1 oz. Mercuric Chloride.
8 oz. Mercury.
2 oz. Microcosmic Salt.
1 lb. Paraffine.
12 in. Platinum Wire.
1 Platinum Sponge.
1 oz. Phosphorus.
4 oz. Plumbago.
⅛ oz. Potassium (metallic).
1 lb. Potassium Bichromate.
2 oz. Potassium Bromide.
½ lb. Potassium Carbonate.
1 lb. Potassium Chlorate.
2 oz. Potassium Chromate.
1 oz. Potassium Cyanide.
1 oz. Potassium Ferricyanide.
¼ lb. Potassium Ferrocyanide.
2 oz. Potassium Hydrate (sticks).
½ oz. Potassium Iodide.
1 lb. Potassium Nitrate.
1 oz. Potassium Permanganate.
½ lb. Potassium Sulphate.
1 oz. Potassium Sulphocyanide.
1 oz. Potassium Bi Tartrate.
¼ oz. Silver Nitrate.
½ oz. Sodium (metallic).
½ oz. Sodium Acetate.
½ lb. Sodium Biborate.
1 lb. Sodium Bicarbonate.
2 lbs. Sodium Carbonate.
1 lb. Sodium Hydrate (sticks).
1 lb. Sodium Hyposulphite.
1 lb. Sodium Nitrate.
½ lb. Sodium Phosphate.
1 lb. Sodium Silicate.
1 lb. Sodium Sulphate.
¼ lb. Strontium Chloride.
½ lb. Strontium Nitrate.
2 lbs. Sulphur Roll.
¼ lb. Tin (metallic).
1 oz. Tin Proto Chloride.
8 oz. Turpentine.
1 lb. Zinc, Mossy, for making Hydrogen.
½ lb. Zinc Carbonate.
¼ lb. Zinc Oxide.
1 lb. Zinc Sulphate.

Continued on page 368.

Chemical Set No. 3, Concluded.

Beakers, nest of 5 (3 to 20 oz.).
Blow Pipe, plain, 8 inch.
Bottles, W. M., two 8 oz.
Bottles, N. M., two 8 oz.
Burette, 25 c. c. 1-10ths.
Corks, 2 dozen, assorted.
Cork Borers, set 1-3.
Cork Screw, wood handle.
Crucibles, Hessian, 2 nests, large 5s.
Crucible Tongs, 9 in.
Deflagrating Spoon, brass, ½ inch.
Dish, Crystallizing, 4 inch.
Dish, Evaporating, 2 oz.
Dish, Evaporating, 6 oz.
Dish, Lead, 3 inch.
File, Triangular, 5 inch.
File, Round, 5 inch.
Filter Paper, 1 pkg., 5 inch.
Flasks, F. B., two 4 oz.
Flask, F. B., 8 oz.
Flask, F. B., 16 oz.
Funnel, glass, 2½ inch.
Funnel, glass, 4 inch.
Gas Bag, with stopcock, 1 gallon.
Gas Generating Flask, quart.
Glass Tubing, 1 lb., 3-16-¼.
Graduate, conical, 100 c. c.
Hand Balance, 5 inch beam, with weights.
Hydrometer, for heavy liquids.
Jar for Hydrometer, 12x2½.
Jar, Specie, for deflagration, two 1 quart size.
Lamp, Alcohol, 4 oz.
Mortar, Wedgewood, 3¾ inch.
Pipette, Volumetric, 5 c. c.
Pipette, Volumetric, 10 c. c.
Pneumatic Trough, student's.
Reagent Bottles, 1 set of 24.
Retort, glass, plain, 16 oz.
Receiver for Retort, 8 oz.
Reduction Tube for reducing metallic oxides.
Retort Stand, 3 ring.
Rubber Tubing, 6 feet, ¼ inch.
Sand Bath, 4 inch.
Spatula, steel, 4 inch.
Stirring Rods, 3, 5x3-16.
Test Glass, 2 oz.
Test Tubes, 2 dozen, assorted.
Test Tubes, 1 dozen, 6x¾.
Test Tube Brush, sponge end.
Test Tube Holder, wire.
Test Tube Support, 13 tubes with drying pins.
Thermometer, Paper Scale, 110 degrees C.
Thistle Tubes, Two.
U Tube, 6 inch.
Watch Glass, 2½ inch.
Watch Springs, for burning in oxygen, ½ dozen.
Wire Gauze, 4x4.
Woulff Bottle, 3 neck, pint.

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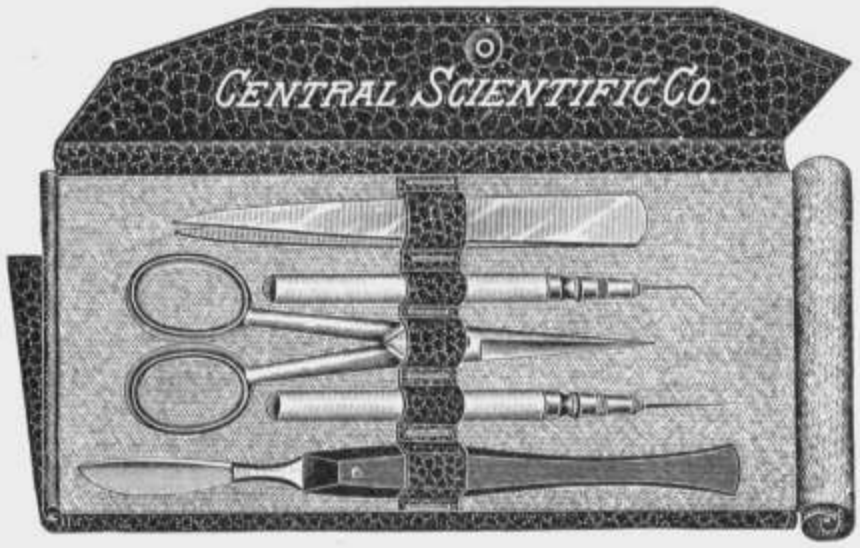

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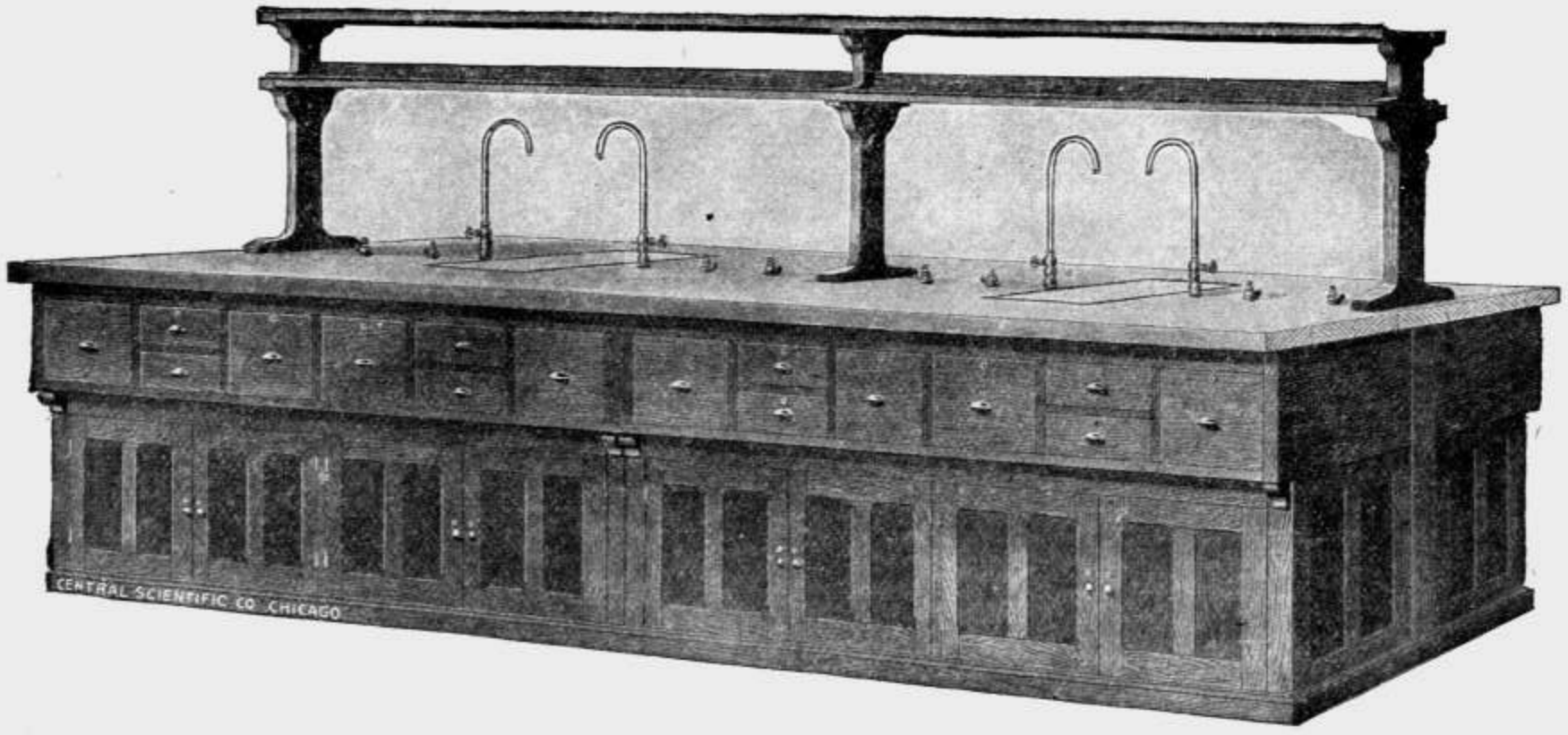

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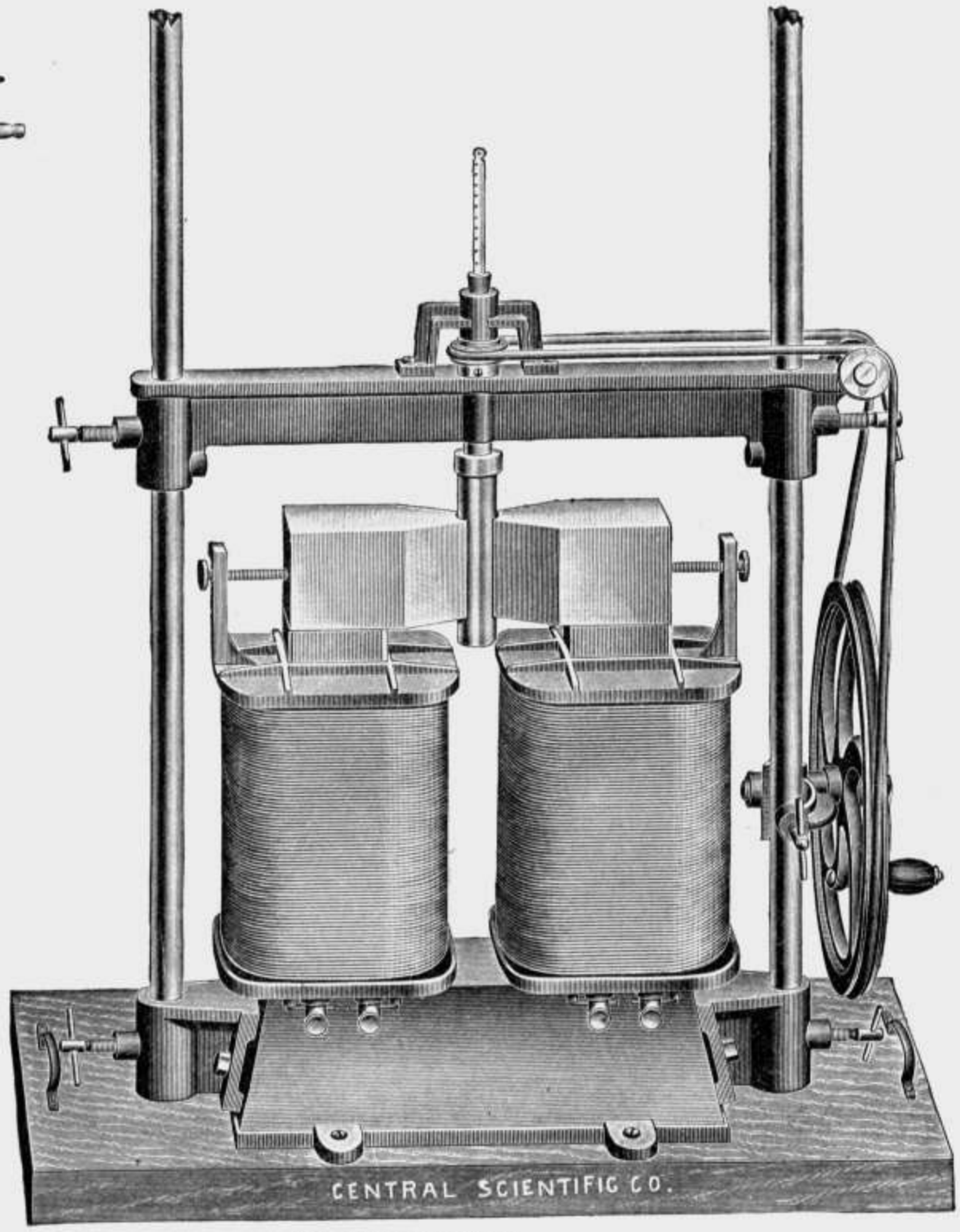

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with

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For description, see next page.

1736. **Electro Magnet.** This apparatus was designed to supply our own laboratory with an electro magnet of sufficient strength and field concentration for magnetizing, experimentation, etc. With its accessories listed below it becomes available for the investigation of the more complex phenomena of the magnetic state, such as Para-Magnetism, Dia-Magnetism, Polarity, Reflection and Refraction of Magnetic lines, Deflection of waves emanating from Radio-active substances.

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