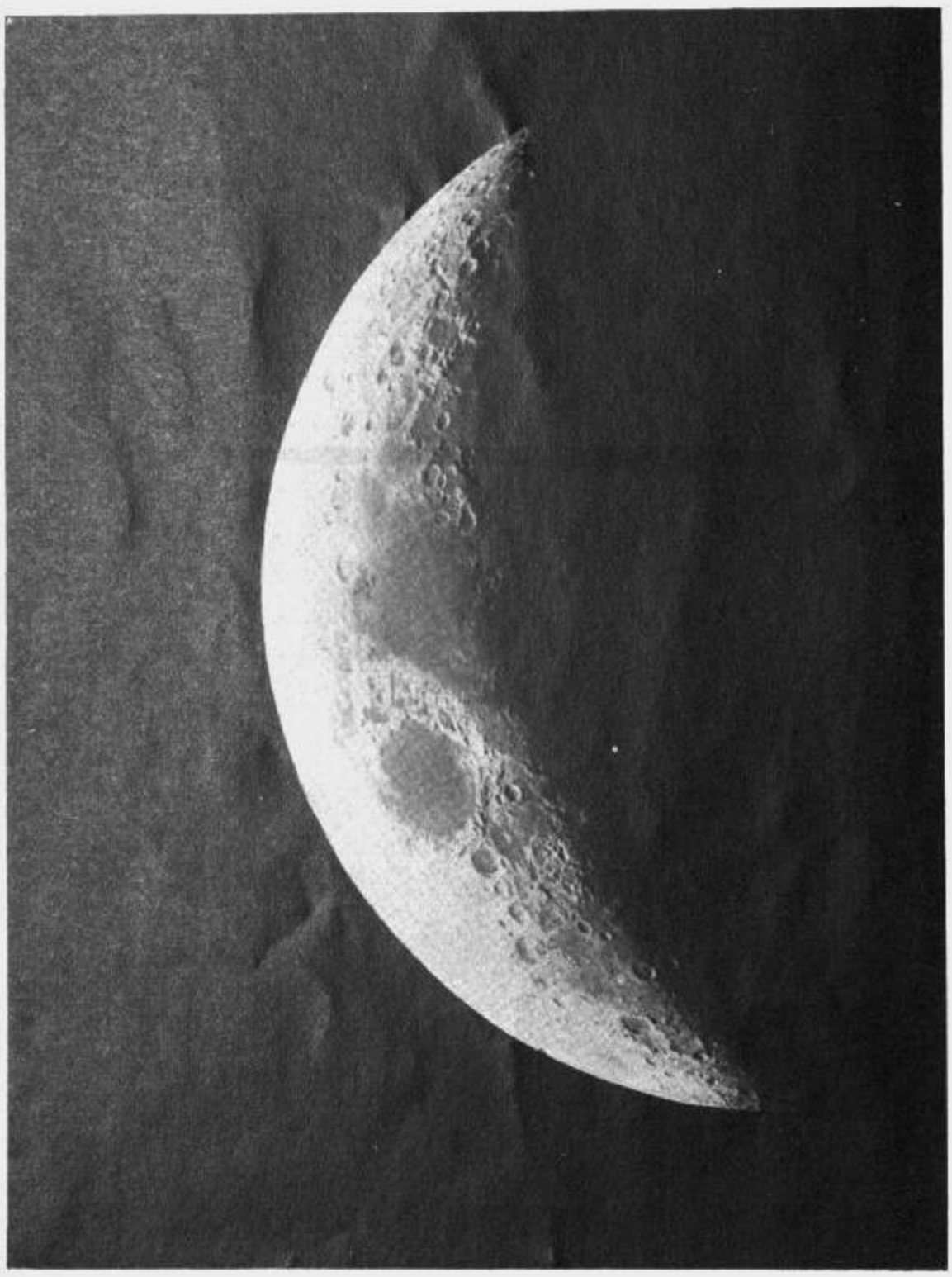
Steinheil 6389

STEINHEIL

MUNICH

Astronomical and Physical Instruments

Photographed with Telescopic Objective Aperture 300 mm ($11^{13}/_{16}$ in.) Focal length 5132 mm (about 17 feet) of the Royal Observatory in Bonn.



Photograph with the same Objective 300 mm/5132 mm $11^{13}/_{16}$ in./about 17 feet) in connection with a Negative Magnifying System; Magnification about $2^{1}/_{2}$ times. Equivalent focal length about 12 Meters (about 40 feet).

PRICE-LIST

OF

ASTRONOMICAL AND PHYSICAL INSTRUMENTS

C. A. STEINHEIL SÖHNE

OPTICAL AND ASTRONOMICAL WORKS

MUNICH

BAVARIA.

Established 1855.

Telephone **No. 6585** Telegrams: **"Optik, Munich".**

Office and Works: **7 Theresienhöhe.**

5250

Terms.

The instruments specified in this list can in general only be made **if ordered definitely (without option of return).** The sizes most commonly required are however nearly always in stock and can be sent on a fortnight's trial, within which time they may be exchanged for other instruments. Reclamations can likewise only be considered if made **within 14 days of the receipt** of the instrument in question.

All prices are net cash. Remittances from abroad should preferably be made by cheque drawn on a German Bank.

Orders should be accompanied by one half of the amount, the other half being payable before delivery. (Government Institutions excepted.)

The firm takes every precaution to ensure secure packing, which is charged for at own cost but is not returnable, and forwards goods insured at own expense, but declines to accept any responsibility for damages during transport. Goods will be sent by the cheapest mode of conveyance unless orders are given to the contrary.

All **dimensions** are given both in the decimal **(metrical)** system and in **English inches.** The prices are quoted in German Marks, one Mark being understood to be equivalent to 1.25 Franc, one shilling (1/20 £), or 25 cents (1/4 $). In the case of other countries payment will be accepted according to the rate of exchange.

The items marked with an asterisk have originated in our works.

The present list cancels the previous lists on astronomical appliances etc.; purchasers are therefore requested to quote this new list (1907) and also the list number when ordering.

Separate lists have also been issued on

a) **Photographic Lenses and Appliances,**
b) **Prism-Binoculars and -Monoculars,**

which will be sent on application.

In the present catalogue our astronomical and physical instruments have been arranged in four groups:

a) Optics proper (objectives, oculars, negative systems, objective prisms, plane and concave mirrors, parabolic mirrors, aplanatic magnifiers, prisms, planoparallel glasses),
b) Telescopes,
c) Spectrum apparatus,
d) Miscellaneous optical instruments.

Group a) will be of interest to those already possessing complete instruments and wishing to add to the optical equipment of such instruments, and to those who, as manufacturers of the mechanical parts of instruments, require a high-class optical complement to the same.

As new in this group must be mentioned the **objectives** made with U. V. **glasses, various oculars,** then the **negative systems** for the construction of reduced telescopes (tele-objectives), and the **parabolic concave mirrors** constructed with the help of specially exact methods of control and measurement and conforming to the highest requirements. And finally the list of **aplanatic magnifiers** has been extended by a new series of greater brightness (1 : 2) and larger field.

Group b) contains in the first place a series of complete telescopes with stands ranging from the small and simple telescope to the large-sized refractor; hereupon follow four series of astronomical telescopes without stands (with doublet and triplet objectives of ordinary glasses and also of glasses without secondary spectrum), and finally a number of special telescopes for various uses, among which the "astronomical binocular" must be mentioned as new.

In order to allow of a better comparison of the various telescopes in respect to their brightness, we have for each series given the diameter of the pencil of rays issuing from the eye-glass (in certain cases the highest and lowest value for this diameter).

The spectrum apparatus of group c) have been more clearly arranged in five series, of which the apparatus for the observation of the ultra-violet region of the spectrum **(quartz spectrum apparatus),** the large **universal spectrometer** and several smaller instruments had up to now not been specified.

Group d) comprises a smaller number of instruments which could not be placed in the foregoing groups; here also several new items have been included.

All wishes in respect to a modified form or new construction of any of these instruments will receive our most careful attention.

The firm has since its establishment set itself the task to manufacture with the highest degree of scientific exactness and perfection optical instruments and appliances of their own computation and design.

The excellence and correct performance of all instruments issuing from their works is therefore fully guaranteed by the firm; all instruments are marked with the abbreviated style "Steinheil München" and the objectives also with the serial number.

In case any instrument through careless handling or long use should become deficient or lose its high efficiency, it is earnestly requested that the same be sent to us for examination and adjustment and never entrusted to strangers for this purpose.

MUNICH 1907.

C. A. Steinheil Söhne

Optical and Astronomical Works.

Contents.

A.

Telescopic Objectives, Oculars, Negative Systems, Objective Prisms, Plane and Concave Mirrors, Parabolic Mirrors, Aplanatic Magnifiers, Prisms, Plano-parallel Glasses.

I. Telescopic Objectives.

The following eight series of telescopic objectives represent a selection of constructive forms differing from one another in computation, effect and brightness, and adapted to meet all possible requirements in the various branches of application for which they are designed.

Series 1 and 2 comprise the telescopic objectives proper of normal construction; the smaller sizes of these series are kept in stock for visual purposes; the further series are on the other hand destined for special purposes and can therefore be made only if ordered definitely.

Series 1, double objectives with a ratio of aperture ranging from 1 : 7 to 1 : 15, may be considered as the true type of telescopic objective; we compute this objective, as originated by us, both with the crown glass and the flint glass in front.

If necessary, the smaller sizes of this series can be made with a brightness up to 1 : 6 or still higher, such objectives being often required for geodetical and similar instruments instead of the triplet objectives; but in the case of the larger sizes the brightness of 1 : 8 or 1 : 10 and even 1 : 12, according to size, should not be exceeded, in order not to forfeit the best possible performance of the glass.

The objectives of series 2, triplets with a ratio of aperture ranging from 1 : 4 to 1 : 6, will be chosen in place of series 1 whenever a high degree of brightness is of primary importance (for comet-finders, terrestrial night telescopes, etc.).

Series 3 and 4 comprise doublet and triplet objectives made of glasses without a secondary spectrum. The peculiar optical constitution of these glasses has made it possible to almost wholly eliminate the secondary spectrum,[1]) the usual corrections at the same time receiving due consideration; objectives constructed with such glasses offer a number of advantages, of which the most important are: the increased sharpness of definition and extraordinary freedom of colouring of the images both for visual and photographic observation and for the observation of spectra.[2]) The doublet objectives can be constructed with a maximum brightness of 1 : 18, the triplets of 1 : 10.

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[1]) A **total** elimination of the secondary spectrum cannot be attained even with these glasses; for the sake of brevity however, the objectives constructed with these new kinds of glass will in the following be characterised as objectives **without** secondary spectrum.

[2]) Vide: "Zeitschrift für Instrumenten-Kunde," June 1899, p. 177.

Series 5 and 6 are doublet and triplet objectives, also constructed with special kinds of glass (so-called "U. V." glass); similar to the last two series, the maximum brightness of these two series does not exceed 1:18 and 1:10 respectively.

For the observation of the ultra-violet part of the spectrum the ordinary kinds of glass are no longer available, since they entirely absorb these rays; in place of quartz (sometimes in connection with fluor-spar or calcareous spar) which was heretofore used for this purpose, these new and special glasses can be used with the greatest success, and compared with quartz, they have the advantage of being free of double refraction and more easily procurable. With objectives constructed with "U. V." glasses, spectrum photographs as far as $\lambda = 310\ \mu\mu$ are possible; also stellar photographs made with "U. V." objectives show a considerably larger number of stars and also more detail in the nebulae etc. than similar exposures with ordinary objectives.

Series 7 has been designed for use in those cases of stellar photography where as large a field as possible is required; these objectives consist of two symmetrically arranged doublets of series 1, resulting in an aplanatic combination with a brightness of about f/8 and a field of about 15° and finest definition. The special glasses of series 3 and 4 or of series 5 and 6, that is to say, glasses with reduced secondary spectrum and glasses which are non-absorbent for the ultra-violet rays can be similarly combined to form such an aplanatic objective at a correspondingly higher price.

Finally, series 8 has been designed for the photography of such faintly luminous objects as nebulae, etc., especially rapid instruments being here necessary. These objectives are computed and constructed according to individual requirements, the unofocal type and in some cases the Petzval type of construction, with a brightness of from f/2.5 to f/4, being chosen.

The lenses of the smaller sizes of the double objectives are generally cemented, those of the larger sizes however uncemented.

The focal distances indicated for the different series are to be regarded as the normal foci and generally represent the shortest length for each indicated aperture (and therefore the greatest advisable brightness); modifications of these normal focal lengths are possible in the case of series 1 and 2 at an extra charge of 25 %; it is also possible to observe any predetermined focal length with an exactitude of ± 1‰ ($^1/_{10}$ inch in 100 inches), a further extra charge of 25 % being hereby entailed.

All telescopic objectives can be supplied corrected either for the optically or chemically efficient part of the spectrum, as the purchaser may desire; in the case of the smaller objectives of series 1 and 2 (up to 108 mm = $4^1/_4$ in. aperture), the correction for photographic purposes involves an extra charge of 10 %.

Since for astronomical purposes more usually objectives of long focus are used, with which only a comparatively small portion of the spectrum can be sharply defined at one and the same time, the summit of the colour curve must, in the case of telescopic objectives destined for photographic purposes, be located at a point of the spectrum differing from that of ordinary photographic lenses.

The result is that the chemical and optical focus no longer coincide, that is to say, the location of the most sharply defined (chemical) image cannot be found with the focussing screen but must be ascertained by careful experiment. Nevertheless, in the case of short foci or of objectives destined for terrestrial photography,

in consequence of the smallness of the faults or the lessened demands made on such objectives, the correction can be carried through in a manner analogous to that for ordinary photographic lenses.

Only the best raw glass is used for the manufacture of the different telescopic objectives, and this is again subjected to the most careful scrutiny and tests with reference to good annealing and freedom from waves and streaks, that is to say, only glass discs which are free of all defects are used; only the crown glass without secondary spectrum cannot, according to the statement of the Jena glass works, be supplied altogether free of fine striae and the like; also the appearance of small bubbles, especially in the larger objectives, cannot be altogether avoided; but such bubbles do not influence the optical efficiency of the objective, a minimal loss of light, at worst less than $^1/_{50}$ %, being the only result.

The mounts of the smaller objectives are of brass, those of the larger of steel; individual wishes in respect to form and execution will be always attended to. Series 7 and 8 are fitted with screw ring and iris diaphragm similar to ordinary photographic lenses.

The objectives are supplied mounted in cells only.

It is advised not to remove objectives from their cells, more especially large objectives, since on the one hand the glasses can easily become strained by an incorrect adjustment of the screws, and on the other hand a bad optical effect may be occasioned by an incorrect adjustment of the lenses themselves; it is therefore best to send objectives to us for the purpose of cleaning, replacing in the cell and examination.

Since the decision of the Paris Congress of 1877 our works make a speciality of telescopic objectives of the largest dimensions (up to 40 inches diameter and more) for the visual and photographic observation of the heavens.

The introduction of Hartmann's test method[1]) in the manufacture of these large objectives has made it possible to calculate with the greatest exactitude not only the total effect of the whole objective in conformity with the highest requirements, but also the execution and effect of each individual zone of the objective.

During the last few years objectives of more than 12 inches diameter have been supplied to the Observatories (mostly State Observatories) in Berlin-Treptow, Bonn, Catania, Copenhagen, Heidelberg, Potsdam, Rome, Upsala, Utrecht, Vienna; we would call special attention to the optical equipment of the great double refractor of the astro-physical observatory in Potsdam with objectives of 20 inches (optical) and 32 inches (photographic) aperture.

[1]) Vide "Zeitschrift für Instrumenten-Kunde," 1902, p. 103, 325.

Series 1.

Doublet Telescopic Objectives

with lenses of normal glasses.

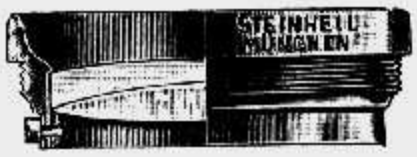

Fig. 1.
Double Telescopic Objective.

Two lenses: a flint-glass meniscus (usually in front) and a biconvex crown-glass lens.

(Fig. 1.)

Ratio of aperture 1:8 to 1:15. — Field 2—3°.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks
1	14	9/16	10,8	4 1/4	**12.—**
2	20	13/16	16,0	6 5/16	**15.—**
3	27	1 1/16	24,0	9 7/16	**18.—**
4	34	1 3/8	32,0	12 5/8	**24.—**
5	41	1 5/8	49,0	19 5/16	**30.—**
6	47	1 7/8	57,0	22 1/16	**38.—**
7	54	2 1/8	65,0	25 5/8	**50.—**
8	61	2 3/8	73,0	28 3/4	**65.—**
9	68	2 11/16	81,0	31 7/8	**85.—**
10	75	2 15/16	114,0	44 7/8	**120.—**
11	81	3 3/16	122,0	48	**150.—**
12	95	3 3/4	142,0	55 15/16	**240.—**
13	108	4 1/4	162,0	63 3/4	**350.—**
14	122	4 13/16	183,0	72 1/16	**480.—**
15	135	5 5/16	203,0	80	**640.—**
16	148	5 13/16	222,0	87 3/8	**900.—**
17	162	6 3/4	243,0	195 3/4	**1180.—**
18	175	6 7/8	262,0	03 1/8	**1480.—**
19	200	7 7/8	300,0	118 1/16	**2100.—**
20	225	8 13/16	337,0	132 3/4	**2900.—**
21	250	9 13/16	375,0	147 5/8	**3700.—**
22	275	10 13/16	412,0	163	**4800.—**
23	300	11 13/16	450,0	177 1/2	**5800.—**
24	330	13	495,0	195 1/4	**7000.—**
25	360	14 3/16	540,0	212 5/16	**9200.—**
26	400	15 3/4	600,0	236 1/4	**12800.—**

Other sizes to order, prices on application.
Intermediate sizes at price of next higher size.

Series 2.

Triplet Telescopic Objectives

with lenses of normal glasses.

Fig. 2.
Triplet Telescopic Objective.

Consisting of a triplet cemented lens: usually a positive crown-glass lens between two flint-glass menisci.

(Fig. 2.)

Ratio of aperture 1:4 to 1:6. — Field 3—4°.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks
27	14	9/16	5,6	2 3/16	**18.—**
28	20	13/16	8,0	3 1/8	**22.—**
29	27	1 1/16	10,8	4 1/4	**27.—**
30	34	1 3/8	13,6	5 3/8	**36.—**
31	41	1 5/8	16,4	6 9/16	**45.—**
32	47	1 7/8	18,8	7 3/8	**58.—**
33	54	2 1/8	21,6	8 1/2	**75.—**
34	61	2 3/8	30,5	12	**100.—**
35	68	2 11/16	34,0	13 3/8	**130.** -
36	75	2 15/16	37,7	14 7/8	**180.—**
37	81	3 3/16	40,5	15 15/16	**225.—**
38	95	3 3/4	47,5	18 3/4	**360.—**
39	108	4 1/4	54,0	21 1/4	**525.—**

Other sizes to order, prices on application.

With these objectives only the astronomical oculars A F, A H, A G, A K and A L, Nos. 124 to 163, and the terrestrial oculars B G and B F, Nos. 172 to 180 can be used.

Series 3.

Doublet Apochromatic Telescopic Objectives

with lenses of glasses without secondary spectrum.

Consisting of two lenses, crown and flint glass, separated by a narrow air space, giving especially colourless and sharply defined images.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks
40	41	1 5/8	74	29 1/8	**45.—**
41	47	1 7/8	85	33 1/2	**58.—**
42	54	2 1/8	97	38 1/4	**75.—**
43	61	2 3/8	110	44	**100.—**
44	68	2 11/16	122	48 3/16	**130.—**
45	75	2 15/16	135	53 1/4	**180.—**
46	81	3 3/16	146	57 1/2	**225.—**
47	95	3 3/4	171	67 5/16	**360.—**
48	108	4 1/4	105	76 3/4	**525.—**
49	122	4 13/16	220	86 5/8	**720.—**
50	135	5 5/16	243	95 3/4	**960.—**
51	148	5 13/16	266	104 7/8	**1350.—**
52	162	6 3/8	292	115 1/8	**1700.—**
53	175	6 7/8	315	124 1/4	**2200.—**
54	200	7 7/8	360	141 11/16	**3200.—**
55	225	8 7/8	405	159 3/4	**4300.—**
56	250	9 7/8	450	177 1/2	**5500.—**
57	275	10 7/8	495	195 1/4	**7200.—**
58	300	11 7/8	540	212 3/16	**8700.—**
59	330	13	595	234 1/4	**10500.—**
60	360	14 3/16	648	255 1/16	**13500.—**
61	400	15 3/4	720	283 1/2	**10200.—**

Other sizes to order, prices on application.

Series 4.

Triplet Apochromatic Telescopic Objectives

with lenses of glasses without secondary spectrum.

Consisting of three lenses (1 crown and 2 flint or 1 flint and 2 crown). Similar to the preceding series, giving especially colourless and sharply defined images. Ratio of aperture 1:10. — Field 3—4°.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks
62	41	1 5/8	41	16 1/8	**68.—**
63	47	1 7/8	47	18 1/2	**86.—**
64	54	2 1/8	54	21 1/4	**112.—**
65	61	2 3/8	61	24	**150.—**
66	68	2 11/16	68	26 3/4	**195.—**
67	75	2 15/16	75	29 9/16	**270.—**
68	81	3 3/16	81	31 7/8	**330.—**
69	95	3 3/4	95	37 7/16	**540.—**
70	108	4 1/4	108	42 5/16	**800.—**
71	122	4 13/16	122	48	**1050.—**
72	135	5 5/16	135	53 1/8	**1400.—**
73	148	5 13/16	148	58 1/4	**2000.—**
74	162	6 3/8	162	63 3/4	**2400.—**
75	175	6 7/8	175	68 7/8	**3300.—**
76	200	7 7/8	200	78 3/4	**4800.—**

Other sizes to order, prices on application.

Note. In the case of objectives with reduced secondary spectrum the colour curve in the spectrum is considerably flatter than with ordinary objectives, and the objectives of series 3 and 4 can therefore, the summit of this curve being suitably located, be used at one and the same time for visual and photographic purposes.

Series 5.

Doublet U. V. Telescopic Objectives

with lenses of special glasses, non-absorbent for ultra-violet rays.

[Combination of lenses as in series 1.]

Especially designed for work in the ultra-violet region of the spectrum, but also available for ordinary purposes.

Ratio of aperture 1 : 18. — Field 2—3°.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks	No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks
77	14	9/16	25	10	**20.—**	83	54	2 1/8	97	38 1/4	**66.—**
78	20	13/16	36	14 3/16	**22.—**	84	61	2 3/8	110	44	**86.—**
79	27	1 1/16	48	18 7/8	**24.—**	85	68	2 11/16	122	48 3/16	**112.—**
80	34	1 3/8	61	24	**32.—**	86	75	2 15/16	135	53 1/4	**160.—**
81	41	1 5/8	74	29 1/8	**40.—**	87	81	3 3/16	146	57 1/2	**200.—**
82	47	1 7/8	85	33 1/2	**50.—**						

Other sizes to order, prices on application.

Series 6.

Triplet U. V. Telescopic Objectives

with lenses of special glasses, non-absorbent for ultra-violet rays.

[Combination of lenses as in series 2.]

Similar to the preceding weaker series especially designed for observation of the ultra-violet region of the spectrum, but also available for ordinary purposes.

Ratio of aperture 1 : 10. — Field 3—4°.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks	No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks
88	14	9/16	14	5 1/2	**30.—**	94	54	2 1/8	54	21 1/4	**100.—**
89	20	13/16	20	7 7/8	**30.—**	95	61	2 3/8	61	24	**130.—**
90	27	1 1/16	27	10 5/8	**36.—**	96	68	2 11/16	98	26 3/4	**170.—**
91	34	1 3/8	34	13 3/8	**48.—**	97	75	2 15/16	75	29 9/16	**240.—**
92	41	1 5/8	41	16 1/8	**60.—**	98	81	3 3/16	81	31 7/8	**330.—**
93	47	1 7/8	47	18 1/2	**75.—**						

Series 7.

Four-Lens Telescopic Objectives

(aplanatic construction) with lenses of ordinary flint and crown glasses.

Consisting of two similar cemented lens doublets, each having a front flint-glass meniscus and a positive crown-glass lens. Brass cell with screw-ring and iris diaphragm.

Ratio of aperture: 1:8 to 1:10. — Field about 15°.

No.	Aperture		Focus		Price	No.	Aperture		Focus		Price
	mm	in.	cm	in.	Marks		mm	in.	cm	in.	Marks
99	54	2 1/8	43	17	**120.—**	102	108	4 1/4	86	33 7/8	**750.—**
100	68	2 11/16	54	21 1/4	**200.—**	103	135	5 5/16	135	53 1/4	**1200.—**
101	81	3 3/16	65	25 5/8	**350.—**	104	162	6 3/8	162	63 3/4	**2400.—**

Other sizes to order, prices on application.

Prices of four-lens objectives constructed with glasses without secondary spectrum on application.

Prices of four-lens objectives constructed with U. V. glasses on application.

Series 8.

Telescopic Objectives of Greatest Brightness

for astronomical photography, especially of faintly luminous objects (nebulae etc.); these objectives are computed in each individual case either according to the uno-focal or the Petzval type.

Brightness 1:2,5 to 1:4. — Field 8 to 10°.

Prices on application. Brass cell and iris diaphragm.

II. Oculars.

The apparent field of an ocular is the angle formed by two rays coming from opposite points of the circumference of the diaphragm and meeting in the eye-point.

The effective field of a telescope may be found by dividing the apparent field of the ocular by the magnification of the telescope.

The magnification of a telescope may be found by dividing the focal length of the objective by the focal length of the ocular.

The diameter of the pencil of rays issuing from the ocular[1] is found by dividing the objective aperture by the magnification; the square of the value thus found represents the relative brightness of the telescope.

Example: A telescope consists of:

An objective with an aperture of 20 mm and 120 mm focus.
an ocular A K, focus 20 mm.

Then, (the apparent field of the ocular A K, 40°, being already known) we get:

Magnification: $\frac{\text{objective focus}}{\text{ocular focus}} = \frac{120}{20} = 6$

Effective field: $\frac{\text{apparent field}}{\text{magnification}} = \frac{40}{6} = 6^2/_3{}^0$

Diameter of pencil of rays $\frac{\text{objective aperture}}{\text{magnification}} = \frac{20}{6} = 3^2/_3$ mm

Relative brightness = (pencil of rays)$^2 = 3^2/_3{}^2 = 13{,}4$.

See also the tables of the magnification and pencils of rays of the existing objectives and oculars, page 20 and 21, and introduction to telescopes, page 32.

Of the following various astronomical oculars only the first type (A D) has the image between the lenses (and is therefore sometimes falsely termed a negative

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[1] When selecting ocular and magnification it must be remembered that the diameter of the pencil of rays (except in the case of especially bright objects) should not be less than 0,3 mm or about $^1/_{15}$ inch, and that on the other hand it would be useless to make said diameter greater than 8 mm or about 1/3 inch, since even in the dark the pupil of the human eye does not open to more than about 1/3 inch and therefore cannot admit more rays however great the pencil of rays.

ocular); with all the other oculars the image is located at a greater or lesser distance in front of the lenses.

For the triplet telescopic objectives (series 2) the achromatic oculars Nos. 124 to 163 and 172 to 180 must be chosen, in order to fully utilise the brightness of these objectives; on the other hand, the doublet objectives (series 1) can be used with any desired ocular.

When additional oculars are ordered for already existing instruments, it suffices to give the serial (manufacturer's) number of the objective of the instrument in question if same possesses our standard thread; in all other cases we require a pattern (thread or ocular); in the case of terrestrial oculars it should further be stated whether they are to be fitted with "draw and spring", as for draw telescopes, in place of the ordinary form with fixed screw mount. The astronomical oculars all possess a rigid tube and screw mount, only the five smallest oculars of the first type (A D) are without screw and are made interchangeable in common sliding sleeve.

If desired, the oculars can be provided with a screw thread other than our standard thread, but in all such cases (with the exception of the English standard screw) pattern screws must be sent to us; such oculars will be supplied without increase of price, but only if definitely ordered and without option of return; oculars with our standard screw can on the other hand, if in stock, be sent on approval.

Fig. 3.
Ocular A D.

A. Astronomical Oculars.

A D Mittenzwey Ocular (improved Huyghen ocular).

Consisting of a convexo-concave collective and a plano-convex eye-lens; free from reflection, image between the lenses. Apparent field about 50°.

(Fig. 3.)

No. 105	A D 81 mm = $3^{3}/_{16}$ in. equivalent focus, in screw mount	Mk.	**80.—**
„ 106	A D 68 „ = $2^{11}/_{16}$ „ „ „ „ „ „	„	**50.—**
„ 107	A D 54 „ = $2^{1}/_{8}$ „ „ „ „ „ „	„	**35.—**
„ 108	A D 41 „ = $1^{5}/_{8}$ „ „ „ „ „ „	„	**22.—**
„ 109	A D 27 „ = $1^{1}/_{16}$ „ „ „ „ „ „	„	**12.—**
„ 110—114	A D 20, 14, 9, 7 and 5 mm = $^{13}/_{16}$, $^{9}/_{16}$, $^{3}/_{8}$, $^{1}/_{4}$, $^{3}/_{16}$ in. equivalent focus, for draw-tube, without sliding sleeve, each	„	**10.—**
„ 115	Sliding sleeve for oculars A D Nos. 110 to 114, with screw	„	**2.—**

Fig. 4.
Ocular A R.

A R Ramsden Oculars.

Consisting of two plano-convex lenses (the plane surfaces on the outside). Image in front of the lenses (simple micrometer oculars). Apparent field about 34°.

(Fig. 4.)

No. 116	A R 54 mm = 2⅛ in. equivalent focus, in screw mount	Mk.	**32.—**
„ 117	A R 41 „ = 1⅝ „ „ „ „ „ „ „	„	**21.—**
„ 118	A R 27 „ = 1 1/16 „ „ „ „ „ „ „	„	**12.—**
„ 119—123	A R 20, 14, 9, 7 and 5 mm = 13/16, 9/16, 3/8, 1/4, 3/16 in. equivalent focus, in screw mount, each	„	**10.—**

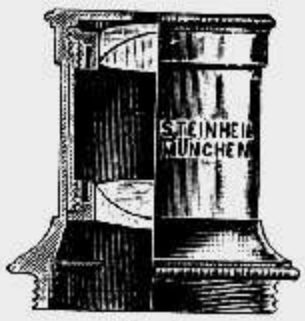

Fig. 5.
Ocular A F.

* A F Achromatic Micrometer Oculars.

Consisting of two symetrically arranged achromatic objectives. Image in front of the lenses. Free from distortion, giving especially sharply defined and colourless images. Apparent field about 36°. (Fig. 5.)

No. 124	A F 81 mm = 3 3/16 in. equivalent focus, with screw mount	Mk.	**130.—**
„ 125	A F 68 „ = 2 11/16 „ „ „ „ „ „ „	„	**84.—**
„ 126	A F 54 „ = 2⅛ „ „ „ „ „ „ „	„	**60.—**
„ 127	A F 41 „ = 1⅝ „ „ „ „ „ „ „	„	**40.—**
„ 128	A F 27 „ = 1 1/16 „ „ „ „ „ „ „	„	**24.—**
„ 129—133	A F 20, 14, 9, 7 and 5 mm = 13/16, 9/16, 3/8, 1/4, 3/16 in. equivalent focus, with screw mount, each	„	**21.—**

Fig. 6.
Astronomical Ocular A G.

* A G Monocentric Micrometer Oculars.

Consisting of three cemented lenses (one concentric crown-glass lens between two flint-glass menisci) of which the radii are all struck from a common centre. Image in front of the lenses, free from distortion and all reflections. Particularly recommended for use with the circle-micrometer steel rings (No. 186) etc. Apparent field about 32°. (Fig. 6.)

No. 134	A G 54 mm = 2⅛ in. equivalent focus, with screw mount	Mk.	**60.—**
„ 135	A G 41 „ = 1⅝ „ „ „ „ „ „ „	„	**40.—**
„ 136	A G 27 „ = 1 1/16 „ „ „ „ „ „ „	„	**24.—**
„ 137—140	A G 20, 14, 9 and 7 mm = 13/16, 9/16, 3/8, 1/4 in. equivalent focus, with screw mount, each	„	**21.—**

Fig. 7.
Astronomical Ocular A H.

* A H Aplanatic Micrometer Oculars.

Consisting of three cemented lenses (one biconvex crown-glass lens between two flint-glass menisci). Absolutely free from colour, distortion and reflections. Image in front of the lenses and at a considerable distance from the first lens. These oculars are therefore particularly adapted for use with cross-line micrometers etc. (Compare also aplanatic magnifiers p. 24). Apparent field about 20°. (Fig. 7.)

No. 141	A H 95 mm = 3¾ in. equivalent focus, with screw mount	Mk.	**60.—**
„ 142	A H 61 „ = 2⅜ „ „ „ „ „ „ „	„	**30.—**
„ 143	A H 41 „ = 1⅝ „ „ „ „ „ „ „	„	**20.—**
„ 144	A H 27 „ = 1 1/16 „ „ „ „ „ „ „	„	**18.—**
„ 145 - 147	A H 20, 14 and 9 mm = 13/16, 9/16, 3/8, in. equivalent focus, with screw mount, each	„	**16.—**

A K Improved Kellner Ocular.

Fig. 8.
Astronomical Ocular A K.

Consisting of a cemented eye-lens with one plane surface and a plano-convex collective lens, both plane surfaces on the outside. Free from reflection and distortion, giving especially clear, achromatic images of wide angle sharply defined to the edges. Image in front of the lenses, just in front of the plane surface of the collective lens. Apparent field about 40°.
(Fig. 8.)

No. 148	A K 68 mm = $2^{11}/_{16}$ in. equivalent focus, with screw mount	Mk. **64.**—
„ 149	A K 54 „ = $2^{1}/_{8}$ „ „ „ „ „ „	„ **45.**—
„ 150	A K 41 „ = $1^{5}/_{8}$ „ „ „ „ „ „	„ **30.**—
„ 151	A K 27 „ = $1^{1}/_{16}$ „ „ „ „ „ „	„ **22.**—
„ 152—155	A K 20, 14, 9 and 7 mm = $^{13}/_{16}$, $^{9}/_{16}$, $^{3}/_{8}$, $^{1}/_{4}$ in. equivalent focus, with screw mount, each	„ **18.**—

A L Orthoscopic Ocular.

Fig. 9.
Astronomical Ocular A L.

Consisting of a single plano-convex eye-lens and a treble cemented field lens; free from colour, reflections or distortion; giving very clear, flat images sharply defined to the edges at a great eye-distance, therefore especially adapted for micrometer work etc. Image in front of the lenses. Apparent field about 40°.
(Fig. 9.)

No. 156	A L 54 mm = $2^{1}/_{8}$ in. equivalent focus, with screw mount	Mk. **52.**—
„ 157	A L 41 „ = $1^{5}/_{8}$ „ „ „ „ „ „	„ **38.**—
„ 158	A L 27 „ = $1^{1}/_{16}$ „ „ „ „ „ „	„ **28.**—
„ 159—163	A L 20, 14, 9, 7 and 5 mm = $^{13}/_{16}$, $^{9}/_{16}$, $^{3}/_{8}$, $^{2}/_{4}$, $^{3}/_{16}$ in. equivalent focus, with screw mount, each	„ **24.**—

B. Terrestrial Oculars.

The terrestrial oculars can be supplied, as desired
a) with fixed tube and screw mount with our own or other thread,
b) with smooth tube and sliding screw sleeve, draw and spring (for draw telescopes),
c) with smooth tube for insertion in existing sleeve.

B D Normal Terrestrial Oculars.

Fig. 10. Terrestrial Ocular B D.

Consisting of four plano-convex lenses (the plane surfaces of the first and fourth lenses on the outside), the images before the first and between the third and fourth lens. Apparent field about 38°. These oculars can only be used in connection with objectives up to f/8; a greater brightness of the objective could not be fully utilised with this ocular.

Enlarged Photograph of the Nebulae in Orion taken with a Parabolic Concave Mirror Aperture 30 cm ($11^{13}/_{10}$ in.), Focal Length 90 cm (about 3 feet) of the Royal Astrophysical Observatory in Potsdam.

No. 182 **Ocular Microscope,** which may be used as an ocular of 3.4 mm (1/8 in.) equivalent focus, for especially great magnification. It is composed of an objective having an image distance of 27 mm (1 1/16 in.) and an object distance of 108 mm (4 1/4 in.) and of an ocular A D of 14 mm (9/16 in.) equivalent focus . . . . . Mk. **42.—**

D. Accessories for the Oculars.

No. 183 **Reversing Prism System,** consisting of three prisms cemented at right angles to each other, in metal case; for reversing the image and making astronomical oculars also available for terrestrial observation . . . . . Mk. **60.—**

No. 184 **Reversing Prism System,** similar to No. 183, but with three oculars A F arranged on revolving disc . . . . . Mk. **150.—**

No. 185 **Cross-lines,** cobweb or platinum wire, for each ocular . . . . . Mk. **3.—**

No. 186 **Cross-lines,** etched on plano-parallel glass disc, for each ocular . . . . . Mk. **5.—**

No. 187 **Circle Micrometer Steel Rings,** on plano-parallel glass . . . . . Mk. **20.—**

No. 188 **Needle Point Micrometer.** Two fine steel (or platinum) needle points in the field of view of the ocular, one fixed and the other moved by a micrometer screw with graduated head. The distance between the points is to be measured by a scale . . . . . Mk. **50.—**

No. 189 **Cross-line Micrometer,** with cross-lines etched on plano-parallel glass, movable across the field by means of a micrometer screw with graduated head . . . . Mk. **40.—**

No. 190 **Position Circle,** for micrometer oculars, graduated in degrees . . . . . Mk. **36.—**

No. 191 **Dynameter,** for measuring the diameter of pencils of rays as a means of determining the telescopic magnification: fitted with aplanatic magnifier and glass scale divided in 1/10 millimeter; with sliding adjustment . . . . . Mk. **40.—**

No. 192 **Adapter Ring,** enabling smaller oculars to be screwed into the mounts of larger Mk. **3.—**

No. 193 **Connecting Tube with Diaphragm,** to permit (especially in the case of draw telescopes) the use of an astronomical ocular in place of the terrestrial . . . . Mk. **5.—**

No. 194 **Ocular Cap Prism,** attachable to eye-piece, for zenith observations; deflection about 80", aperture 9 mm (3/8 in.) . . . . . Mk. **9.—**

No. 195 **Ocular Prism,** for zenith stars; reflection 90°, aperture 27 mm (1 1/16 in.), mounted, capable of rotation and fixation in any position. It screws to the telescope immediately behind the ocular . . . . . Mk. **48.—**

No. 196 **Prof. Vogel's Triple Prism,** arranged for vision in a straight line; for examining the achromatisation of telescopes, mounted, for screwing to ocular . . . . . Mk. **50.—**

No. 197 **Dark Glass,** in fixed mount, for screwing on ocular . . . . . Mk. **2.—**

No. 198 **Dark Glass,** interchangeable in mount, for screwing on ocular . . . . . Mk. **3.—**

No. 199 **Dark Glasses,** unmounted, for No. 198, light, middle, or dark, each . . . . Mk. **1.—**

No. 200 **Zenger's Solar Prism,** consisting of two right-angled prisms cut from two but slightly differing kinds of glasses and having their hypothenuse surfaces cemented together. This results in but little light being reflected at the plane of contact of the two prisms and solar observations can therefore be made with a neutrally coloured image: in mount for fitting on ocular . . . . . Mk. **35.—**

No. 201 **Sliding Wedge,** for moderating light to any degree of brightness, consisting of a wedge of dark neutral tint glass cemented to a similar wedge of white glass, both together forming a parallel plate, size about 10 by 100 mm (3/8 by 4 in.) Mk. **20.—**

No. 202 **Holder for the Sliding Wedge** No. 201, to screw into draw tube and provided with screw thread to take ocular screw, arranged for adjustment of the wedge Mk. **8.—**

No. 203 **Ocular Helioscope** or **Polarisation Ocular;** four plane mirrors, opposed to each other in couples, are arranged at an angle of 45° to the optical axis of the telescope, the one pair of mirrors being adjustable in respect to the other by means of a graduated head. By means of the rotation of the mirror-couples the intensity of the solar image is more or less modified, so that observation of the sun is possible without the intervention of a dark glass and the resulting introduction of artificial colouring . . . . . Mk. **180.—**

Note 1: When using Nos. 183 and 203, attention must be paid to the fact that the draw tube of the telescope must be shortened by about 10 cm (4 in.) as compared with the normal ocular adjustment for infinity; in the case of Nos. 195 and 201/202, this shortening will be 4 cm ($1^{9}/_{16}$ in.).

Note 2: The prices of the accessories, unless otherwise specified, are for astronomical oculars up to 20 mm ($^{13}/_{16}$ in.) equivalent focal length; quotations for accessories for larger oculars will be given on application

Tables of Magnifications and Pencils of Rays.

In order to facilitate the correct combination of a telescope for a given brightness and magnification, we have here added two tables containing the values for the magnifications and pencils of rays resulting from the combination of an objective and ocular to form a telescope, these values varying according to the aperture of the objective and the focal lengths of objective and ocular.

Only the focal lengths and apertures of the objectives of series 1 have been included in these tables, since these objectives are in greatest request; the values for the other series and other focal lengths can easily be found by analogy, the simple formulae on page 13 being taken into consideration.

For practical reasons we have given the individual magnifications only in whole numbers; further abnormally large or small magnifications, which will in practice never be required of the objectives in question, have been omitted; we have also chosen as the lowest and highest limits of the pencils of rays 0,3 mm and 8 mm ($^{1}/_{75}$ and $^{5}/_{16}$ in.). (Vide also footnote page 13.)

Table 1.

Magnifications; Objectives of Series 1 with Oculars.

Objectives				Ocular focal lengths							
Aperture		Focal length		mm and inches							
mm	in.	cm	in.	54 (2 1/8)	41 (1 5/8)	27 (1 1/16)	20 (13/16)	14 (9/16)	9 (3/8)	7 (1/4)	5 (3/16)
14	9/16	10,8	4 1/4	—	—	—	5	8	12	15	22
20	13/16	16,0	6 5/16	—	—	6	8	12	18	24	32
27	1 1/16	24,0	9 7/16	—	6	9	12	17	27	34	48
34	1 3/8	32,0	12 5/8	6	8	12	16	23	36	46	64
41	1 5/8	49,0	19 5/16	9	12	18	24	35	54	70	94
47	1 7/8	57,0	22 7/16	10	14	21	28	40	63	81	114
54	2 1/8	65,0	25 5/8	12	16	24	32	47	72	94	130
61	2 3/8	73,0	28 3/4	13	18	27	36	52	81	104	146
68	2 11/16	81,0	31 7/8	15	19	30	40	58	90	116	162
75	2 15/16	113,0	44 7/8	21	28	42	57	81	126	162	228
81	3 3/16	122,0	48	23	30	46	61	87	136	174	244
95	3 3/4	142,0	55 15/16	26	35	52	71	102	158	204	284
108	4 1/4	162,0	63 3/4	30	40	60	81	116	180	232	324
122	4 13/16	183,0	72 1/16	34	42	68	91	130	203	260	366
135	5 5/16	203,0	80	37	50	74	101	145	225	290	406
148	5 13/16	222,0	87 3/8	41	54	82	111	158	246	316	444
162	6 3/8	243,0	95 3/4	45	59	90	121	174	270	348	486
175	6 7/8	262,0	103 1/8	48	64	96	131	187	290	375	524
200	7 7/8	300,0	118 1/16	55	73	111	150	215	333	430	600
225	8 13/16	337,0	132 3/4	63	82	127	168	240	375	480	674
250	9 13/16	375,0	147 5/8	70	91	139	187	265	420	530	750
275	10 13/16	412,0	163	76	100	152	206	295	458	590	—
300	11 13/16	450,0	177 1/2	83	109	167	225	330	500	660	—
330	13	495,0	195 1/4	91	120	182	247	355	550	710	—
360	14 3/16	540,0	212 3/16	100	132	200	270	385	600	—	—
400	15 3/4	600,0	236 1/4	110	146	220	300	427	660	—	—

Magnifications

Table 2.

Pencils of rays; Objectives of Series 1 with Oculars.

Objectives				Magnifications							
Aperture		Focal length									
mm	in.	cm	in.	5	10	25	50	100	200	400	600
14	9/16	10,8	4 1/4	2,8	1,4	0,5	—	—	—	—	—
20	13/16	16,0	6 5/16	4,0	2,0	0,8	0,4	—	—	—	—
27	1 1/16	24,0	9 7/16	5,4	2,7	1,1	0,5	—	—	—	—
34	1 3/8	32,0	12 5/8	6,8	3,4	1,3	0,7	0,3	—	—	—
41	1 5/8	49,0	19 5/16	8,2	4,1	1,6	0,8	0,4	—	—	—
47	1 7/8	57,0	22 7/16	—	4,7	1,8	0,9	0,5	—	—	—
54	2 1/8	65,0	25 5/8	—	5,4	2,2	1,1	0,5	—	—	—
61	2 3/8	73,0	28 3/4	—	6,1	2,4	1,2	0,6	0,3	—	—
68	2 11/16	81,0	31 7/8	—	6,8	2,7	1,3	0,6	0,3	—	—
75	2 15/16	113,0	44 7/8	—	7,5	3,0	1,5	0,7	0,3	—	—
81	3 3/16	122,0	48	—	8,1	3,2	1,6	0,8	0,4	—	—
95	3 3/4	142,0	55 15/16	—	—	3,8	1,9	0,9	0,4	—	—
108	4 1/4	162,0	63 3/4	—	—	4,1	2,0	1,0	0,5	—	—
122	4 13/16	183,0	72 1/16	—	—	4,9	2,4	1,2	0,6	0,3	—
135	5 5/16	203,0	80	—	—	5,4	2,7	1,4	0,7	0,3	—
148	5 13/16	222,0	87 3/8	—	—	6,0	3,0	1,5	0,7	0,3	—
162	6 3/8	243,0	95 3/4	—	—	6,4	3,2	1,6	0,8	0,4	—
175	6 7/8	262,0	103 1/8	—	—	7,0	3,5	1,8	0,9	0,4	—
200	7 7/8	300,0	118 1/16	—	—	8,0	4,0	2,0	1,0	0,5	0,3
225	8 13/16	337,0	132 3/4	—	—	—	4,5	2,2	1,1	0,5	0,3
250	9 13/16	375,0	147 5/8	—	—	—	5,0	2,5	1,2	0,6	0,4
275	10 13/16	412,0	163	—	—	—	5,5	2,7	1,3	0,6	0,4
300	11 13/16	450,0	177 1/2	—	—	—	6,0	3,0	1,5	0,7	0,5
330	13	495,0	195 1/4	—	—	—	6,6	3,3	1,6	0,8	0,5
360	14 3/16	540,0	212 3/16	—	—	—	7,2	3,6	1,8	0,9	0,6
400	15 3/4	600,0	236 1/4	—	—	—	8,0	4,0	2,0	1,0	0,7

Diameter of pencil of rays in Millimeter.

III. Magnifying Systems, Objective Prisms, Plane and Concave Mirrors.

a] Achromatic Negative Systems.

Consisting of a triple cemented concave lens. On the one hand, in combination with a chemically achromatised objective, these negative systems constitute a reduced photographic telescope (vide page 52), and on the other hand they are used for magnifying the (solar or lunar) image formed by an objective.

The principal point of the whole system is hereby brought far to the front, so that the resulting telescope is considerably shorter than the total focal length of the complete instrument, thus giving large images with a comparatively short instrument. Ratio of aperture 1 : 2. In plain black brass mount.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks	No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Price Marks
204	22	7/8	4,5	1 3/4	**45.—**	207	37	1 1/2	7,5	3	**65.—**
205	28	1 1/8	5,6	2 3/16	**50.—**	208	45	1 3/4	9,0	3 1/2	**80.—**
206	33	1 5/16	6,7	2 5/8	**56.—**	209	67	2 5/8	13,5	5 5/16	**105.—**

Other magnifying systems (negative and positive), also corrective systems for adapting an optical objective for chemical work and vice versa, will be made to order, prices on application.

b] Objective Prisms

refracting angle 3 to 7°

made of finely annealed, almost colourless light-flint: in cell to fit the mount of objective and with device for exact adjustment for the minimum deviation. The aperture of the prism is the same as that of the objective.

No.	Clear aperture mm	Clear aperture in.	Price Marks	No.	Clear aperture mm	Clear aperture in.	Price Marks
210	108	4 1/4	**220.—**	214	220	7 7/8	**1200.—**
211	135	5 5/16	**380.—**	215	225	8 7/8	**2000.—**
212	162	6 3/8	**650.—**	216	250	9 7/8	**2500.—**
213	175	6 7/8	**900.—**	217	275	10 7/8	**3200.—**

Other sizes to order, prices on application.

Objective prisms with greater refracting angles can be made to order, prices on application.

c] Plane Glasses and Spherical Concave Mirrors

circular, unsilvered and unmounted.

Made of finely annealed crown glass; the front face polished accurately plane or spherical; the back ground matted; thickness about 1/10 of the diameter.

No.	Diameter mm	Diameter in.	Price Marks	No.	Diameter mm	Diameter in.	Price Marks
218	up to 34	1 3/8	**15.—**	228	175	6 7/8	**380.—**
219	41	1 5/8	**18.—**	229	200	7 7/8	**470.—**
220	47	1 7/8	**22.—**	230	225	8 7/8	**600.—**
221	54	2 1/8	**28.—**	231	250	9 7/8	**750.—**
222	61	2 3/8	**38.—**	232	275	10 7/8	**950.—**
223	68	2 11/16	**45.—**	233	300	11 7/8	**1200.—**
224	81	3 3/16	**70.—**	234	330	13	**1500.—**
225	108	4 1/4	**120.—**	235	360	14 3/16	**2000.—**
226	135	5 5/16	**200.—**	236	400	15 3/4	**3000.—**
227	162	6 3/8	**300.—**				

Other sizes to order, prices on application.

Plane and spherical concave mirrors of metal instead of glass entail, on account of the greater expense of the material and difficulty of manufacture, an extra charge of 50 %.

Plane mirrors of glass for reflectors and other purposes can also be supplied edged in such a manner that when inclined 45° they are projected as a circle. The price is then the same as that for a circular mirror of the diameter of the longer axis, with the addition of from 5 to 10 % extra charge for edging.

For **silvering** the faces of plane or concave mirrors (so-called direct silvering) we charge Mk. —.25 per sq. cm (Mk. 1.60 per sq. inch) up to 108 mm (4 1/4 in.) diameter; larger mirrors at a correspondingly reduced price. Minimum charge Mk. 3.—.

d] Parabolic Concave Mirrors

for visual or photographic observation of stellar objects in place of telescopic objectives. Most perfect correction of spherical aberration (tested by Hartmann's method); constructed of finely annealed crown-glass, unmounted and unsilvered. Ratio of aperture 1 : 6.

No.	Diameter mm	Diameter in.	Focal length cm	Focal length in.	Price Marks	No.	Diameter mm	Diameter in.	Focal length cm	Focal length in	Price Marks
237	up to 68	2 11/16	up to 40	15 3/4	**100.—**	244	225	8 7/8	135	53 1/8	**1050.—**
238	81	3 3/16	57	22 7/16	**150.—**	245	250	9 7/8	150	59	**1300.—**
239	108	4 1/4	65	25 5/8	**250.—**	246	275	10 7/8	165	65	**1600.—**
240	135	5 5/16	81	31 7/8	**380.—**	247	300	11 7/8	180	71	**2000.—**
241	162	6 3/8	98	38 5/8	**540.—**	248	330	13	198	78	**2500.—**
242	175	6 7/8	105	41 3/8	**680.—**	249	360	14 3/16	216	85	**3200.—**
243	200	7 7/8	120	47 1/4	**850.—**	250	400	15 3/4	240	94 1/2	**4500.—**

For special requirements these parabolic mirrors can also be supplied with a greater brightness (up to **1 : 3**); quotations will be given in each individual case. Charges for silvering parabolic mirrors vide above.

IV. Aplanatic Magnifiers

(old and new type).

This construction originated in 1865 and is principally distinguished by its large flat and throughout achromatic field*), the complete absence of distortion and its long working distance.

The introduction of new kinds of glass has made it possible to add a second improved series of these lenses, distinguished by increased brightness and an especially flat and large field; the combination is similar to the older type although of greater lens diameter. The older type has a ratio of aperture of 1 : 3, the improved new type 1 : 2.

The formula of the aplanatic magnifiers has been applied not only to the construction of the ordinary magnifiers used in the examination of small objects but also to that of photographic focussing lenses, i. e. lenses for focussing the image on the ground glass (vide Price List of Photographic Instruments), and to that of oculars (vide aplanatic micrometer oculars A H). In special cases, e. g. when intended as enlarging lenses of shortest possible focus for photo-micrographic purposes etc., these lenses can also be made to order corrected for chemical rays. This correction occasions an extra charge of 25 %.

The magnifying power of these magnifiers may be found by the formula:

$$\frac{\text{distance of normal vision}}{\text{focal length of lens}} + 1 = \text{magnification};$$

the distance of normal vision being approximately 24 cm or 9 inches, we get as magnification for a lens of 1 in. focal length $\frac{9}{1} + 1 = 10$; from this it also follows that with a short sighted (myopic eye the magnification is less, and with a long-sighted (presbyopic) eye greater, than with a normal eye.

The mounts of the magnifiers are made of metal (brass), either polished — the larger sizes in polished brass ring (Fig. 14) and the smaller in folding mount for the pocket (Fig. 15), — or plain black; the former (polished ring and folding mount) are suitable for direct handling, whilst the latter plainer form is recommended for use with a holder (as provided with No. 267) or with a stand (No. 268). If ordered definitely, mounts made of an alloy of aluminium instead of brass will be provided without extra charge; these are lighter, but at the same time less durable than brass mounts.

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*) The large field of the aplanatic magnifiers can only be fully utilised if the magnifier be held as near to the eye as possible when viewing the object.

For especially high magnification two magnifiers may be combined and mounted as shown in Fig. 16, so that they may be used either together or singly. (Nos. 265, 266, 279, 280).

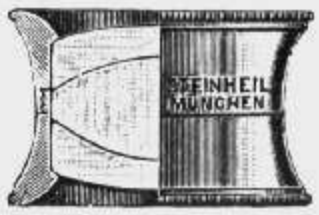

Fig. 14.
Aplanatic Magnifier
in Polished Brass Ring.

Fig. 15.
Aplanatic Magnifier
in Folding Mount

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a] Aplanatic Magnifiers

old type.

Aperture		Focus		Magnification	Polished ring* or folding mount		Plain mount (black ring)	
mm	in.	mm	in.	about	No.	Marks	No.	Marks
35,0	1 3/8	95	3 3/4	3,5 X	251*)	**45.—**	258	**42.—**
22,0	7/8	61	2 7/16	5,0 X	252*)	**20.—**	259	**18.—**
15,0	9/16	41	1 5/8	7,0 X	253	**18.—**	260	**12.—**
10,0	3/8	27	1 1/16	10,0 X	254	**15.—**	261	**11.—**
7,0	1/4	18	11/16	14,0 X	255	**15.—**	262	**11.—**
5,0	3/16	14	9/16	20,0 X	256	**15.—**	263	**11.—**
3,5	1/8	9	3/8	28,0 X	257	**15.—**	264	**11.—**

No. **265** **Aplanatic Two-lens Magnifier,** low power, Nos. **254** and **256** combined in one folding mount; magnifications of single lenses, **10** and **20** X, together **30** X (Fig. 16) . . . . . Mk. **30.—**

No. **266** **Aplanatic Two-lens Magnifier,** high power, Nos. **255** and **257** combined in one folding mount; magnifications of single lenses, **14** and **28** X, together **42** X Mk. **30.—**

No. **267** **Set** of six aplanatic magnifiers Nos. **259** to **264**, including holder, in case . . . Mk. **85.—**

No. **268** **Dissecting Microscope Stand** for these magnifiers Nos. **259** to **264**, with rack adjustment, rotating lens-holder, fixed stage with glass plate attached, movable illuminating mirror, together in case: price exclusive of lenses; (Fig. **17**) . . . Mk. **40.—**
Hand-rests, extra . . . . . Mk. **5.—**

Fig. **16.** Aplanatic Two-lens
Magnifier in Folding Mount.

Fig. **17.** Dissecting Microscope
Stand, with Hand-rests.

b] Improved Aplanatic Magnifiers.

Aperture mm	Aperture in.	Focus mm	Focus in.	Magnification	Folding mount No.	Folding mount Marks	Plain mount (black ring) No.	Plain mount (black ring) Marks
18,0	11/16	36	1 7/16	8 X	269	**25.—**	274	**20.—**
14,0	9/16	28	1 1/4	10 X	270	**20.—**	275	**16.—**
8,0	5/16	16	5/8	16 X	271	**20.—**	276	**16.—**
6,5	1/4	14	9/16	20 X	272	**20.—**	277	**16.—**
4,0	1/8	8	5/16	30 X	273	**20.—**	278	**16.—**

No. 279 **Improved Aplanatic Two-lens Magnifier,** low power, Nos. 270 and 272 combined in one folding mount; magnifications of the single lenses 10 and 20 X, together 30 X Mk. **45.—**

No. 280 **Improved Aplanatic Two-lens Magnifier,** high power, Nos. 271 and 273 combined in one folding mount; magnifications of the single lenses 16 and 30 X together 46 X Mk. **45.—**

V. Prisms.

Those forms of prisms which are most generally used and which will be found enumerated below may be grouped into three classes: (A) those having **two circular polished faces** (for spectrum analysis etc.), (B) reflecting prisms with **three circular polished faces** and (C) reflecting prisms with **three polished faces bounded by straight edges.** The first-named prisms (A) are usually made with a refracting angle of about 60°, the two other series (B and C) with an angle of 90°; in place of these angles any other desired angles can be substituted at an extra charge of 10%.

The accuracy with which the refracting angles of the prisms are usually executed is about ± 15′ (± 1/4°); if a certain given angle is to be realised with an unusual degree of accuracy, the price of the prism is 25% higher; in this case, however, accuracy is guaranteed within ± 30 seconds.

Besides these three typical forms prisms may be made also of any other form or size according to requirement. A few prisms of this kind which have acquired general utility will be found sub Nos. 316 and the following.

For the prisms of series A flint and crown glass are generally used, for those of series B and C usually ordinary crown-glass; but of course it is also possible to construct these prisms with special glasses (with particular refraction and dispersion, among others also the so-called U. V. glasses) in which case, however, an increase of price may be necessary.

For all prisms only the best optical glass is used which is most closely examined and tested beforehand; for reflecting prisms, such as are, for instance, required for prism binoculars, only the most carefully selected colourless and flawless crown-glass (borosilicate-crown) is used, in order to avoid all unnecessary loss of light.

A. Prisms with Two Circular Polished Faces

of flint or crown-glass; refracting angle 60°.

No.	281	Aperture of polished faces	14	mm =	9/16	in.	. . . . .	Mk.	**10.—**
„	282	„ „ „ „	20	„ =	13/16	„	. . . . .	„	**12.—**
„	283	„ „ „ „	27	„ =	1 1/16	„	. . . . .	„	**14.—**
„	284	„ „ „ „	34	„ =	1 3/8	„	. . . . .	„	**18.—**
„	285	„ „ „ „	41	„ =	1 5/8	„	. . . . .	„	**24.—**
„	286	„ „ „ „	47	„ =	1 7/8	„	. . . . .	„	**32.—**
„	287	„ „ „ „	54	„ =	2 1/8	„	. . . . .	„	**45.—**
„	288	„ „ „ „	61	„ =	2 3/8	„	. . . . .	„	**70.—**
„	289	„ „ „ „	68	„ =	2 11/16	„	. . . . .	„	**95.—**
„	290	„ „ „ „	75	„ =	2 15/16	„	. . . . .	„	**130.—**
„	291	„ „ „ „	81	„ =	3 3/16	„	. . . . .	„	**180.—**
„	292	„ „ „ „	95	„ =	3 3/4	„	. . . . .	„	**280.—**
„	293	„ „ „ „	108	„ =	4 1/4	„	. . . . .	„	**400.—**

Quotations for other sizes on application.

B. Reflecting Prisms with Circular Cathetus Faces.

All angles strictly accurate, without pyramidal defects; angle 90°; three polished faces, of crown-glass.

No.	294	Aperture of polished cathetus faces	27	mm =	1 1/16	in.	. . . . .	Mk.	**32.—**
„	295	„ „ „ „ „	34	„ =	1 3/8	„	. . . . .	„	**42.—**
„	296	„ „ „ „ „	41	„ =	1 5/8	„	. . . . .	„	**52.—**
„	297	„ „ „ „ „	47	„ =	1 7/8	„	. . . . .	„	**72.—**
„	298	„ „ „ „ „	54	„ =	2 1/8	„	. . . . .	„	**100.—**
„	299	„ „ „ „ „	61	„ =	2 3/8	„	. . . . .	„	**130.—**
„	300	„ „ „ „ „	68	„ =	2 11/16	„	. . . . .	„	**170.—**
„	301	„ „ „ „ „	75	„ =	2 15/16	„	. . . . .	„	**250.—**
„	302	„ „ „ „ „	81	„ =	3 3/16	„	. . . . .	„	**300.—**
„	303	„ „ „ „ „	95	„ =	3 3/4	„	. . . . .	„	**500.—**
„	304	„ „ „ „ „	108	„ =	4 1/4	„	. . . . .	„	**800.—**

Quotations for other sizes on application.

C. Reflecting Prisms, having Straight Edges, with Polished Cathetus Faces

of crown-glass.

All angles strictly accurate, without pyramidal defects; angle 90°, three polished faces.

No.	305	Length of polished cathetus faces	14	mm =	9/16	in.	. . . . .	Mk.	**16.—**
„	306	„ „ „ „ „	20	„ =	13/16	„	. . . . .	„	**26.—**
„	307	„ „ „ „ „	27	„ =	1 1/16	„	. . . . .	„	**36.—**
„	308	„ „ „ „ „	34	„ =	1 3/8	„	. . . . .	„	**62.—**
„	309	„ „ „ „ „	41	„ =	1 5/8	„	. . . . .	„	**85.—**
„	310	„ „ „ „ „	47	„ =	1 7/8	„	. . . . .	„	**100.—**
„	311	„ „ „ „ „	54	„ =	2 1/8	„	. . . . .	„	**120.—**

No. 312	Length of polished cathetus faces 61 mm = $2^{8}/_{8}$ in.	Mk.	**160.—**
„ 313	„ „ „ „ „ 68 „ = $2^{11}/_{16}$ „	„	**220.—**
„ 314	„ „ „ „ „ 75 „ = $2^{15}/_{16}$ „	„	**300.—**
„ 315	„ „ „ „ „ 81 „ = $3^{3}/_{16}$ „	„	**400.—**

Quotations for other sizes on application.

These prices apply to prisms having square cathetus faces. In the case of prisms whose height is less than the length of the polished faces the price is proportionately less, provided that not less than three prisms are ordered together.

Note. Intermediate sizes will be charged at price of next larger size.

D. Sundry Prisms.

No. 316 **Triangular Prism,** for setting off right angles, reflecting angle 90°, with straight edges, cathetus faces 20 by 10 mm ($1^{1}/_{8}$ by $^{3}/_{8}$ in.), unmounted . . . . . Mk. **18.—**
mounted, with holder and case . . . . . Mk. **22.—**

No. 317 **Triangular Prism,** similar to No. 316, but larger size, cathetus faces 36 by 12 mm ($1^{7}/_{16}$ by $^{1}/_{2}$ in.), unmounted . . . . . Mk. **32.—**
mounted, with holder and case . . . . . Mk. **36.—**

No. 318 **Bauernfeind's Pentagonal Prism,** for setting off angles of 45°, 90° and 180°, mounted, with holder and case . . . . . Mk. **36.—**

No. 319 **Cornu's Quartz Double Prism,** for eliminating double refraction, consisting of a right-handed and left-handed quartz prism of 30° cemented together, aperture 20 mm ($^{13}/_{16}$ in.) . . . . . Mk. **80.—**

No. 320 **Cornu's Quartz Double Prism,** similar to No. 319, larger size, aperture about 40 mm ($1^{5}/_{8}$ in.) . . . . . Mk. **180.—**

No. 321 **Triple Amici Prism,** compensating the deviation of the mean ray; extension of the spectrum about 4°, aperture about 18 mm ($^{11}/_{16}$ in.) . . . . . Mk. **40.—**

No. 322 **Triple Prism (Rutherford Prism).** This prism consists of a heavy flint prism cemented between two crown-glass prisms, whereby the surfaces of the heavy flint-glass become protected from oxydation and the refracting angle may be made so large as to produce total reflection but for its interposition between the two crown-glass prisms. Deviation usually about 52° (for F), Dispersion usually about $3^{1}/_{2}$° (C—F). If a certain given deviation or dispersion is to be realised, the price of the prism will be correspondingly higher. Aperture up to 25 mm (1 in.) Mk. **65.—**
„ „ „ 30 „ ($1^{3}/_{16}$ in.) . . . . . Mk. **80.—**
„ „ „ 40 „ ($1^{5}/_{8}$ in.) . . . . . Mk. **100.—**
Over 40 mm to order.

No. 323 **Quintuple Prism,** consisting of two heavy flint-glass prisms cemented between three crown-glass prisms. These prisms are either arranged for vision in a straight line or in such a manner that the pencils of rays enter at right angles to the first surface and emerge perpendicularly from the last surface. The width of the spectrum is about 15°. Aperture up to 25 mm (1 in.) . . . . . Mk. **100.—**
„ „ „ 30 „ ($1^{3}/_{16}$ in.) . . . . . Mk. **140.—**
„ „ „ 40 „ ($1^{5}/_{8}$ in.) . . . . . Mk. **200.—**
Over 40 mm to order.

Note. In the case of triple and quintuple prisms used with spectrum apparatus, the height of the aperture is smaller than the width, in accordance with the projection of the pencil of rays (from the slit tube on to the prism). The above values of the apertures refer to the horizontal dimension (the width) of the aperture.

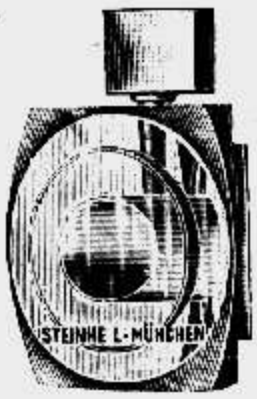


Fig. 18.
Small Fluid Prism.

No. 324 **Small Fluid Prism.** It consists of a prism of glass having two perfectly plane faces inclined about 60° to each other. A hollow cylinder of 20 mm (13/16 in.) bore passes through the centres of these surfaces. This cylindrical chamber communicates with the top of the prism by a conical channel which may be closed by means of an accurately fitting glass stopper. Both openings of the cylinder may be hermetically closed by plano-parallel glass covers. The liquid to be examined is filled in through the conical neck. (Fig. 18.) Capacity 10 to 11 ccm (about 1/3 oz.) . . . . . Mk. **90.—**

No. 325 **Fluid Prism,** similar to No. 324, with cylindrical chamber of 27 mm (1 1/16 in.) diameter. Capacity 15 to 16 cm (about 1/2 oz.) . . . . . Mk. **120.—**

Prices of reflecting prisms for prism binoculars on application.

Quotations given for quartz prisms of various sizes and construction on application.

Passage prism . . . . . vide No. 567
Ocular cap prism . . . . . „ „ 194
Ocular zenith prism . . . . . „ „ 195
Solar prism (Zenger's) . . . . . „ „ 200
Triple prism (Vogel's) . . . . . „ „ 196
Objective prisms . . . . . „ „ 210 to 217.

Prices for silvering prisms, reflecting through glass, vide page 30.

VI. Plano-parallel Glasses.

These, ever since the existence of our works, form a speciality and are made with absolutely parallel surfaces with the help of the most exact methods of manufacture and testing.

The thinnest parallel glasses (1/3 to 1 mm) are chiefly used for reading telescopes in the form of silvered mirrors (vide reading telescopes) and also as galvanometer mirrors.

a) Plano-parallel Glasses of ordinary and arbitrary thickness,

(from 3 to 6 mm = 1/8 to 1/4 in.).

No. 326 Up to 10 mm (3/8 in.) diameter, round, each . . . . . Mk. **4.—**
No. 327 From 10 to 25 mm (3/8 to 1 in.) diameter, round, each . . . . . Mk. **6.—**
No. 328 Larger glasses, up to 100 mm (4 in.) diameter, per sq. cm . . . . . Mk. **1.25**
per sq. in. about . . . . . Mk. **8.—**

b) Plano-parallel Glasses of a prescribed thickness, or of a thickness between 1 and 3 mm

(1/25 and 1/8 in).

No. 329 Up to 10 mm (3/8 in.) diameter or diagonal, each . . . . . Mk. **6.—**
No. 330 From 10 to 25 mm (3/8 to 1 in.) diameter or diagonal, each . . . . . Mk. **12.—**
No. 331 Larger glasses, up to 100 mm (4 in.) diameter, per sq. cm. . . . . Mk. **2.35**
per sq. in. about . . . . . Mk. **15.—**

c) Plano-parallel Glasses of minimum thickness,

(from 1/3 to 1 mm = 1/75 to 1/25 in.).

No. 332 Up to 10 mm (3/8 in.) diameter, round, each . . . . . Mk. **15.—**

No. **333** From **10** to **25** mm (3/8 to **1** in.) diameter, round, each . . . . . Mk. **20.—**

No. **334** From **25** to **30** mm (**1** to 1 1/8 in.) diameter, round, each . . . . . Mk. **28.—**

Note. Plano-parallel glasses of more than **100** mm diameter, or thicker than **6** mm, parallelpipeda, etc. to order.

Silvering plano-parallel glasses (so-called indirect silvering).

If desired, the plano-parallel glasses can be supplied silvered, reflecting from the back of the glass; the silvering is coated with a protective layer.

Prices for silvering plano-parallel glasses:

Up to **10** mm (3/8 in.) diameter, each . . . . . Mk. **1.—**

From **10** to **25** mm (3/8 to **1** in.) diameter, each . . . . . Mk. **2.—**

Larger glasses, up to **100** mm (**4** in.) diameter, per sq. cm . . Mk. **—.25**

per sq. in. about . . . . . Mk. **1.60**

Silvering larger surfaces to order.

Plane mirrors, circular and oval, vide page 23.

B.

Telescopes with and without Stand

for Astronomical and Terrestrial Purposes.

B. Telescopes.

In the following pages the various telescopes forming our standard types and most often constructed by us have been classified and specified; among these the normal telescopes for astronomical and terrestrial observation rank first in place and importance, being followed by a number of special types down to the simple hand-glass.

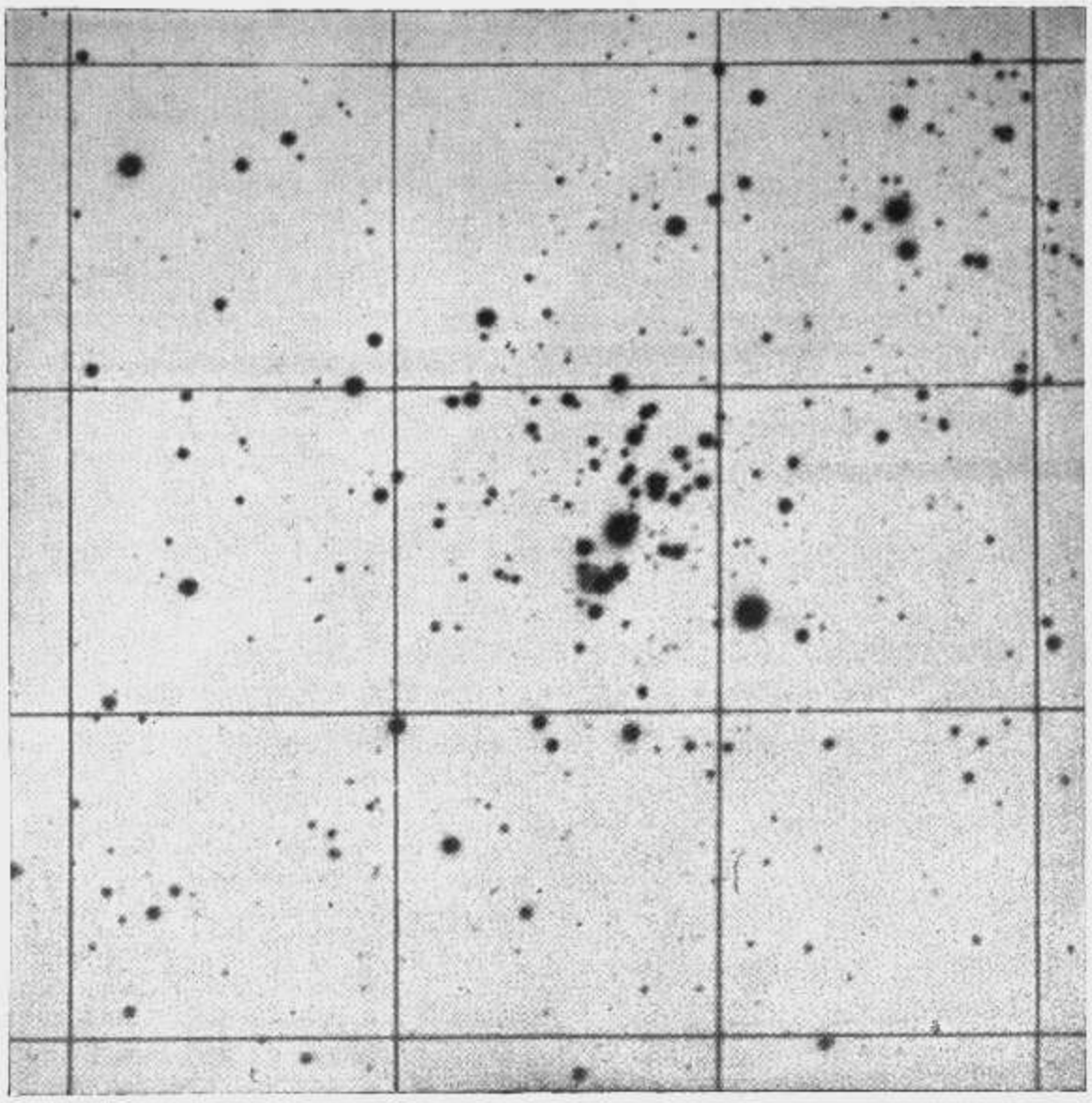
Although suitable instruments for all possible requirements have been included in this list, we are always ready and most willing to prepare estimates for any kind of telescope required; to be able to do this, we must know, in the first place, the purpose for which the instrument in question is destined, then the available means, and finally, the location where said telescope will be used or erected.

The construction and optical equipment of the various types are the outcome of the practical experience of many years; we can therefore recommend the complete telescopes herein specified as the most suitable instruments for their individual branches of application; but instruments differing more or less in construction, accessories or optical equipment from the types contained in this list can, if desired, be supplied; further, we are always ready to design and execute new types of instruments for special cases.

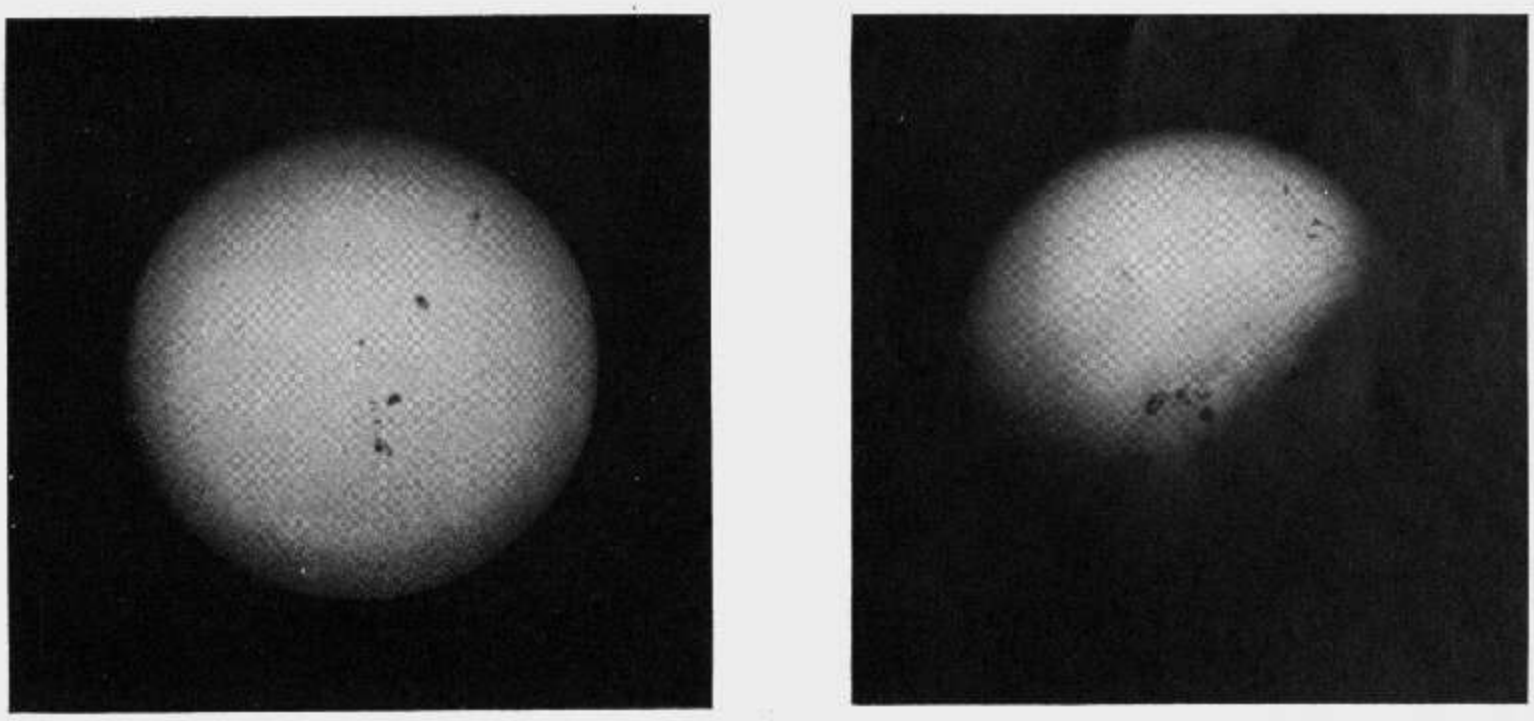
A. Telescopes for Terrestrial and Astronomical Observation.

The following seven series comprise a number of complete telescopes with stands which may be considered as standard types of this class of instrument; beginning with the small telescope on plain stand with horizontal and vertical (azimuth) adjustment, and ending with the great refractor with driving clock and other accessories for the most varied application.

A normal optical equipment, consisting of doublet objectives of series 1 with terrestrial oculars B D and astronomical oculars A D has been selected for the optical



Enlarged Photograph of the Cluster of stars *h Persei,* taken with a Telescopic Objective Aperture 330 mm (13 in.), Focal length 3437 mm (about 11½ feet) of the Royal Astrophysical Observatory in Potsdam.



Two photographs of the Sun (one when partly obscured by clouds) with a Reduced Photographic Telescope Aperture 54 mm (2⅛ in.) Equivalent Focal Length 400 cm (about 13½ feet).

photo by E. STEPHANI, Cassel.

avoid a possible cracking of the ocular lenses or the dark glass through overheating, it is advisable to reduce the aperture of the objective to about one third of its diameter either by simply covering with a card or with the help of an iris diaphragm fixed at the object end of the telescope.

For the **photography of celestial bodies** either a separate telescope on stand (vide "reduced telescopes for photographic purposes" page 52) may be used, or, in the case of large telescopes, a camera with photographic lens or a special photographic telescope may be arranged on the tube of the larger instrument.

To obtain photographs of the sun, the shortest instantaneous exposures are necessary, the objective aperture being at the same time greatly reduced; on the other hand, an exposure of several seconds is necessary to photograph the moon, and to obtain star photographs exposures ranging up to one or more hours, according to their magnitudes, will be required.

Such exposures as the last-named are only possible with a clock-driven telescope. Large instruments are also constructed with two tubes on a common stand, one serving for the photographic exposure, the other for visual observation, or as a finder.

The objectives without secondary spectrum can be so corrected that telescopes fitted with these objectives can be used alternately for visual or photographic purposes, a photographic camera being simply substituted for the ocular.

For terrestrial observation (for military use, for bellevues, and the like) small or large double telescopes with stand can be constructed with widely separated objectives, such instruments giving a far better plastic effect and allowing of more convenient observation than the instruments for one eye. Estimates for these telescopes will be given on statement of requirements.

The bodies of the smaller and middle sized telescopes are of bright black or yellow brass tube, or, if specially desired, of conical wooden tubes veneered with walnut; the large instruments, on the other hand, are provided with steel tube bodies.

From 75 mm (3 in.) aperture upwards the instruments are provided with means for centring the objective; every objective is accurately centred in respect to the optical axis of the telescope before leaving the works.

The sizes up to 75 mm (3 in.) aperture are supplied with a plain pine-wood box to hold the instrument, oculars and all accessories exclusive of stand; larger instruments, from 81 mm ($3^3/_{16}$ in.) aperture upwards, with case for the oculars and accessories only. With the telescopes Nos. 341 to 346 a handsome case with lock and handle for the complete instrument including stand is supplied (vide Fig. 21).

The **fine adjustment of focus** is attained with all telescopes with rack and pinion; the stands are provided for terrestrial observation and in the case of smaller instruments with horizontal and vertical (azimuth) adjustment; large instruments, on the other hand, are supplied with equatorial (parallactical) mountings.

The **motion** of the telescope on its stand is, in the case of small instruments, by hand alone, but all larger instruments are also provided with slow motions for fine adjustment; very large instruments possess besides these two kinds of motion also a clock for automatically communicating the equatorial motion to the telescope.

The telescopes are secured to the stands partly by enclosing the tube in a strong metal cradle (or tree-screw in the case of the smaller sizes) or by hanging

the tube in a forked head. The telescopes are carefully balanced on their stands and can be used in any position. The axis of the mountings of the small instruments are of brass tube, whilst the larger instruments are provided with strong steel tube axes.

For convenience of transport, heavy stands are supplied with rollers and levelling screws, the latter facilitating the correction of the polar altitude. When ordering telescopes with equatorial mountings it is requested that the intended location of the telescope be given, in order that the equatorial mounting may be adjusted for the correct polar altitude; the mountings are generally constructed with fixed polar altitude, but if an instrument is destined for use in different latitudes, the polar altitude can also be made variable.

For accurately and quickly determining the position of any given star in declination and right ascension the equatorial mountings can be provided with **divided circles;** for small instruments these are plainly executed in brass and read to 1^0 or to $^1/_2{}^0$; for large instruments the circles are of German silver and can be more or less finely divided according to the desire of the purchaser and size of the instrument; ordinary circles are read with the aid of magnifiers, very finely divided circles with telescopes.

1. Small Telescopes on Table Stands,

with horizontal and vertical motions.

Telescope mounted on plain brass tubular pillar with iron tripod, stand head provided with horizontal and vertical motions for hand adjustment; suitable for standing on table; case to hold telescope and oculars without stand. Doublet objectives, Series 1. Oculars B D and A D.

Pencil of rays: 0,3 to 1,8 mm diameter.

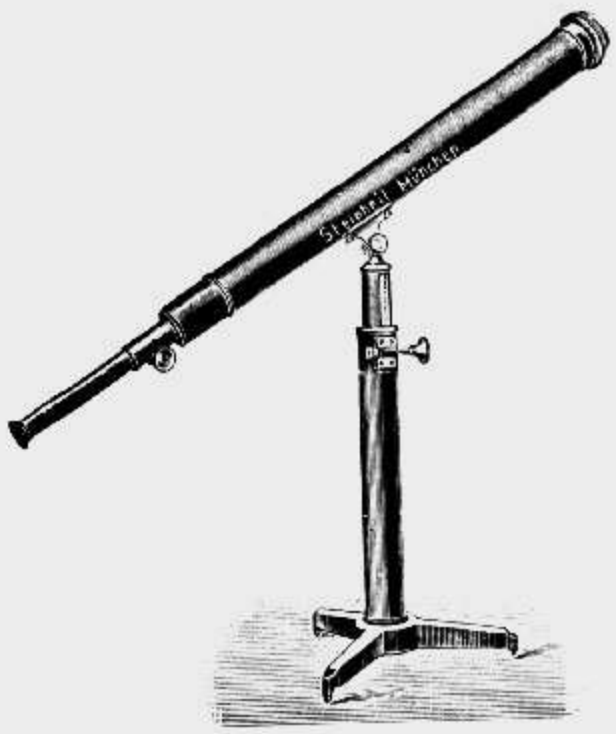


Fig. 19.
Telescope with Table Stand and Rack Adjustment.

No.	Objective aperture mm	Objective aperture in.	Focus cm	Focus in.	Magnifications terrestr.	Magnifications astronomical					Price with stand Marks
335	41	1 5/8	49	19 5/16	27	35	70	—	—	—	**195.—**
336	47	1 7/8	57	22 7/16	32	40	80	—	—	—	**210.—**
337	54	2 1/8	65	25 5/8	30	47	94	—	—	—	**240.—**
338	61	2 3/8	73	28 3/4	34	36	81	100	—	—	**285.—**
339	68	2 11/16	81	31 7/8	37	40	58	90	116	—	**330.—**
340	75	2 15/16	114	44 7/8	42	57	81	126	162	228	**380.—**

Extras	Objective aperture 41 to 54 mm (1 5/8 to 2 1/8 in.) Marks	Objective aperture 61 to 75 mm (2 3/8 to 2 15/16 in.) Marks
Clamp adjustment for height	**15.—**	**20.—**
Rack „ „ „	**30.—**	**50.—**
Vertical slow motion with rod connection to eye-end . . .	**20.—**	**30.—**
Tripod legs folding instead of rigid	**30.—**	**50.—**

If desired, several terrestrial oculars or reversing prism system No. **183** or No. **184**.

Note: If necessary, the case can be arranged to hold the stand also (extra cost about **15** Marks).

2. Small Telescopes on Tubular Table Stands

with equatorial mounting.

Telescope with equatorial mounting; tubular brass pillar stand on iron tripod, adjustable for height (and secured by clamp); hand motion on tubular axes, also horizontally; levelling screws for securing vertical position of pillar. For convenience of transport the complete instrument including stand fits into a handsome oak-wood case with lock and handles. This telescope is especially suitable for villas, bellevues and the like. Double objective, Series 1. Oculars B D and A D.

Pencil of rays: 0,3 to 1,8 mm diameter.

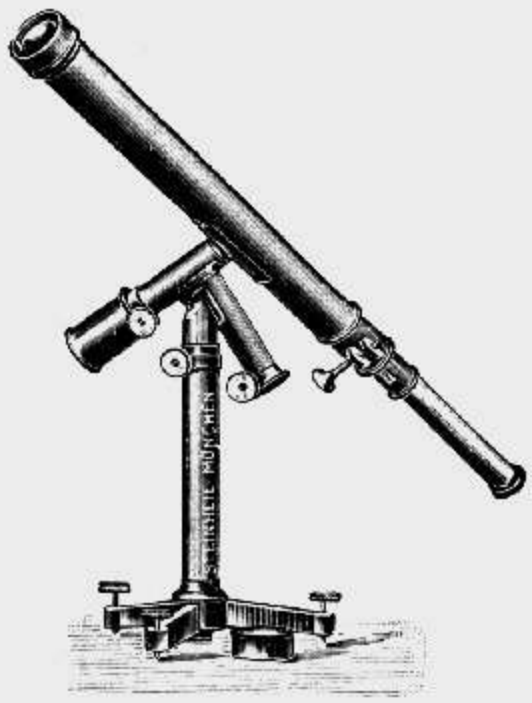


Fig. 20.
Tubular Stand Telescope ready for use.

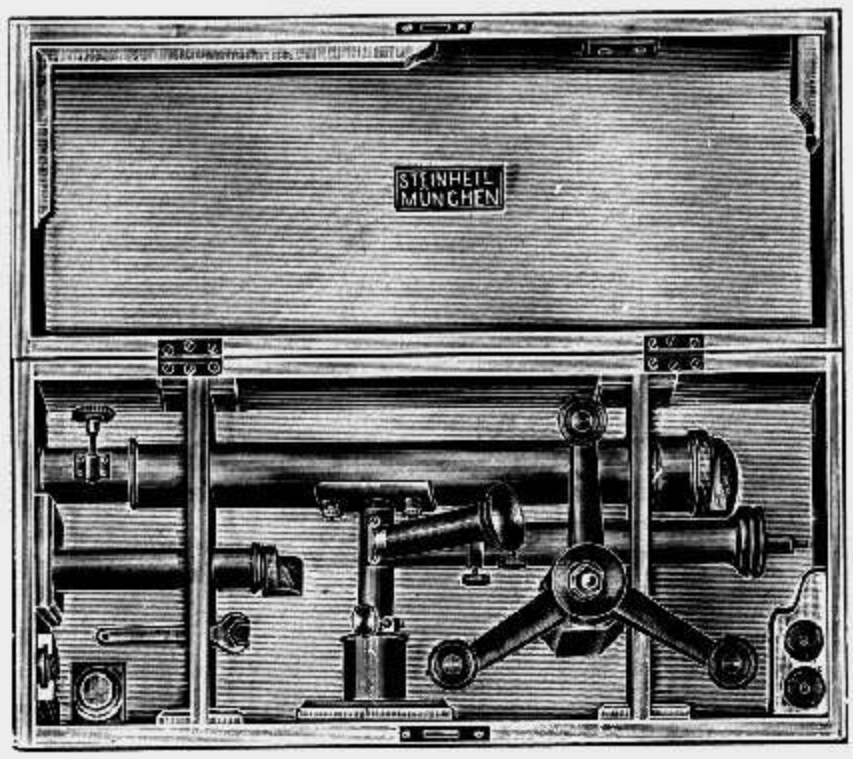


Fig. 21.
Tubular Stand Telescope packed in case.

No.	Aperture		Focus		Magnifications						Price with stand and case
	mm	in.	cm	in.	terrestr.	astronomical					Marks
341	41	1⅝	49	19⁵/₁₆	27	35	70	—	—	—	**325.—**
342	47	1⅞	57	22⁷/₁₆	32	40	80	—	—	—	**340.—**
343	54	2⅛	65	25⅝	30	47	94	—	—	—	**390.—**
344	61	2⅜	73	28¾	34	36	81	100	—	—	**465.—**
345	68	2¹¹/₁₆	81	31⅞	37	40	58	90	116	—	**550.—**
346	75	2¹⁵/₁₆	114	44⅞	42	57	81	126	162	228	**680.—**

The following extras can be supplied with this telescope:
Simple divided circle of brass or German silver reading to 1° or ½°.
Adjustment for height with rack and pinion, for larger instruments with worm gear.

If desired, several terrestrial oculars or the reversing prism system No. 183 or No. 184.

3. Telescopes on Plain Tripod

to stand on ground.

Telescope on wooden tripod, folding and portable; hung in forked head, horizontal and vertical motions; the telescope is balanced in all positions and will not tip even when the clamp is released. Telescope and oculars in plain pine-wood box. Doublet objectives, Series 1. Oculars B D and A D.

Pencil of rays: 0,3 to 1,8 mm diameter.

Fig. 22.
Telescope on wooden tripod, hung in forked head; with reversing prism.

No.	Aperture		Focus		Magnifications						Price with stand
	mm	in.	cm	in.	terrestr.	astronomical					Marks
347	41	$1^{5}/_{8}$	49	$19^{5}/_{16}$	27	35	70	—	—	—	**285.—**
348	47	$1^{7}/_{8}$	57	$22^{7}/_{16}$	32	40	80	—	—	—	**300.—**
349	54	$2^{1}/_{8}$	65	$25^{5}/_{8}$	30	47	94	—	—	—	**330.—**
350	61	$2^{3}/_{8}$	73	$28^{3}/_{4}$	34	36	81	104	—	—	**355.—**
351	68	$2^{11}/_{16}$	81	$31^{7}/_{8}$	37	40	58	90	116	—	**385.—**
352	75	$2^{15}/_{16}$	114	$44^{7}/_{8}$	42	57	81	126	162	228	**475.—**
353	81	$3^{3}/_{16}$	122	48	46	61	87	136	174	244	**565.—**
354	95	$3^{3}/_{4}$	142	$55^{15}/_{16}$	52	71	102	158	204	284	**710.—**
355	108	$4^{1}/_{4}$	162	$63^{3}/_{4}$	60	81	116	184	232	324	**850.—**

Adjustment for height by means of worm gear Mk. **100.—** to Mk. **140.—** extra.

If desired, further terrestrial oculars or reversing prism system No. **183** or No. 184 can also be supplied.

To increase the stability the legs of the stand can be securely connected with each other by means of folding stays.

Fig. 23.
Telescope on wooden stand, with equatorial mounting, finder and adjustment for height.

4. Telescopes on Wooden Stands with equatorial mountings.

Telescope on equatorial mounting; stand consisting of tubular pillar carried by strong portable wooden frame with rollers and levelling screws. Axes up to 108 mm (4¼ in.) aperture of brass tube, for larger sizes of steel; telescope in rigid cradle; hand motions; if desired, slow motions;*) polar altitude usually not adjustable.**) Oculars and accessories in case. Doublet objectives, Series 1.

Oculars B D and A D.

Pencil of rays 0,3 to 2,8 mm diameter.

Note. If desired, divided circles of German silver, extra . . . . . Mk. **120.**— to **180.**—

*) Slow motions . . . . Mk. **180.**— to **300.**—

) Adjustable polar altitude Mk. **50.— to **80.**—

Instead of the equatorial mounting this telescope can be supplied with horizontal and vertical motions at the same price. In this case adjustment for height with worm gear will cost

Mk. **100.**— to Mk. **180.**— extra.

Finders vide Nos. 438 to 443.

No.	Aperture		Focus		Magnifications						Price with stand
	mm	in.	cm	in.	terrestr.	astronomical					Marks
356	61	2 3/8	73	28 3/4	34	81	104	—	—	—	**520.**—
357	68	2 11/16	81	31 7/8	37	58	90	116	—	—	**550.**—
358	75	2 15/16	114	44 7/8	42	81	126	162	228	—	**600.**—
359	81	3 3/16	122	48	46	87	136	174	244	—	**675.**—
360	95	3 3/4	142	55 15/16	52	102	158	204	284	—	**760.**—
361	108	4 1/4	162	63 3/4	60	116	180	232	324	—	**1050.**—
362	122	4 13/16	183	72 1/16	68	91	130	203	260	366	**1250.**—
363	135	5 5/16	203	80	74	101	145	225	290	406	**1600.**—

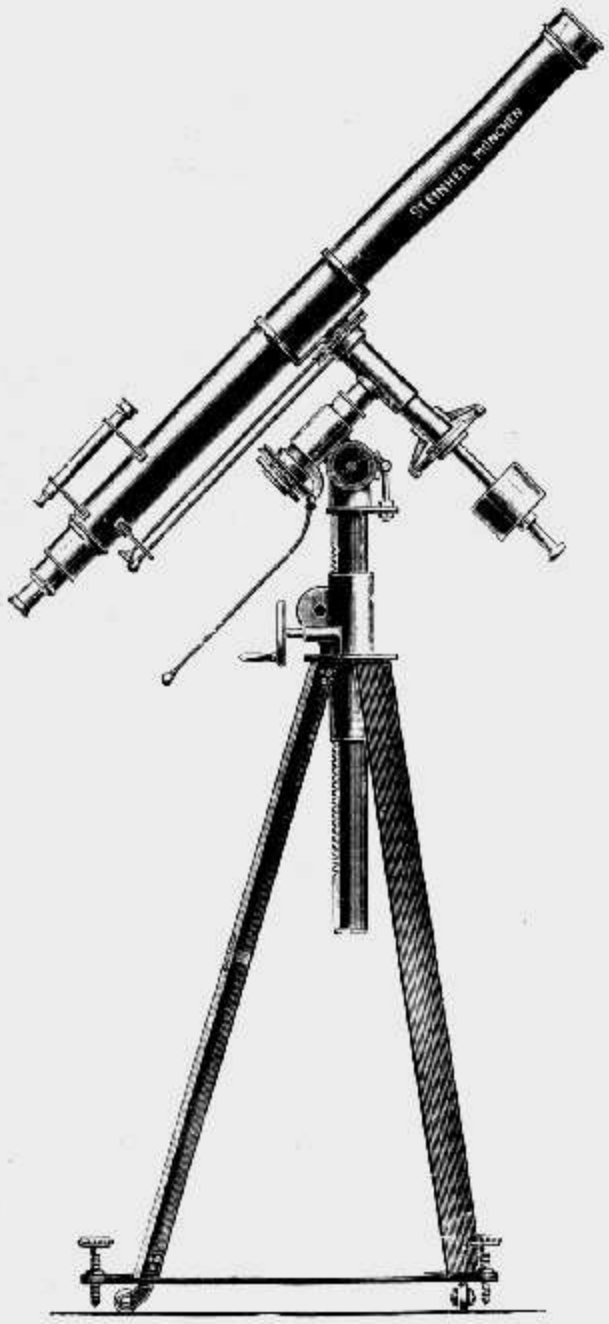


Fig. 24.
Telescope on plain iron stand, with slow motions, finder and adjustment for height.

5. Telescopes on Plain Iron Stands.

Telescope in strong metal cradle, equatorial mounting, brass or steel tube axes; to stand on ground; legs of iron tripod connected with each other and provided with rollers and levelling screws. Hand motions, fixed polar altitude; in the case of smaller instruments the polar altitude can also be made adjustable, if desired. The use of a finder with the larger sizes is recommended, also slow motions and divided circles. Oculars and accessories in case.

Doublet objectives, Series 1.

Oculars B D and A D.

Pencil of rays 0.3 to 2,7 mm diameter.

Slow motions, extra . . . . . Mk. **180.**— to **400.**—
Divided circles of German silver „ **120.**— to **240.**—

Horizontal and vertical mounting without difference in price. In the latter case (mounting in azimuth), adjustment for height with worm gear,
extra Mk. **100.**— to **180.**—

Finders vide Nos. 438 to **445.**

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Magnifications terrestr.	astronomical						Price with stand Marks
364	75	$2^{15}/_{16}$	114	$44^{7}/_{8}$	42	57	81	126	162	228	—	**550.**—
365	81	$3^{3}/_{16}$	122	48	46	61	87	136	174	244	—	**625.**—
366	95	$3^{3}/_{4}$	142	$55^{15}/_{16}$	52	71	102	158	204	284	—	**710.**—
367	108	$4^{1}/_{4}$	162	$63^{3}/_{4}$	60	81	116	180	232	324	—	**850.**—
368	122	$4^{13}/_{16}$	183	$72^{1}/_{16}$	68	68	91	130	203	260	366	**1120.**—
369	135	$5^{5}/_{16}$	203	80	74	74	101	145	225	290	406	**1320.**—
370	148	$5^{13}/_{16}$	222	$87^{3}/_{8}$	82	82	111	158	246	316	444	**1650.**—
371	162	$6^{3}/_{8}$	243	$95^{3}/_{4}$	—	59/90	121	174	270	348	486	**2050.**—

Fig. 25.
Telescope on Iron Stand, with Divided Circles and Slow Motion.

6. Large Telescopes on Iron Stands with equatorial mountings.

Telescope in strong iron cradle, equatorial mounting, on cast iron stand with fluted column, smaller instruments with brass tube axes, large instruments with steel axes; rollers and levelling screws to stand; motions by hand and slow motions; hour and declination circles divided on German silver and reading by magnifiers to 5′ of arc, 20″ of time. Telescope with finder (vide No. 438) balanced for all positions.

Doublet objectives, Series 1.

Oculars B D and A D.

Oculars and accessories in case.

Pencil of rays 0,3 to 3,5 mm diameter.

No.	Aperture mm	Aperture in.	Focus cm	Focus in	Magnifications terrestr.		astronomical						Finder magnification	Price Marks
372	81	3 3/16	122	48	46	—	61	87	136	174	244	—	6	**1170.—**
373	95	3 3/4	142	55 15/16	52	—	71	102	158	204	284	—	6	**1255.—**
374	108	4 1/4	162	63 3/4	60	—	81	116	180	232	324	—	8	**1515.—**
375	122	4 13/16	183	72 1/16	68	68	91	170	203	260	366	—	8	**1655.—**
376	135	5 5/16	203	80	74	74	101	145	225	290	406	—	10	**1870.—**
377	148	5 13/16	222	87 3/8	82	82	111	158	246	316	444	—	10	**2070.—**
378	162	6 3/8	243	95 3/4	—	59	90	121	174	270	348	486	12	**2840.—**
379	175	6 7/8	262	103 1/8	—	64	96	131	187	290	375	524	16	**3160.—**
380	200	7 7/8	300	118 1/16	—	55	73	111	150	215	333	430/600	20	**3640.—**

Estimates for larger sizes on application.
The prices include finder and stand.

Micrometer Oculars and other accessories according to choice.

If desired, a driving clock can also be provided, extra charge . . . . Mk. **600.—** to **1200.—**

Instead of the fluted column, a smooth, round or rectangular pillar standing on stone or cement base, may be selected.

Larger instruments can also be provided with circles with finer divisions; prices for same on application.

7. Large Telescopes on Iron Pillar with Driving Clock. (Refractors.)

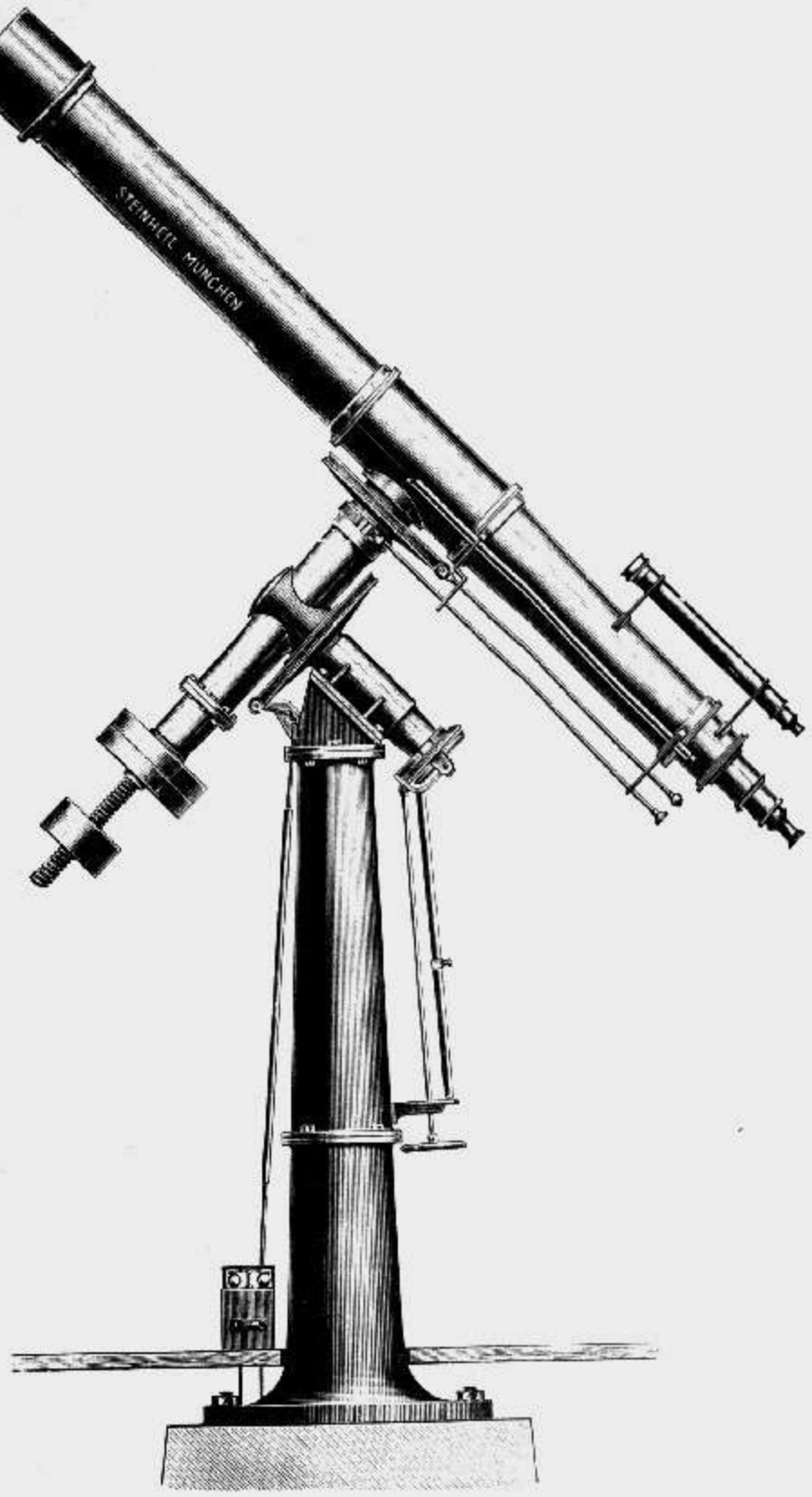


Fig. 26. Large Telescope on Iron pillar with driving clockwork.

The body of steel tube, equatorial mounting, balanced for all positions; on strong cast iron pillar, rigidly secured to base; if desired, small sizes with rollers and levelling screws. Hour and declination circles, divided on German silver and reading with telescopes to 1' of arc and 4" of time; steel axes, motion by hand and slow motions from eye-end and diurnal motion by means of driving clock. The telescope is provided with finder. Oculars and accessories in walnut case.

Doublet objectives, Series 1.

Oculars B D and A D.

Pencil of rays 0,3 to 3,7 mm diameter.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Magnifications astronomical								Finder magnification	Price with stand and accessories Marks
381	162	6 8/8	243	95 8/4	59	90	121	174	270	348	486	—	12	**4600.—**
382	175	6 7/8	262	103 1/8	64	96	131	187	290	375	524	—	16	**5800.—**
383	200	7 7/8	300	118 1/16	53	73	111	150	215	333	430	600	20	**7200.—**
384	225	8 13/16	337	132 8/4	63	82	127	168	240	375	480	674	20	**9000.—**
385	250	9 18/16	375	147 5/8	70	91	139	187	265	420	530	750	20	**12000.—**

Larger sizes to order, prices on application.

We recommend as accessories to these telescopes:

Micrometer oculars A G, A H or A L Nos. 134 to 140, 141 to 147 and 156 to 163.
Micrometer steel ring on plane glass No. 187 or the filar micrometer No. 567.
Sliding wedge and holder Nos. 201 and 202.
Ocular helioscope No. 203.
Star spectrum apparatus No. 552/553.
Ocular spectroscope No. 554.
Protuberance spectroscope Nos. 555 to 557.

If desired, estimates will be given for:

Illuminating apparatus.
Accessories for astro-photography.

B. Telescopes without Stand for Terrestrial and Astronomical Observation.

a) Normal telescopes (without stand) with doublet objectives Series 1.

Ratio of aperture 1 : 12 to 1 : 15. Pencil of rays 0,3 to 3,5 mm diameter.

Ordinary doublet objectives Series 1. Terrestrial oculars B D, astronomical oculars A D.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Magnifications terrestr.	astronomical						Price Marks
386	41	1 5/8	49	19 5/16	27	35	70	—	—	—	—	**145.—**
387	47	1 7/8	57	22 7/16	32	40	80	—	—	—	—	**160.—**
388	54	2 1/8	65	25 5/8	40	47	94	—	—	—	—	**190.—**
389	61	2 3/8	73	28 3/4	34	36	81	104	—	—	—	**220.—**
390	68	2 11/16	81	31 7/8	37	40	58	90	116	—	—	**250.—**
391	75	2 15/16	114	44 7/8	42	57	81	126	162	228	—	**300.—**
392	81	3 3/16	122	48	46	61	87	136	174	244	—	**375.—**
393	95	3 3/4	142	55 15/16	52	71	102	158	204	284	—	**460.—**
394	108	4 1/4	162	63 3/4	60	81	116	180	232	324	—	**600.—**
395	122	4 13/16	183	72 1/16	68	62	91	130	203	260	366	**800.—**
396	135	5 5/16	203	80	74	74	101	145	225	290	406	**1000.—**
397	148	5 13/16	222	87 3/8	82	82	111	158	246	316	444	**1250.—**
398	162	6 3/8	243	95 8/4	—	59/90	121	174	270	348	486	**1550.—**
399	175	6 7/8	262	103 1/8	—	64/96	131	187	290	375	480	**2000.—**
400	200	7 7/8	300	118 1/16	—	53/73	111/150	215	333	430	600	**3500.—**
401	225	8 13/16	337	132 8/4	—	63/82	127/168	240	375	524	674	**4400.—**
402	250	9 13/16	375	147 5/8	—	70/91	139/187	265	420	530	750	**5400.**

Finders vide Nos. 438 to 443.

b) Telescopes of large aperture (without stand) with triplet objectives, Series 2.

Low magnifying power, great brightness. Ratio of aperture from 1 : 4 to 1 : 5. Pencil of rays 0,8 to 5,5 mm diameter.

Ordinary triplet objectives Series 2. Terrestrial oculars B G, astronomical oculars A F.

No.	Aperture		Focus		Magnifications					Price
	mm	in.	cm	in.	terrestr.	astronomical				Marks
403	41	1 5/8	16,4	6 9/16	11	8	18	—	—	**170.—**
404	47	1 7/8	18,8	7 3/8	13	9	20	—	—	**185.—**
405	53	2 1/8	21,6	8 1/2	15	11	24	—	—	**210.—**
406	61	2 3/8	30,5	12	15	12	22	34	—	**260.—**
407	68	2 11/16	34,0	13 3/8	17	13	24	38	—	**300.—**
408	75	2 15/16	37,7	14 7/8	18	14	27	42	—	**375.—**
409	81	3 3/16	40,5	15 15/16	20	16	20	29	45	**500.—**
410	95	3 3/4	47,5	18 3/4	24	18	24	34	53	**675.—**
411	108	4 1/4	54,0	21 1/4	27	20	27	38	60	**900.—**

Finders vide Nos. 438 to 443.

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c) Telescopes (without stand) with doublet objectives Series 3 without secondary spectrum.

Giving especially sharply defined images, free of all false colour. Ratio of aperture 1 : 18, pencil of rays 0,3 to 1,5 mm diameter.

Doublet objectives Series 3 without secondary spectrum, terrestrial oculars B D, astronomical oculars A D.

No.	Aperture		Focus		Magnifications									Price
	mm	in.	cm	in.	terr.	astronomical								Marks
412	41	1 5/8	74	29 1/8	34	53	82	—	—	—	—	—	—	**160.—**
413	47	1 7/8	85	33 1/2	40	60	94	—	—	—	—	—	—	**175.—**
414	54	2 1/8	97	38 1/4	44	70	108	—	—	—	—	—	—	**190.—**
415	61	2 3/8	110	44	55	50	80	122	—	—	—	—	—	**240.—**
416	68	2 11/16	122	48 3/16	61	55	87	136	174	—	—	—	—	**300.—**
417	75	2 15/16	135	53 1/4	50	67	96	150	192	—	—	—	—	**370.—**
418	81	3 3/16	146	57 1/2	54	73	104	162	208	292	—	—	—	**460.—**
419	95	3 3/4	171	67 5/16	63	85	122	190	244	342	—	—	—	**600.—**
420	108	4 1/4	195	76 3/4	72	97	140	217	280	390	—	—	—	**800.—**
421	122	4 13/16	220	86 5/8	80	80	110	157	244	314	440	—	—	**1050.—**
422	135	5 5/16	243	95 3/4	90	90	121	174	270	348	486	—	—	**1350.—**
423	148	5 13/16	266	104 7/8	100	100	133	190	295	380	532	—	—	**1750.—**
424	162	6 3/8	292	115 1/8	—	71	108	146	209	324	418	584	—	**2200.—**
425	175	6 7/8	315	124 1/4	—	77	116	157	225	350	450	630	—	**2800.—**
426	200	7 7/8	380	150	—	70	92	148	190	271	422	542	760	**4500.—**

Larger sizes to order, prices on application. Finders vide Nos. 438 to 443.

Magnifications with the ocular microscope No. 182 (Mk. **42.—**)

for No.	420	421	422	423	424	425	**426**
about	570	650	720	780	860	930	1120 X.

d) Telescopes (without stand) with triplet objectives Series 4 without secondary spectrum.

Ratio of aperture 1:10. Pencil of rays 0,5 to 5,4 mm diameter.

Triplet objectives Series 4 without secondary spectrum, terrestrial oculars B G, astronomical oculars A F.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Magnifications terr.	astronomical								Price Marks
427	41	1 5/8	41	16 1/8	20	30	45	—	—	—	—	—	—	**215.—**
428	47	1 7/8	47	18 1/2	24	34	52	—	—	—	—	—	—	**250.—**
429	54	2 1/8	54	21 1/4	27	27	40	60	—	—	—	—	—	**290.—**
430	61	2 3/8	61	24	30	33	44	68	—	—	—	—	—	**350.—**
431	68	2 11/16	68	26 3/4	34	34	48	75	97	—	—	—	—	**425.—**
432	75	2 15/16	75	29 9/16	37	28	37	54	83	107	—	—	—	**540.—**
433	81	3 3/16	81	31 7/8	30	30	40	58	90	116	—	—	—	**680.—**
434	95	3 3/4	95	37 7/16	35	35	48	68	105	136	190	—	—	**925.—**
435	108	4 1/4	108	42 9/16	40	40	54	77	120	154	216	—	—	**1200.—**
436	122	4 13/16	122	48	44	30	44	61	87	135	174	244	—	**1580.—**
437	135	5 5/16	135	53 1/8	50	25	33	50	67	97	150	193	270	**2050.—**

Larger sizes to order, prices on application. Finders vide Nos. 438 to 443.

Magnifications with the ocular microscope No. 182, for No. 435 436 437
about 320 360 395 X.

Finders for the larger sizes of the series a to d, low magnifying power, large field and high ratio of aperture (1:8 to 1:10), doublet objectives Series 1, oculars A R with crosswires. Pencil of rays 2,8 to 3,4 mm diameter.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Magnification	Suited for telescopes of aperture mm	Suited for telescopes of aperture in.	Price Marks
438	20	13/16	16	6 5/16	6 X	95	3 3/4	**45.—**
439	27	1 1/16	24	9 7/16	8 X	122	4 13/16	**55.—**
440	34	1 3/8	27	10 5/8	10 X	148	5 13/16	**70.—**
441	41	1 5/8	33	13	12 X	162	6 3/8	**90.—**
442	47	1 7/8	43	16 15/16	16 X	175	6 7/8	**110.—**
443	54	2 1/8	54	21 1/4	20 X	200	7 7/8	**140.—**

Larger sizes to order, prices on application.

C. Special Telescopes for Various Purposes.

Fig. 27. Draw Telescope.

1. Draw Telescopes.

Two Groups:

a) with ordinary terrestrial oculars and doublet objectives — higher magnifying power.

b) with achromatic terrestrial oculars and triplet objectives — greater brightness.

Of the following draw telescopes (a and b) the smaller sizes especially are most suitable for hand use and can be recommended for travellers, sportsmen and for marine purposes; with the larger sizes (from, say 41 mm = $1^5/_8$ in. objective aperture upwards) the use of a portable tree screw or stand, to ensure rigidity of the instrument during observation, is strongly advised; possessors of a good photographic tripod can mount the telescope on the same with the help of the tree screw and connecting piece No. 464.

These accessories make it further possible to use such a draw telescope for astronomical observation, after substitution of an astronomical eye-piece for the terrestrial. The "connecting tube with diaphragm" forms an intermediate piece between the telescope draw and the astronomical eye-piece; for solar observation a dark glass is screwed on the eye end in place of the ocular cap.

In order to obtain a higher magnifying power for terrestrial purposes than that generally provided for the complete telescope, other eye-pieces, with shorter focal length, can be used. The magnifications indicated in the lists are, however, the most advantageous for general purposes; higher powers can, as a rule, only be used under very favourable atmospheric conditions.

Mounting: Brass, body veneered with walnut, draws polished. If desired, body all black, with or without leather cover, or with adjustable shade at objectglass end. In the latter case slight extra charge (vide No. 447).

For convenience of focussing these draw telescopes can be provided with a helicoidal or spiral draw at an extra charge of Mk. 20.—; this device can be recommended in preference to rack adjustment, since the smooth cylindrical form of the telescope is retained.

a) Normal Draw Telescopes of high magnifying power,

doublet objectives Series 1, terrestrial oculars B D.

Pencil of rays about 1,8 mm diameter (for No. 447 2,3 mm diameter).

No.	Objective Aperture mm	Objective Aperture in.	Objective Focus cm	Objective Focus in.	Magnification	Weight g	Weight oz.	Number of draws	Length closed cm	Length closed in.	Length drawn out cm	Length drawn out in.	Price Marks
444	20	13/16	16	6 5/16	14	230	8	3	11,5	4 1/2	30	11 3/4	**45.—**
445	27	1 1/16	24	9 7/16	21	390	14	3	16	6 1/4	45	17 3/4	**50.—**
446	34	1 3/8	32	12 5/8	24	510	18	3	19	7 1/2	60	23 3/4	**60.—**
447*)	34	1 3/8	32	12 5/8	15	750	27	2	24	9 1/2	60	23 3/4	**65.—**
448	41	1 5/8	49	19 5/16	22,5	880	31	3	27	10 5/8	76	30	**70.—**
449	47	1 7/8	57	22 7/16	26	1300	46	4	27	10 5/8	88	34 3/4	**85.—**
450	54	2 1/8	65	25 5/8	30	1410	50	4	27	10 5/8	94	37	**100.—**
451	61	2 3/8	73	28 3/4	34	1670	60	4	28	11	100	40	**130.—**
452	68	2 11/16	81	31 7/8	37,5	2450	87	5	29	11 1/2	114	44 7/8	**170.—**
453	75	2 15/16	114	44 7/8	42	3150	112	6	33	13	153	60	**220.—**
454	81	3 3/16	125	49 3/16	46	4000	140	6	38	15	171	67 1/2	**280.—**

*) This telescope is specially mounted for hunting purposes; it has a particularly bright and large field, body all black with adjustable shade. — Accessories see No. 461 and after.

b) Draw Telescopes of special brightness.

Triplet objectives Series 2, terrestrial oculars B F.

Pencil of rays about 2,2 to 2,6 mm diameter.

No.	Objective Aperture mm	Objective Aperture in.	Objective Focus cm	Objective Focus in.	Magnification	Weight g	Weight oz.	Number of draws	Length closed cm	Length closed in.	Length drawn out cm	Length drawn out in.	Price Marks
455	20	13/16	8,1	3 3/16	9	190	7	2	10	4	20	8	**70.—**
456	27	1 1/16	10,8	4 1/4	12	380	14	2	12	4 3/4	24	9 1/2	**80.—**
457	34	1 3/8	19,0	7 1/2	14	560	20	2	19	7 1/2	40	15 3/4	**90.—**
458	41	1 5/8	22,0	8 1/2	16	740	27	2	23	9	45	17 3/4	**105.—**
459	47	1 7/8	28,5	11 1/4	21	950	34	2	25	10	48	19	**130.—**
460	54	2 1/8	32,5	12 3/4	24	1230	44	2	28	11	54	21 1/2	**160.—**

c) Accessories for the above draw telescopes (a and b).

No. **461** Leather sling case for draw telescopes

up to 34 mm (1 3/8 in.) aperture . . . . . Mk. **6.—**

of 41 and 47 mm (1 5/8 and 1 7/8 in.) aperture . . . . . „ **8.—**

„ 54 „ 61 „ (2 1/8 „ 2 3/8 „) „ . . . . . „ **10.—**

„ 68 to 81 „ (2 11/16 to 3 3/16 „) „ . . . . . „ **12.—**

Fig. 28. Tree screw.

No. 462 Tree screw (Fig. 28) for draw telescopes
up to 41 mm (1⅝ in.) aperture . . . . . Mk. **15.—**
of 47 and 54 mm (1⅞ and 2⅛ in.) aperture . . . . . „ **16.—**
„ 61 „ 68 „ (2⅜ „ 2 11/16 „) „ . . . . . „ **18.—**
„ 75 mm (2 15/16 in.) aperture . . . . . „ **22.—**
„ 81 „ (3 3/16 „) „ . . . . . „ **25.—**

No. 463 **Folding wooden tripod,** portable, the legs being telescopic similar to camera tripods; to stand on ground; telescope horizontally and vertically movable. Length of tripod legs adjustable with clamps. The tree screw can be easily removed for separate use.

For telescopes up to 54 mm (2⅛ in.) aperture . . . . . Mk. **50.—**
„ „ of 61 and 68 mm (2⅜ and 2 11/16 in.) aperture . . . . . „ **60.—**
Waterproof cover with strap for this stand . . . . . „ **5.—**

No. 464 **Connecting piece** for fixing tree screw on ordinary camera tripod . . . . . „ **5.—**

Connecting tube with diaphragm for draw telescopes and astronomical oculars see No. 193.
Astronomical oculars A D and A F for draw telescopes see Nos. 105 to 114 and Nos. 124 to 133.
Terrestrial oculars A D and B F for higher magnifying powers see Nos. 164 to 171 and Nos. 177 to 180.
Dark glasses for these telescopes see Nos. 197 and 198.

2. Naval Telescopes.

Fig. 29. Naval Telescope.

These telescopes are of low magnifying power, but of bright and large field. Mounting: Brass, usually black and leather covered (or, if desired, polished and with walnut veneer); adjustable shade and one draw only for quick focussing. (Fig. 29.)

Doublet objectives Series 1, terrestrial oculars B D. Pencil of rays 2,7 to 3,4 mm diameter.

No.	Objective aperture		Focus		Magnification	Length closed		Length drawn out		Price
	mm	in.	cm	in.		cm	in.	cm	in.	Marks
465	34	1⅜	27	10⅝	10	30	11 13/16	55	21⅝	**65.—**
466	41	1⅝	33	13	12,5	34	13 1/2	60	23¾	**80.—**
467	47	1⅞	43	16 15/16	16,5	42	16 1/2	70	27 1/2	**95.—**
468	54	2⅛	54	21¼	20	51	20	80	31 1/2	**115.—**
469	61	2⅜	61	24	22,5	53	21	85	33 1/2	**150.—**
470	68	2 11/16	68	26¾	25	60	23 ¾	95	37⅜	**190.—**

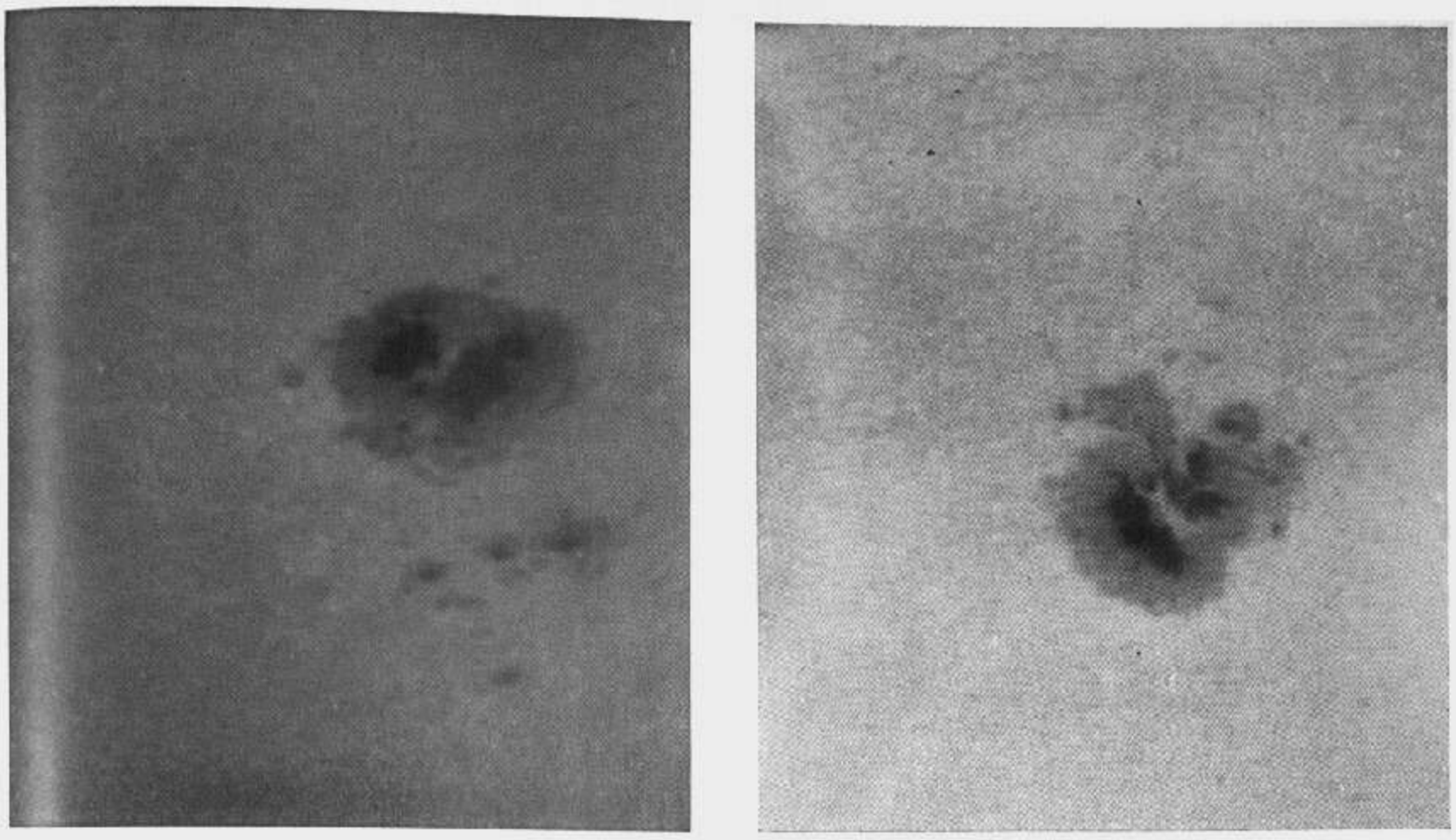
Other sizes to order.

For convenience of focussing:
Rack adjustment, extra . . . . . Mk. **15.—** to Mk. **20.—**
or helicoidal draw, extra . . . . . „ **20.—** to „ **30.—**.

On application, estimates will be given for naval telescopes with triplet objectives Series 2 and terrestrial oculars B G or B F (greater brightness and shorter than the above-specified naval telescopes).

Tree screws see No. **462**.

Stands see No. 463.



Four Photographs of Sun Spots, taken with a Reduced Photographic Telescope, Aperture 54 mm (2⅛ in.) Equivalent Focal Length about 14 Meter (about 47 feet).

photo by A. HENZE, Mizar-Observatory, Charlottenlund, Danmark.

3. Comet Finders.

These telescopes are used for finding weakly luminous objects (comets, nebulae, variable stars* etc.) and therefore possess great brightness and a large field, but low magnifying power.

The smaller of these telescopes (group a) are for hand use, or for use with a tree screw or light stand, the larger (group b) are only for use with a stand. Doublet objectives Series 1 and astronomical oculars A D.

a) Small comet finders (hand finders).

Mounting: Brass, leather covered, without rack adjustment to focus, one draw only.

Pencil of rays 4 to 5,4 mm diameter.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Magnification	Price Marks
471	27	1 1/16	22	8 5/8	5,0 X	**60.—**
472	34	1 3/8	27	10 5/8	6,5 X	**70.—**
473	41	1 5/8	33	13	8,0 X	**85.—**
474	47	1 7/8	43	17	10,0 X	**105.—**
475	54	2 1/8	54	21 1/4	13,0 X	**120.—**

If desired, further oculars with other magnifications.

b) Comet finders with stand.

Mounting: Brass tube body, lacquered or black, or, if desired, wooden body veneered with walnut; rack adjustment for focus. Stand similar to Fig. 23 with horizontal and vertical motions; brass or steel tube with worm gear for height adjustment; strong wooden frame with rollers and levelling screws. Oculars in case.

Pencil of rays to 2,7 to 5,4 mm diameter.

No.	Aperture mm	Aperture in	Focus cm	Focus in	Magnifications			Price Marks
476	81	3 3/16	81	31 7/8	15	30	—	**750.—**
477	108	4 1/4	108	42 9/16	20	26	40	**1080.—**
478	135	5 5/16	135	53 1/8	25	33	50	**1600.—**
479	148	5 13/16	148	58 1/4	27	36	54	**1875.—**

Other sizes, and other magnifications for the above sizes to order, prices on application.

If desired, both series a and b can be fitted with the triplet objectives of Series 2 and achromatic oculars A F, also A K or A L, in order to attain a still greater brightness.

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*) Vide also astronomical binocular No. 501.

4. Reading Telescopes,

for taking readings from graduated scales directly or by means of mirrors.

For this purpose **scale carriers** are used, which are either fixed to the telescope or may be mounted on separate stands. For mirror readings the thin plano-parallel mirrors Nos. 332 to 334 are used.

Mounting: Brass tube, the ocular tube fitted with rack and pinion, adjustable for distances ranging from infinite to about four times the focal length; if specially ordered, the telescopes can be mounted without the use of steel or iron, for magnetic observations.

All oculars are provided with cross wires; in series a) the lowest power ocular has an adjustable diaphragm. These reading telescopes can be supplied either with or without stands.

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a) **Reading telescopes of long focus** (high magnifying power).

Doublet objectives Series 1, astronomical oculars A D.

Pencil of rays 0.7 to 2,2 mm diameter.

No.	Aperture		Focus		Magnifications			Price without stand
	mm	in.	cm	in.	*			Marks
480	27	1 1/16	24	9 1/2	12	27	36	**80.—**
481	34	1 5/16	27	10 5/8	13,5	30	40	**100.—**
482	41	1 5/8	33	13	16,5	36	48	**110.—**
483	47	1 7/8	43	17	22,5	50	60	**125.—**
484	54	2 1/8	54	21 1/4	27,5	60	80	**140.—**

b) **Reading telescopes of short focus** (with bright field).

Triplet objectives Series 2, achromatic astronomical oculars A F.

Pencil of rays 2,2 to 5 mm diameter.

No.	Aperture		Focus		Magnifications		Price without stand
	mm	in.	cm	in.	*		Marks
485	27	1 1/16	11,0	4 5/16	5,5	12	**90.—**
486	34	1 5/16	13,5	5 5/16	7,0	15	**110.—**
487	41	1 5/8	16,0	6 5/16	8,0	18	**130.—**
488	47	1 7/8	19,0	7 1/2	9,5	21	**150.—**
489	54	2 1/8	22,0	8 11/16	11,0	24	**170.—**

Note. The magnifications given above are for the adjustment for infinity, although the telescopes are mostly used at short range.

c) Stands and accessories for reading telescopes.

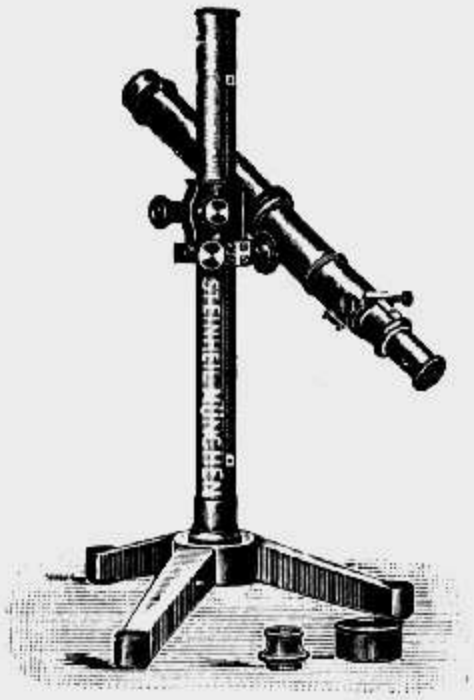

Fig. 30. Reading Telescope with pillar stand and rack adjustment.

No. 490 **Simple pillar stand.** The reading telescope is secured to a brass tube pillar on cast iron tripod by means of a special clamp, admitting of convenient adjustment of height and giving horizontal and vertical motions; the scale is also attached to the pillar. (Fig. 30.)

Price:

for telescopes of 27 and 34 mm (1 1/16 and 1 3/8 in.) aperture	Mk.	**70.—**
„ „ „ 41 and 47 mm (1 5/8 and 1 7/8 in.) aperture	„	**85.—**
„ „ „ 54 mm (2 1/8 in.) aperture	„	**100.—**
Rack adjustment for height, extra	„	**25.—**
Scale carrier for fixing on pillar	„	**15.—**

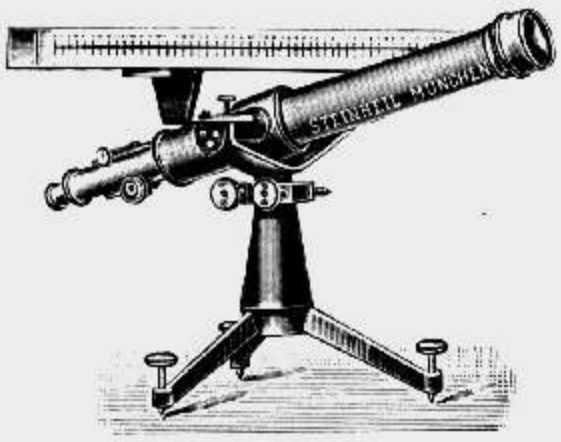

Fig. 31. Reading Telescope with Normal Type Tripod, Scale and Scale carrier.

No. 491 **Standard type tripod for reading telescopes.** The telescope is secured in the cradle of the metal stand and can be adjusted ± 30° in the horizontal plane; the vertical axis is provided with clamping device and slow motion.

The scale can be fixed on the telescope by means of the scale carrier. (Fig. 31.)

Price for telescopes of 27 and 34 mm (1 1/16 and 1 3/8 in.) aperture	Mk.	**75.—**
„ „ „ „ 41 and 47 mm (1 5/8 and 1 7/8 in.) aperture	„	**100.—**
„ „ „ „ 54 mm (2 1/8 in.) aperture	„	**120.—**

Scale carriers for these stands Mk. **15.—**, Mk. **18.—** and Mk. **20.—**.

No. 492 **Improved stand for reading telescopes.** The telescope can be adjusted ± 60° in the vertical plane. Horizontal and vertical adjustment are both provided with slow motion. The horizontal axis, on which the telescope is mounted, rests in two special bearings, one of which can be raised or lowered by means of adjusting screws; the horizontal axis has a removable spirit level facilitating accurate adjustment at right angles to the vertical axis. With the help of the scale carrier the scale may be fixed to the instrument either in a horizontal or vertical position. The frame with the telescope can be raised by rack and pinion. The stand rests on a tripod with levelling screws. The instrument is constructed of brass throughout. (Fig. 32.)

Price inclusive of scale carrier for telescopes of 27 and 34 mm (1 1/16 and 1 3/8 in.) aperture	Mk.	**225.—**
„ „ „ „ „ „ „ „ 41 and 47 „ (1 5/8 „ 1 7/8 „)	„	**250.—**
„ „ „ „ „ „ „ „ 54 mm (2 1/8 in.) aperture	„	**275.—**

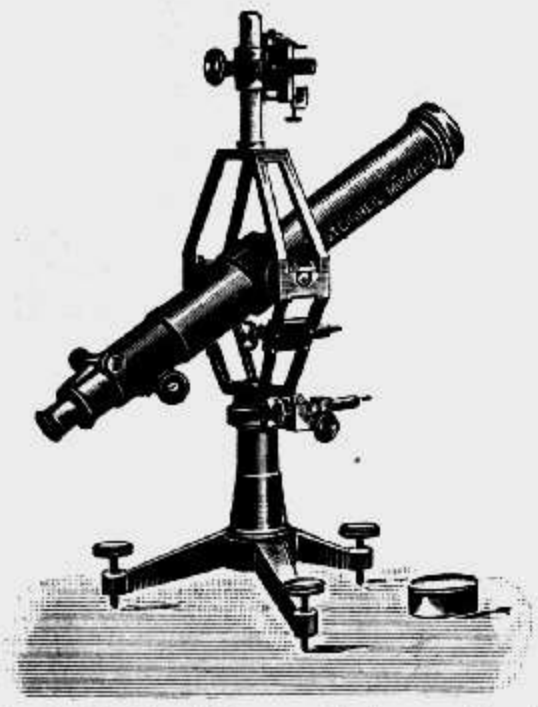

Fig. 32. Reading Telescope with Improved Stand (simpler form).

No. 493 **Improved stand for reading telescopes, simpler form.** This stand is similar to No. 492, but of simpler construction. The bearings are without adjusting screws, the spirit level for the horizontal axis and rack adjustment for height have also been omitted. The instrument is constructed of brass throughout.

Price inclusive of scale carrier for telescopes of 27 and 34 mm ($1^1/_{16}$ and $1^3/_8$ in.) aperture Mk. **160.—**

Price inclusive of scale carrier for telescopes of 41 and 47 mm ($1^5/_8$ and $1^7/_8$ in.) aperture Mk. **180.—**

Price inclusive of scale carrier for telescopes of 54 mm ($2^1/_8$ in.) aperture . . . Mk. **200.—**

No. 494 **Scale carrier stand** for the above telescopes, self-contained, scale horizontally and vertically movable and secured with clamp.

Price . . . . . Mk. **25.—**

No. 495 **Scales,** lithographed, figures reversed, divided in millimeters, one meter (39 in.) long, mounted on wood.

Price . . . . . Mk. **4.—**

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5. Reduced telescopes

for photographic purposes.

Telescopes of very long focus and comparatively short body may be attained by intercepting, before the primary image is formed, the pencil of rays emerging from the objective of the telescope with a lens system of negative focus **(negative magnifying system,** see Nos. 204 to 209), whereby the principal point of the whole system is brought in front of the objective of the telescope.

We have given below a list of reduced telescopes with negative magnifying system for photographic purposes; we can, however supply reduced telescopes of any desired construction, also for ocular observation; these last are especially useful as reading telescopes in those cases where it is desired to attain a comparatively high magnification with a short instrument and low power which will not magnify the cross-wires too strongly.*

The addition of the negative lens, after the manner of the tele-photo lenses (see prospectus of the Photographic Department referring hereto), gives an image of long equivalent focus, the dimensions of the telescope at the same time remaining comparatively small.

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* See "Zeitschrift für Instrumentenkunde", 1892, November, page 374.

These telescopes are chiefly used for solar photography; in order to obtain the necessary short exposures a rapid instantaneous shutter is arranged behind the negative lens; the objective is provided with iris diaphragm. These instruments can also be applied with advantage to lunar photography; further the smallest size can be used for terrestrial instantaneous photography at a great distance (balloon and coast photography).

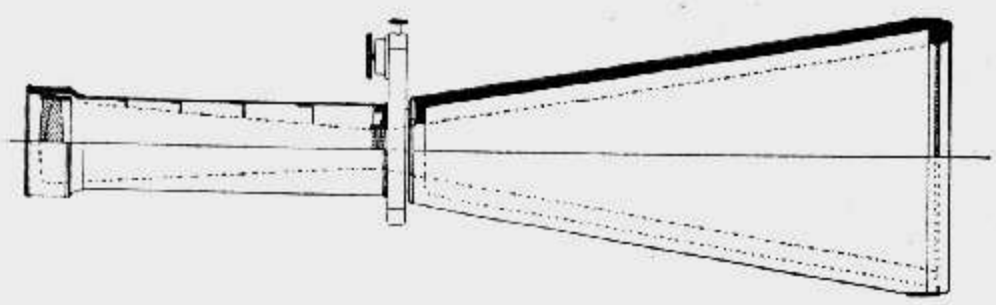

Fig. 33. Section of Reduced Photographic Telescope.

On account of the fixed distance of the negative system from the objective each instrument yields only a single magnification. For the larger sizes especially the addition of a finder is recommended; for the eye-piece of this finder a screen, on which the image of the sun or moon is received, can also be substituted.

These instruments can be used either in connection with a large clock-driven telescope and mounted on the same, or alone, mounted on a stand of their own.

Mounting: Brass tube, polished or black; without stand. Camera with instantaneous shutter and two dark slides.

Doublet objectives, Series I; negative magnifying systems No. 204 to 209.

No.	Aperture		Focus		Diameter of largest obtainable solar image		Longest equivalent focus about		Length of the entire telescope		Price
	mm	in.	cm	in.	mm	in.	cm	in.	cm	in.	Marks
496	61	2 8/8	35	13 3/4	12	1/2	120	47 1/4	65	25 5/8	**300.—**
497	68	2 11/16	81	31 7/8	90	3 1/2	900	354 3/8	114	44 7/8	**380.—**
498	81	3 3/16	125	49 7/8	120	4 3/4	1200	433 1/8	150	51 3/16	**450.—**
499	108	4 1/4	162	63 3/4	200	7 7/8	2000	789	230	90 9/16	**720.—**

Other sizes to order.

6. Reflectors.

Astronomers have lately again turned their attention to the use of reflectors, in place of refractors, especially since it has been found possible to eliminate the former defects of the reflectors, arising from the spherical aberration of the concave mirrors, by a suitable correction of these mirrors (parabolical instead of spherical polish).

Reflectors give a faultless image, wholly free of colour; the fact that the optical and chemical focus coincide make it further possible to adapt a reflector to photographic purposes by simply substituting a camera for the eye-piece.

The concave mirrors are generally constructed with a ratio of aperture of 1 : 6, but can be made of still larger aperture for special purposes (up to 1 : 3); see also parabolic concave mirrors page 23.

Such reflectors can be supplied in various executions and of different design, according to the wish of the purchaser.

7. Astronomical Binocular.

Fig. 34. Astronomical Binocular.

This instrument is intended for the observation of variable stars and as a binocular of great brightness and wide field (7,5°) is even better suited for this purpose than the hand comet finders Nos. 471 to 475. See Ceraski, Moscow Annals IV, 1902, page 121, and also Hagen, Preface to V Series of the Atlas Stellarum Variabilium.

Mounting: Body of brass (or aluminium) with rack adjustment to focus, one eye-piece with helicoidal draw to allow of separate focussing and compensation of any difference in vision, adjustable distance of eye-pieces, two dark glasses for screwing on eye-pieces, neat's leather sling case and leather cord for carrying the instrument without case. (Fig. 34.)

Two doublet objectives Series 1, two achromatic oculars A F 27 mm (1 1/16 in.). Pencil of rays 7 mm diameter.

No.	Aperture mm	Aperture in.	Focus cm	Focus in.	Magnification	Price Marks
500	34	1 3/8	13,5	5 5/16	5 X	Brass **210.—**
501	34	1 3/8	13,5	5 5/16	5 X	Aluminium **250.—**

Special prospectus of these instruments on application.

8. Galilean Binocular (Field-Glass).


Fig. 35. Field Glass.

This instrument is primarily intended for outdoor use (for tourists and military officers) but is also available as an opera glass. This field glass can be supplied in one size and finish only, but with the distance between the eye-pieces varying from 57 to 68 mm (2 5/16 to 2 11/16).

Mounting of brass, lacquered black body and shade covered with shagreen leather. Adjustable shades, leather cord, strong sewn neat's leather sling case. (Fig. 35.)

Doublet objectives, achromatic oculars.

No. **502** Objective aperture 36 mm (1 7/16 in.), magnification 3,4 X, height 8,8 cm (3 1/2 in.), weight 470 g (16 1/2 oz.), distance between oculars 57 to 68 mm (2 5/16 to 2 11/16 in.) according to choice, but not adjustable . . . . . Mk. **39.—**

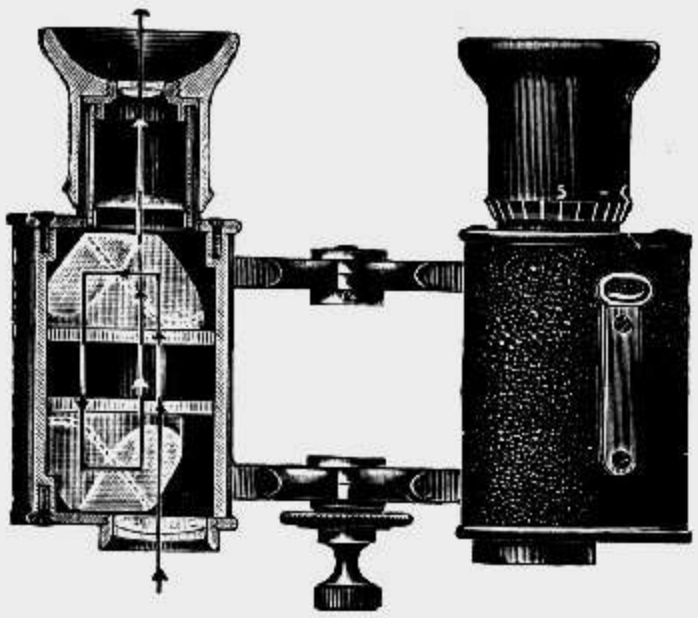

Fig. 36.
Prism Binocular.

9. Prism Binoculars and Monoculars.

Prism binoculars possess the following advantages over Galilean binoculars: wider field (3 to 6 times greater), higher magnifying power (6 to 12×); and on the other hand they are far lighter and less voluminous than telescopes with terrestrial oculars.

The connecting pieces are cast in one piece with the bodies of the instruments, the material used being magnalium. These two factors result in a greater rigidity and smaller weight than is attainable with other types. (Fig. 36).

No.	Magnification	Model	Weight		Height		Width		Field of view at 1000 m [1093 yds.]		Price including leather case
			g	oz.	cm	in.	cm	in.	m	yds.	Marks
503	6	A	360	13	8,5	3 3/8	9 3/4	3 13/16	109	119	**126.—**
504	9	B	430	15	10,5	4 1/8	11	4 5/16	72	79	**144.—**
505	12	C	430	15	10,5	4 1/8	11	4 5/16	67	73	**170.—**
506	4,2	E	440	15 1/2	10,5	4 1/8	10	4	130	142	**160.—**
507	4,2	F	460	16 1/2	10,5	4 1/8	12	4 3/4	130	142	**170.—**
508	6	H	450	16	10,5	4 1/8	12	4 3/4	117	128	**160.—**

The models E, F and H, in consequence of their great brightness and wide field, are especially suited for sportsmen, and military or naval purposes.

Model E is made with the fixed eye-distances of 62, 65 and 68 mm (2 7/16, 2 9/16 and 2 11/16 in.).

Prism monoculars can be recommended in special cases on account of their small weight and size, the prices being about 60 % less than those of prism binoculars.

Prospectus of prism binoculars and monoculars will be sent on application.

C.

Spectrum Apparatus.

C. Apparatus for Spectrum Analysis.

(Spectrum Apparatus, Spectrographs, Spectroscopes and Goniometers.)

The spectra formed in the various apparatus used in spectrum work can be of two kinds, either refraction or diffraction spectra.

Refraction spectra are produced with prisms, the light coming from the slit tube or collimator passing through one or more prisms with refracting angles of about 60°. In this case the direction of the pencil of rays forming the spectrum will be more or less deviated from the original direction of the light ray. Instead of several single prisms of 60° a cemented triple prism may also be used; in those cases where strong dispersion and the retention of the original direction of the ray are required, triple and quintuple prisms for direct vision are selected.

Diffraction spectra are produced with gratings, which may be either ruled on speculum metal, then acting as reflection gratings, or divided (in some cases copied) on glass, then allowing the passage of the light and acting as transparent gratings; in both cases the ray of light is deviated from its original direction.

The chief optical characteristics to be taken into consideration in spectrum apparatus are:

1. the construction and efficiency of the telescope (objective aperture, focal length, ratio of aperture, magnifying, power, diameter of pencil of rays etc);
2. the efficiency of the prism (or prisms) or of the grating (deviation and dispersion);
3. transparency, and
4. resolving power.

The telescope has already been discussed in a former chapter (page 13); the efficiency of the prism depends on its size, refracting angle, the material of which it is composed, and in the case of a combination of several prisms, the construction and number of these prisms. The efficiency of the diffraction grating depends on the surface area of the grating and the number of lines (in the case of concave gratings also on the radius of the curve).

In order to fully utilise the optical efficiency of the telescope and prisms, the height of the slit must be selected in proper relation to the size of the prism and the aperture of the objectives.

The transparency varies according to the material of which the objectives and prisms are constructed; as a rule we may assume:

for ordinary glasses a transparency to about $\lambda = 370\ \mu\mu$
for the U. V. glasses „ „ „ „ $\lambda = 310\ \mu\mu$
for quartz „ „ „ „ $\lambda = 180\ \mu\mu$

The first three characteristics of the prism spectrum apparatus are indicated in the table on page 65. The resolving power depends on the efficiency of the telescope and prisms.

Nearly all these apparatus can be utilised both for visual or photographic observation (see accessories to spectrum apparatus page 64); the accessories required for photographic observation consist in most cases of a box camera with lens, focussing screen, and dark slides; when it is desired to photograph a spectrum the view telescope is then simply removed and replaced by the camera and lens. *

The lenses of the camera sare provided with helicoidal draw and scale for convenient focussing. The dark slides are vertically displaceable so that several exposures can be made one below the other on the same plate.

Lately the tele-objective (see "Reduced Telescopes" Nos. 496 to 499 and also the Prospectus on Tele-objectives) has been successfully used in those cases where a long focal length of the lens in connection with a comparatively short camera, in order to obtain increased resolving power, were required (see "Zeitschrift für wissenschaftliche Photographie", May 1903).

In this case the camera is so arranged that the normal photographic lens can be used either alone or in connection with the magnifying system as a tele-objective; the camera may consist of a box camera (without extension) and giving then one fixed magnification with the tele-objective (about 3,5 ×), or may be with extension for different magnifications (giving images from 3 to 10 times greater than the image obtained with the camera lens proper).

If desired, these apparatus can also be arranged to take the English sizes of photographic plates instead of the Continental sizes, without extra charge.

The objectives of the telescopes are ordinary telescopic objectives, Series 1 and 2 (U. V. objectives, Series 5 and 6 can also be used); in the case of the quartz apparatus simple lenses are used, usually with a ratio of aperture of 1 : 10, the spherical aberration being eliminated by retouching, whilst the photography of the whole length of the spectrum is made possible by slanting the plate. The collimators are provided with millimeter divisions for the convenient determination of the position of the slit.

Both the optical and mechanical equipment of all these spectrum apparatus is of the most precise and careful finish, so that they fully realise all requirements of exact scientific work; special attention has moreover been paid to the greatest possible utilisation of the optical efficiency of all parts.

The instruments specified in the several groups have been especially constructed each for its own class of work; it has been our continual endeavour to perfect

* If when ordering apparatus it is intimated that the photographic complement will be required later, the apparatus can be initially constructed in view of the later easy adaptation of the photographic accessories if ordered later, the cost of adaptation will be about Mk. 30.—. But in either case it will be necessary to send the apparatus to us for the final adaptation.

and to add to these instruments and we are always ready to design and construct apparatus for special purposes or special work on statement of individual requirements*).

The following classification into eight groups, according to the application of the various apparatus, will facilitate the choice of an instrument:

1. Apparatus for direct exact wave lengths measurements
   (Universal Spectrum Apparatus and Grating Spectrum Apparatus),
2. Apparatus for simple wave lengths measurements with the help of comparison spectra or comparison scales
   (ordinary Spectrum Apparatus),
3. Apparatus for qualitative and quantitative spectrum analysis
   (Universal Spectrum Apparatus, Universal Spectrometer),
4. Apparatus for the observation of the ultra-violet portion of the spectrum
   (Spectrum Apparatus with U V Glasses or Quartz),
5. Apparatus for visual spectrum observation with large telescopes
   (Ocular Spectroscopes and Protuberance Spectroscopes),
6. Apparatus for astro-photographical spectrum work
   (Spectrographs for use alone or with telescopes),
7. Apparatus for simple optical and photographical spectrum observation, for hand use or with stand
   (Pocket Spectroscopes, small Spectrographs etc.),
8. Apparatus for determining the refraction and dispersion of different media and for measuring prism angles
   (Goniometers and Spectrometers).

In the following pages we have arranged the different spectrum apparatus in five principal groups:

1. Glass-Prism Spectrum Apparatus,
2. Quartz Spectrum Apparatus,
3. Grating Spectrum Apparatus,
4. Various Spectroscopes,
5. Goniometers and Spectrometers.

The list on page 65 comprises the most customary accessories for spectrum apparatus; a collective set of these accessories, arranged in a case, will be found useful for schools, institutes and for possessors of several instruments; if desired, estimates for such a collection will be given.

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*) The first spectrum apparatus were constructed according to the directions of Kirchhoff and Bunsen in our works in the years 1860 to 1862.

1. Glass-Prism Spectrum Apparatus

with telescope, for visual and photographic purposes.*)

No. 509 **Small Spectrum Apparatus,** simple model, especially adapted for schools, with flint-glass prism of 60°, comparison scale and non-adjustable slit; telescopes fixed on iron tripod; metal caps for protection of objectives and prisms . . . . . Mk. **130.—**
Adjustable slit, extra . . . . . Mk. **5.—**
Adjustable slit and comparison prism, extra . . . . . Mk. **15.—**

No. 510 **Simple Spectrum Apparatus,** flint prism of 60°, telescope with rack adjustment for focussing, collimator with micrometer slit mechanism; telescope and collimator rotatable on carefully adjusted axes; collimator with photographic glass scale telescopes and prisms enclosed in metal case; iron tripod. (Fig. 37.) . . . . . Mk. **275.—**
Extra cost of measuring arrangement with divided head, for slit . . . . . Mk. **10.—**

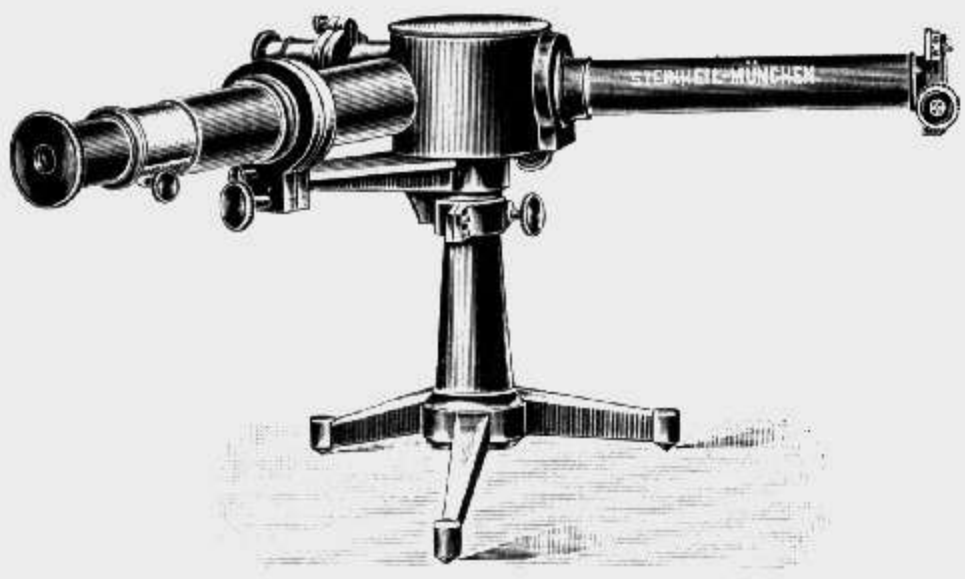

Fig. 37. Simple Spectrum Apparatus.

Photographic complement for size 6 by 9 cm (2⅜ by 3½ in.) see accessories No. 534.

No. 511 **Spectrum Apparatus with two Flint-glass Prisms.** Similar construction and equipment to No. 510, but provided with two flint-glass prisms of 60° instead of one, thereby considerably increasing the dispersion power . . . . . Mk. **400.—**
Photographic complement for size 6 by 9 cm (2⅜ by 3½ in.) see accessories No. 534.

No. 512 **Spectrum Apparatus with Triple Rutherford Prism,** similar to No. 510, the simple flint prism being, however, replaced by a triple Rutherford prism in order to increase the dispersion . . . . . Mk. **430.—**
Photographic complement see accessories page 65.

No. 513 **Spectrum Apparatus with two Flint-glass Prisms, larger size;** construction similar to No. 511, bu with larger prisms and telescopes; this apparatus gives greater magnification, greater brightness and a considerably larger spectrum Mk. **450.—**
Photographic complement, size 9 by 12 cm (3½ by 4¾ in.) see accessories page 65.

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*) For details of the optical equipment and efficiency of these spectrum apparatus see page 64.

No. **514** **Spectrum Apparatus with Triple Rutherford Prism, larger size,** similar to No. **512**, but with larger and brighter telescopes, and larger triple prism Mk. **550.—**
Photographic complement **9** by **12** cm ($3^1/_2$ by $4^3/_4$ in.) see No. 534.

No. **515** **Universal Spectrum Apparatus, small size.** This apparatus is designed for both quantitative and qualitative analysis, and is therefore fitted with micrometer ocular and with two symmetrical adjustable micrometer slits (one simple slit with comparison prism and one double slit, both with divided heads for measuring) and also comparison scale; the telescope can be moved across the whole field of view and has fine adjustment. Width of ocular slit and movement of the crosslines can be accurately measured by means of Vierordt's ocular slide. Besides the ordinary flint prism an interchangeable Rutherford prism is also provided, so that it is possible to work alternately with more or less dispersion (Fig. 38) . . . . . Mk. **600.—**

Micrometer stand and glass cell, also photographic complement 6 by 9 cm ($2^3/_8$ by $3^1/_2$ in.) see list of accessories 531—543.

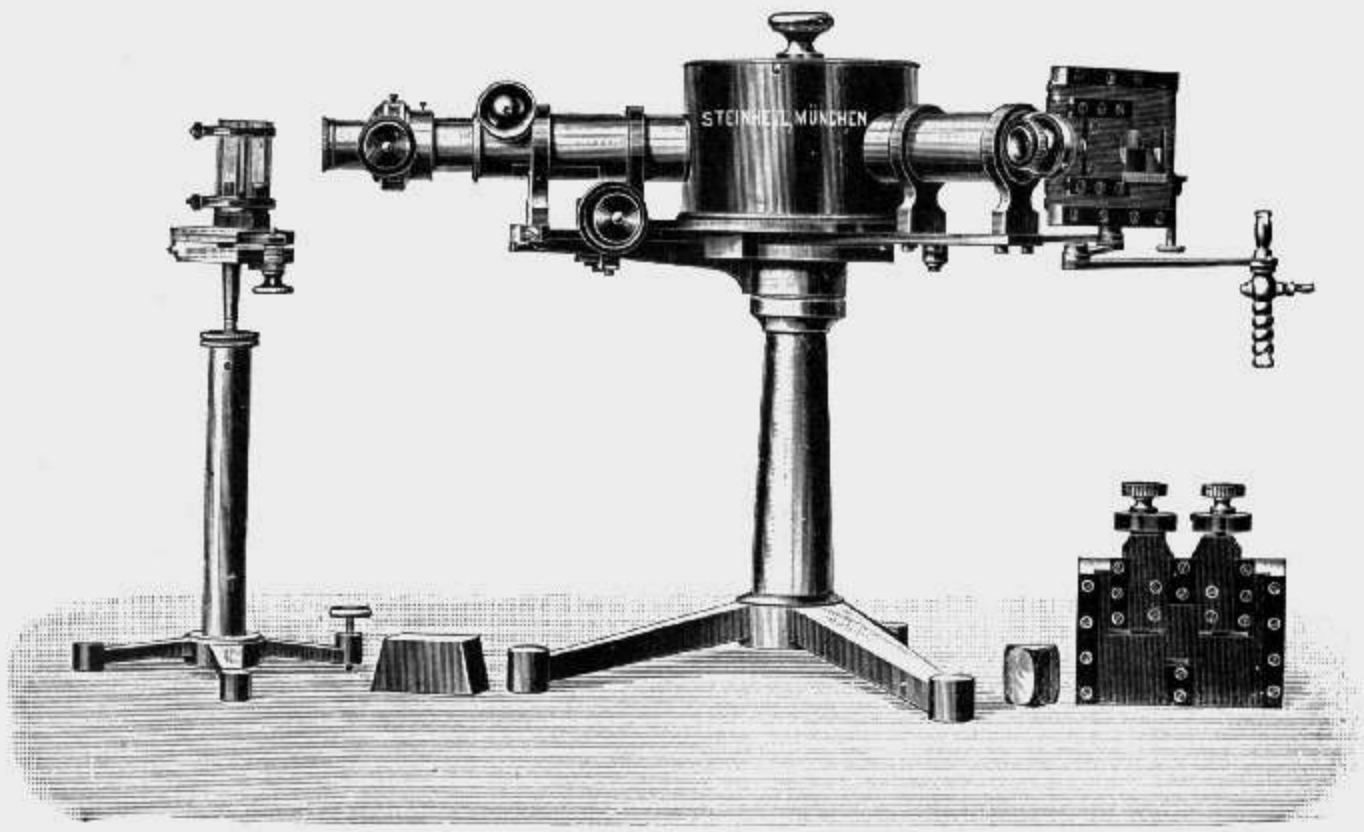

Fig. 38. Universal Spectrum Apparatus with Micrometer Stand.

No. **516** **Universal Spectrum Apparatus, middle size,** similar to No. **515** but with larger objectives and prisms . . . . . Mk. **720.—**

Micrometer stand and glass cell, also photographic complement 6 by 9 cm ($2^3/_8$ by $3^1/_2$ in.) see accessories Nos. 531 to 534.

No. **517** **Universal Spectrum Apparatus, large size,** similar to Nos. 515 and 516, but with still larger telescopes and prisms . . . . . Mk. **810.—**

No. **518** **Universal Spectrum Apparatus with Quintuple Prism,** small size. Same size and equipment as No. 515, but provided with a quintuple prism with strong dispersion instead of the triple prism. . . . . Mk. **700.—**

No. **519** **Universal Spectrum Apparatus with Quintuple Prism,** larger size. Same size as No. 516, but like No. 518 provided with quintuple prism instead of the triple prism Mk. **820.—**

No. 520 **Simple Spectrograph,** consisting of an ordinary spectroscope in combination with a photographic camera. The camera rests on a simple stand, made of brass tube fixed on an iron tripod, and can be turned and clamped vertically. Quintuple prism for direct vision, triple collimator objective, and simple micrometer slit with divided head for measuring the opening. A cylindrical lens may be used in front to concentrate the incident light. Rack and pinion for focussing. Size of plate 13 by 18 cm (5 1/8 by 7 1/8 in.); dark slide, vertically adjustable for making five exposures on the same plate. Especially adapted for testing photographic plates and also for school use. Mk. **210.—**

(Fig. 39.)

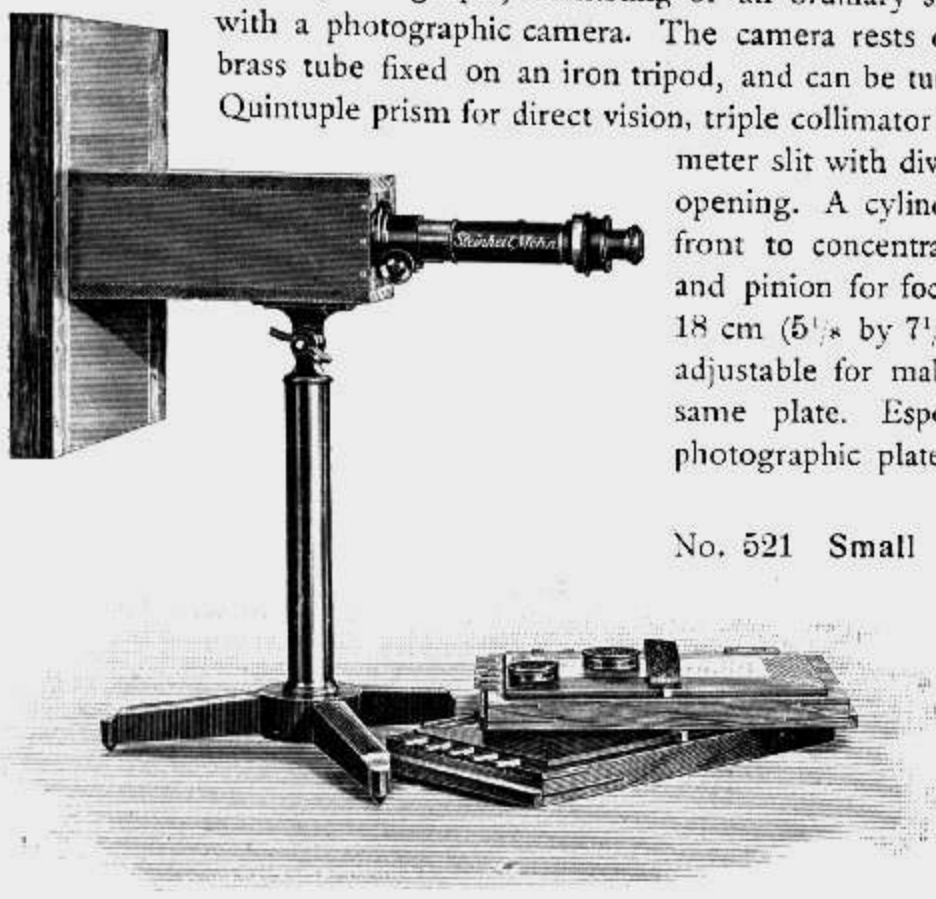

Fig. 39. Simple Spectrograph.

No. 521 **Small Spectrograph,** horizontally mounted for terrestrial and astronomical spectrum photography; two flint prisms of 60°, telescopes arranged on plate, stand with horizontal mounting, aplanatic photographic lens, camera 9 by 12 cm (3 1/2 by 4 3/4 in.) with focussing screen and dark slide . . . . . Mk. **500.—**

Apparatus for visual observation see accessories No. 536.

No. 522 **Small Spectrograph with Equatorial Mounting,** especially adapted for photographing star spectra; construction similar to No. 521, but with the addition of the equatorial mounting; slow motion is provided making it possible to follow the star; the instrument can also be used in the horizontal position; adjustable polar altitude Mk. **800.—**

Apparatus for visual observation see accessories No. 536.

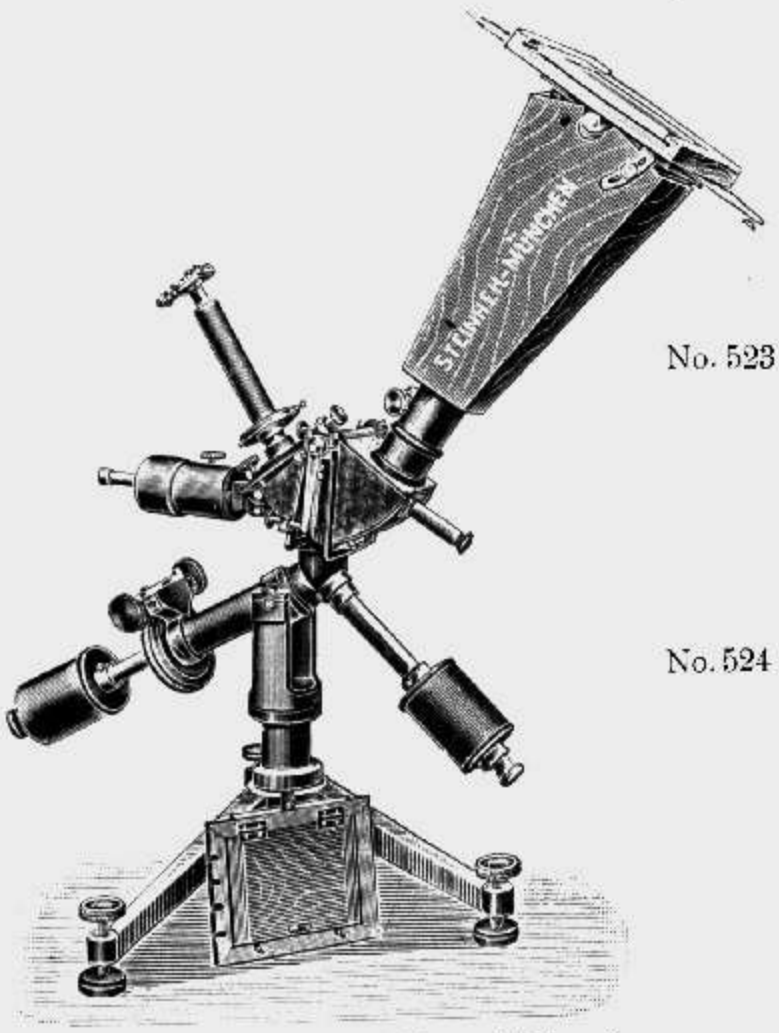

Fig. 40. Large Spectrograph with Equatorial Mounting.

No. 523 **Large Spectrograph, horizontally mounted.** Construction similar to No. 521, but with larger objectives and also three prisms of 50° angle; size of photographic plate 13 by 18 cm (5 1/8 by 7 1/8 in.) . . Mk. **700.—**

Apparatus for visual observation see accessories No. 536.

No. 524 **Large Spectrograph, with Equatorial Mounting.** Equipment similar to No. 523. Construction similar to No. 522, but with instantaneous shutter and therefore also available for solar spectrum photography. Size of plate 13 by 18 cm (5 1/8 by 7 1/8 in.) (Fig. 40.) . . . . . Mk. **1200.—**

Apparatus for visual observation see accessories Nr. 536.

Note. All glass prism spectrum apparatus can, if desired, be provided with prisms and objectives of the new U.V. glasses, at a correspondingly higher price; certain of the instruments can also be supplied with quartz optical equipment.

Accessories to the Glass-Prism Spectrum Apparatus.

No. 525 **Simple Micrometer Slit Mechanism** with adjustable jaw . . . . . Mk. **30.—**
The same with divided head for measuring the width of slit . . . . . Mk. **40.—**
The same with divided head for measuring and with hinged comparison prism Mk. **45.—**

No. 526 **Symmetrical Micrometer Slit Mechanism** with symmetrical movement of the two jaws, divided head for measuring the width of slit and hinged comparison prism Mk. **70.—**

No. 527 **Symmetrical Micrometer Double Slit Mechanism** with two apertures and two divided heads, symmetrical movement of the jaws*) . . . . . Mk. **130.—**

No. 528 **Vierordt's Ocular Slide;** the width of slit and movement of cross lines are regulated by micrometer and can be read on divided head . . . . . Mk. **50.—**

No. 529 **Hartmann's Slit Diaphragms** for shutting off certain portions of the slit.

These diaphragms make it possible to bring any desired number of spectra into one plate and to photograph comparison spectra of any desired width at the side of or on both sides of or between the spectra under observation (see "Zeitschrift für Instrumentenkunde" 1900, page 57).

A set of four with different apertures, including fitting and division of slit Mk. **15.—**

No. 530 **Small Heliostat Mirror,** with simple stand . . . . . Mk. **25.—**

No. 531 **Micrometer Stand,** with adjustment for height, absorption vessel with plano-parallel walls (see Fig. 38) . . . . . Mk. **40.—**

No. 532 **Glass Cell,** aperture 25 mm (1 in.), with plano-parallel walls, interior width adjustable, with mount for fixing in front of the slit . . . . . Mk. **40.—**

Fig. 41.
Condensor with Stand.

No. 533 **Condensor with Stand;** two simple positive lenses in mount, for concentrating the incident light on the prism; mounted on metal table stand, brass tubular pillar on iron tripod, with rack adjustment for height (Fig. 41) Mk. **80.—**

No. 534 **Apparatus for Photographing the Spectrum.** Photographic lens with helicoidal draw, camera with focussing screen and two dark slides, these latter vertically adjustable so that several exposures can be made on one plate.
For plates 6 by 9 cm (2 3/8 by 3 1/2 in.), focus of lens 18 cm (7 1/8 in.) . . . . . Mk. **150.—**
For plates 9 by 12 cm (3 1/2 by 4 3/4 in.), focus of lens 24 cm (9 1/2 in.) . . . . . Mk. **180.—**
Can be fitted to spectrum apparatus No. 510—519.

No. 535 **Magnifying system** for transforming the photographic lens of No. 534 into a tele-objective of long focus
for plates 6 by 9 cm (2 3/8 by 3 1/2 in.) . . . . . Mk. **80.—**
for plates 9 by 12 cm (3 1/2 by 4 3/4 in.) . . . . . Mk. **100.—**
not including cost of a possibly necessary adaptation of camera, which can be supplied either in box form for a fixed magnification or with bellows extension for different magnifications.

No. 536 **Apparatus for visual observation of the Spectrum.** A viewing telescope with rack adjustment to focus is substituted for the camera.**)
For use in connection with Nos. 521 and 522, objective aperture 27 mm (1 1/16 in.), focus 24 cm (9 1/2 in.), ocular A R 27 mm (1 1/16 in.) equivalent focus, magnification 9 X . . . . . Mk. **75.—**

*) The height of the slit of Nos. 524 to 527 is 20 mm (13/16 in.).

**) For visual observation it is also possible to simply substitute an astronomical eye-piece for the focussing screen.

For use in connection with Nos. **523** and **524**, objective aperture **41** mm (1⅝ in.), focus **33** cm (18 in.), ocular A R **27** mm (1 1/16 in.) equivalent focus, magnification **12** X . . . . . Mk. **90.**—

The apparatus Nos. 534 to 536 will be supplied at the prices here quoted if they are ordered at the same time as the instruments for which they are intended; for a later adaptation an extra charge of Mk. 20.— to Mk. 30.— will be made.

The Gauss ocular No. 181 is recommended as an accessory to all spectroscopes for more accurate adjustment of the optical axes of the telescopes and more accurate focussing for infinity. Needle point micrometer see No. 188, Crossline micrometer No. 189.

Table of Glass-Prism Spectrum Apparatus.

No.	Instrument	Dispersion from B to M			Objective Aperture		Ratio of aperture	Ocular Focus		Magnification	Pencil of rays diameter	Price
		degrees	mm	in.	mm	in.		mm	in.	X	mm	Marks
509	Small Spectrum Apparatus	4,5	12	1/2	20	13/16	1:8	27	1 1/16	6	3,3	**130.**—
510	Simple „ „	4,5	19	3/4	27	1 1/16	1:9	27	1 1/16	9	3,0	**275.**—
511	Spectrum Apparatus with 2 Prisms . . .	9	38	1 1/2	27	1 1/16	1:9	27	1 1/16	9	3,0	**400.**—
512	„ „ „ Rutherf. Prism .	7,0	32	1 1/4	27	1 1/16	1:9	27	1 1/16	9	3,0	**430.**—
513	„ „ „ 2 Prisms large size	9	53	2 1/8	42	1 5/8	1:8	27	1 1/16	12	3,4	**450.**—
514	„ „ „ Rutherf. Prism large size . . .	7,0	44	1 3/4	41	1 5/8	1:8	27	1 1/16	12	3,4	**550.**—
515	Universal Apparatus, small size	7,0	21	1 13/16	20	13/16	1:8	27	1 1/16	6	3,3	**600.**—
516	„ „ middle size . . .	7,0	32	1 1/4	27	1 1/16	1:9	27	1 1/16	9	3,5	**720.**—
517	„ „ large size	7,0	44	1 3/4	41	1 5/8	1:8	27	1 1/16	12	3,4	**840.**—
518	„ „ with quintuple prism, small . . .	21	60	2 3/8	20	13/16	1:8	27	1 1/16	6	3,3	**700.**—
519	„ „ with quintuple prism, large . . .	16	68	2 11/16	27	1 1/16	1:9	27	1 1/16	9	3,0	**820.**—
520	Simple Spectrograph	21	120	4 11/16	20	13/16	1:3	—	—	—	—	**210.**—
521	Small Spectrograph, with horiz. mounting	9	70	2 3/4	44	1 3/4	1:10	—	—	—	—	**500.**—
522	„ „ with equat. „	9	70	2 3/4	44	1 3/4	1:10	—	—	—	—	**800.**—
523	Large Spectrograph, with horiz. mounting	12	130	5 1/4	54	2 1/8	1:10	—	—	—	—	**700.**—
524	„ „ with equat. „	12	130	5 1/4	54	2 1/8	1:10	—	—	—	—	**1200.**—

2. Quartz Spectrum Apparatus.

No. 537 **Small Quartz Spectrograph.** The optical equipment consists of two simple quartz lenses, the spherical aberration corrected, of 20 mm (13/16 in.) and 240 mm (9 1/2 in.) focal length, a Cornu quartz prism No. 319, 20 mm (13/16 in.) high and 30 mm (13/16 in.) length of face. The different movements are by hand, the movable parts being provided with simple divisions. Camera with two dark slides 9 by 12 cm (3 1/2 by 4 3/4 in.). By slanting the sensitive plate it is possible to obtain the whole spectrum from B to M (85 mm = 3 3/8 in. long, 2,5° dispersion) in sharp definition. Collimator with slantingly adjustable scale, which can be photographed together with the spectrum . . . . . Mk. **500.—**

No. 538 **Large Quartz Spectrograph.***) Construction and equipment similar to No. 537, but with larger quartz lenses of 40 mm (1 9/16 in.) aperture and 40 cm (15 3/4 in.) focus, larger Cornu prism, 40 mm (1 9/16 in.) high, 50 mm (1 15/16 in.) length of face, and collimator and photographic lens to correspond; lens with rack adjustment. Camera with two dark slides 6 1/2 by 18 cm (2 9/16 by 7 1/8 in.). Fine adjustment of plate; the divisions are also finer than in No. 537. The whole spectrum is 18 cm (7 1/8 in.) . . . . . Mk. **1120.—**

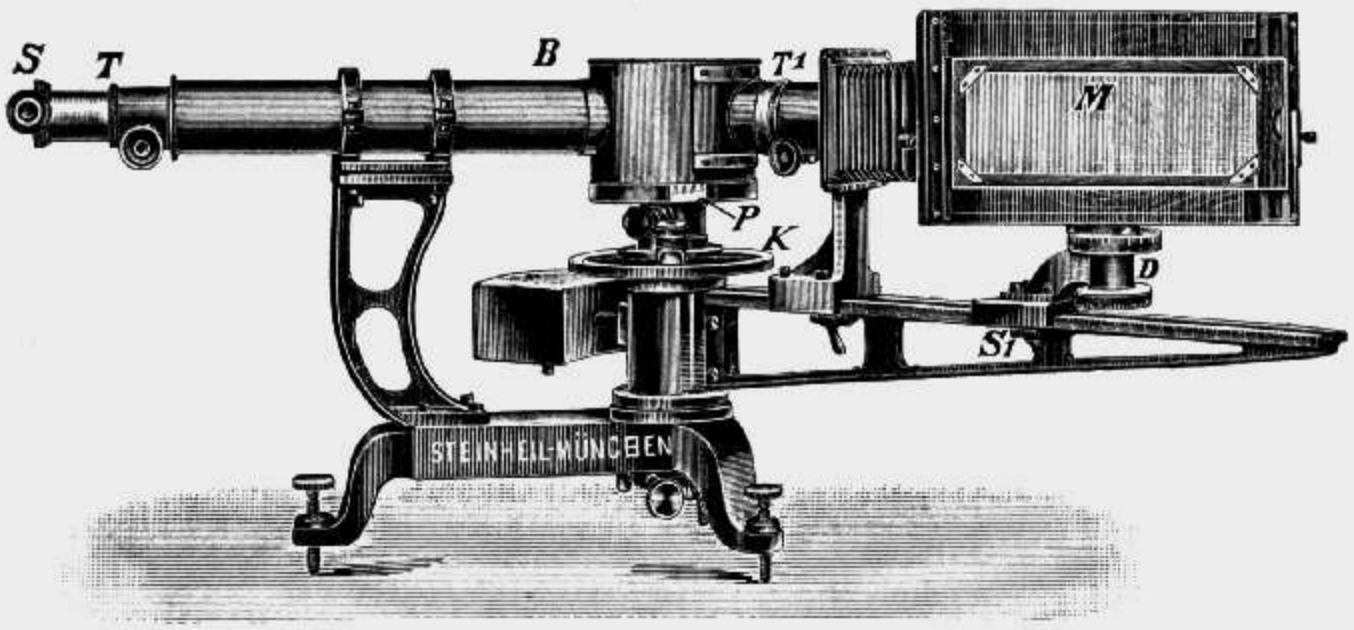

Fig. 42. Large Quartz Spectrograph (without fine adjustment).

If desired, this instrument (No. 538) can also be supplied without fine adjustment (similar to Fig. 42) at a correspondingly reduced price.

Accessories to Nos. 537 and 538.

No. 539 Soret's fluorescent eye-piece, with uranium glass plate to take the place of the focussing screen, for the visual observation of the spectrum . . . . . Mk. **60.—**

No. 540 Quartz cells, with plano-parallel walls, 25 mm (1 in.) aperture . . . . . Mk. **50.—**

Hartmann's diaphragms see No. 529.

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*) See "Zeitschrift für Instrumentenkunde". August 1904.

3. Grating Spectrum Apparatus.

a) fitted with Rowland Metal Diffraction Gratings.

The spectrum is obtained with a plane Rowland diffraction grating; the viewing telescope is fixed, the grating rotatable and the angle of rotation can be read off a divided quadrant with double vernier; the wave lengths are calculated by a simple formula from the observed deviation. For photographic work a lens with camera etc. can be supplied. Camera and viewing telescope are made easily interchangeable. Spectra of the second and third order may be viewed and photographed by moving the collimator and turning the grating.

When photographing spectra of the first order

the smaller size (No. 541) gives a dispersion of about 11,5° = an extension of about 35 mm (1³/₈ in.),
„ larger „ (No. 543) „ „ „ „ 11,5° = „ „ „ „ 47 mm (1⅞ „),

for wave lengths between B and M;

when photographing spectra of the second order

the smaller size (No. 541) gives a dispersion of about 24,5° = an extension of about 77 mm (3 in.),
and the larger size (No. 543) „ „ „ „ 24,5° = „ „ „ „ 102 mm (4 „),

for wave lengths between B and M.

The instruments can be fitted with customer's own gratings at correspondingly reduced prices. The gratings must be sent with order.

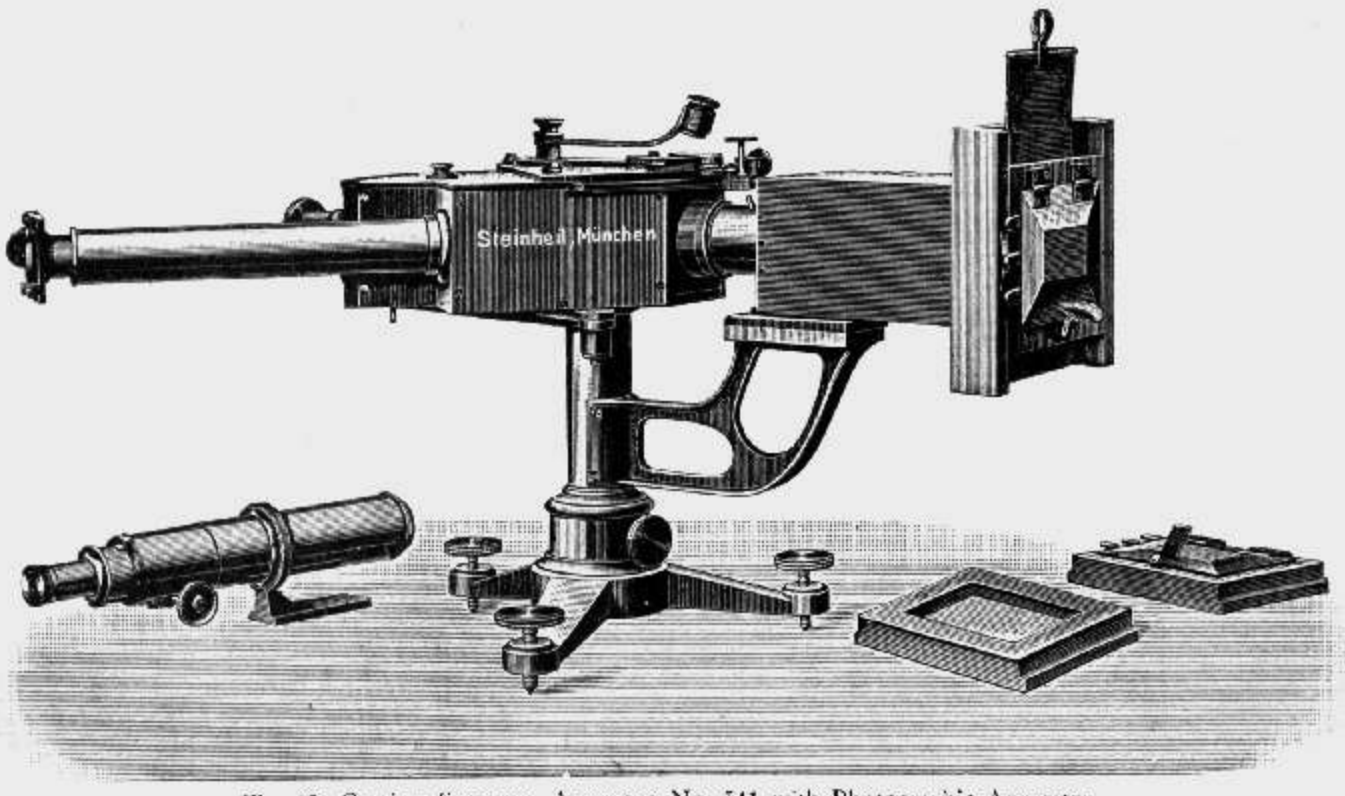

Fig. 43. Grating Spectrum Apparatus No. 541 with Photographic Apparatus.

No. 541*) **Grating Spectrum Apparatus.** Collimator and viewing telescope with objectives of 27 mm (1¹/₁₆ in.) aperture and 24 cm (9½ in.) focus; viewing telescope with rack adjustment for focussing and ocular A R of 27 mm (1 ¹/₁₆ in.) focus (magnification 9×). Adjustable scale telescope with objective of 14 mm (⁹/₁₆ in.) aperture and 11 cm (4⁵/₁₆ in.) focus. Slit with micrometer motion and divided head. Quadrant divided in intervals of 10', double vernier reading to 10" with magnifier; Row-

*) See "Zeitschrift für Instrumentenkunde", September 1898.

land plane diffraction grating with 14438 lines per inch, 1 1/4 in. polished and 5/8 by 1 in. ruled surface. Fine adjustment for grating. Telescopes fixed. (Fig. 43.) . Mk. **650**.—

Photographic complement see accessories No. 549.

No. 542 **Grating Spectrum Apparatus** of simpler construction. Similar to No. 541, but without measuring device etc. . . . . Mk. **480**.—

No. 543 **Grating Spectrum Apparatus.** Larger size, the same as No. 541, but larger. Collimator and telescope objectives of 41 mm (1 5/8 in.) aperture and 33 cm (13 in.) focus, grating with 2 7/16 in. polished and 2 by 1 1/4 in. ruled surface, 14438 lines per inch . . . . . Mk. **900**.—

Photographic complement see accessories No. 549.

No. 544 **Grating Spectrum Apparatus** of simpler construction, larger size. Similar to No. 542, but without measuring device etc. . . . . Mk. **750**.—

b) Grating Spectrum Apparatus fitted with copies of diffraction gratings

(without scale).

No. 545 **Small Spectrum Apparatus, with copy of diffraction grating, simple model,** collimator and telescope with objectives of 27 mm (1 1/16 in.) aperture, 24 cm (9 1/2 in.) focus, viewing telescope movable, with rack adjustment to focus, ocular A R 27 mm (1 1/16 in.) focus and magnification 9×, slit adjustable with divided head, and comparison prism . . . . . Mk. **250**.—

No. 546 **Small Spectrum Apparatus with copy of diffraction grating, with divided circle and slow motion;** similar to No. 545, but with slow motion and circle divided in 1/2°, reading with vernier to 1' . . . . . Mk. **400**.—

No. 547 **Spectrum Apparatus with copy of diffraction grating, simple model,** larger size. Similar to No. 545, but with objectives of 41 mm (1 5/8 in.) aperture and 33 cm (13 in.) focus, viewing telescope with rack adjustment and ocular A R of 27 mm (1 1/16 in.) for magnification 12× . . . . . Mk **340**.—

No. 548 **Spectrum Apparatus with copy of diffraction grating, with divided circle and slow motion,** larger size; construction similar to No. 546, optical equipment similar to No. 547 . . . . . Mk. **500**.—

Accessories to Grating Spectrum Apparatus.

No. 549 **Apparatus for photographing the spectrum,** interchangeable with the viewing telescope; photographic lens (rectilinear 1:8), camera with focussing screen, two dark slides, vertically adjustable;

a) for Nos. 541, 542, 545, 546, size of plate 6 by 9 cm (2 3/8 by 3 1/2 in.), focus of lens 18 cm (7 1/8 in.) . . . . . Mk. **150**.—

b) for Nos. 543, 544, 547, 548, size of plate 9 by 12 cm (3 1/2 by 4 3/4 in.), focus of lens 24 cm (9 1/2 in.) . . . . . Mk. **180**.—

These apparatus will be supplied at the prices quoted if they are ordered at the same time as the instruments for which they are intended; for the later adaptation a charge of Mk. **20**.— to Mk. **30**.— will be made, and in this case it will also be necessary to send the instruments in question to us.

Here also the tele-objective No. 535 can be used with advantage.

Dark slides for Lippmann's colour photography can also be supplied. Extra charge about Mk. **25**.—

4. Various Spectroscopes.

No. 550 **Small Pocket Spectroscope,** with adjustable slit and triple straight viewing prism. Extension of spectrum about 13°. Length of the instrument when closed 9 cm (3½ in.) (Fig. 44) . . . . . Mk. **48.—**

Fig. 44. Small Pocket Spectroscope.

No. 551 **Pocket Spectroscope,** similar to No. 550, but with quintuple prism system and brighter spectrum of about 18° extension. Length when closed about 11 cm (4⅜ in.) . . Mk. **72.—**

No. 552 **Secchi's Sidero-Spectrum Apparatus** for observing the spectra of stars, for screwing on large telescopes; triple direct vision prism. Cylindrical objective Mk. **120.—**

No. 553 **Secchi's Sidero-Spectrum Apparatus,** larger size; similar to No. 552 but with quintuple prism . . . . . Mk. **180.—**

No. 554 **Vogel's Ocular Spectroscope** for examining faint nebulae and comets. Triple prism with achromatic ocular A F of 41 mm (1⅝ in.) focus, slit with comparison prism. For observing fixed stars the slit can be removed and a cylindrical lens attached to the cap . . . . . Mk. **90.—**

No. 555 **Small Protuberance Spectroscope** with quintuple prism of high dispersion for direct vision. Collimator and viewing telescope with objectives of 14 mm (⅜ in.) aperture and 11 cm (4⅜ in.) focus. Viewing telescope with ocular A R, 14 mm (⅜ in.) focus, magnification 8 X, movable across the entire spectrum by means of a micrometer screw with divided head. The number of complete turns of the screw is read off on a sector fastened to the hinge. The instrument is fitted into a circle divided to degress by means of an adapter and the whole screwed into the focussing tube of the telescope with which it is used (Fig. **45**) . . . . . Mk. **320.—**

Fig. 45. Protuberance Spectroscope.

No. 556 **Protuberance Spectroscope with Photographic Apparatus.** The construction and equipment is similar to No. **555**, but in place of the viewing telescope a camera with photographic lens is arranged in the optical axis of the telescope; camera of metal, focussing screen and dark slide 3 by 9 cm (1⅛ by 3½ in.); fine adjustment, division and position circle are the same as in No. **555**; a device for the radial and tangential adjustment of the slit is provided. The instrument is fitted to the telescope by means of slide rails and clamp . . . . . Mk. **520.—**

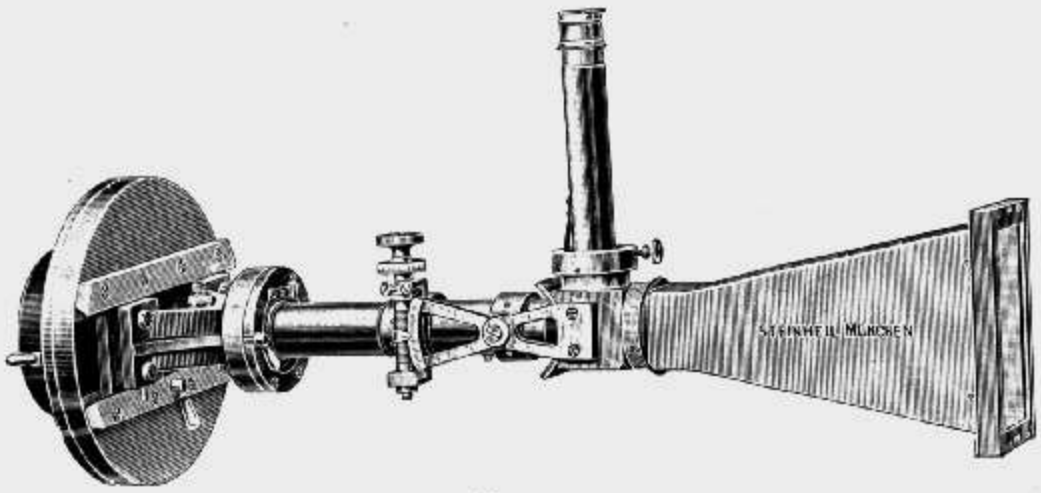

Fig. **46.**
Protuberance Spectroscope with photographic (and visual) apparatus.

In order to permit at the same time visual observation and photographic exposure, a viewing telescope can be arranged at the middle of the instrument (as shown in Fig. 46) at an angle of 90° to the optical axis of the telescope; a reflecting prism in the interior of the spectroscope makes visual observation possible. (Fig. 46). Extra cost . . . . . Mk. **160.—**

No. 557 **Protuberance Spectroscope with Diffraction Grating,** for direct vision, for use with large telescopes; the pencil of rays is directed by means of a prism and objective of 20 mm (13/16 in.) aperture and 16 cm (6 5/16 in.) focal length into a laterally located Rowland metal diffraction grating (1 by 5/8 in. ruled surface, 14438 lines per inch) and is observed through a telescope with objective of 20 mm (13/16 in.) aperture and 16 cm (6 5/16 in.) focal length with an ocular A R 20 mm (13/16 in.) focus (magnification 8 X).

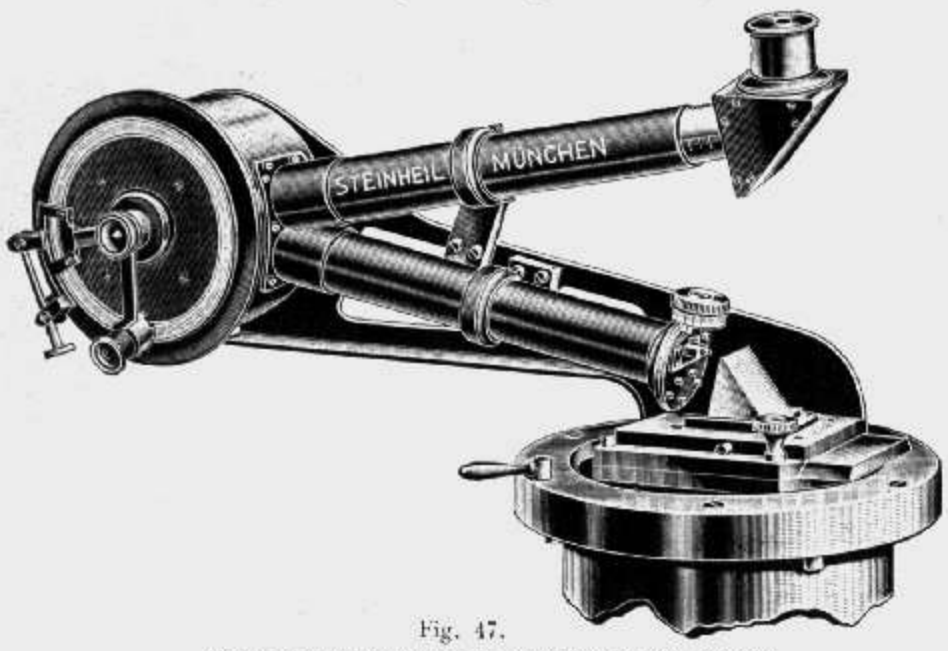

Fig. 47.
Protuberance-Spectroscope with Diffraction grating.

Circle divided in 1/2°, reading with magnifier to 1'. (Fig. 47) . . . . . Mk. **670.—**

5. Goniometers and Spectrometers.

No. 558 **Goniometer,** for determining the refractive and dispersive power of various media and for measuring the angles of prisms. The plane of the horizontal prism stage is inclinable, by which means the refracting edge of any two prism surfaces may always be placed at right angles to the plane of the telescope axes. The stage is, besides, independently of the circle and the viewing telescope, adjustable by hand and micrometer. The circle has a diameter of **16** cm ($6^5/_{16}$ in.) and is divided in $^1/_6$ degrees reading by four opposite verniers to intervals of **10″** by means of reading telescopes. All measurements may be made by repetition. Either objective of the viewing and illuminating telescopes

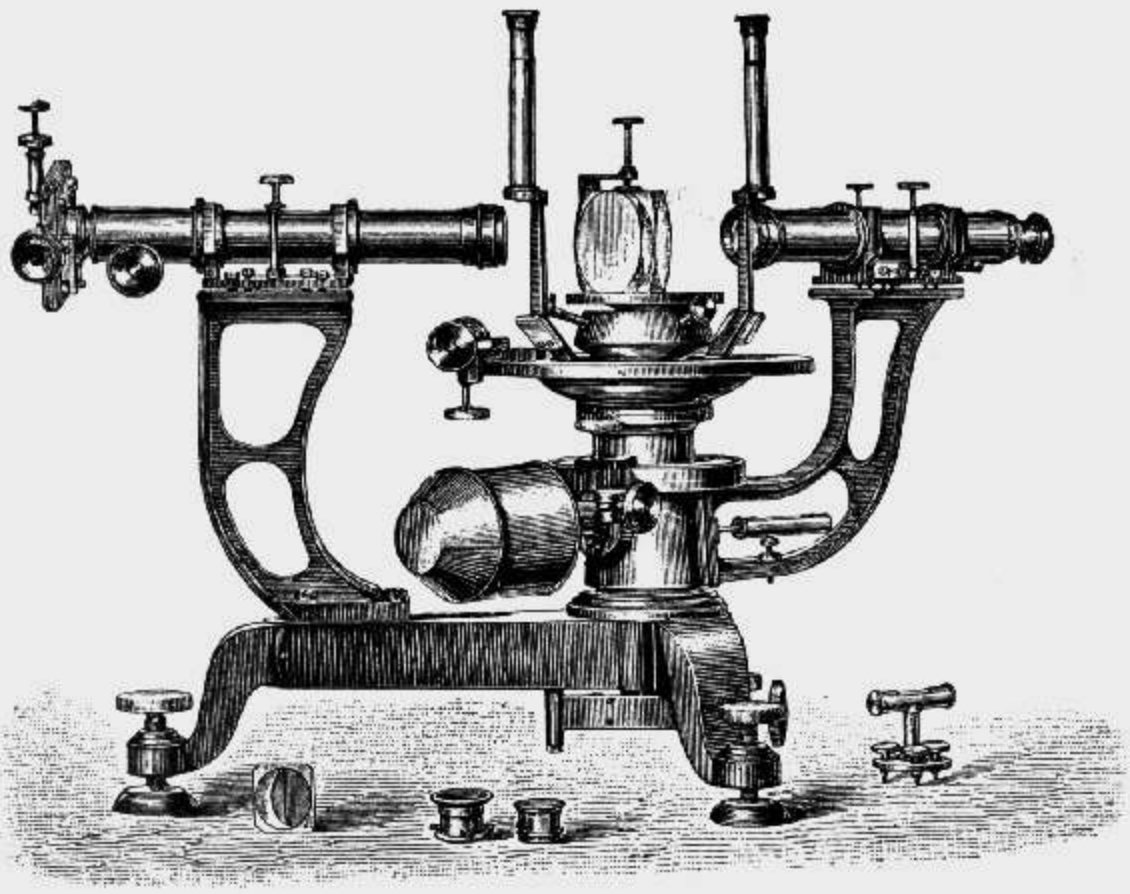

Fig. 48. Goniometer.

has an aperture of 27 mm ($1^1/_{16}$ in.) and a focus of **24** cm ($9^1/_2$ in.). Both telescopes are fitted in sliding collars and may be levelled so as to have their axes intersecting and in one plane. The goniometer is fitted with micrometer slit mechanism with symmetrical motion of the jaws. The apparatus is supplied with an astronomical ocular A R for magnification **12 X**, and a prism of **60°** refracting angle and 34 mm ($1^3/_8$ in.) aperture. (Fig. 48) . . . . . Mk. **1500.—**

No. 559 **Goniometer,** similar to No. 558, but of simplified construction, with non-rotating prism stage and fixed telescopes without sliding collars. The circle is divided in $^1/_2$ degress, the verniers reading by magnifiers. Simple slit micrometer. This instrument is also available as spectrum apparatus . . . . . Mk. **700.—**

No. 560 **Goniometer,** similar in construction to No. **558,** but with optical equipment of greater brightness; collimator and viewing telescope with triple objectives of **47** mm ($1^7/_8$ in.) aperture and **19** cm ($7^1/_2$ in.) focus; viewing telescope with achromatic ocular A F of **14** mm ($^9/_{16}$ in.) focus, magnification **14 X**; angle of prism 60°, aperture of prism 54 mm ($2^1/_8$ in.) . . . . . Mk. **1640.—**

No. **561** **Goniometer,** simplified construction similar to No. 559, but with optical equipment of greater brightness similar to No. 560; non rotating prism stage, fixed telescopes etc. . . . . Mk. **820.—**

No. **562** **Universal Spectrometer.** Externally similar to the goniometer No. 558, but with optical equipment of great brightness; collimator and viewing telescopes with triplet objectives of 47 mm (1⅞ in.) aperture and 19 cm (7½ in.) focal length, the viewing telescope with rack adjustment and ocular A F for magnification 14 X; further the accessories of the large Universal Spectrum Apparatus No. 517 (flint prism, Rutherford prism, two symmetrical micrometer slit mechanisms: one single and one double slit) are also supplied with this instrument.

The circle is graduated both outside and inside and is fixed; besides the rotation of the telescope also that of the prism stage can be measured, so that altogether eight verniers are provided, giving readings to 10″; prisms of any angle, howewer large, can therefore be measured. The adjustment of the prism stage is effected by means of spring screws. For determining the dispersion in small intervals, the telescope support is provided with a graduated fine adjustment.

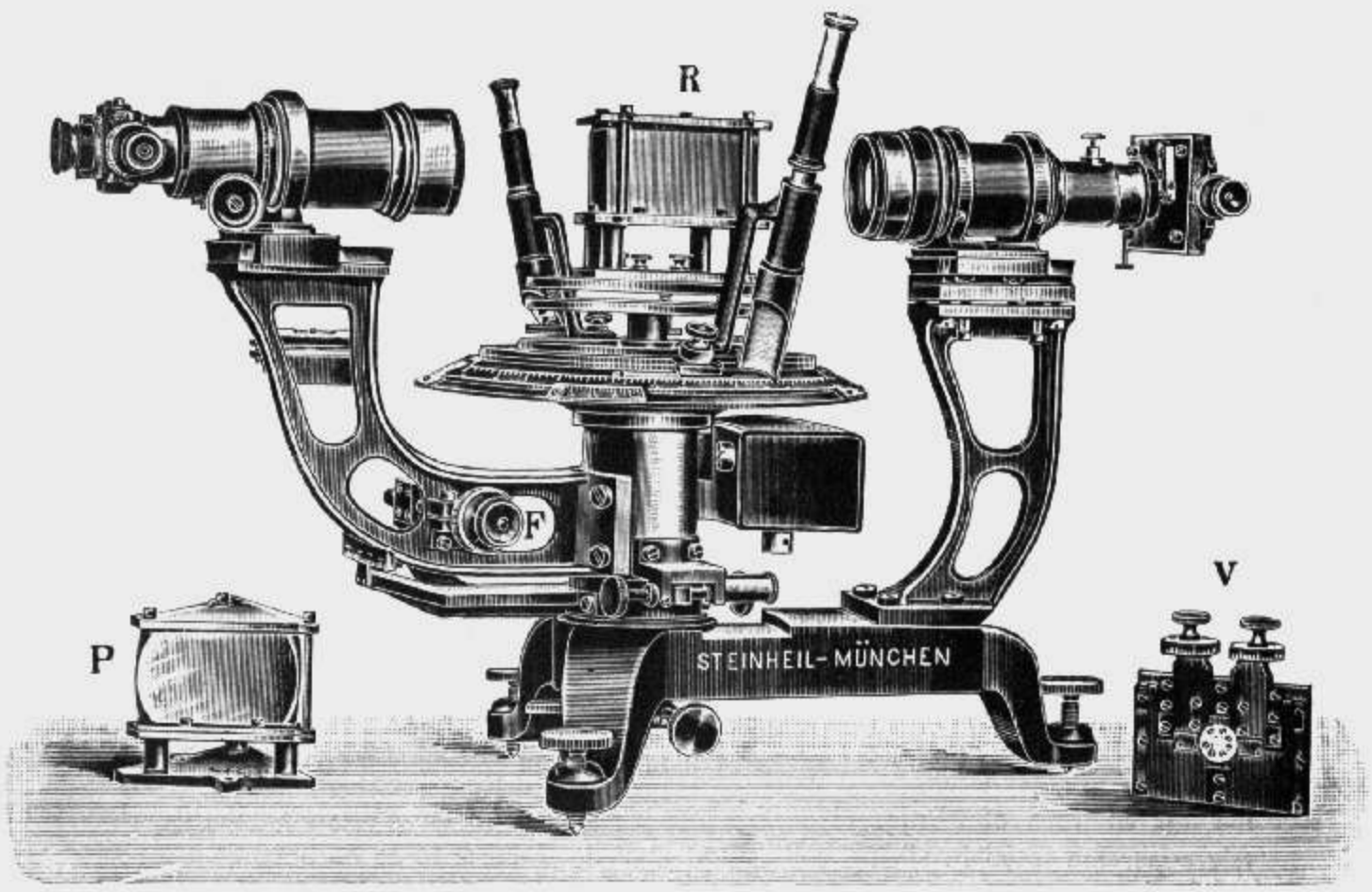

Fig. 49. Universal Spectrometer in use as Goniometer.

The prisms are screwed to the prism stage in suitable mounts; in order to be able to also use large-sized Rowland gratings, the optical axis of the apparatus is arranged much higher above the prism stage than is the case with other instruments. For shutting off daylight a light-tight hood is provided, which is placed over the prism stage and allows the telescope sufficient free play.

In order to be able to also photograph the spectrum, a photographic complement can be supplied with this apparatus; this consists of a specially rapid lens, Unofocal 1 : 4,5, of 19,5 cm (7 11/16 in.) focal length, camera and focussing screen and two dark slides 9 by 12 cm (3½ by 4¾ in.), and is easily interchangeable with the viewing telescope.

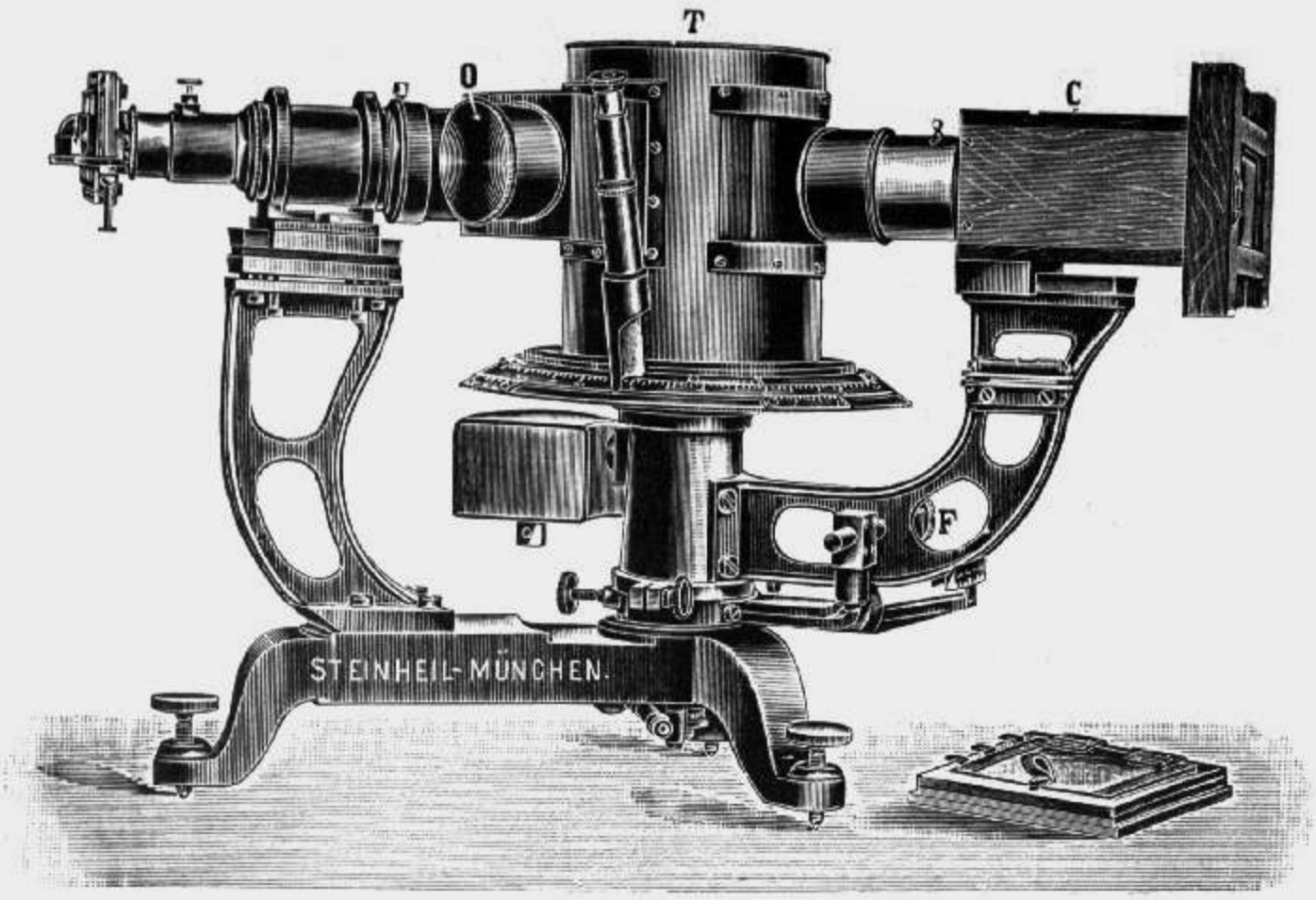

Fig. 50. Universal Spectrometer in use as Spectrograph.

Consequently this apparatus admits of the following comprehensive application:

1. As **Goniometer** for the determination of the refractive and dispersive power of various media and for measuring prism angles of any size, etc. (Fig. 48.)
2. As **Universal Spectrum Apparatus** for qualitative and (with the help of Vierordt's Ocular Slide and the Micrometer Stand Nos. **528** and **531**) also for quantitative analysis of spectra of especially weak luminosity.
3. As **Spectrograph** with very rapid (bright) optical equipment with the help of the photographic complement. (Fig. 49.)

Price of the Universal Spectrometer . . . . . Mk. **1850.—**

Price of the Photographic Complement . . . . . Mk. **210.—**

D.

Miscellaneous Optical Instruments.

D. Miscellaneous Optical Instruments.

No. 563 **Prismatic Circle,** new improved form. This instrument, for nautical observation, was first constructed in the early thirties.*) The present design is a considerable improvement upon the original instrument and differs from the latter chiefly in weight, being much lighter; the reading is also improved and more accurate, and there is a better arrangement of the dark glasses. The instrument is either held in the hand or mounted on the stand (No. 564) and measures angles up to 180°. Telescope with objectives of 20 mm ($^{13}/_{16}$ in.) aperture and 16 cm ($6^{3}/_{8}$ in.) focus. Ocular A R of 20 mm ($^{13}/_{16}$ in.) focus, magnifying 8X; two isosceles prisms with sharp edges, refracting angle 95°, height 10 mm ($^{3}/_{8}$ in.), length of isosceles sides about 40 mm ($1^{9}/_{16}$ in.); circle 165 mm ($6^{1}/_{2}$ in.) diameter, divided in intervals of 10′, verniers reading with magnifiers to 10″ (the circle has a second division in degrees at the extreme edge); the scale is bevelled and the verniers rest upon it. The telescope can be raised by a screw and its axis adjusted parallel to the plane of the circle by two adjusting screws. The telescope support carries above the front of the objective six accurate plano-parallel dark glasses of various shades; these cover only half of the objective and may be lowered when required. The device for fine adjustment has room to pass the telescope when the small index arm, attached to the telescope, is turned upwards. A second ocular A R of 20 mm ($^{13}/_{16}$ in.) focus, adjusted for autocollimation, and three dark glasses of various shades, are also included. Weight of the complete instrument about 1,7 kilo (about 4 lbs.). The instrument and accessories are fitted into an elegant case of walnut or mahogany. (Fig. 51.)

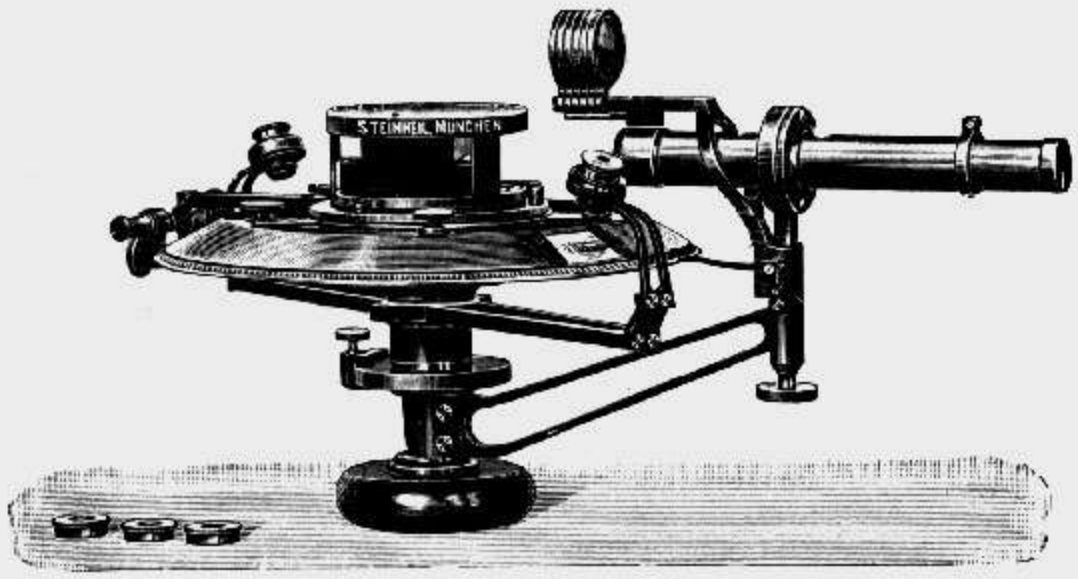

Fig. 51. Prismatic Circle.

Price . . . . . Mk. **750.—**

*) See: "Schuhmacher's astronomische Nachrichten" XI, Nos. 247, 247 and 255.
Hunäus, "Geometrische Instrumente", Leipzig 1882, page 518.
Jordan, "Zeit- und Ortsbestimmungen" Ic, page 259.

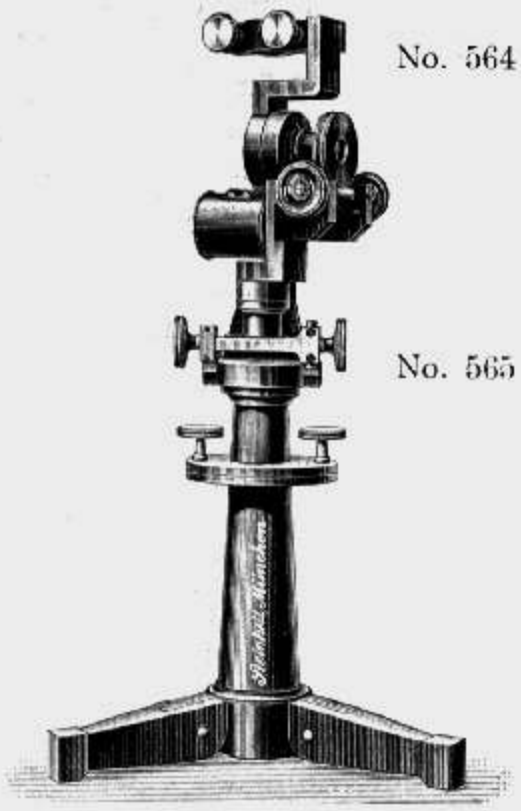

Fig. 52. Stand for Prismatic Circle.

No. 564 **Stand for Prismatic Circle.** Brass pillar and tripod. Horizontal and vertical movements, by hand and with micrometer screw. The prismatic circle is fastened to the stand by a clamp, with two screws, which grip the circle at the base near the holder. The three legs of the tripod fold together; and the stand is divisable into two parts and may be packed in a relatively small case. (Fig. 52.)
Price . . . . . Mk. **180.**—

No. 565 **Universal Instrument for Travellers.** Latest improved model for observations of time and latitude, surveying and levelling. Also available as a transit instrument. The difference between the present model and the instrument described in former catalogues and also in various papers*) may be briefly summarised as follows: The new instrument is more finely divided and the readings being taken with magnifiers and verniers results in greater accuracy of the measurements. The verniers for the vertical circle are fixed immediately upon it and are thus better protected from injury when reversing the telescope. For greater facility and accuracy of reading the divided surfaces are bevelled and the verniers rest upon them. The verniers are provided with cover glasses and the circles with metal covers for greater protection. The fine adjustment of the telescope is now effected at both ends below the telescope support, instead of at the middle of the telescope as formerly.

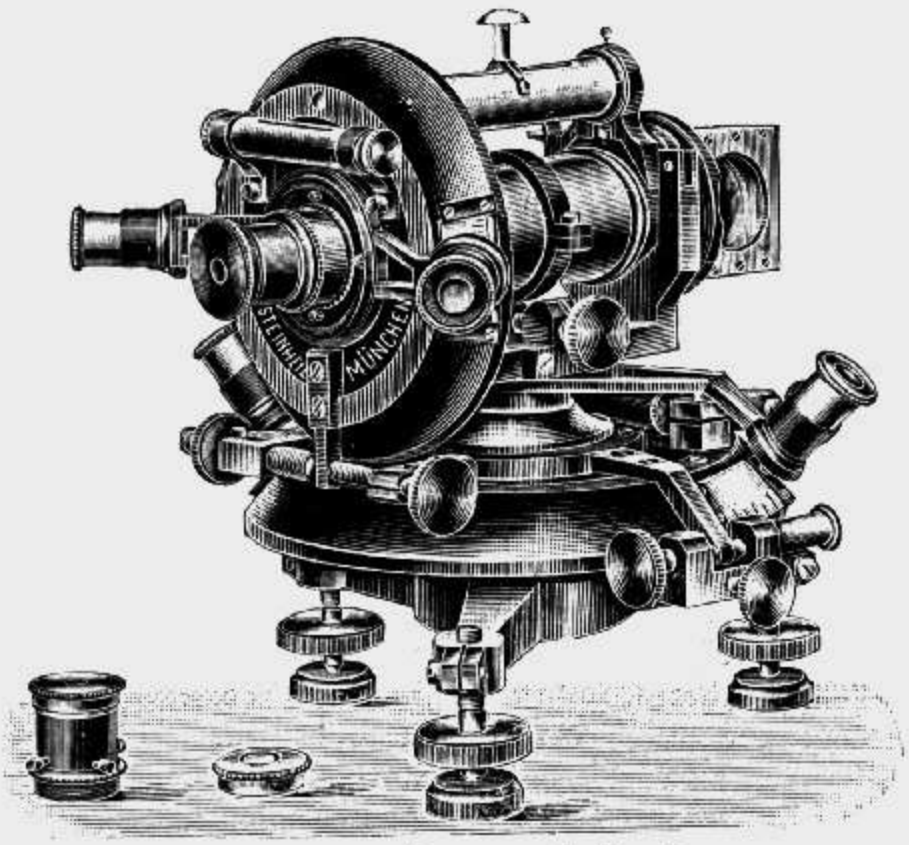

Fig. 53. Universal Instrument for Travellers.

Telescope with triplet objective of 27 mm ($1^{1}/_{16}$ in.) aperture, 11 cm ($4^{5}/_{16}$ in.) focus; two achromatic oculars A F, the one with 9 mm ($^{3}/_{8}$ in.) focus (magnification 12 X) and movable cross-lines and the other with 14 mm ($^{9}/_{16}$ in.) focus (magnification 8 X) and fixed cross-lines (two horizontal and five vertical). The telescope rests in cylindrical bearings upon two Y-shaped supports. In front of the objective a right-angled prism is fixed, which can easily be removed for levelling. The mount of the prism is cut through and the prism at these points ground dull in order to permit of observations with dark lines on a bright ground. Diameter of the horizontal circle 125 mm ($4^{15}/_{16}$ in.), of the vertical circle 96 mm ($3^{13}/_{16}$ in.); both circles are divided in intervals of 20′, reading with magnifiers and verniers to 20″, and are provided with clamps and micrometer motion (but not repeating). The horizontal circle and telescope are provided with levels. Micrometer screws are arranged at both ends of the telescope support for the fine adjustment of the telescope on its axis. The complete instrument fits into a small and portable mahogany case. (Fig. 53.)
Price . . . . . Mk. **720.**—

No. 566 **Set of 16 Different Telescopic Objectives** for demonstrating various defects which are apt to affect the utility of an objective. These defects refer to chromatic and spherical aberrations, distortion, chromatic differences of magnification and all technical imperfections caused by

*) Vide: "Bericht der K. b. Akademie der Wissenschaften" **1864**, Vol. I, page 1.
"Carls Repetitorien", Vol. I, page 149.

deficient centering, faulty glass etc.*) The objectives have all an aperture of 27 mm (1 1/16 in.) and a focus of 33 cm (13 in.). A telescope is supplied with the objectives provided with a screw to take the thread of the latter and fitted with an achromatic ocular A F having an astronomical magnification of 24 diameters. The whole contained in polished walnut case.
Price . . . . . Mk. **375.**—

Fig. 54. Transit Prism.

No. 567 **Transit Prism** for determining time and polar altitude. Telescope of 7 mm (1/4 in.) aperture, 54 mm (2 1/8 in.) focus, magnifying 8 times with achromatic ocular A F; sun-shade, spring adjustment for azimuth and elevation. Packed in small case.**) Detailed directions for use accompany each instrument. (Fig. 55).
Price . . . . . Mk. **105.**—

No. 568 **Pocket Heliotrope** for long distance light signalling. The instrument consists of a horizontal perfectly plane mirror 43 by 27 mm (1 11/16 by 1 1/16 in.), having a circle of 3,5 mm (1/8 in.) diameter in its centre unsilvered. Through this aperture may be seen an orientation image of the sun, which by altering the position of the mirror may be directed to any desired point; all points covered by this image receive light from the heliotrope. This light can be seen about 50 kilometres (32 English miles) with the naked eye. The instrument forms a complete substitute for the telescopic heliotrope. (Fig. 55).
Price . . . . . Mk. **90.**—

Fig. 55.
Pocket Heliotrope.

No. 569 **Filar Micrometer** with position circle of 217 mm (8 9/16 in.) diameter, reading to 10 seconds by two opposite verniers. It has two movable webs, but only one of the screws is fitted with divided head. This instrument is available for observation with bright lines on a dark ground and also dark lines on a bright ground.
Price . . . . . Mk. **1200.**—

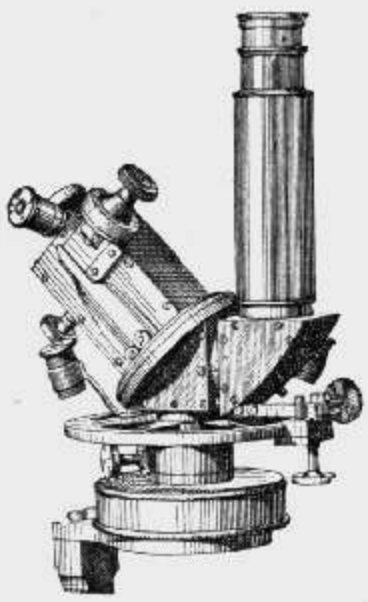

Fig. 56. Ocular Heliometer.

No. 570 **Double Image Micrometer** or **Ocular Heliometer.** The images are formed by two rectangular prisms either of which may be rotated about its axis by means of a micrometer screw with head indicating the amount of rotation. The prisms reflect at 45° and receive parallel light. Although, accordingly, the reflecting surfaces include an angle, the pencils of rays do not, as is the case with the usual form of heliometers, emerge displaced with respect to one another, but remain direct at all angles and the varying distance of the reflecting surfaces from the plane of the image has no influence upon the quality of the image, which does not show parallactical defect. The ocular is formed by a small telescope fitted with objective prism placed parallel to the axis of the telescope. The brightness of the images with respect to one another depends upon their distance from the largest diameter of the field within which the images are displaced. The amount of brightness subtracted from one image produces an equal increase in the brightness of the other. The position circle reads single minutes.***) (Fig. 56.)
Price . . . . . Mk. **860.**—

*) See "Astronomische Nachrichten", Vol. 109, No. 2606, page 210.
**) See "Astronomische Nachrichten", No. 569.
***) See: "Zentralzeitung für Optik und Mechanik", VI. Jahrgang, No. 13, 1. July 1885.

No. 571 **Small Centering Apparatus,** for centering objectives with respect to the ocular; telescope of 7 mm (1/4 in.) aperture and 5,5 cm (2 1/8 in.) focus with ocular A R of 7 mm (1/4 in) focus (magnification 8 X); telescope screwed into plate with three levelling screws; adapted for objectives up to about 81 mm (3 3/16 in.) aperture.
Price . . . . . Mk. **52.—**

No. 572 **Large Centering Apparatus,** similar to No. 571, but with larger telescope. Objective 20 mm (18/16 in.) aperture, 16 cm (6 5/16 in.) focus, magnification 16 X; adapted for objectives of 81 mm (3 3/16 in.) aperture and larger.
Price . . . . . Mk. **70.—**

List of Illustrations.

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