STELLAR SPECTROGRAPHS SPECTROHELIOGRAPHS PROMINENCE SPECTROSCOPES

ASTRO 91E

ASKANIA-WERKE A.G.
BAMBERGWERK
BERLIN-FRIEDENAU
KAISERALLEE 87/88

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ASKANIA

The Optical Department of the Bamberg Works deals with the following Groups of Instruments.

Group Designation	Instruments	Catalogue Reference
ASTRO Astronomical Instruments	Refractors and Reflectors for visual and photographic observations, Azimuth and Parallactic Telescopes, Coelostats and Heliostats, Zenith Telescopes and Cameras, Meridian Circles, Stationary and Portable Transit Instruments, Universal Instruments, Spectrographs, Plate Measuring Instruments, Astrophotometers.	Astro 40
Measuring Instruments	Microphotometers (Hartmann's system), Objective Microphotometers for visual and photographic registration.	Astro 80
	Stellar Spectrographs, Spectroheliographs, Prominence-Spectroscopes.	Astro 91
	Thickness Gauges, Spherometers, Prism Goniometers, Planometers, Optical Benches.	Astro 94
	Astronomical optics.	
GEO	Comparators, Cathetometers, Standard Gauges, Screw-Measuring Machines.	Mass 52
Geodetic Instruments	Universal Instruments, Microscope Theodolites, Repeater Theodolites, Levelling Instruments, Precise Levelling Staves, Heliotropes.	Geo 66
	Küpper's Altimeters.	Geo 82
Geophysical Instruments	Magnetic Standard and Light Portable Theodolites, Declinators, Inclinators, Earth Inductors, Variometers for Horizontal Intensity, Declination, and Vertical Intensity, Recording Apparatus.	Geo 95/96
	Torsion Balances, Eötvös Schweydar pattern.	Geo 93
	Sterneck Four-Pendulum Apparatus.	Geo 71
	Ad. Schmidt Magnetic Field Balance or Magnetometer.	Geo 92
Meteorological Instruments	Seismograph (Schweydar pattern).	Geo 97
	Balloon Theodolites, Recording Balloon Theodolites, Barographs, Measuring Stations for determining the location and speed of moving bodies.	Geo 81
Oceanographic Instruments	Tide-Predicting machine, High Sea Gauge, Distance transmitting devices for Tide gauges.	
	Current Meter	Ozean 1
PHYO Optico-physical measuring Instruments	Pocket Polarizing Apparatus.	Phyo 1
	Portable Polarizer and Small Circle Apparatus.	Phyo 4
	Universal Refractometers.	Phyo 7
	Turbidimeters.	Phyo 10
	Small Half-shadow Polarizer with Quartz Wedge Compensation.	Phyo 11
	Glassware Colour-Viewers.	Phyo 13
	Colorimeters.	Phyo 14
	Spectrometers.	Phyo 15
	Illuminants for Polarizers.	Phyo 16
	Laboratory Spectrographs.	Phyo 17
	Spectral Photometers and Rotating Sectored Discs.	Phyo 20
	Half-shadow Polarizers with Quartz Wedge Compensation.	Phyo 26
	Polarizing Apparatus with circle-division.	Phyo 27
	Glassware Strain-viewers.	Phyo 28
	Spectroscopes Spectral Apparatus and Direct Vision Monochromators.	Phyo 31
	Portable Refractometers.	Phyo 32
KINO Kinotechnical Instruments	Professional Kinematographic Cameras and Stands.	Kino 67
	Ultra-rapid Cameras taking up to 100 pictures per second.	Kino 77
	Dr. von Rothe's Kinecameras for medical purposes.	Kino 90
	Kinematographic Cameras for all scientific and technical purposes.	
NAUTIC Nautical Instruments	Compasses, Compass Binnacles, Repeater Compass Transmission Gear, Deflectors, Deviation-magnetometers, Chart-discs for taking Bearings and Compensation Chart-discs, Sextants, Artificial Horizons, Double Goniometers, Double Protractors, Chart Instruments, Barographs, Barometers, Chronometers, Sounding Machines and Patent-logs, Compass Testers, Sextant-Testers.	Nautic 36
AERO Measuring Instruments	Statoscopes, Altimeters, Airspeed Indicators, Airspeed Pressure Nozzles, Variometers, Tilting Gauges, Horizontal Circles.	Aero 83
Recording Instruments	Altitude, speed, temperature and air density Recorders	
Compasses	Compasses for Pilot and Observer, Bearing Compasses, Repeater Compass Outfits, Chart-discs for taking bearings.	

INTRODUCTORY NOTE

The prism is about the only physical aid that is of any use for the purpose of analysing the very feeble light of the fixed stars. The best instrument to use for extensive and systematic catalogue work is the large aperture objective prism or prismatic camera. For quantitative investigations in spectral analysis however, and also for correct wavelength measurements in the stellar spectra, the most suitable apparatus is the stellar spectrograph fitted with a slit. This is designed in its essentials, on the same lines as the laboratory spectrograph. The telescope projects a sharp image of the star upon the slit of the spectrograph which is mounted in the focal plane of the telescope at the eyepiece end. The clockwork of the telescope keeps this image stationary on the slit. The actual position of the stellar image on the slit can be observed through a small telescope, using for this purpose the light reflected either by the polished jaws of the slit or by a prism surface. The collimator objective of the spectrograph has about the same aperture ratio as the telescope with which the spectrograph is intended to be used. In front of the slit is a small device which has the effect of projecting upon the plate on both sides of the stellar spectrum a comparison spectrum, usually an iron spectrum, so that the exposures can take place simultaneously. (J. Hartmann, Zeitschrift für Instrumentenkunde, Jahrgang 1900.) The comparison spectrum serves as a reference scale in all quantitative investigations in wavelength measurements, and in determining line displacements. To eliminate the disturbing effect of temperature fluctuations, the larger models are encased in electrically heated constant temperature jackets, the temperature being regulated automatically by means of a thermostat. (J. Hartmann, Zeitschrift für Instrumentenkunde, Jahrgang 1901.) For work in the region of short wavelengths, the spectrographs are fitted with ultra-violet optical systems. The larger spectrographs are provided with girder supports to strengthen the casing and to prevent injurious bending strains. (G. Eberhard, Zeitschrift für Instrumentenkunde, Jahrgang 1910.)

The universal spectrographs permit the use of one, two, or three prisms, in recent practice however, it has been found preferable to use separate apparatus for each dispersion.

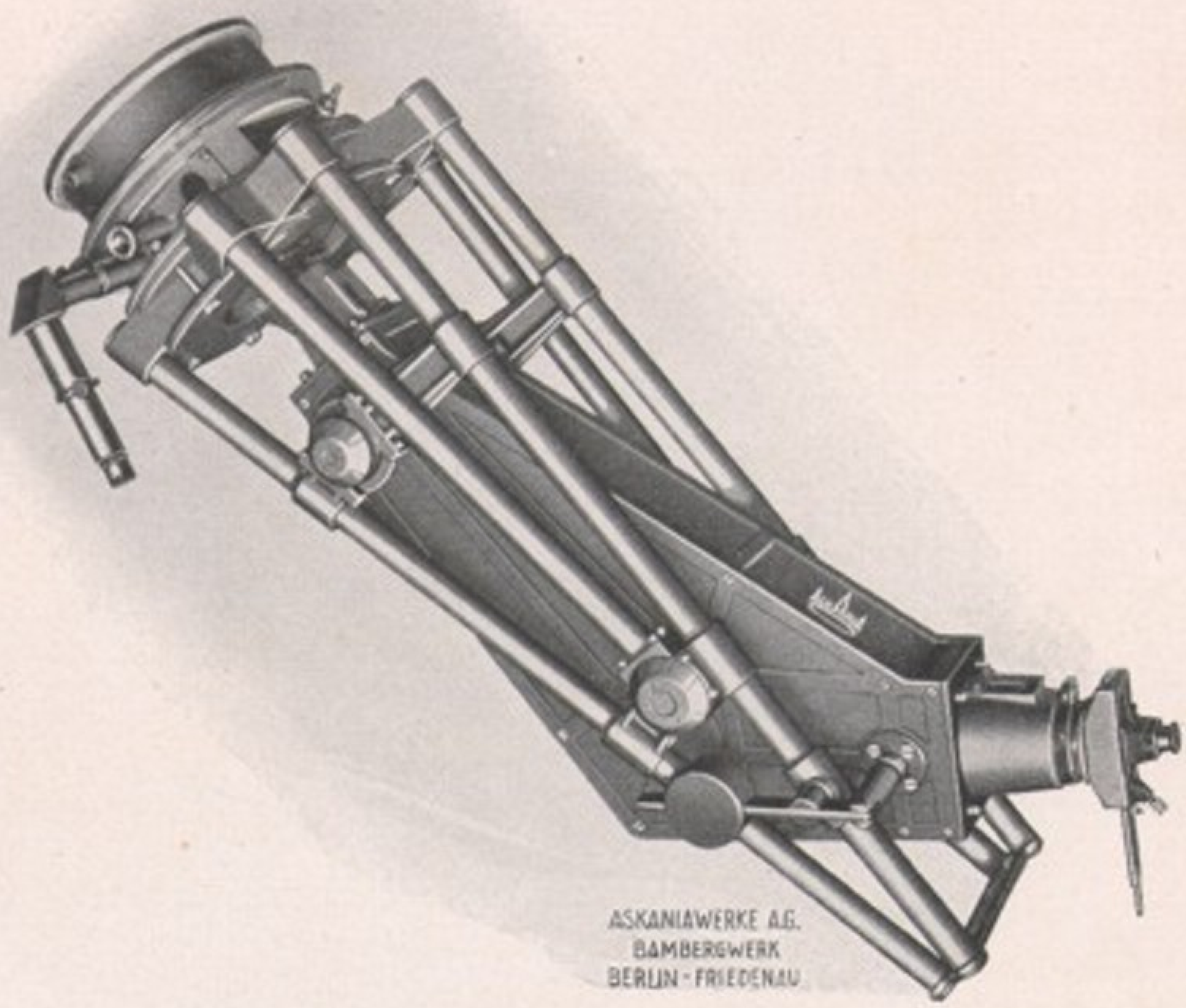
As far back as 1888, Vogel and Scheiner were able to take the first measurements of the radial velocity of fixed stars, using stellar spectrographs of the kind described. Nowadays spectrographs similar in their general character but embodying many far-reaching improvements are in use at most of the larger observatories where they have been employed in the work of observation for many years past. Our present day spectrographs are based upon the combined results of experience gained at observatories all the world over.

In 1868, Janssen and Lockyer simultaneously made the discovery that prominences on the edge of the sun's disc could be observed without waiting for a total eclipse provided that a spectroscope of adequate dispersion were used. This discovery led to the regular observation and measurement of these prominences, by means of a prominence spectroscope specially adapted to the purpose. The diffused light from the sky, which ordinarily renders the prominence invisible, is considerably reduced in intensity by being spread out as a continuous spectrum, and the prominences are observed in the light, practically undiminished, of a single bright line. A prominence spectroscope consists accordingly of a prism spectroscope usually of the direct-vision type and of which the dispersion must not be too low, coupled with a device whereby the edges of the sharp solar image projected by the telescope can be conveniently explored. The slit of the spectroscope is displaceable both radially and tangentially in relation to the edge of the solar disc, so that it can easily be moved round the edges of solar images of different sizes. The observing telescope of the spectroscope can be inclined to the central axis so that different parts of the spectrum are brought into view as required. (A. Wolfer, Zeitschrift für Instrumentenkunde, Jahrgang 1903.)

The spectroheliograph was developed by Lockyer, Hale and Deslandres. In this instrument the collimator and the camera are set parallel to each other, both of them together being passed across the stationary solar image and the stationary photographic plate respectively. The spectra are obtained by means of diffraction gratings, the source of light being in this case sufficiently powerful, but prisms are also used by themselves. By this means it is possible to obtain circular images of the sun's disc in the light of the line of the spectrum to which the instrument has been set. The slit of the collimator in the course of its motion travels across the whole solar image and the camera slit traverses an exactly equal path in front of the photographic plate.

ASKANIA

SPECTROGRAPHS

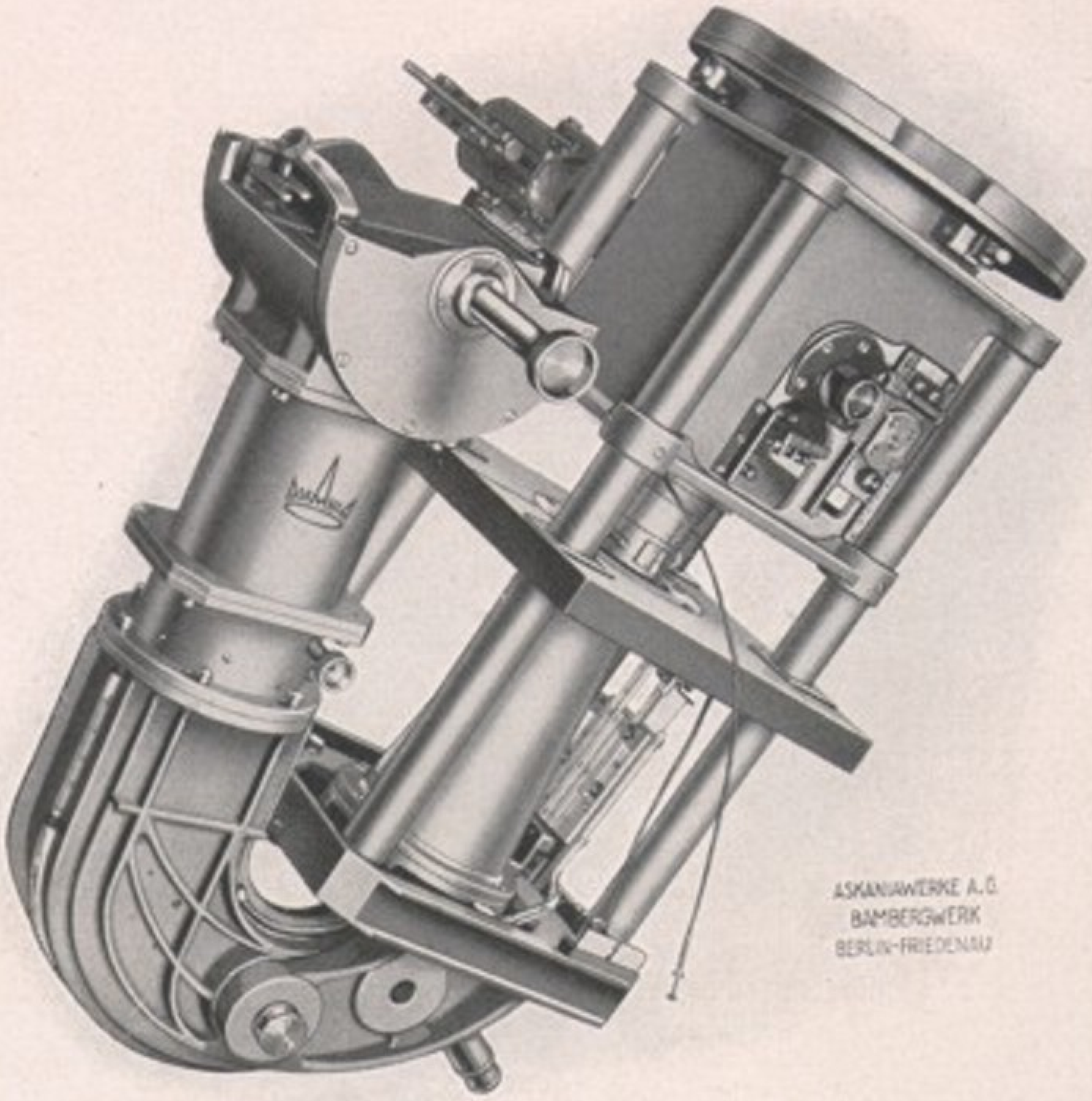


No. 3. Stellar Spectrograph Asp. 6.
(Ludendorff)

In this instrument no attempt has been made to attain great dispersion. It is designed chiefly to give conveniently measurable spectra from stars with wide and diffuse absorption lines, which are decidedly easier to measure at a low than at a high dispersion. A single flint glass prism with a refracting angle of 63° gives a dispersion of abt. 67 A. per mm. at the medium wavelength of $\lambda = 4400$. The double collimator objective has a clear aperture of 40 mm. and a focus of 600 mm., whilst the triple camera lens has an aperture of 44 mm., and a focus of 350 mm. For guiding purposes, the light of the star is observed by reflection from the jaws of the slit through the small telescope. Suitable diaphragms as well as a device for producing the comparison spectrum are provided. The spectrograph is mounted in a very strong rigid casing and balanced by counterpoise weights to prevent any bending strain. The apparatus is kept at a constant temperature during the progress of observations by means of a constant temperature jacket and thermostat.

Weight abt. 58 kg.

No. 4. Constant temperature Jacket for Asp. 6.
Weight abt. 9 kg.



No. 5. Astrospectrograph Asp. 3.
(Eberhard)

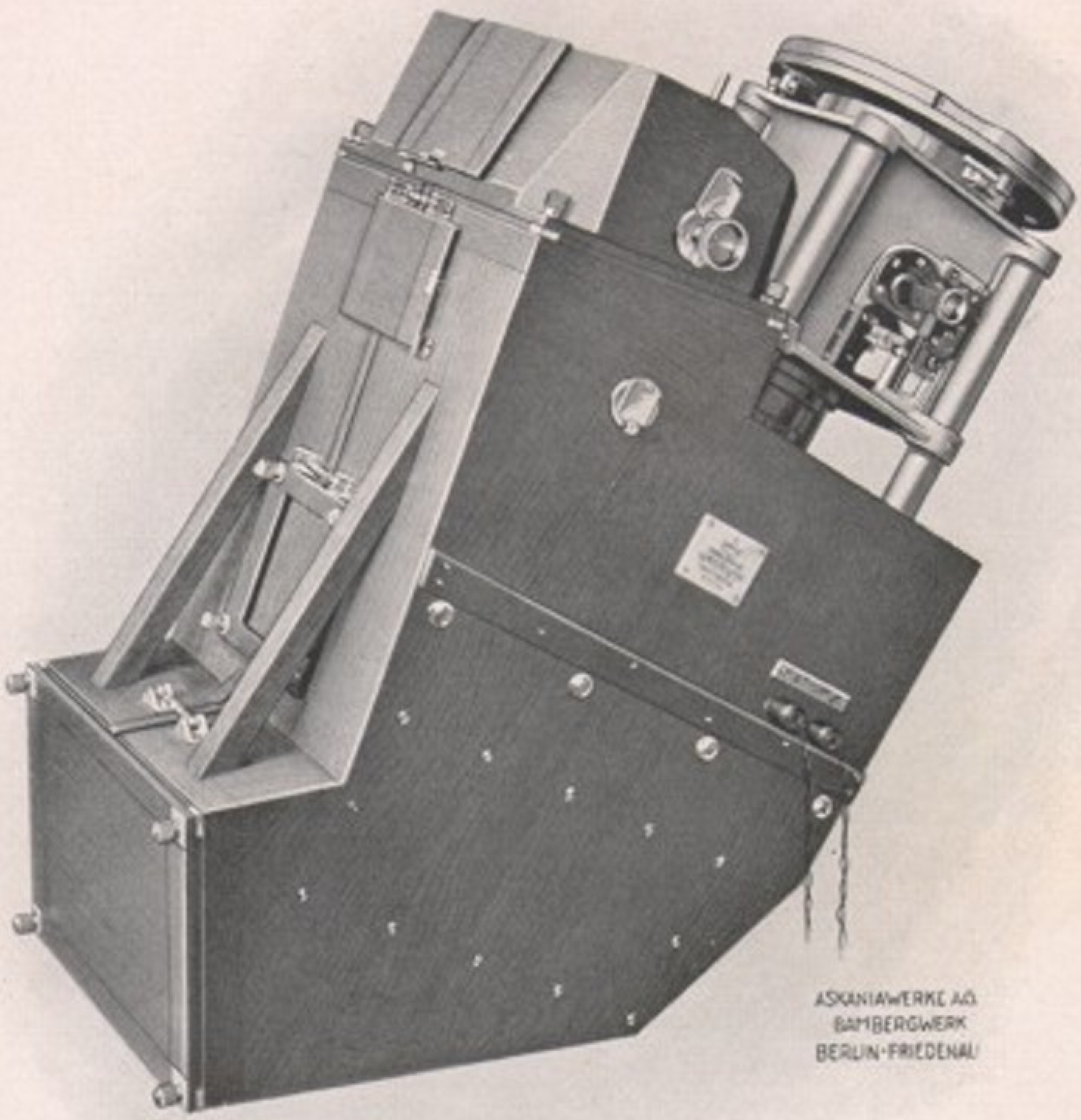
The astrospectrograph Asp. 1 can be transformed into a 3-prism instrument by exchanging the prism-holder, all the other essential parts of Asp. 1 remaining unaltered. The optical axis is deviated in that event to the extent of about 170°. The prism-holder of the apparatus contains 3 prisms of 60° each in the position of minimum deviation. The collimator objective is an apochromatic lens of 45 mm. clear aperture and 360 mm. focus.

This spectrograph is supplied with 3 different cameras. The large one is fitted with an apochromatic lens of 45 mm. clear aperture and 550 mm. focus, which gives a dispersion at $\lambda = 4350$ A. (G′) of 15 A. per mm., the intermediate-sized camera has an apochromatic lens of 45 mm. clear aperture and 360 mm. focus, the dispersion under these conditions at $\lambda = 4350$ A. (G′) being 23 A. per mm.

The small camera has a Zeiss-Tessar lens with a relative aperture of 1 : 45 and a focus of 210 mm. The dispersion at $\lambda = 4350$ A. (G′) is 38 A. per mm. In front of the slit there is a device for producing the comparison spectrum, as well as a suitable diaphragm. The slit is 10 mm. in length.

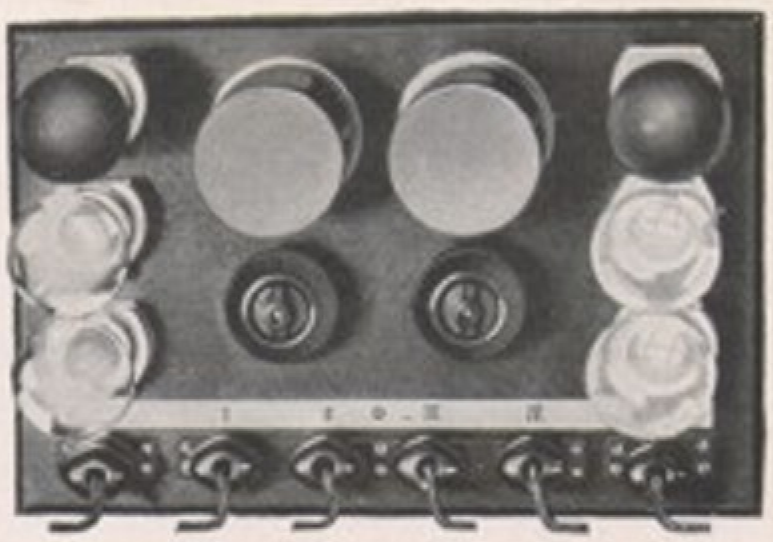
Two contact thermometers reading from $-10°$ C to $+40°$ C are secured to the casing of the spectrograph. These in conjunction with the electrically heated temperature jacket serve to maintain a constant temperature.

The weight of the instrument is abt. 60 kg.

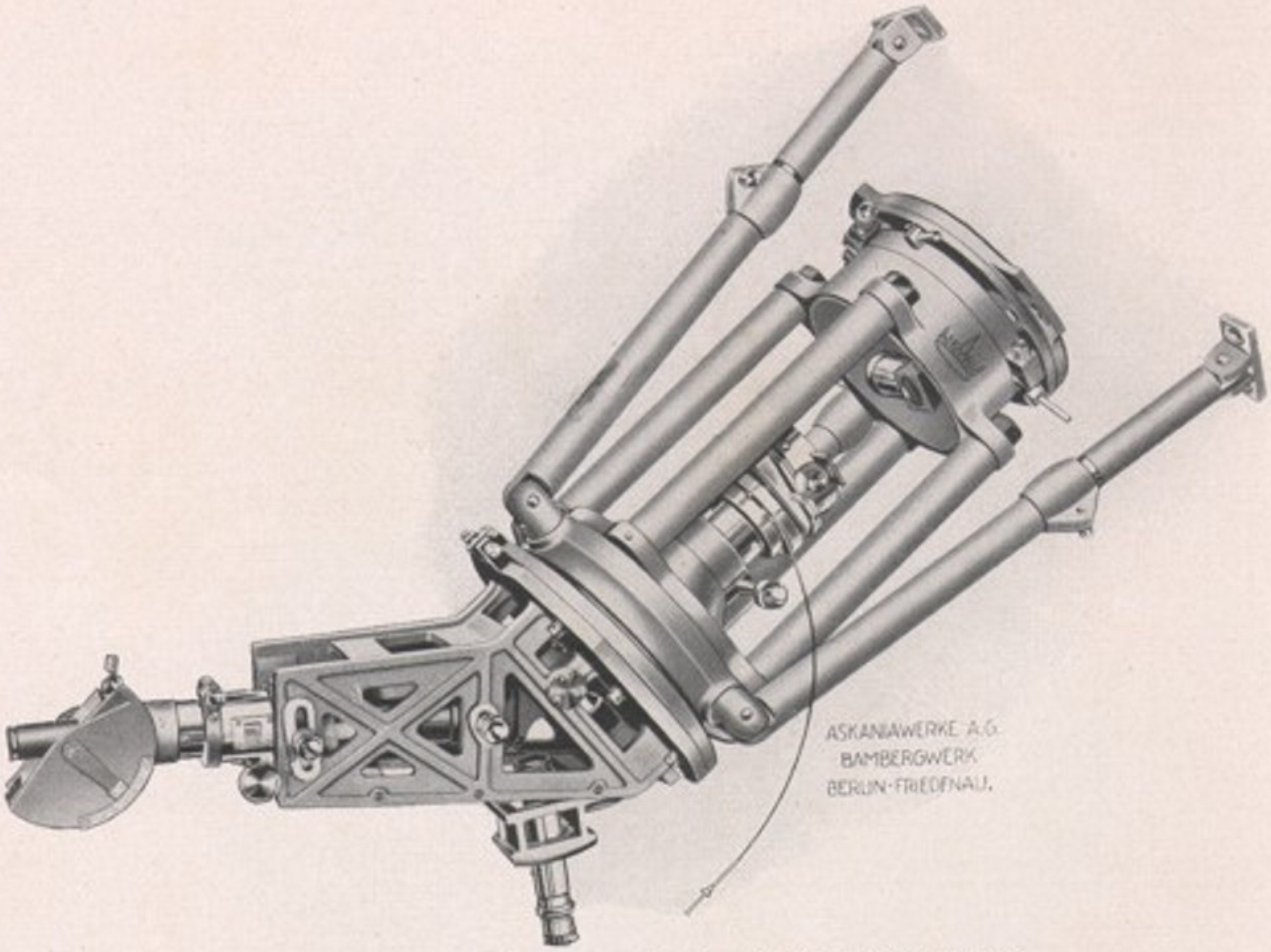


No. 6. Constant Temperature Jacket for Asp. 3.
For heating by switchboard connected to ordinary current supply. Weight abt. 16 kg.

The constant temperature jacket is made of wood and embodies the necessary heating resistances. The contact thermometers are connected to the switchboard. Before commencing work, the contact thermometers are set to the desired temperature, which will be about equal to the average outside temperature. Connection with the current supply having been made, the temperature is maintained constantly at the desired level by automatic electrical regulation (cf. J. Hartmann, Zeitschrift für Instrumentenkunde, Jahrgang 1901).



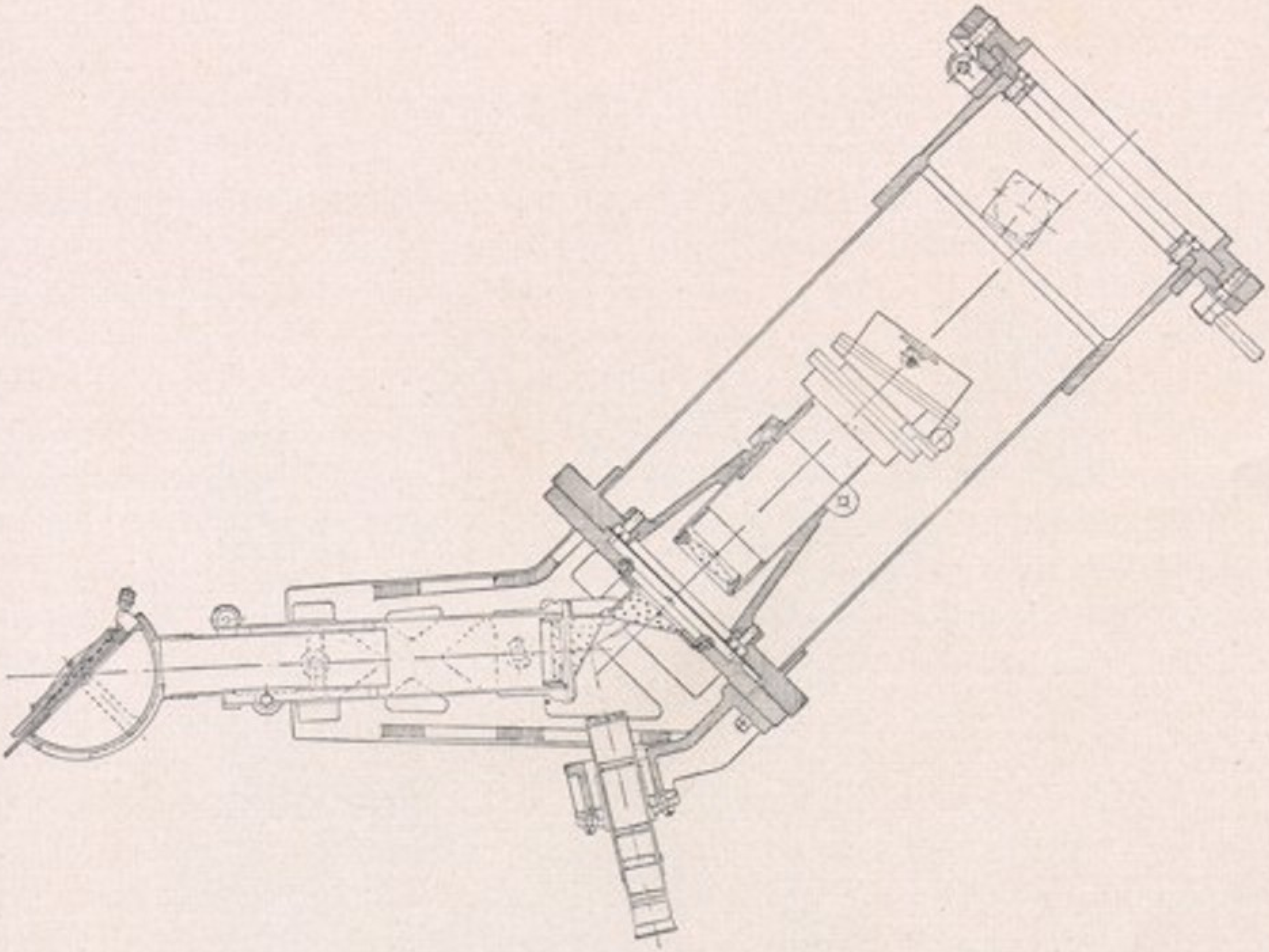
Switchboard.



No. 7. Quartz Spectrograph Asp. 4 (Vogel-Hartmann).
Weight of Spectrograph 7 kg. Collimator abt. 26 kg.

In the Zeitschrift für Instrumentenkunde, Jahrgang 1905, J. Hartmann pointed out that with a spectrograph having only one 60° prism and one plano-convex quartz lens, the spectrum of a star is shown in a plane approximately parallel to the direction of the incident rays, the deviation caused by the prism being only about 45°. As the ordinary slit spectrographs involve a very much greater loss of light than an objective prism, since only a small percentage of the light from the star falling upon the objective is able to reach the photographic plate, this spectrograph has been designed on the principle of the objective prism, which makes it possible for stellar spectra to be photographed down to about $\lambda = 3100$ A. By reason of its very high illumination, the quartz spectrograph is primarily suitable and is in fact intended for photographing the spectra of nebulae and comets of feeble intensity, and also for photometric studies in the ultra violet region of the spectrum.

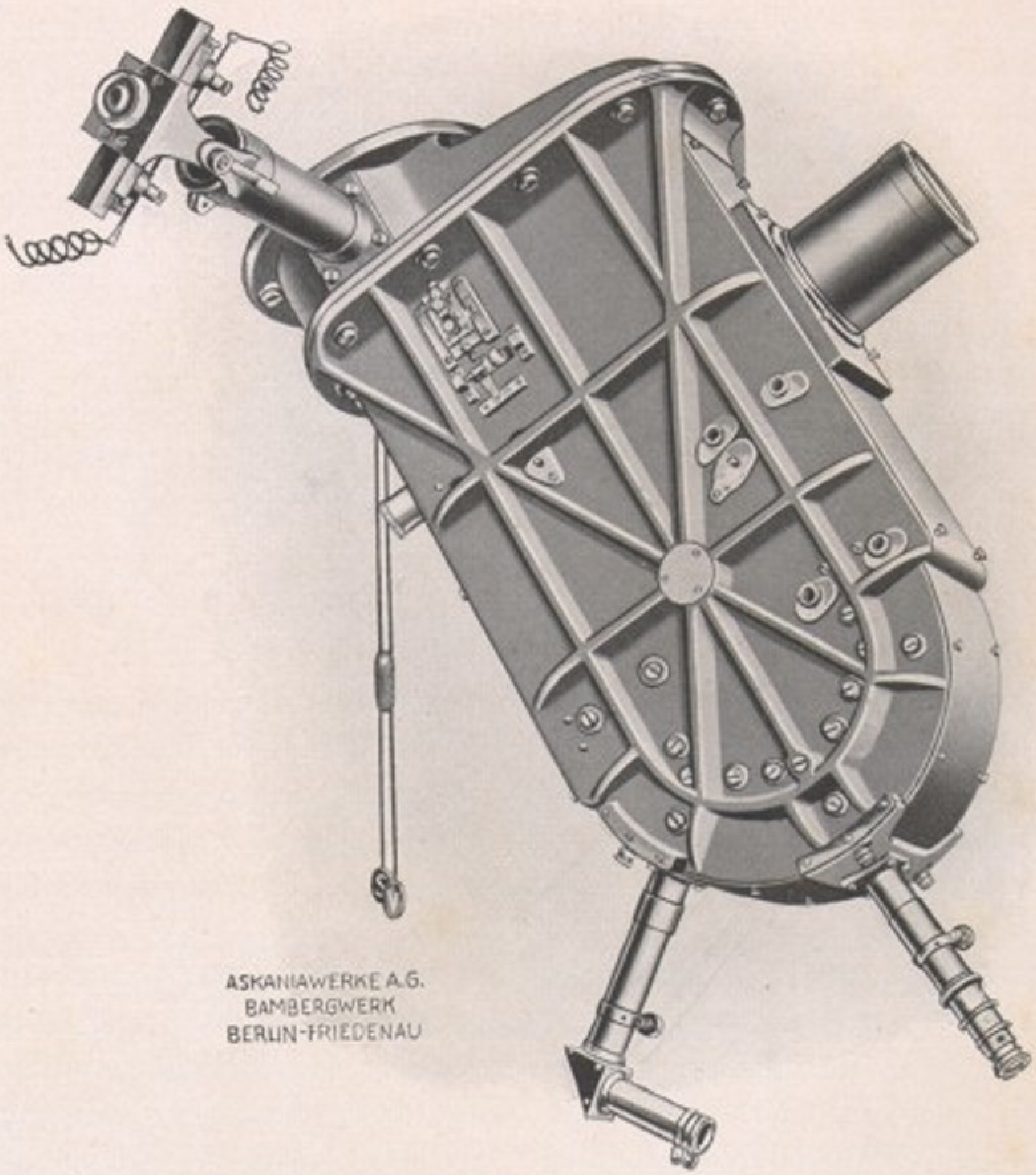
The 60° prism fitted is actually built up of two 30° prisms set in the Joung position, the path of the light both inward and outward being at right angles to the cathetic surfaces. The camera objective is a quartz lens of 40 mm. clear aperture and 320 mm. focus. The dispersion at $\lambda = 4400$ A. is 156 A/mm. and at $\lambda = 3000$ A., 50 A/mm. The great transparency to ultra-violet rays, due to the



quartz optical systems used, is particularly valuable when taking observations at high altitudes. The plate size is $3 \times 6{\cdot}5$ mm. The dark slide has ample play for inclination, and is fitted with screws whereby the plate is clamped firmly in position against the rebates. The position of the camera can be read by vernier on a circular scale with an accuracy of 2′, and the rack-and-pinion camera extension likewise has a graduated scale.

The quartz spectrograph can be used not only as a prism camera but also in conjunction with a large observation telescope and collimator. For this purpose it is attached to an intermediate member containing the collimator, whereby it is at the same time rigidly secured to the observation telescope. The aperture of the collimator, in conjunction with the larger type of telescope will be about 40 mm. assuming that quartz or ultra-violet optical systems be used, and the aperture ratios of the latter will be governed by that of the observing telescope to be used. Owing to the extent to which the optical systems of ordinary astronomical refractors absorb the rays of short wavelength it will not then be possible to carry observation work so far into the ultra-violet as can be done with pure quartz glass; there is thus an advantage in using a reflector instead of a refractor.

To facilitate observation, the telescope proper carries a small auxiliary telescope by means of which the image of the star is held stationary, using for this purpose the light reflected from the first surface of the second prism.



No. 8. Spectrograph Asp. 5.
(Eberhard)

The experience gained at the Astrophysical Observatory of Potsdam over an extended period in the use of stellar spectrographs, has been taken into account in designing the 3-prism spectrograph Asp. 5. Very special care has been devoted to the task of ensuring absolute rigidity in every part of the instrument, this being the only means of attaining the degree of accuracy required. The casing is cast in one piece and all the component parts of the instrument are thereby kept extremely rigid in relation to each other, more especially the collimator and the camera, which lie parallel with each other, the optical axis being deflected by 180°. There is a special intermediate member to connect the spectrograph with the observation telescope. No errors of any consequence due to bending strains need be anticipated.

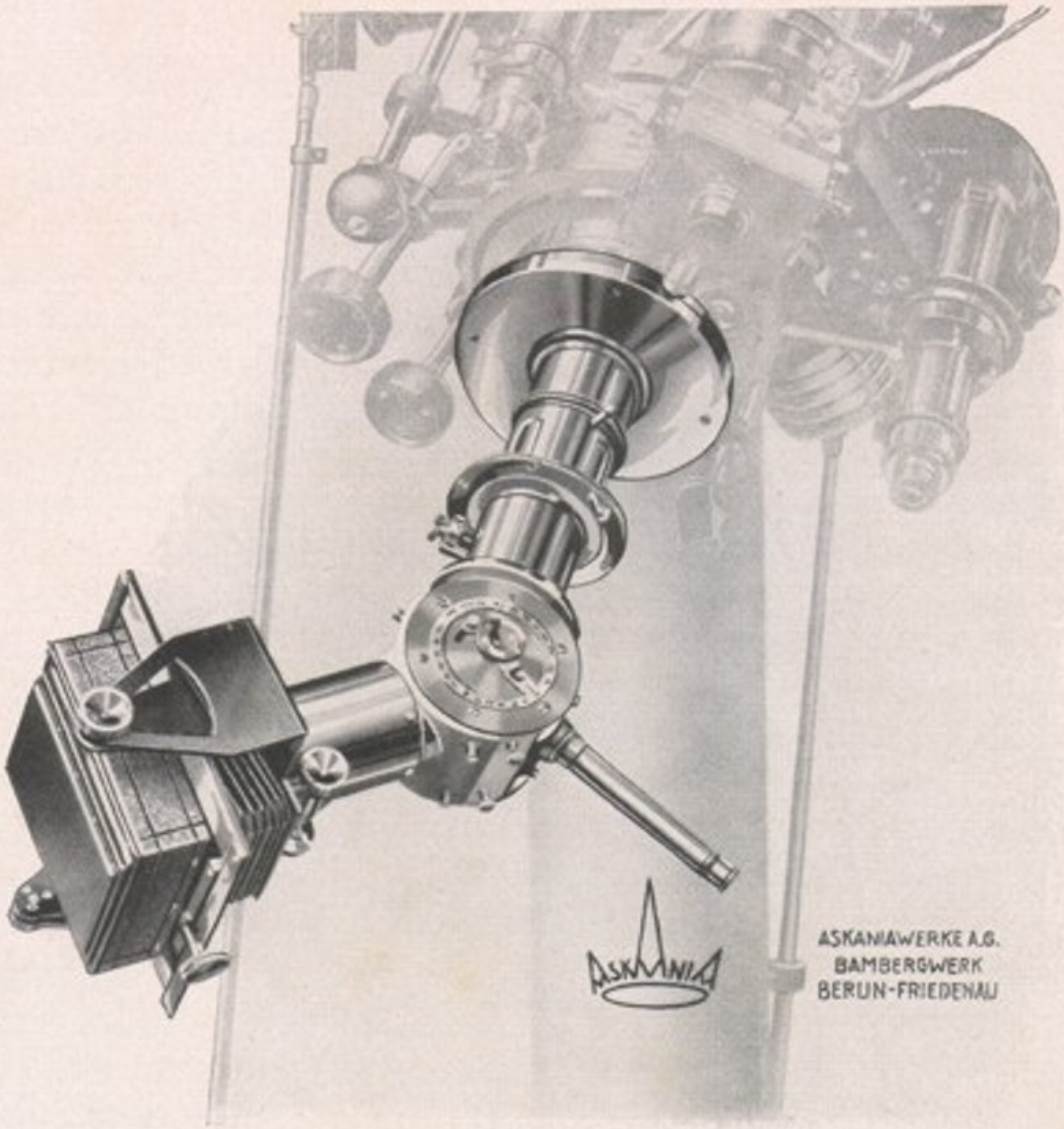
In the prism-holder are 3 prisms each with a refracting angle of 63° placed in the position of minimum deviation. The collimator objective has a clear aperture of 40 mm., and a focus of 360 mm. The field of view is shown with sufficient evenness between $\lambda = 4600$ A. and $\lambda = 7000$ A., and no inclination of the dark-slide is necessary. The dispersion at $\lambda = 4350$ A. is 15 A./mm. Plate size 9×12 cm., length of slit 10 mm.

All movable parts are provided with scales to facilitate setting. The casing which carries the slit diaphragm and the device for producing the comparison spectrum is fitted quite separately from the collimator, so that the latter is not subjected to vibration whilst the former is being adjusted. The diaphragm fitting embodies further improvements and is provided with every facility for making useful adjustments. All the parts are very strong and are adjustable in relation to each other. The divided-drum micrometer eyepiece has a wavelength scale, and is permanently attached to the spectrograph. (G. Eberhard, Zeitschrift für Instrumentenkunde, 1910.)

Weight about 65 kg.

No. 9. Constant Temperature Jacket

see illustration page 9.

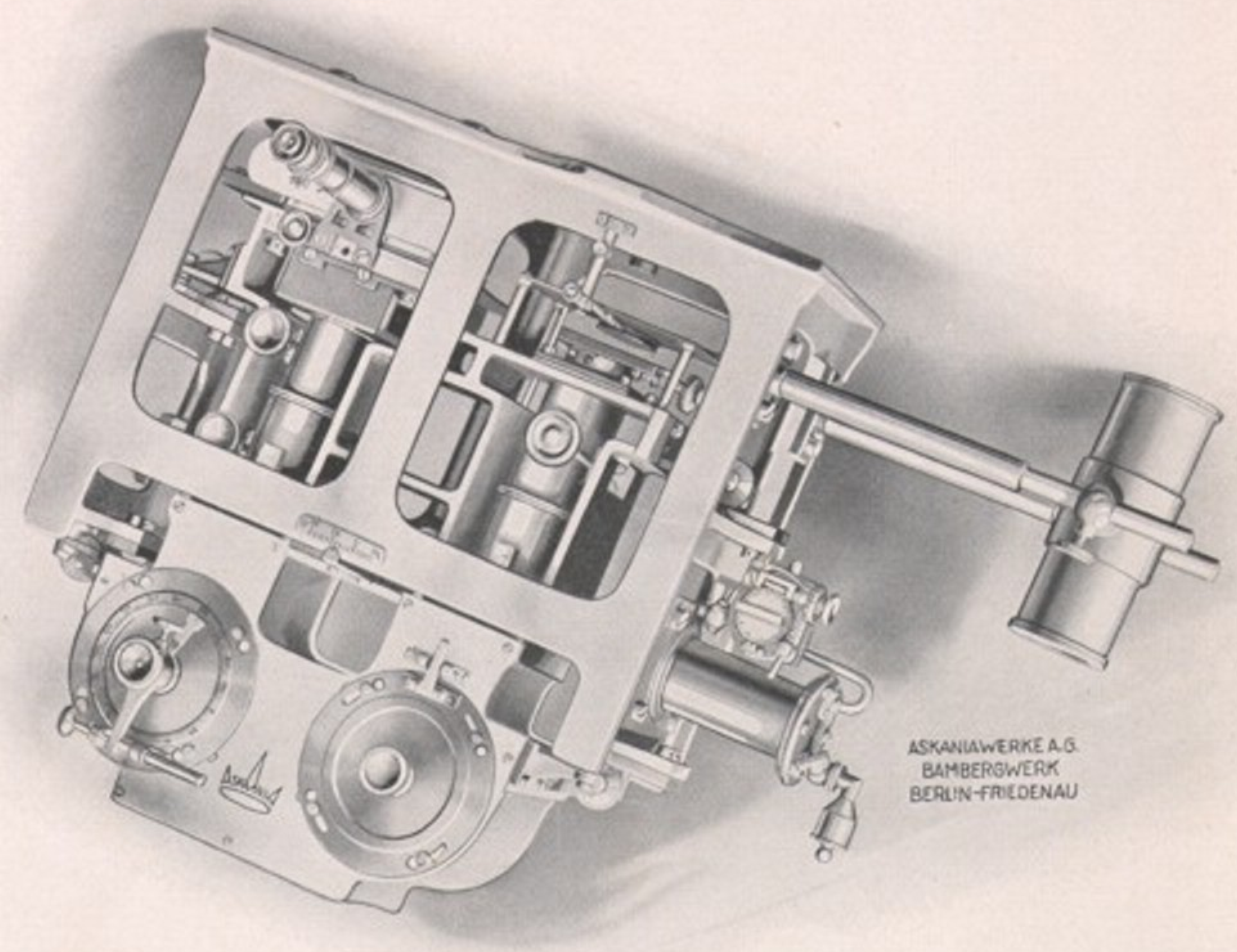


No. 10. Stellar Spectrograph Asp. 2.
(Rosenberg)

This is a small universal spectrograph, specially suitable for observations through instruments of comparatively small size and for the use of amateur astronomers. The attachment to the observing telescope allows freedom of rotation.

Slit 10 mm. in length, ultra-violet 63° prism, interchangeable at will with a 40×50 mm. grating. Setting is effected by means of a scale on the instrument casing. The camera is fitted with a compound shutter working at speeds up to $\frac{1}{100}$ sec. also a roller blind shutter. The collimator and camera objectives have in each case a clear aperture of 20 mm. The collimator objective is of 120 mm., and the camera objective of 180 mm. focus. Dark-slide with adjustable focus and variable inclination. Plate size $4\frac{1}{2} \times 6$ cm. The dispersion of the prism at $\lambda = 4350$ A. is 263 A./mm., at $\lambda = 3000$ A. it is 70 A./mm.; that of the grating when using the 1st order is also 70 A./mm. There is a small auxiliary telescope to facilitate setting and to guide the instrument during exposure. Weight about 10 kg.

SPECTROHELIOGRAPHS



No. 11. Spectroheliograph Asph. 38.

G. E. Hale, writing in "Astronomy and Astrophysics" No. 13, p. 681 (1894) gave a description of a spectroheliograph the design of which has been used as a basis for the instrument above illustrated. The whole body of the spectrograph travels past the stationary image of the sun and the stationary photographic plate. The spectrum is produced by means of a plane grating measuring 50×80 mm. (dispersion in 2nd order 23 A./mm.) or two 65° prisms can be used (dispersion at $\lambda = 3900$ A., is 24 A./mm., at $\lambda = 4350$ A., it is 24 A./mm.), or as a third alternative, three 65° prisms (dispersion at $\lambda = 3900$ A., is 16 A./mm., at $\lambda = 4350$ A., it is 24 A./mm). When there are 3 prisms, the instrument can only be used as a spectrograph or spectroscope. The length of slit is 38 mm., and the plate size 9×12 cm. The diameter of the solar image can therefore be as large as 35 mm. The collimator and the camera are parallel with each other, and as they are used simultaneously, moving at the same speed, the solar images obtained are of circular shape.

The collimator and camera each have a clear aperture of 42 mm. and a focus of 300 mm. The body of the spectrograph moves in its guiding framework by the force of gravity, its speed is regulated by a hydraulic fluid brake having a micrometrically adjustable cock. The fluid used for braking purposes is a mixture of water and glycerine, the freezing point of which is well below 0° C.

Behind the dark slide is a small auxiliary microscope, to assist in setting the spectrum line to be photographed. Weight about 40 kg.

No. 12. Spectroheliograph Asph. 60.

The Spectroheliograph Asph. 60 illustrated overleaf is similar to Asph. 38, but is of such size that it can only be used in conjunction with a horizontal camera and coelostat or in some other like manner. The collimator and objective have an aperture of 60 mm. The slit is 60 mm. in length, and the dimensions of grating and prisms are arranged to correspond. The diameter of the solar image, if it is to be photographed in its entirety, can be as large as 55 mm. As in the previous instance, this instrument travels past the solar image by gravitation, the speed being regulated by hydraulic means. If the apparatus is used with a grating only, the dispersion in 2^{nd} order is 22 A./mm. With two 65° prisms the dispersion at $\lambda = 3900$ A. is 16 A./mm. and at $\lambda = 4350$ A. it is 24 A./mm.

The two rectilinear slits can for this purpose be conveniently exchanged for a curved pair. As a further alternative, three 65° prisms can be used. The dispersion of the apparatus, which in this case can be used as a spectrograph or spectroscope, is 11 A./mm. at $\lambda = 3900$ A., and 16 A./mm. at $\lambda = 4350$ A. A microscope is fitted in front of the plate to aid in setting the instrument.

Weight about 280 kg.

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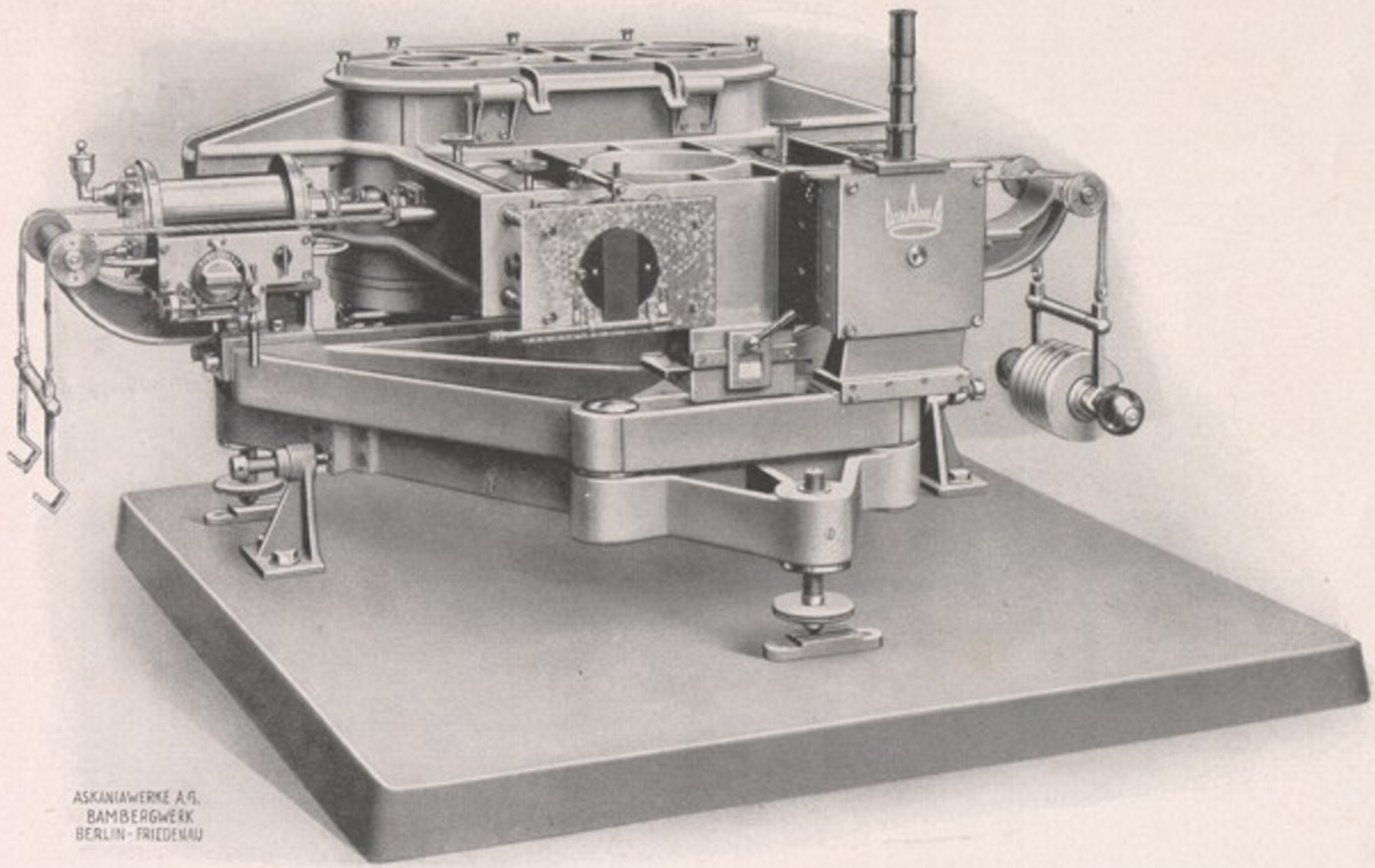
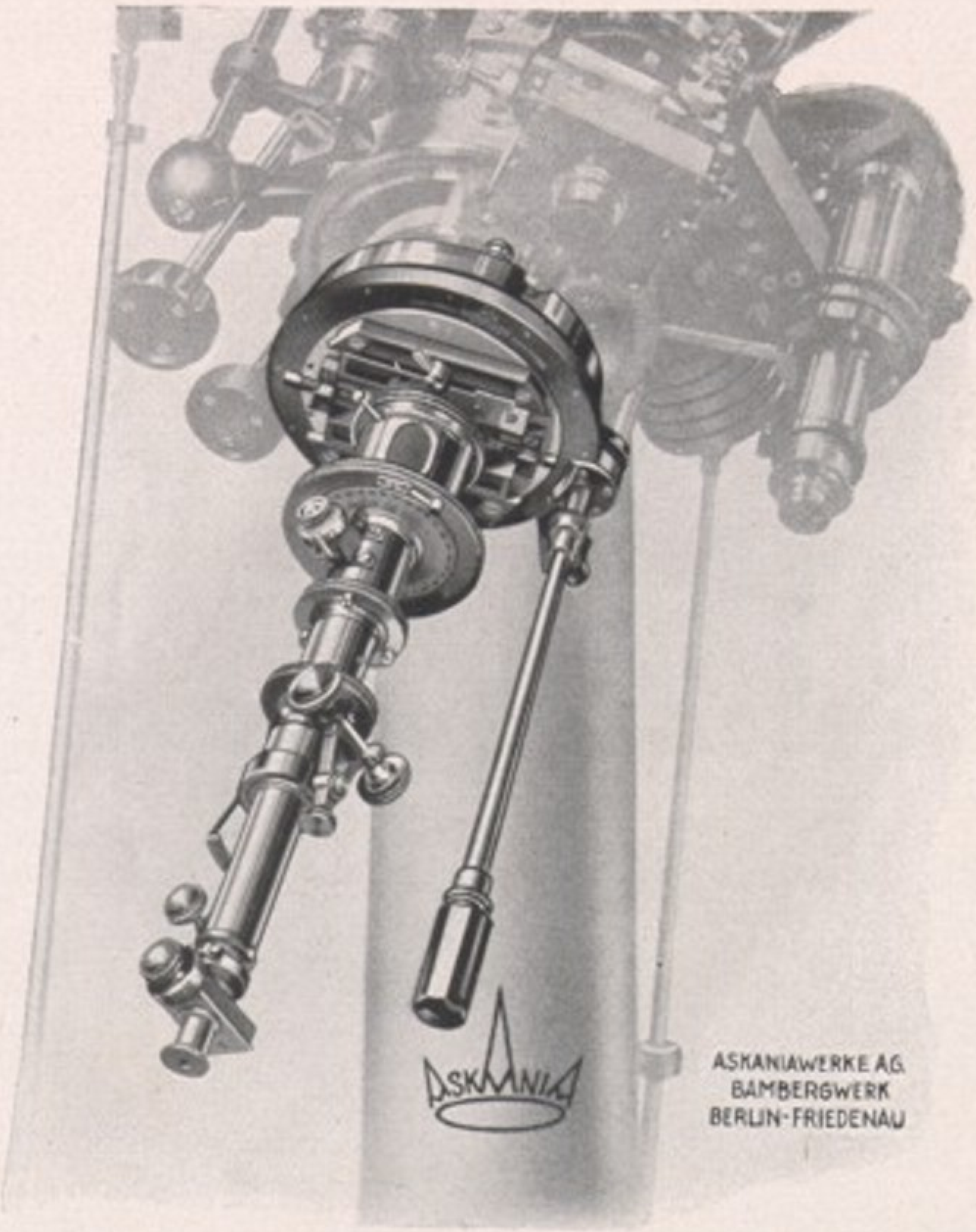


Spectroheliograph Asph. 60

for fixed mounting.

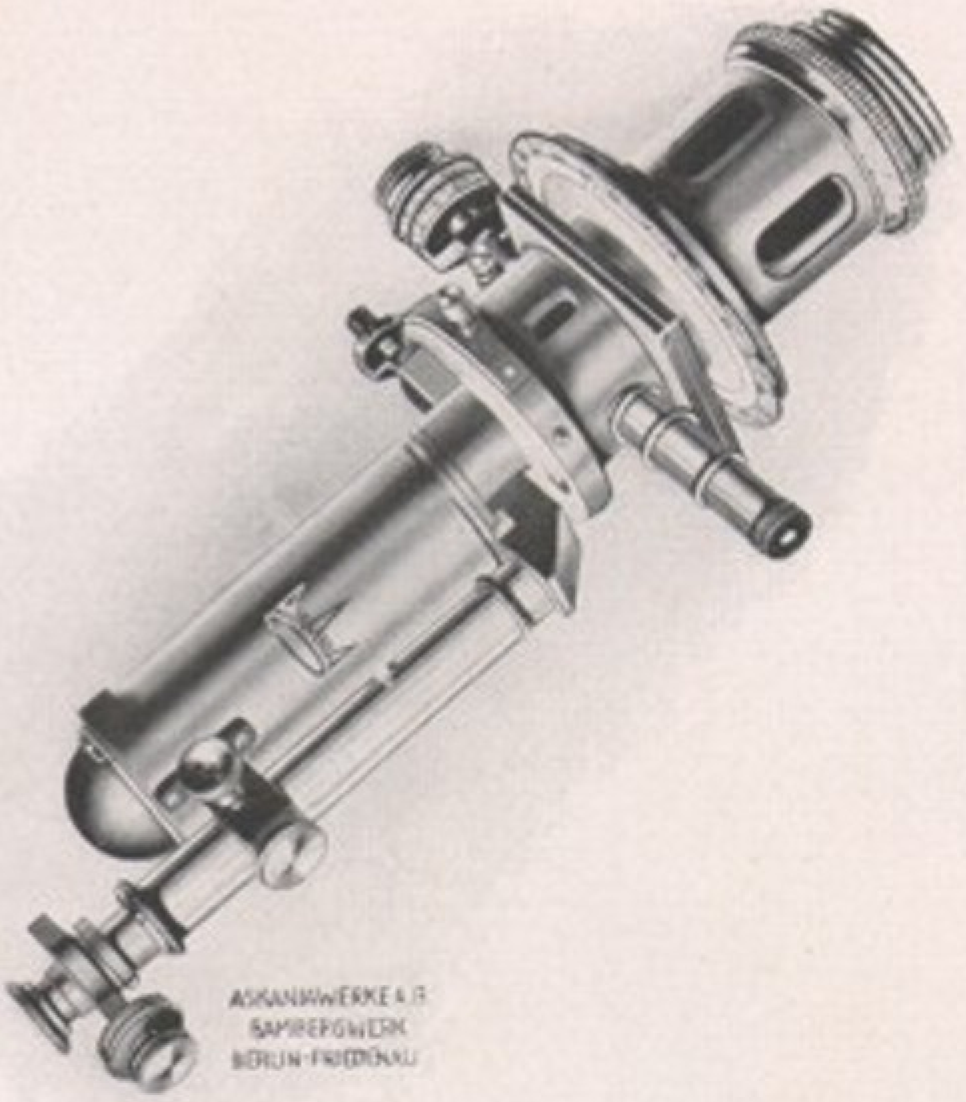
PROMINENCE SPECTROSCOPES



No. 13. Small Prominence Spectroscope Apsp. 1.

This instrument, when attached to the telescope can be rotated round the central axis. It can also, by means of guides, be moved eccentrically in relation to the optical axis, in order to bring the slit of the collimator to the edge of the solar image, for which purpose an adaptor is provided. The length of slit is 11 mm. and the guide attachment has eccentrics ranging up to 20 mm. diameter. The prism holder contains two Amici prisms. The collimator and telescope objectives each have 16 mm. clear aperture and a focus of 95 mm. The slit opens out symmetrically on each side. The observing telescope can be inclined by a rack and pinion movement to bring the desired region of the spectrum into the centre of the field of vision. The eyepiece is provided with a micrometer for measuring the prominences. A prism, interposable by a mechanical device, serves to furnish a comparison spectrum when required. The dispersion, between C and G' is 14°.

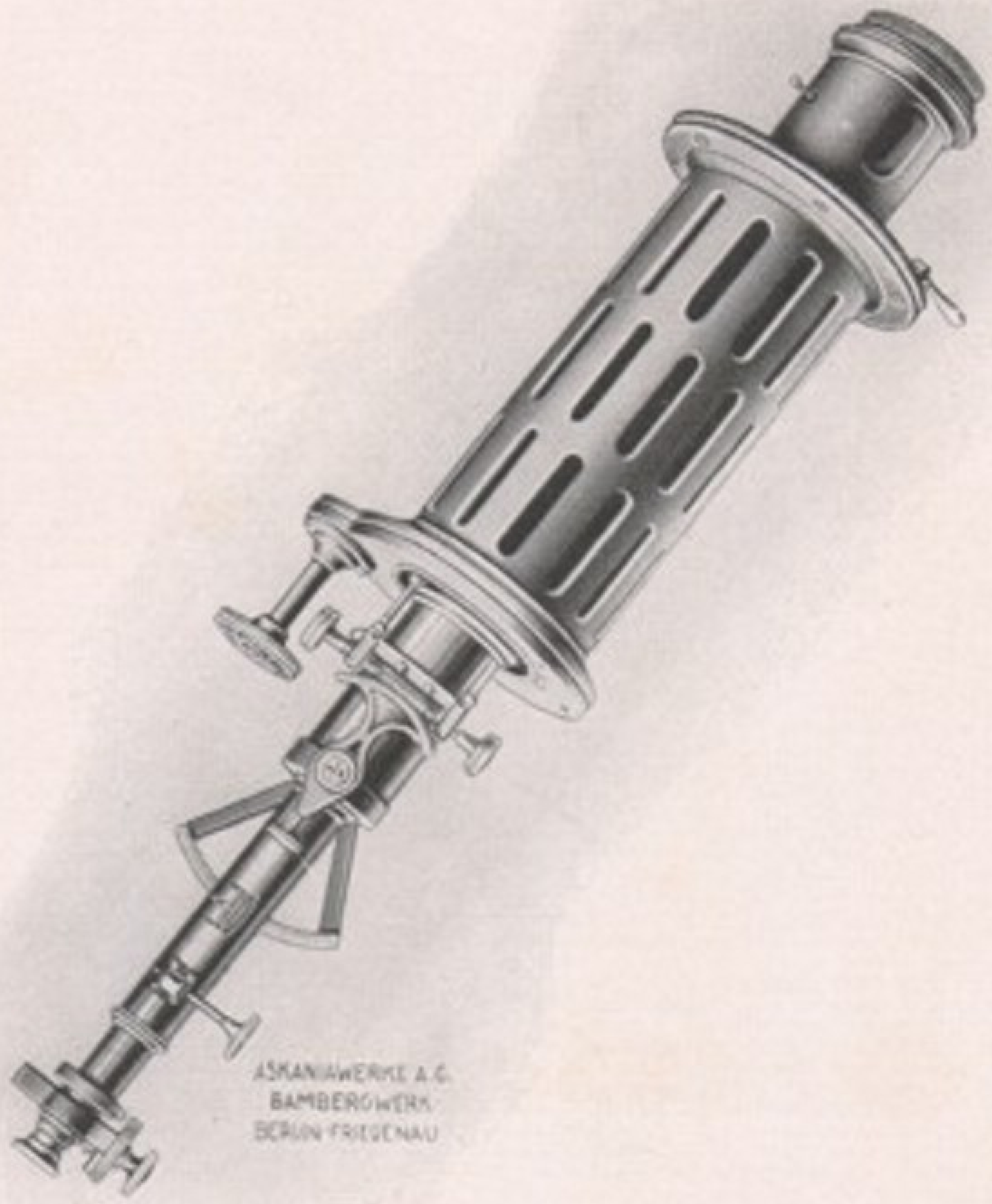
Weight about 6 kg.



No. 14. Prominence Spectroscope Apsp. 2.

This is a short prominence spectroscope with 3 triple direct vision prisms, which between C and G′ give a dispersion of 14°. There is an eccentric rotating positional adjustment for solar images of any size up to 30 mm. focal image diameter. The observation telescope can be inclined and there is a micrometer eyepiece to measure the height of the prominences. The rotatable fitting is provided with an adapter so that for coarse adjustment the solar image can be viewed direct in the plane of the slit.

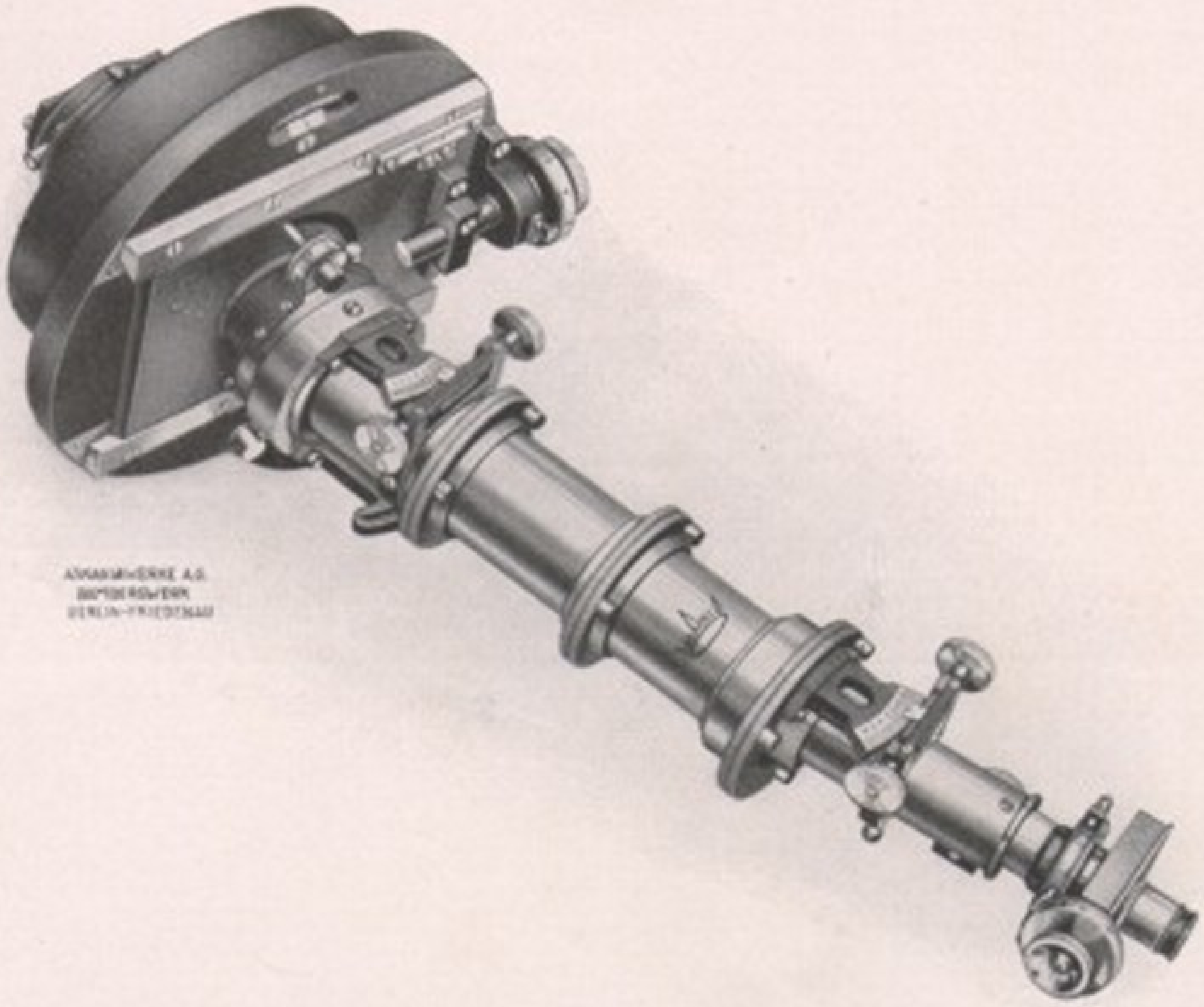
Weight about 8 kg.



No. 15. Prominence Spectroscope Apsp. 3.

The collimator and objective in this instrument each have a clear aperture of 20 mm., and a focus of 170 mm. The prism holder contains two Amici prisms, the dispersion of which between C and G′ amounts to 21°. There is a single slit, rotatable separately, an inclination movement with scale, and a micrometer eyepiece. The length of slit is 10 mm. An eccentric rotating movement is provided so that the edge of the solar disc can be rapidly explored with the slit, and images of any size up to a focal image of 40 mm. diameter can be dealt with. There is an adapter for the coarse adjustment of the image.

Weight about 9 kg.



No. 16. Large Prominence Spectroscope Apsp. 4.
(Wolfer)

The optical system contains three Amici prisms, the dispersion of which (21° between C and G′) is sufficient to permit the use of a slit of adequate width, even when the atmospheric spectrum is relatively bright. The collimator and objective each have 15 mm. clear aperture and 120 mm. focus. For measuring the prominences there is a micrometer eyepiece reading with an accuracy of 0·01 mm. An interposable prism serves to produce a comparison spectrum when required. The connecting fitting has a rotating movement with clamping device. The spectroscope itself runs on substantial guides — its movement being controlled by a strong micrometer screw — so that adjustment for any size of solar image up to 50 mm., diameter is possible. The slit can be opened either symmetrically in relation to the collimator axis or unilaterally, when set tangentially to the solar disc. To facilitate a rapid change from radial to tangential setting or vice versa, the whole spectroscope can be rotated 90° with a single movement. There are adjustable stops to ensure that this rotating movement shall be exactly 90°. The telescope, prismatic system, and collimator can be moved in relation to each other by means of a screw and sector. The screw and sector having been put out of engagement, the telescope can be rapidly used to explore the whole of the spectrum. The slit is easily visible and accessible from outside, so that the solar image can be adjusted without difficulty. (Cf. Wolfer, Zeitschrift für Instrumentenkunde, 1903.)

Weight about 6·7 kg.