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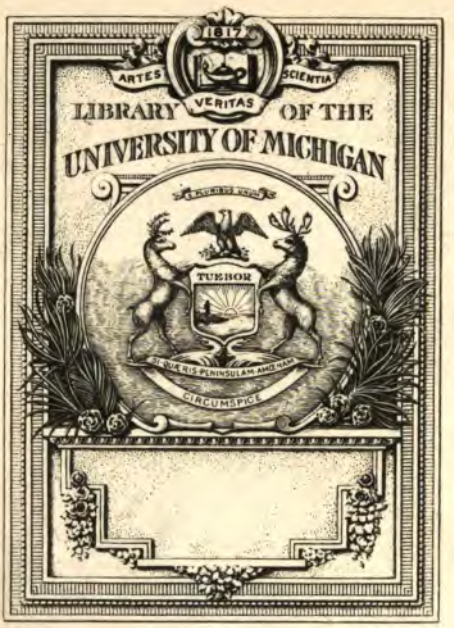
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Left at the Univ Exhibit at Chicago, 1893

The World's Columbian Exposition
Chicago 1893.

German Exhibition. Group 21.

Special Catalogue

of the

Collective Exhibition of Scientific Instruments and Appliances

exhibited by the

Deutsche Gesellschaft für Mechanik und Optik

Berlin.

BERLIN.
Printed by Julius Bahlke
1893.

The World's Columbian Exposition
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CONTENTS:

		Page
Introduction		1
Group 21:		
No. 2751.	C. F. Betting, Wehlheiden nr. Kassel	11
„ 2752.	Otto Bohne, Berlin S.	11
„ 2753.	Hilmar Bock, Oberweissbach nr. Blankenburg	14
„ 2756.	Doerffel & Faerber, Berlin NW.	14
„ 2754.	Arth. Burkhardt, Glashütte, Saxony	15
„ 2755.	Georg Butenschoen, Bahrenfeld nr. Hamburg	16
„ 2760.	Bernhard Halle, Steglitz nr. Berlin	17
„ 2761.	A. Hasemann, Berlin C.	17
„ 2765	W. A. Hirschmann, Berlin N.	19
„ 2763.	Paul Bunge (Propr. A. T. Herzberg), Hamburg	21
„ 2766.	R. Jung, Heidelberg	24
„ 2769.	Max Kohl, Chemnitz, Saxony	35
„ 2770.	A. Krüss (Principal Dr. Hugo Krüss), Hamburg	42
„ 2772.	G. Lufft, Stuttgart (Württemberg)	47
„ 2773.	Jacob Merz, München	49
„ 2774.	Oscar Moeller, Hamburg	51
„ 2776.	W. Niehls, Berlin N.	53
„ 2777.	Albert Ott, Kempten (Bavaria)	54
„ 2778.	A. Pessler, Freiberg (Saxony)	58
„ 2779.	Reiniger, Gebbert & Schall, Erlangen (Bavaria)	58
„ 2780.	Clemens Riefler, München and Nesselwang	61
„ 2782.	F. W. Schieck, Berlin SW.	66
„ 2783.	George Schmidt & v. d. Eltz, Schmiedefeld (Thuringia)	66
„ 2784.	Franz Schmidt & Haensch, Berlin S.	67
„ 2787.	G. A. Schultze, Berlin S.O.	92
„ 2788.	Schulze & Bartels, Rathenow	94
„ 2786.	Schott & Genossen, Jena	96
„ 2790.	Dr. Steeg & Reuter, Homburg (Bath Homburg)	97
„ 2791.	C. Staudinger & Co., Giessen	99

Page

No. 2792. C. A. Steinheil Söhne, München 103
„ 2794. Emil Sydow, Berlin NW. 120
„ 2795. Ludwig Tesdorpf, Stuttgart 124
„ 2796. Wilhelm Uebe, Zerbst-Anhalt 135
„ 2797. Voigt & Hochgesang, Göttingen 137
„ 2798. Voigtlaender & Sohn, Braunschweig 141
„ 2801. Carl Zeiss, Jena 145
„ 2803. Paul Gebhardt, Berlin S. 147
„ 2804. Grand-Ducal Standardizing Institute for Glass Instruments in Ilmenau (Thuringia) 150
A. The Institute's own manufacture 150
B. Exhibited by the subjected firms:
I. Alexander Küchler & Söhne, Ilmenau 151
II. Alt, Eberhardt & Jaeger, Arlesberg 151
III. Ephraim Greiner, Stützerbach 152
IV. Emil Gundelach, Gehlberg 153
V. Franz Schilling, Gehlberg 155
VI. H. R. Lindenlaub, Schmiedefeld 156
VII. Strasser & Rhode, Glashütte 156
„ 2805. W. Dieckmann, Celle (Hannover) 157
„ 2808. G. Kromschröder, Osnabrück 158
„ 2809. C. Bube, Hannover 158
„ 2810. Imperial Physical and Technical Institute, Charlottenburg nr. Berlin 159

Beside Group 21:

No. 1349. Group 123. 119. Hartmann & Braun, Bockenheim-Frankf. o/M. 160
R. Fuess, Steglitz nr. Berlin (German University Exhibition.) 181

INTRODUCTION.

Deutsche Gesellschaft für Mechanik und Optik.

Collective Exhibition of Scientific-Instruments and Appliances.

Group 21.

Group 21 comprises a collective exhibition of the „Deutsche Gesellschaft für Mechanik und Optik", an association of German mechanicians and opticians formed to encourage and support the manufacture of scientific instruments and appliances in every direction.

The manufacture of scientific instruments and appliances implies a high standard of technical skill and equally advanced scientific knowledge. The progress of this department of applied art and science depends in a greater measure than any other department of industry upon the national standard of political and social requirements; its development is, therefore, greatly influenced by the political and social condition of a nation. In **England** the requirements of navigation in the 17th and 18th centuries respecting improved astronomical, nautic and chronometric instruments had reacted beneficially upon the scientific instrument trade and given life to a number of prominent makers whose successors profited by the traditional fame of their predecessors down to the present day. The case was quite similar in **France.** Here the introduction of the metric system, the construction of good astronomical and surveying instruments and the manufacture of exact weights and measures resulted in a general development of the scientific instrument trade. In **Germany** the manufacture of scientific instruments has an old place in technical history, as such well-known old names as **Brander** of Nuremberg or **Ludolph** of Leipzic testify.

Mechanical art attained in Germany real importance only in the beginning of this century when the inventions of **Reichenbach,** the optical discoveries of **Fraunhofer,** the high skill and achievements of **Repsold, Pistor, Breithaupt** and others obtained for it the universal appreciation of the scientific world. During the years 1860 to 1865 the German instrument trade seemingly degenerated. There was, it must be admitted, a race of able and clever mechanicians and opticians who were producing excellent work, but they had not the

power of hindering German scientists of 30 years ago from obtaining their nstruments from French or Englisch rather than German makers.

The causes of this retrogression in so important a department of industry were partly to be found in the unhappy political and commercial condition of Germany, but still more so in the deficient correlation between theory and practice. By a happy coincidence men began to recognize the fact that the prosperity of the scientific instrument trade depended mainly upon the cooperation of scientific and practical men, just at a time when Germany began to rise politically and commercially. German mechanical and optical industry owes, indeed, its present prominent position, which it has attained within the last 20 years, to the judicious manner in which both these coincident factors were made use of.

The entire development of German mechanical art during this time has emanated from the full appreciation of the principle that the practical maker must know the intentions of scientific men which are to be realized by the instruments and also the limits of the required exactness, and, vice versa, that the investigator must not be an entire stranger to the manufacture of his instruments, but must know their theory and with critical knowledge only demand that degree of exactness which is necessary for his work or which is attainable. This amalgamation of theory and practice forms the basis of the activity of the **„Deutsche Gesellschaft für Mechanik und Optik“**, which has now existed for 15 years and whose members, composed of practical and theoretical men from all parts of the empire, combine their efforts and give graphic expression to the results thus obtained in the official organ of the Association, the **„Zeitschrift für Instrumentenkunde“** (Journal of philosophical instruments), a journal which comprises the entire subject of scientific technique. The object of the association being to maintain the scientific interest of its members, to solve important technical problems, such as the adoptation of uniform screws and tube-threads in the construction of instruments, and also to watch over the social and political interests of the industry which it represents, it, naturally, had to look upon the technical education of the rising generation of mechanicians and opticians as one of its prominent duties. Much, indeed, has been done in this direction in Germany within the last 20 years. At the instigation of the Association the Berlin School for Artisans (Handwerkerschule) formed the first evening class for mechanicians, in which apprentices received tuition in drawing, natural philosophy and other subjects which are of practical utility to instrument-makers. This example was followed by numerous other towns and, at the present time, every young mechanician has in most of the larger towns an opportunity to acquire theoretical knowledge in his trade, in many cases under the tutorship of prominent mechanicians; a few of the larger works have even gone so far as to appoint and maintain at their own expense special teachers for their apprentices.

Means were also provided for more advanced studies. In Berlin a class was founded for journeymen mechanists and more recently also for electrical engineers in which **journeymen** in a course of six months had the opportunity of advancing their theoretical knowledge so far as to become competent of holding the posts of fore-men, adjusters and other preferred appointments.

A similar school for electrical engineers has been founded some years ago in Francfort-on-the-Main. Naturally, in all these cases the theoretical education is adapted to the practical requirements of the learners.

Apart of this form of self-help German mechanical industry received a great impetus through the encouragement of art and science afforded by the government during the last 25 years. The erection of numerous large chemical and physical laboratories, the exigencies of ordnance survey and geodesy with respect to astronomical and surveying instruments, the influence of the adoptation of the metric system upon the manufacture of exact rules, weights and sensitive balances and hydrometers, the reaction of the requirements of meteorology upon thermometry and barometry, the beneficial influence which the development of the German navy exercised upon the nautical instrument trade and many other influences have created important problems and thus given the impulse to the development of the scientific instrument trade in Germany. Their strongest support, however, the mechanical arts received when the fact became recogniced that to **permanently** maintain the standard of their development it was necessary that there should exist a governmental institution upon which devolved all those investigations and technical processes which exceed the limits of individual means. This led to the foundation of the **„Physikalisch-Technische Reichsanstalt in Berlin-Charlottenburg“** (the Imperial Physical and Technical Institute in Charlottenburg nr. Berlin). The work of the first or **physical** department of this institution consists in theoretical investigations and the most intricate physical measurements, whilst the second or **technical** department deals with all questions affecting the practical development of technical industry, such as the examination of substances respecting their chemical and physical properties, the examination of new constructions, the testing of optical or thermal glasses and determination of their constants, photometric tests, the production and examination of standard screws for fixing and adjusting (micrometer), very finely divided rules and circles, the examination and attestation of measuring appliances and so forth. It is evident that such direct influence upon manufacture, relieving as it does, the individual, must be of the greatest importance to industry. Indeed, during the 5 years of its existence the Imperial Physical and Technical Institute has done very great service to the mechanical arts, so much so that abroad it has become an object of imitation, and in England and the United States the question of the advisability of founding similar institutions is already being dealt with.

The outcome of these general and energetic efforts — which were mainly stimulated by the zeal and activity of the Director of Institute Dr. **L. Loewenherz,** who died but a few months hence in the prime of his life — is the high standard which the German manufacture of philosophical instruments has reached. It can self-assuredly enter into competition with the industry of any other country, in many respects it probably even occupies the foremost position. In its character we distinctly recognize the product of the combined efforts of theory and practice. This character becomes also externally apparent in the geographical distribution of the manufacturing centers of optical and mechanical industry. Owing to its great number of polytechnical colleges and scientific institutions and also to its prominent political and commercial position the capital of the empire has naturally become the center of mechanical industry.

Next to it come the university towns and the seats of polytechnical colleges, in which, beside the instrument makers holding official appointments in universities and institutions, a number of other instrument-makers are established. This local association of practical manufacture and scientific research and the daily intercourse of makers and scientists greatly favours, by mutual reaction, the growth of this branch of applied science. Beside in Berlin, important centers of mechanical art are to be found in Munic, where the great achievements of **Fraunhofer** and **Reichenbach** are continued by their successors, and in Hamburg, which, beside excelling in astronomical and surveying instruments and appliances for spectrum analysis, possesses, as a natural consequence of its importance as a sea-port, prominent works for the manufacture of chronometric and nautical instruments. In several manufacturing towns the construction of electrical measuring instruments and electro-therapeutical appliances forms a prominent feature, e. g. in Berlin, Frankfort-on-the-Main, Stuttgart and Erlangen. Important branches of instrument manufacture are also found in many other towns, where production is favoured by special local conditions.

It would be impossible to here define the entire extent of the German scientific instrument trade; we must, therefore, limit ourselves to a short sketch of its compass.

The general stamp of German **astronomical** instruments corresponds to the intrinsic character of the German methods of astronomical research. The intruments are not so much distinguished for their size, to which much importance is attached in America, as for their rigidity and greatest possible exactness and highest finish of the constructive details; more importance than to size is attached to ingenious arrangements calculated to minimise the effect of instrumental errors. Important improvements have been made in this direction in the construction of meridian circles of portable transit instruments and of zenith telescopes. Delicately accurate astronomical levels, whose excessively laborious production implies the exercise of the greatest patience and care, have at present reached the highest standard of perfection in Germany. — The reputation of German **surveying instruments** has gained still further ground during the latter years. Recent ordnance survey and measurements of the earth shape have led to many improvements in theodolites, levelling instruments and tacheometers, and the wants of explorers have suggested particularly compact constructions of these instruments. In the case of the instruments intended for ordinary surveying special attention is paid to arrangements for conveniently centering the instruments and to the stability and handiness of the stands. Also instruments for geophysical research have in recent years undergone important improvements; amongst others, registering mareographs are now made of a degree of perfection which was hitherto unknown. In consequence, almost exclusively German instruments are used in the ordnance surveying work of many countries in all parts of the globe. — The manufacture of **nautical instruments**, sextants, octants, mariner's compasses and so forth, has, thanks to the united efforts of the Imperial Admiralty and the mechanical trade, made such progress that now many instruments which formerly had to be obtained from abroad are not only made in Germany in good quality but even of a superior kind to those made abroad. — Particularly noticeable progress originating in the work of the Imperial Assize Commission, has been made in **metrological**

appliances. Accurately divided measures for most exact **metronomical** work are supplied by German instrument makers to all parts of the world. German balances for chemical, physical and metrological work occupy a foremost position; it need only be mentioned here that German manufacture of balances had a prominent share in the equipment of the „Bureau international des poids et mesures"; great care is bestowed upon accurate sets of weights, and porosity is carefully treated as a source of errors. Also the manufacture of **hydrometric** instruments has made great strides ln Germany; the appliances for the examination of spirits recently constructed under the cooperation of the Imperial Assize Commission realize the most critical exigencies of modern applied science. — In the department of **meteorological instruments** Germany now occupies the first position. German makers are supplying the leading meteorological stations at home and abroad with the finest registering thermometers, barometers, rain gauges and hygrometers; in the first rank among these are the ingenious instruments invented by Prof. **Sprung,** constructed on the principle of the running-weight balance. Germany produces also a large number of graduated meteorological instruments. Exact standard, travelling and marine barometers, travelling and surveying aneroids are exported in large numbers. Germany excels particularly in the manufacture of thermometers. Laborious and costly experiments made during many years by the Imperial Assize Commission, the Imperial Physical and Technical Institute and a number of eminent scientists aided by prominent mechanicians have not only resulted in the discovery of the best methods of constructing thermometers, e. g. of fixing the scale, but above all in the production of a glass, the wellknown **Jena standard glass,** which is so composed as to eliminate the most serious defect of the older thermometers, viz. the variability of the zero-point. These achievements which have eventually become of critical importance for the manufacture of clinical thermometers, have brought the thermometer-trade of Germany to a very high level. At present the Imperial Physical and Technical Institute tests 10000 thermometers per annum; in the Standardizing and Testing Institute at Ilmenau, which is under the controllership of the former, 30000 thermometers are tested annually, the greater part of which are for export abroad.

The **optical industry** of Germany rules a large portion of the market. This favoured position it owes partly to the continued assiduous efforts of many practical opticians, in particular, however, to the work of Prof. **Abbe** of Jena, who created the optical basis upon which rests the theory of the microscope and who succeeded, in conjunction with Dr. **Schott** of Jena, in producing glasses of better optical properties than those which had been previously available. This advance in the production of optical glasses has resulted not only in the improvement of the microscope but also in that of telescopes and photographic lenses. Until 1886, the glass-smelting house founded by **Fraunhofer** having in the mean time ceased, the entire optical industry of Germany was, with respect to its **raw-material,** dependent upon the two resources at Paris and Birmingham; but at the same time, it was limited to the few types of crowns and flints which the glass-works at Paris and Birmingham were capable of supplying. The establishment of the Jena glass-works in 1886 placed the opticians of Germany upon their own feet as regards their raw-material for all their productions from

microscope lenses to telescopic objectives. The scientific investigations on the correlation of the optical properties of glass and its chemical constitution, which formed the starting point of the smelting of glass in Jena, have at the same time resulted in a considerable extension of the number of glasses which may be applied for purposes of practical optics, and opticians have now a series of new types at their command which vary considerably from the older crowns and flints with respect to refractive and dispersive power. This extension of the range of available material led in several provinces of practical optics to valuable improvements, which naturally originated in Germany. — Telescopical optics is that department which hitherto has derived the least benefit from the new glasses. Partly on account of the difficulties attending, with some of the new glasses, the production of large discs sufficiently free from defects and partly because of the aptitude of these fusions to yield to atmospheric influences it has been deemed wiser to continue to employ the older types of crown and flint glass for the manufacture of telescopic objectives. — In the construction of **photographic lenses** and of the **microscope** the greatly extended range in the refractive and dispersive powers of the glasses has, in the mean time, given rise to many practical successes in valuable conbinations, which with the older material could not possibly be produced. — In the case of photographic lenses this success is mainly due to to the fact that with the new glasses achromatic doublets may be constructed in which at will the positive or the negative member may be made to have the higher refractive index, whilst with the older material achromatization of a collective lens always assigned the higher refractive index to the negative, in the case of a dispersive lens to the positive member. The removal of this limitation, which was mainly effected by the introduction of the Jena baryta-glasses, has resulted in a series of **new photopraphic combinations.** — In the case of the **microscope** the conditions for the utilization of the progress made in glass-smelting were much more favourable; for in this case also such fusions could be employed which are obtainable only in relatively small quantities, and furthermore the material is in a much less degree required to resist external influences. Consequently, even such glasses as the phosphate and baryta-glasses have been largely employed in microscopic lenses though, for those two considerations, entirely out of place in other combinations. These new glass-types have furnished the means for vast improvements in the chromatic and spherical correction of microscope lenses and in the increase of the magnifying power of the ocular (Apochromatic objectives and compensating oculars). — Very important is also the **German manufacture of spectacles, opera-glasses, stereoscopes and similar instruments.** The extensiveness of this branch of industry is perspicuously illustrated by the fact that in one single town, Rathenow, there are 94 independent optical manufacturing concerns employing 1035 persons. — It is not surprising that Germany, being the home of spectrum-analysis, holds a prominent position in the **manufacture of spectroscopic apparatus.** A number of large optical and mechanical firms are engaged in the manufacture of spectroscopes and many of these are exported to all parts of the world. They range from the largest and finest instruments for astronomical and physical research for chemical and photographic investigations down to the smallest hand spectroscopes. — German **Polarization appliances** also are famous. We may here mention, beside the apparatus used in chemical and physical examination, in

particular the instruments constructed for the examination of sugar and wine, which are as simple in construction as they are perfect in workmanship. — The competention between gas and electric light has, as in other countries so also in Germany, occasioned important improvements in the province of **photometric apparatus.** In this direction the influence of the Physical and Technical Institute has been most marked, two of its members, Mssrs. **Lummer** and **Brodhun,** having devised an ingenious combination of prisms which eliminate an innate defect of **Bunsen's** photometer and formed the basis of technically valuable appliances.

The local distribution of optical manufacture in Germany is as follows:

1) **Astronomical telescopes:** Munic, Berlin;
2) **Photographic objectives:** Munic, Jena, Brunswick, Berlin, Rathenow;
3) **Microscopes:** Jena, Berlin, Wetzlar, Potsdam, Göttingen;
4) **Binoculars and other terrestrial telescopes:** Munic, Brunswick, Berlin, Rathenow;
5) **Spectroscopic Apparatus, Polarimeters, Photometers:** Berlin, Munic, Hamburg, Jena;
6) **Mineralogical preparations** (Quartz and calcite): Homburg, Berlin.

Not less important are the **Measuring instruments for special purposes in physical science** made by German makers with that degree of precision which modern physical research demands. We cannot here enter into detailed enumeration of the numerous instruments of this class but will only remind our readers of the crystallographic instruments for determining the geometrical and physical constants of crystals. — The manufacture of **Chemical apparatus** is greatly supported by the highly developed glass-industry of Germany, which is centralized in the Thuringian districts.

The glass industry of Thuringia embraces the manufacture of glass-house and blow-pipe goods. Both these divisions envolve a series of incidental operations, such as glass-grinding, polishing, etching, sandblasting, graduating, standardizing and so forth.

The glass-house goods comprise mainly:

1) **Glass-tubing for glass-instruments** (thermometers, hydrometers, barometers etc.). Glass-houses for these goods are in Gehlberg, Stuetzerbach, Geyersthal, Frauenwald and Jena. The Jena glass-house supplies the Jena standard thermometer glass, which is so distinguished for its minimal thermal defects; it also makes glasses for high temperature thermometers and compound glass tubes;
2) **Glass tubing** for the manufacture of artificial fruits, flowers, pearls, toys etc. Glass-houses for these goods are e. g. in Schmalenbuche and in Ernsthausen;
3) **Hollow-glass** ware and glass-apparatus for chemical, physical, pharmaceutical, surgical and clinical, commercial and other purposes. This division includes in particular: Boiling flasks, beakers, funnels, cylinders, air-pumps, incandescent lamps etc. The center of manufacture of these goods is Stuetzerbach; but they are also made in many other places, e. g. Gehlberg, Ilmenau, Graefenroda and Geyersthal.

The list of **blow-pipe goods** comprises:

1) **Fine Glass Instruments,** which are chiefly made in Ilmenau, Manebach, Roda, Elgersburg, Arlesberg and Schmiedefeld;
2) **Glass Instruments** for domestic use; chiefly house, window and bath thermometers. Manufacturing centers: Oberweissbach, Neuhaus, Mellenbach and Langewiesen;
3) **Fruits, flowers, pearls,** Christmas tree ornaments, toys and puzzles, marbles etc. Manufacturing centers: Lauscha, Igelshieb, Neuhaus and Ernstthal.

The social importance of the Thuringian glass-trade is mainly due to the fact that in some places (Stuetzerbach, Gehlberg, Schmiedefeld, Lauscha, Neuhaus) nearly the whole population takes part in the manufacture, while in other localities, such as Ilmenau, Manebach, Elgersburg, Oberweissbach etc., a very large part of the population derives its subsistence from this industry. With the glass-industry is also intimately associated the manufacture of the framework for glass-instruments. Thuringia supplies nearly the whole globe with its glass-ware, whilst the philosophical glass-instruments are chiefly made in the larger towns, e. g. Berlin, Bonn, Munic, Cologne etc. The extent and commercial value of the Thuringian glass-trade may be gathered from the fact that Thuringia produces annually about 1 million glass-instruments and at least 3 millions of glass-appliances. One single firm of glass-instrument makers, — one of the largest concerns, however, it should be added, — has an annual turnover of nearly $^1/_4$ million Marks.

The manufacture of **electrical measuring instruments** is proportional to the enormous development of electric engineering. Partly owing to the direct participation of scientists in practical work, the manufacture of galvanometers of all kinds, electrodynamometers, ammeters, voltmeters, electricity-counters, resistance-coils and electrical apparatus of all kinds has made great strides. A great number of notable firms devote themselves to this branch of industry and export considerable quantities to foreign countries.

A large number of the hands employed in electrical engineering pursuits are composed of skilled mechanicians, although owing to the whole sale system of manufacture chiefly unskilled labour finds employment. An idea of the extent of the German trade in **electrical measuring instruments** may be formed from the following data: About 13000 ampèremeters and voltmeters are made annually. Most of these are sent abroad. — Scientific instruments for electrical engineering are made by 5 principal firms, which are distributed in Berlin, Munic and Francfort o/M. There is, besides, a large number of smaller firms who, together with instruments belonging to other departments of physical science, make electrical measuring instruments.

No less importance must be claimed for the German manufacture of **electro-therapeutical apparatus.** The growth of the manufacture of these appliances during the last 5 or 10 years results probably from the continuously increasing application of electricity: 1) as a curative agent for clinical purposes; 2) as the best illuminant for local examination, in particular of bodily cavities, by the employment of small incandescent lamps, and 3) in operative surgery for

cauterizing. These three forms of application of the electric current were, irrespective of constant improvements made in their own department, greatly encouraged by the general progress of electrical engineering, in particular, however, by the recent utilization of accumulators for therapeutical purposes; quite recently it has even become possible to charge these comparatively small accumulators by means of a thermo-pile, which greatly reduces the inconvenience attending the use of other sources of electricity. Electro-therapeutical appliances are chiefly made in Berlin, Francfort o/M. und Erlangen.

Physiological instruments also occupy a wide space. We may specially allude to the ophthalmological instruments, in particular, to Helmholtz's ophthalmoscope, which since its invention has undergone many modifications.

The manufacture of **didactic apparatus** has reached a considerable extension, owing to the stress which is laid by modern educational training upon ocular demonstration; not only science colleges and advanced public schools are, accordingly, provided with well equipped laboratories, but also in elementary schools the possession of an adequate amount of apparatus for purposes of demonstration is deemed imperative. The German educational apparatus, which are extensively used in all parts of the globe, satisfy three important conditions: they are very cheap; they are so dimensioned that all their parts may be easily demonstrated; they are made in their simplest possible form all those details which are necessary only for exact measurements being omitted.

The extensiveness of the German **watch and clock manufacture** is a well-known fact. The manufacture of the so-called „Schwarzwald" clock gives, in Wuerttemberg and Baden alone, employment to 101 firms. The manufacture of regulators, watches, tower-clocks and watches and clocks for special purposes gives work to 51 of the larger establishments; the finest astronomical chronometers and thermometers are naturally only made by a few clockmakers; the reputation of these, however, is far spread.

We will supplement this condensed sketch of the extent of the German instrument manufacture by a few remarks on the technical means employed. German makers utilize largely, by critical selection, numerous new, principally American, inventions in tool-making, but, generally speaking, they prefer to make their own tools according to their special requirements. German makers require, therefore, perhaps rather more time for their productions than their foreign competitors; the process of manufacture bears also little resemblance to whole-sale manufacture and the system of division of labour is only imperfectly adopted; possibly we may find in these very facts the explanation of the individuality of the German instruments.

The commercial value of the German scientific and optical instrument trade is in correspondence with its scientific reputation. This fact will be readily gathered from the following table showing the German export to America, Australia, China and Japan during the last three years:

Export to	1889—1891	
	Quantities Hundred Kilos Nett	Value 1000 Marks Nett
United States of America	1849	3698
British North America	99	198
Mexico	160	320
Central America	25	50
West Indies	38	76
Columbia	25	50
Venezuela	21	42
Brazil	309	618
Uruguay	80	160
Ecuador	39	78
Peru	25	50
Chile	325	650
Argentine Republic	411	822
China	49	98
Japan	276	552
Australia	207	414

The number of persons employed in the manufacture of scientific instruments s considerable, as the following table schows:

Description of goods.	Number of establishments.	Number of persons employed.
Mathematical, physical and chemical instruments	190	3136
Optical instruments	150	2408
Drawing instruments	52	613
Fine balances	47	443
Thermometers and barometers	87	1014

Here only those establishments are considered which employ more than 10 persons. The number of those employing less than 10 persons may be roughly estimated at three times the above numbers.

The collective exhibition, Group 21, forms an elegant picture of the German scientific instrument industry, it does not, however, represent its entire extension. Visitors requiring information on instruments and their makers not found represented in the Exhibition are requested to address **the Committee of the „Deutsche Gesellschaft für Mechanik und Optik“ in Berlin** or **the Editor of the „Zeitschrift für Instrumentenkunde“ in Berlin W.**

Dr. A. Westphal.

No. 2751.

C. F. Betting, Wehlheiden nr. Kassel.

Mechanical Workshops.

Exhibit: **Analytical Balance** for a charge of 200 grammes, with mechanism for charging and discharging the weight pan without opening the case.

By this mechanism substances may be weighed quickly and accurately and with ease. The substance which is to be weighed is placed upon the pan on the left, the case is then closed and the weights are placed upon the pan by simply turning the milled heads projecting on the outside of the case. The latter remaining closed during the entire operation of weighing, disturbances arising from changes of temperature and currents of air are obviated. The weights, which range from 100 grammes to 1 centigramme, remain in the casing. Milligrammes and fractional parts thereof are weighed by means of the riders. The weight of the object having been determined by the mechanical weights only a second set of weights is required for double weighing, the respective weigths being introduced with opened case. The balance has a sensibility of 0,1 milligramme. The beam is made of aluminium, the other oscillating parts of thickly gilt brass. The planes are of carneol.

No. 2752.

Otto Bohne, Berlin S.,

90 Prinzen-Strasse.

Aneroid-Barometers, Registering Barometers, Thermometers and Hygrometers.

The **Aneroid-Barograph** which is shown in Fig. 1 at $^1/_4$ full size, is indisputably the most correct instrument for metereological observations. It indicates not only, like the ordinary barometer, the height of the barometer at any particular moment, but also records

its movements continuously, noting, at the same time, day and hour. These graphical records traced upon a prepared strip of paper form interesting material for future comparisons.

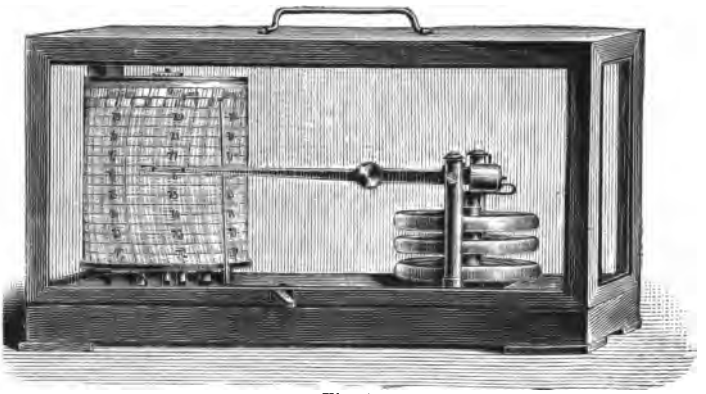


Fig. 1.

The new registering instruments, — such as the barograph and thermograph, which automatically record the position of the barometer and thermometer with a degree of regularity and precision unattainable by the most careful observer, — render metereological observations very little troublesome and thus also interesting to the lay public. The low prices and simple manipulation of these instruments conduce to increase their popularity and encourage the useful and interesting study of weather prognostication.

Fig. 2 represents in $^1/_4$ full size a **barometer for purposes of demonstration.**

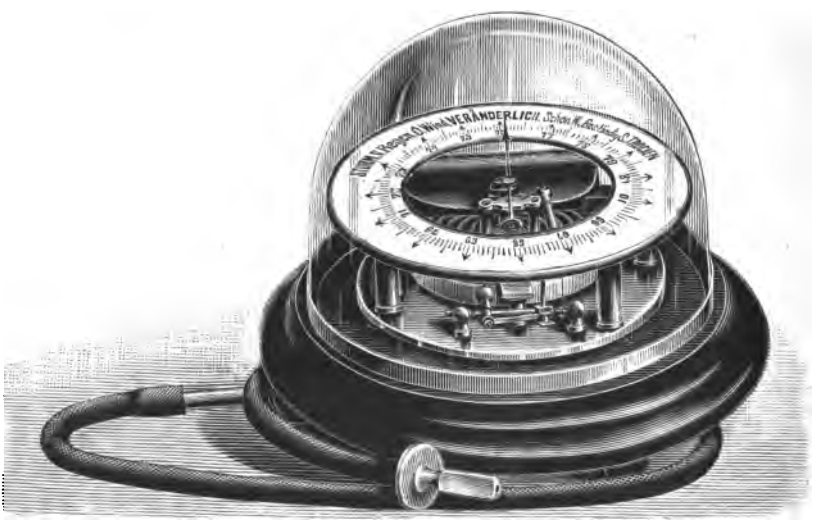


Fig. 2.

The mechanism, which is exposed to view from all sides, is isolated from the external atmosphere by a bell-jar. An india-rubber tube is attached to the side and communicates with the interior of the bell-jar. Barometric changes may be imitated by blowing into the tube or withdrawing air through it, and the movements of the mechanical parts produced by the rise and fall of the barometer may be thus demonstrated and rendered intelligible to an audience.

Fig. 3.

Fig. 3 represents in $^1/_4$ full size a **holosteric barometer** (Improved **Vidi**-Barometer), which is specially adapted for metereological observations. The Imperial German Navy has selected and adopted exclusively this instrument from among the so-called metal-barometers. The scale of this instrument is divided in $^1/_5$ mm or $^1/_{10}$ Engl. lines, as preferred. By the mechanism the reading is magnified up to 23 times; the fifth part of a millimeter of such a scale reads, therefore, as much as $2^1/_3$ mm. Accordingly, very fine measurements may even be made with the naked eye.

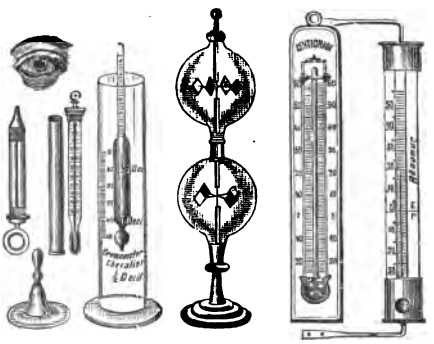
The prices of the above instruments, also those of barometers with altitude scale and metal-thermographs will be found in the price-lists, which may be had gratis and post-free.

No. 2753.

Hilmar Bock, Oberweissbach nr. Blankenburg

(Thuringia).

Gold Medal: Bruessels 1888.



Manufacturer of

Thermometers, Mercurial Barometers, Araeometers; Chemical, Physical and Surgical Glass Instruments and Appliances, Artifical Eyes etc. etc.

No. 2756.

Doerffel & Faerber, Berlin NW.,

44 Dorotheenstrasse.

Ophthalmological and Laryngological Instruments and Appliances. Loring's, Knapp's, Keyser's, Schweigger's, Hirschberg's, Landolt's, Nachet's, Wecker's, Morton's Ophthalmoscopes and others.

Trial spectacle cases, perimeter, Schweigger's hand perimeter, Horstmann's strabometer.

Laryngoscopes and **Dentoscopes.**

(The silver coating is protected by a galvanic deposit of copper and is of special density.)

Illuminating Mirrors.

Illustrated catalogues may be had at the Exhibition or directly from the firm.

No. 2754.

Arth. Burkhardt, Glashütte, Saxony.

Civil Engineer.

First German Calculating Machine Works.

Established in 1878.

Silver Medal IX. Cincinnati Exhibition 1881.

Calculating machine with latest improvements and supplementary types — awarded several national prizes, gold and silver medals at home and abroad, — for **addition, subtraction, multiplication, division** and **calculation of powers, cubes** and **roots.**

Absolute exactness and no mental fatigue!

Three sizes in most exact and elegant construction.

Size 1: Factor O of 6 figures × factor N of 7 figures: Product M of 12 figures.

Size 2: Factor O of 8 figures × factor N of 9 figures: Product M of 16 figures.

Size 3: Factor O of 10 figures × factor N of 11 figures: Product M of 20 figures.

More than 500 machines have been supplied to all parts of the world and given full satisfaction.

100 machines are being used in the principal offices of the U. S. A.

Representatives in the U. S. A.:
Keuffel & Esser Co., New York and Chicago.

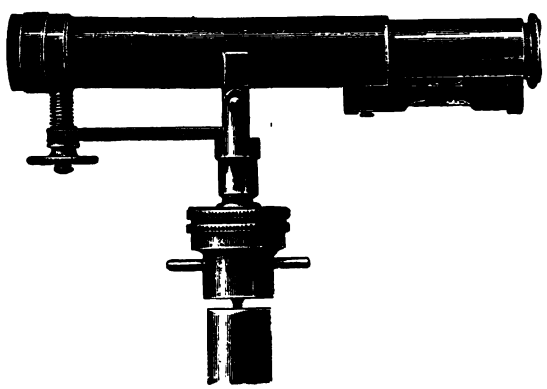
No. 2755.

Georg Butenschoen, Bahrenfeld nr. Hamburg.

Mathematical and Mechanical Instrument Maker,

exhibits a Travelling Theodolite, an Inclinable Levelling Instrument and a number of pocket instruments. It would lead too far were we to attempt to give a detailed description of all the instruments made by this firm. The Pocket Levelling Instruments, invented and patented by the exhibitor, the speciality of the firm, may, however, be explained in a few words.

The instrument, which fits into a case and may be carried in the pocket, is represented in the annexed illustration. It possesses the special advantage that by its means, the spirit-level, cross-lines and the object can be viewed simultaneously, the position of the bubble of the spirit-level not being, as is the case with the usual instruments, controlled externally, but, by means of a mirror placed at an angle of 45^0 between the ocular and the cross-lines, through the telescope, where it is viewed together with the object. The image of the spirit-level appears magnified in the ocular, whereby the exactness of the adjustment is greatly enhanced. The instrument, by this arrangement, attains, with due regard to its size, considerable powers and greatly surpasses the water-level which is still extensively used. The necessary manipulation is very simple, so that those, who are not accustomed to work with the telescope level, will find no difficulty in becoming familiarized with its use.



The business was begun on a small scale but rapidly worked its way upwards. Mathematical and surveying instruments form the principal objects of manufacture, but also nautical and astronomical instruments are made. The instruments find a regular market in all European countries and meet also with considerable demand in transatlantic states.

No. 2760.

Bernhard Halle, Steglitz nr. Berlin.

Speciality: Optical appliances for polarization of light etc.

Preparations of Island double spar: Polarizing prisms. These are made in numbers by a process invented by the exhibitor. By means of a special sawing machine designed by Mr. Halle great accuracy of the angle is obtained; by means of fine polishing appliances the surfaces and angles are further reduced to absolute exactness; the prisms are of the highest degree of perfection; nevertheless the prices are extremely low and compete successfully with those of any other firm.

Beside these, quartz preparations of all kinds are made of the highest perfection. **Glass prisms without pyramidal errors, prisms and plates of rock salt, alum, tourmaline** etc., made in the most accurate manner.

The trade supplied on liberal terms.

No. 2761.

A. Hasemann, Berlin C.,

7 & 8 Nicolai Kirchhof

Maker of Balances.

This factory produces principally balances of best quality with beams suspended in the center.

Exhibited **balances:**

1. **A set of official assize balances Nos. 1 to 4.**

No.	Maximum charge	Sensibility expressed according to the directions of the German Assize Department.
1	50 kilos	1/50000
2	5 „	1/20000
3	1 kilo	1/20000
4	20 grammes	1/4000

(These balances are among the instruments exhibited by the Imperial Assize Commission.)

2. **A machine for adjusting balances.** Fig. 1. This machine was invented in 1875 by H. Hasemann. It automatically adjusts the parallelism of the knife-edges and the equidistance of the points of

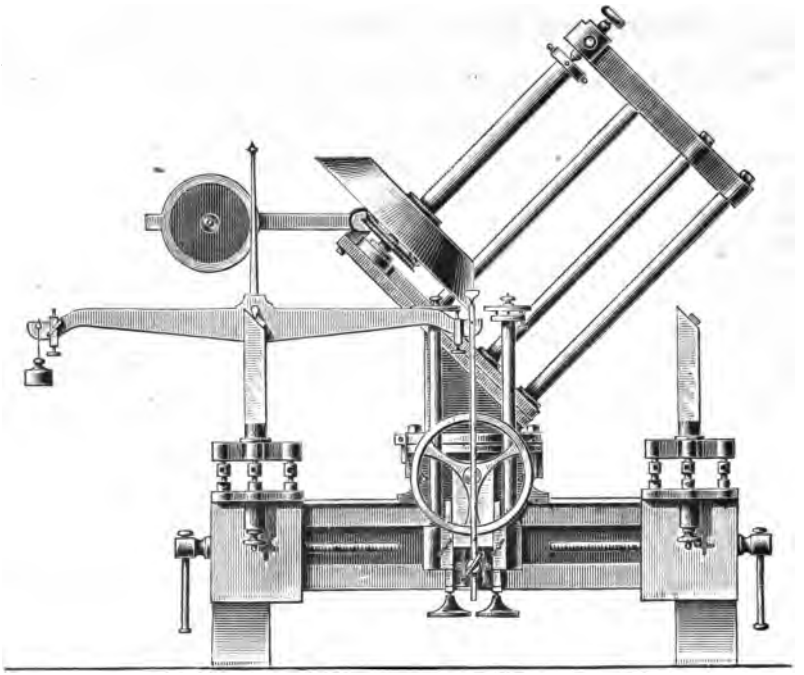


Fig. 1.

suspension of the charges from the fulcrum. By means of a machine of this description used in the factory since 1882 about 10000 balances have been adjusted.

3. Drawing and description of:

„Oscillation of a cylinder upon another cylinder."
(Knife-edge upon knife-edge).

A new pendulum suspension by H. Hasemann.

The edge of a pendulum becomes, through pressure, reduced to a surface.

The author has given this inevitably blunt edge a cylindrical form by a suitable grinding machine and placed the knife-edge thus protected from further deterioration upon a surface of similar form. The horizontal projection **a b** of the travel of C (the fulcrum) upon the cylindrical surface of the pendulum is in the case of a plane $= r \sin \alpha$

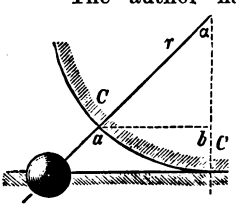


Fig. 2.

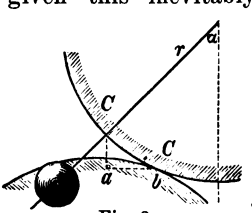


Fig. 3.

(fig. 2), in the case of a cylindrical surface $= r\left(\sin\alpha - \sin\frac{\alpha}{2}\right)$, (fig. 3). — The section at the point of contact between a cylinder and a plane, the line A B, (fig. 4), is, on account of the compressibility of the material, a curved line. . . . . The existence of the components shows that the fulcrum cannot be in A B. Rotation of the cylinder

Fig. 4.

Fig. 5.

is, therefore, necessarily accompanied by a sliding movement along A B and produces therefore friction. The forces, acting in the line of contact of two similar cylindrical surfaces have, on the contrary, no horizontal components, because, as fig. 5 shows, that path is a straight line. A B represents therefore the fulcrum and rotation takes place without friction.

No. 2765.

W. A. Hirschmann, Berlin, N.

14—15 Johannisstrasse.

Manufacturer of Electro-Therapeutical Apparatus.

Established 1862.

1. **Stationary Electro-Medical and Electrolytical Cabinet,** consisting of:

Galvanometer for absolute measurements, resistance box, induction coil, pole reverser, cell numberer, commutator, influence machine and all accessories for Franklinization.

2. **Stationary Cabinet for electro-medical and electrolytical purposes, illumination and galvanic cautery,** arranged for connection with an electric light installation of 110 volts.

The apparatus may be used simultaneously for illumination and galvanic cautery, or for illumination and electrolysis etc., and is fitted with all necessary appliances for connection with electric light installations.

3. **Stationary Electro-Medical and Electrolytical Cabinet,** consisting of:

Galvanometer for absolute current measurements, pole reverser, commutator, induction coil and cell numberer.

4. **Stationary Cabinet for electro-medical and electrolytical purposes,** similar to No. 3, simple construction.

5. **Stationary Electro-Medical and Electrolytical Cabinet** designed for direct connection with an electric light installation of 110 volts.

6. **Battery for Galvanic Cautery.**

7. **Apparatus for Illumination,** for connection with an electric light installation of not more than 110 volts.

8. **Battery for Illumination.**

9. **Battery for Simultaneous Illumination and Galvanic Cautery.**

10. **Electro-Therapeutical Instruments:**

Electrodes of all sizes, flexible electrodes for the ear, nose, larynx, stomach, rectum, bladder etc., electrodes for general faradization etc.

11. **Portable Batteries for galvanic and faradic currents,** with galvanometer for absolute measurements, cell numberer etc.

12. **Portable Faradic Batteries** in various sizes.

13. **Portable Batteries** for galvanic cautery. Portable batteries for illumination.

14. **Galvanometers** for absolute current measurements. These galvanometers are perfectly aperiodical and conveniently portable. They are equally well adapted for stationary and portable batteries.

15. **Resistance Boxes,** metallic and liquid resistances.

16. **Electrolytical Instruments:**

a) for the nose and larynx,
b) for the skin,
c) for gynaecological purposes.

17. **Galvanic Cautery Instruments.**

Snare Handles by Drs. **Kuttner** and **Schech.** Handles for burners. Burners of any form.

18. **Instruments for Illumination:**

a) Head-band lamps for illuminating the nose, ear, larynx etc.,
b) Prof. B. Fraenkel's stand for the same purpose,
c) Laryngoscope with mirrors,
d) Prof. Trautmann's lamp for the ear,
e) Translumination lamp for the frontal cavity,
f) Dr. L. Casper's urethral electroscope, also adapted for the ear, nose and rectum,
g) Dr. Lohnstein's urethral translumination lamp,
h) Dr. Einhorn's stomachic translumination lamp,
i) Dr. Nitze's cystoscope for the illumination of the bladder,
k) Dr. Nitze's irrigating cystoscope for the bladder,
l) Cystoscopic phantom.

Illustrated Price List.

Sole agents for the U. S. A.:

Messrs. Richard Kny & Co.,

17 Park Place **New York.**

No. 2763.

Paul Bunge, (Propr. A. T. Herzberg) Hamburg.

13 Otto-Strasse.

Manufactory of analytical balances.

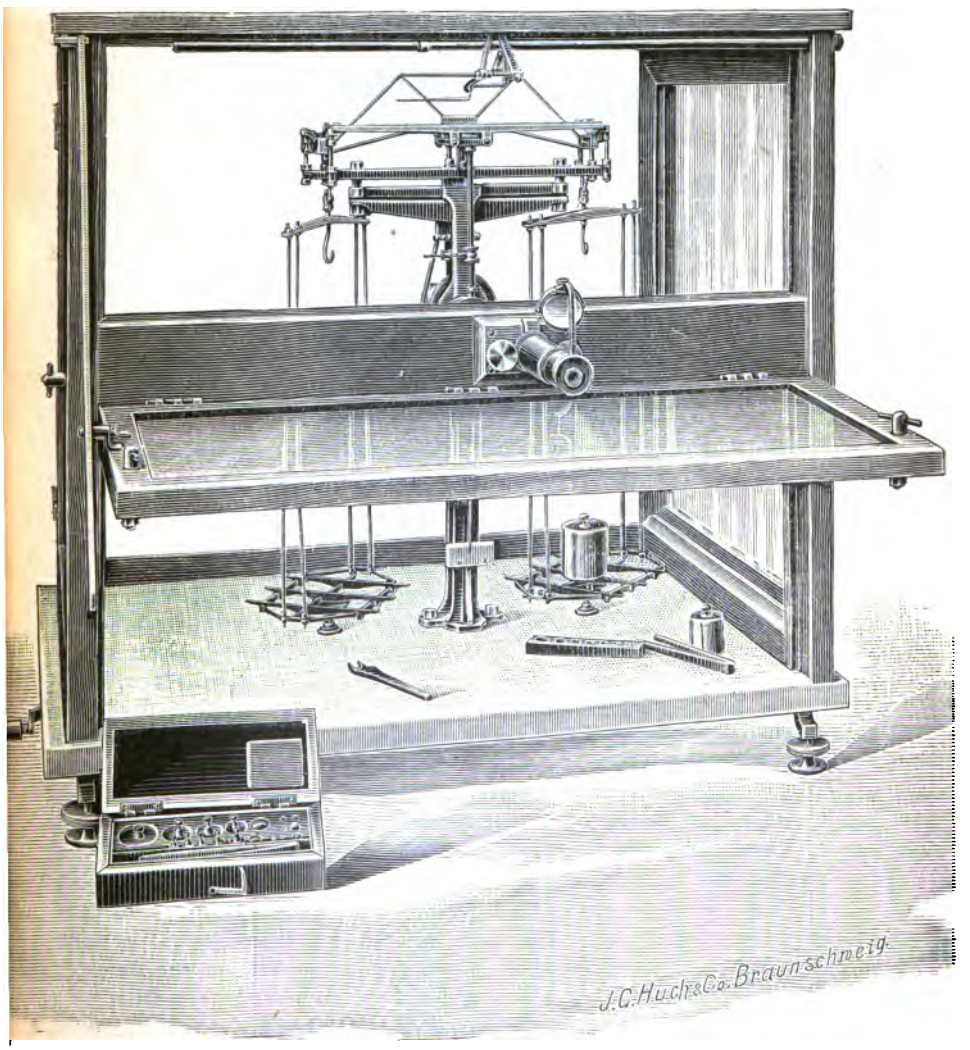


Fig. 1.

1. Physical Balance for a Maximum load of 2 Kilos, (Fig. 1) with Abbe collimator telescope, reflecting prism and concave mirror fitted to the beam, which magnifies the oscillations of the latter about 25 times. The beam is made of the finest argentan. In order to reduce the effects of currents of air the pans are built up of 9 crosses. By reason of the telescopic arrangement the oscillations are very rapid and constant. All the knife-edges and planes of the beam and pans are made of agate.

Length of beam 24 cm.; weighing space 17×32 cm. Degree of sensibility: 5 degrees deflection in the telescope per milligramme, or variable at will. The sensibility is constant for all charges.

Mounted on black glass or white marble plate.

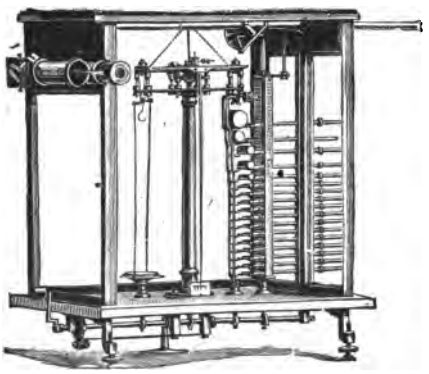


Fig. 2.

2. Analytical Balance for a Maximum charge of 200 grammes (Fig. 2) with arrangement for mechanically charging or discharging the weight-pan without opening the casing; with reading-telescope. By means of sliding carriers having the values of the respective weights marked on them each weight may be placed exactly in the center of the pan, which consists of 17 concentric brackets arranged one above the other; the mechanism is such that no vibration, friction or accidental dropping of weights can take place. By turning a crank forward the frame supporting the carriers descends, the carrier is liberated and may be withdrawn from under the weight. The balance is thrown into action by turning the crank in the opposite direction. As in this case the pointer swings out only one degree per milligramme, the tenths of a milligramme may be read off in the telescope directly and the hundredths may be estimated. The rapidity of the oscillations has, therefore, in this balance been reduced in such a way that it is to that of an equally sensible short beam balance in the ratio of $1 : \sqrt{10}$. The pan for the weighing charge is made of rock-crystal. The rider slide is accurately notched on the dividing engine. The pointer is of a triangular form to obviate vibration.

Length of beam: 13 cm. Sensibility: 0.05 mg.

Mounted on a clamped mahogony board or black glass plate.

Fig. 3.

3. Analytical Balance for a Maximum charge of 200 grammes. (Fig. 3.) Beam of finest argentan. All knife-edges of the beam, suspensions and pans are made of agate. The rider-slide is accurately notched by the dividing-engine, which precludes accidental shifting of the rider. The pointer is triangular to obviate vibration. The pans are made of rock-crystal and about 60 mm. ($2^2/_5$") in diameter. Length of beam 13 cm; weighing space 9×20 cm.

$^1/_{10}$ mg. deflects the pointer 1 degree with all charges.

Mounted on light or black glass or white marble plate.

Illustrated and descriptive catalogues (French and English) of finest analytical, assay, vacuum and bullion balances etc. Gratis.

Gold Medals and Diplomas of Honour:

Vienna 1873. Hamburg 1876. Brussels 1888. Hamburg 1889.

No. 2766.

R. Jung in Heidelberg,

12 Landhausstrasse.

Mechanician.

Gold Medals: Heidelberg 1876. Karlsruhe 1877.

Silver Medals: Mannheim 1880. Brussels 1888.

Diploma of Honour: Antwerp 1891.

Gold Medal.

Exhibits:

I. Micrological Apparatus.

1. **Microtome for cutting large sections. New Model.** Mechanical knife motion and automatic vertical movement of object. Appliances for cutting under liquid.
2. **Thoma's Microtome No. I,** length of bed 40 cm; object holder fitted with two movable axes and with rack and pinion for vertical adjustment of object; freezing apparatus; micrometer screw with audible and adjustable catch; spirit irrigating apparatus (new pattern); the necessary knives, knive supports etc. (Fig. 1).

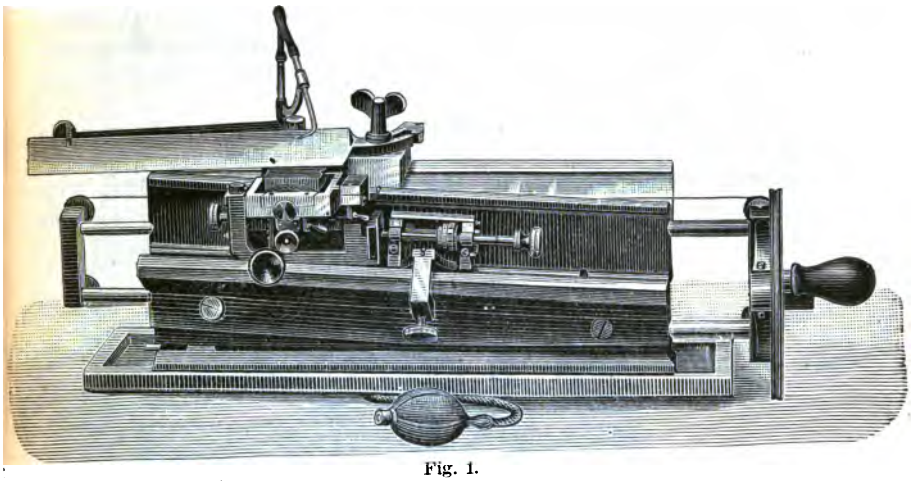


Fig. 1.

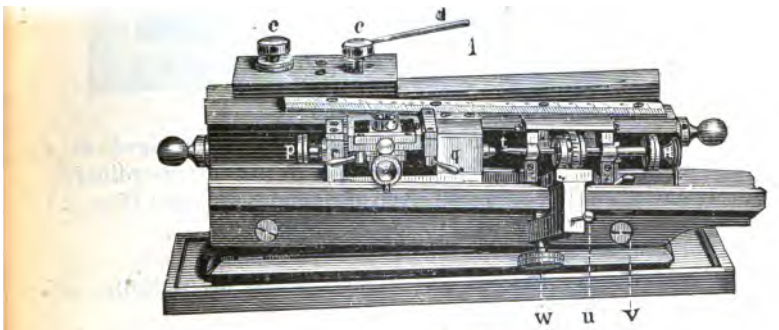


Fig. 2.

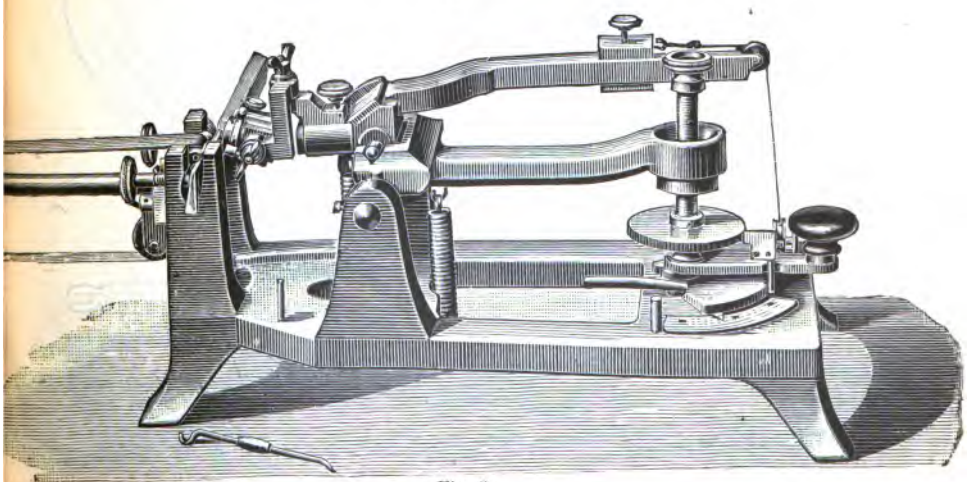


Fig. 3.

3. **Thoma's Microtome No. II,** length of bed 27 cm, with simple object holder, simple micrometer screw, freezing apparatus, knives etc.
4. **Thoma's Microtome No. II,** equipped according to the directions of the Zoological Station of Naples (Fig. 2).
5. **Thoma's Microtome No. III,** simple equipment, with movable object holder, micrometer screw and knives.
6. **Automatic Microtome** for objects embedded in paraffine, with endless transporting band for sections; capable of cutting sections of 0.001 mm thickness (Fig. 3).

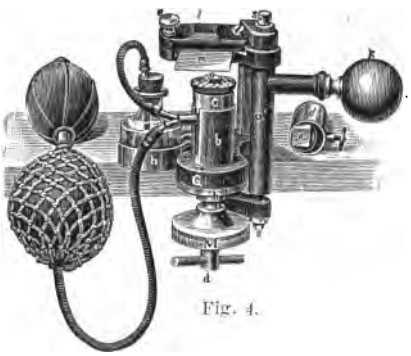


Fig. 4.

7. **Small Microtome** with mechanical knife motion, arranged as a freezing and paraffine embedding microtome. (An extra-ordinarily cheap instrument which commends itself for many purposes; (Fig. 4.) **Registered!**
8. **Small microtome,** similar to No. 7, with automatic feed.
9. A set of **microtome knives** and **Instruments** of **nickelin** and **platino-iridium** for micrological purposes.

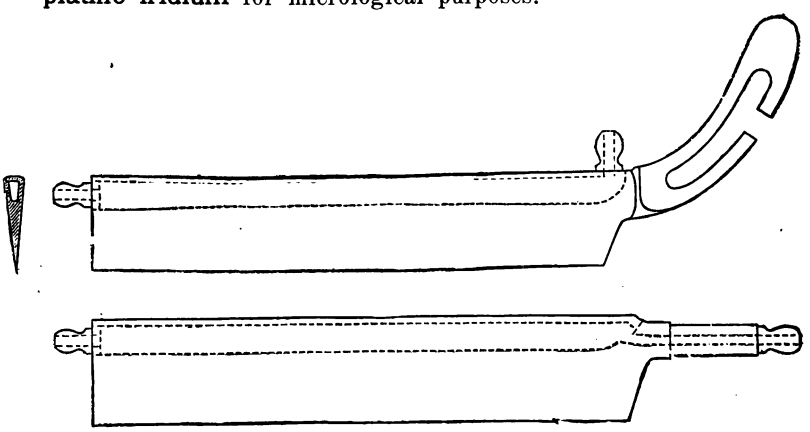


Fig. 5.

10. **Microtome knife** with longitudinal bore for cooling by water or air (Fig. 5).

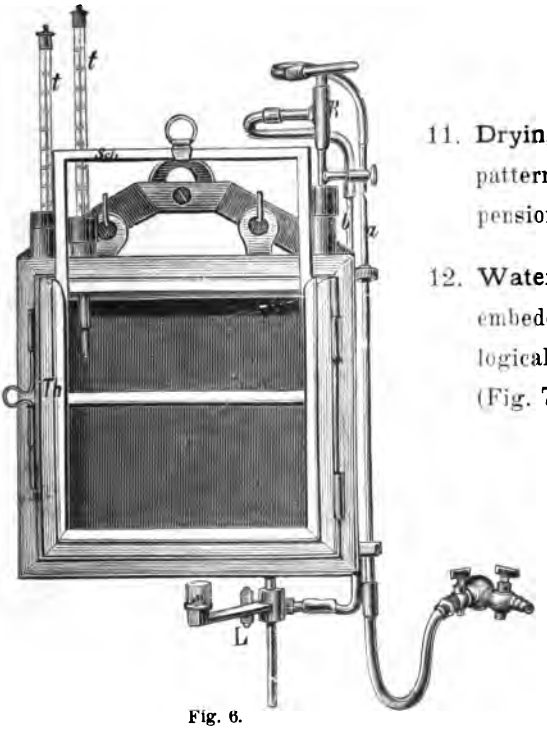


Fig. 6.

11. **Drying Oven**, Heidelberg pattern, large size, for suspension from wall (Fig 6).

12. **Water Bath** for paraffine embedding, Model of the Zoological Station at Naples (Fig. 7).

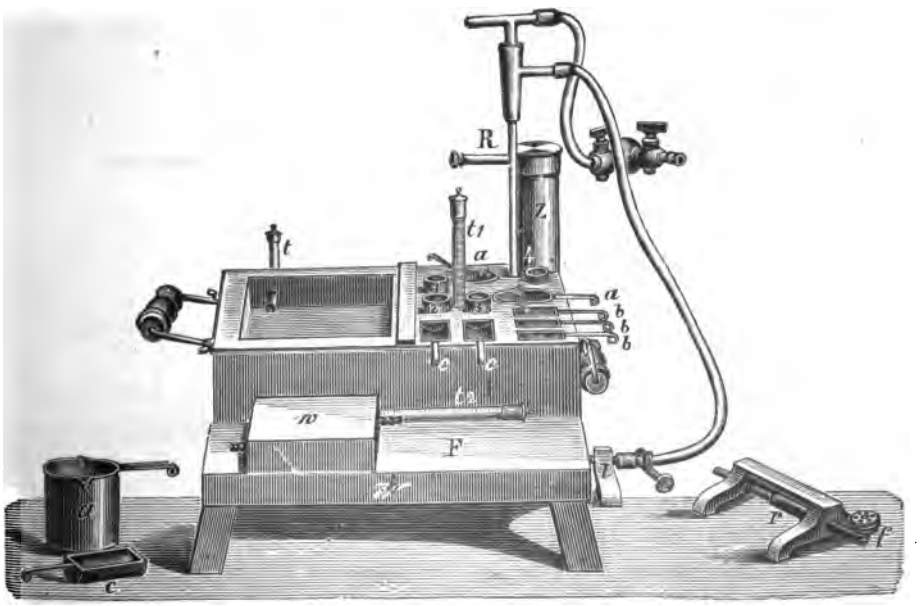


Fig. 7.

13. **Water Bath** for paraffine embedding, similar to No. 12 but smaller.

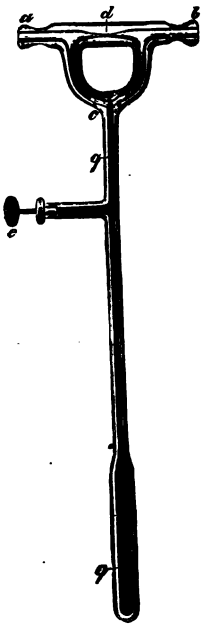


Fig. 8.

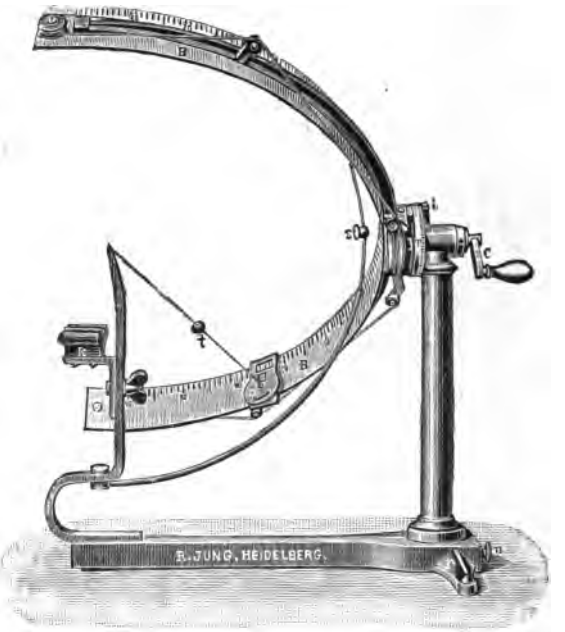


Fig. 9.

14. **Thermo-regulator,** new design. **Registered!** (Fig. 8).

15. **Dissecting stand** with three low powers, with large bright and black reflector.

16. **Hones** for setting microtome knives.

II. Physiological and Ophthalmological Instruments.

17. **Foerster's Perimeter,** new model (Fig. 9).

18. **Pristley Smith's Perimeter** (Fig. 10).

19. New **Perimeter** on adjustable stand (Fig. 11).

20. **Helmholtz's Phacoscope** for studying the changes of accomodation in the eye.

21. **Clock work for coloured discs,** with set of discs, with speed regulator and oscillating prism. New Model (Fig. 12).

22. **Rotating Apparatus** for three colour discs or for one disc of 30 cm diameter. New model.

23. Coloured papers and colour books.

24. Coloured transparent letters.

25. **Rock crystal lenses.**

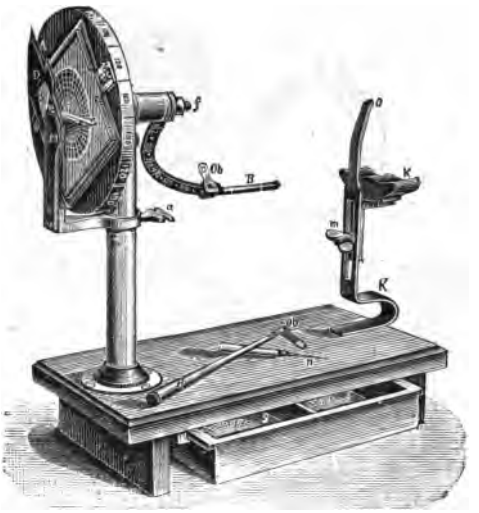


Fig. 10.

Fig. 11.

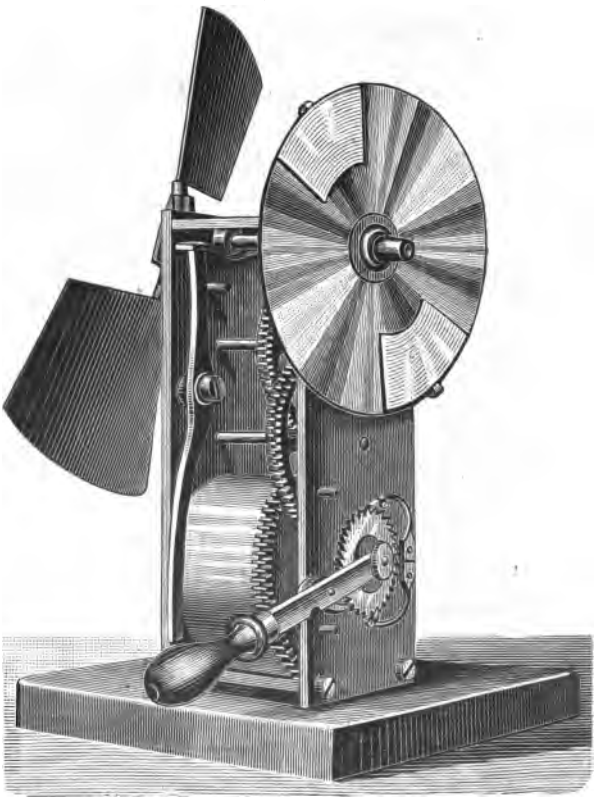


Fig. 12.

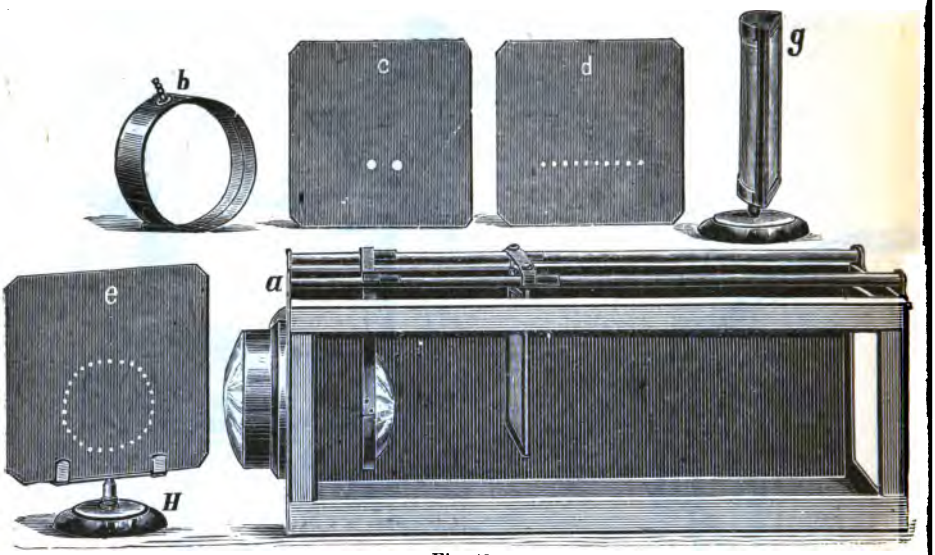


Fig. 13.

26. **Kuehne's Optical Eye** (Fig. 13).

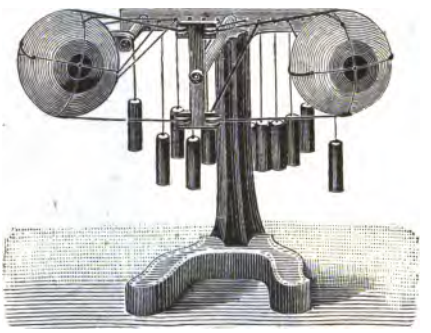


Fig. 14.

27. **Knapp's Ophthalmotrope.** (Fig. 14.)
28. **Knapp's skeleton model.**
29. **O. Becker's Lens Models.** A contribution to the history of the development of the lens in the eyes of vertebrates and to the morphology of the tissues in the lens of the human eye, with illustrated description.
30. **Model of the cornea and iris according to Weiss,** with plano-concave glass to reproduce the effect of the former and thus to show its influence upon the apparent size and position of the pupil (orthoscope).
31. **Weiss's Gauge for measuring the distance of the pupils.**
32. **Sattler's and Nieden's** galvano-cauterizer.
33. **Electrodes** for destroying the roots of troublesome hairs on the eyelids.
34. **Fick's Ophthalmotonometer.**

35. **Pristley Smith's lamp,** improved by Leber, for lateral illumination of the eye and for ophthalmoscopic examination, in particular, suitable for use at the bed side.
36. **Dr. Rindfleisch's Sciascope.**
37. **Dr. Weiss's Exophthalmometer.**

Fig. 15.

38. **Hering's small apparatus** for testing binocular vision (Fig. 15).

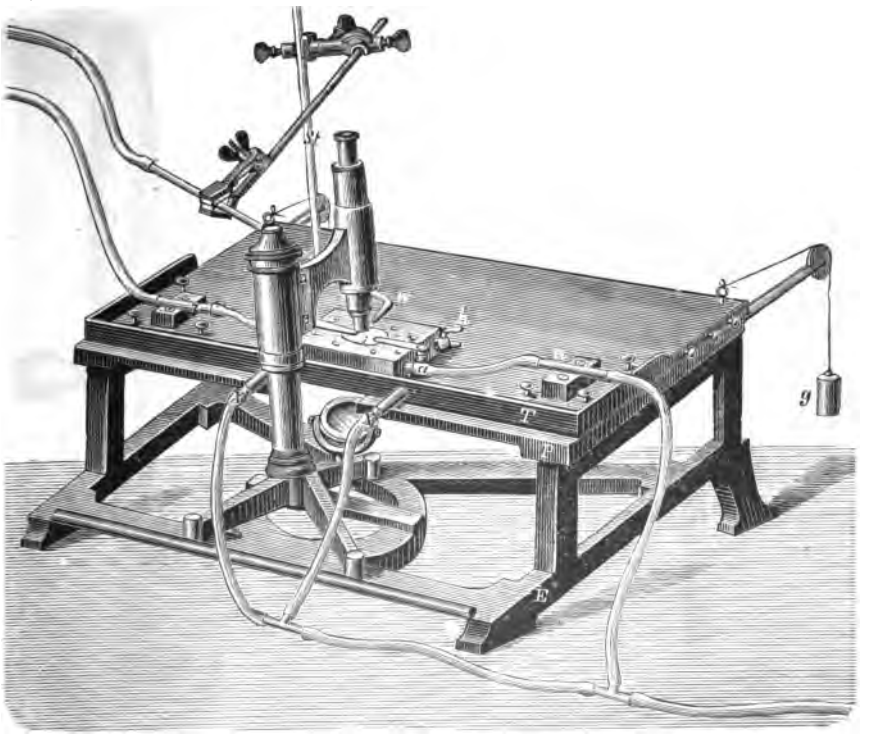


Fig. 16.

39. **Thoma's plates** for studying the circulation of blood
    a) in the mesentery and omentum of rabbits, dogs etc. (Fig. 16),
    b) in the frog's tongue, (Fig. 17),
    c) in the mesentery of the frog,
    d) in the web of the frog,
    e) in the lung of the frog.

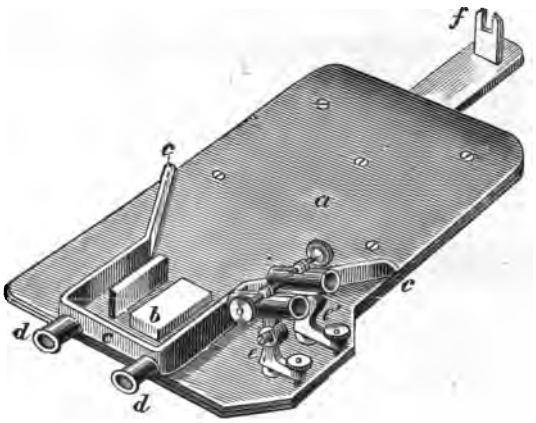


Fig. 17.

40. **Thoma's drawing apparatus,** for low magnifications and reductions (1 to 10 diameters), with large field, drawing paper on horizontal plane (Fig. 18).

Fig. 18.

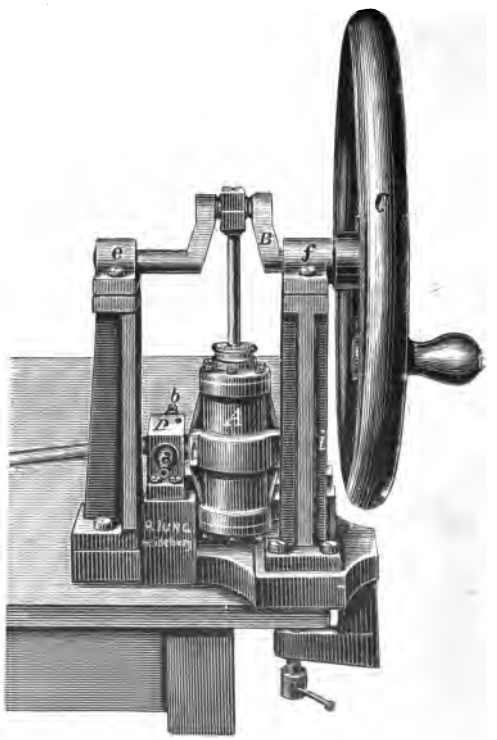


Fig. 19.

41. **Illuminating lens on stand,** 10 cm diameter, with fitting for placing coloured glasses before the lens.

42. **Rotating double acting air pump** for laboratory purposes, injecting, air compressing, transmission of gases etc. Quick working up to 125 cm of the mercury pressure gauge. (Fig. 19.)

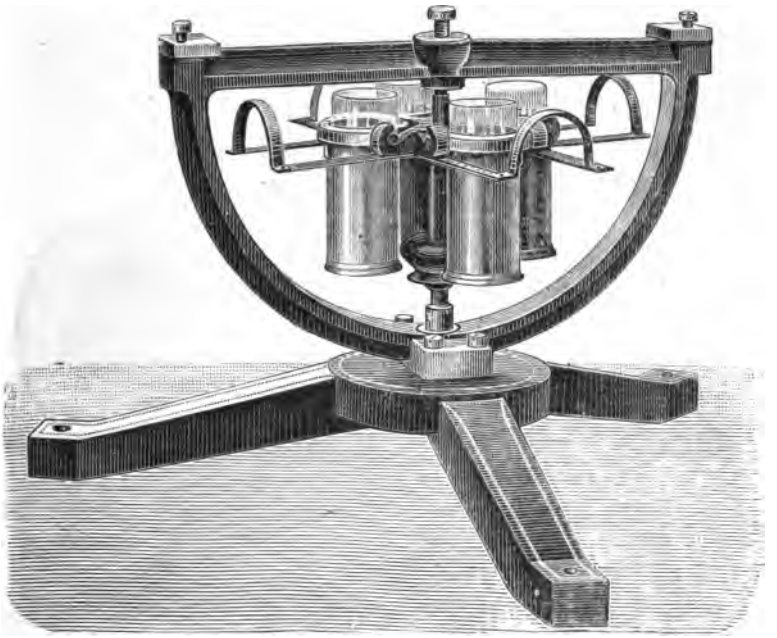


Fig. 20.

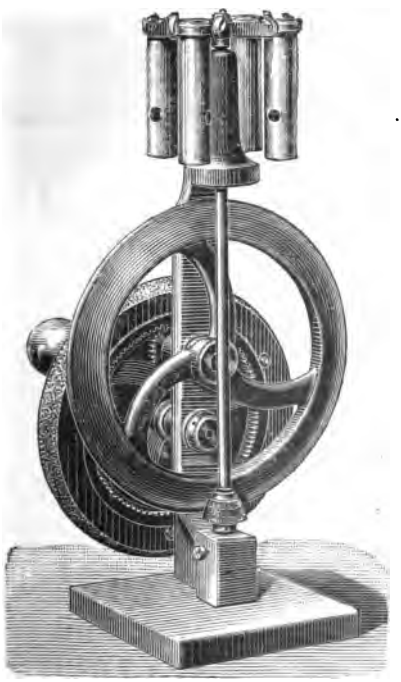


Fig. 21.

43. **Large Centrifuge,** new design, with 4 cylinders for hand or engine power; in the latter case a fly wheel mounted on tripod stand is supplied with the machine. (Fig. 20.)

44. **Small centrifuge,** new design, for high speeds (4000 to 6000 revolutions per minute) with covered gearing and guard placed over the cylinders, of which there are 2 or 4 (Fig. 21, guard not shown).

45. **Helmholtz's model of the mechanism of the auditory organs** (Fig. 22).

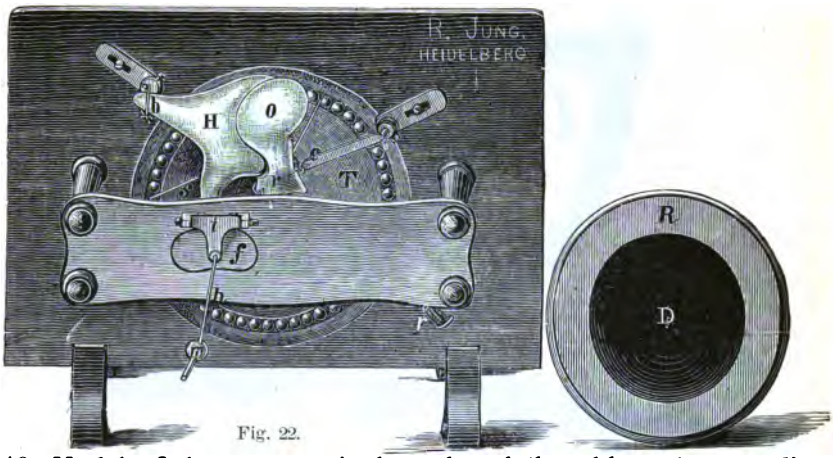


Fig. 22.

46. **Model of the upper spinal cord and the oblongata,** according to the directions of Dr. Ludw. Edinger of Frankfort o/Main. This model was completed in the spring of 1892 and agrees in all

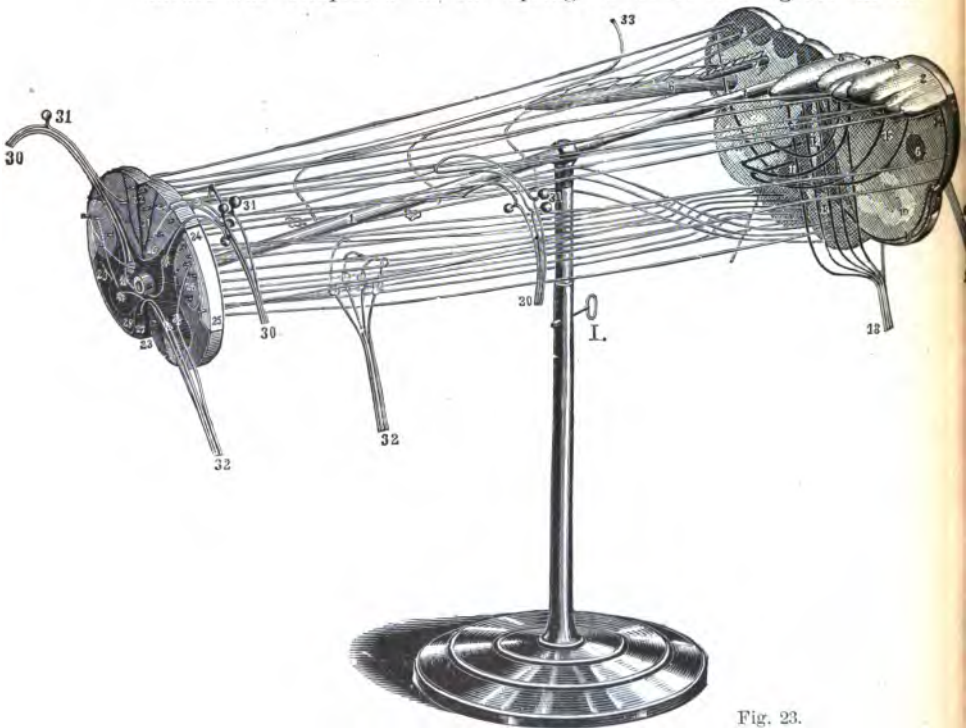


Fig. 23.

particulars with the third edition of Edinger's „12 Lectures on the central nervous system". (Fig. 23.)

Illustrated Catalogue on application. Gratis.

No. 2769.

Max Kohl, Chemnitz, Saxony.

Scientific Instrument Maker.

Speciality: Physical Apparatus.

Price list of 3000 Instruments and Appliances, in German, English and French, containing 1000 Illustrations to be had free on application.

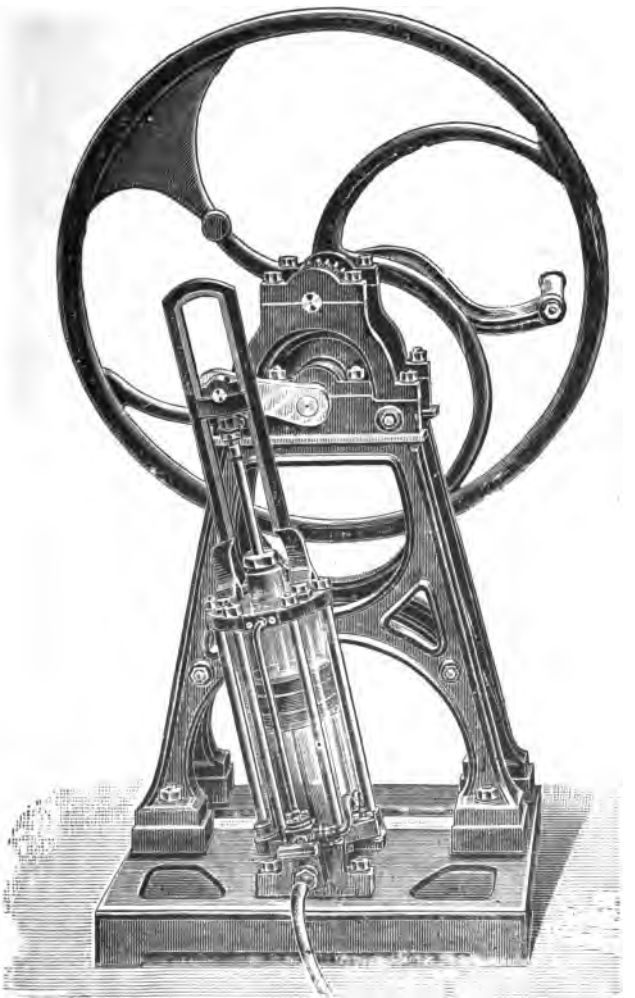


Fig. 1. **Bianchi Air Pump.**

1. Bianchi Air Pump. (Fig. 1.)

This pump is double acting and fitted with Babinet cock. The cylinder being made of glass the piston is protected from oxydation, which cannot be avoided with metal cylinders. The valves are, in contradistinction to older types, placed outside the barrel and are thus easily accessible for the purpose of cleaning the pump. The air pump is capable of producing an exhaustion of 2 *mm* mercurial pressure gauge. The plate is fitted with electrodes communicating with the interior of the recipient.

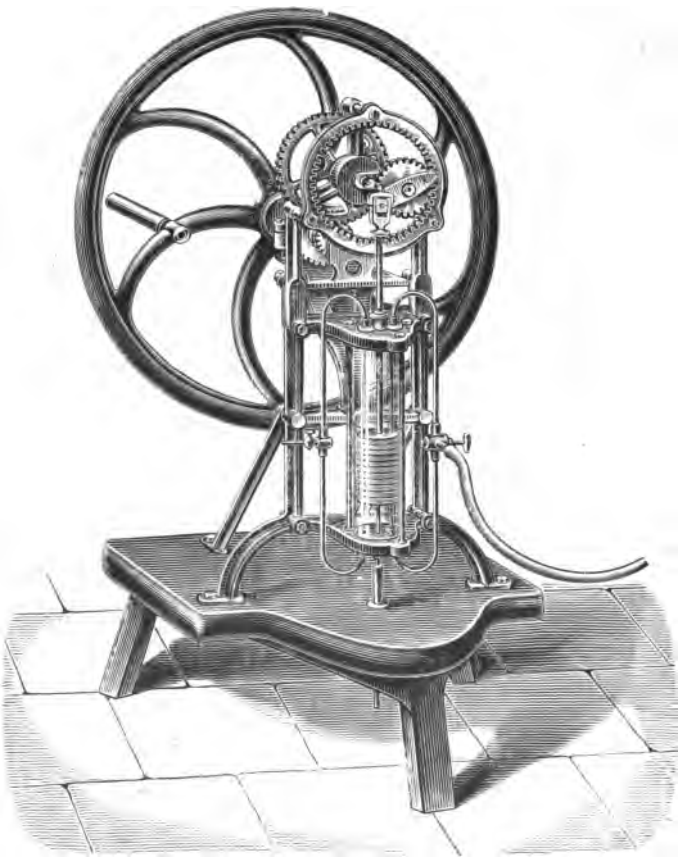


Fig. 2.

2. Deleuil Air Pump. (Fig. 2.)

The metal piston works very easily in the glass barrel. The pump is double acting and may be used both as an exhausting and compressing pump. It is capable of producing exhaustion of 2 *mm* mercurial pressure gauge.

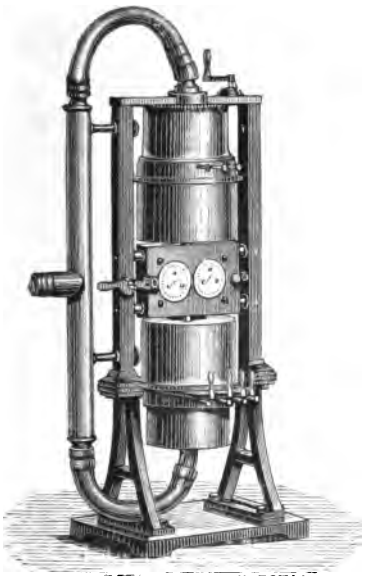


Fig. 3.

3. Helmholtz's Double Syren.

(Fig. 3.)

The double syren is particularly adapted for ascertaining the number of vibrations producing certain notes and for experiments on harmonics, beats and combination notes. The ratch of the train of wheels is fitted with electrical contact which connects it with an electrical second pendulum clock.

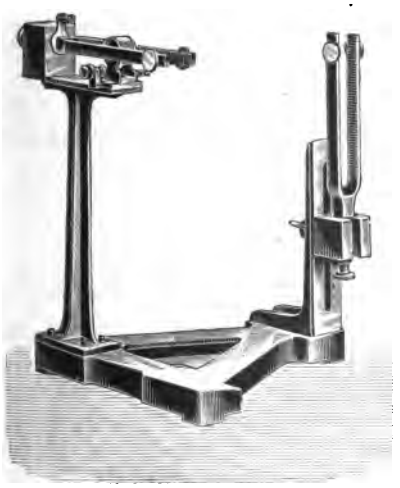


Fig. 4.

4. Tuning Apparatus for producing Lissajous' Curves.

(Fig. 4.)

The tuning forks have excellently ground and polished steel mirrors attached to their limbs and one of the forks is intoned by electro-magnetic means. The following accessories are supplied with the apparatus.

2 tuning forks in C = 256 oscillations,
1 „ „ „ F = $170^2/_3$ „
1 „ „ „ C = 512 „

The apparatus is very suitable for demonstration on the screen.

5. Portable Reflecting Galvanometer with Ocular Scale according to Prof. Weinhold. (Fig. 5.)

The ocular of the telescope attached to this instrument is provided with a transparent scale. A small mirror placed at the side of the ocular throws a pencil of light upon a reflecting prism fixed to the scale whence it passes to the telescope objective. The telescope is

made up of two parts which are at right angles to each other, a rectangular reflecting prism being placed between ocular and objective at the point of intersection of the axes. The light reflected by the small prism in the ocular passes through the objective and meets the mirror attached to a semicircular or annular magnet; it is then reflected by this mirror and returns to the ocular. The image of a cross line placed below the small reflecting prism is in this manner thrown upon the ocular scale and the slightest movement of the mirror rendered visible. The sensibility of this instrument is exceedingly great and may be regulated to a certain extent according to the requirements of the case by means of two controlling magnets. When adjusted for maximum sensibility a deflection of one division of the scale represents about 0.00000013 *Amp.*, when adjusted for its minimum sensibility 0.0000013 *Amp.* The galvanometer is exceedingly portable, being provided with a most effective disengaging catch and having all its sensitive parts well encased and protected. The galvanometer is, therefore, principally used for testing cables and insulations, and is unquestionably the best existing instrument for this purpose.

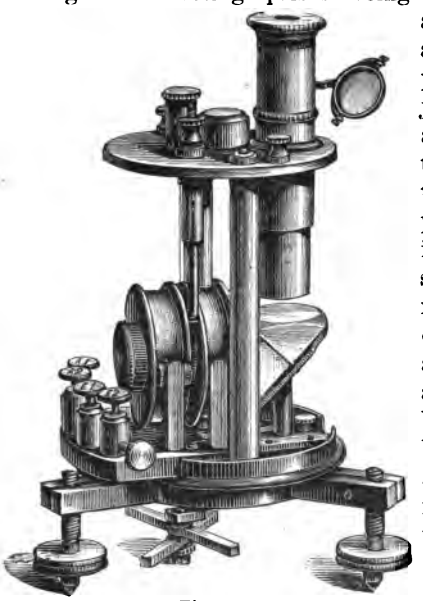


Fig. 5.

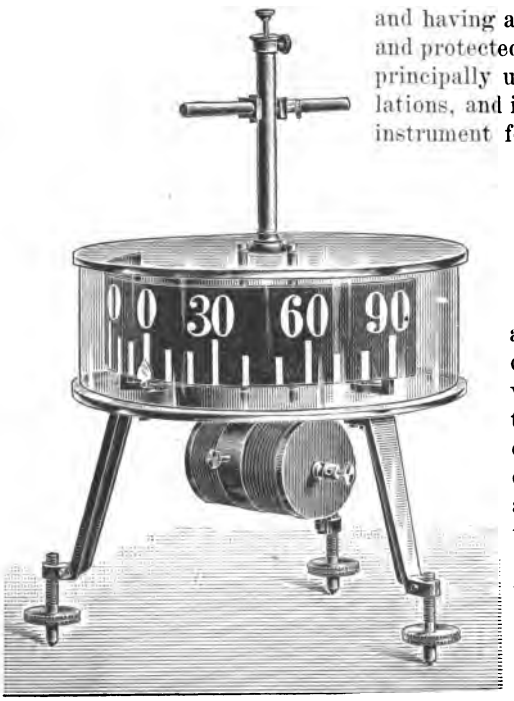


Fig. 6.

6. Beetz's Lecture Galvanometer. (Fig. 6.)

This galvanometer is made in a most convenient form for lecture demonstrations. It is provided with a controlling magnet so as to render it possible to always direct the scale towards the audience and its scale is divided so as to be distinctly visible from the distance. A special feature of the instrument is the facility with which the coils can be interchanged. Two differently wound coils are supplied with the instrument.

7. Wiedemann's Reflecting Galvanometer. (Fig. 7.)

This galvanometer has been designed to meet the requirements of laboratories. It is provided with bell and ring magnet, spherical

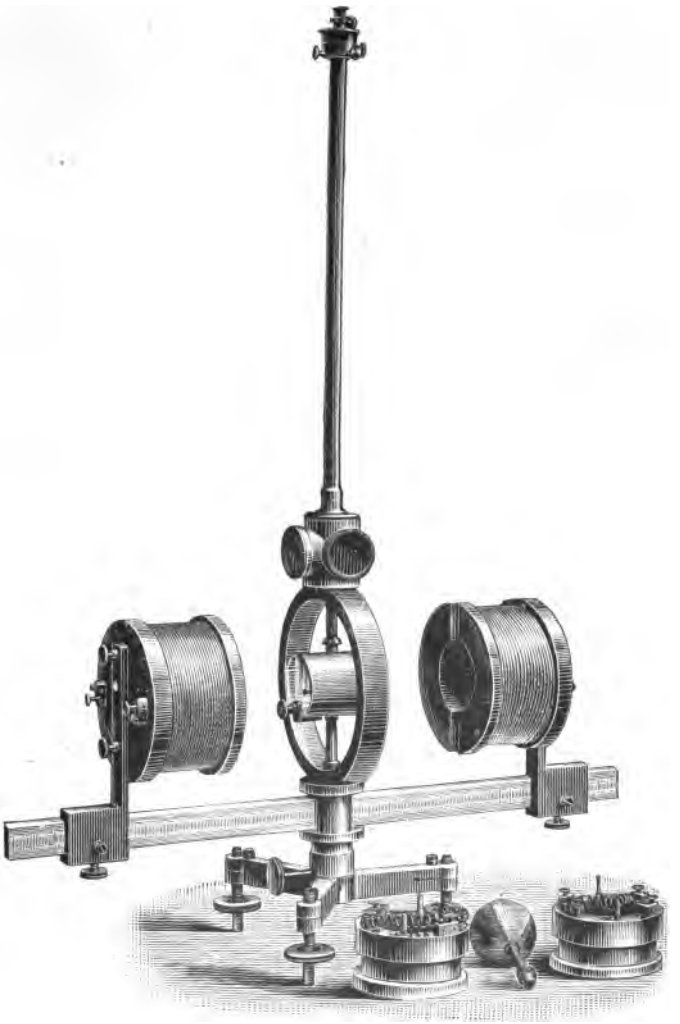


Fig. 7.

copper damper and adjustable damping plates. The coils may be joined up according to requirement.

Accessories:

2 coils of $4 \times 500 = 2000$ convolutions of thin wire,
2 „ „ $2 \times 250 = 500$ „ „ stout „

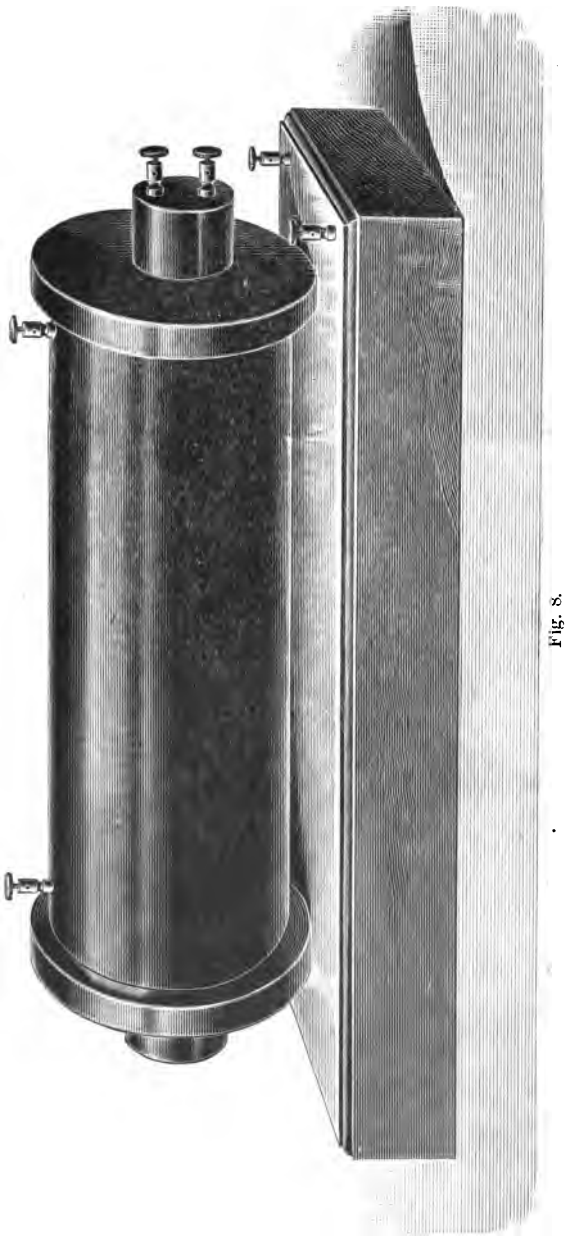


Fig. 8.

8. Ruhmkorff Induction Coil giving 500 millimeter sparks. (Fig. 8.)

The insulation in the secondary coil consists of a soft material which obviates the risk of destruction during transport. The length of the secondary wire is about 75000 meters. The apparatus is provided with a Foucault contact breaker and 2 spark electrode stands fitted with wire clamps for spectroscopic experiments.

9. Electromagnet for Diamagnetic and Paramagnetic Experiments. (Fig. 9)

Accessories:

Suspension apparatus for light paramagnetic and diamagnetic bodies, in glass box.

Apparatus for demonstrating the diamagnetism of flames.

Apparatus for demonstrating the damping effect of induction.

Polarimeter showing the rotation of the polarization plane.

Copper disc for Foucault's currents.

Apparatus for separating aureole and sparks.

10. Miniature Steam Engine and Boiler encased in a nut shell. (Fig. 10.)

The annexed figure is a full sized illustration of the engine. The model has been made in the workshops of the firm and forms

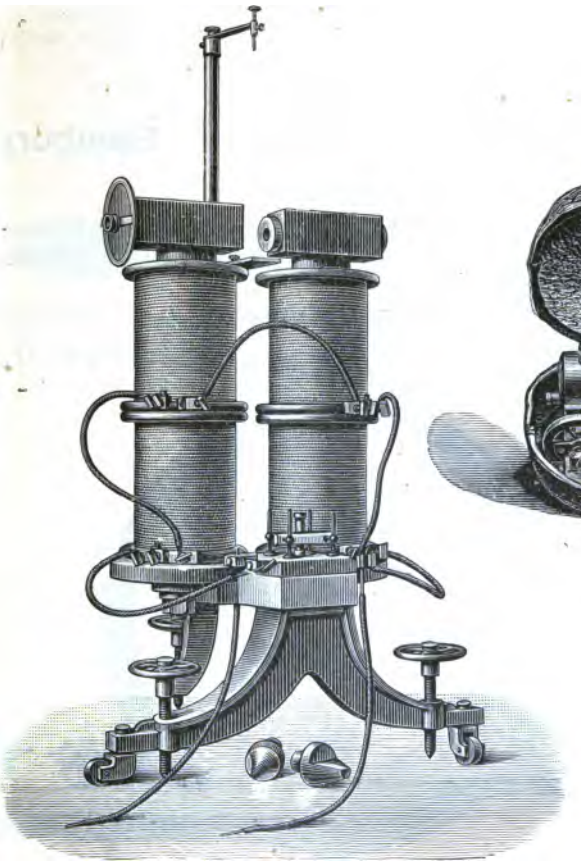


Fig. 9.

Fig. 10.

an interesting example of delicate skill. The following are the dimensions of the engine:

Length of cylinder	5.5	*mm*
Internal diameter of cylinder	2	„
Diameter of fly wheel	10	„
Width of fly wheel	1.5	„
Length of boiler	20	„
Diameter of boiler	8.5	„
Bore of steam inlet pipe	0.4	„
Length of slide valve	1.8	„
Width of slide valve	1.7	„
Length and width of steam ports respectively:	1.3 and 0.2	„

Yet this engine is fitted with safety valve, water inlet and outlet, Watt regulator and water gauge.

No. 2770.

A. Krüss (Principal Dr. Hugo Krüss). Hamburg.

7 Adolphsbrücke.

Optical Works.

Large Automatic Spectroscope with 6 Prisms; with dispersion of 32 degrees; **with fixed telescope. Original Construction.** (Fig. 1.)

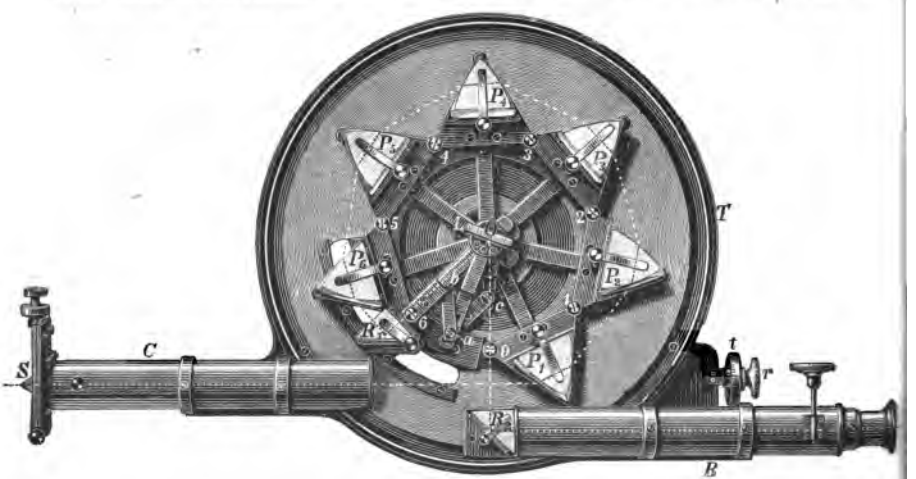


Fig. 1.

In spite of the movement of the prisms, which is necessary to obtain the minimum of deviation for the various rays of the spectrum, the dispersion between the red and violet rays being 32 degrees, the telescope remains fixed and, therefore, also the eye of the observer. This is attained by an ingenious mechanism, and the use of a central mirror. The spectrum may be made to traverse the field, either quickly by hand or slowly by means of a micrometer-screw, which also serves for measuring the distances between the spectrum lines.

Automatic Spectroscope with 6 Prisms, with dispersion of 32 degrees. **Original Construction.** (Fig. 2.)

The automatic adjustment of the prisms is effected by a new ingenious mechanism, which acts with greater ease and precision than those hitherto used. The vertical axis *a*, which is fixed in the center of the prism stage, bears six sliding and rotating rings, each of which is connected to one of the six prisms. The collimator *S* and the telescope *B* have reflecting prisms placed before

their objectives, both tubes being thus directed to the axis of the instrument. By means of the rod *s* the telescope may be connected with the mechanism

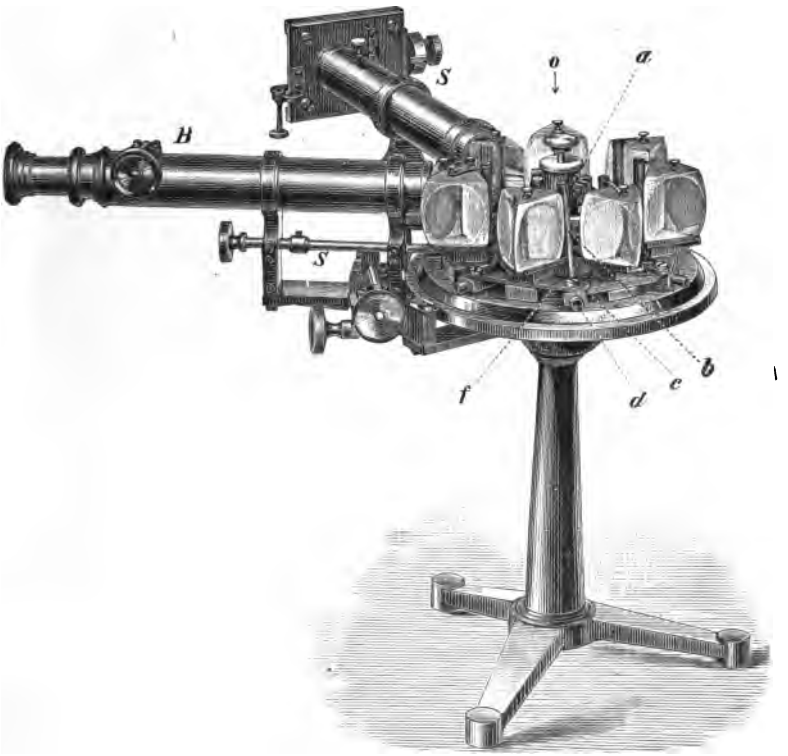


Fig. 2.

behind any of the prisms and thus any number of the latter may be put into action. The apparatus admits, therefore, of working with different dispersive powers.

Universal Spectroscope of Original Construction, for Spectrum Photometry, Qualitative and Quantitative Analysis. (Fig. 3.)

This universal spectroscope is most suitable for physical and chemical laboratories and can be applied for all purposes of physiological chemistry. For qualitative analysis it is fitted with scale tube and simple micrometer slit. With divided drum, platinum lips, comparison prism and lamp for illumination of scale. For quantitative analysis and photometry of the absorption spectra it is fitted with a micrometer double slit with two divided drums (one of these with vernier) and **Vierordt's** symmetrical ocular slit, absorption vessel with parallel sides and **Schulz's** glass body, stand with micrometer adjustment for the latter and lamp for observation.

The Universal Spectroscope is fitted with a flint glass prism of 60° and a triple **Rutherford** prism; these being interchangeable the apparatus may be worked with low or high dispersion.

The telescope is moved by means of a micrometer screw and the amount of movement is read off a divided drum; also the width of the ocular slit and the travel of the cross lines can be measured by means of a divided drum.

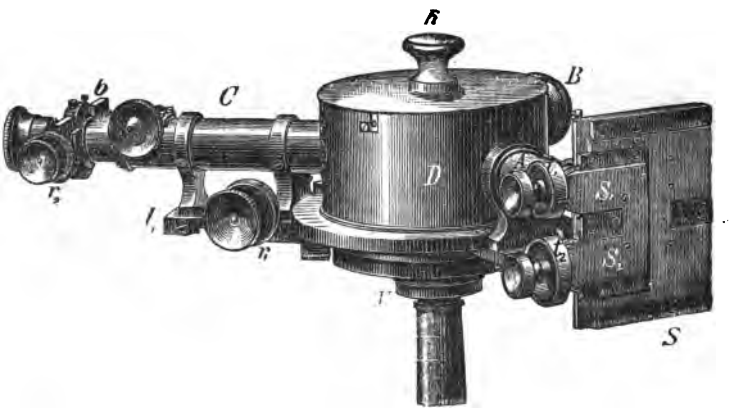


Fig. 3.

The slit, by a very simple arrangement, opens symmetrically with respect to the optical axis.

C. H. Wolff's Colorimeter. (Fig. 4.)

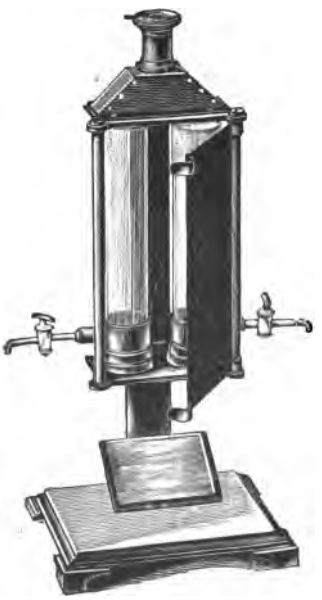


Fig. 4.

This instrument is intended for colorimetric determination of the concentration of coloured liquids by comparison with a standard solution. The light is, by means of a mirror placed below the measuring cylinders, reflected through the latter, and, by means of two reflecting prisms, the two pencils are made to illuminate the two halves of the field of a lens. From the darker liquid as much is allowed to flow off as is necessary to render both halves of the field equally bright. The respective concentrations of the liquids are than in the inverted ratio of the heights of the liquid columns.

This colorimeter may be used for all colorimetric tests in analytical chemistry, e. g. for determining the percentage of ammonia in water, for examination of nitrous acid, for selecting colours or salicilic acid, for quantitative determination of slight admixtures of copper, zinc, chlorine compounds etc.

Fig. 5.

Polarization Colorimeter. Original construction. (Fig. 5.)

A peculiar combination of polarizing prisms with a double quartz plate greatly increases the exactness which is attainable with the colorimeter as ordinarily constructed. For in this case not only the brightness but also the colour of the illuminated halves of the field have to be equalized.

Browning's Pocket-Spectroscope with triple prisms.

Browning's Pocket-Spectroscope, with quintuple prisms.

H. W. Vogel's Pocket-Spectroscope, with mirror arrangement for comparison-spectrum, and with tube holder.

H. W. Vogel's Pocket-Spectroscope, with universal stand, burner, bottles etc.; in case.

Lummer and Brodhun's Photometer. (Fig. 6.)

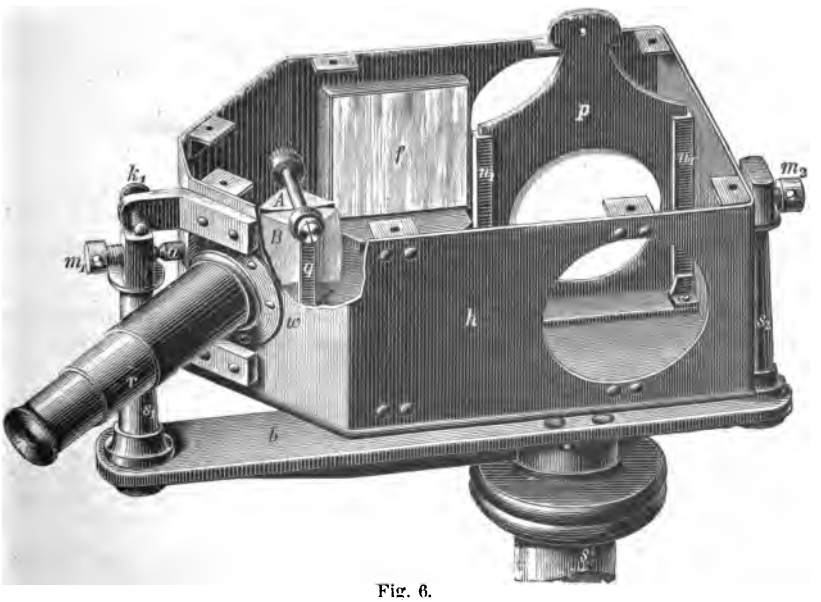


Fig. 6.

The Scale has a length of 3 meters (9′ 10″), it is divided in **half** centimeters. If desired also a scale of intensity measures may be added.

By the arrangement of **Lummer and Brodhun's** photometer the images of the two sides of the screen, which are perfectly similar, are reflected in such a manner that the image of one side appears as a disc completely encircled by the image of the other disc. These differences in the intensity are indicated by a distinct line; with equal intensities this line must disappear.

Bunsen's Photometer revolving on a divided circle, for measuring the intensities corresponding to different angles of emission.

Photometer Mirror with divided circle.

It is inclined at 45° to a horizontal axis and is intended for photometric evaluation of the intensities of light emitted in different directions by fixed lights.

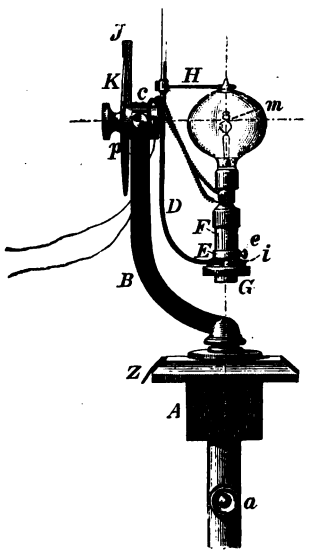


Fig. 7.

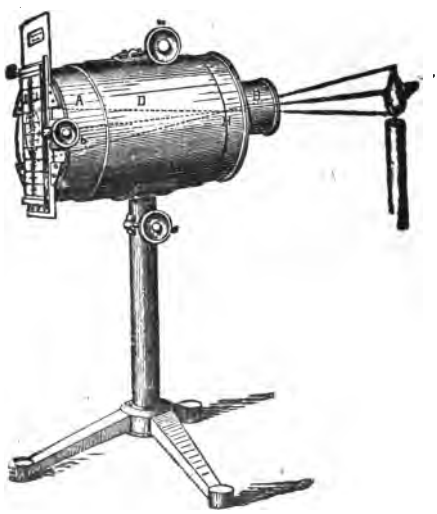


Fig. 8.

Photometric Stand for Incandescent Lamps. (Fig. 7.)

The incandescent lamp revolves on two axes at right angles to one another and its position may be read off.

Optical Flame Gauge. Original Construction, for accurately measuring the length of a flame of a candle or other light. (Fig. 8.)

(Hefner's) Amyl-acetate lamp with optical flame gauge.

Beside these instruments the following instruments made by this firm are being exhibited in other departments:

Spectroscope and **Colorimeter,** which will be found among the apparatus composing the *Hygienic Laboratory exhibited by the Hygienic Institute of the University of Berlin.*

Projection Apparatus and **Lantern Slides** forming part of the *Educational Appliances, exhibited by the Prussian Ministry of Public Instruction.*

No. 2772.

G. Lufft, Stuttgart (Germany).

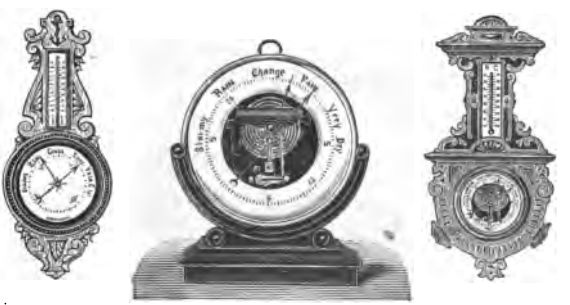
Metal Barometer Works.

Largest Establishment for the manufacture of Metal Barometers.

These works were founded in 1880 and are exclusively engaged in the manufacture of metal barometers, of which many thousands are exported annually to all parts of the world. The firm exercises its utmost endeavours in adapting the barometers with greatest possible exactness to each particular purpose. The exhibits are intended to show to what extent these endeavours have been attended by success; nearly all the different kinds of these barometers are represented in two groups.

Ornamental Barometers.

These are made in any size and style, for hanging and standing, in metal cases and wood frames, with and without thermometers, and form in these days a most important item in domestic decoration.



To satisfy all requirements they are made in all sizes varying from the smallest suspending barometers of $^3/_4$ *inch* diameter dial to large barometers of 3 *feet* diameter for public places, railway stations, shop windows etc.

The mechanism yields very large and exact indications.

Scientific Barometers.

These barometers are made in three sizes, viz. with dials of 45 *mm* ($1^3/_4$ *inch*), 80 *mm* (3 *inch*) and 130 *mm* (5 *inch*) diameter. The latter are fitted with fine leather sling cases.

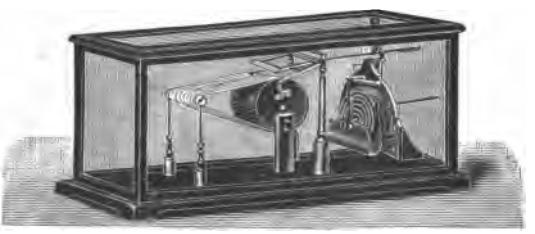
These instruments are made with the greatest care and accurately compensated, so as to render their indications independent of changes of temperature.

In order, however, that they may in this respect be tested at any time, each barometer is provided with a thermometer, which is fitted inside the casing upon the dial; the leather case also is fitted with a thermometer for determining the temperature of the external atmosphere surrounding the instrument.

The dials of these barometers are silvered and are, according to the purpose which the instrument is to serve, graduated in $^1/_2$, $^1/_1$ and $^2/_1$ *millimeter* or $^1/_{60}$, $^1/_{24}$ and $^1/_{12}$ *inch*: if desired they are also provided with so-called „orometric" divisions, i. e. divisions for directly reading altitudes of 1800 *m* (5300 *feet*), 2600 *m* (9000 *feet*), 5000 *m* (16500 *feet*) and 8500 *m* (28200 *feet*).

These instruments may in the simplest manner be used for surveying purposes, by engineers, explorers and aeronauts.

Self-registering Barometers,



which save meteorologists the time wasting trouble of having to read the barometric indications, so that he has to insert the prepared strip of paper into the instruments and to wind up the clock work once a week.

These instruments are compensated, extremely solid and made with great precision. They accurately mark the position of the barometer every 15 or 20 minutes within $^1/_{10}$ millimeter.

25 different kinds of

Watch Form Barometers

are made to supply the wants of tourists. They are made in a great variety of forms and prices.

The best proof of the excellence and popularity of these instruments is furnished by the increasing demand for them and the repeated extensions of the works thereby occasioned. To these proofs of excellence may be added numerous testimonials from universities, meteorological institutes, engineers and others.

The ornamental barometers are only supplied to dealers and export merchants; the scientific barometers are also sold, according to special price lists, to private users.

Each barometer is marked with the trade mark shown above.

No. 2773.

Jacob Merz, München,

31 Blumenstrasse.

Optical Works.

Description of the Exhibits:

1. **Equatorial** (Refractor) having an objective of 6 *inches* effective aperture and a focal length of $65^3/_4$ *inches*. Provided with a rotating finder having an aperture of 19 *lines* and 11 *inches* focus; fitted with erecting ocular; magnifying $8^1/_2$ times.

The instrument rests upon an iron tripod and is fitted with base screws and wheels. It is adapted for low and high positions; it can be levelled and has adjustable polar altitude of 0 to 60^0. Rectascension and declination circles divided on silver. The former divided in $^1/_1$ minutes and reading by verniers to 2 seconds. The latter divided in $^{15}/_1$ minutes and reading by verniers and lenses to 30 seconds.

The instrument is also provided with azimuth adjustment the circle being divided on brass in $^1/_2$ degrees.

The instrument is fitted with clock work (which may be corrected for stellar and solar time). It is supplied with 7 astronomical oculars (5 Huyghenian, 2 erecting) magnifying 26, 39, 88, 99, 132, 198, 330 times. The magnification is capable of increase beyond these figures. Cross line micrometer with fine measuring screw and position circle divided on silver in $^1/_4$ degrees, reading to minutes, with field and cross line illumination, supplied with 6 micrometer oculars magnifying 66 to 330 times. With the instrument are supplied a helioscope and an universal spectroscope.

The instrument being adjustable for either hemisphere and being very portable is adapted for scientific purposes.

2. **Equatorial** (Refractor) having an objective of 5 inches diameter and a focus of 70 *inches*; provided with a finder having an objective of $1^1/_3$ *inch* diameter and 11 *inches* focus, with erecting ocular, magnifying $8^1/_2$ times. The instrument rests upon an iron tripod fitted with levelling screws and wheels and is adapted for a high or low position and has also adjustable polar altitude of 0 to 60^0. Rectascension and declination circles with divisions on brass, the former reading to 10 minutes and reading by verniers 1 minute; the latter divided in $^1/_1$ degrees and reading by verniers to 5 minutes. The instrument is provided with all coarse and fine adjustments and also with azimuth adjustment without circle. The instrument is supplied with 1 terrestrial ocular, magnifying 80 times and 6 astronomical oculars (5 Huyghenian and 1 erecting ocular) magnifying 41, 93, 105, 140, 210, 350 times and capable of higher magnifications.

If desired the following may be added: Micrometer with double and single steel ring, helioscope and spectroscope.

3. The following **ten Objectives:**

1	objective	of	11	*inches*	effective	aperture	and	120	*inches*	focus.
1	„	„	$9^1/_2$	„	„	„	„	117	„	„
1	„	„	7	„	„	„	„	98	„	„
4	„	„	6	„	„	„	„	91, 83, 76, 66	„	„
3	„	„	5	„	„	„	„	64, 60, 59	„	„

Refractors and objectives of larger dimensions than those named are made in the most exact manner to order. Beside these the establishment produces various other optical instruments. It exports to all parts of the globe.

No. 2774.

Oscar Moeller in Hamburg,

73 Valentinskamp.

Steam Factory of Holosteric and New Patent Metallic Barometers.

Holosteric
and
New Patent Barometers.

New Patent Compensation
Plate Thermometers
(metal-index)
and
Contact-Thermometers.

Large manufacture
of
Surgical Instruments.

U. S. A. No. 459977.

German Empire No. 59774.

England No. 18300.

Silver Medal, Hamburg 1889.

France No. 213561.

Silver Medal, Melbourne 1880.

Highest Award.

Highest Award.

Telegraphic address:
Oscar Moeller, Hamburg.

Established
1877.

20000 Metall. Barometers and Thermometers manufactured annually.

Barometers at all prices, of any desired finish and style of framing from the very plainest up to the most elegant masterpieces of wood carving.

The **Patent Barometers,** manufactured exclusively by **Oscar Moeller,** are cheaper than any other type and, besides, excel in the following points:

1. Accurate working and great sensibility, the slightest variation of atmospheric pressure being **at once** rendered apparent, there being no dead movement to absorb it as is the case with complicated lever work;
2. absence of so called „back lash", which is inavoidable in a complicated mechanism;
3. but very little occasion for repairs, none of the parts being exposed to breakage; the instruments are thus capable of resisting shocks and falls and are, in particular, suitable for shipment abroad;
4. absence of back or forward movement of the index, which is a common feature with the more complicated instruments;
5. elegant appearance of the entire visible mechanism;
6. great lightness in weight effecting great saving of freight and postage.

Dials engraved in the following languages: German, English, French, Italian, Spanish, Portuguese, Dutch, Danish, Norwegian, Swedish, Bohemian, Polish, Croatian and Russian.

Sizes of Dials: 80, 95, 115, 130, 180, 260 *mm* diameter; sizes 95, 115, 130, 180, 260 *mm* diameter may also be had fitted with adjustable glass scales. Glass scale barometers are provided with silvered or finely enamelled insides.

Paper Dials, adjustable, are supplied gratis on application. Firms' names on paper dials supplied gratis; if on glass dials 40 Pf. each.

Price lists in German and English and Book of illustrations free of charge on application.

Patent Compensation Plate Thermometers (metal-index), in which, after the manner of barometers, the pointer indicates the temperature, in lieu of atmospheric pressure, on a graduated dial, are supplied mounted in all kinds of frames forming elegant ornaments and useful companions to barometers. They are also supplied in the form of contact thermometers adjusted to sound a bell so as to indicate rise or fall of temperature beyond certain given limits, e. g. the thermometer may at will be set to signal 10^0 as the lower limit of fall and 20^0 as the upper limit of rise of temperature.

The barometers manufactured by this firm are of the greatest sensibility and are warranted to indicate correctly. The exhibits include barometers of a great variety of prices and styles of frames from the plainest wood to artistic wood carving, also barometers with

coloured dials of paper and glass, nickel plated mechanism and silver plated or enamelled insides. Barometers in metal cases. New Patent Compensation Plate Thermometer (metal-index), by which readings of the temperature may be taken at a distance, a great advantage as compared with mercurial thermometers. Contact thermometers of similar construction with one or two indices which may be adjusted to sound a bell at any desired temperature. And a large Maximum and Minimum Compensation Plate Thermometer.

Particular attention is drawn to the Pocket Altitude Barometers.

The great cheapness of these instruments is mainly due to the employment of about 50 machines specially constructed for their manufacture.

No. 2776.

W. Niehls, Berlin N.,

160 Schönhauser-Allee.

Maker of Meteorological and Physical Instruments.

Glass Fusion Scale. Registered. For determining the degree of fusibility of different glasses: with directions for using, in case with test rods. Suitable for glass works, chemical and physical laboratories and for teaching purposes etc.

High Temperature Thermometers, Jena glass 59^{III}, indicating to 550^{0} C. Graduation burnt into glass by patent process. This process not only adds to the permanency of the colour of the division lines but also increases the durability of the thermometers.

Rod Thermometers with graduation burnt in or first etched and subsequently burnt in, by the above process.

Thermometers for clinical purposes. Mineral Oil Tester, according to the directions of the Imperial German Standard Assize Commission.

Breguet's Metallic Thermometer, for class demonstration.

No. 2777.

Albert Ott, Kempten, Bavaria.

Mathematical and Mechanical Instrument Works.

Established in 1873.

Awards: Melbourne 1880; Madrid 1883; Graz 1890; Brunswick 1881; Nuremberg 1882; Augsburgh 1886.

The whole of the exhibits have originated in these works.

1. 1 **Pantograph** (Fig. 1) with limbs 84 *cm* long of nickel-plated brass-tubing, adapted for reductions and enlargements of all ratios from 1 : 20 to 1 : 1. With lead pencil, puncturing pins and glass-marker with lens. Shown in the illustration with pole in the center; ratio 1 : 1. Set up with pole at end; ratio 1 : 2 or 2 : 1.

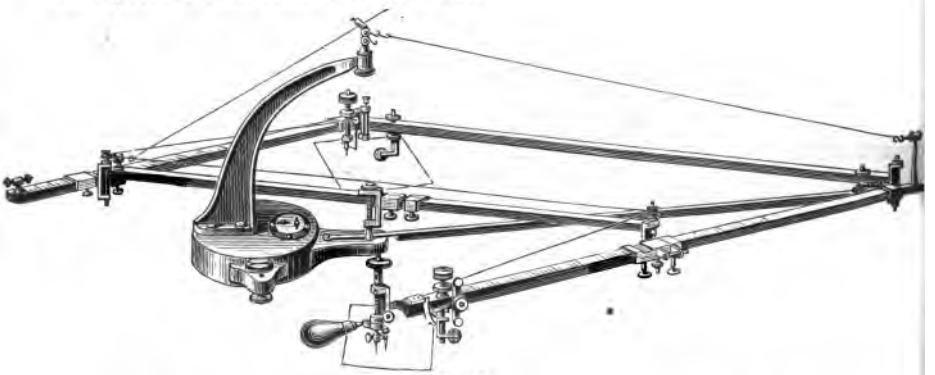


Fig. 1.

(In the German University Exhibition a similar pantograph will be found which has been set up with its pole in the center; ratio 1 : 1)

Of these pantographs, which excel in exactness and handiness, over 600 have been supplied to all parts of the world.

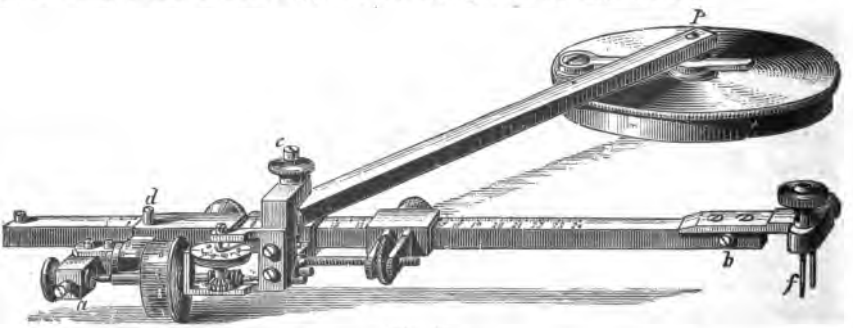


Fig. 2.

2. 1 **Planimeter,** arranged for a fixed ratio of 1 : 1000 (metric system) only.

3. 1 **Planimeter** (Fig. 2) with adjustable tracing-lever and needle-pole, with guide-ruler, adjustable for any measure or any ratio, also suitable for computing indicator-diagrams. The wheel has a circumference of exactly 66 *mm*; the tracing-pin and the pole-axis have at their ends points for fixing the basis of the diagram. Each division read off by vernier on the wheel represents 0,15 *m* (mean ordinate of the diagram).

4. 1 **Planimeter** with adjustable tracing-lever, suitable for all measures and ratios. With pole weight and controlling surface; with glass wheel.

With all these planimeters the wheel has for the last 10 years been supplied with the divisions marked on celluloid; the adjustable tracing-lever is provided with scale, vernier and pointer for adjusting the required ratio. The wheels are usually made of steel, only if specially desired they are made of glass. Over 1000 of these instruments have been supplied.

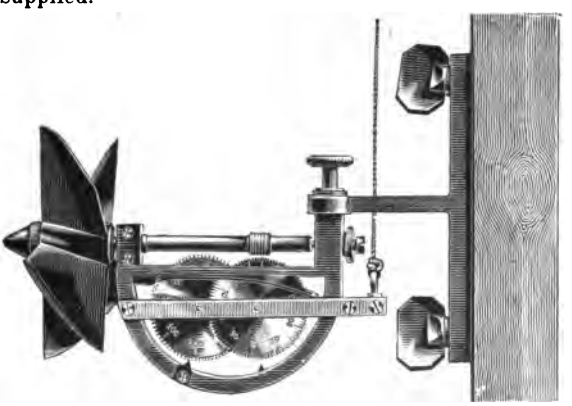


Fig. 3.

5. 1 **Current meter** (Fig. 3), smallest size, with counting wheels for 800 revolutions; attachable to a wood plank; dissectable; in pocket folding case; pitch of vanes 0,15 *m*.

6. **Current meter,** medium size, with counting wheels for 2000 semi-revolutions. The propeller spindle runs in agate bearings; the instrument is provided with mechanical releasing and fixing gear, with pulley and clamp for vertical movement along an iron slotted tube. Pitch of vanes 0,3 *m*.

7. **Current meter,** large size, with electrical transmission of the revolutions to bell and speed indicator may be raised and lowered along a fixed vertical rod; suitable also as a floating vane for showing rate of flow of surface-water. Pitch of vanes 0,50 and 1 *m*.

(The instruments Nos. 6 and 7 have been constructed according to the directions of Prof. A. R. Harlacher of Prague.)

8. 1 **Hanging Circumferenter** for geological and mining purposes, collapsible; in leather sling-case.

9. 1 **Compass Instrument** with telescope for measuring distances, level, azimuth and altitude circles reading to 1′; stand with adjustable legs.

10. A small **Theodolite** (Universal instrument) with brass „telescope“ stand; packing in small case.

11. 1 **Universal Levelling Instrument.**

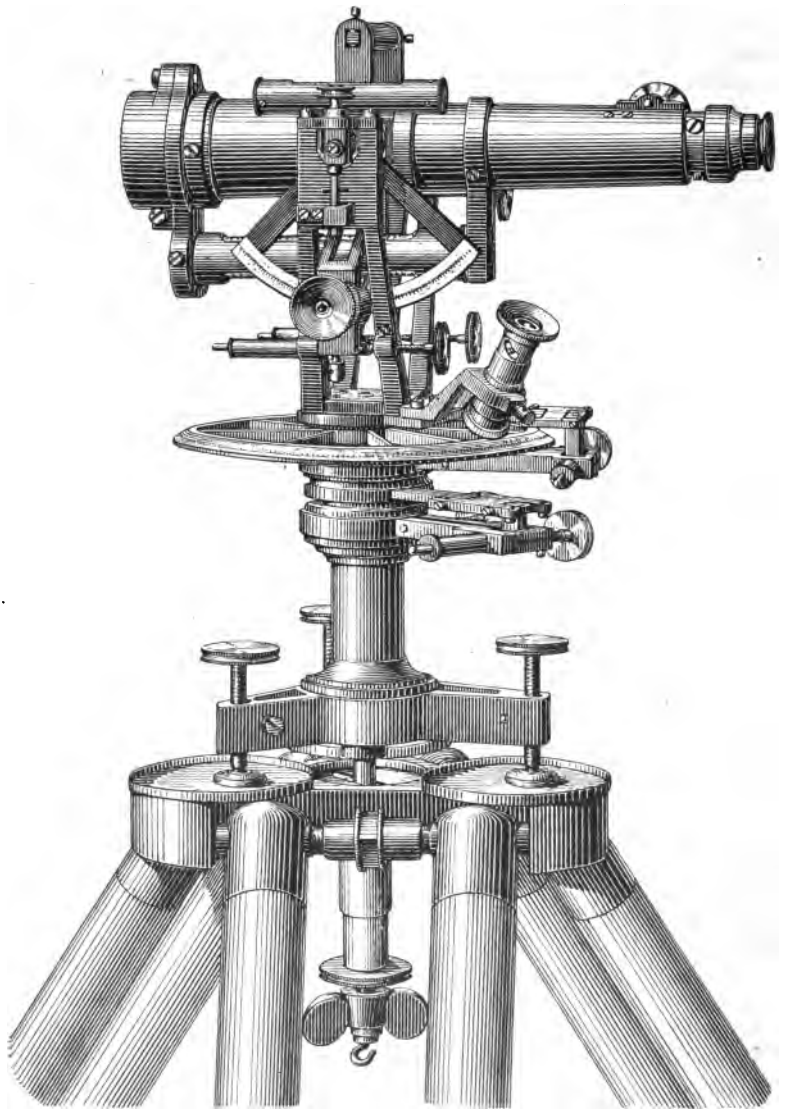


Fig. 4.

12. A **Theodolite (Tacheometer)** (Fig. 4), latest construction, **Patented in Germany** to the inventors, Messrs. **Tichy** and **Ott**; particulary suitable for accurate and speedy work in land-surveying.

The circles are divided on the 360 degrees system, but do not read to minutes and seconds, but to $\frac{1}{100}$ degrees. Distances are measured, by a new method, by means of a staff divided in logarithmic progression, which has to be set up strictly vertical, two supports and crossed levels being appended for this purpose.

By this method distances are measured much more exactly than is possible with other optical distance measuring instruments.

In order to find from the slanting distance the horizontal distance the altitude arc has, beside the ordinary graduation, logarithmic divisions. By subtracting the altitude reading from the height on the staff the reduced distance is directly obtained from ordinary tables of logarithms, and from this and the altitude the difference of elevation between the instrument and the stand-point of the staff can be found.

13. A **Theodolite** similar to No. 11, but with rotating azimuth and altitude circles, either reading by micrometer and lens, to $^1/_{1000}$ degree on the 360^0 circles.

A noticeable feature of the theodolites Nos. 11 and 12 is the form of the stands supplied with them and the manner of packing the instruments in the case.

14. A **logarithmic staff** for Nos. 11 and 12. These staves are made of lengths of 2.05, 2.55 and 3.05 meter for distances of 200, 250 and 300 meters respectively.

15. A **Surveyor's Drawing Board** with table, **Patented in Germany** to the inventors, Messrs. **Tichy** and **Ott**, for drawing with accuracy and despatch tacheometric measurements made with the theodolite. The angles may be drawn either to sexagesimal minutes or centesimals of the 360 degree or 400 grade system. The distances are marked by means of a puncturing-needle which slides along the divided ruler and the points are encircled by means of a rotating lead pencil.

(A detailed description of this apparatus will be found in the catalogue of the Exhibition of the German Universities.)

No. 2778.

A. Pessler, Freiberg (Saxony).

Mechanician.

Four levels, 275 mm long, with air-chamber and double row of numbers. The degree of sensibility (1—2 sec.) will be found marked at the side of each level.

Four reversible levels, one with air-chamber (5—8 sec).

The whole of these levels are made of the best hard-glass suitable for this purpose; they are filled with purest sulphuric aether and tested on an apparatus with **exact** screw.

Over 20000 ground levels (1—60 sec.) have been supplied.

Price-lists to be had of the Agent in the Collective Exhibition.

No. 2779.

Reiniger, Gebbert & Schall, Erlangen (Bavaria).

Manufacturers of Electro-therapeutical Appliances.

BRANCHES:

30 Ziegelstrasse, **Berlin.** | 43 Alserstrasse, **Vienna VIII.** | 55 Wigmore Street. **London W.**

Awarded 12 first and Commendations *Medals, Diplomas at various exhibitions.*

Established *in 1876.*

Represented at the Exhibition by the Electrical Engineer to the firm, Mr. Ottomar Carliczek, Chicago. (Mr. Carliczek's business and private address is notified at the Exhibition stand).

The works include: Mechanical fitting shops, screw turning, milling, joiner's polishing and nickel plating shops, with steam power supply.

Exhibits: 1. **A Stationary Apparatus for Galvano-Faradisation,** in elegant walnut case with glass cover and desk shaped top, with 40

Leclanché cells, **Barbier's** type, fitted with Patent Double Crank Commutator and Dr. **Brenner's** horizontal pole reverser with variable periodicity. Horizontal galvanometer with fibre suspension reading up to 5 milliampères, with two shunt circuits, Dr. **Ziemssen's** rheostat of nickelin wire up to 5000 ohms; Prof. **Du Bois-Reymond's** Induction apparatus with **Meyer's** adjustable current breaker, switch for induction battery of 4 cells, commutator for primary and secondary current, with accessories.

2. **A Leclanché Medical Battery** with stopper connections, consisting of 24 hermetically sealed cells, in oak box with leather handle (simplest design).

3. **A Leclanché Medical Battery,** consisting of 30 hermetically sealed cells, simple crank commutator and pole reverser, in oak box.

4. **A Leclanché Double Apparatus,** consisting of 24 hermetically sealed cells, **simple crank commutator,** pole reverser and **Spamer's** induction apparatus in oak box.

5. **A Leclanché Battery,** consisting of 30 hermetically sealed cells, simple crank commutator, pole reverser and horizontal galvanometer with pivoted needle, Watteville, **Du Bois-Reymond's** sliding induction apparatus with adjustable current breaker, in oak box.

6. **A Leclanché Double Apparatus** consisting of 40 hermetically sealed cells (Model B), **Patent double collector,** pole reverser, horizontal galvanometer with pivoted needle, Watteville, **Du Bois-Reymond's** sliding induction apparatus with adjustable interrupter, in oak box.

7. **A Chromic Acid Battery** of 24 cells, Patent double collector, commutator, vertical galvanometer and arrangement for raising and lowering the carbons and zinks: in polished mahogany box.

8. **An induction apparatus** on polished wood base.

9. **An induction apparatus** on polished walnut base, with switch for 1 or 2 cells.

10. **2 Induction coils** in polished walnut case, 2 dry cells, nickel plated.

11. **2 Spamer induction coils,** simple form in polished mahogany case, nickel plated.

12. **2 Spamer's Original Induction Coils,** nickel plated in mahogany and walnut case respectively.

13. **1 Grenet Induction Apparatus,** nickel plated, in polished mahogany case.

14. **1 Taube's Induction Apparatus,** nickel plated, with interchangeable secondary coil, in polished case.

15. **1 Du Bois-Reymond's Sliding Induction Apparatus,** with simple current breaker.

16. **1 Du Bois-Reymond's Sliding Induction Apparatus,** with **Meyer's** adjustable current breaker.

17. **1 Wimshurst Induction Electrical Machine,** with 4 rotating discs of 52 centimeter diameter.

18. Various **electrodes** for Franklinisation.

19. 1 **Portable Battery for Galvanic cautery and electric lighting** of 4 cells, crank switch for parallel and series coupling and rheostat.

20. 1 Portable battery for galvanic cautery and electric lighting of 6 cells, commutator and rheostat.

21. 1 **Portable Accumulator of 4 cells, commutator for cautery and lighting and 2 rheostats.**

22. 1 **Schech's** Galvanic Cautery case, small size.

23. 1 **Schech's** Galvanic Cautery case.

24. 1 Plate showing Galvanic Cautery Instruments.

25. 1 Electrical Laryngoscope.

26. 1 Electrical Aluminium Lamp with head band.

27. 1 Dental Mouth Illuminator.

28. 1 Electrical Tongue forceps.

29. 1 Electrical Vaginoscope.

30. 5 different Conducting Cords for cautery and lighting.

31. 1 set of Rheophores for galvanisation, faradisation and electrolysis.

32. 1 **Patent Graphite Rheostat in form of an electrode holder.**

33. 1 **Patent Graphite Rheostat in wood frame.**

34. 1 Patent Graphite Rheostat in wood frame with rack and pinion movement for the contact slides.

35. 2 Patent Graphite Rheostats with 2 ledges.

36. 1 Patent Graphite Rheostat with 3 ledges.

37. 1 Crank Rheostat with nickelin wire resistance coils, up to 500 ohms, in 60 grades.

38. 1 Crank Rheostat with nickelin wire resistance coils, up to 5000 ohms, 27 grades.

39. 2 Portable horizontal galvanometers with pivoted needle, reading from 0.1 to 50 milliampères.

40. 2 **Portable horizontal galvanometers with fibre suspension, reading from 0.1 to 500 milliampères.**

41. 2 **Mueller and Edelmann's** Horizontal Galvanometers with fibre suspension and scale reading at a great distance, large and small size, reading from 1 to 500 ampères.

42. 1 Alternating Current Transformer on switch board for cautery and lighting.

43. 1 Stationary Switch Board for cautery and lighting, with water cooler.

44. 1 **Stationary Switch Board for galvanic faradisation,** consisting of oak frame, fitted with large **Mueller** and **Edelmann** horizontal galvanometer with scale reading at a great distance, 2 crank rheostats for resistances up to 1000 and 5000 ohms respectively in 60 grades, graphite rheostat with 4 ledges, pole reverser, Watteville, Du Bois-Reymond's Sliding induction apparatus with adjustable Meyer's interrupter, controlling lamp and 2 instantaneous switches.

No. 2780.

Clemens Riefler, München and Nesselwang.

(Bavaria.)

Manufactory of Mathematical Instruments.

This firm is exhibiting:

1. In two show cases:

   Drawing and Measuring Instruments, in particular original drawing **instruments** *(German Patent No. 2907.)*

2. In a third case:

   a.) An **absolutely Free Pendulum Escapement with impelling action in the axis of oscillation** *(German Patent No. 50739).*

   b.) A **Mercurial Compensation Pendulum** *(German Patent No. 60059; U. S. Patent applied for).*

3. In a fourth case:

   An **Astronomical Clock** fitted with the escapement and pendulum 2a.

I.

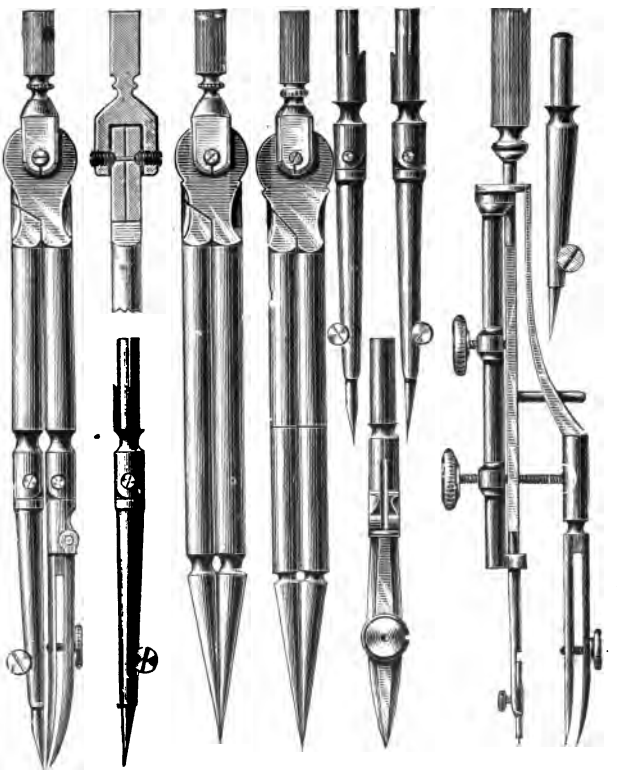
The drawing instruments, which form a speciality of the firm, are of the construction shown in the illustrations and are well known in the technical world as **„Riefler's Round System Compasses"**. The popularity which they have attained is a sufficient proof of their excellence of construction and workmanship, which is secured by a number of special machines fitted with the latest improvements. **It will be well to here mention that poor imitations of these instruments are placed upon the market; to prevent these being confounded with the Riefler instruments each of the latter has the name of „Riefler" stamped upon its head.**

Detailed descriptions of these instruments and specifications of their advantages over the older types written by autorities may be found in the following publications:

Bayer. Industrie and Gewerbeblatt, No. 6, 1886. Dingler's Polytechn. Journ. Vol. 241, No. 4. Der prakt. Maschinenconstructeur, No. 328. Wochenschr. des Vereins deutsch. Ingenieure, 1878 No. 22; 1881 No. 16. Leipzig. Illustr. Zeitung No. 1987. L'Industrie moderne 1889, No. 10. Revue industriale, 1889. Railway Review, vol. XXVIII No. 15. The Tradesman, vol. XIX, No. 4. The Builder and Decorator, vol. III No. 1. The Philadelphia Carpet Trade, vol. 6, No. 2. Building, vol.

VIII, No. 26. The American Stationer, vol. XXIII, No. 7. The Australasian Ironmonger, vol. XXIII, No. 1. Etc. etc.

The following may be mentioned among the numerous other drawing instruments exhibited by the firm:



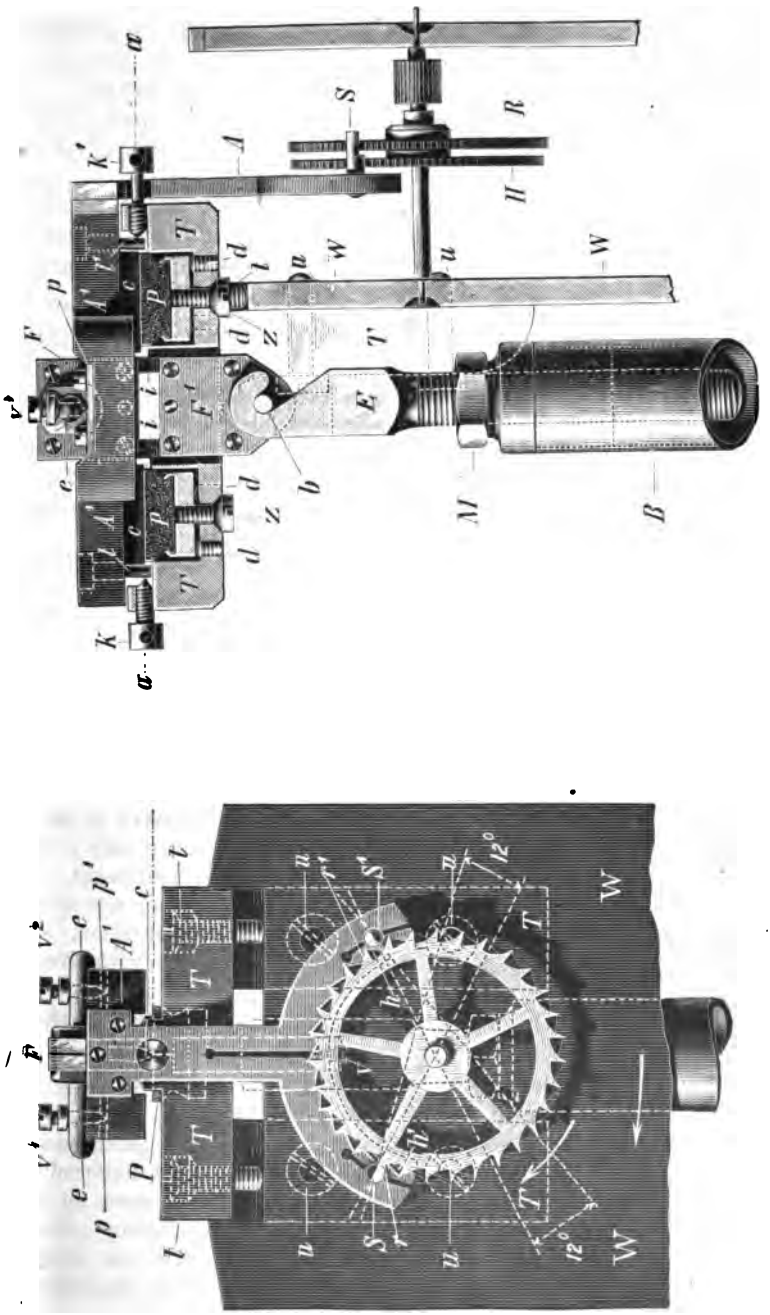
Riefler's Round System Compasses.

Beam compasses, reducing compasses, bisector, trisector, harmonic divider, angle trisector, protractors of various sizes, with and without verniers, measures, cross ruling appliances etc.

II.

The uniformity of movement of our pendulum chronometers depends mainly upon two conditions, viz. upon the accuracy of the escapement and the completeness of the compensation of the pendulum.

In both respects Mr. **Sigmund Riefler,** engineer and partner in the firm, has after many years of experimenting succeeded in constructing pendulums which, according to the practical results recorded at the *Munic Royal Observatory* and elsewhere, **constitute a decided progress in chronometry.**

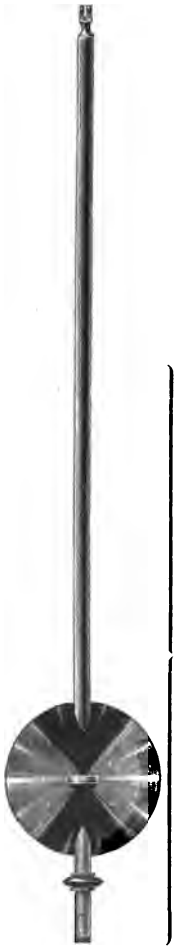


Riefler's absolutely free Pendulum-Escapement D. R.-P. No. 50739.

The essentiality of the escapement of this entirely new chronometric system, which has also been applied to watches and tower clocks, consists in the manner in which the pendulum, **which is absolutely free,** is impelled. This is not effected, as is usually the case, by the fork (this is entirely absent), **but by the pendulum spring.** The latter is, by the action of the wheel work, **slightly deflected,** the center of the deflection coinciding with the axis of oscillation of the pendulum.

The impulse is, moreover, given nearly at the moment, in which the pendulum passes the position of rest and the supplementary arc of the pendulum is 3 or 4 times as large as the arc of elevation; besides, the number of moving parts is less than with any other escapement.

The advantages resulting from the whole arrangement are these: Changes in the magnitude of the transmitted force and the resistance of the pallet action have no practical influence upon the uniformity of the movement, and the chronometer is in a high degree insensible to extraneous disturbances.



Riefler's Mercurial Compensation-Pendulum.

The **Mercurial Compensating Pendulum,** shown in the annexed figure, has also been devised by Mr. **S. Riefler.** Its main body consists of a heavy metal disc of such a lenticular form as to freely cut through the air. A Mannesmann steel tube of 16 *mm* bore and 1 *mm* thickness constitutes the pendulum rod. Nearly two thirds of the tube are filled with mercury. In consequence of this distribution of a small quantity of mercury over a great length, inequalities of the temperatures of the upper and lower layers of air and also sudden changes of temperature have only a slight influence upon the pendulum and the movement.

Unlike all other pendulums, it does not necessitate a subsequent correction of compensation, as in this case the latter can be calculated with greatest possible precision.

Every pendulum made by this firm is, therefore, warranted to have in no case an error of compensation exceeding $\pm$ 0,005 seconds per diem and per $\pm$ 1 ^{0} C.

The principal advantage of this system, i. e. the escapement in conjunction with the pendulum, consists in the increased uniformity of the movement thereby obtained and in that the latter does no more depend upon fortuitous circumstances but admits of strict computation.

With the astronomical clocks supplied by the firm the warranted degree of accuracy is 1 **second per week,** and with chronometers intended for use as standard clocks for private establishments or for

central regulating systems the warranted accuracy is **2 seconds per week.**

In the case of **Riefler's** No. 1 astronomical chronometer fitted up at the Munic observatory the coefficient of compensation of the pendulum for 1° C. is 0,0008 second per diem and the mean error of the movement is 1 second per month.

Detailed descriptions and recorded results may be had on application.

III.

The firm was established in 1841 and possesses 4 establishments worked by 2 turbines and 2 water wheels of an aggregate power of 40 HP.

The manufacture exceeds per annum 30000 compasses and 60000 other instruments. Export extends over all civilized countries. The commencement of export to the United States dates 35 years back.

The firm received first prizes at 10 International and 11 National exhibitions (1892 highest award at Paris, viz. the *Diplome d'honneur*).

Agent of the firm in the U. S.: Messrs **F. Weber & Co.,** 1125 **Chestnut Str., Philadelphia.**

No. 2782.

F. W. Schieck, Berlin SW.

14 Halle'sche Strasse.

Optical Works.

Microscope Works, established in 1819 by the father of the present head of the firm.

15 Gold and other Medals.

Exhibits:

1. **New large Microscope** with **specially large field** of 60 to 90 *cm* apparent diameter; so-called Entomological Microscope. It permits, with magnifications of 300—500, of small insects being viewed in their **entirety.**

2. **New Revolving Trichinoscope** with mechanical stage; with circular object-slides, which may be rotated by means of an endless screw. This microscope has been specially constructed for the examination of meat.

3. A **collection** of **Student's School and Pocket Microscopes.**

4. Microscopical **Preparations and Accessories.**

No. 2783.

George Schmidt & v. d. Eltz, Schmiedefeld.

(Thuringia.)

Wholesale Manufacturers

of Standard Thermometers and Hydrometers.

All kinds of **Chemical** and **Scientific Glass Instruments** and **Apparatus.**

Specialities: Thermometers and Hydrometers of all kinds, Graduated Glass Instruments, **blow pipe made Glass Apparatus,** Geissler's **Vacuum Tubes, Radiometers** etc.; etc.

No. 2784.

Franz Schmidt & Haensch in Berlin S.

4 Stallschreiberstrasse.

Mechanical and Optical Works.

All the instruments produced by this firm are made under personal supervision by thoroughly trained and skilled workmen. The firm is thus prepared to supply the best and to realize the highest requirements. Beside the current manufacture of microscopical, polarizing, spectroscopic, photometric and photo-spectroscopic apparatus the firm is engaged in the production of the finest instruments for scientific investigation. Many of the latter have been made for inland and foreign institutes. Among the scientists to whom instruments of this class have been supplied may be named:

Prof. **Cox** of Montreal, Prof. **Dobrowolski** of St. Petersburgh, His Excellency, Prof. **v. Helmholtz** of Berlin, President of the Imperial Physical and Technical Institute, Prof. **Hering** of Prague, Prof. **Holmgren** of Upsala, Prof. **Arthur Koenig** of Berlin, Prof. **Kundt** of Berlin, Prof. **Landolt** of Berlin, Prof. **V. von Lang** of Vienna, Prof. **Lippich** of Prague, Prof. **J. H. Long** of Chicago, Prof. **Nasini** of Padua, Prof. **Soret** of Geneva, Prof. **H. C. Vogel** of Potsdam, Prof. **H. W. Vogel** of Charlottenburg, Prof. **Leonhard Weber** of Kiel, Prof. **Wiley** of Washington, Mr. **Lewis Wright** of London.

In the following paragraphs a short description will be given of the current apparatus made in this establishment. The greater part of these instruments will be found represented by the exhibits forming part of *Group 21* of the *Collective Exhibition* of the *„Deutsche Gesellschaft für Mechanik und Optik“*. Other instruments made by the same firm are shown among the *German Educational Exhibits* of the *Prussian Ministry of Public Instruction.*

A. Spectroscopic Appliances.

I. Spectrum apparatus with deflected path of rays;
II. Spectrum apparatus with rectilinear path of rays;
III. Spectrum apparatus for astronomical purposes;
IV. Spectrometers of various types;
V. Spectrum apparatus for special scientific and technical purposes;
VI. Apparatus for demonstrating spectrum phenomena;
VII. Auxiliary appliances.

I. Spectrum Apparatus with deflected path of rays.

a. Small Spectrum Apparatus.

Mounted upon a cast iron tripod stand, with column and dish-shaped stage plate fitted with 3 telescopes (viz. observing, slit and scale te-

lescopes). The slit telescope, which is fitted with a comparison prism, and the scale telescope are fixed upon the stage plate; the observing telescope is made to revolve about its vertical axis. (Fig. 1.)

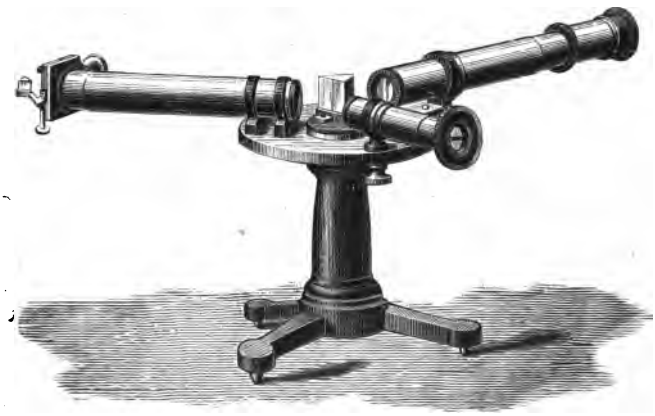


Fig. 1.

b. Medium Size Spectrum Apparatus.

Mounted upon cast iron tripod stand with brass column and closed prism casing, fitted with 3 telescopes as above. The slit and scale telescope are rigidly attached to the prism casing and the observation telescope is connected with the latter in such a manner that it may be

Fig. 2.

adjusted by rack and pinion coarse and micrometer fine adjustment; any portion of the spectrum may thus be brought into the center of the field. The scale telescope is provided with illuminating flame and the slit telescope is fitted with a comparison prism. The height of the prism is 35 *mm;* the telescope magnifies 10 times. (Fig. 2.)

c. Large Spectrum Apparatus.

Mounted upon cast iron tripod stand having a conical brass pillar surmounted by a large dish-shaped plate upon which the scale and the scale telescope are rigidly fixed. The observation telescope is made to revolve about the vertical axis of the instrument. The heavy flint glass prism is 45 *mm* high and is encased in a large black brass hood with detachable cover. The telescope magnifies 10 times, or more if desired.

d. Large Spectrum Apparatus.

Built after the original of **Kirchhoff** and **Bunsen**, mounted upon a large iron tripod having a stout column surmounted by a large iron stage plate, with 4 flint glass prisms of 500 *mm* height and 4 telescopes (slit, scale, observing and reading telescopes). The objectives of the slit and observing telescopes have a focus of 470 *mm* and an aperture

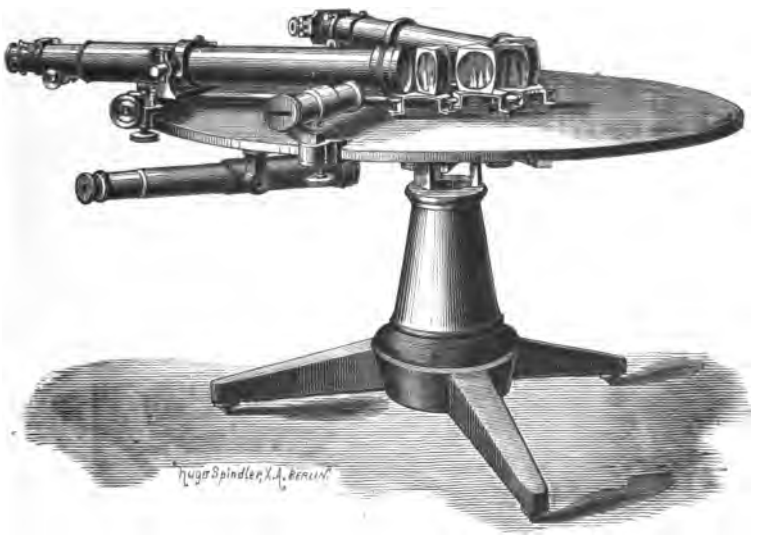


Fig. 3.

of 45 *mm*; the magnification of the latter is 40 and 60. To the observing telescope, which is attached to the stage plate, is connected a plane mirror placed below the stage plate, and by means of a separate reading telescope any position of the observing telescope with respect to large wall diagrams may be read off. (Fig. 3.)

e. Large Spectrum Apparatus with automatic connection of prisms.

Mounted upon cast iron tripod fitted with levelling screws, fixed circle and movable alhidada, Rutherford prisms of 4 *cm* height with automatic connection; dispersion between A and H 44°. The automatic movement is so arranged that 1, 2, 3 or 4 prisms may be brought into play.

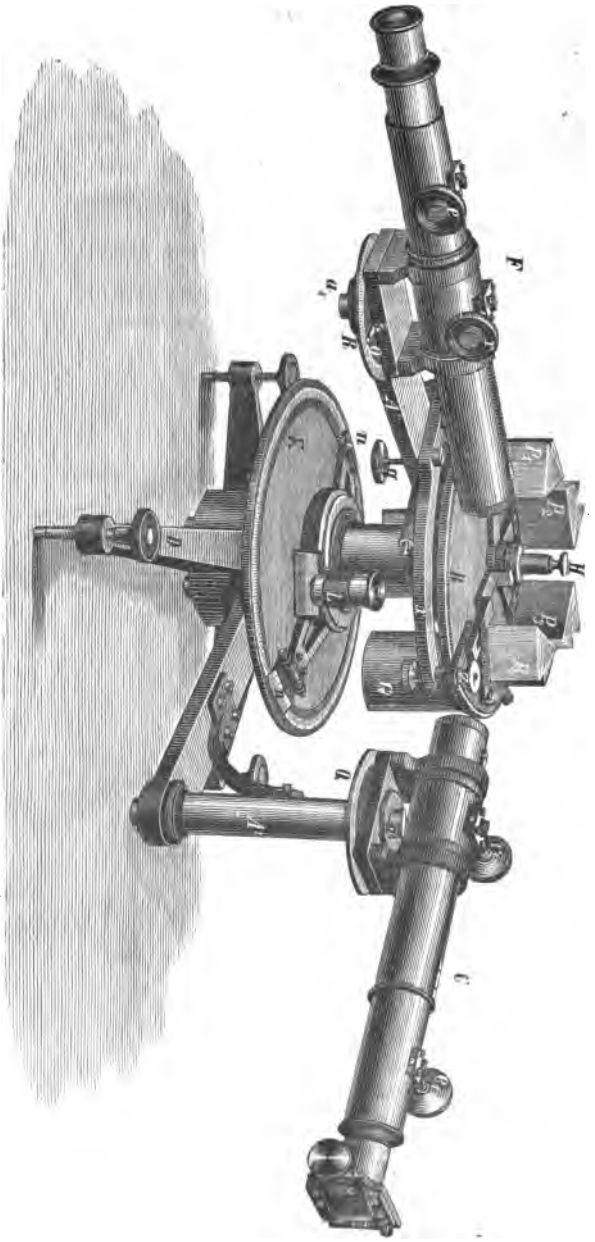


Fig. 4.

The two telescopes have objectives of 350 *mm* focus and 43 *mm* aperture. The magnification of the observing telescope is 30. Divided circle reading to 10 seconds. (Fig. 4.)

II. Spectrum Apparatus with rectilinear path of rays.

The adjustments are made in the manner specified under I. Beside the well-known small Browning pocket spectroscope the following types are made:

a) **Browning's Pocket Spectroscope** with 3 prisms, movable slit and reflecting prism for examining two spectra. (Fig. 5a.)

b) **Spectrum Apparatus according to H. W. Vogel with universal stand.** (Fig. 5a, b, c.) The apparatus is fitted in elegant case with all its accessories, such as bottles, bottle holders, mirror, burners etc. and dissectable stand. Respecting its applicability to many purposes we

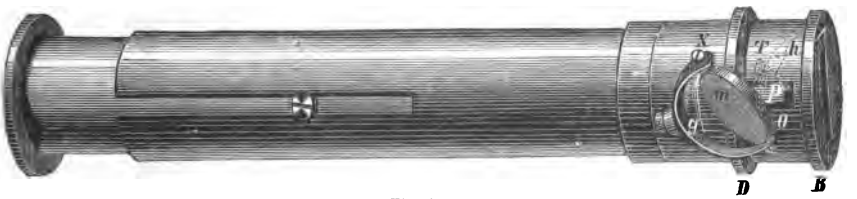


Fig. 5a.

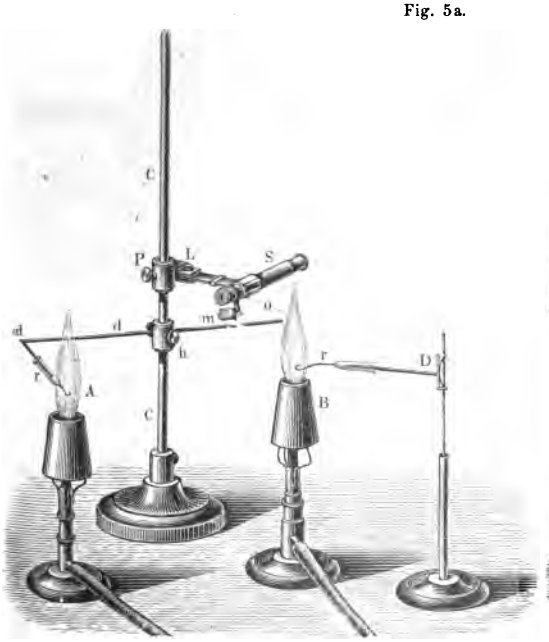


Fig. 5b.

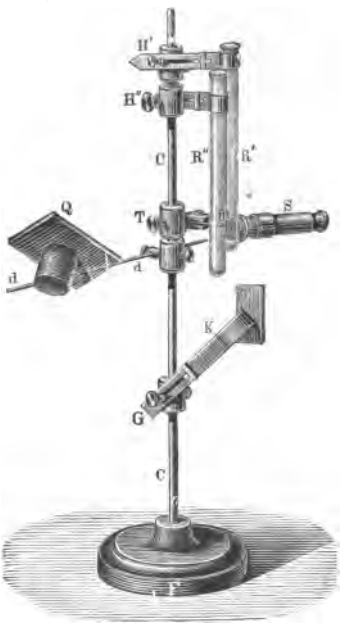


Fig. 5c.

refer to the *„Berichte der Deutsch. Chem. Gesellschaft, 1875 and 1876"*. — If required these instruments are also fitted with scale —.

c) **Hoffmann**'s Spectrum Apparatus. This is made in various sizes, also in pocket form. The apparatus shown in the *German Educational Exhibition* is fitted with scale and comparison prism. The Jansen body consists of two parts whose relative position is adjustable. The Fraunhofer lines remain in all positions at minimum deviation.

III. Spectrum Apparatus for Astronomical Purposes.

a) **Zoellner's Astro-Spectrograph with 2 cylindrical lenses.** Dispersion between D and G : 3^0.

b) **H. C. Vogel's rectilinear path Astro - Spectrograph.** (Fig. 6a und 6b.)

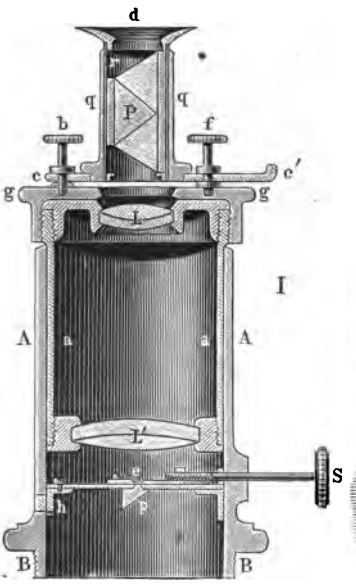


Fig. 6a.

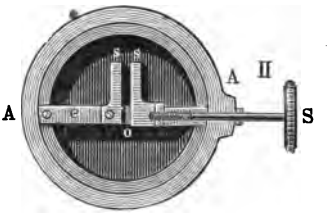


Fig. 6b.

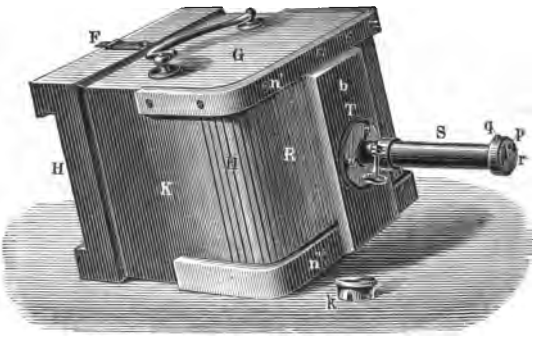


Fig. 8.

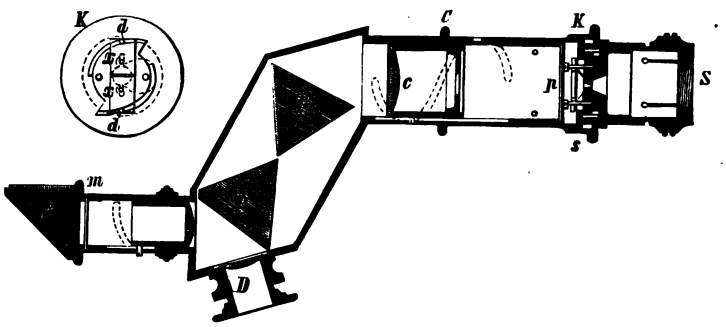


Fig. 7.

c) **H. C. Vogel's Deflected path Astro-Spectrograph.** 2 prisms with scale. (Fig. 7.)

d) **Spectro-Photometer, own construction,** according to suggestions of **H. C. Vogel.**

e) **H. W. Vogel's Small Spectrograph.** (Fig. 8.)

f) **H. W. Vogel's Large Spectrograph** mounted upon a

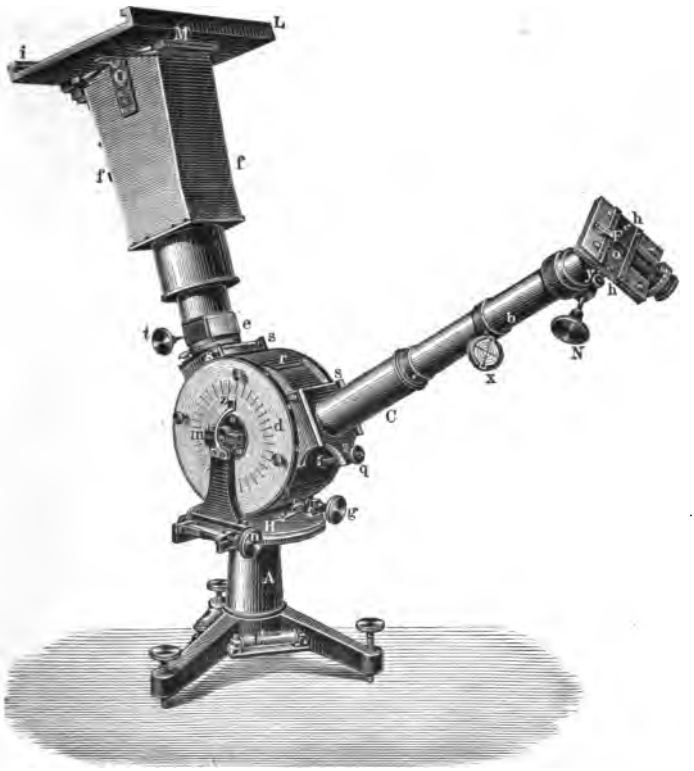


Fig. 9.

standard, with 2 Rutherford prisms of 45 *mm* height and bilateral slit; prisms and telescope automatically connected. (Fig. 9.)

IV. Spectrometers according to Victor von Lang.

These instruments are mounted upon a tripod stand fitted with elevation screws. The tripod supports a gun metal pillar into the bore of which fits a steel center to which is attached the steel circle.

a) **Small size.** Magnification of telescopes 8. The collimator is fitted with micrometer slit and reflecting prism. The positive ocular of the observing telescope may be replaced by a Gauss ocular. The circle is divided in $^1/_2$ degrees and reads by two verniers to minutes.

b) **Medium size.** Magnification of telescopes 10. Telescope and collimator tube in fixed adjustable bearings. The diameter of the divided circle is 170 *mm*. It is divided in $^1/_3$ degrees on German silver, reading to 30 seconds by the two verniers.

c) **Large size.** Magnification of the telescopes 10 or more. Slit with reflecting prism. The circle of 170 *mm* diameter is divided in $^1/_6$ degrees on silver, reads to 10 seconds and is protected from dust by a brass hood.

These sizes are, on account of their stability, specially adapted for automatic connections with several prisms, also for equipment with polarizing apparatus and Babinet's compensator, crystal movement and so forth. The usual collimator may be easily replaced by Kundt's collimator, which is specially adapted for photometric purposes; the latter is fitted with micrometer screw and bilateral slit with helioscopic objective. The latter can be gradually closed by segments.

V. Spectrum Apparatus, for special scientific and technical purposes.

a) **Spectrum-Photometer according to von Vierordt** for photometry or qualitative and quantitative chemical spectrum analysis, with 2 telescopes; the observing telescope is fitted with rack and pinion and ocular slit, the collimator tube with double slit, divided drum and reflecting prism. Large and small model.

b) **Spectrum-Photometer according to Glan** with reversion of the Nicol prism.

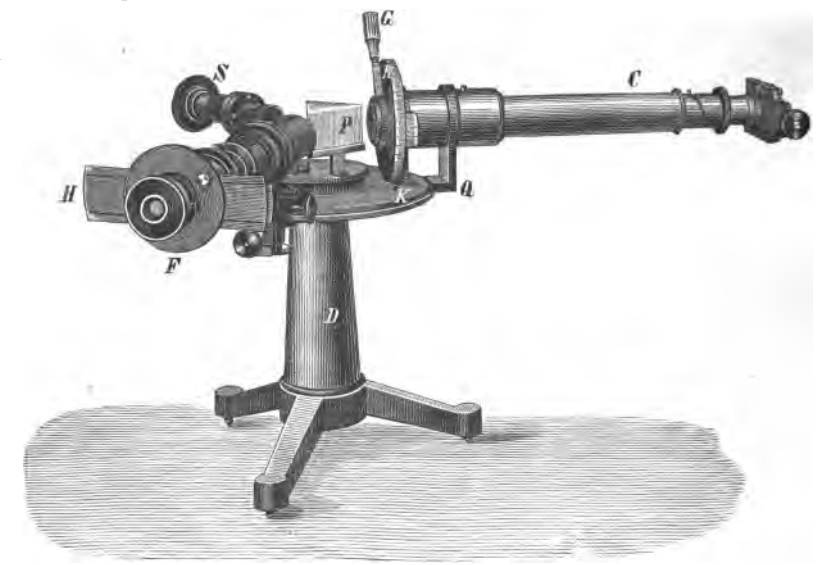


Fig. 10.

One of the most popular apparatus. (Fig. 10.) (For particulars vid. *Poggendorf's Ann., 1877. — Vogel, „Das Spektroskop.")*

c) **Spectrum-Photometer according to A. Koenig.**

d) **Ophthalmo-Spectroscope,** simple and composite, for testing colour blindness, according to von Vierordt's and Holmgren's suggestions.

e) **Spectro-Photometer** made according to Lummer and Brodhun for the *Imperial Physical and Technical Institute.*

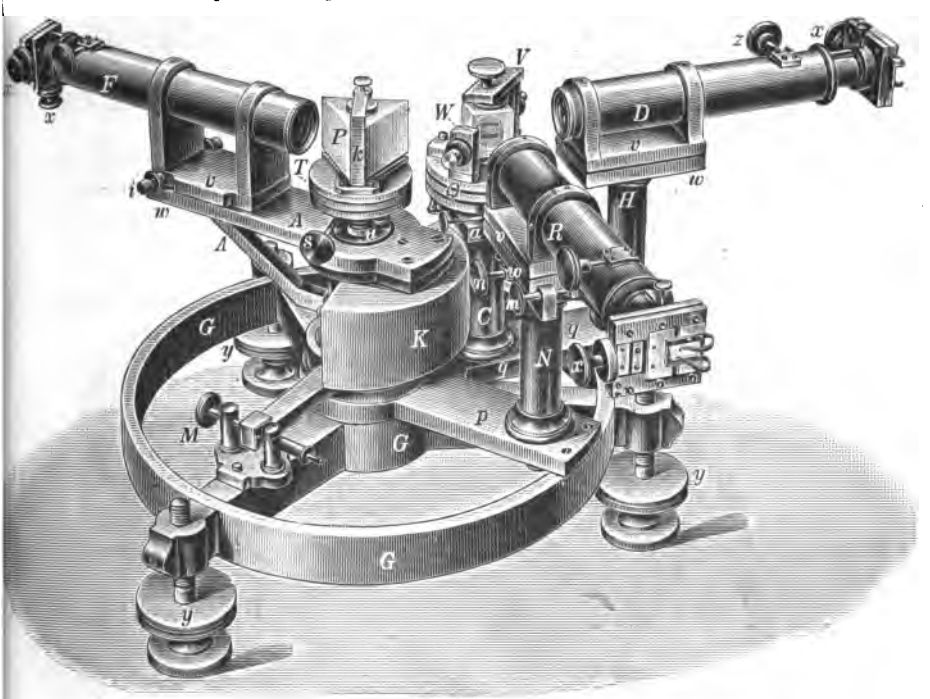


Fig. 11.

The apparatus is fitted with 2 collimators placed at right angles to one another, provided with bilateral slits and micrometer screws. The observing telescope has an ocular slit. The apparatus is sufficiently sensitive for the most exacting requirements. Further particulars may be obtained from the representative of the firm at the Exhibition. (Fig. 11.)

Fig. 12.

f) **Helmholtz's Colour Mixing Apparatus,** for mixing 2 to 4 different spectra of any intensity, with Rochon's prisms and bilateral slits (vid. *H. v. Helmholtz,* „*Handbuch der Physiologischen Optik.*")

g) **Helmholtz's Large Colour Mixing Apparatus** with Lummer and Brodhun's prism combination, 5 telescopes, 4 collimators with bilateral slits and Rochon's prisms, polarizing arrangements before the slits and the observing telescope with ocular slit. The apparatus is shown in the *German Educational Exhibition.*

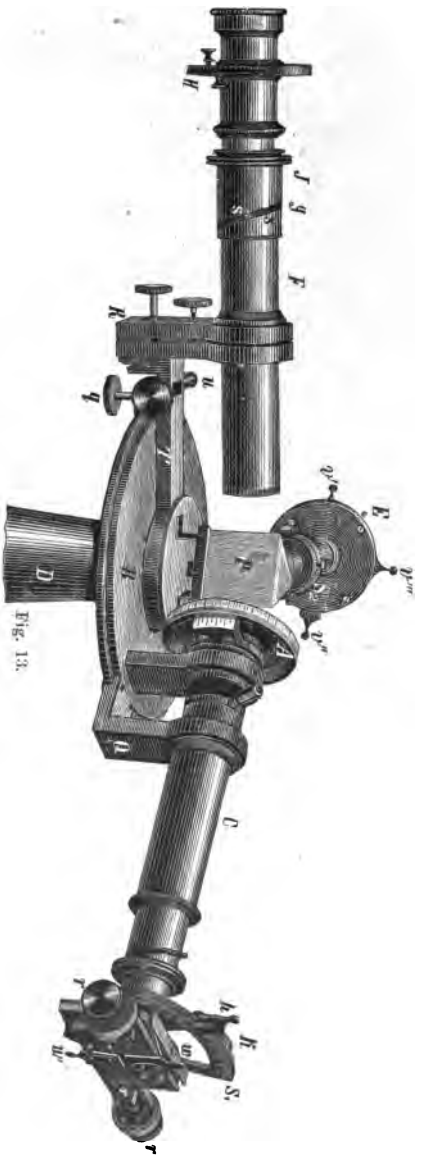


Fig. 13.

h) **v. Frey's and v. Kries's Spectrum Apparatus** for mixing spectrum colours (vid *Report of the Physiological Institute in Leipzic*).

i) **Colour Mixing Apparatus,** own construction, with Donders's bilateral slit. (Fig. 13.)

VI. Apparatus for demonstrating Spectrum Phenomena.

(Among „Apparatus for objective demonstration").

VII. Auxiliary Appliances.

There are a large number of these but only the following few are of special interest:

a) **Steinheil's Hollow Prisms** with plano-parallel sides.

b) **Wernicke's Hollow Prisms,** consisting of 2 crown glass wedges cemented into a glass box, the interspace between the wedges being filled with cinnamomic ethylic aether. The prism is protected from the influence of variations of temperature by a wood casing. The prism is remarkably transparent and possesses great dispersion. It is adapted both for the deflected and the rectilinear path of rays.

c) **Set of Jansen's and Amici's Prisms;** 3 or 4 prims.

d) Rutherford Prisms, consisting of a flint glass and two crown glass wedges; specially recommended for high dispersions.

e) **Reflecting Prisms** of various sizes.

f) **Heliostats** of various types. (Fig. 14, according to Spencer.)

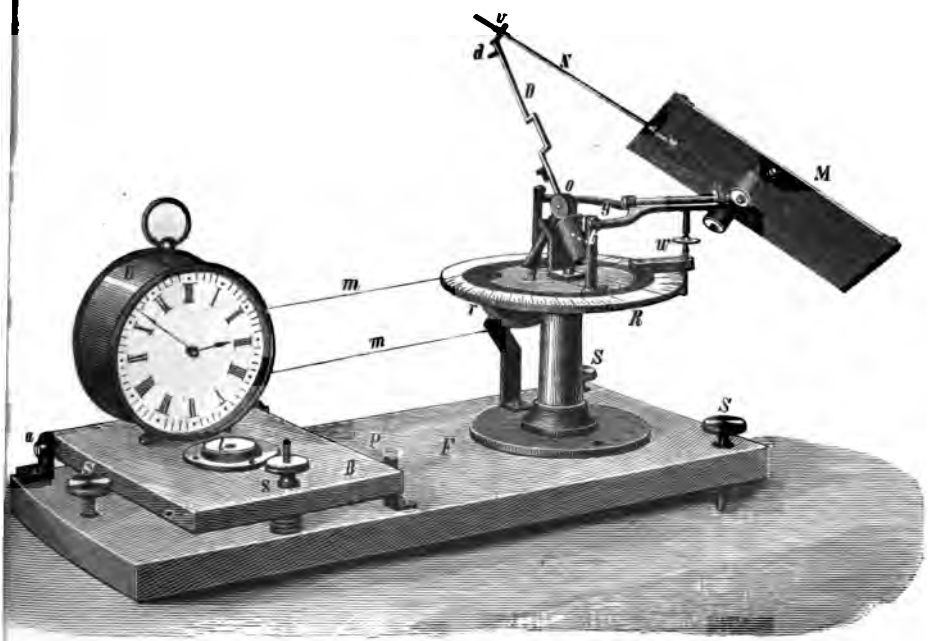


Fig. 14.

g) **Spectrum tubes and tables** etc.

B. Photometric Appliances.

The increased requirements of stronger and better artificial illumination have created a demand for accurate appliances for measuring the power and quality of illuminants.

The following appliances constructed by this firm have met with particular favour:

I. Leonhard Weber's Photometer.

The instrument is adapted not only for determining the intensity of flames or similar illuminants but also that of diffuse light. (Fig. 15.)

The apparatus with its accessories is neatly fitted in an elegant case with handle; it is conveniently portable and therefore specially available for measurements of any kind in cases where other photometers

cannot or can only with great inconvenience be used. The instrument is indispensable for examining the light admitted into school rooms etc.

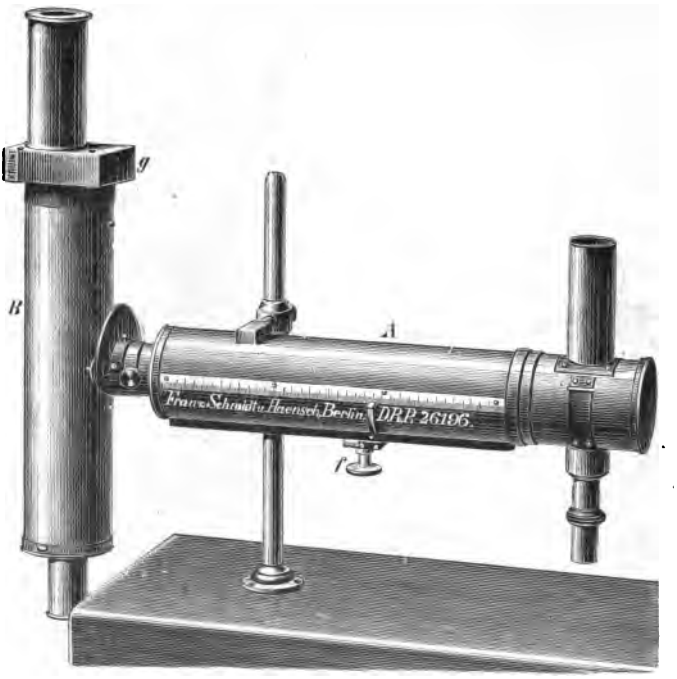


Fig. 15.

Detailed description and directions for use may be had of the firm's representative.

II. L. Weber's Apparatus for measuring solid angles (Fig. 16).

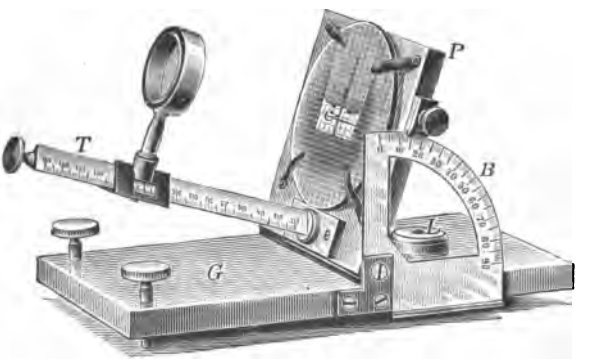


Fig. 16.

For measuring the solid angle contained by the incident rays and the illuminated surface. (For further particulars vid. *Description alluded to above.)*

III. L. Weber's Photometer with Polarizing Apparatus.

The instrument is particularly adapted for measuring the brightness of the sky, the clouds, the relative distribution of the brightness of the sky etc.

IV. Photometer Bench.

It consists of a cast iron frame with 5 elevation screws, 2 rails of drawn steel tubing, one of which is throughout divided in millimeters, the other according to standard candle units. 3 waggons provided with pointers run upon these rails and are fitted with rack and pinion movement and clamping screws for accurately adjusting the height of the various luminants. The bed is made of any required length. As a rule the available length is 250 *cm*. A completely equipped specimen 150 *cm* in length is shown at the Exhibition.

For this photometer bed 2 heads are supplied constructed according to *Lummer*'s and *Brodhun*'s directions, viz.

a. **Photometer head for equalized luminosities,**

b. **Photometer head for equalized and contrasted light.** (fig. 17).

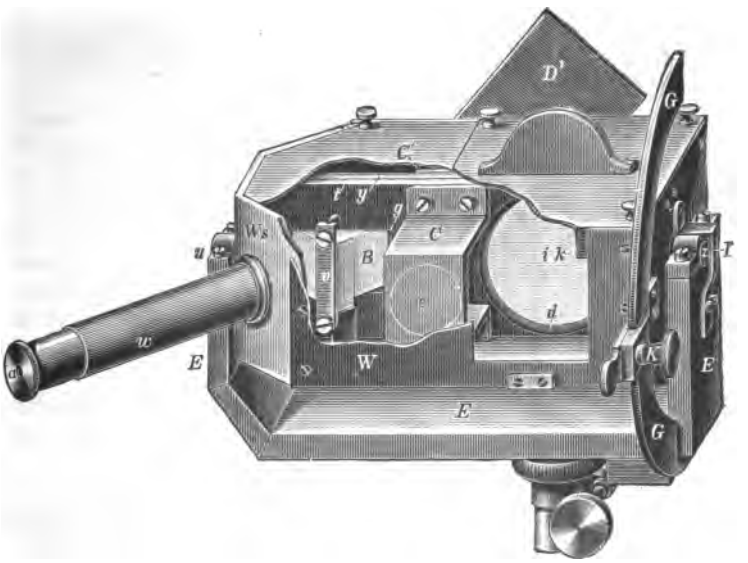


Fig. 17.

Vid. »*Photometric Researches*« by Dr. Lummer and Brodhun in the *Zeitschrift für Instrumentenkunde*, 1892 and in *Schilling, Journal für Gasbeleuchtung und Wasserversorgung, 1892, No. 29.*

These appliances, which were originally constructed at the instigation of the *Imperial Physical and Technical Institution*, are already being largely used by prominent gas and electric light works.

C. Appliances for Objective Demonstration.

The great practical value of objective demonstration becomes more and more acknowledged and, accordingly, this method of instruction is being adopted by an ever increasing circle of colleges and schools. According to the available means and the source of light, apparatus for various forms of illumination and of varying sizes are in requisition, viz. for lamp, zirconium (coal-gas and oxygen) and electric light.

I. Appliances for electric light

of various sizes with double or triple illuminating system and with lenses of 105 to 300 *mm* diameter according to the size of the object which is to be shown on the screen. The apparatus is fitted with water tank. The contact lamp of von Hefner-Altenek, adjusted for 15, 20 or 25 *Ampères* forms a suitable source of light.

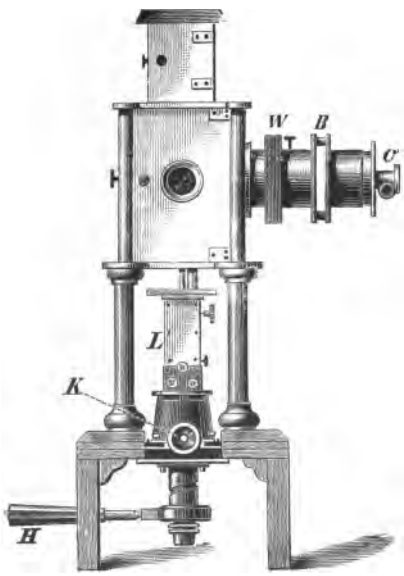


Fig. 18.

a. **Large Camera for Electric light,**

own design, made of brass. Perfectly light-tight casing. The side doors are balanced by counter weights and are made to move upwards. Diameter of the two illuminating lenses 105 *mm*. The whole lamp can by means of a rack and pinion movement be raised and lowered, and by means of a lateral sliding arrangement the source of illumination can always be brought into the optical axis.

b. **Large Mahogany Camera,**

lined with asbestos inside; equipment otherwise similar to that of *a*.

c. **Large Camera,**

own design, of brass fitted with all the above mentioned improvements. The carbons are contained in a casing which is accessible by three doors, the lower portion of the lamp being open for manipulation. (Fig. 18.)

d) **Large camera, own design.**

The two illuminating lenses of 235 *mm* diameter may be placed in different relative positions by means of wheels running upon steel tubes. They are connected with one another and with the camera by

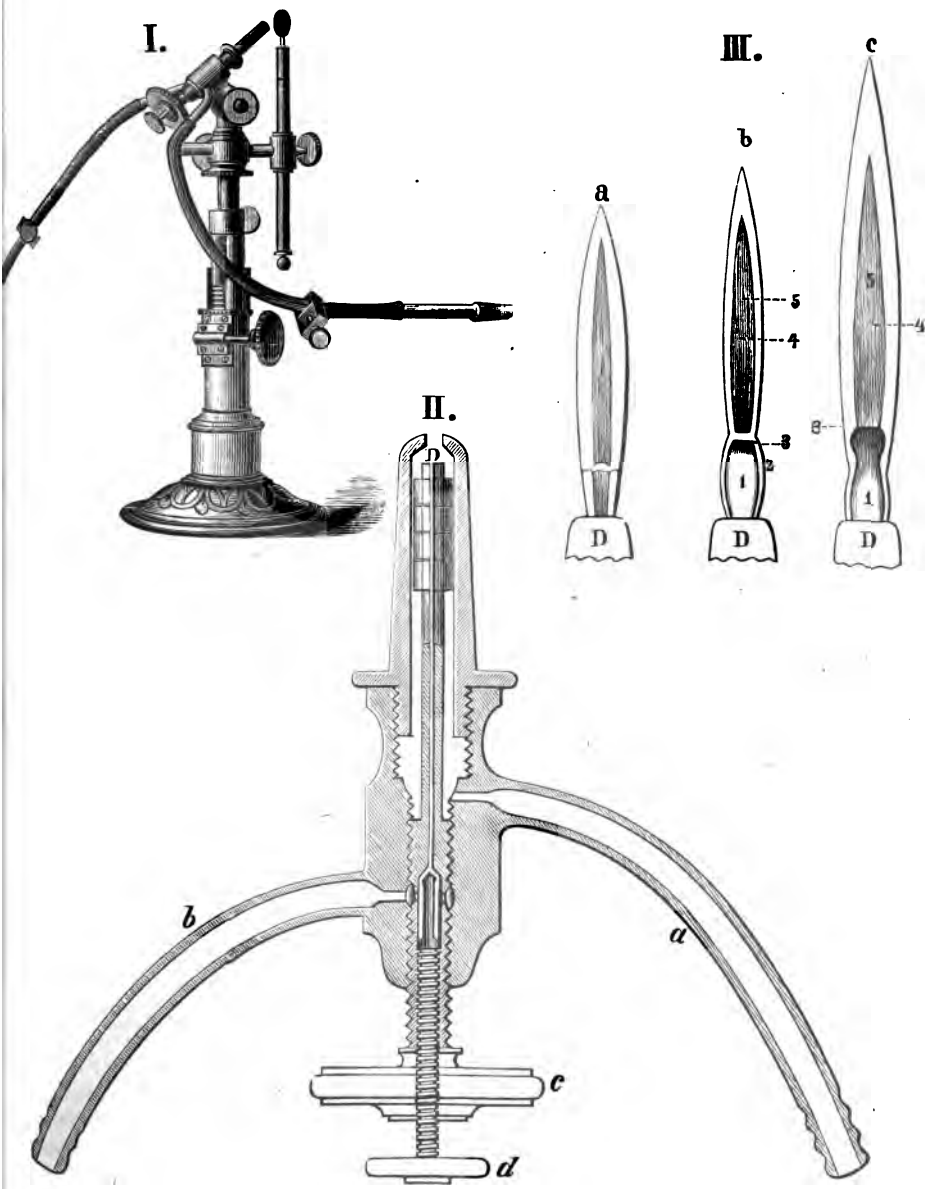


Fig. 19.
Linnemann burner, vide pag. 82.

bellows. Either lens can be quickly removed, it being thus possible to work with a single lens, which greatly facilitates many experiments.

e) **Camera with encased Schuckert lamp,** with slanting carbons, to obtain the best illuminating effect; the carbons may also be placed vertically for spectrum analytical experiments.

II. Projection Apparatus for Zirconium Light.

The zirconium lamp invented by Prof. Linnemann, which is worked by a coal-gas and oxygen burner, emits a light of about 200 candles and is the best substitute for electrical light in cases where the latter is not available. It is mounted upon large and small stands. (Fig. 19 pag. 81.)

a) **Large camera with large Linnemann burner,** with two illuminating lenses of 105 *mm* diameter, all brass lackered black, with nickel mountings.

b) **Small camera with small Linnemann burner,** of tin plate, with two lenses of 105 *mm* diameter, mounted upon mahogany base.

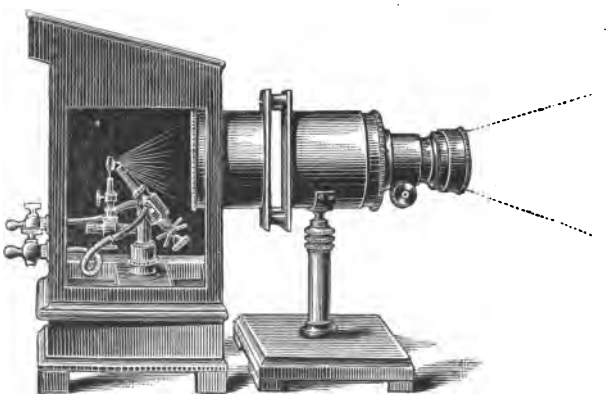


Fig. 20.

If required these apparatus are also supplied with larger lenses and various equipments. (Fig. 20.)

c) **Enlarging camera,** with two lenses of 155 *mm* diameter for photographs not exceeding 9×12 *cm*; mounted on mahogany board, with movable objective bellows, arrangement for moving the illuminating lenses, iron casing for the burners.

d) **Mahogany Enlarging Camera,** with two illuminating lenses

of 235 *mm* diameter for photographs not exceeding 13 × 18 *cm*. (Fig. 21.) This and camera *c* are specially adapted for photography.

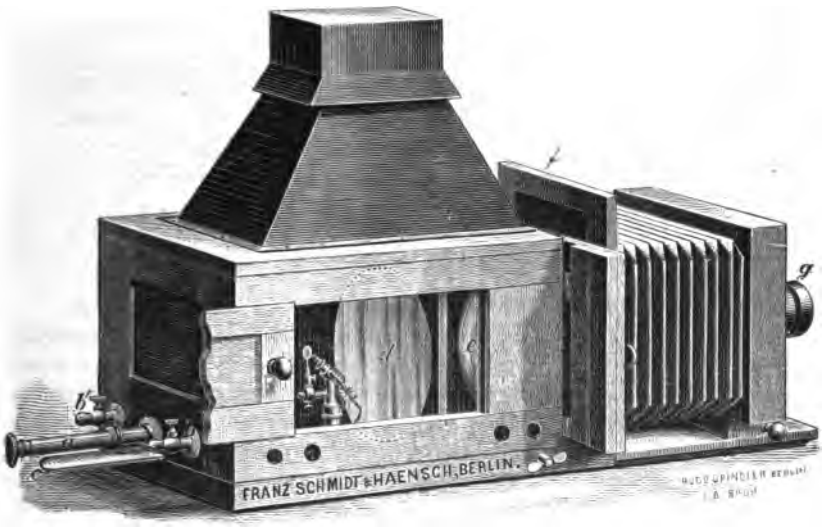


Fig. 21.

III. Optical Benches for demonstrating polarization and spectrum phenomena and for microscopical projection on the screen.

a) **Large optical bench.**

It consists of an iron bench fixed upon a mahogany base board provided with 6 sliding blocks which may easily be moved along the bench and clamped in any position.

The standards for various appliances attached to these sliding blocks are fitted with rack and pinion for adjusting the heights.

The equipment is, of course, adapted for the optical departments which are to be demonstrated. For polarization with parallel and convergent light two large Nicol prisms, black mirrors, sets of glasses, glass clamps etc. are supplied with the bench. For spectroscopy a slit arrangement, collimator lens, prisms placed upon a stage etc. accompany the bench. *A complete optical bench provided with the Schuckert camera Ie is shown at the exhibition.*

b) **Small optical bench,** consisting of two stout nickel plated brass tubes mounted upon mahogany base board, provided with 6 or 7 sliding pieces with draw tubes for adjusting the height.

Equipment similar to that of *a* (Fig. 22). *This bench is shown at the German Exhibition.*

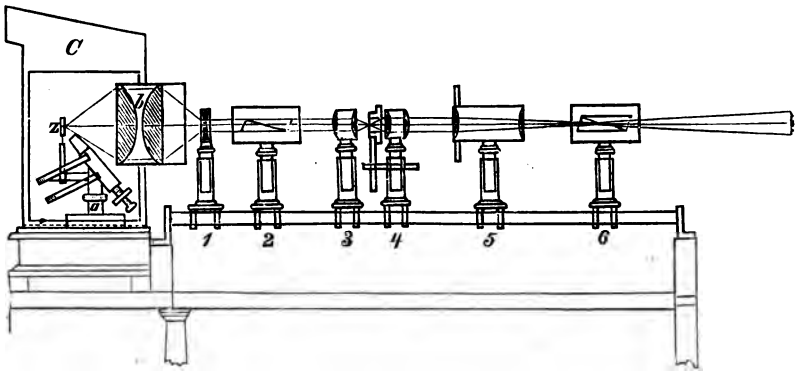


Fig. 22.

c) **Optical bench specially designed for microscopic projection.** It consists of a short bench mounted upon wood base with two slide blocks, one of which is fitted with stage for absorption vessels (light filters) etc., the other forming a suitable support for a complete microscope.

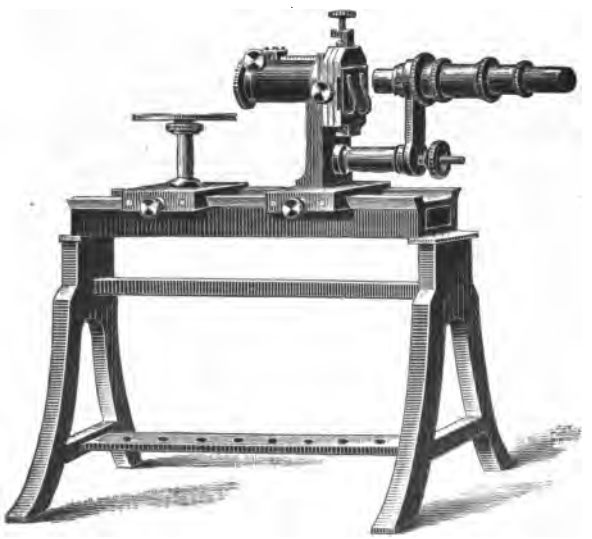


Fig. 23.

The latter consists of a rotating mechanical stage, a condenser fitted with rack and pinion movement and a sleeve for objective tubes adjustable by a micrometer screw.

The sleeve is adapted both for a short tube intended to take low power lenses and for a long tube fitted with worm screw intended for higher powers, apochromatic lenses in conjunction with projection oculars. (Fig. 23.)

d) **Projection head,** for projecting photographs and objects in general by means of photographic lenses. The focus of these lenses must, of course, be adapted to the focus of the illuminating lens of the Camera. *We must here refer to the Separate Catalogue on „Optical Benches", which may be had from the firm's representative.*

D. Polarizing Appliances.

Beside the well known instruments of **Mitscherlich, Laurent, Wild, Landolt-Lippich, Soleil-Ventzke's** colour apparatus and **Jelett-Cornu's** penumbra apparatus, the firm makes also new appliances for observing electric and magnetic rotation, for polari-spectro-photometric research etc. These instruments are all of the most approved form and perfect workmanship, both as regards the optical and mechanical parts.

I. Appliances for didactic purposes.

a) **Dove's apparatus for demonstrating polarization phenomena,** consisting of a divided prismatic beam with sliding pieces provided with brass standards for the accessories, with open telescope fitted with divided circle, with Nicols, condensers etc.

b) **Noerremberg's Apparatus** with accessories.

c) **Wild's, Laurent's apparatus** and others, vid. II.

d) **Arago's, Babinet's, Savart's, Sénarmont's** polariscopes. (vid. also under heading „**Optical benches**".)

II. Apparatus for analytical purposes, for homogeneous light, with divided circular disc.

a) **Mitscherlich's apparatus;** simplest form with two Nicols, 1 lens and 1 observation tube 200 *mm* long, on stand.

b) **Robiquet's apparatus;** equipment similar to that of *a*, but with the addition of a double rock crystal plate.

c) **Wild's apparatus,** large model, on adjustable brass stand, with interposed Savart plate, with circle divided on silver, telescopic reading, with observation tubes of 220, 200 and 100 *mm* length and with sodium gas lamp; the whole apparatus fitted in a mahogany box.

d) **Wild's apparatus,** small model, with observation tube of 100 *mm* length.

(These **Wild** instruments are very sensitive, but are not suitable for long continued working owing to the eye being severely strained by their use.)

e) **Mitscherlich's Penumbra Apparatus, original construction,**

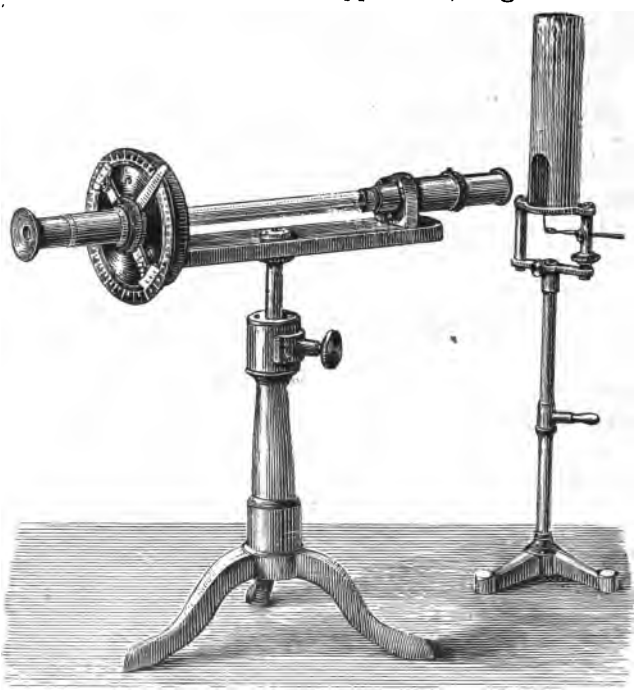


Fig. 24.

with Laurent polarizer. With two observation tubes and sodium gas lamp.

(Eminently suitable for analysis of wine, must etc., Fig. 24.)

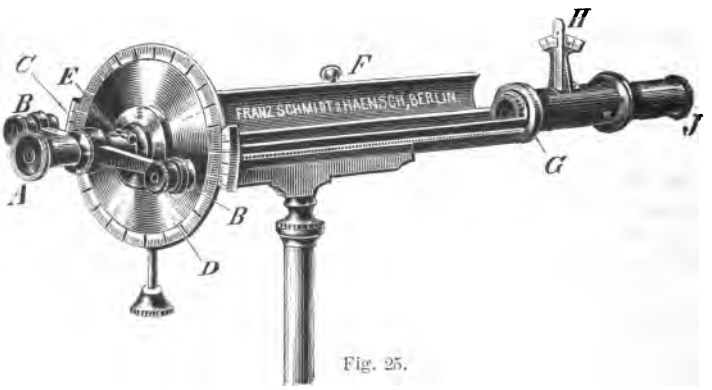


Fig. 25.

f) **Laurent's Penumbra Apparatus,** with Laurent polarizer, consisting of a single Nicol and a rock crystal plate, with observing tubes of 220, 200 and 100 *mm* length and with sodium gas lamp.

(This apparatus is particularly adapted for exact chemical analysis; reading to 1 minute, Fig. 25.)

g) **Landolt's Apparatus** with Lippich's polarizer. Three modalities.

The optical equipment is with all three the same. The instruments differ only in the fineness of the divisions on the circles and the necessary means for taking the readings. The first two instruments are intended for determining the rotating powers of fluids, the third instrument can, at the same time, be used for examining electro-magnetic rotation. The instruments consist of two stout brass or iron standards, which are rigidly connected by stout brass rods. Upon these rests a sliding block which may be easily moved horizontally by means of a lever. The sliding block supports the observation tubes. The rigidity of the mechanical fittings and the arrangement of the optical part render the apparatus extremely sensitive. The **Laurent** polarizer is replaced by a **Lippich** polarizer. The latter consists of a fixed **Glan** Nicol which occupies the entire field and a movable Nicol which fills only one half of the field. By rotation of this latter Nicol the brightness of the penumbra may be regulated. While with **Laurent**'s system only sodium light is applicable the **Landolt-Lippich** instrument possesses the advantage of admitting of any kind of homogeneous light being used.

1. **Landolt-Lippich Apparatus** with observation tubes of 100, 200, 300 and 400 *mm* length, with large silvered circle divided in 1/5 degrees, reading by verniers and simple magnifiers to 0.01 degree. With **Landolt** lamp for homogeneous light. (Fig. 26.)

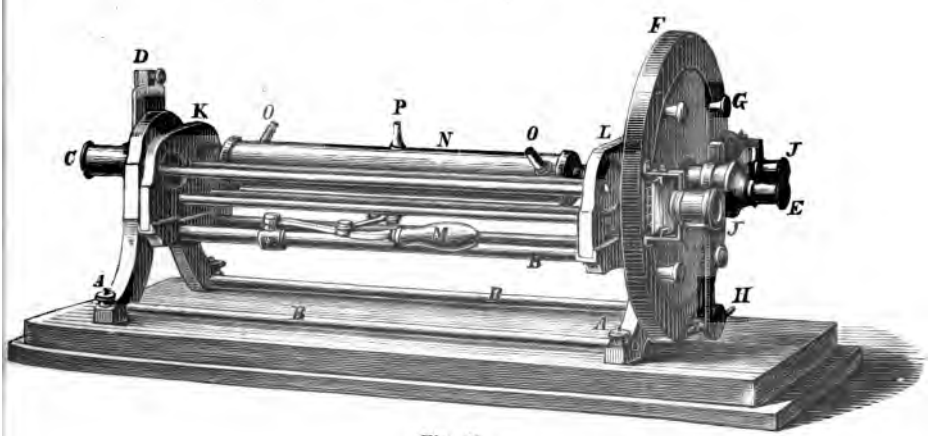


Fig. 26.

2. **Landolt-Lippich Apparatus** with observation tubes of 600, 500, 400, 300, 200 and 100 *mm* length. The circle is divided on silver in 400 parts and reads by two microscopes to 0.001 degree. Accessories: **Landolt's** lamp for homogeneous light and 2 lamps, each with 2 glass rods, for illuminating the divided circle and the microscope drums.

3. **Landolt-Lippich Apparatus** for observing electro-magnetic rotation, with bobbin running on wheels, copper wire solenoid into which is inserted the observation tube. The bobbin runs upon two brass rails and may readily be brought into the optical field. A support for ordinary observation tubes not exceeding 600 *mm* in length is supplied with the apparatus to render it available for the examination of liquids. Accessories: as under 2.

III. Apparatus for white or lamp light with wedge compensation and linear scale.

Equally exact and convenient, but adapted for substances which, like cane sugar, have the same dispersive power as rock crystal; therefore chiefly patronized by sugar refineries and by the custom house,

a) 1. **Soleil-Ventzke's Colour Apparatus**

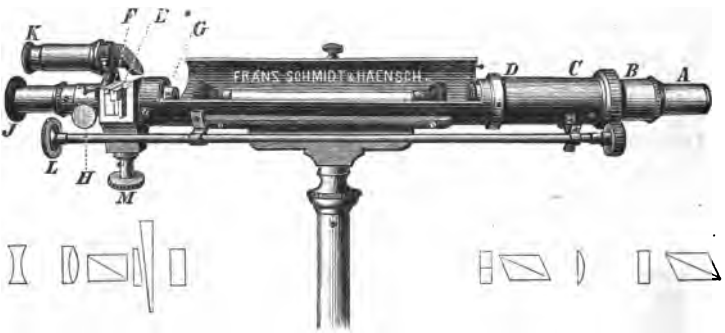


Fig. 27.

with adjustment for certain colours in either half of the field, with observation tube of 200 *mm* and another of 100 *mm* length, in mahogany case. (Fig. 27.)

2. **The same apparatus,** with tubes of 400, 200 and 100 *mm* length.
3. **The same apparatus** with tubes of 600, 400, 200 and 100 *mm* length.

b) **The same apparatus with double wedge compensation. Original design.**

1. for tubes of 200 *mm* length,
2. „ „ „ 400 „ „
3. „ „ „ 600 „ „

(The double wedge compensation with 2 movable rock crystal wedges and scales belonging thereto admits not only of polarization to the left from 0 to 100°, but also of easy control of both scales along their entire length, in 1/10%).

c) 1. **Penumbra Apparatus,** with adjustment for equal brightness of the two halves of the field; for tubes of 200 *mm* length.

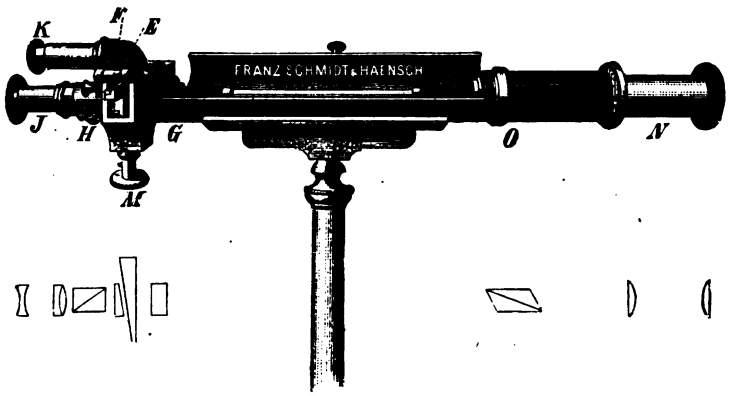


Fig. 28.

2. for tubes of 400 *mm* length,
3. „ „ „ 600 „ „

Equipment and accessories similar to those of *a*. (Fig. 28.)

d) **The same apparatus with double wedge compensation. Original design.**

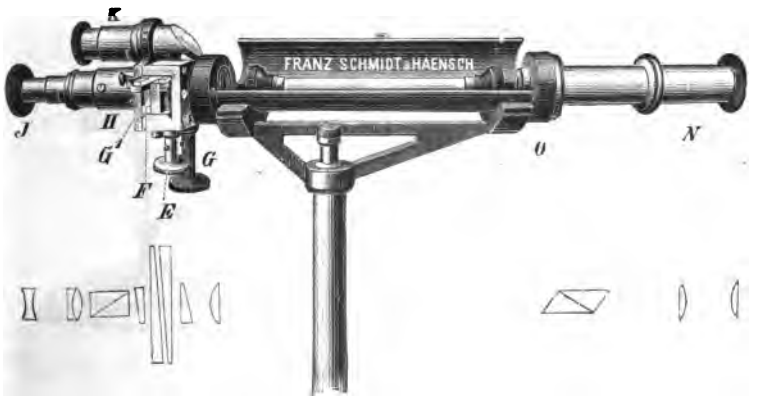


Fig. 29.

1. for tubes of 200 *mm* length,
2. „ „ „ 400 „ „
3. „ „ „ 600 „ „

Equipment and accessories similar to those of a. (Fig. 29.)

Adjustment for **equal colouring** of the field is impossible in cases of colour blindness and it is inexact where the capacity for discerning colours is imperfect; besides, it is, with continued working, for the majority of eyes much more straining than the adjustment for **equal brightness. For this reason the majority of analysts obtain more exact results with the penumbra**

apparatus than with the corresponding colour apparatus, and the penumbra apparatus is, therefore, more and more taking the place of the colour apparatus.

e) 1. **Stammer's apparatus for testing beet root.** It has the same optical construction as the penumbra apparatus **c**. Its scale is, however, limited to a range from 0 to 35°. With two observation tubes of 200 *mm* length.

2. **The same apparatus** for tubes of 400 *mm* length, with 2 tubes 400 *mm* long, in case.

f) **Apparatus, original construction,**

Fig. 30.

similar to **e, for urine sugar and albumen tests,** reading to 0,1%, with one observation tube of 200, 100 and 50 *mm* respectively. In mahogany case. (Fig. 30.)

The instruments enumerated under **a, b, c** and **d** are now only fitted with **nickelin** scales, and a reflecting illuminator is recommended for convenient reading.

IV. Accessory Appliances for Saccharometers.

The following few appliances may here be quoted from the extensive list contained in the special catalogue of these appliances made by this firm.

a) **Observation lamp for petroleum (Hinks'** duplex burner) with metal chimney, with illuminating lens and reflector.

b) **Observation lamp for gas,** original construction (triplex burner) with metal chimney, with illuminating lens and reflector.

c) **Observation lamp for electrical light.**

d) **Observation lamp for sodium light** (for gas) for polari-strobometers and circular penumbra instruments.

e) **Observation tubes** with and without water jacket, Pellet's observation tubes for continuous filling, controlling observation tubes for testing the apparatus with simple wedge compensation.

f) **Standard quartz plates** for testing the apparatus with simple wedge compensation.

g) **Balances,** chemical, for analysis and technical purposes and specific gravity balances; various systems and equipments.

h) **Apparatus for determining the percentage of carbonate** of lime in bone charcoal.

i) **Apparatus** for **Volumetric** determination of the **carbonic acid** contained in saturation gases, according to **Scheibler, Kohlrausch** and others.

k) **Ventzke's Hydrometer.**

l) **Brix's Standard Saccharometer** (Hydrometer).

m) **Beakers, Burettes, Pipettes** etc.

n) **Complete laboratory outfits.**

o) **Complete travelling equipments.**

E. Microscopy.

Beside various forms of reading and cathetometric microscopes, scale telescopes and other dioptric appliances for the above compound instruments, this firm supplies a varied assortment of microscopes for all usual magnifications. *See separate catalogue.*

Sole agents for the U. S. A.:

Messrs. Eimer & Amend

205—211 Third Avenue **New York.**

No. 2787.

G. A. Schultze, Berlin S.O.

Koepenickerstrasse 128.

Glas-Blowing and Mechanical Works.

Established 1850.

Proprietor: Paul Schultze.

Awards:
Paris 1855, Gold Medal of the Academie Nationale.
Paris 1892, Gold Medal.
Munic 1854. — Paris 1855, Exposition Internationale. — Stettin 1865.
Porto 1865, Diploma of honour. — Philadelphia 1876.

The firm is engaged in the manufacture of **accurate glass instruments of all kinds, for scientific, commercial and official purposes,** such as

Standardized Thermo-alcoholometers.
„ „ -hydrometers.
Standard Thermometers, Standard Saccharometers;
Measuring Appliances for laboratories etc. etc.

A speciality of the firm consists in their **thermometers for all kinds of purposes,** of which a large assortment is being exhibited. In the manufacture of this class of thermometers, special weight is attached to greatest possible **distinctness** and **durability.** In order that these two conditions may be satisfied a departure was made from the usual form of sealed thermometers consisting of sealed capillary tube and scale encased in the outer tube, and the scale of the new thermometer was made in the shape of a box. This construction admits of the **dimensions of the scale being made much larger** than is possible with the usual type. This again renders it possible to use **much thicker capillary tubes of prismatic section.** A thick column of mercury is used and this again appears **magnified** several times by the action of the glass. These broad ribbons of mercury, which are visible from a distance, in conjunction with the deep divisions and large figures, impart to these instruments a distinctness which has not been attained elsewhere. The exhibits will bear out this assertion. This mode of construction has the further advantage of admitting of a **much more solid form of**

framing, which may be made of cast iron or yellow metal and thus ensures great durability. The mercury bulbs of these thermometers are protected from bursting by the following device, which has been adopted almost exclusively in all these thermometers. It consists in the bulb of the capillary tube being protected by a closed iron tube which terminates in the connecting flange or nut. The source of heat (steam, boiling water etc.) is thus prevented from touching the glass bulb directly. The iron tube is filled with mercury which completely surrounds the bulb, thus communicating to the latter the external temperature with such rapidity that the indications of such a thermometer are quite as rapid as those of a thermometer with uncovered bulb. This arrangement has proved to be **the most perfect protector of the mercury bulb, and on this account the town council of the City of Berlin employ these thermometers exclusively.**

The special advantages of these thermometers have **quickly** gained a **large market** for them. The firm counts among its regular customers, beside the town council of Berlin, **numerous municipal autorities** and **important establishments,** as may be seen from the references of **gas works, breweries, distilleries, sugar refineries, chemical works etc.**

The firm has acquired the **sole right of manufacture within Germany of patent No. 59861, Schmidt's self-acting steam throttling apparatus** and **No. 40295, Moennich's distance thermometer,** and besides possesses **an original patent for an apparatus for automatic registration of the specific gravity of liquids,** which is particularly valuable for the purposes of **sugar works.**

In 1888 and 1889 the firm received from the **Imperial Assize Commission** an extensive order for the supply of **Standard Thermo-alcoholometers** for the German Customs.

No. 2788.

Schulze & Bartels, Rathenow.

Sole proprieter: Franz Bartels.

Optical Works.

Established in 1850.

I. Department: Spectacle Glasses made of glass and pebble. Cylindrical glasses, illuminating lenses, plano-convex and biconvex lenses for all purposes. Spectacle frames, folding spectacles, ophthalmic appliances, optometers.

Fig. 1. Photograph taken with the older type of lens.

II. Department: a. Telescopes for tourists, military reconnaissance and navigation. Exemplified at the Exhibition 1.) by a **conical marine telescope** as supplied to the German Navy, with object glass of 62 *mm* diameter, extremely large field and 2.) by a **reconnoitring telescope** of 36 *mm* aperture for the artillery.

b) **Telescope Objectives made in the most exact manner,** in particular for measuring-telescopes. Various types according to particular purposes. Optical or chemical chromatic correction. Compensation of spherical aberration in either direction for cathetometers. Very short

focal lengths with relatively large apertures. Exemplified at the Exhibition by a set of telescopic objectives of diameters up to 108 *mm*.

c) **Photographic Objectives.** Aplanatic lenses, lenses for detective cameras, cheap photographic objectives for amateur apparatus.

d) **Tele-objectives according to Dr. Miethe** for direct photography of very distant objects. Exemplified at the Exhibition by a specimen having an aperture of 40 *mm*. (Fig. 1 u. 2.)

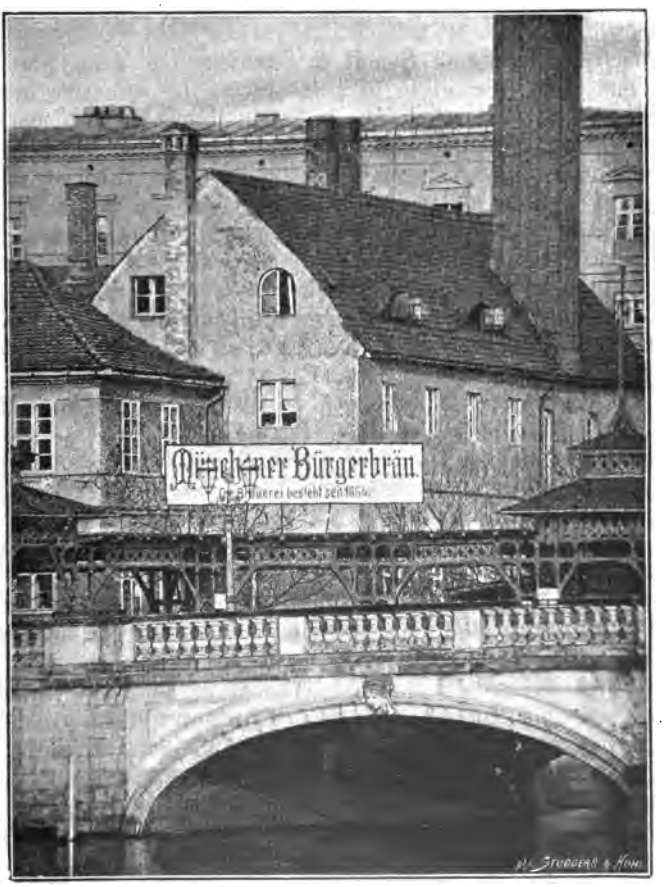


Fig. 2. Photograph taken with Dr. Miethe's tele-objective.
(Showing the part marked in Fig. 1 taken from the same position.)

d) **Hemispheres** for microscopes, polarization apparatus etc. Exemplified by a set of various sized hemispheres.

f) **Binoculars** of a special optical type, for military and marine purposes. Exemplified at the Exhibition by several binoculars as supplied to the German infantry, artillery and navy.

No. 2786.

Schott & Genossen, Jena.

Glastechnisches Laboratorium. (Glass Works.)

Optical Glasses and Glass-tubing for Thermometers etc.

The Glass Works of **Schott & Genossen** in Jena were founded in 1884 and had their origin in a laboratory for scientific experiments in glass smelting. The first investigations made in 1883 and 1884 by **Dr. Otto Schott** in conjunction with **Prof. Abbe**, and later experiments on a manufacturing scale, in which they were liberally supported financially by the Prussian Government, resulted in the production of a series of glasses — beside the ordinary Crown and Flint glasses of the new **Baryta, Phosphate** and **Borate** series, — which led the way to the construction of **improved** optical instruments. We may mention among these: **Improved** microscope objectives of the ordinary (achromatic) series, **Apochromatic microscope objectives** and apochromatic photographic lenses, **Improved** Aplanatic lenses (envolving the use of Baryta glasses), the **Anastigmatic lenses** recently constructed by **Carl Zeiss** and Telescopes with diminished secondary spectrum.

The application of a very accurate process of annealing enables the glass-works to produce pressed lenses and large objective discs **free from internal strain.**

The Laboratory produces also **special** glasses for scientific and technical purposes:

Tubes of the „**Jena Standard Glass**“ (registered trade-mark: **One red line**) with diminished secondary thermal effect and minimised variability of the zero-point, for fine and accurate thermometers. Glasses of a very high and also very low coefficient of expansion. Combustion tubes and tubes for Explosion furnaces. **Compound tubes** for **Water-gauges**, consisting of two glass layers of different expansive powers fused together, capable of resisting, **in a high degree**, sudden changes of temperature and the corrosive action of water.

The Laboratory is prepared to compound and smelt such special glasses which are calculated to lead to improvements.

Exhibits: Discs for Telescope Objectives, polished slabs of Optical Glasses (ordinary Crown glasses, heavy and heaviest Baryta-Crown of high refractive power, Crown glass of high and low dispersion, Phosphate and Borate glasses free from silica, Baryta light flints, ordinary Flint glasses with refractive powers up to 1.9), moulded and annealed lenses for the Zeiss Anastigmatic and other photographic lenses; Prisms for total reflection. — Jena standard glass-tubes, Borosilicate glasstubes, Combustion-tubes, Tubes for Explosion furnaces and Compound Tubes.

No. 2790.

Dr. Steeg & Reuter, Homburg vor der Höhe.

(Bath Homburg.)

Optical Institute.

Established in 1855.

Diploma of Honour:
Graz 1880.
Frankfort a. M. 1881.

Gold medal:
Antwerpen 1885.

Diploma of Honour

and Gold-Medal

Bruxelles 1888.

Gold medal at the I. International Pharmaceutical Exhibition. in Vienna, 1883.

Short description of exhibited objects:

Noerremberg's Polarizing Apparatus with large field and goniometer for measuring the inclination of axes.

Nodot's polarization apparatus, also suitable for projection.

Polarimeter or Saccharometer for quantitative analysis for all kinds of sugar and quinic alcaloids.

Turmalin forceps with and without lens.

A collection of 261 cleft crystals, uni- and biaxial, for experiments on dichroism etc.; and **Noerremberg's** mica films, in mahogany case.

Calcite Preparations: Nicol's Prisms, amongst these one of abnormal size, an unique specimen, 40 mm ($1^2/_3$") across the face; various polarizing prisms à la Foucoult, Glan, Hartnack, Jellet-Cornu; double refracting prism.

Three large rhomboeders with various surfaces.

Quartz Preparations: Large prisms and lenses on brass stands.

A tube of nickel-plated brass with quartz lenses for spectroscopic examinations with Soret's movable ocular and uranium glass disc, double refracting prism and tube for liquids. Babinet's compensator in brass mount.

Quartz wedges, double disc, Bertrand's quadruple plate, double refracting prisms and Fresnel's triple prism; a large sphere.

Selenite Preparations: Various wedges, concave discs, various Selenite figures.

A collection of 16 unannealed glasses, in case.

Interference Apparatus: Fresnel's Mirror Apparatus, on brass stand. Interference prism, Billet's lens, cylindrical lens, all on brass stands. Newton's coloured rings, in brass mount.

Fluorescence: Four cubes of uranium-didym-saphirin glass and fluor-spar, in case.

Perforated case with 5 fluorescent liquids.

No. 2791.

C. Staudinger & Co., Giessen.

Philosophical Instrument Works.

A. Department for Precision Balances and Weights.

I. Rapidly oscillating universal Precision Balance; is substancially a high precision balance, for the determination of weights up to 500 grammes (resp. 1000 grammes) which, as such, comes fully up to modern requirements, but, at the same time, offers this specific advantage, that it enables one to determine smaller weights (up to 100 or 150 grammes) with the same degree of rapidity and consequently, for the ordinary routine of the analyst, affords the same degree of convenience in use as an ordinary quick working analytical balance of small carrying power.

Fitted with Prof. **Dittmar's** gravity-bob and reading microscope.

Beam of aluminium bronze, highly gilt and having cross-knife-edge suspensions. All knife-edges and planes are of agate. The axes of rotation are conveniently in sight.

No. 1. Universal-balance to carry 100—1000 grammes in each pan, in elegant case of mahogany, walnut (or imitation) ebony. Sensibility 0,1—0,01 Milligrammes.

Fig. 1.

No. 2. Universal balance to carry 100 – 500 grammes, otherwise as above.

No. 3. Universal balance like No. 2 but with only one pillar and in plain mahogany case.

II. Short Beam Analytical Balance in double case.

This new arrangement possesses the great advantage of completely protecting the sensitive parts of the balance from detrimental influences, and also affords the means of weighing voluminous apparatus. The absence of the pillar has the further advantage of leaving the base entirely free for weighing operations.

Beam, pan suspensions and pans, are made of aluminium. The three knife-edges and planes are of agate. The rapid oscillating beam is fitted with the most perfect fixation and is provided with an arrangement for weighing very large apparatus below the table.

Charge up to 500 grammes. Sensibility 0,1—0,04 Milligr.

Fig. 2.

III. Analytical Balance (Fig. 2) **(with triangular beam)**; of newest and simplest construction, very suitable for students, in mahogany or metal case, with marble sole, side doors and counterpoised front slide.

Beam of aluminium, pans and pan suspensions of aluminium, or of nickel, or gilt brass. The three knife-edges and planes are of agate. Perfect fixation for beam, pans and pan suspensions, rider scale.

Charges up to 200 grammes in each pan. Sensibility 0,1 Milligr.
Illustrated and descriptive Catalogue gratis.

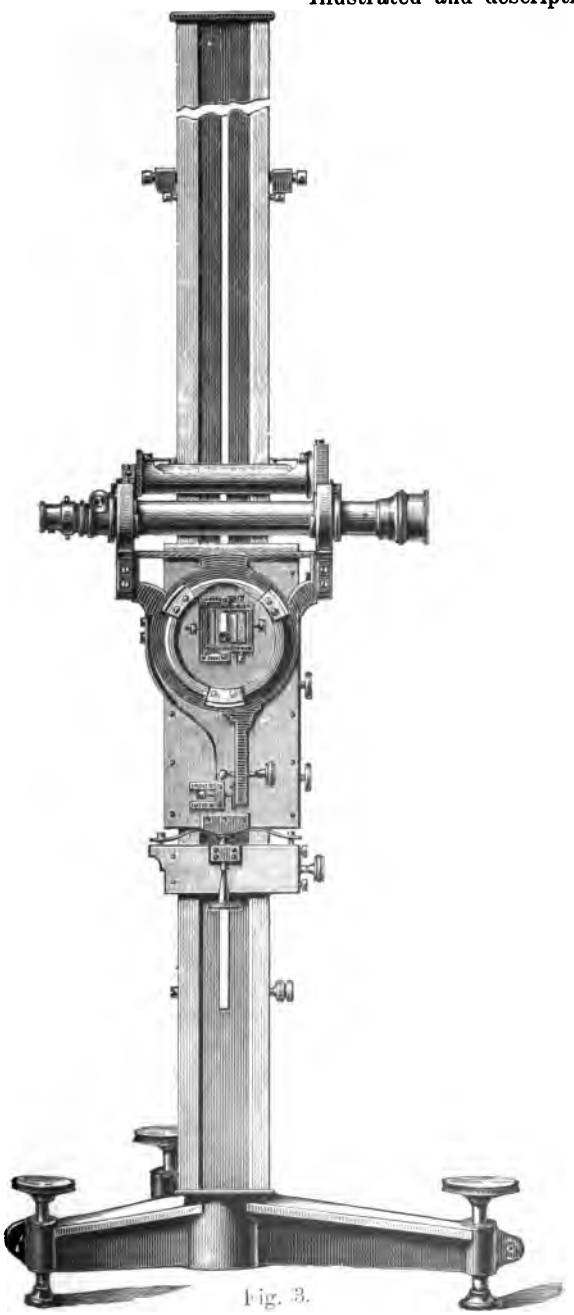


Fig. 3.

B. Department for Physical Apparatus.

Cathetometer (Fig. 3) of newest and most perfect construction, with bronze prism and solid silver divided scale one meter in length. Inclinable telescope and level.

The correction of the telescope, due to errors in the prism, is made on the sliding piece above the focussing point of the microscope, whereby the errors of the prism are directly compensated.

The prism and parts are balanced by a counterpoise, the whole revolving on a vertical axle in a complete circle; the prism may be set perfectly parallel to this axle by means of a micrometer-screw.

Air-pumps (illustrated by photographs) of approved construction, with double-acting piston, self-acting valve-gear etc. The whole working easily and rapidly by means of a fly-wheel for hand or engine power.

Evacuation below $^1/_2$ Millimeter.

Stands of wood or iron etc.

Illustrated and descriptive catalogue gratis.

C. Department for Forrestry and Science:

I. Heyer-Staudinger's tree-gauges of wood, acknowledged to be the best existing gauge, being very light and giving very exact results. Suitable for any climate.

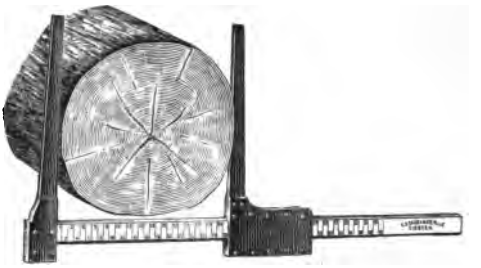


Fig. 4.

II. Walking-stick gauge, made in the form of a convenient forrester's walking-stick with suitable handle.

Gauges of aluminium or brass, made for the purposes of particularly exact calculations.

Illustrated and descriptive catalogue gratis.

No. 2792.

C. A. Steinheil Söhne, München.

Optical and Astronomical Works.

Dimensions are stated in terms of the metric system and of the old duodecimal French measure.

This establishment was founded in 1855 by the physicist Charles Augustus von Steinheil, Council of Ministry and Ordinary Member of the Academy of Sciences, and by his son Dr. Adolphus Steinheil, at the instigation of King Maximilian II. of Bavaria, who wished to perpetuate the reputation which Fraunhofer had won for the town of Munich by his achievements in optical science.

In 1865 the former retired from business and his son entered into partnership with his brother Edward Steinheil and established the now still existing firm of C. A. Steinheil Söhne.

Charles Augustus von Steinheil died in 1870 (14. Sept.). Eight years later Edward Steinheil received a sunstroke on a voyage to Columbia and died in the port of St. Thomas.

The present heads of the firm are: Dr. Adolphus Steinheil, the son of the founder, extraordinary Member of the Academy of Sciences, and, since 1889, his son Dr. Rudolph Steinheil.

From the commencement the practical manufacture of optical combinations was based upon precursory extensive and exhaustive computation of all optical data which were necessary for their systematic production and an equally methodical system of testing served for correctly controlling each separate stage of their manufacture.

The following are the tests which are implied by correct and systematic manufacture:

1. Critical selection of the glasses according to their chemical and optical properties;
2. Determination of the properties of the glasses independently of the data supplied by their makers;
3. Examination of the glasses with respect to defects which may affect the combinations optically or esthetically;
4. Calculation of the prisms and the systems of lenses so as to completely determine, by pure calculation, all the elements of the optical combination. *(cf. „Handbuch der angewandten Optik", by Dr. Ad. Steinheil and Dr. Ernst Voit, Leipzic, Teubner, 1891);*
5. Measurement, by means of the spherometer constructed in 1845 by C. A. von Steinheil of the radius found by mechanical means.

6. Critical examination of the polished surfaces with respect to perfection of sphericity by means of standard glasses, imperfections of the surfaces being indicated by the appearance of Newton's coloured rings.

By adhering to its maxims the establishment developed rapidly and the following are among its principal achievements:

1859. Establishment, in conjunction with Professors Kirchhoff and Bunsen, of the practical forms of the spectroscope;

1865. Construction of periscopes and of telescopic objectives with flint front lens *(patented in Bavaria)*, aplanatic lenses and micrometer oculars;

1866. Completion of the first type of the aplanatic lens *(Bavarian patent* of 1866), which in 1867 was awarded a Gold Medal at the Paris International Exhibition;

1871. Construction of wide angle aplanatic lenses at the instigation of the Austrian ministry of war;

1872. Astro-photographic objectives;

1878. Aplanatic group lenses *(patented)*;

1881. Antiplanetic lenses *(several patents)*;

1885. Panorthic double telescopes *(patented)*;

1887. The head of the firm was invited by the „Academie des Sciences" of Paris to attend the congress held with the object of discussing the subject of the production of photographic celestial charts. On this occasion Dr. Ad. Steinheil protested against the resolution carried by the majority regarding the conditions which govern the production of correctly delineated charts of constellations. For that resolution limited the conditions, which were to be realized, to aperture, focal length and correction of spherical and chromatic aberration. In pursuance of this congress an objective having an aperture of 33 centimeters was ordered by the Astro-physical Observatory of Potsdam and also one of an aperture of 23.5 centimeters, which were completed in September of the year

1889, and which embodied the conditions laid down by Steinheil. The excellence of this objective led to

1890, a similar objective of 33 centimeter being supplied to the observatory of Catania in Sicily; and

1892 a similar objective of 33 centimeter achromatized for the chemical rays, and also a 36 centimeter objective achromatized for the visual rays, both to the Observatory of Upsala.

Beside these a great number of objectives of 10, $9^1/_2$, 9 and 8 inches diameter were made.

A prominent feature is also the manufacture of plano-parallel plates and accurate prisms and, as a speciality, very exact plano-parallel glasses and mirrors of about $^1/_3$ millimeter thickness.

The following table contains a statistical report of the distribution of inland and foreign export during the period 1881 to 1890:

Germany	36.59%	Brought forward	90.83%
Austria-Hungary	13.94%	Switzerland	2.84%
France	12.62%	Great Britain	2.11%
Italy	8.23%	Holland	1.59%
Russia	7.84%	Denmark	0.99%
America	4.63%	Sweden and Norway	0.78%
Spain and Portugal	3.58%	Turquey and Greece	0.45%
Belgium	3.40%	Asia and Australia	0.31%
Carry forward	90.83%	Africa	0.10%
			100.00%

The continuous growth of the establishment necessitated the erection of a new building plant, and on the 1st. March 1890 the business was transferred to the new premises situated outside the town (viz. in Theresienhoehe). The building occupies an elevated and isolated position and is provided with excellently light workshops and testing rooms; among the latter there are a spacious experimental studio and a testing corridore of 40 meter length. The establishment is fitted throughout with low pressure steam warming pipes. The plant includes a number of new machines by means of which objective lenses up to 1 meter in diameter may be produced.

The establishment employs about 50 men within its own precincts and besides a number of others working in their own workshops. It will shortly complete the 40th thousand of astronomical and photographic objectives.

Photographic Apparatus and Instruments.

Photographic Objectives.

Antiplanetic Lenses: *German Patent No. 16354, 13. April 1881.*
British Patent No. 1602, 12. April 1881.
U. S. Patent No. 241437, 10. May 1881.

This type consists of two entirely different parts having greatest possible aberrations of opposite sign. This plan resulted in a considerable reduction of astigmatic aberration and, thereby, in uniform extension of definition and depth over an increased and strictly flat area of the field.

The two pairs of lenses, the anterior one of which is positive while the posterior is negative, are placed as near together as possible. The object of this close proximity is uniform distribution of brightness over the entire field.

The great brilliancy of the antiplanetic lenses renders them particularly adapted for portrait, group and instantaneous photography and also for exposures with artificial light. At the same time, these lenses have been computed in such a manner as to render them capable of producing strictly flat and correctly

delineated images. The lenses become thus eminently suited for projection and enlarging.

The original and enlarged negatives may be produced by the same antiplanetic lens. In the latter case it is, however, necessary to reverse the lens, i. e. to place it so that the posterior lens faces the original which is to be enlarged.

Enlargements of very sharply defined originals produced by this method may be made to exhibit depths which are unobtainable by direct photography with the same rapidity.

The dissymmetrical antiplanetic lenses are made in two types:

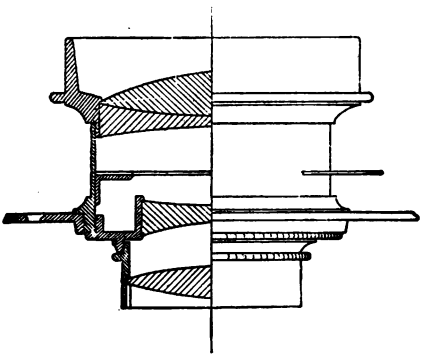


Fig. 1.

Series I. Portrait Antiplanet. Relative aperture 1:4, angle 40^0, four lenses with positive cemented anterior pair and isolated negative posterior pair. The field is limited as a means of obtaining unusual brightness. The latter and definition are uniformly distributed over the image and the lens possesses considerable depth.

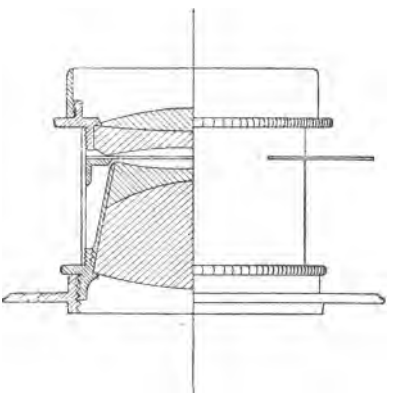


Fig. 2.

Series II. Group Antiplanet, 1:6, angle 60^0; four lenses, two cemented pairs; these are placed as closely together as the interposition of the diaphragm will admit of.

This lens is of only moderately diminished brightness as compared with the preceding series, but its peculiarities have been utilized in increasing both its depth and the field without diminishing its uniformity of definition and distribution of light. These united qualities render the group antiplanets adaptable to a great many uses, which accounts for the popularity of this series.

Universal Aplanatic Lenses. Relative aperture 1:6, angle 60^0.

These lenses originated in the endeavour of constructing objectives of the same rapidity as the group antiplanets but having larger dimensions. The latter type did not appear to be adapted for this purpose on account of the rapid increase of the thicknesses of the lenses necessitated by increase of focal length, and, consequently, increase of weight and diminution of rapidity.

The excellent results obtained with the new series of the rapid

symmetrical type led to the construction of smaller lenses of the same class.

Some of the universal aplanatic lenses consist of two cemented doublets, others of two cemented triplets, but in all cases the combination is symmetrical.

With the system of 6 lenses the principal points coincide with the geometrical center of the objective, i. e. with the plane of the diaphragm. Distortion is thus obviated.

This latter feature renders these objectives particularly adapted for topographic photogrammetry and for copying. On account of their rapidity the universal aplanatic lenses are specially intended for photography of moving objects, which demand short exposures.

The next four series of lenses are of the aplanatic type and have been developed from the aplanatic prototype which originated in this establishment *(Bavarian patent of 1867)*. During these latter years these lenses have been improved by the introduction of glasses which absorb the chemical rays in a considerably less degree than did the older glasses. This improvement enabled the lenses to keep pace with modern requirements.

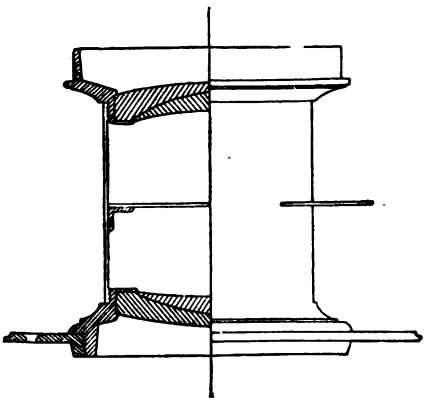


Fig. 3.

Series III: Aplanatic lens 1:7; angle 60^0. Adaptable for portraits, groups, architecture, landscape, copying and sufficiently rapid for instantaneous work.

When it is required to delineate plastic objects in correct proportions, particularly in cases where the object is not many times larger than the image, these aplanatic lenses are also specially supplied with very long focal lengths.

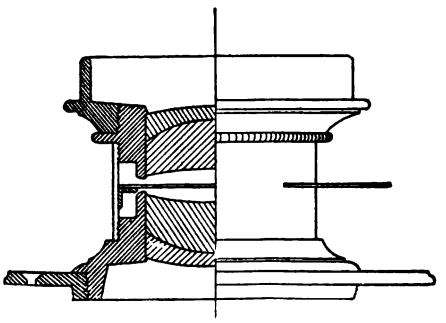


Fig. 4.

Series IV. Landscape Aplanatic Lenses 1:12 to 1:15; field of about 75^0. Specially constructed for landscape phototography, but also adapted for architecture and copying.

Fig. 5.

Set of 4 achromatic landscape lenses of equal aperture (23 millimeter) but different focal lenghts capable of combination in a common mounting fitted with iris-diaphragm.

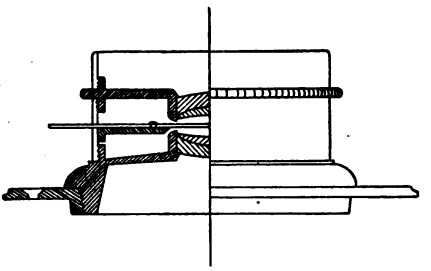


Fig. 6.

Series V. Wide Angle Aplanatic Lenses for architecture and landscape with relative aperture f/20 to f/25, angle of field about 100°.

In this lens definition, depth and angle of field have been greatly increased at the expense of rapidity.

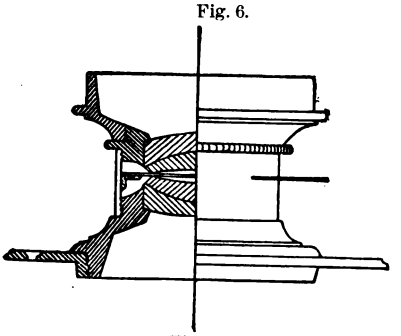


Fig. 7.

Series VI. Wide Angle Aplanatic Copying Lenses, similar to series V in point of rapidity.

By uniting greatest possible uniform definition and brightness with flatness throughout the extended field this type is particularly adapted for copying maps, pictures and engravings and for photo-mechanical processes.

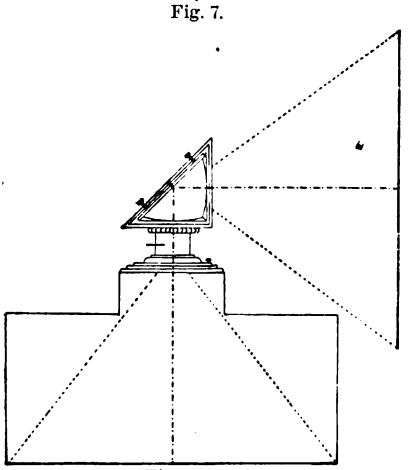


Fig. 8.

Prisms.

For directly producing so-called reversed negatives for photo-mechanical printing processes wide angle aplanatic copying lenses are principally used in combination with rectangular prisms with silvered hypotenuse surface.

Aplanatic Focussing Lenses.

Aplanatic combination consisting of three cemented lenses, with large flat field free from distortion and achromatized for intra and extra-axial rays. (For further particulars vid. M. Schultze's paper in *Schultze's Arch. f. Mikr. Anat. Vol. II, 1866.)*

Tele-photographic Objectives,

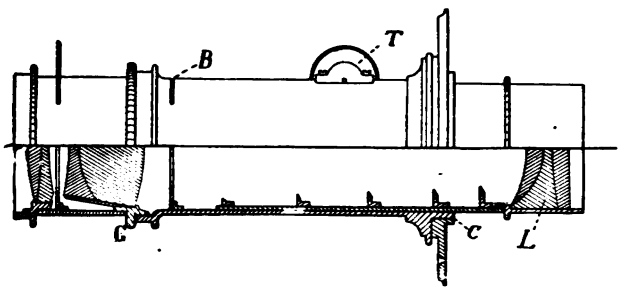


Fig. 9.

consisting of an ordinary photographic objective (of not less than rapidity f/7) and a magnifier achromatized for chemical and visual rays. *(vid. Photogr. Corresp.; Vienna. Leipzic, 1892, June and November, pp. 308 and 546).*

The magnifier is a triple system of negative focus. The combination of the triple system with the photographic objective of positive focus increases the equivalent focal length of the total telescope objective. This equivalent focal length and thus also the magnitude of the image are made to vary according to the distance between objective and concave lens, which is fitted with rack and pinion, the distance between the object and the objective being constant during these variations.

The field of the combination measures about 10°. The magnification may at the expense of brightness be increased to 10 or 15, only a relatively small extension of the camera being required to produce these magnifications; the latter is owing to the principal point of the combination being placed a long distance in front of the latter.

The time of exposure amounts under favourable circumstances only to fractions of a second, but even instantaneous exposures may be made.

The instantaneous photographic telescope,

which was first made for the German navy in 1890, appears, owing to its brightness, to be specially adapted to this purpose. (vid. Dr. Ad. Steinheil's paper on *„Tele-photography", Phot. Corresp. Vienna, Feb. 1892).* The optical part consists of a double objective and a negative elongation lens, having a total equivalent focus of 1.3 meter.

This apparatus produces circular images of 5 centimeter diameter and is particularly suitable for instantaneous photography, for marine and coast survey and also for military reconnoitring and engineering from a balloon.

The entire length of the apparatus is 60 centimeters; it is provided with diopter finder and instantaneous and time shutter, micrometer adjustment by means of rotating ring.

Detective-Cameras

for 9×12, 12×16, 13×18 centimeter plates. Types A, B, C, D.

Type A has the focussing screen rigidly connected to the plate changer.

Types B, C, D have in common with each other movable fronts for accurately focussing near objects.

Type B is fitted with detachable plate changer, which has a changing arrangement for plates or films similar to that of A.

Fig. 10. — Type A.

Fig. 11. — Type A.

Fig. 12. — Type B. C. D.

Fig. 13. — Type B. C. D.

Fig. 14. — Type B.

Fig. 15. — Type C.

Fig. 16. — Type C.

Fig. 17. — Type D.

Type C has a camera front combined with detachable back for double dark slides.

Type D is fitted with a detachable Eastman's rollholder for transparent films.

The common fronts admits of any of the three backs being used.

The detective camera is fitted with a group antiplanet (25, 33 or 38 millimeter aperture) and an instantaneous and time shutter.

Stereoscopic Camera.

Fig. 18.

Fig. 19.

Types A, B, C of the detective form are also made as stereoscopic cameras for $8^1/_2 \times 17$ centimeter plates and are fitted with two accurately paired group antiplanets (21 millimeter aperture) and stereoscopic instantaneous and time shutter.

Pasquarelli Camera.

Fig. 20.

Fig. 21.

Detective camera with Pasquarelli's plate changer *(German patent No. 54014 of 30. IX. 90, Austrian-Hungrian patent 53157/8974, French patent No. 202525, Italian patent No. 10036, British patent No. 20009, U. S. patent No. 445232, 27. I. 1891)* made for plate sizes 9×12, and 6×9 centimeter and arranged to take 12 plates or films.

The plates are changed and registered automatically by the simple turning of a lever.

This camera is also fitted with a group antiplanet (25 or 21 millimeter aperture) and with instantaneous and time shutter.

By the addition to these detective cameras of rack and pinion adjustment and single screw nuts they may be placed upon stands for accurate focussing and quiet exposures.

Universal shutter

for instantaneous and time exposure, made of metal throughout, encased in brass or aluminium and fitted with steel mechanism; simple and quick manipulation, adjustable rapidity, precise action without shock.

Fig. 22.

The shutter opens and closes from the center. The most efficient part of the objective is thus made to act throughout the exposure. It is fitted with pneumatic releasing mechanism. The shutter is designed for being placed partly before and partly between the lenses. — It is made in 5 sizes up to 52 millimeter aperture and also in the form of stereoscopic shutters with two identical apertures placed 85 millimeter apart.

Astronomical and Physical Instruments.

Achromatic Telescope Objectives

of short focus, brightness f/4; composed of three cemented lenses, being one crown glass lens placed between two flint glass lenses, in brass mount.

Achromatic Double Objectives, reversion of Fraunhofer's formula, i. e. flint in front, brightness f/10 to f/18 free from distortion (vid. Dr. Ad. Steinheil's paper in the *„Sitzungsberichte der Münchener Academie der Wissenschaften", Vol. XIX, 1889, p. 413, entitled „Ueber den Einfluss der Objectivconstructionen etc.")*

Astro-Photographic Objectives

composed of two cemented lenses made of glass which absorbs only a very small portion of the chemical rays, corrected for the chemical part of the spectrum regardless of the position of the visual image; field 2^0 to 3^0; specially constructed for sideral and seleno-photography (vid. the papers of Dr. Scheiner, assistant at the Potsdam observatory, in the *„Zeitschrift für Instrumentenkunde", Oct. 1891, p. 374: „Photographische Himmelskarte"* and also in the appendix of the *„Abhandlungen der Königl. Preuss. Academie der Wissenschaften zu Berlin, 1892, Sitzungsberichte, Vol. XXXII, p. 583 etc.: The large cluster in Hercules."*

Oculars.

A. Astronomical Oculars.

A D Mittenzwey Ocular; convexo-concave collective lens and plano-convex eye lens; the image is formed between the lenses; field about 50^0; free from reflections.

Achromatic Micrometer Oculars.

A F Double Ocular consisting of two achromatic objectives; image before the lenses, apparent field about 40^0.

A G Monocentric Micrometer Ocular, consisting of three cemented lenses (2 flint glass menisci and a spherical lens); all radii struck from the same center; completely free from all reflections; apparent visual field about 36^0.

A H Aplanatic Micrometer Ocular, also consisting of three cemented lenses (1 biconvex crown lens placed between 2 flint menisci) and, therefore, entirely obviating reflections; free from distortion, inter and extra-axial achromatization. The image is perfectly flat and the first surface is far removed from the plane of the image. For this reason these oculars are specially suited for use in conjunction with cross line micrometers; apparent field about 20^0.

B. Terrestrial Oculars.

B D Four plano-convex lenses; images formed before the first and between the third and fourth lenses; apparent angle about 44°.

Reading Telescope

for magnetic observations, without steel or iron; brass tube; ocular supports with rack and pinion adjustment; made to focus distances varying from infinity to about 4 times the focal length.

Mounted on metal tripod, swinging 30° in either direction on horizontal axis; micrometer adjustment in azimuth with clamps and scale carrier.

All oculars are fitted with cross lines, the lowest power with adjustable diaphragm.

New Shortened Telescope with Negative System.

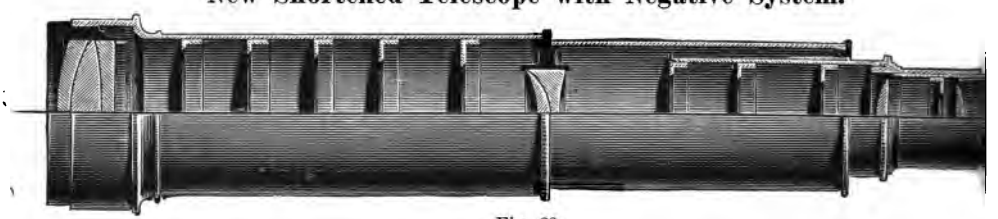


Fig. 23.

The cone of light emerging from the short focus objective is intercepted by a negative system whereby the equivalent focal length of the objective becomes considerably larger than the length of the entire telescope. High magnifications may thus be obtained with low power oculars and relatively small dimensions. Magnification and the length of the entire telescope depend upon the distance between the objective and the negative lens of certain focal length; both decrease as this distance is increased.

The objective, which has a brightness of f/4 and perfectly sharp definition, consists of a biconcave crown glass lens cemented between two flint glass menisci and has been computed together with the concave system as a cemented system consisting of a positive flint glass meniscus and a high biconcave crown glass lens. (vid. Dr. Rud. Steinheil's paper in the *„Zeitschrift für Instrumentenkunde", 1892, November.)*

Tube

of brass, with tubular stand, in polished sycamore case, portable and of elegant appearance.

Mounted horizontally and parallactically and balanced upon cast iron tripod and tubular brass pillar for standing in height of table; tripod with screws for placing the pillar vertical. Vertical pillar may be lengthened for astronomical observations. It may be fitted with divided searching circles reading to 5 angular minutes and 20 time seconds.

The achromatic double objective of the tube has an aperture of 61 millimeter (27‴) and 73 centimeter (27″) focus. The four oculars give the following magnifications: the terrestrial ocular 34, the astronomical oculars 36, 81, 108. Ocular arranged for combination with

sun glass and also with ocular prism of 27 millimeter (12‴) aperture fitted in rotating mount which may be fixed in any position, for observing stars in the vicinity of the zenith.

Shortened Tube with Objective System of 81 millimeter (36‴) aperture and 125 centimeter (46″) equivalent focus. The tube has a length of only 540 millimeter and is mounted upon a similar stand to that of the preceeding telescope.

The terrestrial magnification is 58, the astronomical magnifications are 46, 92, 138, 184 and 230.

Ocular fitted with sun glass; finder of 20 millimeter (9‴) aperture and 16 centimeter (6″) focus: magnification 6×.

Telescope with one elbow,

without stand, with brass tube and ocular movement; micrometer ocular; objective centering head.

A rectangular prism with silvered hypotenuse surface, in centering mount, is placed between the objective and ocular.

The errors introduced by the prism are compensated by the construction of the objective. The images are thus rendered perfectly correct. *(vid. Vierteljahresschrift der Astronomischen Gesellschaft, Leipzig, 1883, 18. Jahrgang, p. 255,* paper by Dr. Ad. Steinheil on „the theory of telescopes.“

Transit prismfor taking time and polar altitudes. *(vid. Kunst- u. Gewerbeblatt fuer Bayern, Munic. 1885, pp. 4—13* and *Astronomische Nachrichten. No. 569).*

Parts: Telescope of 7 millimeter (3‴) aperture and 54 millimeter (2″) focus; the astronomical ocular magnifies 8 times; sun glass; correction in azimuth and altitude. Fitted in small handy case.

Pocket Heliotrope

for signalling at great distances. *(vid. Schumacher's Jahrbuch 1844, Stuttgart* and *Tübingen, Cotta).*

The instrument consists of a horizontal perfectly plane mirror of 43 millimeter (19‴) length and 27 millimeter (12‴) width, the silver coating of which has been removed at the center so as to leave a transparent area of 3.4 millimeter (1.5‴) diameter.

While sighting through this aperture an orientation image may be seen of the sun which by means of the movable mirror may be directed to any desired point. All points covered by this orientation image are illuminated by the heliotrope. It can be recognized at a distance of 50 kilometers. This instrument replaces the telescopic heliotrope.

Goniometer,

for determining refractive and dispersive powers of various media and for measuring the angles of prisms. Mounted upon cast iron stand fitted with levelling screws. This supports a conical hollow steel center which has an alhidada attached to it. A brass spindle which may be rotated by hand and also by means of a micrometer screw

terminates at the top in a brass dish provided with spherical hollow seat. Upon this dish is placed a stage plate with spherical steel sole plate by means of which the refracting edge of the prism may be set perfectly vertical previous to adjustment for minimum deviation.

The common center of the spherical surfaces is situated at the point of intersection of the vertical axis of the instrument and the plane of the axes of the telescopes. In the focus of the objective of the slit telescope, which is provided with means for setting it horizontal and which by its bearings is rigidly attached to one of the feet of the tripod, is placed a Vierordt's micrometer double slit mechanism fitted with symmetrically moving platinum lips (by A. Kruess, Hamburgh, German patent No. 17092).

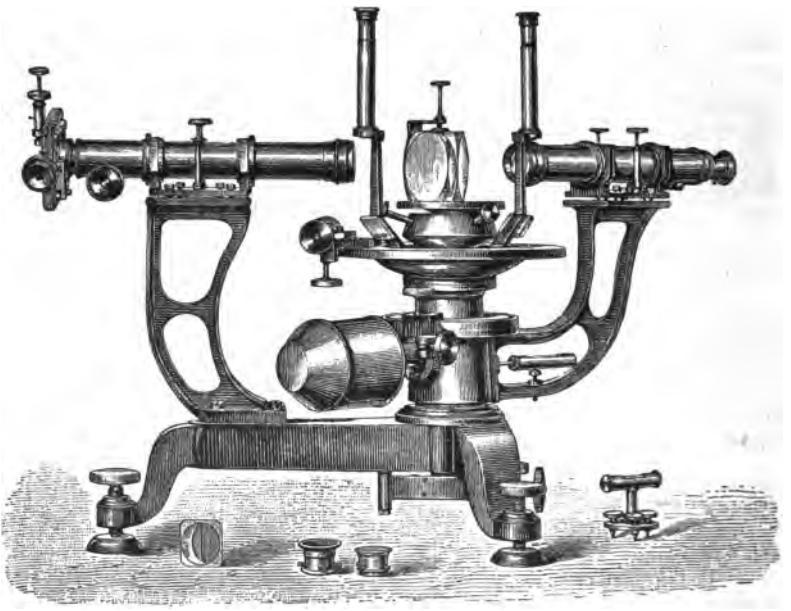


Fig. 24

The sighting telescope is also adjustable in the vertical plane and is fitted with ocular rack and objective similar to that of the slit telescope, of 27 millimeter (12‴) aperture and 244 millimeter (9″) focus. It is provided with micrometer oculars fitted with adjustable diaphragm, magnifying 12, 27, 45 × and may be rotated about the conical steel center by means of a gun metal carrier. The latter may by means of a clamping plate be fixed to the divided circle. This has a diameter of 160 millimeter (6″) and is divided on silver in 1/6 degrees.

The divisions read by the four diametrical alhidada verniers (60 parts = 59 divisions of the limb) and by two adjustable microscopes to 10 angular seconds.

(Vid. *„Handbuch der angewandten Optik“* by Dr. Ad. Steinheil and Dr. Ernst Voit, *Leipzig, Teubner 1891.*)

The goniometer may also be used as a complete apparatus for spectroscopic examinations.

Large Spectrograph,

for photographing the spectra of various illuminants. Mounted parallactically, with adjustment for correcting the polar altitude, so arranged that it may easily be placed in a horizontal position for photography of terrestrial spectra. By moving a single screw it is possible to follow the apparent motion of the sun in cases of continued exposures.

The slit telescope of 34 millimeter (15‴) aperture and 32.5 millimeter (12‴) focus is fitted with Kruess's micrometer slit mechanism with symmetrical movement of the platinum lips. There are three prisms of 50 degrees and 47 millimeter (21‴) aperture; aplanatic photographic lens of 54 millimeter (24‴) aperture and 61 centimeter (22″) focus; spectrum 20 millimeter (9‴) high and about 15 centimeter (5″) long extending from line A to N. To obviate loss of light as much as possible the objective and prisms are made of glasses which absorb the smallest possible portion of the chemical rays. A scale may be photographed together with each spectrum. Instantaneous shutter for short exposures. The adjustable dark slide admits of 3 or more exposures being made upon the same plate.

Spectrum Apparatus according to Kirchhoff and Bunsen,

first made in 1859, specially adapted for comparing the spectra of two luminous sources.

Fitted with a flint glass prism of 60°, 2 telescopes of 27 millimeter (12‴) aperture and 24 centimeter (9″) focus, magnifying 6 ×, one of these being fitted with slit mechanism. Scale telescope with 14 millimeter (6‴) aperture and 11 centimeter (4″) focus. Cast iron foot. Accessories: 2 Bunsen burners, 2 pearl carriers with stand, description and tables for reducing values for Bunsen's apparatus.

Hollow Prism,

for determining the refractive indices of liquid media; capacity 10 to 11 and 15 to 16 cubic centimeter. Glass prism of 60° enclosed by two perfectly plane surfaces. The prism has a cylindrical bore of 20 millimeter (9‴) or 27 millimeter (12‴) diameter passing through it in such a way that its axis passes through the center lines of the prism surfaces. A conical neck passes from the top of the prism to the cylindrical chamber and may be closed by an accurately fitting stopper.

Both openings of the cylinder may be closed by accurately fitting plano-parallel glass plates. The liquid which is to be examined is introduced by the conical neck.

The covers may be removed by quickly heating the external surface. To affix them it is sufficient to clean them thoroughly, to remove all traces of dust and to press them upon the perfect surfaces of the prisms.

Plane test glasses,

for testing perfectly plane surfaces. Glass No. I must fit II and III, and II must fit III with perfect exactness.

Plano-parallel Glasses

absolutely exact, in various sizes and thicknesses. According to thickness classified in

ordinarily thick, viz. 3 to 6 millimeter,
thin . . . . . 1 to 3 „
thinest glasses . . about 1/3 „

Plano-parallel Mirrors,

intended, in particular, for reflecting galvanometers, very thin, about 1/3 millimeter, in case. The plano-parallel mirrors are silvered on one side and form mirrors acting through the glass. The silver is coated with a protecting layer.

Rectangular crown glass prisms

with square cathetus surfaces, with sharp edges, absolutely correct angles and without pyramidal defects.

Triple Rutherford Prism.

Example of dimensions: Aperture of the polished surfaces 27 to 34 millimeters (12‴ to 15‴), consisting of a thallium prism of 90^0 cemented between two crown glass prisms of 20^0, which not only protect the surfaces of the thallium from oxydation but also renders it possible to make the refracting angle of the thallium prism so large that without the addition of the crown glass prisms total reflection would take place.

Aplanatic Magnifying Lenses.

These are so formulated as to possess considerable focal distance and to give an undistorted image achromatized in the central and extraaxial parts of the field (vid. M. Schultze's paper in *Schultze's Arch. f. mikr. Anat. V. II, 1866.)*

Aplanatic lens of 95 millimeter (42‴) equivalent focus; linear magnification about $2^1/_4$; large flat field suitable for examining maps etc.; in polished mounting.

Set of 6 aplanatic magnifying lenses with holder in case.
The mounting consists of a simple blackened ring.

Equivalent foci:	61	41	27	18	13	9	millimeter,
	27	18	12	8	6	4	lines,
Magnifications	3.5	5.3	8	12	16	24	

Set of 5 aplanatic lenses in folding mount; in case:

Equivalent foci:	41	27	18	13	9	millimeter,
	18	12	8	6	4	lines,
Magnifications	5.3	8	12	16	24	

Terrestrial Telescopes.

Hunting draw telescope

in bronzed brass mounting, two draws and sun shade; 34 millimeter (15‴) aperture and 32 centimeter (12″) focus magnifying 15 times, particularly bright field.

Leather case and tree screw.

Panorthic Monocular

with object glass of 16 millimeter (7‴) diameter and very large field.

Polished aluminium or nickeled brass mounts. Total length 28 millimeter, weight about 12 grammes and 21 grammes respectively; for pocket or strap. They may be used with equal advantage by hypermetropic, myopic or normal sighted persons. The linear magnification is about 1.6. These telescopes are not adjustable by draws and have to be adjusted for each individual eye. For this purpose the indication of the spectacle number required for correcting the eye for distance is sufficient for the selection of the proper focus.

Panorthic Double Telescopes

(Jumelles) with double distance of lenses. *(German patent No. 28787.)*

(Examplified by one of magnification 4.4 with object glass of 47 millimeter (21‴) diameter and 12 glasses. Aluminium mount and Russian leather cover. Double draws and adaptable to width of user's eyes.)

This special form of Galileo's telescope is particularly distinguished from all other existing forms in that its achromatization is of a higher order and that, consequently, the definition is greater. Even when the instrument is placed at an angle to the normal direction brillantly illuminated objects sharply set off by the back ground show hardly any coloured fringes.

The ratio of the magnification of the telescope to the size of the field is, in spite of these points of excellence, not less, in many cases even greater than with other types. There are, as a rule, 8 glasses in a double telescope of this kind. Of these, two cemented lenses form the objectives, while the oculars consist of two lenses separated by a short distance. Only in the case of relatively high magnifications (4.4×) each of the ocular lenses consists of two cemented lenses; in this case the double telescope contains 12 lenses.

No. 2794.

Emil Sydow, Berlin NW.

13, Albrechtstrasse.

University Mechanician and Optician, Maker of Ophthalmic Instruments.

Speciality: Ophthalmoscopes, Laryngoscopes, Reflection mirrors.

Awarded several Gold and Silver Medals and Diplomas.

Motto: „Ein Mann, der recht zu wirken denkt,
Muss auf das beste Werkzeug halten."
Goethe.

I. **Complete Set of Standard Test Lenses;** solid walnut case lined with red velvet. Double scale. Lenses ground and numbered in terms of dioptra; mounted in gilt or silver-plated frames, fig 1, on page 121. (Catalogue No. 133). Cylindrical lenses partly greyed for quickly finding the axis. Lid of case made to readily open.

II. The same set in rose-wood case, inside polished ebony. Lid of case made to readily open.

III. The same set. Case of solid walnut throughout. Removable lid.

IV. **Military Spectacle Test Case, No. II,** as used by the German Army Administration; made of oak, exactly according to the direction of the military autorities. Fig. 2. (Catalogue No. 139.)

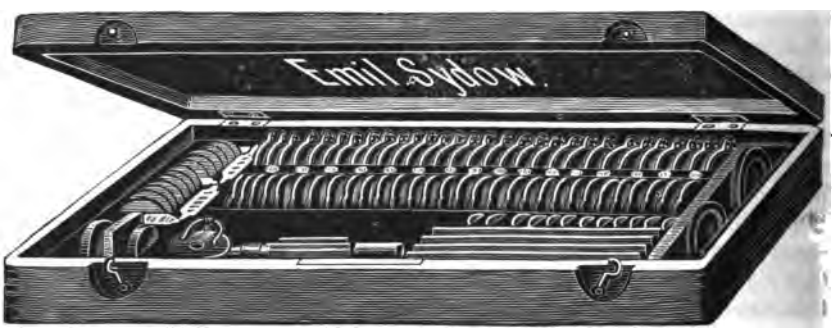


Fig. 2. (Catalogue No. 139.)

Ophthalmic Instruments: Liebreich's Large Stable Ophthalmoscope; Demonstration model on stand, fixing to table, complete; mahogany case. **Ruete's Ophthalmotrope.** Large demonstration model.

Stockes's Variable prism; indicating 1—30°. Stenop. Variable Hand Folding Glass.

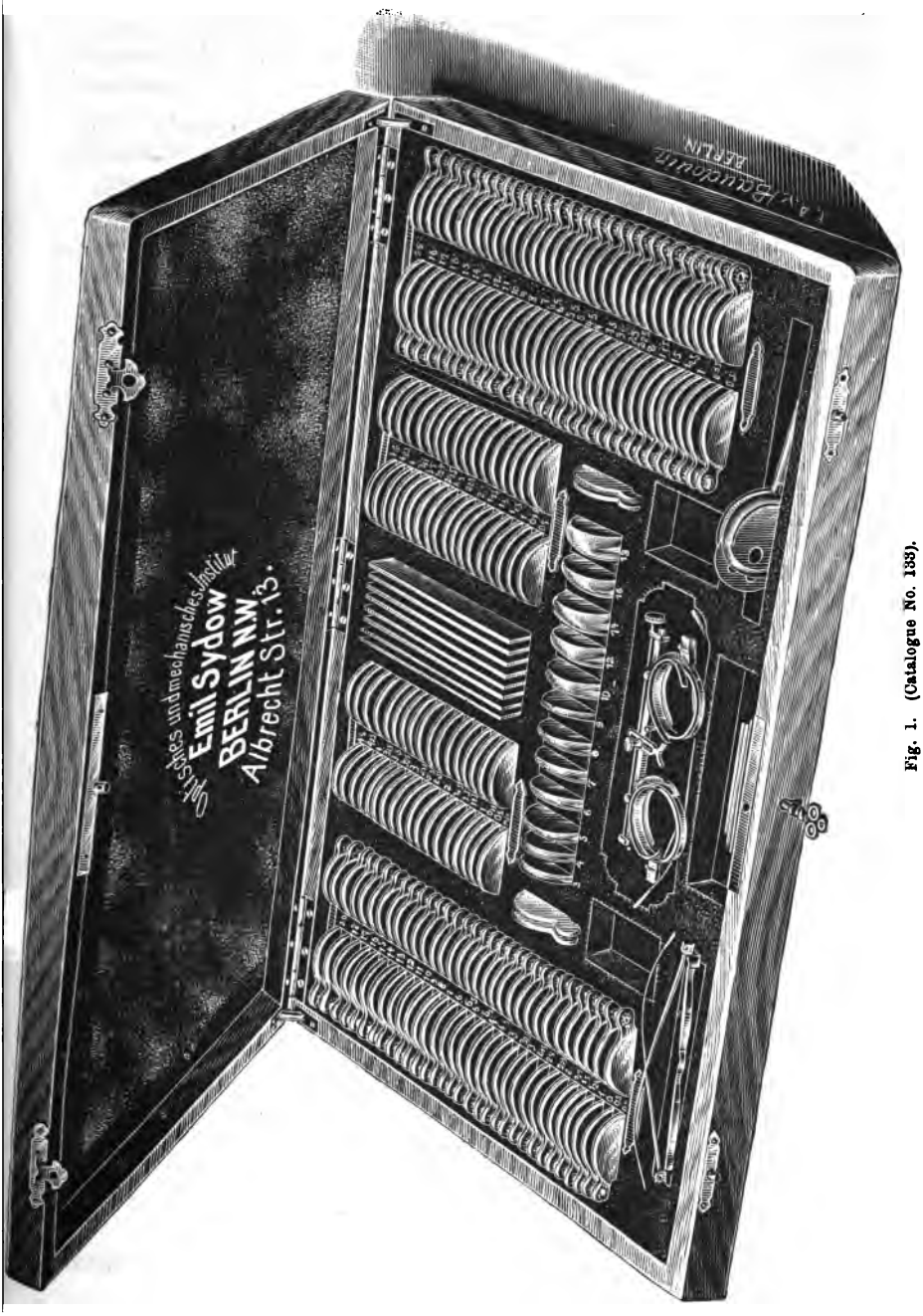


Fig. 1. (Catalogue No. 133).

Gerloff's Orthoscope. Burchard's Stereoscope. Placido's Keratoscope. Galezowski's Strabometer. Horstmann's Strabometer. Laurence's Strabometer. Glass strabometer. **Schweigger's muscle gauge. Snellen's International Colour Scale with spectacles.**

Burchardt's International Sight Tests. Schweigger's Sight Tests. Snellen's and also **Nieden's Sight Tests. Dr. Louis Wolffberg's Relievo Plates;** Edition 1893. **Dr. Louis Wolffberg's** Apparatus for Colour Diagnosis. **Wolffberg's** Perimeter objects.

Electrical Apparatus. Schweigger's newest Electrical Ophthalmoscope, with adjustable incandescent light.

(Entirely new 1893 pattern)

Latest Electrical Cornea Lens, excellent for direct illumination.

Schweigger's Binocular Electrical Ophthalmoscope (Latest 1893 pattern.)

Sciascopes: Schweigger's Sciascope, Latest form.
Roth's „ , „ „
Wolff's „ , „ „ , aluminium.
Roth's Sciascope and Phacometer (New).

Refraction Ophthalmoscopes: Knapp's Refraction Ophthalmoscope.

Schweigger's and **Loring's** Refraction Ophthalmoscope.

(Latest form with toothed wheels)

Roth's Refraction Ophthalmoscope.

(Entirely new automatic pattern)
Patented in Germany, D. R. P. No. 66215.
(Unsurpassed construction.)

Burchardt's Refraction Ophthalmoscope, combining all test lenses contained in the spectacle case and going even beyond these.

Loring's, Morton's, Lyder's and **Borthen's, Hirschberg's** (two patterns), **Julers's, de Wecker's, Landolt's, Noyes's, Haab's, Swanziger's, Grossmann's** and various other Refraction Ophthalmoscopes.

Test Spectacles: Light! Of Aluminium! Light!

Burchardt's Universal Spectacle, with toothed wheel adjustment; excellent instrument for all occurring measurements.

Gutman's Universal Spectacle.

Nachet's, Schweigger's, Burchardt's and other Universal Spectacles.

Perimeters: Pedrazzoli's Perimeters **(New entirely original construction).**

Foerster's Perimeter. **Blix's** Self registering Perimeter.

Schweigger's Hand Perimeter, extremely practical (560 sold), fig. 3. (Catalogue No. 162.)

Fig. 3. (Catalogue No. 162.)

Laryngoscopes. Various Reflectors of aluminium mounted in bronze.

Copper plated Laryngoscope.

Laryngoscopic sets. Illuminating lamps.

Lenses: Hartnack's Spherical Lens, with two powers mounted together.

Hartnack's Spherical Lens, **Bruecke's** and **Zehender's** Lenses. Various specimens.

Miscellanea: Hilgendorf's Auxanograph. Apparatus for sketching small natural objects.

New Automatic Plugging mallet, with elbow joint.

Selle's Microscope Mirror.

Luxurious Special Catalogue Gratis on Application.

No. 2795.

Ludwig Tesdorpf, Stuttgart. (Wuerttemberg.)

Maker of Scientific Precision Instruments.

Adress for letters: L. Tesdorpf, 81 Augustenstrasse, Stuttgart.
Telegraphic address: „Tesdorpf, Stuttgart."

SPECIALITY:

Astronomical Surveying Instruments of the most advanced type and highest degree of excellence.

The firm was established in 1881. — Highest references. Export to all countries. — Instrument maker to many home and foreign governments. — Now exhibiting at International Exhibition for the first time.

For want of space only surveying instruments are being exhibited. But also portable and stationary transit instruments, universal astronomical instruments, refractors with and without parallactic mounting, telemeters (for measuring distances for coast defence) are made in the works.

The firm undertakes the manufacture of scientific instruments of precision according to drawings and sketches.

Catalogues in German and French of all the instruments made in the works may be had gratis and post-free on application.

No. 1. **Tachygraphometer**, Wagner and Tesdorpf's latest type. This instrument, which is intended for speedily working out general and detailed plans, is particularly adapted for land-surveying, **rail-way, canal, road** and **military surveying.** The apparatus is only apparently complicated; in actual use it is **extremely simple as regards its manipulation.** (See Fig. 1.)

Theory of the instrument: The instrument described in the following paragraphs **solves all problems.** with which other tachymetrical theodolites have to be worked out by calculation, **automatically** by purely graphical means. It dispenses with the calculation of the coordinates of the positions of the staves (by the tachymetrical formula $E = D \cdot \cos^2 \alpha$ from the oblique distance measured with the telescope and the divisions sighted on the staff). **The horizontal distances** from the center of the instrument to the position of the staff **and also the absolute elevation above the sea-level are directly projected without the assistance of tables or slide-rules.** (By slightly pressing upon the needle apparatus the readings are instantaneously transferred to the paper, in any desired scale 1 : 500, 1 : 1000, 1 : 2000 etc.)

Description of the principal parts:

1. **The upper body.** The tachymeter itself, which is mounted upon a **metal base-plate P** opened in the center, rests upon three ivory wheels, which can be adjusted vertically and run in accurate guides. The pillar in the center supports the telescope and the distance scale A.

2. **The telescope** mounted on horizontal trunnions, clamp and vertical micrometer adjustment; adjusted for central transit, fitted with new distance

measuring ocular constructed on Reichenbach's principle with adjustable web; objective of 32 millimeter diameter magnifying 36; reversion level with sensibility of 12 sec.

3. **Distance scale A**: connected with the telescope. reading to millimeters to both sides of the zero point; the divisions on the right hand side of the zero point are used when the telescope is placed in its usual position, the divisions on the left hand side are to be considered when the instrument is used as a transit-theodolite.

Note: Upon this scale the distance pointer B fitted with automatic spring stop is made to slide easily. With reductions of 1 : 1000 distances of 210 to 230 meters can be taken, with reductions of 1 : 2000 these distances may, therefore, vary from 420 to 460 meters.

Fig. 1.

4. **The pointer B,** which slides along the distance ruler A, is fitted with two verniers. The lower vernier serves to adjust the distance read off the distance rod, the latter being throughout divided in decimeters and centimeters. The upper vernier is made to rotate and is fitted with special vertical correction and is so arranged that with any position and inclination of the telescope the divisions of the projection triangle R are automatically closely approached by the vernier as soon as the triangle is raised.

Note: When the vernier is on the zero point of the scale A the edge of the upper vernier coincides exactly with the center of the telescope axis.

5. **Scale F** affixed to P, reading to 1 millimeter, for taking the horizontal projection of the oblique distance adjusted by scale A.

6. **Scale G** on the base-plate P, with controlling divisions reading to 1 millimeter and vernier, serving as guide for the sliding-piece K with needle apparatus.

7. **Projection triangle R,** running on wheels with automatic spring stop. By means of this triangle the oblique distance adjusted by scale A is projected with the aid of a vernier upon scale F.

Note I: The vertical scale of this triangle, which reads to 1 millimeter, is not numbered, on account of the great variability of the elevation; heights from 10 to 10 millimeters may, however, conveniently be marked upon the celluloid strip let in for this purpose with lead-pencil and these notations are again easily removed. This vertical scale may be used without changing the notation for differences in height, provided the differences of level between two points of observation do not exceed 15 meters (being 15 millimeters of the scale divisions).

Note II: The projection triangle has at its underside a lug projecting downwards which fits into a cavity in the sliding piece K; this causes the needle apparatus to describe always the same path along the divided ruler F. The readings of scales F and G must, therefore, always agree.

8. **Sliding-piece K** is attached to the needle apparatus. The latter serves to transmit the projection of the distance taken by scale A to the drawing paper.

9. **The wheels.** By means of these and a box bubble placed within the pillar the apparatus is levelled.

Note: The three axes of rotation of the wheels intersecting in the common center of the apparatus, which lies exactly vertically below the center of the telescope axis and at the front edge of the base-plate, the apparatus rotates freely round this point (the zero point of the adjustment). By means of a break attached to one of the wheels the position of the apparatus may be fixed at any moment.

10. **Centering ruler.** This serves to maintain an unchanged adjustment of the instrument while several readings are being taken from one point. This ruler, which has a round projection and diaphragm, is held down upon the paper with the right hand. While taking hold of the pillar with the left hand and moving the instrument with its corresponding round cavity towards the ruler the apparatus may be freely rotated round this center.

Note I: The center of the round cavity, into which the centering-ruler is inserted, lies exactly vertically below the center of rotation of the axis of the telescope.

Note II: When all the verniers are in their zero positions, then also

1. *the edge of the triangle R must coincide with that of the rotating vernier of the sliding piece B.*
2. *the needle point of the sliding piece K must be exactly above the center of the round cavity at the front edge of the base-plate P.*

The under-structure: Principal parts: Stand with Tesdorpf's Tripod Levelling Arrangement, clamp and micrometer levelling adjustment with horizontal tribrach base-plate.

Circle: 10 centimeter diameter, reading to 1/2 degrees, with 2 verniers reading to 1 minute.

Upper sole-plate: tribrach, upon which the apparatus may be mounted in a two-fold manner:

1. for use as a **tachymetrical theodolite,** in all cases where the tachymeter is screwed directly upon this plate;
2. for use as a tachymetrical transit theodolite, in cases where the surveying-table **M** is brought into requisition.

Surveying-table M with rollers S and ratched wheels A for conveniently stretching the drawing-paper.

Note: Upon one of the rollers the finished drawing is rolled up, whilst the other roller deals out fresh paper. The rollers are for this purpose made to move laterally in order that in such cases where the drawing envolves considerable curves it may be displaced sufficiently to keep the vertical pressure of the apparatus near the axis of the lower structure.

Vid. „Jordan, Zeitschrift für Vermessungswesen". 1886. Heft 14 and 16.

No. 2. **Large Compass Theodolite** with repeating arrangement. Horizontal limb of 20 centimeter diameter, with hood and glass-covers above verniers. Vertical circle of 17 centimeter diameter of opening. Both circles divided on silver in $1/6^0$, reading by verniers to 10 sec. directly or 5" by estimation. The vertical circle has besides $^0/_0$ divisions, and its rim is divided by deeply cut lines in $1/2^0$ throughout; figured in terms of zenith distance for better finding fixed stars for geographical orientation. The compass has a needle of 12 centimeter length. The telescope is made to freely revolve on its axis; it has an aperture of 33 millimeter and magnifies 36 times; there are two oculars (1 orthoscopic and 1 inverting ocular for zenith readings), and 2 sun-shades; the telescope axis is traversed by webs, fitted with lamp at side and central reflector for illuminating the field. Crossed levels on alhidada of horizontal limb. Alhidada level with micrometer adjustment for altitude circle; striding level with correction screws resting upon carneol cylinders. Mounted on English model stand. See Fig. 5.

Packed in two cases of polished walnut, containing also plummet, screw-driver, camel-hair brush and lubricating oil.

No. 3. **Repetition Theodolite.** Horizontal spoked circle of 17 centimeter diameter, vertical circle of 12 centimeter diameter, divided on silver in $1/3^0$, two verniers reading to 20", by estimation to 10". Both circles with metal hood and glass covering. Telescope magnifying 30 times. Diameter of objective 32 millimeters. Orthoscopic ocular. Telescope-level, pillar-level and striding level. Alhidada level for the altitude circle. Tesdorpf's tripod horizontal adjustment. See Fig. 4.

Packed in polished walnut case, with necessary fittings and stand.

No. 4. **Compass Theodolite,** similar to No. 5. Horizontal circle 12 centimeter diameter, divided in $1/3^0$; vertical circle of 10 centimeter diameter divided in $1/3^0$, reading to 20". Compass needle of $5{,}^5$ centimeter length; lamp. Tripod with Tesdorpf's horizontal adjustment. Stand and case. See Fig. 2.

Note: The Theodolites No. 2. 4. 5. 6. have besides divisions in $^0/_0$. like No. 20.

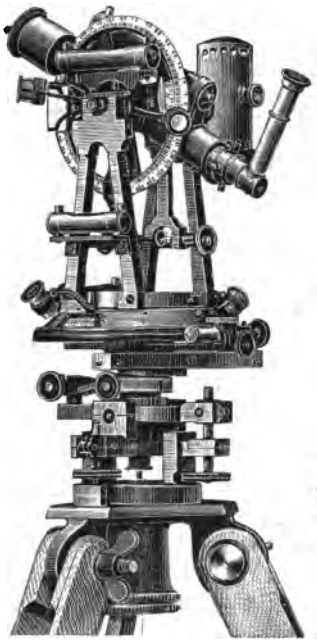


Fig. 2.
Theodolite No. 6.

Under structure of the theodolites with respect to the arrangement of circles, axes and Tesdorpf's horizontal tripod adjustment.

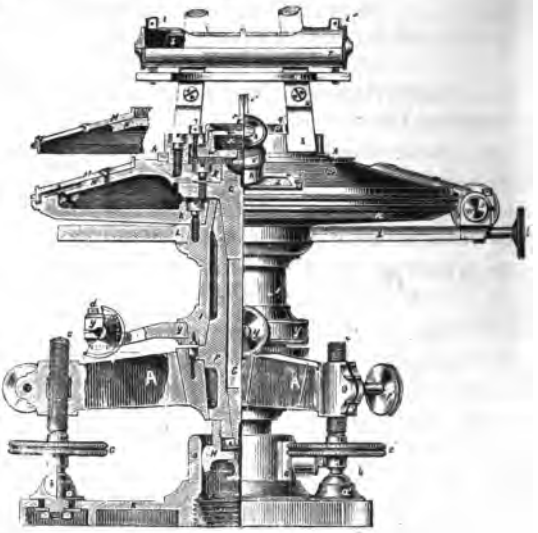


Fig. 3.

Fig. 4.
Theodolite No. 3.

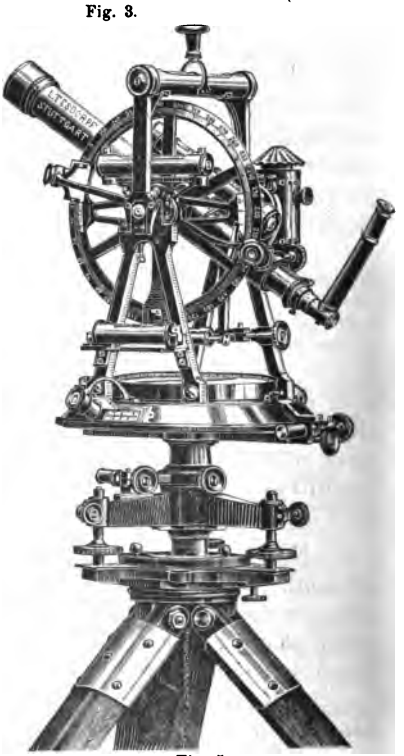


Fig. 5.
Theodolite No. 2.

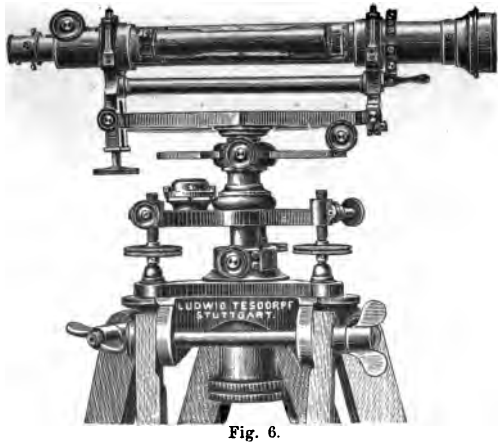


Fig. 6.
Level No. 8.

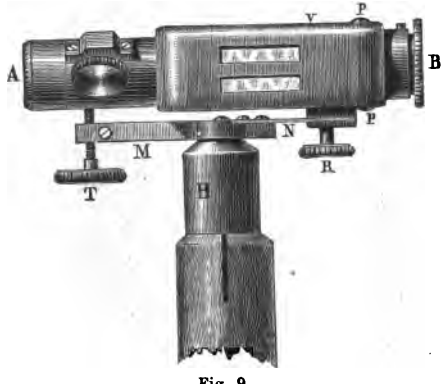


Fig. 9.
Level No. 17a on staff.

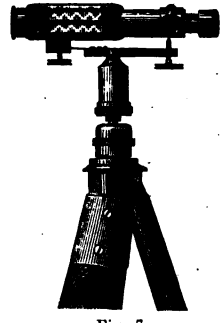


Fig. 7
Patent Pocket Level No. 17a on english model stand.

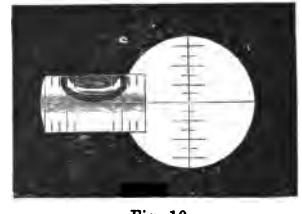


Fig. 10.
View of the level and glass micrometer, the latter divided in 1/2 %, through the eye piece.

Fig. 8.
Patent Level No. 9.

Fig. 11.
Inside of the levelling instruments No. 16 & 17a.
S = mirror. L = level.

Fig. 12.
Xylometer No. 41.

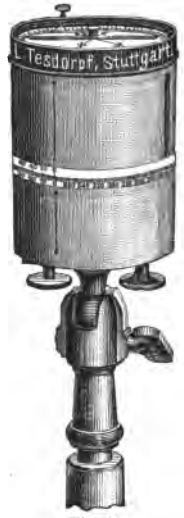


Fig. 13.
Pantometer No. 26.

Fig. 14.
Levelling Instrument No. 15.

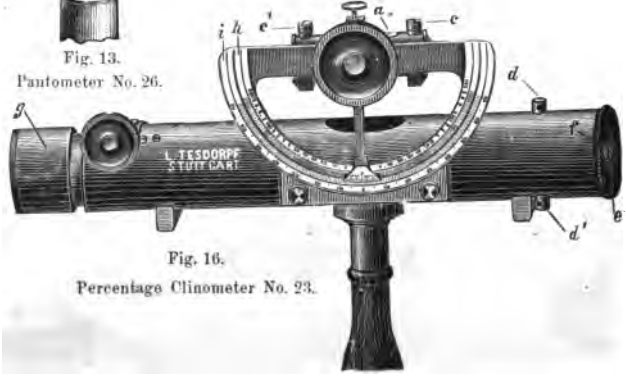


Fig. 16.
Percentage Clinometer No. 23.

Fig. 15.
Universal-Instrument No. 18.

No. 5. **Compass Theodolite with Repeating Arrangement.** Horizontal circle 15 centimeter diameter. With hood and glass covering. Divided on argentan in 1/6°, reading by 2 verniers to 10". Vertical circle of 12 centimeter diameter, divided in 1/3°, reading by 2 verniers to 20". Compass with needle of 10 centimeter length, dial divided in $^1/_1{}^0$. Telescope with 2 oculars (1 orthoscopic, 1 inverting for zenith readings) with 2 sun-shades. Magnifying 24 times. Alhidada level on the horizontal circle. Pillar level, alhidada-level for the vertical circle with micrometer adjustment; telescope-level. Case and English model stand, lamp for illuminating the cross-hairs; distance measuring scale 1:100. Tripod with Tesdorpf's horizontal adjustment.

No. 6. **Compass Theodolite.** Travelling theodolite, similar to No. 4. Horizontal circle of 10 centimeter diameter, divided in 1/2°, reading to 1 minute; vertical circle of 8 centimeter diameter, divided in 1/2°, reading to 1 minute. Compass needle of 4.5 centimeter length; dial divided in 1/1°; 2 oculars; telescope magnifying 20 times; lamp. Patent horizontal adjustment. Case and stand. (See Fig. 2.)

No. 7. **Small Travelling Theodolite.** Tachymeter-theodolite. Divisions on argentan. Both circles of 8 centimeter opening, divided in 1/2°, reading to 1 minute, or 30" by estimation. Telescope magnifying 21 times with objective of 20 millimeter diameter. Box bubble; pillar, telescope and striding levels. Detachable Compass with parallel ruler; length of needle 7 centimeter. Patent horizontal adjustment. Case and English model stand.

No. 8. **Precision Levelling Instrument.** Telescope with hard cast rings resting upon carneol prisms, magnifying 36 times; orthoscopic ocular. Centering objective. Horizontal clamp with fine adjustment. Elevation screw for conveniently and quickly adjusting the reversion level (of 6 sec. sensibility) attached to the side of the instrument. Tripod horizontal adjustment. (See Fig. 6.)

No. 9. **Patent Precision Levelling Instrument.** Telescope with hard cast rings resting on carneol prisms. Magnifying 24 times. **The reversion level** (Sensibility 6—10"), which is visible in the ocular field, **is protected from heat, sun-light or other extraneous influences** in general by metal hoods fitted with ground glass windows; these allow the level to be illuminated in a manner which is most pleasant to the eye. By throwing the hoods back the level may be used in the ordinary way. Mounted upon Patent horizontal adjustment. (See Fig. 8.)

Note respecting Nos. 8 and 9: These instruments, fitted with reversion-levels, have, as compared with other designs fitted with detachable or reversible levels, the important advantage that they dispense with the inconvenience of adjusting the level, also with the reversion of the telescope in its bearings.

These instruments, which are intended for most accurate measurements, can be used without preliminary careful adjustment. The manipulation is simplified in the same degree that the accuracy is increased. The **manipulations** consist in: Adjustment of the level: position I (level on the left); rotation of the telescope in its bearings through 180°; second adjustment of the level: position II (level on the right).

The arithmetical mean of both readings on the rod gives the true horizon.

On the same principle also larger instruments are made magnifying 30, 36 and 60 times.

No. 10. **Levelling Instrument** with fixed telescope mounted on long vertical axis horizontal fine adjustment; telescope of astronomical magnification 30; level of sensibility of 13" per interval of 2 millimeter. Mounted on stand with Patent horizontal adjustment. English model stand.

No. 11. **The same** without fine adjustment; terrestrial magnification 20.

No. 12. **Levelling Instrument** with fixed telescope mounted upon long vertical axic. Horizontal fine adjustment. Telescope with astronomical magnification 21. Patent horizontal stand adjustment.

No. 13. **The same** without clamp and fine adjustment; astronomical ocular 21.

Note: If a terrestrial ocular be used the magnificatien, the tube length being the same, will be 14.

No. 14. **Universal Levelling Instrument** with elevation screw; telescope magnifying 21 times; horizontal circle of 8 centimeter diameter, divided in $1/2^0$, reading to 1'; on light stand, Canvass case.

No. 15. **The same,** without circle, on a lighter stand, in case. See Fig. 14.

No. 16. **Patent Pocket Levelling Instrument** (Wagner's). Telescope magnifying 18 times; reversion-level encased and protected from external influences; bubble directly visible in field of ocular; mounted upon light stand. In leather case. See Fig. 7, 9, 10, 11.

No. 17a. **The same,** with telescope magnifying 12 times; on light stand. **0.5 centimeter can be conveniently read off at a distance of 100 meters. Degree of accuracy: $\frac{1}{20000}$ of the distance.**

No. 17b. **The same,** with telescope magnifying 12 times, in case.

No. 18. **Universal Instrument,** for general plans. Patent »Schmalkalden« Compass with prism, lens and folding-sights, circle divided in 400^0, reading to single grades or 20' by estimation; telescope magnifying 12 times; surveying level of sensibility of 20" fitted with hinged mirror for convenient reading; altitude arc divided in 1/2 grades, reading to 1', besides $^0/_0$ divisions. Degree of accuracy: 5 millimeter per 100 meter distance. In polished walnut case. See Fig. 15.

No. 19. **Instrument for Chain and Compass Survey.**

Small handy instrument for limited areas, The instrument is fixed upon a rod; it is fitted with patent »Schmalkalden« compass; circle divided in 360^0 reading to 1^0, by estimation to 12'.

For measuring rise and fall in terms of $^0/_0$ the diopter instrument No. 20 will be found useful.

No. 20. **Diopter instrument. Type I.** Hand instrument with handle; in case, sail-cloth or leather, as preferred.

Altitude arc divided in $^0/_0$, viz. $0—50^0/_0$ reading $1^0/_0$, $50—100^0/_0$ $2^0/_0$.

The levelling bubble a, (fig. 16) being projected by reflection into the diopter tube may in a moment be brought into its horizontal position during the sighting operation without changing the position of the eye; the level is during this process brought into play by the milled head e.

Bubble a and the pointer are rigidly connected and may be rotated together by means of the milled head.

During each sighting operation this milled head is turned until the bubble appears upon the metal mirror fixed at 45° inside the diopter tube in a symmetrical position with respect to the horizontal cross web. The corresponding altitude can be read directly off the altitude arc.

h = scale of percentages reading to 1%,

i = scale divided in 1/1° reading by vernier to 10 minutes.

No. 21. **The same. Type II,** to fix on staff, with horizontal axis and vertical trunnions, extremely serviceable for general preliminary work or subordinate cross sectional measurements. 2 divisions, for direct reading of rise and fall in percentage. In case with rod.

No. 22. **The same. Type III,** combined with small horizontal circle of 7 centimeter diameter, divided in single degrees, reading to 2', sights as in No. 20. In polished walnut case.

No. 23. **Percentage Clinometer** and **Hand Levelling Instrument.** Combination of No. 20 **with telescope magnifying 12 times.** This instrument has, like Nos. 9 and 17, the front of the ocular fitted with a second lens for viewing the reflected image of the bubble, whereby it is possible to sight the bubble and object simultaneously. See Fig. 16.

No. 24. **Patent "Schmalkalden" Compass** for holding in hand or for screwing upon staff: in leather case.

No. 25. **Hypsometer.** Handy instrument for general forest survey, in particular for forest valuation. This instrument may be used for simple levelling, measurements of heights and distances. Degree of accuracy: 5%.

No. 26. **Pantometer** for limited areas. Horizontal circle reading to 2', with compass and adjustable sights; in polished walnut case.

Note: Instead of the usual hairs the instrument is provided with metallic sight webs. See Fig. 13.

No. 27. **Optical Square,** simple form. Large size.

No. 28. „ „ Small „

No. 29. „ , with three mirrors for setting off angles 90° and for ranging lines.

No. 30. **Prismatic Square,** in case.

No. 31. „ , watch form, in case.

No. 32. **Box bubble** for screwing to levelling rod; accessory to Nos. 1.

No. 33. **Box compass;** declination compass; accessory to No. 1.

No. 34. **Cartometer** with three wheels, in case. This instrument serves, like the planimeter, for computing boundaries. See Fig. 17.

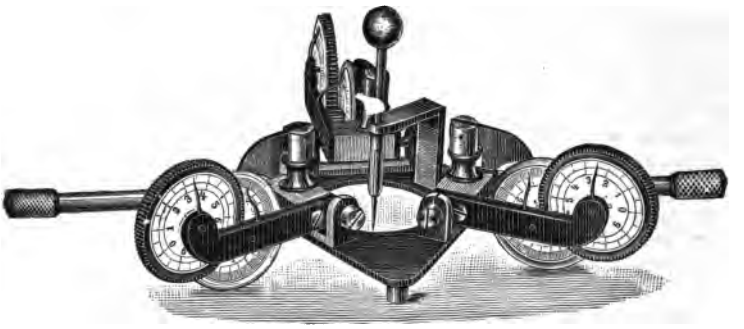


Fig. 17.
Cartometer No. 34.

No. 35. **Cartometer** with 5 wheels, in case.

No. 36. **The same,** with 7 wheels, in case.

These patent cartometers serve for computing the lengths of lines of any form, curves, spirals, serpentines etc.

Special features of the apparatus: (No. 34—36.)

1. Greatest simplicity of manipulation and great accuracy.

2. Lines can be traced backwards and forwards without interruption, the wheels being alternately thrown in and out of gear according to the direction in which the apparatus is made to follow the lines.

The absolute length L results immediately from the product of the arithmetical mean (m) of the tracings made by the instrument with 3, 5 or 7 wheels and the constant K attached to each particular instrument.

$$L = m.\ K.$$

Example:

Ist tracing Position of wheels before, N_1 after tracing, N_2
IInd tracing „ „ „ „ N_3 „ „ N_4
then $N_2 - N_1 = n$, $N_4 - N_3 = n_1$, and $m = \frac{n + n_1}{2}$

No. 37. **Pachymeter** for measuring the thicknesses of metal, paper, card board. for workshop use. Reading directly to 0.005 mm; measuring up to 5 mm.

No. 38. **Pachymeter,** larger size. Divided wheel of 85 mm diameter, with reversible jaw, suitable for cartridge manufacture. Reading directly from 0.005 to 5.0 mm.

No. 39. **Protactor ruler,** made of argentan, semicircle of 20 cm diameter, divided in 360°; $^1/_2{}^0$, reading to 2' with ruler 0.5 m long. Clamp and fine adjustment.

No. 40. **Protractor** for tachymetrical surveying (radial ruler without centration), with special adjustment of the magnetic deviation.

No. 41. **Xylometer,** apparatus for determining the specific gravity of various species of wood; for scientific determination of the qualities of woods.

No. 42. **Hand Compass,** mounted upon staff, with ball and socket joint, and vertical axis of rotation.

No. 43. **Bertram's Heliotrope,** mounted upon wood base. (Signalling apparatus for long distance surveying.)

No. 2796.

Wilhelm Uebe, Zerbst-Anhalt.

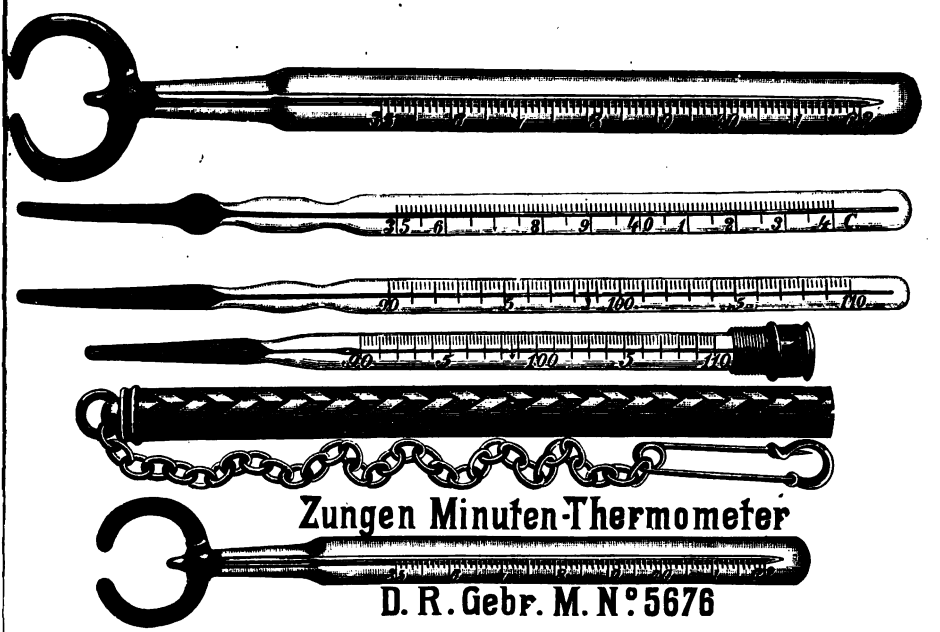
Maker of Chemical and Physical Glass Instruments.

Exporter of thermometers of all kinds, and Glass goods for clinical purposes.

Speciality: Self-Registering Fever Thermometers, with Absolutely Indestructible Index.
Clinical Maximum Thermometers.

Minuten-Aerzte-Maxima-Thermometer

Clinical Minute Maximum Thermometers,
made of Jena standard glass.
The scale backed with red to facilitate reading. Graduated accord-



Zungen Minuten-Thermometer

D. R. Gebr. M. N° 5676

ing to Centigrade or Fahrenheit's scale. With certificates. In elegant nickel, ebonite, aluminium or finest leather cases. Also with certificates of the Imperial Physical and Technical Institute in Charlottenburgh. In all existing forms. Absolutely reliable workmanship.

Tongue Minute Thermometers,

D. R. Gebr.: Registered Design No. 5676, with horse-shoe mercury bulb, exactly fitting the under-side of the tongue; very practical and highly commended by autorities.

Bath, Window and House Thermometers.

Thermometers with movable scale. Provis. German Patent.

Sole Maker: **Wilhelm Uebe, Zerbst-Anhalt,**

Maker of chemical and physical glass instruments.

Artificial Glass Eyes.

No. 2797.

Voigt & Hochgesang, Göttingen.

Principal: **R. Brunnée.**

Makers of Crystallographic-Optical Instruments. Microscopically thin sections of rocks. Minerals, Fossils etc.

I.

Microscope N. 1 A (Fig. 1) constructed according to suggestions of Prof. **C. Klein**[1]) **for advanced mineralogical and petrographic research.** This instrument is fitted with the most recent and perfect apparatus for all possible measurements in parallel polarized and convergent light. The circle, which is made of a suitable alloy, is divided in half degrees. The verniers read to single minutes. The circle is surmounted by a mechanical stage with scales and divided heads for reading and noting its position. The polarizer is so arranged that quick changes may be made from polarized to convergent light.[2]) A second polarizer with very large Nicol prism and highly refracting set of lenses and an objective of numerical aperture 1.53 render the microscope available for measurement of minerals of very low refractive power. The Bertrand lens is fitted with rack and pinion. The optical equipment of the microscope consists of the objectives Nos. 0, 1, 2, 4, 5, 7, 9, oculars Nos. 1 and 4 with micrometer, Nos. 2 and 3 with cross lines, Bertrand's ocular, Calderon's ocular, screw micrometer ocular, Babinet's compensator ocular, one dark ground Nicol prism, one quartz wedge, selenite, quartz and 1/4 undulation mica-plate.

The above described Microscope is exhibited in the exhibition of German Universities.

In the Collective Exhibition, Group 21, the following instruments and appliances are exhibited:

Microscope No. 1 B. made according to the suggestions of Prof. **Klein,** for mineralogical and petrographical research.

The construction of this instrument is precisely the same as that of No. 1 A, excepting that it is not fitted with mechanical stage and that the circle is divided in whole degrees only, the vernier admitting of reading to $^1/_{10}$ degrees.

The instrument is supplied with objectives Nos. 1, 2, 4, 7, 9 and oculars Nos. 2 and 3 with cross lines, Nos. 1 and 4 with micrometer, screw micrometer ocular, quartz, mica and selenite plate.

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[1]) Vid. Nachrichten von der Königl. Gesellschaft der Wissenschaft zu Göttingen 1884, No. 11, p. 434 etc. — Neues Jahrbuch für Mineralogie, 1883, I. Heft 2. — Mikroscop. Physiogr. der petr. wichtig. Mineralien v. H. Rosenbusch 1887, I. p. 120; 1892. I. p. 126.

[2]) Zeitschrift für Instrumentenkunde. 1891. April.

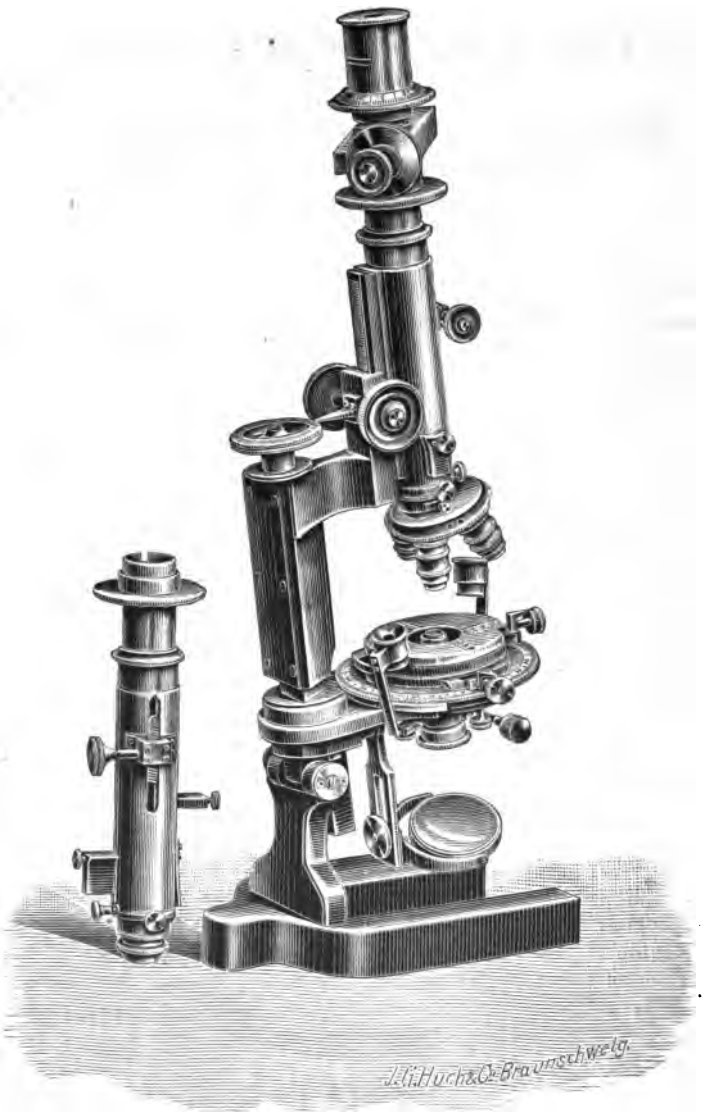

Fig. 1. A. Microscope.

II.

Prof. **O. Lehmann's Crystallization Microscope**[1]) (Fig. 2) for observing the formation of crystals at high temperatures, also during incandescence and electrolysis.

The stand is fitted with two stages revolving about the optical axis. The lower stage is completely covered and is divided in 360°. The upper stage may be adjusted independently of the lower stage.

Three mirrors serve as polarizer, two of these being fixed, while the illuminating mirror, for quickly changing the illumination, is capable of rotation.

The burner is firmly attached to the foot but can be moved aside; the air and gas supply is regulated by two screw-valves. Several blow-tubes may be attached to the stage for rapidly cooling preparations or objectives. For the examination of incandescent preparations a special objective is used; it is provided with a double casing through which a constant stream of cold water is made to flow. The preparation is placed upon a separate stage and rests upon 4 thin platinum points, whereby the loss of heat by conduction is minimized. The specimen may also, by means of two platinum wires, be connected with two ebonite mercury cups which are connected with the poles of a small battery. For electrolytical experiments at low temperatures another stage, supplied with the microscope, is used. If required the instrument may also be provided with a polarizer fitted with a lens combination. In this form it may also be used as a mineralogical microscope proper.

III.

A Collection of 115 thin sections of minerals of petrographic interest, prepared with special regard to the system of crystals and mounted according to crystallographic directions. The collection contains also crystals with certain surfaces for goniometric measurements.

This collection was compiled according to a pattern [collection arranged by Prof. **Klein.**

IV. A Collection of 100 thin sections of eruptive-rock types. To each section is appended a sample of the corresponding rock provided with one polished surface.

This collection is compiled according to Rosenbusch, *Microscop. Physiogr. 1887* and may be supplemented by 250 other rock-specimens.

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[1]) vid. O. Lehmann. Die Krystallanalyse 1890; O. Lehmann, Molecularphysik I. 1888. II. 1889.

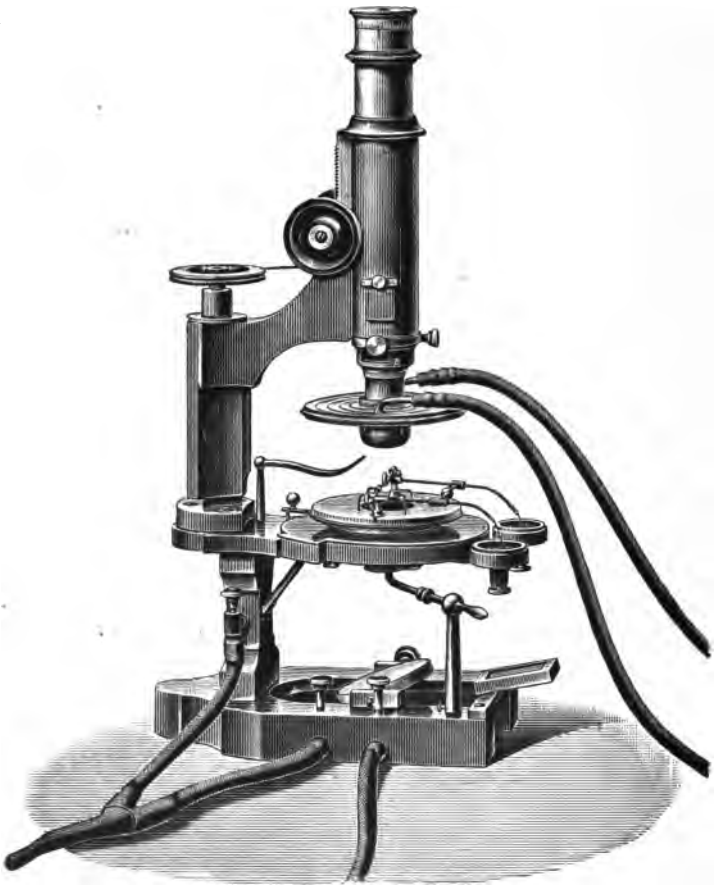


Fig. 2. Crystallization Microscope.

No. 2798.

Voigtlaender & Sohn, Braunschweig.

Optical Works.

(Photographic Objectives, Binoculars and Terrestrial Telescopes.)

The Optical Works of **Voigtlaender & Sohn** were founded by **Christoph Voigtlaender** in Vienna in 1756. In the days of the founder and his son, Frederick, the principal business consisted in the manufacture of spectacles, reading glasses, simple microscopes and hand-telescopes, in particular those of the Galileo type. This, according to present views, simple department of optical industry received a considerable impetus when **Frederick Voigtlaender** in the beginning of this century began to grind periscopical spectacle lenses and in 1811 constructed the first Binocular on the principle of Galileo's telescope. At that time, however, public requirements were too modest to encourage manufacture on a large scale; at the same time the unsatisfactory quality and the optical uniformity of the glasses which were then available and also the absence of satisfactory mechanical means greatly impeded the development of optical instruments.

Not until **Fraunhofer,** in the first quarter of this century, taught how to produce homogeneous glasses capable of variation with respect to their optical properties and suitable for optical combinations and how to determine their optical constants with scientific precision, did it become possible to make decided progress in the development of optical instruments.

The third representative of the firm, **Frederick Voigtlaender,** soon mastered and adopted **Fraunhofer's** methods and with a spectrometer, which he made himself, determined the refractive and dispersive powers of all available glasses. This enabled him to compile optical data for the computation of optical instruments; he utilised this knowledge with the greatest success and supplied the mathematician **Prof. Petzval** of Vienna with the data respecting the available glasses for the calculation of a photographic doublet. According to the calculation of **Prof. Petzval, Frederick Voigtlaender,** in 1839, made the first photographic doublet and thus inaugurated the era of photography, which within 50 years has made greater strides in its development, in the improvements of the methods and means which it envolves, and in the extension of its application to the purposes of art and trade than perhaps any other branch of industry.

The portrait lens, owing to its rapidity, furnished the first means for the photography of living objects. It differed so much in its constructive elements and in its optical powers from any optical system that had been produced previously, that it formed the basis of an entirely new class of optical instruments.

In the earlier part of the period to which we have alluded, viz in the years 1840 to 1860, photography spread very slowly; its methods were intelligible to only a small number of the scientifically educated; moreover the photographic lens of that time still possessed a serious fault, the difference of the chemical and optical foci, which, though apparently an easily curable defect in its practical consequences yet greatly retarded the popularity of photography.

In 1856 the firm succeeded in eliminating this defect by introducing another glass so as to form a compensating element. Shortly after the Collodium process became known, and it may be said that at this time portrait photography began seriously. Also the Orthoscope, the first landscape lens, which possessed a larger field, became only then practically useful; though its construction had been in the possession of the firm as early as 1841.

A few years after the publication of the first photographic lens an improvement was also made in the construction of the binoculars by the introduction of triple objectives and triple eye-pieces, whereby better means were obtained for the compensation of spherical and chromatic aberrations and also for the increase and aplanation of the field. These binoculars with 12 glasses became, particularly in England, very popular, more especially so when the firm some 30 years ago took up the manufacture of the mounting of the binoculars in brass and aluminium. The variety of these binoculars is very large indeed. Binoculars are made magnifying only $2^1/_2$ to 4 times for the theatre, and of higher power, magnifying up to 8 times, for out-door use. These are mounted in a great variety of forms, as the catalogues show (No. 1 to 56).

In the course of years, however, the firm had to yield to the variety of the demand, in particular to that of the German Navy, for optically more simple marine glasses with double objectives and single eye-pieces, containing, therefore, only 6 lenses. Accordingly such simplified binoculars with a large and bright field are now made and supplied to nearly all fleets of the world, in particular to the German Navy, the U. S. Navy and a special form with rapid movement to the Artillery of the German Army. Among the exhibits will be found a sample of this latter binocular, 5000 of which have recently been ordered by the German Army-administration, and also the aluminium model which has been adopted by the War Department in Washington.

While these binoculars were being improved and introduced to the public, attention was also paid to the improvement in the construction of hand-telescopes with terrestrial eye-pieces. These also are made by the firm in various sizes, with object glasses from 1 inch to $2^1/_4$ inch diameter, magnifying 14 to 36 times, fitted either with one drawer of the form adopted by the German navy, made of nickeled German silver, or with three draw-tubes of brass and aluminium for sporting and military purposes.

As long as the collodium process held the monopole, photography remained almost exclusively in the hands of professional photographers. The invention of dry plates opened the field to the amateur about 15 years ago. These greatly simplified out-door photography; landscape and archi-

tectural photography became the most popular branches of amateur photography. For these purposes, however, the portrait lens, with its different degrees of rapidity was not very suitable, owing to its limited field. **Frederick von Voigtlaender,** the fourth and present head of the firm, subsequently constructed in 1877 the **Euryscopes,** symmetrical lenses which gave a large flat and bright field quite free from distortion.

These lenses having rapidly become popular, various successive series were constructed of relative apertures $\frac{F}{5^1/_2}$, $\frac{F}{7^3/_4}$ and Wide Angle lenses of relative aperture $\frac{F}{9}$. These correspond to the series IV, VI, VII and VIII of the present catalogue. The advantages of the symmetrical lenses suggested also improvements in portrait lenses, and in 1883 the long focus portrait lenses were replaced by symmetrical Portrait Euryscopes. (Series II and III of the catalogue).

Until comparatively recently opticians had only a limited range of optical material at their disposal. The series of available glasses was uniformly graduated according to the percentage of lead contained in the glasses. The optical properties of these glasses varied monotonously: a higher percentage of admixed lead always resulting in higher refractive and dispersive powers.

Great changes were effected in this direction when **Prof. Abbe** and **Dr. Schott** established the Jena Glass Works and in 1886 published their new glasses. The production of these new glasses influenced the optical industry in a similar manner, though to a much greater extent, as did **Fraunhofer's** 7 glass-fusions. In the new series practical opticians found at last glasses, whose optical properties appeared to be paradoxical; there were glasses of high refraction and low dispersion and there were others of high dispersive and low refractive power; within certain limit it was even possible to couple any desired dispersion with any given refractive index.

Messrs. **Voigtlaender & Sohn** have been the first opticians who utilized this extension of the optical means in as much as they completely reformulated in 1888 their symmetrical lenses, which until then had contained two flint-glasses, and replaced the latter by two extremely transparent crown-glasses. The Rapid Wide Angle Euryscope Series V, the W. A. Euryscope Series VII and the Single Landscape Lenses IX were introduced as new species of photographic lenses.

Although all these new constructions embodied great improvements in definition and covering power, yet it was not possible with the symmetrical objective to compensate thoroughly astigmatic aberrations, the chief defect of wide angle lenses. By employing a totally dissymmetrical combination of pairs of glasses of normal and abnormal properties the firm of **Carl Zeiss of Jena** has recently succeeded in almost completely eliminating this last defect. Since the spring of 1891 Messrs. **Voigtlaender & Sohn** have by friendly arrangement with the firm of **Carl Zeiss,** added to their older series these Zeiss Anastigmatic lenses, of which 6 series classified according to their relative apertures from $\frac{F}{4}$ to $\frac{F}{18}$ are now made.

This addition, to their former series, of wide angle lenses with flat and anastigmatic field fills the last gap which had been felt.

The entire list of objectives of various classes made by the firm forms a most complete selection of lenses for all purposes and satisfies all the wants of professional, amateur and scientific photographers.

In the 137 years of its existence the firm has steadily grown and always kept pace with the requirements of the time by utilising improved methods and employing the best modern machinery. The works in Brunswick include new extensive buildings provided with high and spacious workshops electrically illuminated by own machines and accumulators. The firm employs now about 100 men. A hall of 120 square meters area has been reserved for examining and testing binoculars and telescopes, and a studio having an area of 100 square meters has been set apart for testing photographic lenses. The conditions of illuminations are so favourable in these spaces as to render experiments therein independent of the differences of light.

The lenses are ground by machinery, whilst the polishing, which is controled by standard lenses, is mainly effected by hand, in order to avoid the detrimental effects of heating to which large lenses are exposed, if polished by machinery, and also to obtain the means of individual correction. — A speciality of the works consists in their »Ramollir« or remoulding plant, in which they »press« or mould their own lenses. This plant consists of a double totally independant set, thus warranting to carry on the work without interruption. Each plant consists of a preliminary heating and annealing oven and the »pressing« oven. Being thus independant of other glass works the firm is in a position to effect any order without loss of time.

The U. S. A. Agents of the firm are:

For Photographic lenses: **Messrs. Benjamin French & Co.**
319 Washington Street, Boston.

For Binoculars and Hand-telescopes: **Messrs. Tiffany & Co.**
Union Square, New-York.

No. 2801.

Carl Zeiss, Jena.

Optical Works.

A. Microscopes and Microscopical Accessories.

Complete Series of apochromatic objectives and compensating eye-pieces.
Complete Series of achromatic objectives and Huyghenian eye-pieces.
Accessory apparatus for testing objectives.
Complete Series of Microscope Stands.
Apparatus for projection and photo-micrography.
Microscopes for crystallographic and petrological research.
Illuminating apparatus for white and for coloured light.
Spectroscopic eye-pieces.
Apparatus for measuring and counting microscopical objects.
Dissecting microscopes and magnifiers.

All as described in the Catalogue of Microscopes and Microscopical Accessories. (Catalogue No. 29, 1892, German, English and French editions.)

B. Photographic Lenses, Zeiss Patent Anastigmats, Six Series.

Series I,	1 : 4,5,	equivalent focus	130—354	mm	(5 —14 in.)
Series II,	1 : 6,3,	„ „	85—590	„	(3,3—23,6 „)
Series III,	1 : 7,2,	„ „	96—586	„	(3,8—23,1 „)
Series IVa,	1 : 9,	„ „	120—820	„	(4,8—65 „)
Series IV,	1 : 12,5,	„ „	62—906	„	(2,5—35,7 „)
Series V,	1 : 18,	„ „	86—946	„	(3,4—37,3 „)

All as described in the Catalogue of Photographic Lenses, 1891, and Supplement, 1892. (German, English and French editions.)

C. Optical Measuring Instruments for scientific and technical purposes.

Abbe's Spectrometer and accessory apparatus.
Abbe's Large Refractometer.
Percentage Refractometer.
Refractometer for determining the percentage of salt in sea-water.
Refractometer for special technical purposes (Butyro-refractometer).
Crystal-refractometers.
Contact-Micrometer.
Small Comparator.

Spherometer.

Focometer, apparatus for measuring the focal lengths of systems of lenses.

Fizeau-Abbe Dilatometer.

Apparatus for demonstrating the optical connection between diffraction spectrum and the image of an object.

All as described in the Catalogue of Optical Measuring Instruments, 1893. (German, and English editions.)

Historical and statistical notes.

The firm of **Carl Zeiss** was founded in 1846 by **Dr. Carl Zeiss,** who died in 1888. At present upwards of 500 persons are employed in the optical and mechanical workshops (incl. the foundary, joiner's shop, smithy etc.) in the exclusive manufacture of optical instruments and apparatus for purely scientific and fine technical purposes; viz. microscopes and their accessories, photo-micrographic apparatus, photographic lenses and optical measuring instruments of various kinds.

The gross value of the annual production in these goods has since several years exceeded one million Marks. About one half of the goods remain in Germany, the other half is for export. The latter extends to all countries in and beyond Europe where scientific work is done.

There are three departments, viz.:

1. **Microscopic and Photo-Micrographic Department.**
2. **Photographic Lens Department.**
3. **Department of Optical Measuring Instruments.**

These departments are under one commercial management, but are each under the supervision of scientific specialists. The scientific, technical and commercial staff consists in all of 20 persons. There are, at the present time, 3 general directors, viz. **Prof. Abbe, Dr. Schott** and **Dr. S. Czapski.**

Until 1875 Mr. **Carl Zeiss** was the sole proprietor of the works. In that year **Prof. Abbe,** who had been associated with the establishment since 1866, became a partner, and in 1881 **Dr. Roderich Zeiss,** the eldest son of the founder, entered as third partner. After the death of **Dr. Carl Zeiss** his son retired from business in 1889, and the Optical Works were handed over in 1891 to the **„Carl Zeiss Memorial"** in Jena, which had been founded by **Prof. Abbe** in 1889 for the promotion of scientific and social aims.

Since the 1st July 1891 the establishment has ceased to be private property. It transacts its business on account of the „Carl Zeiss Memorial", which is endowed with the legal powers of a person and whose representative is the Government of the Grand-dukedom of Saxony.

The Jena Glass Works (of **Schott & Genossen**), which are affiliated with the Optical Works, having been founded in 1884 by **Dr. Otto Schott** in conjunction with the then proprietors of the firm of **Zeiss,** are since 1891 joint property of **Dr. Schott** and the **„Carl Zeiss Memorial".**

No. 2803.

Paul Gebhardt, Berlin S.,

85 & 53 Prinzenstrasse.

Mechanician and Optician.

Established 1870.

Factory and Ware-house of scientific, physical, electrical, optical, mechanical and chemical apparatus and appliances for class-demonstration.

List of Exhibits:

Mechanics:

System of 2×3 brass **pullies,** with stand and weights.
Model of a **crane,** of metal, with double gear.
Hydraulic press with brass cylinder.

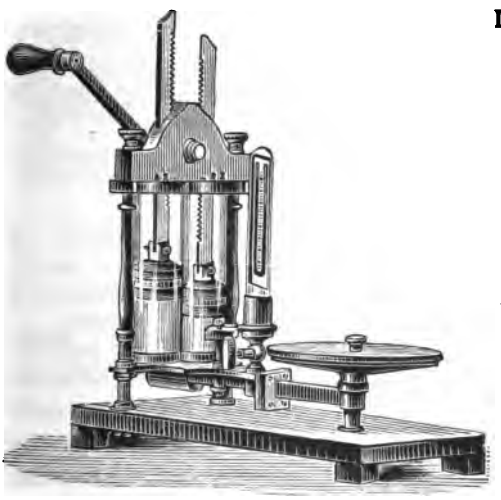


Fig. 1.

Large double barrelled air-pump (Fig. 1) with **Babinet's** cock, glass cylinders and vacuum-gauge. Accessories: **Barometer test, dasymeter, Magdeburg hemispheres** of brass. **Mercury shower** with cock and mercury-bottle with screw on stand. **Apparatus for demonstrating propagation of sound in vacuum,** electrical, with recipient and binding-screws.

Iron **Centrifugal machine,** horizontal and vertical, adjustable. Also:
2 balls of unequal weight.
Watt's regulator.

Acoustics:

Fig. 2.

Stopped lipped pipe.

Reed-pipe with reed striking upwards, funnel and glass window, **stopped lipped pipe** with divided sliding rod.

Cagniard la Tour's Syren, with tachometer. (Fig. 2)

Tuning fork on sound-board.

Telephones for demonstration or use, one of these dissectable.

Optics:

Simple goniometer (graduated arc and radial stop).

Glass prism, mounted on adjustable stand.

Spectroscope with flint glass prism, comparison prism, slit, sighting and scale telescope.

Heliostat with clock-work.

Model telescope for demonstration, with lenses and diaphragms in skeleton frame.

Newton's Coloured Rings Apparatus, in brass mount.

Heat:

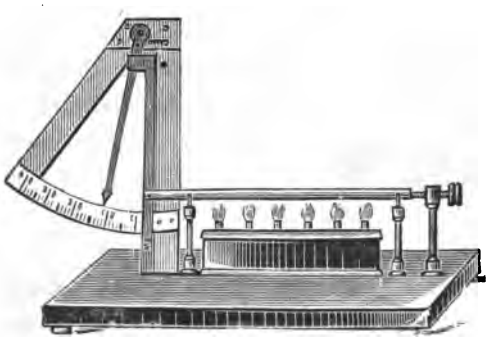


Fig. 3.

Muschenbrock's Lever Pyrometer (Fig. 3), with 3 different metal rods, for demonstrating the expansion of metals by heat.

Sectional model of a **steam-engine cylinder** and valve-gear.

Electricity:

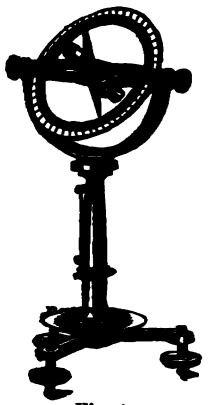


Fig. 4.

Compound magnet (2 bar-magnets with armature). **Magnet Needle** on stand.

Declination and inclination compass (Fig. 4), on brass stand with levelling screws, divided circle, micrometer adjustment and needle with agate cap.

Gold-leaf electroscope, with condenser discs.

Self-exciting Electrical Induction Machine with one fixed and one revolving disc: powerful.

Fulminating tube, Fulminating plate, Rotating globe on isolated stand, **Smoke condensing apparatus.**

Bertram's galvanometer with silvered dial. (Fig. 5)

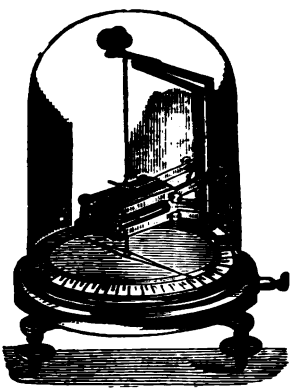


Fig. 5.

Motor for rotating **Geissler's** tubes, with tube.

Morse apparatus with clock-work and keys.

Apparatus for rotating a movable magnet round a stationary circuit, a magnet round its own axis and a movable circuit round a magnet.

NEW! Apparatus for demonstrating the galvanic current surrounding a fixed magnet, with commutator.

Du Bois-Reymond's induction apparatus.

Simple **induction coil.**

Rumkorff Induction-coil, with condenser and commutator; also **Geissler** tube and holder.

Geissler tube with uranium-glass figure, on stand.

Automatic carbon-regulator with reflector for electrical light.

Miscellanea:

Gravert's combined Wool-gauge and dynamometer, **Menzel's** Wool-gauge. **Hartmann's** Wool-gauge, **Thaer-Kleinert's** Wool-gauge.

Illustrated descriptive catalogues may be had gratis and post-free.

Physical and Chemical Laboratories supplied with complete outfit: and special estimate worked out.

Nr. 2804.

Grand-Ducal Standardizing Institute for Glass Instruments, Ilmenau (Thuringia).

This Institute was founded in 1889 by the Government of the Grand-dukedom of Saxe-Weimar with the cooperation of the Imperial Physical and Technical Institute in Charlottenburgh. Its immediate aim was to support the manufacture of thermometers in the Thuringian States by officially testing and standardizing thermometers, an undertaking in which the Imperial Institution in Charlottenburgh had already been engaged on a larger scale. The business of the Institution developed in a most satisfactory manner, to such an extent, indeed, that already in the first year the number of thermometers tested and certificated amounted to more than 20000. At the present time, i. e. the beginning of 1893, the number of the tested instruments of this kind exceeds already 80000.

The Institute extended its operations also to the development and encouragement of the manufacture of instruments within the Thuringian States, in particular, that of accurate measuring instruments. The Institute possesses, thanks to the liberality of the grand-ducal government, for this purpose a collection of valuable appliances.

The Government has also planned the erection of a technical school for glass-blowers and glass-instrument makers, and probably this plan will be carried out in the course of this year (1893).

The Institute has recently undertaken to test lactometers, lactobutyrometers, hydrometers for sulphuric acid and saccharometers, also graduated glass measures, with the exclusion of those instruments which are under the control of the Government Assize Department.

To facilitate the export trade in standardized instruments the Institute supplies certificates with translations in the English, French, Italian, Spanish, Russian, Dutch, Swedish and Danish languages.

In the thermometric tests the Institute enjoys the cooperation and stands under the control of the Imperial Physical and Technical Institute and affixes to the certificates both its own seal and that of the latter institute.

The Institute exhibits the following samples of its own manufacture:

1. A **Standard Thermometer** for temperatures from 30 to 100° C., each degree being divided into 10 parts; a **Chemical Standard Thermometer** with scale division ranging from 100 to 200° C., each degree being divided into 5 parts, and with mark indicating the zero point; a **Chemical Standard Thermometer** with scale ranging from 200 to 300° C., divided into half degrees, and marks indicating boiling and zero point.

2. 11 Hydrometers for determining the specific weight of sulphuric acid, with range of scale of 10 units of the 2nd decimal, divided into units and half units of the 3rd decimal.

Beside these the Institute is exhibiting a collection of Glass Instruments and Apparatus, which have been entrusted to its care by the subjoined firms. The data respecting the business capacity of these firms have been supplied by their respective representatives.

I. Alexander Küchler & Söhne, Ilmenau (Thuringia).

Makers of Glass Instruments of great accuracy.

Specialities:

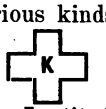
a) **Thermometers** of the highest degree of accuracy for scientific and technical purposes, with or without certificates from the **Government Testing Institutes at Charlottenburgh and Ilmenau;**

b) **Hydrometers** for all purposes: accurately adjusted according to the standards of the Government Testing Institutes, also with official certificates;

c) **Graduated Measuring Instruments** of all kinds, Warranted, also with official certificates.

The following samples are exhibited:

1. Syphon and Cistern Barometers;
2. Various Maximum and Minimum Thermometers for dwelling houses and windows, Contact Thermometers, Bath and Brewer's Thermometers;
3. Standard, Chemical and Clinical Thermometers;
4. Hydrometers of various kinds;
5. Geissler's and Crookes's Apparatus, various kinds and designs.

Those exhibits which bear the mark  **are accompanied by official certificates of the Institutes of Charlottenburgh and Ilmenau.**

After the close of the exhibition all the instruments are to be sold at a high discount. Please to address the manufacturers, Messrs. Alexander Küchler & Söhne, Ilmenau (Thuringia, Germany).

II. Alt, Eberhardt & Jaeger.

Thuringian Glass Instrument Works with Branch Works of Keiner, Schramm & Co. in Arlesberg nr. Elgersburg (Thuringia) and Glass Works in Schildhorst nr. Kreiensen.

This firm was founded in 1873 and has since made steady progress (last year's turn-over: M. 750000). It employs altogether about 450 hands and possesses in Ilmenau new work-shops provided with excellent accommodations and fitted with the best machines. It obtained several awards in exhibitions. The firm maintains a large

stock of the goods which it manufactures and also undertakes, on a small commission, to purchase for transatlantic buyers all articles belonging to its own class of goods which are supplied in the German market. The registered trade mark of the firm of A. E. & J. is a „Human eye", thus:

All articles sent to the Exhibition bear this mark.

The firm is capable of supplying extensive orders and manufactures a great variety of glass instruments and appliances; it also supplies goods made according to special design and is also prepared to supply large quantities of whole-sale goods.

Beside the glass-house, the blow pipe and graduating work-shops, there are also departments for grinding, turning, wood-working and packing-case making.

The firm makes and supplies:

1. All kinds of **Thermometers** for technical, chemical and clinical purposes, thermometers for dwelling-rooms, windows and bath-rooms, travelling thermometers, in numerous forms, with or without official certificates.
2. **Hydrometers** of any kind, Saccharometers, Lactometers, Acid-hydrometers and Alcoholometers, with or without official certificates.
3. **Barometers** of any kind and design.
4. **Appliances for demonstration** purposes in schools and University Colleges.
5. **Apparatus for** the equipment of **Laboratories**; also those made of porcelain, sheet-iron, tin, platinum, nickel, copper, wood etc.
6. All kinds of **Apparatus** for **Chemical** and **Physical** Laboratories, for **Sugar-refiner's** and **Brewer's** laboratories.
7. **Graduated Goods**; e. g. Graduated Measures, Gas burettes, Hydrometers etc.
8. Glass-goods for **Clinical** and **Surgical**, and for **Microscopical** and **Bacteriological** purposes.

These various groups are represented by exhibits.

The General Catalogue of the firm comprises 18 special priced catalogues. Telegraphic address: „Glasalt Ilmenau".

III. Ephraim Greiner, Stuetzerbach (Thuringia).

Glass Works,

with departments for the manufacture of glass hollow-ware and tubing, glass-blowing, standardizing, accurate grinding and etching; with own joiner's and turner's work-shops.

Exhibits:

1. **Thermometers** for clinical, chemical, pharmaceutical, brewing, distilling, dairy and technical purposes and for private and domestic use.

2. **Alcoholometers, Hydrometers, Saccharometers,** for chemical laboratories and many branches of industry.

3. A few **Appliances** for the **Analysis of Gas** and **Smoke.**

4. Various **Appliances** and Instruments for **lactometric** purposes.

5. A number of **Appliances and Instruments for Chemical, Physical, Pharmaceutical, Educational** and other purposes.

6. Various **Burettes, Pipettes, Graduated Glass-measures, Lactometer-flasks, Graduated Boiling-flasks, Acetometers, Acedimeters** (for tartaric acid), Albuminometers, **Einhorn's Saccharometers** for fermented fluids and **mash - acid hydrometer.** One nest of **Evaporating Dishes** and one set of **Boiling Beakers** with and without spout.

IV. Emil Gundelach, Gehlberg (Thuringia).

Glass Works: Glass hollow-ware for chemical and technical purposes made of glass capable of resisting, in a high degree, the corro-

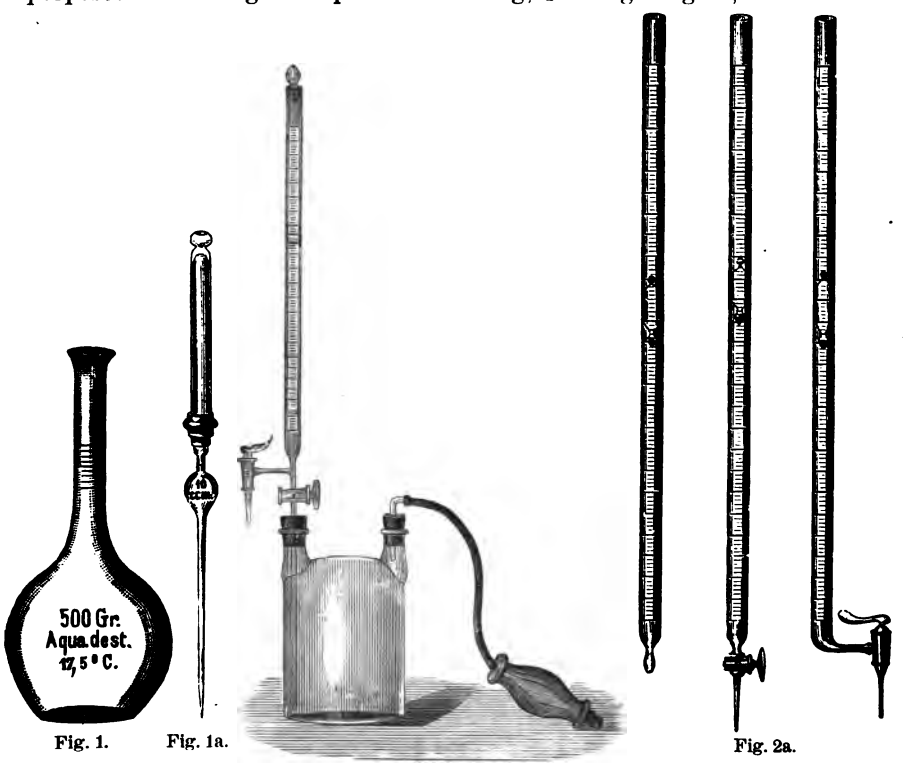


Fig. 1. Fig. 1a. Fig. 2. Fig. 2a.

sive action of chemicals, such as Beakers, Boiling-flasks, Retorts, Specimen-bottles, Cylinders, Bell-jars, Glass-tubing of all kinds etc.

Glass Instrument Works: All Apparatus and Appliances for Chemical, Physical and Commercial purposes, such as graduated goods and volumetric appliances and apparatus for gas-analysis, mercury air-pumps, apparatus for demonstration etc. etc.

Incandescent Lamp Works: Only such lamps are made which are used for demonstration or **clinical, astronomical** and **optical** purposes, for the illumination of closed hollow bodies of any kind or for decorative purposes.

The Factory supplies its own gas and is provided with gas-engine power.

Exhibits:

1. **A Collection of Graduated Appliances.** Graduated flasks with auxiliary scale on the neck, **fig. 1,** for quickly and accurately reading the pouring mark; graduated pipettes and full-pipettes (adjusted to deliver one precise quantity), among these so-called „poison-pipettes", **fig. 1a,** provided with india-rubber collar and suction-tube; a few burettes and graduated flasks with certificates by the Standardizing Institute at Ilmenau.

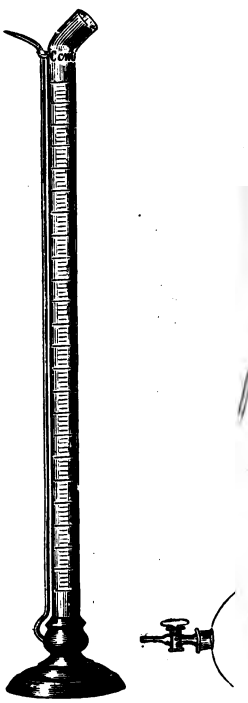


Fig. 2b.

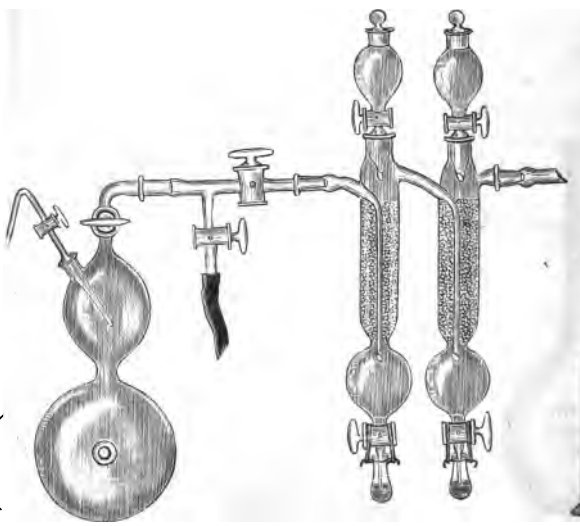


Fig. 3.

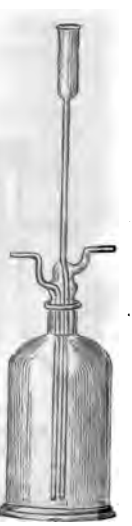


Fig. 4.

2. **Graduated Burette** with 2 cocks and a flask containing the liquid, **fig. 2**; **Brink's, Mohr's, fig. 2a,** and **Gay-Lussac's** burettes, **fig. 2a,** the latter with glass loop protecting the outlet jet from breaking off.

Part of the graduated flasks, **Gay-Lussac's** burettes and a few of **Mohr's** burettes are backed by a white enamel stripe with dark middle line, by **Schellbach's** process. Viewed through the meniscus formed by the liquid this dark middle line appears deeply incised and thus, especially with the aid of a mirror, as in the case of the burette shown in fig. 2, a very exact reading may be taken. The same result is attained by double graduation.

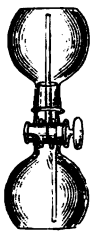


Fig. 5.

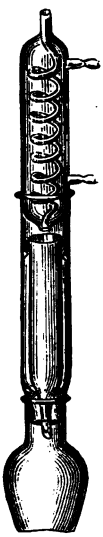


Fig. 8.

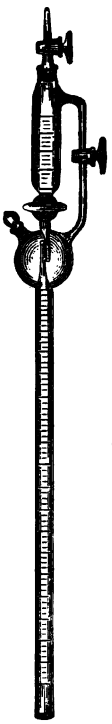


Fig. 6.

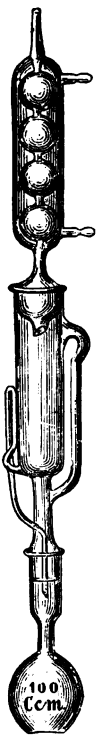


Fig. 7.

3. Part of **Pflueger's Mercury Air-pump** for physiological purposes (analysis of blood-gas), **fig. 3.**

4. **Gas Washing Bottle,** with inlet funnel acting also as a safety tube, fig. 4.

5. **Molinari's Apparatus for milk-fat analysis, fig. 5.**

6. **Capronica's** Apparatus for **estimating nitrogen in urine** (Ureometer), **fig. 6.**

7. **Soxhleth's Fat Extraction Apparatus, fig. 7.**

8. **Foerster's Fat Extraction Apparatus, fig. 8.**

9. Various other appliances and one set of Boiling Beakers.

10. A set of **Incandescent Lamps** for demonstration and decoration.

V. Franz Schilling, Gehlberg (Thuringia).

Glass Works: Glass Hollow-ware and Glass Instruments. Exhibits:

1. **Graduated Appliances for Analytical Measurements:** Burettes, Pipettes, **Schiff's** Burettes, Cylindrical Graduated Measures, Graduated Flasks.

2. **Apparatus for Gas-analysis:** Appliances for determination of **carbonic acid, Alkalimeters, Bunte's Burettes (Jueptner's** modification), **Winkler's** Gas-burettes (**Hempel's** modification) and **Hempel's Gas-pipettes.**

3. **Muencke's** and **Dr. Norblad's Gas Generating Apparatus.**
4. Apparatus for the estimation of nitrogen in urine.
5. **Broegger-Harada's** Apparatus for separating minerals contained in heavy solutions (with large cock of 15 to 20 *mm* bore).
6. **Mercury Air Pump,** own construction (small size).

This pump excels over other pumps in the following respects:

a. It works conveniently and is reliable. By repeatedly lifting and lowering the mercury vessel successive evacuations are obtained without the necessity of alternately opening and closing cocks. A valve in the mercury pressure vessel protects the pump from being broken in the event of careless lifting;

b. The Dehydrating Apparatus is simple in its construction. It is to be charged with anhydrous phosphoric acid and consists of a simple bulb, which is ground to fit directly into the shell of the cock, so that it may be taken off without necessitating the removal of any other part of the pump. The cock is so constructed that one turn disconnects the dehydrating apparatus, so that the pump may also be used without the latter. The pump has the further advantage that it may be safely and easily packed for transport as it is composed of small separate parts.

7. **Various Appliances,** a Collection of **Glass-cocks** (exact reproductions of Geissler's cocks), samples of Glass tubing, Beakers and Boiling flasks.

VI. H. R. Lindenlaub, Schmiedefeld in Thuringia.

Glass-blowing and Glass Instrument Works; manufactures **Thermometers, Hydrometers** and **Glass Appliances of any kind** and excels in the manufacture of **Radiometers** and **Geissler's Tubes.**

Exhibits:

1. Geissler's Tubes.
2. Radiometers of various kinds, **Radiometers registering the number of rotations.**

VII. Strasser & Rhode, Glashütte nr. Dresden.

Clock and Watch Works.

Exhibits:

1. **Micrometer Gauge with short callipers,** suitable for accurately calibrating carbon filaments for incandescent lamps, glass-tubes etc.;
2. **Micrometer Gauge with long callipers,** which may be conveniently used in mechanical work-shops and glass-blowing establishments.

No. 2805.

W. Dieckmann, Celle. (Hannover.)

Sculptor.

Geographical, astronomical and chiming art clock.

This clock rests upon a pedestal made of American walnut wood, treated in the style of modern renaissance of the 16th century. The clock and pedestal together have a height of 2.70 meter. The front dial is made of ivory, ebony, rose wood and mother of pearl. The other dials are made of enamel, the figures and hands of fire gold. Beside the main dial the clock has on either side of the case 8 dials which indicate the times of the following towns:

Left side:

Europe: Berlin, Stockholm, St. Petersburgh, Constantinople, Vienna, Rome, Paris, London.

Right side:

North and South America: Washington, New York, Philadelphia, Carracas, Buenos Ayres, Quito, Mexico, San Francisco.

On the opposite side of the main dial the clock has a permanent calender movement which indicates the day of the week, the day of the month, the time difference between mean and actual solar time and the phases of the moon. This movement effects also automatically the change of day in leap years.

The clock work is actuated by a spring and requires winding once in 8 days; It strikes the quarter and full hours. Every hour after the striking of the full hour the clock sets a musical movement in motion which plays a fresh piece every hour.

The clock and pedestal are decorated with 54 sculptured representations and ornamentations.

The clock is for sale. Intending purchasers are requested to communicate with Mr. Hirschmann, the representative at the Exhibition.

No. 2808.

G. Kromschröder, Osnabrück.

Manufacturer of dry gasmeter with seemless diaphram.

BRANCHES:

Wien III. Erdbergerstr. 68. **Zwolle.** (Holland.)

No. 2809.

C. Bube, Hannover.

Maker of Linear Measures.

Fabrik-Zeichen.

Mathematical, Drawing, Builder's and Folding Divided Rules of all kinds. — Steel measuring tapes, Measuring chains etc.

Speciality: Folding Rules with Patent Fixing Clamp, patented in the U. S. A. and in all the principal European countries.

The works were established in 1854.

Awards:

Hannover 1859: Bronze Medal.
Moscow 1872: Larger Silver Medal.
Vienna 1873: Medal of Merit.
Hannover 1878: First Prize.

Agents in the U. S. A.:

Keuffel & Esser Co.,

265 State Street, Chicago, and **127 Fulton Street, New York.**

No. 2810.

Imperial Physical and Technical Institute.
Charlottenburg nr. Berlin.

I^st^ Department: 25 Marchstr.;
IInd Department: 151 Berlinerstr.

The Imperial Physical and Technical Institute comprises two departments. The work of the first or **Physical Department** consists in such physical researches and measurements which are calculated to lead to the solution of scientific problems of great general importance and which envolve sacrifices exceeding the resources of private individuals or schools.

The object of the second or **Technical Department** is twofold, viz

1. To carry out physical and technical investigations which may from time to time be ordered by the Autorities or which may be calculated to promote the manufacture of philosophical instruments or to contribute to the growth of other branches of German industry;

2. To test and certify graduated instruments and standardizing appliances, **provided these do not more properly belong to the Assize Department.**

The following are the exhibits of the Institute: Samples of graduated appliances admissible for attestation, thermometers,tuning forks etc. accompanied by their respective certificates. — Samples of materials adapted for fine mechanical and electro-technical art, standard screw threads and tempering colours, instruments and appliances, illustrations, diagrams and publications.

A detailed description of the exhibits will be found in the *Zeitschrift für Instrumentenkunde, Berlin, Springer; New York, B. Westermann & Co., 1893, 4th number.*

No. 1349.

Group 123. 119.

Hartmann & Braun,

Bockenheim-Frankfort o/M.

Scientific Instruments and Electrical Apparatus.

(150 Employees and Steam power of 36 kilowatt)
Silver medal, Paris 1881. — Gold medal, Turin 1884.
Silver medal, London 1885. — Gold medal, Antwerp 1885.

This firm is exhibiting in a separate room situated at the exit of the German Division on the Ground Floor of the Electricity Building. This room contains a fully equipped laboratory, in working order, suitable for an electrical research laboratory, a central lighting station or for an extensive electrical manufacturing concern; also a collection of measuring apparatus for workshop use, for electrical fitting and cable laying, ampèremeters and voltmeters, resistance apparatus, electrical measuring instruments for continuous and alternating currents; finally, a collection of electrical and magnetic instruments of precision.

In the centre of the room.

1. **Appliances for measuring resistances** of 0.01 to 11 million ohms, consisting of a universal resistance bridge with plug connections, reflecting galvanometer with reflecting magnet and reading telescope.

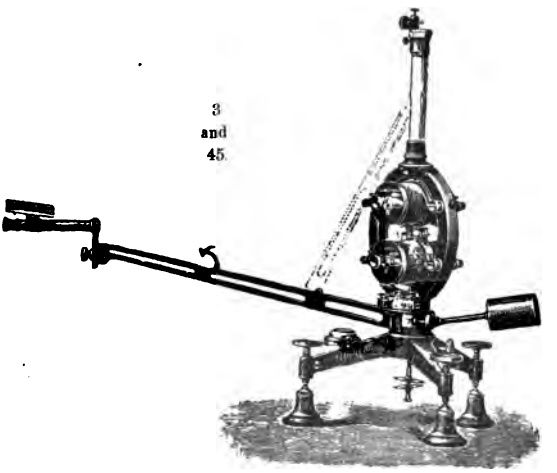
2. **Apparatus for measuring current strengths and E. M. F.'s** by the compensation (»Null«) method, consisting of a Clark standard cell and ballast resistance, resistance box for main and shunt circuits, a branch resistance of 0.01 ohm, an aperiodical reflecting galvanometer with Siemens' bell magnet and reading telescope.

3. Apparatus for measuring high insulation resistances consisting of an astatic cable galvanometer with Bruger's magnets, several shunt resistances, a scale lamp for objective reading, a megohm with 10 subdivisions as standard of comparison, a battery of dry accumulators with universal pachytrope and switches.

4. Apparatus for measuring capacities of cables, consisting of a ballistic reflecting galvanometer with Weber's magnets, a reading telescope, a condenser of one microfarad with subdivisions, together with charge and discharge keys.

The reflecting galvanometers of the preceding four groups are mounted upon isolated brick piers, the optical reading appliances belonging to them are placed upon adjustable Gauss stands.

4 and 42.



3 and 45.

Upon tables arranged along the walls.

5. Apparatus for measuring small resistances, in particular, for testing the conductivities of materials, consisting of a resistance bridge with key, ampèremeter and sensitive galvanometer. Range from 0.00001 to 5 ohms.

The measurements are made on the principle of the Wheatstone bridge, modified, however, in such a manner that by double reading the intermediate resistances are eliminated. The result is obtained without extensive calculation by **direct reading** from the scale of the apparatus. By means of universal clamps conductors of any section and also carbons may be placed in the circuit.

6. Apparatus for testing iron and steel with respect to magnetic permeability and coercive properties, consisting of a standard electromagnet, a Lenard's bismuth spiral, a bridge for determining the strength of the magnetic field, a galvanometer constructed on Deprez's principle and an ampèremeter.

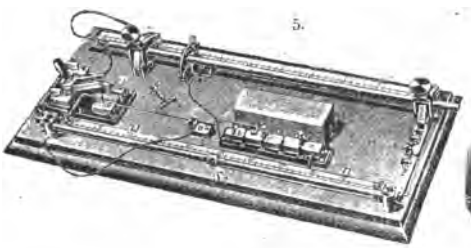
7. Apparatus for determining the resistances of electrolytes according to Kohlrausch, consisting of a Kirchhoff-Wheatstone bridge, cylindrical form, an induction apparatus for generating alternating currents, an unifilar suspension electro-dynamometer, a telephone, three U-tubes with platinum electrodes and Arrhenius' resistance vessel.

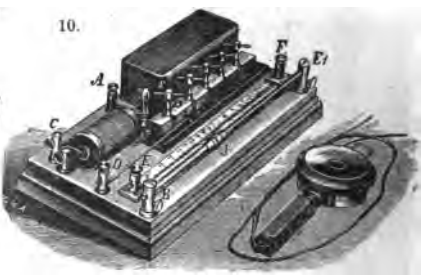
8. Photometric apparatus, consisting of a large precision photometer with Lummer-Brodhun's comparison prism, standard amylacetate lamp, universal incandescent lamp stand, revolving mirror for determining the illuminating power of arc lights at various angles of emission, voltmeter and wattmeter for measuring E. M. F's and energy expended in incandescent lamps.

By means of an intransparent curtain a dark room can be expeditiously improvised.

Small Appliances.

9. Resistance Bridge for determining the resistances of solid conductors, e. g. iusulated wire wound on a bobbin, with aperiodical needle galvanometer. Range from 0.1 to 10000 ohms, **reading directly** without calculation.





10. Small universal resistance bridge, according to Kohlrausch, for determining resistances of solid conductors and electrolytes, e. g. the internal resistance of cells by means of alternating currents, generated by means of an induction coil supplied with the apparatus. A telephone is used for measuring in place of the galvanometer. Range from 0.01 to 1000 ohms, **direct reading.**

The two preceding appliances are specially adapted for workshop use.

11. Wheatstone-Kirchhoff Bridge with measuring wire of 1 meter length, which may be extended for very accurate measurements by additional stretched wire resistances. The meter wire is calibrated by means of a second contact slider, which renders the apparatus also available as a Thomson double bridge. Precision resistance box or single standard resistance coils serve as comparison resistances.

12. Differential Galvanometer with index for comparing any resistances; the latter will be found among the exhibits in the shape of a decade crank resistance box and a series plug resistance box.

13. Differential Galvanometer with bobbins, wound with resistances in the ratio of 1 : 20. By means of this instrument the resistance of an incandescent carbon filament may easily be found by Voller's method.

14. Apparatus for determining small resistances according to Kirchhoff's differential shunt method, consisting of a standard resistance of 0.01 ohm, two precision resistance boxes and a differential galvanometer, the latter modified according to Deprez.

15. Nippoldt's Testing Apparatus for Lightning Conductors, consisting of Wheatstone bridge **reading directly,** contained in the casing of a telephone, a small induction coil together with cells for generating alternating currents, or if desired a simple galvanometer, the whole in a sling case; also a folding earth plate.

The resistance due to the passage from the lightning conductor to the earth plates has, on account of the polarization taking place at the plates, like the resistances of electrolytes, to be measured by means of alternating currents, hence a telephone is substituted for a galvanometer. It is useless to measure the resistances of the metallic conductors, as these can only be examined by ocular inspection.

15.

16.

13 and 51.

16. Tangent Galvanometer for currents and E. M. F.'s, with Kohlrausch water voltameter for calibrating by volume of gas generated, and a comparison ampèremeter.

The method of calibration by means of the Kohlrausch water voltameter is extremely simple and does not involve the use of an analytical balance, as is the case with the silver or copper voltameter. The tangent galvanometer has a range of 3 milliampères to 25 ampères; with the aid of shunts or additional resistances its range may be extended considerably.

17. **Silver Voltameter and Copper Voltameter** for calibrating industrial galvanometers, the former for a current of 0.25 amp., the latter for currents up to 5 amp. Also Kohlrausch's **Water Voltameter.**

Analytical balance for determining the weight of silver or copper deposited by the voltameters.

18. **Direct Reading Aperiodical Torsion Galvanometer,** ranging from 1 to 100-fold. Various models

for current strengths within the limits of 1 milliampère and 10 amp.;

for E. M. F.'s within the limits of 0.01 and 1000 volts;

also combined in one instrument with shunts and additional resistances for 0.1 to 18 amp. and 0.1 to 180 volts.

These torsion galvanometers are constructed on the lines of Deprez's galvanometer, but embody a series of very important improvements, the main object of which are to maintain a constant homogeneous magnetic field, to shield the instrument from the influence of the extraneous circuit and to add to the portability of the instrument.

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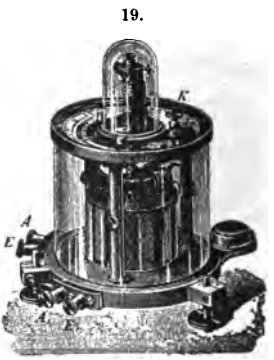


19. **Torsion Electrodynamometer** for continuous and alternating currents. Various models, for use

as ampèremeter for currents up to 50 amp.,

as voltmeter for E. M. F.'s up to 180 volts,

as wattmeter for energy up to 120 voltamp.

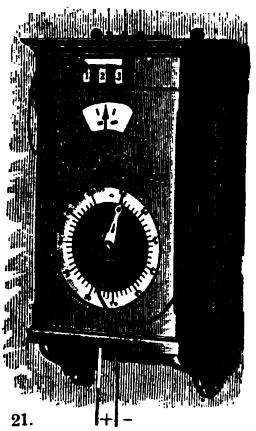
The indications of these instruments are based upon the movements produced by a solenoid acting upon a double rotating solenoid with similar outer and inner poles: NS—SN.

The convenience of **direct reading** by means of a scale having nearly proportional divisions, the range from 1 to 100-fold measurement, the damping arrangement, in particular however the absence of magnets or iron render these instruments eminently suitable for calibrating other instruments.

Apparatus
for measuring Temperatures by Electrical Instruments.

20. **Braun's Pyrometer** for temperatures up to 1000° and up to 1500° C, based upon the variation of the resistance of a platinum wire wound so as to obviate self-induction inside a non-combustible box and forming one branch of a Wheatstone bridge. The sensibility is so great that with the highest temperatures an increase or decrease of but a few degrees is rendered apparent. The absolute accuracy is extremely great, the instrument being standardized by numerous comparisons with a porcelain air thermometer.

The necessary manipulations are extremely simple and imply **no previous experience.** The temperatures are **directly read** from a scale on the apparatus; the latter may be set up at a distance of several meters from the oven. This pyrometer forms therefore a most suitable controlling instrument in metallurgical and ceramic operations.



21.

21. **Tele-thermometer,** similar in principle to the pyrometer but limited to temperatures between 30° and 300° C. Within these limits the scale may be adjusted as required.

The manipulation is still simpler than that of the pyrometer. The telethermometer is principally adapted for regulating the temperature in schools and public buildings from a central heating station, for conservatories, or inaccessible spaces, e. g. malt-kilns, drying rooms, baking ovens etc.

Measuring Apparatus according to Kohlrausch.

In the case placed at the right hand side of the entrance.

22. **Wheatstone-Kirchhoff Bridge.** The resistance wire which is 3 meters long, is wound upon a cylinder of white marble, there being 10 convolutions; the permanent connections are ensured by brushes; the sliding contact is made by a small wheel. The comparison resistances of 1, 10, 100, 1000 ohms and the resistances which are to be measured are interchangeable by means of plug connections. Eminently suitable for exact measurements.

23. Unifilar Suspension Electro-dynamometer for small currents with mirror reading. The current is led to the movable bobbin by the suspension wire and a platinum coil, acting as a damper, dipped into dilute sulphuric acid.

24. Portable Differential Galvanometer with mirror reading. Provided with a small magnetic steel mirror suspended within the oval multiplier. The amount of damping may be regulated by means of a copper sliding piece. The sensibility is rendered variable by various thicknesses of the duplex winding and by a controlling astatizing magnet. Without astatization and with a resistance of 50 ohms a deflection of 1 mm reads 0.0000004 amp. at 1 meter distance of scale.

25. Absolute Tangent Galvanometer. The current passes through a copper ring which can be accurately measured. All unnecessary metal parts are avoided. The reflecting magnetometer, which is free from metal, may be removed and replaced by a needle.

23.

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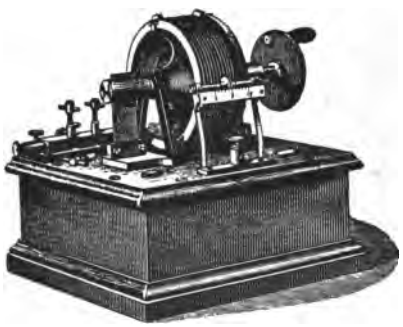
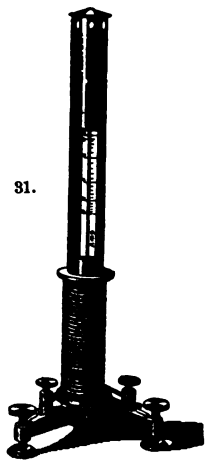




31.

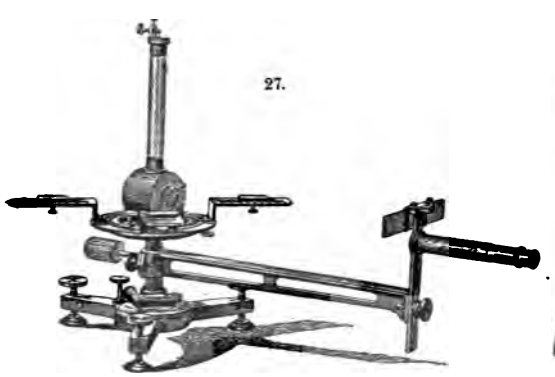
26. Portable Bifilar Suspension Variometer for Terrestrial Magnetism. Tubular strongly damped magnet suspended by two fine wires placed a short distance apart. The constants are found by means of a torsion circle provided with vernier and micrometer adjustment. Expeditiously set up. Changes of position controlled by stationary mirror.

27. Intensity Variometer for Terrestrial Magnetism. The magnetic steel mirror is, by means of 4 small deflection magnets, placed at right angles to the meridian, so as to neutralize the influence of variation of declination. The sensibility may be regulated to any de-

sired degree. A small reading telescope is directly attached to the instrument. Degree of precision: 1 : 10000.

28. **Simple Local Variometer** for measuring local changes of the horizontal intensity. Only one instead of four deflection magnets; a simple needle instead of a magnetic mirror; otherwise similar to 27, but of greater portability. Degree of precision: 1 : 1000.

29. **Absolute Bifilar Suspension Magnetometer.** By exact measurement of the relatively great distance of 12 *mm* between the wires, the deflections due to the reversal of the tubular magnet give the product of the magnetism of the bar magnet and the terrestrial magnetism in absolute measure. Simultaneous observation made with a unifilar suspension magnetometer gives the intensity of the terrestrial magnetism in absolute measure. The advantages of the method consist in rendering the measurement of time and of the influence of temperature dispensable.


27.

24.

30. **Absolute Bifilar Suspension Galvanometer.** The magnet is replaced by a wire ring of many convolutions which may be measured exactly. The deflections of this ring due to a current represent the product of strength of current, area of circuit and terrestrial magnetism. This instrument may be used for absolute measurements of currents or terrestrial magnetism by using it in combination with an absolute tangent galvanometer or a single suspension magnetometer.

31. **Spring Galvanometer.** A tube of thin sheet iron sides is suspended by a torsionless spiral of many convolutions and is drawn into a solenoid by the current. The amount of the attraction is seen from a scale divided in ampères. The indications are aperiodical and independent of strong extraneous currents. The instruments are adapted for currents up to 3000 amp.

Standards made according to the standards in possession of the Imperial Physical and Technical Institute, Berlin-Charlottenburg.

In the case at the left hand side entrance.

32. Clark's Standard Cell. The mercury electrode formed by amalgamated platinum, is sealed in a porous pot together with the mercurous sulphate paste, by which means the cell is rendered portable. A thermometer dipping into the cell has its scale outside. The glass is protected by a metal casing. E. M. F. = 1.438 (15° C.)

33. Standard Resistances, of 0.1, 1, 10 etc. up to 10000 ohms, made of manganine or constantan i. e. a material the coefficient of temperature of which may be neglected, with nickel plated electrodes for immersion in mercury cups.

The resistance coils are accurately calibrated and soldered with silver to the electrodes contained in perforated metal cases. Paraffine baths may therefore be used for measurements at constant temperatures.

34. Standard Resistances, 0.01, 0.001 and 0.0001 ohm, which may also be used as shunts for exact current measurements; made in a similar manner to those described in 33, excepting, that thin laminae are substituted for the wires; fitted, apart of the electrodes, with two binding screws, which branch off at the exact terminals of the resistances.

34.

0.001 and 0.0001 are contained in entirely closed metal cases fitted with cooling worm and stirrers for paraffine filling.

35. Paraffine baths with nickel plated double mercury cups, suitable for 2 to 4 standard resistances, with stirring apparatus driven by a tiny electromotor.

36. Small Compensation Apparatus containing a Clark standard cell and high ballast resistances (100 000 ohms), a commutator, switch and a very accurately adjusted resistance box also of 100 000 ohms; the latter is adjustable up to 10 000 ohms by plugs and cranks, by means of which the resistances which are to be placed in the compensation circuit may be found. Very intelligible and compact arrangement and convenient manipulation.

37. Large Compensation Apparatus. Similarly arranged but with entire adjustable resistance box and having besides an equalization resistance, whereby the correction of the temperature in the Clark cell is introduced into the apparatus which thus becomes direct reading.

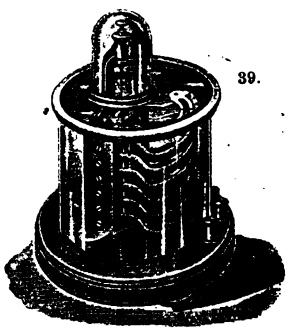
The remainder of the instruments constructed by this firm.

In the centre case.

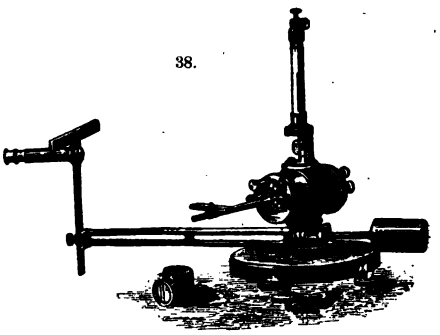
38. Portable Telescope Galvanometer. Bell magnet in very narrow copper piece effecting aperiodical damping; clamping for safe transport; expeditious adjustment by means of circular level. Multipliers wound with double convolutions, movable and interchangeable. Telescope attached to instrument with scale placed at 25 cm distance. Suitable for all galvanometric measurements occurring in workshop, laboratory and outdoor work.

Sensitiveness without astatization at 100 ohms: 1 mm deflection = 0.000 000 9 amp.; with astatization at 4000 ohms: 1 mm deflection = 0.000 000 09 amp.

39. Suspended Coil Galvanometer. A broad and homogenious magnetic field is obtained by a number of powerful magnets having common poles. Movable bobbin suspended by quartz thread, with safe clamping for transport. The current is admitted by extremely thin



39.



38.

silver laminae. The oscillations are aperiodical also when no current is passing and when high resistances are placed in the circuit. With index and mirror reading. Also arranged for use as a differential galvanometer.

Sensitiveness at 10 ohms: 1 degree of index = 0.000 005 amp., or with mirror reading: 1 mm at 1 meter distance of scale = 0.000 000 1 amp.

40. Micro-Galvanometer, Rosenthal's principle, with)(shaped astatic magnetic system, the 4 poles of which dip into 4 small solenoids. Great sensibility combined with small consumption of wire. Particularly suitable for physiological and thermo-electric currents.

Sensitiveness at 200 ohms: 1 mm*) = 0.000 000 006 amp.

41. Astatic Reflecting Galvanometer with Nobili's magnetic system inserted from the side and closely surrounded by the multipliers. Adjustment of damping by means of various copper shells.

Sensitiveness at 10 ohms and 10 seconds duration of oscillations: 1 mm = 0.000 000 15 amp.

42. Ballistic Reflecting Galvanometer, according to Weber's arrangement, with short tube magnets and interchangeable multiplier. Adjustable duration of oscillations : 15 seconds.

Sensitiveness at 50 ohms: 1 mm*) = 0.000 000 02 amp.

43. Large dead beat Reflecting Galvanometer. Rigid structure; bell magnet in lentiform copper damping shell, may be interchanged for a ring magnet; double wound multiplier with rack and pinion movement; astatization by means of a ring of soft iron. In this instrument are combined the special features of the types of Siemens, Wiedemann, du Bois-Reymond, Becquerel and Braun.

Sensitiveness without astatization at 400 ohms: 1 mm*) = 0.000 000 07 amp.

44. Simple dead beat Reflecting Galvanometer, similar in construction to 43, but a little smaller and simpler. Multiplier arranged to be moved by hand. Suspension by quartz thread.

Sensitiveness: nearly the same as with 43.

45. Astatic Aperiodical Reflecting Galvanometer. Bruger magnets consisting of the two coupled halves of a vertically suspended hollow cylinder, which combine the advantage of diminished inertia with considerable magnetic momentum and high degree of astatization. Suspension by quartz thread. Damping adjustable within wide limits. Conveniently set up; fitted with small telescope, 50 cm distance, directly attached to instrument, so as to render the instrument available for outdoor use.

Sensitiveness at 5000 ohms and 15 seconds duration of oscillations: 1 mm*) = 0.000 000 002 5 amp.

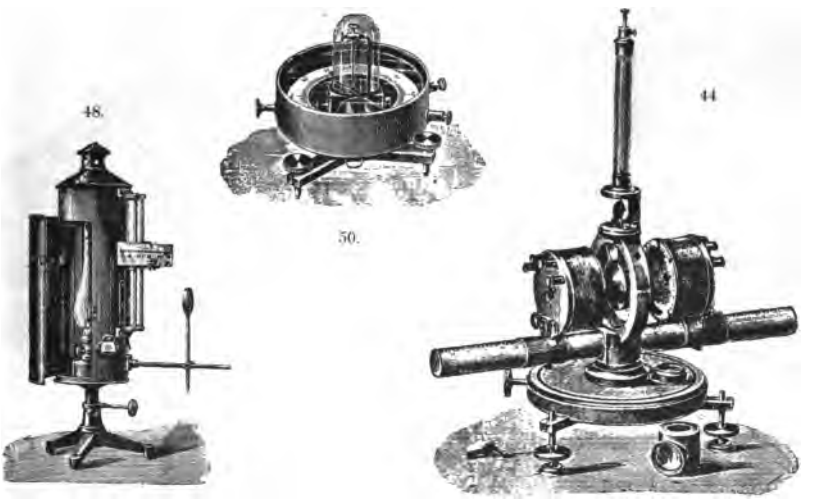
*) With reflecting galvanometers the sensitiveness refers always to a deflection of 1 mm at a distance of scale of 1 meter.

46. Reading Telescopes for observation with reflecting instruments. 3 different sizes with bright field, objectives of 30, 40, 55 *mm* aperture and euroscopic micrometer oculars; micrometer adjustment in either plane and vertical rack and pinion movement. Rigid structure; entire absence of iron.

47. Simple Reading Telescopes of 27 *mm* aperture; with convenient scale support, for use in a horizontal and vertical position. Two different patterns; one to be adjusted by hand, the other one by rack and pinion.

48. Lamp Stand and Scale for use with reflecting instruments, with petroleum burner, Argand burner or incandescent lamp. Scale arranged to be observed from the front or from the back.

49. Scales for mirror reading; very accurately divided in lengths of 40, 60, 80, 100 120 *cm*, of **wood T** section, with narrow paper strips, also **transparent celluloid** mounted in wood lath; also of **plate glass,** transparent or greyed, and of **milk glass,** the latter kind being specially adapted for telescopic measurements.



50. Box Galvanometer, with bell magnet suspended by silk fiber or quartz, in powerful damper with stopping spring; intelligible arrangement; made to revolve on metal foot; with high or low resistance.

Sensitiveness: at 5 ohms: $1^0 = 0.000\,05$ amp.

51. Aperiodical Differential Galvanometer with index reading; very portable. Double wound multipliers, movable and interchangeable; sensibility variable within wide limits. When the astatization is introduced, which can easily be done, the sensitiveness at 100 ohms is: $1^0 = 0.000\,002$ amp.

52. Vertical Galvanometer, Deprez's principle; an exceedingly handy instrument.

Sensitiveness: $1 = 0.0001$ amp.

Rheostats for scientific exact measurements

very accurately calibrated,
of constantan or manganine wire, wound so as to obviate self-induction.

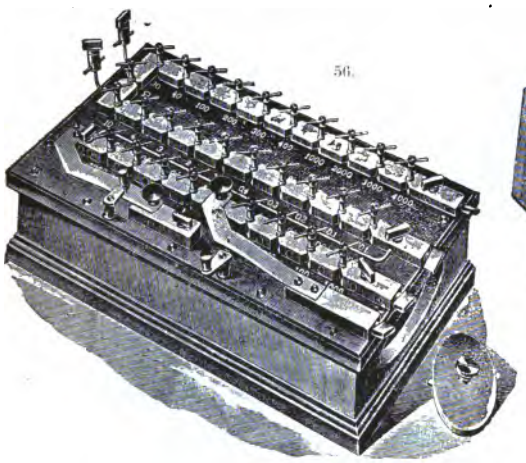
53. **Series** of 0.1, 0.2, 0.3, 0.4, 1, 2, 3, 4, 10, 20 etc. to 4000 ohms, i. e. in combinations of upwards of 11 111.1 ohms, with plug connections. Also in

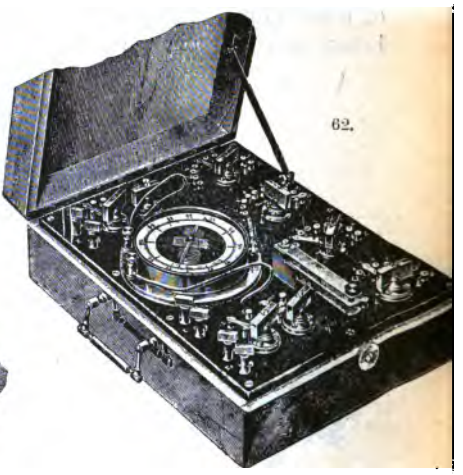
54. **Decades** of 4 × 2 + 1 + 1 or 10 × [0.1, 1, 10, 100, 1000, 10 000, 100 000] ohms, with plug connections. Also in the form of

55. **Branching Rheostats,** with pairs of 1, 10, 100, 1000 and 10 000 ohms. Also in the form of

56. **Resistance Bridges** composed of series or decade resistance boxes with branch resistances. Finally, in the form of

57. **Shunts and Addition Rheostats,** for diminishing the sensitiveness or extending the range of galvanometers.





Rheostats for industrial exact measurements.

58. **Single Resistances** of 1, 10, 100 up to 10 000 ohms.

59. **Series** of 1, 2, 3, 4; 10, 20, 30, 40; 100, 200 etc.; giving a total maximum of 11 110 ohms, with plug connections. Also in

60. **Decades** of 10 × [1, 10, 100, 1000] ohms with crank changer. Finally, in the form of

61. **Resistance Bridges,** combined decade and branch resistances.

62. **Portable Resistance Bridge,** with galvanometer, of 0,01 to 1 million ohms, for comparing E. M. F.'s of single cells, consisting of 4 decades, 3 pairs of branch resistances, pole reverser, switch and with key; all parts fitted with crank manual; in case fitted with lock.

All resistances are joined by separate conductors to the connecting pieces, there being no common conductors. By means of terminal plugs which are to be inserted at the side any one of the resistances may be branched off.

Electrical Measuring Instruments for School Purposes.

In the following instruments particular attention has been paid to simplicity and intelligible arrangement of the parts and care has been taken to render the movements of the pointers and the divisions on the dial distinctly visible from a distance of 10 meters.

63. Lecture Galvanometer with bell magnet, powerful damper, with pointer; interchangeable multipliers; also for use as a differential galvanometer. The pointer magnet may be replaced by a reflecting magnet. The galvanometer may thus be used as a reflecting galvanometer for projection on the screen or for telescopic reading.

64. Simple Lecture Galvanometer, with 2 bar magnets, one of these, the astatizing magnet, being detachable. The whole instrument can be taken to pieces.

65. Resistance Bridge with stretched measuring wire of 1 meter length, divided in half decimeters for the audience and in millimeters for the purposes of the lecturer.

63.

66. Open Wire Coils, wound so as to obviate self-induction, of 1 and 10 ohms, forming comparison resistances.

67.

67. Lecture Voltmeter. Iron core drawn into solenoid. Counteracting spring. The rectilinear movement is by means of a lever transmitted to the centre of the pointer. Range 0.5 to 3 volts. Also suitable for measuring the voltage of single cells. By means of an additional resistance the range may be increased 10 times.

68. Lecture Ampèremeter, similar construction, range 0.2 to 2 ampères, with shunt up to 10 ampères.

69. Induction Apparatus. The secondary coil is detachable and the iron core may be replaced by a magnet. The apparatus is adapted for Faraday's experiments on induction.

70. Telephone having all its parts exposed to view, forming an alternating current galvanometer for measurement of fluid resistances, e. g. the internal resistances of cells in connection with bridge 65 and induction apparatus 69.

On the Platform in the centre of the room.

71. **Large Electromagnet** with vertical bobbins, fitted with all appliances for Faraday's experiments, also with

72. **Waltenhofen's Induction Pendulum** and

73. **Lenard's Bismuth Spiral** for measuring magnetic fields.

74. **Weber's Earth Inductor** for determining terrestrial magnetic inclination. A magnetometer supplied with the inductor for adjusting purposes renders it suitable for a tangent galvanometer.

75. **Astatic Oscillation Galvanometer** according to Weber, for observing inductive impulses by the earth inductor. Adjustable damping.

76. **Magnetometer** according to Gauss and Weber, for determining the terrestrial magnetic declination and the horizontal intensity by observations of oscillation and deflection.

77. **Reflecting Electrometer** for measuring electro-static potential differences. The peculiar arrangement and shape of the vane renders the deflections proportional within wide limits. Ranging from 1 to 500 fold between 1 and 50000 volts.

78

107.

79.

Industrial Direct Reading Instruments for large currents,

for E. M. F.'s, Intensity,
Insulation resistances, Energy expended.

Displayed along the walls.

78. **Voltmeter and Ampèremeter for continuous currents.** Circular cases, two sizes. Attraction of core of rolled sheet iron into solenoid; torsion counter spring (compensation of temperature by double spiral). Transformation of reciprocal in circular motion by means of lever with jewelled pivots. The peculiar form of the iron core admits of the form of the dial being varied at will.

Range from 1 to 20-fold reading, numerous models for all currents up to 3000 amp.

79. Voltmeter and Ampèremeter for continuous and alternating currents. Circular case. Two different sizes. Reciprocal action within a solenoid (attraction or repulsion) of two or more extremely light segments of a cylinder shell of soft iron. Index on aluminium center with jewelled steel points.

In spite of the presence of iron these instruments are available both for continuous and alternating currents, with the same calibration, irrespective of the rapidity of pole reversion. Range from 1 to 10-fold.

Made as a voltmeter in 15 differently calibrated forms, from 0.5 to 3000 volts.

Made as an ampèremeter, in 16 differently calibrated forms, from 0.5 to 3000 amp.

88.

85.

91.

80. Double Solenoid Voltmeter and Ampèremeter for continuous and alternating currents.

An annular iron core of extremely small polar distance is excentrically pivoted between two conaxial solenoids; the current tends to place the core conaxial with respect to the solenoids.

81. Hot wire Voltmeter and Ampèremeter, for continuous and alternating currents; with small consumption of energy. In the case of the voltmeters the bend of a short, very thin wire, through which the current passes, is heated and the amount of the expansion is transmitted by a peculiar device to the axle of the pointer. These voltmeters are by means of suitable introduction of resistances calibrated to indicate from 3 to 3000 volts.

In the case of ampèremeters a shunt is added to the heating wire or a heating wire of suitable thickness is made to heat a metal tube fixed at one end and the expansion of the latter is transmitted by means of a contact lever to the center of the index.

Both instruments are provided with arrangements for compensating influences of external temperature.

82. Electrostatic Voltmeter for high voltage, in circular case. By the peculiar shape and arrangement of the working parts the intervals of the scale are rendered nearly proportional. Range from 1 to 10-fold, between 100 and 50000 volts.

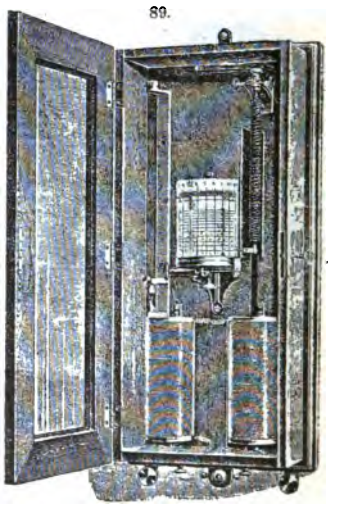
83. Aperiodical Voltmeter and Ampèremeter for continuous currents on Deprez's principle. In circular case.

84. Differential Voltmeter for controlling the voltage in the two circuits of three wire systems.

85. Universal Voltmeter for controlling the voltage in central electric light installations, for continuous and also for alternating currents with scale divisions visible at a great distance; scale embracing the range of voltage of a particular plant. Two sizes of 50 and 35 centimeters diameter.

87.

89.



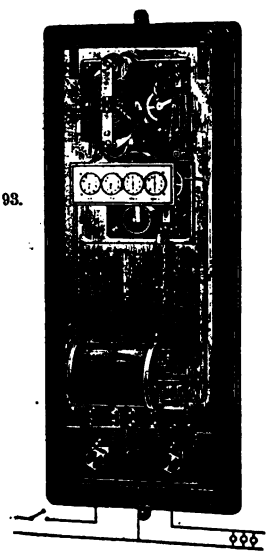
86. Contact Voltmeter with minimum and maximum efficiency, for giving visible and audible signals or for actuating automatic voltage regulators and cell switches, in the latter case with the aid of intermediate **Relais.**

87. Signalling Voltmeters with direct reading of the normal voltage. Incandescence of a **green** lamp signifies that the voltage has become too low, that of a **red** lamp that it has risen too high. An alarm bell is sounded at the same time.

88. Voltmeter for special purposes, e. g. for testing accumulators, for electro-plating, for ships, railways and tram-cars, in various forms according to the special purpose.

89. Registering Voltmeters and Ampèremeters, on the principle of Kohlrausch's spring galvanometer, which is particularly adapted for this purpose on account of its relatively powerful action, the rectilinear movement of its iron core suspended by a torsionless spring and its perfect damping. With 24 hours and 8 day clock work for the registering drum.

90. Wattmeter for direct reading. In circular case. External shunt connection as with the voltmeter and ampèremeter; the system is similar to No. 19, but arranged vertically and fitted with horizontal axis pivoted between two points. For currents up to 30 ampères and for voltages up to 150 volts. With extra shunts and additional resistances for several hundred ampères and several thousand volts.



93.

91. Ohmmeter in circular case for permanent connection with the circuit, for taking at any time direct readings of the resistances of insulations in ohms. By means of a commutator either the positive or the negative pole may be examined with respect to earth connection. The instrument can be made for any constant voltage.

92. New Ohmmeter for taking direct readings of resistances. Astatic magnetic system with differential multiplier, so arranged that the indications of the instrument are affected neither by terrestrial magnetism nor by the magnetic momentum of the needle nor by the voltage of the battery. Range from single to hundredfold reading.

93. New Volt-Coulombmeter. The current which is to be registered deflects the movable system of a wattmeter; a spring supplies the counterforce and is drawn out at short intervals by a very simple clockwork actuated by the current. The travel of the spring is transmitted to a registering set of wheels provided with electro-magnetic coupling which becomes disconnected whenever the strength of the current and the tension of the spring are in equilibrium. This play is repeated every minute. Range from single to 200-fold.

94. Motor-Coulombmeter. By a peculiar arrangement the velocity of this motor, which is provided with electrical damping, is rendered proportional to the current. By a special device absolutely certain starting is ensured even with the weakest current. An automatic switch for the

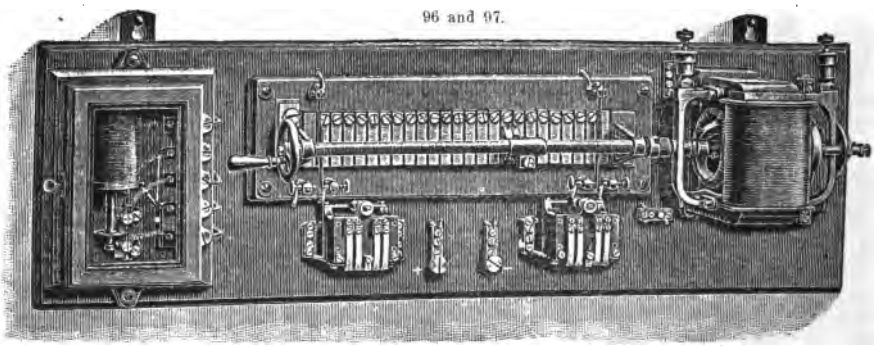
armature wire prevents the motor from consuming any current except when in motion.

95. Automatic Cut-outs for a certain maximum or minimum. Efficient within 3%.

96. Automatic voltage Regulator. The sliding contact which serves for connecting and disconnecting resistances is moved by a screw in a straight line. The screw is coupled to a small electro-motor. The latter takes its current in either direction through a contact voltmeter.

97. Automatic Switch for regulating the voltage by connecting and disconnecting **accumulators** with the circuit. Similar in construction to No. 96.

98. Differential Arc Lamps with stationary luminous point. A steady uniform light is obtained by the introduction of a clock work which retards the movement of the carbons. Low structure, various decorative designs, to burn from 5 to 15 hours, for currents from 1 to 15 amp.



96 and 97.

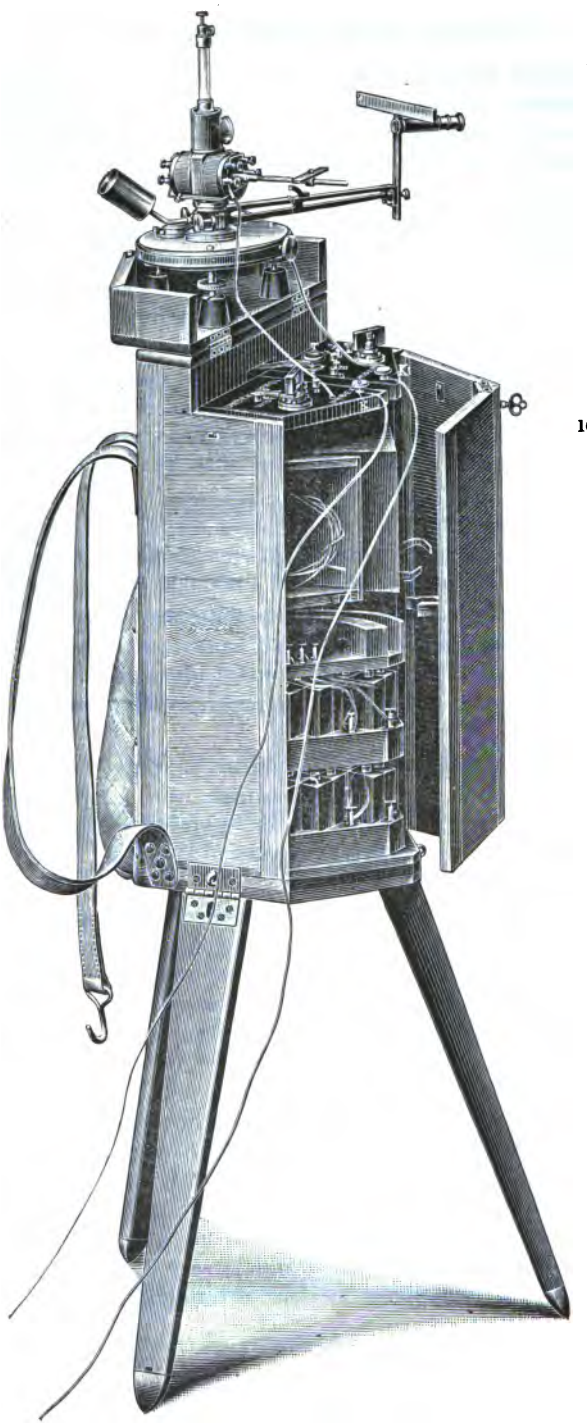
99. Small Electromotors of $^1/_{20}$, $^1/_{15}$ and $^1/_8$ HP, wound as series motors, and of $^1/_4$, $^1/_2$ and 1 HP wound as shunt motors. The speed of the former varies according to the load, the latter run at almost constant velocities. Both types are very efficient and well built.

100. Portable dynamo-machine for blasting; in wood case with leather strap. It generates at a speed of about 3 rotations of the crank per second 0.85 amp. and 75 volts (efficiency of 65 watts). Total weight 10.5 kilos. The igniting electrodes consist of thin platinum wires embedded in the cartridge.

Portable measuring appliances for use in the installation of electrical plants.

Exhibited at the entrance of the Exhibition room.

101. Portable Measuring Apparatus for Cable Laying. Two-wheeled firmly built truck fitted with resistance bridge for usual resistances, an apparatus for testing insulation resistances by the method of deflection, with a telescope galvanometer. Underneath a space is provided for a stand upon which the galvanometer may be placed. By



102.

means of a cloth folded upon the truck a tent can speedily be pitched for the protection of the galvanometer and other instruments. A measuring battery of 100 dry accumulators, with pachytrope for selecting various voltages, and a controlling voltmeter and ampèremeter complete the apparatus.

102. **Portable Apparatus for measuring the resistances of cable insulations,** consisting of a telescopic galvanometer with 3 shunts, comparison resistance, a battery of 100 cells with key; in oak trunk with folding feet by means of which the trunk may be converted into a stand. Range up to 500 megohms.

103. **Similar Apparatus** with simple needle galvanometer and 50 cells. Modification of the method of direct deflection, **independent** of the voltage of the current generator. The results are found nearly without calculation by a curve supplied with the apparatus. Range up to 10 megohms. Weight 14 kilos.

104. **Ohmmeter,** also in oak case fitted with folding legs, containing 50 cells. **Direct** reading of the required resistance of the insulation within the limits of 1000 and 1 000 000 ohms. Weight 14 kilos.

105. **Insulation tester** for the examination of domestic installation consisting of an induction coil which is made to act by continuous current either upon a galvanometer of 100000 ohms resistance or by alternating current upon a sounding apparatus with resistances up to 30000 ohms.

106. **Portable Bridge** with direct reading for resistances of solids and electrolytes, e. g. for measuring the internal resistance of cells or for testing earth connections of lightning conductors. Galvanometer, easily set up. Measuring telephone and cells. All in oak case. Weight 11 kilo (vid. No. 10).

107. **Portable Voltmeter and Ampèremeter,** mounted on tripod or fitted in wood box with handle. The voltmeters intended for fitters are so arranged that by means of a crank changer single portions of the winding may be coupled in multiple arc or in series. The instruments are accordingly provided with two scales, the range of one forming the continuation of that of the other. The voltage may thus be measured within very wide limits.

108. **Simple Incandescent Lamp Photometer,** constructed on Foucault's principle in such a manner that the candle power of the lamps may be compared without **dark room.** Either a paraffine candle or a standard incandescent lamp may be used as a standard of comparison. The ratio of intensity may be read directly by a scale with range from single to 10 fold reading. The apparatus is very light being only 1 meter long. It may also be used for outdoor determination of the luminosity of arc lamps.

R. Fuess,

Steglitz nr. Berlin,

Düntherstrasse 2/8.

(Formerly J. G. Greiner jun. & Geissler.)

The exhibits are shown in the *German University Exhibition.*

I. Mineralogical Division.

41 Photographs of the principal instruments used in mineralogical research; 3 sets in gilt frames.

1 large **Microscope,** Model No. 1.

Accessories and small **auxiliary apparatus** adjusted for microscope No. 1, mahogany case.

1 **Microscope,** Model No. 3.

1 **Microscope,** „ „ 5.

1 **Adams's Polarizing Apparatus,** with goniometer for measuring optical axes.

1 **Klein's Reflecting Goniometer.**

1 **Universal Heliostat.**

1 Case with **set of thin rock sections.**

II. Meteorological Division.

1 **Sprung's** and **Fuess's Barograph.**

1 **Sprung's** and **Fuess's Anemograph** with electrical registering apparatus.

1 **Sprung's** and **Fuess's** Pluviometer, with electrical registering apparatus.

1 **Aspirating Psychrometer** according to Prof. **Assmann.**

(Complete equipment for travellers in tropical climates.)

1 **Aspirator for Psychrometers.**

III. Meteorological Instruments for Explorers.

1 **Fortin** Barometer for measuring altitudes.

1 Hypsometer „ „ „

1 **Assmann's** small Aspirator Psychrometer.

1 Sling-Thermometer.

IV. Hygienic Division.

1 **Anemometer** for examining ventilations.
1 **Anemometer** with crossed bowls. Smallest model.
1 **Koppe's Hair-Hygrometer.**
1 **Maximum and Minimum Thermometer.**

V. Architectural Division of the Prussian Ministry of Public Works.

1 **Registering water mark** designed by **Seibt** and **Fuess.**
1 **Water mark** with divisions and figures on china.

10 Photographs of the principal instruments for registering water marks designed by **Seibt** and **Fuess,** in frame.

(All information respecting these instruments may be obtained from Mr. ***Winter,*** *mechanician in the German University Exhibition.*

INDEX.

Alcoholometers: Schultze 92.
Anemometers: Fuess 181.
Aneroid-Barometers: Bohne 11. — Lufft 47. — Moeller 51.
Astronomical Instruments and Appliances: Merz 49. — Riefler 61. — Steinheil Söhne 103. — Tesdorpf 124.

Balances: Betting 11. — Hasemann 17. — Bunge (A. T Herzberg) 21. — Staudinger & Co. 99.
Barometers, mercurial: Bock 14. — Küchler & Söhne 151. — Alt, Eberhardt & Jaeger 151. — Greiner 152. — Fuess 181.

Calculating Machines: Burckhardt 15.
Clocks: Riefler 61. — Dieckmann 157.
Colorimeters: Krüss 42.

Didactical Purposes, Apparatus for: Kohl 35. — Gebhardt 147.
Drawing Instruments: Ott 54. — Riefler 61. — Sydow 120. — Tesdorpf 124.

Electrical Instruments and Appliances: Hartmann & Braun 160.
Electro-Therapeutical Instruments: Hirschmann 19. — Reiniger, Gebbert & Schall 58.

Forrestry, Appliances for: Staudinger & Co. 99. — Tesdorpf 124.

Gasmeter: Kromschröder 158.
Glass Instruments and Appliances: Bock 14. — Niehls 53. — Schmidt & v. d. Eltz 66. — Schultze 92. — — Uebe 135. — Küchler & Söhne 151. — Alt, Eberhardt & Jaeger 151. — Greiner 152. — Gundelach 153. — Schilling 155. — Lindenlaub 156. — Strasser & Rhode 156.

Hygrometers: Bohne 11.

Laryngological Instruments: Doerffel & Färber 14. — Sydow 120.
Levelling Instruments: Butenschön 16. — Ott 54. — Tesdorpf 124.
Levels: Pessler 58.

Mathematical Instruments: Butenschön 16. — Ott 54. — Riefler 61.
Measures: Bube 158.
Meteorological Instruments: Bohne 11. — Bock 14. — Lufft 47. — Moeller 51. — Fuess 181.
Micrological Instruments: Jung 24.
Microscopes: Schieck 66. — Schmidt & Haensch 67. — Voigt & Hochgesang 137. — Zeiss 145. — Fuess 181.
Microtomes: Jung 24.
Mineralogical Appliances: Voigt & Hochgesang 137. — Fuess 181.

Ophthalmological Instruments: Doerffel & Färber 14. — Jung 28. — Sydow 120.

Optical Instruments and Appliances: Halle 17. — Krüss 42. — Merz 49. — Schieck 66. — Schmidt & Haensch 67. — Schulze & Bartels 94. — Schott & Genossen 96. — Steeg & Reuter 97. — Steinheil Söhne 103. — Voigtländer & Sohn 141. — Zeiss 145.

Pendulum Apparatus: Riefler 61.
Photographic Appliances: Schulze & Bartels 94. — Steinheil Söhne 103. — Voigtländer & Sohn 141. — Zeiss 145.
Photometric Appliances: Krüss 42. — Schmidt & Haensch 67.
Physical Apparatus: Kohl 35. — Krüss 42. — Schmidt & Haensch 67. — Staudinger & Co. 99. — Steinheil Söhne 103. — Voigt & Hochgesang 137. — Zeiss 145. — Gebhardt 147.
Physiological Instruments: Doerffel & Färber 14. — Jung 28. — Sydow 120.
Polarizing Appliances: Krüss 42. — Schmidt & Haensch 67. — Steeg & Reuter 97.
Polarizing Prisms: Halle 17. — Steeg & Reuter 97.

Saccharometers: Schmidt & Haensch 67. — Schultze 92.
Spectroscopical Instruments and Appliances: Krüss 42. — Schmidt & Haensch 67. — Steinheil Söhne 103.
Surveying Instruments: Butenschön 16. — Ott 54. — Tesdorpf 124.

Theodolites: Butenschön 16. — Ott 54. — Tesdorpf 124.
Thermometers: Bohne 11. — Bock 14. — Moeller 51. — Schmidt & v. d. Eltz 66. — Schultze 92. — Uebe 135. — Standardizing Institute 150. — Küchler & Söhne 151. — Alt, Eberhardt & Jaeger 151. — Greiner 152. — Fuess 181.

Water marks: Fuess 181.

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