ish provinces is set down as consisting of one pound of rye bread, two pounds of potatoes, an ounce of meat, half an ounce of salt, and one sixth of an ounce of coffee.

Nor can the Prussian be said to be much better off as concerns his lodgment; high rents, confined spaces, little comfort, and less cleanliness being the rule throughout the kingdom. In the large towns, with very rare exceptions, artisans live in lodgings; several families herd together—sometimes as many as fifteen individuals crowding into one small, low, damp room—twenty-five cents a week a head being the Berlin tariff for sleeping accommodation and convenience for washing. Three years since the returns showed there were in the capital 15,574 dwellings with an average of six to seven occupants per room. In the country and in the small towns—unless lodgings are provided by the employer—working folks generally have a house of their own: a house, such as it is. In Memel it will be a mere mud cabin with nailed up windows; in Silesia, a one-storied thatched house, with diminutive windows, and rooms just high enough to allow the proprietors to stand upright in them. The miners of the circle of Ottweiler, in the Rhine province, are perhaps the best off in this respect, being looked after by the government itself. "The three royal coal mines of Heinitz have three large sleeping houses belonging to them to accommodate 800 men. The Rheden mine has two of these for the accommodation of 400 men. The miners pay thirty-six cents a month, for which they have a bed and towels, and the use of half a press. To enable miners to settle in the neighborhood, the Miners' Union has purchased 1,350 acres of land for founding a mining colony. It sells at cost price, or leases at a moderate rent, one sixth of an acre of land to any one who will build a house upon it, and one sixth of an acre upon the same terms for a garden. Money for building purposes is also advanced at four per cent interest, to be deducted from the wages, with a present of from 100 to 120 dollars as a premium for building." These houses at Ottweiler are, as might be expected, neat and cheerful; but, with the exception of them, the description "bad, small, and densely crowded" applies generally to the habitations of the Prussian workman, in whatever part of the land he may be domiciled.

A better condition of things might be looked for where such pains are taken to render the laborer worthy of his hire. Primary education is obligatory for all children from the age of six to that of fourteen, and afterwards the journeyman or apprentice may continue educating himself at the "Fortbildungsschulen," open Sundays, and occasionally upon week days, for a somewhat higher degree of instruction. When a Prussisn lad has received the education prescribed by law, he chooses his trade, and binds himself to a master, who, for his labor, gives him board, lodging, and instruction. Apprenticeship seldom lasts more than three years, at the end of which time the young workman gets a certificate from his master, and sets out upon his travels—"wandering," as it is called, being reckoned necessary ere he can claim admittance into the ranks of journeymen. He usually makes a point of visiting the places specially famed for excellence in his branch of trade. If he be a stone-cutter, he must not miss Munich and Cologne; if a locksmith, Berlin and Vienna; if a tailor, Dresden must become his residence for a while; if no one wants his services at any town he enters, the Journeyman's Fund there supplies him with the means of taking him elsewhere. The more ambitious artisans are not satisfied with tramping through Germany, but betake themselves to foreign lands, where not a few of them are tempted to remain—and no wonder! Traveling about the world with open eyes cannot but do the travelers good, and the practice is therefore to be commanded; it is, however, doomed; the new Industrial Code of the North German Confederation has pronounced against it, by declaring wandering no longer compulsory, and that traveling handicraftsmen have no claim for assistance upon their associates in the trade. The Code only came into operation in October, 1869, so that what effect its provisions will have cannot yet be seen. By it a variety of restrictions upon the freedom of industry were swept away; all engagements between man and master are declared to be matters for mutual agreement, to be canceled by a fortnight's notice on either side; and the old prohibitions against workmen uniting, for the purpose of obtaining more favorable wages and conditions of work, more especially by means of strikes, are repealed. But, at the same time, "any one inducing, or seeking to induce, others, by physical force, threats, or outrages, or by placing them under an interdict, to take part in these coalitions," was made punishable by three months' imprisonment. Nevertheless, in Prussia, as elsewhere, labor and capital are continually wasting their resources in trying each other's strength and obstinacy.—*Chambers' Journal.*

THE APPLICATION OF PHOTOGRAPHY TO MILITARY PURPOSES.

Modern warfare may, in many respects be considered as so many applications of science. Not only is war *materiel* designed and manufactured now-a-days upon the most approved data, and according to theories worked out with mathematical accuracy, but a large section of our soldiers are educated in such a manner as fully to appreciate the value of their resources, and so to overcome difficulties which years ago would have been regarded as impossibilities. No instance demonstrates this more satisfactorily than the recent Abyssinian expedition, which, whatever may be said of it as a campaign, cannot but be regarded as one of the most wonderful feats of engineering accomplished in modern times. The nearer warfare approaches perfection, the more decisive, and therefore less cruel it necessarily becomes, as witness the brief duration of the wars of late years on the Continent; and for this reason the improvements in warfare effected by science cannot by any means be regarded as a misapplication of knowledge.

Our present remarks bear reference to the applications made of a very modest branch of science, if science, indeed, it can be called, our object being to demonstrate the many uses made by the War Department of photography. In the special application of this art-science to military matters, our Government is certainly in advance of others, if we except, perhaps, that of France. No less than three establishments have been organized in connection with the army in which photography is extensively practiced, the most important of them being the General Establishment at Woolwich; but, besides these, there are again many Royal Engineer stations, both at home and abroad, which are furnished with photographic requisites and employ the camera for divers purposes. At Chatham, the photographic establishment assumes the character of a school of instruction, at Southampton it forms an adjunct to the Ordnance Survey Office, while at Woolwich, of which department we desire more particularly to speak, the duties performed by aid of the camera are as various as they are numerous. For registering patterns, recording experimental results, imparting military instruction, and for other purposes too multifarious to enumerate, photography is extensively used, the faithful accuracy of sun pictures, as likewise the facility with which they are produced, causing the art to be eagerly employed in any way where it can be made available.

As an example of the value of photography in instruction, we would cite an interesting series of pictures taken to illustrate ordnance drill. This series comprises upwards of one hundred views, and demonstrates the practical working of the various kind of guns, mortars, rockets, etc., in the service. One picture, for instance, will illustrate the command, "Prepare for action;" a gun will be shown surrounded by a group of artillerymen in the positions they have been instructed to occupy on the issue of that order, each man having his respective number attached to his cap as a distinguishing mark. The next illustration in the series is probably that of "Load," and the next again "Fire," both of which will represent the change in position of the men, as one operation succeeds another, and the various duties performed in turn by each gunner or number, for it must be remembered that in gun drill every man is told off to a particular number and intrusted with a separate and distinct duty. Thus, on the promulgation of any new system of drill, or of any modification in the method of working, it is merely necessary for the military authorities to forward pictures of this kind to the different instructors, who cannot fail at once thoroughly to understand the new exercise; and even the rawest recruit who had assigned to him a certain number at a gun, would see at a glance the exact position he is to occupy by a reference to the photographs.

Another not less striking instance of the importance of photography in this connection may be given. At the outset of the Abyssinian campaign it will be remembered that several thousands of pack-saddles were required for transporting war *materiel* into the interior. These pack-saddles were made in and sent direct from England to Annesley Bay, so that the troops coming from Bombay knew nothing of their construction, nor of the method in which they were to be packed. This ignorance in the hurry of affairs would have been of serious consequence (for a military pack-saddle of the present pattern is a somewhat complicated contrivance) had not the authorities at home been fully alive to the subject and foreseen the threatening difficulty. A mule at Woolwich was harnessed and packed, after some experience had been acquired in the matter, in the most suitable and approved manner, and the animal then carefully depicted by the aid of the camera; the disposal of the harness and trappings, and the correct way in which the packages were to be carried, were thus clearly shown in a photograph, numerous copies of which were immediately sent out to Annesley Bay and distributed among the officers of the Quartermaster-General's department.

In recording experimental results photography again fulfills a duty which could not be discharged so rapidly and impartially by any other means. The stone iron-cased shields and armor targets built up of metal plates of different thicknesses, and then fired at by shot and shell of all descriptions, are carefully photographed after each decisive experiment, and a record of indisputable accuracy thus obtained. With a picture before us of a target, constructed to represent the side of an armor-plated vessel, which has been experimented on, we can at once form an accurate estimate of the impression made upon the iron wall by shot of different calibers, while rear and side views of the structure will show plainly the amount of damage which the backing or skin of the shield has suffered. As may be imagined these prints form important illustrations to the written reports made from time to time to the War Office authorities.

The photographing of newly adopted Government patterns, whether in the shape of guns, carriages, wagons, mantelets, tents, etc., is also an important section of the work undertaken at Woolwich, as likewise that of producing pictures relating to army equipment, such, for instance, as demonstrate the setting up of cooking apparatus, disposal of ambulances, refitting of ordnance in the field, etc. There is, moreover, the pursuit of photo-lithography to be mentioned, by means of which designs and sketches are copied and transferred to stone for printing off in the ordinary manner.

The subject of working photography in the field is a matter to which much attention has been given at the general establishment, for it will be readily conceived that the simplest and most effective methods of working, as likewise the different uses to which the camera may be put during warfare are questions of very serious study.

The photographic copies, many thousands of which are annually produced and distributed over all parts of Her Majesty's dominions, are not now printed upon silver paper in the ordinary way, but by the so-called carbon or autotype process, a method which produces prints of an absolutely permanent character. Ordinary silver prints are always liable to become faded and stained after the lapse of a few years, owing to the presence in the paper itself, or in the atmosphere with which it comes in contact, of sulphur compounds which attack the metallic silver composing the image. In the carbon pictures, however, no silver at all is present, the composition of the image being a mineral pigment in combination with an insoluble chromium.

Our description of the General Photographic Establishment at Woolwich has been very brief indeed, but enough has been said to show to what an important extent the art is employed in connection with the War Office; the department which we have described is a branch of the chemical establishment of the War Department, which was first organized in 1854, by Mr. Abel, and has gradually become intimately and indispensably connected with every branch of the military service.—*Nature.*

A Geological Excursion in the Moon.

[Translated for the Maine *Journal of Education* from *Cosmos*].

Under this title Stanislas Meunier recently gave a lecture filled with interesting facts, and pleasantly illustrated by numerous photographic projections by the aid of the Drummond light.

The professor remarked at the opening that it is not wholly certain that there are not on the surface of the earth specimens of lunar rocks, since there is no absolute proof that the meteorites are not ejections from the volcanoes of the moon. He moreover added that one can very profitably study at a distance the geological structure of inaccessible localities.

The moon, which appears to be wholly deprived of all atmosphere and consequently of water, presents two very different kinds of rocks, those which constitute the mountains, and those which constitute the so-called *seas*. The former, from the form which they present, and the analogy of that form with that of terrestrial volcanoes, are evidently volcanic rocks. The others, according to Lecoq, are dry sands or melted rocks.

One may, in some instances, study very closely the structure of mountains, and draw, for example, the analogy of the form of the circles in the moon with that of the circles of granite and porphyry in the earth. Schrotter and Herschel both discovered in various mountains of the moon places where a very fine stratification may be seen.

This study of the mountains of our satellite has led to a comparison with the mountains of the earth, and in some instances very striking analogies have been found, especially at the Puys d'Auvergne, the volcanoes of Teneriffe, Palma, etc.

Finally, the observations of astronomers have furnished a basis upon which Chacornac proposes a theory concerning the geogony of the moon. It comprises three grand periods: 1. The formation of the circles. 2. The extension of the muddy diluvium which constitutes the seas. 3. The formation of the comparatively small craters.

After reviewing the various observations cited to prove the actual activity of the lunar volcanoes, the lecturer adopted the opinion of Beer, Moedler, and Arago that the moon is a *dead star*. He then went on to prove that this inference may also be drawn from that singular appearance upon the surface of the moon to which has been given the name of *grooves*. There are grooves with parallel sides nearly a mile in width, and from ten to one hundred and twenty-five miles in length. About ninety have been counted, and it is very probable that they are still in the process of formation. It was a very long time before any reliable explanation of the grooves was given. We are indebted to Professor Lecoq for it (*Traité de Géologie*). It has been further developed by Saeman, who made it the subject of a special article printed in the *Bulletin de la Société géologique de France.*

According to these geologists the grooves are due to the cracking which is evident on the surface of the moon as a result of the loss of heat. There is no reason to suppose that at a former period the moon had not upon its surface both an atmosphere and water. But the latter penetrating the crust, as it does upon our globe, has been gradually absorbed in proportion as the crust has increased in thickness. All the water had disappeared long before the cooling process had reached the center. The loss of heat continuing, the rocks in solidifying contracted in a way analogous to that which basalt manifests, and the grooves are the result. Into these grooves the atmosphere settled.

Everything indicates that the earth is actually passing through the various states through which the moon has already passed. It is estimated that already one fiftieth of its primitive ocean has been absorbed, and that what remains will have been drunk up when the thickness of the crust shall be one hundred miles. Our whole earth, from what is known of it, would easily absorb fifty oceans like ours, so that the water at present upon the earth, being once absorbed and which constitutes only $\frac{1}{24000}$ of its weight, would become absolutely insensible to the most precise chemical analysis.

Then the earth will crack open, as the moon has done, and its atmosphere will settle into the fissures beneath its surface. A long time before this all life will have ceased.

The prediction which the study of the moon allows us to make in regard to our globe will evidently be realized only in a far distant future, for after the experiments of Bischof nine millions of years will be needed for the earth to cool down 15°, a loss almost imperceptible, since the internal heat adds only one thirtieth of a degree to the temperature at the surface. We may go further and apply to the sun everything which has been said of the earth and the moon. Being larger, it will cool less quickly, but the time will nevertheless come, at least everything seems to indicate it, when it will have absorbed its waters and its atmosphere, and the fissures will be formed upon its surface. Our whole solar system will then be only an assemblage of dead worlds.

Improved Steam Generator and Water Heater.

This boiler is formed in sections secured together by means of flanges or ears and bolts, with packed joints, the sections being provided with fire flues, water and steam passages, furnace, and fuel magazine, the whole being designed to extend the principle of base-burning—so successfully applied to stoves—to the furnaces of steam boilers.

The number of sections is immaterial as regards the general principle of the device, this number being varied according to the required size and capacity of the boiler.

Fig. 1 is a sectional view of the boiler, which may be used for heating water by steam for domestic use when not required for motive power. It has a door in the dome above the fuel magazine through which the charge of fuel is placed in the furnace. It also has another door giving access to the fire below when necessary in starting, etc., and another still lower opening into the ash-pit. The conical dome or cap receives the smoke and incombustible gases and discharges them into the smoke stack. The boiler may be jacketed, if desired, and is usually so jacketed, but the jacket is omitted in our engraving to show the method of joining the sections.

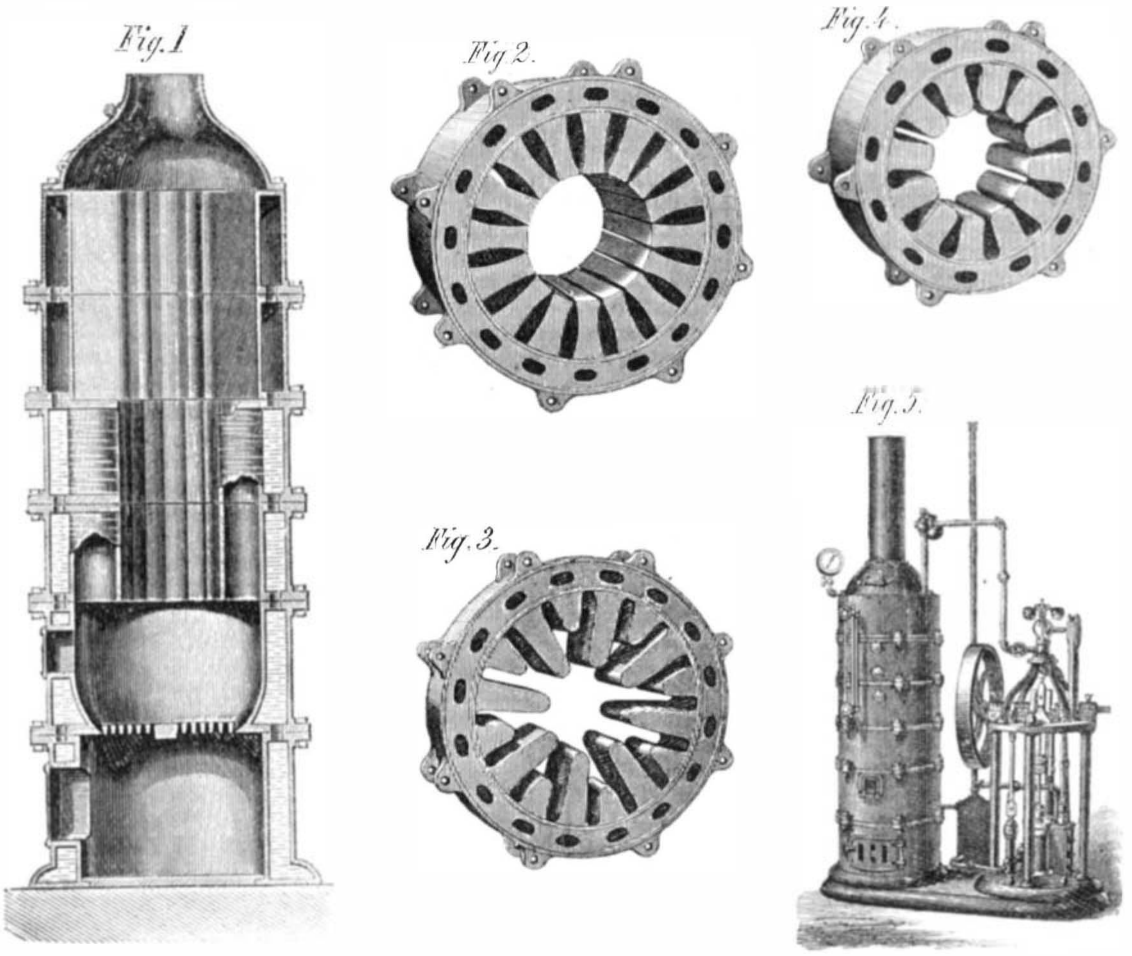
The sections, Figs. 1, 2, and 3, are cast each in a separate piece, with flues, water spaces, and communicating orifices entire. They are then faced up in a lathe and packed with simple elastic packing inserted in grooves in the faces of the sections, which are then bolted together, as shown in Fig. 1. Various forms of the sections are used, as shown in the engravings; but in none of them are the joints exposed to the fire, and the packing is consequently no more exposed than in ordinary steam joints.

Small boilers of this kind may be used advantageously for generating steam for heating purposes, and as great heating surface in proportion to the contained water is obtained by this peculiar construction, they must get up steam very quickly.

Fig. 5 shows the boiler attached to an engine designed by by the inventor of the boiler. The boiler and engine are of three-horse power, and stand on a single cast-iron bed plate twenty-six by fifty-seven inches in extent. The boiler is twenty inches in diameter and fifty-four inches high, exclusive of the bed plate and smoke dome. It has thirty square feet of fire surface, and holds about twenty gallons of water when filled to center of gage.

A water heater is constructed on the same plan as the flue section of the boiler, steam being used instead of fire for heating. This engine and boiler give, we are told, three full horse power for one day of ten hours, at an expense of only 100 lbs. of coal. We are further informed that quite a number of the boilers are in use and are giving excellent satisfaction.

This boiler was patented March 22, 1870, by Orlando Clarke, and is manufactured by Messrs. Clarke and Utter, Rockford Iron Works, Rockford, Illinois.



CLARKE'S STEAM GENERATOR AND WATER HEATER.

Improved Universal Shaft Coupling.

The object of this invention is to provide a closed joint, so constructed that it will be as flexible as the old style of universal coupling, but which, at the same time, shall cover all the working parts, so as to obviate the need of boxing, required by law in many of the States to prevent accidents.

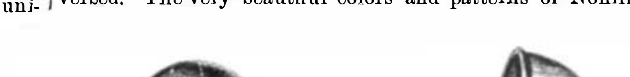
This is accomplished in a simple and ingenious manner readily understood by reference to the accompanying engraving.

A, is a hemispherical shell, taking the place of the old style crutch on its end of the shaft; a spherical shell, B, slotted at E, taking the place of the crutch on the end of the other section of shafting. The spherical shell, B, fits into A, as shown.

A bolt, C, passes across the open end of the shell, A, and through a hole in the middle of a larger bolt, D. The latter bolt reaches out to the sides, but does not penetrate the shell, B, and it cannot be withdrawn from the shell without first removing the smaller bolt, C, which passes through it, as its ends meet and engage with the inner walls of the spherical shell, B. This connects the two sections of shafting, so that they cannot come apart till the bolt C is taken out.

The slot in the shell, B, passes over the bolt, C, which plays therein, and thus a universal motion is obtained, while the parts which are likely to become entangled in clothing or belting, are entirely covered by the shells.

Patented, through the Scientific American Patent Agency, July 26, 1870, by Moses A. Keller, of Littlestown, Pa., whom address for State or shop rights.



KELLER'S IMPROVED SHAFT COUPLING

SOFT soap it is said, will soften the hardest putty.

Professor Tyndall on Electrical Phenomena and Theories.

One remarkable peculiarity in these lectures of Professor Tyndall is, the effective way in which several of the more subtile effects of electrical change and power are made manifest to a large audience by the instrumentality of beams of electric light, manipulated in various ways. Thus, for instance, the elongation of a solid bar of iron, when it is thrown into the magnetic state, by being encircled in the folds of a voltaic current, conveyed by a helix, is shown by the starting of a spot of light, some six or eight inches upon a screen, when the molecular condition of magnetism is excited by the passage of the current. A beam of light falls upon a small mirror, carried at the extremities of the arm of a lever, so resting upon the end of the iron bar, that when the lever is lifted by the magnetic elongation of the bar, the beam of light is shot off from the mirror as a long weightless index. The change in the position of the molecules of iron by the action of magnetism is also proved by throwing the beam through a vertical cell of glass, containing magnetic oxide of iron suspended in water. When the cell is exposed to the influence of the poles of a strong electro-magnetic, the light passing through the cell and contained liquid to a screen beyond, brightens, in consequence of the metallic molecules turning themselves "end on" to the incidence of the beam. The lines of magnetic force assumed, when iron fillings are sprinkled over the poles of a magnet, are portrayed by the intervention of a system of lenses, which depicts the image upon the screen. The formation of the "tree of lead" upon the negative electrode of a voltaic current, when a salt of lead is decomposed by the current, is shown in the same way; the arborescent crystals glowing and dissolving alternately on the opposite poles, immersed in the solution as the direction of the current is reversed. The very beautiful colors and patterns of Nobili's rings, formed when lead is thrown down by voltaic decomposition upon a polished plate of steel, are exhibited by a similar intervention of lenses, and the illumination from the electric beam.

An artificial telegraph cable, whose resistance to the transmission of the electric current is made identical with 14,000 miles of an actual marine cable, is formed by introducing into the path of the current gaps, consisting of feebly conducting liquids and condensers, so distributed as to represent the respective distances by telegraphic route to Gibraltar Malta, Suez, Aden, Bombay, Calcutta, Rangoon, Singapore Java, and Australia. A mirror, belonging to each gap, lies in the path of the currents, carried by a galvanometer, constrained to deflect its needle from the position of both on the instant that the passage of the current is felt. Before the current is sent through the apparatus, ten dots of light, cast from the mirrors by the instrumentality of electric illumination, lie upon the screen, in a straight vertical range. When the current is passed through the apparatus, dot after dot starts aside upon the screen, as the current fills the condenser immediately before each mirror, and then flows beyond to deflect the galvanometer immediately in advance. The deflection of the successive galvanometers, and the corresponding traverse of the beam of light upon the screen, is seen, under this arrangement, to take place at successive steps or intervals which exactly express the intervals of time which the electric current would require to reach the several stations named, in the actual progress of telegraphy The starting aside of spot after spot upon the screen when the current is sent through the apparatus, and the subsequent return of spot after spot to the position of original test in inverse order, forms a very striking illustration of the fact that the resistance of an electric cable is in some degree dependent upon its length, and that time is consumed in overcoming this resistance. The most interesting and telling of all these beam-of-light illustrations, however, is certainly the one which is employed to indicate the excitement of diamagnetic force in a tube of copper, when it is suspended between the poles of an electro-magnetic. The tube is carried by a string of silk, and rotates rapidly under the influence of a twist given to the string. The string also carries above the tube a series of small mirrors, which reflect the light of an electric beam, so that a continuous elliptical band of illumination is formed on the screen whilst the twisting is continued. The instant the electro-magnet is made active by the transmission of the current through its helix, the copper tube acquires diamagnetic polarity by induction, and under the influence of this polarity the rotation is arrested, and the bands of light upon the screen is changed into a small stationary spot or illumination. When the electro-magnet is unmade by the arrest of the voltaic current, the spot of light again becomes an elliptical band, under the resumption of the twisting of the silk string with its mirrors and copper tube.

Of the numerous other very pleasing and telling illustrations exhibited in these lectures, space only permits allusion to be made to a very few which have been selected from the series, as being worthy of especial mention. The sound produced by the molecular vibration in iron when its mass is transiently magnetized by the voltaic current, is made audible by suspending an iron poker upon two sounding boards, and making it the core of a helix, conveying an electric current. An assistant is converted into an extemporized electrophorus, by flapping his black coat with fur while he stands upon a glass-legged stool. Small fish of gold leaf are made to float in the air current given off from the knob of a charged Leyden jar. A thick drinking glass is shattered by the expansion of the water contained in it, when sparks formed under the intensifying power of fifty condensers joined "in cascade," and primarily charged by a voltaic battery of one thousand cells, are passed through the liquid. To demonstrate the relation of resistance to heating power, a long line of wire is arranged in alternate links of platinum and silver, and when the voltaic current of due intensity is passed through the length, each stretch of the platinum wire is seen to glow with brilliant red heat, while the stretches of silver wire between remain still invisible. A beautiful series of Geissler's vacuum tubes were brought into successive operation, in which the auroral discharge was broken into stratified leaves, in which the glow was extinguished by the approximation of the poles of an electro-magnet, in which a feeble glow was converted into bright stratified light by the influence of a magnet; and beautiful beyond all the rest, the light from the inclosed negative terminal of the voltaic battery was arranged into the well-known lines of magnetic force, when subjected to the influence of the poles of a magnet.

SUCCESSOR TO PROFESSOR MAGNUS.—This lately deceased *savant* is to be succeeded by Professor Helmholtz, from Heidelberg University, who has been elected by the Council of Berlin University a Professor of Physics.