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AUTOMOBILE FIRE ENGINES.*

By EMILE GUARINI.

THE Weyher & Richemond Company, of Patin, Department of the Seine, recently furnished to the fire department of the city of Paris a very interesting automobile steam fire engine. Through the courtesy and personal assistance of Lieutenant-Colonel Vuilquin, of the said fire department, I have been enabled to make a thorough study of the machine. The boiler is of the multi-tubular type, having curvilinear tubes. The working pressure is 10 kilogrammes per square centimeter (142¼ pounds per square inch), which is raised almost instantly. The engine is a compound one, with variable cut-off, of about 30 effective horse-power. It makes 300 R. P. M., and may be instantly changed from a compound to a double-cylinder, high-pressure engine, under which conditions it delivers more power. This change is found useful in starting and when ascending grades. By the movement of a lever, the motor can be disconnected from the driving wheels and thrown into gear with the pumps, which have a capacity of 1,800 liters (575½ gallons) per minute. The engine is geared to a normal speed of 24 kilometers per hour (14.9 miles). The automobile is arranged so as to carry twelve lengths of large hose, six of small hose, four suction pipes, 300 liters (52.84 gallons) of water, 120 kilogrammes (264½ pounds) of coal, twelve men, large and small pikes and hooks, and other accessories. The city of Paris also possesses an electric automobile fire engine, an illustration of which is here shown. As will be seen, it consists first

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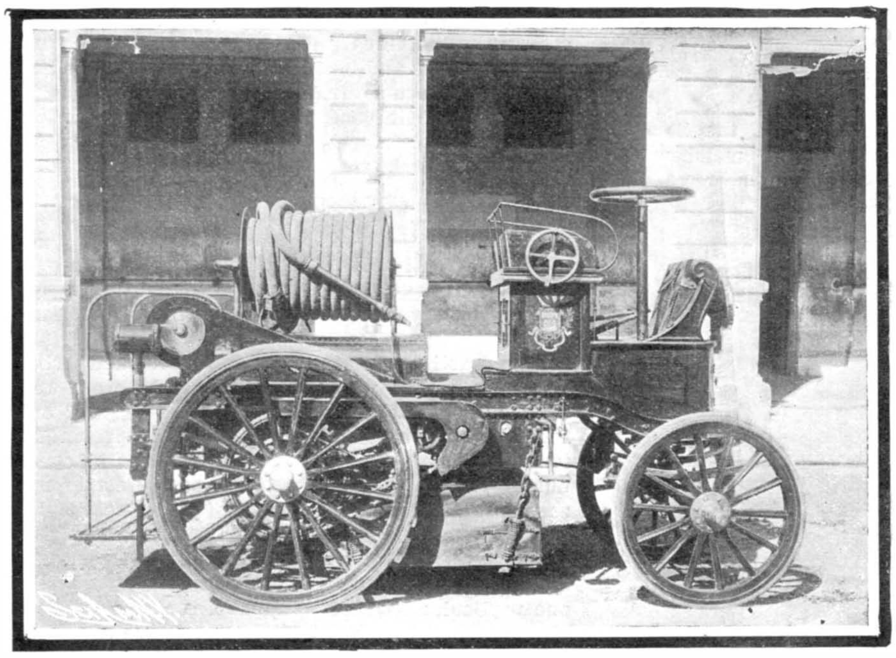
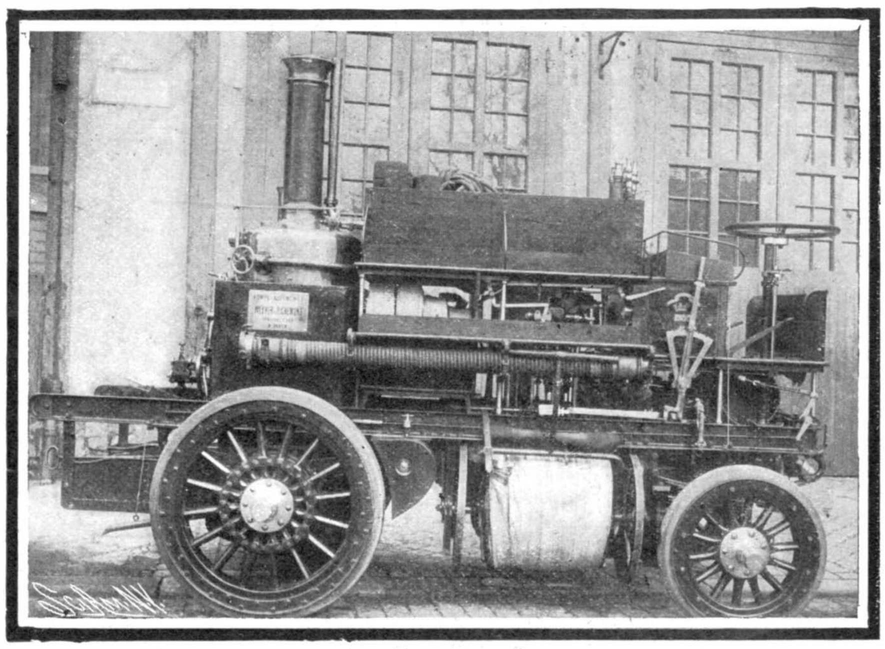
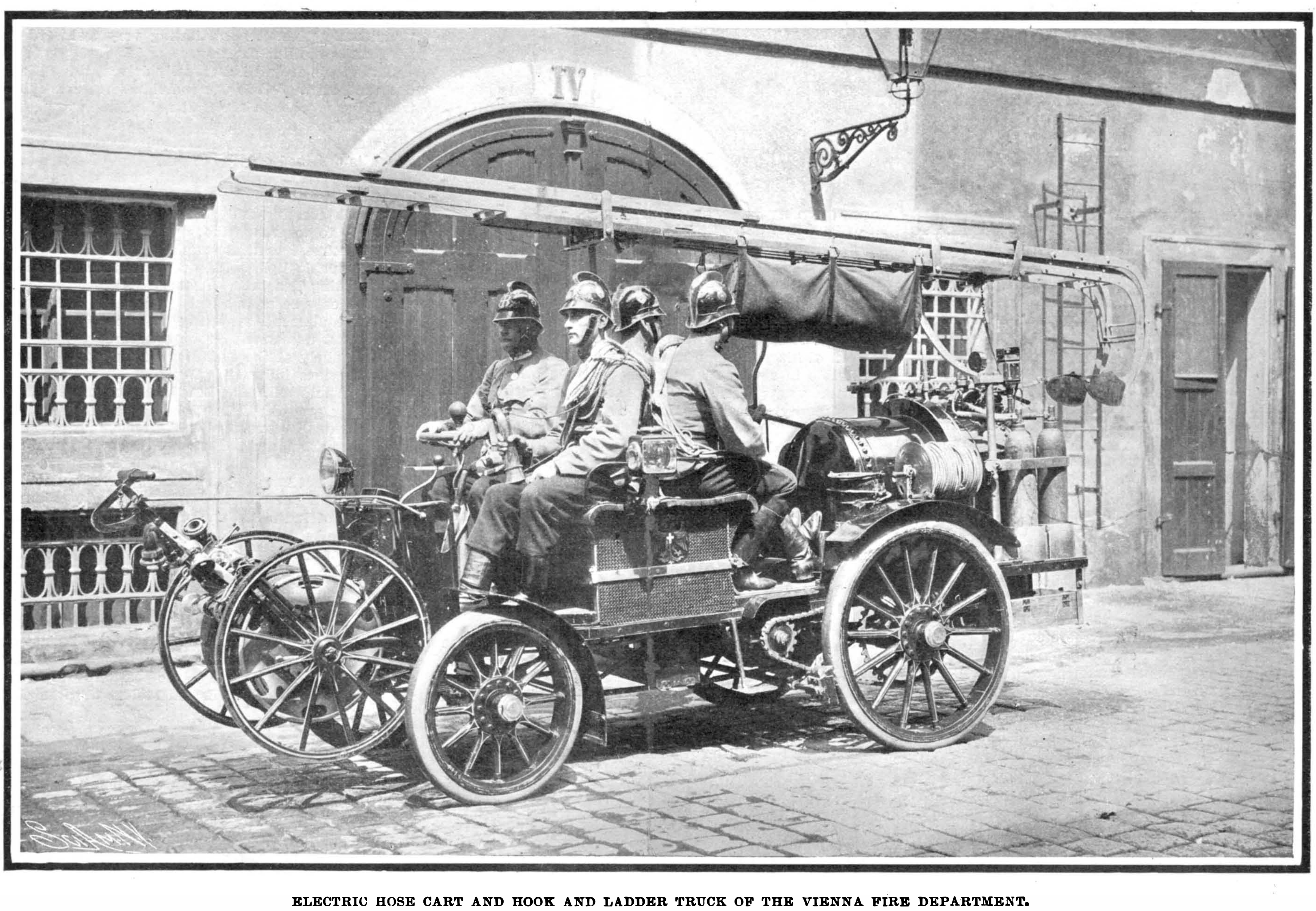


ELECTRIC AUTOMOBILE FIRE ENGINE OF THE PARIS FIRE DEPARTMENT.



STEAM AUTOMOBILE FIRE ENGINE OF THE PARIS FIRE DEPARTMENT.



ELECTRIC HOSE CART AND HOOK AND LADDER TRUCK OF THE VIENNA FIRE DEPARTMENT.

FOREIGN AUTOMOBILE FIRE ENGINES.

of an electric vehicle carrying a pump for extinguishing fires, said pump being at first supplied from a large tun filled with a specially compounded extinguishing liquid. There is, moreover, a reel carrying 40 meters (131¼ feet) of hose. The motor which is used to propel the vehicle serves, when the automobile is at rest, for driving the pump. This system offers the advantage of an immediate departure from the engine house, and, upon arriving at the fire, an equally rapid starting of the pumps, thus realizing an effective attack upon the burning building with much less loss of time than under ordinary methods.

The electric automobile fire engine weighs about 2,290 kilogrammes (5,048 pounds) net, and about 2,900 kilogrammes (6,393 pounds) gross, when in running order, and carrying three men and 400 liters (105.68 gallons) of water. It is capable of running 60 kilometers (37¼ miles) at a rate of 19 kilometers (11.79 miles) an hour without being recharged. At this speed the current consumption is 50 amperes. Upon a good road it will run 22 kilometers (13.66 miles) an hour with a current consumption of 60 amperes. The pump is of the three-cylinder type, and it forces the water with a pressure proportionate to the current used by the motor. The delivery at 20 amperes corresponds to about 60 pounds to the square inch, while with 35 amperes a pressure of about 120 pounds can be had. The pump delivers 80 liters (21.13 gallons) of water per minute through a nozzle 7 millimeters (.275 inch) in diameter at a pressure of 60 pounds per square inch, and 200 liters (52.84 gallons) per minute through a 10-millimeter (.393 inch) nozzle at a pressure of 105 pounds per square inch. The pump drives the water through the axis of the reel into the rubber hose, which is wire-wound and has an interior diameter of 35 millimeters (1.377 inch). It is also capable of raising the water, at the suction end, 7 meters (22.96 feet). The gearing of the motor is so arranged that it can run the vehicle or the pump without either conflicting with the other. It is a 4-kilowatt motor, operated by a storage battery weighing 580 kilogrammes (1,278 pounds), and having a capacity of 180 ampere-hours.

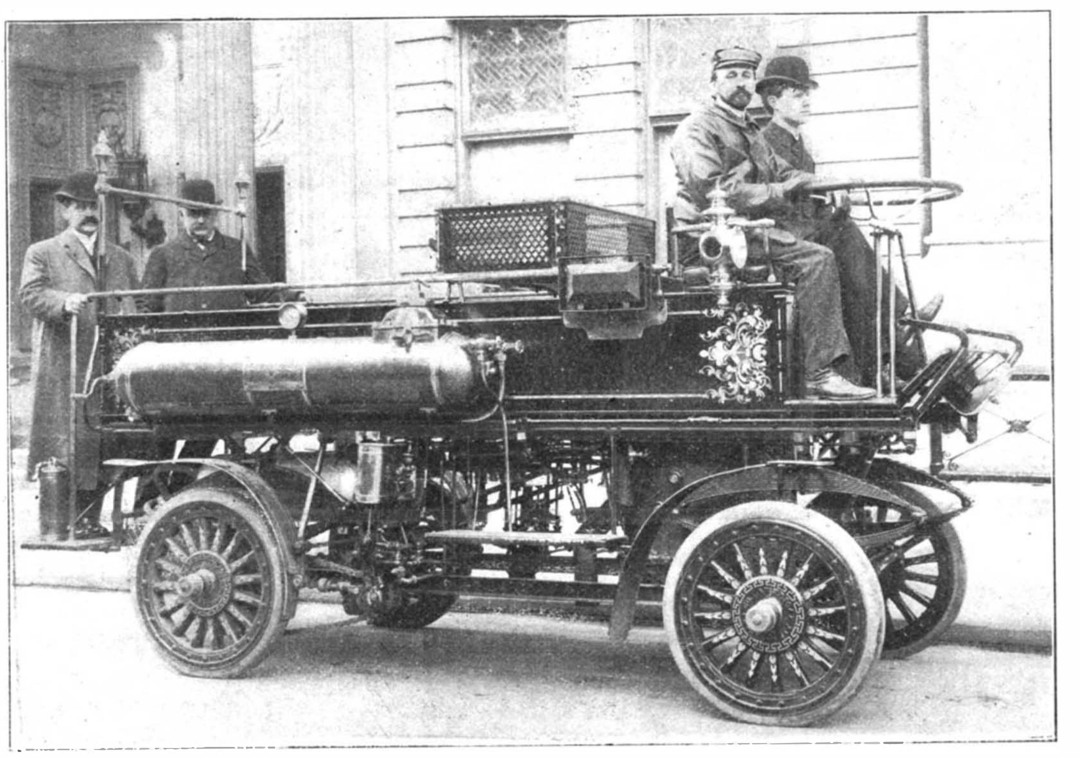
Three screw-threaded openings issue from the water compression chamber, one having a diameter of 7 millimeters (.275 inch), one of 10 millimeters (.393 inch), and one of 12 millimeters (.472 inch). The smallest one is coupled on when the pump is working from its sole supply of water carried in the tank, which enables it to run five or six minutes at the pressure above stated. The second, or 10-millimeter opening, is used whenever there is an opportunity to draw the water from some other source, and the accumulators have sufficient capacity to run the pump under these conditions for six hours. The third, or 12-millimeter opening, is used when there is a good pressure at the hydrants. Under such favorable conditions the hose is attached to this, the engine suction hose is withdrawn, and the pump is not used. Where such favorable conditions exist, the rôle of the pump is simply to provide an instantaneous means of fighting the fire while the connections to the hydrants are being made, i. e., during a lapse of five or six minutes at most.

Arrangements have been installed, by means of which a portion of the energy of the accumulators may be used for illumination on dark nights, either through arc or incandescent lights. The latter are preferable in cases where it is feared that explosives are in the neighborhood of the fire.

Three men compose the crew of an automobile fire engine of this type, and even two will be able to run it. One man runs it through the streets, attends also to the pumps and, upon occasion, can couple it to the hydrant. A second man, the fireman proper, unrolls and lays the hose and directs its stream upon the fire. If there is a third man he assists the second in his duties, attaches the suction hose, and thereby increases the rapidity of the work and saves time. The crew of the engine are always dressed and on the *qui vive* for the alarm, so that their departure is effected without delay.

For five years now the city of Vienna, Austria, has not had a steam fire engine in service. In the place of steam pumps chemical engines are used. In other words, the fire-fighting apparatus consists of cylinders of sheet steel, mounted upon wheels, and containing 600 liters of water, which is thrown upon the fire by means of compressed carbonic-acid gas.

The compressed carbonic acid is carried upon the truck in steel cylinders. The photograph which we append, and for which we are indebted to the obliging chief of the fire department of Vienna, will give a clear and precise idea of the form and construction of the vehicle. It is in fact an electric automobile, capable of a speed of 24 kilometers per hour, which is more than is permissible in the cities. In the cut also can be seen all the accessories with which the engine is furnished, as well as their various positions. As the picture shows, the carbonic-acid cylinders and the water reservoir are placed at the rear of the vehicle.



A "LA FRANCE" CHEMICAL FIRE ENGINE PROPELLED BY INDIVIDUAL STEAM ENGINES GEARED TO THE REAR WHEELS. THIS ENGINE BELONGS TO THE FIRE DEPARTMENT OF NEW LONDON, CONN.

MODERN METHODS OF OPERATING MACHINE TOOLS ELECTRICALLY.

Before the Engineering Society of Columbia University on Tuesday, February 2, Mr. Putnam A. Bates, an engineering graduate of the University, and well known as connected prominently with the management of the Crocker-Wheeler Company, gave an interesting lecture on "Modern Methods of Operating Machine Tools Electrically." The lecturer was appropriately introduced by the president of the Society, Mr. Gustav Wittig, and at the close the members expressed themselves as greatly pleased, passing a vote of thanks to Mr. Bates. The general text of the lecture follows:

It is particularly gratifying to the electrical engineer of to-day to note the fact that through the handiwork of his profession in making the use of electricity possible in commercial arts, its adoption has not only become very general, but is looked upon practically as a necessity. The great flexibility, comparatively low cost of installation, and economical distribution of electric power, have given it a firm standing in general machine shop equipment. The question, therefore, of whether or not in machine shops power shall be distributed by means of electricity, is to-day hardly considered, as the advantages obtained by this method have been so successfully proven that there is little room left for doubt. Hence, the subject which is given attention is what method of electric distribution shall be adopted and in what manner shall the electric motors be arranged with respect to the work which they have to accomplish.

In considering the subject of individual drive, some have said "that while considered alone and for the individual tool, this method is ideal, yet the objection will occur that the enormous multiplication of small motors means increased complication and greatly increased cost, and that if this method is employed it should be limited to tools requiring from 5 to 10 horsepower and upward, and that group drive should be used where the tools require less than these amounts."

If the saving in the coal bill due to the decreased losses in transmission obtained by individual drive throughout a machine shop or factory only is to be considered, the objection above referred to might in a measure be correct, but as a matter of fact the coal bill in a year amounts to such a small percentage of the total operating expenses of any manufacturing establishment that a small variation in this one way or the other hardly merits more than passing consideration.

The element in our factory costs which requires our most careful consideration is that of the labor cost involved in turning out a given piece of work. A very small percentage of decrease in our total labor bill will, as a rule, justify a greatly increased first cost, provided that cost will directly bring about the reduction of labor. Besides eliminating the disadvantages of line shafting, belting, and the inflexibility of location, the individual drive of machine tools by electric motors increases the efficiency and output of machine shops. It is not necessary, therefore, to lay down any specific line of demarkation as to the size of the tool on which it would be advisable to apply an individual motor, but rather to consider in the case of each particular tool the class of work which is to be done and the character of the shop in which the system is to be installed. It can then be determined as to whether the increased facilities which the individual motor-driven tool affords, will not offset the objection claimed against the individual method of tool drive, which is "greater first cost." These increased facilities lie in the direction of variable speeds, under instant control, over any range, with every speed constant regardless of the load, the ability to maintain high cutting speeds due to superior facilities for manipulation and the absence of shut-downs from belt troubles.

If we fail to find that the advantages just mentioned offset the only objection claimed, before dismissing the problem there must be credited against the first cost of the individually-driven tool the cost of countershafts, hangers and belts, also the cost of the increased power to overcome friction losses due to the shafts getting out of line and the tool operator's time lost in lacing and repairing the belts, to say nothing of the unhandy methods which are required for the starting and stopping, and shifting from one speed to another. Upon giving all of these points careful consideration, we will find that the first cost of the individually equipped shop is not much if any greater than one arranged for group drive. Particularly is this so in the face of the advantages obtained by the former method of drive.

The practice of using portable tools and bringing the tools to the work rather than the work to the tools, which is becoming so popular to-day, is only a further development of the individually-driven motor tool idea. The portable tool, which cannot be operated unless it is driven by an individual electric motor, serves as an excellent example of what we should endeavor to accomplish in our efforts to make all our machine tools as simple and useful as possible. They should not be so arranged that they must always be in one particular location in a shop, for it may be desirable to use this portion of the shop, as time goes on, for other purposes, or possibly it will become necessary to crowd in additional machines of the same type as those already in use, and it is not every shop that is so arranged as to permit of the installation of additional tools without necessitating very awkward connections to the line shafting.

If the tools are all individually driven, this difficulty does not exist. While the individual method of electric drive provides a material reduction in the cost of power, this factor is not its greatest recommendation, the greatest benefit being derived from the elasticity which is obtained only by the adoption of this method. With individually-driven tools there is no longer any necessity for the rigidity of arrangement which obtains with shafting and belting, so that if it becomes necessary to rearrange the plant at any time, the expense is reduced to a minimum.

The valuable light which possibly the shop or factory building has been constructed especially to provide, can only be maintained by avoiding the adoption of any equipment requiring overhead construction which must necessarily prove a hindrance in this regard. A study of the evolution of the introduction of electricity into industrial plants, first for lights, second for cranes and elevators, third for constant-speed motors for group drive, and lastly variable-speed motors individually connected to the tools, indicates clearly that the group method can hardly be compared with individual drive so far as advantages are concerned, or it would not have been necessary for manufacturers to spend their energies in developing the ingenious applications of individual motor-driven tool equipments, which have been offered to the market during, we may say, the past year or so.

While the driving of groups of tools by means of constant-speed belted motors permits of the elimination of very heavy belting and long line shafts, and in this regard is an advance toward the ultimate end—electric drive of individual machines—it does not and cannot offer that which is by far the most important feature of electric drive, i. e., the possibility of placing the speed control of the driven tool at the immediate will of the operator.

With these preliminary remarks as to general problems governing questions which have to be determined before a purchaser can properly select the electric system which is best suited for his own plant, I will pass now to a description of a particular system of electric drive which gives certain positive advantages due to its methods of variable-speed control. The system described is one designed and perfected by the Crocker-Wheeler Company, of Ampere, N. J.

The ordinary belt-driven tool usually has a speed range obtained by mechanical means, of from 20 : 1 to 50 : 1, with increased speed steps of about 30 to 50 per

cent. The Crocker-Wheeler system for the multiple voltage operation of machine shops not only extends the speed range, but also reduces the speed increment per step to about 10 per cent, which has been found by experience to be as small an amount as would be desirable to use. This system is a method of electric power distribution at different voltages, which enables standard motors to be operated at various speeds by changing the potential of the current at the motor terminals. The generating plant supplies the highest voltage of the system. This voltage may be termed the primary and is divided by a three-unit balancing transformer into three unvarying voltages of unequal value, which are maintained between the wires of a four-wire circuit, various connections of which offer six different and distinct voltages.

The principle on which this system of speed control is based is that in a separately excited shunt motor the speed of the armature is proportional to the voltage supplied to its terminals. If this voltage remains constant the speed will remain constant even with varying load. It is the function of the balancer to maintain these voltages constant and to accommodate the unbalance of currents between the four wires of the distribution circuit. As the conditions of machine tool operation will result in the various motors of the system being nearly equally distributed on the circuits, the unbalanced currents will be but a small percentage of the total current taken by all the motors. The intermediate wires of the system are extended to the variable-speed motors only, the constant-speed and crane motors and the lighting being supplied in the usual manner from the outside wires at the generator voltage.

Those motors requiring variable speed are connected to the four-wire circuit by means of a controller of the drum type adapted for mounting on the tool in a place convenient to the operator. The action of this controller is such that as the drum revolves the armature terminals of the motor are connected in the proper sequence to the six circuits afforded by this system, and the travel of the drum from one position to the next is so quickened by the action of a spring that contacts are made and broken at a high rate of speed, preventing the formation of arcs and eliminating the possibility of the drum stopping between contacts. This gives six fundamental motor speeds, which are subjected to a further refinement by varying the motor's field strength sufficiently to cover the gaps between them.

The speed range obtained on the voltage points alone is 6 : 1, being proportional to the ratio of maximum to minimum voltages. The addition of field resistance points above the highest voltage points extends the total range of the controller to a value of 10:1. For exceptional cases the range may be increased to a maximum of 12:1, the proper range in any case being determined by the character of the machine and the work which it performs. The Crocker-Wheeler system as outlined has certain positive advantages of which the most important are the following: 1, variable speed, under instant control, over any range; 2, every speed constant regardless of the load; 3, controllers simple and convenient of attachment; 4, the horse-power of the motor but slightly in excess of that required by the tool; 5, output of machine tools much greater than when they are belt-driven; 6, ease of adaptation to existing shops with a two-wire system of electric power distribution; 7, employment of standard motors; 8, ability to maintain high cutting speeds due to superior facilities for manipulation.

Motors used in an ordinary shop equipment may be divided into classes A, B, C or D, according to the nature of their duty. Class A is the constant-speed motors such as drive groups of small tools by shafting, this class being kept as small as possible consistent with best judgment based on a careful study of all of the advantages which should be credited to the individual drive idea in comparison with the one disadvantage which may or may not exist, that of a possible slight increase in first cost. In many cases, however, even this one disadvantage may be lost sight of in the face of the advantages which are to be obtained through flexibility of location and ease of manipulation. Class B, controllable-speed motors, generally of the series-wound type, as used on cranes. The duties which the motors in both of these classes have to perform is such that their demand for current is intermittent and often excessive, consequently they are best suited for connection to the outside mains and such speed regulation as they may require can be obtained by rheostatic control.

The other two classes, C and D, are controllable-speed motors for the drive of individual tools where the speed should be maintained constant at any one of a number of fixed values. Class C covers driving pressure blowers, punch presses, planers, etc., which demand approximately constant torque at all speeds, the horse-power diminishing with the speed. This characteristic of the tool being identical with the power characteristic of the motor on this system, the normal horse-power of the motor need not be greater than the maximum demanded by the tool.

Class D covers those motors operating lathes, boring mills, etc., where the torque increases as the speed diminishes. If the range required by these tools is to be obtained by using a motor through its maximum range, the motor would be very large and unnecessarily expensive. For this class a speed range of approximately 3:1 has been selected as a basis for the determination of the most suitable sizes of motors with respect to the duty which they have to perform. A motor, therefore, to give a constant horse-power throughout this range, must have a normal rating of about twice the horse-power required by the tool. This range, however, may be extended to cover the entire range required by the tool by using one or more additional gear runs. The method is an advantageous compromise between the use of an excessively large motor with no gears and a constant-speed motor with many gears.

The extreme facility of manipulation which this system affords enables the machinist to push his tool to the highest limit of cutting speed, thereby giving large increases in output. Results show that as much as 20 per cent increase in output over a belt-driven tool may be obtained by this system of motor drive. As by actual test in commercial plants, it has been demonstrated that 2¼ per cent increase is sufficient to warrant the outlay necessary for individual drive, the possibility of large saving in operating expenses through the adoption of this system is at once apparent.

CONTEMPORARY ELECTRICAL SCIENCE.*

SPECTRUM OF CATHODE LIGHT.—H. Deslandres has investigated the spectrum of the negative glow in order to apply the information thus gained to the elucidation of stellar spectra. A similar investigation conducted in 1886 enabled him to predict the presence of the nitrogen band $\lambda = 391$ in the spectrum of the aurora, which has since been verified by Paulsen. The present investigation was suggested by the observation of carbon bands in the spectrum of the new comet. The gases studied included carbonic oxide, carbonic acid and pure acetylene, and they were examined in a vacuum tube with aluminium electrodes and a quartz end piece. The investigation resulted in the discovery of a new band spectrum in the extreme ultra-violet ($\lambda = 300$ to 200) which brings the number of known carbon spectra up to six. This new spectrum is especially noticeable in the oxygen compounds. In the hydrogen compounds, the continuous spectrum emitted by hydrogen in this region interferes. Unfortunately, the discovery is useless astronomically, since even if comets emitted the new spectrum, it would be intercepted by the atmosphere on account of the extremely short wave-length of the rays. The spectrum is one of great simplicity, all the bands belonging to a single series. This points to a simplicity of structure of the radiating body. The author believes that at the cathode the molecular structure of the gas is simple, whereas near the anode the radiation is given out by molecular aggregates or compounds.—H. Deslandres, Comptes Rendus, September 14, 1903.

GENERAL RADIO-ACTIVITY OF METALS.—A. Voller points out a flaw in the experiments by which MacLennan and Burton (see The Electrician, September 11, 1903, p. 839) claimed to have proved that all metals are radio-active. In the first place, the potentials are very small and are subject to many errors. And, further, as Hallwachs has already pointed out, it is necessary to take into account all the possible E.M.F.s of the electrometric system. If various metals are used, the E.M.F.s between them and the electrometer can only be eliminated by using electrometer needles of the metal which is in contact with the quadrants. MacLennan and Burton do not appear to have used a similar precaution. In their arrangement there is nothing to show that the E.M.F. between the metals and the quadrants was taken into account, or that when lead, aluminium, zinc, tin, and copper rods were used in turn, quadrants of the same metals were mounted in the electrometer. If, therefore, the quadrants were of brass, the E.M.F. of brass to lead, etc., would be brought into play, and would account for the values observed by the authors, and attributed by them to the general radio-activity of metals. On the other hand, it cannot be denied that the spontaneous projection of positive ions by all metals, if conclusively established, would mean a very important advance in our knowledge of electron phenomena.—A. Voller, Phys. Zeitsch., October 1, 1903.

ELECTRO-ETHEREAL THEORY OF LIGHT.—Lord Kelvin finishes his volume of Johns Hopkins University Lectures by founding an electro-ethereal theory of the Stokes-Kirchhoff vibrators in the dynamics of spectrum analysis and of the Maxwell-Sellmeier explanation of dispersion. In the new theory every single electron, or "electrion," within a mono-electrionic atom, and every group of two, three, or more electrions within a poly-electrionic atom, is a vibrator which, in a source of light, takes energy from its collision with other atoms, and radiates out energy in waves traveling through the surrounding ether. A mono-electrionic atom has the same quantity of positive electricity as the electrion has of resinous. Hence it attracts the latter to its center. The author makes an assumption which explains why the rigidity of the ether is practically the same throughout space, whether occupied by ponderable matter or not. It is that the radius of an electrion is so extremely small that the quantity of ether within its sphere of condensation is exceedingly small in comparison with the quantity of undisturbed ether in a volume equal to the volume of the smallest atom. Thus, if an atom is "positively electrified" by being temporarily deprived of its electrion, ether vibrating to and fro through it will experience no inertial or other resistance. Thus the actual inertia-loading of ether to which the refraction of light is due is produced practically by the electrions, and but little, if at all, perceptibly by the atoms, of the transparent body.—Lord Kelvin, Phil. Mag., October, 1903.

THIN METALLIC FILMS.—In 1857 Faraday showed that leaves and films of gold and silver supported on glass were changed by a temperature much below the melting point of the metal from a moderate translucence to clear transparence, and from high metallic reflecting power to comparative deadness. G. T. Beilby supposes that even at a temperature much below the melting-point, sufficient freedom is conferred on the molecules by the heating to enable them to behave as the molecules of the liquid metal would do, and to arrange themselves under the influence of surface tension either in films or in drop-like or granular forms. Tests of the electric conductivity of the films deposited on glass or mica showed that the general result of heating these films to temperatures above 300 deg. was ultimately to increase their resistance from relatively small values of the order of 0.2 to 50 ohms up to very high values, sometimes reaching thousands of megohms. In no case was there anything to suggest such complete discontinuity as the electrical tests could lead one to expect. In the gold film especially there appeared to be such a depth of granules in the film as would, even with the most open packing, supply a conductor of fair average cross-section. The under side appeared continuous and closely adherent to its support.—G. T. Beilby, Proc. Roy. Soc., August 31, 1903.

SLOW CATHODE RAYS.—P. Lenard discovered in October, 1899, that the impact of ultra-violet light upon a negatively charged conductor causes the latter to give out rays having all the characteristics of cathode rays, but traveling at a rate of only a thirtieth of the velocity of light. He has now investigated them by means of phosphorescence, which is somewhat difficult to produce owing to the slowness of the rays. He also studied the effect of these slow rays on various gases, and found that they make the gases themselves emit cathode rays. The rays may be made visible on a screen by a suitable adjustment of the potentials of the electrode and the screen. If the former is charged to —500 volts, the rays just produce a luminous patch on the uncharged screen. But if the latter is charged to 4,000 volts the potential of the electrode exposed to the ultra-violet light may be reduced to —4 volts without stopping the phosphorescence. The distance between electrode and screen is 14 centimeters. When the electrode is neutral the rays do not go further than 8 centimeters, owing to diffusion and the influence of the earth's magnetic field. The substance employed for the screens was a mixture of cadmium sulphide, bismuth, and $Na_2S_2O_3$. The luminous efficiency is very considerable, amounting, as it does, to 10 Hefner units per watt. This compares very favorably with the 0.3 Hefner units per watt of the electric glow lamp.—P. Lenard, Ann. der Physik., No. 11, 1903.

DISINTEGRATION OF GLOWING METALS.—G. Aeckerlein has studied the connection between the disintegration of metals glowing under the influence of an electric current, the conductivity of the gas and the evolution of occluded gas from the metal. The platinum or palladium wire was suspended in a vertical glass tube, its end being weighted by a mercury bob provided with a pointer dipping into mercury, which completed the circuit. The first result obtained was that the conductivity of the gas is not solely due to the projection of metallic particles, since no definite connection exists between the quantity of electricity and the quantity of metal disintegrated. Indeed, the author often observed a considerable current through the gas without appreciable disintegration. An electric field, whether static or oscillating, has no effect upon the disintegration. Hydrogen does not prevent the disintegration, though it reduces it. High temperature alone does not produce disintegration, but it stimulates disintegration when the current passes. The evolution of occluded gas is neither a necessary nor a sufficient condition of disintegration, but it encourages it. The negative charge assumed by glowing bodies in air is not necessarily connected with disintegration, since a negative potential of 2,000 volts does not produce it by itself. High temperature and the current appear to be the two essential conditions.—G. Aeckerlein, Ann. der Physik., No. 11, 1903.

DISCHARGING POWER OF ULTRA-VIOLET LIGHT.—E. Ladenburg draws attention to a notable difference between the photo-electric effects observed by Elster and Geitel and that observed by Lenard in an absolute vacuum. The former physicists, working with ordinary light, found a decisive influence of the direction of the plane of polarization. The latter found that the effect depends solely upon the amount of light, and not upon its direction of vibration. The author suggests that this may be due to the fact that the ultra-violet light penetrates below the surface, whereas the ordinary light does not. Experiment shows that this supposition is correct. He used mirrors of burnt-in platinum upon which nickel mirrors of various thicknesses were deposited electrolytically. He found that the so-called fatigue of the mirrors is due to some change in the condition of the surface produced by the light. The maximum current is obtained with the brightest polish. The series of metals arranged in order of current strength begins with platinum and ends with nickel, but shows no connection with other physical properties. The current depends simply upon the amount of incident ultra-violet light, and not upon its angle of incidence or polarization. In the case of nickel, the distance to which the light penetrates into the metal is about 8 wave-lengths.—E. Ladenburg, Ann. der Physik., No. 11, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

[Continued from SUPPLEMENT No. 1475, page 23635.]

RADIUM.—II.

RADIATION OF RADIUM SALTS.—The rays emitted by the radium salts extend in a straight line. They are not reflected, refracted, or polarized. They form a complex mixture that may be divided into three main groups, which have been designated by Mr. Rutherford α, β, and γ (Fig. 16).

The action of an intense magnetic field, and the greater or less ease with which they are capable of traversing different substances, permit of distinguishing them. Let us imagine a small quantity of a radium salt to be placed at the bottom of a deep cavity formed in a block of lead, *P* (Fig. 16). The rays will then escape in the form of a rectilinear pencil. Let us arrange this little cup in a uniform and very intense magnetic field produced by a powerful electro-magnet (Fig. 17) placed in such a way that its north pole shall be in front of the plane of the figure, and its south pole behind the cup. Under such circumstances, the three groups of rays α, β, and γ will be separated.

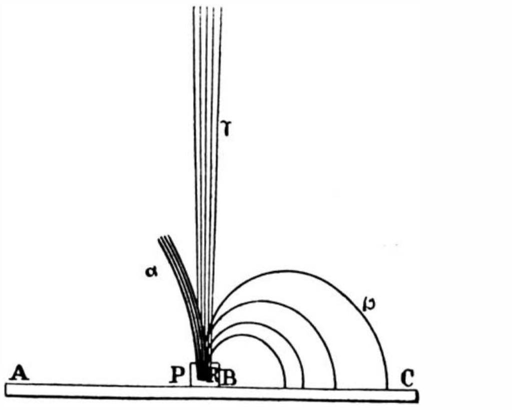


FIG. 16.—ACTION OF A MAGNETIC FIELD UPON RADIUM SALTS.

The α rays are very slightly deflected toward the left of their rectilinear trajectory, even by the most intense fields. They form the most important part of the radiation of radium, at least if we decide to measure the radiation by the extent of the conductivity that it communicates to the air.

The β rays are very strongly deflected by the magnetic field, and that, too, in the same manner and in the same direction as the cathodic rays.

Finally, the γ rays are not deflected at all from their rectilinear trajectory, are analogous to Roentgen rays, and form but a small part of the radiation.

Let us now briefly examine the composition of these different groups of rays. The α rays of radium are but slightly penetrative. They are very rapidly absorbed by the air at their exit from the radium salts, and a sheet of aluminium a few thousandths of an inch in thickness arrests them completely.

The law of the absorption of these rays by screens permits, independently of the action of the magnetic field, of clearly distinguishing them from Roentgen rays. In fact, in traversing successive screens, the α rays become less and less penetrative, while the contrary phenomenon occurs with Roentgen rays. In order to explain this result, the theory has been advanced that these rays are formed of projectiles the energy of which diminishes during the traversing of each screen. It is found, too, that a given screen absorbs the α rays much more strongly when it is placed far from the radium than when it is placed very near.

The α rays are very slightly deflected by the most intense electric and magnetic fields; and they were even first considered as rays that were non-deflecting under such action. Mr. Rutherford, by a very ingenious arrangement, has succeeded in demonstrating and measuring the deflection of these rays in the magnetic field. As a result of these experiments, the α rays are found to behave like projectiles having a high velocity and charged with positive electricity. They are analogous to Goldstein "canal rays" (Canalstrahlen). According to the last measurements made by M. Descoudres, the velocity of these projectiles is twenty times less than that of light. If we admit that the electric charge of one of these projectiles is the same as that of an atom of hydrogen in electrolysis, we find that its mass is about the same as that of an atom of hydrogen.

The α rays form a group that seems homogeneous. They are all deflected by the magnetic field in the same manner. It is these rays that act in the small apparatus devised by Mr. Crookes and called by him a "spinthariscope." In this apparatus there is arranged at the extremity of a wire, *a* (Fig. 18), a fraction of a milligramme of a radium salt. This fragment is placed at a few hundredths of an inch from a Sidot sulphide of zinc screen, *E*. Upon examining the screen turned toward the radium, by means of a strong lens, *L*, and in darkness, we observe small luminous points upon it. These continually appear and disappear, and remind us of a sky studded with scintillating stars. The effect is very curious. We may imagine that every luminous point that appears and disappears results from the shock of a projectile.

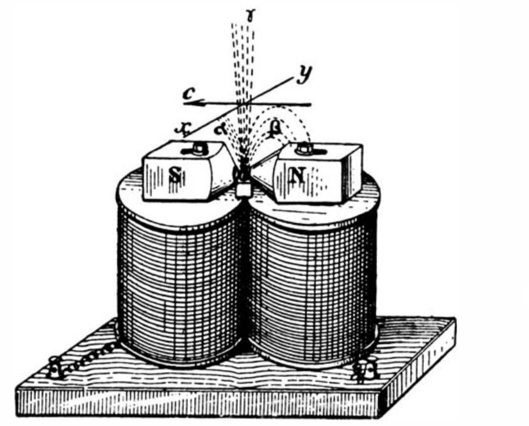


FIG. 17.—ACTION OF A MAGNETIC FIELD UPON RADIUM SALTS.

β Rays.—The β rays of radium are analogous to cathodic ones. They are easily deflected by a magnetic field, as shown by the following experiment. A glass bulb containing a salt of radium, *R*, is placed at one of the extremities of a thick-walled lead tube, *A B* (Fig. 19), and the tube is placed between the poles, *N S*, of an electro-magnet, and at right angles to them. At a certain distance from the end, *B*, of the lead tube is arranged an electroscope, *E*, charged with electricity. The rays emitted by the radium salt, and which are conducted by the tube, cause the discharge of the electroscope. If a current is sent through the wire of the electro-magnet, the β rays will be thrown against the walls of the electroscope tube, the γ rays alone will act, and the discharge will take place very slowly. As for the α rays, they will be immediately absorbed by the air in the vicinity of the radium salt, and will be unable to reach the electroscope. If we cease passing the current through the electro-magnet, the β rays will rapidly cause the discharge of the electroscope.

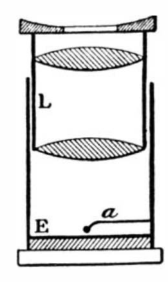


FIG. 18.—THE CROOKES SPINTHARISCOPE.

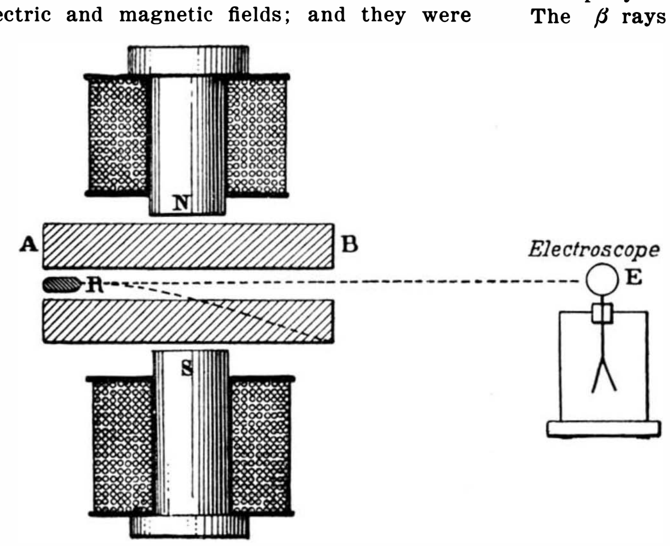


FIG. 19.—DEFLECTION OF β-RAYS BY MAGNETIC FIELD.

The β rays form a heterogeneous mixture. They may be distinguished from one another by their penetrating power and by the variable deflection that they undergo in a magnetic field. Certain of them are easily absorbed by a sheet of aluminium a few ten-thousandths of an inch in thickness, while others traverse several hundredths of an inch of lead.

The trajectories described by the β rays deflected by the magnetic field are circular and situated in a plane at right angles with the direction of the field. The rays of the circumferences described vary within wide limits. If the rays are received upon a photographic plate, *BC* (Fig. 16), the latter will be acted upon by rays which, having described circular trajectories, are turned back upon the plate and intersect it at right angles. M. Becquerel has shown that the action thus produced constitutes a wide diffuse band—a true continuous spectrum; proving that the pencil of deflected rays emitted by the source is formed of an infinity of unequally deflectable radiations. If the plate be covered with different absorbing screens, formed of paper, glass, or metal, a portion only of the spectrum will be abolished, and it will be found that the rays most deflected by the magnetic field, i. e., those of which the trajectory has the smallest radius, are the ones most strongly absorbed. With each screen the action upon the plate begins only at a certain distance from the radiant source, and this distance is greater in proportion as the screen is more absorbent.

The β rays of radium are charged with negative electricity, and an experimental demonstration of this fact confirms the analogy of these rays with cathodic ones. The latter, in fact, are, as M. Perrin has proved, charged with negative electricity, and are capable of carrying their charge through metallic envelopes connected with the ground and through insulating plates. At all the points at which the cathodic rays are absorbed, there is a continuous disengagement of negative electricity. This disengagement, however, is slight, and so, in order to make it evident, it is necessary that the conductor which absorbs the rays shall be perfectly insulated. For this purpose, the conductor is sheltered from the air either by imbedding it in a good solid dielectric or placing it in a tube containing a very perfect vacuum.

The apparatus employed (Fig. 20) consists of a conducting disk, *M*, connected by a metallic rod, *t*, with an electrometer. The disk and rod are surrounded with an insulating material, *i*, and the whole is covered with a metallic jacket, *E*, which is permanently grounded. If this apparatus be exposed to the radiation of a radium salt, *R*, placed outside it in a small leaden cup, the rays will traverse the metallic plate and the insulating plate and be absorbed by the disk, *M*. There is then observed through the electrometer a continuous disengagement of electricity. The quantity of electricity produced is very slight, and is in the neighborhood of 10^{-11} coulombs per second with a very active radiferous layer of chloride of barium 1.0781 inch thick by .387 square inch area, the rays utilized having traversed, before being absorbed by the conductor, *M*, a thickness of .0004 of an inch of aluminium and .011 of an inch of ebonite. When the radium salt is placed at a distance, and a less active product is employed, the charges are still smaller. A contrary experiment may be performed by placing the radium salt in the center of the insulating material and connecting the cup that holds the salt to the electrometer (Fig. 21). Under such circumstances, it is found that the radium takes a positive charge equal in size to the negative charge of the first experiment. The very penetrating rays of the radium carry the negative charges with them. These two experiments show that a radium salt contained in a perfectly insulating vessel becomes charged spontaneously with electricity, like a Leyden jar. This fact may be easily ascertained with a sealed glass jar that has contained a radium salt for some time. If a line be made with a diamond upon the wall of the jar, a spark will jump through the glass where it has been cut by the diamond, and, at the same time, the operator will feel a shock in his fingers in consequence of the passage of the spark.

Radium is the First Example of a Body that Becomes Spontaneously Charged with Electricity.—It may be supposed that the β rays are formed by projectiles (electrons) charged with negative electricity and projected from the radium with great velocity. The measurement of the deflection of such rays under the action of a magnetic field permitted M. Becquerel, and afterward M. Kaufmann, to determine the velocity of these projectiles. These velocities, variable with the different β rays, are comprised between 2.36×10^{10} and 2.83×10^{10} centimeters per second. It will be seen that certain β rays have a velocity approaching that of light. On the other hand, theoretical considerations allow it to be supposed that the mass of each of these projectiles is 2,000 times smaller than that of an atom of hydrogen. It will be readily understood that projectiles of such extremely small mass and impelled with such velocity may have a very great penetrating power as regards matter. The rays of radium,

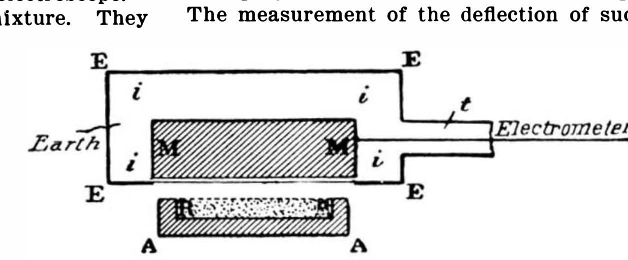


FIG. 20.—APPARATUS FOR THE STUDY OF β-RAYS.

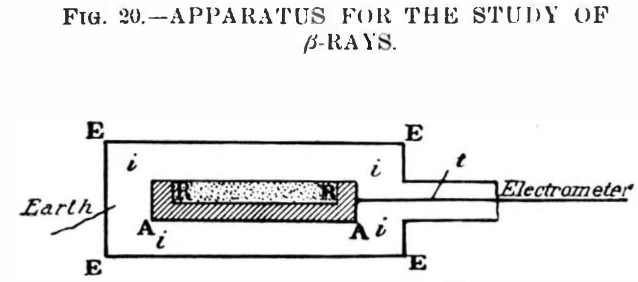


FIG. 21.—APPARATUS FOR THE STUDY OF β-RAYS.

and principally the β rays, are capable of diffusing themselves. If we project upon a thin screen a pencil of rays proceeding from a radium salt, the α rays will be absorbed and the γ rays will partially traverse the screen in the state of a well-defined pencil with sharp edges. As for the β rays, they will be diffused in all directions. This diffusion, however, does not appear to be a constant property of the β rays. M. Becquerel has shown that a pencil of β rays projects itself in a well-defined state into paraffine.

γ Rays.—The γ rays are in all respects comparable to Roentgen rays, and therefore possess no electric charge. They form only a very small part of the radiation of radium. Certain γ rays have an extraordinary penetrating power, some being capable of traversing several fractions of an inch of lead.

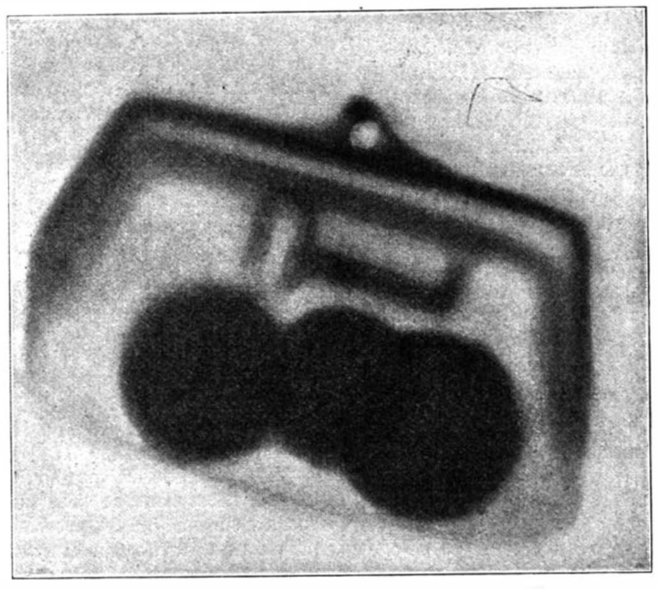


Fig. 22.—RADIOGRAPH OBTAINED WITH RADIUM SALTS.

Effects Produced by the Radiation of Radium.—*Effects of Fluorescence and Luminous Effects.*—The rays emitted by radium salts cause the fluorescence of a large number of bodies. With some substances, the fluorescence is very beautiful when the radiferous product employed is very active. The alkaline and alkaline-earthy salts, the double sulphate of uranyl and potassium, organic matter (cotton, paper, sulphate of cinchonine, skin), quartz, and glass become phosphorescent through the action of Becquerel rays. Among the different varieties of glass, that of Thuringia is particularly luminous. The most sensitive bodies are platinocyanide of barium, which takes on a magnificent green phosphorescence, and that of potassium, which becomes blue. Willemite, a natural crystal of silicate of zinc, Sidot's sulphide of zinc, and the diamond, under such circumstances, exhibit great brilliancy. Finally, kunzite, a new mineral found in America, becomes salmon-rose.

All the groups of rays seem to be capable of producing phosphorescence. Willemite and platinocyanide of barium are particularly luminous with the penetrating β rays, while with the α rays it is preferable to employ Sidot's sulphide of zinc. The fluorescence of platinocyanide of barium may be observed even when the latter is separated by an absorbing screen. A screen of this same salt is also luminous when it is separated from the radium by the human body. The phosphorescence is very visible, even when the radium salt is placed two or three yards away from the screen. Under such circumstances, however, the salt must be employed in a very active state. With a crystal of platinocyanide, the luminosity produced is very intense, especially when the radium salt is placed against the crystal. The beautiful phosphorescence obtained with the diamond is capable of a practical application. It is possible, in fact, through the action of radium rays, to distinguish this gem from its imitations, all of which have an extremely slight luminosity as compared with that of the diamond.

With zinc sulphide, the luminosity persists for quite a long time after the action of the radiation has been arrested. It may be admitted that the spontaneous luminosity of the radium salts is due to the fact that they are rendered phosphorescent by the action of the Becquerel rays which they emit.

Coloration of Bodies by the Action of Radium Rays.—As a general thing, phosphorescent substances, submitted to a prolonged action of radium salts, are gradually altered and then become less excitable and less luminous under the action of such salts. At the same time, it is found that the majority of these bodies undergo a very notable alteration in their coloration. On the other hand, it is possible to admit that these variations in color are accompanied with a chemical modification of the phosphorescent substance.

Radium rays color glass violet, brown, or black. The color is produced throughout the glass, and persists after the salt of radium that produced it is removed to a distance. The alkaline salts become colored yellow, violet, blue, or green; transparent quartz is converted into smoky quartz; colorless topaz becomes orange yellow, etc. Under the action of the radiation of radium, the platinocyanide of barium becomes brownish, but partially resumes its former hue after it has been exposed for some time to light. The sulphate of uranyl and of potassium become yellowish. Glass colored by radium and afterward heated to about 500 deg. C. (932 deg. F.) loses its color, and the loss of color is accompanied with an emission of light. This phenomenon, which is known as "thermoluminescence," had already been observed with certain bodies, such as fluorine, which becomes luminous when heated. This luminosity becomes gradually exhausted; but the power of becoming luminous by heat may be restored to fluorine by exposing it to the action of a spark or of a radium salt.

The phenomenon is identical with that of glass exposed to the rays of radium. A transformation occurs in the glass while it is submitted to the action of radium salts, since the coloration increases progressively. When the glass is heated, the same transformation takes place, the color disappears, and the phenomenon is accompanied with an emission of light. The glass is restored to its former state, and is capable of being again colored by the action of radium rays. It is possible that a modification of a chemical nature occurs, with which the production of light is intimately connected. This phenomenon may be general. The fluorescence produced by the action of radium salts may depend upon a chemical or physical transformation of the substance that emits the light.

Chemical and Photographic Effects.—Radium rays call forth various chemical actions. It might be possible to arrange in this group all the phenomena of fluorescence and coloration already described. Aside from such considerations, the radiations emitted by the salts of radium are capable of producing very marked chemical reactions. Thus, while phosphorus is converted into red, paper is colored yellow by the action of radium and simultaneously becomes fragile, so that it tears very easily.

The production of ozone is noticed in air which is in close proximity with radium. In order for ozone to be produced, however, it is essential that there be direct contact in some place between the air and the radium. This reaction seems rather to be connected with the phenomenon of induced radio-activity, however, and this we shall discuss later.

The radium salts themselves seem to undergo an alteration under the action of the rays that they emit, and become colored and disengage oxygenated compounds of chlorine, if the salt is a chloride, and of bromine, if the salt is a bromide. M. Giesel has shown that a solution of a radium salt gives out hydrogen continuously. The radiation of radium acts upon the substances employed in photography in the same manner as does light. This property permits of obtaining radiographs comparable to those obtained with the X-rays, and much more simply. A small glass bulb containing a few hundredths of a grain of a radium salt replaces the Crookes tube and the numerous apparatus required for its operation. It is possible to operate at a great distance and with sources of very small dimensions and yet obtain very fine radiographs (Fig. 22). Under such circumstances, the β and γ rays are employed, the α rays being very rapidly absorbed. The radiographs thus obtained are destitute of sharpness. The β rays, in traversing the object to be radiographed, undergo a diffusion, in fact, and occasion a certain flatness. In order to obtain very sharp radiographs, it is well to get rid of the β rays by causing them to deflect by means of a powerful electro-magnet. This can be done by employing the arrangement shown in Fig. 23. The object, *O*, to be radiographed is placed upon the photographic plate, *P*, surrounded with black paper. The bulb containing the radium salt is placed at *R*, between the poles of an electro-magnet. If the latter be excited, the γ rays alone will be utilized, and since these form but a small part of the total radiation, the exposure must be considerably lengthened. It then requires several days to obtain a radiograph. The radiograph of an object such as a pocket-book requires a day with a radiant source consisting of a few hundredths of a grain of a radium salt placed about a yard away from the sensitized plate. If the bulb is placed at a distance of 7.8 inches from the plate, the same result may be obtained in an hour. All the active salts of radium must be excluded from the laboratory to prevent such photographic materials as chance to be therein from becoming altered.

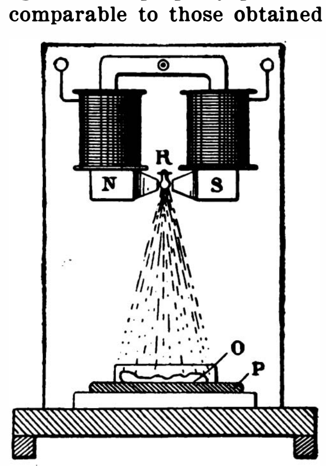


Fig. 23.—ARRANGEMENT FOR RADIOGRAPHY WITH RADIUM SALTS.

Ionizing Action of Radium Rays.—Radium rays render the air that they traverse a conductor of electricity. This important property is made use of in the measurement of the radiation of radio-active substances.

When a very few grains of radium are brought near a charged electroscope, the latter is immediately discharged. The discharge occurs also, but much more slowly, when the electroscope is protected by a thick wall of metal. Lead and platinum readily absorb the radiations, but the most transparent metal is aluminium. Organic substances are relatively very transparent to Becquerel rays.

The following experiment, devised by M. Curie, very brilliantly demonstrates the conductivity acquired by the air under the influence of the salts of radium. The secondary terminals, *P P*', of an induction coil, *B* (Fig. 24), are connected by wires with two sets of electrodes, *M* and *M*', sufficiently distant from one another and offering two distinct paths for the passage of the spark. The electrodes are so regulated that the sparks shall pass as abundantly as possible between the balls of each of them. If a bulb containing radium be brought near one pair of electrodes, the sparks will cease to pass through the other, since the path offered by the first is much less resistant than that offered by the second. The experiment also succeeds very well when the bulb of radium is protected by a plate of lead an inch or so in thickness. The action of the spark is not greatly diminished, while a great portion of the radiation is arrested by the plate. It would seem that, in this phenomenon, the very penetrating rays are the most efficacious.

The mechanism of the conductivity produced in gases by Becquerel rays is analogous to that connected with X-rays. Under the influence of the radiation, the gas is ionized, i. e., its molecules undergo a peculiar dissociation, the final result of which is to create in the gas centers charged with electricity called "ions." This ionized gas, placed in an electric field, acts as a conducting gas. The more active the substance is, the greater is the number of ions produced, and the higher is the conductivity. The conductivity is therefore intimately connected with the activity of the substance, and it is this fact that justifies in part the application of this property to the measurement of the radiations from radio-active substances.

In a laboratory in which one is working with radium salts, it is impossible to have a well insulated apparatus, since the air of the room is a conductor. It therefore becomes necessary to employ special arrangements, such as that which consists in surrounding the charged conductors with solid dielectrics. M. Curie has shown that radium rays act upon liquid dielectrics as upon air, communicating to them a certain electric conductivity.

The Use of Radium Salts in the Study of Atmospheric Electricity.—The radium salts are capable of advantageously replacing flames on the Kelvin water-drop apparatus generally used up to the present in the study of atmospheric electricity. For this purpose the radium salt is inclosed in a small, flat, metallic box, one of the faces of which consists of a very thin plate of aluminium. This box is secured to the end of a metallic rod connected with an electrometer. The air is made conductive around the end of the rod, and the latter takes the potential of the surrounding air. The measuring is done with the electrometer.

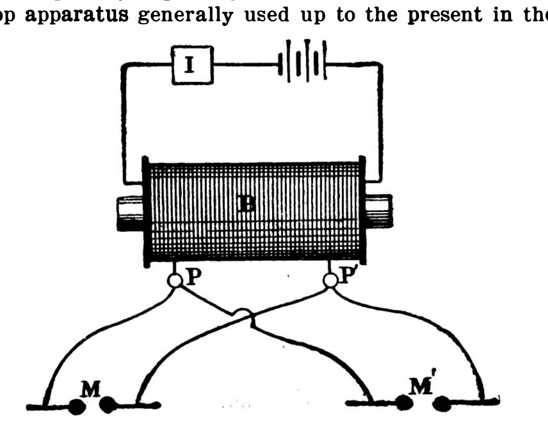


Fig. 24.—EXPERIMENT SHOWING THE EFFECT OF RADIUM SALTS UPON THE CONDUCTIVITY OF AIR.

Physiological Effects.—Radium rays produce various physiological actions. They have, for instance, a very marked action upon the epidermis. If a small celluloid capsule containing a very active radium salt be

placed upon the skin and left thereon for a short time, no particular sensation will be observed; but fifteen or twenty days afterward, a red spot will appear upon the skin, and later a scar at the place where the capsule was applied. If the action of the radium has been long enough, a sore will be produced that it will take several months to heal. In one experiment, M. Curie allowed a relatively inactive radiant product to act on his arm for ten hours. The spot became red immediately and later formed a sore which it took four months to cure. The epidermis was destroyed locally, and it only regained its normal condition after a long and painful healing process, and with the formation of a noticeable scar. In another experiment, the exposure to the radium salt lasted only half an hour, yet the burn did not appear till fifteen days after. It formed a blister which required fifteen days to heal. Finally, in a third experiment, in which the exposure lasted only eight minutes, the red spot did not appear until two months later, while the burn was, on the whole, insignificant.

These experiments show that it is necessary to avoid contact with or nearness to a radium salt for any length of time, except when it is inclosed in a thick lead envelope or box. The action of radium rays upon the skin is analogous to that produced by X-rays or the ultra-violet light. It is capable of production through any bodies whatever, but the effects are then less marked.

These few experiments formed the starting point for numerous attempts to cure lupus, cancer, and various other skin diseases. Up to the present, the results obtained have been encouraging. The technique of the treatment of such diseases is very simple. The epidermis, partially destroyed by the action of the radium rays, is formed again in a sound state.

The action of radium on the skin has been investigated by Dr. Daulos, of the St. Louis hospital, in experiments on the treatment of lupus. Dr. Daulos found that the diseased surface, when submitted to the action of radium, underwent a series of progressive modifications of intensity. At first a red spot gradually formed; then, after a length of time varying from six to eight days, according to its previous condition, the epidermis assumed a whitish color and finally sloughed off; small isolated sores were produced, increasing in size and finally forming an ulceration which secreted a reddish fluid in considerable quantities. A month later, the ulceration healed and a white, smooth, pliant scar formed. This treatment is very simple, and quick in comparison with those employed heretofore. It is painless, and only rarely causes ugly scars.

At present, a large number of experiments are being made at Paris, as well as at Vienna, London, and New York, and it is to be hoped that the treatment of skin diseases by radium will eventually take an important place in therapeutics alongside of the therapeutical use of X-rays, the successes of which are already numerous. If the effects obtained are comparable to those produced by Roentgen rays or ultra-violet light, it is probable that the treatment by radium rays will be preferred, since, with the possession of a few fractions of a grain of the new element, it will be unnecessary to purchase costly and cumbersome apparatus. M. Giesel has shown that the radium rays act upon the eye. When a bulb containing a salt of radium is placed in the vicinity of the eyelid or temple, in darkness, a sensation of light is produced in the eye. MM. Himstedt and Nagel have shown that, in such experiments, the centers of the eye become luminous by phosphorescence under the action of the radium rays, and that the light that is perceived has its source in the eye itself. The blind, in whom the retina is intact, are sensitive to the action of radium, while those whose retina is diseased experience no luminous sensation due to the rays.

The radiation of radium has a bactericidal effect, and prevents or interferes with the development of microbian colonies. Such action, however, is not very intense.

M. Danysz, of the Pasteur Institute, has particularly studied the action of the rays upon the brain and spinal marrow, and has found it to be very energetic. He has found, moreover, that if a bulb containing a very active salt of radium be placed for an hour along the vertebral column of an animal, the latter will become paralyzed at the end of a few days and quickly die. Analogous phenomena occur when a bulb is placed upon the cerebral mass of a rabbit, the skull of which has been trepanned. M. Bohn has shown that radium modifies the tissues of animals in the course of growth. Finally, M. Giesel has noticed that the leaves of plants submitted to the action of radium radiations become yellow and then wither.

Action of Temperature upon the Radiation.—The radiation of radium is the same whether the latter be placed in liquid air (t = —180 deg. C., or —292 deg. F.) or be at surrounding temperature. This is demonstrated by various experiments. Thus the luminosity of a radiferous barium salt persists if a bulb containing radium be plunged into liquid air. At the temperature of the latter, radium continues to excite the fluorescence of platinocyanide of barium. If at the bottom of a test-tube there be placed a bulb containing a salt of radium and a small screen of platinocyanide of barium made luminous by the presence of the radium, and if the test-tube be afterward immersed in liquid air, it will be found that the platinocyanide of barium screen is as luminous as it was before immersion.

Such are, briefly stated, the principal effects of the radiation of the salts of radium. It remains for us to study a phenomenon of a different nature, and somewhat far-reaching in its consequences. This phenomenon, which is known by the name of "induced radio-activity," will be the subject of the concluding part of our study.

(To be continued.)

RADIO-TELLURIUM.

THE recently announced discovery of a new substance, called by its discoverer, Prof. W. Marckwald, "radio-tellurium," has been made the subject of some interesting discussions in Nature. Mr. Soddy objected to the use of the term. Prof. Marckwald replies as follows:

"Shortly after the discovery of polonium by M. and Madame Curie, Giesel found that this substance quickly lost its radio-activity, and he characterized it therefore as inducedly active bismuth. P. and S. Curie themselves had, indeed, shortly before the publication of my first paper on the subject, defined polonium as 'une espèce de bismut actif.' The observations of Giesel and the Curies differ from one another on two points. Giesel's polonium emitted α and β rays and lost its activity within a few weeks, while that of the Curies sent out only α rays, and lost the greater part of its activity only after the lapse of a few months. More recently Giesel has shown that bismuth, by prolonged immersion in a solution of pure radium bromide, can become permanently (?) active, and then emits only α rays.

"Hence there exists with certainty an inducedly active bismuth giving out only α rays, and this might with accuracy be called polonium. There exists, further, a bismuth giving out α and β rays—Giesel's polonium. In this I have found traces of radio-tellurium, and I have shown that after the removal of the latter the remaining substance shows strong β and diminished α radiations. Finally, after the discovery of radio-tellurium, Madame Curie has purified her polonium by fractional precipitation of the subnitrate, and has ultimately arrived at a substance, of which she describes precipitates, the properties of which agree neither with those of bismuth nor with those of radio-tellurium. This substance she calls polonium. It can be seen from this brief summary that the idea associated with the name polonium is an extremely variable and indeterminate one.

"In the investigation of bismuth separated from Joachimsthal pitchblende in an essentially different way from that of Madame Curie,* I found a small quantity of tellurium which was extraordinarily active. From one kilogramme of bismuth I was able to separate only about a tenth of a gramme of tellurium. This had not previously been found in the pitchblende.

"Since the substance was distinguished from ordinary tellurium at first only by its radio-activity, I named it radio-tellurium 'provisionally.' To give a final name to it seemed to me to be premature. The example of polonium showed clearly enough the confusion arising from giving a permanent name to a thing before the thing itself has been accurately defined. Hence Madame Curie can least of all afford to reproach me with being too hasty in my naming.

"The further investigation of radio-tellurium showed how necessary was my caution, for it proved that the substance consisted mainly of ordinary tellurium. It was possible, however, to separate, in a quantity amounting at most to a few tenths of 1 per cent, a radio-active substance of extremely high activity in proportion to its quantity. This substance, of which up to the present I possess only a few milligrammes, I have named radio-tellurium 'provisionally.' Ought I, as Mr. Soddy seems to suggest, to call it also polonium, and so increase the present confusion?

"Mr. Soddy appears to wish the justification for a new name to depend on the proof of the constancy of radio-activity of my substance. This suggestion of Mr. Soddy's was not necessary to induce me to pursue experiments in this direction. Such are already undertaken in the most accurate manner, but their results, which must be waited for, have not the least to do with the question of nomenclature. The name polonium does not denote a particular substance which has the property of losing its radio-activity with the course of time—who could at present be sure of the constancy of activity of radium?—but merely radio-active bismuth. So far as the constancy of the radio-tellurium emission is concerned, I may here cite the following experiment. A copper plate of about 8 square centimeters surface, on which not more than a few hundredths of a milligramme of the purest radio-tellurium have been precipitated, now, after nine months, radiates so powerfully that the phosphorescence of zinc blende and of barium platinocyanide can be made visible to an audience of several hundred people.

"Mr. Soddy has thought fit toward the close of his article to attribute to certain German organic chemists the custom of 'rechristening well known bodies.' In a way that can hardly be misunderstood, he insinuates that this may be traced to an endeavor to claim for themselves the discoveries of others.

"This somewhat objectionable charge Mr. Soddy has in no way shown to be grounded. Polonium can, indeed, hardly be reckoned as one of the well known bodies.

"I can also the more easily refrain from answering this aspersion as I am aware that some of the most prominent English chemists have a quite different opinion of their German colleagues from that of Mr. Soddy. I would recommend in this direction a perusal of Prof. P. F. Frankland's address to the chemical section of the British Association in 1901.

W. MARCKWALD."

To this communication Mr. Soddy replies:

"Prof. Marckwald's communication will probably be welcomed by the scientific world on account of the opportunity it affords of settling finally the disputed question as to the nature of the body named by him 'radio-tellurium.' In my own mind, before I had read Prof. Marckwald's letter, a doubt still lingered as to the identity of the body with Madame Curie's polonium on account of the very definite statement made by Prof. Marckwald in his first communication on the subject that the activity of his body did not decay with time. This to me was an insuperable difficulty in the way of considering the two bodies to be identical. The other reasons Prof. Marckwald has advanced—and it is not likely I should have ventured to express an opinion without having made myself acquainted with these reasons—seemed to arise out of a misconception on the part of Prof. Marckwald himself as to the nature of polonium. This point I hope to discuss later, but first I wish to deal with the, to me, important question of the constancy of the radio-activity of radio-tellurium. It is satisfactory to learn that accurate determinations are in progress. Everyone will understand that the results must be waited for. What I did not appreciate before reading Prof. Marckwald's letter was that his conclusion that the activity of radio-tellurium did not decay with time was merely an impression unsupported by actual measurements.

"The experiment quoted, that a sample of radio-tellurium after nine months still illuminates a phosphorescent screen brightly, would seem to illustrate my point that Prof. Marckwald even now seems to be under a misapprehension as to the nature of polonium. After nine months, polonium, according to the work of its discoverer, would still possess at least one-half of its initial activity. I suppose no one would maintain that it is possible to remember over a period of nine months the various degrees of luminosity, produced by a radio-active preparation, with sufficient accuracy to be sure of a diminution by one-half of the initial luminosity during that interval. In two or three years the decay of activity of polonium should be obvious even with this rough test, but it certainly would not be sufficiently marked in nine months. We may therefore take it as settled that there is absolutely no evidence at the present time for supposing that radio-tellurium possesses a more constant radio-activity than polonium. If only this point has been made clear, this correspondence may be considered to have justified itself.

"According to Prof. Marckwald the idea associated with the term polonium is an extremely variable and indeterminate one. It seems to me that this is to put a wrong valuation on the work of its discoverer. Madame Curie gave the name to the hypothetical constituent of the bismuth separated from Joachimsthal pitchblende which caused its radio-activity. The radio-activity in question is distinct from that of any known radio-active substance, for it comprises only the emission of the α or non-penetrating type of radiation. Moreover, it slowly decays with time, and diminishes to half the initial value in about a year. Madame Curie has always been careful to point out that she has not succeeded in separating polonium from bismuth, or in obtaining any spectroscopic or other more direct proof of its existence. The name polonium applies to the body *causing this particular kind of radio-activity*. Hundreds of workers, I suppose, have obtained from the Société de Produits Chimique de Paris specimens of polonium prepared by Madame Curie's method, and have satisfied themselves by their own observations as to the character of its radio-activity. Now Prof. Marckwald has never claimed that he has isolated his body radio-tellurium, although he has been more fortunate than Madame Curie in effecting its concentration. Hence the name radio-tellurium applies also to the hypothetical constituent causing the radio-activity rather than to the preparation itself. Many, no doubt, have obtained also specimens of radio-tellurium from the firm of Dr. Sthamer, of Hamburg, and have compared its properties with those of polonium.

"The meaning applied by Prof. Marckwald to the word polonium may be illustrated by these sentences quoted from his letter: 'Shortly after the discovery of polonium Giesel found that this substance quickly lost its radio-activity. . . .' 'Giesel's polonium emitted α and β rays and lost its activity within a few weeks.' 'In this (Giesel's polonium) I have found traces of radio-tellurium, and I have shown that after the removal of the latter the remaining substance shows strong β and diminished α radiation.'

"The question at issue is therefore a very simple one. Is Prof. Marckwald justified in applying Madame Curie's name to Prof. Giesel's preparation? 'Giesel's polonium,' according to Prof. Marckwald's statement, is a mixture of two radio-active constituents: (1) radio-tellurium, (2) a constituent giving β as well as α rays. The latter, since it can neither have been polonium nor radio-tellurium, need not be further considered in the present discussion. It *may* be something new and interesting, but, on the other hand, there is nothing to show that it was not merely a trace of radium present as an impurity. In either case it does not concern us, and two bodies only, Madame Curie's polonium and Prof. Marckwald's radio-tellurium, need be further considered. Both are obtained from the same variety of pitchblende, both are distinguished

* Madame Curie has recently published her method of separation. I separated the bismuth from the pitchblende by precipitating it as oxychloride by the addition of much water to the hydrochloric acid solution.

from all the other radio-elements by the fact that they only give α rays, and both possess at least a considerable fraction of their initial activity after the lapse of one year. Now Prof. Marckwald used the same* raw material as Madame Curie, namely, the bismuth extracted from the Joachimsthal pitchblende. Since he states that his method separated *all* the active constituent we may feel certain (1) that radio-tellurium must certainly contain polonium; (2) that as it gives no β rays it contains none other of the known radio-active elements; (3) that as the radio-active properties of the two preparations are indistinguishable, the active constituent of Prof. Marckwald's preparations is the same as that of Madame Curie's preparation, and therefore by every recognized canon should be termed polonium.

"Prof. Marckwald's work has shown that there are present on a maximum estimate 4 milligrammes of the active constituent in two tons of pitchblende, or in 8 kilogrammes of the bismuth salt separated from it. Hence what possible bearing can such a small trace of substance have upon the analytical reactions of the relatively vast bulk of the raw material? In laying stress on these reactions, he frequently seems to apply the term polonium to Madame Curie's preparation rather than to its radio-active constituent.

"The same criticism might be applied to the following sentence, to be found in his most recent communication (Berichte, 1903, p. 2665): 'Whether this Curie's polonium does not perhaps contain also some radio-tellurium is a question which must be left to the discoverers of polonium.'

"With regard to the view expressed that polonium is merely radio-active bismuth, or inducedly active bismuth, in support of which an opinion once expressed by Madame Curie is quoted, the answer, of course, is that Prof. Marckwald's own subsequent work has shown otherwise. By the experiment of depositing on a stick of pure bismuth the whole of the polonium present in a solution, he makes it evident that the latter cannot be bismuth. Those who are acquainted with the work of Rutherford in 1900 on 'induced' activity know that the whole conception of radio-active induction has been built up on a simple misconception of the phenomena it is designed to explain. The conception had its origin in the belief that the *rays* from a radio-active substance could excite radio-activity in otherwise inactive matter, which was not in accordance with the facts known at the time it was put forward.

"Giesel repeated the identical experiment of Prof. Marckwald with a solution of pure radium, and found that a stick of bismuth after immersion becomes permanently (?) active and then only emits α rays, and Prof. Marckwald, in spite of his own work, concludes that there exists with certainty an inducedly active bismuth giving only α rays, which might with accuracy be termed polonium. He, however, omitted to state that Giesel obtained the identical result if a stick of platinum or palladium were immersed in the radium solution. Hence it might be argued that there exist an inducedly active platinum and an inducedly active palladium, both of which might with accuracy be termed polonium. The alchemists considered that they had turned iron into copper by means of a solution of blue vitriol, until it was pointed out that the latter substance contains copper. It has never been shown that any of the effects of the so-called 'radio-active induction' are really due to the conversion of an inactive element into radio-active matter. From the existing evidence to the contrary, it would seem more reasonable to suppose that they admit of a similar interpretation to that now adopted to explain the cuprification of iron. FREDERICK SODDY."

OUR FLOOD WARNING SERVICE.†

By CHARLES ALMA BYERS.

In view of the fact that with the coming of spring one begins to expect to hear reports from some part of the United States of the ravaging of some damaging flood, a review of the river and flood service of the United States Weather Bureau, in regard to its growth, its plan of action, and what it is accomplishing, should be of more than passing interest, and especially so to the millions of people who live within the probable flood areas. The appalling floods of last spring along the Kansas, Missouri, and Mississippi rivers, in which something like $40,000,000 worth of property and many human lives made up the unwilling sacrifice to the Greek Poseidon, is still fresh in the memory of all; and when one is told that through the flood warning service of our weather bureau this great loss of property was cut down by millions and the destruction of human life by hundreds, interest in the subject before us is increased many fold. Nevertheless, that such noble work was really accomplished is a reasonable probability when one has studied the matter, although there can be no statistics produced to actually prove it; and had there been sufficient funds on hand to carry on the work, the service rendered could have been much better. This is especially true in regard to the Kansas River flood, for on account of the lack of money, observations and forecasts could only be made in a general way. There were no means for obtaining information of any description of the condition above the threatened points, and consequently the warnings sent out could only be to the effect that serious floods were probable. Along the lower Missouri and upper and lower Mississippi, however, there were better means established for obtaining the required information, and, as a consequence, the service rendered was better proportionately.

At the head of the river and flood service of the United States Weather Bureau, whose office is in Washington, D. C., is Dr. H. C. Frankenfield. It is he who notes each rise and fall of an inch or less of the great rivers and their tributaries, who ever keeps tab on the conditions of the weather, the state of the ground, whether absorbent or non-absorbent, the velocity of the streams, and on all other things that may affect the rise or fall of a river, and who thereby practically holds in the palm of his hand means for protecting thousands of human lives and millions of dollars' worth of property from the ravaging of floods. And no one could be found who is better able to manage this work than is Mr. Frankenfield. He has made it almost a life study. He has seen the service grow from its beginning and it is mainly due to his work that it has had such a rapid growth. In 1870 there were only a few stations for flood and river observation, which were located at regular weather bureau observing places. Since then the number has been increased to 375. Of this number 49 are regular weather bureau stations, 246 are special river observing stations, and 80 are special rainfall stations. At the regular weather bureau stations are located the headquarters of the various meteorological districts into which the country for convenience is divided. Head officers in charge of these headquarter stations receive daily and monthly reports of the meteorological and river conditions from the different sub-stations of their respective districts. It is from these reports that a knowledge is gained of the various and relative conditions existing throughout the whole district directly and the entire country indirectly.

The distribution of special observing stations over any certain district depends upon the character of its watershed. There may be either many or few in proportion to its size. Where the area is comparatively level the rivers run slowly and more time is given for reporting observations. Consequently the stations may be farther apart where the country is level than where it is of a precipitous character. In areas of the latter nature, the flow of the river being much more rapid, the changes in its rise or fall must be more hastily observed and reported to the stations farther down the stream. As an illustration, no more stations are required for the Mississippi River, which is more than 2,000 miles long, than for the Pittsburg district, which comprises the Allegheny and Monongahela rivers. The speed of the water in the lower Mississippi varies from 50 to 90 miles a day, while in the Allegheny River it sometimes exceeds 200 miles in the same length of time. It is seen by this that it takes a flood in the Mississippi River from three to four times as long to exhaust itself as it does one in the Pittsburg district, and the distribution of observation stations over the districts must be made accordingly.

In forecasting the probability of a flood in any certain river, there are many things to be considered. First of all, of course, there is the total amount of precipitation over the watershed of the river system affected to be taken into consideration, and then the duration, the distribution, and the character of the rainfall for the area. By no means does everything depend upon the volume of the water alone. If it has been a long, steady, but mild rain, the water will have had more time to run off than had it been short and heavy. The distribution also has much to do with the probability of a flood, for much depends upon whether it is a local or general rain. Again, the character of the precipitation, whether rain or snow, must be considered. If it is snow, the danger of a flood lies in the rapidity of its melting, not in the volume alone. There are also many other complications that enter into the subject of precipitation and floods. There is the topography of the country, whether level or precipitous, whether covered with foliage or comparatively bare, and, if bare, whether cultivated or not. The run-off of the water, of course, where the area is level, would be very slow, and also where the ground is covered with heavy vegetation, while cultivated soil would absorb much more of the water than would uncultivated ground. All these things must be considered. Then, too, there are other conditions of the soil that figure in the subject. Much depends upon whether it is rocky, clayey, sandy, frozen or not, dry or moist. Rocky soil would absorb very little water, clayey only a little more, and sandy a great deal. Frozen ground is comparatively waterproof, and of course where the soil is already moist there is little or no room for more absorption. The seasons are also quite an important factor in the matter of floods. In the spring melting snow, and especially in mountainous areas, must be looked for; and also there are occasionally freeze-ups in the tributaries of the river, which temporarily dam the water, that must be known of and considered by the forecaster.

The plan of action of this branch of the weather bureau in case of a flood seeming probable is one of thoroughness and one demanding promptness. As soon as it is known that a flood is imminent in any particular district, the head officer of that district immediately issues warnings to all persons interested. In these warnings the stage of water expected and the time of its arrival at various places are given. To give the condition as much publicity as possible is aimed at, and the whole machinery of his office is brought into action to accomplish that aim. Warning notices are furnished to newspapers for publication, posted in post offices and other public places, and sent by telephone and telegraph to every place possible. Of course, in many cases these warnings are unheeded and thereby much is lost that could be saved. This much work, really accomplished by the bureau, is practically thrown away.

The warning notices are usually given out from seven to fourteen days in advance of the flood, and as a rule they are very accurate both in regard to stage of water and time of arrival. Sometimes, however, as in the case of fast-running rivers, to be perfectly accurate is impossible, yet errors of more than a foot in the stage of water seldom occur, and it is very infrequent that the time of arrival is missed by more than a few hours. One striking illustration of accuracy in the forecasting of a flood was shown in the Mississippi River district in the flood of last May and June. Seven days after the warnings were issued at St. Louis a special warning was given out stating that in four days a stage of water of 38 feet might be looked for, 33.5 feet being the gage mark at that time. Five days later, minus a few hours, the predicted stage was reached.

CAPT. SCOTT IN THE ANTARCTIC.

The British Antarctic expedition under Capt. Scott, with the two ships that were sent to relieve it, has returned safely to New Zealand after two years of strenuous work crowned with brilliant results. No polar party has ever been more richly rewarded for heroic endeavor to extend the bounds of geographical knowledge. The past year's work has notably supplemented the three great achievements of the first year of the expedition.

It will be remembered that Capt. Scott traced the eastern edge of the Antarctic continent for 350 miles south of his winter quarters at Mount Erebus, attaining on this sledge journey the latitude of 82 degrees 17 minutes south. We have therefore a fair survey of 800 miles of this coastline extending mainly north and south, and not counting the coastal irregularities, which would increase the mileage of known shoreline to over 1,000 miles. From his furthest south, ranges of mountains continued to stretch away a little east of south as far as the eye could reach.

The second conspicuous result was the journey of the "Discovery" for 640 miles east of Mount Erebus along the edge of the great ice barrier to the shores of another land never seen before, which has been named King Edward VII. Land and is regarded as another segment of the coastal regions of the Antarctic continent. About 170 miles to the west of this shore Capt. Scott made a sledge excursion over the ice southward nearly to the 79th parallel; and from a balloon he saw many parallel lines of undulation extending southward as far as vision reached. To all appearances, a great bight penetrates the continent between Victoria Land and this more eastern land region.

The third achievement was Armitage's sledge journey from Mount Erebus westward into the continent for about 100 miles from the coast, ascending glaciers and mountains to a smooth, open, snow-covered plain over which he traveled for some distance, till failing supplies compelled him to return to the ship.

The short dispatches from New Zealand give us some idea of what has been added to this record by the past year's work.

No further attempt was made to attain a greater distance southward. Capt. Scott's furthest on his sledge journey of the previous year remains the nearest approach to the South Pole.

A sledge journey was made over the sea ice to a point 160 geographical miles southeast of the ship. No land was found; but this wide-spreading ice plain, unbroken by storms of the open ocean or by enormous ice pressure as in the Arctic Ocean, seems to confirm the belief above expressed that this region is a bight of the ocean to the north of it and not a part of the ocean itself.

The exploration of the continental mass to the west of the "Discovery's" winter quarters was extended far beyond the point in the interior reached by Armitage in the previous year. Capt. Scott's sledge party traveled inland 270 miles from the ship, about forty miles further south, and 100 miles further west, than the point reached by Armitage. He found that the vast continental plateau rises to a height of 9,000 feet above the sea, or 1,000 feet higher than the elevation attained by his assistant.

Some of his most interesting discoveries were made after the "Discovery" had been freed from the ice a few months ago. He found that the Balleny islands were identical with the three Russell islands of Ross. It has long been conjectured that they were possibly the same, although the position given by Ross differed considerably from that of Balleny; but it required actual investigation to settle the matter.

It was also found that the extreme eastern part of the coast line indicated by Wilkes does not exist. It is not the fault of the American explorer that there has been much confusion and uncertainty with regard to the eastern end of the coast known as Wilkes Land. It has long been certain that it would take an accu-

* The point raised in the footnote to Prof. Marckwald's letter is, I take it, a side issue. He brings forward no evidence that the bismuth separated from the pitchblende by sulphureted hydrogen (Curie) is different in its radio-active properties from that separated by himself as oxychloride, nor any reason for supposing that the active constituent in the two cases might be expected to be different. It is true that his bismuth contained a minute proportion of ordinary inactive tellurium, which was probably almost or quite absent in Madame Curie's preparation. This fact he made use of as the basis of his elegant method of concentrating the active constituent, and he seems to have at first confused the difference of behavior of the two raw materials to differences in the chemical nature of the active constituents rather than to the fortuitous presence of a trace of tellurium. But his own later experiments (Berichte, 1903, p. 2663) show that when the tellurium is removed from the solution his methods of precipitating the active constituent completely fail, but again work perfectly if a few tenths of a milligramme of ordinary telluric acid in aqueous solution are added.

† Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

rate survey to ascertain the facts concerning this region.

If the cable reports Capt. Scott correctly, the importance of his discovery is considerable; for it disproves the hypothesis that the coast of Wilkes Land is extended eastward in a long connected line to Victoria Land. The fact seems to have been definitely established by the discoveries of the Germans at the western extremity of Wilkes Land, that the land masses there are a part of the continental coast, but if the statement attributed to Scott is accurate, it is probable that there is an important recession of the shore to the west of Victoria Land, which may thus be a broad peninsula.

Few geographical events of recent years have equaled this work in importance, and the details will therefore be awaited with much interest.—New York Sun.

THE RECENT VOLCANOES OF SOUTHWESTERN IDAHO AND SOUTHEASTERN OREGON.*

By ISRAEL C. RUSSELL.

SOME account of the recent but now extinct volcanoes of southern Idaho was presented in my report on field work done in 1901,† and additional data in this connection were obtained during the reconnaissance which furnishes the basis of the present report. In 1902 the Cinder Buttes, the most instructive group of recently extinct volcanoes thus far discovered in Idaho, were revisited, and three separate centers of recent volcanic activity in southern Oregon, not previously known to geologists, also examined. The facts observed in connection with these four modern and still well-preserved volcanoes or groups of volcanoes, when taken in connection with the studies already made of many other similar examples in the same region, not only contribute to a better understanding of volcanic phenomena in general, but aid in an important way in the interpretation of the records of the far more extensive lava flows of greater age in the same region.

The more instructive features of the recent volcanoes of Idaho, described in the report referred to above, may be briefly summarized as follows: The lava extruded is in all instances a dark basic rock, and may all be classed as basalt. In physical characteristics it ranges from compact, columnar rock to highly scoriaceous and even pumice-like material. The lava was extruded from the volcanic conduits in two ways: Part, and by far the larger part, flowed out in a highly liquid condition and spread widely over the surface before cooling and hardening, and part was blown into the air as angular fragments, or as clots, bombs, etc., which fell on the adjacent surface and built more or less conspicuous elevations. The material extruded in each of these ways presents many variations in its physical condition, dependent on secondary influences.

Of the lava which flowed out in streams two principal varieties may be recognized; one division includes the rocks formed by the cooling of the molten material on land, which, although at times highly scoriaceous, especially at the surface of the sheets, is in general a dense, compact rock, and on account of the formation of joints as it cooled is frequently columnar; the other division contains the lavas which entered surface water bodies and became expanded and "shredded," or shattered by the resulting steam explosions. The lava which was blown into the air presents an interesting series of forms, ranging from angular fragments produced by the shattering of the material after it had become cool and rigid, through clots, bombs, lava cakes, etc., formed of more and more plastic lava, to splashes of the magma which were still highly liquid when they fell.

From the two principal variations in the manner in which the volcanoes discharged their lava, two types of elevations about the mouths of their conduits resulted. The explosive eruptions led to the building of lapilli and cinder cones, a considerable range in the forms produced resulting from the degree of rigidity or plasticity of the projected fragments and the extent to which they cooled before striking the surface.

* Extracted from Bulletin 217 of the U. S. Geological Survey.
† Bull. U. S. Geol. Survey No. 199.

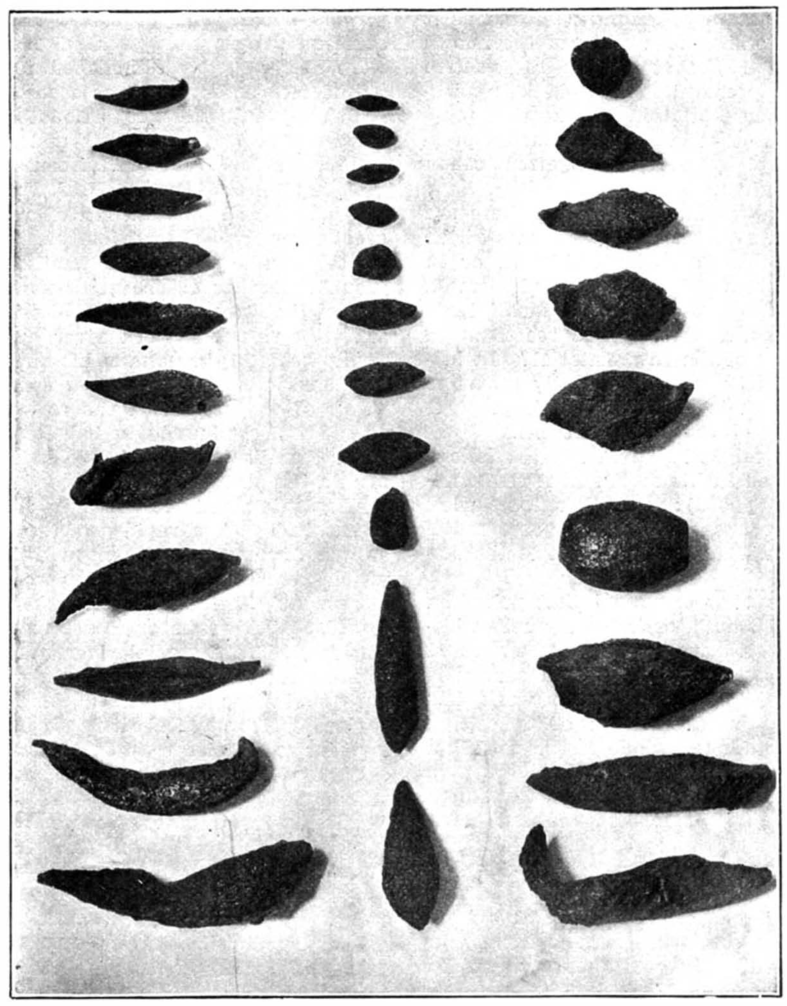
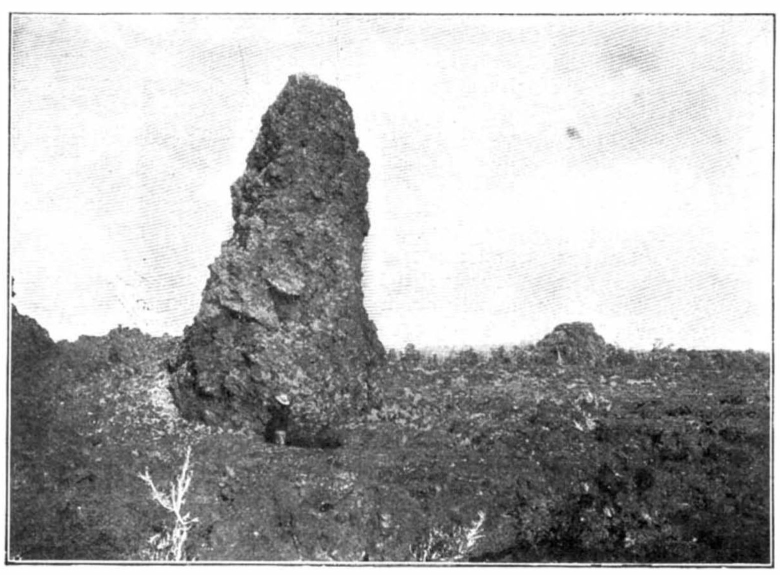


FIG. 5.—VOLCANIC BOMBS, CINDER BUTTES, IDAHO.

Four-tenths natural size.



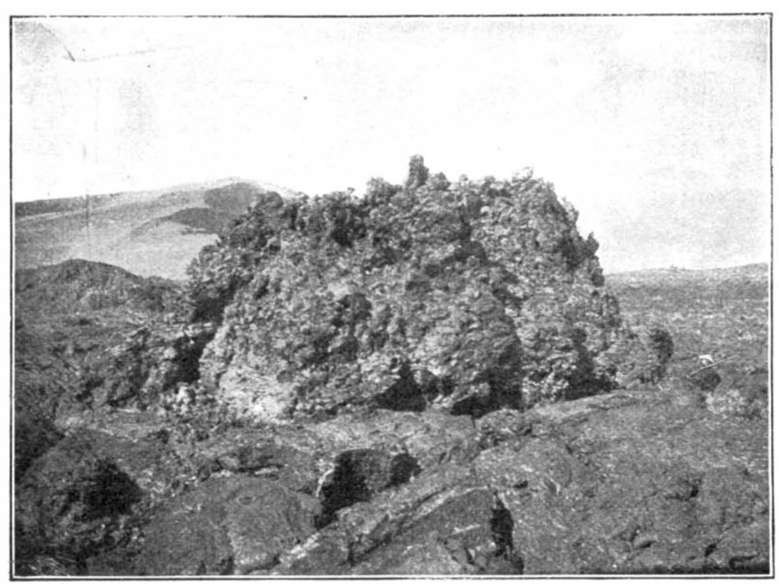


FIG. 3.—ISLAND OF LAPILLI IN LAVA STREAM, CINDER BUTTES, IDAHO.

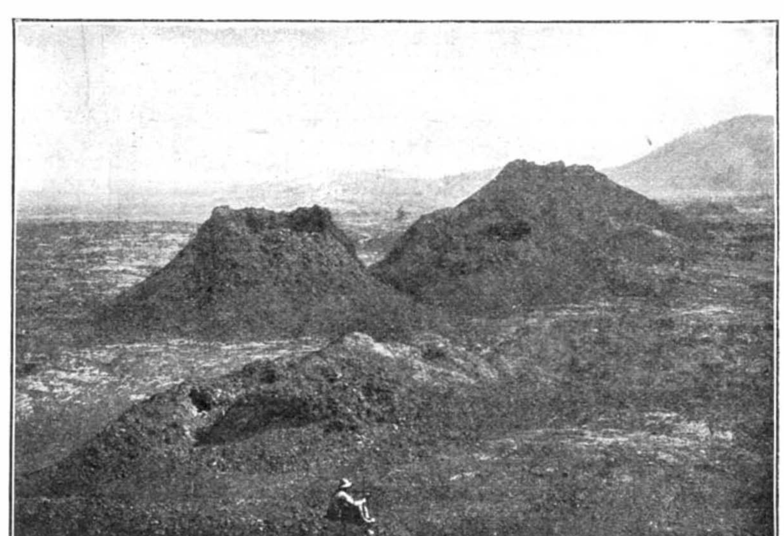


FIG. 4.—SCORIA AND BOMB CONES, "THE ICE WELLS," CINDER BUTTES, IDAHO.

These elevations are usually steep sided and contain depressions or craters in their summits, and as a class may be termed cinder cones. The lava overflows occurred for the most part quietly, without explosions, although in general, as it is believed, following explosive eruptions which opened the volcanic conduits for the free discharge of the molten rock which rose later and was poured out in such volume that the extruded material cooled in a mound above the orifice from which it came and flowed outward in all directions, forming what it is convenient to term lava cones. The cinder cones are high in reference to their diameters, with steep and normally concave slopes, while the lava cones are usually low, with gentle and at times convex sides and immensely expanded bases.

One of the most notable facts connected with the volcanoes in question is the vastness of the lava fields spread out about them in comparison with the size of the cinder or lava cones found at the summits of the conduits from which the material came.

On the surfaces of the lava flows there are two principal features, which are dependent on the ratio between the motion of the lava and the degree of rigidity of the crust formed on its surface as cooling progressed. When the cooling and stiffening of the surface occurred without marked disturbance from the flow of the still liquid material beneath, smooth, swelling, convex surfaces resulted, which at times were wrinkled and even forced upward into hollow folds. These folds show the characteristics of *pahoehoe*, as such surfaces are termed in the Hawaiian Islands. When, however, the underflow beneath a brittle crust caused it to become fractured, and the fragments thus produced were tossed about in much the same manner that the cakes of ice in an ice jam are crushed together, and piled up, a rugged surface, simulating what is termed *aa* in the Hawaiian Islands, resulted.

The numerous instructive features just referred to, which were described and discussed in some detail in the report on the observations made in 1901,* were found in the crater and lava flows of southeastern Oregon examined in 1902, and still other phenomena belonging to the same general category were observed. The re-examination of the Cinder Buttes enabled me to verify and extend the results previously recorded.

FIG. 6.—VOLCANIC BOMB, CINDER BUTTES, IDAHO.

Four-tenths natural size.

CINDER BUTTES.

The Cinder Buttes are situated on the west side of the Snake River Plains, about 70 miles west of Blackfoot, Idaho. They are not conspicuous on account of size, as the highest crater in the group rises but 600 feet above the adjacent plain, but are remarkable for the vast amount of lava that flowed from them and for the many instructive details they present in reference to the behavior of volcanoes which erupt basic and easily fusible lava.

The additional facts concerning this most interesting group of craters and lava flows, at least in a measure supplementing the account of them already published,† relate principally to the floating away of large fragments of a ruptured tuff cone on the surface of the outflowing lava stream, a greater variety in the volcanic bombs occurring about the crater than was previously known, and the occurrence of distinct beds of compact lava in the walls of cinder cones, due to the running together and hardening into a single mass of many splashes of liquid lava, etc.

Breached Cinder Cones and Crags of Tuff Floated on Lava Streams.—There are several well-defined craters built of lapilli and scoria among the Cinder Buttes, which were breached by the lava that escaped from them, and in one instance of this nature large masses of the parent crater were floated away on the surface of the lava stream which escaped through an opening in its wall. The floated masses range in general from 20 to 50 feet in diameter and from 40 to 50 feet or more on a side. They occur in a well-defined train, extending down the lava stream which escaped from a breach in the parent crater for a distance of about 2 miles. The masses are always angular and are bounded by rough surfaces that have resulted from fracture. They consist of reddish tuff, formed by the partial consolidation of lapilli, or of adhering clots of lava that were plastic when they were brought together. In color and composition they correspond with the portion of the cinder and lapilli cone still remaining intact, and differ from all other rock in their vicinity. They are in striking contrast with the black, generally smooth, but in places wrinkled or fractured, lava surface on which they occur. About the base of nearly every one of the crags the surface of the sustaining lava is depressed so as to form a moat-like trough which completely encircles it. Some of the features just described, including the depressions encircling the bases of the crags, may be recognized in the accompanying photographs (Figs. 1 and 2).

It is of interest to note that the surface of several of the lava streams about the Cinder Buttes, for a distance of a mile or two from their sources, has subsided since it hardened, owing to an outflow of the still liquid lava from beneath a rigid crust. The amount of this subsidence is in several instances from 50 to 70 feet. As a result of such subsidence in the central part of a lava stream its marginal portions are sometimes left stranded, and a precipitous broken escarpment, facing the subsided area, borders the portion of the stream from which the lava outflowed. On the border of a lava stream which has been lowered at times large blocks of the stranded crust slope downward toward the subsided area.

In the case of the Northwest lava flow, i. e., the one on which the crags of tuff, etc., described above, occur, there has been a subsidence of the surface of the flow throughout the first mile or more of its course, and a lowering of the crust formed on its central part of 50 to 70 feet. A portion of the flow, a square mile or more in area on the west side of the stream, was left stranded by this subsidence at a higher level than the surface of the lava, which continued to flow to the north.

From the facts briefly described above it seems evident that the crags of tuff, etc., on the surface of the Northwest lava streams are fragments of the breached crater from which the lava came, and that they were floated on the surface of the plastic lava. The floated fragments are composed of rock which, on account of its porous and usually scoriaceous condition, is lighter than the usually compact lava on which they occur, but they depressed the viscous surface on which they rested in the same manner that a brick might depress the surface of pitch. The floated fragments were not carried to the end of the lava flow, for the reason that a crust was formed on the stream of molten rock from beneath which the still liquid material escaped. Owing to the outflow beneath, the crust remained stationary and with its freight of tuff was gradually lowered to the position it now occupies. That the crags to which attention has been directed are not islands in the lava stream is clearly shown by comparing them with well-characterized occurrences of that nature, one of which is shown in Fig. 3. The stranded blocks of lava about an island in a lava stream which has subsided are inclined away from it, as may be seen in an example of this nature shown in the photograph just referred to. In such instances the result is much the same as may be observed on the borders of a river which has subsided after a sheet of ice had formed on its surface; in instances of this

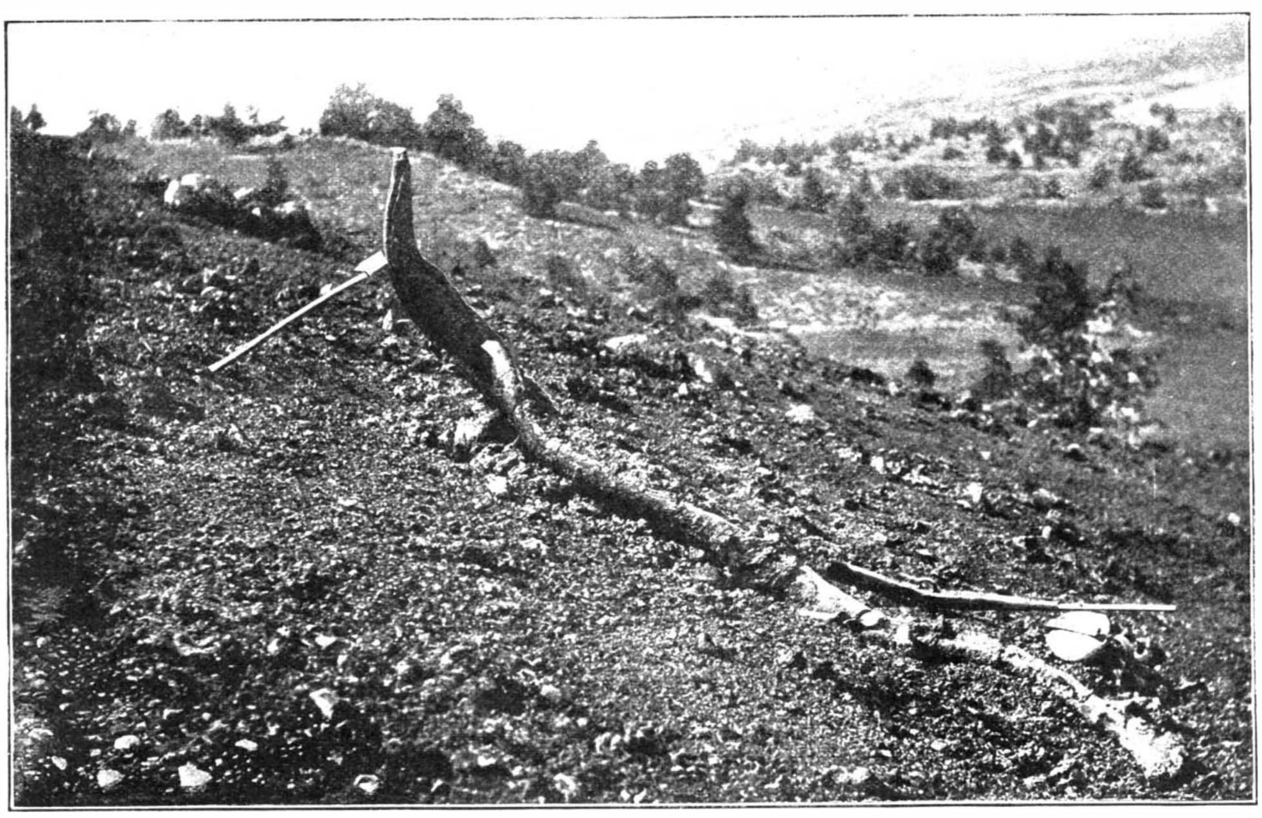


FIG. 7.—VOLCANIC BOMB, CINDER BUTTES, IDAHO.

Length, 13 feet; greatest diameter, 8 inches.

* Bull. U. S. Geol. Survey No. 199.
† Bull. U. S. Geol. Survey No. 199.

nature, as is well known, cakes of ice left stranded on the banks of the stream are inclined downward toward its center. About the islands in a lava stream which has been lowered by the outflow of the liquid rock from beneath a solid crust, the portions of the crust left stranded slope away from the central part of the island and nothing resembling the moat-like depression observed about the floated crags described above is even suggested.

In some instances observed about the Cinder Buttes, the subsidence of the central part of a lava appear to have been so gentle that the surface sheet of stiffened but still somewhat plastic material was not seriously broken, and still remains in the condition of *pahoehoe*. At other times a more rapid lowering of the surface, or the presence of a rigid and brittle crust, caused a large amount of fracturing and the heaping up of the pieces produced so as to make a characteristic *aa* surface. About the bases of the floated crags on the Northwest lava flow, described above, typical examples of each of these classes of lava surfaces are to be found. In some instances the crags rise from smooth, swelling, and frequently corrugated *pahoehoe* surfaces, and at other places are surrounded by the chaos that is characteristic of *aa* surfaces.

Volcanic Bombs.—The volcanic bombs strewn about the Cinder Buttes are so abundant that in several instances they form a large part of the material of which the craters are composed and present several well-characterized varieties.

The term "volcanic bomb" is usually employed to designate the class of projectiles blown out of volcanoes, which, on account of their revolving about an axis during their flight and while still plastic, assumed more or less regular spherical or ellipsoidal shapes. Typical examples of such bombs, ranging in form from nearly perfect spheres to elongated oval bodies with projections or "ears" at the ends of the longer axis, were obtained in abundance. The central body as well as the projections in those examples are marked by spiral lines and ridges, produced by the rotation of the mass while yet hot and viscous or plastic. Illustrations of such forms which preserve unmistakable evidence of having rotated while yet plastic are presented in Figs. 5 and 6. The bombs which most nearly approached the typical shapes just referred to range in size from less than an inch in length to masses that are 9 feet long and 12 feet in circumference in the center. In addition to the bombs with characteristic spherical or ovoid shapes, many other forms, some of them conspicuously irregular, were noted.

In some instances, as illustrated in Fig. 6, a mass of plastic lava, after being fired into the air and acquiring the common "football" shape, seems to have fallen straight downward, and the projecting ends or ears, being still plastic, were bent inward and perhaps flattened on the central portion of the mass. A great variety of bombs of this description, with recurved and infolded ears, was observed. Examples are also common of masses of lava which were projected into the air, and on falling acquired a pear-shaped or teardrop form. These bodies which seem to have fallen straight downward, as is indicated by their shapes, are of all sizes up to 2 feet or more in diameter. In many instances the tapering end is curved, or even folded down onto the body of the bomb, so as to produce shapes curiously like certain varieties of squash with curved necks. These pear-shaped and squash-shaped bombs were in many observed instances evidently still plastic when they struck the ground, as is shown not only by the fragments of lapilli, etc., adhering to their lower surfaces, and partially embedded in their outer crusts, but by a bulging at the base or flattening due to a change of shape on striking.

In addition to the bombs with more or less symmetrical forms, due to masses of plastic lava cooling and stiffening while rotating in the air or falling from aloft, there are many irregularly shaped bodies which originated in a similar manner. These are frequently greatly elongated, loosely twisted shreds, perhaps several feet long and only a few inches in transverse diameter in the thickest part. One of the most bizarre of these irregular forms is represented in Fig. 7. This ram's-horn-like body of dense light-colored lava measures 13 feet in length and 8 inches in diameter in the thickest portion. It lies on the west side of the highest of the Cinder Buttes, about one-third of the way from its base to the top, and was hurled through the air to a distance of about one-half mile. On striking, it was still sufficiently plastic to become indented by the stones on which it fell, some of which still adhere to its lower surface. On account of its plastic consistency it did not break when it fell, but has since been fractured, probably on account of changes of temperature.

Many projectiles, either complete or more or less shattered, of the same general character as the one shown in Fig. 7, occur about the Cinder Buttes, and in most if not all instances they are composed of dense, compact, light-colored rock, which on freshly fractured surfaces looks not unlike hard-burned stoneware and resembles the material forming the immediate borders of basaltic dikes or the whole of very thin dikes of similar character. It is evident that the lava forming the irregular shred-like bombs cooled quickly from a liquid or highly plastic condition, and that the steam and gases contained in the original magma escaped, for the most part, without leaving vesicles.

When the bombs are broken so as to expose their interiors they present at least three well-defined variations in structure. Certain ones, including the elongate, twisted forms described above, are compact throughout or exhibit only irregular and, frequently, much extended cavities, such as steam or gases leave in cooling lava, and are either light, and in fact almost white, or glossy black in color. In sections at right angles to the longer axis something of a spiral arrangement of the steam cavities, cracks, etc., is apparent, and on their exterior there is more or less evidence of the influence of rotation while the mass was still plastic. The bombs having these characteristics seem to have been formed of highly plastic or nearly liquid lava, from which the contained steam and gases escaped freely.

Bombs of a second variety, characterized by their rudely spherical shapes, rough exteriors, and highly vesicular and frequently nearly hollow interiors, but without surface crusts, spiral lines or ridges, or projecting ears, occur in abundance, especially in the walls of parasitic cones or what may perhaps be termed driblet cones of large size. These rough spheres range in diameter from a few inches up to 2 feet or more, and the walls of the large cavities within frequently present the appearance of "pulled dough," as if marked expansion of the steam cavities had occurred while the material was viscous. The bombs of this variety are sometimes flattened and bear on their under surfaces impressions of the material on which they fell. At times they adhere one to another, and in some instances were sufficiently plastic to flow after coming to rest. The occurrence of these bombs in chimney-like piles, about openings in lava streams, and in the walls of the so-called ovens to be described later, indicates that they were tossed out of openings in the crusts of lava streams, but did not make any considerable journey in the air. They form a connection between projected clots of vesicular lava, such as are commonly termed "cinders," and true bombs, which were thrown to a considerable height and cooled while rotating.

The third common type of bombs includes those which are cellular within—the vesicles diminishing gradually in size from center to circumference—and inclosed in a thin rind or crust. In some instances there is a thin layer of cellular lava on the outside of the hard rind, but more frequently the surface is smooth, glossy black, and in many examples broken by shrinkage cracks, which have been widened by the expansion of the material within after a thin surface crust had formed.

The interior structure of these bombs closely resembles that of certain bombs found on Ascension Island and described by Charles Darwin. In each case there is a conspicuous and gradual increase in the size of the vesicles in the central scoriaceous mass, from the inner side of the inclosing rind to the center. The explanation of this peculiar internal structure advanced by Darwin is as follows:

"This structure is very simply explained, if we suppose a mass of viscid, scoriaceous matter to be projected with a rapid, rotatory motion through the air, for while the external crust, from cooling, became solidified (in the state we now see it), the centrifugal force, by relieving the pressure in the interior parts of the bomb, would allow the heated vapors to expand their cells; but these being driven by the same force against the already hardened crust would become, the nearer they were to this part, smaller and smaller or less expanded until they became packed into a solid, concentric shell. As we know that chips from a grindstone can be flirted off when made to revolve with sufficient velocity, we need not doubt that the centrifugal force would have power to modify the structure of a softened bomb in the manner here supposed. Geologists have remarked that the external form of a bomb at once bespeaks the history of its aerial course, and we now see that the internal structure can speak with almost equal plainness of its rotatory movement."

As stated in my report on a reconnaissance in Idaho in 1901,* the observations then made concerning the cellular bombs strewn about the Cinder Buttes are not in harmony with the explanation quoted above. Later studies serve to strengthen this conclusion and to lend additional support to the hypothesis advanced in the bulletin referred to. In brief, the explanation of the cellular condition of the bombs in question, and the increase in the size of the vesicles they contain from beneath the crust to the center, which apparently best satisfies the observed facts, is that masses of steam-charged lava, tossed into the air from pools of liquid rock in craters, cooled quickly at the surface and formed a dense crust, which prevented further escape of steam from within, and as the lava continued to cool, the change gradually progressing from the circumference inward, there was an extrusion from the cooling lava of steam or gases previously held in solution in the molten rock. The regeneration of steam or gases in this manner would tend to expand a bomb, thus leading to a cracking of the first formed crust and a widening of the cracks.

The change referred to would also favor the formation of larger and larger vesicles within a bomb as the cooling and stiffening of the material composing it progressed. In addition to the facts referred to tending to support the hypothesis here restated, it may be noted that the bombs seen about the Cinder Buttes which show the internal structure, neither in their forms nor in their surface markings exhibit evidences of rapid rotation, and moreover occur on the crests and inner slopes of craters or in situations that do not indicate a long aerial flight. The impression that one gains from seeing large numbers of these bombs in the position in which they fell is that they are formed of masses of plastic lava which were tossed out of craters with only sufficient rotary motion to give a spherical form, but were not fired high in the air and did not acquire the spindle shape with twisted projections at either end, so characteristic of bombs that rotate rapidly while cooling.

* Bull. U. S. Geol. Survey No. 199.

Bombs of the various external shapes and with the wide range in interior structure described above occur in great numbers about the Cinder Buttes, and in fact furnish a very considerable portion of the fragmental material of which they are composed. Mingled with the bombs in the walls of many of the craters, as previously described,* are great quantities of thin, nearly flat, cake-like masses of lava, which were formed by the cooling and hardening of small bodies or splashes of lava that had been projected into the air and were still liquid when they fell. These flat cakes furnish illustrations of one extreme of the many variations presented by the material thrown out by volcanoes during explosive eruptions; a series which includes scoria, clots, several varieties of volcanic bombs, and angular fragments, such as lava blocks, lapilli, volcanic dust, etc. This wide range in the products of volcanic explosions in reality presents an orderly sequence, dependent on the degree of fluidity, plasticity, or rigidity of the material at the time it was blown into the air.

If the material forming the summit portion of the column of lava within the conduit of a volcano becomes rigid before steam explosions beneath cause it to be fractured, and the fragments blown into the air, angular blocks of lava, lapilli, dust, etc., are produced. If the material is plastic or viscous, clots may be blown out, and cool as scoriaceous masses, or so-called cinders, which have rough, irregular, but not fractured surfaces. If such clots are projected high in the air and cool while rotating, bombs result. Should the lava be still more thoroughly fused at the time it is projected into the air, it may still be liquid on striking, and form lava cakes, or even spread over the surface and, additional material of the same character being supplied, form tile-like sheets. This entire sequence is admirably illustrated by the projectiles which accumulated to form the Cinder Buttes.

The occasional presence of balls of dense lava on the surfaces of lava flows, described by J. D. Dana in the case of certain lava streams in the Hawaiian Islands, and observed by me in Idaho,† as well as the presence of analogous spherical masses of lava in the crater walls of certain of the Cinder Buttes, suggest, as a tentative hypothesis, that during the boiling of lava in a crater, masses of fused rock may become cooled, and, owing to the rotation produced by the movement of the molten or plastic material about them, acquire a spherical form before being blown out or carried away by outflowing lava. The compact, rough-surfaced, spherical balls sometimes found about volcanoes appear to have originated in some such manner, and not from the rotation of plastic material projected into the air.

The sequence of events in the history of the Cinder Buttes, as recorded by the accumulations of projectiles still remaining and by the extensive lava flows which were discharged from the same volcanic vents, is briefly as follows: The eruptions in a large number of instances began, so far as can be judged from the evidence now available, with explosions which caused considerable quantities of cool and rigid lava in the form of lapilli, dust, etc., to be projected into the air. Later came similar violent discharges of plastic lava which formed scoria and volcanic bombs, and later still, liquid lava was ejected. This fell before cooling, and spreading over the surface when it struck formed lava cakes. Following these explosive discharges, or accompanying the later ones, great volumes of highly liquid lava were poured out. This lava was extruded quietly and flowed over the surface of the surrounding plain so as to form sheets many square miles in area. The close of the eruptions, in several instances at least, was not characterized by a return of the conditions which produce explosions, but the outflow of liquid lava decreased gradually and finally ceased, the craters being left with nearly level floors of highly vesicular rock having the surface characteristic of *pahoehoe*.

Lapilli Cones, Cinder Cones, etc.—The term cinder cone is commonly used to designate the piles of projectiles which have accumulated about volcanic vents, irrespective of their precise character. While the cones and craters referred to are in general composed of irregular scoriaceous masses of lava, usually referred to as "cinders," it will be seen from the brief description given above of the wide range in the nature of the projectiles of which they are composed that several varieties of "cinder cones" should be recognized.

When angular fragments of hard lava, such as blocks of rock, lapilli, dust, etc., are blown out of volcanic vents, they usually fall about the opening from which they come and accumulate in a conical pile with a depression or crater at the summit. The outer slopes of these cones frequently form angles of 30 deg. to 35 deg. with a horizontal plain, the angle being essentially the angle of repose of the fragments of which they are built, but their profiles are concave instead of straight lines. The reason for the downward curves presented by the sides of such cones is not definitely understood, but seems to depend on the fact that the structures are built of fragments of different sizes and

* Bull. U. S. Geol. Survey No. 199.
† Bull. U. S. Geol. Survey No. 199, p. 114.

shapes. Vertical sections through such piles commonly show, as is well known, two series of beds, one series dipping away from the crater in the summit, and forming the outer slopes of the cones, and the other series dipping from the rim of the crater toward its bottom. The junction between these two series of opposite-dipping beds in the rim of a crater is not a sharp angle, as sometimes represented, but a curve, convex upward. The cones referred to are symmetrical when built of fragments projected vertically, unless the influence of the wind in carrying the material in one direction more than another made itself felt. Cones or craters built of angular fragments with surfaces produced by fractures are sufficiently distinct from the similar structures built of other kinds of projectiles to be specially designated, and may with propriety be termed *lapilli craters*, or lapilli cones in case a depression in the summit of the pile is absent.

When the material projected into the air from a volcanic vent is plastic, and falls in irregular clots and rough scoriaceous masses, it frequently forms steep-sided piles with chimney-like openings within. Owing to the frequently large size of the masses which fall, their rough surfaces, and also to the fact that they are in many instances still plastic when they come to rest, the slopes of the structures produced, both on the outside and within, are commonly steep, and in some instances are nearly vertical, but the outer slopes of these hollow piles are normally less steep than the walls of the openings within. Piles of congealed clots of this nature present several instructive variations. At times they are steep-sided chimney-like forms, such as are illustrated in Fig. 1. In other instances their encircling walls are contracted at the top so as to leave only small openings, and in extreme examples of this nature a complete roof is formed by the adhering of the clots blown out, and a beehive or oven-like structure results. The chimney-like elevations produced in the manner just referred to have been designated driblet cones by J. D. Dana, but for the entire series of cones, craters, etc., built of scoriaceous or cinder-like clots of lava the term cinder crater or cinder cone seems appropriate.

For the sake of avoiding a lengthy discussion of the classification of elevations produced by the accumulation of volcanic projectiles about the vents from which they were blown out, I may briefly state that in certain instances well-characterized volcanic bombs form the greater portion of an elevation with a crater in its top, and in some instances similar elevations are composed principally of lava cakes formed, as already explained, by the cooling of splashes of liquid lava after coming to rest. Examples of cones or craters formed exclusively or in large part by the two methods just cited, however, are so rare that special names for them do not seem to be necessary.

It frequently happens that a volcanic hill or mountain is composed of projectiles of all the classes considered above, as, for example, when large angular blocks of lava are ejected, together with lapilli and dust, and at some time in the life of the volcano plastic or liquid lava is blown into the air and forms scoria, bombs, lava cakes, etc. Such composite cones or craters built of the products of explosive eruptions are illustrated by several characteristic examples among the Cinder Buttes.

There is one feature of lapilli and scoria cones which does not seem heretofore to have attracted attention. Interbedded with the fragmental material in the walls of such craters there are sometimes irregular sheets of compact and usually reddish lava, ranging in thickness from a few inches or less to many feet, and presenting all variations in extent from a few square inches to several hundred square yards, and resembling true lava flows. These compact layers occur both in the outer and inner slopes of a crater, and at times a single bed in one part belongs with the steeply sloping layers of the inner cone, and changing its dip in the part beneath the crater's rim, passes into the outward-dipping series of beds. As may be seen at the Cinder Buttes, such beds of compact lava sometimes contain scoriaceous masses, and on their edges become thin and terminate irregularly in accumulations of lapilli or scoria.

The range in size of the compact beds just described, the presence in them of the scoriaceous masses, and the manner in which they terminate, etc., show that they are due to an accumulation of liquid or highly plastic splashes and clots of lava, which united one with another as they fell. In harmony with this explanation is the fact that in many instances a sheet of lava of the nature under consideration is completely inclosed in lapilli or scoria. In sections of lapilli and scoria cones to be seen among the Cinder Buttes numerous examples of interbedded sheets of compact lava may be seen which are due to the running together of liquid or highly plastic splashes and clots in the manner just explained, and similar occurrences were seen elsewhere, particularly at the Jordan Craters described below.

The notes presented above are intended as a supplement to the more general account of the Cinder Buttes contained in Bulletin No. 199 of the United States Geological Survey, and I trust will be followed by a detailed survey of that unique region. In the publication just referred to, several isolated craters and groups of craters situated in southern Idaho are described, and the list of these recent volcanoes is here extended by an account of three similar centers of eruption in southeastern Oregon.

(To be continued.)

ACTION OF ANÆSTHETICS ON PLANTS.

It not unfrequently happens that the passer-by in autumn is startled to find horse-chestnuts and other spring-flowering trees producing a second crop of flowers. A similar occurrence is not infrequent in pear or apple trees and in the common laburnum. This autumnal flowering is due to one of two causes. In some cases after the flowers have been produced on the "old wood" or on short "spurs," the Kurztriebe of the Germans, formed in the previous autumn, other flowers are produced on the long shoots of the present year. The difference in the general appearance of a tree producing its flowers on the "spurs" and of one where the blossoms are produced on the "extension shoots" is often greater than that observable between distinct species, and yet, of course, there is no specific difference between them. The autumnal production of flowers on the yearling shoots is generally assigned, but in a vague, indeterminate fashion, to changes in external conditions. Be that as it may, there are some varieties such as the Napoleon pear which every year behave in this fashion. The operations of pruning are regulated by the way in which the buds are produced on the old or on the new wood of the year, so that the gardener has to take cognizance of appearances which might be, and indeed are, generally ignored by the systematic botanist.

Another cause of autumnal flowering is due to precocity or anticipation. This is the matter which in particular has suggested this note. The flower buds are formed in their usual place, but, for some reason or other, growth and development are hastened, and the flowers which in ordinary circumstances should unfold in the following spring are seen to expand in autumn.

In one of the squares in Paris last autumn the whole or the greater part of the horse-chestnut trees were in bloom, young foliage being interspersed among the flowers. On closer examination it was seen that the older leaves had almost all fallen prematurely or were shriveled up as if the roots had been deprived in some way of their necessary supplies of water. Similar instances of autumn flowering are familiar to observers, and they seem generally to be due to summer drought, to removal at an unpropitious period, or to any cause which interferes with the normal course of nutrition. Allusion is made to these phenomena because they throw light on the experiments of Johannsen, of Copenhagen, who was the first to show the effect of ether vapor in hastening the flowering period of various shrubs. The action of the vapor of chloroform and that of ether in arresting the movements of the leaflets of the sensitive plant (mimosa) have long been known, but the action has been considered to be purely local.

Matters were in this state when Johannsen pushed his experiments further, and in a different direction, and proved that the flowering of lilacs could be hastened by exposure to the vapor of ether. He thought that if he shortened the resting stage of the shrubs during which their activity is dormant, he would be enabled to induce the earlier and more rapid production of flowers. Exposure to the vapor of ether he found arrested the growth of the plant and secured its earlier and more complete "rest." Johannsen's experiments have been repeated on a large scale in Germany and in France, the general method of procedure being the following: In a case as nearly air-tight as possible, the lilac bushes are placed at a temperature of about 65 deg. F. Light is excluded. From the top of the case is suspended a small cup into which the ether is poured by means of a funnel through an aperture, made for the purpose, and immediately closed. Owing to the explosive nature of the vapor the greatest care must be taken to avoid the presence of any flame. Thirty or forty grammes of ether are enough for a hundred cubic liters of air. The plants are subjected to the influence of the vapor for forty-eight hours. On their removal from the ether chamber the leaves fall, if they have not already done so. The plants are then removed to a cool house and gradually subjected to forcing in the ordinary manner.

By these means the expansion of the blooms is hastened, the etherized plants producing their blooms several days before those treated in the ordinary manner. The gain of a few days is a matter of great importance to the grower for market in the winter season, as he gets so much better a price for his goods. Moreover, the cost of fuel is reduced, for the same amount of heat is not required for forcing, as we have seen that the time required is diminished. Not only lilacs, but many other flowering shrubs have been experimented upon, and with such good results that the process has been adopted on a large scale, and in our own country Mr. Jannoch has, we learn, adopted the plan with most successful results.

A writer in the Jardin of January 20 narrates how he exposed plants of lilacs to the vapor of ether in the manner above described on December 7, removed them to the greenhouse on December 9, and on January 1 the flowers were sufficiently expanded for use in the decoration of his apartments. Other varieties followed at a few days' interval. *Spiræa thunbergii* etherized on December 7 was in full bloom on December 24.

M. Minier, who made these experiments, placed his apparatus in a temperature of 13 to 16 deg. C., and the plants were subjected to the ether vapor for forty hours. They were afterward placed in a house where the temperature ranged from 13 to 16 deg. C. at night to 15 to 18 deg. C. by day.

The photographs showing the contrast between the etherized and the non-etherized plants are very remarkable and bear witness to the value of the process in securing bloom in the dull season when the chrysanthemums are beginning to go off. It is noteworthy that the operation is most successful in November and December, and that if delayed until January the results are not so serviceable, as flowering plants can then be obtained in the ordinary way.

It is surmised that the anæsthetics act by causing the removal of the water from the protoplasm, thus drying it up to a certain extent and causing a suspension of its activity. Dr. Johannsen's observations are summarized in a *brochure* published in French by M. Maumené, and entitled "Nouvelle méthode de culture forcée des arbustes et des plantes soumis à l'action de l'éther et du chloroforme," Paris, 1903. Abstracts from these publications have been given in various Continental and English horticultural journals, particularly in the October part of the Journal of the Royal Horticultural Society, which contains a paper on the subject by M. E. Lemoine, of Nancy, to which reference may be made for fuller details.—Nature.

A NEW INVENTION FOR RENDERING VESSELS UNSINKABLE.*

By HERBERT C. FYFE.

A FEW days ago the writer formed one of a party which journeyed from London to Southampton Water in order to witness on board the Hamburg-American liner "Deutschland" the first public demonstration in any country of the new Stone-Lloyd hydraulically-controlled marine safety bulkhead doors for rendering vessels unsinkable.

This system, which is now being fitted on several of the largest and swiftest mail steamers in the world, is the invention of a Scotchman, Mr. G. C. Ralston, and the patents are controlled jointly by Messrs. J. Stone & Co., of Deptford, and the Norddeutscher Lloyd.

The invention has been adopted on the German vessels "Deutschland," "Kaiser Wilhelm II.," "Kronprinz Wilhelm," "Bremen," "Barbarossa," "Friedrich der Grosse," "Königen Luise," "Necker," "Roon," "Zeiten," "Seydlitz," "Gueisenan," "Schleswig," etc., and on one British boat plying between Holyhead and Dublin.

On some of these ships it has been installed for some little time, and frequent and severe tests are made almost daily on board, to prove the reliability and usefulness of the system. Not until it had been thus thoroughly tried on a practical, everyday working scale on large vessels was it shown to the guests invited by Messrs. J. Stone & Co. on board the famous liner "Deutschland," whose record of 23.51 knots across the Atlantic has never been surpassed. All the underline doors on the "Deutschland" (twenty-four in all) have been fitted with the system, and now all the passenger steamers owned by the Hamburg-American and North German Lloyd companies are being fitted with it. The Stone-Lloyd system can be fitted to any vessel which is provided with bulkhead doors. Its advantages are: The very short time in which all the doors can be shut from the bridge; the lever arrangement on each door, by means of which any of the crew can make their escape; the automatic system, which closes all doors in the damaged compartment on the inrush of water; and finally the fact that hydraulic power is used.

In this system the automatic principle is applied for the first time in connection with the closing of bulkhead doors; it is very much quicker in its action than any previous system, and the inventor does not claim too much when he declares that a ship fitted with his apparatus would be unsinkable. It is pointed out that the extra cost would be saved over and over again in a few years by the reduction in the cost of insurance. The interest on the extra first cost of the apparatus (in the case of the "Deutschland," where some three miles of piping were used, it was £10,000) should not amount to anything like as much as the annual saving in cost of insurance; so that ship owners, instead of being out of pocket by adopting the system, should be actual gainers in the matter. Passengers will naturally prefer to travel in unsinkable ships.

For the following details relating to the working of the apparatus we are indebted to Mr. G. C. Ralston, the inventor. The officer of the watch can, in case of threatened danger, simultaneously close the whole of the bulkhead doors throughout the vessel, and render her practically unsinkable, by simply opening a small hydraulic valve on the bridge or in the captain's cabin, an electric gong in each compartment being set ringing for about ten to twenty seconds before the doors commence to close, so as to give the crew due notice. In order to provide for the escape of any of the crew who might be shut up in one of the compartments when the bulkhead doors were closed, the apparatus is designed in such a way that any one so situated can operate a lever on the particular door which bars his exit, which door will then open, allow him to pass through, and afterward automatically close behind him. (This provision effectually disposes of any desire there would otherwise naturally be on the part of the crew to tamper with the arrangement if there were no ready means of escape provided for them, should they be shut in a compartment when all the doors had been simultaneously closed from the bridge.)

Should a collision take place, or the vessel strike upon a rock, and the officer of the watch fail from any cause to close the bulkhead doors, then the inrush of water into the damaged part of the vessel would at once cause a float to rise, which would automatically operate a valve in connection with the bulkhead doors

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

in the immediate vicinity of same and cause them to close, so that the damaged compartment of the vessel would at once be automatically shut off from the other compartments, and the vessel would thus be rendered perfectly safe. Further, after a door has been closed by this action, it cannot be operated from the bridge until the compartment is cleared of water, but the door can be opened by hand from either side of the bulkhead.

Each door can also be opened and closed from the deck, as well as from the inside or outside of the compartment, and can be operated by means of ordinary mechanical hand-gear, as well as automatically.

The inventor chose hydraulic power because it was simple, reliable, absolutely free from danger, easily understood, and readily reparable when out of order by any ordinary workman, and therefore the most suitable for ship purposes.

His experience fully confirms the official report of the German committee of experts appointed to consider the motive power to be employed on German vessels for the opening and closing of bulkhead and other doors.

A few extracts from this report may be given.

STEAM.

"This should, under no circumstances, be used as a motive power in the opening and closing of bulkhead doors, because of the dangers attached thereto. In the event of one of the pipes breaking, the room in which this may be is rendered inaccessible, and there is always a danger of some one being scalded."

that the discipline of the crew might be unfavorably influenced. This objection, however, may be met when we consider that any such reliable apparatus challenges at all times the conscientious discharge of a man's duty. From a technical point of view, a reliable mechanical arrangement for the opening and closing of bulkhead doors, from any one or number of points in the vessel at the same time, whether singly or any number together, must recommend itself to the consideration of those engaged in the construction of vessels, and more especially to those who make laws for the safety of life and property at sea; a point not to be forgotten is the tactics which can be exercised, by the aid of a reliable mechanical power, in the opening and closing of doors on board men-of-war."

The plans here reproduced show the system as fitted on the "Deutschland" and "Kaiser Wilhelm II."

On the "Deutschland" pressure is supplied to all the doors by a pressure-main running the whole length of the ship, and which is in communication with four capacious patent steam hydraulic accumulators, of entirely novel design, and which are of sufficient capacity, when fully charged, to supply pressure of 500 to 700 pounds per square inch, to close twenty-four doors, and to open and close a group of eight doors, even should the pumps be stopped. The accumulators and pressure-main are charged by a powerful duplex, long-stroke, slow-speed, hydraulic pressure-pump, which is capable of supplying pressure to close all doors in 10 to 15 seconds without the accumulators.

The hydraulic pump draws from a 500-gallon tank,

The exhaust main, which runs the whole length of the ship under the floor plates, exhausts from a 200-gallon tank in the engine room, from which a small auxiliary pump is also available for pumping at high pressure into the hydraulic pressure-main.

The joints in the whole of the mains, cylinders, etc., are especially prepared to withstand high pressures, and will last for years without renewal.

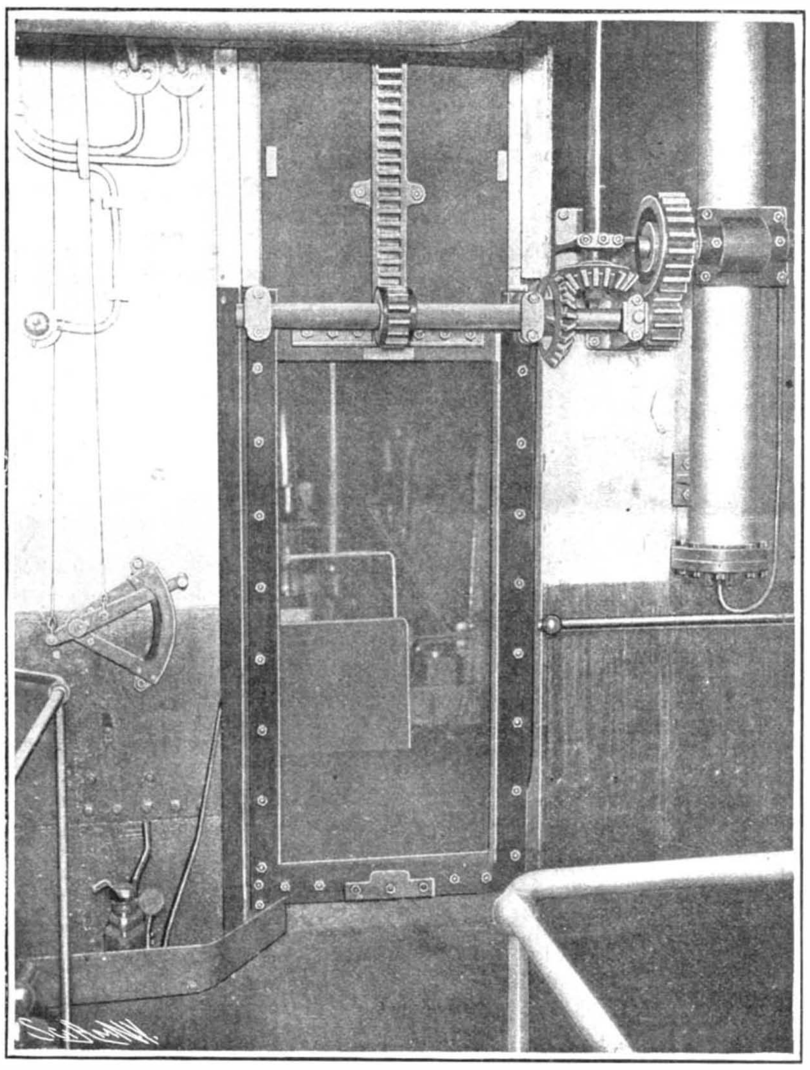
The pressure fluid consists of three parts of water to one part of glycerine, which prevents freezing and consequent bursting of pipes, and acts as a lubricant to bearing surfaces, and also as a preservative to leathers, packings, and joints.

The temperature of the mains, which in many cases pass across the top of the boilers, and in close proximity to steam pipes, is kept down by constant circulation.

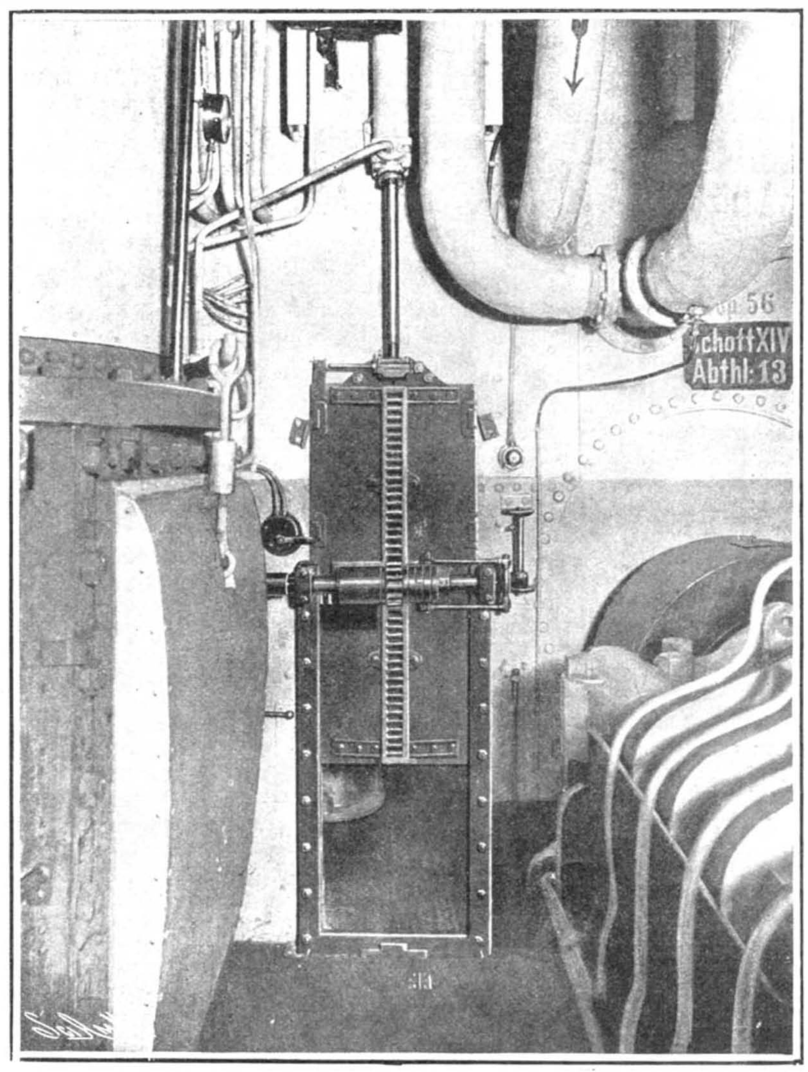
The arrangement, as fitted in the Norddeutscher Lloyd's mail steamer "Kaiser Wilhelm II." and illustrated, consists of a hydraulic pressure main running the whole length of the ship, the pressure in which is maintained by means of an accumulator charged with compressed air and water by pressure pumps, one of which pumps air, and the other water, which it draws from a tank into which the exhaust from all door cylinders is connected.

The pump, tank, and accumulator are placed above the waterline, thus insuring the closing of the doors, even should the compartment containing the pump, etc., be flooded.

Instead of an accumulator, pressure may be taken from another source, such as from the feed pumps.



THE DOOR WIDE OPEN.



CLOSING THE WATERTIGHT DOOR.

THE VERTICAL, SLIDING, WATERTIGHT, BULKHEAD DOOR OF THE "DEUTSCHLAND."

ELECTRICITY.

"Against the use of electricity there are various objections. In the event of the conducting wires becoming damaged, there is always a danger of fire breaking out; also in the event of the motors or engines being stopped or started quickly, sparks may unexpectedly cause the contacts to become useless; further, any great over-pressure of the installation may easily bring about an interruption of the current, and melt the safety plug. Under similar circumstances, a steam engine or hydraulic apparatus will come to an immediate standstill. The greatest objection, however, to the use of electricity is the great difficulty, even for an experienced hand, to detect any interruption or breakage of installation or of the conducting wires. For economical reasons, too, steam, compressed air, and hydraulics are to be preferred to electricity."

COMPRESSED AIR.

"The expense in providing the air pumps does not in any way recommend this means as a motive power in such instances."

HYDRAULICS.

"This is certainly one of the cheapest and most reliable motive powers for working any kind of safety apparatus from a distance. Hydraulic machinery can be applied as a direct motive power. It is noiseless in action; cheapness, safety, speed, and power are combined in it; and on board vessels it is highly advantageous for driving supplementary engines.

"There may, perhaps, be some objections to the use of any automatic mechanical power in the opening and closing of bulkhead doors, the chief of which may be

which, together with the pump and accumulators, is above the waterline, thus insuring that the hydraulic installation shall not be stopped if the water should rise in the compartment in which pump, etc., is situated.

A branch from the pressure-main rises to the bridge, and the pressure can there be turned, by means of a distribution box, into either of two smaller pilot mains, running the whole length of the ship, one for operating the controlling valve at each door to close the door, and the other for opening same.

Each door is fitted with a hydraulic differential cylinder of area sufficient to close the door with a force of from 30 hundredweight to 2 tons (or more if desired), and the area of the opening cylinder is such that a greater force is available to open the door.

Each door is fitted with Stone's patent hydraulic controlling valve, to which is connected the main pressure-pipe, and also the opening and closing pilot mains; connections are also made to each end of the cylinder for respectively opening and closing the door to the exhaust main, and also to Stone's patent automatic bilge float valve for closing the door of a compartment on the rise of water on either side.

The valve may be operated to open or close the door from a handle fitted to both sides of the bulkhead, and the door will remain in the position corresponding to the last movement of the handle; but if either of the pressures to open or to close all doors is on from the bridge, the door will automatically open or close corresponding to the bridge pressure, or if the automatic bridge float valve is acting, the door will automatically close.

The accumulator supplies pressure, by means of a main, to the bridge, whence it is diverted by means of a four-way cock into two other mains, used respectively for opening and closing all doors, by operating the valves accordingly, and supplying pressure to the hydraulic cylinders.

An exhaust main is connected to all the hydraulic cylinders, and discharges into the tank from which the pressure pump supplies itself.

If the four-way cock on the bridge be closed, i. e., if all doors be closed, each door of the ship, if required, can be opened or closed from below, to enable men to escape from the damaged compartments.

Our photographs show the new, vertical, sliding, watertight bulkhead doors—Stone-Lloyd system of hydraulic gear—on the "Deutschland" and "Kaiser Wilhelm II."

The right-hand picture shows the door open on the "Deutschland." The hydraulic cylinder on the right drives the door shaft by powerful spur gear, the bevel wheels being in connection with the hand gear on the upper platform. The handle moving over a sector is duplicated on the other side of the bulkhead, and operates the controlling valve on the upper platform by steel wire cords.

The left-hand photograph shows the door on the "Deutschland" half open. These doors can be stopped and maintained in any position so long as the pressure is not on from the bridge, or from the automatic bilge float valve.

If desired, as in the case of filled coal bunkers, the automatic and bridge control can be taken away from

these doors by closing a valve; or the opening action can be taken away, so that the doors can be closed from the bridge or from the automatic bilge float, but only opened by hand when required for use.

The accumulators have been especially designed to meet the requirements of hydraulic installations working at high pressure, and are intended to close all doors should the pumps for any reason be stopped.

Separate cylinders are used for steam and water, and these are separated by an air-space, preventing the heating of the pressure fluid; the rams are entirely separate, and are connected by steel tie rods. Owing to the free circulation of air between the cylinders and the complete separation of the rams, the water cylinder cannot become heated.

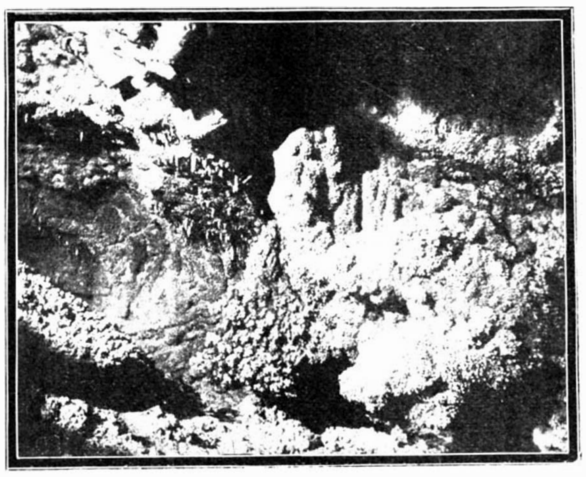
THE CRYSTAL CAVE OF SOUTH DAKOTA.

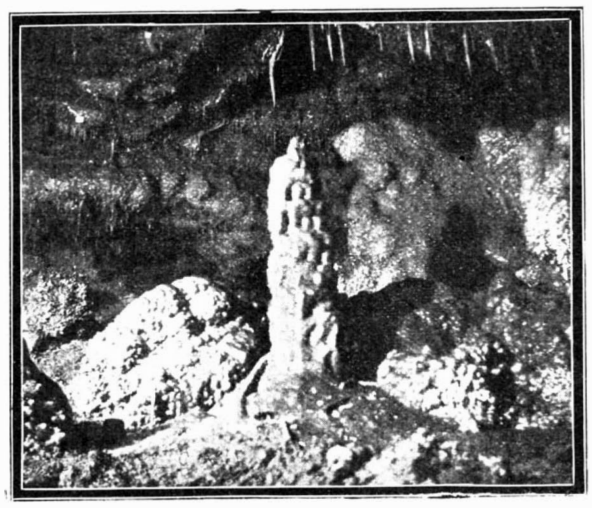
By Edmund Otis Hovey.

Visitors at the Columbian Exposition at Chicago will recall a unique exhibit, which was installed within an artificial mound beneath the great dome of the Horticultural Building. Rooms and passageways were fitted up with a lining of crystallized calcite from caves in South Dakota, and the whole was called the reproduction of the Grand Crystal Cave of the Black Hills. The formations displayed in this artificial cavern were not those of the stalactites and stalagmites familiar to cave visitors the world over, and the writer determined to see for himself the locality which had furnished such peculiar cave specimens. The opportunity, however, did not come for several years, but when it came it was seized, and the experience well repaid the effort. Rumor stated that the cave had been completely despoiled of its beauties for the purposes of the exhibit at the Chicago Exposition; fortunately, this is only partly true. Much was taken from other caves in the vicinity, and the original cavern still possesses a large part of its pristine attractiveness.

Crystal Cave is situated in the Carboniferous limestone bordering the wild canyon of Elk Creek in Lawrence County, South Dakota. It may be reached easily by the narrow-gage road running through the canyon from Piedmont on the Fremont, Elkhorn and Missouri River Railroad to Lead, the famous mining town on the High Line of the Burlington Railroad. The cave is beneath the McBride ranch, and accommodations for a protracted sojourn can be obtained at the ranch house, if desired, but the whole trip, including all that one wishes to see of the cave, can be made easily in a day from either Piedmont or Lead.

The original entrance to the cave was through an opening in the vertical wall of the canyon. This was so difficult of access that Mr. McBride has blasted a passageway to one of the upper chambers, so that one goes into the cavern almost on a level from a point near the ranch house. This entrance is much less picturesque than that in the canyon, but it is far more practical. Entering the cave then on our tour of exploration, we find ourselves in a few moments at the intersection of the new way with the gallery leading from the old entrance. This receives the name of the Vegetable Room, on account of the use to which the expansion of the gallery is put during the long winters. Turning at once to the right, we encounter almost immediately the Fat Man's Misery; every cave must have such a name attached to some one of its tortuous passages. Here the feature is an unimportant one, serving to discourage only the least ambitious of would-





Photos by S. Mascovich.

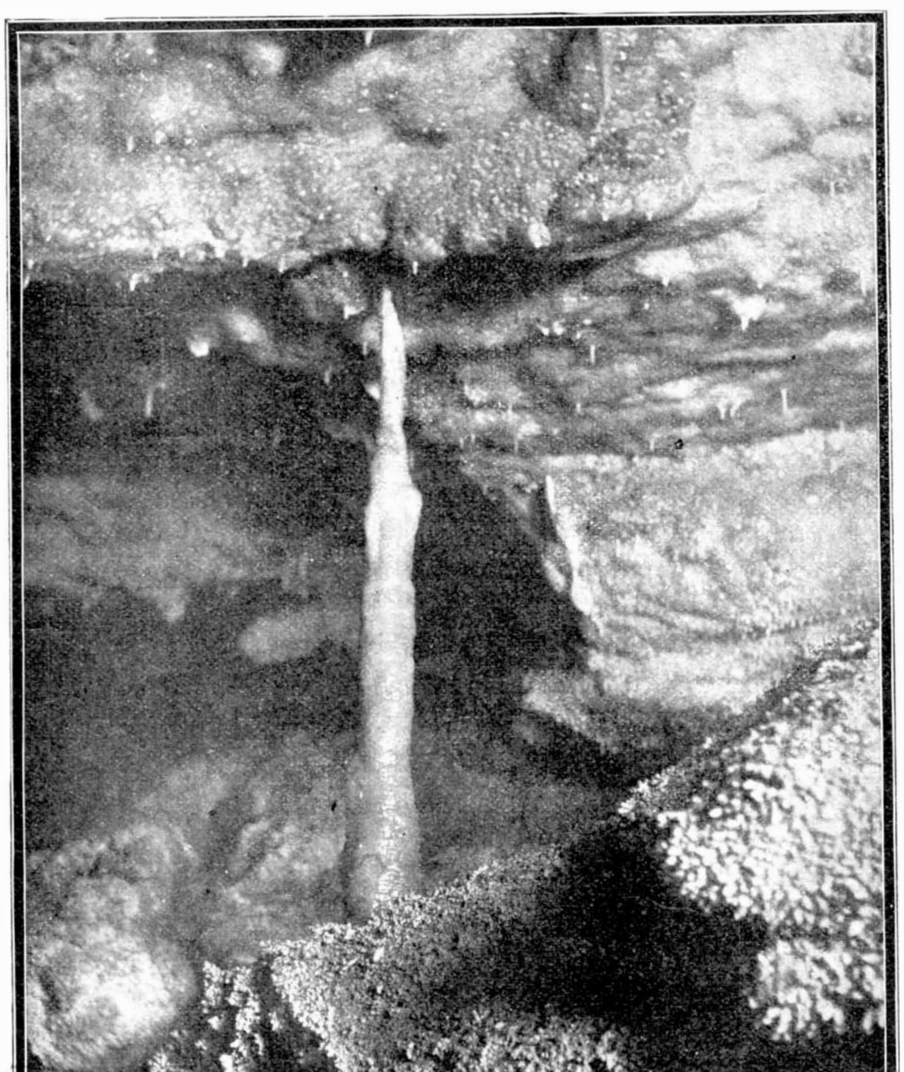
TOWER OF BABEL (IN THE ABODE OF THE FAIRIES).

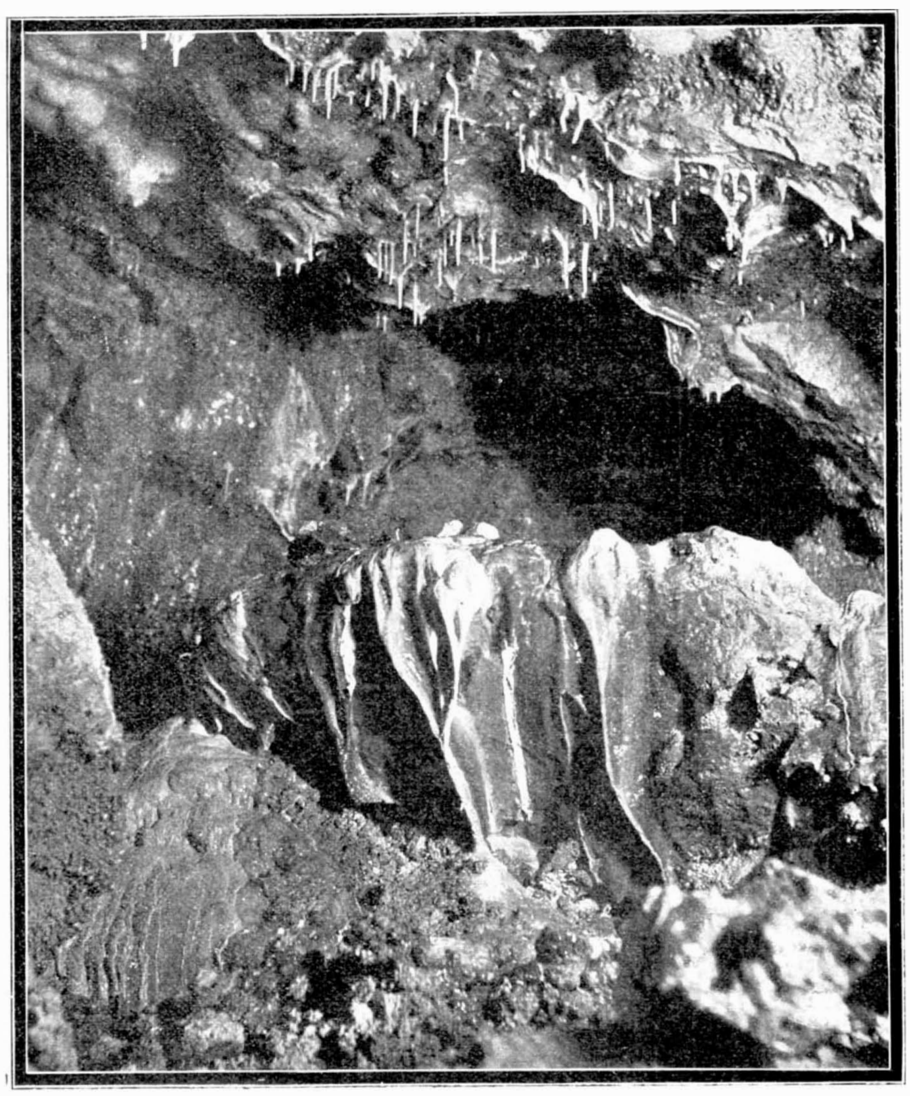
be cavern explorers. From it we emerge into the Mold Room, which has received its name from the long tufts of beautiful silky mold which adorn some old boards and timbers which have been in the cave for years. The crystal lining of the walls is an earnest of what is beyond. In the Seal Room weathered limestone forms are fantastically referred to these animals for resemblance.

Beyond the Seal Room one hurries stooping along over Poverty Flats, a broad, low, shelving passage named from the total absence of crystals, and goes down Bunker Hill by means of wide, natural steps into the Pyramid Room. Some "box-work" is encountered here, which reminds one of the formation which is so abundant at Wind Cave in the southern part of the Black Hills, but this is coated with crystals of dog-tooth spar, while that at the Wind Cave is covered with little balls resembling popcorn. The box-work itself is due to the nature of the limestone forming the country rock. This rock is intersected in all directions by thin veins of impure calcite, which are harder than the rock itself and resist erosion better. Around the walls of the cave the limestone disintegates and runs out from between the calcite veins, leaving angular cavities, which go by the name of "boxes," and the aggregate of these boxes is called "box-work." The subsequent action of the waters has been to coat the walls of the boxes with botryoidal granular calcite at Wind Cave, and with dog-tooth spar at the Crystal Cave. At the farther end of this room great slabs of rock have fallen from the ceiling, and lie about in the greatest confusion. Some of these form the "Pyramid," which gives the room its name. Beyond the Pyramid Room we are shown the Flower Garden, whose wealth of calcite crystals shows that we are getting past the more accessible parts of the cave, which suffered so much at the hands of vandals. Through the Needle's Eye one crawls laboriously on hands and knees for fifteen feet to reach Gorgal Hall. The proverbial camel would have a hard time of it reaching this pretty region.

From Gorgal Hall, Rocky Run leads into the Bad Lands. Rocky Run is hard to traverse, on account of the great slabs of limestone which lie piled in confusion upon the floor. These slabs as well as the walls and ceiling of the gallery are coated with thickly set crystals of dog-toothed spar. Box-work of coarse type abounds. The Bad Lands consist of limestone worn into shapes which remotely suggest those which one encounters in the famous region of clays east of the Black Hills. A sharp turn brings us again into the Pyramid Room, but at the end farthest from where we first entered and left the hall. Word is given to extinguish our lights, and as soon as our eyes become accustomed to the intense darkness, we perceive that a glow as of subdued moonlight suffuses the Pyramid, and we can hardly persuade ourselves that we are hundreds of yards within heavy beds of limestone, and that we are not gazing upon some weird scene in an elfin canyon in the open.

Continuing our journey after a brief enjoyment of the artificial moonlight, we soon find ourselves in Red Hall, a large room which is characterized by areas of red limestone, showing where the coating of dog-tooth spar has peeled off. Going nearly to the bottom of this room, and then ascending through a low passageway where all the party except Ivan McBride, the sturdy two-and-a-half-year-old son of the proprietor,





Photos by Cross.

CLEOPATRA'S NEEDLE. RIBBON ROOM.

THE CRYSTAL CAVE OF SOUTH DAKOTA.

have to stoop to care for their heads, we enter the city of Notre Dame. This is a room 100 feet long, 50 feet wide, and 30 feet high, which is ornamented by heavy box-work on the ceiling, which is so thick as to look as if the room were hung with blankets in heavy folds. Calkins Gallery, which is separated from the last hall by a narrow ridge, shows bare wall and ceiling of red and white limestone, with here and there a patch of the coating of calcite crystals, but the general barrenness is much relieved by the numerous cavities in the walls, which are lined like geodes with exquisite assemblages of small crystals. On the floor of this room there lies the largest aggregate of crystals in the cave. It is about twelve feet long and ten feet high, and rests upon the floor. At the end of the gallery the guide calls our attention to the Swiss Cottage, perched in picturesque manner upon a projecting shelf of the cliff. Nature has built the cottage from platy masses and crystals of calcite.

Leaving Calkins Gallery, which is about 125 yards long, we climb through a long passageway in which is the Whale, an elongated block of limestone with a crystal-lined cavity for a mouth, and enter the Eagle Room. Here fantastic shapes meet the eye on all sides, carved out of the solid rock by the erosive forces, or outlined by crevices or discolorations on walls or ceiling. The best of these are the ones known as the American Eagle and the Elephant. The latter is six feet long, and is hung by his back from the ceiling, presenting a curious appearance. Rip Van Winkle's Stairway leads from the Eagle Room down a crevice twenty to thirty inches wide through sixty to seventy-five feet of vertical descent to the First Water. It is a rough scramble, requiring the aid of hands and knees as well as feet to make progress. The whole crevice is lined with gleaming crystals, and there is heavy box-work at the top; it is a fairies' passageway. Beyond the First Water, which is said to be about two hundred feet below the entrance, a crawl of fifty yards through the Brick Oven brings us to the Dripstone Paradise, where we first encounter stalactites in the cave. The stalactites are small but numerous, and look very pretty as they hang from the ends of crystals. Evidently they are subsequent to the crystals in formation. There is some "popcorn" work on the bottom of this room, and in places stalagmites have grown upward from the floor to join the stalactites. In the Coral Room beyond we come upon a little stream of limpid water coming out of the darkness, and flowing forever toward some unknown outlet.

Traversing the Red Flats, where there are beds of red residual clay, we enter the Lake Room, containing a large pool of water. In one corner of the room are the Chimes, which are some small stalagmo-stalactites upon the edge of the shelf, constructing a fairy grotto with a musical screen. The beauties of the cave increase as we push our investigations farther, but we must always work for our enjoyment, and our trials doubtless add to our pleasure, at least in retrospect. The Abode of the Fairies is at the end of a twenty-five-foot crawl. Here slender stalactites abound, and stout stalagmites add to the picturesqueness of the scene. The Tower of Babel in this grotto is a stalagmite about three feet high and ten inches in diameter at the base. It is fluted and storied like its ancient prototype. Cleopatra's Needle is a slender column composed mostly of stalagmite, rising from the crystal-coated floor and meeting a tiny stalactite depending from the roof. The Needle is five feet long. The Bridal Veil, another feature of this room, is a thick, translucent stalagmite formation, which looks like a frozen waterfall. In the pools near by one can see the process going on, which on a larger scale filled the cave with its beautiful crystal lining. In another part of the cave the stalagmitic growths have formed what is known as the Rocky Mountain Range. Looking at the ceiling here, one sees that the numerous crevices have determined the lines along which the growth has taken place. In the Ribbon Room a series of stalactites has formed on the very edge of a limestone ledge, and the water as it has continued its downward course has caused the continuation of the stalagmites in ridges or "ribbons" to a lower level.

When one compares this cave with its more frequented neighbor in the Southern Hills, the Wind Cave, he notes several interesting points of resemblance and difference. Both caverns have been excavated from the heavy carboniferous limestone, which forms such an important geological feature of the Black Hills region. Both have been developed in numerous levels, one below another. Eight such levels are made out distinctly in the Wind Cave, but the number in the Crystal Cave is probably not so great. Large imposing rooms, such as those which characterize the Indiana and Kentucky caves, are absent from these Dakota caves, although extensive galleries are found in both the Wind Cave and the Crystal Cave. Both caves are lined almost completely with a coating of calcite, which in the Wind Cave takes the form of botryoidal crystalline aggregates, while in the Crystal Cave the lining consists of small crystals of dog-tooth spar crowded closely together. It seems probable that in both caves the lining is the result of deposition from highly-charged calcareous waters, which filled the caverns after their excavation, the circulation or exchange of water being so slow or gradual as not to interfere with the uniform deposition of calcite on floor, walls, and ceiling of the rooms. Subsequently the caves were rapidly drained of this water, and now Wind Cave is remarkably dry, while Crystal Cave contains but little water. A noteworthy feature of Wind Cave is the practical absence of true dripstone formations, that is, stalactites and stalagmites, except from the uppermost tiers. In Crystal Cave, however, there is considerable stalactitic and stalagmitic ornamentation, which is best developed in the lower tiers of the cavern. The strong wind which is so noticeable at the Wind Cave, and from which that cavern derives its name, is less perceptible at the new entrance of the Crystal Cave; but in the vertical crevice, known as Rip Van Winkle's Gallery, in the latter cave, one feels a strong upward draft of air. Extensive dripstone formations are not to be expected in a region like the Black Hills district, for the reason that the annual rainfall is comparatively slight, and the area of the limestone exposed to the superficial waters is comparatively small.

There are many other caves in the Black Hills region, but Crystal Cave and Wind Cave are the largest and most highly ornamented of any thus far reported. They form two attractive features in a portion of the United States which has received from travelers less attention than its peculiar scenery warrants. The granite crags of the Harney Peak district, the rugged canyons of Elk Creek, Spearfish Creek, and other streams, the massive tower of the Mato Tepee in the Northwestern Hills, the laccolithic masses of igneous rock known as Little Missouri Buttes, Sundance Mountain and Bear Butte, and the gentle slopes of the Red Valley, which was known to the Indians as the Race Course, taken in connection with the gold mines of several types which have been developed in the hills within the past quarter of a century, form a series of attractions which each year is arresting more and more the attention of the tourist.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Oil Cake and Corn in France.—Oil Cake.—During 1902 France imported 109,260 tons of oil cake and meal of all sorts, against 116,968 tons in 1901 and 111,860 tons in 1900. The imports for the first eight months of 1903, 1902, and 1901 were 85,225 tons, 71,573 tons, and 72,639 tons, respectively.

A large portion of the imports comes from Russia, from which country, besides other kinds of oil cake, is imported a linseed cake very rich in oil, which is extracted in France by treatment with bisulphide of carbon. The receipts from Russia in 1902 were 39,362 tons.

The United States participated to the extent of about 20 to 25 per cent in the total importations of oil cake into France, the amounts received from the United States being 24,052 tons in 1902, 21,702 tons in 1901, and 27,736 tons in 1900. For the first eight months of 1903 the imports of oil cake from the United States were 14,320 tons, against 16,876 tons during the same period in 1902 and 11,952 tons in 1901. No classification is made in the custom house statistics of the different kinds of cake which come into France; but while more American corn cake has been imported this year, the quantities of linseed cake are probably about the same as in former years, and those of cotton-seed-oil cake considerably less.

As a result of the large increase in the supplies of oleaginous seeds the production of cake in France has augmented in a similar proportion. During the year 1902, 148,922 tons of the native product were exported, against 111,439 tons in 1901 and 98,521 tons in 1900.

Germany is the largest consumer of French oil cake, the exportations to that country in 1902 being 89,007 tons. Other countries to which the native product was sent are Belgium, Norway, and Sweden. France is obliged to do both an exporting and importing trade in oil cake, for the reason that large quantities of certain kinds of cake are produced annually which the French farmers are not in the habit of using for cattle feeding or fertilizing purposes, while the native production of the kinds which are in demand for local consumption is not sufficient.

Faulty Shipping.—American gluten corn cake is very much appreciated by the French farmer, and large quantities have been imported lately from the United States. So many bitter complaints have been received at this consulate in regard to the condition of the cargoes which have arrived here during the past few months, however, it is to be feared that there is great danger of losing the French market for this product. Of the 4,855 bags of American gluten corn cake which were discharged at Havre from the steamer "Dona Maria" during the first week in October, more than one-half were damaged. As the receivers had paid for the cake against documents, their loss was heavy. As this kind of cake is delicate and easily spoiled, the greatest care should be taken by the American exporter to see that it is properly prepared for shipment to foreign markets.

Corn.—The grain crop of France in 1902 being a good one, the importations of foreign cereals all showed a falling off as compared with the previous year.

The importations of corn also showed a decided decrease. They were 26,783 tons, against 70,642 tons in 1901 and 72,119 tons in 1902. Of the corn receipts the Argentine Republic sent 13,945 tons; Roumania, 6,137 tons; Turkey, 3,019 tons; and the United States only 3,684 tons, which was the total amount of American corn received in France, against 86,218 tons in 1901 and 119,672 tons in 1900. To the high price of American corn last year and to the abundant French harvests may be attributed, to a great extent, the falling off of the imports of our great cereal; but another principal reason was the wretched condition in which the grain arrived. Attention has been called to this matter in the last two annual reports of this consulate and in a special report dated May 7 last and published in Consular Reports for July, 1903.

During the present year the imports of American corn into France have increased. For the first eight months of 1903 they were 55,623 tons, against 3,682 tons during the same period of 1902. I am assured by the local grain dealers that had our corn been in better condition their purchases would have been much heavier. In fact, they suffered so much loss and annoyance from handling the American grain that they stopped buying it altogether. They also tell me that if the new crop does not come forward dry and in a healthy condition they will look to our competitors to supply their wants.

As foreign outlets are necessary for the sale of the surplus of our monster corn crops it would be wise for our grain shippers, commercial exchanges, and chambers of commerce to pay special attention to having American corn intended for foreign markets in good shipping condition before loading, and to require the steamship companies to make proper arrangements for transporting the grain after it is loaded.

It is to be hoped that the investigations which are being made by the United States Department of Agriculture as to the causes of deterioration of American corn, and the remedies for the same, will bear good fruit, and that our American grain exporters will realize the necessity of keeping up the standard of corn for foreign use, if they wish to hold the trade they already have or to gain new markets.—A. M. Thackara, Consul at Havre, France.

Trade Opportunities in Abyssinia.—The Welthandel (World's Trade), a supplement of the German Export Review, says that the organ of the manufacturers' association, Hand in Hand, calls attention to the fact that Abyssinia, in spite of contradictory statements of English newspapers, is to be considered one of the most important markets of the near future. The article is as follows:

"Some time ago the English papers spoke very disapprovingly of the question of exports from European industrial countries to Abyssinia, and gave it as their opinion that Abyssinia will not for a long time to come be ready for European exports. This is apt to prove false. Abyssinia is no longer an uncivilized country, and since the beginning of Emperor Menelik's reign, is on the way to become a country after the European fashion. Europeans are called in as heads of government departments, the silver monetary standard is being introduced, the establishment of branches of European banks is planned, and European merchants are induced to locate.

"A few months ago the first Abyssinian railroad from the harbor of Djibuti to Harrar was completed, and other railroads, financed by French or English companies, have been secured. The question of modernizing the trade of Abyssinia has become an actual one, and European industrial states, especially Austria and Russia, begin to interest themselves in a comprehensive export to Abyssinia.

"So far, France and England have almost a monopoly of the commerce with Abyssinia, and the thirty European firms in the Abyssinian capital of Adis-Abeba are dependent upon French and English products.

"At a meeting of Austrian exporters the opinion prevailed that in consequence of the desire of the people of Abyssinia, European exports thereto in almost all branches will become of great value, and that Austria, on account of her favorable ship connection from Trieste and of an old, although half-forgotten, commercial treaty with Abyssinia, would be in a position to overcome all competition if the respective ship companies would reduce their freight rates.

"Russia also has a favorable and quick ship communication from Odessa, and the visit of the Russian fleet to Menelik on the occasion of the opening of the Djibuti-Harrar Railroad was dictated by the commercial aspirations of Russia.

"So far, nothing is known of any similar steps on the part of Germany for the purpose of clearing the road for German exporters to Abyssinia, though Germany has the best chance for such exports, as her steamers for German Africa pass Abyssinia and therefore ship communication is already established."

The article further expresses the wish that German manufacturers will not neglect their opportunity, but seize it before the field is occupied by others.—Richard Guenther, Consul-General at Frankfort, Germany.

American Products in Turin.—Americans have the monopoly of the trade here in sewing machines, typewriters, and cash registers. I am often agreeably surprised to find many other American products in this market, such as radiators, printing presses, bicycles, stoves, cooking utensils, canned meats, and other articles of food. I have seen but one sample of crackers and am of the opinion that these, with the proper push, would find a good market here.

I have noticed considerable American machinery in this city and dealers speak in terms of praise thereof, but complain of the transportation cost to get it to this market.

A dealer showed me samples of American cut goods for the manufacture of shoes and told me that considerable quantities of such goods are imported into Turin.

A call on a chamber of commerce official resulted in the statement that while they had no official figures, it being too early in the year, he could say that in consequence of the advance in price the importation of cotton from the United States had very materially de-

clined and that manufacturers here had correspondingly reduced their output.

I hear considerable said to the effect that England, France, and Germany give Italian purchasers more liberal credits than the Americans grant. German manufacturers especially send agents here, ascertain the standing of buyers, and to those who are found to be responsible six and nine months' time is granted.

Tobacco and salt are government monopolies and are sold only in stores authorized by the government, called "Sale e Tabacchi." Immense amounts of tobacco are imported from the United States into Italy, and here, in government establishments, manufactured into cigars, cigarettes, and chewing and smoking tobacco. I am informed that great quantities of these cigars are exported to South America, especially to the Argentine Republic, where a large Italian population creates a good demand therefor.

There may be more, but I know of but four hotels in this city that have elevators, and rocking and revolving office chairs are exceedingly rare. Of the latter I would be unable to indicate a bank or business room where one could be seen.—Pietro Cuneo, Consul at Turin, Italy.

American Steam Thrashing Machine in Damascus.—In Damascus the departure and the arrival of the annual pilgrims' caravan are the leading events of the year. The superintendent of these pilgrimages, representing the Khalif, is Abdul Rahman Pasha, a young pasha of high intelligence, one of the strong men of the Empire. In July, 1903, as the owner of large estates, both in Cœle-Syria and the Hauran, he received from Indiana, through the agency of Michel Effendi Nasser, of Beirut, a modern steam thrashing rig, the second machine of its kind that ever came to these shores. Its recent "triumphal march" through Damascus stirred the "White City of the East" from center to circumference. On its way into the country it broke down bridges innumerable, but pulled itself and train out of the creek beds beautifully, and it had the honor of being started on its pioneer career in the presence of the governor-general of the province, the field marshal in command of the fifth army corps, and many other gentlemen of high station in Ottoman civil and military life. With its self-feeder, automatic bagger, straw bruiser, etc., it is a marvel of ingenuity, and its service to this country, in blazing the way for labor-saving machinery, with its accompanying amelioration of industrial and social conditions, in a region east of Mount Hermon, where people live and work as did their forefathers when Abraham crossed their pastures with his Chaldean flocks, is beyond estimation. In the Hauran to-day thousands of acres are lying idle; they are likely now to be reclaimed, and the predatory Bedouin tribes who infest the country will have to retire before the new order of things.—G. Bie Ravndal, Consul at Beirut, Syria.

Cider and Jam in England.—During the past two or three years there has been a great revival of the cider trade. Cider is now being recommended by doctors for rheumatism and gout, and it has become quite a popular drink. The cider of England is usually very good, and is attractively put up. There is no reason why the United States should not get a good share of this trade. It is said that much of the cider for this season's consumption will be made from Canadian apples; in some cases, the apples being cut up and dried in Canada and sent to Devonshire and Herefordshire and submitted to a process to produce "home-made" cider. The jam trade in England is suffering from the increased price of sugar and the failure of the English fruit crop. Jam pulp is being sent from Canada to be put up by local manufacturers, and a large trade in French and German jams is expected.—James Boyle, Consul, Liverpool.

Professor of Mining Wanted in Brazil.—The State of Bahia is about to organize a school of mines and wishes to arrange for a competent professor of mining. The State will make a contract for three years to pay the equivalent of from $3,000 to $4,000 a year as salary, with free transportation. It will be necessary that the applicant be a graduate of some recognized American school of mines and have both a practical and theoretical knowledge of mining. A speaking knowledge of Portuguese or Spanish is preferred, but lack of such will be no bar to a good man. Applications should be addressed to Dr. Miguel Calmon du Pin e Almeida, Secretario da Agricultura, Industria, etc., Bahia, Brazil, or may be sent to this consulate for delivery.—H. W. Furniss, Consul at Bahia, Brazil.

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ELECTRICAL NOTES.

The view that the atoms of the elements consist of a number of negatively electrified corpuscles inclosed in a sphere of uniform positive electrification has suggested to J. J. Thomson the mathematical problem of the motion of a ring of negatively electrified particles placed inside of a uniformly electrified sphere. He investigates the positions of equilibrium which the electrons will assume under the action of their mutual repulsion on the one hand and the attraction of the sphere on the other. He finds that the conditions of equilibrium vary steadily with an increasing number of electrons, but that at certain points a sudden change occurs. These points correspond to those at which the elements change their properties in the periodic system, and it seems, therefore, very probable that the electron theory may be made to account for the properties of the chemical elements themselves. The author considers only the various arrangements of the electrons in one plane, as he has not yet succeeded in finding a general solution for spherical distribution; but the results already attained are extremely suggestive. Those elements which easily lose a single electron are monovalent electro-positive elements such as sodium. Those which become more stable on acquiring another electron are monovalent electro-negative elements like chlorine. Those which lose or acquire two electrons are divalent elements, and those which are incapable of permanently acquiring or losing electrons are elements of no valency like argon and helium. Radio-activity is accounted for as follows: Some systems of electrons are stable when rotating with an angular velocity greater than a certain value, but become unstable when the velocity falls below this value. Such a fall may be brought about by radiation from the atom. When, after a long interval, the velocity reaches the critical velocity, there will be what is equivalent to an explosion of the electrons, the electrons will move far away from their original positions, their potential energy will decrease, while their kinetic energy will increase. The kinetic energy gained in this way might be sufficient to carry the system out of the atom, and we should have, as in the case of radium, a part of the atom shot off. In consequence of the very slow dissipation of energy by radiation the life of the atom would be very long.—J. J. Thomson, Phil. Mag.

In view of the recently celebrated twenty-fifth anniversary of the birth of the commercial electric incandescent lamp, it may be interesting to recall that it was in the early spring of 1877 that the defects of electric lighting first enlisted Edison's abilities. In the succeeding ten months much was accomplished, and the incandescent light assumed a practical aspect which commended itself to the attention of business men. The outcome of this movement was the incorporation in October, 1878, of the Edison Electric Light Company, with a capital of $300,000. On October 16, 1879, Edison decided that he had reached conditions where he thought a carbon filament might be made into a lamp. A cotton thread was the first substance utilized, and a groove in the shape of a hair-pin was cut in a nickel plate, the groove being just wide enough to hold the thread. This was placed in a small nickel mold and filled with charcoal. Five hours were spent in carbonizing and cooking the mold, after which, upon taking the filament out of the groove, it was found to be of such extreme fragility that it promptly fell to pieces, even in such practised hands as those of Edison's able co-operator, Mr. Charles Bachelor. Repeated experiments were attended by the same disastrous results until a late hour in the night of the 18th, when a filament was rescued intact from its miniature crematory, only to be again fractured in the act of securing it to the conducting wire. There had been no sleep for the workers since the commencement of the experiment, on October 16, yet so potent was the spell of inspirational genius that Mr. Bachelor at once yielded to Mr. Edison's frantic suggestion that they should make a lamp before they slept, or die in the attempt. On the 19th several filaments were obtained, all of which broke in clamping; but finally, on the morning of the 20th, after many alterations in the clamping devices, a perfect specimen was secured. In carrying this fragile substance, the focus of so many hopes, from the laboratory to the glass blower building, a malicious zephyr whirled it from its fastening and reduced it to impalpable powder. Utterly unmanned by this misfortune and unhinged by insomnia and fasting, Mr. Bachelor rushed into the presence of his partner and delivered himself of the following despairing sentiment: "Edison, it's gone, broken by the wind; I'm sick, I'm disgusted." But on the morning of the 21st events assumed a more fortunate guise. A lamp was finally completed, lighted, and eagerly watched by the thirty or more experimenters attracted by the unusual interest of the proceedings. Partially relieved by the success of the trial, Edison, Bachelor, and some others took a few hours' sleep, at the end of which time they were greatly elated to find that the lamp was still burning, without any apparent waste of carbon. This delicate thread of light was anxiously watched for several days, after which Mr. Edison decided to raise the candle-power very high, in order to see how long the carbon would resist the strain. A greater power was attained than the inventor's most audacious dreams had ventured to picture, and sustained through an anxious period of two days; then the soft glow faded, and the tiny filament melted "like the baseless fabric of a vision." This was the pioneer flame of the Edison incandescent light.—From Cassier's Magazine.

ENGINEERING NOTES.

Water is so nearly incompressible that "practical" men are apt to think of it as absolutely so; yet here comes along Prof. Toit with the assertion that if the water in the ocean were not compressed as it is by its own weight the level of the sea would be 116 feet higher than it is at present. In that case two million square miles of what is at present dry land would be submerged, and then where would we be? So much we owe to one little thing.—American Machinist.

The United States consul at Pretoria, South Africa, makes a report regarding American-built steam boilers that is scarcely flattering, to say the least. A firm imported an American steam plow at heavy expense and found after it had been examined by the official inspector of machinery that they would be unable to make any practicable use of the machine, simply because the inspector would not allow the rated pressure—140 pounds per square inch—to be carried. On account of the faulty construction 110 pounds was the maximum limit. Just previous to this incident it appears that nine new American boilers were rejected at Johannesburg as absolutely worthless. In the light of these facts it would appear that some of our boiler-makers who are looking for foreign trade should bestir themselves and find what requirements must be complied with in boiler building for that trade. Not all governments are as indulgent in this matter as Uncle Sam.

It is probable that the future will see a decreasing amount of structural steel used in the floor framing, and an increasing amount of reinforced concrete, the development progressing until the only structural steel used will be in the columns, in stay beams connecting the columns of sufficient strength to support the centers for the concrete, possibly of less strength than that, and in wall beams. The monolithic reinforced concrete floor slab possesses many advantages and is slow in development, mainly by reason of the opposition of the vested interests in clay products, which secure the retention of unfavorable building laws. The advantages are: Greater resistance to fire; less thickness and consequently a less height of building for a given number of stories; greater resistance of the building to external forces; less weight; no large voids; less cost. Brick, stone, and terra cotta are the materials used at present in constructing the walls. Concrete is offered as a substitute. When it is good, it is as good as any other substances; but for walls it is not likely to be uniformly good, nor is it likely to be consistent in color or as pleasing in appearance as stone. Glazed terra cotta is probably the best substance if properly made and set, because since each rain washes it off, it is less likely to be injured by fire, and when injured is more easily replaced. Any material is liable to serious damage from fire in adjoining properties. The greatest improvement that could be made would be a law requiring all new structures to be fireproof within certain limits, and making owners of property in which a fire originated responsible for all of the damage caused by the fire regardless of where this damage occurred or how the fire started. We are using such large quantities of steel in our buildings, and, in fact, are absolutely dependent on it for strength, that we need more knowledge to protect it absolutely from fire and rust, and should improve our practice in applying the knowledge we have, which is certainly sufficient to enable us to guarantee a life of fifty years.—Architectural Record.

It has not been thoroughly ascertained as yet by scientific investigation why the coking properties of coal are influenced by stamping or compressing, and while it is only imperfectly understood how the process is affected by external or mechanical influences, it is a fact that compressing coal improves its coking qualities. An explanation of this could perhaps be that in using coal of a low percentage of volatile matter, the voids between the particles of coal are too large for the small available quantity of products of distillation necessary to exert a binding influence. It may, therefore, be assumed that by compressing the coal and reducing the spaces, bringing the particles of coal closer together, a firmer binding is effected. Whatever the theoretical explanation may be, the practical advantage of compressing the coal before coking is that the coking capacity is increased, which enables a poor coking coal to be converted into a more or less reliable coke. The output of available coke is also increased by several per cent, as the percentage of small coke and dust is reduced to a minimum. By stamping the coal is reduced about 30 per cent of its original bulk. On account of the small clearances allowed between the cake of coal and the oven walls, the coal cakes less to the walls, and the pushing out of the coke is greatly facilitated, whereby the wear and tear of the walls is very materially lessened. In consequence, in building new ovens the oven walls can be made quite parallel, which is of great importance in the even heating up, and also reduces the cost of construction. The coking time proves to be about the same whether the oven is working on stamped or unstamped coal. The coke made from the machine-stamped coal is particularly suitable for the production of pig iron, as by the use of such coke the quantity necessary for the blast-furnace process is from 10 to 15 per cent less in bulk than when using coke from unstamped coal. All these advantages constitute the main reason why such keen interest has of late been manifested in the question of coal stamping; advantages which not only enable coal of poor quality to be utilized for coking purposes, but also are conducive to the saving of time and labor in

the case of such coal thoroughly suitable for coking.—Extract from article by Alfred Ernst in Mines and Minerals.

TRADE NOTES AND RECIPES.

To Decolor Vinegar.—Many persons, fearing adulterations, prepare their vinegar themselves, oftenest with red wine, which gives an unpleasant color. This will disappear completely if about 40 grammes of pulverized charcoal or boneblack are introduced in each liter of vinegar. In two or three days it is filtered, and is then perfectly decolored.—Science, Arts, Nature.

Coloring of Copper.—A fine red color may be given to copper by gradually heating it in an air bath. Prolonged heating at a comparatively low temperature, or rapid heating at a high temperature, produces the same result. As soon as the desired color is attained, the metal should be rapidly cooled by quenching in water. The metal thus colored may be varnished.—La Nature.

Waterproofing of Cloth and Tissues of Various Kinds.—To render new clothing waterproof a bath of benzine containing from two to five per cent of alumina, one to three per cent of paraffine, and no soap, is employed. If old garments are to be treated, they are dipped into a warm bath of soap, 2 per cent, then into a cold bath of alumina of from 2 to 5 per cent, and afterward into a solution of from 1 to 3 per cent of paraffine in benzine. The alumina is prepared with alum, 10 parts; carbonate of soda, 2 parts.—Le Cosmos.

Raspberry Juice of Dark Red Color.—Such a juice is obtained by adding to the crushed raspberries, before the fermentation, slight quantities of sugar in layers. The ethyl-alcohol forming during the fermentation is said to cause a better extraction of the raspberry red. Furthermore, the boiling should not be conducted on a naked fire, but by means of superheated steam, so as to avoid formation of caramel. Finally, the sugar used should be perfectly free from ultramarine and lime, since both impurities detract from the red color of the raspberries.—Konserven Zeitung.

Ink for Writing on Glass.—It is sometimes quite useful to be able to trace an inscription on a bottle or other glass vessel, and thus avoid the slips of paper which are soiled and easily detached. The preparation of an ink for this purpose is simple, and it may be regarded as a paint. Dissolve, cold, 20 grammes of brown lacquer in 15 centiliters of lamp alcohol, and on the other hand, 35 grammes of borax in 25 centiliters of distilled water. Mix the two solutions, cold. Color with one gramme of methylin violet.—Science Pratique.

Process for Nickeling.—The Electro Metallurgic Company obtains deposits of nickel by employing a bath composed of water, 30 liters; chloride of nickel, 0.4 kilogramme; pyrophosphate of soda, 7 kilogrammes; chloride of ammonia, 0.6 kilogramme; carbonate of ammonia, 0.25 kilogramme. The pyrophosphate of soda cleans the metal. The carbonate of soda and the carbonate of ammonia produce the alkalinity of the bath absolutely necessary, and determine the production of the local electric currents by their action on the metal. The chloride of ammonium serves to increase the electric conductibility of the bath. It is necessary to adhere to the proportions mentioned, which have been established by a long series of experiments.—Science Pratique.

Soldering of Metals on Glass and Porcelain.—To reach a result valuable for chemists and physicists the glass or porcelain is metalized and afterward treated as a metal, and consequently soldered with tin, like other metals for which that solder is used. The metalization of the glass is effected by depositing first a coat of platinum, then on top of that a coat of electrolytic copper. The deposit of the platinum is assured by spreading a mixture of platinum chloride and chamomile oil with a brush on the part to be soldered, slightly heated. It is slowly evaporated, and when no further vapor occurs, it is heated to the dark red. The platinum chloride is reduced, and the metal formed remains adherent to the glass. The tube thus platinized is immersed in a solution of cupric sulphate somewhat concentrated, and connected at the negative pole with a battery of feeble current, for example a Daniell's. The copper deposited is malleable and adheres strongly to the glass.—Le Cosmos.

Recharging of Batteries.—Sometimes electric bells fail of service, and the cause cannot be ascertained. Generally, it proceeds from the exhaustion of the source of electricity. The remedy is simply to recharge the battery. This operation, which in reality is easy, embarrasses some persons. Here is some practical advice, supposing in general that Leclanché elements are employed:

Empty and wash the elements. Then put back the porous cell into the jar containing the carbon and peroxide of manganese. Add sal ammoniac, 200 grammes for the large size, 100 grammes for the middle size, 14 centimeters high, and 80 grammes for the small size. Then pour water into the jar until three-quarters full. Put in the zinc, renewed if the old one is worn, and establish the connections. The liquid of the battery ought to remain at the level mentioned. It should be clear, which will be the case so long as there is a reserve of salt not dissolved. When the liquid assumes a milky aspect, it denotes that the sal-ammoniac is not in sufficient quantity, and this should be added. Batteries should be placed in a dry spot, and the outer vessels should not be in contact.—La Nature.

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