bones resting on top of the large upright stone. In the south quarter of the mound was another stone set up like the first, with a skeleton in the same position as the other, and resting by the side of this stone was a large grooved stone ax. And in the west quarter of the mound was still another hewn stone set up, and a skeleton by it in a sitting position, with the hands resting on top of the stone in front of it, and near the hand bones of this skeleton were two large ornamented shells and a large flint spear head. The three large stones were all of the same material and shape, placed at about the same distance from the triangle in the center. Behind each stone was a skeleton in a sitting position facing the large stone in front of it, one in the east, one in the south, and one in the west, and nothing in the north.

J. W. E.

Bristol, Tenn., Aug. 5, 1890.

ELECTRICITY AS APPLIED TO THE EXTINGUISHING OF FIRES.*

By H. F. LUFKIN.

To speak of electricity as even a possible agent in the extinguishing of fires would seem absurd if we look for our information only in the daily press, which would lead one to believe that the mode or form of motion known as electricity was potent only as an incendiary to instigate conflagration and death. You will readily concede that of all the elements in nature none possesses so wide a range of applicability as electricity. Since its first commercial use by Cook and Wheatstone in their railway telegraph in 1836 and 1838, followed by Morse in 1844, its development has been simply wonderful, especially in the past fifteen years. In the telegraph it is made to convey intelligible characters; in the telephone, articulate sounds; with it metals may be welded, light produced, power distributed, metals deposited by electrolysis, surgical operations performed by electrocautery, nervous systems are toned up by galvanism and faradism, our street cars are operated by it and our steam roads will soon follow, it pumps the organs in our churches, it runs the sewing machine in household and factory, it mines our coal and hauls it out, and why, I may ask, should it not be applied to the extinguishing of fires? Surely it is to-day an important factor in that direction, for does it not, with wonderful intelligence, advise you, not only of the first manifestation of a fire, but of its exact location by means of the automatic fire alarm? Let us go a step further and cause it also to turn the water on, and thus extinguish the fire.

Retrospection in this application of electricity shows us an almost undeveloped field. There has been some work done in the line of electric motors applied to pumps for domestic water supply where the city pressure is insufficient for all domestic requirements; also in the application of electric motors and pumps for supplying water under pressure for hydraulic elevators. As applied to fire department uses, there have been devised a number of electric motors and pumps, or electric pumping engines on trucks, which may be hauled about as the present fire engines are. This involves the necessity of a convenient place for connection with the electric light or power wires of a city at or near each fire hydrant, and also involves the maintenance of an expensive complement of horses as in the present system. The pumping capacity also of any portable engine is, of necessity, limited to a weight and construction which can be readily hauled by a pair of horses with reasonable speed over the varying grades of a city. This, at times, is a serious matter in cities where heavy grades are frequent, especially in the winter time, when streets are obstructed by snow, ice, etc. Prompt response to an alarm is, of course, a necessity, and involves the driving through crowded streets at a speed which is, certainly to the uninitiated, frightful, though singularly free from accident.

In lieu of these portable pumping engines and their several more or less objectionable features, I would submit for your consideration a system of stationary pumping engines, the operation of which I trust I may be able to make clear to you with the aid of these diagrams.

Let me first call your attention to the diagram, Fig. 1, illustrating a stationary system of water distribution for fire purposes under electrical control.

In this diagram, A represents a hydraulic piston, the valves of which are controlled by the electro-magnet, B, the circuit through the magnet, and therefore the piston valves, being controlled by the switches, C C C, etc.

E represents a starting box or rheostat in circuit with the electric motor, F, which is connected by belt or gear to the pump, G. Radiating from the pump, G, is a system of piping connecting to hydrants or plugs, H H H, etc.

The diagram here shown is supposed to represent a city block or square. The pumping apparatus is represented in the center of the block, though it is obvious that it may be placed in any convenient location which may be available and where it will be out of reach of frost, the system of piping being provided with a draw-off valve near the pump, so that the system may be completely drained, if necessary, after use.

The operation of this system is as follows: The hose carriage, with its complement of men, drives up to any of the fire plugs; the hose being attached, the switch, C, is turned. This operates through the magnet, B, and the piston, A, to throw over the switch on the starting box, and thus immediately throws the motor and pump into action. Each district would, of course, be provided with its motorman, who would attend all fires in his district and care for the motor, pump, etc., during the fire, and whose duty it should also be to daily inspect the apparatus in his district to see that it is kept in proper repair. The motors would in these cases be connected to the mains of some company supplying electricity for light or power, whose charge for this service should certainly be merely nominal.

The water could be drawn from a city supply or from an independent supply provided for fire purposes only. The capacity of these stationary plants also may be equal to the capacity of ten or fifteen engines if necessary, and the motor so connected to the pump that the pressure would remain the same on the system, whether

only one stream or the full capacity of the plant were called for. These situations could also be made to cover a considerable territory if desirable, and the several districts included in a general system could be connected together with suitable valves between them, so that they could be operated separately or together, as the exigencies of the fire might demand.

A plant of this character, with a capacity of 200 horse power, which would be capable of delivering about

present in use. The blowing out of a thermostat or other device which now brings the sprinkler into operation could also be made to start a motor and pump, and thus furnish a practically inexhaustible supply of water in place of the limited tank supply now in use. There are, however, numerous recorded instances where these automatic sprinklers have been "too previous," if I may be allowed the expression. In this connection I would ask your consideration of the

FIG. 1.—ELECTRIC FIRE-EXTINGUISHING PLANT.

2,500 to 3,000 gallons of water per minute, or say 165,000 gallons per hour, against 150 pounds pressure, could be set up and piped to cover quite a number of city blocks, say ten or fifteen, at an expense of \$20,000. The cost to operate this plant at its full capacity would not exceed \$10 per hour, or at the rate of 16,500 gallons of water for every \$1 of cost. When the fire is out the cost stops absolutely. The wear and tear expense on a large plant of this kind should not be as great as on a single steam fire engine, to say nothing of the cost of maintaining horses and harness.

With this reference to a possible application of electricity to a pumping system for fire department uses, let us see what can be done in the way of protecting isolated buildings. The automatic sprinkler has become a familiar sight in many of our large stores and warehouses, and the reduction in insurance rates wherever these sprinklers are applied is ample evidence of their value. A modification of the system as at present applied suggests itself to me in the use of a motor and pump in place of the roof tank at

diagram 2, which illustrates a sprinkler system which, while not automatic in its action, possesses some features of advantage over the automatic system, especially in stores or warehouses which are constantly patrolled, and therefore under surveillance. In this system, the pump, G, and motor, F, are controlled by the same devices of piston, A, and magnet, B, as the system previously described. Connected to the pump and distributed through the several rooms or apartments to be protected is the system of sprinkler piping, H. On each floor, or in each department, if desirable, is situated a valve in a branch from the main piping, controlling the sprinkler system of the floor or apartment. This valve is controlled by a piston, A, and magnet, B, similar to the ones controlling the motor and pump. The several magnets in the building are independently in series with the motor magnet. On each floor, or in any number of places on the floor, are convenient push buttons or switches, C, which being closed act to start the motor and pump and at the same time open the valve in any apartment connected with the switch

FIG. 2.—ELECTRIC FIRE-EXTINGUISHING PLANT.

* A paper read before the convention of the National Association of Fire Engineers at Detroit, Mich., August 20, 1890.

closed. Where desirable, a second system of switches might be arranged which would act to stop the motor and pump and close the valves.

It seems to me that in a theater a system of this description would be particularly desirable. There could be located in any number of places about the theater sets of switches controlling the entire house. On the discovery of a fire in one of the dressing rooms the sprinkler could be started in the room from any of these several switchboards or in the room itself. In this manner, also, the exits and lobbies could be literally flooded, and thus allow of the harmless escape of the audience, even should the fire practically surround them.

These are some of the possibilities of electricity as applied to the extinguishing of fires, and I submit that, while electricity is making such giant strides in the mechanical arts, its inevitable application as a power for the operation of fire department apparatus is by no means a remote possibility, but will be found an actual necessity.

[Continued from SUPPLEMENT, No. 772, page 12338.]

MEETING OF THE BRITISH ASSOCIATION, 1890.

THE INAUGURAL ADDRESS, BY SIR FREDERICK AUGUSTUS ABEL, C.B., D.C.L. (OXON.), D.SC. (CANT.), F.R.S., P.P.C.S., HON. M. INST. C.E., PRESIDENT.

MINING SAFEGUARDS.

THOSE who have been content to labor long and arduously with the objects steadily in view of advancing our knowledge of the causes of mine accidents and of developing resources and measures for removing or combating those causes can cherish the conviction that recent legislation in connection with coal mines, based upon the results of those labors, has been already productive of decided benefits to the miner, even although it has fallen short of what might reasonably have been hoped for as an outcome of the very definite results and conclusions arrived at by the late Royal Commission on Accidents in Mines (in the recent much lamented death of whose universally respected chairman, my late esteemed friend and colleague, Sir Warrington Smyth, the scientific world has sustained the loss of an ardent worker, and the miner, of an invaluable friend).

The fearful dangers arising from the accumulation of inflammable dust in coal mines, and the equality of mine dust with firedamp in its direful power of propagating explosions, which may sometimes even be, in the first instance, established chiefly or entirely through its agency, have now been long recognized as beyond dispute; and it is satisfactory to know that permission to fire shots in mine workings which are dry and dusty has, by recent legislation, been made conditional upon the previous laying of the dust by effective watering. In some mining districts, moreover, the purely voluntary practice has been extensively adopted by mine owners of periodically watering the main roads in dry and dusty mines or of frequently discharging water spray into the air in such roads, which must tend greatly to reduce the possible magnitude of the disastrous results of a firedamp or dust explosion in any part of the mine workings.

The encouragement given to the application of the combined resources of ingenuity, mechanical skill, and knowledge of scientific principles, through the elaborate but thoroughly practical comparative trials to which almost every variety of safety lamp has, during the last few years, been submitted by competent and conscientious experimenters, has resulted in the provision of lamps to the hand of the miner which combine the essential qualities of safety, under the most exceptionally severe conditions, with good illuminating power, simplicity of construction, lightness, and moderate cost. Very important progress has also been made, since the first appointment of the late accidents in mines commission, toward the provision of thoroughly serviceable and safe portable electric lamps for use in mines. Of those which have already been in the hands of the miners, several have fairly fulfilled his requirements as regards size, weight, and illuminating power of sufficient duration, but much still remains to be accomplished with respect to durability, simplicity, thorough portability, and cost, before the self-contained electric lamp can be expected to compete successfully with the greatly improved miners' lamps which are now in use or available.

The recent legislation in connection with mines is certainly deficient in any sufficiently decisive measure for excluding from mine workings certain forms of lamps which, while fairly safe in the old days of sluggish ventilation, are unsafe in the rapid air currents now frequently met with in mines. It is, however, very satisfactory to know that the strong representations on this subject made by the late commission, combined with the force of example and with the conclusive demonstration of the superiority of other lamps, by exhaustive experiments, have led within the last two years to the very general abandonment of the unprotected Davy, Clanny, and Stephenson lamps in favor either of simple, safe modifications of these or of other safe and efficient lamps, and that one possible element of danger to the miner has thus been eliminated, at any rate in many districts. In one important respect recent improved legislation has failed to effect a most desirable change—namely, in the substitution of safety lamps for naked lights in workings where small local accumulations of firedamp are discovered from time to time. There appears little doubt that one of the three fearful explosions which have occurred within the last twelve months, the explosion at Llanerch colliery, near Pontypool—was caused by the continued employment of naked lights in a mine where inspection constantly revealed the presence of firedamp. This, and two other terrible disasters, at Mossfield colliery, in Staffordshire, at Morfa colliery, near Swansea, which have occurred since the last meeting of the Association may have seemed to weaken the belief that the operation of the recent mines regulation act, which was based upon some of the results of seven years' arduous labor of the late mines commission must have resulted in very substantial improvement in the management of mines, and in the conduct of work by the men. Happily, however, there is a consensus of opinion among those most competent to judge—i. e. the government mine inspectors—that very decided benefits have already ac-

crued from the operation of the new act. Although far from embodying all that the experienced mine owners, miners, and scientific workers upon that commission, as well as practical authorities in Parliament, concurred in regarding as reasonably adaptable, from the results of observation and experiment, to the furtherance of the safer working of mines, this act does include measures precautionary and preventive, of undeniable utility, well calculated to lessen the dangers which surround the miner, and to add to his personal comfort underground. We may hope, moreover, that the operation of the act is paving the way to more comprehensive legislation in the near future, for it can scarcely be doubted, by the light of recent sad experience, that there are directions in which both masters and men still hesitate to adopt, of their own free will, measures or regulations, methods of working or appliances and precautions, which are calculated to be important additional safeguards against mine accidents, and which are either left untouched, or only hesitatingly and imperfectly dealt with in the recent enactments.

ACCIDENTAL EXPLOSIONS.

My labors upon the late mines commission represent only one of several subjects in connection with which it has been my good fortune to have opportunities of rendering some slight public service in directions contrasting with one of the main functions of my career, by endeavoring to apply the results of scientific research to a diminution of the risks to which particular classes of the community, or the public at large, are exposed—of being sufferers by explosions, the results of accidents or other causes.

During the pursuit of bread-winning vocations, and even in ordinary domestic life, the conditions, as well as the materials, requisite for determining more or less disastrous explosions are often ready to hand, and their activity may be evoked at any moment through individual heedlessness or through pure accident. Steam, or gases confined under pressure, volatile inflammable liquids, combustible gases, or finely divided inflammable solids, are now all well recognized as capable of assuming the character of formidable explosive agents; but with respect to the three last named, it is only of late that material progress has been made toward a popular comprehension and appreciation of the conditions conducive to danger, and of those by the fulfillment of which danger may be avoided. Thus, the causes of explosions in coal-laden ships, together with the occurrence of spontaneous ignition in coal cargoes, another fruitful source of disaster, were made the subject of careful inquiry some years ago by a royal commission, upon which I had the pleasure of working with the late Dr. Percy, whose invaluable labors for the advancement of metallurgic science will always be gratefully remembered.

The light thrown by that inquiry upon the causes of those disasters, and upon the conditions to be fulfilled for guarding against the accumulations of firedamp, gradually escaping from occlusion in coal, and of heat, developed by chemical changes occurring in coal cargoes, has unquestionably led to an important reduction of the risks to which coal-laden ships are exposed. Subsequent official inquiries and experimental investigations, in which I took part with the late Sir Warrington Smyth, and some eminent naval officers, consequent upon the loss of H.M.S. Doterel, through the accidental ignition of an explosive mixture of petroleum spirit vapor and air (and other calamities in war ships originating with the gradual emission of firedamp from coal), have resulted in the adoption of efficient arrangements for ventilating all spaces occupied by, and contiguous to, the large supplies of fuel which these vessels have to carry.

The thorough investigation, by Rankine and others, of the causes of explosions in flour mills, which in years past were so frequent and disastrous, has secured the adoption of efficient measures for diminishing the production of, and the dissemination through channels and other spaces in the mills, of explosive mixtures of flour dust and air, and for guarding against their accidental ignition. The numerous terrible accidents caused by the formation and accidental ignition of explosive mixtures of inflammable vapor and air in ships carrying cargoes of petroleum stored in barrels or in tanks have, by the investigations to which they have given rise, led to the indication of effective precautionary measures for guarding against their recurrence. Again, the many distressing accidents, frequently fatal, which have attended the domestic use of those valuable illuminants, petroleum and mineral oils of kindred character, have been made the subject of exhaustive investigations, which have demonstrated that these disasters may readily be prevented by the employment of lamps of proper construction, and by the observance of very simple precautions by the users of them; and a recent official inquiry which I have conducted with Mr. Boverton Redwood has furnished most gratifying proof that very substantial progress has been made within the last few years by lamp manufacturers in the voluntary adoption of such principles of construction as we had experimentally demonstrated to be essential for securing the safe use of mineral oils in lamps for lighting and heating purposes, the employment of which has, within a brief period, received enormous extension in this and other countries.

THE PETROLEUM INDUSTRY.

The creation and rapid development of the petroleum industry has, indeed, furnished one of the most remarkable illustrations which can be cited of industrial progress during the period which has elapsed since the British Association last met in Leeds. One year after that meeting, viz., on August 28, 1859, the first well drilled in the United States with the object of obtaining petroleum, was successfully completed, and the rate of increase in production in the Pennsylvania oil fields during the succeeding years is shown by the following figures:

In 1859, 5,000 barrels (of forty-two American gallons) were produced. In the following year the production increased to 500,000 barrels, while in the next year (1861) it exceeded 2,000,000 barrels, at which figure it remained, with slight fluctuations, until 1865. The supply then continued to increase gradually until in 1870 it reached nearly 6,000,000 barrels, while in 1874 it amounted to nearly 11,000,000 barrels. In 1880 it amounted to over 26,000,000 barrels, and in 1882 it reached 31,000,000. Since then the supply furnished

by the United States has fallen somewhat, and last year it amounted to 21,500,000 barrels. The production of crude petroleum in the Pennsylvania fields, large as it has been, has not, however, kept pace with the consumption, for we find that the accumulated stocks, which on December 31, 1888, amounted to over 18,000,000 barrels, had become reduced to about 11,000,000 barrels at the close of last year. At this rate the surplus stock above ground will have vanished by the end of the current year. In addition to the petroleum raised in Pennsylvania, there is now a very large production in the State of Ohio, but this has not yet been employed as a source of lamp oil. It is, however, transported by pipe line in great quantities to Chicago, for use as liquid fuel in industrial operations.

A few years after the development of the United States petroleum industry, the production of crude petroleum in Russia also began to extend very rapidly. For more than 2,500 years, Baku, on the borders of the Caspian Sea, has been celebrated for its naphtha springs, and for the perpetual flames of the fire worshippers, fed by the marvelous subterranean supplies of natural gas. To a limited extent neighboring nations appear to have availed themselves of the vast supplies of mineral oil at Baku during the past thousand years. By the thirteenth century the export of the crude oil had already become somewhat extensive, but the production of petroleum from it by distillation is of comparatively recent date. In 1863 the supplies of petroleum from the Baku district amounted to 5,018 tons. They increased to somewhat more than double during the succeeding five years. In 1869 and following three years the production reached about 27,000 tons annually, and in 1873 it was about 64,000 tons. Three years later, 153,000 tons were produced, and in the following five years there was a steady annual increase, until in 1882, the production amounted to 677,269 tons. In 1884 it considerably exceeded 1,000,000 tons, and last year it had reached the figure of about 3,300,000 tons. The consumption of crude petroleum as fuel for locomotive purposes has moreover, now assumed very large proportions in Russia, and many millions of gallons are annually consumed in working the vast system of railways on both sides of the Caspian Sea.

The imported refined petroleum used in this country in lamps for lighting, heating, and cooking was exclusively American until within the last few years, but a very large proportion of present supplies comes from Russia. The imports of kerosene into London and the chief ports of the United Kingdom during 1889 amounted to 1,116,205 barrels of United States oil and 771,227 barrels of Russian oil. During the same period the output of mineral oil for use in lamps by the Scottish shale oil companies probably amounted to about 500,000 barrels.

Another important feature connected with the development of the petroleum industry is the great extent to which the less volatile products of its distillation have replaced vegetable and animal oils and fats for lubricating purposes in this and other countries. The value of petroleum as a liquid fuel and as a source of gas for illuminating purposes has, moreover, been long since recognized, and it is probable that one outcome of the attention which is now being given to the hitherto unworked deposits of petroleum in the East and West Indies, South America, and elsewhere, will be a very large increase in its application to these purposes. In the East Indies there are vast tracts of oil fields in Burma, Baluchistan, Assam, and the Punjab. The native Rangoon oil industry is one of great antiquity, although the oil was only used in the crude condition until about thirty five years ago, at which time Dr. Hugo Muller, with the late Warren de la Rue, whose many-sided labors and generous benefactions have so importantly contributed to the advancement of science, made valuable researches on the products furnished by crude oil imported from Rangoon. The resources of the oil fields of Upper Burma, especially of the district of Yenangyoung (or creek of stinking water), have since then been developed by British enterprise, and have attained to considerable importance since our annexation of Upper Burma.

The great extension of the petroleum trade is gradually leading to very important improvements in the system of transport of the material over water and on land. Until recently this has been carried out entirely in barrels and in cases. The consequent great loss from leakage and evaporation, accompanied by risk of accident, is now becoming much reduced by the rapidly increasing employment of tank steamers, which transport the oil in bulk. Tank railway wagons have for some time past been in use in Russia, and there is a prospect of these and of tank barges being adopted here for the distribution of the oil, while in London the practice is already spreading gradually of distributing supplies to tradesmen from tank road wagons. Some considerable doubt as to whether the risk of accident has not rather been altered in character than actually reduced by the new system of transport has not unnaturally been engendered in the public mind by the occurrence within a comparatively short period of several serious disasters during the discharge of cargoes from tank vessels.

The memorable explosion which took place in October, 1888, on board the Ville de Calais, in Calais harbor, with widespread destructive effects, was followed by a similarly serious explosion in the Fergusons, at Rouen, last December, and, more recently, by a fire of somewhat destructive character at Sunderland, resulting from the discharge into the river of petroleum residues from a ship's tanks. In all these cases the petroleum was of a nature to allow inflammable vapor to escape readily from the liquid, so that an explosive mixture could be rapidly formed by its copious diffusion through the air. No similar casualty has been brought to notice as having happened to tank ships carrying petroleum oil of which the volatility is in accordance with our legal requirements, and this points to the prudence of restricting the application of the tank system to the transport and distribution of such petroleum as complies with well established conditions of safety.

NATURAL GAS

Another most remarkable feature connected with the development of the petroleum industry is presented by the utilization, within the last few years, of the vast supplies of natural inflammable gas furnished by the oil fields.

In America this remarkable gas supply was for a long time only used locally, but before the close of 1885 its