deposits it in a tank carried upon the rearmost pair of wheels.

When the machine is traveling at a rate of three miles per hour, the broom makes 91 revolutions per minute, and each bucket of the chain pump makes 4.8 journeys up and down per minute. The breadth of road sprinkled is about 8 feet. The sprinkler is found to be thoroughly efficient in preventing any dust rising even in the driest weather. The bristles of the brush are so chosen that the machine works without clogging on snowy ground. Any danger of obstruction of the chain pump is avoided by the comparatively small number of brackets. It has been estimated that two machines of this type, working one behind the other for 7 or 8 hours a day, perform the same work as 20 men working for the same length of time. Each machine requires one driver. A disadvantage is perhaps to be found in the weight of the machine, which is considerable, but which has of late been somewhat reduced by the simplification of certain parts.

ELECTRICITY IN MODERN MINING DRAINAGE INSTALLATIONS.

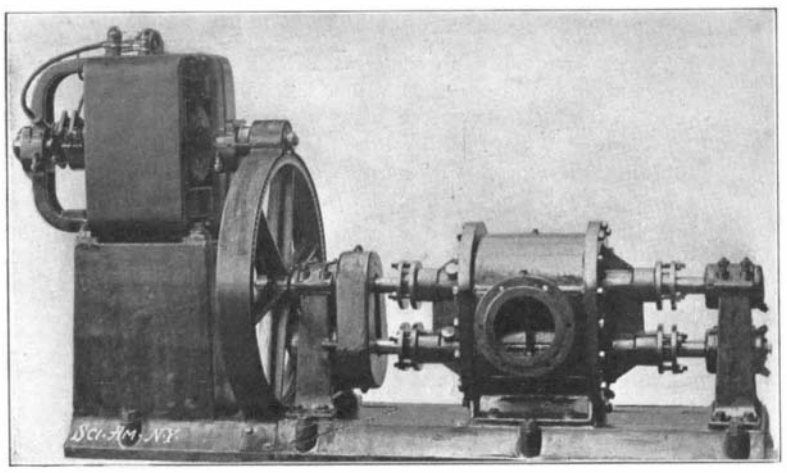
BY FRANK C. PERKINS.

The drainage of mines by electrically operated pumps has now reached a stage of reliability and economy in America as well as in Europe. It was necessary on account of the size of the shafts to construct the pumps and motors in parts which could be easily transported through these shaft openings and drifts. It was necessary for both the pump manufacturers and electrical manufacturers to make concessions in the speed limits of their products. The polyphase induction motors for mining pumps are reduced in speed for direct connection, and the design of the pumps now provides as high speeds as possible. The pumps designed by Prof. Riedler and the engineers of Ehrhardt & Sehmers, as well as those of the Breslau Engineering Works, of Europe, are operated at from 100 to 300 revolutions per minute and are highly efficient for mine working.

An electrically operated mining pump at Planitz has a Siemens & Halske alternating current motor placed at the center of the crank shaft with one plunger at each end, while in the case of the pump at the Ferdinand mine the motor stands on one side of a twin pump. The Planitz pump has a capacity of one cubic meter of water per minute at 145 revolutions per minute, the height of lift being 250 meters. A liquid starter is used with this alternating current motor. The capacity of the twin electric pump at the Ferdinand mine is 1.5 cubic meters per minute at 184 revolutions per minute, the head being 200 meters. At the latter mine there is also in use a much larger electric pump driven by the same type of motor direct connected at the side of a triple pump which has a capacity of 5.5 cubic meters of water per minute at a speed of 146 revolutions per minute, the height of lift being 300 meters.

Taking the efficiency of the dynamo machines, electric cables, and electric motors as tested at 93, 97, and 93 per cent respectively, the useful efficiency of the complete electrical plant is 83 per cent. The high speed pumps have an efficiency of 83 per cent and steam engine 85 per cent, so that the net useful efficiency of steam engine, generator, line, motor, and pump would be 50.5 per cent. The loss of condensation and leakage in a long steam pipe is very large and the steam must be kept up, while in case the electric pump is stopped for short periods no current is being used. The electric mine drainage plant is therefore of higher efficiency and has greater reliability with lower working expenses than hydraulic, steam, or compressed air systems.

The Helios alternating current motor mining pump in the underground installation at Germania I. mine of the Gelsenkirchener Bergwerks-Aktiengesellschaft,



A JAEGER ELECTRIC ROTARY PUMP.

consists of a 160 horse power Drehstron motor mounted between the plungers of a compound twin pump. This pump was constructed by the Maschinenbauanstalt Breslau on the Bergman system, and it has a capacity of 3 cubic meters of water per minute under a head of 160 meters. The polyphase motor built by the Helios Electricitats Aktiengesellschaft of Cologne-Ehrenfeld, operates at a speed of 180 revolutions per minute and is connected directly to a 2,200-volt three-phase circuit.

The Rateau-Gruben ventilator of the Germania II. mine is operated by a 400 horse power motor of the three-phase type. This great ventilator is directly coupled to the motor, which runs at a speed of 238 revolutions per minute and is driven from the same 2,000-volt alternating current circuit directly without reduction by transformers.

At the electric drainage installation carried out for the Hösch Steel Works at the Kaiserstuhl II. shaft at Dortmund a 750 horse power three-phase motor mining pump was installed by the Maschinenfabrik Oerlikon of Oerlikon, near Zurich, Switzerland. The motor frame of this machine is about 14 feet in diameter and 900 millimeters in width. The motor operates at only 75 revolutions per minute on a pressure of 19,000 volts. The present working of the electric pump requires it to raise five cubic meters of water per minute from a depth of 300 meters, but the outfit is designed to raise the same quantity of water at full load a height of 400 meters. The over-all efficiency of this pumping plant between the indicator and the water pumped to the shaft mouth when the steam engine was fully loaded amounted to from 65 to 67 per cent, which may be considered remarkably good.

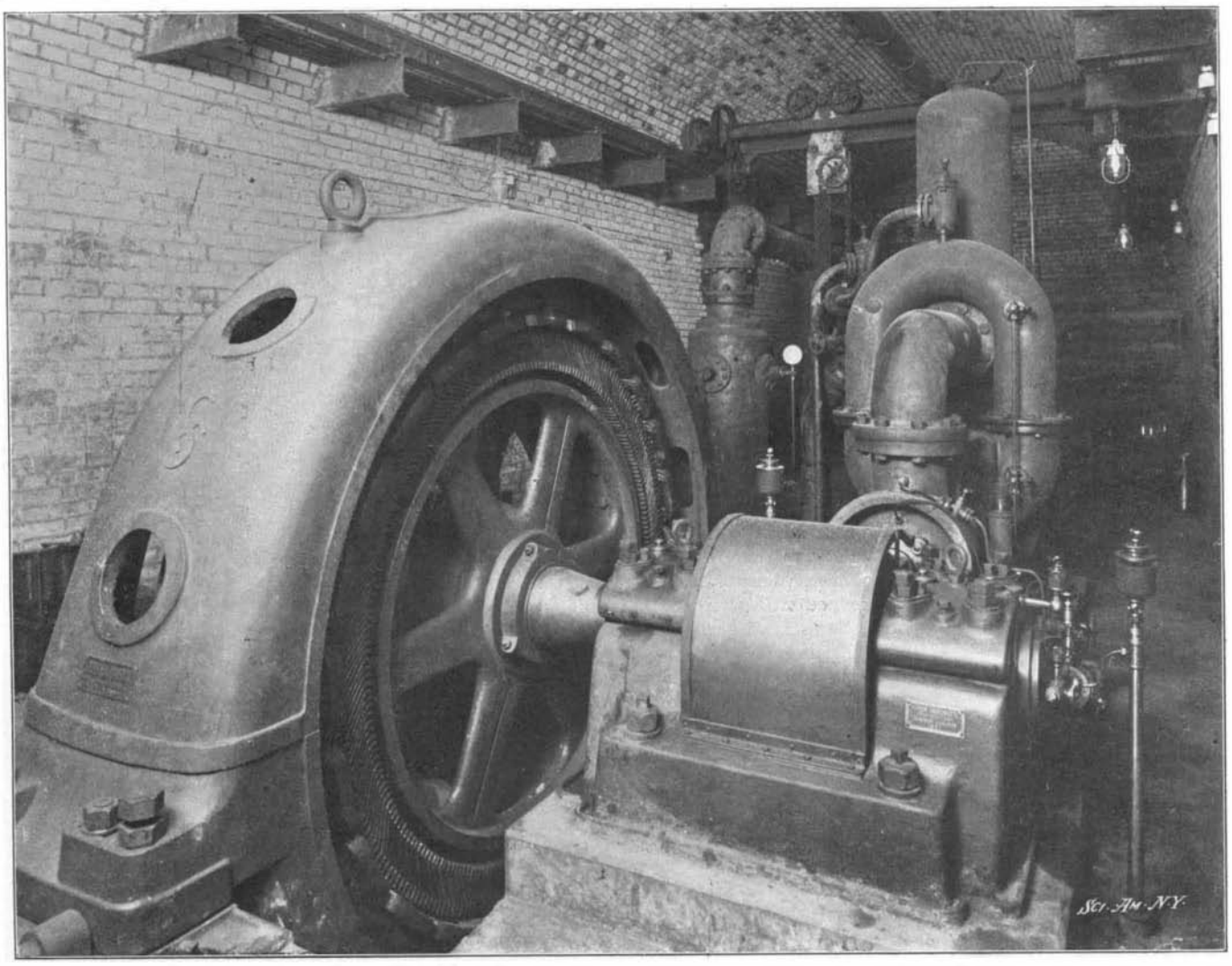
The high power mine pump working by electric power in Germany and throughout Europe has been carefully worked out and the alternating current slow-speed induction motors of the polyphase type have done remarkably well in this service.

The underground electric pumping plant of the Glückauf shaft of the Zwichauer Steinkohlenbau-Vereines was installed by the Schuckert Company of Nurnberg. There are two Bergman Zwillingpumpe, each directly connected to a 220-volt three-phase motor. These motors operate at a speed of 180 revolutions per minute and are supplied with current directly from the 2,000 volts polyphase power transmission line, although other machinery driven by electric motors in the mine has the current transformed down from 2,000 to 500 volts. In this plant, as well as nearly all of the large electrically operated mining plants in Germany, a large, well-equipped, and economical power plant is installed above ground for supplying the necessary power for use in the mines.

Many of the mines of England are operated by electric power. Large numbers of electric hoists, pumps, cutters, and auxiliary mining machinery have been supplied by Ernest Scott & Mountain, Limited, and their prominent engineers. In England as well as in America and on the Continent of Europe direct-current motor-driven pumps of both plunger and centrifugal types are in use with both open and closed or iron-clad motors according to the location and their liability to be subjected to moisture and rough usage.

The rotary pumps of C. H. Jaeger & Co., of Leipzig-Plagwitz, are extensively used abroad, and in the American mines the Worthington, Blake-Knowles, Deane, Goulds, and Allis-Chalmers types are commonly employed. The Risdon duplex and triplex electric pumps manufactured in San Francisco are largely used in the western part of the United States. They are double geared to reduce the speed and two motors are employed, as it is found impossible frequently to get very large machines down existing shafts. Where a special shaft for mine pumping is made, large motors are preferable, as they have much higher efficiency as well as lower speeds. Three Risdon electric triplex pumps driven by induction polyphase motors have been recently placed in an underground station with a capacity of 6,000 gallons per minute, the water being raised 1,000 feet. An extra large underground chamber is required for pumps of this character but with large motors there is greater economy of space.

At an ironstone mine in Yorkshire, England, which had been flooded, an electric pump of the centrifugal Scott & Mountain type was used. It was designed to deal with 1,000 gallons per minute against a head of 150 feet and ran at a speed of 700 revolutions per minute, a 100 horse power motor being used. The mine being flooded and the dip 3 inches to the yard, and it being necessary to have the pumps portable, this type of plant was suggested. In practice the electric pumps were lowered each 80 yards, which at 3 inches to the yard is equivalent to a suction of 20 feet vertical head. The inlet and outlet branches of the pump consisted of flexible rubber pipes, the total length over flanges being 27 feet, so that the raising main was laid as the pumps were gradually lowered. After each lowering of the pumps three 9-foot lengths of pipe took the place of the positions where the electric pumps operated, the suction pipes then forming



SIEMENS-HALSKE ALTERNATING-CURRENT MOTOR DRIVING A MINING-PUMP IN AN UNDERGROUND INSTALLATION.

the rising main. For English electric pumps operating under heads from 500 feet to 1,000 feet double gearing is very largely used.

On one colliery in the North of England a large quantity of water had to be pumped underground by dip pumps. The company originally drove the pumps by wire ropes from engines at the pit bottom. The existing pumps were converted into electric pumps driving through machine worm gearing from the motors to the pumps, eight outfits being equipped each with 6 horse power motors. It is stated that the annual saving of the electric over the old method of pumping, after allowing for interest and depreciation, was such that the electrical machinery paid for itself in three years.

It is generally recognized as a fact beyond question that electricity is the most economical and convenient form of motive power for mine haulage and hoisting. It is especially suitable for pumping and ventilating installations on account of its flexibility, permitting ready extension and change as mining conditions frequently require.

During recent years the polyphase power transmission system has been introduced extensively and has been found to be a valuable means of supplying the necessary power for mining operations. Where the several shafts of a mine are located more than a mile apart, the latest practice is to establish a main generating station near one of the main shafts where sufficient power is generated to supply the entire mine including all of the shafts. The two-phase or three-phase alternating current is generated at high potential directly by the generators, or the potential is raised by step-up transformers for transmission and again reduced in pressure at the various shafts for distribution in the mine.

From the sub-stations at each shaft highly insulated lead covered and armored cables conduct the current to the electrically driven drills, ventilators, pumps, and hoists. While at present the direct current is considered most practical for electric mining locomotives, the polyphase machines are coming into use rapidly and are growing in favor. The present necessity in some mines of having direct current for use with certain classes of electrically operated mining apparatus is met at polyphase installations by providing rotary converters at the sub-stations or motor-generators, changing the alternating current to a continuous current of any desired voltage wherever required.

The polyphase system has been in operation with great success at the mines at Karwin. The main generating station is located at the Hohenegg shaft, where there are in operation an electrically operated pumping plant, 110 horse power ventilator, and hoisting apparatus. For supplying current to the Albrecht shaft at Peterswald, more than three miles away, and the Gabriel mine at Karwin, the current is raised to 10,000 volts pressure and reduced in voltage again at the shafts.

Typhoid Fever Serum.

A typhoid antitoxin serum invented by Dr. Allen Macfayden and indorsed by no less a person than Lord Lister is the latest medical discovery. Dr. Macfayden is the Director of the Jenner Institute of Preventive Medicine. Briefly stated, Dr. Macfayden's discovery consists in this: He has found that by crushing the cells of the typhoid bacillus in liquid air, the intercellular juices are not only obtained without living organisms, but are also rendered highly toxic. When injected into living animals, these juices produce a blood serum which acts as an antidote against the poison generated by the typhoid bacillus. The novel feature in this process is the use of liquid air, the function of which is not fully understood as yet.

A Prophecy of the Failure of Our Coal Supply.

In a lecture before the National Geographical Society, Prof. C. D. Walcott, Director of the United States Geological Survey, said that the anthracite coal fields of the United States would be exhausted in sixty years at the present rate of consumption and that by the year 2203 the bituminous coal fields will also be worked out. After this the country will be compelled to secure its fuel supply from the lignite beds of the West.

A Bacteria Safety Lamp.

News has been received from abroad that Prof. Hans Molisch, of Prague, has discussed a new use for bacteria. In a communication to the Vienna Academy of Sciences, he described the specifications of a mining lamp, the light of which is supplied by luminous bacteria. The lamp consists of a glass jar lined with a compound of saltpeter and gelatine previously inoculated with bacteria. In the culture thus constituted, bacteria developed prodigiously, in two days causing the jar to be illuminated with a bluish green light which lasted for several days and gradually disappeared in about a fortnight. The light is cold and harmless. Faces can be recognized, it is said, for a distance of two yards and large type can be read by it.

Automobile News.

The International Gordon-Bennett cup race, which was run last year as a part of the Paris-Vienna contest, will this year be held in Ireland on a circular course. The total distance to be covered is 131 miles. The race will be started in the early morning hours of July 9. America is to be represented, for the first time, by a team of three chosen by the Automobile Club from among the winners in some competitive trial races, which will take place the middle of April.

The Automobile Club of Great Britain has planned an endurance run for 1903 which will be more severe than anything ever before attempted, says the New York Sun. It will literally test the limit of reliability, for no stops whatever are to be allowed for, and an operator may not even clean his vehicle. Every minute spent in examining, oiling, or in any way touching the machine, except to regulate its speed and guide it, will be penalized. The run will be one of 1,000 miles and will be run on successive days, starting and finishing at Crystal Palace. When an operator starts out he will take an observer with him who will make the notes that will cost him marks. Not even punctures or blocked roads or railroad gates will be accepted as non-penalizable causes. Every one must take his chances. When the machines come in at night, the operators must jump out and leave them without doing a thing. The club's stewards will take charge of the competing vehicles at the gate of the garage. If the machine must necessarily be oiled or tinkered, the operator must do it in the morning and be penalized one mark for every minute he spends at it. He positively must not wash off the mud. Automobilists in New York are inclined to think that the time is now ripe for some arduous test of this sort in this country, according to what a couple of them said recently.

In the present stage of the development of the automobile, the pneumatic tire is the weakest and most unsatisfactory part of the vehicle. The cost of tire repairs and replacements is frequently the heaviest running expense of the vehicle, while the delay and inconvenience often caused by the failure of a tire cannot be measured in money. This is especially true of the large and expensive tires used on the heavy, fast machines, which wear most rapidly and are most costly to replace. These tires cost from $40 to $79 each, a set of four costing from $160 to $316. A set for a light carriage of the runabout type costs from $50 to $80, so that the expense of these very necessary parts of the vehicle is apparent. Of late, says the N. Y. Times, the experiment has been tried of substituting solid tires on the rear wheels for the pneumatic ones, and the results are said to have been very satisfactory. The vibration was not increased to an uncomfortable degree, and the tractive force of the vehicle, especially on a hill, was much increased. Hills which could not be climbed with a vehicle fitted with pneumatic tires on all four wheels, were surmounted when solid tires were placed on the rear wheels. It is believed by persons who have studied the matter that there are but two solutions to the problem. One is to make the pneumatic tire absolutely puncture proof by using a metallic or otherwise protected tread, and the other is to substitute a mechanical device between the frame and the body of the vehicle which will take up all the jars of the road. Much work has been done along both lines, but without success so far.

An important congress has been held in London by the officials of the various great trunk railroads of Great Britain relative to the adoption of electric traction upon their different systems. The most important point discussed was concerning the position of the current rail in connection with the ordinary two rails, its distance therefrom, height, and position. As electric traction for trunk railroads is on the eve of introduction in Great Britain this congress was assembled to prevent various standards being adopted upon the different systems, which would thus seriously interfere with intercommunication between one company and another to the detriment of their welfare and traffic. By the adoption of one standard common to all the railroads, electric locomotives and trains could be as easily run over various systems as the present steam locomotives achieve the same object. Those railroads which are already introducing electric haulage upon certain sections of their roads are adopting different standards according to the amount of space available for the placing of the current rail, and although the difference is only a matter of one or two inches, yet it is of vital importance that they should adopt measurements which will be easily applicable to the other systems. This step is imperative, as Mr. Yerkes' electrification of the London underground railroad is in progress, and, as the trunk railroads have running powers thereon, the latter will have to adopt electric locomotives, since no steam locomotives are to be permitted in the tunnels after the conversion to electricity is completed.

Engineering Notes.

The ore-carrying trade of the past season on the Great Lakes was the greatest ever known, and active preparations have already been commenced for a still greater one next year, when the total tonnage will, it is anticipated, reach 29,000,000 or even 30,000,000 tons. The United States Steel Corporation is about to place an order for twenty of the largest ore-carrying vessels ever constructed, each with a capacity of 9,000 tons. Orders have been given to double-track the line of the Bessemer Railroad from Conneaut to Bessemer. This line is controlled by the Carnegie company.

A new type of file, specially devised for working upon gun metal, has been introduced into the engineering department of the Chemin de Fer du Nord, France. The feature of this tool which distinguishes it from the general type of file, is a series of shallow channels which cross its face diagonally at an angle of 30 deg. and placed about half an inch apart. The raised portions of the surface of the file between these channels are occupied by the teeth of the tool. The advantages of the file are that it clogs less rapidly, and can easily and quickly be resharpened on the sand-blast, while it increases the work of the engineer who uses it in connection with gun metal filing, by 30 per cent.

Almost every day brings forth some evidence of the extreme durability of the pressed steel car. A few days ago in Pittsburg, one of these cars while being shifted was sent down a track which ran close to a stone wall of very substantial construction in the Panhandle freight yards. The brakes failed to work at the proper time and the car crashed into the bumper with terrible force. The upper part of the car was forced over the bumper against the stone wall, which was cracked in four places and which had every appearance of being ready to fall when it was taken down. The car was not seriously damaged and on being placed on the tracks again was able to resume its trip without any attention whatever.

The new rail mill at Ensley, Ala., has been recently started, and the announcement is made that it is ready to take orders for immediate and future delivery for basic open-hearth steel rails. The operation of this mill is part of a gigantic industrial programme which has been carried out at this point by the Tennessee Coal and Railroad Company, and it indicates a great stride in the advancement of the iron and steel industry of the South. Ensley, which is practically a suburb of Birmingham, is now one of the most promising towns of the South, a considerable population having been attracted to the place by the extensive steel and iron works which have been established there within the past few years.

The Transport comments upon the failure of German locomotive manufacturers to fulfill expectations as to time of delivery of locomotives for the East Indian Railway. The reasons put forward by Indian railway companies for giving locomotive orders to German instead of English builders was quicker delivery and saving in cost. The latter is considered a relative term, and the truth of it cannot be tested until the foreign locomotives have been at work. The other reason has proved to be fallacious. In September, 1901, the East Indian Railway ordered forty engines from a German firm, which were to have been delivered in August, 1902, on the ground that thirty-nine weeks and £30,000 would be saved. The fact is that up to the middle of October none had been delivered at all, and completion of the contract is not expected until the end of the year. A year ago the Assam-Bengal Railway ordered ten engines from Germany, to be delivered in April, 1902, but not one of them has yet been delivered; nor were the twenty-two German engines ordered by the Bombay, Baroda & Central India Railway delivered within the forty-two weeks promised.

Modern Machinery contains some interesting facts about the minuteness of some of the screws made in an American watch factory. It takes nearly 130,000 of a certain kind to weigh a pound. Under a microscope, they appear in their true character—perfectly finished bolts. The pivot of the balance wheel is only one two-hundredth of an inch in diameter, and the gage with which pivots are classified measures to the ten-thousandth part of an inch. Each jewel hole in which a pivot fits is about one five-thousandth of an inch larger than the pivot to permit sufficient play. The finest screw for a small-sized watch has a thread of 260 to the inch, and weighs one one-hundred-and-thirty-thousandth of a pound. Jewel slabs of sapphire, ruby or garnet are first sawed into slabs one fiftieth of an inch thick and are shellacked to plates so that they may be surfaced. Then the individual jewels are sawed or broken off, drilled through the center, and a depression made in the convex side for an oil cup. A pallet jewel weighs one one-hundred-and-fifty-thousandth of a pound; a roller jewel a little more than one two-hundred-and-fifty-six-thousandth. The largest round hairspring stud is four-hundredths of an inch in diameter and about nine-hundredths of an inch in length.

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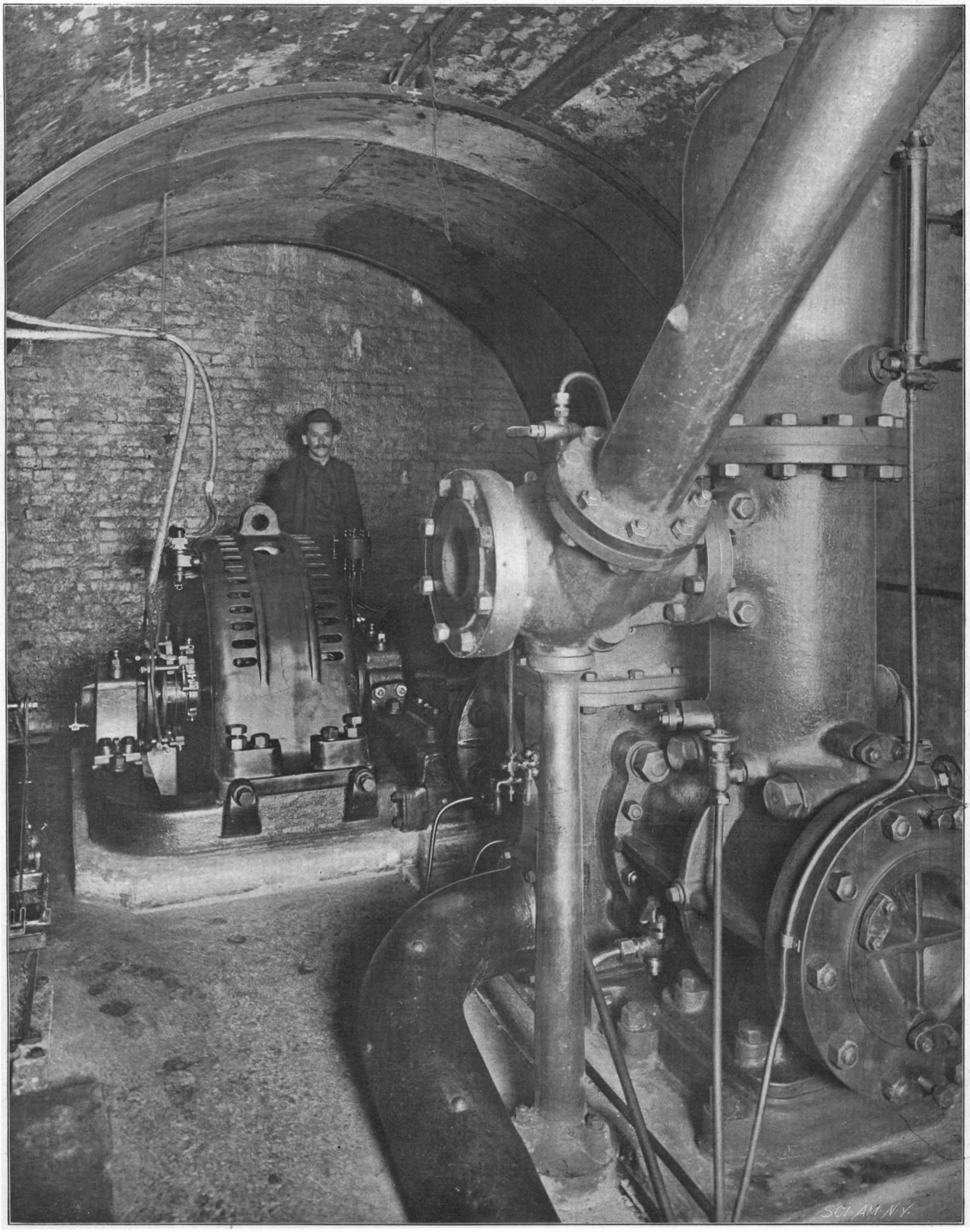

ELECTRICITY IN MODERN MINING INSTALLATIONS.—AN ALTERNATING-CURRENT MOTOR DRIVING A MINING-PUMP UNDERGROUND.—[See page 223.]