will prove profitable in its working, since it is of ample size to cope easily with the numbers of travelers requiring to journey over the few miles between Fratton and Havant at any time of the day. Should the coach prove successful, further vehicles of the same kind will be constructed for service upon other similar short sections of the railroads, and will in all probability be requisitioned for suburban traffic.

While the southern trunk railroads have adopted the steam motor for these automotor coaches, the North-Eastern Railroad has decided to utilize the petrol motor for the same purpose and is carrying out a series of experiments with various types of motors, to ascertain which is the best suited to their requirements. Orders have been placed with the Wolseley Motor Company, of Birmingham, and the Napier Motor Car Company, of London. The former company is building two motors, each to develop 95 horse on the brake. They are of the horizontal type, while the Napier belong to the vertical category, though it is anticipated for this class of work that the former will prove more satisfactory. These engines have not yet been completed, so we are unable to publish a photograph of the petrol-propelled coach.

The cars measure 53 feet, 3 inches from buffer to buffer, and the greatest width is 9 feet, 6 inches over balks. It is carried on two four-wheeled bogie trucks, the distance between which from center to center is 34 feet. The wheels are of 3 feet, 6 inches diameter over treads, and are provided with the usual type of axle-boxes, springs, etc.

The third-class coach is designed to carry 48 passengers, while the first and second class composite vehicle has accommodation for 14 and 24 passengers respectively. In the front of the coach is the compartment for the petrol motor, which is direct-coupled to an electric generator mounted on one baseplate. This compartment also contains a small exciting dynamo for exciting the fields of the generator, and for charging a small battery of accumulators for lighting, etc. This battery is contained in a suitable box slung beneath the frame in the center of the coach. The engine compartment also contains one complete set of control apparatus—controllers, regulating resistances, and switches—for driving the car, for driving the coach forward, while another set is installed at the other end of the coach for driving in the opposite direction. Each bogie is fitted with a powerful electric railroad motor.

The prime motor is a Wolseley 80 horse power four-cylinder petrol engine of standard type. The four cylinders are each 8½-inch bore by 10-inch stroke, giving 81 brake horse power at 420 revolutions, and with an acceleration up to 480 revolutions the engine gives 95 brake horse power. The cylinders work in pairs on two crankpins at 180 degrees from each other, thus obtaining two impulses at every revolution. The electric generator is of 60-kilowatt capacity, 500 volts, at 450 revolutions per minute, with a 5-kilowatt exciter. An electric railway motor of 50 horse power is mounted on each of the two bogies. There is a battery of 40 accumulators carried beneath the coach, of about 90 amperes capacity, for lighting and starting the petrol engine through the exciter. The choking and accelerating levers, and all controlling apparatus for the engine room and dynamo, are conveniently situated in the engine room. The necessary gear, such as brakes, controllers, etc., for driving the coach is installed in duplicate, one set at each end of the car, to enable the driver to occupy the front of the car when going either way.

The Westinghouse automatic air brake is installed, acting on all wheels, the air compressor being driven by a small electric motor. Powerful screw compensated hand brakes are also provided, a brake wheel being fixed at each end of the coach for its operation. A siren is fitted to each coach, operated by compressed air from the Westinghouse brake reservoir. Petrol and water tanks are provided of sufficient capacity to enable the car to run continuously for five hours at speeds up to 30 miles per hour. Ample silencers and exhaust boxes are also provided.

THE COAL INDUSTRY OF PENNSYLVANIA.

BY W. FRANK M'CLURE.

Five years ago Great Britain produced more coal than America or any other country of the globe. Since that time the United States in one year has mined 25,000,000 tons more than Great Britain and all her possessions. This is one of four important facts peculiar at this time to American coal mining. The other three are found in the development of the vast Southern resources, the combining of mining properties, and an evolution of the industry.

The development of the Southern fields gives some promise that the United States will yet become an important exporter of coal. The numerous consolidations of mining properties are believed to be the first steps toward another such giant combination as that represented by the United States Steel Corporation in the world of iron and steel.

Since surpassing England, the United States has not only maintained her prestige, but has increased it. The annual output has grown nearly one-half in five years, and is now figured at one-third that of the world. While there is an end in sight to England's coal, in America there is no visible end except to Pennsylvania anthracite. The annual American production now exceeds 293,000,000 tons, of which more than 225,000,000 tons are bituminous. To dig out this coal nearly a half million men are employed, of whom less than 150,000 are engaged in the famous hard-coal regions, which are located in Pennsylvania save very small beds in New Mexico and Colorado.

Five hundred or more feet beneath the surface of the ground of the anthracite or bituminous regions of Pennsylvania there exist many busy mining centers. So varied is the topography of the coal regions, and so different are the conditions and the necessities in the different localities, that no description of the construction of mines and methods of mining and transportation can be true of all mines, even though of the same type. The mines pictured on another page are of the shaft type, and are to be found in largest numbers in the hard-coal districts. The hard-coal mines are likewise the deepest. Occasionally an extreme depth of 1,500 feet is attained. The mine foreman's office, which is shown in the illustration, is 550 feet beneath the surface in the soft-coal fields of the Connellsville regions. The mine in which this view was taken is owned by the United States Steel Corporation, and is the deepest one in that section of the State.

Incidentally, there are two other styles of mines to be found in both anthracite and bituminous fields—"drifts" and "slopes." The drift mine is dug straight into the mountain from one side. The passageway or heading may have an upward trend. The slope mine slants downward to the extent of perhaps thirty-five or forty degrees, the main heading often measuring a mile or more in length.

Occasionally coal is found in quantities near the surface of the ground. This is true to-day in parts of Missouri. At both Hazelton and Summit Hill, in Pennsylvania, coal has been extracted by an uncovering operation known as "stripping," and which is regarded as apart from mining proper. An interesting process also is "pocket mining," but this is practised comparatively little to-day. An outcrop of coal at various points on the side of the mountain suggests the possibility of a rich mineral vein. Digging is begun directly into the bed of coal projecting at the surface. This form of mining is seldom highly profitable, for when the digging has progressed at considerable expense to a point where the mine should be expected to pay, all operations are suddenly cut short by the encountering of solid rock, which, owing to some upheaval of the past, has "faulted" the vein of coal from its natural course. These pockets at intervals in the mountains where pocket mining is done present an interesting sight. About Shickshinny, Pa., they are numerous.

Descending by means of an elevator into the depth of the soft-coal mine before mentioned, we find ourselves in front of a whitewashed haulageway which extends far into the distance. The mine is a strictly modern one. Nearby we find a door leading into the mine foreman's office, and this in turn connects with the office of the fire boss. The foreman sits at his desk in the midst of mine reports and books of rules. Like the miners in the distant rooms, he is breathing fresh air, made possible at this depth by an air course which parallels the elevator shaft, the bad air being drawn out by means of fans, while the pure air rushes down the shaft to take its place. In close proximity to the foot of the elevator shaft are the stables of the mules, and these are likewise whitewashed. The mules in such a mine as this do not see daylight for months at a time. The haulageway, the offices, and the stables are lighted by electricity.

In shaft mines, and especially those of anthracite, mules are used very extensively. Where mechanical power is employed to haul trains in the main haulageways, these beasts bring the cars only from the side headings or the rooms. In bituminous drift mines the evolution has included the introduction of miniature trolley trains of forty or fifty cars, each train being in charge of a motorman and brakeman. In anthracite drifts steam locomotives of a small and peculiar type known as "hogs" haul the trains. In a slope mine cable trains transport the coal. One end of the cable is attached to the train, and the other winds upon a drum at the power house. When the cable turns a corner it passes around what is known as a "bull wheel." Twenty-five one-ton cars may comprise a cable train of soft coal. Anthracite cars often hold four and a half tons. In soft-coal mines the man in charge of the cable train is called a "rope rider." In bringing his cars out of the mine he sits upon the ring which connects the cable with the train. In the anthracite slopes a man stands upon the side of a car ready to "sprag" the wheels when a stop is made. Spragging consists in throwing short but stout lengths of wood into the openings between the four spokes of the car wheel.

The differences in the modern soft-coal mine and the anthracite mine are very perceptible. It has been found impossible to employ electrical machinery and mechanical inventions in the actual mining operations in anthracite. Therefore picks and hand drills with blasting powder are still the mainstay of the anthracite miners, and the 4,000 machines in use in the United States are all at work in soft coal. More than fifty per cent of the big increase in bituminous coal production in the past few years is accounted for by the rapid introduction of machines. They are now in use in half the States and Territories. One-third of the bituminous product of Pennsylvania is mined by their aid. These machines make the undercut that is to loosen the coal at the bottom. They cut as far back as the vein is high. The blade, which is four to six feet in length, severs the block of coal at the bottom and drills bore holes horizontally at the top. Powder is crowded into these holes and a fuse, or squib, is lighted. Blasting operations are similar in the anthracite regions. There, however, the miner may break down enough coal at one blast to keep his helper busy loading for two days.

The photograph of the room in the hard-coal mine illustrates nicely the great height of the veins of coal in the anthracite districts. The height of the bituminous vein is often not more than four or five feet, thus making the quarters of the miners rather cramped. In the mining of anthracite only two-thirds loosened from the vein is of value. The miner must use good judgment in loading only the paying coal. To handle and transport chunks in which slate predominates is unprofitable. Even the better coal has more or less slate in it, while in bituminous coal the slate is principally at the top and bottom of the vein and not mixed with the product as mined.

Off from the main or side headings of a hard-coal mine "breasts" or "chambers" are opened. In bituminous fields these are known as "rooms." A tunnel or neck forty to sixty feet long may connect the room proper with the main passageway. Beyond the neck the chamber may broaden out to a width of thirty or more feet, continuing indefinitely. The coal between the rooms forms what is known as a "rib" or "pillar." As the rooms begin to broaden to their maximum widths, timber props are placed between the floors and ceilings to support the loose rock and earth. Apart from supporting the great mass of solid rock, they are of little service.

When all the coal that it is practical to mine in the chambers has been extracted, the work of drawing the ribs between the rooms is begun, eventually allowing the rock above to cave in. In addition to securing the coal in the ribs, this process is necessary, that the weight of the mountain bearing upon the entrance to the mine may be lightened. As mining progresses, the weight is thrown upon the main heading, until, were it not for the drawing of the ribs, this main passageway would close.

When drawing a rib, the soft-coal miner keeps but one car beside him. He can not tell how much of the rib he will be able to remove before the rock above his head will fall. The first warning of approaching danger is a drumming noise from the layer of stone overhead. Sometimes this noise may be heard hours before the final crash; in anthracite mines it may be perhaps weeks before. Again, it may come with marked suddenness.

The coal breaker, about which the public has heard not a little during the last big coal strike, is an anthracite institution. The breaker is mentioned perhaps oftener than some other important plants chiefly because of the tender ages of the thousands of workers employed within them. The character of anthracite coal as mined makes it imperative that the breaking of it shall comprise a branch of the coal industry. The large chunks must be broken and the slate must be separated.

A modern coal breaker built on the side of a hill at Mocanaqua, Pa., will serve to illustrate the construction and operations connected with this important branch of producing coal. This breaker is 300 feet in length and 180 feet in height. Ten tons of spikes and nails were used in its construction. It is capable of turning out 1,000 tons of clean coal per day. Some breakers have a capacity several hundred tons more. The Mocanaqua breaker was originally built at a cost of $50,000, but with recent improvements and the installation of the latest machinery its total cost reaches $100,000. It is heated by steam.

Two 4½-ton cars of anthracite are brought to the head of the breaker at one time over a little railway leading from the mine in the side of the mountain. The coal when dumped from the cars passes over a screen thirty feet in length, through which the fine coal sifts. The big chunks next pass to the breaker proper, where the rolls crush it until none of the product is larger than what is known as "steamboat size." It next runs into a screen which is cylindrical in shape, and not unlike a locomotive boiler in appearance. As the coal is handled in this device, it falls through perforations of different sizes, each size dropping into a separate chute. On benches at intervals on these chutes, sit the breaker boys, presided over by a boss. As the coal passes slowly down the chute at their feet, these lads pick the slate from it and throw the refuse into a parallel chute. The inexperienced boys are always at the upper end of the chutes. They succeed in picking a part of the slate from the coal, and then it passes to the next workmen in line, who continue the operation until, by the time the product has reached the last boys in the rows—the ones at the bottom of the chutes—it is pretty well cleaned. From the chutes the various sized coal finds its way into bins, from which it is discharged into cars.

It is said to be difficult nowadays to find as many breaker boys as are needed, and, partly on this account, mechanical contrivances for sorting have recently been installed at great cost in modern breakers. These inventions are spiral in shape, and provide for ridding the coal of much of its slate by centrifugal force. But even with these machines the final operation must be performed by boys or men.

A large amount of the soft coal in Ohio and Pennsylvania is brought to the lower harbors of the Great Lakes, bound for the Northwest and Canada. The cars which carry this coal have a capacity of 100,000 pounds, whereas, in the early days of the coal industry in this country, coal cars scarce carried 1,800 pounds. On reaching the lake ports, coal for Canada may be taken sixty miles across Lake Erie in car ferries. But the bulk of the coal that comes to the lake ports is unloaded directly into the holds of lake vessels by means of most wonderful and massive machines, which pick up a 50-ton car and dump its contents as quickly as a pail of coal could be emptied into the magazine of a stove. Some of these machines can be operated by three men, and yet have a capacity of 500 tons per hour. A large and modern coal vessel will carry a coal cargo of 6,000 tons. The cargo record is 7,800 tons. More than 2,500,000 tons of coal have gone to the head of the Great Lakes in a single season.

Marconi's Recognition of Italy's Services.

The large rentals and heavy royalties demanded by the Marconi Company are said to be the chief reasons why the United States government has decided to adopt the Slaby-Arco or some other system. It is interesting, therefore, to note that Mr. Marconi is not quite as selfish as the reports which have been circulated would seem to indicate. He has ceded his apparatus to the Italian government, free of charge, giving permission to have it reproduced in military establishments, provided that his patents be not infringed. It is said that twelve wireless telegraph stations will be established on the coast and on the islands off the Italian coast, each station having an average range of about 200 miles. Some of the stations are to be completed before the end of the present year, and the others within the first six months of 1904. The arrangement as to rates deserves some attention.

The receipts from telegrams sent from stations on the Italian coast will be paid into the government treasury; the receipts from mesages sent from ships equipped with the Marconi apparatus will go to the Marconi company, and finally, the Italian government will receive a fixed tax of one lire per message above the ordinary cost of telegrams.

The Use of Phosphorus Matches Prohibited in Germany.

The Reichstag has passed a bill forbidding the use of white or yellow phosphorus in match-making after January 1, 1908. The Secretary of the Interior, speaking in favor of the bill, said that phosphorus not only caused necrosis three or four years after a workman had left a match factory, but that the disease thus contracted was hereditary, so that whole families were affected. So subtle were the effects, that the bones were fractured without the person being even aware of the fracture at first. The government has reported favorably upon a match-manufacturing process said to be safe and harmless.

On May 9, the largest glass bottles even blown were made at the plant of the Illinois Glass Company for exhibition at the World's Fair. The capacity of each bottle is 45 gallons. It was not until after many unsuccessful attempts that the bottles were made. Four perfect bottles were produced. Each stands nearly 6 feet high and measures about 16 inches across the bottom. The men who blew the bottles each supplied about 11,000 cubic inches of air.

Engineering Notes.

It is likely that a system of power fans will be used to ventilate the New York subway when it is completed. The problem, however, of suitably ventilating the subway will not be formidable, for the reason that the stations are close to the surface of the ground. In this respect the New York system will differ widely from that of London, where the tubes are so far underground that the air quickly becomes vitiated.

A great pumping scheme is to be carried out in South Staffordshire, England, by means of which over 40,000,000 tons of coal which are at present submerged will be released and rendered available for mining. The district in which the scheme is to be carried out includes the important industrial centers of Tipton, Wednesbury, and Bilston. The project has been contemplated for many years past, but it is only recently that the scheme has been reduced to any practical form.

His Majesty's battleship "Hood" arrived at Devonport recently after steaming from Malta, a distance of 2,035 miles, without a rudder. On docking at Malta it was found that the rudder could not be satisfactorily repaired, and that it would be necessary to fit a new one, which must be cast in England. The disabled rudder, weighing fifteen tons, was accordingly hoisted on board and lashed fast on the deck, and on October 21 the "Hood" left Malta rudderless, arriving at Gibraltar on October 24, having done 981 miles at an average speed of twelve and a half knots an hour. Leaving the Rock on the following day in a strong northeasterly gale she ran into a fog on the last day of her voyage (Tuesday), but ultimately reached Plymouth the same evening, having made the 2,035 miles in a little over six days, or at an average speed of nearly thirteen knots an hour. This would be a good performance for any battleship under normal circumstances, but for a vessel without a rudder in a heavy sea, continually being twisted round out of her course, it is a feat of seamanship reflecting the greatest credit on her officers. It should be added that the "Hood" was convoyed by cruisers.

In these days of high coal prices and strikes, it is interesting to know that peat gas has been employed as fuel at the Motala Steel Works, Sweden, for the past thirty years, originally for the puddling furnaces, and to a still greater extent, subsequently, for the open-hearth furnaces. The peat is obtained from the further side of Lake Wetter, across which it is brought in sailing vessels and unloaded directly into large storehouses, whence it is trammed to the gas producers. The yearly consumption is from 13,000 to 16,000 cubic yards of dry kneaded peat, costing about 75 cents per cubic yard delivered at Motala. Two large gas producers are used, from which the gas is led to the open-hearth furnaces through a condenser for ridding it of some of its moisture. Although the peat gas, owing to the distance the peat has to be brought, is dearer than coal gas, it is used preferably in most Swedish steel works in consequence of the insignificant amount of sulphur and phosphorus it contains. In the rolling mill there is a smaller peat-gas producer for one of the plate furnaces, and thin steel plates especially scale less in rolling when the furnace is fired with peat gas.

The designs of the Quetta Nushki Railroad in Persia as a light road capable of being brought up to the standard of other frontier railways, when the circumstances so demand, have been completed and accepted by the government of India. The length of the line is 82½ miles, and the estimated cost is about 7,000,000 rupees, or 85,000 rupees per mile. The route selected for the construction of the track involves passing through three mountain barriers, viz., the Chiltan, the Mashelak, and the southern tail of the Khwaja Amran range, which separates the Quetta plateau from the Nushki plain, by the intermediate steppes of the Mastung and Sharud plains. The road leaves the existing Bolan section of the Northwestern Railway twelve miles from Quetta, and three from Spezand Station. Through the three mountain ridges the work is heavy, and a good permanent foundation is provided for. Otherwise the country is comparatively easy, and a surface track only, capable of improvement later on, is at present intended. The steepest grades are 1 in 50, compensated for curvature, and the sharpest curve has a 573-foot radius. A tunnel at Spezand is to be built, 2,600 feet long, five miles from the commencement, and the heavy works in the Sheikh Wasil gorge, miles 27 to 32, are to be put in hand at a cost of about 4,750,000 rupees during the current financial year, and work on them will be commenced at once. These are the only heavy works in the first 50 miles; and as soon as they are negotiated there will be no further difficulty in at once carrying out the road to that distance. This will give immediate access to the Sharud plain, and will enable the entire line to be completed with speed and economy. This railroad will not only be an important one from a commercial point of view, but is also of great political significance.

Electrical Notes.

During a research into the electro-chemical behavior of sulphur Mr. F. W. Küster has observed that during the electrolysis of a solution of a polysulphide, both the current and the voltage undergo periodic variations, which are shown to be due to the deposition of sulphur on the anode. The periodicity of the phenomenon is, however, difficult to understand. In order to throw light on this, a number of measurements of the potential differences between electrodes of platinum or of silver and solutions of sodium polysulphides were made. The results show that such electrodes may be regarded as sulphur electrodes, just as a platinum plate saturated with oxygen may be regarded as an oxygen electrode.

When we consider what an important adjunct the telegraph has become to the railroad, says The Electrical World and Engineer, it is hard to get one's self back to the time of the Baltimore & Ohio experiments of 1844, and to take seriously Prof. Morse's suggestion that if a break were found in the telegraph wire, the train should stop long enough to repair it. But this is what he said: "Very little interruption would take place if the train that discovered a break would stop not more than five minutes, and, being furnished with pieces of wire already prepared for the purpose, any one could simply unwrap and scrape the broken ends and unite them by twisting the ends of the pieces of wire to them."

This country is rapidly becoming the center for the manufacture of cables for underground telephonic communication over long distances. The reason for this is not due to any economical or other aspects in the actual manufacture, but is entirely the result of atmospheric influences. One of the greatest difficulties that confronts the problem of telephone practice over long distances in England, is the provision of satisfactory insulating material. All insulating substances at present utilized in the manufacture of cables absorb the electric current to a certain degree. The extent of this absorption depends upon two factors—the nature of the dielectric employed and the potential of the current transmitted through the wire. In the cases of high-tension currents the leakage in this direction is so small as not to be worthy of notice, but in the case of a telephone cable, where the potential of the current is very low, this absorption is a matter of grave importance. So far the best dielectric yet discovered is anhydrous paper, which is extensively adopted in England. This substance has the lowest specific inductive capacity of any known dielectric. In order that cables composed of anhydrous paper may be rendered absolutely trustworthy and satisfactory, it is imperative that the process of manufacture should be carried out in a perfectly dry atmosphere. Should the paper come into contact with moisture at any time during the making, its future good working will be absolutely nullified. In Great Britain, owing to the natural humidity of the atmosphere, it is absolutely impossible to manufacture the material; while in this country, owing to much drier atmospheric conditions, we are enabled to turn out a perfect article. Consequently, the industry has fallen into desuetude in Great Britain, while this country is becoming the center of the supply.

M. S. Leduc recently explained before the Academy of Sciences in Paris his method of inducing sleep and anæsthesia by electrical currents. He employs an interrupted current in a low-resistance circuit, and sleep is induced by gradually augmenting the E. M. F. in the circuit. From further information we have received it seems that the frequency of the current used is from 150 to 200 periods per second. Besides the interrupter, there is also placed in the circuit a milliampere meter, the period of oscillation of which is much longer than the duration of the interruption of the current. Under these conditions, when the instrument is traversed by an intermittent current the needle undergoes a permanent deviation, which enables the intensity of the currents having the same intermittence and the same duration to be compared. Leduc has experimented with currents of varying degrees of intensity, but those which gave the best results had from 150 to 200 intermittences in the second with a tension of from 12 to 30 volts. The cathode is made of hydrophilous cotton impregnated with a solution of sodium chloride of the strength of 0.60 per cent, and covering with a plate of metal. This is placed on the shaven head of the animal to be experimented on, while the anode is placed on the hinder part of the back, which is also shaved. The E. M. F. is increased till convulsions take place, and the animal falls on its side and respiration ceases. The handle of the regulator is then brought backward till respiration returns, and with a certain strength of current, tranquil, ordinary sleep is induced. The duration of the sleep is variable, in many instances lasting for two hours or more without any ill effects upon the subject. The return of consciousness is effected by the removal of the current, and no injurious consequences are said to follow.