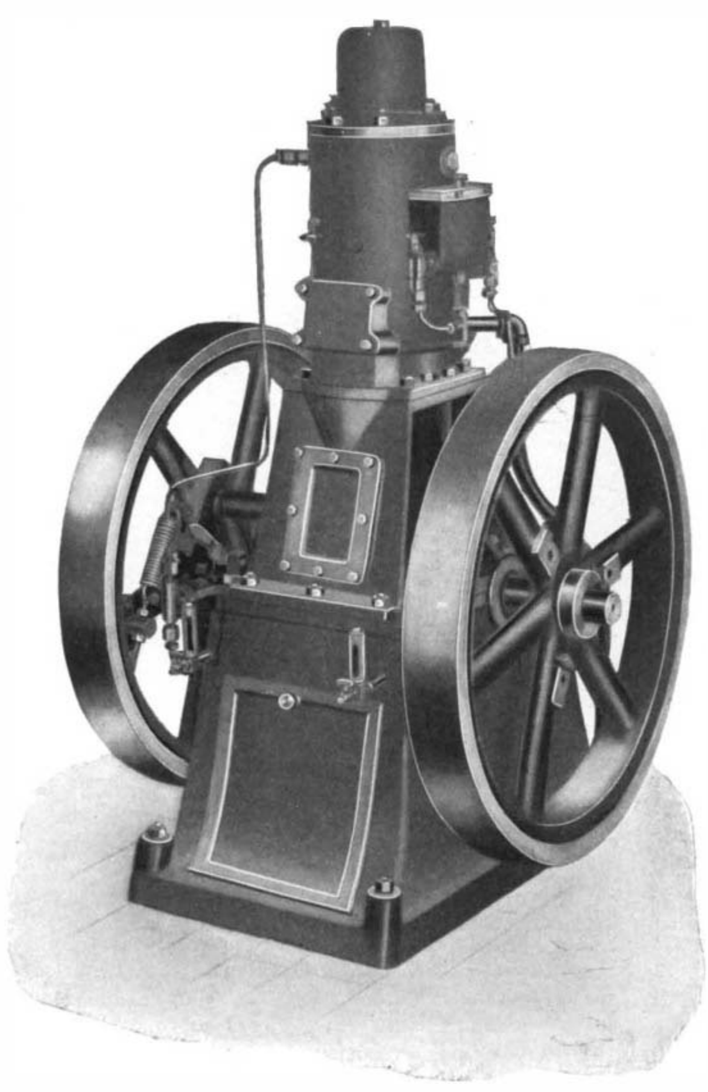
A SIMPLE KEROSENE ENGINE.

Considerable improvement has been made in the past few years in the utilization of kerosene oil as a motive power for combustion engines. Kerosene oil can be had almost anywhere, and on this account the problem of supplying a cheap small power is greatly simplified. Our illustrations show a new type of kerosene engine recently introduced, which has the merit of simplicity in a remarkable degree. It is of the two-cycle type, in which an explosion occurs in the cylinder at every revolution of the crankshaft; but its two most important features are that it operates without valves, and that the oil is forced by means of a small pump into the cylinder in the form of a spray through a suitable nozzle at the instant the piston begins to descend on its downward stroke, thereby avoiding premature explosions. Referring to the diagram, it will be noticed that the ignition is accomplished by the usual ignition hot tube or dome *D* at the upper end of the cylinder, the dome being protected by a damper cap to prevent heat radiation after the engine is started. A concentric cap fits over the inner cap. When both apertures coincide, the heating lamp for starting is placed inside; after starting, the outer cap is rotated till the apertures are covered.



A VALVELESS KEROSENE ENGINE.

The operation of the engine is as follows: the ignition dome *D* is heated for five minutes or more by a Primus kerosene blue-flame torch, then the handle of a small oil pump (seen on the left-hand side in the larger engraving) is operated a few times, to force the oil up from the tank *T* through the nozzle *O* into the cylinder *F*. One or two quick turns of the flywheel are given, then the engine starts.

On the up-stroke of the piston *P*, air is drawn in through two holes *A* in the base, and follows the piston through the port *B* into the crankcase *C* as soon as the piston uncovers the port. On its descent the piston slightly compresses this air in the crankcase until its upper end uncovers the exhaust *E* and also the air inlet *I*, then the exhaust gases pass out of *E*, and by the curved top of the piston the air from the crankcase is projected upward at the same time into the cylinder and locked there upon the upward stroke of the piston *P*, which closes the air inlet *I* and exhaust port *E*.

The air in the cylinder is then further compressed and heated by the continuation of the up-stroke of the piston, and just as the latter is about to descend a minute quantity of kerosene is injected by the oil feed pump and is immediately vaporized and mixed with the air, forming an explosive mixture that is in turn ignited by the hot dome *D*, the explosion driving the piston downward. The combustion is so perfect that the cylinder always remains clean and the piston is never clogged by soot. There is thus a positive entrance of the air and oil to the cylinder in regular sequence. *G* is an oil well for one of the main bearings, and *H* is a faucet for drawing off the oil collecting in the bottom of the crankcase.

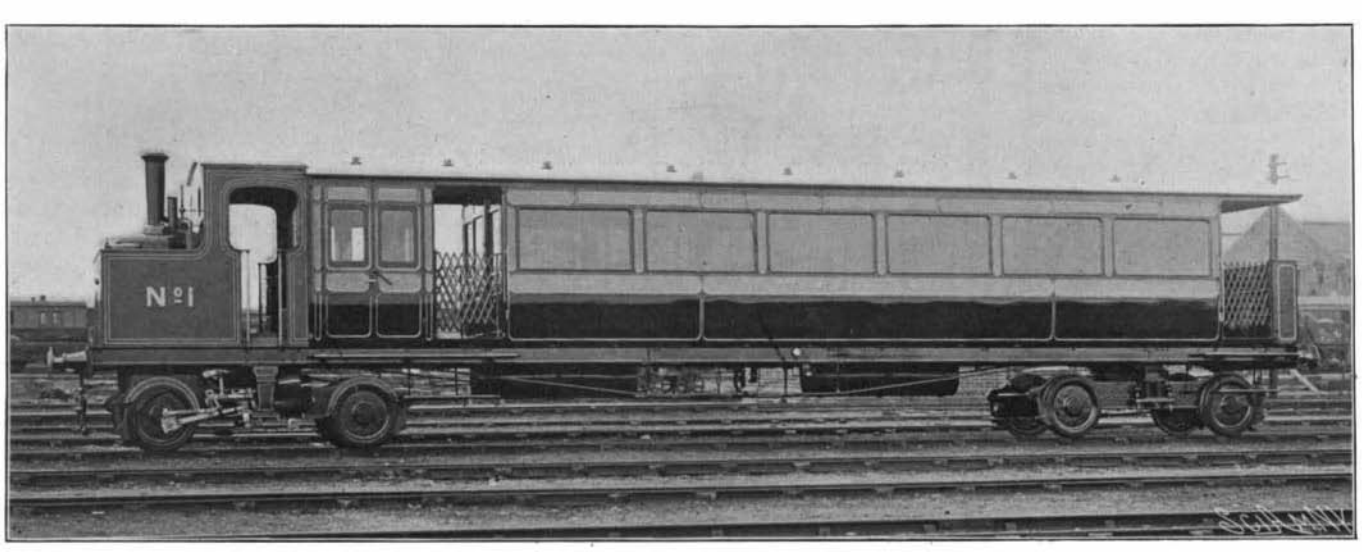
The tank containing the lubricating oil is located on the outside of the engine near the upper end, from which two small feed pipes lead, one for lubricating the cylinder, the other for the centrifugal oiler, which carries the oil through a small hole (not shown) in the center of the crankshaft to oil the crankpin. In this way oiling by the usual splash system is avoided.

The main-shaft bearings are fitted with the latest type of ring oilers, having glass cups, and it is said only require filling but once a month. The exhaust from the engine is smokeless and odorless, provided the right quantity of oil is used for lubrication.

An eccentric on the main shaft with a variable throw, regulated by an exceedingly simple governor, changes the stroke of the oil-feed pump to suit the load. The engine responds very quickly to the varying quantities of fuel it receives, and the governing action is consequently positive and very close. This results in high efficiency, and makes it possible to obtain a brake horse power with 0.7 to 0.8 pound of oil, or a little less than a pint, which weighs about 0.85 pound. The Diesel engine, which is the most economical one made, consumes 0.45 to 0.55 pound of oil per brake horse power.

It will thus be seen that the American engine compares very favorably with it. When running with a three-quarters load, the engine consumes slightly less oil per horse power than when carrying a full load. In other words, it shows the highest efficiency at three-quarters load, and then requires a consumption of about one-tenth gallon of oil per horse power per hour. If stopped, the engine can be started within five minutes without reheating. We are advised that the engine has lately been introduced by the American and British Manufacturing Company, and is now manufactured at the Ordnance works of the company at Bridgeport, Conn.

The model we saw in operation showed fully five brake horse power, and easily carried a load of sixty 16 candle power incandescent electric lamps. The engine can be started to run in either direction as may be desired, and is so simple that it can be managed by a person of ordinary intelligence.



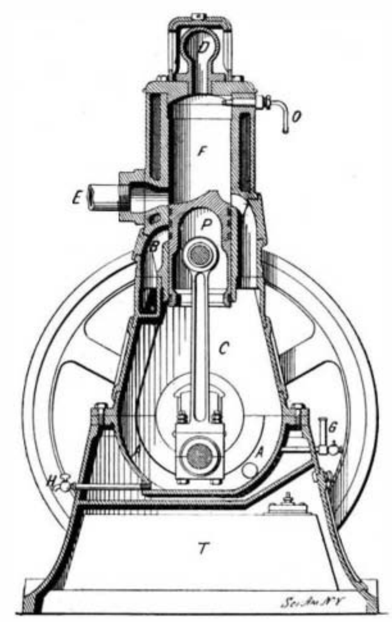
MOTOR COACH BUILT FOR THE LONDON AND SOUTH-WESTERN RAILWAY.

MOTOR COACHES FOR BRITISH RAILROADS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Now that the automobile has asserted its superiority over other systems of rapid locomotion upon the highroads, and the engines for propelling the vehicles have been developed to a high standard of efficiency, the adaptation of the motor car to railroads is being seriously considered. In Great Britain several attempts are being made to introduce the motor-propelled vehicle upon certain branches of the railroads. Although the North-Eastern Railway Company was the first to decide upon the innovation, the first actual coach built upon these principles for use has been constructed conjointly by the London and South-Western Railroad and the London, Brighton, and South Coast Railroad, two trunk lines operating in the south of England.

The self-propelled motor coach possesses many advantages over the existing system for some phases of railroad working, the most obvious of which is its



SECTIONAL ELEVATION OF KEROSENE ENGINE.

utilization as a feeder to the through lines. Some branch lines extending through sparsely-populated areas cannot be profitably operated, although a train service is absolutely necessary. It is for such exigencies that the self-propelled motor coach is peculiarly suitable, since the cost of maintenance is much less than that of a fully-equipped train.

The experimental coach constructed by the London and South-Western and the London, Brighton and South Coast Railroads, a photograph of which we are enabled to publish herewith through the courtesy of Mr. Drummond, the chief engineer to the former railroad, is intended for service between Fratton and Havant, a short line on the south coast joining the main trunk systems of the respective companies.

This coach consists of practically an ordinary passenger vehicle, with a small space allotted in the fore part for the accommodation of the motor. The latter in this instance is of the steam type. The coach is 56 feet in length over all, including the engine. It is carried upon two four-wheeled bogie trucks, the driving mechanism being attached to the two fore wheels of the front bogie. The passenger accommodation is divided into two compartments, one for first-class, and the other for third-class passengers. The compartment for the latter has a capacity for 32 passengers, the seats being arranged in the manner that prevails in American cars, on each side of the gangway, which extends through the center of the car. The first-class compartment is built to seat ten passengers, the seats in this instance being arranged longitudinally on either side of the car. Between the space reserved for the passengers and the motor is a small space for the conveyance of ten tons of baggage. The boiler, to economize space, is of the vertical type. The front pair of wheels of the fore bogie truck, as already stated, are the drivers, the cylinders being of 7-inch diameter and 10-inch stroke. A cab is provided for the engineer and his fireman. As will be recognized from our illustration, the motor has been compressed in as small a space as possible, and the general arrangement of the vehicle is very ingenious. The coach has been designed with the idea of attaining a speed of 30 miles an hour in half a minute after starting. There is no doubt that this class of self-propelled motor coach 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