than the European manufacturers employ in making their coal briquettes.

This binding cement is one of the important features of the Chicago coal briquettes, and it marks the chief difference between the American and European product. The binding material was discovered through the experiments made in pressing various metallic ores into briquettes. Applied to coal dust, this cement proves much harder than that used in Europe, and consequently yields less readily to the disintegrating effect of the fire. By retaining their shape longer when burning, the American briquettes prove much more satisfactory from a heating and economical point of view. They also lose less from wear and tear in transportation and general handling. And finally the smoke nuisance is reduced to a point where it ceases to be an important factor in the question.

There is one large factory in Chicago which has been successfully manufacturing the American coal briquettes for several months, and with a daily output of 200 tons, or about 60,000 tons a year, the plant is probably the most representative of its kind in this country. The success of this Western plant has already started a similar movement in the East, and a second plant may soon be built near the Atlantic seaboard.

In Chicago, Illinois, soft coal is employed for the briquettes, with a slight quantity of anthracite mixed with it to give it more hardness, but on the Atlantic seaboard hard coal would have to be used to make the briquettes popular. The so-called "slack" coal of the mines is employed for this purpose, and after the slate and sulphur have been eliminated by washing and other processes, the coal is reduced to dust by means of powerful crushers manufactured especially for this work. These crushers are powerful enough to pulverize the most resisting substance that may be mixed with the coal, and nothing but dust of a fine, even texture comes from it.

THE SHAH OF PERSIA LEARNING HOW TO OPERATE A SERPOLLET CARRIAGE.

The dust is carried from the crusher to a heater, where a temperature is maintained between 180° and 200° F. This heat is sufficiently below the igniting point of coal, and high enough to make the binder adhere firmly, to produce the desired results without in any way injuring or changing the chemical condition of the coal dust. An automatic elevator next carries the heated coal dust to the floor above, where it is mixed with the binder while still warm. The mixers are experts in their line, who know the exact proportion of different substances needed to make the briquettes hard.

The binding materials are contained in enormous tanks on this floor. In one huge tank there is slaked lime mixed with just sufficient water to make it thick and creamy. In a second tank there is a soft mass of bitumen heated to a temperature of 350°, while in the third tank there is cold bitumen. With these ingredients at hand the mixer performs his work according to formula. With weighing apparatus for each ingredient he fills another receptacle, capable of holding a thousand pounds, with the different compounds, until the right consistency is obtained. As the success of the whole process consists in the proper mixing of these ingredients, it is highly important that the measurements should be exact, and the work is performed under the supervision of competent experts. In this gigantic mixer the coal dust and the binding material are thrown by automatic machinery, and when they have been properly stirred and mixed they fall through an opening to the room below, where the powerful presses are ready to convert them into suitable sized briquettes.

The mixture, which is now about as thick as paste, is first fed into small moulds arranged on a wheel. As this wheel revolves with the paste in its pockets, a second wheel meets it with indentations to correspond to the first. The two come together so that an enormous pressure is exerted, and the briquettes are squeezed by a force equal to five tons to the square inch. This great pressure moulds the briquettes into solid, compact masses, and when they are dropped out they are nearly as hard and firm as bricks. At present the size of these briquettes is about equal to small egg coal, and they weigh between five and six ounces each. They are adapted to use in ranges, furnaces, and the open grate. The size and form, however, are merely arbitrary, and the moulds can be made to suit the demand of any special grate or furnace. New moulds can be made and substituted for the present ones very easily. It is simply a matter of making new wheels and putting them in the place of the present ones.

The great improvements recently made in coal-washing machinery now make it possible to produce briquettes from washed coal screenings at an extremely low cost. In addition to the ordinary briquettes, for use in the home furnaces for generating heat and in locomotives and factories and mills for producing steam power, a special size briquette will be manufactured for marine purposes. This is made with the idea in view of utilizing every available space in the storage rooms of a steamer. These marine briquettes are in the form of bricks of a rectangular shape, and they can be stored so compactly that a ton will occupy only 23 cubic feet. Specimens of these marine briquettes have been submitted to the Navy Department, and suitable tests will be made. For this purpose the coal will be washed to eliminate all sulphur and all chances of spontaneous combustion, saving thereby in storage capacity and cost. On the Western railroads, especially on the Illinois Central Railway, tests have been made with the soft-coal briquettes, and the results are so far satisfactory that the demand for them is greater than the present supply.

Preparations are being pushed now for starting two or three coal briquette manufacturing plants on the Atlantic coast, and before spring these will be in full operation. The coal dust of the anthracite mines will be used for making the briquettes in the Eastern factories. In Pennsylvania these dust heaps amount to millions of tons, which washed and loaded on cars can be purchased in unlimited quantities as low as ten cents per ton at the mines. In the West and South the briquetting of the lignite coal and soft coals, that will not bear transportation, promises to be the most successful, and this coal can be used without producing smoke or cinders to any appreciable degree.

THE SERPOLLET STEAM AUTOMOBILE.

Among the new automobiles to be seen in the Transportation Palace of the Champ de Mars was the steam automobile invented by M. Serpollet, the combustible being ordinary petroleum. The Serpollet system of steam generators has been already applied to a number of the tramway systems of Paris and other cities. The inventor, who is one of the pioneers in steam traction, has recently perfected a system of steam automobiles which has attracted considerable attention among engineers and sportsmen. The Shah of Persia, on a recent visit to Paris, was greatly pleased with the new machines, and purchased one for his own use. One of the illustrations represents the Shah taking lessons in driving the machine from M. Serpollet. The Shah was so well pleased with the vehicle that he conferred upon the inventor the Order of the Lion and Sun. Another engraving shows the Prince of Wales in his double-seated phaeton of eight horse power, the view having been taken during a recent excursion in Germany.

The mechanism of the system consists essentially of a spiral tube boiler, a four-cylinder engine, and an automatic feeding device. The boiler is constructed upon the same principle as that now in use in the steam tramway system, this consisting of a flattened copper tube of very small opening and thick walls, coiled into a spiral; for the tramway boilers the tube is heated by coke, but for the automobiles a special form of petroleum burner is used. When water is forced into the tube, the vaporization is instantaneous; and as the walls of the tube are very close together, the water cannot assume the spheroidal state, and thus all danger of explosion is avoided. The petroleum burner has been constructed to produce an especially hot flame with the use of ordinary oil, and to this end

H. R. H. THE PRINCE OF WALES IN A SERPOLLET CARRIAGE.

it is conducted under pressure to the burner, where it is volatilized and mixed with air, forming long blue flames like those of a Bunsen burner; the petroleum is thus entirely consumed without odor or smoke. The burner is first heated by a small quantity of alcohol, and when sufficiently hot to vaporize the petroleum, the latter is turned on and produces the flame. The boiler is not subject to deposits, on account of the rapidity of water circulation, and by the cleaning out which may be given by allowing a violent back rush of steam and water.

The circulation is so arranged that the expenditure of petroleum and water and the steam pressure are always a function of the force to be produced. The arrangement of the parts will be seen in the diagram, which shows the water and oil reservoirs, and the boiler in the center; below the boiler, at *P* and *P'*, are the automatic oil and water pumps with their valves, *S* and *S'*. To the left is the water pump for starting, *P*, with its lever, *L*, and valve, *S''*. At *C*, below, is a series of eccentric disks which operate the pumps by means of the lever arm. The petroleum arrives under pressure by the tube, 2, and is forced by the pump into the burner, 4. The water, forced by one of the pumps into the tube, *c*, goes from there either to the boiler or to the regulating valve, *K*. The steam from the boiler goes to the engine by *e* and has a branch to the regulating valve; the latter communicates with the reservoir by the tube, *m*. As long as the steam pressure is not above the normal, the valve is out of action, and all the water from the pump is sent to the boiler; but when the pressure below the piston reaches a certain point, it is forced up and makes communication between *F* and *m*, and part of the water is returned through the valve to the reservoir until the steam pressure falls again to the normal. The valve has a handle at *M* which serves to empty the boiler by allowing a back rush to the reservoir.

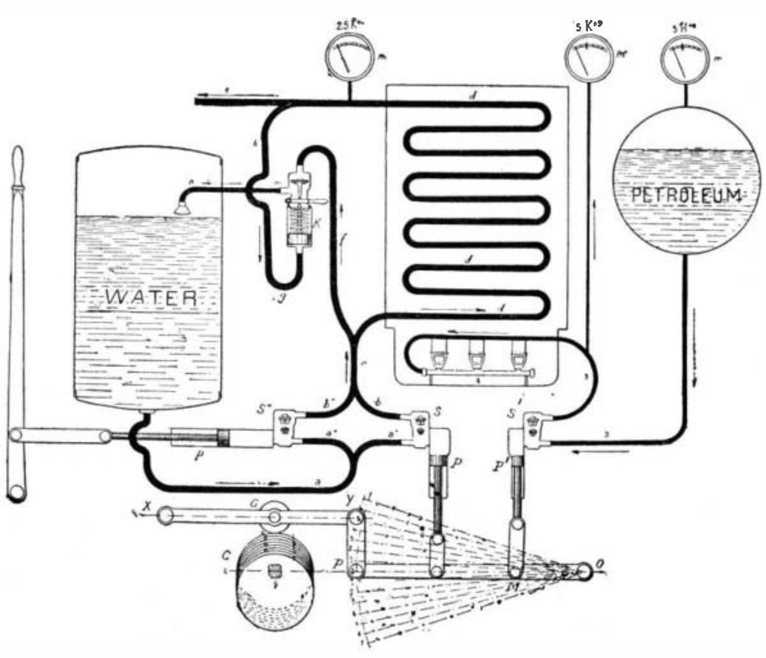
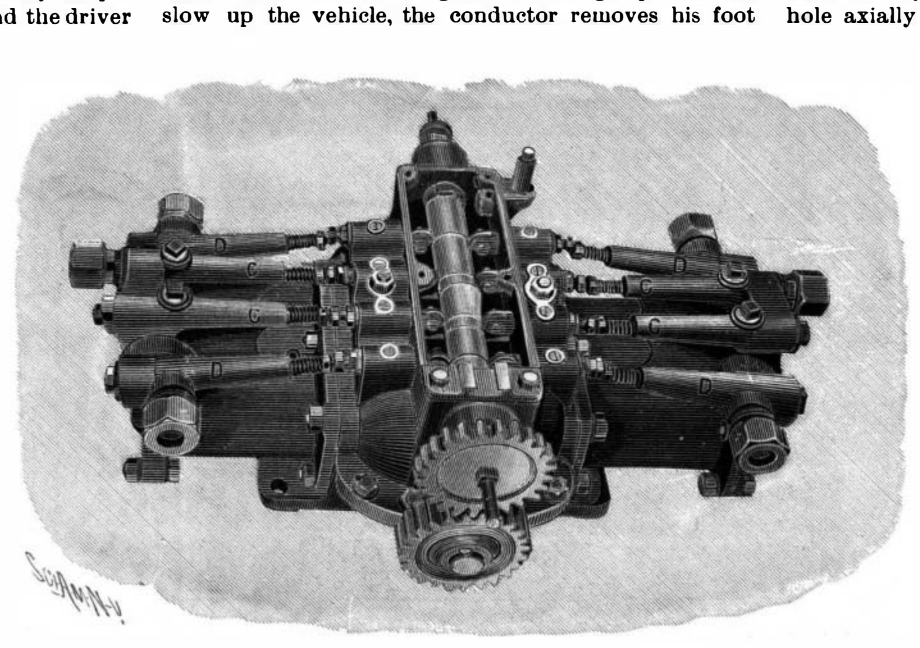


DIAGRAM SHOWING THE CIRCULATION OF FUEL, WATER AND STEAM.

One of the essential features of the system is the arrangement by which the production of steam is varied according to the work required of the motor. The boiler is constructed of tubes which contain but little heat-reserve, and it is necessary that the production of heat at the burner should vary with the water supply. The water and oil pumps are connected by the lever, *M*, which is worked by a cam formed of a series of eccentric disks, *C*, and the series may be displaced laterally to bring the disks successively under the roller, *G*, of the arm. The first disk is concentric, No. 1 is eccentric by 0·1 inch, No. 2 by 0·2 inch, and so on, and the result is that the stroke and output of the pumps depend upon the disk which is under the roller, the set of disks being displaced by a controlling lever. As the oil and water pumps are connected to the same lever, the heat produced by the burner is always proportional to the water feed, the relation having been established once for all by knowing the quantity of water which a gallon of petroleum can transform into superheated steam. This arrangement is very simple and strong and does not get out of order, and the driver is not required to look after the intensity of the burner, which always corresponds to the amount of steam needed. The motor is shown in our engraving. It has two cylinders on each side, these being similar in construction to those of a petroleum motor, the use of stuffing boxes being entirely dispensed with. The four piston rods operate the crank-shaft in the center, this being inclosed in the case and running in oil. The eight valves, *C*, *D*, are external and their rods are operated by rollers worked by a series of cams on the upper shaft, which is arranged in concentric and eccentric portions and may be displaced laterally by a lever to vary the action of the valves at will; thus at rest the cylindrical portions are opposite the rollers and no effect is produced. For the starting, the shaft is pushed to the back and only one set of valves is operated, the others being then successively thrown into action. The motor may also be reversed by the same arrangement. The movement of the motor is transmitted by the second gear to an intermediate shaft containing a clutch, which allows full or mean speed of the vehicle.



MOTOR OF THE SERPOLLET STEAM AUTOMOBILE.

The oil reservoir receives a constant pressure from a small air pump. The vehicle is started by working the lever of the supplementary water pump, *H*, which serves to inject a small quantity of water into the heated boiler, where it is transformed into superheated steam and starts the motor, which then works with its normal supply. The steam passes from the boiler into a main valve, which is controlled by a foot pedal in front and is normally closed; by this arrangement the conductor is sure that an accidental start will not be made if he leaves the vehicle, and, besides, the motor is thus always under control. To slow up the vehicle in crowded places or to avoid obstacles, the steam admission is diminished by raising the foot from the lever. The steam goes from the motor to the cleaning boxes and to the condenser, which is formed of a series of long copper tubes. The water of condensation is returned to the reservoir. The conductor has before him the levers for the pumps, the feeding cams, and the valves of the engine, as well as the necessary pressure gages. The transmission is made by a differential and chain to the rear wheel of the vehicle.

The operations of starting and controlling are quite simple. A small quantity of alcohol is used to heat the burner, which takes about five minutes; then by the small pump a pressure is made in the oil tank and the cock opened to the burner, which lights up with a blue flame, and the boiler is heated up in two or three minutes.

The conductor places the clutch in the middle position, which disconnects the motor from the vehicle and regulates the motor to the starting position, then puts his foot on the admission pedal, starting the motor with the least pressure and heating the cylinders, the oil and water feed working but slightly. When the cylinders are heated, which takes but a few strokes of the piston, the clutch is thrown on the full or mean speed and the feed-pumps placed at a maximum, continuing to feed by hand until the vehicle reaches a certain speed by the automatic feed, which is then regulated as desired.

In going down grades the feed is thrown off and the burner turned down; it is then brought to a maximum and lowered again to the right point. To slow up the vehicle, the conductor removes his foot from the pedal, which stops the motor instantly, and the brakes are applied.

A COMPANY has been formed in New York to work the sulphur mines in the Taccorah Mountains, a distance of eighty miles from the seaport of Arica, Chile. The plans of the company are still in embryo, but New York is to be the receiving depot for the output. To establish refineries at Arica would mean investment of the greater part of the capital; the transportation of machinery and of coal would also be a matter of great expense, it is therefore possible that the raw sulphur will be taken to New York.

THE FIRST-CLASS BATTLESHIP "WISCONSIN."

The first-class battleship "Wisconsin," recently completed by the Union Iron Works, possesses interest for our readers from the fact that she was built in the yard which turned out the famous battleship "Oregon." The latter vessel, like the "Wisconsin," is one of a class of three ships, and like her she is the fastest in her class. The "Alabama," the "Illinois" and "Wisconsin" were authorized on June 10, 1896. The first-named vessel was allotted to the Cramps, of Philadelphia, and has already undergone her trials with great success, achieving a speed of 17·01 knots an hour. The "Illinois" is approaching completion at the yard of the Newport News Shipbuilding Company, and the "Wisconsin" has recently completed her official trials, on which she made an average speed or 17·17 knots per hour. The principal dimensions of the vessel are as follows: Length, 368 feet; beam, 72 feet 2½ inches; mean draft, when the ship is fully equipped ready for sea, with all stores on board and a normal coal supply of 800 tons, 23·6 feet. The displacement of the vessel with two-thirds of ammunition and two-thirds of stores on board is 11,565 tons. Her bunkers have a maximum coal capacity of 1440 tons. She is propelled by twin engines, one of which is herewith illustrated as it appeared in the shops of the Union Iron Works previous to being erected in the ship. They are of 10,000 estimated indicated horse power, although this was considerably exceeded on the trial trip, when the maximum indication reached 12,322. They are of the inverted three-crank, triple-expansion type, and while they conform broadly to the specifications drawn up by the Naval Bureau of Engineering, the builders have introduced specialties of design, which they have already used with marked success in other naval vessels built for the government. The most noticeable of these is the framing of the engines, which is formed of forged built-up columns at the back, and turned columns for the front side of the engine. The forged column is of a type which was first used by these builders in the engines of the "Olympia," and later in those of the battleship "Oregon." It is built up of forged plate sides, on which are flanges for securing the column to the bedplate and to the cylinder bottoms. Between the sides is bolted in the casting which forms the main guides, and below the guides the sides are spread, and a web-plate is worked in, the lower half of the frame being thus in the form of an inverted Y. It is claimed by the builders that this type of frame provides unusual rigidity, and the forged iron is more reliable than the material of the usual cast steel frames. The high-pressure cylinder is 33½ inches in diameter, the intermediate 51 inches, and the low-pressure cylinder 78 inches in diameter, the common stroke being 4 feet. The crank shaft is made of three interchangeable and reversible sections; the crank pins are 14¾ inches in diameter by 17 inches long; and there is a 7½-inch hole axially through the shaft and crank pins. The thrust shafts are 14 inches in diameter, and the propeller shafts 14¾ inches in diameter, with a 9¾-inch axial hole throughout their entire length, except in the after section, where they pass through the hub of the propeller, in which portion the hole is tapered.

The engines are fitted with straight-push, reversing gear, and the air pumps are independent of the main engine. The main circulating pumps, which supply the condensers, may be used to empty the bilge of the ship, for which purpose they have a capacity of 12,000 gallons per minute. The screw propellers are three-bladed and are made of manganese bronze. They are 15½ feet in diameter and the pitch is 17 feet 6 inches. Steam is supplied by eight single-ended steel boilers in four compartments; the boilers are 15 feet 6½ inches in diameter and 10 feet in length.

The "Wisconsin," as will be seen from our photograph, which was taken as the vessel was returning from her official trip, is a fine, seaworthy vessel with a good freeboard of about 20 feet forward and 13 feet aft. Her main battery of four 13-inch breech-loading rifles is carried in two barbette turrets; the barbettes are plated with 15 inches of Harveyized steel, and the turrets with 14 inches. She has a waterline belt from 7 to 8 feet in depth, which varies in thickness from 16½ and 9½ inches at top and bottom respectively amidships to 4 inches at the stem. This belt extends as far aft as the after barbette. With this armor is associated a steel deck 2¾ inches in thickness on the flat, 3 inches in thickness forward, and 4 inches from the after end of the armor belt to the stern. The main rapid-fire battery consists of fourteen 6-inch rapid-fire guns, ten of