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.

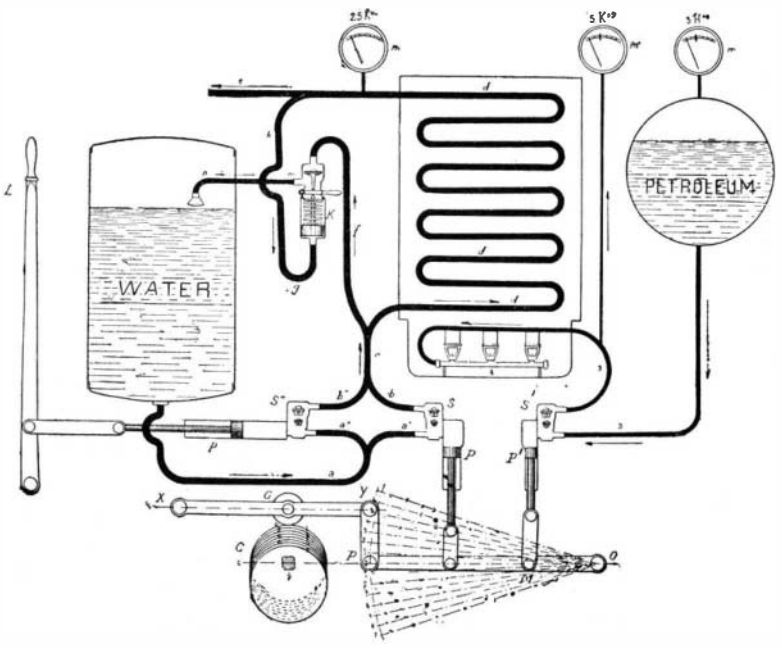


DIAGRAM SHOWING THE CIRCULATION OF FUEL, WATER AND STEAM.

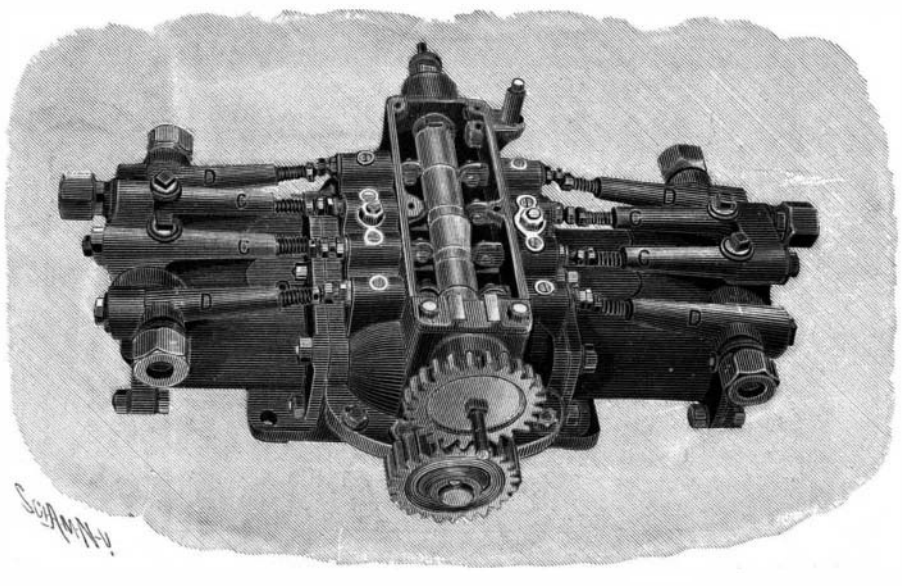
One of the essential features of the system is the arrangement by which the production of steam is varied according to the work required of the motor. The boiler is constructed of tubes which contain but little heat-reserve, and it is necessary that the production of heat at the burner should vary with 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.

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.



MOTOR OF THE SERPOLLET STEAM AUTOMOBILE.

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

SCIENTIFIC AMERICAN

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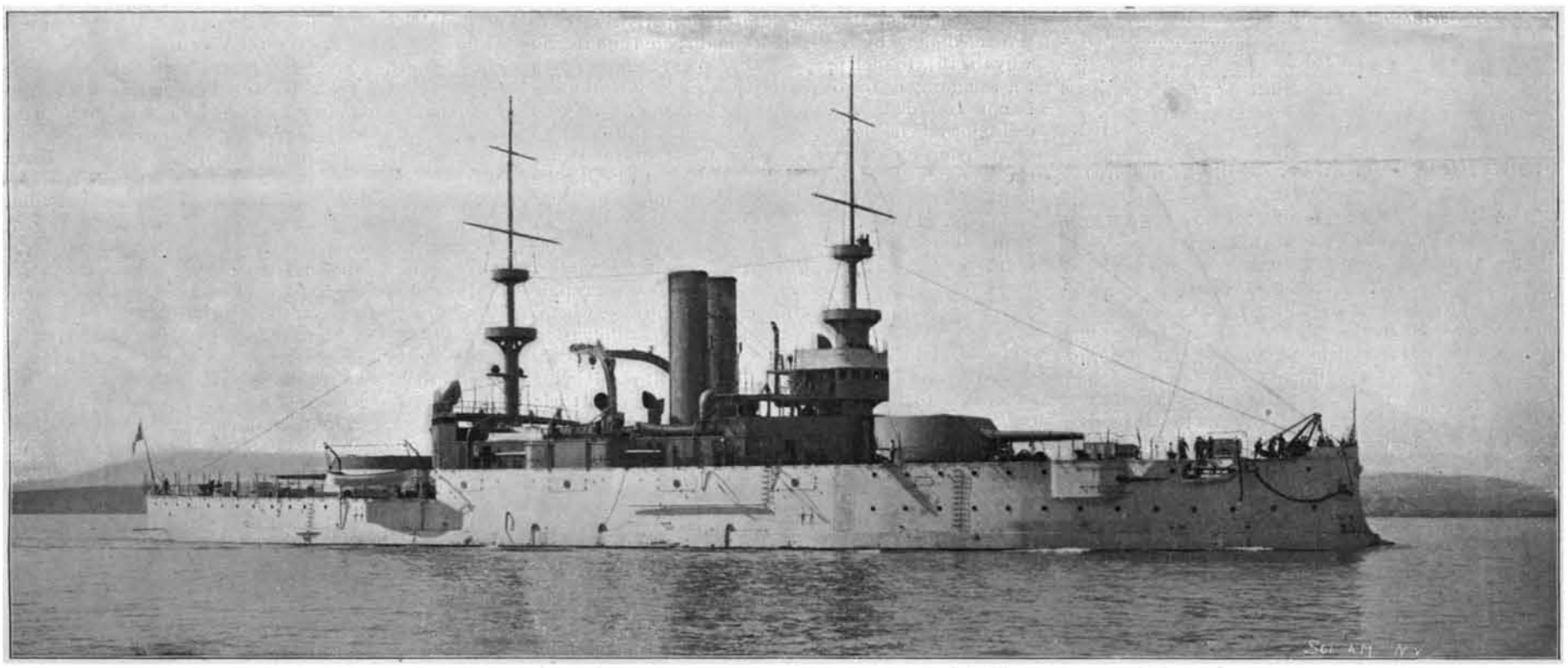
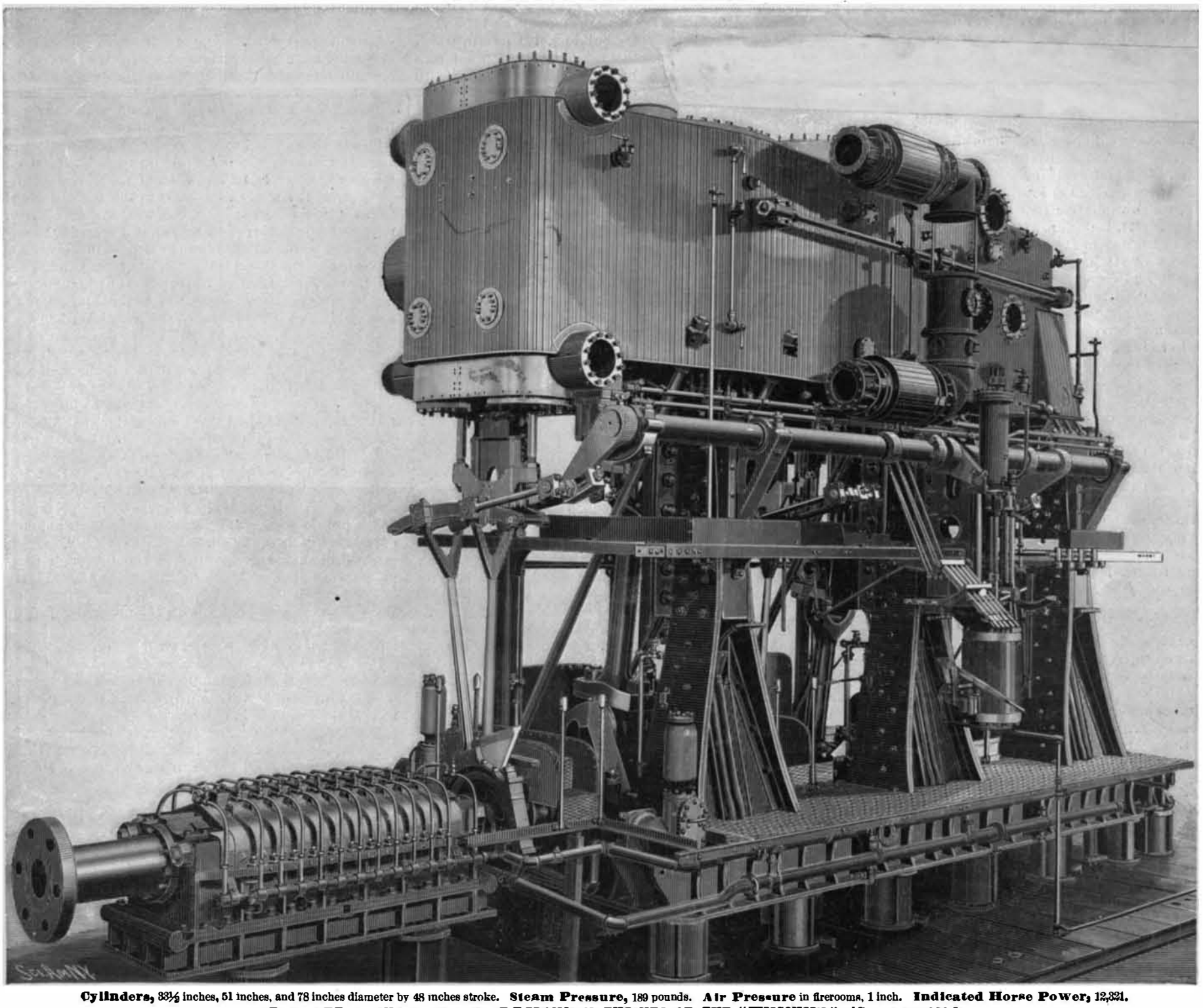


Displacement, 11,565 tons. **Speed,** 17·17 knots. **Maximum Coal Supply,** 1,440 tons. **Armor:** Belt, 16 to 4 inches; deck, 2¾ to 4 inches; gun positions, 15 inches. **Armament:** Four 13-inch; fourteen 6-inch rapid-fire; sixteen 6-pounders; four Colts; two 3-inch field guns. **Torpedo Tubes,** 4. **Complement,** 498.

UNITED STATES BATTLESHIP "WISCONSIN."



Cylinders, 33½ inches, 51 inches, and 78 inches diameter by 48 inches stroke. **Steam Pressure,** 189 pounds. **Air Pressure** in firerooms, 1 inch. **Indicated Horse Power,** 12,321.

ONE OF THE TWIN-SCREW TRIPLE-EXPANSION ENGINES OF THE "WISCONSIN."—[See page 358.]

which are carried on the main deck and four on the spar deck. Of those on the main deck, eight are carried within a central citadel, which is protected with 6 inches of Harveyized armor, the armor extending in the wake of the guns and running across at the ends of the battery diagonally to a junction with the 12-inch armor of the barbettes. The two other guns on the main deck are carried well forward in sponsons armed with 6 inches of Harveyized steel. The four guns on the spar deck are carried immediately above the central rapid-fire battery and are likewise protected with 6 inches of armor. The secondary battery is made up of sixteen 6-pounders, six 1-pounders, four Colts and two 3-inch field guns. There are also four Whitehead torpedo dischargers. The total complement of officers and men will be 493. Considering that the keel of the vessel was not laid until February, 1897, it is evident that improved facilities are enabling our shipbuilders to turn out these big vessels more rapidly than they could when earlier vessels of the "Oregon" type were built.

Automobile News.

Columbia University is the first college to have an automobile club.

A race from Paris to Berlin will be held by the Automobile Club of France, and the German Emperor has offered prizes to the value of 50,000 francs.

The reports of the French trials of heavy vehicles show that British makers are ahead of French manufacturers as regards this particular type of car.

The automobile drivers of Chicago are forming a union for those who handle vehicles for electric motors. Gas, oil and steam automobiles are not included.

The next automobile and cycle show of Paris will be held in January at the Grand Palais of the Champs Elysées. The building is a magnificent one for the purpose.

An automobile service will be established between Sea Cliff, L. I., and its railway station, a mile and a half distant, as the attempt to establish a trolley line has ended in failure.

Permission has been given to the New York Electrical Vehicle and Transportation Company, owners of the Fifth Avenue stage line, to change their motive power and extend their route.

C. Kirk Eddy, of Saginaw, Mich., was thrown with great violence upon the asphalt pavement when his vehicle was pushed into the curb while going at a high rate of speed. His death occurred on November 11 from the injuries which he sustained.

Ferry employes of the ferries around New York have to inspect each automobile to see how it is propelled, and if gasoline is the motive power the operator is told that he cannot cross the ferry until he has emptied the gasoline tank. This is in accordance with Section 4472 of the United States Revised Statutes.

A new electric automobile bell has been devised. The magnet incloses a coil, and the hammer is a steel rod, which has a reciprocating motion through the axis of the magnet. The latter is inclined at a slight angle, which causes one end of the rod to strike one peal, the other end on its return striking the opposite bell. As they are differently tuned, the tone produced is harmonious. The bell can be controlled by pushes on the ends of the controlling lever.

In connection with the run to Southsea, Mr. A. Harmsworth has offered a five pound cup for the motor vehicle which, in the opinion of the judges, may, on its arrival at Southsea Common, be the most presentable and cleanly as regards general appearance, says The Motor Car Journal. Mr. Harmsworth is of the opinion that the public become prejudiced against automobiles by seeing them arrive in town smothered in dust and looking generally disreputable. The automobile drivers do well to show pride in the appearance of their carriage, and to remove the dust and the other stains of travel from themselves and their vehicles before entering towns.

It is stated that a movement is on foot to do away with automobile shows. The reason for the step is to be found in the experience of bicycle manufacturers. As long as a few of the leading makers engaged spaces at the show, all of the others felt obliged to be represented. This results in a heavy expense. A plan has been formulated for starting a train of automobiles around the country, beginning next March. The train will visit all cities of consequence and remain from one to four days in each, in order that the residents may inspect the automobiles and have their merits explained to them. It is thought that this will benefit the industry to a greater degree than can be accomplished by holding shows, and the expense would not be greater than in going from one show to another.

THE Pollak-Virag system has been improved so that instead of signals being received in the form of a wavy line, similar to that traced by the siphon recorder, messages can now be actually printed on the paper in ordinary round-hand Latin characters at the rate of a thousand words a minute.

Science Notes.

There are 2,009 medical students in the city of Naples, 780 in Turin, and 530 in Rome.

Prof. S. P. Langley had the honorary degree of Doctor of Science conferred upon him by Cambridge University, England, on October 11.

The Duke of Abruzzi has given his exploring vessel, "Stella Polare," to the Italian navy. It will be stationed at Spezia and kept as a souvenir of the trip.

There are few countries in the world where American made playing cards are not found. They are attaining remarkable popularity in the far East, Japan liking them particularly.

Condensed milk wafers are going to be used in connection with the emergency ration test in Oklahoma. It is thought that condensed milk food will give better success than chocolate, which has been found to be of little service during the first test, which has just been completed. The milk food is made up in the form of wafers. When dissolved with water, it forms a kind of soup.

M. Rozé, of Paris, has devised a new type of airship. It consists of two huge cigar-shaped balloons placed in juxtaposition and tipped with aluminium. The car, capable of accommodating eight persons, is suspended from these aerostats. The airship is provided with two propellers, one forward and one aft, and the vessel carries a twenty horse power gasoline motor, to develop the necessary power for driving these propellers. The trial trip will take place next month.

The following remarkable statement comes from Consul-General Hanauer, of Frankfort. He says that M. De Gall, inspector of forests at Lemur, France, has invented a process for melting wood. By means of dry distillation and high pressure, the escape of developing gases is prevented, thereby reducing the wood to a molten condition. After cooling off, the mass assumes the character of coal, yet without showing a trace of the organic structure of that mineral. The new body is hard, but can be shaped and polished, is impervious to water and acids, and is a perfect electrical non-conductor. If the inventor can make a satisfactory substance of this kind, it will undoubtedly have a considerable future.

The greatest drawback of the incandescent gas lamp mantle is its liability to break, owing to its fragile nature, under the effect of the miniature explosions which occur whenever the gas is lighted or extinguished. To preserve the mantle from any disruption by this means a device has been invented by a gentleman in London, consisting of a movable ring cover, placed over the air holes of the burner. This cover is carried upon a sliding pin, which makes contact at its lower end with a cam projection from the tap lever, in such a manner that the air holes are closed by the ring when the gas is not alight, and they are not opened to their full extent until the flame has been ignited. In turning off the gas supply the air holes are closed before the flame is extinguished.

At the Egyptian Hall in London one of the principal items of the cinematograph exhibition is a film of the last solar eclipse, taken at the station in North Carolina by Mr. J N. Maskelyne, of the Royal Astronomical Society. The films give a very interesting idea of the character of the eclipse, and the inner coronal ring long previous to and after the totality of the eclipse is reproduced with great distinctness. The photographing of the slender partial phases and the corona, in order to obtain correctly graduated exposures upon biographic films, necessitates the placing of a thin wedge of yellow glass, backed by a similar wedge of plain optical glass, in front of the film, so as to move longitudinally. The camera is provided with a small ruby glass window, and through this the operator is able to follow the diminishing eclipse crescent, and to maintain the regular intensity of the image by gradually moving the wedge along.

The Public Health Department of the London County Council has issued to its medical officers a memorandum regarding the signs and symptoms of the bubonic plague, specially prepared by Dr. James Cantlie, who was connected with the plague hospitals at Hong Kong, and whose valuable services have been secured by the London authorities in case the epidemic should visit the city. The rat has generally been described as a potential means of distributing the disease, but according to Dr. Cantlie's investigations upon this subject, it is not so much the animal itself that spreads the virus abroad, but the insect parasites that infest its coat. When the rat has been killed, these parasites forsake the animal and seek refuge upon any persons in the vicinity. If they are not immediately expelled by hygienic methods, they will irritate the skin, and the scratching of the irritation, which necessarily follows, frequently causing abrasions, permits the bacilli to be infused into the blood. Consequently immunity from attack by these pestiferous parasites can only be assured by careful personal cleanliness, since it has been conclusively proved in the hospitals that the disease cannot thrive where strict hygiene is maintained.

Engineering Notes.

The rise in the price of fuel on the Scottish railways during the past half year was no less than 58·8 per cent.

The Great Northern Railway Company is building at Superior, Wis., a steel grain elevator with a capacity of 2,500,000 bushels.

A number of bloodhounds has been purchased for a western railroad in order to pursue train robbers. They were bought from the Idaho penitentiary.

Thirteen thousand seven hundred and five tons of coal were hoisted recently in twenty-two hours on the Toldeo docks of the Hocking Valley Railroad.

The old "Pavonia" and "Cephalonia" of the Cunard line, which are landmarks on the line between Boston and Liverpool, have been sold. It is said that the former was sold to an Italian shipping firm for $77,000.

In Russia every shop building has its holy picture and lamp, and it seems odd to an American to think of religious services being held in boiler and machine shops as they are occasionally in Russia. The Locomotive Engineering recently had an illustration of one of these pictures.

American exports in New Zealand are rapidly increasing, specially hardware. The American firms have wisely adopted the plan, which lies at the base of all successful export trade, of supplying what the colonies desire and not trying to force on them whatever the manufacturers wish to sell.

The French Minister of Marine recently made a tour of the harbor of Toulon in the submarine vessel "Gustave Zede." He also made an exhaustive examination of the internal mechanism of the craft, and declared that it was as perfect as present submarine science could make it.

The contractors who are carrying on the new national harbor works at Dover (England) recently accomplished a fine piece of work in deep-sea laying. The present Admiralty pier, which is about 1,000 yards in length, is being extended seaward, and forty blocks, each weighing forty tons, were laid in a single day.

In the new switch tower in the Grand Central yard, New York city, the windows are of green glass. It is a great protection to the eyes of the employes, and enables them to keep their vision at its normal strength at all times. The switch tower contains 176 levers, which operate the switches and signals by compressed air.

The maintenance of beaches along the New England coast is being successfully accomplished by the "groyne system." These "groynes" consist of a series of posts planted firmly in the sand, with close planks extending from post to post. The "groyne" is constructed at right angles to the beach, and its position prevents the waves acting on it injuriously. Sand is intercepted by the planking, rapidly forming a new beach and preventing erosion.

It might be interesting to our readers to know that in the large modern sailing vessels having six masts the names are as follows: The first is called the foremast; second, the mainmast; third, the mizzen-mast; fourth, the spanker-mast; fifth, jigger-mast; and sixth, driver-mast. In placing the masts the foremast is usually put about 24 feet from the end of the keel, and the driver 50 feet from the after end of the keel. The intermediate masts are spaced at the same distance.

The German pencil trade is suffering severely from competition of American lead pencil makers. The ingenious labor-saving machinery of American factories and their large scale of production, and specially cheaper prices at which they can supply themselves with cedar wood, are the chief causes for the failure of German makers to hold their own. The fact is that Germany is practically dependent upon the United States for her supply of cedar and the best of the wood is kept in America.

The forts at Dover (England) have been recently rearmed with quick-firing, long-range, 6-inch wire-wound guns. During the experiments, however, five of them were discovered to be defective, and were immediately removed to Woolwich, and others mounted. Great secrecy has been maintained regarding the nature of the defects, but it is supposed to have existed in the breech. These unwieldy weapons have to be hauled from the landing stage in the harbor to the summit of the cliffs, a total distance of two miles.

An extraordinary accident occurred at Buffalo November 18. Fifty-thousand tons of iron ore piled on the Minnesota docks sank out of sight, owing to half of the dock, 600 feet, giving away, and the entire dock was wrecked. The ore continued to sink all day long, and thirteen hours after the accident it was 8 feet below the surface. The cause of the cave-in is a mystery. Borings for 30 feet showed nothing but solid clay and there was no fear of a quicksand, but it is probable that this is what caused the collapse. The docks were equipped with the most modern ore-handling machinery, and the loss is almost a total one.