SPECTRAL PHOTOGRAPHY.

BY THE LATE GEORGE M. HOPKINS.

Probably the oldest method of taking a spectral photograph is to expose the plate for a brief period, in the camera, with a skeleton, or person in ghostly apparel, some hideous monster, or even a large bunch of flowers as a subject, afterward using the same plate again in the camera, upon the subject to be taken, with the spectral images, and then developing the whole plate, at one operation.

Another method of producing spectral photographs is to make a very thin positive image on glass, of the same size as the plate to be used in producing the spectral photograph, then placing the plate in the holder, as usual, with the weak positive superposed, and making the exposure through the positive, thereby giving on the negative plate, along with the person, a ghostly image of any prearranged subject. This is a very good way of producing a ghost picture; but it is liable to detection if the same weak positive is used the second time.

Another method of producing such images is to paint in outline on the background the figure desired, by using a solution of quinine sulphate. The image when dry is invisible to the eye, but is capable of producing an image on a sensitive plate.

In some recent experiments still another method of producing spectral pictures was discovered. This method, together with a specimen, is illustrated in the accompanying engravings. It consists in supporting a mirror in front of the photographic lens, which is smaller in diameter than the lens, so as to cause an image of an object, at one side of and at right-angles to the axis of the lens, to be reflected into the camera, and produce an image simultaneously with the image of a person or object, the same being formed by the marginal rays, which pass to the photographic lens, around the edges of the mirror. The mirror being entirely out of focus does not appear on the photographic plate. By this very simple contrivance combined images of various objects may be made upon the same plate.

The amount of light reflected into the camera by the mirror is regulated by the distance of the latter from the lens, and the marginal rays which enter the lens may be regulated by the diaphragm. The apparatus required for this experiment is very simple indeed. It consists simply of an apertured plate, slipped over the lens, and clamped between the lens and the collar. This plate is bent at right angles, and the horizontal arm is slotted. In the slot is placed a screw, having a shoulder which is clamped against the plate by a milled nut. The head of the screw is slotted, and provided with a clamping screw, for holding a downwardly projecting wire, to which is attached a small mirror by means of beeswax. The wire should be provided with a coat of dead black varnish, to prevent it showing on the plate. The mirror should be varied in size to suit the lens to which it is applied. In the present case it consists of a silvered microscope slide-cover ⅝ inch in diameter, and about 1-200 of an inch thick. Thin glass is used for this purpose to avoid the forming of a double image of the specter. The simplest way to silver the slide cover is to scrape the amalgam from a small piece of looking-glass, leaving a disk the size of the glass to be silvered. By placing a minute drop of mercury on the disk and allowing it to remain a few minutes the disk may be slid from the piece of looking glass to the thin cover glass. If the transfer is successful it is allowed to remain for a few hours and then varnished with shellac varnish. If too much mercury has been used, the surplus can be taken up by means of a thin piece of tinfoil applied to the back of the mirror, which is allowed to remain.

By a little practice in the adjustment of the mirror and shutter, the proportionate amount of light for the specter and for the subject may be regulated. The object representing the specter is mounted on black cloth, preferably black velvet, so that no other object than the specter will be represented by reflection.

A screen may be placed between the sitter and the specter, so that the delusion may be made complete. By folding the screen over the specter when it is not in use, the litter will be concealed, so that by careful manipulation, the trick will not be discovered by the sitter.

To Separate Adhered Postage Stamps Without Destroying the Paste.—It is often desired to separate postage stamps that are stuck together without destroying the paste, so that they can be used without another application of paste. This can be done by dipping the stamps in water for a few seconds (not as long as is usually done), shaking off the excess of water, and heating with a match as much as possible without burning. The heat expands the water between the stamps and separates them. so that they can be easily pulled apart, and are ready for use.—W. L. S.

THE NEW ARMORED CRUISERS "TENNESSEE" AND "WASHINGTON."

The two new armored cruisers, the "Tennessee" and "Washington," which are to be built by contract, will have a speed of 22 knots, the same as for the "Maryland" and "St. Louis" classes of armored cruisers now building, and one knot in excess of the designed speed of the earlier armored cruisers, the "New York" and "Brooklyn." Although they will be slower than many foreign modern cruisers, the "Tennessee" and "Washington" excel in battery power and protection any armored cruiser built, building, or designed, and they are the equal of many of the battleships of the world. With the high protection and battery, it may be asked in what respect these vessels differ from a battleship. It may be stated that they bear the same relation to the battleships as the cavalry does to the infantry in the army. With four knots greater speed than the vessels of the "Connecticut" class of battleships, they are able to move more quickly from point to point, and with their excess of speed over the battleship, they are able to give battle or run away from the enemy's battleship as they please; and with their powerful offensive and defensive qualities, they are able, in case of necessity, to put up a stiff fight with the finest battleship afloat. As compared with the "Maryland" class of armored cruisers now building, there is increased protection to the gun positions by the installation of splinter bulkheads, greater isolation of the 6-inch gun positions being thus secured. Of the twenty-two 3-inch guns which are carried, only six are without full protection, and even these are placed in casemates forward and aft on the gun deck and protected in front by two inches of nickel steel.

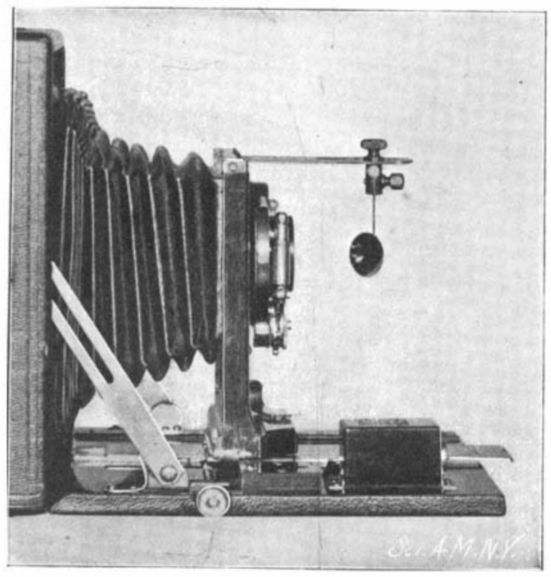


Fig. 1.—MIRROR FOR PRODUCING SPECTRAL IMAGES.

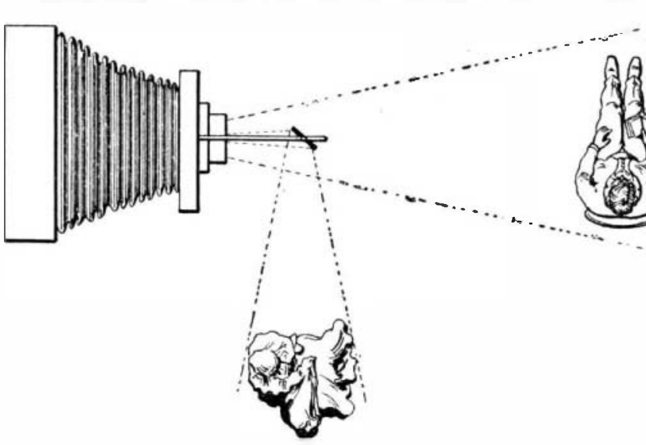


Fig 2.—ARRANGEMENT OF SPECTER, MIRROR AND SUBJECT.

Fig. 3.—A GHOST STORY.

The battery power has also been greatly increased by the substitution of four 10-inch guns on the new vessels in place of four 8-inch guns on the "Maryland" class, the relative perforating power of the 10 and 8-inch guns through Krupp armor by cap projectiles at 3,000 yards being in the ratio of 15 to 10.3. The number of 6-inch guns has also been increased from fourteen on the "Maryland" class to sixteen on the "Tennessee" class.

The general features and dimensions of these vessels are as follows:

Length on load waterline	502 feet
Breadth, extreme, at load waterline	72 feet 10½ inches
Displacement on trial, not more than	14,500 tons
Mean draft to bottom of keel at trial displacement	25 feet
Maximum displacement, full load condition, with coal bunkers full, full supply of stores, ammunition on board, and water in boilers	15,950 tons
Mean draft at maximum load	27 feet
Coal carried on trial	900 tons
Total coal bunker capacity	2,000 tons
Steaming radius at 10 knots per hour, about	6,500 knots
Steaming radius at full speed, about	3,100 knots
Appropriated for hull and machinery	$4,659,000

The trial of the vessels will be conducted on the normal displacement of 14,500 tons given above, and a draft of about 25 feet, the vessel being supposed to carry, in this condition, the normal supply of coal given above, and two-thirds supply of ammunition and general stores. The hull is to be of steel, with the usual cellular subdivisioning of the double bottoms and the hull spaces.

The freeboard of these vessels at the line of the main deck is about 18 feet amidships, 24 feet forward, and 21 feet 6 inches aft; and, of course, increased in wake of the superstructure, which extends to the upper deck.

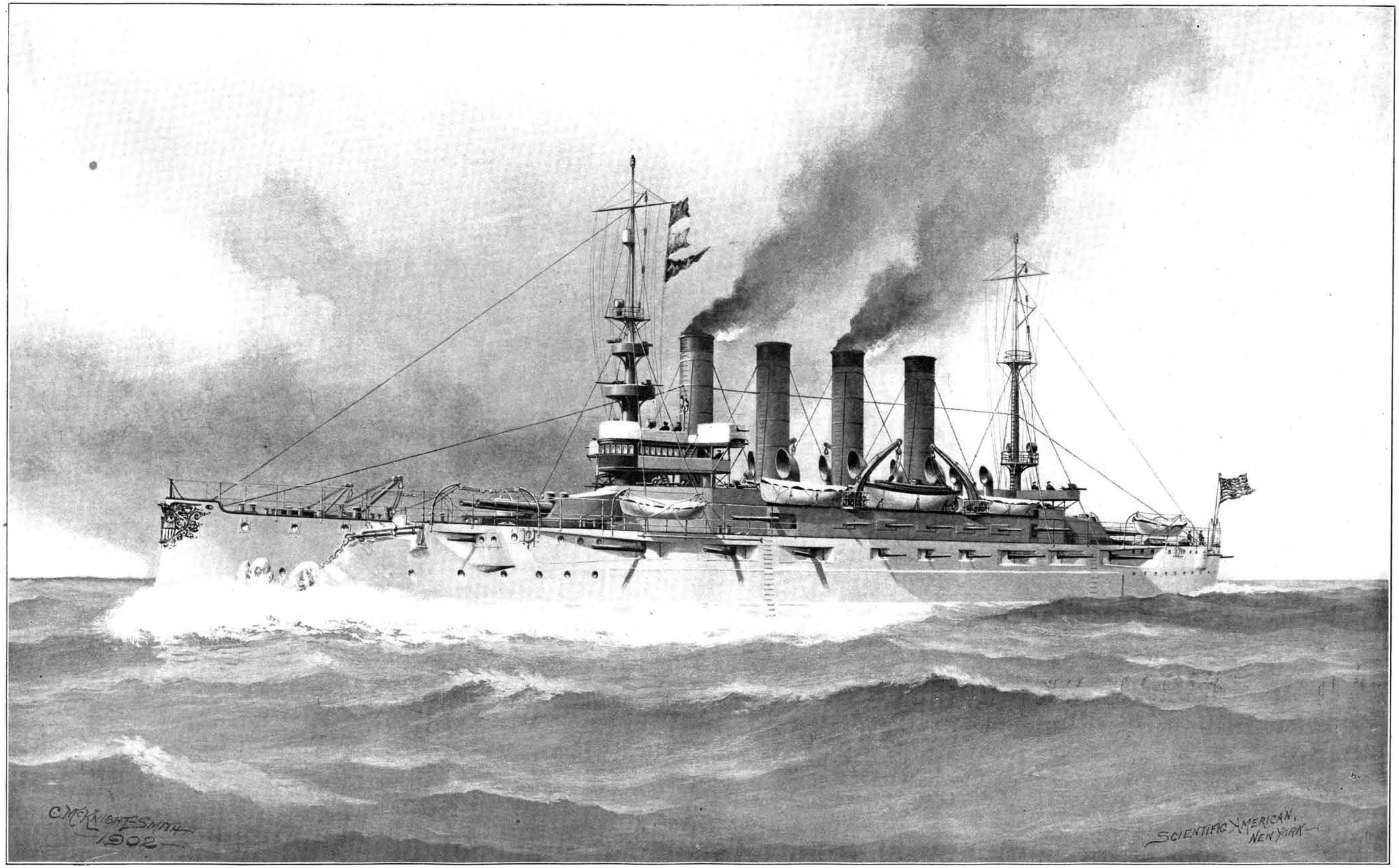
The hull is protected by a 5-inch belt of armor extending from 5 feet below the normal waterline to the upper deck in wake of 6-inch guns; this armor extending completely to the bow and stern near the water line to form a waterline belt, being reduced in thickness at the ends to 3 inches. Extending from the gun deck to the protective deck are bulkheads of 5-inch armor which form the forward and after limits of the belt armor. Between the gun and berth decks are similar bulkheads located in wake of the 10-inch barbettes which are fitted on the gun deck and form the forward and after limits of the side armor between the main and gun decks. Above the gun deck in wake of the 3-inch battery, 2-inch nickel steel is fitted. The 6-inch guns on the gun deck are isolated by splinter bulkheads of 1½-inch nickel steel, extending continuously across the ship, and 2-inch nickel steel extending fore and aft.

The 10-inch turrets are protected by 9 inches of armor on the sloping face, 7 inches of armor on the sides, 5 inches in the rear, and with top plates of 2½-inch nickel steel. The barbette armor is 7 inches thick in front, reduced to a thickness of 4 inches at the back and below the gun deck, where protected by the belt and casemate armor. The protective deck, which extends from bow to stern, will be 1½ inches thick on the flat over the engine and boiler spaces, 4 inches thick on the slopes at the side, extending down to the bottom of the belt armor, 3 inches on the slope, forward and aft. A cofferdam 30 inches thick will be worked from end to end of the vessel between the protective and berth decks.

The armament will be as follows: Main battery: Four 10-inch breech-loading rifles, sixteen 6-inch breech-loading rifles. Secondary battery: Twenty-three 3-inch rapid-fire guns, twelve 3-pounder semi-automatic guns, two 1-pounder automatic guns, two 1-pounder rapid-fire guns, two 3-inch field pieces, two machine guns of 0.30 caliber, six automatic guns of 0.30 caliber.

The 10-inch guns will be mounted in two elliptical, balanced turrets protected by armor as described above, and they will be under complete electrical control, as will also be their hoists and their loading and training mechanism. The 6-inch guns will be mounted four in independent, armored casemates on the main deck, the remainder in broadside on the gun deck, all on pedestal mounts, the back and side plates of the casemates on main deck being of 2-inch nickel steel. At each end of the vessel four of the 6-inch guns can be trained directly ahead or directly astern respectively, so that it is possible to obtain a direct-ahead fire with the main battery of two 10-inch and four 6-inch guns, and the same number at the stern. The 3-inch guns will be mounted as follows: Six in sponsons on the gun deck, six in broadside on the gun deck, and ten in broadside on the main deck. The 3-pounders and smaller guns are mounted on the upper deck, bridges, in the tops.

The ammunition and shell rooms are so arranged that about one-half the total supply of am-



Length on Waterline, 502 feet. **Breadth,** 72 feet 10½ inches. **Speed,** 22 knots. **Displacement on Trial Draught of 25 Feet,** 14,500 tons. **Displacement on Maximum Draught,** 15,950 tons. **Armor:** Belt, 5-inch: central battery, 5-inch; bulkheads, 5-inch; main turrets, 9-inch; barbettes, 7-inch; deck, 1½-inch on flat, 4-inch on slopes. **Armament:** Four 40-caliber 10-inch; sixteen 50-caliber 6-inch; twenty-two 50-caliber 3-inch; twelve 3-pounder semi-automatics; 14 small guns. **Complement,** 858.

THE NEW ARMORED CRUISERS "TENNESSEE" AND "WASHINGTON."

munition will be carried at each end of the ship. With the increase in battery, special care has been required in developing these designs to secure an adequate rate of supply of ammunition from the magazines to the guns. For handling 6-inch and 3-inch ammunition, the ships have been provided with a central passage extending completely from the forward to the after magazines, and four side passages at each end to extend a sufficient distance forward and aft to provide for handling the ammunition within the armor protection, on the decks above. All of these passages are at the level of the upper platform deck, and such quantity of both 6-inch and 3-inch ammunition is stowed at this level as would probably be required in any action. The remaining ammunition is stowed where it can readily be whipped up by hand when time is available, from the lower to the upper platform.

For handling ammunition along the central passage, there will be ammunition conveyors, which are nothing more than traveling platforms, onto which ammunition can be loaded at one end and delivered abreast the various ammunition hoists at different points in its travel. Provision has been made by means of power hoists, to handle the 6-inch, 3-inch, and 3-pounder ammunition at the rate of seven pieces per minute. In addition to the power supply, there has been provided sufficient means for a supplementary supply of ammunition by hand, to interfere as little as possible with the power handling, so that, with the combined means of supply, it will be possible to supply ammunition to all of the guns at a rate equal to that at which they can be fired.

The full complement of the vessels, as flagships, will consist of: One flag officer, one commanding officer, chief of staff, 19 wardroom officers, 12 junior officers, 10 warrant officers, 814 men.

The masts will be fitted for the installation of wireless telegraphy.

The propelling engines will be of the vertical, twin-screw, four-cylinder, triple-expansion type, of a combined indicated horse power of 23,000. The steam pressure will be 250 pounds, and the stroke 4 feet.

The engines will be located in two separate watertight compartments. Steam, at a working pressure of 250 pounds, will be supplied by sixteen boilers of the straight watertube type, placed in eight watertight compartments, having combined grate surface of at least 1,590 square feet, and heating surface of at least 68,000 square feet.

LEADING TYPES OF 1902 FRENCH LIGHT-WEIGHT AUTOMOBILES.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The following descriptions of some of the French light-weight cars that have become prominent the past year, may be of interest to many of our readers. We have given considerable space to the description of the Renault car, as this deserves special mention, since it won the Paris-Vienna race last summer, thus proving the enduring qualities of a light-weight machine in a hard and rapid road test, and demonstrating that its staying powers equaled, if not surpassed, that of the heavy, locomotive-like car, that had heretofore been so prominent in France.

This machine has been designed especially to secure lightness and simplicity in the mechanism, combined with a sufficient motive power. Its design has been carefully studied, and it is no doubt due to this fact that it has proved so successful. The general arrangement of the parts will be noticed in the plan view of the frame, and in the different photographs. The motor, which is mounted in front, is, however, larger than the one shown; it is of the upright 4-cylinder type, and has been newly designed. The cylinders are mounted in pairs, as usual, upon a long aluminium crank case. The motor develops 24 horse power, and weighs 286 pounds, including the flywheel and friction clutch. The inlet and exhaust valves are superposed; the former are automatic, while the latter are operated from a cam-shaft. The front view shows the relative position of the motor and the water-cooling system. A large water-jacket surrounds the motor cylinders and valve chambers, and is closed at the top, for each pair of cylinders, by an aluminium cap which receives the water-tube. The water tank is of small dimensions, and is placed above and behind the motor. The radiating tubes are placed on each side and partly inclose the motor. The water circulation is carried out on the thermo-siphon principle, which is coming into use in France. The water circulates by gravity alone, the heated water coming from the top of the motor rising to the upper reservoir, from which it descends again through the cooling tubes, and enters the motor at the lower part. In this way the use of a water-pump is not necessary.

The carbureter is of the float-feed atomizer type The admission of gas is regulated by a governor on the motor, and also by a pedal adapted for the purpose, whose position may be fixed by a thumb-nut placed just below the steering wheel. During stops or long descents, the motor speed may thus be reduced to less than 400 or 500 revolutions per minute, or the motor may be stopped. The quantity of air entering the carbureter is also regulated, according to the speed of the motor, by a small handle placed beside that of the ignition shifting one. The method of electric ignition deserves mention, as the new system designed by M. Carpenter is employed. The spark-break is made much more quickly than usual. The trembler of the induction coil, instead of breaking contact directly, when it is attracted, does not do so until nearly at the end of its movement, when at the maximum speed; at this point it strikes against an auxiliary contact spring, making a very quick break. The resulting spark is much better, and the motor can be run at a higher speed.

The friction clutch and transmitting mechanism are shown in the diagrams. The friction clutch and flywheel are mounted together. Inside the flywheel, *V*, is a cone-socket upon which is applied the conical piece, *U*, of aluminium. The two cones are normally pressed together by a spring, *X*, and are separated by the rod, *Q*, which is operated by the pedal, *l*. A double set of ball-bearing collars are used to take up the thrust.

From the friction clutch the main transmission shaft passes first through the speed-changing box, and thence to the differential. This shaft is divided into two parts, one a square portion which carries the sliding set, *A E*, comprising the two gears, and one of the jaws of a clutch (seen between *E* and *D*). The second part, carrying the other jaw of the clutch, passes out of the gear box and through a double-jointed transmission rod to the differential, where it carries a bevel driving gear. The main shaft, made thus in two portions, may be operated as a whole when the clutch is in contact; or, by separating the jaws of the latter, the first part may be made to operate the second at different speeds by using the intermediate gear set below. The lower shaft carries a set of gears, *B G C*, for the two speeds and reverse. The transmission can be made either through *A B C D* for the first speed, *E G C D* for the second, or by direct coupling through the jaw clutch for maximum speed, by sliding the upper gear-set back and forth. The method of throwing the gears into contact is a special feature of the Renault machines. The lower shaft, *B G C*, rotates in a pair of eccentric bearings; it is not shifted to the right or left but can take a to and fro movement so as to approach the upper set. In this way the teeth do not engage in the ordinary way by a side movement, but strike each other face to face over their entire surface. The gears are first thrown opposite each other, then one set is applied to the other progressively, so that the teeth of one mesh with those of the other. In this way there is much less shock than usual in the speed changing, and the meshing of the gears is effected easily. Two movements are therefore necessary to change gears—one the shifting of the set, *A E*, and the second a forward and back movement of *B G C*. This is accomplished in a very simple and effective manner by a single movement of the lever. An upper shaft, *P*, operated from the driver's lever, carries a screw thread, *F*, which works in the collar of the gear-shifting fork, *F*. When the shaft is rotated, the screw moves the fork back and forth to shift the gears. To bring up the lower set, *B G C*, the same shaft carries a cam, *H*, on the right, which operates a rack. The latter engages with the bearing of the lower shaft, which is mounted so as to take a rotary movement. The shaft is mounted eccentrically in this bearing, and when the latter is rotated, the shaft is elevated or depressed, throwing the gears in or out of contact. A similar rack is used on the left side. The relative position of the fork and the cam is such that the two operations succeed each other properly; thus upon turning the shaft, *P*, the speed-changing takes place as follows: First, *B G C* is lowered; next the set, *A E*, is displaced laterally; then *B G C* is raised, throwing the proper gears into mesh. The reverse is obtained as usual by a supplementary gear, *S*, mounted on a separate shaft and engaging with *A*. Upon shifting to the extreme left, *A* drives *B* through the gear *S*, giving the reverse movement. The transmission is made direct through the clutch for the maximum speed. This system of direct transmission, which is coming into use, is a decided advantage, especially for the racing machines in which the high speed is nearly always engaged, as the use of gearing is dispensed with.

The maneuver of the upper shaft is obtained by a toothed sector, *L*, fixed on the shaft, *K*, at the extremity of which is the speed-changing lever, *J*. The sector engages with a small pinion, *M*, and turns it rapidly. On the same shaft with *M* is carried a bevel gear of larger diameter, which drives a small pinion, *O*, the latter being mounted at the extremity of the shaft, *P*. By this arrangement of double gears, a displacement, even slight, of the main lever, produces a rapid rotation of the shaft, *P*. The lever, in passing from one notch to the other, turns the shaft rapidly enough to allow of the three movements above mentioned. The gears which operate the shaft, *P*, are inclosed in a separate case of special form, mounted close to the speed-changing box, as will be noticed.

The main transmission rod carries a joint at the end of the speed-changing box and a second at the differential, affording a flexible transmission. The position of the joints is calculated so that when the machine is loaded the rod takes a horizontal position. The differential case is of steel, and has fixed to it two steel tubes, through which pass the main axles of the wheels. The side thrust of the axles is taken up by a ball-bearing collar mounted at each side of the differential case; these collars can be regulated from the outside by screw-rings. At the ends of the tubes are mounted the journals of the main axles, which are also provided with thrust bearings.

The Peugeot racing car, which has been quite successful in this year's events, differs considerably from the preceding. One novel feature is the use of a water-cooling device somewhat similar to that employed on the Mercedes cars. It is the first machine of any note in which such a system is used in France. The radiator is mounted in front of the motor, as will be observed; it is made up of a great number of short copper tubes around which the water circulates, its construction giving it a honeycomb appearance. The water is circulated by a centrifugal pump of large output, driven from the flywheel by friction, and sending the water from the motor to the radiator, where it is quickly cooled. In the rear of the radiator is a ventilating fan driven by the motor. This fan draws a current of air through it independently of the speed of the car. The cooling being thus aided by the fan, a much smaller quantity of water can be used, and in fact the 4 gallons which are contained in the water-jackets and piping system, are sufficient for the cooling without the use of a separate reservoir. In this way a considerable gain in weight is secured. The exhaust pipe has been made especially large, with a good-sized muffler quite near the motor, designed to reduce the back pressure to a minimum.

The friction clutch is similar to that used in the Renault car. Chain transmission is employed to drive the rear wheels. The speed-changing mechanism and differential are mounted together in a large, flat, aluminium box, leaving only the ends of the axles for the driving sprockets projecting on each side. The speed-changing device gives three speeds and a reverse. It is operated by a single lever placed at the side of the driver's seat. The movement is transmitted to a vertical shaft, which operates a fork used to shift the gears. These are of the ordinary sliding type, but are arranged, like those of the Renault, to drive direct on the fast speed. On this speed, the motor shaft is direct-connected with the bevel gear that drives the differential of the countershaft, so that the only loss in transmitting power is in the one set of bevel gears and the sprocket-and-chain drive employed from the counter-shaft to the rear wheels. The reverse is obtained by an intermediate pinion.

The Decauville light-weight car is another of the leading types. It is here shown with a four-seated carriage body; when used as a racer the rear seats are removed. The motor, *M*, mounted behind the radiator, has two cylinders of 4.4-inch diameter and the same stroke, giving 10 horse power at a speed of 1,000 revolutions per minute. A characteristic feature is the mounting together of the motor and speed-changing box, so as to form a solid piece. This secures a rigid transmission, which is independent of the movements of the frame, and avoids jamming of the bearings. The friction clutch is mounted between the motor and the speed-changing box. The latter has three speeds and a reverse, and is similar in principle to the others. Many of the new machines are adopting the method of direct connection between the motor and differential at full speed, also the double-jointed rod transmission. Here, however, the rod is short, and passes obliquely to the differential. A novel feature of the Decauville machine is the use of the small dynamo, which keeps the ignition accumulators always charged by means of a set of automatic switches. In this way the mishaps due to the exhaustion of the battery are avoided. The radiator is fed by a centrifugal pump, driven by the motor.

A light-weight car which has been especially prominent this year is the Darracq. When built as a high-speed racing car, as shown in the photograph, it has a 4-cylinder motor giving 20 horse power. The views of the frame show the same machine with a 2-cylinder motor of 12 horse power, which runs at 1,200 revolutions per minute. The arrangement of the mechanism resembles closely that of the preceding type. Behind the motor is the friction clutch, then comes a speed-changing box which has also the interlocking system for full speed. The shaft turns in ball-bearings. The differential carries at each end a steel tube which incloses the rear axles. Ball-bearings are used to take up the thrust of the axles. A jointed-rod transmission is also used from the speed-changing box to the differential.