

THE PARIS METROPOLITAN UNDERGROUND RAILROAD.

The opening of the first section of the Paris Metropolitan Railway, on July 19, marks an interesting event in the history of rapid transit, for certainly no city in the world has been so behindhand in transportation matters or which will so soon be adequately provided. It is true that it was possible for any one to travel by the Ceinture Railroad from one great railway station to the others, but the changes were numerous and the line did not affect the transit problem.

Paris is very closely built, and large sections of it depend entirely upon omnibuses and street railways, but for many years the service has been slow and entirely inadequate. The Parisians understood the need for some rapid system of transportation, and in 1856 a project was agitated for connecting the center of Paris with the circumference. It was not until 1871 that the authorities began to study seriously the problem. A remarkable report was issued, and the scheme, as outlined, has been followed to-day as regards the main ideas. In 1889 the need of a new line was strongly felt, and when the Exposition of 1900 was resolved upon the necessity for haste was apparent. In 1896 plans were formulated for supplying the insufficiency

and to the project, it revised its decision and substituted the normal gage, but with this restriction, namely, that the cars should be smaller than those of the companies, and that the tunnels should be of such size that the cars of the Metropolitan could circulate only on the city system. In this way the city will always be master of the line, and the companies, if they intend to connect with the city line, will have to make their time-tables according to its wishes. This condition may become illusionary, however, for when the State gave the concession to the city, it reserved the right of letting the railroad companies make connections with each other in Paris if they found it convenient.

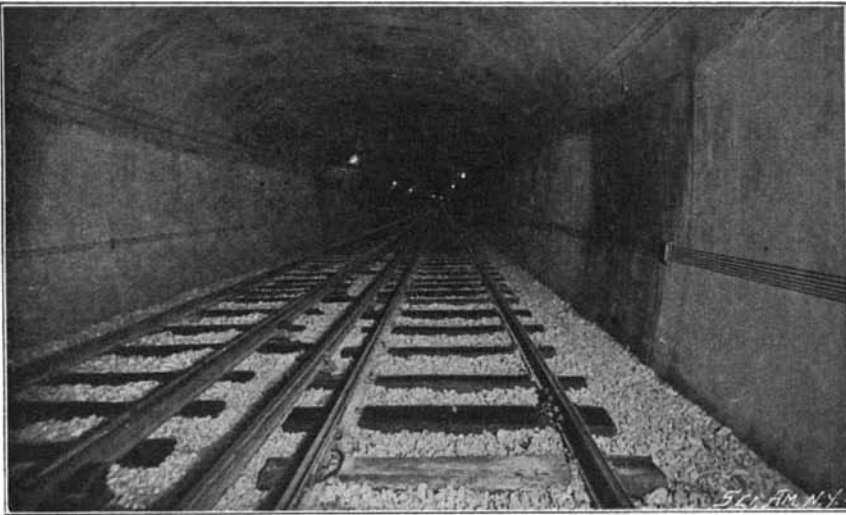
The Municipal Council approved the project on July 9, 1897, and on March 30, 1898, a law was promulgated making the work one of public utility. The law of April 4, 1898, authorized the city to borrow 165,000,000 francs and the modification in width required this sum to be raised to 180,000,000 francs.

Only a small section of the projected system has been completed and not all the trunk-lines and branches have been authorized.

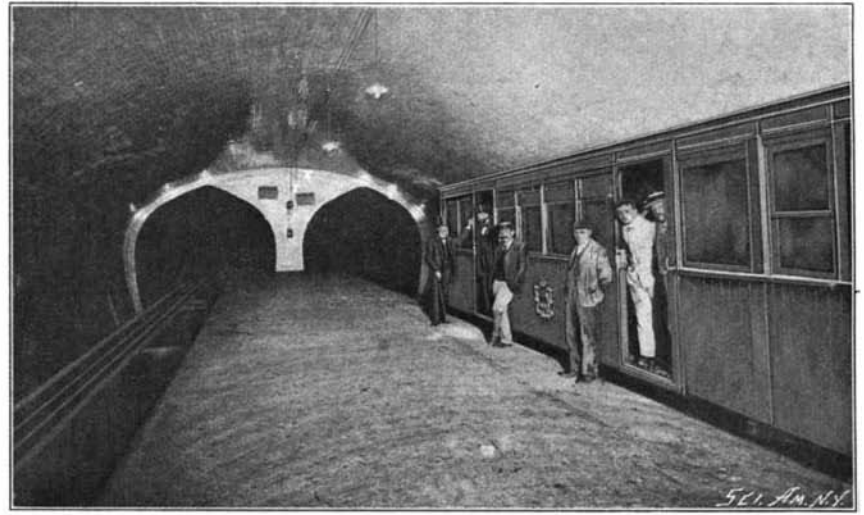
Following is a list of the lines in the order of construction: 1. From the Porte de Vincennes to the Porte

Boulevard Diderot, and runs parallel with the Vincennes road till it reaches the gate of the same name. Of the two other lines in course of construction, the most important is that running from Place de l'Etoile to the Trocadéro. This has a junction with the first-mentioned line, so that passengers from the Bastille and Rue de Rivoli can take the train directly for the Trocadéro. The third line starts at the Porte Dauphine, and runs under Avenues Bugeaud and Victor Hugo to Place l'Etoile. It is the beginning of the great circular railway. The Place de l'Etoile is a kind of central station. Under its roadway the tracks branch out in all directions.

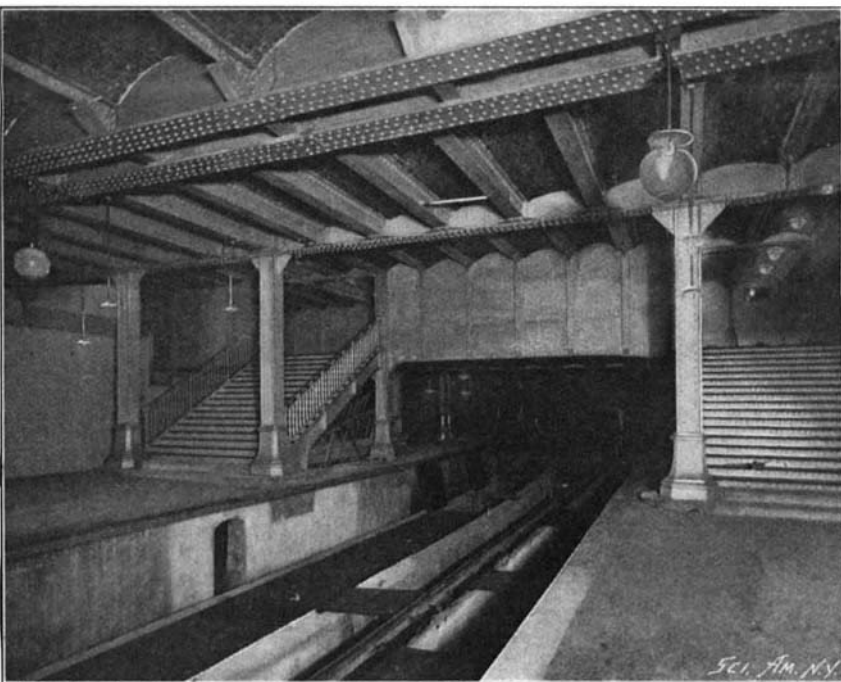
When the three lines which constitute the first section of the Metropolitan Railway are entirely completed, the total length of them will be 26 miles, but at present only the Porte Maillot and Porte de Vincennes Lines have been finished, and the extensions to the Porte Dauphine and the Place du Trocadéro are only partly completed. The total length of the main line and the two branches is 8¾ miles, the main line being 7 miles long. The main line calls for eighteen stations, but now eight only are being used. There are three stations on the line which runs from the Place de l'Etoile to the Porte Dauphine, and four on



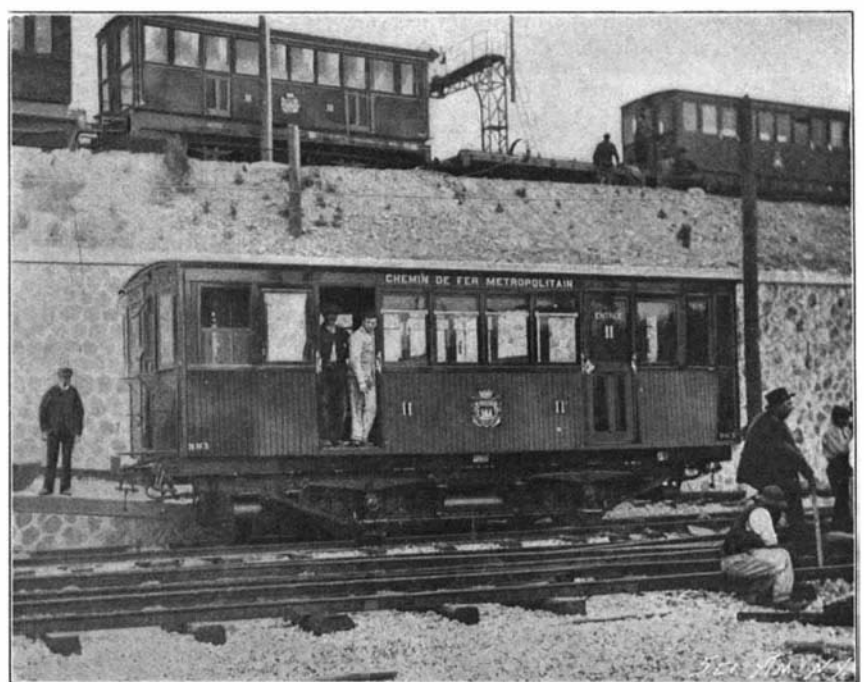
Tunnel, showing Third Rail



Vincennes Station and Tunnels.



Station on Metropolitan, showing Bridge Across Tracks.



Rolling Stock in Car Yard.

THE NEW PARIS UNDERGROUND RAILWAY.

in transportation facilities and also to attempt to build up outlying quarters. The gage was to be of such a dimension as would insure the autonomy of the line. Electric traction was to be used. The tunnels, viaducts, etc., were to be built by the city of Paris, and other expenses were to be paid for by a concessionaire.

One condition of success of the Metropolitan seemed to be the connection of its lines with the railroad stations of Paris. Such connection would offer great advantages, as it would permit travelers to cross the city without going out of the stations, and would thus effect a great saving of time. The greatest advantage was doubtless the possibility of going from any point in the city to the different stations of the suburbs without changing cars. This argument should have caused the Municipal Council to decide upon a junction, but it had the opposite effect. The Council feared that if the Parisians had such inducements for living in the suburbs, the population would decrease, and their octroi, or municipal tax, would diminish. It also feared that the railroad companies would some day have too decisive a voice regarding the Metropolitan, and would thus become the managers after having been evicted as tenants. After having decided upon a track one meter in width, which would have altogether put an

Dauphine, with a connection to the Porte Maillot. 2. Circular line starting from l'Etoile and following the outside boulevards. 3. Ménilmontant to the Porte Maillot. It separates from the two preceding lines at the Rue de Constantinople and passes through the Rue de Rome, the Boulevard Haussmann, the Rues Auber, Quatre Septembre, Réaumur, Turbigo, and Temple. 4. From the Porte d'Orleans to the Porte Clignancourt. This is the north-south transverse line. 5. Boulevard de Strasbourg to Pont d'Austerlitz. It connects the Place de la Bastille to the circular line. 6. Boulevard de Vincennes to Place de l'Italie. 7. From the Place Valhubert to the Quay de Conti. 8. Palais Royal to the Place de la Danube by the Rue Lafayette. 9. From l'Opéra to Auteuil by the Place de la Concorde and the Invalides.

All the lines comprise two systems, a number of transverse lines and a circular line, with other short lines connecting them together at various points.

The part now actually finished consists of one complete line and the beginning of two other lines. The first is the main transverse east-west line, which connects the Bois de Boulogne with the Bois de Vincennes. It passes under the avenues of the Grande-Armée and the Champs Elysées, follows the Rue de Rivoli and the

the Trocadéro branch. In reality there are in all twenty-three stations only, for the central station on the Place de l'Etoile is really a single station composed of three distinct parts. The stations are of five different types. One station is open, seven stations have metallic ceilings, and seventeen stations are vaulted. At the terminal stations the trains go around a loop, so that no switching is necessary. The ordinary tunnel sections have a maximum width of 23 feet 4 inches, and the clear space above the rails is 14 feet 9 inches. The stations are 246 feet long and 45 feet wide. The platforms are 13 feet wide, and are raised 3 feet above the level of the tracks. The total width of the cars is 7 feet 10½ inches, the gage being 4 feet 8½ inches.

At the Bastille Station, where the Metropolitan crosses the St. Martin Canal, there is an open cut and an open station, but with this exception the line runs entirely underground. The ticket offices are reached by stairs from the street, and all the passages, halls, etc., and the chief stations, are lined with white vitrified brick. The stations are well lighted, and the tunnel is also lighted throughout its extent. Some of the stations have their platforms connected by overhead bridges. The rate of fare on the road is five cents for first-class and three cents for second-class tickets.

Return second-class tickets are issued at an expense of four cents. There are no first-class return tickets, and even the use of the second-class tickets must be commenced before nine o'clock in the morning, as they are intended for the use of workmen. The distance is covered in about thirty-five minutes, including stops, which average twenty to twenty-five seconds. The trains will leave about every ten minutes, and each train has one motor car and two trailers.

The motor car is given up to second-class passengers. It accommodates twenty-eight persons and the trailers accommodate forty persons. The motor cars are provided with two hundred horse power motors, enabling a quick start to be made and a high-sustained speed while running through the tunnel. The track weighs 106 pounds to the yard. The current is conveyed by a third rail. The conductor rail is supported by insulators secured to every third or fourth tie. The cars are brilliantly lighted by electricity. The trailers have ten lamps and the motor cars eight lamps and two head or signal lights. At present twenty-two motor cars have been delivered and more than double that number have been ordered. The motor cars have the usual fuse boxes, lining, arresters, etc. Westinghouse airbrakes are used and the compressors are run by an electric motor. Contact is obtained with a third rail by means of two shoes, and in the car yards overhead wires are used. A four-wheeled trolley carriage running on the wire receives the current and delivers it to a motor car by means of a cable and plug.

The electric power by which the cars are driven will be generated in a central power house between the Quai de la Rapée and the Rue de Bercy. The boilers, engines, dynamos and auxiliary machinery have all been built by Schneider & Company, of Creusot. The Bercy power house will directly supply current for that portion of the road lying between Vincennes and the Louvre station. The other portion will also receive current from the main power house, but through the medium of a transforming sub-station at the Place de l'Etoile. The central station will consist of three batteries of six boilers each; a group of 1,500 kilowatt generators furnishing a direct current at a pressure of 600 volts; four groups of 1,500 kilowatt generators, furnishing a three-phase current of 5,000 volts and 25 periods; various auxiliary machines, exciters, transformers, and a battery of accumulators. Normally, the direct current is used for the Vincennes-Louvre section; but, if necessary, the three-phase system also can be called into requisition. In the sub-station, nine static transformers of 250 kilowatts each will step-

down the 5,000 volt current to 860 volts. Three rotary transformers of 750 kilowatts each will feed current to the line at a pressure of 600 volts. The sub-station equipment also includes a battery of 250 Tudor accumulators of 1,800 ampere-hour capacity.

The total expense of the tunnels, viaducts, stations, etc., has been \$7,400,000, and the company which has the concession has also spent a considerable sum. The concession is to run for thirty-five years.

The construction of the railroad is fully described in the SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 1211, 1226, and 1243.

THE HOWELL DISAPPEARING CARRIAGE.

The work at the Sandy Hook Proving Ground is by no means confined to the mere test of the ballistic qualities of the army guns; but considerable time is

When the gun is in its firing position, with the levers vertical, the counterweight, hanging freely by its upper end, from the main axle, lies in front of the gun levers, and is kept separated from them a distance of about twenty inches by the telescopic spring cylinders.

The hydraulic cylinder lies between the telescopic cylinders on the under side of the counterweight box, and is journaled to it by suitable bearings. The piston of this cylinder is attached to a cross shaft joining the ends of the levers, and in this position is withdrawn from the cylinder about twenty inches.

The general operation of the carriage is as follows: On firing, rotation of the system takes place about the main axle; the gun moves to the rear and downward, the gun levers being caught by a ratchet when the loading position is reached. The lower end of the levers moves forward and upward, compressing the

spring cylinders, and forcing in the piston of the hydraulic cylinder, thus transmitting their rotation to the counterweight. The relative motion of about twenty inches allows the counterweight to gradually acquire the full velocity of recoil and greatly reduces the shock due to the sudden acceleration of so large a mass.

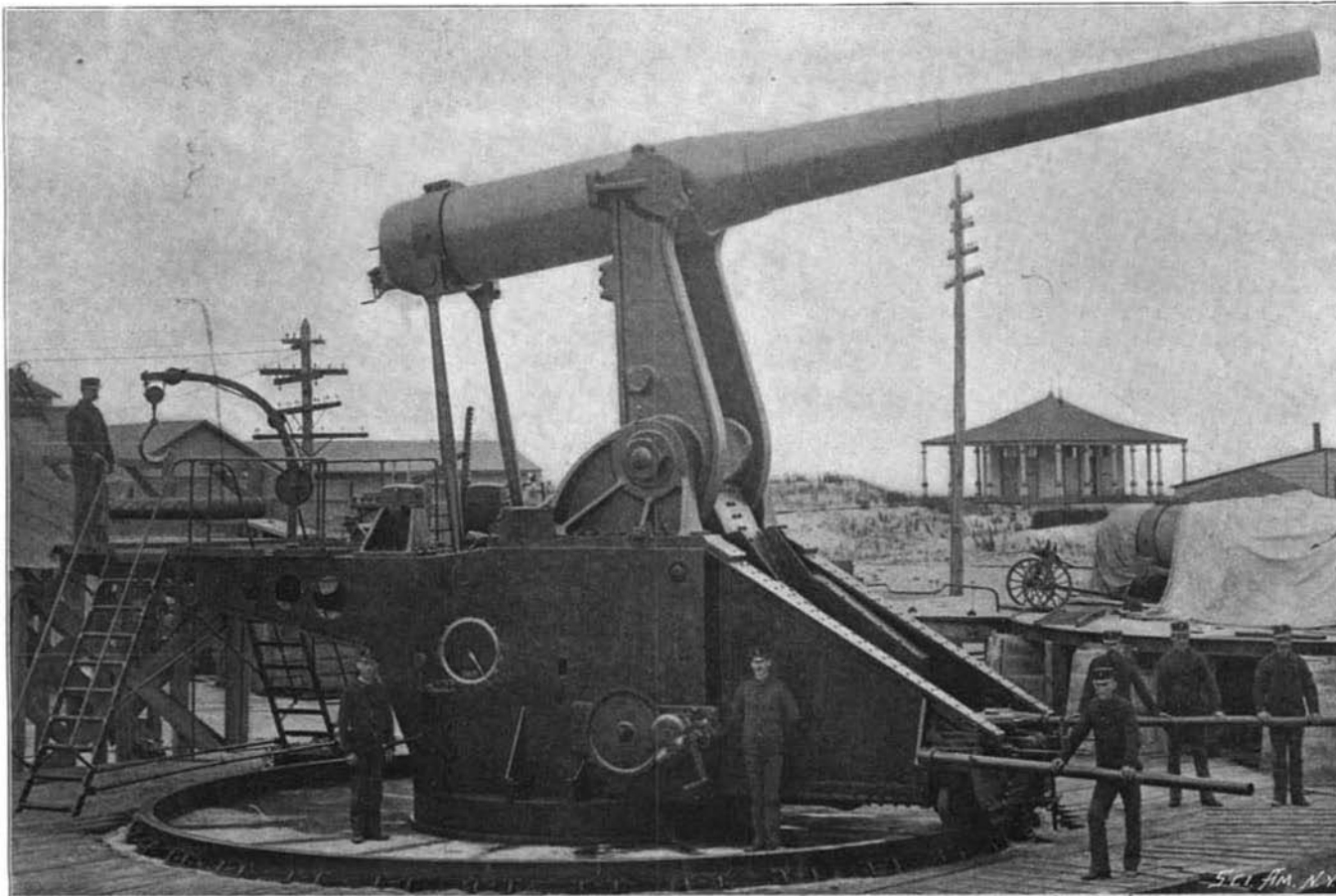
In the firing position nearly the total mass of the counterweight is suspended from the main axle, but during the recoil of the system, as the lever arms rotate from the vertical position, the weight is gradually transferred to them until in the horizontal position they carry practically the whole mass.

When the gun is loaded the ratchet holding the gun levers is released, the counterweight, due to its preponderance over the gun, moves downward and backward, carrying the system into the firing position; as the gun levers approach the vertical, the mass of the counterweight is again transferred to the main axle, and the telescopic springs force the lever arms away from the counterweight.

The main recoil cylinder is mounted in trunnion bearings between the chassis below the main axle; its piston being attached to the counterweight. When the gun is fired the piston is withdrawn; the oil passes through ports in the piston head from front to rear, forming the hydraulic brake, which absorbs the greater portion of the energy of recoil due to firing.

Two independent chains of gearing mounted on the two cheeks of the chassis engage in circular racks on the gun levers and serve as a means of lowering the gun from firing to loading position during practice drills.

The gun is elevated and depressed, either in the loading or firing position, by means of a band and two arms connected with two racks; the racks, actuated by



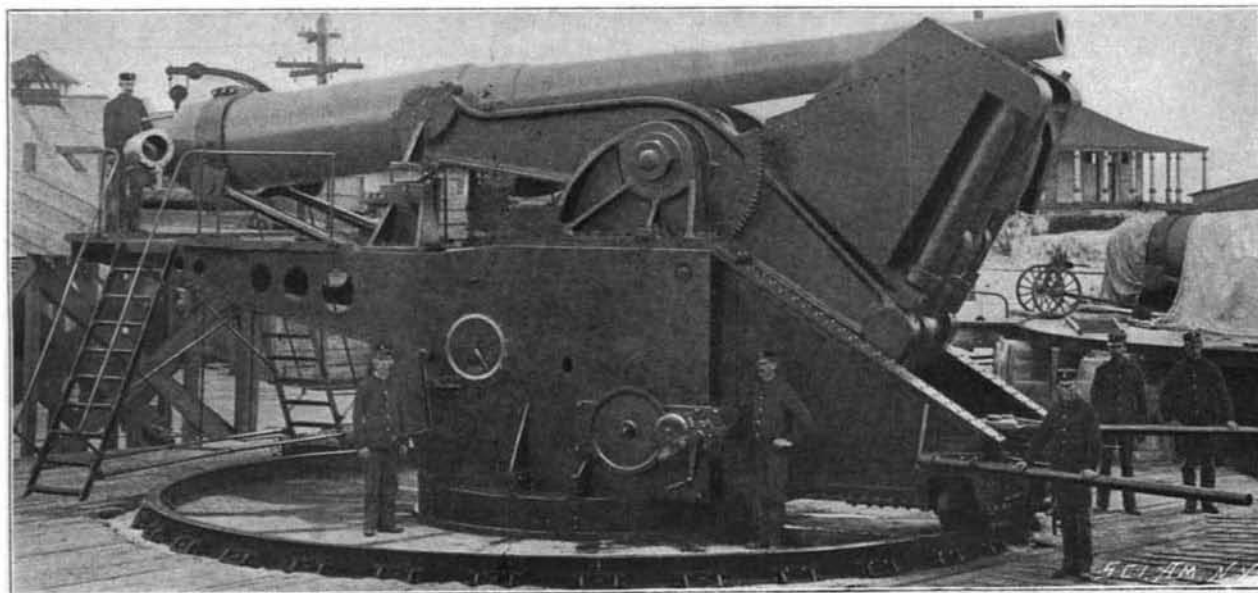
TEN-INCH RIFLE ON HOWELL DISAPPEARING GUN CARRIAGE; FIRING POSITION.

expended on the various gun-carriages that are submitted to the War Department. The mount is of only less importance than the gun, particularly in that class of mount which is designed to withdraw the gun behind shelter immediately upon its being fired.

The disappearing gun-carriage, which forms the subject of our illustrations, is now undergoing tests at Sandy Hook and has given fairly good results. It belongs to that type in which the gun is mounted on the extremities of two gun levers that rotate about a fixed axis. To the other extremity of the levers is attached a counterweight, which brings the gun from the loading to the firing position and assists in checking recoil when the gun is fired.

The principal parts of the carriage are: Lower roller path, rollers, upper roller path, chassis, main axle, gun levers, counterweight, main recoil cylinder, auxiliary recoil cylinder, elevating gear, retraction gear, traverse circle and traversing gear.

The distinctive feature of the carriage is the method of attaching the counterweight, there being an hydraulic and two telescopic spring cylinders, interposed between the bottoms of the levers and the weight.



HOWELL DISAPPEARING GUN; GUN DEPRESSED.



FRONT VIEW.