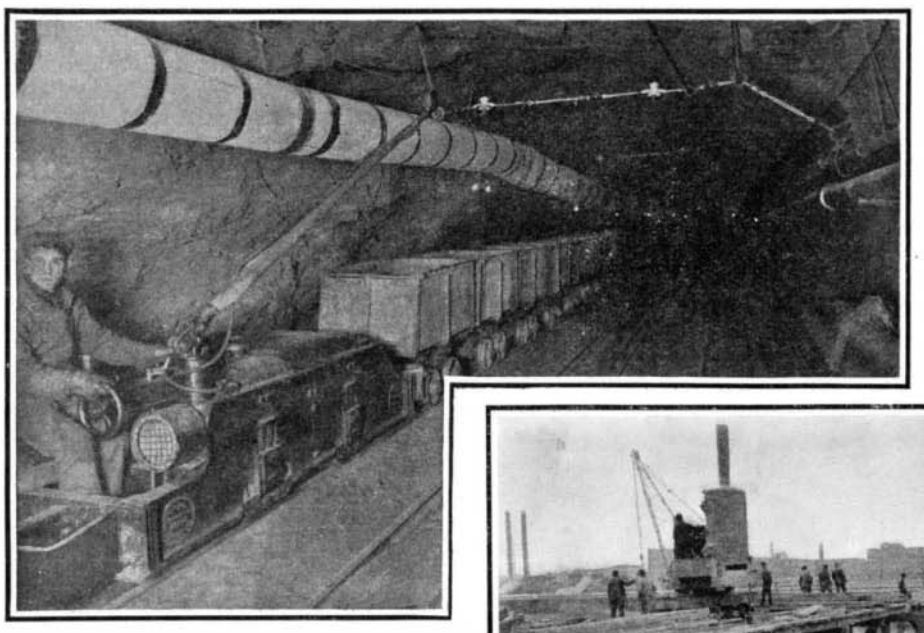
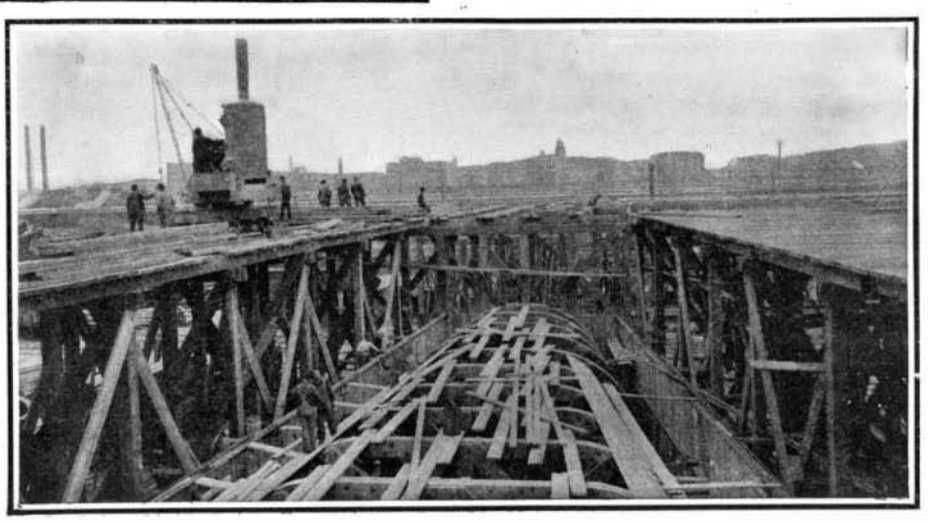
## THE CORTLANDT STREET TUNNELS AND TERMINAL BUILDING, NEW YORK.

It is probable that not many of the citizens of New York appreciate the magnitude of the system of tunnels beneath the Hudson River and under the streets of Manhattan and Jersey City, which the corporation, known as the Hudson Companies, is at present engaged in pushing through to an early completion. It is well known that four separate tube tunnels are being built through the silt below the Hudson River, but it is not so well understood that these tunnels are connected, both in Jersey City and in Manhattan, with the various transportation systems, subway, surface, and elevated, by means of extensions of the sub-river tunnels, which will parallel the Hudson River on both sides of it. The two northerly tunnels that have been completed extend under the Hudson from Fifteenth Street, Jersey City, to Morton Street, New York, whence they continue under Morton Street, Greenwich Street, and Christopher Street and up Sixth Avenue to a large terminal station at 33d Street. This branch will also have stations at 9th, 14th, 18th, 23d, and 28th Streets. At 9th Street and Sixth Avenue, a branch tunnel will be extended eastward under 9th Street to a connection with the Rapid Transit Subway below Astor Place.



**Electric Locomotive Hauling Excavated Material in Hudson Companies' Tunnel Station, 85 Feet Below Present Pennsylvania Railroad Station.**



**Cut and Cover Work on the Section of Tunnel Connecting the Jersey City Terminal Stations.**

THE CORTLANDT STREET TUNNELS.—The southerly pair of tunnels, known as the Cortlandt Street tunnels, are being built below the Hudson River from an underground station excavated beneath the present Pennsylvania Railroad Company's terminal station in Jersey City, to a large terminal station and building which is being constructed on a large block of ground in Manhattan bounded by Fulton Street on the north, Cortlandt Street on the south, and Church Street on the east. From the center of the Cortlandt Street terminal station, a subway will give access for passengers below Dey Street to the present Fulton Street station of the Rapid Transit Subway.

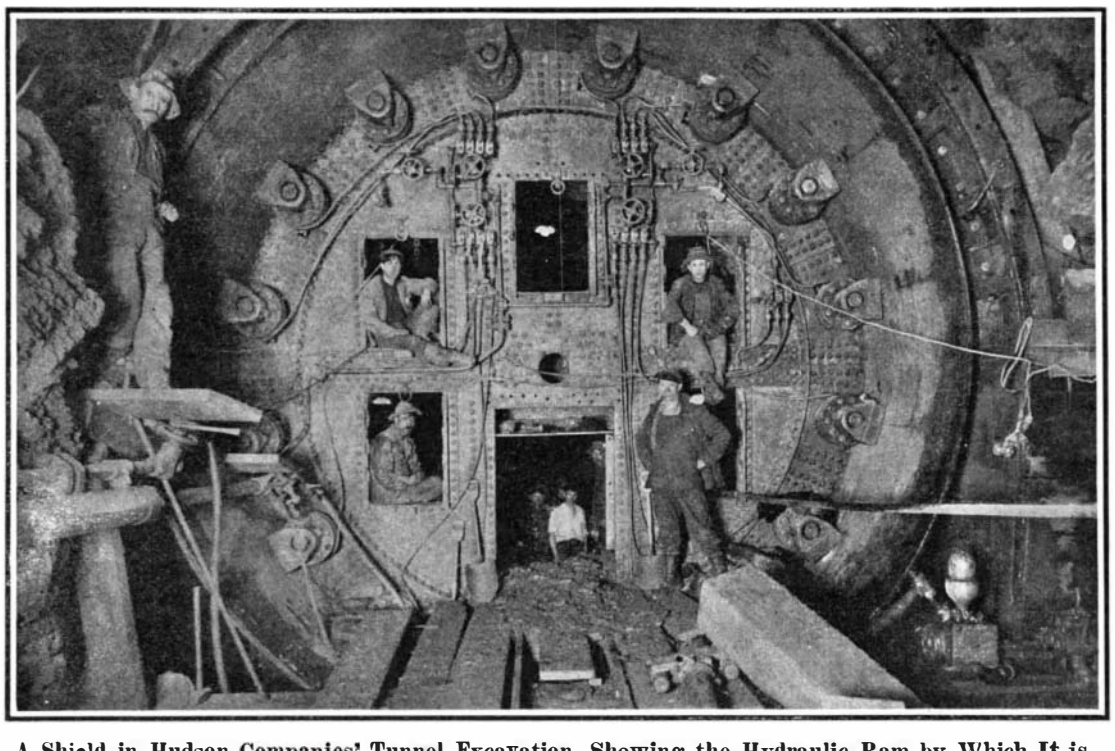
The Morton Street and Cortlandt Street tunnels will be connected on the Jersey side by twin tunnels, which will extend parallel with the Hudson River and below Washington Street from the Pennsylvania to the Lackawanna stations. Furthermore, there will be an extension of the Cortlandt Street tunnel in a westerly direction for about three-quarters of a mile, below the main line tracks of the Pennsylvania Railroad. From this tunnel the tracks will emerge to a station in the heart of the downtown business district of Manhattan, or at one of several stations in the heart of the shopping district, while if he wishes to make connections with the New York Subway, he can do so at either the Fulton Street or Astor Place terminals.

JERSEY CITY DEEP LEVEL STATION.—It is seldom that an important engineering work of this magnitude is carried out as quietly as has been the work of excavating these tunnels and stations; indeed, there is one part of the work, the announcement of whose completion will come as a great surprise to the New York public. We refer to the construction of a large subterranean station, 85 feet below the present terminal station of the Pennsylvania Railroad in Jersey City. So quietly has this work been done, that although the company has cut out of the solid rock a station 150 feet in width, and with its approaches nearly a thousand feet in length, not a word as to the progress of this excavation has leaked out. The excavation is practically completed, and the task of concreting and finishing is well in hand. By reference to the accompanying map, it will be seen that the station provides for four, and in some places five, parallel tracks and the necessary platforms. Passengers coming in from Newark, or from the Lackawanna and Erie terminal stations, can either continue to Cortlandt Street, Manhattan, or by taking the elevators which run from the tunnel station up to the concourse of the Pennsylvania Railroad station above, they can take a train to points on the Pennsylvania system, or take one of the surface trolley cars. Similarly, passengers arriving by way of the Hudson tunnel from Cortlandt Street can either take the elevators to the station above, to connect with local or long-distance steam trains, or they can continue through the Washington Street tunnel to the other Jersey City terminal stations, or they can continue their journey without change of car to Newark, the first three-quarters of a mile of the trip to that city being made in the tunnel, and the rest of it over the Pennsylvania Railroad steam tracks.

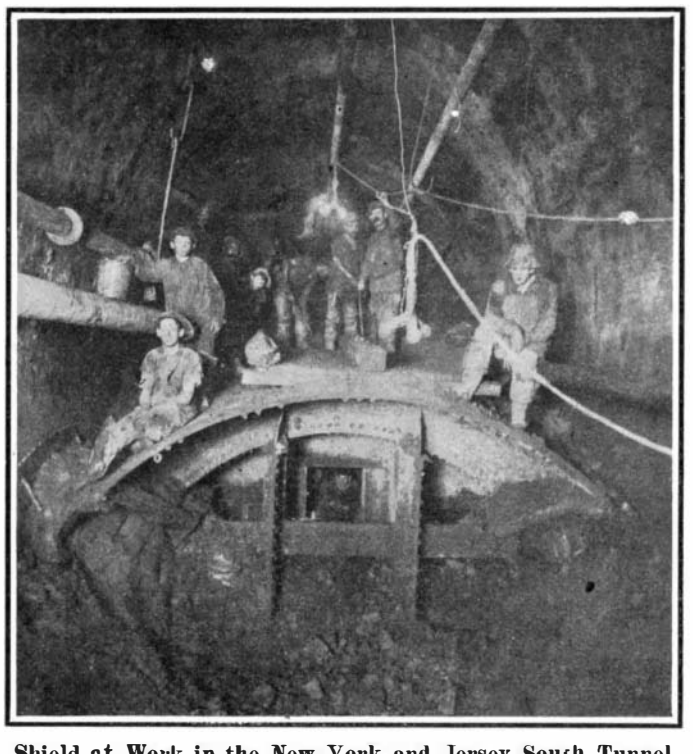
The present state of the work is shown on the accompanying map by heavy black lines; and it will be seen that not only is the excavation completed for several blocks on Washington Street, and under the Pennsylvania Railroad station, but the tunnels have also been driven for about 3,500 feet underneath the Hudson River toward the Manhattan shore.

Special note should be made of the very rapid progress made with these two tunnels. They are being forced through the mud by simple displacement; that is to say, the mud is being crowded aside instead of being taken in through the vertical doors in the front of the shield, which was the method pursued in the earlier work on the Hudson River tunnels. In July of last year, the north tunnel was advanced and the massive rings put in and bolted up, for a distance of 962 feet, and the south tunnel for a distance of 678 feet, making a total of 1,640 feet of tube tunnel built in a single month. The greatest record for one day was made on August 13, when one of the tunnels was advanced 72 feet in 24 hours.

CORTLANDT STREET TERMINAL BUILDING.—The terminal at Cortlandt Street will be by far the largest office building in the world. It will contain twenty-two floors and four thousand offices. The site upon which it is being built extends for 400 feet on Church Street and 480 feet on Fulton and Cortlandt Streets. In order to find suitable foundations, it was necessary to go everywhere down to rock; and since the lower floors below ground level are also below water level, it was decided to inclose the whole of the area with a huge monolithic foundation wall of concrete 78 feet



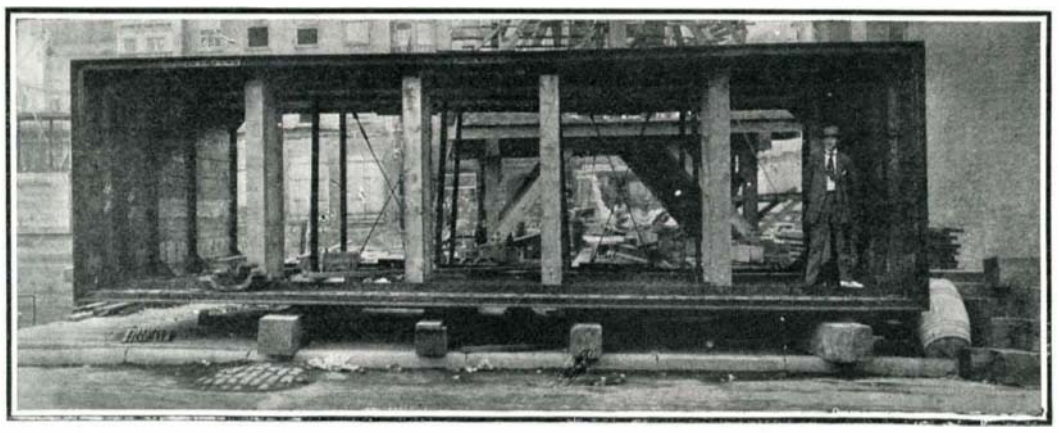
**A Shield in Hudson Companies' Tunnel Excavation, Showing the Hydraulic Ram by Which It is Advanced and the Doors in Front Face by Which Excavated Material is Taken into Tunnel for Removal.**



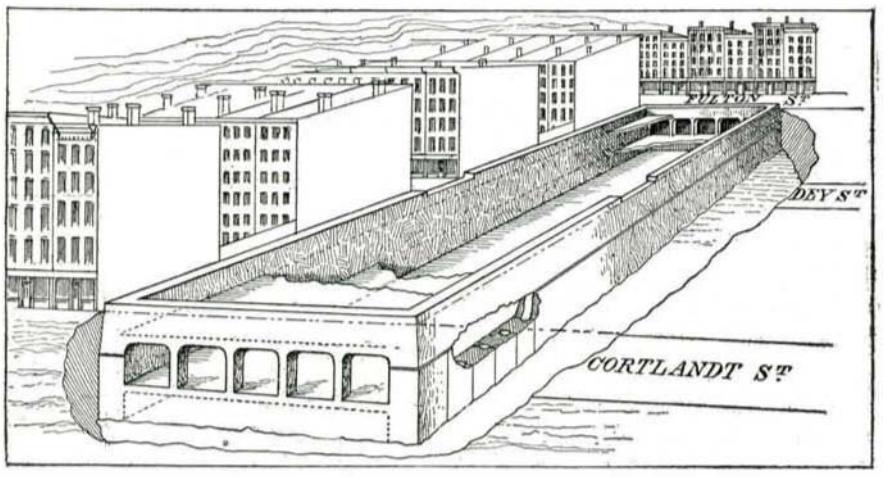
**Shield at Work in the New York and Jersey South Tunnel Approach.**

THE CORTLANDT STREET TUNNELS AND TERMINAL BUILDING, NEW YORK

in height and 8 feet in maximum thickness. The sinking of this foundation was a task of great magnitude, and it has been accomplished by means of rectangular caissons 8 feet in width by about 15 feet in length, which are sunk end to end, and entirely around the outside line of the building, down to bedrock. In order to key or dowel the adjoining blocks together, half-round forms are placed against the end walls of the caissons during the ramming of the concrete. These are subsequently withdrawn, the abutting sections of the caisson wall cut out, and the vertical circular hole thus formed is filled up with concrete tightly rammed in place. This not only keys the abutting sections of the walls together, but serves also to seal them against the inflow of water. That portion of the building contained within



**One of the Caisson Forms Used in Building and Sinking the Huge Concrete Wall, 8 Feet Thick and 75 Feet Deep, Inclosing the Foundations of the Cortlandt Street Terminal Station.**

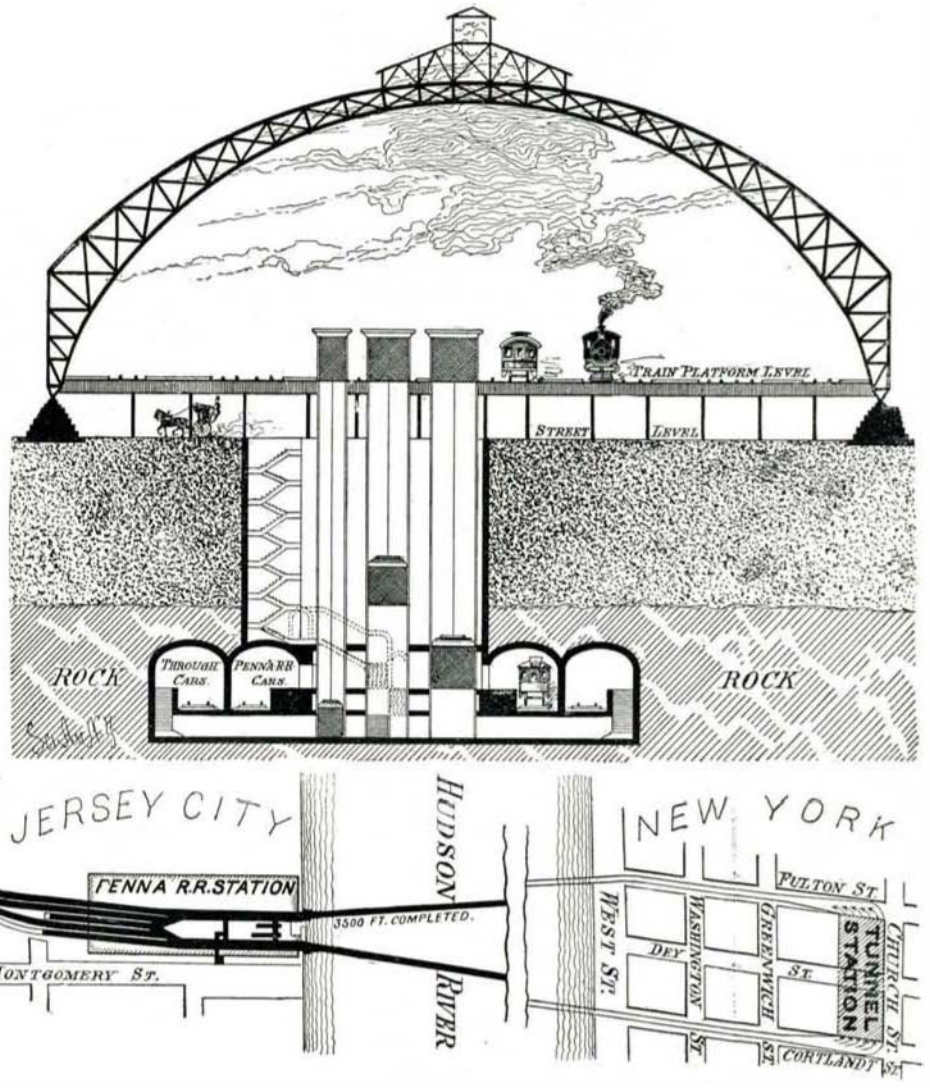



**View of the Huge Concrete Foundation of the Cortlandt Street Terminal Station of the Hudson Companies Tunnels. It Forms Practically an Unbroken Rectangular Box 8 Feet Thick, 75 Feet Deep, 180 Feet Wide and 420 Feet Long. The End Walls Will be Pierced to Admit the Five Tunnel Tracks.**

in this wall, and lying below street level, will have three floors, the first below the street being the concourse floor, the second the station floor for the tunnel trains, and the lowest containing the power plant. Above the street level the building will be carried up as two separate structures, one on each side of Dey Street, built in the style of the Italian Renaissance. Up to the fourth story the building will be finished in polished granite and Indiana limestone; above that it will be of brick and terra cotta. An idea of the size of the building may be obtained by comparing it with the Broad Exchange building, at present the largest office building in Manhattan, which contains seven million cubic feet of space. It would take nearly three Broad Exchange buildings to fill the space occupied by the Cortlandt Street Terminal building, and in the four thousand offices will be accommodation for at least twenty-five thousand persons. This great population will be handled by thirty-nine elevators, which between them will probably handle some thirty to forty thousand people daily.

THE TERMINAL STATION.—The trains arriving from New Jersey will enter the station on five parallel tracks, which will extend entirely across the length of the building, and will be served by six platforms. There will be absolutely no switching. The trains, which will consist during the rush hours of eight cars each, the cars being provided with both center and end doors for rapid loading and unloading, will discharge their passengers upon the platform on one side, and receive their passengers from the platform on the opposite side—an arrangement which entirely separates incoming and outgoing passengers, both on the platforms and on the cars, and conduces to great rapidity of handling.

Passengers will enter the building upon the street floor and pass to the concourse on the floor below by stairways, inclined planes, and elevators. Here will be the waiting rooms, telegraph and telephone rooms, restaurants, and other conveniences of a large railway station. Access will be had from the concourse to the station floor by stairways and elevators. The cars, which will be built of steel, will be large enough to accommodate fifty persons. During the rush hours, it is proposed to operate eight-car trains on a headway of one and one-half minutes between trains; and as the passage under the river will probably average only three or four minutes, a resident of Jersey City should be able to reach the shopping district or downtown district in from six to ten minutes after leaving the Jersey side.




**Plan and Section, Showing the Large Tunnel Station, 85 Feet Below the Pennsylvania Station, Jersey City, and Its Connection, by Tunnels Below the Hudson, with the Cortlandt Street Terminal, New York. The Heavy Black Lines Show, in the Plan, the Extent of the Completed Work.**

In conclusion, we may mention that as soon as the new Pennsylvania Railroad station at 33d Street has been completed, the big terminal station in Jersey City will be abandoned for steam trains and turned over for the use of the Hudson Companies, who anticipate such an increase in traffic that they will need all the tracks in both the tunnel and surface stations to accommodate the trains.

**Building the Roof of the Hudson Street Station.**

**THE CORTLANDT STREET TUNNELS AND TERMINAL BUILDING, NEW YORK.**

### A Sparklet Inflator.

A handy device which should possess many attractive features to automobilists has recently been introduced to the English market by the inventors of the Parsons non-skid device for wheels. It is called a sparklet inflator, and consists of a small cylinder charged with $CO_2$ gas, such as is used for the aeration of mineral waters. It has been found that this gas exercises no deleterious effect upon the rubber used for the manufacture of the inner tube, and owing to the fact that oxygen is absent, it is stated to be more suitable for inflation than air. The cylinder is fitted with a gage, valve, and short length of rubber tubing for connecting it with the valve of the tire. All that is necessary is to attach the connecting pipe to the inner-tube valve piece, and open the valve controlling the passage of the gas from the cylinder, the gas issuing in a steady stream at a uniform pressure, as may be observed by reading the gage. Directly the tire is fully inflated, the gas supply is cut off by closing the valve, and the tube replaced. One great advantage in handling cylinders charged with this gas is that no danger is incurred. In the remote event of a cylinder breaking no explosion would result, but the liquid gas would rapidly evaporate in the form of a mist. Each cylinder, though only about 16 inches in length by 2 inches in diameter, contains when fully charged sufficient gas for the full inflation of a tire 34.3 by 3.55 inches ten times, and the empty cylinders can be easily and cheaply recharged. As a labor-saving device these cylinders possess many advantages. A tire can not only be inflated expeditiously, but without that physical effort required in accomplishing the operation with a

foot pump, which in the case of a large tire which has to be inflated to a pressure of 90 pounds or more is an exhausting and tedious task. The convenience of these gas inflators was strikingly demonstrated on the occasion of the last Herkomer trophy trials, when the competing Daimler cars were all equipped with this device, and the saving in labor and time which their utilization effected was appreciated by the respective competitors.

### The Seventh National Automobile Show.

Last week, for the second time, the Licensed Association of Automobile Manufacturers held its show in Madison Square Garden. Some idea of the features of the new cars exhibited was given in a forecast of this show in our Automobile Number. A brief summary of improvements noted is given herewith.

Thirty-six different firms exhibited some 176 different gasoline pleasure cars. All but one of these firms showed a 4-cylinder car; six of them also exhibited a 6-cylinder car; one a car with an 8-cylinder, V-type motor; one a 3-cylinder, 2-cycle car, besides a car fitted with a 4-cylinder, 2-cycle engine as well; three, double-opposed cylinder cars, and one a light car with a 2-cylinder air-cooled V motor; while three exhibited a single-cylinder car, one of these being of the very light, air-cooled type. Practically all of these machines were fitted with engines having mechanically-operated inlet valves in place of the old-style, suction-operated, automatic type. A majority of the engines had jump-spark ignition either from a high-tension magneto or from the usual accumulators and coils. A small percentage was equipped with make-and-break ignition supplied with current from a low-tension magneto, and several were fitted with both systems. The use of mechanical lubricators appeared to be well-nigh universal. Imported ball bearings are employed lavishly on most of the large, high-priced cars; but roller bearings also find favor with many of the makers, one of whom calls attention to the fact that from the motor to the rear wheels the power is transmitted solely on and by rollers. The special form of roller bevel drive which makes this statement possible, will be found illustrated in our Automobile Number. The sliding gear transmission is almost universally used, also, the only exceptions being some of the single, double-opposed, and 8-cylinder cars (which were fitted with a 2-speed planetary gear), and the light one-cylinder and two-cylinder V-motor cars, which had a friction-disk device. A large 4-cylinder limousine with a dynamo and electric motor in line with the crankshaft and arranged so as to form a magnetic clutch, contained the only real novelty in the way of transmissions. For novel mechanical transmissions, one has to revert to the Automobile Club show held last month in the Grand Central Palace. The most novel of these transmission gears will be found described in our Automobile Number.

Other mechanical features noted on the new models, such as the driving of fans and lubricators positively by gears, we have already commented upon. On one high-grade car that still uses a belt-driven fan, two round leather belts are used in place of the single flat belt employed by some of the other manufacturers. No automatic motor-starting apparatus—a feature of the recent Paris Salon—was shown; but this is an improvement that will come in time and that has been produced more quickly abroad on account of the offering of several special prizes. Small cylinders of compressed carbonic acid gas—at a pressure of 1,000 lbs. per square inch—are now to be had at a reasonable figure. These are used for inflating tires and are fitted with a special reducing valve and gage by means of which any pressure up to 300 pounds can be had and indicated. About twenty tires can be inflated per cylinder. Compressed acetylene is also carried on most of the large cars. A recent improved system of compressing and absorbing this gas makes it possible to carry sufficient in a cylinder of medium size to supply one ½-foot burner for 100 hours. Electric headlights and searchlights fed by current from a dynamo run by the engine are still one of the developments of the future. One firm which builds a small dynamo for keeping the ignition cells constantly charged has worked out this idea on a small scale, and doubtless in another year we shall see its commercial application. A brilliant, never-failing light at night should always be instantly available when the car will run.

The display of electric vehicles this year was large and interesting, there being no less than 29 pleasure vehicles of this type exhibited in the concert hall. No less than 17 of these were runabouts, having a radius of from 50 to 75 miles on a charge, and capable of speeds up to 20 and even 30 miles an hour. The most distinctive of these was modeled on the lines of the popular 4-cylinder gasoline runabout with rumble seat, the battery of 32 cells being placed forward under the bonnet. Fitted with a 3½-horse-power motor hung forward of the rear axle, and driving it through bevel gears, this car is said to be capable of traveling at a speed of 30 miles an hour for 1½ hours, or of making from 75 to 80 miles at a speed of 15 miles an hour It is fitted with six speeds forward and three speeds backward.

Another novelty in electric machines is the use of pressed steel frames and double internal and external expanding brakes on the rear wheels, in addition to an electric brake. A well-known manufacturer showed machines with interchangeable bodies. By removing six bolts the Stanhope body can be readily taken off and replaced by a closed coupé body for winter use. Still another variation of this idea makes it possible to transform an open rig into a closed coupé by setting the closed body upon the open one. Chain and gear drive appear to be about equally distributed among the electric vehicles. Where the former is used, it is sometimes of the single and sometimes of the double side-chain type. The necessary speed reduction from the motor to the countershaft is obtained generally by a special form of wide, silent chain.

Besides the runabouts and other light electric machines, a considerable number of heavy, closed vehicles were shown. These, as a rule, are fitted with about forty cells of storage battery, thus making them capable of being readily recharged from the usual lighting circuits. Some makers, however, still cling to a reduced number of cells, though the general tendency seems to be to increase the number, even in the lighter rigs, to as many as twenty-four or thirty. The pasted form of storage battery is used almost entirely in the pleasure vehicles. The grids are made heavier in one type of these cells, thereby giving them a longer life although slightly increasing the weight. The Edison battery was not on exhibition in the present show, nor was it seen in any of the electric vehicles.

So numerous were the exhibitors of parts and accessories, that every nook and cranny of the Garden, from the basement to the third tier boxes, was filled with small exhibits. Some of the most noteworthy of these were the displays of different steel makers, who are producing special grades of steel for automobile use. One company exhibited a crankshaft forged from a solid billet by bending and without taking any cuts out of the steel. In this way the grain of the steel is preserved, and a much stronger crankshaft is produced. A test of a small steel rod about a foot long and half an inch in diameter, by weighting the rod at each end with 150 pounds, thus springing it out of line at the center 7-16 of an inch, and then revolving it rapidly with an electric motor, was most interesting. The total number of revolutions was recorded by speed counters, and these were found to run up to nearly a million before the steel would break. Another firm exhibited a four-speed transmission, having double bevel gears for direct drive on two of the speeds, and which was said to have run 36,000 miles in a 4-cylinder car. The gears were in a remarkable state of preservation considering the distance they had driven the machine.

A number of quickly detachable rims of ingenious design and a self-healing inner tube formed the chief novelties in the tire line. One of the best quickly-detachable rims consisted of a ring with a groove into which a locking ring was expanded as soon as the tire-retaining ring was slipped into place. No tools whatever were required to operate this device. The self-healing tube had a central layer of silk waste and some gummy substance, which immediately closed up the hole if the tire was punctured. A considerable number of non-skidding tires and protective bands were also shown.

About a dozen different types of speedometers were on exhibition. Most of these were devised to operate by centrifugal force, and all of them required a flexible shaft from the wheel to the instrument when an odometer was combined with the speedometer. A new form of electric speedometer consisting of a voltmeter placed on the dash, and operated by current from a small magneto placed at the wheel, was the only one which did not require a flexible shaft, although it will be recalled there are several makes of air instrument in which merely flexible tubing is necessary if the speedometer is used alone. A new form of imported instrument, besides the usual speedometer and total and trip odometer, had a clock combined in the same casing.

A compressed-air brake applicable to any automobile was another novelty in the accessory line, while the use of compressed air for this purpose, and also for operating the clutch, was shown applied in a very thorough manner in a 60-horse-power touring car of a well-known make. This machine is a distinctively American production, and has incorporated in it ideas which will no doubt be copied by some of the foreign makers.

The exhibit of commercial vehicles in the basement was not a particularly large one, its most striking feature being the use of the electric truck. Machines of this type have been adapted to a large number of purposes, and have been found to give a considerable degree of satisfaction for city work. When it comes to hauling large loads for long distances, gasoline trucks must necessarily be used. The combination gasoline-electric truck has not yet made its appearance. Such a vehicle would seem to offer many advantages

### Science Notes.

At a recent meeting of the French Academy of Sciences, Prof. Delage read an account of a series of experiments made by M. Marage on the sense of hearing in fishes. Many difficulties were encountered in performing accurate experiments. If a fish be placed in a tank, the sound being reflected from all the walls, the animal having no clew as to the origin of the sound vibrations, will make no attempt at fleeing. If, however, the fishes are experimented on in the state of liberty, these investigations will be found still more difficult. At all events, fishermen do believe in the sense of hearing of fishes. Marage used an India-rubber funnel to transmit the sound to the water, this funnel being tuned to the number of vibrations of the sound in question. The vowels a, e, i, o, u, were produced within a range of four octaves, and with the energy generally used with deaf-mutes. The experiments were made on fishes, both at liberty and in captivity. In the latter case, a diver was able to perceive and to analyze the sound vibrations in the water to distances up to 100 feet. Although these vibrations failed to show any effect on the fishes, M. Marage thinks it quite possible that the animals may hear the noises produced by fishermen. It should, however, be remembered that this rudimentary sense of hearing is compensated by highly-developed senses of touch and vision.

The fact that a luminous emanation of variable shape will appear in the dark at such points on the surface of the earth below which there are extensive ore deposits at a more or less considerable depth, was recorded in Germany as far back as 1747. Immediately before or during a thunderstorm these phenomena are said to be especially striking. Similar observations have more recently been made in North America in the neighborhood of ore deposits. Though much should be ascribed to superstition and to errors of observation, the fact nevertheless has been confirmed by recent investigation. The electric emanation given off from the surface of the earth (see Prometheus, No. 891) has in fact been repeatedly ascertained photographically by Mr. K. Zenger. Plates coated with fluorescent substances were used. It may thus be taken for granted that the emanations in question occur with an especially high intensity at those points of the ground where good conductors of electricity are found in large amounts in the neighborhood of the surface of the earth, in other words, above ore deposits, which are very good conductors of the electric current. Lignite and coal, especially when containing pyrites, are fairly good conductors. The difference in the intensity of radiation as compared with points free from any ore would seem to be recognized by means of photography, thus affording to geologists a rather simple means of locating ore and even coal deposits.

A force now almost universally recognized as important, but ridiculed a few years ago, is the correspondence schools. These schools betake themselves to the student wherever he may be and lay before him knowledge that he should possess. While it is true that much, if not most, of the information given him could be purchased at a price much less than he pays the correspondence school, still the student is not familiar with technical literature and would not know what to buy. The correspondence schools make the selection and the student pays the bill. When all is said, however, about the superiority of the living teacher over the printed page, it still remains true that there are "many of us" and that it is impossible to open too many avenues for those who desire instruction. There should be no aristocracy of learning. Let each one get all he can in the way easiest for him and let no one fortunate enough to secure a high grade engineering education begrudge the lone engine-man far removed from books, schools, or persons of education, the little he may glean from his correspondence papers. William E. Curtis, the celebrated correspondent of the Chicago Record-Herald, never thought he was conducting the greatest correspondence school in the world, nor did his vast number of readers ever realize that they were taking a corresponding course, until the advent of the correspondence school. Yet the fundamental ideas in both lines of work are identical. The idea of the correspondence school is the one fact in educational annals of the past twenty years that stands out prominently because of its pure bigness. Probably not less than two million people in the United States have taken one or more courses in some correspondence school.

There are many massaging devices which call for the use of the electrical current, so that their employment is restricted to homes and establishments where the electricity is available. A new apparatus recently placed on the market is driven by a water motor attached to the spigot. The head of water secured from an ordinary water supply is entirely sufficient for this purpose, and the apparatus is a handy combination as well as an economical one.