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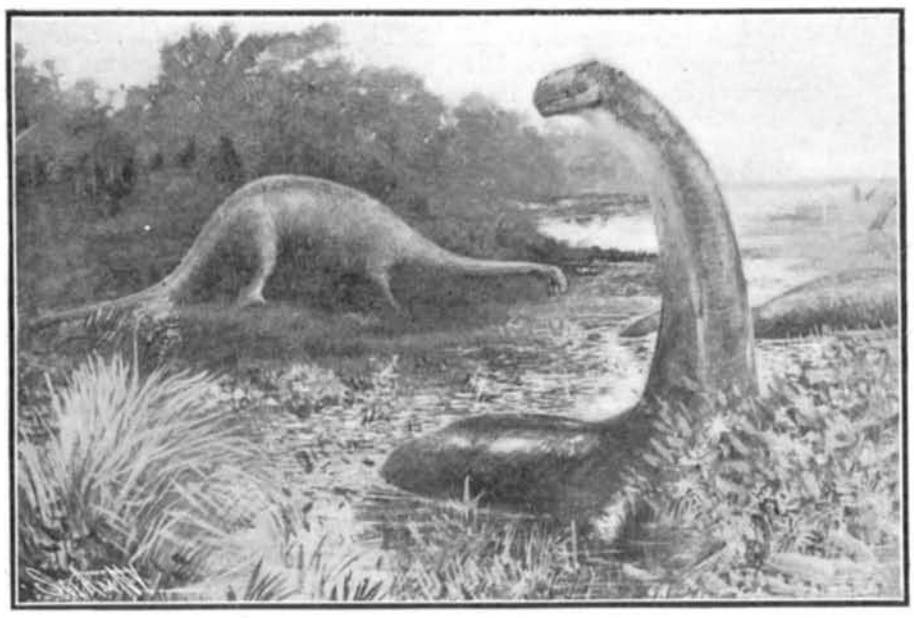
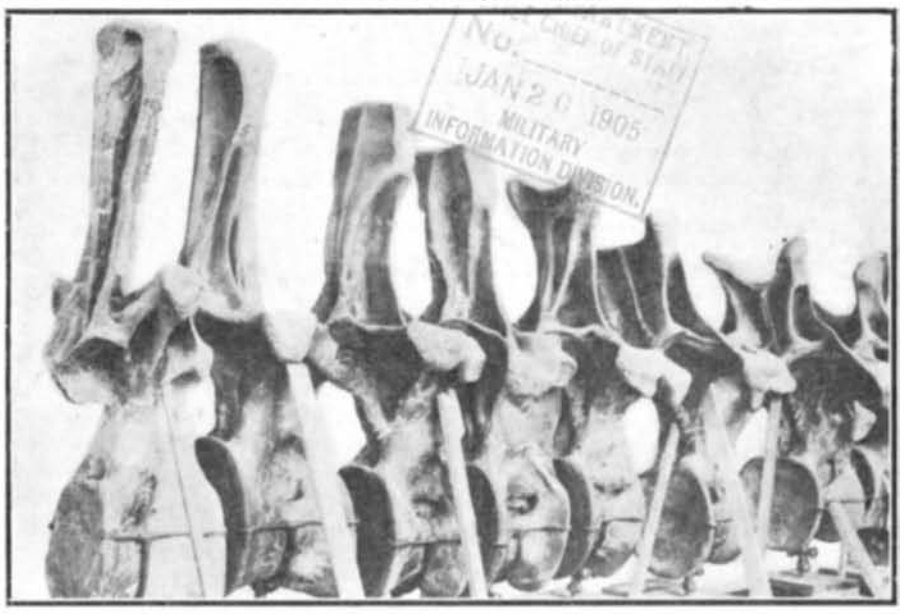
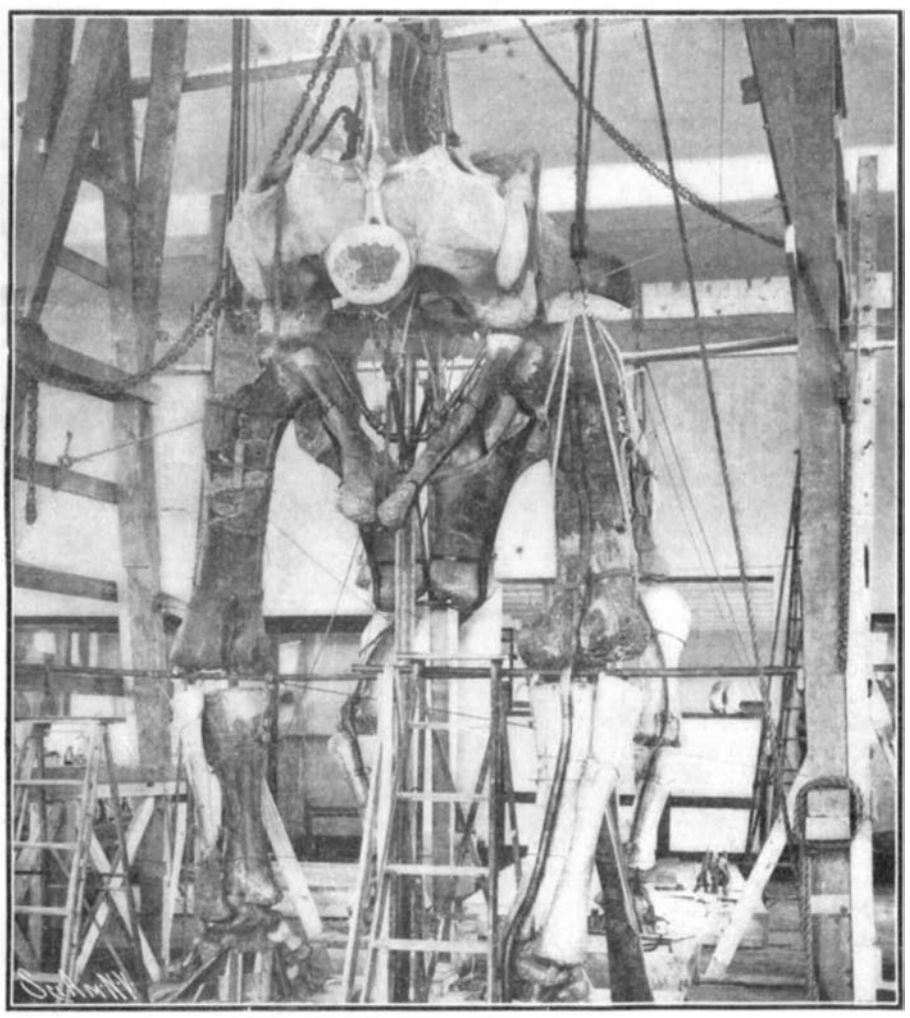


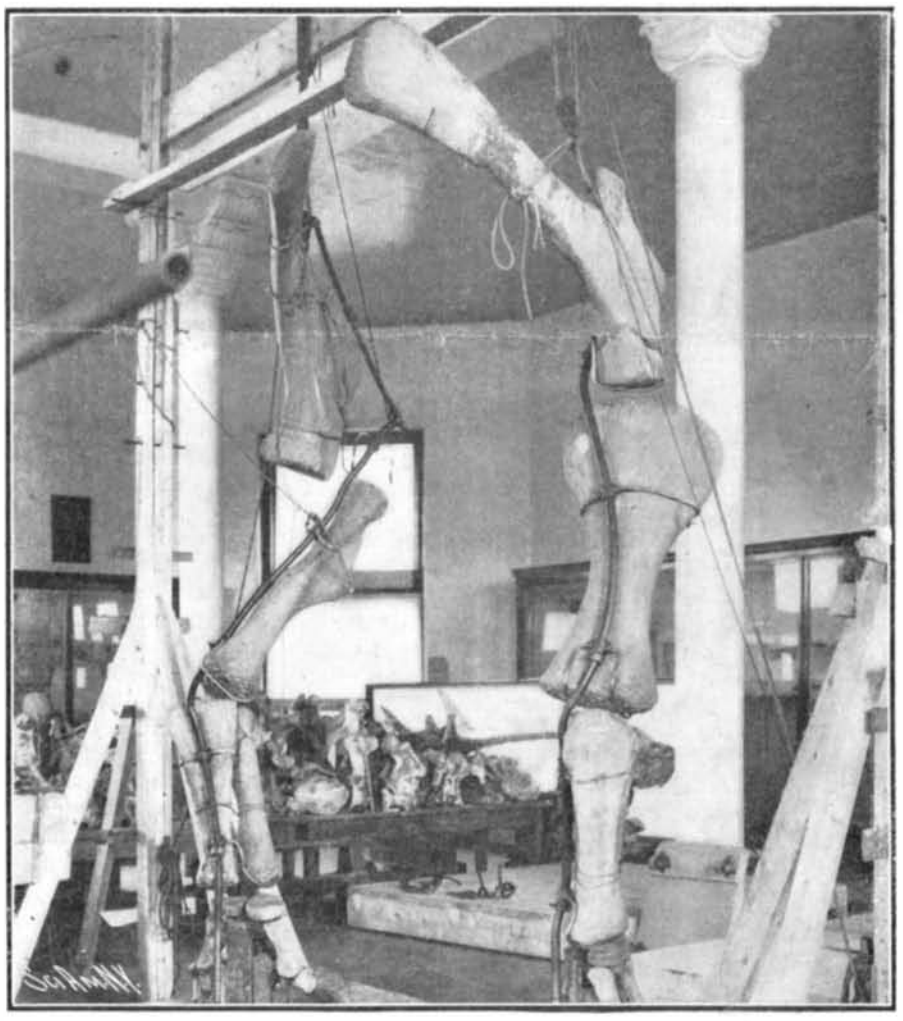
Drawing by Charles R. Knight. **Brontosaurs as They Probably Appeared at a Period Estimated at Seven Million Years Ago.**



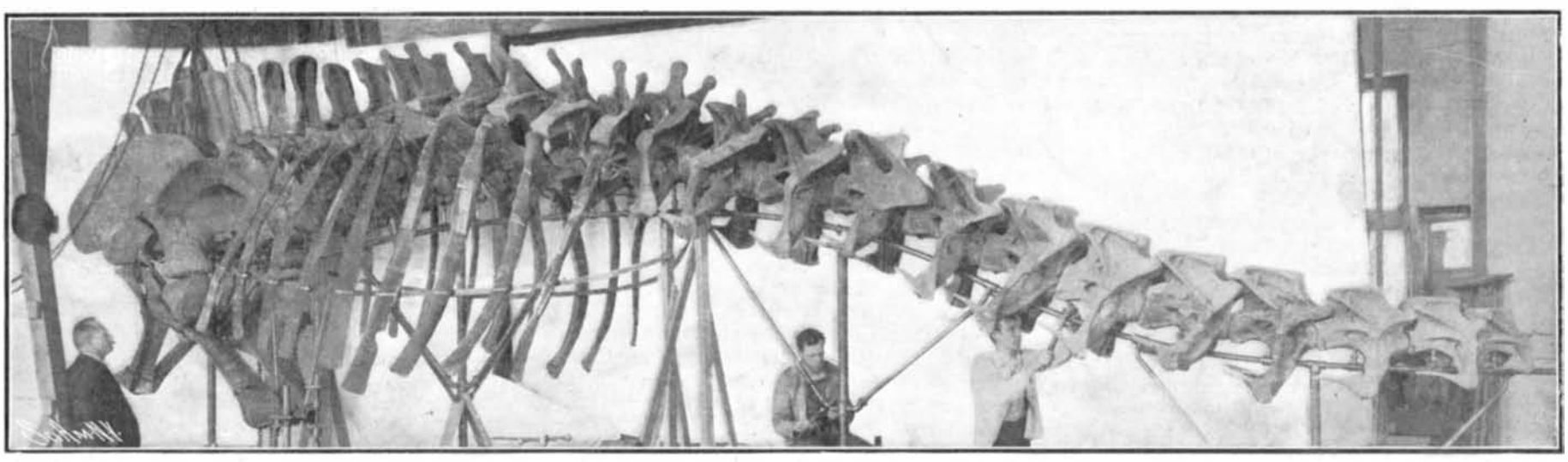
Part of the Vertebral Column. The Structural Similarity with the Modern T-shape is Apparent.



The Hind Legs. Height of the Reptile at the Hips, About 15½ Feet.



Fore Legs, Showing Method of Mounting.



A Portion of the Brontosaurus Skeleton, from the Hips to the Head, Showing the Iron Work Used in the Reconstruction. The Total Length of the Animal is Estimated at 62 Feet

THE RESTORATION OF THE GIANT LIZARD, THE BRONTOSAUR, AT THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.—[See page 42.]

SCIENTIFIC AMERICAN

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NEW YORK, SATURDAY, JANUARY 21, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

SCHEDULE VERSUS SAFETY.

The greatest credit is due to the Interurban Company for the admirable manner in which they have operated the new Subway during the two months of its active service. Systems as large as this have usually grown from small beginnings, and developed gradually to the full magnitude of their traffic; but in this case, the turnstiles were opened and the full flood of a great city's traffic was allowed to flow into the Subway, as though the opening day were but one in a long series of years of successful operation. Not even the Interurban officials, however, will claim that the operation of the system is so perfect that no further improvements can be made; and, indeed, an incident occurred recently in the early hours of the morning which served to show that in one respect at least the security of the passengers can be very materially increased. We refer to a rear-end collision, which took place between two trains on the local tracks at the Worth Street station, and to the fact, which was brought out by this incident, that although the automatic stop is used on the express tracks, this most excellent device has not as yet been installed on the local tracks. The automatic stop, it will be remembered, is a small lever placed on the tracks, which is raised whenever the adjacent signal is at danger, and when in this raised position serves to shut off the current on a passing train, and set the emergency brakes. This stop is considered, and rightly so, to be an absolute preventive of rear-end collisions.

Now, the action of the stop in the case of a breakdown of any train, is to delay the whole service on that particular line back of the obstruction, every train being held with a clear stretch of track between itself and the train ahead. This, of course, means that the blocking of one train involves the instant blocking of a long stretch of trains behind it. In order to avoid such delay, the management decided not to install the stop on the local tracks; but to adopt a modified operation of the block signal system, under which, when the signals are against him, the motorman is permitted to proceed "under a slow bell" until he brings himself as near to the train ahead as to his judgment may appear to be advisable. By thus playing fast and loose, as it were, with the inexorable demands of the block-signal system, the following trains are kept moving much longer than they otherwise would be, before being brought up by the obstruction. This conduces, of course, to a closer observance of the time schedule; but it is done at a very evident sacrifice of those safeguards which the block-signal system is intended to throw around the passenger.

It is this practice of leaving to the judgment of the engineer as to how far and how fast he may proceed beyond a signal that is set against him, that is answerable for a large percentage of the accidents that are occurring on our steam railroads with such alarming frequency; and it cannot be denied that the adoption of the same method on the local tracks of the Subway has materially lessened the security of travel on that system. It is to be hoped that the officials, prompted by the recent collision, will see the wisdom of applying the automatic stop not merely to express tracks, but to every track on the road.

THE AMERICAN EXHIBIT OF FOREIGN AUTOMOBILES.

The fact that in this year's annual automobile show it has been necessary to find a separate hall in which to house the foreign exhibits, is striking evidence of the rapid growth of the domestic industry. In previous exhibitions there has been a hint of the separation that has taken place this year, in the fact that for the last two or three years foreign exhibitors have been grouped in a separate room at Madison Square Garden. The demand this year has been so great, that every foot of available space at Madison Square has been required for the exhibition of domestic machines, with the result that, for the first time, the foreign makes are to be found in an entirely separate building. As it is, there is a sufficient number of first-class foreign machines and their accessories to entirely fill an exhibition hall which occupies one complete floor of the largest department store in New York city.

Our succeeding issue, which will be a special number, devoted to the annual Automobile Exhibition as illustrative of the development of the American industry, will include detailed illustrations of some of the leading foreign machines; and it will suffice in the present article, which is devoted to a general survey of the foreign exhibit, to mention some of the more important points of novelty that have been developed during the past twelve months. In the first place, testimony should be borne to the characteristic beauty of design and excellence of finish that distinguish every machine. Although, in general contour and proportions the cars conform to the standard of last year, there have been some modifications produced in the form of the bonnet and the curves and proportions of the body that have added not a little to their handsome appearance. There is a general tendency to abolish the rear door and substitute the side door, which is placed either in the body of the tonneau, or else is formed by an ingenious arrangement, either of a swiveling or a lifting front seat, which makes it possible to enter the automobile directly from the sidewalk, and avoid the old inconvenience of having to step into the street. A machine that attracted much favorable comment was a brougham intended for city use, in which the bonnet is dispensed with, and the motor is placed beneath the driver's seat, which is hinged at the forward end, and can be lifted for inspection of the engine. This arrangement permits a considerable shortening of the wheel base, and provides a brougham that is more easily maneuvered in a crowd of vehicles, particularly in moving to the sidewalk in front of a theater or crowded store. This is a step in the right direction, at least in such cases as are intended more particularly for city use. There has been a considerable development of the inclosed or partly inclosed automobile, of the type that has been so popular during the past season, and some very pleasing designs are exhibited.

We note a tendency to abandon the over-light metallic car bodies, and return to the more substantial wood. This, of course, has the disadvantage of increasing the weight of the machine—a fact that has been noted with some alarm by the French tire makers, one of whom has recently offered a prize for a machine having the lightest car body compatible with reasonable strength.

In the design and construction of the chassis, engines, and running gear, there is no striking novelty to record. The pressed-steel frame has become the standard type, although a few makers exhibit a frame built up of standard shapes. There is a general adoption of the protecting pan, curving across the frame beneath the engine and transmission gear—a device so obviously useful that it is surprising it should not have been incorporated long ago. It is a common practice to equip each engine with two separate methods of ignition, the high-tension magneto and the battery and coil. The former is preferred, and the batteries are held in reserve in case of a breakdown of the magneto. In this connection mention should be made of a magnetic clutch, exhibited on a Belgian car, in which magnets, incased in the flywheel, are energized by current from the magneto or from the batteries. The device has apparently given excellent results, and if so, we may look for its very general adoption. Another promising form of clutch carries a series of springs behind the leather casing, by means of which the power is transmitted so gradually, that the car can be started when the transmission is on the high speed. The performance of these two clutches will be watched with keen interest during the coming season.

Many minor improvements were noted in the direction of providing a more convenient access to the various levers for control of the engine, the transmission gear, and the brakes; the foot-brake levers, in particular, being made longer, and so placed as to be operated with more of a forward and less of a downward thrust than in the earlier machines. In tires, the most notable improvement is the introduction of a non-slipping variety, in which a leather sheath is vulcanized over the tire proper, this sheath carrying a leather strip the full width of the tread, on which are riveted a mass of flat steel plates or studs, which serve the double purpose of giving improved adhesion and at the same time protecting the rubber tires from wear and puncture. The exhibit, as a whole, is a demonstration of that excellent workmanship and general beauty of design which have enabled the foreign makers, in spite of the remarkable development of our own industry in this country, to import into the United States, as they did last year, over three million dollars' worth of machines.

A MONUMENTAL BUILDING.

In planning the truly magnificent station which is to take the place of the present Grand Central Station of the New York Central Railroad, the company have shown a full appreciation of the magnitude of the problem and of the inexorable necessity that is laid upon them of building not merely for to-day, but for the vast increase of travel of the far future. When the present structure was built, back in the seventies, it was the wonder of the day; and because of its magnitude, its great arch of glass and iron, its many parallel tracks, its long stretch of office buildings, and other features of greatness, the Grand Central Station was, for many years, an object of much civic pride in New York city. It was built with a strict eye to the future; nevertheless, but two decades had passed when the company began to realize that so rapid was the increase in traffic, that their great station was great no longer, and that before long they must begin to pull down and build on a far more generous scale. The question of enlargement was receiving serious consideration, when the enormous inconvenience, not to say danger, attending the running of steam-operated trains through the tunnel approach to the station became so acute, that legislative powers were sought to enable the company to dispense with steam locomotives altogether, and operate the terminal yard and the suburban traffic by electrical traction. The opportunity presented by this change of motive power enabled the company at the same time to greatly enlarge and entirely reconstruct the station yard and the terminal buildings.

The magnificent structure, of which we present illustrations on another page, is the outcome of a continuous study of the problem by the architects, Messrs. Warren & Wetmore, associated with Messrs. Reed & Stem, and by the engineering staff of the New York Central Company. Every possible arrangement of tracks and type of building was considered, and no less than two hundred different sets of plans are now on file in the architects' office, as evidence of the care with which the problem was studied. The present designs were adopted because they conform to certain important principles which were laid down as indispensable to the successful operation of a great terminal station such as this, chief among which were the following:

The station must be considered as a great gateway to the city and, therefore, must be simple and dignified in its architecture, and must provide the broadest possible facilities for the inflow and outflow of traffic. It was this consideration that condemned those plans which contemplated the erection above the station of a vast office building; for such a structure would have congregated several thousand people at the very point where it was desired to provide a broad unobstructed thoroughfare for incoming and outgoing passengers.

The progress of the passengers from the street to the cars and from the cars to the street, must take place as far as possible in two direct and entirely separated channels; the incoming and outgoing crowds never meeting or intermingling with those moving in the opposite direction.

In passing from the street to the cars, the passenger should take the steps incidental to departure in their natural consecutive order, with as little running to and fro as possible; the waiting room, the ticket office, the baggage room, the concourse, and the departing platform presenting themselves successively to him as he moves to his particular train. Similarly, the incoming passenger should find the incoming baggage room, the cab stand, and the means of exit to subway station or to street, presented to him in quick and logical succession.

The express and long-distance passengers, whose progress through the station either in departing or arriving is necessarily retarded by ticket purchasing and the checking of baggage, should be entirely separated from the suburban passengers, who almost invariably pass direct from the street to the car without any delay in the station.

Lastly, in view of the vast increase which must necessarily and rapidly take place in the future, the station must be built on a scale much larger than is absolutely needed by the present volume of travel; and this provision must extend not merely to the area devoted to passengers in waiting rooms, ticket lobbies, and concourse, but to the station yard itself, which must be extended in area to accommodate the larger number of trains that will be required.

Now, it must be admitted, after an impartial study of the plans of this great undertaking, that the above requirements appear to have been fully met and all the provision for the future made that can reasonably be asked.

Architecturally, the station building will present a massive and dignified appearance, worthy of what is probably the most important railroad terminal in America. The architecture of the building is throughout and without exception an expression of the plan; none of the decoration being used merely for architectural effect, but everything serving some useful, struc-

tural purpose. Thus the main piers under the great arched roof of the concourse, and at the intersection of the roof and its transept, are necessary to carry the load of the massive steel work of the roof. This is true even of the two massive piers that flank the main entrance on Forty-second Street, their great mass serving to take the horizontal thrust of the arches. The only possible exception is the pairs of columns between the arches of the Forty-second Street entrance; and these are placed there merely to accentuate the fact that this is the main approach. The proportions of the façade are truly monumental, the main arches being 33 feet in width by 60 feet in height, and the cornice being about 75 feet above the street level. The whole structure will be faced with gray granite, and with its great frontage of 300 feet on Forty-second Street and twice that distance on Vanderbilt Avenue, and with an open width of street of from 130 to 140 feet to afford a fitting point of view, it must long remain one of the most successful of the monumental buildings of New York city.

THE LIFE OF A BARREL.

BY GEORGE E. WALSH.

The introduction of improved machinery in its manufacture has made the American cooperage business the largest in the world. There are upward of 300,000,000 barrels and circular packages manufactured in this country annually, and the demand increases so that this output must be steadily broadened in order to keep pace with the growth of the business. The largest consumption of barrels is in the cement business, which approximately demands 35,000,000 a year for the trade, while flour comes next, with a demand for 22,500,000; fence staples, bolts, nuts, and nails require 18,000,000, and sugar 15,000,000. Roasted coffee, spices, crockery, and fruits and vegetables use up about 5,000,000 barrels a year each, while the glassware trade, baking powder companies, distilled liquor manufacturers, and candy, tobacco, and cheese packers are big users of barrels, averaging in each trade from 2,000,000 to 3,000,000 barrels. The consumption of barrels for molasses, oil, lard and pork is also enormous, while dry paint, glue, snuff, oatmeal, screws, castings, and general hardware articles annually increase the demand on the cooperage supply.

While the amount of expenditures for barrels can be closely estimated for a given year, it is not possible to say how many barrels are in actual use. The life of a barrel is put down at one year by the trade; but that is far from true. The great majority of barrels have as many lives as a cat. They begin as sugar or flour barrels, and are then sold to the farmer for shipping his produce to market. It may be they are returned to him several times, carrying potatoes or pickles to market in the first trip, and then cabbages or lettuce in the next, each cargo being lighter in weight than the previous one, owing to the weakened condition of the barrel. Finally, the barrel may serve out its life work as a garbage receptacle, and be burned in the end in some tenement home to keep out the winter's chill. Thus it may be said that a barrel serves a more useful career than almost any other manufactured article, and its life is much longer than a season.

The demand for barrels is steadily increasing because modern machinery has made it possible to make them for the trade cheaper than almost any other form of package. That it is the most convenient form of package has long been acknowledged. The ancient cooper's art was a skilled one, and the work of cutting out the staves and then assembling them required long practice and apprenticeship. To-day machinery performs in a fraction of the time what hand labor did so slowly and clumsily.

The modern veneer machines have been instrumental in reducing the cost of barrels. Hand labor is eliminated here to such an extent that the work of feeding the machines constitutes most of the requirements of the operators. The staves are cut to the required thickness by the machines, and then pressed into shape by hydraulic pressure until they are ready for the assembling machine.

A feature of barrel-making in this country is the grading of the circular packages so that all the lumber brought to the factories can be utilized. One class of barrels must be absolutely water-tight, without a flaw of any kind in their staves. Barrels made for the oil, whisky, and paint trade must not only be flawless, but they must have a resistance power equal to a lateral pressure of five hundred pounds. In order to secure this the staves must be put to a rigid test beforehand, and they must be cured so there will be no danger of shrinkage and damage when put into use. Lumber used for this work must be carefully selected, and it must be cured by nature's slow but sure process. Kiln-dried lumber would never do. The condition of kiln-dried wood is such that it would prove too brittle.

The choicest oak, hickory, ash, or other hard wood must be selected for barrels used for such purposes, and their cost is consequently in proportion to the extra labor and cost of the raw product. Out of every dozen trees in an ordinary woods only four or five will be found to pass the most rigid examination and tests.

The second grade of barrels comprises those which have to endure a great lateral strain, but which do not have to be water-tight. To this class belong the sugar barrels, and all those used for packing hardware. The staves must be made of hard wood, but they only require strength and a power to resist three or four hundred pounds lateral pressure. It is possible to use for these barrels most of the lumber rejected for the first class of barrels. There must not be knot holes in the barrels, however, for tightness to some extent is essential. While the sugar and flour barrels have paper lining inside of them, they will spill more or less of the contents if holes and cracks of an unusual size are left in them.

The third grade of barrels includes those used in the hardware trade and for packing tobacco, spices. and coffees. The weight of these articles is no less than sugar or flour, but their sides need not be so tight. The barrels and kegs for the hardware trade must be stout, but lumber can be used that is somewhat defective. Knots are not necessarily a bar to the use of staves. Some of the rough lumber used up in this way is practically of little or no use for the manufacture of any other kinds of circular packages. The cost of the raw material being smaller, the barrels can be sold to the trade from fifty to sixty per cent less than those made for sugar, molasses, oil, whisky, and paints.

The question of hoops for these commercial barrels is fully as important as the staves. The use of wire and flat iron hoops has become quite universal, but where wooden hoops can be used as well, they always receive the preference. The most satisfactory method is to use wooden hoops, reinforced by iron or wire ones. A great many of the barrels used in the trade are thus held together. There is a uniformity of strength existing between staves and hoops which must be carefully computed in the manufacture of barrels for the different trades. To make hoops that would break at a straining point of two hundred pounds for barrels that were built of staves guaranteed to withstand a pressure of five hundred pounds would be a waste of good material. If anything, the hoops must have a resistance more than equal to that of the staves. The hoops are consequently the most important part of the barrel. Stout hoops will hold a barrel together even when the staves are weak, and it is possible to hoop a barrel of 200 pounds resistance so that it will resist a pressure for a time of 500 pounds. The breaking power of either the wooden or wire hoops is carefully computed for each class of barrels, and when properly made and applied they will insure a long life to the circular packages. The life of the barrel is estimated by the life of the hoops, and to prolong it beyond that period new hoops must be supplied.

DETERMINING A SHIP'S BEARING BY WIRELESS TELEGRAPHY.

A Boston inventor has devised a means for determining the bearings of navigable vessels under all conditions of weather, the object being to provide improved indicating devices for use with a ship's compass and the usual sailing-charts, whereby the bearings of known objects at a distance from the ship may be positively determined at times when owing to fog or storm the landmarks may be invisible.

The invention is based upon the scientific fact that "Hertzian-wave" impulses or signals may be conveyed over long distances without connecting-wires. This principle is utilized to determine the position of the ship with relation to known landmarks, thus rendering navigation safer and avoiding delays in the movement of vessels caused by foggy or stormy weather when the usual sight observations cannot be taken.

The apparatus, carried on the ship, is applied to or connected with the binnacle, which incloses the ship's compass; and it consists, primarily, of a receiving instrument electrically connected with an upright conductor so shielded that it can receive only the wave, impulse, or signal (coming from a transmitting station on shore or from another ship or lightship) through a lateral opening or slot when such exposure is in proper range radially with said ship or shore station. The conductor is surrounded by a rotatable shield, cap, or tube slotted vertically to admit the wave or impulse from a given station at such time only, in its rotation, as the slot or opening is approximately between said station and the inclosed conductor. With this apparatus or its equivalent when used on shipboard a rotatable pointer is employed extending over and close to the compass, always in the same radial vertical plane as the slot or exposure, to indicate on the face of the compass the bearing of the station from which emanates the signal or impulse reaching the receiving instrument through such slot or exposure.

With this system of taking bearings each lighthouse and prominent landmark will have a distinctive name or number by which it is known and designated on sailing-charts, and each will be provided with a transmitting instrument adapted to continually repeat its name or number or to automatically transmit such impulse, wave, or signal as shall make the identity of the station certain. Then when a ship appears off the coast provided with the receiver and compass attachments, the elevated conductor receives through the slot of its rotating and intermittingly-acting shield the impulse sent seaward from the transmitting stations, and the navigator notes at once on his chart the bearing of the station as denoted on his compass-dial by the indicating pointer. From another shore-station he receives a different signal, and by the cross-bearings thus secured he obtains his reckoning, showing exactly where on the chart his ship should be. A transmitting instrument on the ship will at such times be able to communicate with the shore-station, thus making its presence and its exact location known.

SCIENCE NOTES.

A telegram has been received at the Harvard College Observatory from Prof. W. W. Campbell at Lick Observatory stating that a sixth satellite of Jupiter, suspected by Perrine in December, was discovered by him January 4, 1905. The position with respect to Jupiter from previous plates taken in January, is as follows: Position angle 269 deg., distance 45. The distance is decreasing 45 sec. daily. The apparent motion is retrograde and the magnitude 14. Derived from observations with the Crossly reflector on December 3, 8, 9, 10, and January 2, 3, 4.

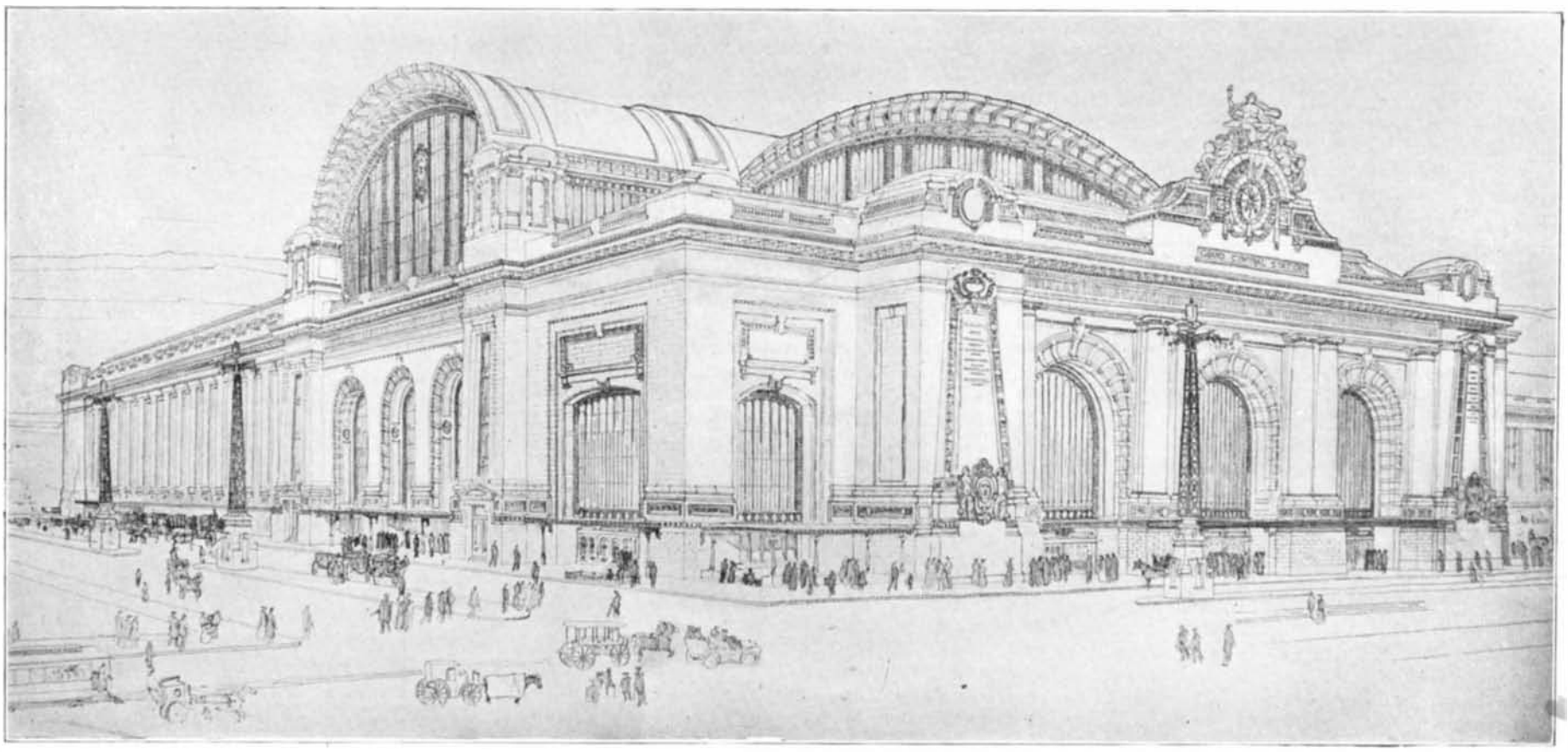
A clock which will run for two thousand years has been invented by Richard Strutt, son of Lord Rayleigh. The motive power is a small piece of gold-leaf which is electrified by means of a very small quantity of radium salt. It bends away from the metal substance and keeps moving under this influence until it touches the side of the containing vessel. At the moment of contact it loses its electrical charge and then springs back and is again electrified, and the process repeated. Sir William Ramsay considers that this may be made into a very reliable time-piece at an expense of about $1,000.

President Roosevelt has become the honorary president of a committee representing the United States, which is to be a portion of an international organization, including the heads of all of the Powers of Europe, to make excavations at Herculaneum, which, together with Pompeii, was destroyed by an eruption of Vesuvius in the year 79 A. D. Prof. Waldstein has secured the consent of the King of Italy to act as the head of the international committee. King Edward will be at the head of the committee in England, Emperor William in Germany, President Loubet in France, and King Oscar in Sweden. The international committee will have headquarters in Rome, over which the King of Italy will preside. Representatives of every nation will be at Herculaneum, and, once started, the work will be pushed rapidly.

E. Demoussy has made a series of experiments to show the growth of plants in an atmosphere charged with carbon dioxide gas. In this case the plants reach an increased development over the plants growing in ordinary air. He used two glass boxes each of over one cubic yard capacity and containing a number of pots. The first was not entirely closed and was used for the plants growing in ordinary air. The air supply was sufficiently renewed to give the average conditions, and a number of tests gave the normal amount of carbonic acid, or 3-10,000ths. In the second box a certain amount of carbonic acid gas was introduced each day so that the proportion reached 18-10,000ths. In the evening this became less, but never fell below 12-10,000ths, so an average of 15 could be admitted, this being five times the amount contained in ordinary air. During the day the plants were protected from the sun's rays by cloth covers, and at night the boxes were opened so that they were well aired. For the experiments he chose four sprouts as nearly alike as possible, placing them in ordinary flower-pots in garden earth, one pair in each box. The observations were made from the end of May to the end of July, at which time the plants were cut and weighed. The following results show the increase in growth due to the carbonic acid. The weights are those of all the part of the plant lying above ground. At the beginning the weights were very small, as the plants had just sprouted; only the geranium, mint, and fuchsia came from buds. The first figure gives the weight in ordinary air and the second in the air charged with gas. Coleus, 34 grammes; 50 grammes. Lettuce, 21; 36. Geranium, 45; 118. Castor, 26; 45. Mint, 28; 36. Red tobacco, 30; 54. White tobacco, 51; 101. Poppy, 21; 30. Fuchsia, 30; 29. All but one, the fuchsia, show a great increase, with an average of 60 per cent. The appearance of the plants is the same in both cases, but the dimensions are somewhat greater in the latter case. For many of the plants the flowering is more rapid and abundant in the charged air. The fuchsia alone does not show any difference, but this may be due to the fact that the plants were but little developed in either case, as the conditions of high temperature and moisture were probably unfavorable for its growth.

THE NEW GRAND CENTRAL STATION, NEW YORK.

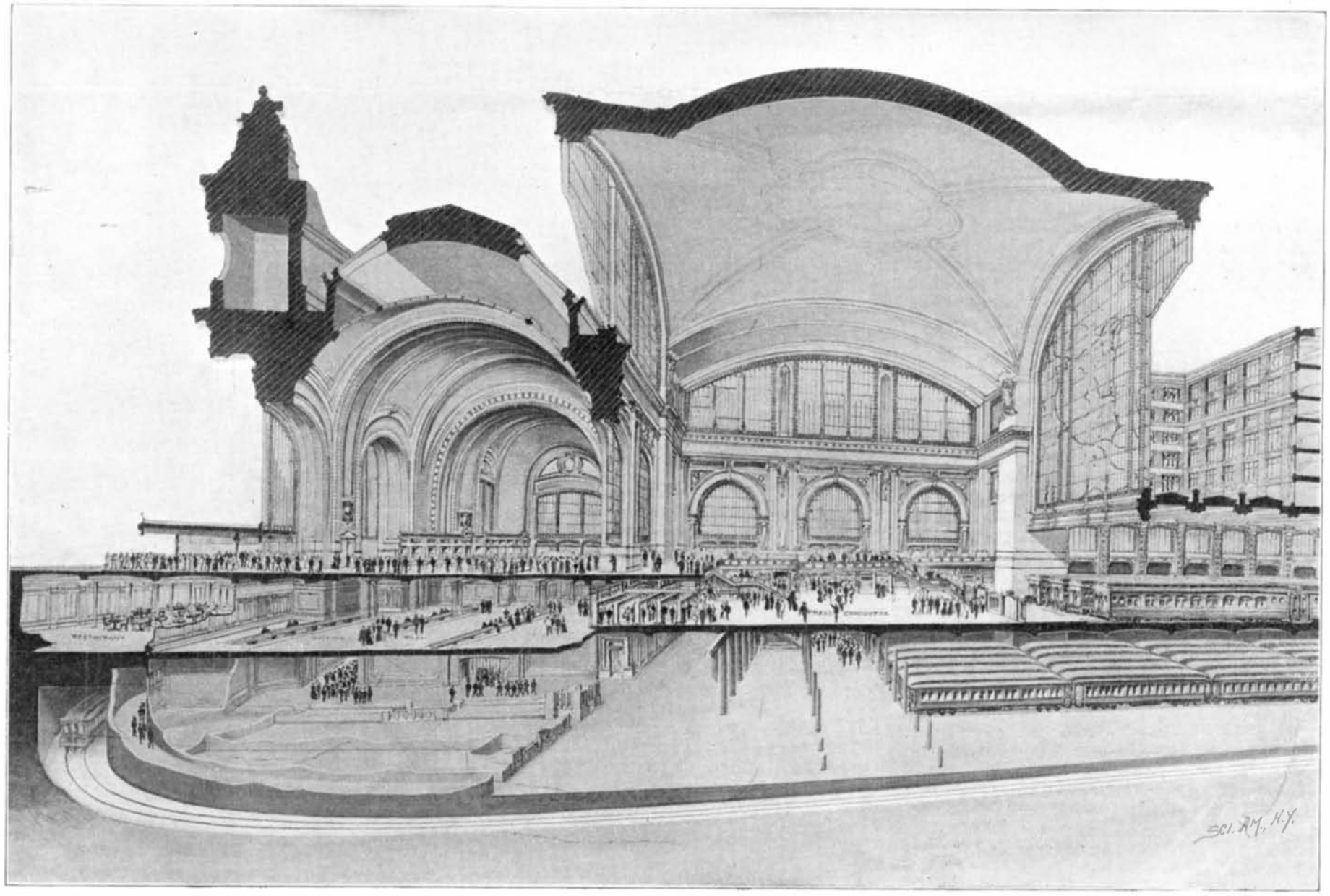
In the editorial columns of this issue will be found a discussion of the fundamental principles laid down by the architects of the new Grand Central Station, for their guidance in determining both the internal arrangements and the general architectural appearance of this great structure. The station building proper, together with the general offices of the company and ing determined in every case by the structural engineering necessities of the station. The southerly façade will stretch for 300 feet on Forty-second Street, and the westerly façade will reach for 680 feet on Vanderbilt Avenue. The building will extend 625 feet on Forty-fifth Street, 400 feet on Lexington Avenue, 275 feet on Forty-fourth Street, and 260 feet on Depew Place. The southerly half of the building incloses the height. On entering, the passenger will find himself in a vast ticket lobby, 90 feet in width by 300 feet in length. In the center of this building will be a long, oval structure, containing the ticket offices. To the right of this, and forming part of the main lobby, will be the outgoing baggage room. On the opposite side of the lobby the passengers will leave the ticket lobby through three main arches, corresponding to the en-



Frontage on 42d Street, 300 feet; on Vanderbilt Avenue, 680 feet. Height to cornice, 75 feet.

Warren & Wetmore and Reed & Stem, Architects.

The New Station as it Will Appear from the Corner of Forty-Second Street and Vanderbilt Avenue.



Restaurant. Suburban Loop.

Ticket Lobby, 90 x 300 feet. Waiting Rooms.

Grand Concourse, 160 x 470 feet, 150 feet high. Suburban Concourse.

Express Tracks. Suburban Tracks.

LONGITUDINAL SECTION THROUGH THE NEW GRAND CENTRAL STATION, NEW YORK, SHOWING THE TWO TIERS OF TRACKS.

the post office and express buildings, will cover the blocks lying between Vanderbilt and Lexington Avenues from Forty-fifth to Forty-third Street, inclusive, and the block fronting on Forty-second Street between Vanderbilt Avenue and Depew Place. The main architectural features are governed strictly by the ground plan, the dominant architectural elements be- station proper, this portion extending as far north as the northerly side of the great arched roof, seen in the perspective view. The northerly part of the building is given up to the offices of the company.

The imposing main entrance to the station on Forty-second Street is composed architecturally of three massive arches, each 33 feet wide and 60 feet in trance arches, and enter a broad gallery, which runs around three sides of the grand concourse. The ticket lobby and this gallery, it should be understood, are at street level. From the gallery, passengers will descend by four broad staircases, each 25 feet in width, to the floor of the grand concourse, which, by the way,

(*Continued on page* 46.)

A CHICKEN-FEEDING MACHINE.

BY W. FRANK M'CLURE.

Fattening fowls for the market by means of machinery, on first thought to most people seems ridiculous, hardly more so, however, than the hatching of chickens by means of an incubator a few years ago. The incubator has come to stay, and the chicken feeder, although an innovation, has found a place in some of the largest poultry yards. Modern genius in recent years has affected the poultry farm just as decidedly as it has the apiary or the stock farm, and its problems have offered a wide field for scientific study.

It is claimed that chickens fattened by machinery comprise sweeter and tenderer meat than those fattened in the ordinary way. Fowls are fed in this manner for two or three weeks prior to killing, and in that time increase in weight from two to three pounds. The chickens are not allowed exercise in this time, and are allowed no other food than that which is received from the machine. The feeding is done twice a day, and one man can feed 300 chickens in a day. It is a patent liquid food that is fed in this manner, the ingredients of which, of course, are known only to the maker.

The feeding machine is nicely illustrated in the accompanying photograph. The food is forced through a tube by means of a suction pump, which in turn is operated by a foot pedal. The tube, which is about ten inches in length, reaches through the chicken's mouth into its crop. In the photograph this tube is shown on the outside of the fowl's neck, reaching to about the same point as when inserted in the mouth. When the crop is full the flow of liquid food stops instantly, and the chicken is not injured in the least. This feeding by machinery is done chiefly in the preparation of roasters for the market and for finishing the fattening of broilers.

Notable progress has also been made among poultry raisers in the increased production of eggs. It is claimed to-day that it is within the power of the poultry owner to make his hens lay an average three years' crop in two years, and that even molting is controlled at the will of the owner. This is an important discovery in this day, when the demand for eggs is so enormous and the price so high. In the last annual report of the Secretary of Agriculture, a statement is made which gives an idea of the size of the annual consumption of eggs in this country. This report states that the hens of the United States lay 1,666,000,000 dozens of eggs a year, the value of which in one month is enough to pay the interest of the entire national debt for one year. There is little question that the scientific study that has been given the subject of poultry raising in recent years has added materially to this annual egg production over what it otherwise would have been. Proper housing, for example, has come to be recognized as an absolute essential. Also, as pure air is required for the healthy human being, so also the well-bred fowl to-day is given plenty of fresh air, while at the same time drafts are avoided.

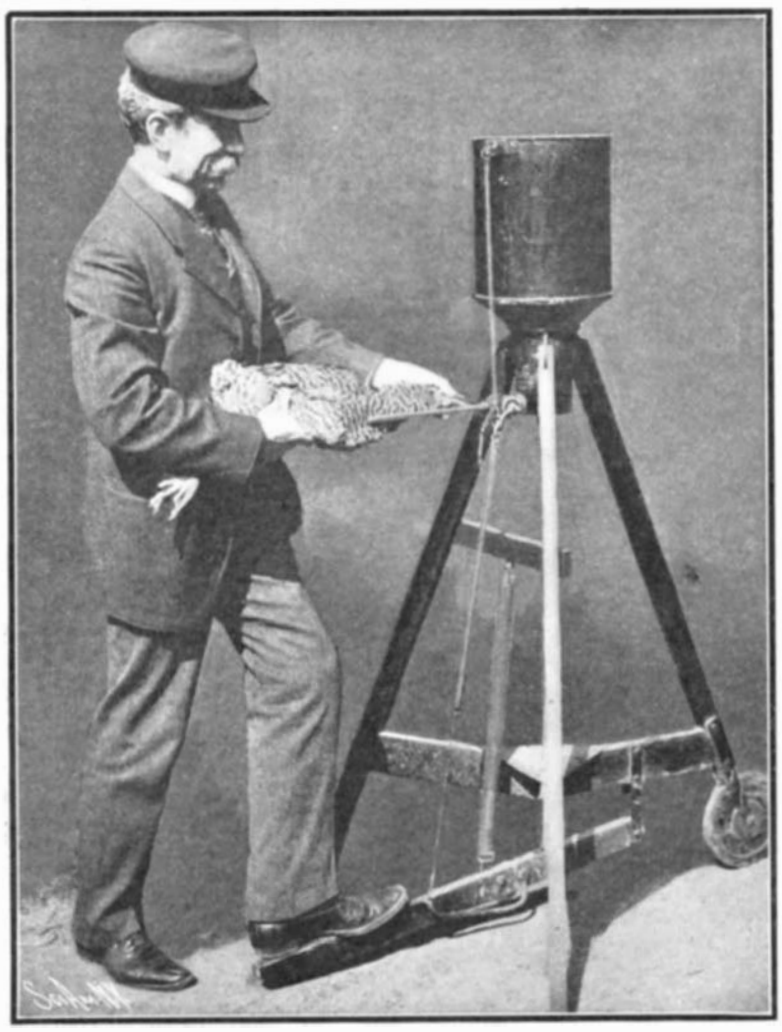
It is not unusual nowadays to see numerous small chicken houses scattered over a large field where the poultry business is carried on upon an extensive scale. This arrangement, of course, admits of the various flocks being housed separately. Artificial heat is seldom resorted to in heating these houses, except in extreme cold weather. With all surroundings conducive, it is not unusual for one hen to lay sixteen dozen eggs in one year, and even better records than this are often made. Few poultrymen, however, attain such records with their flocks unless they have made a study of the numerous scientific methods of caring for them.

A new application of wireless telegraphy has been introduced by two English inventors. The device is purely for entertaining purposes, consisting of the operation of musical boxes placed at different points from one common center. There is a receptacle in which the coin is placed, and immediately a musical box placed at a distance, such as in another room, commences to play.

NEW CŒLOSTAT AND HORIZONTAL TELESCOPE OF THE ASTROPHYSICAL OBSERVATORY OF THE SMITHSONIAN INSTITUTION.

A novel form of cœlostat has been designed by Mr. S. P. Langley, of the Smithsonian Institution, for the study of the absorption of the solar envelope and for measuring the energy of sun-spot spectra. Mr. C. G. Abbot describes this instrument as follows in the Smithsonian Miscellaneous Publications:

The beam is reflected due south from a rotating mirror and thence due north from a second mirror over the top of the first. The beam from the first mirror shoots upward at an angle with the vertical equal to the sum of the angles of latitude and declination; and for the sun at Washington this angle is about 62 deg. at summer solstice and 16 deg. at winter solstice. Therefore to give a horizontal northerly directed beam the second mirror is to be inclined forward 14 deg. at the former period and 37 deg. at the latter.



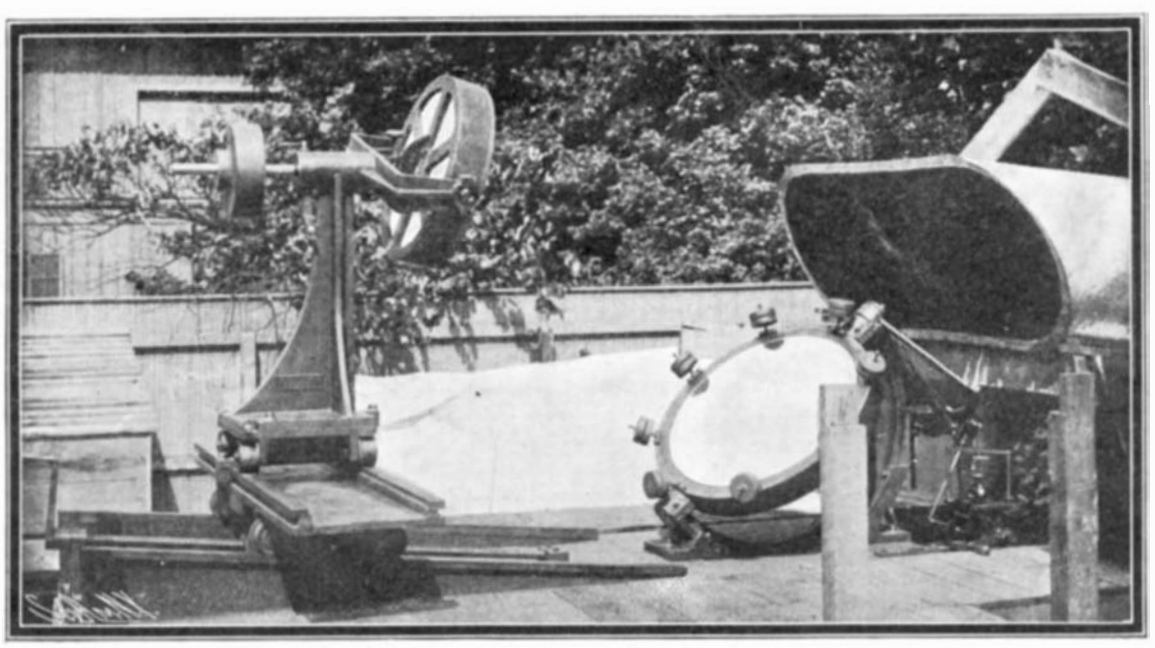
A CHICKEN-FEEDING MACHINE.

In this form of cœlostat the moving mirror is never used in very different positions, so that owing to the consequent probable constancy of figure in the mirror it seems to be well suited to long exposures in stellar photography.

At noon of the equinoxes the second mirror if exactly south of the first would cut off the beam, and at summer solstice it must be further south than in winter to reflect the beam clear over the first mirror. Accordingly the second mirror is provided with a carriage and two pairs of tracks at right angles like the slide rest of a lathe, so that the mirror may be displaced to the west a little before noon when the sun is in its southern declinations, and can be shifted back to the east a little after noon. The north and south track is for the purpose of shifting the second mirror for different declinations of the sun, the mirror being at the south end of the track at the summer solstice.

As it has been thought that this solution of the difficulties attending the use of the cœlostat will prove of interest and value to astronomers, a large instrument of this type was ordered from the J. A. Brashear Company and sent for exhibition to the recently-closed Louisiana Purchase Exposition. The accompanying engraving is reproduced from a photograph of this cœlostat as now being tested at the Astrophysical Observatory, in connection with the long-focus mirror above mentioned. There is also shown in the illustration a portion of the "churned" tube of the horizontal telescope, of which more will be said later. The cœlostat carries a thirty-inch and a twenty-five-inch mirror, the former turned by a polar axis driven at the rate of one complete rotation in forty-eight hours, the latter mounted on a carriage with traverse motions at right angles like the slide rest of a lathe. The cell of the second mirror is carried by trunnions in a fork, itself capable of turning about a horizontal north and south axis, and by these two motions of rotation, with their fine adjustments, the beam may be sent in any direction whatever, though most favorably in a nearly northerly one. In actual use the reflected beam is depressed about 6 deg. from the horizontal to feed the long-focus mirror, which is 55 feet north and about 3½ feet below the center of the first mirror of the cœlostat, directly under which the beam passes toward a focus on the third pier, some 85 feet further south. To provide for this depression of the beam from the horizontal, the north and south, or declination, track of the cœlostat is inclined upward at a corresponding angle, so that the reflected beam may always clear the first mirror. The length of travel of the lower base of the second mirror on this north and south track is five feet and the lower base itself has an east and west track six feet long on which the upper casting is moved to and fro to allow for avoiding the shading of the main cœlostat mirror by the cell of the twenty-five-inch mirror between 11 o'clock and 1 o'clock near the times of the equinoxes.

Early experiments on an artificial star with the long-focus mirror, before the completion of the cœlostat or the installation of a tube, showed conclusively that the "boiling" caused by irregularities of the atmosphere over the grass-grown soil between the mirror and its focus was far too great to permit anything like satisfactory definition on the solar image, and therefore the novel device of a tube with provision for stirring the air by means of a blast was ordered. It consists of a main horizontal tube 24 inches in internal diameter with diaphragms at five-foot intervals, and with an inclined flared tube uniting with the main tube at the north end close in front of the concave mirror. At intervals of about five feet, five-inch ducts lead to air-mains 14 inches in diameter, which in turn at length unite in two twenty-inch mains leading to the intake and blast respectively of a twenty-nine-inch fan blower with direct-connected 2½-horsepower electric motor. It is so arranged that the openings in the telescope tube communicate with the blast and suction of the blower alternately, so that the air within the tube is repeatedly carried through the system and churned over and over. Thus the path of the beam from the cœlostat to the focus of the mirror is thoroughly stirred, but nothing has been done as yet to introduce stirring between the cœlostat and the sun. It is possible that an attempt will be made later to stir the path of the beam in the eighty feet immediately above the cœlostat, if it is found impossible to get good enough definition with the present arrangements.



THE TWO-MIRROR CŒLOSTAT OF THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY.

It should be recalled that the conditions required for bolometric work are quite different from those suited to direct eye vision or to photography. Bolometric studies require unchanging transparency of the air, else difference in the galvanometer deflection may be due to alterations in transparency of

the intervening medium and not to the properties of the source of light. Thus those times when thin cirrus clouds, fog, or smoke cover the sun, which are well known by solar observers to be the times when "boiling" is apt to be diminished, and which are the most favorable opportunities for visual and photographic observations, are quite unsuitable for bolometric work. Indeed, the best time for this is somewhat after noon on those clear October days when "boiling" is apt to be at a maximum, but cloudiness at a minimum, and it is probable that the definition obtained in such conditions will never be the best.

Trials made thus far have demonstrated the great value of the stirring apparatus, not only to diminish "boiling," but to preserve a constant focal length and tolerable definition. "Boiling" is still of course noticeable, because the long reach of air above the coelostat is not stirred, but the image is far better than could be obtained with the earlier appliances, and owing to the massive piers and to the simplicity of driving mechanism, it is less subject to jars and wandering.

THE BRONTOSAUR. HOW A GIANT PREHISTORIC ANIMAL WAS DISCOVERED, TRANSPORTED AND RESTORED.

In 1897 Mr. Walter Granger, of the expedition sent out in that year by the American Museum of Natural History of New York, found in the southeastern part of central Wyoming, not far from the Medicine Bow River, the first fruits of the greatest collection of the fossilized remains of extinct reptiles that has ever been discovered in any one locality. Previous prospectors had taken fossils from the region, but had abandoned it for other fields, so that Mr. Granger really rediscovered it. It will be remembered, from various accounts published since then, that weathered fragments of dinosaur bones were so common at this place that they were taken for bowlders of peculiar shape, and that a couple of Mexican sheep herders had used these fossils for the foundations of their hut. This Bone Cabin Quarry, as it came to be called, was about ten miles south of the famous Como Bluffs, from which a considerable number of fossilized skeletons had previously been taken. The finest specimen among these is Prof. Marsh's *Brontosaurus excelsus*, now one of the treasures of the Yale Museum.

When fossil bones of one kind are found in different places within a reasonable distance of one another, they usually occur in one stratum, which has cropped out at different points. This is true of the remains found at the Como Bluffs and at the Bone Cabin Quarry, the bone layers there exposed being of the same age, and originally an unbroken level stratum which may be designated as "the dinosaur beds." When the contiguous Laramie Mountains and the Freeze-Out Hills were formed by the shrinking of the earth's crust, this stratum was correspondingly warped and wrinkled into numbers of great folds or rock waves. Surface erosion of wind and water has been responsible for the subsequent removal of great portions of the crests and upfolds or "anticlines" of these waves, thus exposing the edges and allowing the weathering out of the fossilized contents of the strata. This layer, usually about two hundred and seventy feet in thickness, is entirely of fresh-water origin, but both above and below it are strata which show that there had been previous and subsequent invasions of the sea, the first forming the ichthyosaur and the latter the mosasaur beds. Owing to the uplift of the various mountain ranges, this great dinosaur graveyard is found to crop out along the entire eastern face of the Rocky Mountains, around the Black Hills and in all parts of the Laramie Plains. Dinosaur bones may be found almost everywhere, but up to the present, in no locality have they been seen in such profusion as in the two well-known places mentioned before.

In the excavations at the Como Bluffs the remains were found thoroughly scattered and from twenty to a hundred feet apart, an entire skeleton or even the larger part of one being extremely rare. In the Bone Cabin Quarry, on the other hand, the American Museum expedition found a vast number of skeletons, not only close together, but often closely commingled, remains of most of the animals of that region at that period, from the largest of the giant dinosaurs to the smallest and most bird-like kind. The Bluffs appear to represent the ancient shore line of a muddy estuary or lagoon, such as is depicted in the accompanying drawing of a Brontosaurus restoration by Charles R. Knight. Prof. Henry Fairfield Osborn, curator of the Department of Vertebrate Palæontology at the American Museum, believes that at the Bone Cabin Quarry, on the other hand, the conditions were different; that this was the area of an old river bar which, in its shallow waters, arrested the more or less decomposed and scattered carcasses that had slowly drifted down stream toward it, from almost the entire region through which the river took its course.

The greatest of these creatures were the giant dinosaurs, and very probably no animals existing on land have ever approached them in size and bulk. The evidence of the freely commingled remains shows us that at least three distinct kinds of these giant dinosaurs existed at the same time in the same region.

The dinosaur named *Diplodocus* by Marsh is most completely known. The American Museum's first find in the Bone Cabin Quarry was the previously unknown hind limb of this dinosaur, a find that showed it was distinguished by relatively long, slender members and may popularly be called the "long-limbed dinosaur." The major portion of a great skeleton unearthed in the Bluffs and a larger one found about ten miles north of the Bone Cabin Quarry furnished practically complete knowledge of the great bony frame of this giant lizard. By contrast the second, the Brontosaurus, or "thunder saurian" of Marsh, was relatively shorter in body and more compactly built, but more massive in structure. Considerable portions of the skeletons of perhaps a score of the great herbivorous dinosaurs are preserved in the Yale, Carnegie (Pittsburg), Field Columbian and American museums, while much less abundant and more incomplete remains have been found in England near Oxford. Of another type, and much smaller in size, were the carnivorous dinosaurs. They were bipeds with bird-like feet and sharp claws, and, in contrast with the two foregoing types, had large heads with sharp, pointed teeth. The marks of these teeth have been found upon the tail vertebræ of both *Diplodocus* and *Brontosaurus*, showing that if the carnivora did not destroy the ponderous and slow-witted lizards of the other types, they at least fed upon their carcasses.

In 1898 the largest known and at the same time the most complete Brontosaurus skeleton was discovered about three miles west of the Bone Cabin Quarry. It was worked out with great care, and is now being restored and mounted complete at the American Museum under the direction of Prof. Osborn. When finished it will be the only mounted skeleton of a Brontosaurus in the world, though at the Yale Museum the pelvis and hind legs of a dinosaur of this kind are mounted, and another splendid skeleton of a Diplodocus is being reconstructed at the Carnegie Museum, Pittsburg.

As can be readily understood, the natural processes incident to the preservation of these fossils almost preclude the possibility of finding an entire skeleton. Especially is this true of the smaller bones, such as those of the head, or those not firmly bound together by strong ligaments. These often become scattered or so badly crushed by the weight of the strata which accumulate above them that it is not worth while to mount or even reconstruct them. The Brontosaurus now in course of erection at the American Museum is unusually well preserved, and it is, fortunately, of nearly the same size as the Yale Museum specimen. This fact smoothed over a number of difficulties. The skull was not found, and in fact is known only by incomplete portions of the jaw and of the back of the head. The reconstructed skull is based on these fragments and on the known skull of a nearly related species. The heads of these herbivorous dinosaurs, by the way, were comparatively small in size and altogether out of proportion with the ponderous body. We can hardly understand how this very small head with its light jaws and slender, spoon-shaped teeth could adequately supply the food necessary to nourish the great creature. Prof. Osborn is of the opinion that the animals fed on some very plentiful and nutritious water-plant, which was swallowed in large quantities without mastication, there being no grinders or molars in the head.

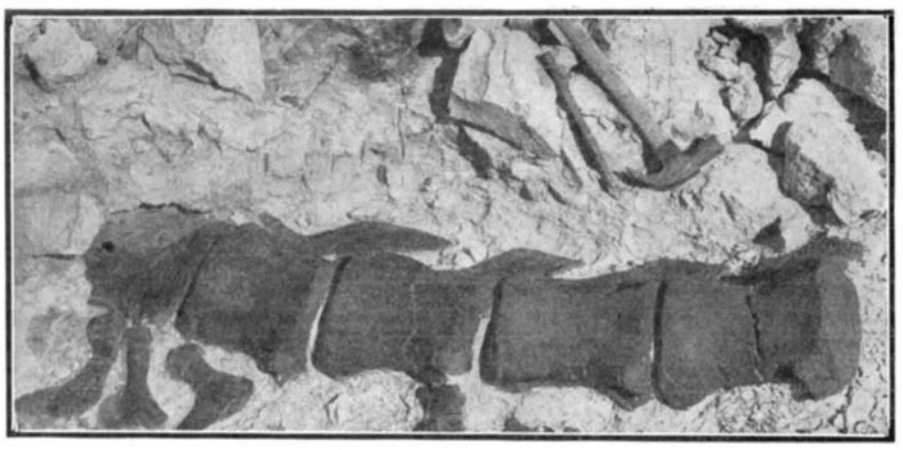
The Brontosaurus was among the most highly specialized of the herbivorous dinosaurs—probably the last of the race. Evidence of this is found in the wonderful construction of the bones, especially of the vertebræ. The bones were excessively light for their size and strength. They are so shaped that every unnecessary particle is dispensed with, are hollowed out wherever possible and braced wherever necessary, and are porous in the centra. The accompanying photograph of the vertebræ clearly shows the remarkably efficient construction, from an engineering standpoint, to withstand the enormous strains and stresses incident to moving the huge bulk of a creature from 60 to 70 feet long. It shows also how similar the principle of structure is to the modern T-iron one. From the tip of the tail to the head the structure of the vertebræ changes with the mechanical requirements. Exactly what these were, however, has not been thoroughly studied, as little is known about the musculature of the body. A further demonstration that the Brontosaurus was highly specialized is given by the pelvis. In primitive vertebrates there is little connection between the pelvis and the backbone. Here the pelvis and the adjacent vertebræ are intimately connected. The anterior tail vertebræ are peculiarly shaped to strengthen the pelvis, and the one nearest to this is, in fact, a part of it. The lateral flange of this vertebra is in part probably a modified rib, being deepened to give added strength with which to resist the tremendous torsional strains on this portion of the frame, the pivotal center of motion undoubtedly being at the hips.

It is supposed that the two inverted V-shaped prongs under the hind legs were used to rest upon in a sitting posture, and that there was a great pad of cartilage or connective tissue at the point of each V. It is not believed that the Brontosaurus was able to sit up on the hind legs and tail like the modern kangaroo, as at no point of the tail is found the peculiar bend or the fusion of vertebræ usual in this case.

The Brontosaurus was supposedly aquatic, but not marine. As in most aquatic animals, the ends of the bones at the joints are rough instead of smooth. It is, in fact, beginning to be doubted whether it ever came out on land, though the comparative lightness of its bones, usual in walking or flying animals, but not in swimming ones, seems to indicate that part, at least, of its life was spent out of the water. The five toes on the hind feet are thought to have been used to force the body along the muddy bottoms of the shallow lagoons which the Brontosaurus supposedly frequented. Palæontologists have not, however, accounted for the single claw on each forefoot. The fact that there really was only one claw on each forefoot is proven by the numerous fossilized footprints that have been found.

The mental and physical labor, the time and patience necessary successfully to complete a restoration of this kind, can hardly be appreciated by the layman. The expeditions that are sent out each year to search for fossils or to recover those already found, entail great labor and expense. The real work begins, though, with the removal of the fossils from the rock, clay, or shale matrix, and this excavation is a very

Covering the Excavated Bones with Plaster of Paris.
The figures on the plaster show what each bone is and where it was found.



Appearance of the Fossil Bones when Uncovered.

THE RESTORATION OF THE GIANT LIZARD, THE BRONTOSAUR, AT THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.

delicate operation, as the bones are brittle and fracture easily. As they are uncovered little by little, the bones are closely covered with tissue paper or very thin muslin and gum arabic. Over this, as they are gradually laid bare, plaster of Paris is applied, till the entire bone is covered. Sometimes, if the bones are much shattered, no attempt is made in the field to excavate them, but the surrounding matrix is cut out and shipped in a block. In the case of the large bones, the plaster envelope is strengthened with wooden ribs and the whole bound with wet rawhide which is then allowed to shrink and closely bind the whole. The fossils are next carefully crated and hauled to the nearest railroad siding for shipment. This sometimes means a bad trip of many miles over rough country and is frequently the cause of much difficulty.

The actual laboratory work of patching up fractured bones, restoring or reproducing missing ones, of putting them properly together and in a proper posture, means months of thought and labor. It can readily be understood that it is a matter of some difficulty to pose a skeleton 60-odd feet long and 15 feet high at the pelvis. Some of the individual bones are enormous. The femur of the hind leg is 5 feet 10½ inches long, the total length of the body being estimated at 66 feet, while the remarkably small head is only 27 inches long. In the Field Columbian Museum are preserved the limb bones of a related species, the Brachiosaurus, the femur of the hind leg being 6 feet 8 inches long. Assuming the proportions to be the same, the Chicago specimen would have been 70 to 72 feet over all.

The construction of the iron framework used in a restoration of this kind is no mean feat of practical engineering. The photographs of the hind and fore limbs give a clear idea of the way in which this is done. For supporting the weight of the large bones of the limbs and backbone, heavy wrought-iron pipe of large size is used. This is bent and curved so as to conform closely to the natural angularities, as shown. The bones are fastened to this by means of lighter piping and reducing crosses. Light channel irons and flat bands are also used, as may be seen in the manner in which the bones of the pelvis are supported and bound together. The photograph of the vertebræ shows how these are joined to the heavy supporting pipe by means of smaller pipe and reducing tees.

Some idea of the length of time that work of this kind takes may be gathered from the fact that it took two men at least a year to work the bones out of the matrix, at least six months to restore the missing parts, and at least ten months to mount the bones, weld and bend irons, etc. Nor does this include the time spent by the field parties or by Prof. Osborn and other scientists, and Mr. Adam Hermann, head preparator of the department, in planning and laying out the work.

This department of the American Museum is one of the most interesting ones in the institution. The collection comprises the extensive material collected by the late Prof. E. D. Cope, chiefly between 1870 and 1890, and the much larger collections made by the expeditions which have been sent out by the Museum every year beginning with 1891.

We are indebted to Prof. Osborn for courtesies in the preparation of this article.

The Congo (Belgian) Telegraph.

The telegraph and telephone lines of the Belgian Congo region show some peculiarities both in the construction of the lines and their operation, owing to the climate and the character of the country. Where the lines run through the forests, the wires are placed as much as possible upon trees and in other cases upon iron poles. The wire, which is of phosphor-bronze, is painted black, so as not to attract the attention of the natives, who lay hands upon all the copper they can find. The other brilliant objects of the line, such as the insulators, are also painted black. A cutting 30 feet wide is made through the forest for the line, so that there is no risk of fire or from falling trees. Besides the telegraph offices of Leopoldville, Kwamouth, and Coquithatville, there are nine telephone offices and six cabins. The latter are used for communicating with the steamboats on the river. The first hours after sunset are the best for telephoning, and it is possible to telephone direct from Matada to Kwamouth, or 380 miles. From the latter point to Boma, or 410 miles, the voice is still heard. After 10 o'clock A. M. the heat makes it impossible to use the telephone, especially in the rainy season. This is due to the fact that a return wire is not used, and the use of the earth return is accompanied by great disturbances in the middle of the day. The greatest enemies of the telephone lines are the wild animals. In the rainy season atmospheric discharges often strike the wires, therefore the lines need to be constantly inspected and repaired. Within the last two years the government has been experimenting with a wireless telegraphy system between Boma and Ambrizette to connect the land lines with the submarine cable.

THE TASMANIAN BLUE GUM—AN IDEAL TIMBER FOR HARBOR BUILDING.

BY HAROLD J. SHEPSTONE.

The erection of the great National Harbor, at Dover, on the south coast of England, has called attention to the wonderful properties of the Tasmanian blue gum (*Eucalyptus globulus*). It is at once one of the strongest as well as the most durable and densest timber in the world. It is so heavy that it will sink like a piece of lead, while it is also practically immune from the attacks of the seaworm. These facts have only lately been more or less known to timber experts, but the presence of a large number of piles of Tasmanian blue gum at Dover, where they were tested together with other timber, has shown in the most striking manner the superiority of this wood for the erection of staging in salt water.

Before dealing further with the wonderful strength and remarkable density of the blue gum, it is as well to note that the harbor where this wood is being extensively employed is one of the biggest engineering feats ever undertaken. It is being formed by extending the well-known Admiralty Pier at Dover some 2,000 feet, the erection of an eastern arm 3,320 feet in length, and the building of a breakwater 4,200 feet long. Naturally, the carrying out of such a huge undertaking called for an enormous amount of timber, the minimum quantity required being given as follows: Hardwoods, principally greenheart and rock elm, 25,000 cubic feet; and softwood, pitch pine, redwood, etc., 75,000 cubic feet for permanent work; and for merely temporary staging, 550,000 cubic feet of blue gum and other hardwood; and pitch pine, etc., for superstructure, 850,000 cubic feet; or some 1,500,000 cubic feet of timber in all.

It was not necessary, of course, to go to Tasmania for the execution of such an order, so far as quantity was concerned; indeed, some of the timber used for piles at Dover has been imported from Vancouver's Land, and on the whole there has been very little fault to find with it. Then why, one may well ask, did the contractors avail themselves of the services of their timber expert, Mr. W. Heyn, and dispatch him on a journey of 14,000 miles to Tasmania, to bring home piles which could have been purchased cheaper in America or Canada? The reasons were many. To secure Oregon piles 100 feet in length and 18 to 20 inches square (the necessary dimensions) was by no means difficult; but Tasmanian blue gum piles were preferable, chiefly on account of their greater specific gravity. In the first place, it was found impossible to get a pile of Oregon 100 feet in length into position for driving into the ground through 47 feet of water at low tide, on account of the strength of the tides and currents, unless it was "weighted" with iron at the end. This at once entailed an extra expense in material and labor of nearly $50 per log.

But the blue gum possessed other advantages over its rival Oregon. The *Teredo navalis*, or seaworm, literally honeycombing its way through the latter, rendered it after some time unfit for further use as a pile. As a rule, the timber was injured through the ravages of this little animal after a period of about eighteen months to two years. Now, it is not difficult to see that as the piles are only employed to carry temporary staging, so as to enable the 40-ton concrete blocks of which the harbor walls are being built to be placed in position, a great saving is effected by using them over and over again as the blocks are laid. That was impossible for any great length of time in the case of Oregon wood, but with Tasmanian blue gum it was entirely different. Being immune from the attack of the sea insect, the greater proportion of the blue gum piles at Dover have been in constant use for over three years, some having been driven three or four times, and there is no reason why they should not be re-employed in this manner till the whole work is completed. On account of their high gravity it is not necessary to weight them, and should they get carried away by accident they would sink where they fell, and could easily be recovered, instead of floating about as Oregon would do, a menace to the works or to ships or steamers. Some idea of the density of this wood may be the better understood when it is stated that it has a specific gravity of 75 pounds to the square foot, whereas water is but 65 pounds. A pile of blue gum, therefore, 100 feet long and 20 inches square, would turn the scale at nearly 10 tons, while an Oregon log of similar dimensions, having only a specific gravity of 48 pounds per square foot, would only weigh 6 tons, and consequently float.

To obtain a pile 100 feet in length and 20 inches square, parallel from top to bottom, demands a tree 15 to 18 feet in girth 5 feet from the ground, and about 150 feet to the first branch. The Tasmanian blue gum easily attains this height. Indeed, so far as height and general beauty are concerned, the blue gum is no mean rival to the famous Redwoods of California. A large quantity of the timber to be seen at Dover came from the yards of Messrs. Gray Brothers, of Adventure Bay. Mr. Gray, the head of the firm, states that they often come upon trees from which they could cut piles 160 feet long (that is, 60 feet longer than required by the contractors at Dover), before the first branch is reached, and others 230 feet high measure 7 feet through at the butt. Nor are these figures by any means the largest recorded for Tasmanian blue gum. Mr. Perrin, formerly Inspector of Forests in Tasmania and afterward in Victoria, mentions having measured a fallen blue gum at Geeveston (on the Huon River) which had a length of 330 feet; and Mr. R. M. Johnston, the eminent government statistician, speaks of "the Tolosa blue gum," also 330 feet high; and Baron von Meuller, the well-known Australian naturalist, says of a blue gum growing at Southport in Tasmania that it contained "as much timber as would suffice to build a 90-ton schooner." And when speaking of these giants, it should be borne in mind that they are not isolated cases, mere curiosities, but that trees of from 200 to 250 feet are fairly common in the forests, extending over thousands of acres in the Huon and Peninsula districts of Tasmania, rising high and clear of boughs like the masts of great ships.

The wonderful strength and lasting qualities of the Tasmanian blue gum have been more than demonstrated at the Dover Harbor Works, where their employment has given the greatest satisfaction, thus calling attention in the most emphatic manner to the commercial value of Tasmanian timber. Tests very carefully made and at long intervals show that the Tasmanian wood will sustain about double the weight of English oak before breaking, and will even regain its elasticity after bearing a weight at which oak breaks, while as to its longevity under water no limit appears so far to have been reached. Many instances could be quoted in confirmation of this statement. An old ferry-boat built of blue gum in 1818, and which for more than fifty years has been lying a wreck between high and low water mark on the banks of the Derwent in Tasmania, shows no signs of decay to-day, and the wood, beyond a few stains from the iron fastenings, is perfectly sound. A portion of this old vessel is shown at the Hobart Museum, among a collection of Tasmanian timber. In speaking of the commercial value of this particular wood, one must not forget that a good deal of it is to be found growing within six to ten miles of the seashore, thus considerably reducing the difficulties of transportation to the timber ships, which is effected on rudely-formed tramways.

Another Tasmanian tree deserving of mention here is the stringy bark (*Eucalyptus obliqua*). In height and size this tree is quite equal to its brother, the blue gum, and when cut it is by no means easy to distinguish it from the blue gum. Its specific gravity is usually about five pounds per cubic foot less, but it is often found with knots, which render it less desirable for piles required to carry very heavy loads, besides being more liable to seaworm attacks. It closely resembles English oak, particularly when used for flooring, for which it is well adapted.

It is interesting here to note that sleepers cut from the stringy bark and blue gum are most excellent. They have been used on the Dover Harbor Works for four years, exposed to the most trying weather, salt and fresh water, very heavy traffic of locomotives, goliath cranes, etc., being continually shifted and relaid as the engineers of the service require, and yet they are in as good condition to-day as they were when first put down. Large quantities of these sleepers are being sent from Hobart to South Africa, where they are highly esteemed. Their great feature is their durability, their average life being no less than twenty years. They cost about $1.50 each, against $1 for Baltic or soft timber sleepers, which do not last one-third of the time. This wood is also admirably adapted for wood paving, and if properly laid on a good concrete foundation, will last under heavy traffic fifteen to twenty years, and does not polish through use, thus giving a sure foothold for horses.

The Huon pine is another Tasmanian wood deserving of notice here. For exquisite beauty when polished and for all decorative purposes it certainly comes before the stringy bark. Of this timber Mr. R. M. Johnston says: "It is the grandest and most beautiful of all Tasmanian soft woods." Though so beautiful that it appears little short of wicked waste to use it for any but decorative purposes, it is, in truth, remarkably long lasting, declining to succumb to the attacks of insects, whether in water or on land. It is largely used in boat building. Still another beautiful wood is the Tasmanian blackwood, a species of acacia, which very closely resembles mahogany, and which is used by the English government at Woolwich Arsenal in the manufacture of gun carriages. It is also employed in the making of billiard tables, sideboards, and decorative work.

For much of the above information, and for the loan of the photographs accompanying this article, the writer has to acknowledge his indebtedness to Mr. W. Heyn, head of the timber department of Messrs. S. Pearson & Son, the contractors for the Admiralty Harbor Works at Dover. As already mentioned, Mr. Heyn was sent

to Tasmania to select piles, and while there, at the request of the Tasmanian Ministry, read a paper before the Royal Society of Tasmania on the timber in that colony. Being acknowledged as an expert on the subject, and having had a long experience in Baltic and American timber, his remarks were naturally listened to with considerable attention, and printed for circulation in the state by the government. In an interview with the writer, he was enthusiastic about the wonderful properties of the Tasmanian timber, but spoke sadly of the waste he witnessed in the great forests of that state, caused through bushfires and useless ring-barking, etc. At the same time he had a good word to say for the Tasmanian axmen, declaring them to be among the finest in the world, as the splendid workmanship shown in the squaring of the Dover piles proves. Indeed, at a short distance, it is difficult to distinguish whether they are sawn or hewn. It is a curious fact, and complimentary to American industry, that they infinitely prefer the American ax to that made in any other country.

Before leaving Tasmania Mr. Heyn read a second paper before the Society, in which he declared that the government of that State could take a leaf from the method of the Agricultural Department at Washington by establishing a school or schools of forestry such as are to be found in the United States and other great countries. The work of such an institution should include, in his opinion, the importation of desirable seeds from different parts of the world, as well as collection of native seeds for afforesting the waste lands on the island; growth and distribution of nursery stock, particularly of trees likely to benefit, materially and physically, Tasmania; and practical teaching, with ocular demonstration, of the art of forestry to those desiring it. The institution would also see that the laws for the protection of forests were rigidly enforced.

TASMANIAN AXMEN SQUARING BLUE-GUM PILES IN THE BUSH.

SPAN OF OXEN AT WORK IN A TASMANIAN BLUE-GUM FOREST.

"BIG BEN" GUM TREE.

Its height is nearly 250 feet; its circumference, five feet from the ground, is 95 feet; its interior measures 20x25 feet.

A New Variety of Potato.

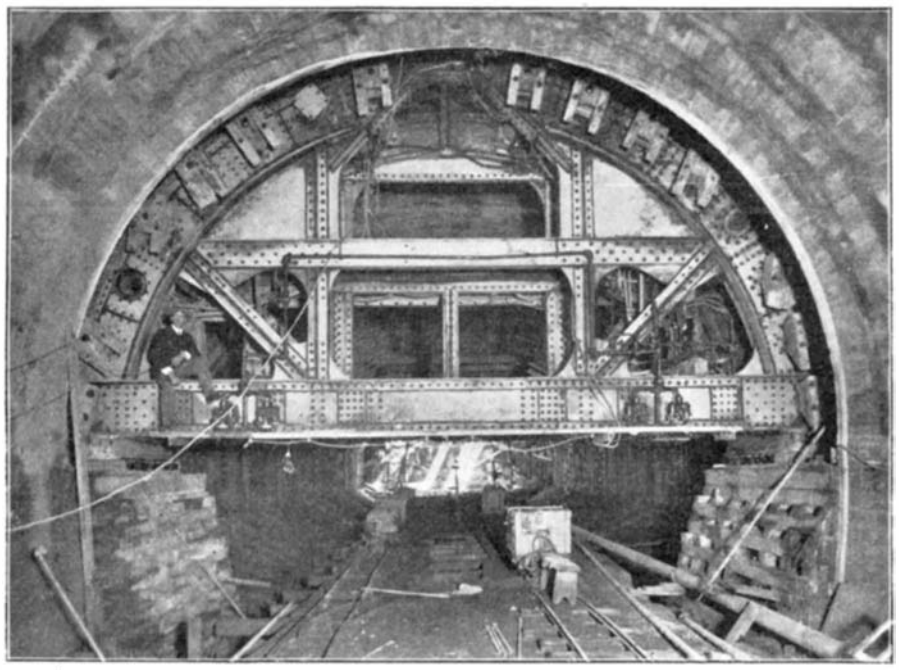
M. Labergerie has been making some experiments in France upon a new variety of potato which not only has the advantage of growing in damp earth, but gives an extraordinary yield. This variety is known as *Solanum commersoni*, and comes from Uruguay. He obtained some specimens from Prof. Davin, of the Marseilles Botanical Garden, who had recently secured some of the plants. M. Labergerie commenced planting the potatoes in a fertile and wet soil on the banks of a stream. They began to grow regularly, and in 1904 he already had 11,500 plants. He finds that the yield is no less than 100 tons per hectare (which figures about 30 tons per acre) in wet soil, and but 3 tons per acre in dry soil. The potatoes are exceptionally large and weigh 2½ pounds, and at the same time are of good quality. The branches of the plant are as long as 12 feet. The potatoes contain a large proportion of starch, and he finds 17 per cent in the present specimens. The taste is good, and in this regard will compare very well with the ordinary varieties. The plant is considerably influenced by water and light. It appears that the Solanum was considered formerly as only good for cattle, but we now find that it can be developed so as to be nutritious and good-tasting. At the same time it prefers wet soil where ordinary potatoes will not flourish.

COMPLETION OF THE EAST BOSTON TUNNEL.

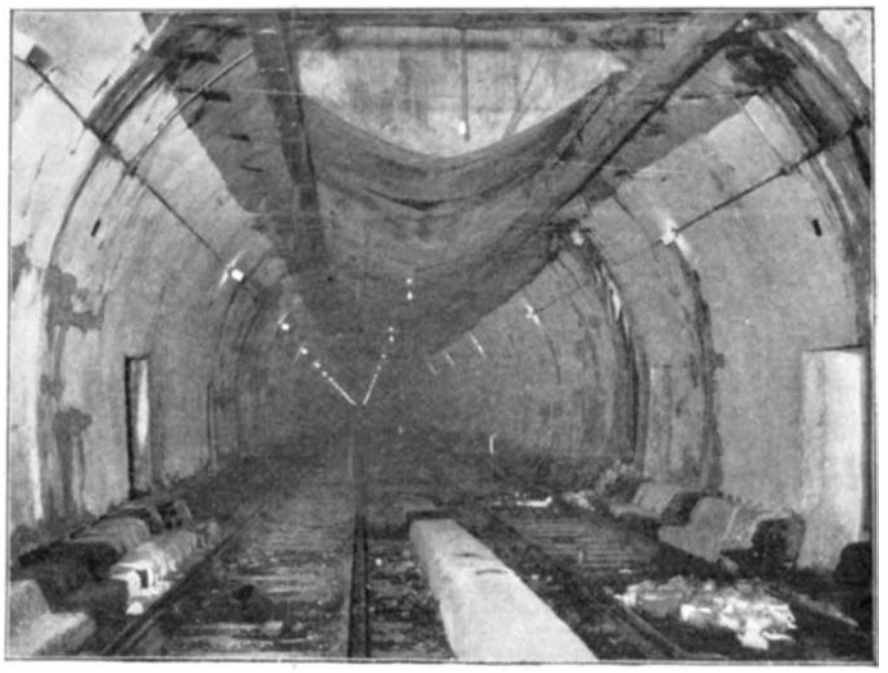
The completion of the East Boston tunnel marks the inauguration of one of the many rapid-transit subway systems which are being constructed in the leading cities of the world. The tunnel was built by the Boston Transit Commission, under Mr. Howard A. Carson as Chief Engineer; and it forms a most important extension of the system of trolley subways which that city constructed several years ago. We take this opportunity to refer to the indebtedness of New York city and all municipalities that either already have, or will shortly inaugurate, subway systems to the city of Boston, which, in successfully putting through her subways, proved the practicability and great convenience of such a system where the traffic conditions on the surface are badly congested.

The new tunnel extends from Scollay Square, an important station on the Boston Subway, beneath a wide arm of Boston Harbor, to Maverick Square in East Boston, the total distance between these two points being 7,480 feet, or 1.4 miles. From Maverick Square the tunnel falls on a grade that varies from 4.7 to 5 per cent for a distance of 2,000 feet. Here the lowest point of the tunnel below low water is reached, the bottom of the masonry being 82.3 feet and the top of the rail 73.3 feet below mean low water. At this point is located a pump well, where all water that enters by seepage is collected and pumped out. The location of the well is about 550 feet out from the East Boston shore line. From this point the tunnel rises for about 2,000 feet on a grade of 0.5 per cent, until it reaches a point approximately below the Boston harbor line. The grade then steepens to 2.5 per cent until the first station on the Boston side is reached, at a point just beyond Atlantic Avenue. Another 1,500 feet on an upgrade of 4 per cent, reducing in the last 300 feet to 2.5 per cent, brings the tunnel to near Devonshire Street station, and then 500 feet of 3.5 per cent ascent brings the new tunnel to a junction with the existing Subway at Court Street adjoining Scollay Square.

Apart from its great importance as affording a direct double-track trolley road from Boston to East Boston, the tunnel possesses particular interest because of the

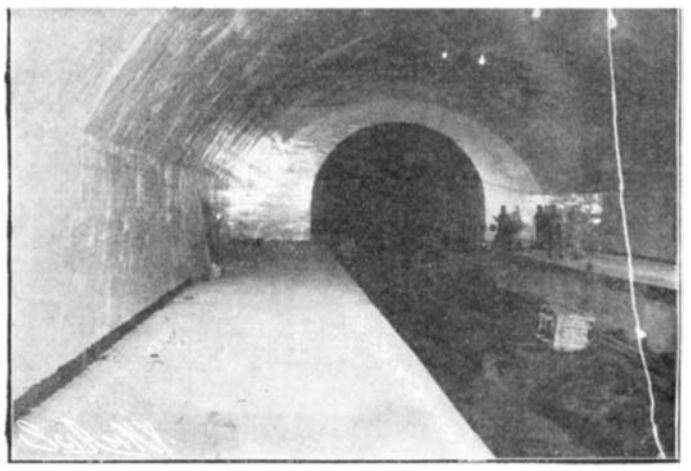


Rear View of Shield With Which the Upper Half of Tunnel Was Excavated.

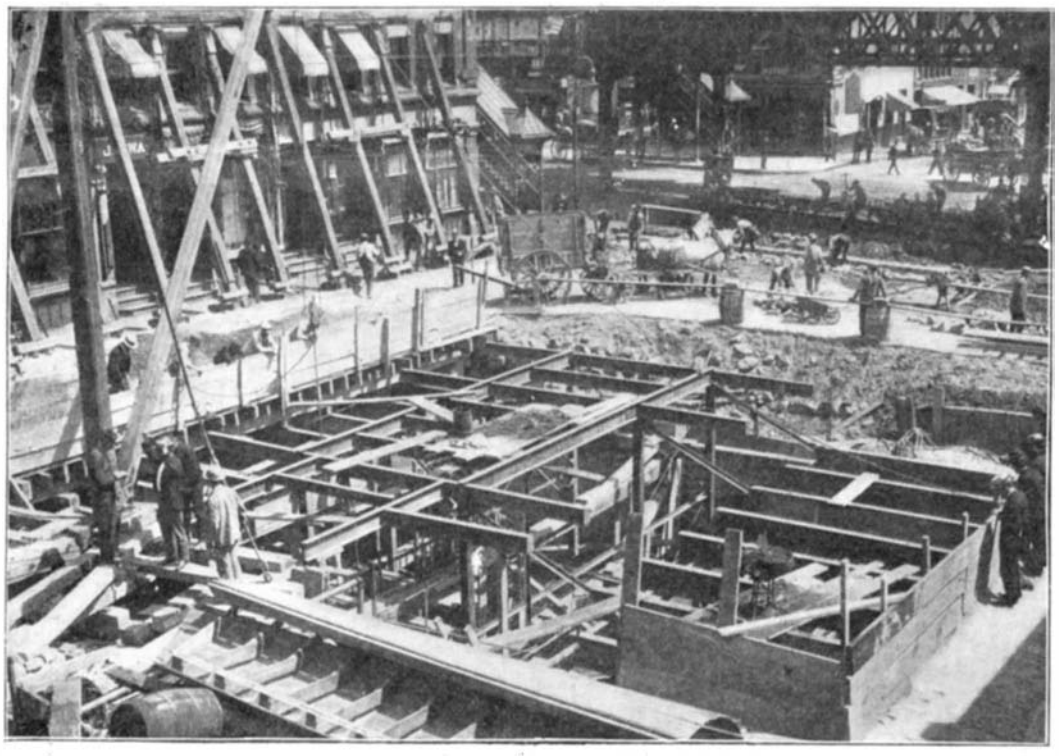


View in Completed Tunnel, Showing the Ventilating Duct in the Roof.

Devonshire Street Station, Showing Method of Interior Finish.

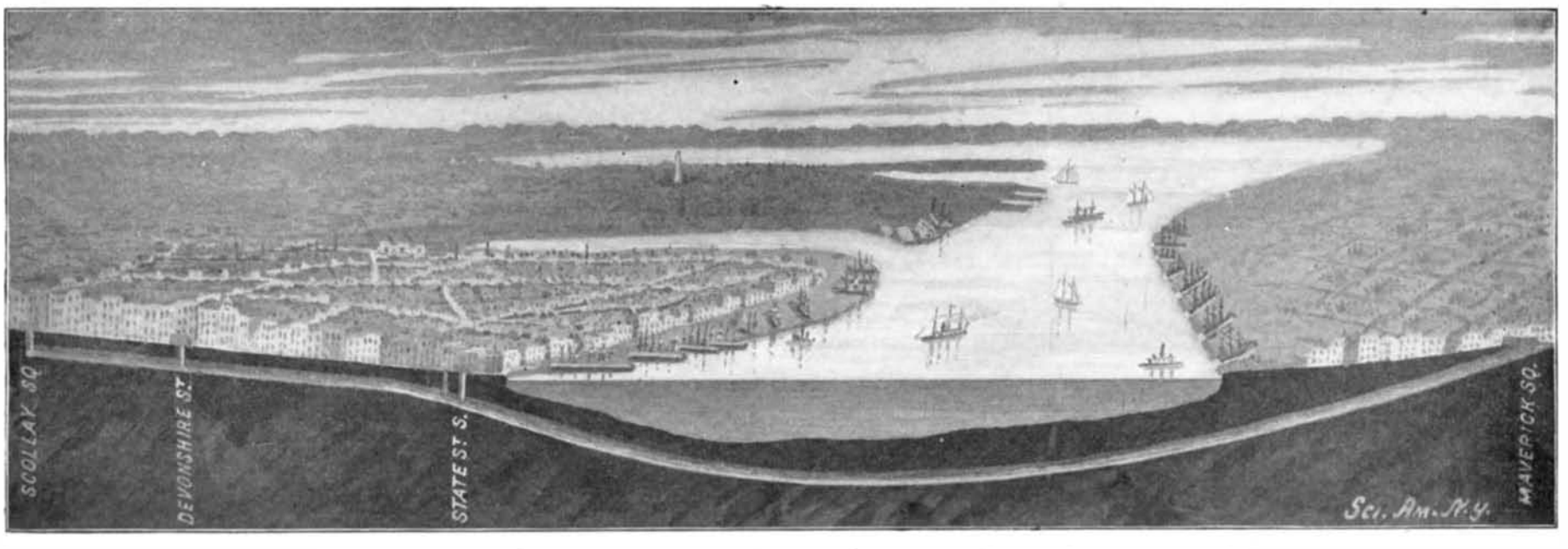


View in Completed State Street Station.



State Street Station Under Construction.

Exit, Maverick Square, East Boston.



Sectional View of the New Tunnel from Scollay Square, Boston, to Maverick Square, East Boston.

COMPLETION OF THE EAST BOSTON TUNNEL.

boldness of the plan upon which it was so successfully carried through. In the first place, it is notable as being the only double-track tunnel thus far built in America. The tunnels under the Hudson River and under the St. Clair River, and those now under construction beneath the East River, in connection with the Brooklyn Rapid Transit lines, being single-track tunnels and of considerably less sectional area. The width of the tunnel under the harbor where it is lined with ribbed tile is 23 feet, and in the upper part of State Street and Court Street it is 23.67 feet wide. The height of the tunnel from the top of the rail to the roof in the upper part of State Street and Court Street is 14.17 feet, and in the lower part of State Street, and under the harbor, the height is 17.3 feet. The excavation was done partly in open cut, this method being used where the tunnel lay near the surface, and there were no physical or other difficulties to prevent its use, and partly by means of shields and compressed air, the latter system being used in the construction of about 4,900 feet of the tunnel. It is the latter part of the construction that is most interesting, because it was carried through by an entirely new and exceedingly bold method which, as far as we know, has never been attempted under similar conditions.

When the borings for the proposed tunnel were made, it was found that it would pass through a stratum of exceedingly fine bowlder clay, of a consistency much firmer and more reliable than is usually found in subaqueous tunneling of this kind. Hitherto in such tunnels, where the shield has been used, among which might be mentioned the Blackwall tunnel under the Thames, London, and the tunnels under the St. Clair and Hudson rivers in this country, it has been customary to use a completely circular shield, which is pushed forward by hydraulic pressure, the tunnel as it is excavated being lined with a heavy segmental cast-iron lining, which is bolted together and grouted to render it perfectly water-tight. For a double-track road like this, however, the use of a circular tunnel would have involved much more excavation than was really necessary to accommodate two lines of trolley cars, there being a considerable amount of waste space in such a tunnel both above and below the cars. The engineer, therefore, determined to take advantage of the firm nature of the material, and build the tunnel with a semicircular roof, perpendicular side walls, and a flat invert. The irregular section that this method necessitated, made it impossible to use a shield in the ordinary way. Consequently, a semicircular half-shield was used for the construction of the upper half of the tunnel, and the lower half was built by means of drifting, in the manner now to be described.

Two bulkheads were constructed, one at each end of the central portion of the tunnel extending below the river, and these were provided with the usual air locks. The next step was to drift out two small tunnels, one in the line of each side wall, and large enough to permit these walls to be built therein. The walls were built of concrete and carried up to the springing of the semicircular arch. On the top of the walls was laid a heavy trackway, upon which rested the ends of the semicircular shield. The shield was then advanced by hydraulic pressure in the customary way, the clay being dug out, passed back through the central openings, and removed through the air locks. The concrete roof, three feet in thickness, was then rammed in place, being temporarily supported on falsework, in the customary manner. The material lying between the side walls was then excavated down to grade and the concrete invert was built in place. Except for a blowout, and one or two minor accidents, this very bold and original method of excavation was carried through successfully. The pneumatic pressure served to hold the clay in place until the concrete side walls, arch, and invert had been built in place and given sufficient time to harden. The boldness of this scheme will be appreciated when we remember that at extreme high water, the bottom of the excavation was exposed to a head of about 100 feet of water, and that until the concrete shell had been built in and had set there was nothing to prevent inward collapse, except the natural tenacity of the clay, assisted by the pneumatic pressure.

The work presented many features of engineering interest, arising in some cases from the cramped location, and in others from the fact that lofty buildings abutted on the tunnel and care had to be taken to provide against lateral displacement. To relieve the lateral thrust due to the weight of the concrete arch, and its superimposed load, a series of cross-tie rods with turnbuckles was let into the arch near the crown. These were so arranged that when the concrete had set, the rods could be removed. In some portions of the tunnel near the high levels, the structure was built with a flat roof, the necessary bending strength being secured by embedding twisted steel rods in the concrete—a method of construction known as reinforced concrete.

In order to secure proper ventilation, an air duct was formed at the crown of the arch, extending from Webster Street, East Boston, to and under the harbor to the Atlantic Avenue station. It has a cross section of about 48 square feet, and is formed of a diaphragm one inch in thickness, made of metal and inclosed in cement mortar. This diaphragm is attached to the tunnel walls by steel rods and plates which are then incased in concrete. At the center of the duct, midway between the two ends, is a partition which divides it into two approximately equal portions. On each side of the partition there are fourteen openings, each 4 feet long and 1 foot 5 inches wide, formed in the flat portion of the ducts; and at intervals of about 550 feet there are other groups of openings diminishing in number as they approach the chambers above the surface in which the fans are located. These openings are fitted with doors which can be opened or closed from the tunnel below. Fresh air enters the tunnel from the portal at East Boston and through the station near Atlantic Avenue. This air moves to near the middle of the tunnel and then passes up through the openings into the duct, through which it is drawn back to the east and to the west, and leaves the tunnel through the ventilating fans located near each end of the tunnel.

Work on the tunnel was commenced May 5, 1900, so that the work has taken about four and a half years to complete. Its approximate cost is $3,300,000.

THE NEW GRAND CENTRAL STATION, NEW YORK.

(*Continued from page* 40.)

is considerably the largest of its kind in the world. Its width is 160 feet, its length 470 feet, and the height from the floor to the top of the domed roof is 150 feet. The noble arched and domed roof of the concourse will extend entirely across the full width of the station building, a distance of 300 feet, or from Vanderbilt Avenue to Depew Place; but the concourse floor will be carried westerly under Vanderbilt Avenue for a distance of 170 feet. Back of the concourse, and located under the ticket lobby, will be the main waiting room, which will have twice the area of the waiting room of the present station. Surrounding it will be several retiring rooms, telephone and telegraph booths, and the various other conveniences of a modern station. Back of the waiting room will be a large restaurant, located beneath the broad approach to the station. Across the northerly end of the concourse will extend the customary line of gates admitting to the express platforms. Beyond the gates will be located no less than thirty-four stub tracks, with broad platforms between them, the average width being about 16 feet, extra space being provided, in order to avoid the crowding which is such a troublesome feature under existing conditions. Of these thirty-four tracks, the westerly eight or ten will be reserved preferably for incoming trains, and the arriving passenger, on passing through the gates onto the concourse, will find himself opposite a large cab stand, and with conveniences right at hand for securing his trunk and driving away with it with as little delay as possible. In addition to leaving directly by cab, he has the choice of four other means of exit from the station; for he may pass by a covered walk directly to the Subway, or by a 25-foot stairway to the concourse gallery and so into the main ticket lobby, or he can pass out to Madison Avenue and Forty-third Street by a covered subway, or crossing the concourse, he may leave by another covered subway to Lexington Avenue. It will be understood, of course, that the thirty-four tracks extend the full width of the concourse, the most easterly track abutting on Depew Place and the most westerly on Vanderbilt Avenue, and this, of course, necessitated some careful engineering work in supporting above these tracks the immense weight of the northerly half of the station building, containing the company's offices. Care has been taken to so arrange the supporting columns that none of them shall interfere with the passenger platforms. To recapitulate, it should be explained that the ticket lobby and the gallery are at street level, and the express tracks, the main concourse, the express waiting rooms, and the restaurant are at a level 15 feet lower than that of the street.

The plans for the new station involved, as an absolute prerequisite to success, that the suburban travel should be entirely separated from the express; and it was considered that the best way to insure this was to place the suburban tracks below the express tracks and provide a suburban concourse, waiting rooms, and other conveniences on this lower level. Moreover, it was decided that, with a view to further separating the two classes of travel, separate entrances and exits should be provided, so that the suburban passengers could enter or leave the lower level from the street or the Subway without meeting the long-distance travel. Access to the suburban tracks and station is obtained by gradually depressing the two outside tracks in the entrance tunnel below Park Avenue until they reach the lower level. In the rush hours the suburban trains will pass into the station and around a loop which will extend beneath the restaurant on the express level, the trains passing out again without breaking bulk. Toward the close of the rush hours, alternate trains will discharge their passengers from the series of seven stub tracks, which occupy the train space within the loop and in front of the suburban concourse. Trains will be stored here and in the station yard until the evening rush hour, when they will be switched out into service again. Provision is made at the inner end of the loop for connection direct to the tracks of the Rapid Transit Subway below Fourth Avenue; and it is a fortunate circumstance that Mr. Parsons, the Chief Engineer of the Subway, by moving the two tunnels below Park Avenue over toward the curb line, made provision for this connection with the New York Central system, although, at that time, the New York Central Company was not disposed to consider any such connection.

The suburban station is provided with a broad concourse and with the necessary waiting room and other conveniences, all arranged on the lower level, and with separate exits both to the Subway and to the street. This station is, to all intents and purposes, absolutely independent of the express station above; although provision is made by means of staircases for communication direct from the ticket lobby and the main concourse to the suburban station.

In conclusion, it should be mentioned that the capacity of the Park Avenue tunnel has been increased at least one hundred per cent by the great enlargement of the station yard. One of the most serious obstacles to a further increase in the number of passenger trains under existing conditions, is the fact that the storage yard for express trains is at present located at Mott Haven, and every express train that enters New York has to make the trip through the tunnel four times, twice in entering and leaving the station with passengers, and twice in making the round trip to the yard for cleaning purposes. With the enlarged area of yard provided in the new arrangement, the storage of express trains will take place at Forty-second Street, and the tunnel will be relieved proportionately.

The whole of the station yard will be operated electrically, as will also the suburban trains on the New York Central, the Harlem, and the New Haven Railroads. Suburban trains will be operated on the multiple-unit control system with motors on the car axles, and shorter trains will be run at more frequent intervals. The long-distance expresses will be hauled as far as Croton on the main line, White Plains on the Harlem Division, and Portchester on the New Haven Road, by electric locomotives. It is expected that the local service will be in operation in from two to three years' time, and that the whole scheme will be completed about a year later.

The Current Supplement.

The current Supplement, No. 1516, opens with a continuation of our correspondent's review of the Paris Automobile Show. His two articles, taken in connection with the Automobile Number of the Scientific American, which is to bear date January 28, will give the reader a most excellent review of automobile progress in Europe and America. Mr. Ambrose Swasey writes on "Some Refinements of Mechanical Science." Dr. O. F. Herz discusses at length the great frozen Siberian mammoth which he unearthed in 1901, in an almost perfect state of preservation. Splendid pictures accompany the text. Prof. William Bateson's article on breeding and heredity is continued. Prof. G. W. Ritchey presents another chapter on the "Modern Reflecting Telescope, and the Making and Testing of Optical Mirrors." In this installment he discusses silvering. Arthur Gulston's splendid discussion of ice-breakers and their services is concluded.

Next Week's Special Automobile Issue.

This is the season of the year when the prospective automobile buyer casts about him for a machine that suits his taste and purse. For several years the Scientific American has come to his assistance by publishing special automobile issues, in which the very latest types of cars, big and little, costly and cheap, have been described with a fullness of detail and a wealth of illustration that have been of immense assistance in such a selection. This year the Scientific American will outdo anything it ever before attempted in this direction. Next week's Special Automobile issue will contain forty-four pages, and will be larger than any of its predecessors. The subject of the colored cover is a wild automobile ride through a blinding snowstorm.

Naturally, the issue will be devoted largely to the products of American manufacturers; but the foreign maker has by no means been forgotten. Commercial vehicles, novelties of the Automobile Show, motor bicycles, racing cars, automobile accessories, are also discussed. For the general reader extra pages have been incorporated in the issue, which pages are devoted, not to automobiles, but to the usual subjects described and illustrated in these columns.

RECENTLY PATENTED INVENTIONS.

Of General Interest.

ANIMAL-TRAP.—J. KERNS, West New York, N. J. In the present patent the object of the inventor is to provide a new and improved animal-trap, more especially designed for trapping alive fish, crabs, and other animals, the trap being simple, easily set, and quick in action. The trap can be readily lowered into the water for the fish, crabs, etc., to get to the bait and to become entrapped alive within a basket.

PLUG.—E. M. HALL, Raymondville, N. Y. Mr. Hall's present invention is an improvement in plugs for use in rolls of paper, and has for its object the provision of a novel construction whereby to prevent the plug from slipping out of the roll during storage and shipment of such paper-rolls.

DUMB-WAITER SHAFT.—G. GERAERDTS, New York, N. Y. In this patent the invention relates to masonry; and its object is to provide a new and improved dumb-waiter shaft or like structure formed mainly of building-blocks or tiles and arranged to insure the formation of light but exceedingly strong and durable walls.

CUFF-HOLDER.—A. P. GILLEN, Chicago, Ill. The invention relates more especially to that type of cuff-holders which are secured within the coat-sleeve and secure the cuff independently of the shirt-sleeve. The principal object is to provide a holder in which the cuff may be readily adjusted without changing the position of the holder within the sleeve. A further object is to provide a holder operated by pressure upon the outer surface of the sleeve and which is so constructed that it may be set and held in open position ready to receive the cuff, so it may be introduced and secured with great ease and rapidity.

DENTAL TOOL.—E. FORQUIGNON, New York, N. Y. The inventor's object is the provision of a dental tool to be used for scaling off calcareous deposits from the teeth and also to enable the dentist to conveniently and quickly form and scrape a tooth-carrying rubber plate to accurately fit the same against the hard palate or roof of a person's mouth.

PAY-ROLL.—C. T. CHICHESTER, Placerville, Cal. The intention of the inventor is to provide a new and improved pay-roll for the use of merchants, contractors, lumbermen, or other employers of labor arranged to embrace a time-book, a ledger, and a receipt-book to show at a glance how an account between an employer and an employee stands at any time.

SINGLE-TRIGGER MECHANISM FOR DOUBLE-BARREL GUNS.—J. C. BROYLES, Birmingham, Ala. The invention relates to locks for double-barrel guns, and particularly to that class wherein a single trigger controls and operates both hammers. The trigger is so arranged that by sliding forward or back it is adapted to come in contact with the respective sears of the two hammers. Thus either barrel may be fired at will, according to the position in which the trigger is set, or the barrel may be fired successively without such shifting of the trigger.

PASTE FASTENING FOR RUGS OR CARPETS.—C. C. CONNER and T. GRIMLER, New York, N. Y. The invention of Messrs. Conner and Grimler relates to fastenings for rugs or carpets, their more particular object being to produce a fastening of suitable form to be held in place by paste and, if desired, to utilize a partial vacuum as an auxiliary means for securing the fastening in position.

SPRING-ROLLER.—W. A. HADDEN, New York, N. Y. In this case the invention refers to improvements in spring-rollers particularly adapted for use with heavy shades, displaying fabrics, and the like. With a spring-roller as usually constructed it often happens that in rolling up, the end of the shade or other material will, through the spring force, pass over the roller several times, thus weakening the spring force and making it necessary to remove the roller to rewind the spring. The invention provides suitable means to obviate the above difficulties.

Hardware and Tools.

WRENCH.—H. PHELAN, Jimenez, Mexico. Mr. Phelan's invention relates to improvements in wrenches of the type having a fixed jaw and a sliding jaw, an object being to provide a wrench of this character that will be comparatively light yet strong and that may be quickly adjusted to a nut or pipe.

Prime Movers and Their Accessories.

EQUALIZING-GEAR FOR RECIPROCATING PRIME MOVERS.—M. NEUMAYER, New York, N. Y. The inventor's object is to provide a power-equalizing gear for prime movers having a pair of cylinders and pistons reciprocating therein, arranged to give the piston which has passed a central position a rapidly increasing mechanical assistance from the other piston to eliminate all danger of the prime mover stopping when a piston reaches the central critical position referred to.

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Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 6404.—For manufacturers of the electric candy machine known as "Fairy Floss" or "Cotton Candy."

For logging engines. J. S. Mundy, Newark, N. J.

Inquiry No. 6405.—For makers of decorative glass spangles or ornamental cut glass.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 6406.—For manufacturers of copper plated sheet iron and steel.

Perforated Metals. Harrington & King Perforating Co., Chicago.

Inquiry No. 6407.—For paper decorative panels for tapestry work, also for theatrical scenery from which to paint.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St., Chagrin Falls, O.

Inquiry No. 6408.—For makers of a pneumatic drag saw.

Adding, multiplying and dividing machine, all in one. Felt & Tarrant Mfg. Co., Chicago.

Inquiry No. 6409.—For information concerning "Patrick Metal."

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 6410.—For disks of prepared paper for igniting wicks of pocket cigar lighters; the disks are about 1 inch in diameter, having on the face small patches of chemical substance.

Special Machinery to order, manufacturing, metal stampings, etc., Brickner Machine Co., Tiffin, Ohio.

Inquiry No. 6411.—For makers of fancy paper shades for electric light globes.

Robert W. Hunt & Co. bureau of consultation, chemical and physical tests and inspection. The Rookery, Chicago.

Inquiry No. 6412.—For makers of wooden blocks containing spirit plumb.

Patent for sale or on royalty.—Combination watch, fob chain, key and chatelain bag protector. D. Summa, 129 Thompson Street, New York City.

Inquiry No. 6413.—For makers of wooden thumb screws.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company. Foot of East 138th Street, New York.

Inquiry No. 6414.—For dealers in patented novelties.

I have every facility for manufacturing and marketing hardware and housefurnishing specialties. Wm. McDonald, 190 Main St., East Rochester, N. Y.

Inquiry No. 6415.—For makers of steam engines from ⅛ to 1 h. p.

The SCIENTIFIC AMERICAN SUPPLEMENT is publishing a practical series of illustrated articles on experimental electro-chemistry by N. Monroe Hopkins.

Inquiry No. 6416.—For machines for making briquettes from marsh mud, or who control the process.

WANTED.—Revolutionary Documents, Autograph Letters, Journals, Prints, Washington Portraits, Early American Illustrated Magazines, Early Patents signed by Presidents of the United States. Valentine's Manuals of the early 40's. Correspondence solicited. Address C. A. M., Box 773, New York.

Inquiry No. 6417.—For machinery for cleaning clothing.

Any metal, sheet, band, rod, bar, wire; cut, bent crimped punched, stamped, shaped, embossed, lettered. Dies made. Metal Stamping Co., Niagara Falls, N. Y.

Inquiry No. 6418.—For makers of ice machinery and outfit; also for makers of corrugated iron arches for building.

We manufacture gasoline motor and high-grade machinery, castings best quality gray iron. Select patterns, and let us quote prices. Frontier Iron Works, Buffalo, N. Y.

Inquiry No. 6419.—For large quantities of draw knife with 6-inch blade.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 6420.—For makers of bottles for soda water with Codd's ball stoppers.

WANTED.—Having a thoroughly organized agency force, we are desirous of securing Exclusive Pacific Coast Agency of Articles of Merit, where personal solicitation is required. Address Suite No. 2, 47 Geary Street, San Francisco, Cal.

Inquiry No. 6421.—For makers of earthen baking utensils containing asbestos.

CALCULATING MACHINES.—Wanted, first-class firm willing to take up the agency and sale in the United States and Canada of a well-known calculating machine. Terms very favorable. Apply Grimme, Natalis & Co., Braunschweig, Germany.

Inquiry No. 6422.—For makers of fiberloid.

Rowe's Automatic Carpenter's Hammer Device.—United States, Canada and Great Britain patents granted. Will sell same outright, consider royalty or correspond with some one with capital. Send for descriptive circular. Geo. H. Rowe, Patentee, Box 442, Ennis, Texas.

Inquiry No. 6423.—For machinery for the desiccation of cocoanut.

Inquiry No. 6424.—For makers of call boxes similar to those employed by the Western Union Co.

Inquiry No. 6425.—For makers of woven wire bed springs, also spiral springs.

Inquiry No. 6426.—For machinery for evaporating sweet corn for table use.

Inquiry No. 6427.—For makers of art metal furniture.

Inquiry No. 6428.—For makers of electric storage batteries, such as are used for propelling automobiles and recharged by electricity.

Inquiry No. 6429.—For parties to build 1,000 or more autos per year, complete, on contract, drawings and samples furnished.

Inquiry No. 6430.—For an estimate of cost of small plant of machinery for making tin boxes of all sizes.

Inquiry No. 6431.—For makers of hollow wire, small pressure tank and gasoline lamps.

Inquiry No. 6432.—For machinery and appliances for oil refining.

Inquiry No. 6433.—For makers of door openers and closers.

Inquiry No. 6434.—For machinery for crushing and grinding green foodstuffs, to prepare same for drying, also for machinery for such drying.

Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.

Scientific American Supplements referred to may be had at the office. Price 10 cents each.

Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled.

(9520) W. A. T. asks: Would you kindly give me directions for a spark coil for 3-horse-power gasoline engine? Size of core, feet and number of wire for primary; also feet and number of wire for secondary. I have 550 feet of No. 18 cotton-covered wire that I would like to work into the coil. Want coil to give about ½-inch spark. A. SUPPLEMENT No. 1281, which we have sent you upon your order, gives full information concerning a coil for gas engine ignition, if one has general knowledge of the work of construction. Lacking this, it would be best to get Norrie's "Induction Coils," price $1, which gives detailed instruction in this work, together with tables of data for all the parts of coils of all sizes up to a 12-inch spark. Do not use so coarse a wire as No. 18 in a secondary coil, and use a coarser wire in the primary. Two layers of No. 14 will be right for primary, layer 6 inches long. Three-fourths pound of No. 36 silk-covered will be right for secondary to give a half-inch spark. Core should be ⅞ to 1 inch in diameter and 7 inches long. 2. If a person sparked his engine with a magneto, would he need a coil also? A. A magneto can be made which will render a coil unnecessary, but a battery and coil are necessary till the machine has speed enough to enable the magneto to generate.

(9521) C. S. J. asks: I wish to learn the cause of trichinæ in pork. A. The trichina spiralis is a worm, a parasite of the hog. It is often found in great numbers in the flesh of these animals, in the encysted condition but still alive. If such meat is eaten without cooking thoroughly, the parasite is taken into the body and is rapidly propagated. The worm came originally from the rat. As hogs eat rats, they pass into the hog and thence into man. The only preventive is thorough cooking. This kills the trichinæ. No rare or underdone pork should ever be eaten. The risk is too great. The cost of immunity is so little, that anyone may be safe. Cook all pork thoroughly. 2. The cause of ptomaine poisoning by eating pork. What causes the presence of the poison, how the poison can be prevented, and whether or not there is any way of detecting the presence of poison before using the meat? A. Ptomaines are formed by decomposition. If only fresh food is used, one will be safe from these poisons.

(9522) H. S. N. asks: I have been a reader of your paper for several years, and always enjoy reading it. I should like to submit a problem for solution. The problem is this: Several years ago I took a picture of a fast train while running, a Michigan Central flier, at a point about two miles east of Decatur. On development the plate showed a blur of 1-32 inch, i.e., the pilot did. I used a Vive extra rapid plate; the focus of the lens was 6 inches; the distance of the engine, the pilot, from the camera, 50 feet; the length of exposure, 1-100 of one second; camera was placed at an angle of 15 deg. with the track. What was the speed of the train? The camera was a Vive, 4¼x4¼, meniscus lens. A. The solution of your problem of the speed of the train is not difficult, at least so far as a sufficiently close approximation is concerned. Start with the fact that the image of the pilot moved 1-32 inch during exposure. Since the lens is 6-inch focus and the pilot is 50 feet away, the pilot moved across the line drawn through the center of the lens, 100 times 1-32 inch, or 3.125 inches, since 50 feet is 100 times 6 inches. And since the camera made an angle of 15 deg. with the track, we must divide the 3.125 inches by the sine of 15 deg. to find the distance the pilot moved during the exposure. This gives 12.07 inches as the distance the train moved in the time of exposure, or 1-100 second. In one second it moved 1,207 inches, or 100 feet 7 inches. This is a speed of somewhat over 71 miles per hour. As we said above, this is an approximate solution, but still not far from the result which an exact solution would give.

(9523) J. S. M. asks: Will you kindly answer in your column of Notes and Queries the inclosed questions relative to Roman computation? I suppose the matter is simple enough, but I have never come across any work explaining it, nor any person whom I have asked who could throw any light on the subject. A. Very little is known concerning the method by which the Romans used their very inconvenient notation for performing the ordinary calculations. They are supposed to have used the abacus for all except the most simple problems. This instrument is in common use now by all Chinamen, and it is not difficult for any one to see it used wherever these men may be found. A description of the abacus may be had from any encyclopedia. There was a rod for each denomination of numbers to millions, seven rods each carrying five balls. Another set of short rods corresponded to these, and had one ball sliding on each. They could thus count by fives and carry by tens. Other rods supplied their need for calculating ounces. Further than this their business did not require them to go; they never needed to divide the distance of the sun by the velocity of light. They died in total darkness in regard to both of these data of the universe. As we said at the outset, we do not know the detail of the method by which the Romans made their calculations. Their mode of writing numbers was not like ours by placing like denominations in the same column, but each letter had its significance, and each number could be added by itself on the abacus, since each rod meant a denomination.

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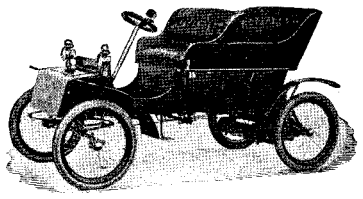

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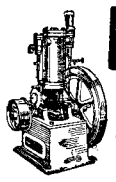

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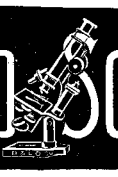

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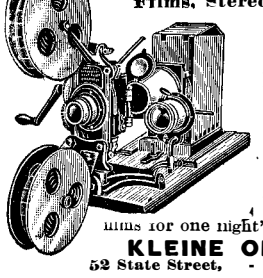

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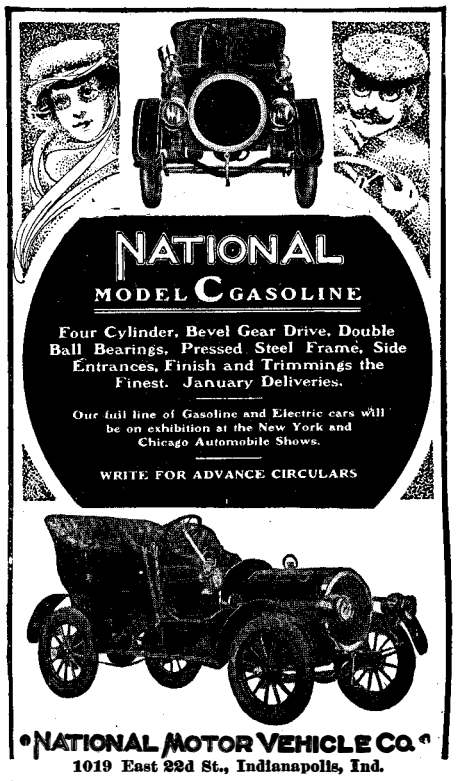

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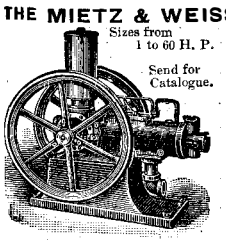

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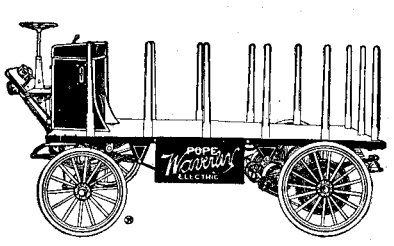

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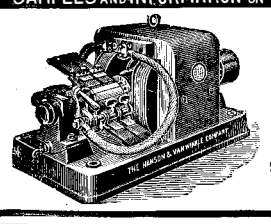

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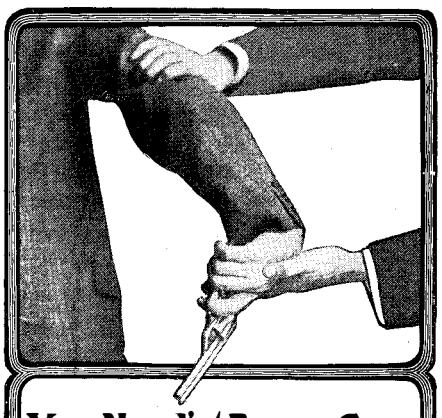

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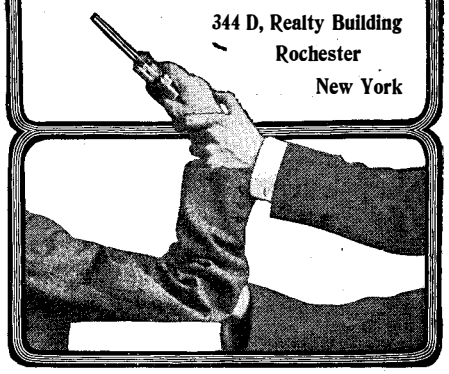

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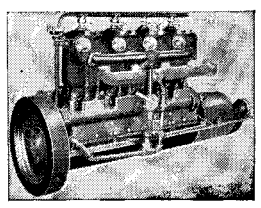

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