THE DOUBLE-DECK SURFACE AND TUNNEL STATION OF THE HUDSON COMPANIES IN JERSEY CITY.

New York city is, at the present time, the greatest center for engineering works of magnitude in the world. In proof of this, it is sufficient to state that the work in the way of terminal railway stations, bridges, tunnels, and water supply now under construction in or near this city represents a total outlay of over $600,000,000, or about three times as much as the estimated cost of completing the Panama Canal. One of the largest of these public works is the elaborate system of tunnels and terminals, which is being built by the Hudson Companies to provide better transit facilities between Jersey City and Manhattan Island—a work, the cost of which, when fully completed, will probably be over $50,000,000.

This system of rapid transit (for such it is) has grown out of the abortive attempts, made some thirty years ago, to drive a tunnel from Jersey City to Manhattan, between Hoboken and the foot of Morton Street. Meritorious as was the original scheme in plan and purpose, it failed for mechanical and financial reasons. Considering that subaqueous tunneling was then in its infancy, and that modern methods of driving were unknown, it is surprising that the original company should have accomplished what it did; but lack of mechanical appliances, coupled with the treacherous character of the river silt through which the tunnels were being driven, to say nothing of the difficulty of securing the necessary capital, led to the abandonment of the work. Thanks to the far-sightedness and energy of Mr. McAdoo, president of the Hudson Companies, the work of completing the abandoned tunnels was taken up a few years ago, the necessary capital subscribed, and the work of driving the tunnels through to Manhattan commenced. Under the care of Charles M. Jacobs, chief engineer, who brought to the work a large experience and the very latest methods of driving with the Greathead shield, the tunnel soon began to make rapid progress toward the Manhattan shore.

Before the work had been long in progress, it was realized that, if the scheme for providing rapid transit between the two cities was to be adequately carried through, it would be necessary to provide additional tunnels at a crossing located in the latitude of the "downtown" financial district; and accordingly, the company laid out a route extending from the Pennsylvania Railroad Company's terminal station in Jersey City to Cortlandt and Fulton Streets in Manhattan. At the same time, the scheme was developed to its logical conclusion, by planning to build tunnel lines parallel with the Jersey foreshore, extending from the Hoboken terminal of the upper pair of tunnels to a connection with the Jersey City terminal of the Cortlandt Street tunnels. Also, with a view to placing Jersey City in direct touch with the uptown shopping district, it was planned to continue the Morton Street tunnels, easterly below Manhattan to Sixth Avenue and northerly below Sixth Avenue to Thirty-third Street, and build a branch line from Sixth Avenue to Astor Place. The plans also called for a huge terminal station and building, extending on Church Street from Cortlandt to Fulton Street, the tunnel to contain five parallel tracks, and the terminal office building to be twenty stories in height on a block 180 feet wide by 420 feet long.

This ambitious undertaking has been pushed along during the past two or three years with untiring energy, and with a remarkable absence of the delays which would seem to be so inseparable from large engineering works of this character. At the present writing the two upper tunnels are completed, and the Hoboken terminal station is nearly so. Also the extension of the tunnels below Manhattan Island has been fully completed to Sixth Avenue, and is nearly completed to Eighteenth Street. The work of excavation is well under way from Eighteenth to Thirty-third Street. As matters now stand, there is every indication that trains will be in operation from the Hoboken terminal to Eighteenth Street and Sixth Avenue before the winter sets in. The Cortlandt Street tunnels have been driven 82 per cent of the distance below the Hudson River, and the big terminal building is now up to the eighth floor. It is expected that this building will be completed by May 1, 1908, and that the tunnels connecting with it will be ready for service in the autumn of the same year.

From an engineering standpoint, one of the most attractive features of the Hudson Companies system is the large underground station, which has been excavated below the present terminal of the Pennsylvania Railroad Company in Jersey City. This station, which is 150 feet in width, and with its approaches nearly 1,000 feet in length, has been cut out of the solid rock at a depth of 85 feet below street level, and, as will be seen from our front-page engraving, lies immediately below the large Pennsylvania Railroad Company's train shed. The walls and roof are finished throughout with a heavy lining of concrete. The station provides for four, and in some places five, parallel tracks, two for through trains, and two for local trains. Access is had either directly from street level by a subway below the floor of the upper station, or from the station floor itself, by means of six passenger elevators. Two elevators lead directly to the street, and four elevators of exceptional size, each being capable of holding over a carload of passengers, lead directly from the platforms of the tunnel station to the platforms of the Pennsylvania station overhead.

Joint traffic arrangements have been made between the Hudson Companies and the Pennsylvania Railroad Company, according to which, as soon as the new Pennsylvania terminal station on Thirty-third Street is completed, the present terminal in Jersey City will be handed over for operation to the Hudson Companies. All long-distance travel on the Pennsylvania lines destined for upper New York will be carried directly through that company's tunnel to Thirty-third Street; while the long-distance travel on the Pennsylvania destined for lower New York will transfer at Harrison for the Hudson Companies' lines, and will enter New York by the Cortlandt Street tunnel route. Eventually, the Hudson Companies will be in a position to carry passengers to Newark and vicinity, either by ferry, and by surface lines over the present tracks of the Pennsylvania Railroad, or direct by tunnel beneath the Hudson River, said tunnel tracks emerging by an incline near Harrison.

An excellent feature in the operation of this system is the fact that a new type of car of absolutely uninflammable construction will be used exclusively. The cars, which were designed expressly for this service, will be entirely free from wood, and even the cushions of the seats will be of fireproof material. It is estimated that 250 cars will serve to maintain a constant succession of trains through the tunnels on a headway of one and a half minutes. During the rush hours there will be eight cars to the train. Operation will be by the multiple-unit system, and every car will be equipped with motors. Advantage was taken of the fact that the cars were to be built entirely of steel, to provide them with a wide margin of strength over cars of the ordinary construction. They are designed on the bridge or girder principle, which has been preserved in spite of the fact that in addition to the usual end doors, center doors are provided on every car.

These middle or side entrances are operated by compressed air; the impulse for operating which will be given by the motorman at each end of the car. At the proper moment, he will move a lever, which will close or open not only the doors on the end platforms, but also the double doors on the sides of the cars. The force of this impulse, however, will be controlled, so that there never will be any possibility of a person being caught between the doors. In other words, the force which closes the doors will be just sufficient to do so; and should a passenger be about to enter the car at that moment, it will be possible for him to stay the progress of the closing door with the hand.

These center doors are on both sides of the cars, and have been thus installed for the purpose of solving some of the rapid transit problems which always exist in any large terminal station in New York. For instance, the trains of the Hudson Tunnel system will run between platforms in the new terminal station building at Church and Cortlandt Streets; there will be five tracks running between six platforms. Alternate platforms will be used for the purpose of loading and unloading the cars. Passengers will pass out of a train just arrived on to an unloading platform, the side doors of the cars permitting them to discharge their passengers in a comparatively few seconds' time. The doors on that side of the cars will then be closed, and the doors on the opposite side will be opened to admit passengers from the loading platform, who desire to embark. Thus the incoming and outgoing passengers cannot collide, and there can be no congestion.

The cars are large and comfortable, and capable of seating over fifty persons each. There are no cross seats, as at present exist in the elevated and subway trains, because the side doors of the cars take up the space at present occupied by the cross seats; but for the convenience of those who may be compelled to stand on the three-minute run under the river, there is a series of posts extending from the floor to the roof of the car, to which one may conveniently cling or lean. The floors of the cars have been laid with cement which may be readily washed, thus giving it the highest sanitary efficiency. In the cement floors will be imbedded quantities of carborundum, which is a very hard abrasive material, impossible of wear under the feet of the passengers, and which makes it impossible for a passenger to slip.

A new method of cutting steel is said to have been patented by a Belgian engineer. The process consists in first heating the metal by means of an oxy-hydrogen flame and then cutting it by a small stream of oxygen gas, which unites with the steel and forms a fusible oxide, which flows freely from the cut. It is said that the cut is fully as smooth as that made by the saw, and is only 1-100 inch wide.

Coffee Substitute Culture in California.

A syndicate of Stockton capitalists has purchased a 500-acre tract of very rich land on Robert's Island, one of the numerous fertile river islands west of Stockton, and expects soon to commence the cultivation of "coffee."

They are going to put this large tract into "blackeye beans," which are used extensively in the manufacture of the cheaper grades of coffee. The bean takes a nice brown color, has a good flavor, and cannot be detected from the genuine coffee bean—the imported article—except by an experienced expert; and even such a person would find it difficult to detect the counterfeit in a ground mixture of the real article.

The blackeye bean owing to the demand for it in the manufacture of coffee sells readily for five cents per pound; much cheaper than real coffee can be purchased for. The blackeye bean is not at all injurious, as has been determined by repeated experimenting and chemical tests; but, on the contrary, it makes a very nutritious drink when mixed with real coffee, as is always the case, and the flavor is delicious. In fact, about the only thing against the blackeye bean is, that it is *not* coffee, and no enthusiastic coffee drinker would knowingly drink any substitute. This is the first attempt to cultivate the blackeye bean in California.

Prize for Lucerne Cultivator.

Consul-General J. G. Lay, of Cape Town, transmits the following information concerning a competition for a lucerne cultivator in South Africa, which should interest American agricultural implement manufacturers:

The endeavor to obtain the best cultivator for lucerne sown broadcast has led the Cradock Agricultural Society, of Cape Colony, to arrange a competition in 1908, at which a prize of $500 is offered for the successful implement. Practically no lucerne is sown by drills in Cape Colony, but thousands of acres are sown broadcast, and the acreage is increasing so rapidly that the cultivator awarded the prize will undoubtedly have a large sale. A "drag" implement, similar to that used for drilled crops, will not do for broadcast lucerne, owing to the damage done the crop in cultivation.

The trial is for a "general purpose" implement to be used on lucerne from one year old and upward, to produce a fine tilth of not less than three inches in depth (with the object of conserving moisture), to destroy grass and weeds, and which must leave the surface of the ground as even as it found it, and in good condition for irrigation. The judges will inspect the lucerne three weeks after and also six weeks after the trial to see the effects. Entries must be made not later than noon on January 1, 1908, and the implements must be on the grounds appointed for the trial by February 1. The selling price of the implement at Cape ports must not exceed $145.

Some suggestions as to the style of cultivator suited to the work have been given by the secretary of the agricultural society and embrace the following points:

The machine should run on wheels, which will admit of its traveling from place to place, and have a roller or drum revolved at a rapid speed by gearing from the main or traveling wheels, fitted with long spring arms or teeth, the roller being suspended and capable of being lowered or raised by the usual lever or quadrant, so that the teeth can be raised out of harm's way when traveling, and lowered for either very shallow or deeper cultivation. The chief difficulty will be in arranging so that the machine will not dig out lucerne as well as weeds. The principle will be best made clear to foundry and machine shopmen by stating that it would be the power wood-molding plane adapted to cultivation, where the traveling pace of the team would represent the "feed" of the molding plane, and the drum and teeth would represent the blade holder and the revolving blade. By adjusting the proportion of the speeds of the traveling wheels and the drum unquestionably any fineness of tilth can be produced in either dry or irrigated land. It must have teeth with spring or give in them both forward and backward, and also spring or give sidewise, or across the machine, sufficient to admit of a tooth slipping off a large lucerne root. Straight spikes seem to be best, of spring steel, an arrow at the point, say one-half or three-fourths inch in diameter, for just such a distance as they will enter the ground, and hooked or bent only at the extreme end sufficiently to make them enter the ground without having more weight in the machine than is necessary for strength. A spring tooth of flat section, with a half turn in the middle, seems likely to give the required spring in both directions, provided the tooth is fairly long. The principles involved are embraced somewhat in an English hay-tedding machine.

Further details concerning the cultivator, with the conditions of entry and trial, as well as the name and address of the secretary of the agricultural society, are on file in the Bureau of Manufactures for the information of those interested.

A New Locomotive Smoke-Consumer.

Travelers over the New York Division of the New York, New Haven & Hartford Railroad have wondered why no improvement has been introduced to stop the belching forth from the locomotives of clouds of black, sooty smoke when fresh coal-dust fuel is thrown upon the furnace fire.

After some preliminary experimenting a locomotive equipped with a new smoke consumer, the invention of Charles Schneider, the Railroad Commissioner of Austria, was attached to a train leaving New Haven, Conn., for Springfield, Mass., on the afternoon of September 12, and drew the train to its destination without the slightest appearance of smoke or cinders. Many of the passengers left the windows open and never experienced any disagreeable cinder sensation. The smoke and cinders are drawn from the firebox into a compartment where they are consumed, securing greater economy in fuel consumption as well as increased steaming capacity. It is stated, in view of the success of the invention, that other engines will be shortly fitted with the apparatus.

It is to be hoped the company will use every effort to eliminate this intolerable smoke nuisance, not only for the benefit of its patrons, but for that of the various towns and cities its road passes through.

Roman Antiquities in Austria.

The last few days of the month of July witnessed the discovery of some very interesting relics at Saifnitz, near Tarvis, in Austria, the excavations made (at the order of the Central Committee for Art and Historical Monuments—"Zentralkommission für Kunst und Historischen Denkmäler") there having brought to light several portions of an old Roman monument. These, when put together, formed a complete portion of a funeral monument of about twelve feet in length. A step-shaped pedestal carries a large block, cut rectangularly transversely and longitudinally, which served as a stand or base for an oval housing or niche crowned with a pine cone (so far not all found) and which contained half-length representations in *alto relievo* of some deceased Roman and his wife. The housing is covered in by a gable-like roof, and is ornamented on top with scroll work; the sides are decorated with figures in relief, while in the front there is an inscription to the memory of the deceased and to the giver of the monument. Although the new find is by no means equal, in solidity and artistic conception, to the famous tower-shaped and obelisk-like monuments (showing traces of Greek influence) found in the Rhenish provinces, it nevertheless ranks easily first among all the rare antiquities so far discovered on Austrian soil.

Radium in the Rocks of the Simplon Tunnel.

The rocks through which the Simplon tunnel has been driven have been found to contain radium, and for the most part in quantities much greater than has hitherto been ascribed to either sedimentary or igneous rocks. Speaking of this at the recent meeting of the British Association, Prof. J. Joly pointed out that such quantities of radium if generally distributed throughout the rocks of the massif would be sufficient to disturb any forecast of the temperature which under normal conditions would be encountered at the level of the tunnel. It is suggested that the radium was in fact the source of the discrepancy between the predicted and the observed rock temperatures.

As it is improbable that these results apply only to this particular sedimentary accumulation and locality, they appear to point to hitherto unsuspected quantities of radium (and its parent elements) in the immediate surface materials of the earth. It seems impossible to avoid the conclusion that these elements were precipitated along with the sediments entering into the composition of the massif. The question then arises whether the accumulation of such quantities of radio-active elements may not enter as a factor in the events attending mountain-building. It can be shown that an area of sedimentation whereon has been accumulated some 10,000 meters of sediments, having a richness in radium comparable with the Simplon rocks, must necessarily become an area of greatly lessened crust-rigidity, and would hence become the probable site of crust-flexure under tangential compressive stress.

Further investigation will be required before such views can be generalized and the importance of radium as a source of instability of the earth's crust be determined. Apart from any speculations as to the influence of radium as the cause of an energetic substratum, the shifting of radium and its parent elements by denudation must be regarded as a convection of thermal energy, and this convection, if the quantities involved are sufficient, must, under the conditions referred to above and the unceasing action of denudation, become rhythmic in operation, and at the same time must result in shifting the areas of high temperature and crust-weakness from age to age as the site of sedimentary accumulation changes.

Correspondence.

Permanent Way Construction.

To the Editor of the SCIENTIFIC AMERICAN:

May I crave the hospitality of your columns for the following suggestions as to permanent-way construction?

1. A substantial *longitudinal sleeper* under each rail.
2. *Cross ties* of timber bolted to the upper side of the sleepers, so as to preserve the gage.
3. The *rails* bolted on to these ties.
4. Short pieces of timber under the rails, with the grain running parallel with the ties.

In this way each rail is provided with a *continuous cross-grain bearing*, which transmits the weight of the wheels directly to the ground; while the ties at the same time secure a rigid fixity of gage.

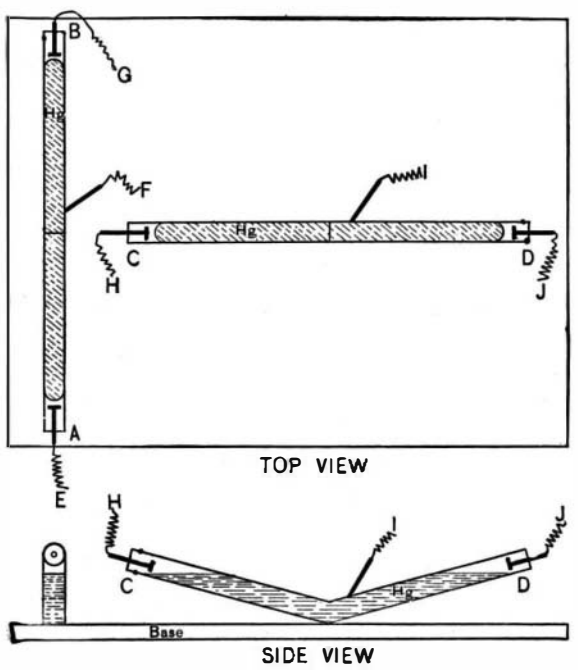
A. J. ALLEN.

London Institution, Finsbury Circus, London, E.C.

Controlling the Balance of Aeroplanes.

To the Editor of the SCIENTIFIC AMERICAN:

Referring to the article by R. W. Goddard in the SCIENTIFIC AMERICAN SUPPLEMENT for June 29, 1907, on the use of the gyroscope with suitable electric connections in balancing and steering aeroplanes, it would seem to me that a much simpler scheme might be devised to do much the same work as that described. Two bent glass tubes partially filled with mercury, fitted at each end with an adjustable contact point, might be fastened at right angles to each other on a suitable mounting. (See sketch.) If the aeroplane should tip toward *A*, the mercury would run toward that end of the tube, forming an electrical connection between the wires *E* and *F*; *F* being a wire sealed in



ELECTRIC CONTROLLER FOR AEROPLANES.

the glass tube and always in contact with the mercury. In like manner tipping toward *B*, *C*, or *D* would form connections between *G* and *F*, *H* and *I*, and *J* and *I* respectively. By adjusting the contact points in the ends of tubes, it would seem to be possible to automatically keep the aeroplane on a level keel. Steering could be accomplished by tipping the mounting as described by Mr. Goddard. The above scheme would be much more simple than that described by Mr. Goddard, and as far as I can see, would produce practically the same results. CLARK L. SWEZEY.

West Haven, Conn., July 24, 1907.

The Current Supplement.

The current SUPPLEMENT, No. 1655, is of more than usual interest. The first-page article is devoted to illustrations of devices for coaling vessels at sea, the coaling-vessel being self-propelled. An article on the test of alcohol lamps and stoves by S. M. Woodward and B. P. Fleming is timely, in view of the fact that we are now able to obtain denatured alcohol at a moderate price. The article is profusely illustrated. The utilization of waste products is admirably described in an article by Dr. Theodor Koller, entitled "Iron Slag." "New Problems of the Weather," by Messrs. Moore, Humphries, and Fassig, of the Weather Bureau, describes some of the recent work in aerial, meteorological, and magnetic observations. "Different Types of Ice Houses," by A. S. Atkinson, gives in a concise form valuable technical knowledge which will doubtless benefit many of our readers. "Recent Contributions to Electric Wave Telegraphy" is the substance of a lecture recently delivered at the Royal Institution by Prof. J. A. Fleming, F.R.S. "The Telescope and Its Achievements" by D. B. Marsh is interestingly written. The Engineering Notes, Electrical Notes, Trade Notes and Formulæ will be found in their accustomed places.

Production of Precious Stones in 1906.

The collection of statistics for the production of precious stones is one of the most difficult tasks performed by the Mineral Resources branch of the United States Geological Survey. Not only is the production made up of small lots and scattered finds brought in at different times and disposed of to different people, but often the persons mining gem minerals do not care to furnish figures showing production, which then has to be estimated or omitted entirely. Fortunately for the statistician, the men willing to furnish information greatly outnumber those of the secretive class.

In an advance chapter from "Mineral Resources of the United States, Calendar Year 1906," on the production of precious stones in 1906, Mr. Douglas B. Sterrett, of the United States Geological Survey, has brought together all available information concerning the gem production of the United States as well as that of other important producing countries.

In comparison with this country's vast production of the utilitarian minerals, its output of those used chiefly for ornament is insignificant. Of the precious stones of all kinds (except pearls) produced in the United States in 1906, the total value was but $208,000 and nearly $190,000 of this amount represents the value of six gems ranking as follows:

Tourmaline	$72,500
Sapphire	39,100
Chrysoprase	32,470
Turquoise	22,250
Spodumene (kunzite and hiddenite)	14,000
Beryl	9,000
	$189,320

The balance was distributed among various gem minerals, including garnets ($2,700), quartz gems of different kinds ($6,050), amethysts ($700), rubies ($600), and rarer or less well known varieties in small values.

Of the stones produced to the greatest value in the United States, the tourmalines come from California, Maine, Colorado, and Connecticut; sapphires from Montana, North Carolina, and Idaho; chrysoprase from California; turquoise from Arizona and New Mexico; the spodumene gems, kunzite and hiddenite, from California; and the beryls from California, Colorado, North Carolina, Massachusetts. New Hampshire, and Maine. The rubies were reported as scattered finds from North Carolina and Idaho.

The value of the diamonds in place, discovered in Arkansas in the latter part of the year, is not included in the statistical part of Mr. Sterrett's report, but a history of the discovery and a description of the manner of occurrence, prepared by Messrs. George F. Kunz and Henry S. Washington, is appended thereto.

Each year there is an unrecorded production of pearls from fresh-water mussels of many rivers of the United States, principally from the Mississippi Valley region, and pearls have also been found along the Atlantic and Gulf Coast States from Maine to Texas. The American pearls vary so greatly in color and tint that it is difficult to exactly match a number of them for necklaces and other jewelry. On the other hand, the exquisite color and fine luster of our pearls more than offset the disadvantages of such irregularities and make them much desired in the gem market.

The pearl industry is carried on in such a way that it is not possible to collect statistics of production, but one of the largest pearl dealers in the Mississippi Valley estimates the value of pearls and slugs produced in 1906 at $381,000, with prices ranging from $1 to $2,000 each for the pearls and $1.50 to $60 an ounce for the slugs. An estimate by the United States Fish Commission places the value of pearls produced in the United States in 1906 at about $500,000.

The chapter on precious stones above referred to will soon be ready for distribution and copies may be obtained free of charge by applying to the Director of the United States Geological Survey, Washington, D. C.

Plugged sleepers have been used with marked success in large numbers by Chief Engineer Fredericia, of the Danish State Railway. A plain 1½-inch cylindrical creosoted plug of beech or birch is driven tight in a 1 1-3-inch hole bored in the sleeper and the spike is driven in a hole bored in this plug. Worn-out sleepers plugged in this way have been found to give good service, as the rail seems to be held down with exceptional firmness, and deterioration due to the pounding of loose rails is prevented.

The Railway and Engineering Review states that the Erie Railroad has adopted a new form of steel pole for carrying overhead wires. It is of tripod construction instead of the four or more legs usually employed. It consists of special U bars arranged at angles of 120 deg. round the axis of the pole, and bound together by malleable castings. This method is said to give an absolutely rigid fastening without any hole being drilled in the U section.

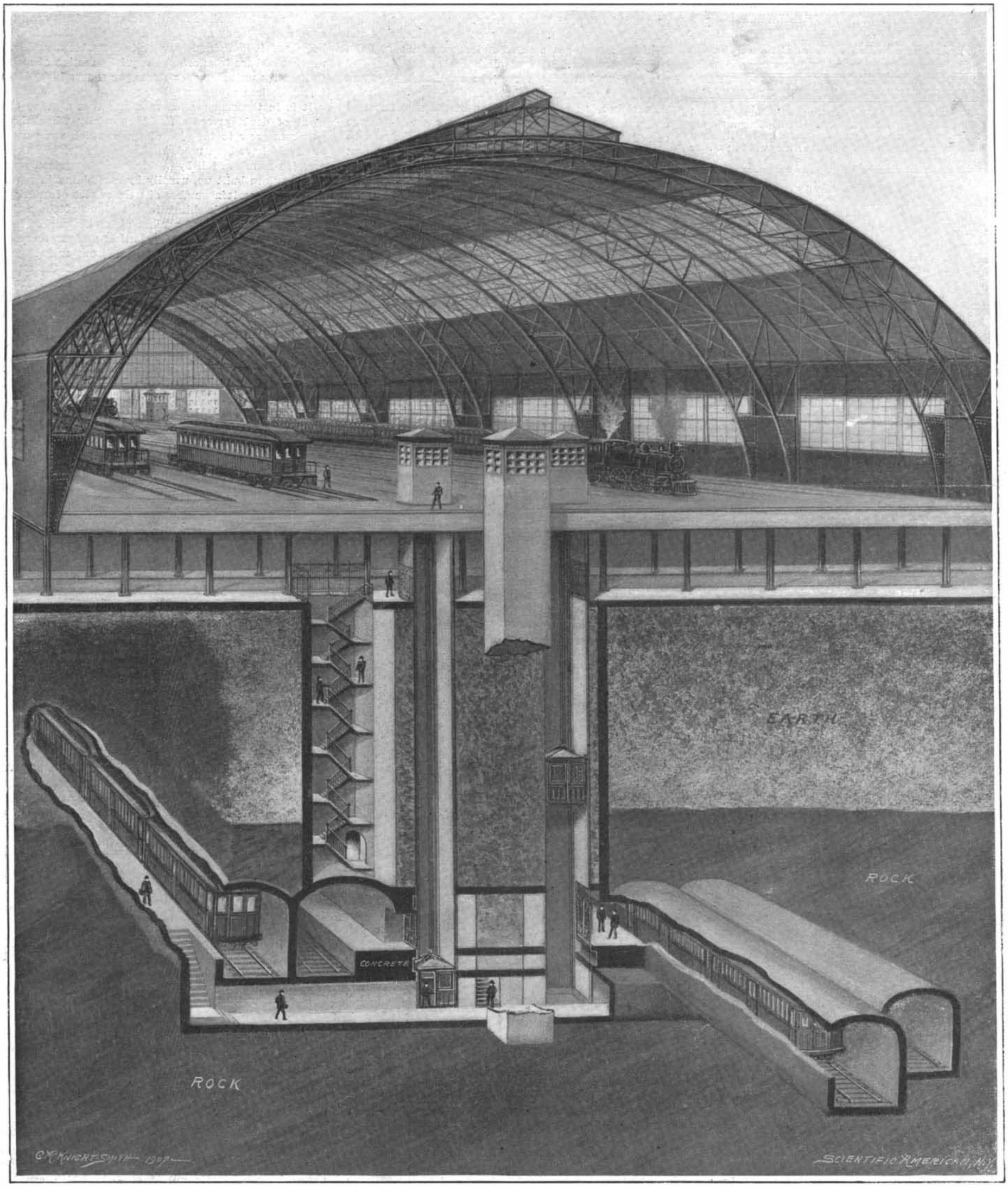
SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1907, by Munn & Co.]

Vol. XCVII.—No. 12.
ESTABLISHED 1845.

NEW YORK, SEPTEMBER 21, 1907.

10 CENTS A COPY
$3.00 A YEAR.



This station has been blasted out of the solid rock at a depth of 85 feet below street level. When the new Pennsylvania Railroad terminal at 33d Street, New York, is completed, the big trainshed shown above will be handed over to the Hudson Companies, who will operate it in conjunction with the tunnel station below.

THE JERSEY CITY TUNNEL STATION OF THE HUDSON COMPANIES. THIS STATION IS 1,000 FEET LONG AND IS BUILT BELOW THE PENNSYLVANIA TERMINAL.—[See page 206.]