nal and annual revolutions of the earth as well as the movements and phases of the moon.

The zodiacal circle is highly artistic. Made of beaten copper, the twelve signs are executed in fine style and move upon a star-spangled blue ground which represents the firmament.

The dial plate is essentially of copper, the indices, as well as the hands, are of pure copper enhanced by a washing of gold.

In the outer circle we find the quaint old Roman numerals from I to XII. Equally spaced between them are rosettes which serve for the half-hours. Behind this is the blue background with its galaxy of sparkling stars over which, as indicated above, move the signs of the zodiac.

Just within this is a smaller circle containing the 24 hours of day so arranged that the number 12, indicating the hour of noon, falls under the Roman XII at the top of the dial and the 12 of the midnight hour is just above the VI at the bottom of the dial. To the right and the left and half way between these two, are placed the figures 6, which respectively represent the morning and the evening hour. The innermost field of the dial is divided into two sections, one of which is painted white, the other black. The white represents the horizon. Mounted upon this inner field are two gilded rings of which one represents the Tropic of Cancer, and the other the equator, while the raised ring, also gilded, between the white field and the 24-hour circuit, represents the Tropic of Capricorn. Beginning from the bottom the first movable object we have on the dial is the circle containing the signs of the zodiac. This ring is supported upon two crossed iron rods, and they are so arranged that one of them passes through the vernal point on one side while its opposite end runs through the autumnal point on the other. Of the other rod the two ends pass respectively through the summer and winter solstices. The signs are arranged in a consecutive order contrary to the motion of the hand of the clock; thus we have first Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, and Pisces. The outside edge of the zodiacal circle is supplied with a graduated scale of 360 deg., which is intended for the Dragon hand. Supported also upon the crossed rods that carry the zodiac is an eccentric circular band called the calender disk, because upon it the days and the months are engraved, and these are so ordered that the rods pass through the dates of March 21, the first day of spring; September 23, the beginning of autumn; June 21, the commencement of summer, and December 23, the first day of winter. Next above the zodiac is the dragon belching forth flames of fire, its head reaching over the zodiac as far as the graduated scale, while the writhing tail extends backward among the signs. This dragon hand is intended to represent the path of the moon. Directly above this hand is placed the sun indicator. It consists of a plain iron rod supporting at one end the radiant face of the sun made of embossed copper and handsomely gilded. This face reaches to the lower rim of the zodiac. Next above the sun hand is that of the moon, likewise a thin iron rod, bearing upon its end a hollow hemisphere of which the rounded half is gilded while the plane surface is painted black. This supporting rod is hollow, and through it runs a movable rod to which the moon is attached, and upon which it revolves, thus showing its phases. The miter wheels at the center of the clock, that produce this motion of the moon, are attached to the sun hand. The moon is also arranged so that it too appears to pass through the signs of the zodiac. Revolving above the moon arm is the regular hour hand of the clock, and this takes the form of a human hand with extended index finger, placed also upon the extremity of a simple iron rod. This finger just reaches to the feet of the Roman numerals. When looking at the dial, to experience its full effect, the observer must imagine himself as standing upon the earth at the center of the dial. Then the whole system, except the hour hand, will make one complete circuit in 24 hours. The zodiac revolves once in a sidereal day, which is 23 hours and 56 minutes, while the sun requires 24 full hours to get around. He thus loses 4 minutes every day, and being retarded by that much passes consecutively through each zodiacal sign until at the end of 365¼ days he will have completed the circuit and reached again his original starting point. In its procession through the zodiac the sun hand moves over the calendar ring and indicates the date; when the sun hand is tangent to the calendar ring in the white field it shows the time of sunrise; when the same tangentiality takes place in the black field it shows the time of sunset. The sun hand then indicates first the annual motion of the sun in the zodiac, the twenty-four hours of the day, the date, and sunrise and sunset for every day in the year.

The moon falls so far behind the sun hand in its procession through the zodiac that in 27½ days, an ordinary month, it is again at its starting point, and in 29½ days it is again in conjunction with the sun or has completed a synodic month. During this turn around the face of the clock it makes one complete revolution upon its own axis, thus displaying its phases to the observer. When it is directly over the sun it presents its black or dark side to the observer, and it is then new moon; after about 7⅜ days it is at right angles to the sun, then half the gilded and half the black side are visible—in other words, it is in its first quarter; 7⅜ days later it will be directly opposite the sun and the whole of its gilded side will be presented to view; it is now of course full moon. Since the orbit of the moon is inclined to the orbit of the earth, otherwise called the ecliptic, by an angle of about 5.9 deg., the moon's orbit cuts the ecliptic at two points. Consequently the moon in its passage will be half the time above the ecliptic and during the other half fall below it. The first point is termed the ascending node, and the other the descending node. The revolution of the moon through its nodes is called the dragon month, and this is shown, as we indicated above, by the dragon hand. These nodes are also known as the dragon's head and the dragon's tail. The line connecting these two nodes is called the line of the moon's nodes, and this is what the dragon shows upon the dial. When the moon passes over the dragon's head it is just then going through the ascending node; when, on the contrary, it crosses the dragon's tail it is going below the ecliptic or is at its descending node.

The line of the moon's nodes changes its position in the ecliptic very quickly; it turns in a direction contrary to the succession of the zodiacal signs, wherefore the dragon hand hurries on in advance of the zodiac, contrary also to the direction of the sun, and consumes 18½ years for a complete circuit through the zodiac. An eclipse of either the sun or the moon can only take place when the moon is either at new or full moon and is passing through one of its nodes. For this reason in an eclipse of the sun, which can only take place at new moon, the moon being at the same time at its node, the sun hand, the moon hand, and the dragon will be directly over each other whether at the ascending or descending node. An eclipse of the moon, on the contrary, can only take place at full moon, the satellite being, of course, at the moment, at one of its nodes. This case will be indicated by the clock by bringing the sun over the head of the dragon while the moon will be over its tail, or, *vice versa*, the sun over the dragon's tail with moon over its head. In this wise, then, the dragon shows the motion of the moon through its nodes, the procession of these nodes in the ecliptic, as well as the lunar and solar eclipses.

The calculation of the clockwork is so worked out that a new adjustment of the hands need only take place after the lapse of 100 years.

The Julian year of 365¼ days was selected, and this will differ from the Gregorian century by just one day in 100 years.

At present the astronomical part of this wonderful clock is temporarily inoperative. This portion of the works has been sent to a manufacturer of turret clocks in the city of Ulm to be set in order and refurbished, and it is hoped that the clock will soon again indicate all that we have described above with the minute exactness with which it has been credited in former years.

Upon a stone balcony just under the clock panel, the ceremony of offering allegiance to each new Kaiser has been performed, by the city fathers and the citizens ever since 1473. On either side of the clock were painted heralds or kings at arms bearing aloft the standards of the empire and of the city of Ulm, and in the gable just below the present small clock face was a procession of the three Magi of the East in their adoration of the Holy Child. Above this was a sun-dial, and topping all peered through an opening in the wall a figure of a human face which was doubtless connected with the clockwork and moved from side to side to tell the time on the sun-dial. Upon the ridge of the gable is a small belfry of which the roof was at one time gilded. In this little house was hung the poor sinner's bell. The bell tower proper is a slim ridge-turret that sits upon the ridge of the highest roof finished with glazed tiles.

The Current Supplement.

An illustrated article on the Japanese hydro-electric power plant at Kyoto opens the current SUPPLEMENT, No. 1524. The carbureting of heavy oils is a subject well discussed by R. Desmarest. Prof. Dewar's discoveries of new uses for liquid air will be read with interest by students in physics. The Warren rotary engine, which has been successfully used in actual practice, is described and illustrated. Dr. F. M. Perkin gives some valuable hints on electrotyping. How a simple, effective, and inexpensive lightning recorder may be constructed is told by Henry G. Alciatore. Prof. Vivian B. Lewes, whose work in the chemistry of gases is known to every scientist, writes on the theory of the incandescent mantle with the forcefulness and originality characteristic of all his work. The last installment of an article on Lhasa and Central Tibet is presented. Many illustrations of Tibetan scenes also appear. A most entertaining article is that bearing the title "The Good Old Times," which shows that whatever our fathers may think of the degenerate conditions in which we now live, we have reason to be thankful that we belong to the twentieth century. Mechanically considered, the most valuable article is one by Thornton Knowles on Epicyclic Trains. Diagrams are, of course, presented to illustrate the text. An article on "Elements Verified and Unified" presents an account of modern physical conception.

A STUDY OF THE BROOKLYN BRIDGE PROBLEM.

BY EDWARD WHITEHEAD CURTISS, M.E.

The city bridge department, knowing the bridge is loaded to near the maximum load it was designed to carry, as a cautionary measure, to prevent overloading, has made rules as to loading. At least 102 feet of empty track space must exist between every two trolley cars on the bridge, and but one elevated train on each track is permitted upon the center span at the same time. These rules are necessary, as the load on the bridge during periods of heaviest traffic is within 125 tons of the maximum load the bridge was intended to carry. A single elevated train or a few street cars would exceed this margin of weight, and if through carelessness they should move onto the span before the train ahead has left the span, the bridge would be overloaded. If it were thus overloaded, it would not, however, be in danger of failure, because it was built with a large factor of safety. But that was twenty-two years ago. What is its factor of safety now? The bridge department should be the best authority. During several administrations it has enforced precautionary rules. The chief engineer stated before the State Railroad Commission: "The Brooklyn Bridge is an antiquated structure, unfitted for the demands made upon it, and should be rebuilt after the completion of the Manhattan Bridge within the next five years." The problem involves a combination of difficulties. The solution is to transport the people over the bridge as fast as they arrive. The factors in the problem are: 1. Safety of passengers. 2. Weight of load on the bridge. 3. Number of persons to be transported. 4. Number of cars required. 5. Speed of cars necessary. 6. Time required for loading and unloading cars. 7. How to make the change without interrupting transportation. 8. Cost of the new system. 9. Time required to put a new system in operation. 10. A proper terminal station. Lack of cars moving over the bridge, and not lack of loading facilities, is the cause of the congestion. More cars and lighter cars is the only remedy. This forces us to a plan for special bridge cars without heavy machinery.

The system of transportation illustrated on the front page of this issue is designed to meet all the above-named conditions. An endless train of cars is operated across the bridge with a circular loop at each terminus, cable traction is used, and the motors, brakes, third-rails, trolley-wire supporters, wires, etc., are dispensed with. Light trucks with small wheels are substituted for the heavy ones now used, and more than double the number of cars can be operated, without increasing the weight; and by operating them on one set of tracks we have an endless train of cars, and may increase the speed with no danger of collision. But this requires that the train shall not stop, and we are forced to use a slowly-rotating loading-platform with access to it by stairways located at the center, where motion is slow. Two cables would be used, driven by electric motors, the motors and cable in duplicate to be used on alternate days. This would reduce the danger of a "tie-up" to a minimum. The electric current could be independently generated, or purchased from power companies. This plan includes no untried feature, unless it be in the combination. Moving sidewalks were tested at the Chicago and Paris expositions, with difference in speed between adjoining platforms of three miles an hour. These cars are inclosed, and the difference in rotary speed of stairways is reduced to one-half mile an hour. Such a plan as this would accommodate all the present passenger traffic on the tracks used by the elevated trains, and the space now used by trolley cars could be used for vehicle traffic, and the capacity of the bridge would be doubled. As the number of cars would be more than double that now used, more than twice the number of persons could be transported without increasing the load on the bridge. A speed of ten miles an hour would do this, but the speed could be changed to meet the changing demands for transportation. All the time now wasted by stopping, starting, backing, switching, and waiting trains would be devoted to moving the people over the bridge, and the motive power required to do it would be less.

At each terminal station there is a circular platform, 200 feet to 400 feet in diameter. The platforms are kept in constant rotation. They ride on wheels, which roll on tracks laid in concentric circles, and the whole is carried on an elevated structure. Stairways at the center of the platforms give adequate and convenient means of access to the rotating platform from the street below and from passageways above from and

to the elevated stations). These stairways also serve as exits for arriving passengers. The loops in the endless train of cars are arranged so as to encircle about three-fourths of the platforms, the cars locking with the platform edge, and rotating the platforms at the same speed as the moving train. People will then be able to step from one to the other with as much ease and safety as they now step from the parlor-car to the dining-car of a moving express train. The stairways, which are attached to the platforms near the center and extend downward to near the ground, rotate with the platforms, but the motion is so slight as to be scarcely noticeable. If the platforms are made 400 feet in diameter, at twenty-miles-an-hour speed of the cars, the stairways would have a rotary speed of one mile an hour. Beneath each stairway, and leading to it, would be an intermediate circular platform, twenty feet in diameter, on a level with the ground. It would rotate in the same direction, with a speed one-half that of the stairways, or one-half mile an hour. An automatic fence prevents a person falling off the platform.

Each platform would have four stairways, twenty feet in breadth, which would accommodate more than 100,000 persons an hour. Congestion on the platforms would be impossible, for if persons packed the stairways as closely as they could, each occupying two feet of breadth, forty persons would fill the eighty feet of stairways; but when they arrived at the edge of platform, beside the cars, they would be more than thirty-one feet apart, the edge being 1,250 feet long, and 940 feet of cars being always in contact with the platform. If a person failed to step off the car, moving at ten miles an hour, he would be carried over the bridge again, and back, and would lose twelve minutes; but if he did not step on the car during the first revolution of platform, he would lose but fourteen seconds, when he would begin his second revolution. He would have sixty-four seconds to step on or off the car as against twenty-eight at present. The proposed plan would reduce the load on the bridge and distribute the load more uniformly.

Results Compared.	Present System.	Proposed System.
Load on span (cars and passengers)	868 tons	716 tons.
Length of loading platforms	440 feet	940 feet.
Number of cars at platforms	10 cars	24 cars.
Number of cars per hour	440 cars	1320 cars.
Number of persons in each car	150 persons	75 persons.
Speed of cars per hour	10 miles	10 miles.
Time for loading	28 seconds	64 seconds.
Number carried per hour at 10 miles	50,000 persons	100,000 persons.
Number carried per hour at 20 miles	——	200,000 persons.
Railways required	4 tracks	2 tracks.
Speed of cars, 20 miles per hour	(Impossible)	200,000 persons.

Roebling's report says: "I propose a speed of 20 miles an hour, as being perhaps the one most likely preferred. But this may be increased to 30 or 40 miles per hour, with absolute safety." (Page 246, Franklin Institute Journal, 1867.)

To render the above plan most effective, the Manhattan loop should extend over Park Row, where a curvature with radius of 125 feet to 200 feet could be obtained. The Brooklyn loop could be built near Tillary Street, between Fulton and Washington Streets. This would practically connect City Hall with Borough Hall.

Pipe Made of Asbestos and Condensed Milk.

An inventor who lives in Orange, N. J., has invented a new kind of tobacco pipe. The stem and bowl are made of asbestos, either by rolling together asbestos paper or thin strips of asbestos forming a tube of the right thickness and dimensions for the bowl of the pipe, hollow at both ends. One end is filled in by strips of asbestos so cut and fitted as to occupy the opening. The stem is prepared in the same manner and is fitted with a mouthpiece. The strips of asbestos forming these tubes are coated with a paste composed of condensed milk and plaster of Paris. In order to burn out the paste the pipe is baked. The inventor states that any color from light brown to ebony can be obtained by varying the heat.

The Dominion Iron and Steel Company has, it is understood, decided to adopt at its works at Sydney, Nova Scotia, a new and inexpensive process for the manufacture of pig iron, utilizing waste iron ore, which costs from 60 to 75 cents a ton. Iron ore in this condition can be used only when it is solidified. For a great many years chemists endeavored to solve this problem, but it was only a few years ago that W. Owen, consulting engineer and foreign representative of Bruck, Kretschel & Co., steel manufacturers, of Osnabrück, Germany, made the discovery. Since then the process has been adopted by seven German and two or three English steel companies with eminent satisfaction. The waste is first solidified, usually in bricks, and in this condition is placed in blast furnaces, when pig iron is produced. The plant which the Sydney steel company proposes to install will cost about $8,000, and will have a daily output of about 75 tons. It will be the first of the kind erected on the continent, and the company will have the exclusive rights for the Dominion of Canada.—George Hill. Vice-Consul-General, Halifax, Nova Scotia.

Correspondence.

The Unsanitary Cake of Soap.

To the Editor of the SCIENTIFIC AMERICAN:

In the last number of the SCIENTIFIC AMERICAN I noticed an article by Mr. G. F. Shaver concerning disease dissemination through toilet soap, as used in public toilet rooms, etc.

It seems quite incredible that the Americans who are so strict and scrupulous in hygienic matters, should have overlooked such a serious evil, which is so very simple to prevent. It struck me as rather strange, therefore, when I came to this country a year ago, and found to my surprise, that even in the first-class hotels the common cake of soap—going every day through a hundred different hands and so getting thoroughly impregnated with germs—seemed to enjoy its existence.

Is there anything simpler and cleaner than the device now in use in nearly every public toilet room in most of the countries abroad? The cake of soap is a thing of the past, and its place is taken by a handy little soap-powder distributer fixed on the washbowl. This apparatus is generally made out of nickel-plated brass, having a cylindrical form; the standard size is, as far as I can recollect, about 4½ to 5 inches high, its diameter being about 1 to 1½ inches. On the top is a flat knob and in the base a small opening. By pressing the knob, the distributer will deliver through the opening a small quantity of antiseptic soap-powder, which is collected by holding one hand under the apparatus. This distributer is not only used in public toilet rooms, but can be found on the washstands in very many private houses. HUCK GERNSBACK.

New York, March 7, 1905.

Do Animals Think?

To the Editor of the SCIENTIFIC AMERICAN:

Mr. Burroughs, in an interesting way, tells us why he thinks that animals do not think, in the February number of the Harper's. He writes: "We are too apt to speak of the lower animals in terms that we apply to our own kind. We can hardly avoid it, but all modern comparative psychologists account for all their actions without attributing to them any of the higher faculties. A certain situation leads to a certain act, not because the animal thinks about it as we do and is conscious of its purpose, but because certain sense impressions give rise to certain impulses, and these impulses result in the act. There is no mental process, no mental image at all in the matter, any more than there is in a man when he instinctively dodges a blow or responds to a fine day or to the odors of his dinner. Sense impressions do it all. . . . We so habitually impute thought to animals that we come unconsciously to look upon them as possessing this power. We know that under similar conditions we think, and therefore we impute thought to them, but of mental images, concepts, processes like our own, they probably have none. Innate or inherited impulse, which we call instinct or internal stimulus, explains most of the actions of the animals. An internal stimulus is applied, and the reaction is quick. Does not man wink, dodge, and sneeze, laugh and cry, and do many other things without thought or will? To adapt means to an end is an act of intelligence, but that intelligence may be inborn and instinctive, as in the animals, or it may be acquired, and therefore rational, as in man. We know that animals do not think in any proper sense as we do, or have concepts and ideas, because they have no language. Thinking in any proper sense is impossible without language; the language is the concept. Our ideas are as inseparable from the words as form is from substance. We may have impressions, perceptions, emotions, without language, but not ideas.

"Animals know only things through their senses, and this knowledge is restricted to things present in time or space.

"Reflection, or a return upon themselves in thought—of this they are not capable." It is very evident to the merest novice in the study of mental philosophy that Mr. Burroughs is no adept. He makes definitions wholly original. He affirms without supporting evidence. And then, too, he affirms that with regard to animals lower than man that is true of all, including man.

For illustration, he says: "Animals know only things through their senses," when, as a matter of fact, material things—and there can be no immaterial things—can only be known through what are scientifically called the sensory nerves.

He affirms that animals know only things through their senses present in time or space; in other words, that they have no memory—a statement entirely contradicted by multitudinous instances, as cited by eminent psychologists, such, for instance, as Lewes and Romanes.

Again, Mr. Burroughs affirms that thinking in any proper sense is impossible without language. He settles the question between the nominalists and realists with this dictum. I should like, with all due deference and modesty, to show that there are plausible reasons for doubting his *ipse dixit*. As the result of a small study of brain phenomena, we have concluded that all that we denominate thinking is due to the presence of reflected images, retained by the nerves of the brain, of outward objects or forces.

That a word first impinges on the nerves of the brain, making there an ineradicable impression. And a word is either perceived as sounds or figures of letters. The impression remains, and comes before the cognizing *ego* as a congerie of sounds or figures.

Mr. Burroughs says that thinking is impossible without language. By language he evidently means words composed of alphabetical symbols of sound. We think him mistaken. We believe that it is possible for an architect to design a cathedral without recalling the name of a single constituent necessary for its construction. We believe that a geometrician is almost entirely independent of language in its alphabetical sense.

We believe that the deaf and dumb think entirely with the images of sensible phenomena.

Thinking is not necessarily voluntary either, as Mr. Burroughs concludes. If so, the great majority of human beings do no thinking or very little. Even Herbert Spencer's great works were the issues of involuntary action of that brain of his, as he tells us in his autobiography. Most of the greatest works, literary and otherwise, were the product of human brains acting without order from the individual will. As the stomach produces in digestion blood and bile, as the generative organs produce human beings, so experience shows to great men their brains produce poems, books, temples. How could it be otherwise?

If a Shakespeare willed a great play, a Milton a great poem, it was because these came into their perception involuntarily first of all. No man that ever lived has willed into existence that which did not first exist. There is going on in these skulls of ours a vast deal that comes not into our consciousness for the arbitrament of our judgment and the action of our wills.

"To adapt means to an end is an act of intelligence, but that intelligence may be inborn and instructive, as in the animal, or it may be acquired, and therefore rational, as in man." (Burroughs.)

This is a very unphilosophical remark, we must confess.

To adapt means to an end is in man only rational because it is acquired, is certainly a very peculiar statement.

If an animal adapts means to an end, does the fact that this act of intelligence is inborn or acquired make it any the less an act of intelligence? How can we deny reason, which is the comparing of objects and drawing conclusions and forming plans, to the builder of a dam, be he a man or beaver? The adapting of means to ends by the spider, by the bird, by the beaver, the ant, the ostrich, and most other animals of the brute genus displays intelligence, and this is an attribute of mind.

Mr. Burroughs affirms that winking, dodging, sneezing, laughing, crying, are not thinking in men any more than in animals; that they are only the result of sense impressions.

I think it very hard to show that all we think and do, from sneezing to preaching, is not the resultant issue of sense impressions. "Of mental images like our own, animals probably have none." (Burroughs.)

The image of a chair or table must have the same appearance on the sense of a fly as on the sense of a babe in the cradle. Of course knowledge affects the conception formed of a table. A cat sees precisely the same image of a chair that I do, and forms a conception of it which includes its figure with the use which the cat may put it to. Our conceptions of the chair differ, but are they not both conceptions?

Yes; there is not the slightest doubt to be entertained that all our consciousness of thought and all thought, conscious or otherwise, is the result of the brain's activity of all the animal creation, each animal, from ant to man, having the sort of machinery of mind suited to its conditions and needs.

FRANCIS WASHBURN.

Newburg, N. Y., February 23, 1905.

A new type of stove, the object of which is the abolition of smoke, no matter what fuel is employed, has been demonstrated in London. The invention comprises a screen of tubular fire bricks, made of special material built up in the furnace in such a position that all the products of the fire pass through the screen. The latter quickly becomes incandescent, and flashes the gases as they pass through, thus preventing the formation of carbon. By the aid of this device, coal of the worst description can be burnt in the ordinary boiler with practically no smoke, and with a considerable saving in cost. For the purposes of demonstration, cheap damp coal dust was burned. The only result was a light gray cloud at the top of the chimney stack, which cleared away in a few seconds.

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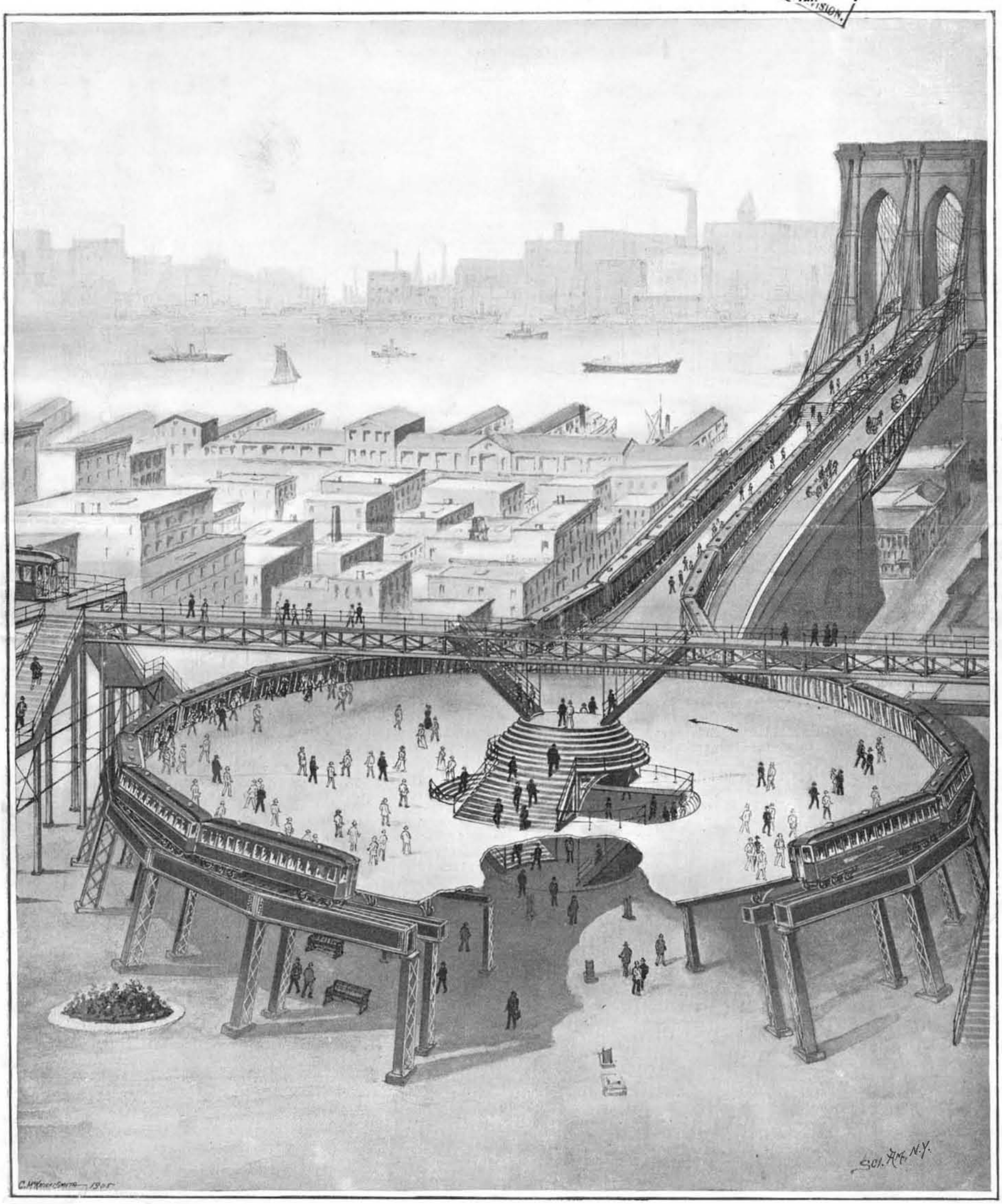

An endless train of light cars running across the bridge and around a loop at each end. Each station consists of a circular, saucer-shaped platform 400 feet in diameter, the outer edge forming chords of a circle, each equal to the length of a car. The cars lock with this platform and turn it. The cars and the outer edge of platform move at 20 miles an hour. The passengers alight and embark through side doors, one to each seat. Entrance to the platform is at the center by stairways, whose lowest steps move at a speed of one mile per hour. There are no stops, the system running continuously.

A Design for Relieving the Congestion and Increasing the Capacity of the Terminals and Trains.

PROPOSED ENDLESS-TRAIN LOOP AND ROTATING STATION FOR BROOKLYN BRIDGE.—[See page 222.]