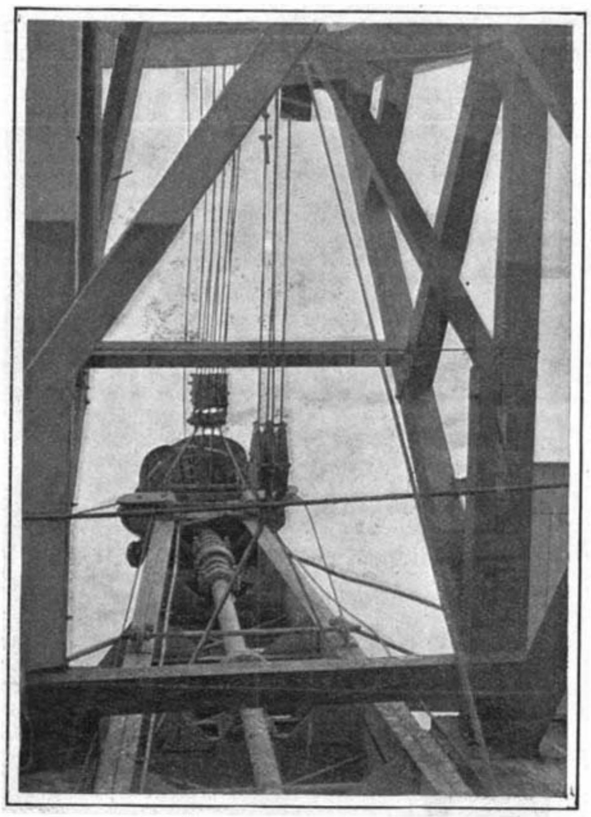
BUILDING A TOWN SITE BY SUCTION DREDGE.

BY DAY ALLEN WILLEY.

In a recent issue of the SCIENTIFIC AMERICAN appeared an interesting description of how the city of Galveston is being rebuilt upon the sand—but sand of such a character that the community can well be said to be upon a solid foundation. The work which is being done in raising Galveston Island farther above the sea level is indeed a noteworthy engineering feat, and is an indication of what can be accomplished by using the modern suction dredge.

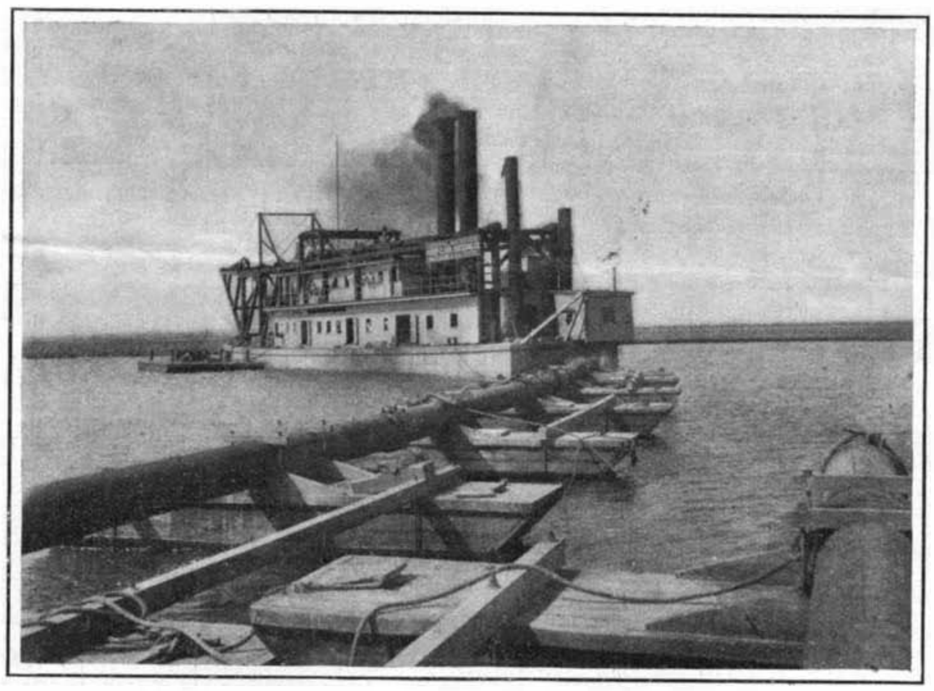
It is an interesting fact, however, that another site for a city is being created on the New Jersey coast—entirely by mechanical methods—which in magnitude rivals the undertaking at Galveston. The town of Cape May, N. J., takes its name from the point which marks the junction of Delaware Bay and the Atlantic Ocean. The community is situated a few miles north of the cape proper on the Atlantic coast. It occupies a portion of a low flat peninsula. From the northern end of Cape May to what is known as Cold Spring Inlet the formation is principally salt meadows, a portion of which is covered with water at high tide, and during storms is frequently completely submerged. With the exception of a row of sand dunes immediately upon the beach, all of this land is but a few feet above the sea level even at low tide. Like other marshes of the same character, it is densely covered with grass and other vegetation, and its formation near the surface is a mixture of loam and clay, which, on account of the action of the water, has become a mud bank covered with slime. This portion of the seacoast has been entirely valueless, and a menace to the public health on account of the gases arising from it; while it has been a prolific breeding place for mosquitoes.

About two years ago the idea of making some use of this marsh meadow was agitated. An investigation was made by engineers, who decided that it could be filled in by means of hydraulic excavators to such a distance above high tide as to prevent its being submerged, and could thus be utilized for a town site, or for some other purpose. The question next arose as to the best method of obtaining the enormous amount of material which would be required to raise the meadow to the proper altitude. With the approval of the government, it was decided to entirely remove a section of the formation adjacent to Cold Spring Inlet—to form a harbor of refuge for sea-going vessels, by enlarging the inlet from its present depth of 8 feet at low tide to a minimum depth of 35 feet, the average depth of the harbor to be at least 35 feet. An idea of the extent of the project can be gained when it is stated that the area to be filled in comprises about 5,000 acres, extending about four miles north and south with a width varying from one to three and a half miles. All of this land is to be raised to a minimum height of 15 feet above its ordinary level, allowing sufficient grade for the construction of suitable sewerage and drainage systems. The section of meadow which will be entirely removed contains nearly 500 acres, and most of it will be excavated to a depth of nearly 40 feet below the surface of the water, in order to secure sufficient "filling" for the town site. The Galveston project calls for the moving of about 11,000,000 cubic yards of material; but that at Cape May will require the removal of over 30,000,000 cubic yards before it is entirely completed, and will probably be the most extensive excavation project which has yet been attempted in the United States.



Interior of the Ladder, Showing Shaft Driving the Agitator and the Bearings in Which the Shaft Rocks.

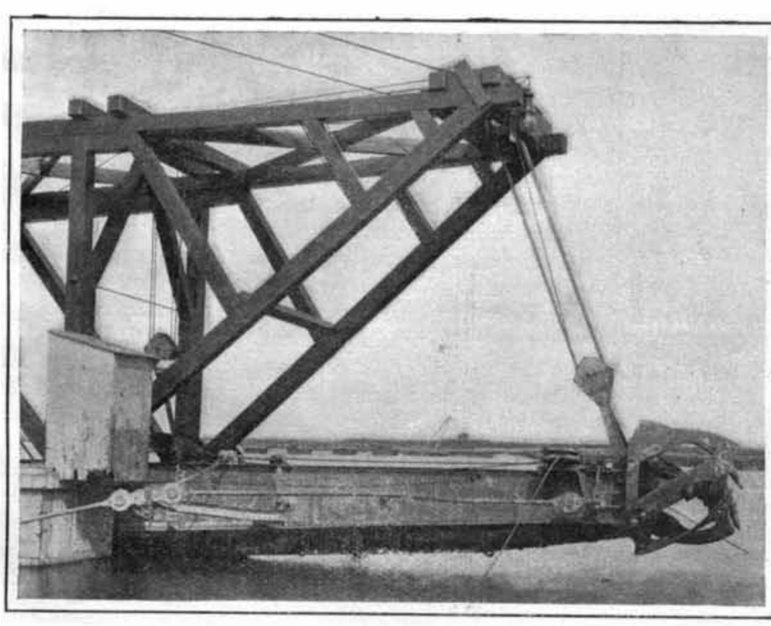
The Discharge End of the Pipe.



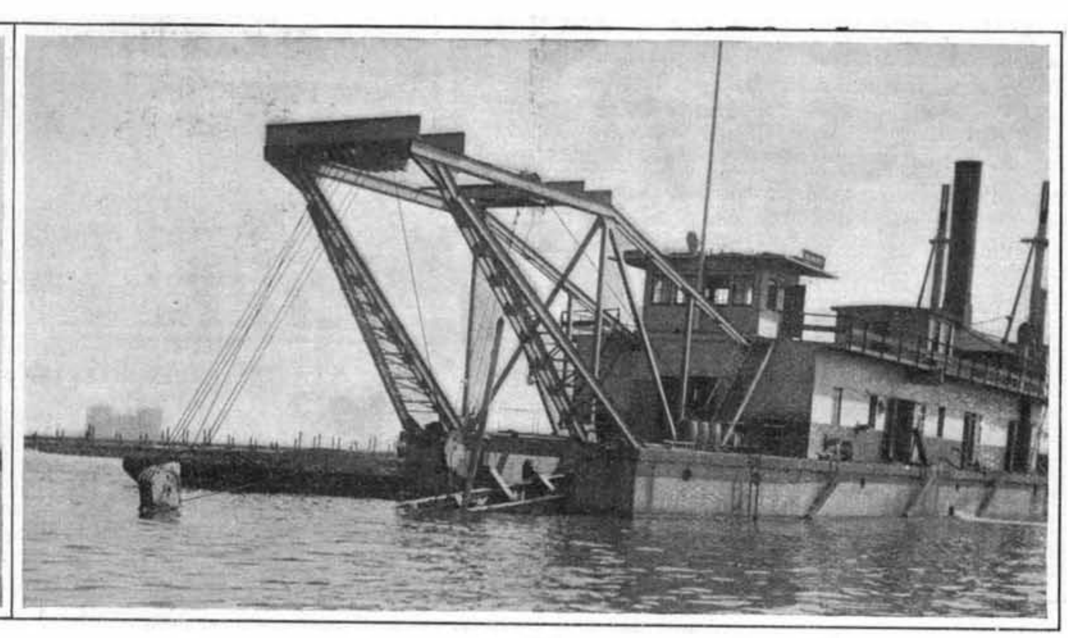
Stern View of the "Mackenzie," Showing Discharge Pipe.

In the scheme at Cape May it may be said that the marsh land is literally turned upside down—but a small portion of the material on the surface being available for filling, and the bulk of it being secured from below the water level. To excavate and remove the material a type of excavator has been placed in service which differs radically from the majority of machines of this class. Perhaps the most interesting feature of the type of dredge that is employed is the agitator, by which the material is loosened and separated. This is a powerful circular cutter consisting of curved steel blades set in a framework which is designed on the principle of the ordinary cutter on a lawn mower. The outward end of this cutting head on the largest dredge is 8 feet in diameter and 6 feet in length. As the illustrations show, it is attached to a steel shaft leading backward to an engine mounted on the front portion of the dredge, which is used exclusively to revolve it. This engine is of 200 horsepower. The cutting head and its driving cylinder are suspended in what is termed a ladder, which is set into the forward portion of the hull and is connected by swinging joints, so that it can be raised and lowered by a block and tackle extending from the outward end of the ladder over a heavy wooden framework bolted to the hull. On the largest dredge in service, the "General Mackenzie," this ladder is 75 feet in length. It also supports the suction pipe leading into the cutting head. The pipe is 30 inches in diameter, and it is connected with a centrifugal pump which is driven by a three-cylinder engine of 1,500 horse-power, the cylinders being 42, 28, and 14 inches in diameter respectively. The discharge pipe served by the pump is also 30 inches in diameter. It is constructed in sections, and it is supported in the water upon pontoons in the usual manner.

As may be imagined, this excavator is of very large capacity. It will take out 10,000 cubic yards of material in a day of ten hours, and discharge it at a distance of 7,000 feet, or over one mile from the point of excavation, if desired. When in service, the excavator works entirely upon the submerged formation. The cutting head is pressed against the bank, and rapidly disintegrates the earth and other material, causing the portion above to become undermined and fall into the water, where it becomes so loosened that it can be drawn through the suction pipe in a semi-liquid state, and readily carried to the point of discharge. Each of the excavators is moored by spuds of Oregon pine, and can be readily handled



Agitator Lifted, Showing Design of Cutting Head.



The Agitator and Suction Pipe Submerged and in Operation.

BUILDING A TOWN SITE BY SUCTION DREDGE.

by means of swing lines, which are controlled by auxiliary engines devoted entirely to this purpose. All of the larger dredges are provided with individual electric light plants; so that the work can be carried on night and day if desired. On the largest excavator a crew of fifty men is employed, divided into shifts of eight hours each. This number is sufficient for all purposes requiring manual labor.

As fast as the meadow is filled in to the requisite height, the pipe lines are removed to another section. Around it is constructed a dam of earthwork, with openings or weirs left at frequent intervals through which the water escapes. On the section of the filled land nearest the ocean, the water discharged through the conduits has been carried into the sea by means of a pipe line. By employing this method, the only work required, except that performed by the excavators, has been to grade the surface with horse machinery. Fortunately, most of the material which has been taken out of the meadows consists largely of sand, from which the water escapes quickly, leaving a dry and firm formation. Already an eight-story hotel has been constructed upon this made ground without any difficulty due to settlement.

It can well be said that a new city is being created upon this worthless salt marsh, for the portion which is being filled in is of sufficient area to allow 7,500 dwellings to be erected in addition to the necessary space for streets and avenues. A sewerage system is being constructed which will drain into Delaware Bay; but owing to the slight fall, the system will be served by a pumping station having a capacity for handling 360,000 gallons an hour. At the present time, five excavators are removing the marsh to a depth of about 40 feet at the rate of ten acres a month. It is an interesting fact that the largest of these dredges, which was designed by Mr. Frank Furst, of Baltimore, was built at Orange, Texas, and towed up the Atlantic coast to Sparrows Point, where its machinery was installed. It was then taken by sea to the present scene of operations. This excavator probably has the largest capacity of any in the world for removing material by the suction method. The work is being performed under the supervision of Ellis Thompson, chief engineer, and Charles W. Tarr, resident engineer.

A CURIOUS ILLUSION.

BY GUSTAVE MICHAUD, COSTA RICA STATE COLLEGE.

When we are looking at anything, the image of what we see paints itself on the retina as it would on the ground glass of a photographic camera, upside down. Through some nervous process we invert again the upset image and set it or rather see it right. In the following experiment the opposite operation is made. An image which, through some artifice, is made to paint itself right side up on the retina is turned over by the general upsetting process and appears to us to be upside down.

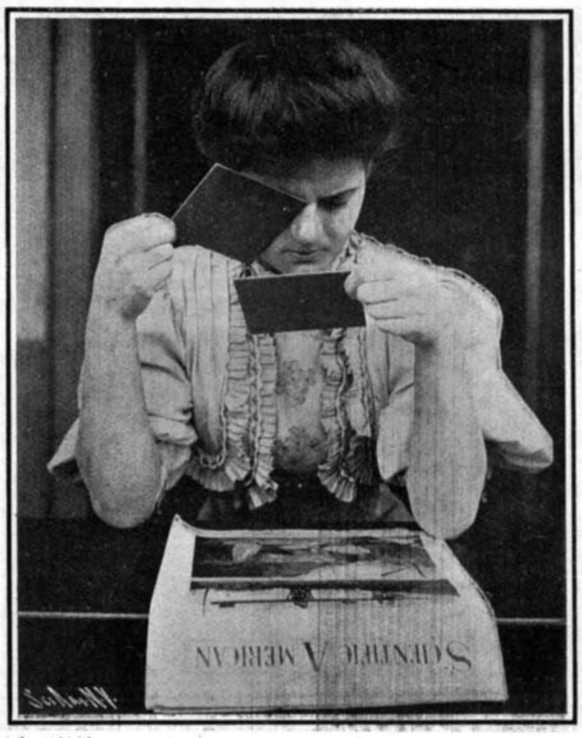
Take two pieces of dark-shaded pasteboard. In the center of one, bore a pin hole. Near a corner of the other make a cluster of three pin holes arranged about as the angles of an equilateral triangle, and at a distance of about 1-16 of an inch from one another. Lay on the table before you a well-lighted sheet of printed matter. Place the card with the three holes in contact with your eye, and through the cluster of three holes look at the center of the other card, this being placed between your eye and the printed matter at a distance of from two to four inches from your eye.

The cluster of holes through which you are looking will then seem to you to be a single aperture and the single hole in the center of the card which you hold far away from your eye will seem to you to have vanished but, instead of it, you will distinctly perceive, on the same card, three holes through each one of which you can easily read a different part of the printed text. These three holes are unlike those which you made on the card kept near your eye, for if the latter are arranged thus: $_{\circ}{}^{\circ}{}_{\circ}$ those on the card which you examine will be arranged in the opposite way: $^{\circ}{}_{\circ}{}^{\circ}$ and *vice versa*.

As the single luminous hole on the card you hold at a distance from your eye is still abnormally close to it, its image will be formed behind the retina or, in other words, the rays will strike the retina before meeting. In ordinary circumstances this fact causes the image to be blurred, but as, in this case, only thin pencils of light are admitted, the rays of which they are made may be considered as nearly parallel and a tolerably good image of the hole will be formed even at some distance of the point where the rays meet. Photographers take advantage of that property of a thin pencil of light whenever they use a small diaphragm to get "depth of focus." Moreover, as the pencils themselves strike the retina before having crossed each other, the triangle they form on the retina is arranged just as it is on the card, right side up. The nervous element, however, blindly upsets this image as it does upset ordinary inverted images, and this gives us the queer sensation of seeing upset what we know to be erect.

If the card with the central hole is now slowly drawn farther away from the eye the three luminous holes get nearer each other and finally unite into one and the same image. The position of this coincides with that of the retina.

At that stage of the experiment, if the observer is short sighted, even to a slight degree, he will find that, on withdrawing the card still farther, nearly at full arm length, the three luminous dots reappear, but, this time, right side up. Owing to an abnormal convexity of the crystalline lens the image is formed before the retina; the luminous pencils have crossed each other before striking the retina; the image is inverted; the eye inverts it again and it is therefore seen right side up.



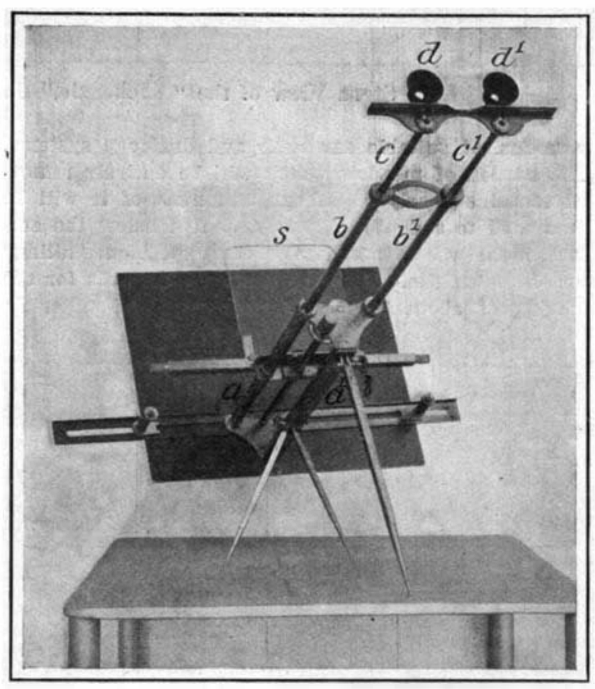
A CURIOUS OPTICAL ILLUSION ILLUSTRATING INVERSION OF IMAGES.

AN X-RAY STEREOSCOPE.

BY DR. ALFRED GRADENWITZ.

In connection with the use of X-rays for medical purposes one of the most important tasks, as is well known, is to ascertain the location of foreign objects in the human body. Now the depth of such foreign bodies can be generally found only by taking two views from points ninety degrees apart. However, this process is frequently rather troublesome, requiring as it does a placing of the patient in different positions, which is not always practicable. Moreover, the heavier bones frequently prevent the taking of such views.

Endeavors have therefore been made of late to produce stereoscopic X-ray diagrams, and to determine from the plastic picture the desired depth. In this process, however, which has been applied with more or less success, the relief is only apparent, being due to the lack of sharpness of a combined picture produced by superimposing a negative and a positive X-ray diagram. The results derived from the inspection of such pictures thus hardly justify the expenditure of time and trouble made in preparing them.



THE X-RAY STEREOSCOPE INVENTED BY DR. GILLET OF BERLIN.

Dr. J. Gillet, a military surgeon, of Berlin, has suggested a novel method, dispensing with the production of relief effect and securing in place thereof an accurate measure of the depth in question. The "X-ray stereometer" invented by him and constructed by Heinz, Bauer & Co. is based on the well-known principle of stereoscopic vision.

If two corresponding stereoscopic picture points (that is to say, two corresponding points on photographs of the same object, obtained by displacing the objective through the distance between the eyes) be inspected in such a way that the left-hand picture is observed by the right eye, and the right-hand picture by the left eye, the convergence of the optical axes will result in the two corresponding points being combined to a stereoscopic picture suspended in space, the crossing being the point at which the picture appears. This point can be located in the following manner with the naked eye:

A pointed object, e. g., a pencil, is kept midway between the two corresponding points, immediately in front of the latter, and while the pencil is slowly approached toward the nose at right angles to the plane of the picture, both eyes should attempt simultaneously to fix the picture points and the point of the pencil, when the former will be found to approach each other more and more as the pencil point is moved away from them until they finally coincide with the latter at a single point, the crossing in question. Whenever the pencil is moved a short distance sideways, forward, or backward, the crossing is at once decomposed into two different points, thus showing the accuracy with which this point is located.

The distance of the crossing from the two corresponding picture points is dependent on the distance between the eyes and the picture and, on the other hand, on the mutual distance of the axes of the eyes, being the greater as the latter is smaller and the former greater. The distance of the eyes from the picture has, however, alone to be taken into account in ordinary practice, the mutual distance of the axes of the eyes being generally constant, viz., equal to about 65 millimeters (2.6 inches).

From the above, it will be readily understood why it is only necessary to prepare two corresponding X-ray diagrams with a lateral displacement of the X-ray bulb of some 65 millimeters, in order immediately to read (after adjusting for the crossing with the naked eye) the distance between the X-ray plate and the foreign body in question; the vertical distance between the anticathode and photographic plate (viz., the focal distance) should obviously be given.

The parallel extensible brass tubes *a a'*, *b b'*, *c c'*, consisting of three sections, correspond, when fully extended, to a focal distance of the X-ray tube of 24 inches, which, after folding *c c'*, decreases 20 inches, and after also folding *b b'* from 4 inches to the smaller focal distances of 1.6 inch and 1.2 inch respectively.

The glass plate, *s*, provided with a vertical millimeter scale, serves as searcher, and is adjusted longitudinally of the instrument and transversely of the X-ray shade of the foreign body in question, by means of two special pinions. The millimeter scale plays the same part as the pencil point in the fundamental experiment described above, allowing the depth of the stereoscopic image to be determined. By means of two pointers the foot points of the stereogram can be so adjusted with regard to the lenses *d* and *d'*, as to be traversed by the lines of vision striking the picture. These lenses, secured to the front ends of the brass tubes, *c c'*, are situated apart a distance of 2.6 inches.

Measurements are carried out by means of the apparatus in the following manner:

The X-ray stereogram, covered with a squared celluloid sheet, is so adjusted that its foot points coincide with the pointers. The tube having then been drawn out to the actual focal distance, the stereoscopic picture should be searched by means of the glass plate, *s*, until it is cut by the vertical black line on the glass scale. The distance of the glass plate from the stereogram should finally be read on the millimeter scale, whereby the distance of the foreign body will be obtained.

This process, it is true, implies the capacity of stereoscopic vision, that is, the capacity of imparting to the axes of the eyes a certain convergence toward the center. In the case of observers lacking this capacity or having no practice in this respect, the process will be a little more complicated:

The right eye having been closed, the glass scale should be so adjusted by means of the left eye that its black middle line passes through the right-hand shadow of the object in question. The left eye should next be closed and the right eye be used in the same way for adjusting the left-hand shadow. After thus finding a position of the middle line in which both requirements are complied with without any alteration, that is, simultaneously, the scale line will have been brought to the proper position, and by simply reading its distance from the plate on the scale of the pinion, the height of the foreign body above the surface of the plate will be found.