of the engine was the use of eight 1½-inch iron rods extending from the engine frame to the rear of the large granite chimney "to secure as far as possible the frame from longitudinal motion or vibration, to steady the engine, and relieve the walls of the building."

The latter object was assisted by placing two inches of India rubber between the masonry and the iron entablature and pilasters, and also by placing India rubber washers between the bolt-heads and the exterior parts of the walls. No feed pumps were attached to the engines, the boilers being fed from the rainwater system beneath them by direct acting steam pumps built by Worthington & Baker. The steain was supplied by three boilers 26 feet in length, 7 feet in diameter in the waist, of the single return drop flue type.

In the well, below the foundation plate of the engines were two lifting pumps, each 36 inches in diameter with an 8-foot stroke. In addition to the usual suction valve near the bottom of the pump chamber, there are two suction valves placed near the bottom of the suction pipes. The valve seats are of a composition metal. The suction pipes connect with an air chamber, placed centrally between the pumps, which reaches to the bottom of the engine bedplate. The total weight of the metal in the engine is 267 tons and the total cost of the engine was $90,241.29.

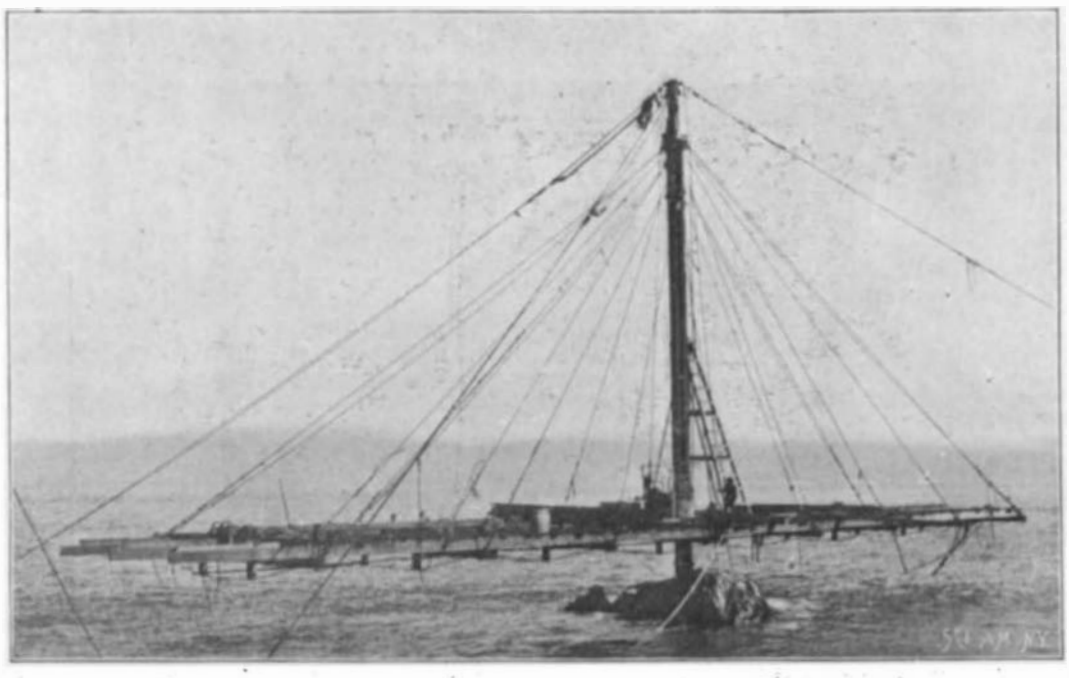
The new pumping plant, as planned by Capt. P. C. Asserson, Civil Engineer, of the Brooklyn Navy Yard, will be placed in a circular sunken chamber below the surface of the ground. It will consist of two 30-inch direct-connected, electrically driven centrifugal pumps, with a combined capacity of 60,000 gallons per minute. There will also be a 12-inch electrically driven centrifugal drainage pump as shown in the drawing. The ceiling of the subterranean engine room will consist of I-beams covered with 6 inches of concrete and one inch of cosmocrete. The cosmocrete finish will be at the general grade of the Navy Yard, and entrance will be had to the pumps by means of a hatch opening onto a spiral stairway.

REMOVING OBSTRUCTIONS IN SAN FRANCISCO BAY.

Removal of some of the most important of the obstructions to navigation which exist in the harbor of San Francisco has been undertaken by the government and is now under way. The present movement contemplates obliteration of Arch and Shag Rocks and two of the neighboring shoals comprising altogether some fifty thousand square yards of soft conglomerate rock. The obstructions referred to lie to the northwest of Alcatraz Island, dividing the channel between it and Angel Island in two and forming dangerous currents in a portion of the bay right in the path of the most largely frequented route of passenger and freight traffic. The work will not be completed under two years, but when finished, will remove obstructions which have caused numerous wrecks and the loss of many lives.

Work has begun on Shag Rock, which at high tide lifts its dangerous summit only a few feet above the water. The shoal surrounding it is oblong in shape and, generally speaking, about 180 feet in diameter. The purpose is to level the rock so as to secure a mean depth of 30 feet at low water.

A mast composed of 12×12 scantling, 24 inches square and 68 feet high, has been raised on the top of the rock and secured by guys anchored to the floor of the bay. Suspended from the mast is a platform 30 feet wide and 180 feet in length which is arranged to turn in all directions. On this the steam drills are operated, driven from an engine occupying a barge alongside. The drill is driven somewhat below the depth contemplated and into the holes are placed sticks of dynamite which are exploded, a few at a time, and thus the rock is destroyed in small sections, the débris being dredged up from the bottom and deposited in the deeper portions of the bay. The platform is above the reach of the highest tide, and work can go on without interruption during even moderate storms. The amount of rock to be removed at this point is 3,799 yards. The work is under charge of Major W. H. Henry, Chief of the River and Harbor Improvements of the United States Corps of Engineers.

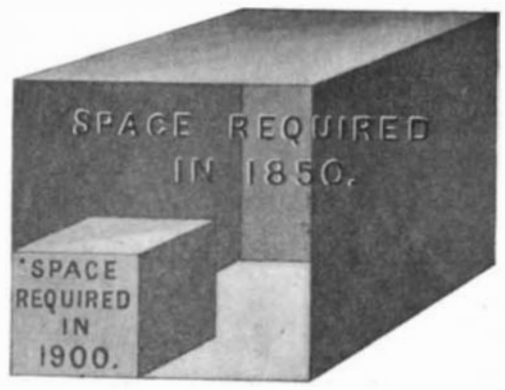


REMOVAL OF SHAG ROCK, SAN FRANCISCO HARBOR.

A LINE of automobile tourists' coaches is to be run in the Irish Lake district. The route is 55 miles long, and with the present horse traction the journey has to be spread over two days. The roads are very good, but there are two mountain passes which will try the hill-climbing qualities of the motors. If they prove successful all the horse coaches will be abandoned.

Clothing the Arid Regions with Vegetation.

The great arid and semi-arid regions west of the Mississippi are unable to sustain large flocks or herds because of conditions which prevent vegetation from producing reliable food crops. In the great Death Valley Desert the average rainfall is so small that most of our cultivated plants are withered up, and throughout large parts of the semi-arid regions this same lack of sufficient rain makes the life of farm crops at least very precarious and uncertain. Another drawback is that the alkali soil contains so much carbonate of soda that few plants can live and thrive in the land. Our common barley will live in soil that contains 25,000 pounds of alkali salts to the acre; but on a good deal of the land there are 30,000 and more pounds to the



COMPARISON SHOWING RELATIVE AMOUNT OF SPACE REQUIRED BY PUMPING PLANT OF THE SAME CAPACITY IN 1850 AND 1900.

acre, at which point barley withers up and dies. Even alfalfa, which generally does well in alkaline soils, will not flourish in some of the vast areas in the Rocky Mountain and Pacific Coast regions where the soil is intensely alkaline.

The agricultural experiment stations of the West have been experimenting for years with different plants which will thrive in these arid regions sufficiently to furnish food to cattle. The plants suited to such places have to live in a climate where there is very little rainfall, and in a poor soil, with a large percentage of alkali salts mixed with it. After years of tests with hundreds of grasses and plants the Australian salt bushes have given the best results and seem to promise wonderful changes in clothing the deserts with vegetation.

These Australian plants or salt bushes belong to the same class or family as the common pig weed of our gardens and roadsides, which is now looked upon by farmers as a great nuisance, although it was first introduced into this country as a great boon to the farmers. There are several members of this family which possess remarkable resisting powers to alkali in the soil and also to droughts. Experiments have been made with a great number, and the species that has given the most satisfaction is Atriplex semibaccata; but the California Experiment Station has also distributed for general use another trailing species. A. leptocarpa, and two shrubby species. Atriplex halimoides and A. vescicaria. These four species of Australian salt bushes have been found to possess the qualities which are needed for the dry, arid, alkali regions of the West.

In Australia these salt bushes are found in the regions of dry, hot summers with the annual rainfalls limited almost entirely to the winters. The difficulty of making plants thrive in such lands is well known to botanists, and the few vegetable growths that do flourish are usually devoid of any nourishing qualities as food for animals or human beings. The salt bushes are exceptions. They have fattening qualities for animals that is remarkable, and experiments have shown that they are equal pound for pound to alfalfas the great feeding plant of the West.

The Australian salt bushes are capable of flourishing on poor soils where most other plants do not succeed, and they will live in soils that contain as high as 50,000 to 70,000 pounds of alkali salts to the acre. Instances are on record where they have grown in soil impregnated at the rate of 75,000 pounds of alkali to the acre. On the "black-alkali" soil of the upper San Joaquin Valley, in California, the Atriplex semibaccata was tested successfully, although no other useful plant could ever be made to flourish there. In fact many of the species of salt bush failed to give a good crop on this land until the above species was tested.

Experiments have been made with the Australian salt bushes since 1881 in this country for the purpose of adapting them to the great arid plains. The well-known economic botanist, Baron Von Mueller, first sent the seeds of the Australian salt bushes to California in that year, and they were planted at the Berkeley station and several sub-stations throughout the State. For some time little progress was obtained, and the plants were not accorded the popularity their merits deserved. This was largely because the right species had not been discovered. The Atriplex semibaccata is a smaller plant than many of the others, and is a trailing rather than an upright growing species; but it has many advantages over all the others. When once established in any soil it covers the surface with vegetation, which remains green until heavy frosts, making a steady growth all the time. It is a perennial, and the roots are not killed by the frost, but sprout up again the following spring. It grows in strong alkali soil where other plants will not live, and in soils so poor that most vegetation dies for the lack of nourishment, and even in lands where there is a stiff hardpan and very little summer rain, All these points tend to make the plant the most valuable to farmers and cattle raisers in the Far West that has been discovered in the past quarter of a century. It will bring into profitable grazing use thousands of acres of arid land that has heretofore been worthless.

The salt bush will supply excellent and abundant food for hogs, sheep, cattle, and horses. Throughout the long dry summer season, it grows steadily and keeps green and succulent, from two to four crops in one season can be harvested from it. No matter how slight the rainfall may be the plant seems to thrive and produce its abundant crops. Where the alkali and poverty of the soil are very decided, the plant does not give its highest results, but even in its modified growth the crops it produces are sufficient to support a large number of cattle. From two to four cuttings of good hay make the average yield to-day in the arid regions where the salt bush has been established, and farmers in the arid regions are planting the crop as fast as they can secure sufficient seed.

The Tulare Experiment Station has distributed in the last few years about 5,000 pounds of seed. In a few years the wide distribution of the plants should enable the farmers to produce all the seed they will need, and the plants will then become established over a wider range of territory. The fattening and health-giving qualities of the salt bush especially recommend it to the growers of cattle and sheep in the great Western deserts and plains. The sheep not only like the vegetation as a food, but it is said that the animals brought up on it produce a wool of superior quality, with a fiber unusually strong, glossy, and even. It is claimed by some that the fine quality of the best Australian wool is due to the salt bush as a daily food. In this respect, however, some species of the plants are far better than others, and it remains yet for the experiment station to ascertain which one will affect the wool the most favorably. G. E. W.

Immigration in 1899.

The total arrivals for the year ending June 30, 1899, were 311,715, an increase of 82,416 or 36 per cent. Of the total arrivals Europe furnished 297,349; Asia 8,972; Africa 51. In all other countries, 5,343. There were 195,277 males and 116,438 females. According to age, 43,983 were under fourteen years; 248,187 were from fourteen to forty-five and 19,545 were forty-five years or older. As to illiteracy, 60,446 could neither read nor write, and 1,022 could read, but were unable to write. The total amount of money which they exhibited to the officers was $5,414,462; 174,618 had less than $30 each.

Census Inquiry Regarding Canals.

The prompt and careful responses to the recent request by the Director of the Census, for information relating to canals and ditches, indicate that the importance and value of a complete and accurate census of irrigation are appreciated by those engaged in this branch of agriculture.

Director Merriam is very well pleased with the great interest evinced in the work of collecting data, and is confident that with the continued assistance of the irrigators and the press, the present investigation will be a success.

The returns from the preliminary inquiries furnish evidence of the material progress made in arid America and give promise of an advance in the twentieth century exceeding the wonderful development of the Mississippi Valley during the past decade. The boundary line, which so long has divided the arid and humid regions, will no longer stay the onward march of agriculture. To-day it is realized that just beyond that line lies an empire greater and far more resourceful than any yet conquered. With the narrowing of the unoccupied limits of government lands in the humid zones the question of reclaiming the arid and subhumid regions grows in importance, and is to-day claiming the attention of the wisest minds of the nation.

Many of the preliminary schedules sent out in December and January have been received and are already tabulated. The mailing of the principal schedules is being pushed as rapidly as possible.

The questions in this schedule are numerous and important. Director Merriam requests that they be carefully answered, as upon these answers an accurate and perfect census of irrigation largely depends.

The scope of the present inquiry is broad. Its purpose is to determine the present conditions and results of irrigation, and to tabulate the same in such a manner that they may be fully comprehended by every one. Such a work successfully conducted, will result in bringing about a more complete realization of the fact that the development of irrigation is affecting the prosperity of our nation as well as the progress and stability of many Western States.

Geography and Exploration in 1899.

No great geographical discoveries have been recorded during 1899, but a great deal of exploration work has been accomplished. Considerable interest has been taken in preparing expeditions of Antarctic research, of which the Belgian expedition has returned with some important results. Mr. Borchgrevink has begun his work at Cape Adar on the Antarctic mainland. The search for Andrée has helped to increase our knowledge of parts of the Arctic coast, says Popular Science Monthly. In Asia, Captain Deasy has laid down the whole of the course of the Yarkand River, which was before unknown.

The expeditions sent out by Canadian surveys are constantly opening up new country and the maps produced are of great value. Mr. A. P. Low, finds Labrador to be a country less bleak and hopeless than has been generally believed. Sir William Martin Conway has done some very creditable explorations in the Andes and in Tierra del Fuego the scientific results of which are of considerable value. In Chili, Dr. Staffer and his colleagues have explored the wonderful fiords of the coast and rivers which came down to them from the Andean range. Dr. Moreno has described the results of twenty-five years' exploration of the great Patagonian plains, and the readers of the SCIENTIFIC AMERICAN will remember the article which was recently published on Prof. J. B. Hatcher's explorations in Patagonia. One of the most important scientific enterprises was the German oceanographical expedition in the Valdivia under Prof. Chum, which went south through the Atlantic to the edge of the Antarctic ice and north through the Indian Ocean to Sumatra, and home through the Red Sea.

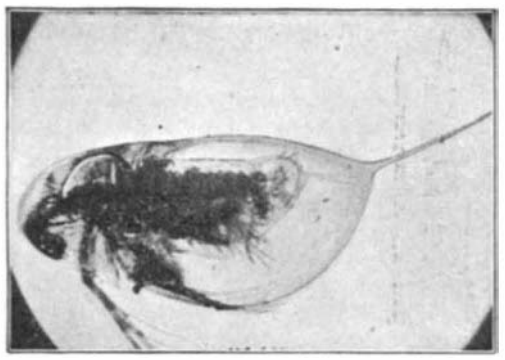
Old Stage Effects.

We are apt to consider that stage effects are an invention of the present century. This may be so in some cases, but many of them are very old. The limelight is probably the most valuable accessory for modern stage effects. It was introduced some time around 1837 or 1838, and was regarded as a great curiosity. Its expense, however, prevented its being used to any extent for a long period. In 1480, intricate machinery was regularly used in religious plays for the simulation of various natural phenomena. Earthquakes always seem to have been the most pleasing and taking of effects, and we hear of them as far back as 1692, when Evelyn refers to a puppet show in which an earthquake effect was used. The old paper snow for winter effects was largely abandoned, and in France waste clippings of glove manufacturers are used instead. The white glove clippings fall better in the air than small pieces of paper, and they cling better to the scenery and to the actor's garments as they descend. The ordinary nautical effects are of considerable antiquity. Full-rigged ships were in use in Paris as far back as 1713.

A NEW APPARATUS FOR INSTANTANEOUS PHOTO-MICROGRAPHY.

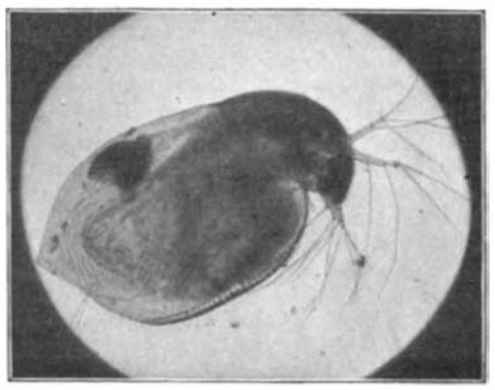
BY PROF. A. C. SCOTT.

The subject of photo-micrography is alike important to both biological and physical science. It involves not only accurate and interesting work with micro-



COPEPOD, 200 DIAMETERS, 1-35 SECOND EXPOSURE.

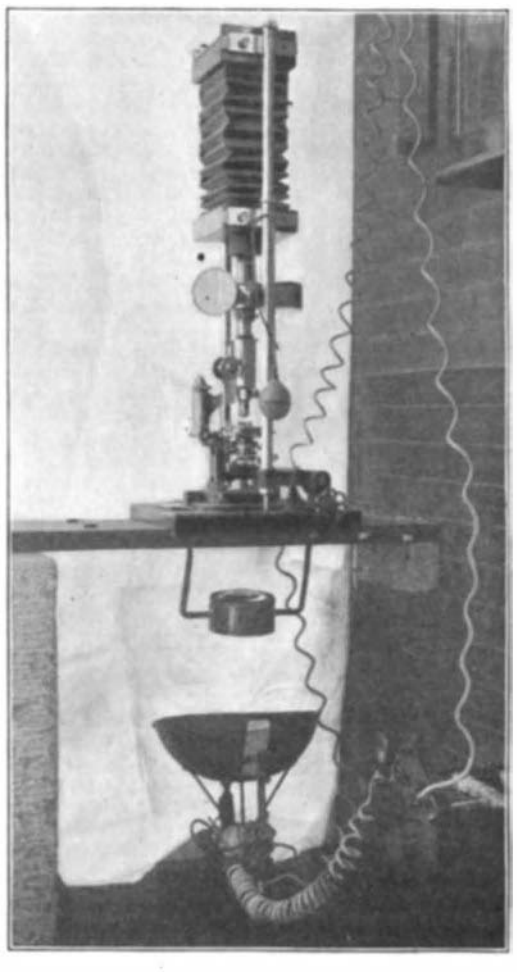
scopic organisms, but from the physical which includes the photographic side, much care is required in the selection and manipulation of the proper microscopic lenses, in connection with the source of light employed, stain used upon the subject to be photographed, if a mounted slide, and the chemistry necessarily connected



COPEPOD, 250 DIAMETERS, 1-40 SECOND EXPOSURE.

with the handling of the photographic plate itself, in order to obtain the best results.

The different general methods employed in this work together with proper magnification for certain forms, kind of illuminant, with ray filters, exposure, and character of plate, require separate treatment, as the chief



APPARATUS FOR INSTANTANEOUS PHOTO-MICROGRAPHY.

object of this article is to describe a new apparatus for making instantaneous photographs of living microscopic animals.

After having worked upon photo-micography for some time for the purpose of obtaining photographs of microscopic slides for illustration with the optical lantern, and having determined the conditions requisite to the production of good results with mounted slides, the thought occurred to the writer that if an instantaneous photograph of a living organism could be made, it might be valuable to the biologist and instructive to the physicist.

It will at once be apparent to those who have worked along this line that a powerful light is necessasy for instantaneous work; in my own work with the apparatus an arc light consuming 2,200 watts is employed which gives, in the position used about 4,000 c. p. This light, as will be seen from the picture of the apparatus entire, is placed at a distance a little greater than the focal length of a condensing lens, so that the intensity of light upon the object and objective is considerably greater than would be the case without the lens. Of course a different position of the lens and light would magnify the intensity of the light greatly, but that is undesirable beyond a certain limit as the heat would be detrimental to the microscope objective.

With the proper arrangement of the light the essential feature in making the instantaneous photographs shown herewith is the combination shutter and view tube which is made to be clamped by means of three thumb screws to the draw tube of the microscope. This apparatus is fastened on after the ocular has been inserted in the draw tube. The mechanism of the apparatus is as follows:

Upon a movable brass plate inside a light tight box, (shown in Fig. 1, just below the camera bellows) is a 90-degree prism mounted in such a way that all of the light which passes through the microscope is projected upon a piece of ground glass at the end of a cone, which may be lengthened or shortened in order to give correct focus to the object here, when it is properly focused upon the ground glass of the camera directly above the microscope. Next to the prism is a hole in the brass plate for allowing light to pass from the microscope directly to the photographic plate when the prism is moved by means of a spring and pneumatic release, and finally a sufficient amount of the solid brass left to cover the opening when exposure has been made.

To take a photograph the microscopic animal is placed in a drop of water upon a suitable glass plate, the light is turned on and the shutter so set that the object may be focused upon the ground glass of the cone. The plate holder is inserted and the dark slide drawn leaving the plate exposed inside the camera bellows. The movements of the animal are easily seen upon the ground glass and when the desired position is obtained the shutter is released, the prism moves out of the way, aud the light passes to the plate. Cramer's isochromatic plates have given the best satisfaction with this instantaneous work. Although the apparatus is not perfected to the writer's complete satisfaction, exposures as short as $\frac{1}{40}$ of a second have been very satisfactory. Neither of the negatives whose prints are shown with this article had more than $\frac{1}{25}$ of a secend exposure. It seems perfectly possible with good microscope objectives and the best arrangement of illuminant to obtain thoroughly satisfactory negatives in $\frac{1}{100}$ of a second.

The apparatus may be of some value other than photographic to biologists from the fact that it allows one to study the movements of a living microscopic organism with both eyes with perfect ease instead of by the common one-eye method which is apt to be tiresome.

The Water System of Pompeii.

Pompeii, like most Roman cities, had an excellent water system, but we are able to judge of the systems in other places only by the small remains, but in Pompeii, the whole system has been laid bare, and in "Pompeii, Its Life and Art," by August Mau, translated by Prof. Francis W. Kelsey, there is an interesting description of the water supply of the city. Remains of the great aqueduct near Avellino, a dozen miles east of Nola, have been discovered, and this aqueduct followed the base of Vesuvius and furnished water to Naples, Puteoli, Baiae and Misenum, but the source from which Pompeii received its water supply has not been discovered. The construction of the older baths showed that a free use of water was contemplated. There were many fountains along the streets, most of them at the corners. They were filled by pipes connected with the water system of that city, and these fountains bear witness to long use by depressions which have been worn in the stone by the hands of those who leaned forward to drink. Water towers were found at the sides of streets, they were small pillars of masonry which were raised to the height of 20 feet. There was a small reservoir of water on the top, presumably of metal. In all the houses of any size and importance there were flowing jets. Thus, in the famous house of the Vettii which was discovered a few years ago there are no less than sixteen jets, and water was not stinted in any of the three baths which have been discovered. The water-pipes were made of sheet lead folded together, the transver sesection somewhat resembling that of a pear. Their size was regulated by the pressure and the water was turned on and off by stop-cocks which were much like those in use to-day.