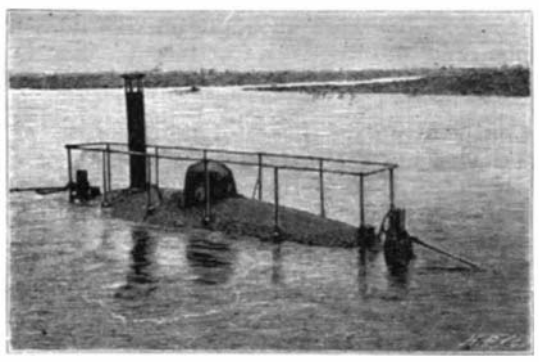
THE BAKER SUBMARINE BOAT.

During the past three months several trials have been made in the Detroit River, near Detroit, of the Baker submarine boat, shown in the accompanying illustrations, and, at the direction of Commodore Folger, of the Naval Ordnance Bureau, Mr. W. Scott Sims, an inventor well known in connection with the Sims-Edison torpedo boat, is looking into the capabilities of this new boat as affording a possibly valuable addition to the navy. The boat has needed some repairs since its preliminary trials, and, as soon as these are effected, it is expected that it will be taken to Newport and placed under the supervision of government officials for further experiments.

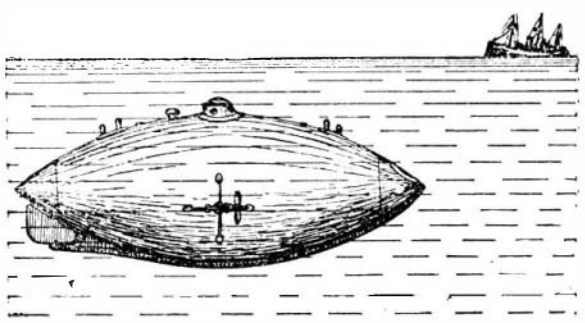


SUBMARINE BOAT—AFTER PARTIAL SUBMERGENCE.

Mr. George C. Baker, the inventor of the new craft, is a Chicago business man. The hull is designed to withstand the pressure of the water at a depth of eighty to a hundred feet, and with this view it is constructed of three-inch oak plank, six inches wide. Its dimensions are 40 feet over all, 9 feet beam and 14 feet deep, from top of conning tower to bottom of hull being 16 feet. The boat is self-contained throughout, and needs no shore connections to drive it. The driving power is in duplicate, an electric plant and a steam plant, the former for running under water and the latter for surface propulsion, the steam plant being so arranged that it can be used to generate electricity for charging the storage batteries.

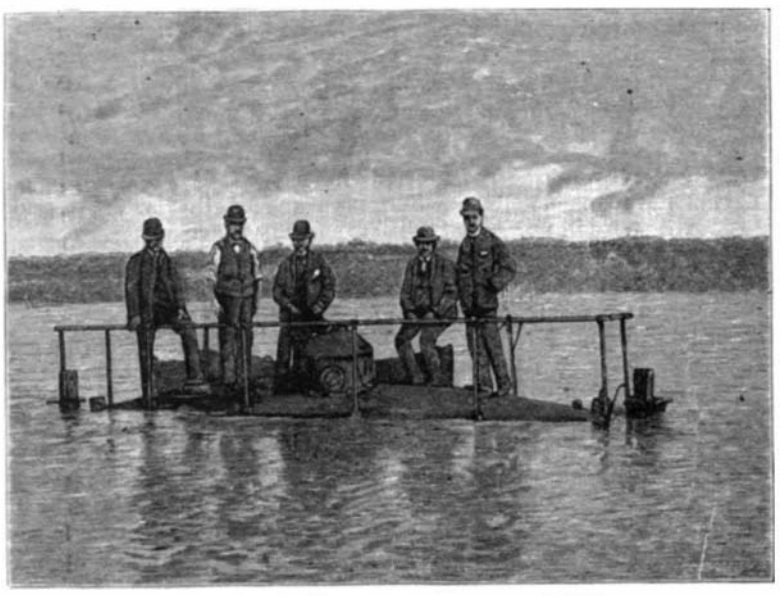
The electrical equipment consists of a 50 horse power motor, built by C. D. Jenney, of Fort Wayne, Ind., and 232 Woodward storage cells of the "M. S." type. The motor was designed for a pressure of 220 volts and runs at a maximum speed of 900, turning the two screws, which are four-bladed, at a maximum speed of 300 revolutions per minute. This rate of revolution, it was calculated, would give the boat a speed of from eightto nine miles per hour. The gearing is very substantial and of steel. The motor is connected to run as a dynamo by the simple movement of convenient switches. When it is run as a generator it is speeded up to 1,025 revolutions per minute, so as to give a charging pressure of 220 volts. The cells are charged in four sets of 58 each and are discharged in two sets of 116 cells each, this arrangement giving at the motor an available pressure of 232 volts. In the top of the boat, within easy reach of the pilot's assistant, there is a convenient controlling switch connected with galvanized sheet iron resistance coils in the forward end of the boat. By this switch and a circuit breaker the speed may be varied as desired.

The steam plant consists of a 4½ by 5½ foot Roberts water tube boiler, with telescopic stack, which is lowered and the stack hole covered when fire is not required. The 7 × 7 inch Willard engine can be thrown in gear with the main shaft, and it can also be belted to the motor. There are two 24-inch propeller wheels, one on either side, connected with one shaft amidships. To the ends of the shaft are attached gear wheels, working in the gear attached to propellers, which are turned in any position by means of a sleeve around the shaft. This sleeve is connected to a hand wheel with chain belting. By means of this hand wheel the propellers may be placed in any position. The propellers are protected by brackets from coming in contact with any obstruction. The rudder fits close to the hull and the boat answers to it readily.



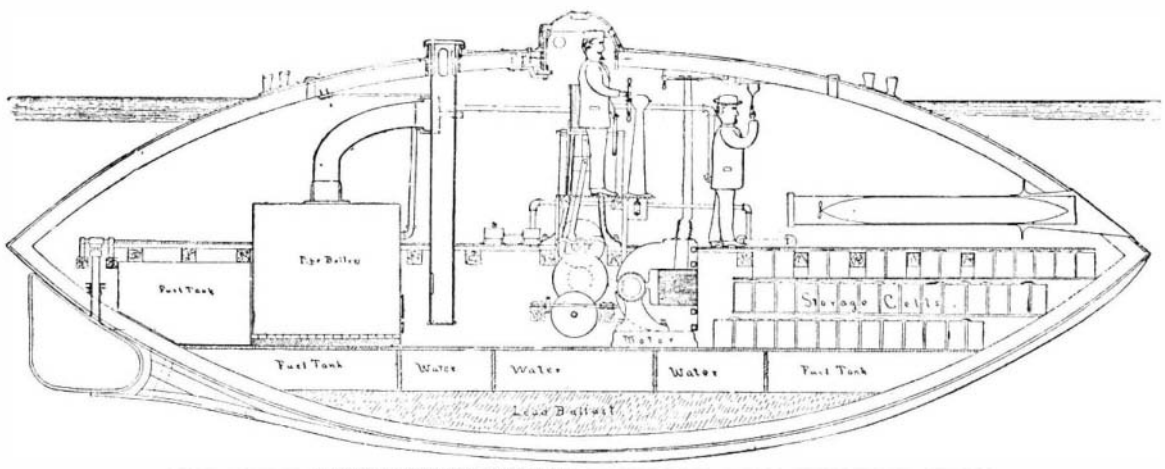
SUBMARINE BOAT—AS IT APPEARS UNDER WATER.

It is expected that, ordinarily, only two men will be necessary to operate the boat, a pilot and an electrical engineer, and the air supply needed for their comfortable maintenance under water will, it is intended, be afforded by the quantity held by the hull itself at the time of submergence, this volume being equal to 1,500 cubic feet. In one of the trials two occupants were within the closed vessel two hours and forty-five minutes without experiencing any unpleasant effects. The boat has about 75 tons displacement, the hull weighing 20 tons, the ballast 30 tons, the storage battery cells 10 tons, engine and boiler and gearing 8 tons, and motor 3 tons, leaving 4 tons buoyancy. The normal draught of the boat leaves about two feet of the crown of the hull above water.

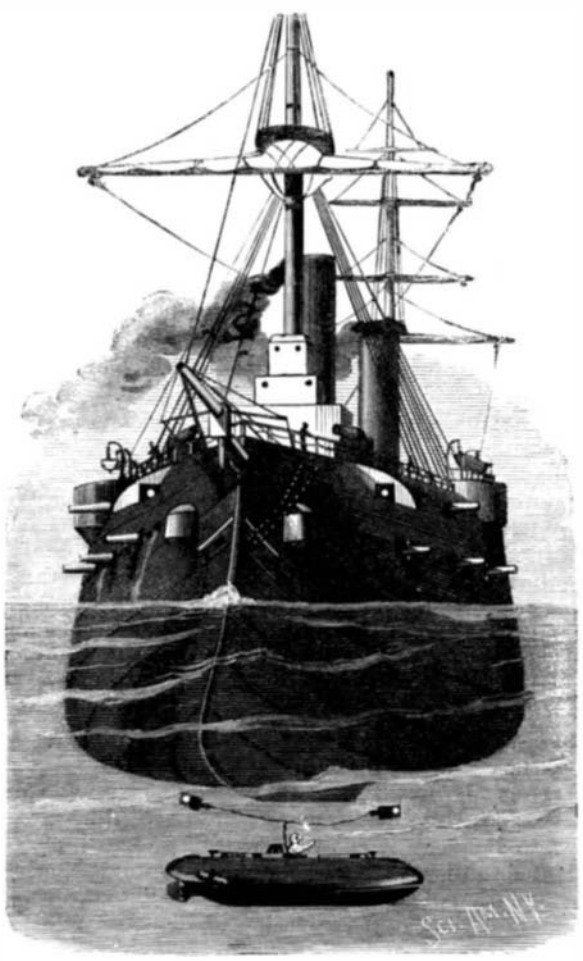


SUBMARINE BOAT—JUST BEFORE STARTING.

In starting, the pilot and electrical engineer enter through a man-hole in the conning tower, and the cover is drawn over and fastened, when the boat is air-tight. The electrically-connected pump is started and two or three tons of water is pumped into the water bottoms, this additional weight leaving nothing of the boat above the surface except the top of the hull and conning tower. To sink directly downward the wheels are turned perpendicularly to the shaft and the motor is started. The amount of spare buoyancy determines the amount of power necessary to sink the boat. When the desired depth is attained, then the propeller wheels are turned at an angle of about 45 deg. and the boat is propelled forward, neither rising or sinking unless the pitch of the wheels is changed. When the commander or pilot wishes to ascend, the machinery is stopped and the reserve buoyancy causes the boat to rise to the surface. Any accident that would stop the machinery would also cause the boat to ascend. The storage battery plant is designed to contain enough power to run the boat three hours at a speed of eight miles an hour.



THE BAKER ELECTRICALLY-DRIVEN SUBMARINE BOAT—SECTIONAL VIEW.



THE TUCK SUBMARINE TORPEDO BOAT OF 1885.

The torpedo boat of Mr. J. L. Tuck, and the method of operating it, represented in one of the views, was built at the Delamater Iron Works in 1885. It was 30 feet long, 7½ feet broad, and 6 feet deep. It had several small compartments to be filled with water when the boat was to be sunk, and a number of 6-inch iron pipes filled with compressed air to furnish a supply for its single occupant. Its propeller was turned by an ordinary dynamo, run by storage batteries, and it had a common rudder for horizontal steerage, and a horizontal rudder for guiding it toward or away from the surface. A well-hole in the center of the deck was fitted with an air-tight hatch, from which an individual in a diver's suit, by means of suitable devices, might direct those inside in elevating, lowering and propelling the boat. It was designed with this boat to attach torpedoes to the bottom of a vessel, then run away to a safe distance and explode the torpedoes by means of wires paid out while moving away.

Irrigation in Washington.

Census Bulletin No. 198 has been prepared by Mr. F. H. Newell, special agent of the Census Office for the collection of statistics of irrigation, under the direction of Mr. John Hyde, special agent in charge of the statistics of all branches of agriculture, and relates to the State of Washington, in which there are 1,046 farms that are irrigated out of a total of 11,237 farms in the 13 counties in which irrigation is practiced. The total area of land upon which crops were raised by irrigation in the census year ending May 31, 1890, was 48,799 acres. The average size of the irrigated farms, or more strictly of irrigated portions of farms on which crops were raised, is 47 acres. The average first cost of water right is $4.03 per acre, and the average cost of preparing the soil for cultivation, including the purchase price of the land, is $10.27 per acre. The average present value of the irrigated land of the State, including buildings, etc., is reported as $50 per acre, showing an apparent profit of $34.45 per acre, less cost of buildings. The average annual cost of water is $1.75 per acre, which, deducted from the average annual value of products per acre, leaves an average annual return of $16.35 per acre.

Cause of the Unequal Wearing Away of Electric Light Carbons.

In an electric arc the positive pole is hotter than the negative, the positive showing a temperature of about 4,000° C., the negative showing a temperature of 3,000° to 3,500° C. This difference of temperature produces a counter electromotive force which acts like ohmic resistance. The cause of the positive pole wearing away twice as fast as the negative is due to this difference in temperature.

Vibrations.

Prince Kropotkin gives an interesting article on electricity as a mode of motion, in a recent number of the *Nineteenth Century*. It summarizes the results of the latest researches as simply as their nature admits of, and the net result of seemingly conclusive experiments is that with vibrations or wave lengths in the ether:

0·000,012 to 0·000,016 in. long, we have..... .. chemical energy.
0·000,016 to 0·000,030 " " " " .... .light.
..... to 0·000,129 " " " " ....radiant heat.
..... to yds. or miles. " " " .....electricity.

If these results may be accepted, we have squarely before us the problem: Given, vibrations of any length in the "ether" (whatever that is), to modify their length at will. The problem of the transformation of energy reduces down to that. When some benefactor of mankind has solved that problem, if it ever is solved, a new era indeed in civilization will open. We may then have electricity from heat, light without heat from electricity or any other form of energy, and divers and sundry other things which we can now only dream of, or perhaps not that. When we consider that pretty much all that is now known of the real nature of electricity, heat and energy is the fruit of the last twenty years (Joule's equivalent and first series of experiments were not announced until 1849), it seems a pretty safe conclusion that science is yet young, and that all which has been yet achieved is but a trifle compared with what is yet to be achieved. Moreover, we know that in the living organism, heat and energy, energy and light, energy and electricity, are transformed into each other by some mysterious process with the greatest ease, and to a large extent according to the will or needs of the organism. It may be that this power is one of the properties of living "protoplasm," and that man will never be able to understand it or to imitate it until he has learned the secret of life itself; but all the recent tendency of science is to indicate that the secret of transforming one form of energy into any other may yet be discovered, and perhaps by very simple means, compared with which our steam engine will seem but a "relic of barbarism."

The fact that electricity, like heat, light, and radiant chemical energy, is a manifestation of energy, has long been known, but up to the last four or five years scientists have been uncertain as to the manner in which energy existed in the electric current. The old idea of an electric fluid, which is still prevalent outside of scientific circles, served to mislead investigators. At present, however, the researches of such scientists as Hertz, Lodge, Crookes, Sir William Thomson and Tesla seem to have established the fact that electricity, like heat and light, is merely a vibration in the so-called "ether" which is believed to permeate all space. It is notable that all the original theories as to what we now call forms of energy were materialistic. The Newtonian (corpuscular) theory of light, which was the generally accepted one for half a century, was that light was an effect produced by an incessant fire of infinitesimal but material cannon balls thrown off in all directions from the light-giving body. Heat was a material something stored in the pores of the visible body. Electricity was a "fluid." All these assumed material substances have been shown to be non-existent, and not necessary to explain the phenomena. But there still remains one grave difficulty with the later theories. The notion of a material ether itself is almost as contrary to what we know of the nature of other matter as the corpuscular theory of light, and almost as much a mere evolution of the scientific inner consciousness, to explain what is otherwise inexplicable. We have not a particle of direct evidence to prove that there is a substance with properties such as we assign to this ether. We have only to eliminate the notion of a material ether, as we have eliminated the notion of material light particles, and we shall be down to hard pan! "I believe because it is impossible," the old monk declared. The modern scientific man, possibly, would do well to reverse this logic and declare: I disbelieve because it is so very convenient a theory, with nothing but its convenience to support it.—*Engineering News.*

A New Metallic and Rubber Wire Mat.

A new style of woven wire mat, to which is attached a soft rubber cleaner, with edges and top roughened to fit every shape in the sides or edges of boots and shoes, has recently been patented and put upon the market by Messrs. Emerson & Midgley, of Beaver Falls, Pa. Another description of mat or rug coming from the same firm is made of variously colored galvanized wire and has a thin rubber strip held on its edges by polished metal loops, the construction being such that there is no point upon which the most delicate trail of a lady's garment is liable to catch. The mats lie loosely on the floor, without fastening, so that they can be readily lifted, rolled up, and washed or shaken, and are furnished lettered as desired, three inch brass letters being used for the purpose. A mat of this kind is now in use at the entrance of the SCIENTIFIC AMERICAN office. They are manufactured by the Trenton Iron Company.

POLYCHROME PROJECTIONS BY MEANS OF UNCOLORED PHOTOGRAPHS.

For the last two years there has been much talk in the United States on the subject of a remarkable application of photography to the reproduction of natural colors—an invention attributed to Mr. Ives, of Philadelphia.

In reality, Mr. Ives, who is a very ingenious scientist and a fortunate investigator, has, aside from a few variants, merely put in practice a process published in France in 1869 by Mr. Louis Ducos du Hauron and Mr. C. Cros.

These two inventors, without any connection existing between them (Mr. Cros living in Paris and Mr. Du Hauron in Agen), conceived the same idea at about the same time. It consisted in the use of photography in the decomposing of the essential colors of any polychrome object whatever. The method published by each of them is nearly the same, and leads to the obtaining of three negatives of the same object, prototypes that are identical with each other as regards lines and dimensions, but different as regards the manner in which the various colors are reproduced.

This result, obtained by means of photography, is analogous to that sought for by a chromolithographer when he is executing the various monochromes of a subject upon stone, and which correspond to distinct colors, the superposition of which, at the moment of printing, are to give a polychrome nearly like the original. The work of selection due to photography may be so nearly complete that three negatives, the positive impression of which will be done with the three colors, yellow, red, and blue, may suffice for the obtaining of a most satisfactory polychrome image.

As a proof of the exactitude of the method devised by them, Messrs. Du Hauron and Cros have published various methods of recognizing the value of their photographic analysis of the colors of an object. Among the number of the synthetic processes that they have described there is one to which it is well to call more especial attention, because it consists in the use of a projection, upon a screen, of a combination of three positive pictures, each illuminated through a medium of a different color. The recomposition of the true colors is to be effected upon the screen.

It is useless to dwell upon the error committed by the two inventors when they say that the colored media should be yellow, red, and blue. They recognized this error later on, and in March, 1879, Mr. Cros, who, moreover, had come to an agreement concerning it with Mr. Du Hauron, distinctly directed the use of violet, green, and red screens.

We desire to well establish this question of priority in favor of our two fellow countrymen, not only because there seems to be a disposition on the other side of the Atlantic to consider Mr. Ives as the inventor of the process that we are about to describe, but also because the experiments relative to this process, now being tried in France, are of a nature to cause its adoption with a view to substituting, in cases where the thing will be possible, polychrome for colorless projections, which are evidently less attractive.

There is reason to hope that many lecturers will soon have recourse to these kinds of projections of a truly fascinating effect, and we must then know who were the inventors of this so curious an application of photography, which is perhaps destined to render many services, as yet unforeseen, to science and the fine arts.

This act of justice accomplished, we shall try to explain, as clearly as possible, the principles that serve as a basis to these photographic projections, in order that the bringing of them into play may be more easily understood.

In the first place, it is necessary to produce the three negatives of which it has just been a question. Upon the good quality of these will depend the success of the final synthesis. They should, as we have said, be identical with each other as regards dimensions, but differ as to the rendering of the distinct colors of the original.

An example will make the result that it is a question of obtaining better understood. Let us suppose that we have to analyze the colors of a polychrome object composed of three colors, yellow, red, and blue. We shall have to obtain a first negative containing the yellows and the combinations thereof, a second containing the reds and their combinations, and, finally, a third negative corresponding to the blues and their combinations. It is evident that if this result can be obtained, we shall have effected a decomposition such that the mixture of the radiations corresponding to each of these three colors, and assorted by the positives and in the desired proportions, will necessarily recompose the total coloration of the object reproduced.

Owing to the property that certain coloring substances possess of modifying the nature of films sensitive to light, it is possible to use sensitized plates adapted to the printing of blue and violet radiations to the exclusion of green, yellow, and red, or of yellow and green radiations to the exclusion of blue and red, or, finally, of yellow and red to the exclusion of blue.

The three prototypes of the same object will have to be reproduced in a camera of the same focus, the first upon the sensitized film most susceptible of receiving the impression of the blue radiations. A plate called "ordinary" is the one most suitable, since such plates, as well known, are not very sensitive to green, yellow, and red radiations. The second negative will be taken upon a sensitized film capable of receiving the yellow and green radiations, but not the red. These kinds of plates are easily obtained by incorporating with the sensitized film a dye that possesses the property of absorbing the yellow and green rays.

At the same time there should be interposed between the plate and the objective a translucent yellow screen for the purpose of retarding the action of the blue rays.

In order to obtain the third prototype, we use a plate treated like the preceding, but with a dye that gives it sensitiveness to the red rays as well as to the yellow. As for the blue, they must have no action upon this plate, such action being prevented by means of an orange-yellow screen.

As soon as a few experiments on the analysis or decomposition of colors have been made in this way, which is absolute only as regards the result to be obtained, but which is susceptible of modifications as regards the means to be employed, we shall have sufficiently mastered the process to succeed every time. After the negatives have been obtained, two methods of employing them are at our disposal. They may be used for pigmentary impressions of polychrome images analogous to those of chromolithography, and in this case it will be necessary to superpose the three monochromes, yellow, blue, and red, furnished by each negative corresponding to each of these three colors.

We have not to occupy ourselves at this moment with such application, as interesting as it is. The other application, which forms the main object of this article, relates to polychrome projections. It is well to remark, only, that when it is a question of projections, the colored media are not the same as in the case of pigmentary impressions, although the negatives are the same. For such impressions it would be absolutely impossible to attain the object if we employed ternary yellow, red, and blue, while the use of the same ternary in the recomposition of the colors by means of radiations would give improbable effects of color. Such recomposition can be effected only by the aid of the three primary colors indicated by Young and Helmholtz, viz., violet, green, and red.

We remark, in fact, that if we mix these three radiations by projecting them separately upon the same point of a white screen, we obtain pure white—a result that is not produced with the mixture of the blue, yellow, and red radiations made under the same conditions.

Now it is found that the color of each of the media to be employed is precisely the complementary of the color adapted to the pigmentary impression. Thus the negative which would furnish the pigmentary yellow will give, in view of the projection, a diapositive that it will be necessary to cause violet radiations to traverse—violet being the complementary color of yellow.

The negative of the pigmentary red is that which produces the diapositive to be illuminated in green, the latter being the complementary of red.

Finally, the negative of the pigmentary blue is that which, for the projection, will give the diapositive of orange yellow, the complementary of blue. Thanks to these preliminary explanations, the facts that are to follow and that we are going to explain will be better understood.

The putting in practice of the recomposition of colors requires the use of a lantern in three parts, or, at least, of a special apparatus constituting a single lantern provided with three projection objectives. To simplify things, let us be content for the time being with the ordinary three-bodied apparatus constructed by Mr. Moltine, which has been used by us for our own experiments. This apparatus is represented in perspective and in action in Fig. 1, and the arrangement of it is shown by the diagram in Fig. 2. Three distinct luminous sources, F, F, F, illuminate the lanterns, 1, 2, and 3. Such illumination may be furnished by an oxyhydrogen light or by electricity, or else by kerosene lamps or illuminating gas with Auer burners. The three black diapositives are placed at D, D, D, and behind each of them is located the colored medium corresponding to the analytical value of the diapositive appropriate to its special radiations. Behind D, therefore, is placed a violet glass, behind D No. 2 a green glass, and behind D No. 3 an orange yellow one.

The projections of the three uncolored (black) monochromes, D, D, D, are exactly blended into a single image perfectly registered upon the screen, I, I′, I″, on which the three objectives, *o*, *o′*, *o″*, project the image.

Each of these three radiations, as shown in the diagram, reaches all the parts of the composite image projected; and from the combinations with each other of these three sorts of radiations, violet, green, and red, result all the possible colors that can be obtained with the seven colors of the spectrum. We have a proof of this, moreover, when we witness the truly wonderful spectacle of the immediate recomposition upon the screen of the infinite shades of color of the original, and