THE LATEST SUBMARINES OF THE UNITED STATES NAVY.

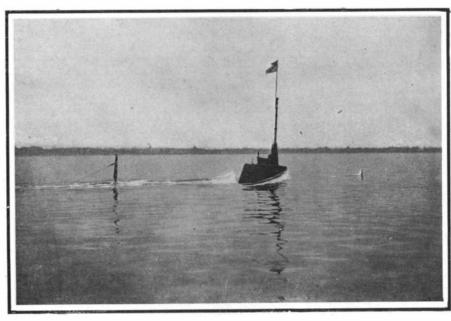
As in all mechanical development an improved type of any particular device is an evolution from its predecessors, so in general, the modern Holland torpedo boat, of which the government is now building a number, is a descendant of the original little craft of that name, which first made its appearance at the close of the Spanish war.

below the surface of the water. At these depths the pressure of the water is great, so that the hull must be made sufficiently strong to withstand it.

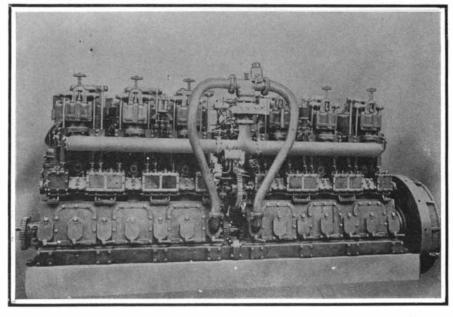
Up to the present, it has been found that the most efficient size for a boat is about 140 feet long and 14 feet in diameter. With such dimensions, a boat can be built which will fulfill all requirements which the naval authorities of the world demand from it. That is to say, it can cruise on the surface for long dis-

pletely submerged with nothing visible above water, for a distance of 150 miles.

There are two distinct conditions in which the boat may be used. In the first, commonly known as the surface condition, the boat is prepared for cruising. A considerable portion of her hull is above water, a removable navigating bridge is in place, and she is driven by large, powerful, internal-combustion engines. Under these conditions she is managed in about the

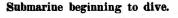


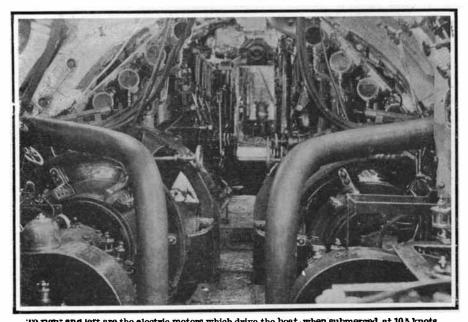
The dark object in the center is the conning tower. The periscope to which the flagstaff is attached projects above water when the boat is submerged and by its means the commanding officer can view surrounding objects as clearly as though he looked through a field glass at the surface.



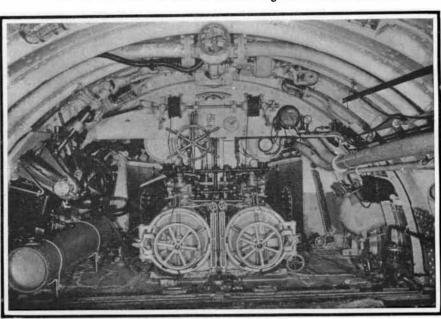
These engines are used only in traveling at the surface. They can drive the boat at 14 knots. For submerged work they are uncoupled and the boat is driven by two electric motors. The latter take their energy from storage batteries which have been charged by the gas engines.

One of the twin internal-combustion engines of the submarine.



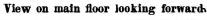


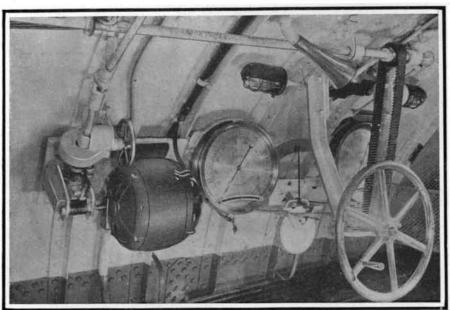
ro right and left are the electric motors which drive the boat, when submerged, at 10.5 knots per hour.



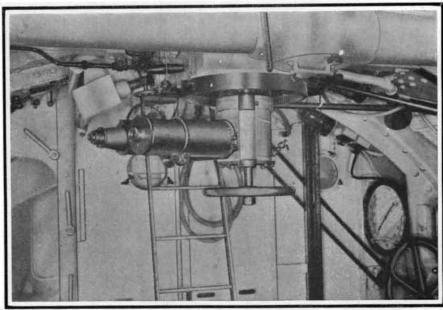
In the center are the two torp dodischarge tubes. To the left is the electric motor and gear by which the doors in the nose of the submarine are opened for discharge of orpedoes.

Looking aft in engine room.





The hand wheel to the right operates the diving rudders used for steering in a vertical plane. In front of the wheel is a gage whose pointer shows the depth in feet of the boat below the surface. The curved dark line below pointer is a spirit level which shows the inclination of the boat.



This shows the roof, not the floor, of the submarine interior. The horizontal eyepiece and the vertical telescope tube are rotated by means of the hand-wheel whose pinion engages an internal gear ring.

Diving wheel and depth pressure gage.

e gage. Eyepiece at bottom of periscope. THE LATEST SUBMARINES OF THE UNITED STATES NAVY.

The form of hull is generally described as cigarshaped. It is built of the very best quality of mild steel, and the workmanship is of the highest order, for the reason that every seam and rivet must be perfectly tight, in view of the service which the boat is called upon to perform. Not only do vessels of this type undergo all the stresses of sea and weather which other vessels are subjected to, but in addition they are required to navigate at considerable depths tances at a speed of fourteen knots. At lower speeds its radius of action extends to several thousand miles. For submerged work large storage batteries are provided, which furnish energy sufficient to drive the boat from ten to eleven knots for a period of over an hour. The same electrical energy will drive her at a lower speed for a much longer time. The latest submarines, built for the government by the Fore River Company, at about five knots speed can run com-

same way as any vessel built to run upon the surface. As for sea-going qualities, our submarines have been found in practice to be excellent. In ordinary weather they are fully as comfortable as any surface craft of the same dimensions, and even in the heaviest weather they are entirely seaworthy.

The second distinct condition exists when the boat is submerged. To pass from the surface to the sub-(Continued on page 305.)

Home-Made **Experimental Apparatus**

In addition to the following articles, the Scientific American Supplement has published innumerable papers of immense practical value. of which over 17,000 are listed in a carefully prepared catalogue, which will be sent free of charge to any address. Copies of the Scientific American Supplement cost 10 cents each.

If there is any scientific, mechanical, or engineering subject on which special information is desired, some papers will be found in this catalogue, in which it is fully discussed by competent authority.

A few of the many valuable articles on the making of experimental apparatus at home are given in the following list:

ELECTRIC LIGHTING FOR AMATEURS. The article tells how a small and simple experimental installation can be set up at home. Scientific American Supplement 1551.

AN ELECTRIC CHIME AND HOW IT MAY BE CONSTRUCTED AT HOME, is described in Scientific American Supplement 1566.

THE CONSTRUCTION OF AN ELECTRIC THERMOSTAT is explained in Scientific American Supplement 1566.

HOW TO MAKE A 100-MILE WIRELESS TELEGRAPH OUTFIT is told by A. Frederick Collins in Scientific American Supplement 1805.

A SIMPLE TRANSFORMER FOR AMA-TEUR'S USE is so plainly described in Scien-tific American Supplement 1572 that anyone can make it.

A %-H.-P. ALTERNATING CURRENT DY-NAMO. Scientific American Supplement 1558.

THE CONSTRUCTION OF A SIMPLE PHO-OGRAPHIC AND MICRO-PHOTOGRAPHIC TOGRAPHIC AND MICEO-PHOTOGRAPHIC APPARATUS is simply explained in Scientific American Supplement 1574.

A SIMPLE CAMERA-SHUTTER MADE OUT OF A PASTEBOARD BOX, PINS, AND A RUBBER BAND is the subject of an article in Scientific American Supplement 1578,

HOW TO MAKE AN AEROPLANE OR GLID ING MACHINE is explained in Scientific American Supplement 1582, with working drawings.

EXPERIMENTS WITH A LAMP CHIMNEY EXPERIMENTS WITH A LAMP CHIMNEY. In this article it is shown how a lamp chimney may serve to indicate the pressure in the interior of a liquid; to explain the meaning of capillary elevation and depression; to serve as a hydraulic tournique, an aspirator, and intermittent siphon; to demonstrate the ascent of liquids in exhaustive tubes; to illustrate the phenomena of the bursting bladder and of the expansive force of gases. Scientific American Supplement 1583.

HOW A TANGENT GALVANOMETER CAN BE USED FOR MAKING ELECTRICAL MEAS-UREMENTS is described in Scientific American Supplement 1584.

THE CONSTRUCTION OF AN INDEPENDENT INTERRUPTER. Clear diagrams giving actual dimensions are published. Scientific American Supplement 1615,

AN EASILY MADE HIGH FREQUENCY APPARATUS WHICH CAN BE USED TO OBTAIN EITHER D'ARSONVAL OR OUDIN CURRENTS is described in Scientific American Supplement 1618. A plunge battery of six cells, a two-inch spark induction coil, a pair of one-pint Leyden jars, and an inductance coil, and all the apparatus required, most of which can be made at home.

SIMPLE WIRELESS TELEGRAPH SYSTEMS are described in Scientific American Supplements 1363 and 1381.

THE LOCATION AND ERECTION OF A 100-MILE WIRELESS TELEGRAPH STATION is clearly explained, with the help of diagrams, in Scientific American Supplement 1622.

THE INSTALLATION AND ADJUSTMENT OF A 100-MILE WIRELESS TELEGRAPH OUT-FIT, illustrated with diagrams, Scientific American Supplement 1623.

THE MAKING AND THE USING OF A WIRELESS TELEGRAPH TUNING DEVICE, illustrated with diagrams, Scientific American Supplement 1624.

HOW TO MAKE A MAGIC LANTERN, Scientific American Supplement 1546.

THE CONSTRUCTION OF AN EDDY KITE. Scientific American Supplement 1555.

THE DEMAGNETIZATION OF A WATCH is thoroughly described in Scientific American Supplement 1561.

HOW A CALORIC OR HOT AIR ENGINE CAN BE MADE AT HOME is well explained, with the help of illustrations, in Scientific American Supplement 1573.

THE MAKING OF A RHEOSTAT is outlined in Scientific American Supplement 1594.

Good articles on SMALL WATER MOTORS are contained in Scientific American Supplement 1494, 1049, and 1406.

HOW AN ELECTRIC OVEN CAN BE MADE is explained in Scientific American Supplement 1472.

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Good srticles on INDUCTION COILS are con-ained in Scientific American Supplements 1514, 522, and 1527. Full details are given so that he coils can readily be made by anyone.

HOW TO MAKE A TELEPHONE is described in Scientific American Supplement 966.

A MODEL STEAM ENGINE is thoroughly described in Scientific American Supplement, 1537. HOW TO MAKE A THERMOSTAT is ex-lained in Scientific American Supplements 1561, plained in Scient 1563. and 1566.

ANEROID BAROMETERS, Scientific American Supplements 1500 and 1554.

A WATER BATH, Scientific American Supplement 1464.

A CHEAP LATHE UPON WHICH MUCH VALUABLE WORK CAN BE DONE forms the subject of an article contained in Scientific American Supplement 1563.

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attains the level of the break in the meridian. The laws of refraction and total reflection can then be studied by directing luminous pencils toward the center of the globe, in the equatorial plane, and viewing them with the eye placed in the same plane.

In his electroscope (Fig. 4) Chassagny has made use of the fact that platinized glass is sufficiently transparent to allow objects to be seen clearly through it and yet reflects bright images of objects nearer the eye. A vertical and rigid strip of copper and a flexible strip of aluminium foil are suspended from a copper rod and inclosed in a case of which two opposite sides are of glass and the rest of metal. The rod carries a charging disk at its upper end and is insulated by passing through a block of paraffin, which rests on the top of the case. One of the glass sides is platinized, and outside it is placed a graduated quadrant which is seen by reflection, while the deflected strip of aluminium is seen through the glass.

Chassagny's galvanometer (Fig. 5) is inclosed in a wooden case, which is attached to the wall. In a strong magnetic field, formed by placing the like poles of two horizontal horseshoe magnets almost in contact with each other, is suspended a coil of wire of electrolytic copper. The intensity of the field is further increased by a soft iron, cylinder, supported independently inside the coil. A large mirror, attached to the coil, reflects the image of a lamp to a screen, where the movements of the spot of light can be followed by the whole class. The galvanometer is provided with three shunts.

In Chassagny's apparatus for the study of electromagnetic induction (Fig. 6), a coil of wire is attached, with its plane vertical, to one end of a lever which can turn round a horizontal axis, and is balanced by a counterpoise on the other end. A vertical horseshoe magnet, with its poles directed upward, is placed so that the coil can be brought between the poles, or raised above them, by turning the lever on its axis. The positive and negative currents produced by these movements are indicated by a galvanometer connected with the coil. An alternating current is produced by allowing the lever to oscillate freely. Other experiments in induction may be made by sending through the coil a current from a battery.

M. Chassagny has devised a number of other ingenious instruments, including a very practical rheostat, a eudiometer, a baroscope, etc.

THE LATES' SUBMARINES OF THE UNITED STATES NAVY.

(Continued from page 296.)

merged condition, certain valves in the interior of the boat are opened. This allows the water from the sea to run into great tanks built within the boat, and thus virtually sink her. These tanks are closely gaged, so that just the required amount of water is taken in. Under normal conditions, when the boat is at rest with the ballast tanks filled, she will have a few hundred pounds reserve buoyancy, which is represented by the top of her conning tower protruding above the water. If desired, this buoyancy may be entirely destroyed by admitting a small additional amount of water, equal in volume to the volume of that part of the conning tower above water. While in the submerged condition, all communication with the outside atmosphere is necessarily cut off. The crew, usually about fifteen men, then breathes the air contained in the body of the boat. The amount of air originally contained within the hull is sufficient to support life with comfort for at least twenty-four hours. But, in addition to the air thus contained, the boat carries a large supply of compressed air in steel flasks, which, if used for breathing purposes, would be sufficient for a number of days.

After having brought the boat to the submerged condition in the manner (Continued on page 306.)



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On December 11th, 1909, the SCIENTIFIC AMERICAN will issue a number devoted entirely to this Middle West region, a number which will set forth broadly and lucidly not only the agricultural interests of that region, but also those larger engineering undertakings which are destined to transform the Middle West, in part at least, into a manufacturing territory.

With that object in view the Middle West Number will publish articles on the following subjects:

I. THE CHICAGO AND GULF WATERWAY.—An illustrated description of Chicago's drainage canal, an engineering work which stands without a parallel in the world.

II. CHICAGO AS A RAILEOAD CENTER.—Very few Americans realize that Chicago is the greatest railroad center in the world, and that it may be likened to a great hub from which radiate the spokes of American transportation.

III. THE WONDERFUL GRAIN TRADE OF CHICAGO.—Chicago is an enormous wheat bin, into which much of the grain raised in the middle West is poured. The conveying and handling of that huge amount of grain has necessitated the erecting and constructing of ingenious machinery and elevators.

IV. SHIPPING ON THE GREAT LAKES.—Most of the iron ore that is now smelted in Pennsylvania is mined in the middle West. To transport it to the blast furnaces of the East at a cost which will enable American steel makers to compete with foreign steel makers, it has been necessary to devise a new kind of lake transportation. Ships of 10,000 and 12,000 tons burden have been constructed which convey ore at small cost through the Great Lakes, and which are without a counterpart anywhere in the world.

V. THE HANDLING AND SHIPMENT OF IRON ORE.—The above-mentioned fact that iron ore is mined in the middle West and smelted in the East has necessitated not only the construction of special freight-carrying steamers, but also the designing of special machinery for loading and unloading the ore from the steamers.

VI. FREIGHTING ON THE MISSISSIPPI.—The Mississippi is the great natural waterway of the middle West. It places the cities along its banks in direct water-communication with every port in the world. That is why freighting on the Mississippi is a more important industry than most of us may realize.

VII. THE STEEL INDUSTRY.—Although the steel industry is still centered in Pennsylvania, the scene of its activity is gradually shifting. One of the greatest steel plants in the world is that which has been built at Gary. It is safe to say that nowhere else in the world will be found a plant so remarkably equipped and so efficient.

VIII. THE FREIGHT SUBWAY SYSTEM OF CHICAGO.—Chicago can boast of a rational system of handling freight by means of subways. Freight is carried from the railway car directly to the warehouse by means of tunnels aggregating sixty miles in length.

IX. THE WATER SUPPLY OF CHICAGO.—Chicago's source of water is Lake Michigan. The city is supplied with water by means of a tunnel which extends two miles out into the lake.

X. RECLAIMING ARID LANDS.—The United States Government has under way many irrigation projects for the purpose of reclaiming lands which are arid, but which will blossom if properly

XI. HARVESTING THE GRAIN OF THE MIDDLE WEST.—Farms that cover not acres but square miles, crops that aggregate not simply bushels, but car-loads, have rendered it necessary to plant and harvest on an unprecedented scale in the middle West. The ingenious agricultural machinery which has been designed to cope with these peculiar conditions is described and illustrated.

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etc., to install a plant for manufacturing condense malted and evaporated milk. Inquiry No. 9034.— rmanufacturers of ery that could reduce stumps to kindling wood.			
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٦.	M. Berliner	54	
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above described, powerful electric motors are started by throwing in a switch. The e motors derive their energy from storage batteries c tai ed in the boat, and drive the propellers. The same storage batteries furnish current for numerous auxiliary motors used for pumping, steering, handling torpedoes, etc.

The motion of the boat when under way is controlled by two sets o rudders; one of these sets, kno n as the vertical rudders, directs the boat's course to port or starboard just as does the rudder of an ordinary ship. In addition, there are provided horizontal rudders, which serve to co trol the motion of the boat in a horizontal plane; that is to say, the depth at which she runs is regulated by these rudders. For steering in the horizontal plane, instruments are provided, so that the boat may be navigated with the same degree of accuracy as. boats on the surface. The first of these instruments is known as a periscope. This consists of a vertical tube which extends from above the surface of the water to a few feet within the submarine. At the top of the tube is an object glass: at the bottom an eye-piece. Two reflecting mirrors, one at the top, the other at the bottom of the vertical tube, cause the image to be transferred from the object glass to the eye-piece. The operator can turn the periscope so as to sweep the whole horizon. To the writer, who recently made a five-hour trip in one of our latest boats, the view was as clear as though he were at the surface looking through an ordinary field glass. Hence when running submerged with the top of the periscope just out of the water, the navigator can see with perfect ease surrounding objects. If for any reason it should be desired to run at a still greater depth, compasses are provided by which the course may be steered with accuracy. For steering, submerged, in the vertical plane, instruments are provided which in a way take the place of the compass. One of these is a large pressure gage, which indicates the depth at which the boat is running. Another is a form of spirit level, which indicates the inclination of her axis. By the use of this, the man controlling the horizontal rudder is able to r n at a perfectly even depth. While in the submerged condition, the boat is of course amply illuminated by electri lights. There are no ports or windows in the boat, and so far as sensations are concerned, one is unable to determine whether he is running on the surface or submerged.

The arm of the submarine is the automobile torpedo. A number of these may be carried. They are discharged through torpedo tubes located in the bow of the boat. Any modern type of automobile torpedo may be used. In view of the fact that the submarine is enabled to approach unseen to within a few yards. if desired, of the most powerful battleship, a long-range torpedo is not required. For this reason the weight devoted to motive power in the ordinary torpedo may be largely used to increase the destructive power, so that the proper arm for the submarine would be far more powerful and destructive than the ordinarv auto obile torpedo.

While the project of the submarine is comparatively old, it has so happened that but few of them have been used in real war. The first case on record is that of a little hand-power submarine boat built by David Bushnell in 1776. Having obtained permission from the American general in command to use this submarine against the English fleet anchored north of Staten Island, he instructed a sergeant named Ezra Lee in its use. After several attempts, Lee made an attack on one of the ships. His purpose was to fix a torpedo to her side, then go away and allow it to explode. thus destroying the ship. Unfortunately, the ship was sheathed with copper, and he was unable to attach his mine. Lee then drifted away from the shi, having abandoned his mine, which, after drifting about for an hour, exploded, throw

(Concluded on page 307.)

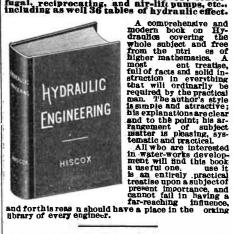
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ing up a great volume of water, and thus warning the English of the great danger they had escaped.

Another case on record is that of the Confederate submarine "David," which, during the blockade of Charleston in the civil war, was manned by volunteers, and by hand power was propelled out to the U. S. S. "Housatonic," which she destroyed by the explosion of a mine in contact with her hull.

During the Spanish-American war the modern submarine had not made its appearance. During the Russian-Japanese war both sides ordered boats, but the war was finished before these vessels became available. At present all the leading naval powers are acquiring submarines in large numbers, so that during the next war we may expect to see them figure largely in the various operations.

In the trip in a submarine above referred to the Editor was impressed with the smoothness and accuracy with which the submarine went through her submerged evolutions. The movements, quick response, etc., of the boat were such as to inspire complete confidence in her stability and general efficiency.

There can be no question that the sub marine has at last "come into its own." Among the captains of the battleships and the line officers in general at Provincetown, there was noticeable a growing respect for these craft, due to the varied and accurate work which the flotilla had accomplished during the summer maneuvers. There has been a steady but slow growth in the speed of the submarine. Its control is now perfect, and its radius of action is being rapidly increased. Our largest boats have a radius of about one thousand miles; and two are under construction on the Pacific coast which will have a cruising radius of about three thousand miles. This means that the submarine is taking on full seagoing qualities. It must no longer be regarded as restricted to seacoast operation. The time is not far distant when an admiral searching for the enemy upon the high seas may include a submarine flotilla in his fleet. The profound significance of this fact upon strategy and tactics will be appreciated by every naval expert.

In his study of living beings, the physiologist has one guiding principle which plays but little part in the sciences of the chemist and physicist, namely, the principle of adaptation. Adaptation or purposiveness is the leading characteristic of every one of the functions to which we devote in our text-books the chapters dealing with assimilation, respiration, movement, growth, reproduction, and even death itself. Spencer has defined life as "the continuous adjustment of internal relations to external relations." Every phase of activity in a living being is a sequence of some antecedent change in its environment, and is so adapted to this change as to tend to its neutralization and so to the survival of the organism. This is what is meant by adaptation. It will be seen that not only does it involve the teleological conception that every normal activity must be for the good of the organism, but also that it must apply to all the relations of living beings. It must therefore be the guiding principle, not only in physiology, with its special pre-occupation with the internal relations of the parts of the organism, but also in the other branches of biology, which treat of the relations of the living animal to its environment and of the factors which determine its survival in the struggle for existence. Adaptation therefore must be the deciding factor in the origin of species and in the succession of the different forms of life upon this earth.

In consequence of the part played by the gas-lighting equipments of the trains involved in some recent accidents, states a contemporary, the Prussian railway authorities have decided to convert all their sleeping cars now fitted for gas lighting (some 170 cars) for electric lighting.



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