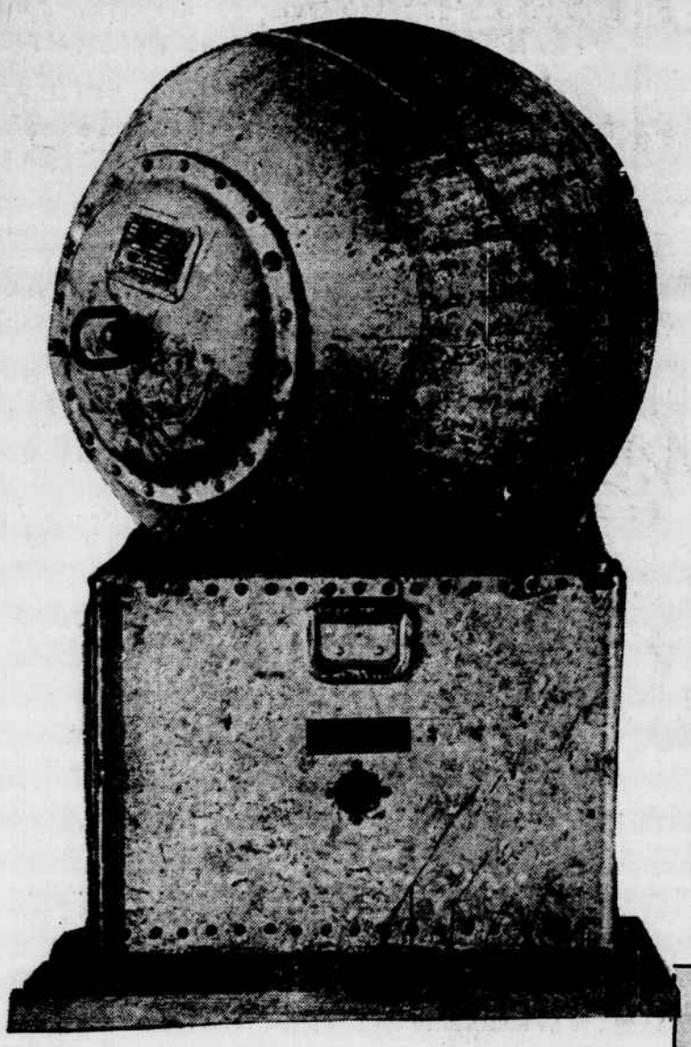
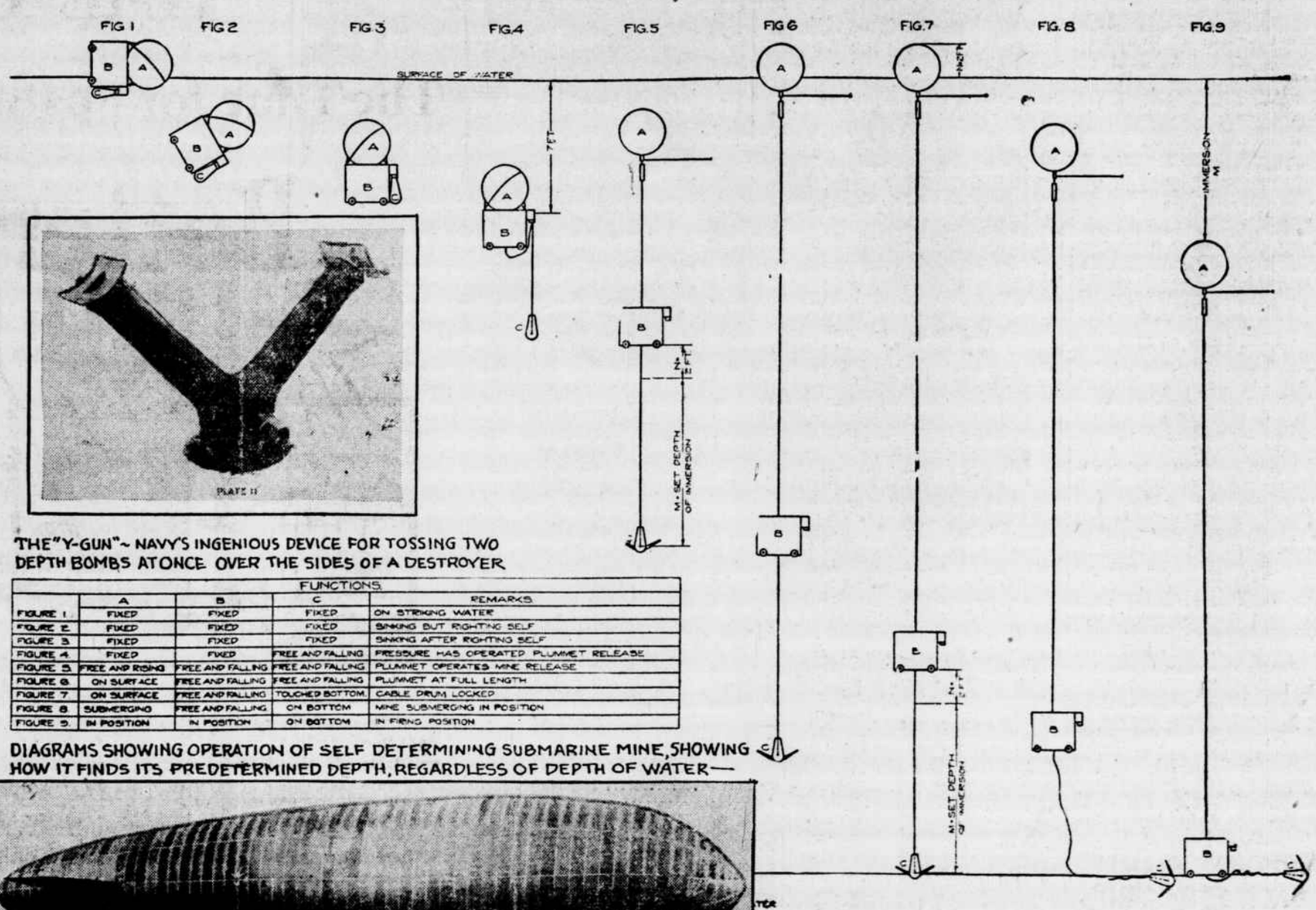
SCIENTIFIC MARVELS DEVELOPED BY WAR

A New Era in Invention—Shipbuilding Methods and Devices Worked Out by Scientifically Trained Minds of This Country.



FIRST PUBLISHED PHOTOGRAPH OF NEW TYPE AUTOMATIC-DEPTH SUBMARINE MINE, WITH BOX-LIKE ANCHOR THAT CONTAINS MECHANISM THAT REGULATES THE DEPTH. HUNDREDS OF THOUSANDS OF THESE WERE LAID IN A BARRAGE ACROSS THE NORTH SEA.

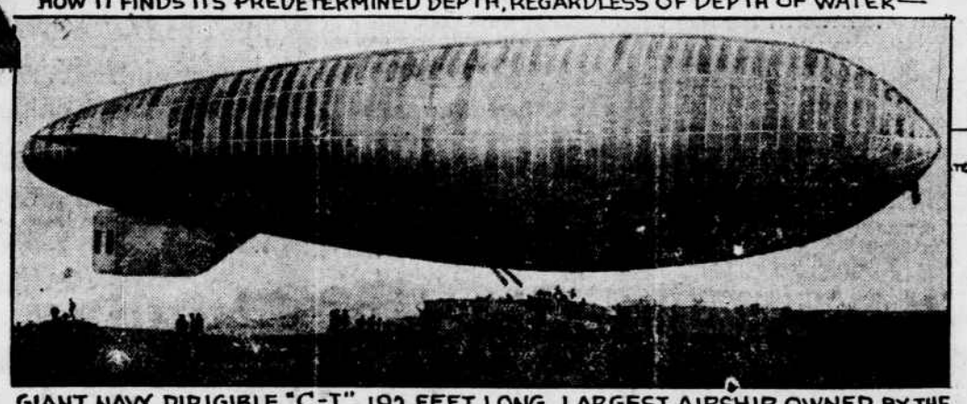
THE "Y-GUN"~ NAVY'S INGENIOUS DEVICE FOR TOSSING TWO DEPTH BOMBS AT ONCE OVER THE SIDES OF A DESTROYER



FUNCTIONS				
	A	B	C	REMARKS
FIGURE 1	FIXED	FIXED	FIXED	ON STRIKING WATER
FIGURE 2	FIXED	FIXED	FIXED	SINKING BUT RIGHTING SELF
FIGURE 3	FIXED	FIXED	FIXED	SINKING AFTER RIGHTING SELF
FIGURE 4	FIXED	FIXED	FREE AND FALLING	PRESSURE HAS OPERATED PLUMMET RELEASE
FIGURE 5	FREE AND RIDING	FREE AND FALLING	FREE AND FALLING	PLUMMET OPERATES MINE RELEASE
FIGURE 6	ON SURFACE	FREE AND FALLING	FREE AND FALLING	PLUMMET AT FULL LENGTH
FIGURE 7	ON SURFACE	FREE AND FALLING	TOUCHED BOTTOM	CABLE DRUM LOCKED
FIGURE 8	SUBMERGING	FREE AND FALLING	ON BOTTOM	MINE SUBMERGING IN POSITION
FIGURE 9	IN POSITION	IN POSITION	ON BOTTOM	IN FIRING POSITION

DIAGRAMS SHOWING OPERATION OF SELF DETERMINING SUBMARINE MINE, SHOWING HOW IT FINDS ITS PREDETERMINED DEPTH, REGARDLESS OF DEPTH OF WATER—

A-MINE, B-ANCHOR, C-PLUMMET, M-IMMERSION IN FEET, N-2 FT.-DISTANCE MINE SETS OUT OF WATER~



GIANT NAVY DIRIGIBLE "C-I", 192 FEET LONG, LARGEST AIRSHIP OWNED BY THE AMERICAN GOVERNMENT. DISCOVERY OF METHOD OF PRODUCING HELIUM GAS CHEAPLY FROM NATURAL GAS WELLS INSURES SAFETY OF AIRSHIP FROM FIRE.

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By FRANK P. STOCKBRIDGE.

It is hardly going too far to say that the most important collection of scientifically trained minds ever assembled in one place, and set to work upon a single group of related problems, was the organization of scientists, inventors and technical engineers gathered at the Navy Department in Washington known as the Naval Consulting Board, headed by the most famous inventor in the world, Thomas A. Edison. Very few people in the Navy Department, and still fewer outside of the Navy Department, realize that for practically the entire period of America's participation in the war Mr. Edison made his personal headquarters in a room in the Navy Department, close to that of the Secretary of the Navy.

He spent almost all of his time, day and night as is his custom, working upon scientific and technical problems which were under considertaion by the Naval Consulting Board; to his genius not only as an individual scientist and inventor but as a guide and inspiration to others, were due many of the devices and methods adopted by our navy both for offensive and defensive purposes which proved of immeasurable value in the destruction of German submarines and in keeping the German fleet bottled up at Wilhelmshaven and Heligoland.

Before the armistice was signed the quarters of the Naval Consulting Board and its staff of technicians had expanded until they occupied almost one entire wing of the gigantic new Navy Building in Washington, that wonderful piece of solid concrete construction containing forty-three acres of floor space, which was built, figuratively speaking, almost overnight, by the Navy Bureau of Yards and Docks. Many of the scientific discoveries and inventions which had their practical application developed by the Naval Consulting Board, are still secrets and will continue to be secrets, revealed only to the officers and men charged with responsibility for their operation.

Our army is being demobilized; its military activities are terminated for the time being at least, and in the hope of every American, permanently. But even a league of nations cannot relieve a country, with a seacoast like ours, from the necessity of policing our own shores; a league of nations, indeed, may conceivably require America to participate in the organization, maintenance and operation of an international sea police that will call for ever greater naval resources than the signing of the armistice found us possessed of, efficient and extensive as those were.

From War Work to Peace.

So while the concern of the public, other than mere curiosity, with the scientific achievements of the army, is centered chiefly and properly upon the possible application of these technical developments to the pursuits of peace, the matter of our naval strength is one of continuing interest in peace as well as in war, and even though there may be little or no direct application to industry and commerce resulting from the scientific researches and developments of the Naval Consulting Board, some of these secrets, which can now be disclosed for the first time, have an interest and importance extending beyond their usefulness in the war which has just terminated.

Of these technical secrets, so far as they may now be disclosed, perhaps the most important, as they certainly are the most spectacular, are the depth bomb and the Y-gun for tossing it over the side, the method of planting mine fields so that the mines will float at an exact predetermined depth below the surface, the discovery of a non-inflammable buoyant gas for observation balloons and dirigibles, and the perfection of the wireless telephone with its adaptation to the purpose of detecting thep resence and location of submarines.

Frequent as have been the references in the newspapers to the depth bomb or, as it is called in the navy, the depth charge, the principle upon which it operates has never been explained. It is not permissible even yet to disclose the exact details of its operation, but the rather romantic story of its genesis may be told now.

The idea of the depth bomb had its origin in the most audacious scientific "fake" of recent years. About five years ago the scientific world was startled by the announcement that a young Italian inventor had perfected a method of setting off explosives at a distance by means of wireless impulses. The story was plausible. Such wonderful things had already been accomplished by wireless, and the exact nature and possibilities of the Herzian waves were still shrouded in so much mystery, even to the scientists who had been working with them, that anything seemed possible.

Control By Wireless.

The success of John Hays Hammond, Jr., in controlling the machinery and steering of a boat at a distance by wireless had received much deserved publicity; I shall refer in a later article to some of Mr. Hammond's contributions to our navy's technical resources during the war. Nicola Tesla had demonstrated wonderful phenomena attributable to the wireless transmission of electrical impulses.

So when this young Italian announced that he could not only set off a charge of explosives at a distance of several kilometres by wireless impulses, but could control and direct those impulses so that they would travel only at a certain angle and in a given direction, even the most wary scientists received the announcement with an open mind, while technical men not specially skilled in wireless affairs were almost convinced by the mere statement.

The naval value of such an invention would obviously be enormous. If wireless impulses could be directed against an enemy battleship, and thereby cause its mechanism to explode, naval warfare would be revolutionized if not abolished. It is no wonder, therefore, that the Italian Admiralty accepted the young inventor's invitation to a demonstration of his remarkable achievement. Two wireless power stations had been set up some distance apart. It was explained by the inventor that he had not yet so perfected the details that he was able to turn the Herzian waves at will in any direction.

High Explosive Bomb.

He had, however, arranged his wireless projectors, he said, so that the waves from the two crossed at or about a certain point and at this angle, formed by the two streams of wireless waves, any explosive that might be present would be immediately set off.

He had prepared a bomb. The bomb contained a charge of high explosive. It was surrounded by buoyant material wrapped tightly with many wrappings of heavy cord, and varnished so as to be waterproof; the bomb obviously contained no mechanism other than the charge of explosive. The angle formed by the crossing of the two lines of wireless waves, the inventor explained, occurred somewhere in mid-channel in one of the Italian rivers. He was not able to determine the exact point, so the bomb was dropped into the stream and allowed to float down.

Sure enough, when it reached a point approximately where the inventor said it would intercept the two wireless impulses, the bomb exploded. The Admirals and Italian Government officials present were duly impressed. They begged for another demonstration. Not long afterward the same experiment was tried with the same result. The story got into the newspapers. It was printed in the European press; it was cabled to America. Full-page articles were given in the Sunday papers and several other demonstrations were regarded as of sufficient importance to justify cabling the news that they had occurred.

Then, one day, the cables carried the news that the young Italian inventor had eloped with the daughter of the Admiral who had been supervising the experiments for the Italian Government. Nothing more was heard of the inventor. Partially completed bombs found in his laboratory were examined. It was found that they would explode, when placed in water, after a certain period of immersion.

A tiny, almost invisible pin-hole, penetrating from the outside to the interior, admitted water after a slight lapse of time, to contact with a pellet of metallic sodium. Sodium, on contact with water, bursts into a violent flame with accompanying high temperature, and it was this little pellet of sodium that set off the explosive charge, through the action of the water, when the bomb had been in the stream long enough for the water to reach the sodium. The wireless control stations were "fakes." The entire object, so far as anyone has discovered, of the young inventor's effort, was to win the affections of the Admiral's daughter. In this respect his invention may be said to have been a success.

Water Contact Explosive.

It was the suggestion of setting off an explosive by means of water contact which could be delayed until the bomb had been in the water a certain length of time or had reached a certain depth that formed the basis of the invention of the submarine depth charge. The depth charge itself looks like nothing so much as an ordinary galvanized ash can. It is a cylinder, thirty inches high and twenty inches in diamenter. It contains in its interior about seventy-five pounds of trinitroxylol, an explosive even more powerful than the famous TNT.

The mechanism by which this explosive is set off is simple and sturdy enough to be practically fool-proof, and yet at the same time can be regulated with such delicacy of adjustment that the charge will inevitably explode at precisely the predetermined depth, as indicated by a scale and an adjustable pointer on the exterior of the bomb. Water is not admitted to the interior until the external pressure has rached a point which depends upon the depth below the surface. The instant this depth is reached, however, whether it be thirty feet or three hundred feet, the explosion occurs, and so precise and accurate is the operation of the depth charge that there is not recorded a single failure to perform exactly as planned.

Depth bombs are fired in pairs from the Y-gun. In the beginning of their usefulness they were simply dropped overboard from the stern of a destroyer or submarine chaser, which immediately proceeded to go away from there at full speed. By means of the Y-gun, two depth charges at once are tossed overboard, striking the water a sufficient distance from the vessel to minimize the danger, although at no time do naval men care to linger long in the neighborhood where a depth charge has just been dropped.

The Y-gun looks like nothing so much as the familiar "siamese coupler" seen in front of tall buildings, to enable the Fire Department to attach two lines of hose to a single standpipe. It is merely a gun with two barrels, set at an angle of about ninety degrees to each other, both barrels being fired by a single charge which is placed in a chamber in the neck of the Y. The depth charge is laid on its side in a cradle, shaped to hold it in position, the cradle having attached to it a stem or arbor which exactly fits the bore of the Y-gun.

Navy Invents Y-gun.

The powder charge used to fire the Y-gun is not as great as that used in the ordinary one-pounder naval quick firing gun. Nothing could be simpler and, as the experience of our destroyers and submarine chasers—all of which are equipped with the Y-gun and a supply of depth charges—demonstrates, nothing could be more effective for the destruction of submarines, once their presence has been detected, than the depth charge. From the viewpoint of military effectiveness the depth charge and the Y-gun probably rank first among the scientific achievements of the Naval Consulting Board.

The biggest single military job our navy did in the war was the laying of a mine barrage across the principal channels of the North Sea, a barrage which could have have been and doubtless would have been extended, had the war continued, so as to make it absolutely certain that any attempt on the part of the German fleet to come out would have resulted in complete disaster. The speed and efficency with which these mines were laid excited the wonder and admiration of the personnel of the British naval forces with which our navy was co-operating.

The mines themselves are marvels of Yankee ingenuity, as well as the method of laying them. A mine laying ship could steam ahead at full speed and lay mines at exactly regular intervals, each mine being anchored in place and so attached to its anchor as to float at an exact predetermined depth below the surface of the water. Our North Sea barrage consisted of some hundreds of thousands of mines placed at three different depths in parallel rows, from seven to fifteen feet below the surface of the water.

How mines can be tossed overboard in a heavy sea, with the sure knowledge that they will remain floating at a fixed spot and at a fixed depth below the level of the water, is a puzzle that even many men in the navy who have been actually engaged in this mine laying work do not fully understand. It is easy to understand how a certain length of cable may be attached to an anchor at the end and a mine at the other and if the depth of the water is known of course the length of the cable can be adjusted to hold the mine at a certain depth below the surface. This is the old fashioned method.

Need Careful Soundings.

It involves very careful soundings for every mine and of a certain amount of guesswork and chance. The water at the point where one mine is placed may be a hundred feet deep; twenty yards farther on, where the next mine is planted, it may be 200 feet feet deep. Another twenty yards and the depth may be 300 feet. These variations in depth make no difference whatever with the laying of the new American naval mines, the mechanism of which I shall attempt to describe as clearly as possible.

The mine itself is a simple affair, consisting of a spherical buoyant chamber containing in its interior a quantity of high explosive and with projections so arranged that a vessel striking the mine from any angle or on any side will immediately set off the explosive. The Yankee trick that enabled us to lay this great North Sea barrage lies in the mine anchor and the mechanism which it contains. The mine anchor is a cubical box of galvanized sheet iron. It is weighted on the bottom sufficiently to furnish a firm anchorage, even in storm weather, for the bomb that floats above it and to which it is attached by a thin wire cable.

Inside the square box of the anchor is a reel from which run two lengths of wire cable. One of these is attached to the mine itself and is long enough to reach from the surface approximately to the bottom in any depth of water in which it is practicable to lay mines. The other cable is attached to a solid lump of metal called a plummet. Before it is launched the mine nests in the open top of the box-like anchor and is attached by a simple catch which loops over a projection on the mine itself. On the bottom of the anchor box are four flanged wheels which run on rails laid on the deck of the mine laying ship.

These rails lead to the stern of the ship and end there at a port through which the mine is launched overboard. Two, three, four or more lines of rails, leading into the launching ports from switches and side tracks inside the ship, where the mines are stored, make it possible to launch mines at the rate of two or three a minute or even faster if necessary.

The trick that determines the depth below the surface at which the mine will float once it is anchored safely at the bottom is turned by adjusting the length of the cable to which the plummet is attached before the mine is launched. Is it desired to have the mine float at a depth of seven feet below the surface? Then the plummet line is exactly seven feet long, and this is what happens when the mine, nested in its anchor box, is dropped overboard:—

Water Frees Trigger.

First the entire apparatus starts to sink, the weight of the anchor dragging the buoyant mine below the surface. A few feet below the surface the water pressure acts upon a trigger, releasing it, and thereby unfastening the catchi that holds the mine to the anchor box. The mine rises to the surface, the anchor box continues to sink, its downward progress now accelerated, since it is relieved of the buoyancy of the mine. But the solid plummet has reached the end of its cable and is hanging at the same distance below the anchor that it is desired to have the mine float below the surface.

So long as the weight of the plummet is suspended from the anchor box the windlass or reel from which the mine cable is paid out continues to function and the anchor descends, with the mine itself still floating on the surface. The instant the plummet touches bottom the removal of the strain on the plummet cable releases a catch inside the anchor box, which locks the reel and prevents the paying out of any more cable.

If the plummet cable is seven feet long it is quite apparent that this locking of the reel will occur when the anchor is just seven feet from the bottom. But the anchor continues to sink and pull the mine down with it, now that the mine cable no longer runs freely from the reel. The mine itself, therefore, is drawn down from the surface to a depth of seven feet or to such other depth as may have been determined in advance by the length of the cable of its particular plummet.

This method of planting mines, and the mine anchor mechanism that makes it possible to lay them rapidly and in large numbers, has been among the most carefully guarded of the navy secrets.

Naval Aviation Work.

Because so much has been said and written about military and naval aviation the impression prevails that the dirigible balloon has proved a failure and that lighter than air types of aircraft are of no importance. Quite the contrary is true. The so-called "sausage" type of captive balloon is one of the most important elements in the observation service of war on land. The development by the navy of the kite balloon, which at a height of a mile or less is towed behind a ship, gives a wider range of observation of the enemy's movements than would be possible in any other way. And the dirigible itself, both the rigid or Zeppelin and non-rigid or "Blimp" type, have been highly developed by the navy.

A very important part of our Navy Department's programme for a larger navy consists in material additions to the fleet of dirigible balloons, and it is due to the work of the scientists of the Naval Consulting Board that the dirigible has now become very much the safest and surest machine for aerial navigation.

Instead of the Zeppelin being a failure, it was in every respect, except that of its extreme vulnerability to direct attack, a great success. The Zeppelin, like every other type of balloon, had the weakness, however, that the only lighter than air gas available in large quantities for filling it was hydrogen, which is the most inflammable of all gases. A single incendiary bullet piercing the envelope of a military balloon ignites the hydrogen, and the balloon crashes to earth in flames. It was only by being set afire that Zeppelins were brought down.

To obtain a substitute for hydrogen was regarded as impossible. The problem was undertaken by American scientists, however, and efforts were directed toward possible sources of supply of the gas helium, the strange substance found in minute quantities in atmospheric air, discovered about fifteen years ago by Lord Rayleigh and Sir William Ramsay. Helium is only slightly heavier than hydrogen, but it is entirely non-inflammable.

Helium Ten Cents a Foot.

Army and navy scientific investigators and experts of the Bureau of Mines co-operated in the effort to solve the problem. It was known that helium is found wherever radio-active minerals are present. Some of the oil wells in the Texas fields were known to produce radio-active substances. A series of experiments disclosed the presence of helium in fairly large quantities in the natural gas obtained from wells in the vicinity of Petrolia, Texas.

By a process of refrigeration and compression this gas was treated first for the removal of its gasolene content and then for the extraction of the helium. It was found that, taking the value of the gasolene and other by-products into consideration, the actual cost of the helium so produced was only ten cents a cubic foot. The cheapest it had ever before been produced for was $1,500 a cubic foot!

Government Now Owns Pipe Lines.

As a result of long and patient experiment and triumph over obstacles the United States now owns pipe lines connecting a number of Texas gas wells with a central compression and storage plant, where helium is confined under pressure in hermetically sealed tanks, in which it can easily be transported to any point where balloons are to be charged. With the navy planning the establishment of balloon observation posts every few miles along all our coasts, as well as the construction of many more great dirigibles, some of them of the Zeppelin type, the importance of this source of supply of a safe gas for inflating balloons can hardly be overestimated.

So far from having finally settled the controversy between the advocates of the heavier than air airplane and the lighter than air airship, the experience of the war has simply opened the question still wider. The advisability of an unlimited supply of helium gas at a low price has already given encouragement to the adherents of the dirigible as opposed to the plane, and predictions of globe encircling non-stop flights in aircraft, capable of carrying a hundred or more passengers, are being made.