INVENTIONS OF THE
GREAT WAR

PREFACE

The great World War was more than two-thirds over when America entered the struggle, and yet in a sense this country was in the war from its very beginning. Three great inventions controlled the character of the fighting and made it different from any other the world has ever seen. These three inventions were American. The submarine was our invention; it carried the war into the sea. The airplane was an American invention; it carried the war into the sky. We invented the machine gun; it drove the war into the ground.

It is not my purpose to boast of American genius but, rather, to show that we entered the war with heavy responsibilities. The inventions we had given to the world had been developed marvelously in other lands. Furthermore they were in the hands of a determined and unscrupulous foe, and we found before us the task of overcoming the very machines that we had created. Yankee ingenuity was faced with a real test.

The only way of overcoming the airplane was to build more and better machines than the enemy possessed. This we tried to do, but first we had to be taught by our allies the latest refinements of this machine, and the war was over before we had more than started our aerial program. The machine gun and its accessory, barbed wire (also an American invention), were overcome by the tank; and we may find what little comfort we can in the fact that its invention was inspired by the sight of an American farm tractor. But the tank was a British creation and was undoubtedly the most important invention of the war. On the sea we were faced with a most baffling problem. The U-boat could not be coped with by the building of swarms of submarines. The essential here was a means of locating the enemy and destroying him even while he lurked under the surface. Two American inventions, the hydrophone and the depth bomb, made the lot of the U-boat decidedly unenviable and they hastened if they did not actually end German frightfulness on the sea.

But these were by no means the only inventions of the war. Great Britain showed wonderful ingenuity and resourcefulness in many

directions; France did marvels with the airplane and showed great cleverness in her development of the tank and there was a host of minor inventions to her credit; while Italy showed marked skill in the creation of large airplanes and small seacraft.

The Central Powers, on the other hand, were less originative but showed marked resourcefulness in developing the inventions of others. Forts were made valueless by the large portable Austrian guns. The long range gun that shelled Paris was a sensational achievement, but it cannot be called a great invention because it was of little military value. The great German Zeppelins were far from a success because they depended for their buoyancy on a highly inflammable gas. It is interesting to note that while the Germans were acknowledging the failure of their dirigibles the British were launching an airship program, and here in America we had found an economical way of producing a non-inflammable balloon gas which promises a great future for aerial navigation.

The most important German contribution to the war—it cannot be classed as an invention—was poison gas, and it was not long ere they re-

gretted this infraction of the rules of civilized warfare adopted at the Hague Conference; for the Allies soon gave them a big dose of their own medicine and before the war was over, fairly deluged them with lethal gases of every variety.

Many inventions of our own and of our allies were not fully developed when the war ended, and there were some which, although primarily intended for purposes of war, will be most serviceable in time of peace. For this war was not one of mere destruction. It set men to thinking as they had never thought before. It intensified their inventive faculties, and as a result, the world is richer in many ways. Lessons of thrift and economy have been taught us. Manufacturers have learned the value of standardization. The business man has gained an appreciation of scientific research.

The whole story is too big to be contained within the covers of a single book, but I have selected the more important and interesting inventions and have endeavored to describe them in simple language for the benefit of the reader who is not technically trained.

A. Russell Bond

New York, May, 1919

CONTENTS

LIST OF ILLUSTRATIONS

(C) Underwood & Underwood

Lines of Zig-Zag Trenches as viewed from an Airplane

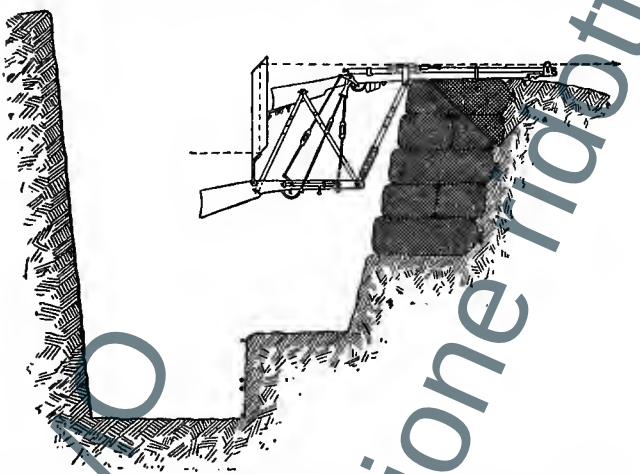
Courtesy of "Scientific American"

French Sappers using Stethoscopes to detect the Mining Operations of the Enemy

to drive the invaders out of the country. The construction of the trenches along some parts of the battle-line was particularly difficult, because of the problem of drainage. This was especially true in Flanders, where the trenches in many cases were below water-level, and elaborate pumping-systems had to be installed to keep them dry. Some of them were concrete-lined to make them waterproof. In the early stages of the war, before the trenches were drained, the men had to stand in water for a good part of the time, and the only way they could get about at all in the miry trenches was by having "duck-boards" in them. Duck-boards are sections of wooden sidewalk such as we find in small villages in this country, consisting of a couple of rails on which crosspieces of wood are nailed. These duck-boards fairly floated in the mud.

Some of the trenches were provided with barbed-wire barriers or gates calculated to halt a raiding-party if it succeeded in getting into the trench. These gates were swung up out of the way, but when lowered they were kept closed with a rather complicated system of bolts which the enemy would be unable to unfasten

rubbish, tin cans, or any object that had been penetrated by a bullet and note the direction taken by the bullet. This would give a line leading toward the source of the shot, and when a number of such lines were traced, they



Redrawn from Military Map Reading by permission of E. C. McKay

FIG. 1. A "sniperscope" with which a sharpshooter could take aim without showing his head above the parapet

would cross at a spot where the sniper or his gun was stationed, and a few shell would put the man out of business. Dummy heads of papier mâché were sometimes stuck above the parapet to draw the fire of enemy snipers and the bullet-holes which quickly ap-

peared in them were studied to discover the location of the snipers.

Sometimes fixed rifles were used. These were set on stands so that they could be very accurately trained upon some important enemy

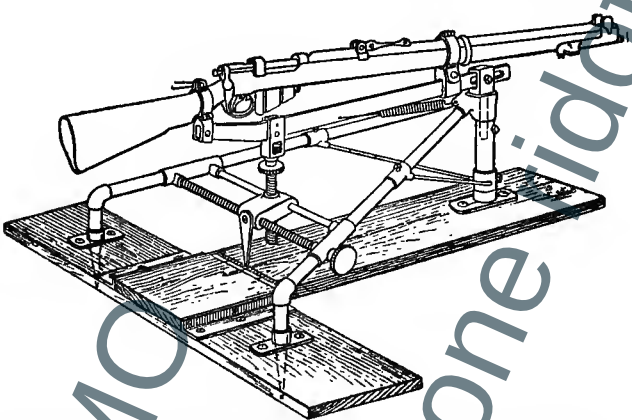


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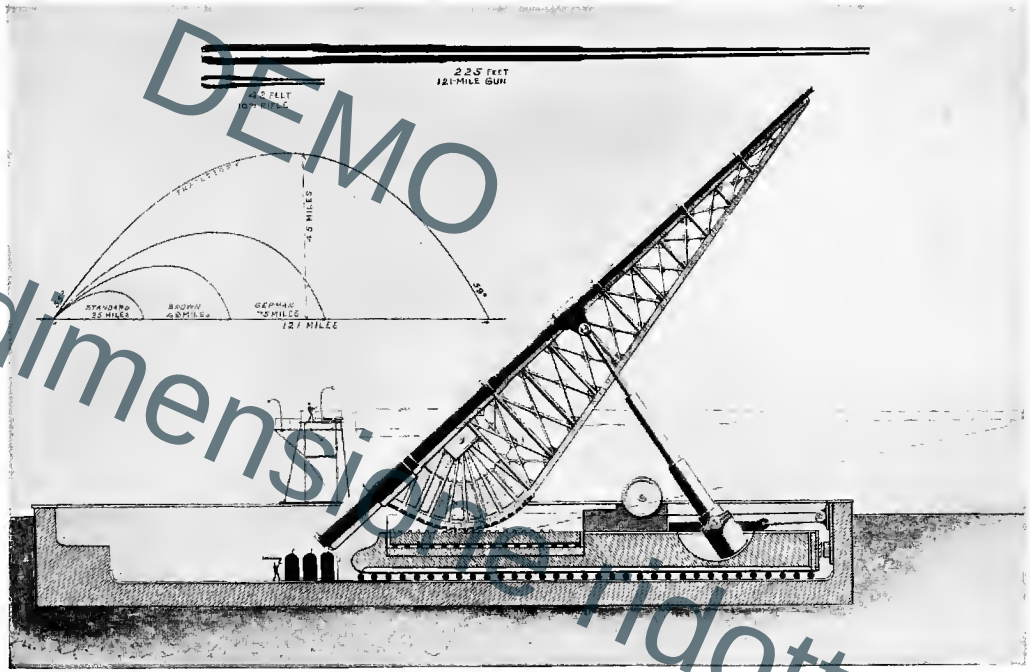
FIG. 2. A fixed rifle stand arranged to be fired after dark

post. Then they could be fired in the dark, without aiming, to disturb night operations of the enemy. Often a brace of rifles, as many as six, would be coupled up to be fired simultaneously, and by operating a single lever each gun would throw out the empty cartridge shell and bring a fresh one into position.



Courtesy of "Scientific American"

The 121-Mile Gun designed by American Ordnance Officers.

(C) Underwood & Underwood

American 16-Inch Rifle on a Railway Mount

much more without using some special support for the muzzle end of the gun, to keep it from "whipping" too much. It is likely that the long-range German gun was provided with a substantial support at the muzzle to keep it from sagging.

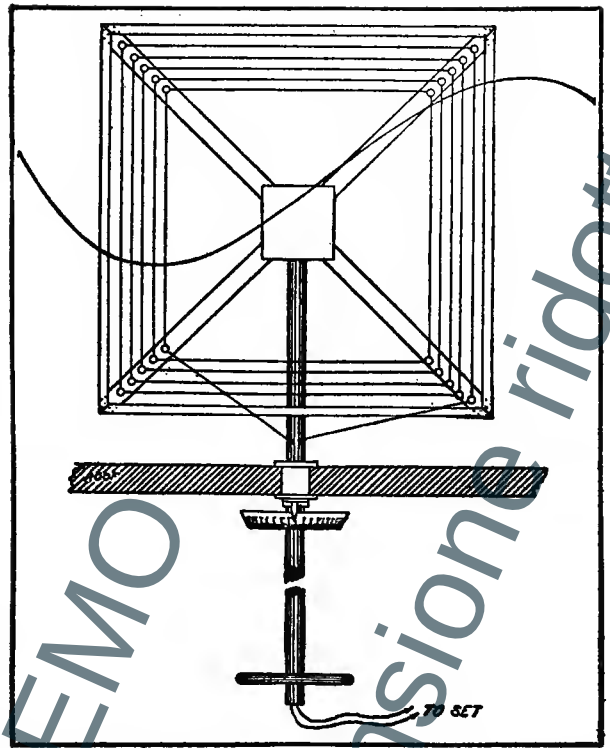
Every once in a while a man comes forth with a "new idea" for increasing the range. One plan is to increase the powder-pressure. We have powders that will produce far more pressure than an ordinary gun can stand. But we have to use powders that will burn comparatively slowly. We do not want too sudden a shock to start with, but we wish the powder to give off an enormous quantity of gas which will keep on pushing and speeding up the shell until the latter emerges from the muzzle. The fifty-mile gun that was proposed twenty years ago was designed to stand a much higher pressure than is commonly used, and it would have fired a 10-inch shell weighing 600 pounds with a velocity of 4,000 feet per second at the muzzle.

The Allies built no "super-guns," because they knew that they could drop a far greater quantity of explosives with much greater accuracy from airplanes, and at a much lower

Liquid Fire Streaming from Fixed Flame-throwing Apparatus

Courtesy of "Scientific American"

Cleaning Up a Dugout with the "Fire Broom"



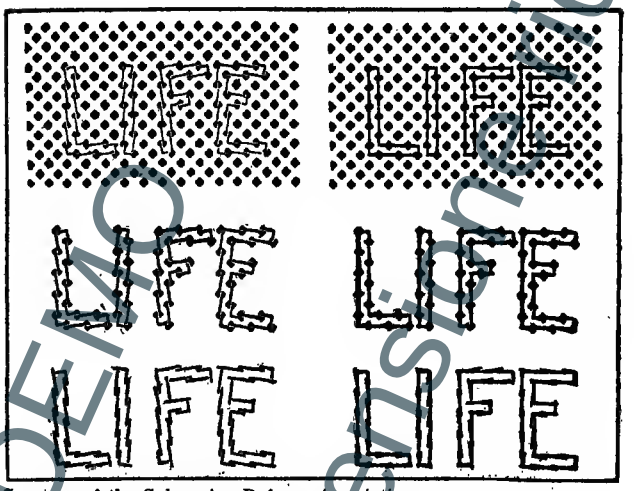
Courtesy of the "Scientific American"

FIG. 11. The radio compass turned parallel to an oncoming electro-magnetic wave

Observing the Enemy from a Papier-Mâché Replica of a Dead Horse

FIG. 13. Parallel lines that look straight

FIG. 14. Parallel lines that do not look straight



Courtesy of the Submarine Defense Association

FIG. 15. Letters that look all higgledy-piggledy, but are really straight

Fig. 14, and they no longer look straight. Take the letters on the left, Fig. 15. They look all higgledy-piggledy, but they are really straight and parallel, as one can prove by laying a straight-edge against them, or by drawing a straight line through each letter, as shown at the right, Fig. 16. Such illusions were used on ships. Stripes were painted on the hull that tapered slightly, from bow to stern, so that the vessel appeared to be headed off at an angle, when it was really broadside to the watcher at the other end of the periscope.

There are color illusions, too, that were tried. If you draw a red chalk-mark and a blue one on a perfectly clean blackboard, the red line will seem to stand out and the blue one to sink into the black surface of the board, because your eye has to focus differently for the two colors, and a very dazzling effect can be had with alternating squares of blue and red. Other colors give even more dazzling effects, and some of them, when viewed at a distance, will blend into the very shade of gray that will make a boat invisible at six miles. When U-boat commanders took observations on a ship painted with a "dazzle" camouflage, they saw a shimmering

image which it was hard for them to measure on the fine graduations of their periscopes. Some ships were painted with heavy blotches of black and white, and the enemy making a hasty observation would be apt to focus his attention on the dark masses and overlook the white parts. So he was likely to make a mistake in estimating the height of the smoke-stack or in measuring the apparent length of a vessel.

A JOKE ON THE PHOTOGRAPHER

Early in the submarine campaign one of our boats was given a coat of camouflage, and when the vessel sailed from its pier in the North River, New York, the owners sent a photographer two or three piers down the river to photograph the ship as she went by. He took the picture, but when the negative was developed, much to his astonishment he found that the boat was not all on the plate. In the finder of his camera, he had mistaken a heavy band of black paint for the stern of the ship, quite overlooking the real stern, which was painted a grayish white. The artist had fooled the photographer and at a distance of not more than two or three hundred yards!

SEEING BEYOND THE HORIZON

The periscope of a submarine that is running awash can be raised about fifteen feet above the water, which means that the horizon as viewed from that elevation is about six miles away, and if you draw a circle with a six-mile radius on the map of the Atlantic, you will find that it is a mere speck in the ocean; but a U-boat commander could see objects that lay far beyond his horizon because he was searching for objects which towered many feet above the water. The smoke-stacks of some vessels rise a hundred feet above the water-line, and the masts reach up to much greater altitudes. Aside from this, in the early days of the war steamers burned soft coal and their funnels belched forth huge columns of smoke which was visible from twenty to thirty miles away.

When this was realized, efforts were made to cut down the superstructure of a ship as much as possible. Some vessels had their stacks cut down almost to the deck-line, and air-pumps were installed to furnish the draft necessary to

keep their furnaces going. They had no masts except for slender iron pipes which could be folded down against the deck and could be erected at a moment's notice, to carry the aërials of the wireless system. Over the ship from stem to stern was stretched a cable, familiarly known as a "clothes-line," upon which were laid strips of canvas that completely covered the superstructure of the ship. These boats lay so low that they could not be seen at any great distance, and it was difficult for the U-boats to find them. They were slow boats; too slow to run away from a modern submarine, but because of their lowly structure, they managed to elude the German U-boats. When they were seen, the U-boat commanders were afraid of them. They were suspicious of anything that looked out of the ordinary, and preferred to let the "clothes-line ships" go.

THE BRITISH MYSTERY SHIPS

The Germans had some very unhealthy experiences with the "Q-boats" or "mystery ships" of the British. These were vessels rigged up much like ordinary tramp steamers, but they were loaded with wood, so that they

(C) Committee on Public Information From Western Newspaper Union

Camouflaged Headquarters of the American 26th Division in France.

(C) Underwood & Underwood

A Camouflaged Ship in the Hudson River on Victory Day

to destroy them. But occasionally, when conditions permitted, mine-sweepers undertook to raise the mines and reclaim them for future use against the enemy. The work of seizing a mine and making it fast to the hoisting-cable of the mine-sweeper was usually done from a small rowboat. Raising the first mine was always the most perilous undertaking, because no one knew just what type of mine it was and how to handle it with safety, or whether there was any way in which it *could* be made harmless. There were some mines, for instance, that contained within them a small vial partly filled with sulphuric acid. The mine carried no prongs, but if it were tilted more than twenty degrees the acid would spill out and blow up the mine. Such a mine would be exceedingly difficult if not impossible to handle from a boat that was rocked about by the waves.

After the first mine of the field was raised and its safety-mechanism studied, the task of raising the rest was not so dangerous. A water telescope was used to locate the mine and to aid in hooking the hoisting-cable into the shackle on the mine. The hook was screwed to the end of a pole and after the mine was

hooked, the pole was unscrewed and the cable hauled in, bringing up the "devil's egg" bristling with death. Care had to be taken to keep the bobbing boat from touching the delicate prongs until the safety-device could be set.

However, this painstaking and careful method of raising mines was not often employed. Shallow-draft mine-sweepers would run over the mine-field, dragging a cable between them. The cable would be kept down by means of hydrovanes or "water kites" deep enough to foul the anchor cables of the mines. The "water kites" were V-shaped structures that were connected to the cable in such a way that they would nose down as they were dragged through the water and carry the cable under. The action is just the reverse of a kite, which is set to nose up into the wind and carry the kite up when it is dragged through the air. By means of the cable the anchor chain of the mine was caught and then the mine with its anchor was dragged up. If the mine broke loose from its anchor it could be exploded with a rifle-shot if it did not automatically explode on fouling the cable.

FLOATING MINES

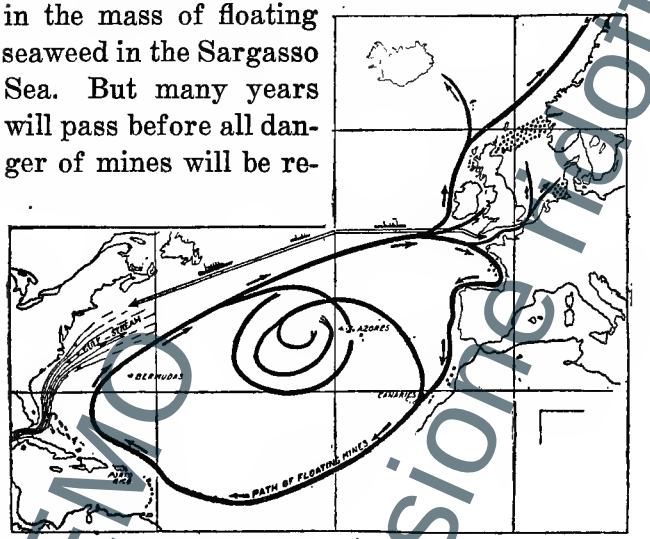
When England entered the war she mined her harbors because, although she had the mastery of the sea, she had to guard against raids of enemy ships carried out in foggy and dark weather. But the mines were no protection against submarines. They would creep along the bottom under the mines. Then cable nets were stretched across the harbor channels to bar the submarines, but the U-boats were fitted with cutters which would tear through the nets, and it became necessary to use mines set at lower depths so that the submarines could not pass under them; and nets were furnished with bombs which would explode when fouled by submarines. In fact, mines were set adrift with nets stretched between them, to trap submarines. Floating mines were also used by the Germans for the destruction of surface vessels and these were usually set adrift in pairs, with a long cable connecting them, so that if a vessel ran into the cable the mines would be dragged in against its hull and blow it up.

The laws of war require that floating mines be

of such a design that they will become inoperative in a few hours; otherwise they might drift about for weeks or months or years and be a constant menace to shipping. Sometimes anchored mines break away from their moorings and are carried around by ocean currents or are blown about by the winds. A year after the Russo-Japanese War a ship was blown up by striking a mine that had been torn from its anchorage and had drifted far from the field in which it was planted. No doubt there are hundreds of mines afloat in the Atlantic Ocean which for many years to come will hold out the threat of sudden destruction to ocean vessels; for the Germans knew no laws of war and had no scruples against setting adrift mines that would remain alive until they were eaten up with rust.

The chart on the next page shows the course of ocean currents in the North Atlantic as plotted out by the Prince of Monaco, from which it may be seen that German mines will probably make a complete circuit of the North Atlantic, drifting down the western coast of Europe, across the Atlantic, around the Azores,

and into the Gulf Stream, which will carry them back to the North Sea, only to start all over. (See Fig. 23.) Some of them will run up into the Arctic Ocean, where they will be blown up by striking icebergs and many will be trapped in the mass of floating seaweed in the Sargasso Sea. But many years will pass before all danger of mines will be removed. In the meantime, the war has left a tremendous amount of work to be done in raising anchored mines and destroying them.



Courtesy of the "Scientific American"

FIG. 23. Ocean currents of the North Atlantic showing the probable path of drifting mines

(C) Press Illustrating Service

A Dutch Mine-sweeper engaged in clearing the North Sea of German Mines

Courtesy of "Scientific American"

Hooking Up Enemy Anchored Mines

THE AWKWARD "EAGLES"

A curious boat that we undertook to furnish during the war was a cross between a destroyer and a submarine-chaser. After the submarine had been driven out to sea its greatest foe was undoubtedly the destroyer, and frantic efforts were made to turn out as many destroyers as possible. But it takes time to build destroyers and so a new type of boat was designed, to be turned out quickly in large numbers. A hundred and ten "Eagles" (as these boats are called) were ordered, but the armistice was signed before any of them were put into service; and it is just as well that such was the case, for in their construction everything was sacrificed to speed of production. As a consequence they are very ugly boats, with none of the fine lines of a destroyer, and they roll badly, even when the sea is comparatively peaceful. They are five-hundred-ton boats designed to make eighteen knots, which would not have been fast enough to cope with U-boats, because the latter could make as high a speed as that themselves, when traveling on the surface, and the two 4-inch guns of the Eagles would have been far

outranged by the 5.9-inch guns of the larger U-boats.

SEAPLANE TOWING-BARGES

When the war on the U-boat was carried up into the sky, many new naval problems cropped up, particularly when German submarines chose to work far out at sea. Big seaplanes were used, but they consumed a great deal of fuel in flying out and back, cutting down by just so much their flying-radius at the scene of activities. A special towing-barge was used. These barges had trimming-tanks aft, which could be flooded so that the stern of the barge would submerge. A cradle was mounted to run on a pair of rails on the barge. The body of the seaplane was lashed to this cradle and then drawn up on the barge by means of a windlass. This done, the water was blown out of the trimming-tanks by means of compressed air and the barge was brought up to an even keel. The barge with its load was now ready to be towed by a destroyer or other fast boat to the scene of operations. There water was again let into the trimming-tanks and the seaplane was let back

into the water. From the water the seaplane arose into the air in the usual way.

Unfortunately, when the sea is at all rough it is exceedingly difficult for a seaplane to take wing, particularly a large seaplane. A better starting-platform than the sea had to be furnished. At first some seaplanes were furnished with wheels, so that they could be launched from platforms on large ships; and then, to increase the flying-radius, seaplanes were discarded in favor of airplanes. Once these machines were launched, there was no way for them to get back to the ship. They had to get back to land before their fuel was exhausted.

On the large war-vessels a starting-platform was built on a pair of long guns. Then the war-ship would head into the wind and the combined travel of the ship and of the airplane along the platform gave speed enough to raise the plane off the platform before it had run the full length of the guns. But as long as aviators had no haven until they got back to land, there were many casualties. Eager to continue their patrol as long as possible, they would sometimes linger too long before heading for home

and then they would not have enough fuel left to reach land. Many an aviator was lost in this way, and finally mother-ships for airplanes had to be built.

THE "HUSH SHIPS"

The British Navy had constructed a number of very fast cruisers to deal with any raiders the Germans might send out. These cruisers were light vessels capable of such high speeds that they could even overtake a destroyer. They were 840 feet long and their turbines developed 90,000 horse-power. The construction of these vessels was for a long time kept a profound secret and it was not until the German fleet surrendered that photographs of them were allowed to be published. Because of this secrecy the boats were popularly known as "hush-ships." They were not armored; it was not necessary to load them down with armor plate, because their protection lay in speed and they were designed to fight at very long range. In fact, they were to carry guns that would outrange those of the most powerful dreadnoughts. Our largest naval guns are of 16-inch caliber, but the "hush ships" were each to carry two

Courtesy of "Scientific American"

Electrically Propelled Boat or Surface Torpedo, Attacking a Warship, under Guidance of an Airplane Scout

Courtesy of "Scientific American"

Hauling a Seaplane up on a Barge so that it may be Towed at High Speed by a Destroyer

18-inch guns. The guns were monsters weighing 150 tons each and they fired a shell 18 inches in diameter and 7 feet long to a distance of 30 miles when elevated to an angle of 45 degrees. The weight of the shell was 3600 pounds and it carried 500 pounds of high explosive or more than is carried in the largest torpedoes.

At the 32-mile range the shell would pass through 12 inches of face-hardened armor and at half that range it would pass through armor 18 inches thick, and there is no armor afloat any heavier than this.

MOTHER-BOATS FOR AIRPLANES

Armed with such powerful guns as these, the "hush ships" would have been very formidable indeed; but when the guns were mounted on one of the cruisers, the *Furious*, they were found too powerful for the vessel. It was evident that the monsters would very seriously rack their own ship. So the guns were taken off the cruiser and it was turned into a mother-ship for airplanes. A broad, unobstructed deck was built on the ship which provided a runway from which airplanes could be launched, and this runway was actually broad enough to permit air-

planes to land upon it. Under the runway were the hangars in which the airplanes were housed. Other "hush ships" were also converted into airplane mother-boats and there were special boats built for this very purpose, although they were not able to make the speed of the "hush ships." One of these special boats had funnels that turned horizontally to carry off the furnace smoke over the stern and leave a perfectly clear flying-deck, 330 feet long.

TORPEDO-PROOF MONSTERS

As for the 18-inch guns, they were put to another use. Early in the war the British had need for powerful shallow-draft vessels which could operate off the Flanders coast and attack the coast fortifications that were being built by the Germans. The ships that were built to meet this demand were known as monitors, because like the famous "monitor" of our Civil War they carried a single turret. These monitors were very broad for their length and were very slow. At best they could make only seven knots and in heavy weather they could not make more than two or three knots.

To be made proof against torpedoes these

boats were formed with "blisters" or hollow rounded swells in the hull at each side which extended out to a distance of twelve to fifteen feet. The blisters were subdivided into compartments, so that if a torpedo struck the ship it would explode against a blister at a considerable distance from the real hull of the ship and the force of the explosion would be expended in the compartments. The blisters were the salvation of the monitors. Often were the boats struck by torpedoes without being sunk.

Unfortunately, this form of protection could not be applied to ordinary vessels, because it would have interfered seriously with navigation. The blisters made the monitors very difficult to steer and hampered the progress of a ship, particularly in a seaway.

With ships such as these the British bombarded Zeebrugge from a distance of twenty to twenty-five miles. Of course, the range had to be plotted out mathematically, as the target was far beyond the horizon of the ship, and the firing had to be directed by spotters in airplanes.

At first guns from antiquated battle-ships were used in the monitors; then larger guns

were used, until finally two of the monitors inherited the 18–inch guns of the *Furious*. A single gun was mounted on the after deck of each vessel and the gun was arranged to fire only on the starboard side. No heavily armored turret was provided, but merely a light housing to shelter the gun.

AN ELECTRICALLY STEERED MOTOR-BOAT

The British war-vessels that operated in the shallow waters off the coast of Flanders were a constant source of annoyance to the Germans. Because of the shallow water it was seldom possible for a submarine to creep up on them. A U-boat required at least thirty-five feet of water for complete submergence and it did not dare to attack in the open. This led the Germans to launch a motor-boat loaded with high explosive, which was steered from shore. The motor-boat carried a reel of wire which connected it with an operator on shore. There was no pilot in the boat, but the helm was controlled electrically by the man at the shore station. As it was diffcult for the helmsman to see just what his boat was doing, or just how to steer it when it was several miles off, an airplane flew high

above it and directed the helmsman, by radiotelegraphy, how to steer his boat. Of course, radiotelegraphy might have been used to operate the steering-mechanism of the boat, but there was the danger that the radio operators of the British might send out disturbing waves that would upset the control of the motor-boat, and so direct wire transmission was used instead. Fortunately, when the Germans tried this form of attack, an alert British lookout discovered the tiny motor-boat. The alarm was given and a lucky shot blew up the boat with its charge before it came near the British vessel.

CHAPTER XVI

Reclaiming the Victims of the Submarine

NEARLY fifteen million tons of shipping lie at the bottom of the sea, sunk by German U-boats, and the value of these ships with their cargo is estimated at over seven billion dollars. In one year, 1917, the loss was nearly a million dollars a day.

Of course these wrecks would not be worth anything like that now, if they were raised and floated. Much of the cargo would be so damaged by its long immersion in salt water that it would be absolutely valueless, but there are many kinds of merchandise that are not injured in the least by water. Every ship carries a certain amount of gold and silver; and then the ship's hull itself is well worth salving, provided it was not too badly damaged by the torpedo that sank it. Altogether, there is plenty of rich treasure in the sea awaiting the salvor who is bold enough to go after it.