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The North Sea Gate Swings Shut

Being the story of the second of the three splendid achievements of the United States Navy in the World War—the laying of the greatest submarine mine barrier in all history, which effectually prevented the Kaiser's U-boats from leaving their secret bases for the steamer lanes of the Atlantic

By KENDRICK SCOFIELD

FROM THE BOLD shore line of Scotland to the rock-ribbed coast of Norway, across the shambling reaches of the bleak North Sea, there has been stretched a barrier of death. From the surface down to the fifty-fathom depth, below which no sub-sea craft would dare to navigate, American submarine mines of a hitherto unapproached destructiveness swing in the shifting currents, anchored to the sea floor 500 to 1,000 feet beneath them. For 250 miles they present an almost impassable obstruction which at certain points reaches a thickness of thousands of yards.

The barrier, or to give it its modern designation, the barrage, is the United States Navy's answer to the challenge of the Hun U-boats. Although surrender has swept the kaiser's submersibles from the waters of the Western Ocean, the mines still guard the gates to the spawning-grounds from which the slinking submarine was wont to slip from its secret base to take its toll of innocent lives and non-combatant shipping. And more than that, it is another monument to the genius of naval ordnance, the second of the great triumvirate achievements of our sea fighters, ranking in importance with those two other magnificent accomplishments, the building of the United States Navy Railway Batteries and the construction of the oil pipe line across Scotland.

As with the Naval Batteries and the Pipe Line projects, the North Sea Barrage is distinctly an American concept and preponderantly an American performance—although officially a joint offensive of the United States and British Navies—from the moment that the United States Navy Bureau of Ordnance began working upon the germ of the idea until the time that a fleet of United States mine layers, piebald in camouflage and decks choked with perfected mines, steamed out across the North Sea, leaving a wake of death-dealing bombs under the all-concealing smoke screens from a convoy of hovering, alert destroyers.

Naval Mines

Taking the mine on board the mine layer. The mine is run in on a track.

Between the inception of the idea and the completion of the barrage there were accomplished many ponderous tasks, each a labor unto itself, yet each a part of the more gigantic work of rendering the U-boat impotent. One branch of the Ordnance Bureau developed the intricate and mechanically perfect mine, and, radically departing from custom and precedent, forced its production at the unprecedented rate of 1,000 a day, an undertaking considered well nigh impossible of realization at the outset. Another group of naval experts planned and constructed the first large capacity mine-loading plant ever built, where destructive charges of Trinitro-toluol were melted and moulded into the under-sea engines of destruction. A third contingent of naval officers procured and outfitted a fleet of mine layers. A fourth tackled and solved the problem of providing and equipping assembling plants on the coast of Scotland. A fifth made sure that the mines were transported, in spite of the menace of hostile submarines, to the permanent bases of the great mine laying operations overseas.

Upon the task there was employed a force of more than 7,000 bluejackets and their commanding officers, and for the mines alone more than $30,000,000 was expended. Yet, among the many expedients adopted by the nations at war with Germany to circumvent the U-boat in its sub-sea prowlings, the North Sea Barrage has proved the most effective in combatting submarine frightfulness. From the day the new firing device was perfected to the time the first of the mines were actually planted, less than a year elapsed.

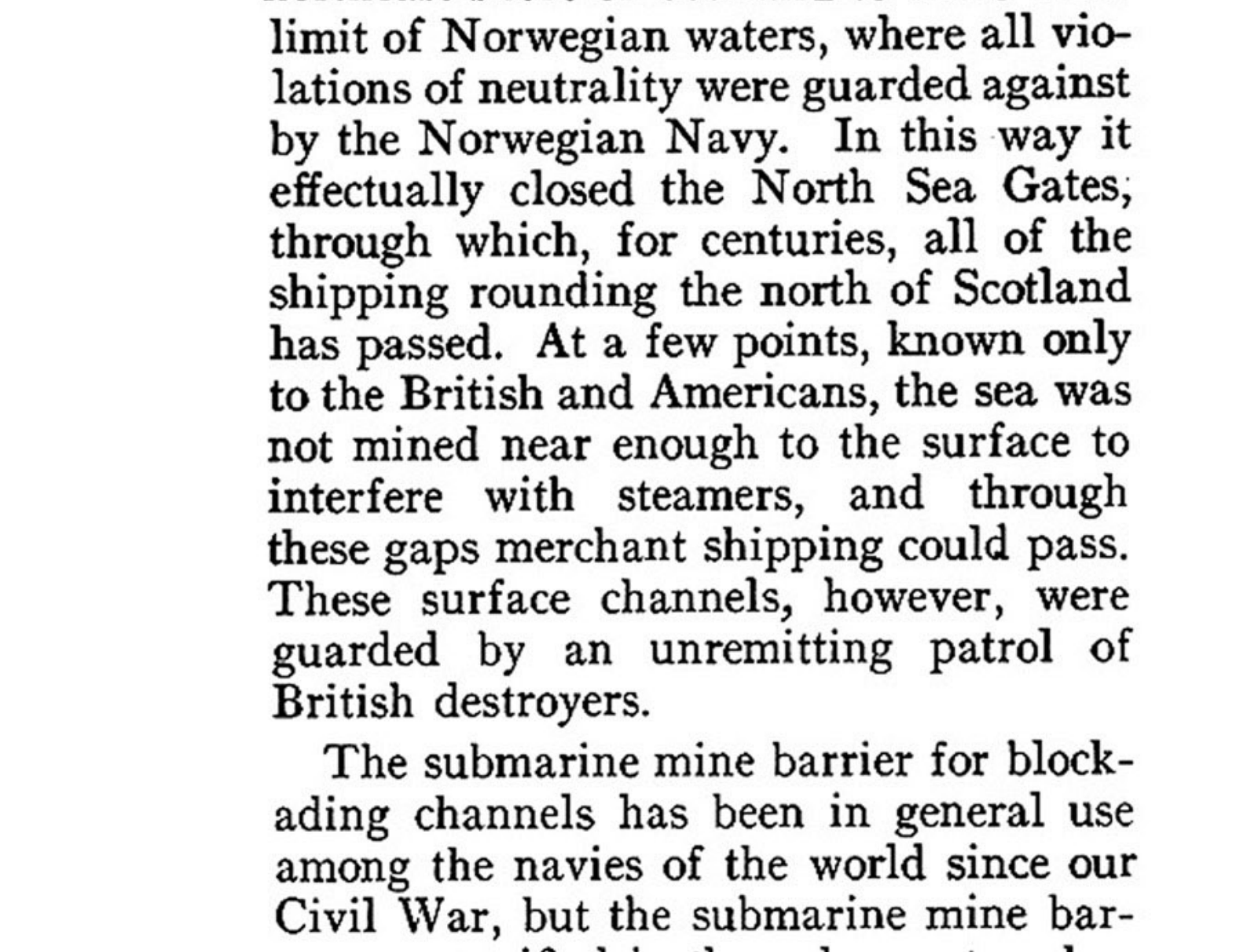
How many Hun U-boats blindly blundered on to certain and complete destruction among the mines, will naturally never be known. The great barrage was at no time patrolled in its entirety; yet strong circumstantial evidence supports the conclusion that perhaps a score of German submarines were scotched while attempting to nose a perilous way through the successive curtains of mines laid for their destruction. And added to circumstantial evidence is this significant fact: while the Associated Governments have at all times possessed remarkably accurate information as to the number of under-sea boats launched by Germany,

Destroying a defective mine. When a mine fails to submerge and anchor, a rifle shot from a destroyer removes the menace to merchant ships.

and have carefully checked against this total the number known to have been sunk or captured at sea, the original armistice terms, which called for the surrender of 160 submarines, were later changed to a much lower figure, since at the conclusion of hostilities the Hun's submersible fleet did not satisfy the number of boats demanded. The inference, therefore, is that the missing boats were lost without trace in the mined North Sea depths.

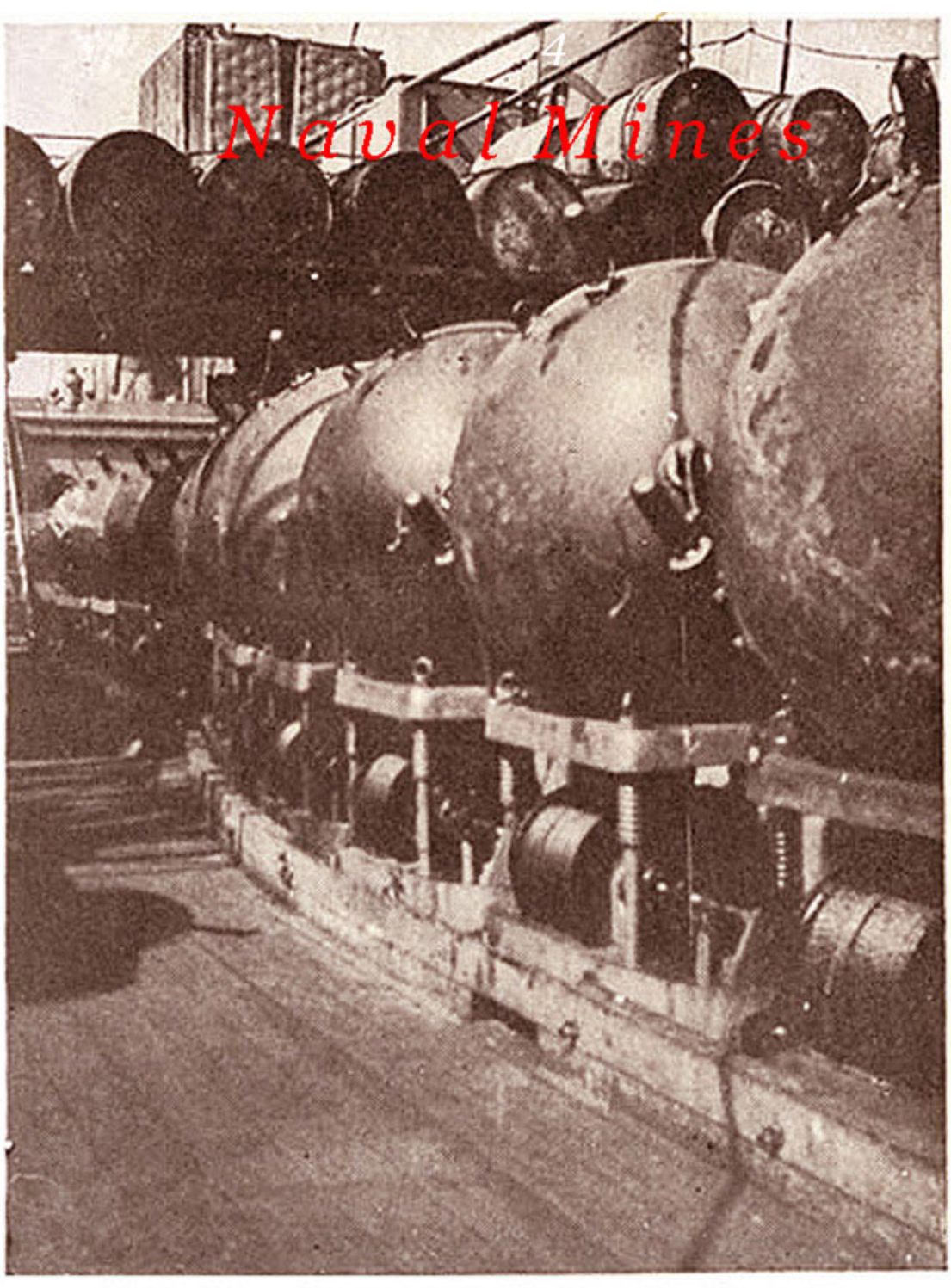
The field to-day contains, roughly, 100,000 mines, eighty-five per cent of which are American mines, laid by American planters. As vast as is this mined area, our Navy could have continued dropping the under-water bombs indefinitely, enlarging the danger space to any desired extent. When in full operation, it spreads boldly out from the northeast shore of Scotland to the 3-mile limit of Norwegian waters, where all violations of neutrality were guarded against by the Norwegian Navy. In this way it effectually closed the North Sea Gates, through which, for centuries, all of the shipping rounding the north of Scotland has passed. At a few points, known only to the British and Americans, the sea was not mined near enough to the surface to interfere with steamers, and through these gaps merchant shipping could pass. These surface channels, however, were guarded by an unremitting patrol of British destroyers.

The submarine mine barrier for blockading channels has been in general use among the navies of the world since our Civil War, but the submarine mine barrage, as typified in the only great undertaking of its kind—that in the North Sea—is, from the standpoint of its scope and the gigantic character of the under-



Mine layers steaming out to the "field" where, under smoke screen protection, they will lay the barrage against the Hun submarines.

taking, a means of offense peculiar to the great world conflict. Yet, because submarine mine operations are not in themselves new, thousands of inventors have devoted lifetimes of genius to the development of deep-water engines of destruction which may be planted in fairways and channels and left to protect rivers and harbors against the incursions of enemy craft. Back in 1585 the submarine mine made its appearance in war when an Italian engineer, during the



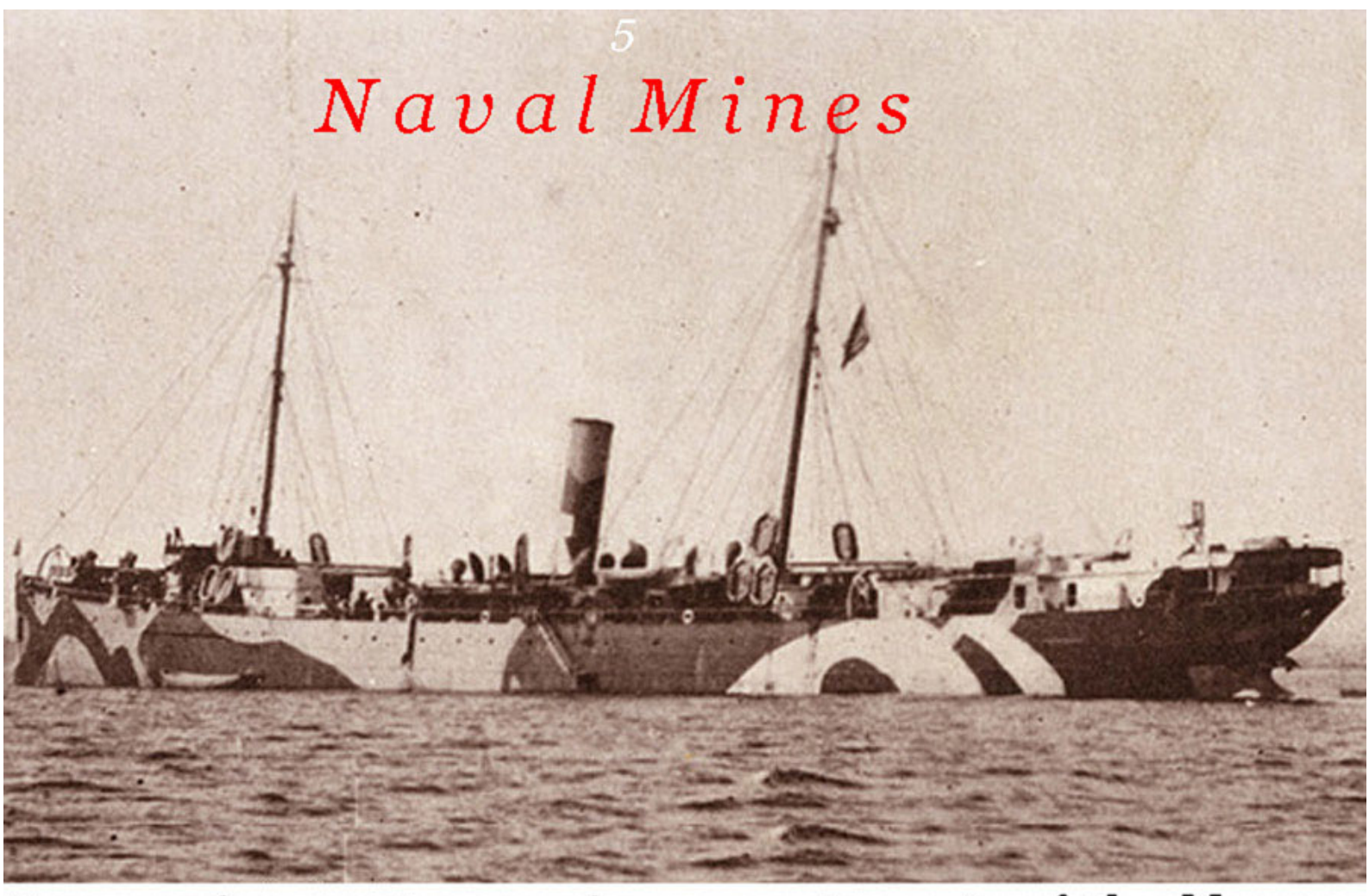
Mines resting on their tracks on board a mine layer.

siege of Antwerp, filled several small iron vessels with a crude form of gunpowder, attached an equally crude clockwork mechanism to detonate the explosive, and floated them down-stream to demolish a bridge. And so for the past century or more from time to time a great variety of submarine mines have appeared. Generally a submarine mine consists of a spherical or cylindrical member charged with an explosive —in times past gunpowder, guncotton or dynamite, and in more modern days with some such explosive as trinitro-toluol. This charge is exploded by an ignition mechanism, sometimes operating by the force of collision with its victim, sometimes by electrical current thrown on from a station ashore, and at other times by the breaking of a small phial of picric or other acid, these latter being known as "chemical mines." Both in form and manner of ignition, the types of submarine mine vary almost infinitely.

It was, therefore, only natural that when the sea wolves of the Hun began harrying commerce from the ocean lanes and shelling the open boats in which passengers and crew took uncertain refuge, that one of the first expedients to be thought of to combat this type of sea warfare was the submarine mine, for, both on sea and land, the great conflict has been pre-eminently an engineering war, not only of chemistry and explosives, but of engineering in all its branches.

From the products of the inventors of the past twenty-five years could be drawn all types of modern engines of destruction which the slightest jar would wake to infernal explosiveness, and it is no exaggeration to say that literally thousands of plans were advanced, the majority of which had to do with variations of the principles underlying the construction of the submarine mine. New mine types were added to those already extant, and combinations of mines with nets and cables were worked out in wonderful complexity and to a high degree of theoretical efficiency. Yet none of the plans suggested were considered feasible or practical in dealing with the U-boat menace. Like everything else in the world conflict, any counteroffensive against the submarine demanded something monstrous and inconceivable, something hitherto unheard of, that would carry the war into the depths of the sea and be as certain as the tides.

At the very outset of the war, the United States Navy, as the result of a long and exhaustive study of the U-boat menace from every available angle, pinned its faith on these things as possible foils for the submarine: first, a convoy system to protect ships at sea; second, a destroyer and submarine chaser patrol equipped for launching depth bombs; third, an aerial patrol using a combination contact and depth charge,



Converted coastwise merchantman, formerly of the Morgan line, now a mine layer in the war zone "piebald in camouflage."

and, fourth, the bottling of the submarines in their hidden lairs by means of a submarine mine barrage. Three of these expedients were rapidly put into operation by the Navy, but the fourth, the blockading of the U-boat bases, presented peculiar difficulties.

While the rest of the world wrestled with the knotty problem, the British Admiralty adopted a form of submarine mine obstruction for the protection of her own ports, closing the British Channel; a feat signalized by one war poet, who sang:

"We have shut the gates by Dover Straits
And north where the tide runs free;
Cheek by jowl our watchdogs prowl
Gray hulks on a grayer sea!"

But the "Gates by Dover Straits" are little more than twenty miles wide, and the water there is only about 50 fathoms deep, so that the work of the British in these waters, while the most pretentious up to that time, presented no apparently insurmountable difficulties.

To shut the U-boats in their North Sea bases, as the United States Navy desired to do, presented an entirely different problem. To accomplish this, there would be needed a curtain of mines—a barrage and not a mere obstruction—ten times as long as that stretching across the British Channel and anchored in water to sound whose greatest depths off the Norwegian Coast required a 150-fathom lead. In addition, an entirely new type of mine was demanded; one that could be absolutely depended upon to function and one which could be produced at the rate of 1,000 a day to a minimum of 100,000 mines. Again, a single line of mines would be of little value. Modern high explosive mines cannot be planted close together, for the detonation of one sets up a progressive succession of explosions capable of sweeping a mine field clear in a few moments, and, on the other hand, a ship or submarine, with moderately good luck, can easily work its way through a single line of mines planted, for instance, 200 feet apart. Therefore, a "staggered barrage" was necessary—several lines of mines laid at uncertain intervals, one behind the other, and arranged so that mines in the third or fourth row would block the gaps between mines in the first and second rows. Again, in dealing with submarines, the sea must be mined from the surface to the extreme depth to which a submarine can venture in safety without danger from hydrostatic pressure—about 300 feet—which required mining at various levels. Against such a barrier, the mathematical chances of a ship or a submarine navigating the mined areas of the North Sea would be extremely slight.

This is the way the matter was solved

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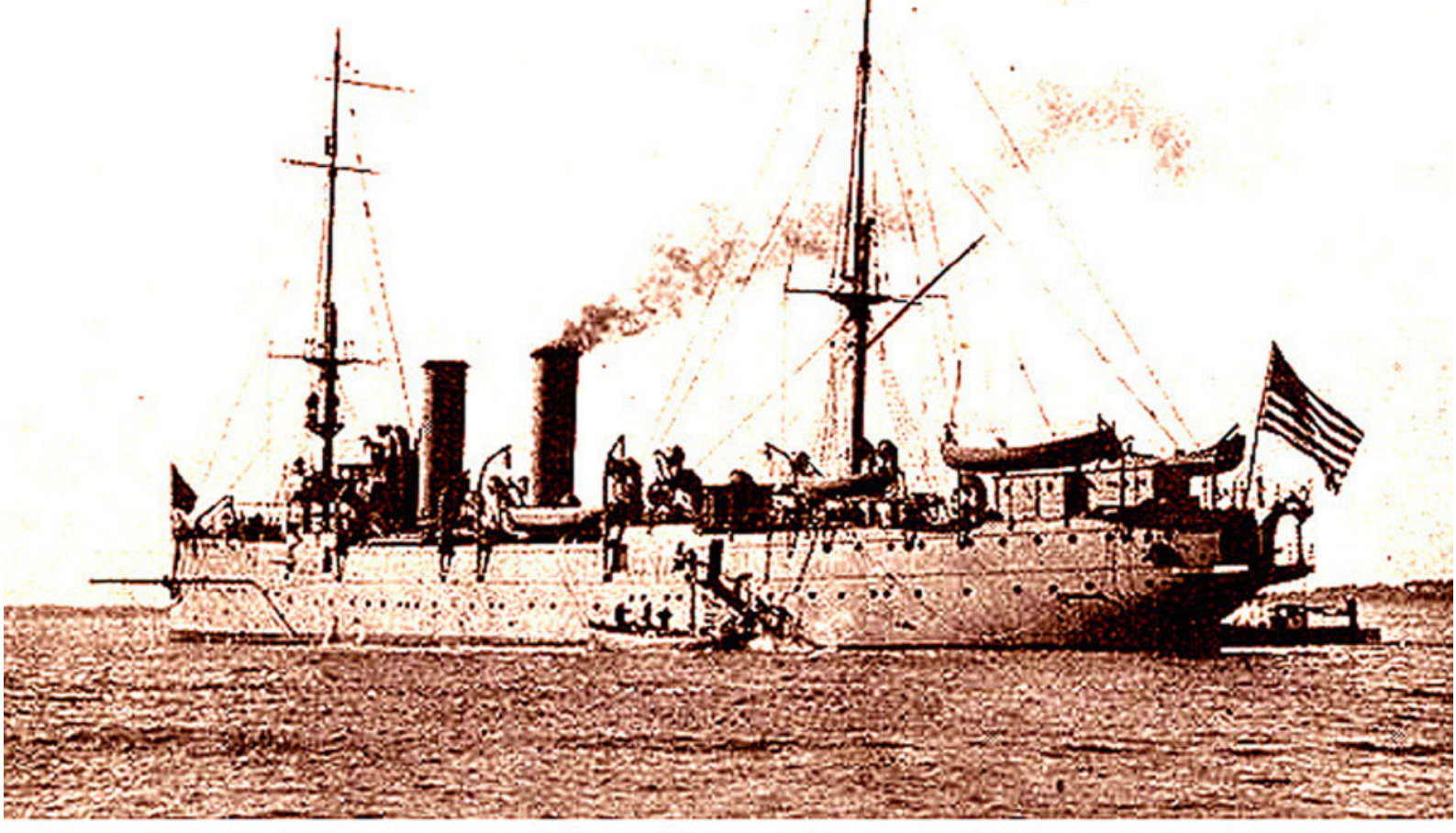

The mine layer San Francisco. The mines are launched from the stern. This stern, peculiar to mine layers, is clearly shown in this picture.

in theory, but the operation of mining in the North Sea where the barrage was to be put down, was a new and difficult problem to naval officers. There the soundings range from 50 to 150 fathoms with long stretches averaging about 80 fathoms. Yet there was a job to be done and the Navy undertook to do it in the Navy way.

Commander S. P. Fullinwider of the mining section, Navy Bureau of Ordnance, had been one of the originators of the basic idea which culminated in the North Sea barrage and which demanded some new application of the old submarine mining principles. He, therefore, with other officers of Admiral Earle's Bureau, set about locating a suitable submarine mine, since upon the mine depended the efficacy of the barrier. Although the Navy had its choice of many mines, each effective under most conditions, a mine for use in the contemplated North Sea operations had to be a sure-fire device under all conceivable circumstances and capable of completely demolishing any wandering U-boat which might ever so lightly scrape along its sleek iron sides when anchored at predetermined depths, yet be harmless to navigation should wave or weather chance to break its moorings and permit it to rise to the surface.

For a time it seemed as if the ordnance experts had set for themselves an ideal impossible of realization. Then, in May, 1917, there appeared among the thousands of anti-submarine devices offered to this government one which was the product of the genius of an American inventor, Ralph Browne. The device in itself was novel. It was not offered as a submarine mine, but as a demolisher of U-boats, in which capacity the naval experts decided it had little practical value —at least in the form submitted. Yet in one of the components of Browne's device —an ingenious electrical arrangement which embodied totally new principles— Commander Fullinwider saw that at last had come to light what could be made a valuable integral part of the firing mechanism of a new type of mine, the type so long sought for and admirably adapted for use in the great barrage.

So strong was the belief of the commander and his associates in the potentialities of the new electrical mechanism that they finally overcame Browne's initial objections to divorcing this factor from his complete anti-submarine device. Thereupon the Bureau, in collaboration with the inventor, set about applying it to a firing mechanism. The new detonator, when tested July 9, 1917, gave such gratifying results that the tentative plans for the great barrage, submitted earlier to the Navy Department, were immediately revived and a joint American-British offensive agreed upon. In this, the United States Navy undertook to supply a minimum of 100,000 of the new mines and to plant them where they would inflict the greatest damage upon the Kaiser's submarines. With the great mine

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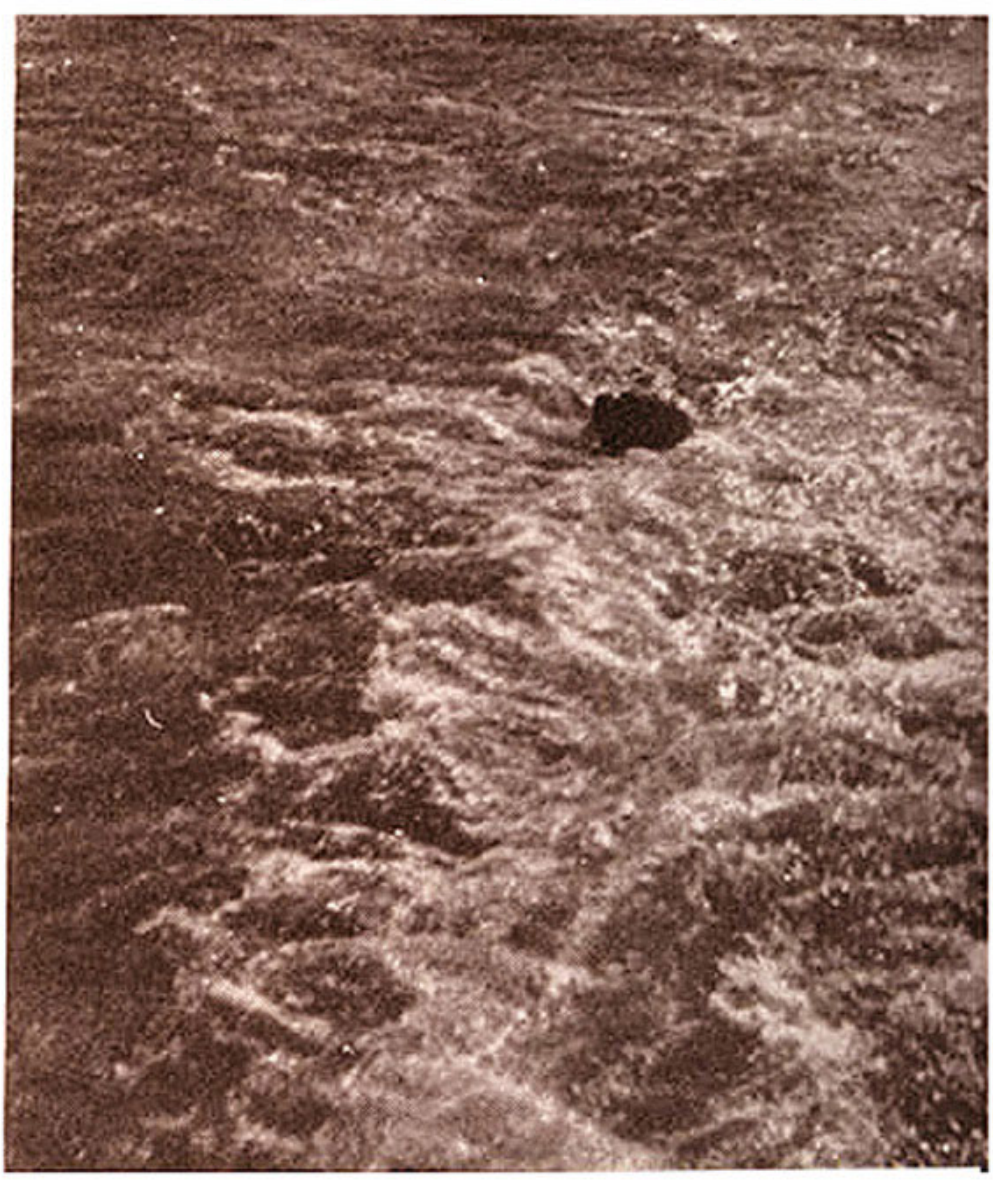

When launched the mine floats on the surface for a few seconds.

work was 85 per cent an American undertaking.

The work of coördinating the new firing device with other features of a new mine was a matter of great labor, but the great tanks of explosives, as they swing to-day in the currents of the North Sea, are in the opinion of ordnance experts, the most practical of their kind that have ever been brought to such a plane of perfection.

Details of the firing mechanism and a few of the other salient features of the new sub-sea terror are still censored; but it may be stated that the North Sea Barrage is made up of contact mines which are detonated by a device which functions when the mine is struck, the consequent explosion setting up through the water a tremendous pressure wave sufficient to crumple the shell of the staunchest of U-boats within a radius of from 75 to 100 feet.

As it goes overboard, the mine unit is composed of a spherical sheet metal shell about 3 feet in diameter and about ⅛ inch in thickness, which rests upon a cubical sheet-metal box equipped with four small iron wheels used in launching the mines from tracks aboard the mine layers. The metal sphere is the mine proper. It contains the firing mechanism and a 300-pound charge of tri-nitro-toluol, one of the most powerful explosives known, and ordinarily referred to as TNT. This charge exerts a far greater energy than the propellant used in the huge 14-inch naval rifles which hurled shells to a distance of 30 miles during the Allied offensive that closed hostilities on land. The cubical box is a combination anchor and housing for the mooring gear. It contains the reel of wire rope which connects the mine with its anchor and an automatic "depth-taking gear"—a heavy plummet attached to another reel of cable running out to the side through the metal casing of the box—which insures the mine being moored at a predetermined distance below the surface.

The operation of the mine is ingenious and interesting. Assume that it is desired to moor a mine 30 fathoms (180 feet) below the surface, the depth of the water at the point where the mine is to be set being unknown. First the depth-taking gear is adjusted. This is done by setting the depth-taking cable drum so that the heavy plummet can pay out only 180 feet of the cable to which it is attached. Then the mine is dropped overboard.

Here is what happens. The mine and the anchor go overboard together, at

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Marking buoys used in the mine fields.

which time the heavy plummet connected with the depth-taking gear is released. While mine and anchor, upheld by the buoyancy of the spherical member, float for a few seconds, the plummet pays out on its cable until it hangs suspended 180 feet below the anchor box. The jerk of the plummet, reaching the end of its line, releases the devices which hold mine and anchor together, and the anchor box begins to sink, paying out the main mooring cable, the mine proper remaining on the surface. When the anchor has descended to within 180 feet of the bottom, the plummet strikes the sea floor. This releases the plummet cable from the weight of the plummet and operates a mechanism in the anchor box above, automatically locking the main mooring cable drum and preventing the mooring cable from paying out farther. When the main mooring cable ceases to run, the anchor, having filled with water, has become heavy enough to drag the spherical mine below the surface, and the desired submergence is reached when the anchor rests beside the plummet on the bottom.

In addition to the new firing principle and the depth-taking mechanism, the new mine is designed to meet the conditions of the Hague Conventions which require a mine to be non-explosive while floating. This is accomplished through adjusting the firing mechanism so that it demands a certain amount of hydrostatic pressure to bring into full coöperation the component parts of the detonating device.

Ready for planting, a mine weighs about 1,350 pounds, of which 800 pounds is in the anchor and mooring devices. Each mine costs approximately $300 to manufacture.

When, in July, 1917, the new secret detonating device was found satisfactory, the mine unit, as it swings to-day in the sub-sea currents, had not even been completely designed. Yet this was not permitted to handicap progress and a corps of naval designers set to work perfecting the missing parts. As soon as each part was on paper, models were made, tests of the particular compotent involved conducted and the separate parts started toward production.

The question of manufacture was a knotty one. The capacity of existing naval plants for the manufacture of mines was scarcely more than 1,000 a month; production of 1,000 a day was essential. There were no commercial manufacturers of submarine mines. To build and equip a complete government plant would occasion a delay of at least a year before the actual manufacture could be begun. In the face of the submarine menace, such delay was unthinkable.

Seeing an analogy between the prob-

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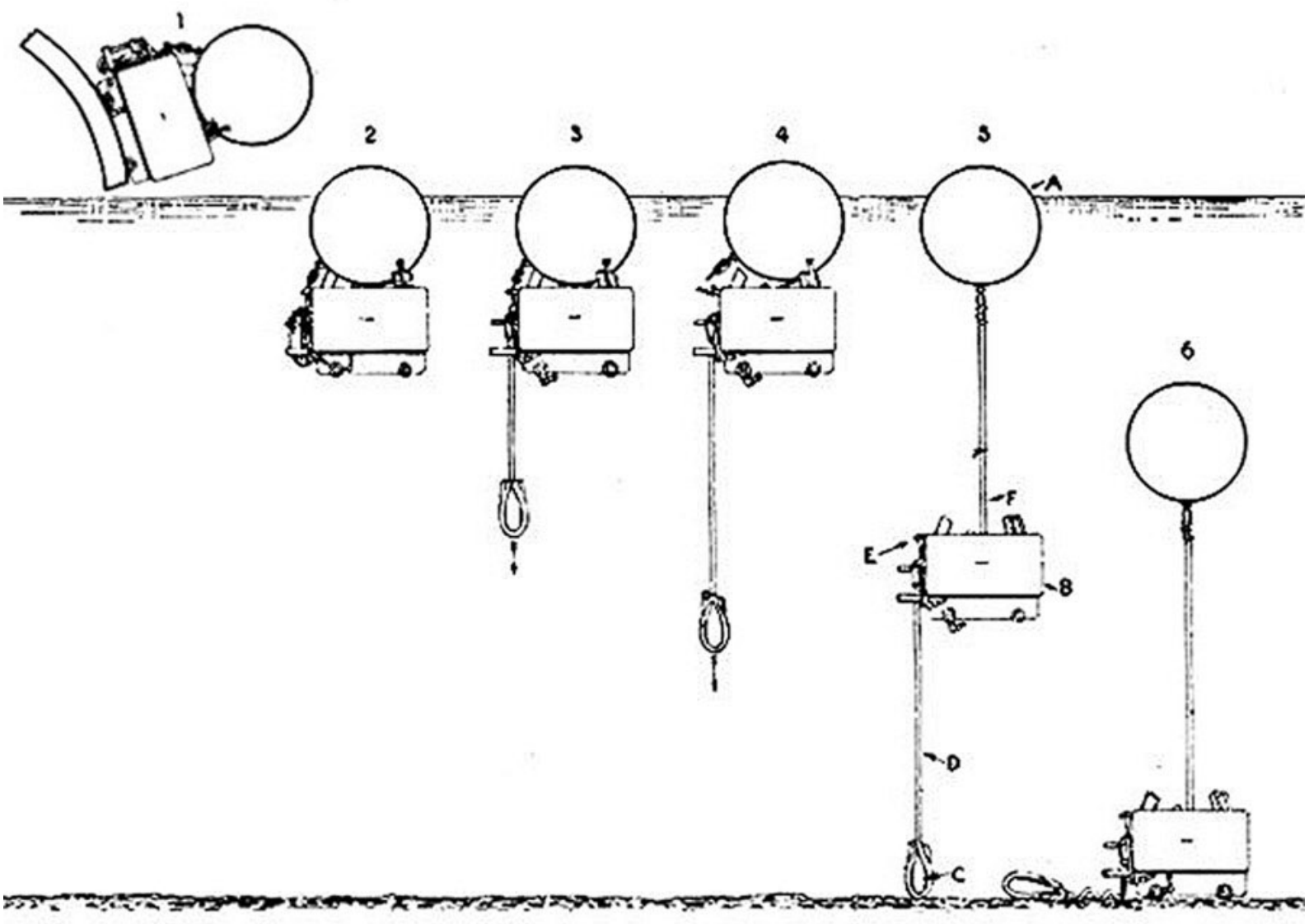

The operation of the mine is here shown. For a few seconds mine and anchor box float. Then the anchor box lock is tripped; the box begins to sink, paying out the main mooring cable as it settles.

lem of producing the new submarine mines at a minimum rate of 1,000 a day and the manufacture of small motor cars of the so-called "assembled types," the Navy Department conceived the idea of an "assembled mine"—that is, a mine of standardized parts manufactured at widely separated plants and put together at a central depot. To abandon the usual manufacturing routine and adopt so radical a departure was a hazardous course. It meant that before a single mine could be assembled and tested, each one of perhaps a hundred plants would have to "tool up" and get into the swing of standardized production. But the Navy experts believed this possible, and as a matter of fact it was many months after production began that any mine was tested in its entirety. Yet the very audacity of the plan contributed to its success and the fact that the parts were manufactured in different localities materially aided the Navy Department in their efforts to keep the momentous affair an inviolate secret.

Fortunately the period during which the mine parts were put into production coincided with a marked decline in the manufacture of pleasure automobiles. Therefore, as soon as each drawing was completed, it was possible to let the contract to some manufacturer of automobile accessories, whose shop had suffered from the falling off in its own field yet was tooled for exactly the kind of work required, and to various pressed steel concerns throughout the country. There were placed 140 such contracts, many of the major contractors subletting among 400 other and smaller manufacturing concerns so that production started at full speed. But coal shortages, freight embargoes and zero weather were to be reckoned with, and for a time it seemed as if the manufacturing program would be seriously disrupted, especially when one of the largest concerns failed utterly to comply with its deliveries. But in spite of congestions the other contractors were able to redouble their efforts so that the delays suffered were negligible.

While the mine parts were being placed in production, the naval experts began construction upon three giant plants to take care of the components as they were delivered. Naval engineers were dispatched to Norfolk, Va., where the first of the great plants was to rise, and there took over a suitable site adjacent to a huge steamer pier, while others started overseas to locate bases there. The Norfolk plant was the pioneer of its kind; never had any mine-loading depot with so great a capacity been undertaken. It was fitted with the most elaborate labor-saving machinery and equipped as a huge shop where the charges of TNT were added to the spherical member of the mine units. There the sheet metal shells were carried by a conveyor system past great reservoirs of molten trinitrotoluol—which explosive, incidentally, may be brought to the melting point without any very great danger of detonation—and when the fact that a 300-pound charge had been poured registered upon a scale attached to the conveyor, the mine was mechanically carried on, its high explosive core being permitted to solidify. With a required capacity for loading 1,000 mines a

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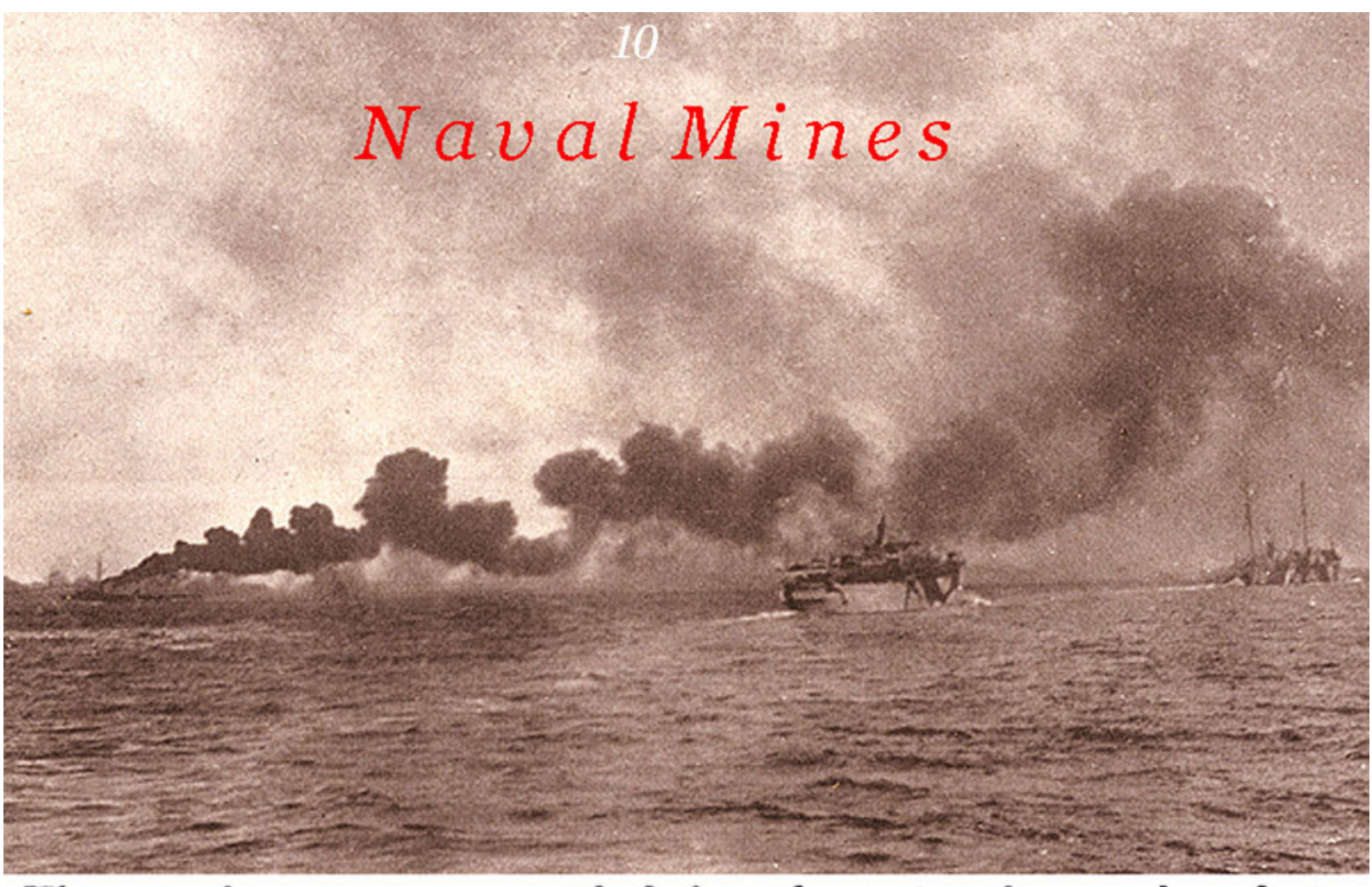

The smoke screen provided for the mine layers by their destroyer escort. Behind this impenetrable bank of smoke the mine layers worked against time silently swinging shut the North Sea Gate.

day, this plant frequently reached a high water mark of 1,400 and, in addition, the force at this depot prepared the other mine components for shipment abroad from the big pier.

During the construction of the Norfolk Mine Loading Plant, more than twenty merchant vessels were taken over by the Navy Department and refitted as "carriers" for the sole purpose of transporting the "knocked down" mines across the seas. The first consignment left Norfolk early in February, 1918, just seven months after the tests of the new detonating device made the laying of the great barrage possible. That shipment and scores of succeeding shipments made their voyages through submarine-infested waters safely, with the exception of the *Lake Moor*, which, on April 11, 1918, was torpedoed by a Hun U-boat, taking to the bottom with her a cargo of about 1,500 mines.

By the time the first shipment of mine parts reached Europe, there were ready for its reception two enormous assembling plants, one at Inverness, on the northeast coast of Scotland, and another several miles away at Invergordon. There Captain O. G. Murfin, U.S.N., who had left the States in November, 1917, charged with establishing permanent bases abroad, had taken over two great stone distilleries, inactive because of the wartime regulations curtailing the manufacture of liquors, and established therein a complete plant for the storage of mine parts, the assembling of complete mines, and their issue to the mine planters. In these depots a conveyor system similar to that used in the large automobile plants was followed, the mine anchor box being placed upon a track at one end of the building, and passing along rows of expert assemblers to emerge at the far end of the shop a complete barrage unit. About the assembling and storage depots were constructed barracks capable of housing 1,000 men in comfort, as well as additional storehouses, machine shops and spur tracks to adjacent railroads.

Back in the United States, besides keeping the loading plant going at capacity, the naval officers concerned in the project set about organizing a fleet of mine planters, as soon as an adequate number of "carriers" had been assured for the transportation of the mines. This work was placed in charge of Captain R. R. Belknap, who procured and outfitted ten vessels with the two United States Navy mine planters *Baltimore* and *San Francisco* as a nucleus. The other steamers of the fleet were chartered or purchased from owners of coastwise shipping and were readily converted for their new task.

Some of the vessels permitted the carrying of mines on only one deck; others on two or even three decks. Wherever a deck was available for this work, a line of track was laid from bow to stern, both to port and starboard. Sometimes these tracks were so connected by switches that the decks assumed the appearance of a corner in a railroad yard. It was possible to shift mines from deck to deck by means of hoists installed for the purpose. While mines may be carried on all available decks, it is desirable to launch them from the highest point possible; therefore, on the new mine planters there was but one launching deck. On the launching deck, to which the mines may be lifted by the hoists from what might be termed the "magazine decks" below, the port and starboard tracks were converged at the stern in what is known as a launching port through which the track rails extended over the water for a distance of three or four feet. The mine planters, under command of Captain Belknap, sailed for Scotland in May, 1918, reaching the bases before the first day of April.

When the mine laying fleet reached Scotland, Rear Admiral Joseph Straus, U.S.N., who had been placed in command of the mine-laying operations and had preceded the mine planters abroad with a force of several thousand bluejackets, took general command of the project. The work of actually planting the

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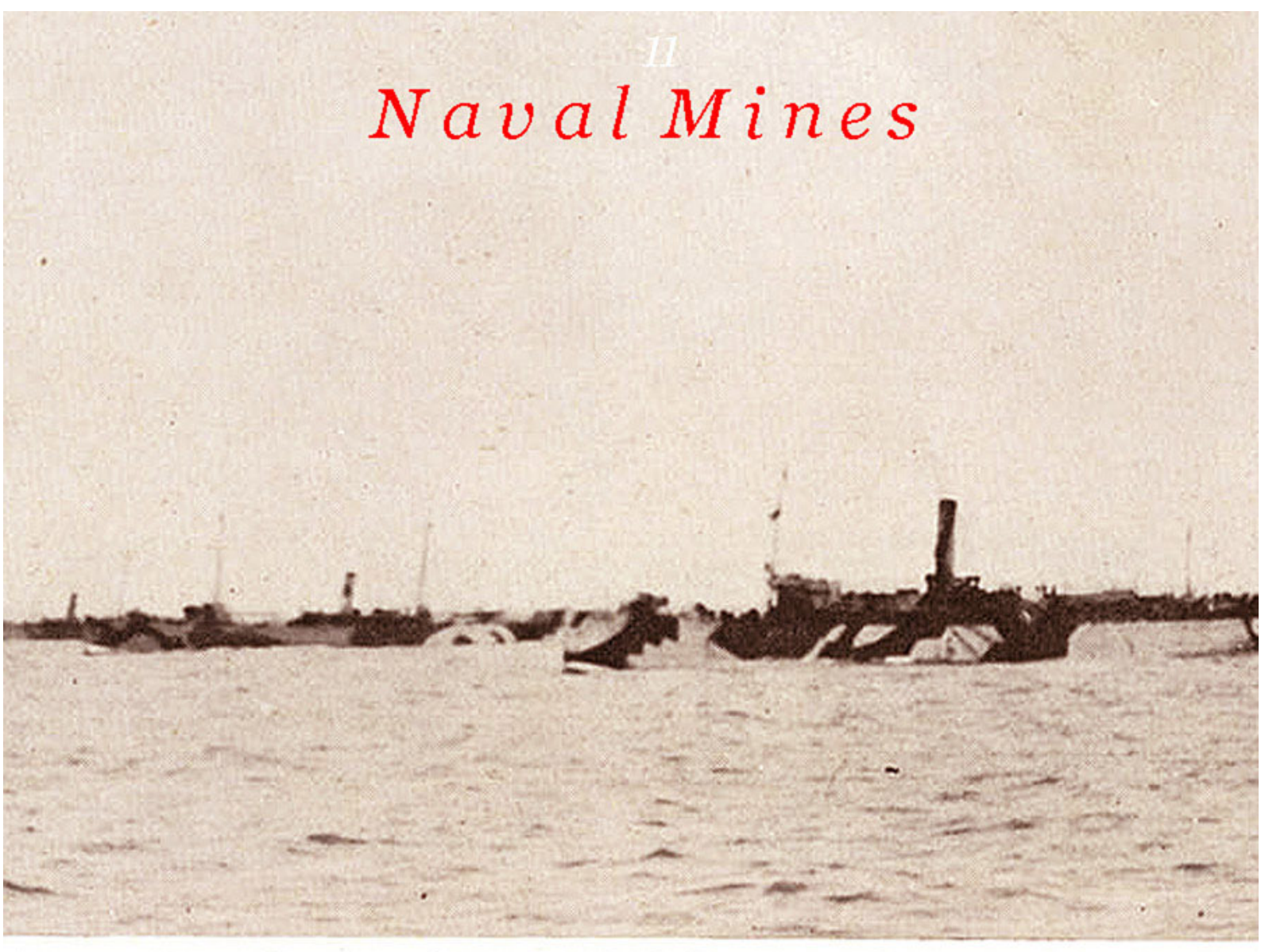

Camouflaged mine layers at the mine field and ready to begin "planting." There is much in the method employed suggestive of Yankee methods of planting corn.

mine field fell into two divisions; the task of assembling the mines ashore and loading them on the mine layers, superintended by Captain Murfin, and the task of launching the mines in the North Sea waters which was directed largely by Captain Belknap.

Early in June, 1918, our mine layers were ready to start upon the actual planting of the huge field from which a death harvest of U-boats and undersea crews was to be reaped. From the long sheds along shore at Inverness and Invergordon huge lighters put out, each one filled with mines. These were hoisted to the decks of the mine planters, set upon the tracks and pulled toward the bow to make room for other mines until the tracks were filled. According to the size of the mine layer and the number of decks fitted for mine planting, the vessels of the fleet carried from 150 to 600 mines each.

The project, in addition to having involved difficult engineering problems, also was attended by some danger. The waters where the mines were to be dropped were directly in the paths taken by the Hun U-boats in leaving or returning to their bases, and were within range of the possible area of operation of the Hun High Seas Fleet. Again, although generally out of airship range, an occasional lumbering Zeppelin would be sighted. So no measure of protection for the mine layers was overlooked. Their hulls were mottled with camouflage, and wherever they worked a smoke screen from a convoy of British destroyers rendered them nearly invisible.

Laying mines in a smooth sea was found to be comparatively easy, and quite as safe as any wartime venturings upon disputed high seas are likely to be; but our mine layers worked whenever opportunity offered, in calm seas or in rough, in fair weather or when pea-soup fogs rolled down from the Arctic Circle to make navigation a blind and hazardous work with so many ships traversing the same restricted waters. With the American fleet worked several British mine layers, dropping the English standard mine.

On June 8, 1918, the fleet of American mine planters steamed in a long line out from Moray Firth. The plan was then to complete a single line of mines, anchored at various levels, clear across the path taken by the submarines to their killing grounds. Therefore the laying was done in relays, the planters steaming abreast.

"Lay Mines!" came the order and the first planter began dropping her high explosive eggs. The fleet steamed at a predetermined speed and at carefully calculated intervals the mines went overboard. The mines were drawn to the after launching ports by means of cable and winches and, at the clanging of a bell, were started toward their anchorages by hand.

As soon as the tracks of the first mine layer were empty, the second took up the work and in this way the laying continued until the first segment of the barrier was laid in place.

But the men engaged in the great undertaking soon found that although every precaution was taken, there was an element of risk in the work which could not be prevented. Now and again one of the mines would explode soon after striking the water, and the chances of disaster—should a humpy sea throw the stern of a planter in contact with a mine in process of launching—could only be discounted by a high measure of skill in putting the mines over at precisely the proper moments. But good luck and skill combined proved effective and the field was laid without loss of life or of ships.

When the first line had been completed, the mine layers began to strengthen the barrier, laying several parallel rows behind the first lines. Since the work of laying was done only at opportune times, it is difficult to say how long it took to drop the mines forming the North Sea barrage, but frequently the Ameri-

can fleet laid more than 5,000 mines in four hours of steaming, the usual rate of planting being one every 15 seconds.

The putting down of the first 100,000 mines in no way completed the great task. There are occasional explosions in the field which break the continuity of the barrier and gaps are created by other causes. So a submarine barrage, as long as it is necessary to keep hostile craft from navigating closed areas, is never considered complete. It is consequently constantly supplemented by paralleling the rows of the original barrier and, although this operation, in connection with a barrage as expensive as that in the North Sea, would have been a task of no mean proportions, our Navy could easily have performed it, had hostilities continued, having established machinery for the production and planting of mines adequate to meet any demand made upon it.

And now that the terms of the armistice have drawn the fangs of the U-boats and sent most of them, captive craft, to such Ally harbors as that of Harwich, where the majority have been "tied up," what is to become of the North Sea barrage, the greatest of all deep water mining operations? The mines near the surface which might be menaces to navigation will be swept up and channels cleared through the present danger areas. If by chance any of the mines from the lower levels break loose and float, they will be rendered harmless through the operation of the pressure devices, and can be sunk by a rifle bullet. But to salvage the hundred thousand mines would be both impractical and fraught with great danger. Sea water has a destructive way of its own with metal intrusted to its depths and the recovered equipment would be of little or no value.

The mines have done their alloted work. Therefore, when an enduring peace shall have been assured, the vast North Sea barrage will be left to wave and weather, the mines to become the playthings of shifting currents, until some day in the future it will entirely disappear.

The mine unit is composed of a spherical sheet metal shell, containing a 300-pound charge of T.N.T. and a cubical box which is a combination anchor and housing for mooring gear.