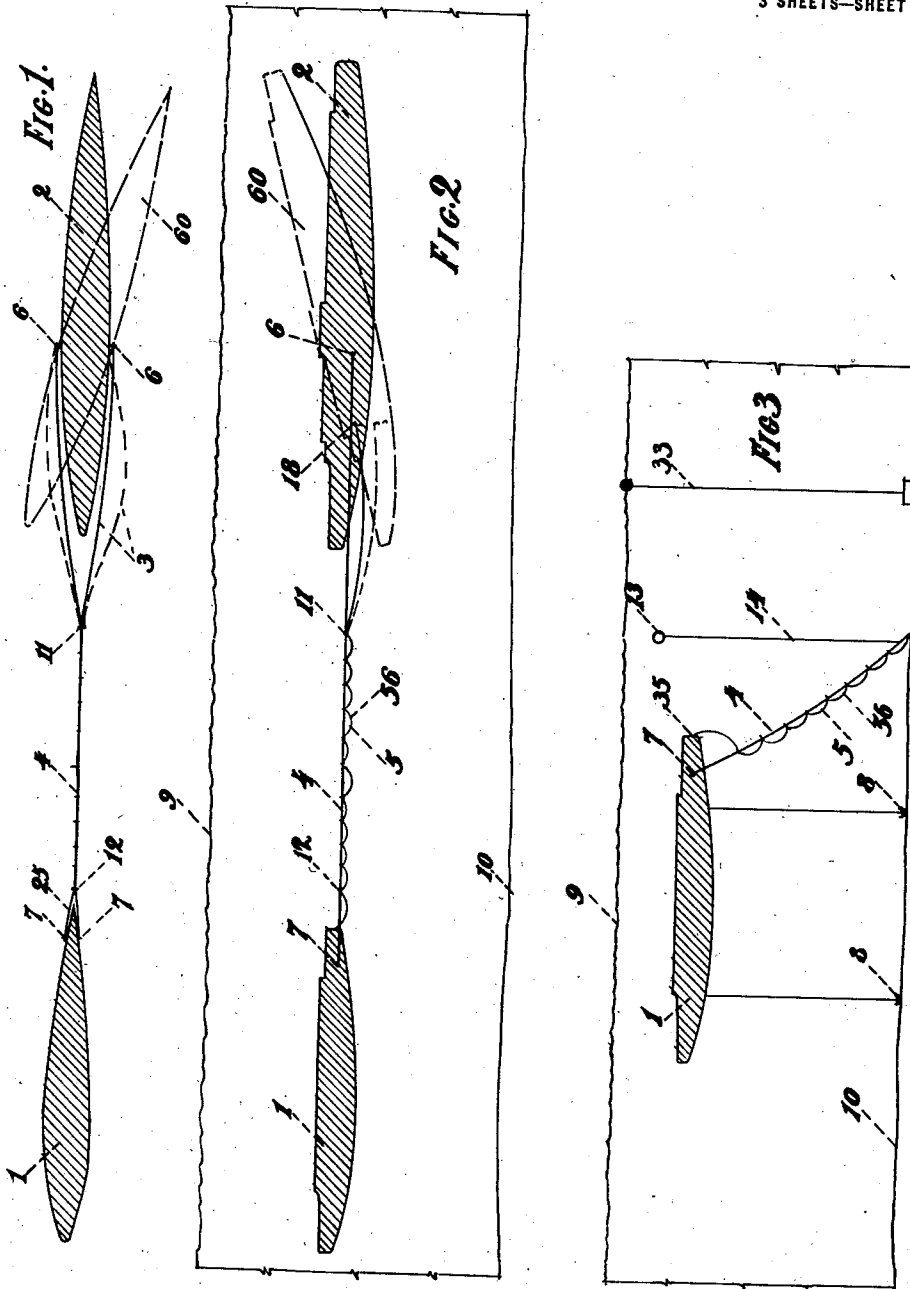


W. W. POTTER.
SUBMERGIBLE AND TOWABLE SUPPLY BASE.
APPLICATION FILED OCT. 7, 1915.

1,301,738.

Patented Apr. 22, 1919.
3 SHEETS—SHEET 1.



WITNESSES
Hermon M. Tamm
Thomas J. Carley

INVENTOR
William Woodburn Potter

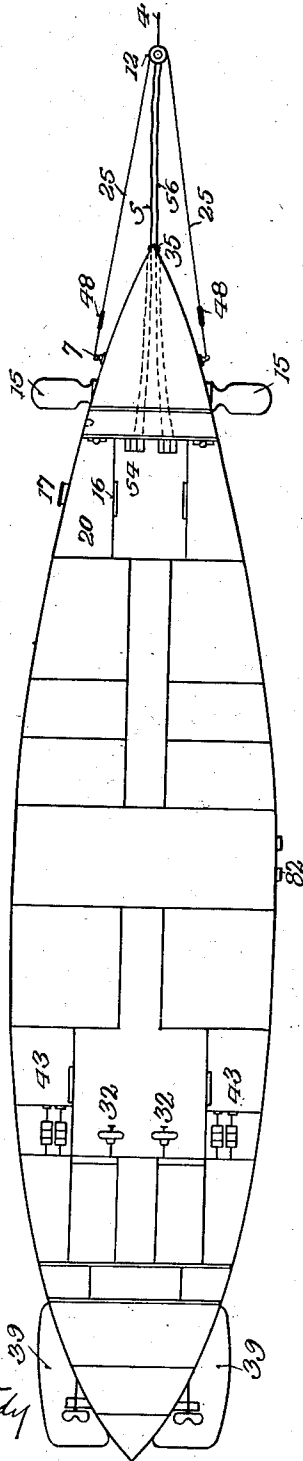
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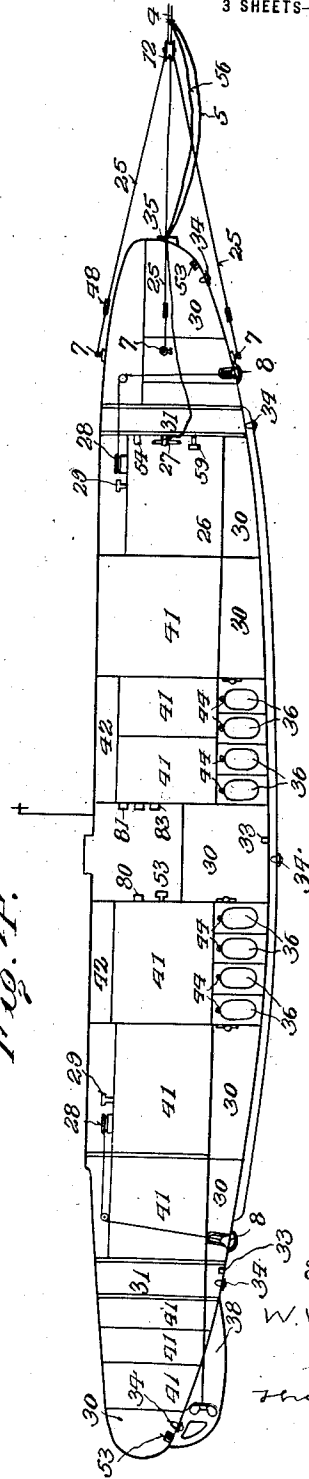
3 SHEETS—SHEET 2.

Fig. 5.



Witnesses
Harry Hillman
Nell K. Raedy

Fig. 4.



Inventor
 W. W. Potter
 by
Thos H Low
 Attorney

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 3 SHEETS—SHEET 3.

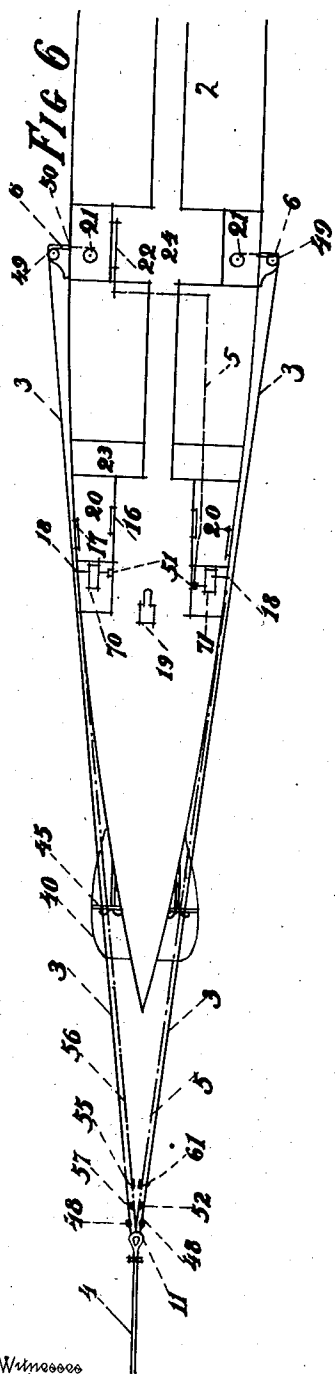


FIG. 6

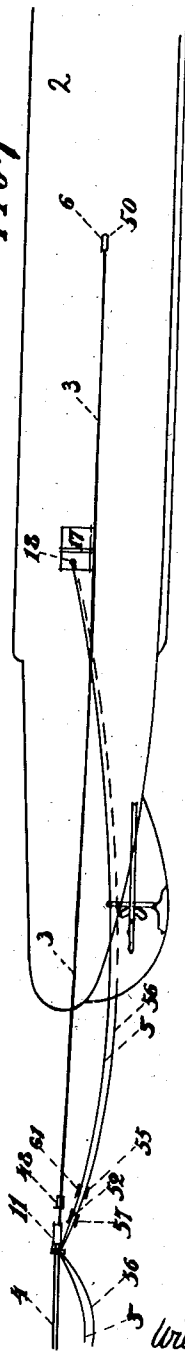


FIG. 7

FIG. 8

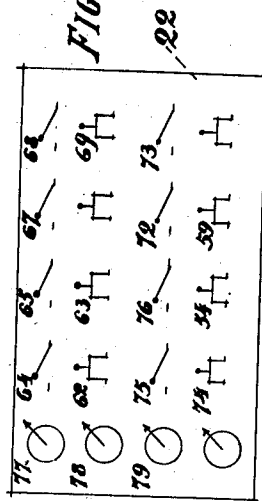
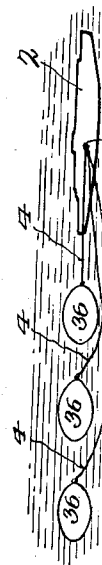


FIG. 9



Inventor

William Woodburn Potter

Witnesses

Thomas M. Turner
 Thomas J. Earley

UNITED STATES PATENT OFFICE.

WILLIAM WOODBURN POTTER, OF PHILADELPHIA, PENNSYLVANIA.

SUBMERGIBLE AND TOWABLE SUPPLY-BASE.

1,301,738.

Specification of Letters Patent.

Patented Apr. 22, 1919.

Application filed October 7, 1915. Serial No. 54,515.

To all whom it may concern:

Be it known that I, WILLIAM WOODBURN POTTER, a citizen of the United States, residing at Philadelphia in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Submergible and Towable Supply-Bases, of which the following is a specification.

My invention relates to tows including especially submergible barges of a novel type controllable electrically from a towing submarine.

While means heretofore have been devised for towing under water, such means were used for a very limited purpose and would be impractical for the purposes of my invention. By the novel means herein-after set forth, I successfully solve the problem of controlling under water a vessel from another vessel.

While my invention is not limited to any specific means of control, I prefer to use any of the well known electrical devices for controlling the tow under water in combination with my tow line and electric cable.

It is apparent that the difficulties of towing under water are much greater than surface towing. Not only are submerged vessels exceedingly tender but they are also blinded and there are no means of communication one to the other in a visual way.

In order then, to make towing under water practicable, means must be provided on the towing vessel for preventing the tow from disturbing the stability of the towing vessel, and means must be provided for controlling the actions of the tow from the pilot or towing vessel, certainly a more complicated and a more difficult problem than controlling a vessel towed on the surface. It is a problem heretofore not solved. Means must also be provided on the pilot for indicating the position of the tow.

These mechanical means of indicating the position of the tow are essential in order that the means of control may be intelligently utilized.

Heretofore, little or no advance has been made in the art of under water towing. Control has been so imperfect that such under water towing has been limited to comparatively small objects, such as torpedoes. Even in these cases it has been found necessary to either keep the towing vessel on the surface or else to provide rigid connection

between the submerged vessel and its tow with very limited action. Floats, rods or other means of visually indicating on the surface the position of the under water tow were the only means provided heretofore and the inability to see under water was heretofore a stumbling block to successful under water towing.

My invention broadens the field of under water towing and I have devised means of overcoming the difficulties by minimizing the influence of the tow on the stability and on the buoyancy of the towing vessel.

I provide means of controlling the tow at will; both laterally and vertically from the pilot. I particularly provide means of controlling at will the buoyancy of the towed vessel. By electrically connected tell-tales on the pilot I indicate the position and actions of the tow.

Moreover, I have devised a new type of vessel, combining certain features of the tank steamer with features heretofore limited to the submarine. I term this novel type "under-water supply barge" or "mobile submergible base."

This mobile base has the advantage over the ordinary tank steamer or over a moored supply base in the fact that it can be controlled at will as regards to its submergence from the pilot. It has an advantage over the submarine in that it is more simple and therefore is cheaper and quicker of construction. It need have no engines or accommodations for a crew and its appointments can be limited to the actual means, electrically connected to the towing vessel, for controlling, course, submergence, trim and indicating devices, mooring devices, etc. It has the combined advantages of being adapted for under water towing and for mooring. The transference of stores under water can be effected. Owing to its comparative cheapness it can be abandoned when empty without great loss.

By means of my invention any number of submergible supply bases can be deposited at any part of the globe and used as depots for replenishing the supplies of the submarine.

More than one submergible barge can be towed by the submarine; either by securing barge 2 to the first barge in the same manner as barge 1 is secured to the submarine, or it may be secured direct to the submarine.

I am able by means of my invention to carry on the submergible barge explosive submerged mines, which can be dropped or planted at the will of the captain of the submarine.

Submarines of the present existing types can tow the submergible barge, very little extra space or alteration being required to properly handle my invention.

By means of my invention important stores necessary for extended operations of submarines can be carried on the submergible barge. Oil and other fluids can be piped to the various tanks or compartments.

I am enabled to control the submergible barge by installing novel means for towing and steering the tow from the towing vessel, and above all by controlling from the towing vessel the buoyancy and the stability of the tow.

I overcome any tenderness of the submarine while submerged by providing means to insure steadiness of both the strain and the direction of the pull of the towing cable, as well as means of attaching the towing cable to a point at or near the center of resistance of the submarine.

To control the horizontal and vertical rudders any of the well known means may be employed, though electrical are preferred. Similarly any of the well known means for pumping out or flooding the barge, or any of its individual compartments may be utilized, such as a Kingston sea valve motor and electric pump, to control the buoyancy or to fill or empty the divers compartments.

Means are provided by the use of the divers' compartments to transfer under water the stores from the barge to the submarine.

Means are provided for operating diving fins or rudders to cause the barge to dive, controllable from the submarine, in addition to or in combination with the submerging or ballast tanks.

A crew of one or more persons can remain on board the barge submerged or otherwise, whether it is being towed or anchored independent of the submarine. It is not necessary, however, for a crew to be maintained on the barge in order to control its actions from the submarine or other outside sources.

The barge can also be raised or submerged, or otherwise controlled from other than a towing vessel when such other unit is equipped with the means described in my invention.

Other features are set forth in the detailed description:

Figure 1, is a plan showing a submarine towing a submergible barge, with the general arrangement of securing the one to the other.

Fig. 2, is a side elevation of a submarine

towing a submergible barge with the general arrangement of securing the one to the other.

Fig. 3 is a side view of the submergible barge at anchor submerged for use as a concealed base of supply.

Fig. 4 is a sectional longitudinal view of the submergible barge showing the connections with the tow.

Fig. 5 is a plan of Fig. 4.

Fig. 6 is a plan of the stern of the submarine showing in detail the connection.

Fig. 7 is a side view of Fig. 6.

Fig. 8 shows in detail the switch board control on the sub-marine.

Fig. 9 is a side elevation of a sub-marine towing mines while submerged.

Fig. 10 is a plan showing a submarine towing while submerged a barge secured alongside.

All the above figures are diagrammatic, well known features being omitted or merely outlined, or otherwise indicated. Thus no attempt is made to show any of the individual wiring connecting the various electrical devices with the switchboard control or the individual piping of the drainage system and its connection to the electric pump or the drainage valve box with its various electrical circuits leading to the various switches on the switchboard control.

Figs. 1 and 2 show a submarine 2 towing the barge 1 with the towing cable 4. To enable the barge to be towed under water as well as on the surface of the water means are provided as hereinafter described so as to neutralize the effect which the towing strain would otherwise have on the towing vessel, as well as means for minimizing the veering of the towed vessel.

At or near the bow of the submergible barge or towed vessel 1 is attached the four part bridle 25 to the sides and top and bottom of the barge at points 7 removed somewhat aft of the extreme bow. The bridle is used and attached at points 7 in order to facilitate steering the tow and enable the towing line to prevent veering and keep the tow on its course. Each line of the bridle 25 is provided with springs 48 to lessen any sudden shock. The four strands of the bridle then extend forward to the ring 12, Figs. 4 and 5, where it is attached to the towing rope or cable 4. The other end or forward end of the cable 4 is provided with a similar ring 11, Figs. 6 and 7, to which are secured the lines of the submarine bridle 3 which lead from this ring along each side of the submarine to arms 6. These arms are of a length suitable so that the bridle will properly clear the side and projections of the submarine when towing. If preferred the bridle could be made fast direct to the sides of the submarine. At 45 I show guards

for protecting the propellers from being fouled by the bridle or conduit.

At the outer end of the arms is a pulley 49, Fig. 6 through which the lines of the bridle pass. The bridle lines are placed on the sides of the hull so that in towing the stability and course of the submarine will be least interfered with. The best point of fastening the lines of the bridle or the location of the arms 6 would be at or near the center of resistance. This center of resistance is defined as that point in the mid-ship cross section through which passes the resultant of all forces opposing head-on motion through the water when the submarine is submerged at normal submerged trim. It is a fixed point somewhere between the center of gravity and the center of figure of the mid-ship section of the submarine. Its exact position is determined by the position of the center of gravity, by the symmetry of the form of the cross section and by the skin resistance of the wetted surface. The position of the center of resistance could be found experimentally in a model basin by towing under water, attaching the tow-line at various points on the hull of the mid-ship cross section. That point of attachment of the tow-line, where the steering, when towing, is easiest, is opposite the center of resistance. It is well known that submarines when submerged are tender owing to the small metacentric height. If the towing cable were attached directly to the stern, any strain not in a direct line with the course of the vessel would tend to disturb, and make more difficult of control, the stability and the handling of the submarine. It is most important to overcome this towing difficulty. I do so by bringing the towing strain at or near to the center of resistance. The nearer the strain is brought to the center of resistance the less the effect will be on the stability of trim of the submarine. Since the stability of the vessel depends upon the metacentric height, this metacentric height may be changed as required to facilitate the towing of a vessel. By means of fastening the tow line to the best possible point on the towing vessel and a tow line peculiarly adapted to the purpose, I solve the problem of under water towing.

In Figs. 1 and 2, I illustrate by the position of the tow shown in the dotted lines how my invention would overcome the tendency which the towing strain would exert to disturb the stability of the towing vessel. Fig. 1 shows the relation which the towing vessel 60 bears to the tow when out of horizontal alinement, and Fig. 2 the relation of the two vessels when out of vertical alinement. Since the strain of the tow line is taken at or near the metacenter the tendency to disturb the stability or equilibrium is reduced to a minimum.

The lines of the bridle 3 can be lengthened or shortened by leading them after passing through the pulleys 49 through hawse holes 50 to a capstan 21.

Having explained the method of arranging the towing cable for under water towing, I now similarly explain the method I have invented of controlling the tow from the towing vessel. Heretofore it has been impractical to tow under water on account of not being able to exercise proper control over the towed vessel. By my invention this difficulty, as well as the difficulty owing to the influence which the towed vessel exerts on the stability of the tow is overcome.

The preferred form of control is electrical, exercised by means of electric wires running in conduits 5, from the barge 1 to submarine 2. These electric conduits start from the switchboard 22 and continue through hull of the submarine permanently installed up to fixed couplings 51 where the rigid installation ends. To this coupling are joined the flexible electric conduits from the interior of the submarine to those leading outside. At this place is provided an automatic winding drum 71 around which are wound the conduits for paying out or hauling in. This conduit continues through a hawse hole 18 to the barge, secured in any suitable way to the towing cable 4 and continues, fastened at intervals, to the end of cable at 12 and thence entering the bow at 35 or other point of the barge where they are led to compartment 26 to a coupling and distribution board 27, from which the separate circuits lead throughout the barge to their respective electrical devices elsewhere described. Means of attaching or detaching the electric conduits of the two vessels is provided at 61, at or near 11 where the towing cable is also uncoupled.

A plurality of electric wires are contained in the conduit above described leading from the control room 24 and switchboard 22 to the various electric or other devices on the barge elsewhere described, which operate and control the various features in connection with my invention. As the system of the fixed electric installation within the vessels does not differ from those now in general use, I do not show in the drawings the leads of all the individual circuits. The electric current to operate all the electric devices which I provide is preferably furnished from the storage batteries of the submarine.

The electrical control installed on the submarine enables the captain to control the barge in tow in a similar manner as he controls the submarine. Thus in submerging the ballast tanks 30 of the barge are filled by opening the sea valve 34 which may be of the well known Kingston type and operated by the motors 33 from the control room 24 of the submarine by means of the switch

control board 22. By operating the proper switch at 62 the motor is started which actuates the valve and fills the desired ballast tank.

5 To increase the buoyancy of the barge the electric pump 53 is started after the necessary connections have been made by means of switches 63 on the control switchboard 22. This electric pump is enabled by means
10 of the electrically controlled valve box to drain at the will of the captain anyone of the ballast or trimming compartments. Any of the common systems of drainage may be used. This control of the buoyancy of the
15 submergible barge from the towing submarine is both novel and important. It enables the submergence of the tow to be regulated perfectly from the towing submarine, without the tow affecting appreciably the
20 buoyancy of the submarine. Heretofore the submergence of a tow has been regulated mechanically by means of floats on the surface. Former methods are only applicable to support given by a vessel towing from
25 the surface, or to towing in which the buoyancy of the towed vessel is constant. In my invention the buoyancy of the towed vessel is varied at will from the tow.

Necessarily heretofore the buoyancy of
30 the towed vessel was constantly positive. In my method the control of the submergence is accomplished by varying the buoyancy of the tow at will by electric means from the towing vessel so that it may be made either
35 positive or negative, and is thus regulated without the necessity of floats. In my method the result attained is also independent of the relative size of the two vessels and I overcome the well known condition
40 that the submarine while submerged, is especially sensitive to changes of buoyancy. This advantage is essential to any practical means of towing large vessels under water when either or both vessels are sub-
45 merged.

The stability and trim of the barge is gained by means similar to those now used on submarines. Indeed my invention does not include any novel means of steering, sub-
50 merging or trimming the tow except in so far as I adapt devices already known so that they may be used while controlled from the towing vessel. Thus I provide on the barge the usual trimming tanks 31 which I flood or
55 empty from the submarine in a similar manner to the ballast tank. If desired, however, water may be pumped directly by the pump 53 from one tank to the other, and control-
60 lable electrically from the submarine by switches 75 and 76, Fig. 8 on panel board 22 in the control room 24.

I now describe the means of conveying oil fuel or other fluids from the barge to the submarine. The barge 1 is provided with a
65 plurality of storage tanks 41 for fluids which

are required for the activities of the subma-
rine. These tanks are connected by means
of a pipe line to compartment 26 where cou-
plings are provided with cut off valves 54
Figs. 4 and 5, and the pipe conduits con- 70
tinued through the bow at 35 and attached
to towing cable at 12 and led along cable to
11 Figs. 4 and 5 and thence through hawse
hole 18 Figs. 6 and 7 and around the wind- 75
ing drum 70 for the extension of the pipe
lines, and thence to the couplings 51 where
the rigid installation of pipes begins and
continue to the storage tanks on the sub-
marine. At 57 is also provided a cut off
valve to control the flow in similar manner 80
as for the electric conduits. At 19 is pro-
vided a pump which can be operated by
hand or otherwise and the fluids pumped
from the tank on the barge to the tank on the
submarine. 85

I provide on the submergible barge a ver-
tical steering rudder 38 and horizontal div-
ing rudder 39. These rudders are each pro-
vided preferably with an electric steering
engine 43 of well known type. I control the 90
steering engine by electric circuits leading
between the barge and the submarine to the
electric lever 64 on switch board 22, Figs. 6,
7 and 8 in control room 24, by means as
elsewhere described. 95

I control a diving fin or rudder 15 near
the bow of the barge in similar manner as
above.

I provide anchors 8 preferably one for-
ward and one aft of a kind now used on 100
submarine, the anchor lines to be attached
to a capstan 28 and motor 29 which I control
by means of an electric circuit between said
motor connected to storage batteries and the
switch controls 67 and 68 in control room 24. 105
These anchors can thus be lowered or
weighed; also when the submarine is slow-
ing down, the stern anchor may be let out to
act as a drag to prevent over riding.

I provide an electric driving engine 32 on 110
the barge to relieve the towing strain from
the submarine or to retard the barge in its
progress in coming to a stop or in slowing
down. This engine or motor is connected to
and run from storage batteries on the sub- 115
marine, the motor being also connected to
the propeller shaft. I control the motor
from the submarine by means of electric cir-
cuits carried from said motor to the switch-
board 22 in control room 24 on the subma- 120
rine at a point 68, Fig. 8.

On the barge in addition to other articles
are carried mines 36 for mine laying in any
desired manner. These are hung in com-
partments open to the sea. The mines are of 125
any of the well known types, provided with
the usual anchors, anchor lines and auto-
matic setting devices.

The mine is released automatically by elec-
trical control at 68, Fig. 8, from the subma- 130

rine by means of a tripping device or hook 44. The mine may also be dropped by a diver.

When submerged under usual conditions it is difficult to see the tow and exercise visual supervision over it.

In order to properly advise the captain on board of the submarine as to the state of buoyancy or the depth of submersion of the barge I provide automatic means of indicating the depth by electric connection between the barge and submarine. I provide on the barge a pressure gage 58 which indicates electrically the depth of the barge on a dial 78 on the submarine and thus enables the captain to exercise all necessary control.

In like manner the course of the barge is automatically communicated by means of a repeater compass 77 in the control room of the submarine and connected to a Sperry gyroscopic compass 81 on the barge.

These indicators which show the course, submergence and stability of the tow are the eyes for the under water towing, and since visual means of supervision can no longer be exercised these indicators are an important feature of my invention. Though the indicators are themselves old, their use has been heretofore limited to the vessel on which they were installed. By extending their use outside of the vessel I overcome any blindness in the control of under water towing and I provide a combination in under water towing as complete as any surface towing.

In like manner I indicate the stability of the barge by providing pendulums 80 electrically connected to the submarine, which indicates on a dial 79, Fig. 8. This enables the captain of the submarine to exercise the proper control.

I now describe the method of attaching the tow to the towed vessel while the latter is submerged or both vessels are submerged.

The diver can then disconnect pipe line 56, electric conduits 5, etc., each one in turn, after first having turned off the valve 57 or switch 52 to prevent the escape of fluids or electric current respectively, and the ends of these conduits 55 and 61 respectively capped and protected from water intrusion.

As a means to locate the submerged tow I provide a marking buoy 13 and line 14 Fig. 3 attached to the towing cable 4 and conduits 5 and 56. All these can now be cast overboard and the submarine proceed on its way. The submergible barge now acts as a concealed base of supplies and can be left indefinitely submerged until it is desired to obtain supplies for the submarine or for the submarine to take the barge in tow again. The barge may also be marked by a line carried to the shore or other means for finding it. To take the barge in tow again when both barge and submarine are

submerged, the reverse of the operation above described is gone through.

Should the barge be submerged and the submarine be on the surface of the water the work of picking up or casting off the barge will be more simple from the deck of the submarine.

Before disconnecting the electric conduits and pipe lines the submarine can replenish its supplies from the submerged barge in the manner herein described, by means of my invention. Oil fuel or other liquids can be thus transferred through the pipe lines.

To transfer bulky stores from the barge to the submarine while both are submerged one of the diver's compartments 20 on the submarine is brought close to one of the diver's compartments 20 on the barge and the two vessels secured to each other. A diver on the diver's platform on the submarine, which we will assume is open to the sea, can by unlocking and opening the port 17 (the compartment 20 on the barge first having been flooded) enter said compartment 20 on the barge and procure such articles as may be therein and transfer them to the submarine. Should it be so desired the diver may enter into the hull of the barge by closing port 17 of barge, cause the water to be emitted from compartment 20 and air let therein in the usual manner.

These various electrical controls which have been described above and shown in the drawings may be any of the well known types in use in submarines or on other vessels. The means used at present to control the submarines are also adapted to control the tow from the towing vessel.

While I have set forth specific means of control I do not limit myself to the specific means explained and shown in the drawings as my invention includes all suitable means of controlling the tow from the towing vessel.

If desired one or more of the electric means of control shown and explained may be dispensed with.

Moreover my invention is not limited to towing astern but includes also towing a barge along side the sub-marine as shown in Fig. 10. 2 is the sub-marine and 1 represents the barge, which is towed alongside being rigidly secured together by the spars or spurshores 84. It is obvious that when so secured the barge may be controlled mechanically from the sub-marine without the necessity of the electric connections which I, however, prefer. No specific means of securing the barge are included in my invention.

In Fig. 9 is shown the sub-marine 2 towing while submerged a number of mines 36 by means of the separate tow lines 4. These mines are elongated shaped to facilitate towing and are otherwise of the usual type

and fitted with the customary accessories. It will be noted that the tow lines are fastened to the sub-marine at 6 opposite the center of buoyancy to facilitate towing. By the use of independent tow lines it is obvious that the mines may be cast adrift separately and easily.

Now that electric control has so developed that it is possible and practical for the captain of the ship or sub-marine to control the entire operation of his ship by means of various electrical devices, such as pumps, steering engines, and so forth it becomes possible and practicable by installing similar electrical devices on the tow to enable the captain to as easily control by means of electrical connection the tow as he controls his own vessel. I have invented no special electrical devices but merely utilize the forms already devised to enable the captain of the sub-marine to extend the control that he now exercises over his sub-marine to include also a barge or other vessel when taken in tow.

Under present conditions the fuel consumption of the sub-marine is not lessened when submerged in proportion to the stores consumed. When submerged the fuel consumption must remain constant as ballast must be taken in to replace the stores. By enabling the sub-marine to tow part of the necessary stores the necessity for taking ballast on the sub-marine is overcome up to the time the tow is emptied and cast adrift.

I provide such close union and such a perfect combination between the tow and the towing vessels as to successfully solve the problem of under water towing.

My invention is limited to means of controlling the buoyancy, stability and course of the tow by means of electrical connections between the control room on the towing vessel and the electric pumps, trimming tanks, buoyancy chambers and the like, installed on the towing vessel. Previously the control was limited to certain rudders which did not furnish sufficient control to make under water towing practicable.

My invention includes a type of boat adapted for a submerged base and capable of being taken in tow under water.

My invention includes a type of vessel especially adapted for towing under water and for mooring under water. It is both adapted to be moored and picked up by a submarine when submerged. It consists essentially of a vessel preferably consisting of a hollow cigar shape shell especially adapted for towing and carrying stores under water. To adapt this type of vessel for use as a mobile submergible base means of mooring and unmooring under water are included.

I desire to include within the scope of my claims all the uses to which my invention may be susceptible.

What I claim is:—

1. In combination a submarine, a submergible barge in tow thereof, electric means for controlling the buoyancy and the course of the towed vessel from the submarine and electric means of indicating on the submarine the submergence and course of the towed vessel whereby the relative position of the tow is indicated on the submarine.

2. A submarine, a submergible barge towed thereby by a cable, means on the barge for varying its trim, electrical means for actuating the aforesaid means from the towing submarine, and means for indicating on the towing submarine the trim of the barge.

3. A submarine, a submergible barge and a tow line having at the end a four part bridle each part secured to equally spaced points on the cross section of the towed vessel removed from the bow.

4. A submarine, a submergible barge, towed thereby by a cable, means of controlling electrically the tow from the submarine, and means of indicating, electrically, the relative position of the tow on the submarine, whereby, when both submarine and tow are submerged, the relative position of the tow may be known without visual means.

5. A submarine, a submergible barge, in tow thereof, and a towing cable, connecting the submarine and submergible barge, consisting of a two-part bridle at the towing end, each part of the bridle end, attached to the mid-ship section of the hull of the submarine, at a point of the hull opposite the center of resistance.

6. A submarine, a submergible barge, in tow thereof, having a towing cable, having its end attached to the mid-ship section of the hull, of the submarine opposite the center of resistance, and means of keeping the towing cable clear of the propeller blades.

7. A submarine, a second submarine in tow thereof, by cable, and means of indicating, electrically, on one submarine, the relative position of the other submarine, whereby, when both submarines are totally submerged, their relative positions may be known without resource to visual means of locating their positions.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM WOODBURN POTTER.

Witnesses:

JESSE WILLIAMS,
HERMAN M. TREVART.