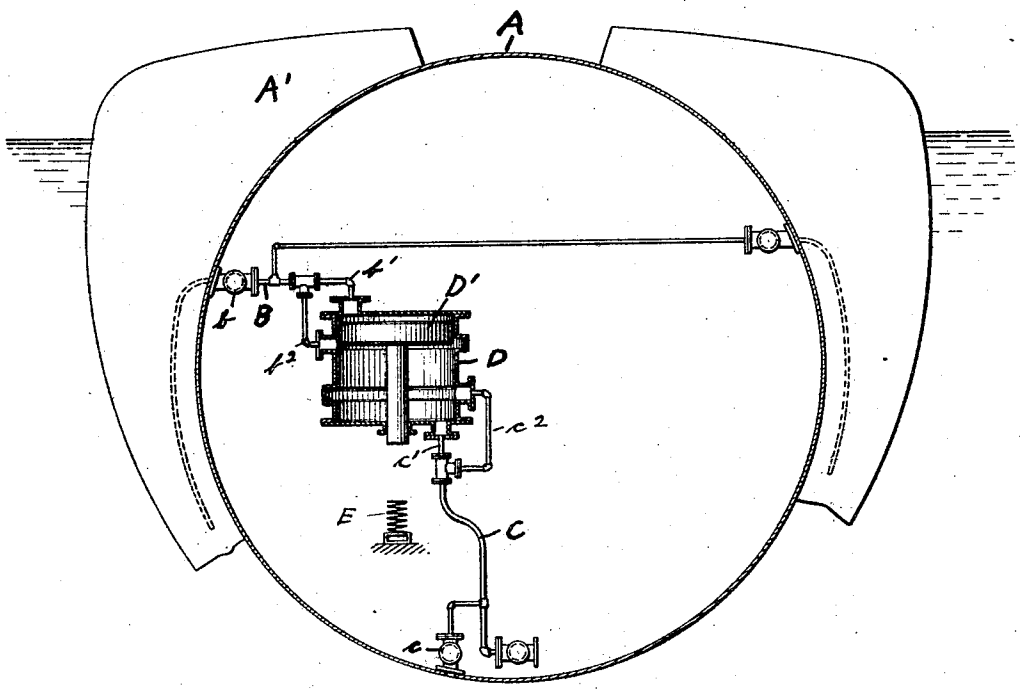
G. BAUER AND F. KRAMER.

APPARATUS FOR PREVENTING ESCAPE OF OIL FROM SUBMARINE TANKS.

APPLICATION FILED AUG. 31, 1921.

1,414,615. **Patented May 2, 1922.**



Inventors
Gustave Bauer and Fritz Kramer
by their Attorneys.
Dean Fairbanks Obright & Hirsch

UNITED STATES PATENT OFFICE.

GUSTAV BAUER, OF HAMBURG, AND FRITZ KRAMER, OF BLANKENESE-DOCKENHUDEN, NEAR HAMBURG, GERMANY.

APPARATUS FOR PREVENTING ESCAPE OF OIL FROM SUBMARINE TANKS.

1,414,615. Specification of Letters Patent. **Patented May 2, 1922.**

Application filed August 31, 1921. Serial No. 497,242.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that we, GUSTAV BAUER, a citizen of the Republic of Germany, and a resident of Hamburg, Germany, and FRITZ KRAMER, a citizen of the Republic of Germany, and a resident of Blankenese-Dockenhuden, near Hamburg, Germany, have invented certain new and useful Improvements in Apparatus for Preventing Escape of Oil from Submarine Tanks, (for which we have filed applications in Germany April 6, 1916, Patent No. 335,191, and England July 7, 1920, Patent No. 147,192,) of which the following is a specification.

This invention is a connecting means for use between two sources of fluid pressure whereby pressure in one will be automatically maintained below that of the other and the pressure difference kept within comparatively narrow limits, even though there be a comparatively wide variation of the higher pressure.

The invention may be used for various purposes, but we have particularly in mind the control of the pressure of the fuel oil tank of submarines. Such tanks are commonly situated outside of the main hull of the submarine and the walls are not built to resist very great pressure differences on opposite sides of the walls without the strain developing leaks. The escape of oil either owing to leaks or in consequence of the direct connection of the tanks with the water betrays the position of the boat by floating on the surface of the water.

The present invention is a device for automatically maintaining in the interior of the tanks a pressure which is less than the pressure of the water surrounding the tanks. The said device may for instance comprise a differential piston interposed between the tanks and the water surrounding them, with the larger surface under the influence of the pressure of the oil in the tanks and the smaller surface under the influence of the pressure of the surrounding water. The movement of this piston being thus dependent on the external pressure of the water and the internal pressure of the oil in the tanks may also permit a compensating liquid to enter the tanks to replace the oil withdrawn from them, or the compensating liquid to be admitted when oil passes out of them as a result of leakage, or the compensating liquid to be withdrawn as the submarine rises to the surface and the external pressure decreases. The compensating liquid may be the surrounding sea water and may, without detriment, be first utilized to operate the differential piston itself and then be allowed to pass into the interior of the tanks, the piston acting as a valve to control the entry of this liquid. Any well known kind of reversing device may be employed for reversing the piston at its extreme positions.

In order that the said invention may be clearly understood and readily carried into effect, one embodiment of the same will now be described.

The accompanying drawing shows diagrammatically in cross section a submarine provided with a form of the invention.

A represents the hull of the submarine and A′ one of the oil tanks. B represents a pipe leading to the tank A′ through a valve or cock b, and C represents another pipe leading to the exterior of the submarine through a valve or cock c. Between the pipes B and C, and connected therewith there is a cylinder D containing a differential piston D′ with its lower surface of smaller area than its upper surface. The pipe B is connected with two openings b', b^2 in the cylinder D, and the pipe C is also connected with two openings c', c^2 in the said cylinder.

When the submarine is on the surface the piston D′ normally occupies a position near the bottom of the cylinder with the end of the piston rod bearing against a spring E. When the submarine dives the increase in the pressure of the sea water on the lower surface of the piston causes the latter to rise until a pressure is produced in the tank A′ in proportion to the difference in the area of the two surfaces of the piston. If the volume of the cylinder at any time is not sufficient to produce the necessary pressure, the opening b^2 will be uncovered by the piston so as to permit sea water to enter the tank from the pipe C, this operation continuing until the pressure in the tank is sufficient to move the piston downwards sufficiently to close the opening b^2. The piston should only expose the opening b^2 to such an extent as will keep the reduction of pressure constant and therefore only un-

covers the lower edge of this opening which with the piston, may be regarded as a controlling valve.

Should it be required to draw oil from the tank A′ when the submarine is in its submerged condition, the ratio of the sea and tank pressure is maintained as the piston allows an amount of water to pass into the tank equal to the amount of oil withdrawn.

When the submarine rises to the surface, the piston owing to the pressure of the sea on the smaller surface thereof, moves downwards until its rod bears against the spring E. The apparatus therefore keeps up the reduction of pressure in the tank even when the submarine rises to the surface until the volume in the cylinder between the openings b^2 and c^2 is used up, but this does not occur within wide diving limits provided that no appreciable volume of air exists in the tank. If the pressure in the interior of the tank further increases in proportion to the decreasing external pressure, the piston continues to move downwards and, compressing the spring E, uncovers the opening c^2 in order to establish communication between the sea and the interior of the tank. This can only happen when air has collected in large quantities prior to diving, as otherwise the volume of the cylinder between the openings b^2 and c^2 is sufficient for the expansion of the compressed fluid. In consequence of the escape of the fluid under pressure the pressure in the tank now falls until the pressure of the spring E is sufficient to overcome the fluid pressure pressing upon it and to move the piston back, whereby the opening c^2 is again closed.

Instead of the said differential piston any other device which gives a differential pressure effect may be employed, such for example as two pairs of enclosed gear wheels meshing with each other after the manner of oil pumps; these gear wheels in order to produce the differential effect, are of differential diameter and are coupled together. In a similar manner, instead of this differential gear wheel arrangement, other pump arrangements which act in the same general way as regards the differential pressure effect, may be employed for the production of the reduced pressure in the tanks.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. Means for use on submarines for preventing the escape of oil from the oil tanks which are situated outside the submarine and are not built to resist pressure, comprising a device which automatically operates to maintain in the interior of the tanks a pressure which is less than the pressure of the water surrounding the tanks.

2. Means for preventing the escape of oil from the oil tank of a submarine, comprising a differential pressure device which is interposed between the tanks and the water surrounding them and is under the influence of the pressure in the tanks and the pressure of the surrounding water, substantially as described.

3. A submarine having an oil tank and connections between said tank and the outside sea water including a differential piston having its larger surface exposed to the pressure in the tank and its smaller surface exposed to the pressure of the sea water.

4. A submarine having an oil tank and a differential pressure device which is interposed between the tanks and the water surrounding them and is under the influence of the pressure in the tanks and the pressure of the surrounding water, substantially as described.

5. Two sources of fluid pressure and a connection between including a differential piston having one surface exposed to the pressure of one source and the other exposed to the pressure of the other source, and means for establishing a by-pass around said piston when the latter is in either of its limiting positions.

6. Two sources of fluid pressure and a connection between including a differential piston having one surface exposed to the pressure of one source and the other exposed to the pressure of the other source and means for establishing direct connection between said sources when the piston is in either of its limiting positions.

7. Means for maintaining a pressure difference within predetermined limits between two sources of fluid pressure, including a differential pressure device with opposite working surfaces exposed to the two fluid pressures and means for establishing connections between said sources when the pressure difference increases beyond or falls below said limits.

8. Means for preventing the escape of oil from the oil tank of a submarine, comprising a cylinder having one end connected to the tank and the other end connected to the sea, and a differential piston within said cylinder and separating said ends.

9. Means for preventing the escape of oil from the oil tank of a submarine, comprising a cylinder having one end connected to the tank and the other end connected to the sea, and a differential piston within said cylinder and separating said ends, said cylinder having a port adjacent to the first mentioned end and uncovered by the piston to permit open communication between the tank and sea when the piston is at said end.

10. Means for preventing the escape of oil from the oil tank of a submarine, comprising a cylinder having one end connected to the tank and the other end connected to the sea, and a differential piston within said

cylinder and separating said ends, said cylinder having a port adjacent to the second mentioned end and uncovered by the piston to permit open communication between the tank and sea when the piston is at said end.

11. Means for preventing the escape of oil from the oil tank of a submarine, comprising a cylinder having one end connected to the tank and the other end connected to the sea, and a differential piston within said cylinder and separating said ends, said cylinder having ports adjacent to each end thereof and uncovered to permit free flow through the cylinder between the tank and sea when the piston is at either end of its range of movement.

12. An arrangement for preventing the escape of oil from pervious outboard containers of submarine boats, comprising means for maintaining the interior of the container at a pressure below that of the water which surrounds the container, for every depth of immersion.

Signed at Hamburg, in the county of Hamburg and State of Hamburg, this 6th day of August, 1921.

DR. GUSTAV BAUER.
FRITZ KRAMER.