July 23, 1968 M. TERRELL 3,393,524

SUBMERGING VESSELS

Filed Nov. 25, 1964 3 Sheets-Sheet 1

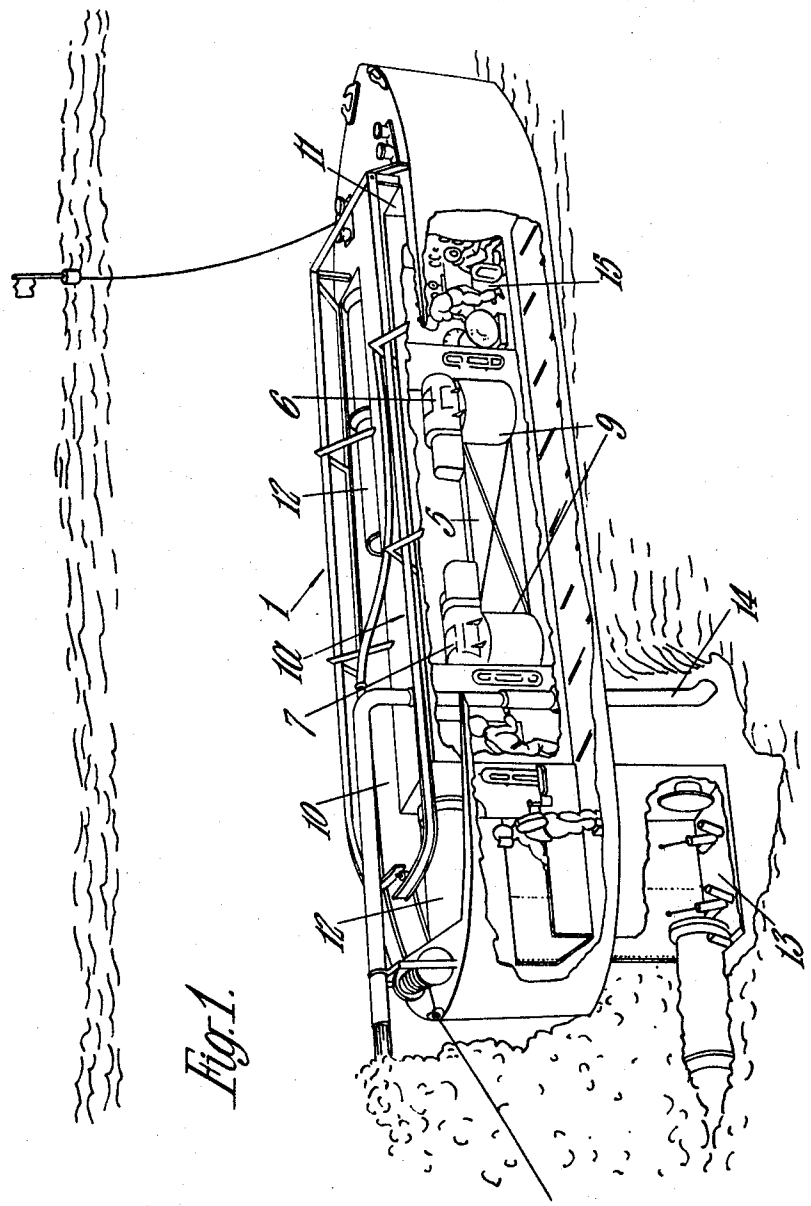


Fig. 1.

July 23, 1968 M. TERRELL 3,393,524

SUBMERGING VESSELS

Filed Nov. 25, 1964 3 Sheets-Sheet 2

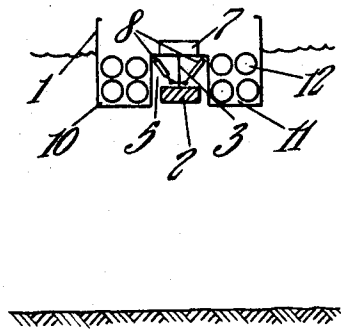


Fig. 2a.

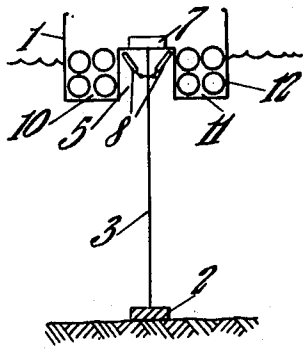


Fig. 2b.

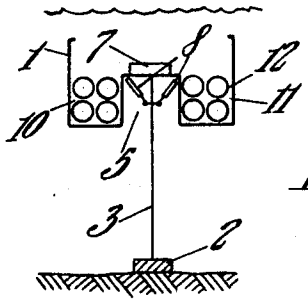


Fig. 2c.

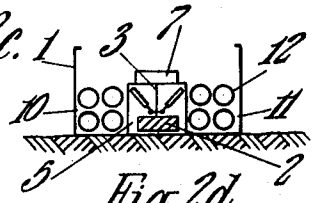


Fig. 2d.

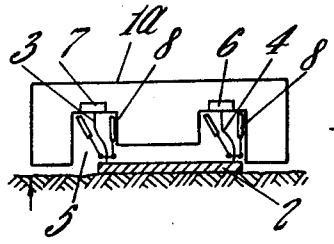


Fig. 3c.

July 23, 1968 M. TERRELL 3,393,524

SUBMERGING VESSELS

Filed Nov. 25, 1964 3 Sheets-Sheet 3

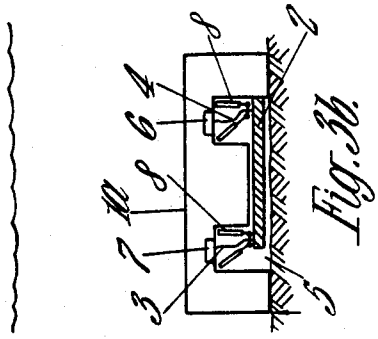


Fig. 3b.

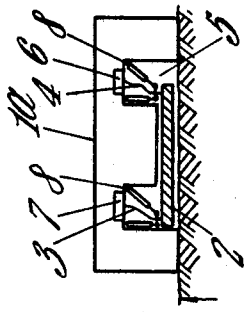


Fig. 3c.

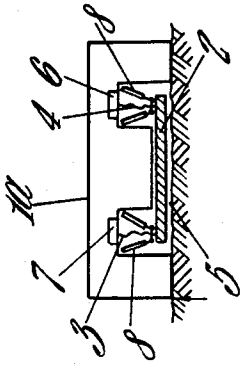


Fig. 3a.

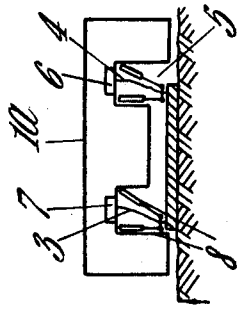


Fig. 3d.

United States Patent Office 3,393,524 Patented July 23, 1968

3,393,524

SUBMERGING VESSELS

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Filed Nov. 25, 1964, Ser. No. 413,808
15 Claims. (Cl. 61—69)

This invention relates to submerging vessels of the type which can be lowered onto a sea or river bed or the like to perform various operations either internally or externally of the vessel.

Diving bells of the type having an open bottom in which one or more people can be lowered onto a sea or river bed or the like in an envelope of gases, are well known but suffer from certain disadvantages, viz. this type of bell relies on a surface vessel with winching equipment for its submerging and surfacing operation; the bell cannot be maneuvered on the sea or river bed, the bells have to have sufficient weight to overcome their own buoyancy to give a reasonable working area whilst keeping the buoyancy to a minimum makes the bells inherently unstable, so that they can normally only be used in relatively quiescent waters.

It is an object of the present invention to provide a self-contained vessel which can be used in like manner to a diving bell for performing operations on a sea or river bed or the like, and which can submerge and surface itself and which can manoeuvre itself along the sea or river bed or the like when submerged.

According to the invention a submerging vessel system is provided comprising a pair of linked parts, one of which is negatively buoyant and the other of which can have its buoyancy adjusted to make the system as a whole either positively or negatively buoyant, and the parts being relatively movable both horizontally and vertically so that the system can submerge and surface itself, and manoeuvre itself along a sea or river bed by relative movement of the parts.

The invention also consists in a submerging vessel system having a positively buoyant part associated with a negatively buoyant part such that the system as a whole can be made positively or negatively buoyant and which parts can be moved relative to one another both in the vertical and horizontal plane so that the system may submerge and surface itself and manoeuvre itself along a sea or river bed or the like, by relative movement between the parts.

Conveniently, the relative movement between the parts may be controlled from a chamber within one of the parts, and the negatively buoyant part may be a weight attached by cables, chains or the like to the positively buoyant part and locatable within an open bottomed enclosure in the positively buoyant part, the arrangement being such that the weight can be moved vertically in and out of the enclosure on the cables, chains or the like, either by muscular or mechanical power, to enable the vessel to submerge and surface itself, and such that the weight can be moved about within the enclosure to enable the vessel to manoeuvre itself along a sea or river bed or the like. The enclosure may constitute a chamber which provides the positive buoyancy to the positively buoyant part.

The invention may be applied to vessels designed for numerous purposes for example drilling, dredging, surveying, exploration, undersea photography and the like. One particular application is for use in a vessel designed for laying pipes on a sea or river bed and this application will now be described by way of an example with reference to the accomapnying drawings in which:

FIGURE 1 is a part cut away perspective view of a pipe-laying vessel in operation on a sea bed,

FIGURE 2*a* is a diagrammatic end view of the vessel on the surface,

FIGURE 2*b* is a diagrammatic end view of the vessel during a first stage of submersion,

FIGURE 2*c* is a diagrammatic end view of the vessel during a second stage of submersion,

FIGURE 2*d* is a diagrammatic end view of the vessel fully submerged and resting on a submerged surface,

FIGURE 3*a* is a diagrammatic side view of the vessel on the submerged surface showing the first stage of operation to effect a movement of the vessel along the surface,

FIGURE 3*b* is a view similar to FIGURE 3*a* showing the second stage of operation during movement of the vessel along the surface.

FIGURE 3*c* is a view similar to FIGURE 3*a* showing the third stage of operation during movement of the vessel along the surface,

FIGURE 3*d* is a view similar to FIGURE 3*a* showing the fourth stage of operation during movement of the vessel along the surface,

FIGURE 3*e* is a view similar to FIGURE 3*a* showing the fifth stage of operation during movement of the vessel along the surface.

The vessel comprises generally a positively buoyant hull part **1** (comprising the main body of the vessel) the buoyancy of which can be adjusted by flooding and emptying the hull **1**, a ballast chamber **1***a* and a weight **2** which is attached to part **1** by cables **3** and **4** and which can be accommodated in an open bottomed enclosure **5**. The cables **3** and **4** are attached to winches **6** and **7** for moving the weight relative to part **1** in the vertical plane, and eight pivotally mounted hydraulic rams **8** are mounted in enclosure **5** for moving the weight about within the enclosure by engaging projecting portions of the weight. The rams **8** and winches **5** and **6** are enclosed in a tank **9** defining enclosures **5** to eliminate free surface.

The vessel has pipe wells **10** and **11** for storing lengths of pipe **12**, means for delivering pipe lengths to a jointing jig **13**, a dredging tube **14** and controls and an engine and control chamber **15** from where the movements of the weight **2** are controlled.

Considering now the FIGURES 2*a* to 2*d*, the submerging operation is as follows:

As shown in FIGURE 2*a* the part **1** is loaded with pipe sections and the vessel as a whole is positively buoyant so that it floats on the surface. The weight **2** is then winched down until it rests on the seat or river bed and part **1** being relieved of the mass of weight **2** floats higher in the water (see FIGURE 2). The hull **1** is then flooded with water but still has, due to the enclosed air in the ballast chamber **1***a*, a positive buoyancy. By flooding part **1**, however, the system as a whole takes on a negative buoyancy so that the hull **1** which is buoyant under the influence of the ballast chamber **1***a* can be winched down to the sea or river bed as shown in FIGURE 2*c*. Part **1** comes close enough to weight **2** so that the rams **8** can be engaged in the projections on the weight **2** and the force due to the buoyancy of the ballast chambers transferred from the wires to the rams. The system can then be manoeuvered as described below so that the pipes can be discharged on the sea bed. At the end of the operation the winches **7** take the force due to the ballast chamber **1***a* so enabling the rams **8** to be disengaged. The hull **1** can then be allowed to rise to the surface controlled by the winches **7** under the influence of the buoyancy imparted by the ballast chamber **1***a*.

The method of manoeuvering the vessel along a sea bed is shown in FIGURES 3*a* to 3*e*. By lifting weight **2**

as shown in FIGURE 3*a*, swinging it right by rams **8**, FIGURE 3*b*, and then lowering it onto the sea bed again, FIGURE 3*c*, the positively buoyant part **1** can be floated off and swung across by rams **8** to the position shown in FIGURE 3*d*. Lifting weight **2** again as in FIGURE 3*e* then causes the part **1** to be brought down onto the sea bed and the process can be repeated. By this arrangement the vessel can be moved in either direction longitudinally and depending on the dimensions of enclosure **5** and the mounting of rams **8**, in a lateral direction.

It will be appreciated that numerous modifications are possible within the scope of the invention, thus in small vessels for example the negatively buoyant part could be manipulated manually from a chamber within the positively buoyant part, in which case the enclosure in which the weight is accommodated is the operating chamber. Also, it is not essential that the negatively buoyant part be locatable within an enclosure of the positively buoyant part. The negatively buoyant part could remain at all times external but limited to the positively buoyant part whilst being controlled from another part which might be separate from the hull. Thus, a pair of weights could be employed say on opposite outer surfaces (for balance) of the positively buoyant part, the rams and winches being on said outer surfaces. Furthermore, a number of such units consisting of a positively and negatively buoyant part linked together and relatively movable as described above, or parts thereof, could be connected together to form a large structure with many units operating under the control of a single controlling part.

Whilst some structures may be required to submerge and surface through such a depth of water that the linkage between the two parts when separated by the depth of water may be conveniently achieved by means of wires, cables, or the like, other structures which only require limited vertical manoeuverability may dispense with these methods of achieving considerable vertical movement and retain only the rams or similar devices for the limited vertical movement required.

A system which may also use the invention may be required to be negatively buoyant with only one part of it positively buoyant.

I claim:

1. A submerging vessel comprising a pair of parts, means for adjusting the buoyancy of the vessel between a positive value and a negative value enabling the vessel to submerge and surface itself and means linking said parts together for controlled walking movements along a submerged surface with each part alernately resting on the surface whilst the other part is moved over the surface by reaction against the part resting on the surface.

2. A submerging vessel comprising a positively buoyant part, a negatively buoyant part, means for adjusting the buoyancy of the positively buoyant part between a first positive value at which the vessel as a whole is positively buoyant and a second positive value at which the vessel as a whole is negatively buoyant to enable the vessel to submerge and surface itself and means linking said parts together for controlled walking movements along a submerged surface with each part alternately resting on the surface whilst the other part is moved over the surface by reaction against the part resting on the surface.

3. A submerging vessel comprising a first part, a second part of negative buoyancy means for adjusting the buoyancy of said first part between a first value at which the vessel is positively buoyant and a second value at which the vessel is negatively buoyant whereby the vessel can submerge and surface itself and means suspending the second part from the first part for controlled walking movements of said parts along a submerged surface with each part alternately resting on the surface whilst the other part is moved over the surface by reaction against the part resting on the surface.

4. A submerging vessel comprising a positively buoyant part, a negatively buoyant part, means for adjusting the buoyancy of the positively buoyant part between a first positive value at which the vessel as a whole is positively buoyant and a second positive value at which the vessel as a whole is negatively buoyant, extensible and retractable cable means suspending said negatively buoyant part from said positively buoyant part for submerging and surfacing operations of the vessel by relative vertical movements of said parts and means permitting controlled walking movements of said parts along a submerged surface with each part alternately resting on the surface whilst the other part is moved over the surface by reaction against the part resting on the surface.

5. The vessel of claim **4** in which said last named means comprises means defining an open bottomed enclosure in the positively buoyant part for accommodating said negatively buoyant part with horizontal and vertical clearance.

6. The vessel of claim **4**, including power means for effecting controlled walking movements of said parts.

7. The vessel of claim **5**, in which said power means comprises pivoted ram means.

8. The vessel of claim **5** including ram means pivoted to said positively buoyant part and extending into said chamber for releasable attachment to the negatively buoyant part to effect walking movements of the parts.

9. A submerging vessel comprising a first part, a second part of negative buoyancy, means for adjusting the buoyancy of the first part between a first value rendering the vessel positively buoyant and a second value rendering the vessel negatively buoyant whereby the vessel can submerge and surface itself, and means interlinking said parts for controlled walking movements along a submerged surface with each part atlernately resting on the surface whilst the other part is moved over the surface by reaction against the part resting on the surface.

10. The vessel of claim **9** in which said second part is suspended from said first part by extensible and retractable cable means for effecting submerging and surfacing operations of the vessel by relative vertical movements between the parts.

11. The vessel of claim **10** including winch means for extending and retracting said cable means.

12. The vessel of claim **9** including means defining an open bottomed enclosure in said first part for accommodating said weight during walking movements of the parts.

13. The vessel of claim **9** including power means for effecting walking movements of the parts.

14. The vessel of claim **13** in which said power means comprise ram means pivoted to said first part for releasably engaging said second part during walking movements of said parts.

15. A submerging vessel comprising a positively buoyant hull, means defining an open-bottomed enclosure in said hull, a weight, extensible and retractable cable means suspending said weight from said hull, means for adjusting the buoyancy of the hull between a first positive value at which the vessel is positively buoyant and a second positive value at which the vessel is positively buoyant and a second positive value at which the vessel is negatively buoyant whereby the vessel can submerge and surface itself by relative vertical movements between the hull and weight, winch means for extending and retracting said cable means to effect said vertical movements, and ram means pivoted to said hull and extending into said enclosure for releasably gripping the weight and moving said weight relative to the hull within said enclosure to effect walking movements of the vessel along a submerged surface with the hull and weight alternately resting on the surface.

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5

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