No. 644,093.

Patented Feb. 27, 1900.

J. F. PLACE.

MARINE AIR COMPRESSOR.

(Application filed May 27, 1899.)

(No Model.)

2 Sheets—Sheet 1.

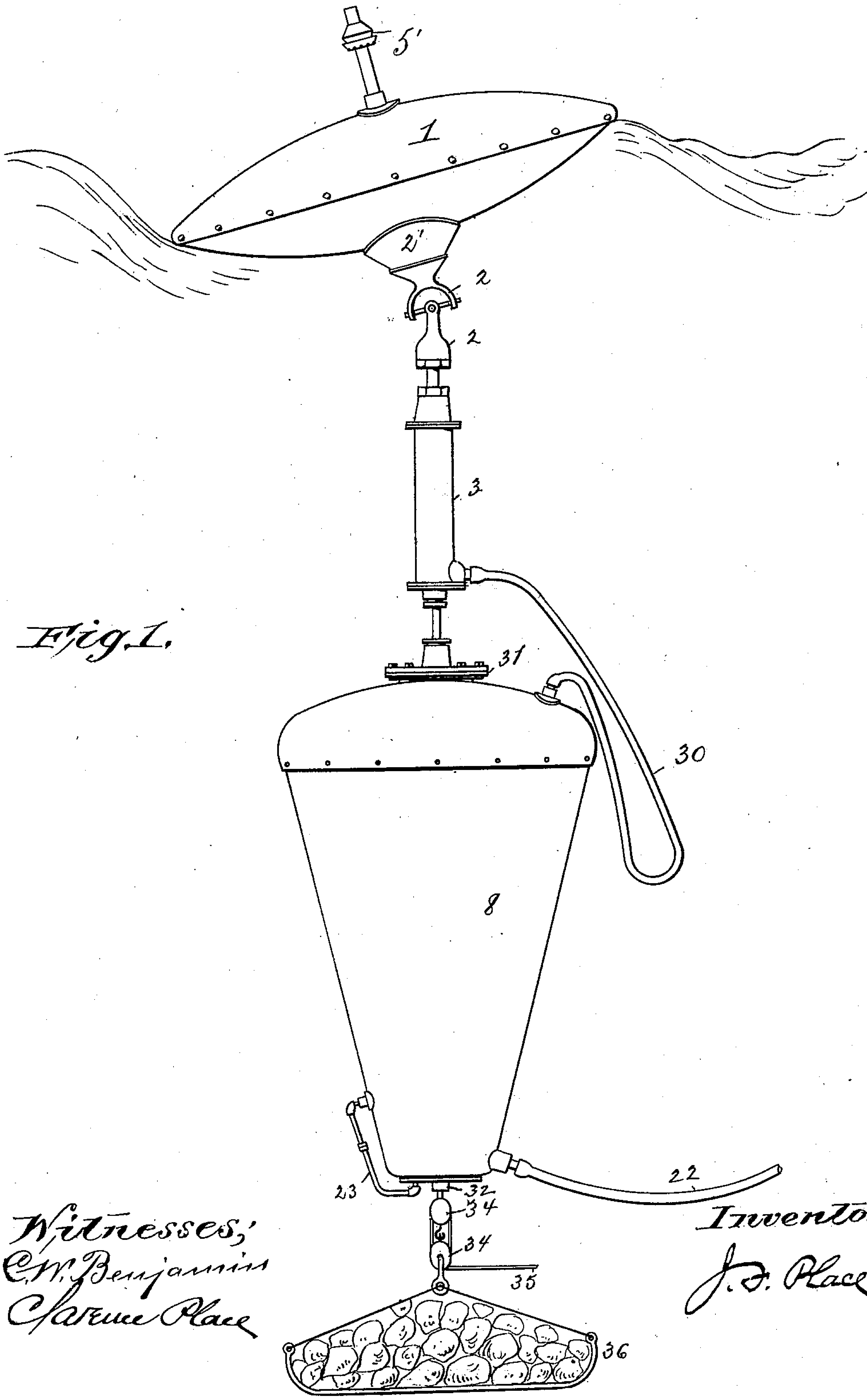


Fig. 1.

Witnesses;
C. W. Benjamin
Clarence Place

Inventor;
J. F. Place

No. 644,093.

Patented Feb. 27, 1900.

J. F. PLACE.

MARINE AIR COMPRESSOR.

(Application filed May 27, 1899.)

(No Model.)

2 Sheets—Sheet 2.

Fig. 3.

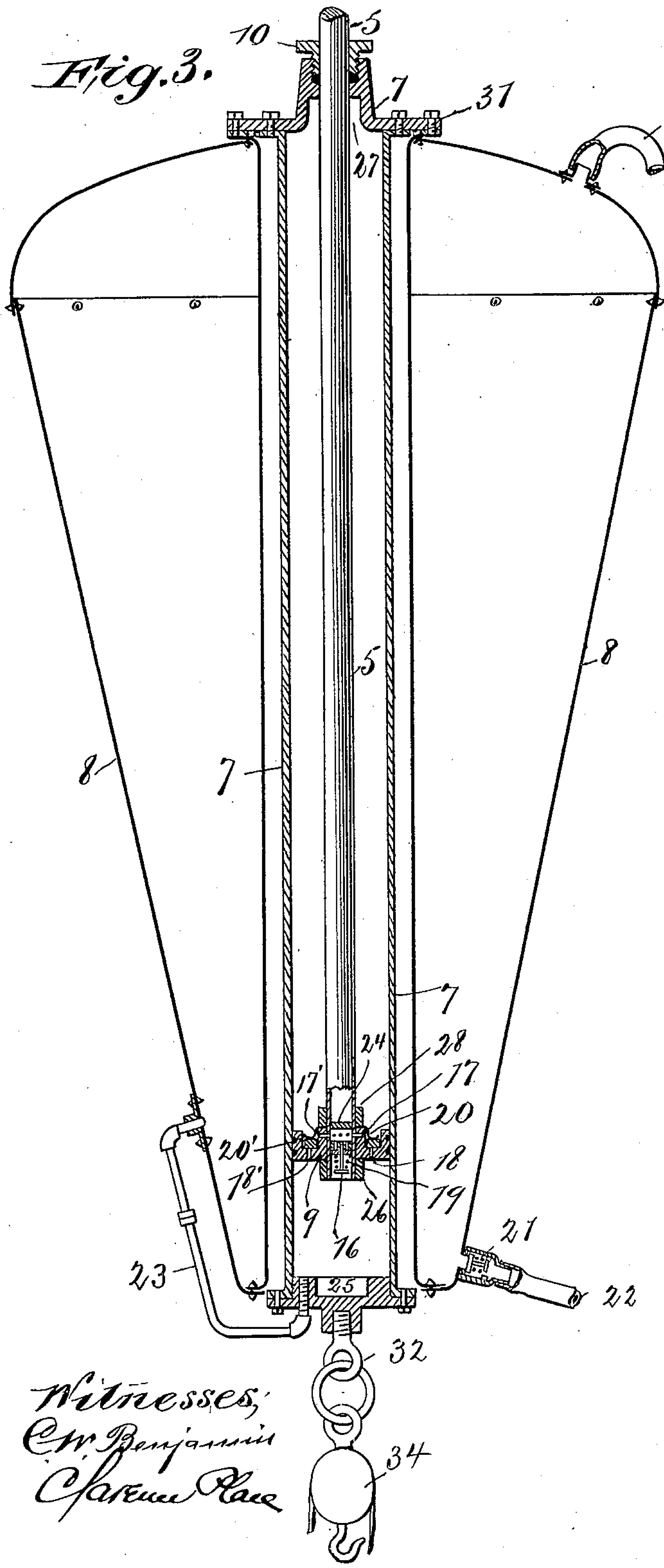
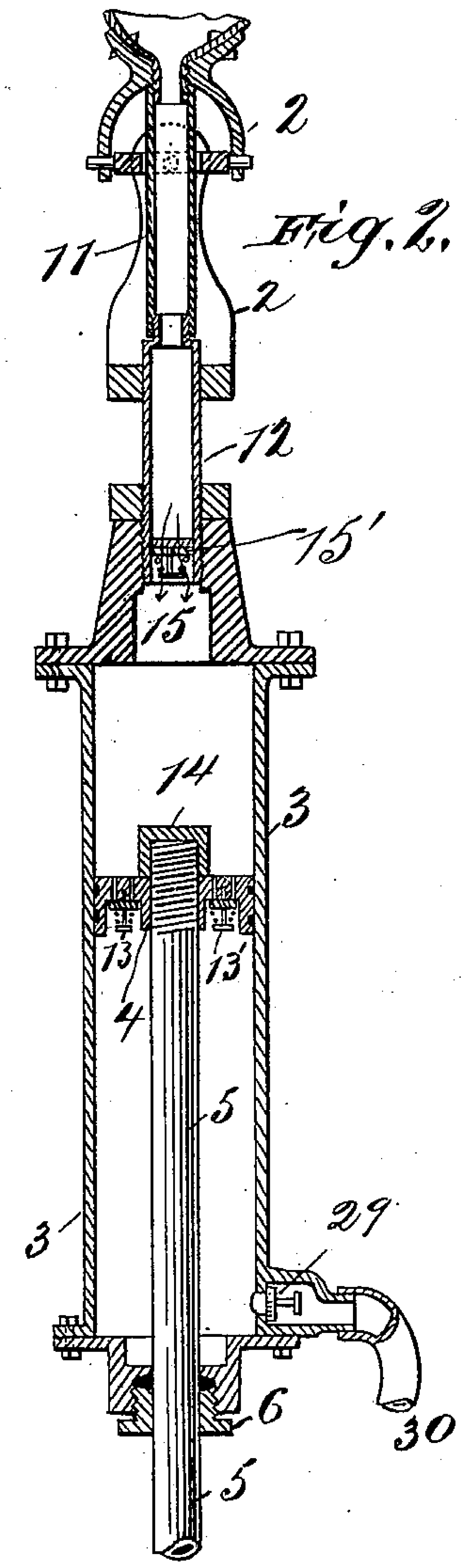


Fig. 2.



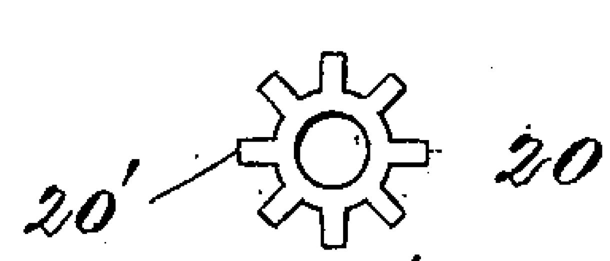


Fig. 4.

Witnesses;
C. W. Benjamin
Clarence Place

Inventor.
J. F. Place

UNITED STATES PATENT OFFICE.

JAMES F. PLACE, OF GLEN RIDGE, NEW JERSEY.

MARINE AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 644,093, dated February 27, 1900.

Application filed May 27, 1899. Serial No. 718,497. (No model.)

To all whom it may concern:

Be it known that I, JAMES F. PLACE, a citizen of the United States, and a resident of the borough of Glen Ridge, county of Essex, and State of New Jersey, have invented certain new and useful Improvements in Marine Air-Compressors, which invention relates to means for the utilization of the power of the waves of the ocean or other large bodies of water, of which the following is a specification, reference being had to the accompanying drawings, which form a part thereof.

The object of my invention is to utilize the energy of the motion of the waves of the ocean, sea, or lake by making use of the same to compress air, which can be stored or distributed for subsequent use or converted into electric energy by means of an ordinary engine and dynamo.

My invention is an improvement on my method embodied in application Serial No. 716,485, filed May 12, 1899, relating to improvement in marine air-compressors, in which the air-compressor (consisting of a primary and secondary cylinder) is submerged and is sustained and held in position by a totally-submerged buoy or air-reservoir.

The special object of this improvement is to secure a quicker automatic adjustment of the compressor to the different height, size, and strength of different waves and to the rise and fall of different tides, also to avoid straining of the parts on the upward stroke and to insure full work of the piston in the air-compressor cylinder on its down or working stroke, and besides insuring as little friction as possible to relieve the submerged buoy of weight and tendency to topheaviness, and thus aid in keeping the compressing-cylinder in an upright position at all times. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of my improved submerged air-compressor connected to floating buoy and totally-submerged buoy, as shown. Fig. 2 is a vertical section of my improved submerged air-compressor cylinder, showing air connections with floating buoy, piston and valves, and piston-rod. Fig. 3 is a vertical section of the totally-submerged buoy, which is also used as an air-reservoir, with the automatic adjusting or fluid compensating cylinder, showing piston and valves and the lower part of piston-rod, which is the same piston-rod as shown in Fig. 2. Fig. 4 is a plan view of the flat-spider spring belonging to the piston of the automatic compensating cylinder.

Similar reference-marks refer to similar parts throughout the several views.

1 is the floating buoy, which floats on the surface of the water and on the top side of which is attached a protected air-inlet passage 5′, and to the under side of which is fixed a plate 2′ and a flexible or universal joint or flexible connection 2, and 3 is the submerged air-compressing cylinder attached thereto and suspended therefrom. 4 is the piston in said cylinder and fitted to work therein. (See Fig. 2.)

5 is the piston-rod, which runs through the lower end of the air-compressing cylinder 3, through an ordinary stuffing-box 6, and through another stuffing-box 10 into the automatic compensating cylinder 7, which may be incased in or attached to the submerged buoy 8, thus connecting the two cylinders endwise. This totally-submerged buoy or air-reservoir is located below and beneath the floating buoy and air-compressing cylinder and substantially in line therewith, and it supports the compensating cylinder and the piston-rod 5, keeping both substantially erect at all times. This automatic compensating cylinder is of larger diameter than the air-compressing cylinder and is called a "compensating cylinder" because it does no work, except to automatically adjust the distance between the floating buoy 1 and the submerged buoy or air-reservoir 8 to compensate for the different size or height of the waves and the difference in depth of water at high and low tide. When working, it is filled with air, which is supplied from the totally-submerged buoy or air-reservoir 8 through the pipe 23, or it may be filled with oil or any other fluid or liquid, in which case the pipe 23 is dispensed with and the aperture where the pipe enters the cylinder is closed. Only when air is used is it of larger diameter than the compressing-cylinder. If oil or any other non-compressible liquid is used in it, then it

may be of the same or even smaller diameter than the air-compressing cylinder.

9 is the compensating cylinder piston, which is made to fit the compensating cylinder and is fixed to the lower end of the piston-rod 5 and fitted to work in said compensating cylinder. It will be noticed that this piston-rod 5 has two pistons rigidly connected together by the rod, one on the upper end in the air-compressor cylinder and one on the lower end in the compensating cylinder, the rod connecting the two cylinders together through the two stuffing-boxes referred to.

11 is a flexible air-tube which goes through the flexible connection or universal joint 2 and, with the fixed metal tube 12, forms an air-passage for the air in the floating buoy to pass to the upper part (above the piston) of the compressing-cylinder 3. On the under side of the piston 4 I place an ordinary air-inlet check valve or valves 13 and 13′. Over the top of the piston-rod at 14 I fix a cap-nut, which holds the piston to the rod and at the same time when it enters the recess 15 in the cylinder-head on its upstroke forms an air-cushion for the piston.

15′ is a check-valve opening into the cylinder, which closes when the projection (or cap-nut) 14 enters the recess 15.

In the piston 9 (see Fig. 3) of the compensating cylinder 7 I have both inlet and outlet or upward-opening and downward-opening check-valves.

16 is an outlet or downward-opening check-valve with passages 17 and 17′, which allow the air to pass from the upper side or space above the piston through these passages and the valve into the lower part of the cylinder or space below the piston.

18 and 18′ are inlet or upward-opening check-valves which allow the air to pass (through these valves) from the lower part of the cylinder to the upper side of or space above the piston.

The outlet check-valve 16 is held to its seat by a very strong spiral spring 19 of great tension, and the inlet check-valves 18 and 18′ are held to their seats by a flat spider-springs 20 and 20′, Fig. 3. (Shown more clearly in Fig. 4.) This flat spider-spring I make of very light steel, so that its pressure of the valves 18 and 18′ to their seats is very light—hardly sufficient tension to overcome the weight of the piston-rod 5 and its two pistons 4 and 9. Spiral spring 19 is one of much stronger tension than spring 20.

At 21 is an outlet check-valve in the submerged buoy, which connects with the air-hose 22, which is carried ashore to a compressed-air-receiving tank or to other air-reservoirs afloat, if preferred.

23 is a pipe connection forming an open air-passage from the interior of the submerged buoy 8 to the lower part of the compensating cylinder 7.

At 24 I fix a plug to shut off the inside of the piston-rod 5 from the air-space above the check-valve 16. The piston-rod 5 can be made solid; but I prefer a hollow rod, as shown in the drawings.

25 is a recess in the lower cylinder-head of the compensating cylinder 7 to form an air-cushion for the piston when the projection 26 enters the same on the limit of its downstroke, and 27 is a similar recess in the upper end of cylinder to serve the same purpose when the projection or round nut 28 enters it on the limit of its upstroke.

In the submerged air-compressing cylinder 3, Fig 2, near its lower end below the piston, I place an outlet check-valve 29, which connects with the flexible pipe or tube 30, which is attached to the submerged buoy or air-reservoir 8. This flexible tube forms an air-passage to carry the compressed air from the compressing-cylinder to the submerged buoy or air reservoir 8, as this submerged buoy serves as a storage-tank for the compressed air before it is carried ashore in the tube 22. The compensating cylinder 7 is fastened to the submerged buoy by bolts through the flange 31 at the top. (See Fig. 3.)

At 32 I fix an eyebolt to the lower end of the compensating cylinder, to which is attached an ordinary block and tackle 34, the rope 35, Fig. 1, passing to the shore, by which the submerged buoy, with its compensating cylinder, can be raised or lowered at convenience. The whole is held by the anchorage 36, (see Fig. 1,) which may be any sort of sunken raft or platform loaded with weights or stones, or it may be any suitable fixed anchorage made fast to the bottom.

It will be noticed that the weight of the compressor-cylinder 3 is suspended entirely from the floating buoy 1 and that no part of said weight rests upon the submerged buoy 8 or upon the piston-rod 5. This is one special feature of my improvement. The location of the cylinders may be transposed without detriment to the working of the mechanism—that is, the compensating cylinder may be on top, attached to floating buoy, and the compressing-cylinder below the same, attached to the totally-submerged air-reservoir or buoy. The preferred construction, however, is as shown in the drawings. The spring 19, (see Fig. 3,) which holds the check-valve 16 in the compensating cylinder piston to its seat, is made of great tension, sufficiently strong that it will not allow the valve to open until a greater pressure is exerted per square inch than the amount of compression per square inch in the compressing-cylinder on the under side of the piston 4. Thus it will be seen that as a wave of ordinary height acts on the floating buoy the piston-rod and pistons remain stationary, as the area of the lower piston is larger than that of the air-compressing piston (if air is used in the compensating cylinder) and the compressor-cylinder rises with the floating buoy, compresses the air in the lower part of the cylinder 3, and forces it through the check-valve 29. As the floating buoy falls into the hollow of the wave the compressor-cylinder falls with it and the piston remains stationary, while the air readily passes through the valves 13 and 13′ from the top side into the lower side of the cylinder below the piston 4, the check-valve 29 having closed. If the tide rises or if a wave of extra height and size—as in a storm, for instance—comes, then the action is repeated; but when the piston has reached the bottom of the cylinder it passes the aperture of the valve 29, forms an air-cushion of the air then below it, and the pressure is at once increased on the upper side of the lower piston 9 in the compensating cylinder 7, and the increased valve-pressure on the spring 19 causes it to act, and the valve opens and the fluid passes from the upper part of the compensating cylinder into the lower part below the piston and allows the piston 9 and piston-rod 5 to rise and lengthen the distance between the two buoys until the floating buoy has reached the crest of the wave. Then when this floating buoy drops into the hollow of the wave the piston-rod and the pistons remain practically stationary and the compressor-cylinder falls with the floating buoy. The round cap-nut 14 enters the recess 15, (see Fig. 2,) forming an air-cushion, and a pressure is exerted on the check-valves 18 and 18′ on the under side of the compensating-cylinder piston 19 greater than the weight of the piston-rod and pistons, and the valves quickly open against the springs 20 and 20′, and the fluid passes from the under side of the piston through the valves 18 and 18′ into the upper part of the cylinder 7 and allows the piston and rod to fall, thus shortening the distance between the two buoys until the floating buoy reaches the hollow of the wave. This action is repeated with every wave. The open pipe-passage 23 keeps the compensating cylinder at all times supplied with air when air is used in the same and at the same pressure as that in the submerged buoy 8 and of equal pressure above and below the piston 9. This pipe 23 is dispensed with, as heretofore explained, when oil or other liquid is used in the compensating cylinder.

The object and tendency of the submerged buoy is to at all times keep the compensating cylinder, piston-rod, and its two pistons substantially erect and in line endwise, and while allowing free action to all parts without straining the same to keep the floating buoy as nearly as possible at all times directly over the submerged buoy and yet allow it any natural and irregular movement given to it by the waves.

The length of the compressing-cylinder may be about the height of the ordinary wave where it is to be located, while the compensating cylinder and piston-rod must be considerably longer or of sufficient length to cover the difference between high and low tide and the highest and most ordinary wave.

The compressor-cylinder can be made very considerably longer than the height of an ordinary wave and it will work equally as well. In that case I take care to see that the size of the openings in valves 18 and 18′ are made very small, and the spring 20 is made of a tension smaller than enough to overcome the weight of the piston-rod 5 and its pistons, so that the tendency of the piston 9 is to slowly drop or settle down in the cylinder—not so fast as to appreciably shorten the stroke of compressor-piston 4, but yet enough so that the piston 4 will work in the lower part of the cylinder 3 at all times, regardless of the height of wave or corresponding length of stroke, thus insuring full compression of the air and complete discharge from the cylinder 3 of the compressed air with every stroke.

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

1. In a marine air-compressor of the class described, an air-compressing cylinder flexibly connected to the under side of a floating buoy; in combination with a totally-submerged buoy or air-reservoir having a compensating cylinder attached thereto; and a piston-rod having a piston on each end, one of said pistons being located and fitted to work in the said air-compressing cylinder and the other in said compensating cylinder, substantially as shown and described.

2. In a marine air-compressor of the class described, having two buoys, one floating and the other totally submerged; an air-compressing cylinder; and a compensating cylinder; in combination with a piston-rod connecting said two cylinders together through two stuffing-boxes; said piston-rod having a piston on each end, one in the air-compressing cylinder and the other in the compensating cylinder, substantially as shown and described.

3. In a marine air-compressor of the class described, having two buoys, one floating and the other totally submerged; an air-compressing cylinder and a compensating cylinder; in combination with a piston-rod connecting said two cylinders together through two stuffing-boxes; said piston-rod having a piston fixed to the end within the air-compressing cylinder, and another piston of larger area fixed to the end within the compensating cylinder, substantially as shown and described.

4. In a marine air-compressor of the class described having two buoys, one floating and the other totally submerged below the first; an air-compressing cylinder attached to and suspended from the under side of said floating buoy by a flexible connection fixed between said floating buoy and said air-compressing cylinder; in combination with a compensating cylinder of larger inside diameter than said air-compressing cylinder; said compensating cylinder being supported or sustained substantially erect by said submerged buoy below, substantially in line with said air-

compressing cylinder; and a piston-rod connecting said two cylinders together through stuffing-boxes; said piston-rod having a piston fixed to its upper end within said air-compressing cylinder, and a piston fixed to its lower end within said compensating cylinder, substantially as shown and described.

5. In a marine air-compressor of the class described, operated by a floating buoy and having a submerged air-compressing cylinder and a totally-submerged compensating cylinder; the combination of a piston working in said compensating cylinder; a valve opening from the lower part of said compensating cylinder below the piston into the upper part of same above the piston, and a valve opening from the upper part of said compensating cylinder above the piston, into the lower part of same below the piston, substantially as shown and described.

6. In a marine air-compressor of the class described, operated by a floating buoy and having a submerged air-compressing cylinder; and a totally-submerged compensating cylinder; the combination of a piston working in said compensating cylinder; a valve opening from the lower part of said compensating cylinder below the piston into the upper part of same above the piston, and held to its seat by a spring of small tension; and a valve opening from the upper part of said compensating cylinder above the piston into the lower part of same below the piston, and held to its seat by a spring of much stronger tension, substantially as shown and described.

7. Air-compressing mechanism for utilizing the power of waves, comprising two buoys, one floating on the surface of the water, and the other totally submerged and anchored beneath the same; and two cylinders connected together substantially in line endwise by a piston-rod having a piston on each end, substantially as shown and described.

8. Air-compressing mechanism for utilizing the power of waves, comprising two buoys, one floating on the surface of the water and the other submerged and anchored beneath the same; and two cylinders, connected together substantially in line endwise by a piston-rod having a piston on each end, one of said pistons being of larger area than the other, substantially as shown and described.

9. Air-compressing mechanism for utilizing the power of waves, comprising two buoys, one floating on the surface of the water and the other submerged and anchored beneath the same; and two cylinders, one considerably longer than the other, connected together substantially in line endwise by a piston-rod having a piston on each end, substantially as shown and described.

10. Air-compressing mechanism for utilizing the power of waves, comprising two buoys, one floating on the surface of the water and the other totally submerged and anchored beneath the same; two cylinders each having a piston; a piston-rod fixed at each end to one of said pistons; and an inlet or upward-opening valve, and an outlet or downward-opening valve, in one of said pistons, whereby under pressure the fluid in cylinder passes from above to below or from below to above the piston, through said valves, substantially as shown and described.

11. Air-compressing mechanism for utilizing the power of waves, comprising two buoys, one floating on the surface of the water, and the other totally submerged and anchored beneath the same; a compressing-cylinder and a fluid compensating cylinder, each with a piston fitted thereto respectively, said compensating cylinder being considerably longer than the compressing-cylinder; and said two pistons being rigidly connected together by a piston-rod, substantially as shown and described.

12. In an air-compressing mechanism for utilizing the power of waves, two cylinders, one considerably longer than the other and each having a piston; a piston-rod which connects together said two cylinders endwise; a valve opening from the space below the piston in the longer cylinder into the space above the same, and a valve opening from the space above said piston into the space below the same, substantially as shown and described.

13. In an air-compressing mechanism for utilizing the power of waves, two cylinders, one considerably longer than the other and each having a piston; a piston-rod which connects together said two cylinders endwise; a valve opening from the space below the piston in the longer cylinder into the space above the same, and held to its seat by a spring of comparatively-light tension, and a valve opening from the space above said piston into the space below the same, and held to its seat by a spring of much stronger tension, substantially as shown and described.

In witness whereof I have hereunto signed my name, this 23d day of May, 1899, in the presence of two subscribing witnesses.

JAMES F. PLACE.

Witnesses:
CLARENCE PLACE,
JULIO G. GADSDEN.