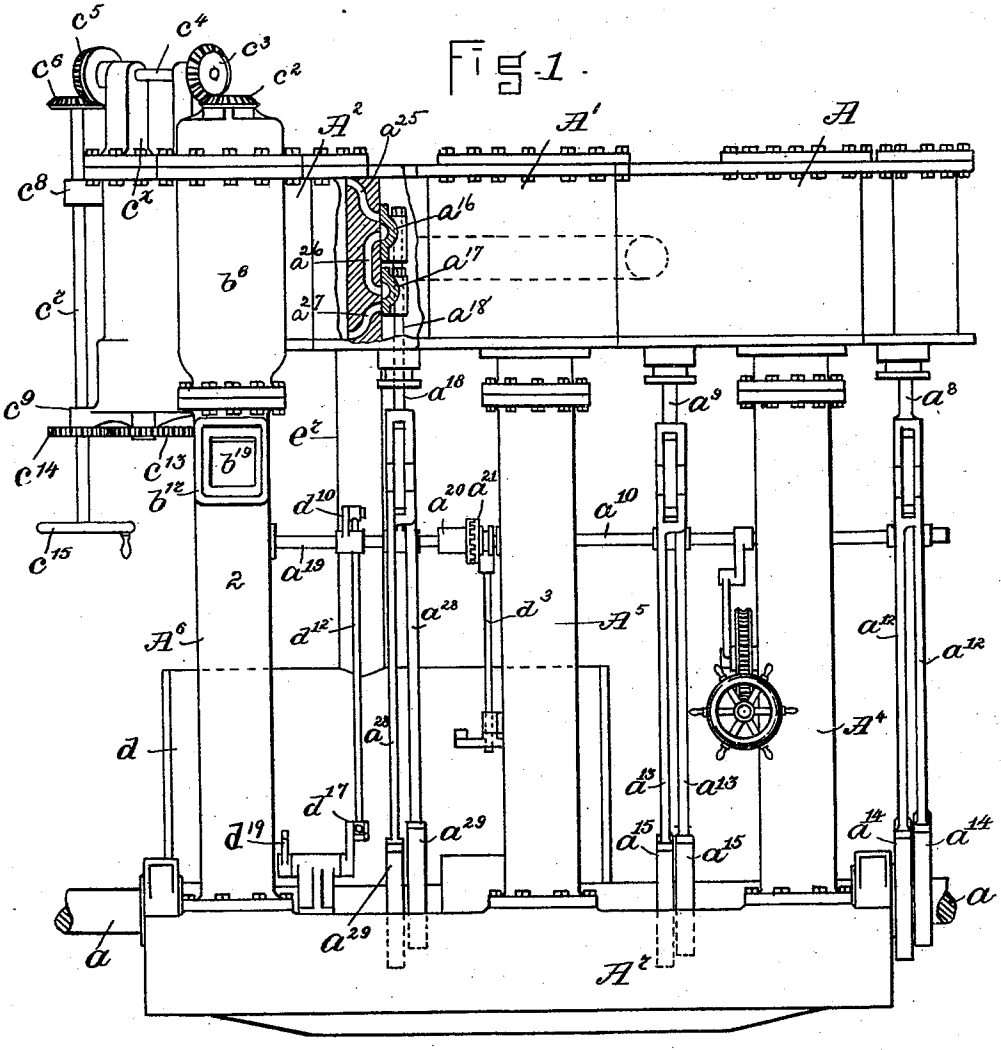
(No Model.) 3 Sheets—Sheet 1.

J. M. ANDERSEN.

ENGINE.

No. 477,921. Patented June 28, 1892.

Fig. 1.



WITNESSES.

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S. C. Fearing.

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By Jas. H. Churchill

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(No Model.) 3 Sheets—Sheet 2.

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ENGINE.

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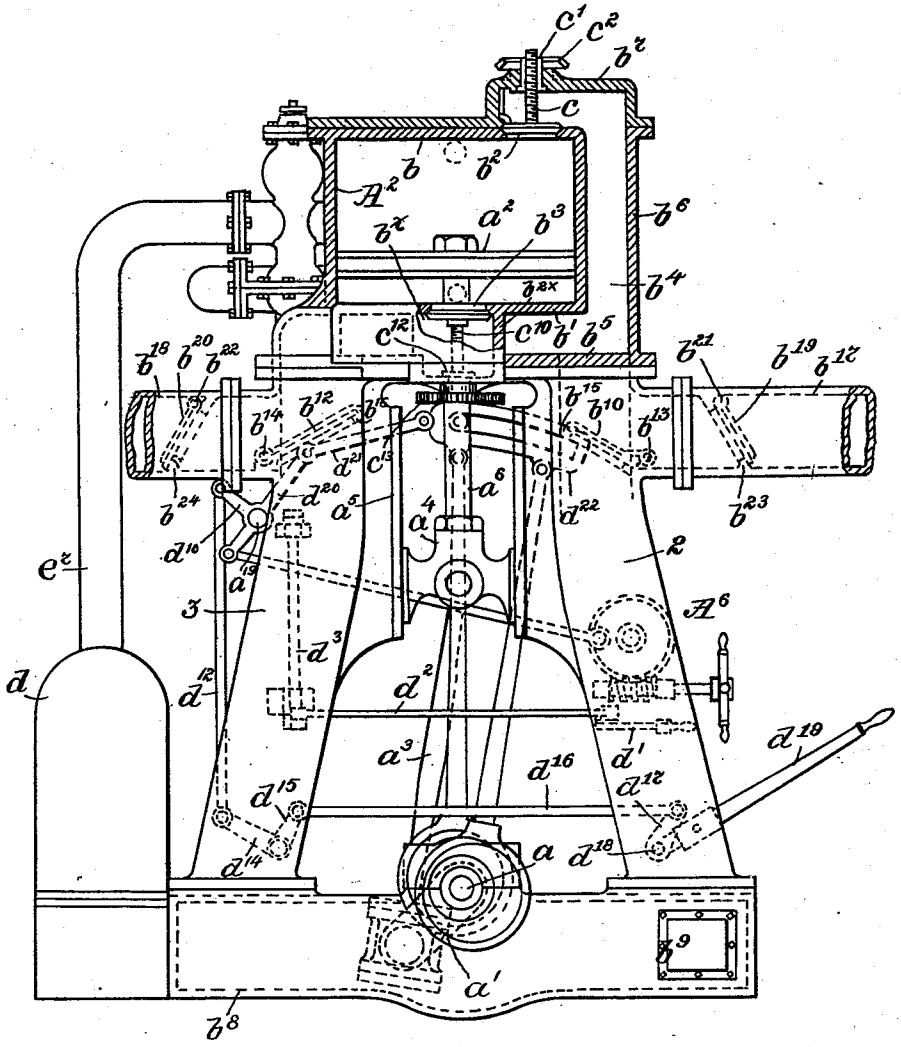

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

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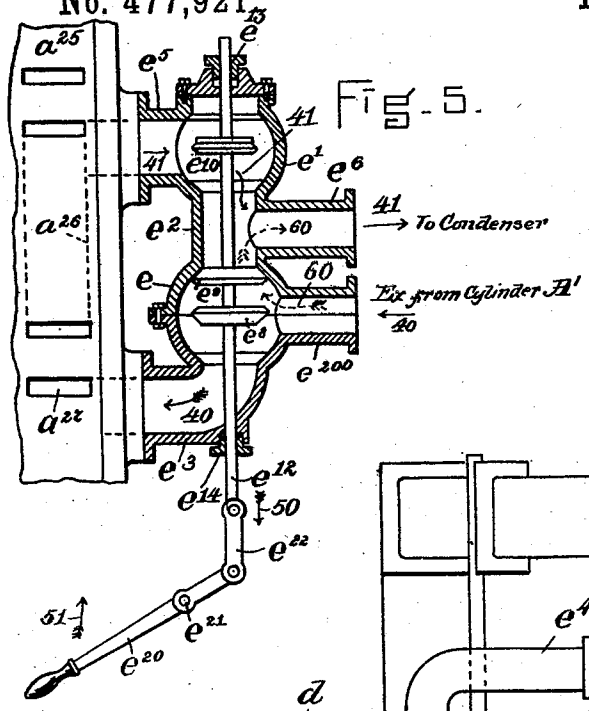

Fig. 5.

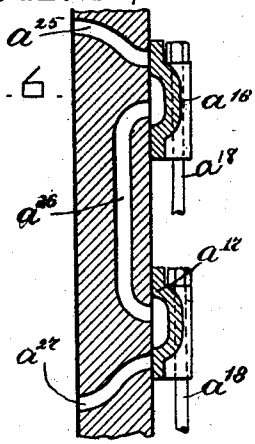

Fig. 6.

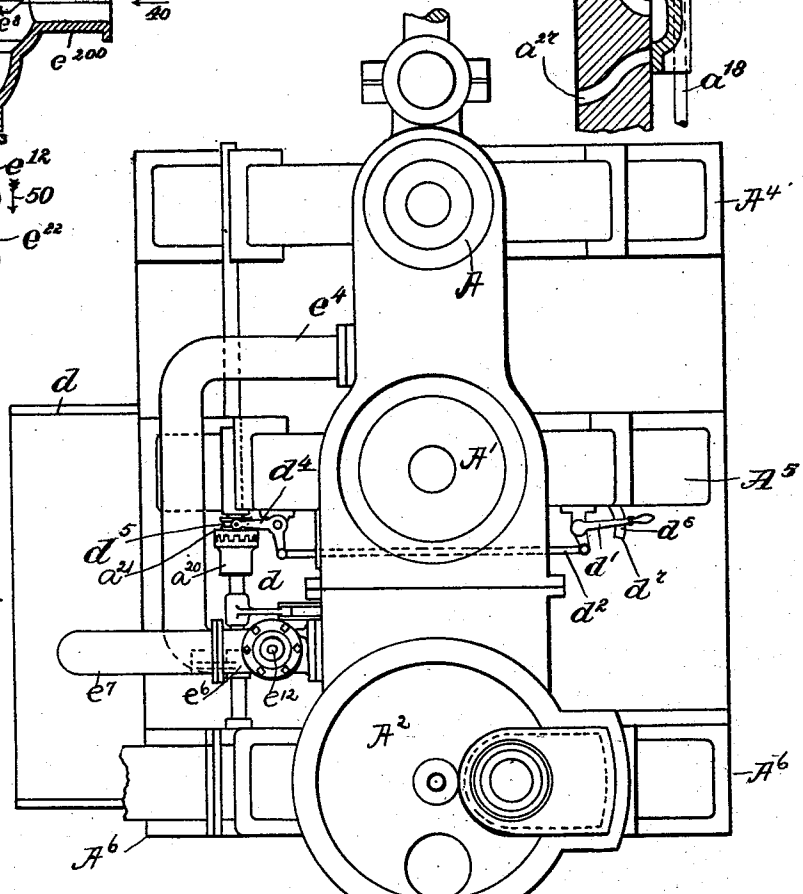

Fig. 3.

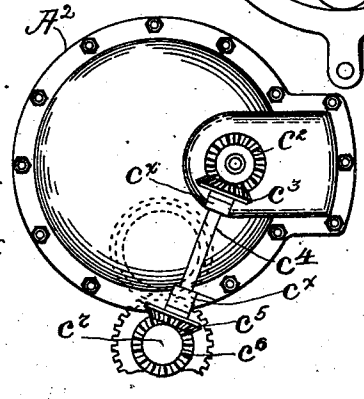

Fig. 4.

WITNESSES.

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UNITED STATES PATENT OFFICE.

JOHAN M. ANDERSEN, OF BOSTON, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO ALBERT ANDERSON, OF SAME PLACE.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 477,921, dated June 28, 1892.

Application filed March 18, 1892. Serial No. 425,484. (No model.)

To all whom it may concern:

Be it known that I, JOHAN M. ANDERSEN, a subject of the King of Norway and Sweden, residing in Boston, county of Suffolk, and State of Massachusetts, have invented an Improvement in Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

This invention relates to steam-engines, and has for its object to improve the construction of the same, whereby the said engine may be readily converted into a pumping-engine.

My invention is particularly applicable to multiple-expansion engines such as now commonly used on board steamships. Steamships as now commonly equipped are provided with multiple-expansion engines employed to propel the ship and with independent water-pumps adapted to be driven by the said engine or by separate engines. The water-pumps referred to are designed to be used to free the vessel from water in case of leakage or accident; but in practice it frequently happens that the capacity of the water-pumps is insufficient to take care of the water let into the vessel by a large leak or hole in its hull, such as might be caused by collisions or similar accidents. In accordance with my present invention the multiple-expansion steam-engine may be constructed so as to be used as an ordinary steam-engine to propel the ship, but which may be quickly converted into a combination steam and pumping engine, whereby the ship may be supplied with a pump of substantially large capacity in addition to its regular complement of pumps, the capacity of the additional pump alone being sufficient to take care of a substantially large volume of water. I prefer to employ a triple-expansion engine comprising a high-pressure, intermediate, and low-pressure cylinders and to utilize the low-pressure cylinder as a pump in case of emergency, the remaining cylinders—namely, the high-pressure and the intermediate—acting as the high and low pressure cylinders of a compound engine to drive the piston of the additional pump or low-pressure cylinder.

My invention in a steam-engine, therefore, consists in the combination of the following instrumentalities, viz: a steam-cylinder provided with steam inlet and outlet ports, a valve to control said ports, a piston in said cylinder, a main or crank shaft to which the said valve and piston are connected, a water-port for said cylinder, and a valve to control said water-port, normally closed when the cylinder is used as a steam-cylinder and opened when the said cylinder is used as a water cylinder or pump, substantially as will be described.

Other features of my invention will be pointed out in the claims at the end of this specification.

Figure 1 is a side or front elevation, partially broken out, of a multiple-expansion engine embodying my invention; Fig. 2, an end elevation of the engine shown in Fig. 1, looking toward the right, the low-pressure cylinder being broken out to enable the operation to be more readily understood; Fig. 3, a top or plan view of a sufficient portion of the engine shown in Figs. 1 and 2 to enable my invention to be understood; Fig. 4, a detail in top or plan view of the low-pressure cylinder; Fig. 5, a detail in section and elevation of the valve construction preferred by me for converting the steam-engine into a combination engine and pump, and Fig. 6 a sectional detail of one form of steam-valve for the low-pressure cylinder.

The multiple-expansion steam-engine with which I have chosen to illustrate my invention is herein shown as an upright triple-expansion engine comprising the high-pressure cylinder A, the intermediate cylinder A′, and the low-pressure cylinder A^2.

The cylinders A A′ A^2 are supported, as shown, upon three sets of columns A^4 A^5 A^6, resting upon a suitable bed-frame A^7. The columns A^4 A^5 may be made solid or hollow, and the columns A^6 made hollow, for a purpose as will be described.

The cylinders are provided with suitable pistons joined by suitable connecting-rods to a main or crank shaft *a*, having bearings in the bed-frame A^7 and provided with suitable cranks to which the connecting-rods are joined, only one crank *a*′ being indicated by dotted lines, Fig. 2, to which the piston a^2 of the low-pressure cylinder A^2 is joined by the

connecting-rod a^3, the said connecting-rod being pivoted at one end to the cross-head a^4, sliding in vertical guides a^5, and to which the piston-rod a^6 of the piston a^2 is fastened.

The cylinders A A′ have co-operating with them any usual or well-known form of steam-valve, (not herein shown,) but which have their valve-rods a^8 a^9 suitably connected in any usual or desired manner to a rock-shaft a^{10}, joined by eccentric-rods a^{12} a^{13} to eccentrics a^{14} a^{15} on the crank-shaft a.

The low-pressure cylinder A^2 has co-operating with it a steam-valve, preferably of the construction herein shown, it consisting of a double valve or two valves a^{16} a^{17}, (see Fig. 6,) mounted on a single valve-rod a^{18}, joined to a rock-shaft a^{19}, independent of the rock-shaft a^{10}, but adapted to be coupled or firmly fastened thereto by a suitable clutch mechanism, herein shown as a toothed hub a^{20}, fast on the rock-shaft a^{19}, and a corresponding toothed hub or sleeve a^{21}, keyed or otherwise fitted on the rock-shaft a^{10} to slide thereon, to be engaged with and disengaged from the toothed hub a^{20}, for a purpose as will be described.

The valves a^{16} a^{17}, as herein shown, are of the well-known form of D-valve, the valve a^{16} operating or registering with a port a^{25}, leading to one end of the low-pressure cylinder A^2—as, for instance, the top of the said cylinder—and also with one mouth of an exhaust port or passage a^{26}, made in the low-pressure cylinder, but which does not lead directly into the said cylinder. The valve a^{17} registers with a port a^{27}, leading to the bottom of the low-pressure cylinder, and also with the other mouth of the port or passage a^{26}. The valve-rod a^{18} is connected to the rock-shaft a^{19}, which is joined by the usual eccentric-rods a^{28} to the eccentrics a^{29} on the crank-shaft a.

To enable the low-pressure cylinder A^2 to be used as a pump, the latter is provided, preferably at both ends, with ports, herein shown as located in the top b and bottom b' of the said cylinder and normally closed by valves b^2 b^3, preferably disk-valves, having beveled edges to fit correspondingly-beveled seats. The upper end of the cylinder A^2 is adapted to be connected through the port controlled by the valve b^2 with a passage b^4, extended from above the cylinder down one side to the bottom of the same, the said passage being formed, as herein shown, by the cylinder A^2, a bottom plate b^5, side plate or casting b^6, and top plate or casting b^7. The lower end of the cylinder A^2 is adapted to be connected through the port controlled by the valve b^3 with a passage $b^\times$, formed by the bottom b' of the cylinder and the plate b^5 and cut off or separated from the passage b^4 by the wall or upright plate $b^{2\times}$. The passage b^4 communicates with the leg 2 of the hollow column A^6 and the passage $b^\times$ with the leg 3 of the said column. The columns A^6 are preferably connected at their lower ends by a passage b^8, made in the bed-frame A^7, the latter being provided with an opening b^9, constituting a water-inlet port, through which the water to be discharged by the low-pressure cylinder when used as a pump is admitted to the passage b^8.

The legs 2 3 of the columns A^6 are provided near their upper ends, preferably in close proximity to the cylinder A^2, with upwardly-opening valves b^{10} b^{12}, (shown as flap-valves,) which may be of any usual or well-known construction, they being pivoted, as at b^{13} b^{14}, and normally resting on lugs or stops b^{15} b^{16} on the inside of the hollow legs 2 3. The hollow legs 2 3 of the column A^6 have connected to them above the valves b^{10} b^{12} discharge-pipes b^{17} b^{18}, also provided with suitable outwardly-opening valves, herein shown as flap-valves b^{19} b^{20}, pivoted, as at b^{21} b^{22}, and normally resting against valve-seats b^{23} b^{24} on the inside of the discharge-pipes b^{17} b^{18}.

The valves b^2 b^3 are designed to and preferably will be made to move simultaneously in opposite directions when the cylinder A^2 is to be used as a pump. This result may be accomplished by means of gearing, as will now be described. The valve b^2 is provided with a threaded rod or stem c, extended through a threaded sleeve c', projected through the plate b^7 and having fast to it a bevel-gear c^2 in mesh with a bevel-pinion c^3, fast on a shaft c^4, having bearings in uprights $c^\times$, supported on the cylinder A^2, (see Fig. 1,) the shaft c^4 being provided near its opposite end with a bevel-pinion c^5 in mesh with a bevel-pinion c^6, fast on a shaft c^7, (see Fig. 1,) having bearings, as shown, in lugs or ears c^8 c^9, secured to or forming part of the cylinder A^2. The valve b^3 is provided with a stem or rod c^{10}, having screw-threads which run in an opposite direction from the screw-threads on the valve-rod c, so that the valves b^2 b^3 may be moved simultaneously in opposite directions. The valve-rod c^{10} is extended through a threaded sleeve c^{12}, projected below the cylinder A^2 and having fast to it a gear c^{13} in mesh with a pinion c^{14} on the shaft c^7, the latter being provided, as herein shown, with a hand-wheel c^{15}, by which the said shaft may be rotated to open and close the valves b^2 b^3.

In the normal condition of the engine the cylinder A^2 forms the low-pressure cylinder for the engine, the steam from the intermediate cylinder A′ exhausting from said intermediate cylinder, into the valve-chest of the low-pressure cylinder, from whence it passes alternately through the ports a^{25} a^{27} into the cylinder A^2, and the exhaust-steam from the low-pressure cylinder passes from said cylinder to the condenser d. When the engine is working as a triple-expansion engine, as just described, the rock-shaft a^{19} is clutched to the rock-shaft a^{10} and both rock-shafts are working as one shaft. If now it is desired to use the low-pressure cylinder as a pump, the rock-shaft a^{19} is disconnected from the rock-shaft a^{10}, which may be effected, as herein shown, by means of a lever d', joined by a connecting-rod d^2 to a vertical rock-shaft d^3, (see

dotted lines, Fig. 2,) the said rock-shaft having secured to or forming part of it near its upper end a forked arm d^4, (see Fig. 3,) engaging a groove d^5 in the clutch-sleeve or hub a^{21}. The clutch-sleeve a^{21} may be held in engagement with its co-operating hub a^{20}, as herein shown, (see Fig. 3,) by means of a stop-pin or stud d^6 on an arm d^7, secured to one of the columns A^5.

When the low-pressure cylinder is to be used as a pump, the exhaust-steam from the cylinder A′ is led directly to the condenser d and the steam-valves a^{16} a^{17} are moved to their central position, one lap of the valve a^{16} covering the port a^{25}, and one lap of the valve a^{17} covering the port a^{27}, thereby closing the steam-ports leading to the cylinder A^2. The valves a^{16} a^{17} may be moved into their central position by rocking the shaft a^{19}, which may be accomplished, as shown, by means of a crank d^{10} on the rock-shaft a^{19}, joined by the rod d^{12} to a bell-crank lever, having one arm d^{14} pivoted to the rod d^{12} (see Fig. 2) and its other arm d^{15} joined by a rod d^{16} to a crank d^{17} on a shaft d^{18}, having secured to it a lever d^{19}, the rock-shaft a^{19} having another crank d^{20} (shown only in Fig. 2) connected by a link d^{21} to the slotted slide d^{22} of the usual and well-known link-motion valve-gearing to which the eccentric-rods a^{28} are connected.

In order to convert the low-pressure cylinder A^2 into a pump, the pipe or passage leading from the cylinder A′ to the cylinder A^2 must be closed, and a pipe or passage leading from the cylinder A′ to the condenser is opened, and at the same time the exhaust pipe or passage from the cylinder A^2 must be closed. In order that the change above described may be accomplished in substantially an instant and by one mechanism, I prefer to employ a valve chest or casing and an arrangement of valves substantially such as shown in Fig. 5. Referring now to Fig. 5, the valve-casing referred to consists, as shown, of two substantially spherical portions e e', connected by a tubular portion e^2. The spherical portion e is provided with an inlet pipe or opening e^{200} and an outlet-pipe e^3, the inlet-pipe e^{200} in practice being connected to the exhaust-pipe e^4 for the cylinder A′, and the outlet-pipe e^3 being connected to the steam-inlet pipe or port of the valve-chest containing the slide-valves a^{16} a^{17} of the low-pressure cylinder, as shown in Fig. 5, the slide-valves being omitted. The spherical portion e' of the valve-casing is connected by the pipe e^5 to the exhaust or discharge passage a^{26} for the valve-chest of the low-pressure cylinder A^2. The tubular portion e^2 has connected to or forming part of it an outlet-pipe e^6, to which is connected the pipe e^7, leading to the condenser, as shown in Fig. 3. The valve-casing referred to contains within it, as shown in Fig. 5, three disk valves e^8 e^9 e^{10}, mounted on a single valve-rod e^{12}, extended through suitable glands or stuffing-boxes e^{13} e^{14} at the ends of the valve-casing, two of the valves, as e^8 e^9, being located in the spherical portion e and the valve e^{10} in the spherical portion e'. In the normal condition of the engine—that is, when it is working as a triple-expansion steam-engine—the valves e^8 e^9 e^{10} occupy the positions shown in Fig. 5, the valve e^8 being open to connect the exhaust-pipe from the cylinder A′ with the steam-inlet pipe e^3, leading to the valve-chest of the cylinder A^2, the valve e^{10} being also open to connect the steam-exhaust pipe e^5 from the valve-chest of the cylinder A^2 with the pipe e^6, leading to the condenser d, while the valve e^9 is at such time closed to cut off direct communication between the pipe e^2 and the pipe e^6. With the valves e^8 e^9 e^{10} in the positions shown in Fig. 5 the exhaust-steam from the cylinder A′ passes through the valve-casing, as indicated by arrows 40, into the cylinder A^2, and the exhaust-steam from the cylinder A^2 passes, as indicated by arrows 41, to the condenser.

As represented in Fig. 5, the exhaust-steam from the cylinder A′ passes through the pipes e^2 e^3 into the valve-chest of the cylinder A^2, and thence through the port a^{27} into the cylinder A^2 below the piston a^2, moving the latter upward and forcing the exhaust-steam in the cylinder A^2 above the piston a^2 out through the ports a^{25} a^{26} to the pipe e^5, from whence it passes through the spherical portion e', tubular portion e^2, through the pipe e^6 to the condenser.

When it is desired to use the cylinder A^2 as a pump, the valves e^8 e^9 e^{10} are moved downward in the direction indicated by arrow 50, which may be accomplished, as herein shown, by means of a lever e^{20}, pivoted, as at e^{21}, and connected to the valve-rod e^{12} by link e^{22}, the said lever being moved in the direction indicated by arrow 51. The lever e^{20} is moved in the direction indicated by arrow 51 until the valve e^8 cuts off communication between the pipes e^2 e^3 and the valve e^{10} cuts off the pipe e^5 from the pipe e^6, the valve e^9 being opened by the said movements, so as to connect the pipe e^2 directly with the pipe e^6. With valves e^8 e^{10} closed and the valve e^9 opened, as described, the exhaust-steam from the cylinder A′ passes directly to the condenser, as indicated by dotted-line arrows 60, and the engine is composed of a high-pressure cylinder A and a low-pressure cylinder A′. When the valves e^8 e^9 e^{10} are moved into their positions just described, it will be understood that at substantially the same instant the rock-shaft a^{19} is disconnected from the rock-shaft a^{10} by operating the lever d', and the valves a^{16} a^{17} are moved to their central position to close the ports a^{25} a^{27} by operating the lever d^{19}, and the valves b^2 b^3 are opened by turning the wheel c^{15}.

With the parts in the positions just described the piston a^2 of the cylinder A^2 is still driven by the crank-shaft a, and on the upstroke of the piston a^2 water is drawn through the port b^9 into the passage b^8, up the hollow

leg 3 into the passage $b^{\times}$, through the port in the bottom b' of the cylinder A^2 into the said cylinder below the piston a^2, and on the downstroke of the piston a^2 the water in the cylinder below the piston a^2 is forced out through the port in the bottom d' into the passage $b^{\times}$, thence through the discharge-pipe b^{18}, the valve b^{20} being opened by the water passing through the pipe b^{18}, while the valve b^{12} in the hollow leg 3 is closed by the said water. On the downstroke of the piston water is drawn up the hollow leg 2 through the passage b^4 into the cylinder A^2 above the piston a^2, and on the next upstroke of the piston a^2 the water above the said piston is forced out through the passage b^4 and discharge-pipe b^{17}, the valve b^{19} being opened by the water passing through the pipe b^{17} and the valve b^{10} being maintained closed by the said water.

Owing to the large size of the cylinder A^2, the capacity of the same when used as a pump is substantially great, and consequently a large volume of water may be taken care of by the said pump.

My improved engine is especially designed and adapted to be used on steamships, and it will readily be seen that in case of emergency the pumping capacity of the ship may be largely increased with it.

Although especially adapted to be used as a marine engine on steamships, my improved engine may be used to advantage in other places.

I have herein shown my invention as embodied in a triple-expansion engine; but I do not desire to limit my invention in this respect, as it may be embodied in other forms of engine. So, also, I have represented the convertible engine as driven from the main shaft a, and while I prefer this construction I do not desire to limit my invention in this respect, as the steam-cylinder a^2, capable of being converted into a pump of substantially large capacity, may be used with an electric or other motor mechanism.

I claim—

1. In a steam-engine, the combination of the following instrumentalities, viz: a steam-cylinder provided with steam inlet and outlet ports, a valve to control said ports, a piston in said cylinder, a main or crank shaft to which the said valve and piston are connected, a water-port for said cylinder, and a valve to control said water-port, normally closed when the cylinder is used as a steam-cylinder and opened when the said cylinder is used as a water cylinder or pump, and means to operate the steam-valve to cut off the admission of steam to the cylinder, substantially as described.

2. In a steam-engine, the combination of the following instrumentalities, viz: a steam-cylinder provided with steam inlet and outlet ports, a valve to control said ports, a piston in said cylinder, a main or crank shaft to which the said valve and piston are connected, water-ports at opposite ends of the said cylinder, valves to control said ports, normally closed when the cylinder is used as a steam-cylinder, and gearing to connect the said water-valves, whereby they may be opened by one actuating mechanism, and means to operate the steam-valve to cut off admission of steam to the cylinder, substantially as described.

3. In an engine, the combination of the following instrumentalities, viz: a plurality of cylinders provided with pistons, a main or crank shaft to which the said pistons are connected, one or more ports in one of the said cylinders additional to the regular ports, one or more valves to control said additional ports, and mechanism to disconnect the said ported cylinder from the remaining cylinders, whereby the said ported cylinder may be driven as a pump by the remaining cylinder or cylinders, substantially as described.

4. In a multiple-expansion steam-engine, the combination of the following instrumentalities, viz: a plurality of cylinders provided with pistons and connected together for expansion of the steam from one cylinder to another, valves for each of said cylinders to control the admission of steam to the cylinders, a main or crank shaft to which the said pistons and valves are connected, one or more ports in one of said cylinders additional to the ports controlled by the steam-valves, one or more valves to control said additional ports, and valves to control the passages leading to the cylinder provided with the said additional ports, whereby the said multiple-expansion steam-engine may be converted into a combination steam-engine and pump, substantially as described.

5. In a steam-engine, the combination of the following instrumentalities, viz: a high-pressure cylinder and a low-pressure cylinder, valves to control the admission of steam to the said cylinders, a rock-shaft to which the valve of the high-pressure cylinder is connected, a second rock-shaft to which the valve of the low-pressure cylinder is connected, a clutch mechanism to couple the said rock-shafts together, a main or crank shaft to which the said rock-shafts are connected, an additional or water port in the low-pressure cylinder, a valve to control said port, and valves to open and close the inlet and outlet passages to the low-pressure cylinder, whereby the low-pressure cylinder may be converted into a pump driven by the high-pressure cylinder, substantially as described.

6. In a steam-engine, the combination of the following instrumentalities, viz: a high-pressure cylinder and a low-pressure cylinder provided with pistons and with valves to control the admission of steam into said cylinders, columns to support the said cylinders, the column of the low-pressure cylinder being made hollow and provided with a water-inlet port, a valve in said hollow column, a

discharge-pipe connected to said hollow column, a rock-shaft to which the steam-valve of the high-pressure cylinder is connected, a second rock-shaft to which the steam-valve of the low-pressure cylinder is connected, means to detachably couple the said rock-shafts together, a main or crank shaft to which the pistons of the said cylinders are connected, means to connect the rock-shafts to the crank-shaft, a water-port in the low-pressure cylinder communicating with the hollow column, a valve to control said port, and valves to control the inlet and outlet passages for the low-pressure cylinder, whereby the low-pressure cylinder may be converted into a pump, substantially as described.

7. In a multiple-expansion engine, the combination of the following instrumentalities, viz: a high-pressure cylinder A, a low-pressure cylinder A^2, and an intermediate cylinder A', a bed-frame, columns A^4 A^5 to support the cylinders A A', and a hollow column A^6, provided with legs 2 3 to support the low-pressure cylinder, a main or crank shaft, pistons in the said cylinders connected to the said crank-shaft, valves to control the admission of steam into said cylinders, a rock-shaft a^{10}, to which the valves of the cylinders A A' are connected, a rock-shaft a^{19}, to which the valve of the cylinder A^2 is connected, means to move said shaft to place the valve of the cylinder A^2 in its central position, a clutch to couple the said shafts together, and means to operate said clutch, water-ports in the cylinder A^2, a passage connecting one of said ports with the hollow leg 2 of the column A^6, a second passage to connect the other water-port to the hollow leg 3 of the said column, valves in the said hollow legs, valves b^2 b^3 to control the water-ports, and means to operate said valves, a valve-casing intermediate of the cylinders A' A^2 and having ports or passages connected to the exhausts of the cylinders A' A^2 and to the inlet of the cylinder A^2, and valves to control said passages, whereby the cylinder A^2 may be converted into a pump, substantially as described.

8. In a steam-engine, the combination of the following instrumentalities, viz: the steam-cylinder A^2, provided with a piston a^2, a crank-shaft to which said piston is connected, steam-ports for said cylinder, and a valve to control said ports, means to operate said valve to cut off admission of steam to the cylinder, additional water-ports at the opposite ends of the cylinder, and valves to control the same, a passage b^4, communicating with the port b^2, and a passage $b^\times$, communicating with the port b^3, substantially as described.

9. In a steam-engine, the combination of the following instrumentalities, viz: the steam-cylinder A^2, provided with a piston a^2, a crank-shaft to which said piston is connected, steam-ports for said cylinder, and a valve to control said ports, means to operate said valve to cut off admission of steam to the cylinder, additional water-ports at the opposite ends of the cylinder, and valves to control the same, a passage b^4, communicating with the port b^2, and a passage $b^\times$, communicating with the port b^3, a hollow column 2, communicating with the passage b^4, a valve b^{10} in said column, a branch pipe b^{17}, and a valve b^{19} in said branch pipe, a hollow column 3, communicating with the passage $b^\times$, a valve b^{12} in said column, a branch pipe b^{18}, and a valve b^{20} in said branch pipe, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHAN M. ANDERSEN.

Witnesses:
JAS. H. CHURCHILL,
SADIE C. FEARING.