J. DELBRIDGE.

AIR COMPRESSOR OR PUMP.

APPLICATION FILED DEC. 29, 1906.

941,627. Patented Nov. 30, 1909.

3 SHEETS—SHEET 1.

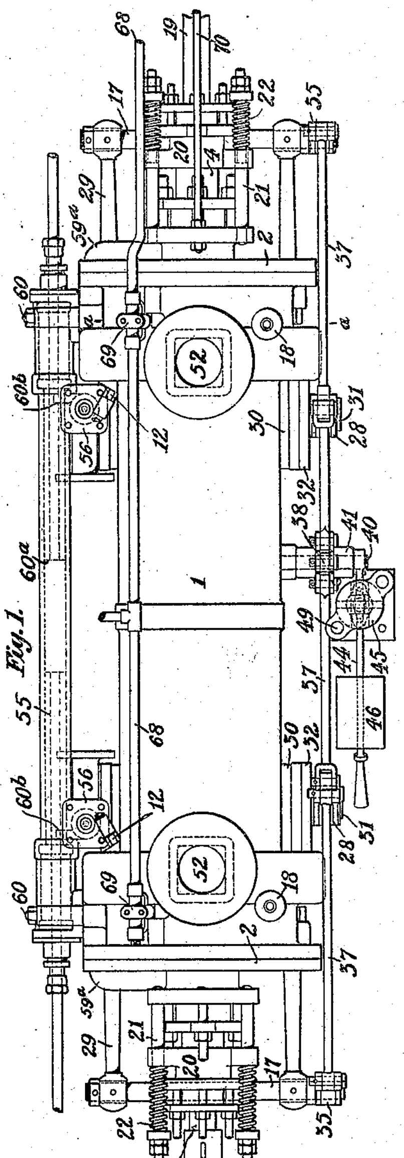


Fig. 1.

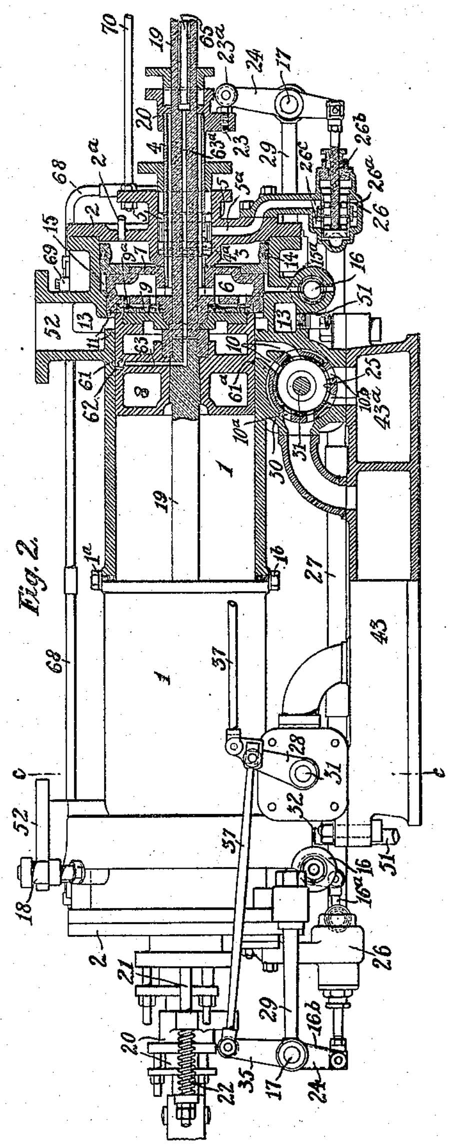


Fig. 2.

WITNESSES

W. P. Burke

Alvin E. White

INVENTOR

John Delbridge

By A. M. Wallace White

ATTY

J. DELBRIDGE.

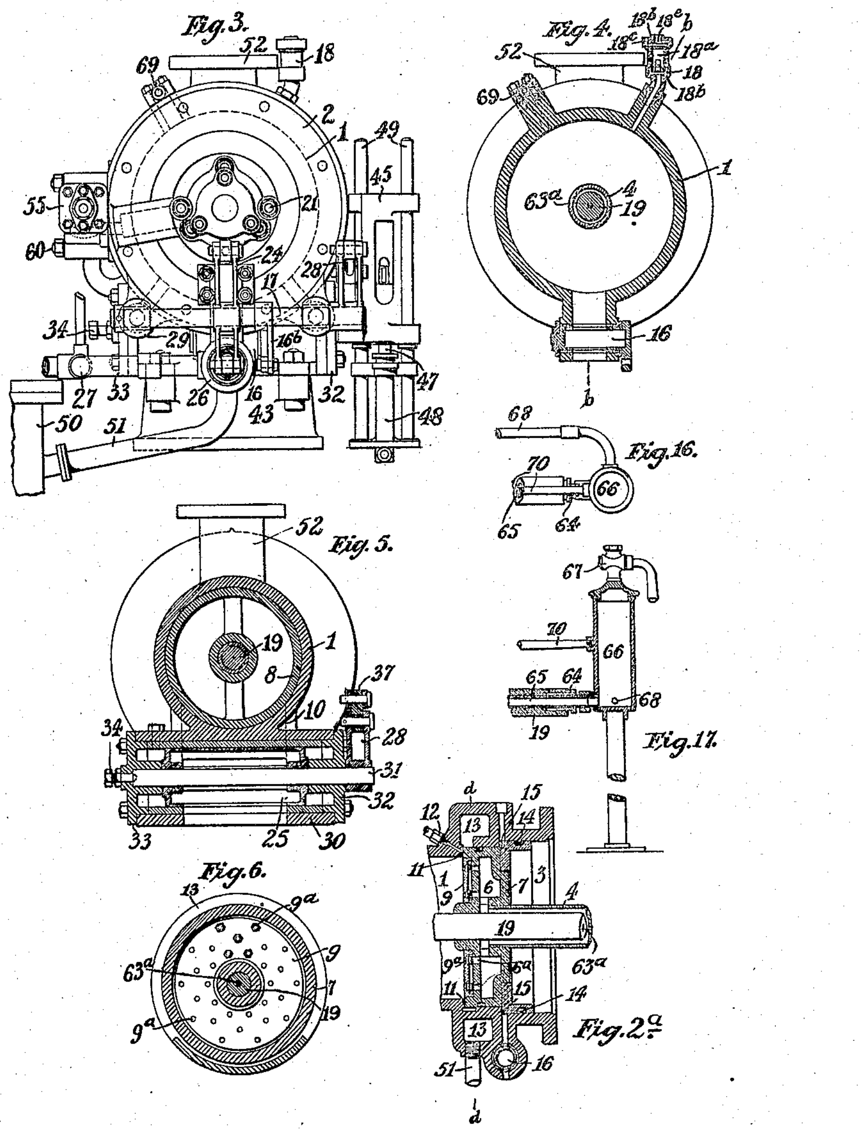
AIR COMPRESSOR OR PUMP.

APPLICATION FILED DEC. 29, 1906.

941,627.

Patented Nov. 30, 1909.

3 SHEETS—SHEET 2.



WITNESSES

W. P. Burke

Alvin G. White

INVENTOR

John Delbridge

BY A. McMillan White

ATTY.

ANDREW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

J. DELBRIDGE.

AIR COMPRESSOR OR PUMP.

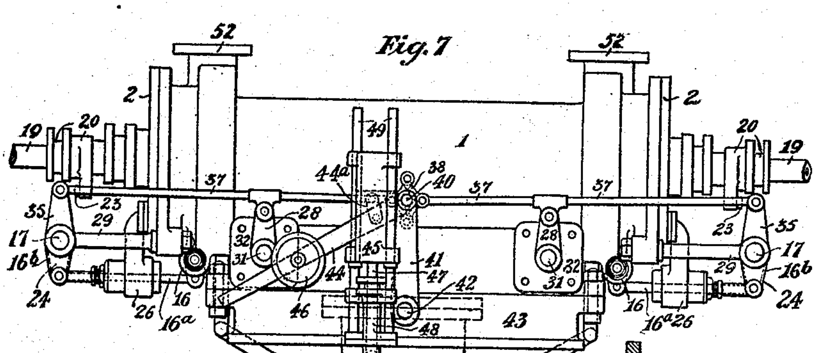
APPLICATION FILED DEC. 29, 1906.

941,627.

Patented Nov. 30, 1909.

3 SHEETS—SHEET 3.

Fig. 7



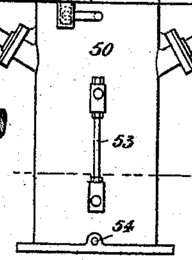


Fig. 8.

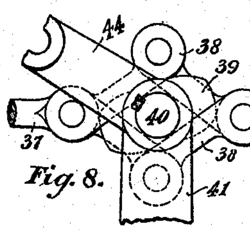


Fig. 9.

Fig. 10.

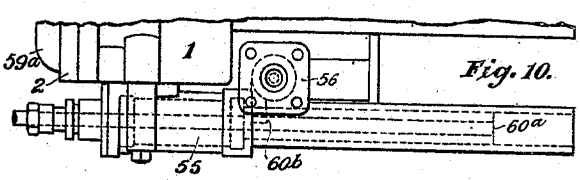


Fig. 11.

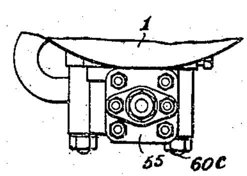


Fig. 12.

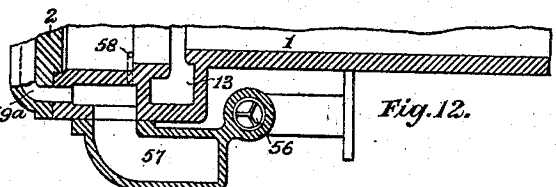


Fig. 13.

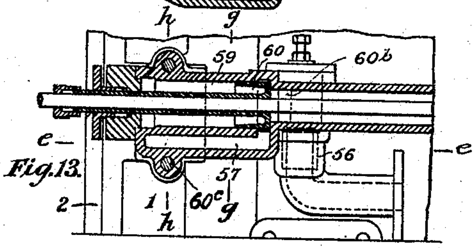


Fig. 14.

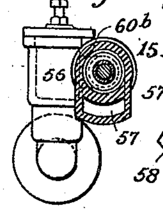
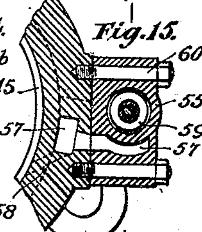


Fig. 15.



WITNESSES

W. P. Burke

Alvin G. White

INVENTOR

John Delbridge

By M. Wallace White

Att'y.

UNITED STATES PATENT OFFICE.

JOHN DELBRIDGE, OF WINDSOR, VICTORIA, AUSTRALIA.

AIR-COMPRESSOR OR PUMP.

941,627. Specification of Letters Patent. **Patented Nov. 30, 1909.**

Application filed December 29, 1906. Serial No. 349,966.

To all whom it may concern:

Be it known that I, JOHN DELBRIDGE, a subject of the King of Great Britain and Ireland, residing at 34 Gladstone street, Windsor, in the British State of Victoria, Commonwealth of Australia, have invented a new and useful Improved Air-Compressor or Pump, of which the following is a specification.

This invention relates to an improved air compressor which is usable also as a pump although it has been designed mainly for use as an air compressor.

An essential feature in an air compressor is that as nearly as possible a constant temperature of the air be maintained during its compression stage, such being accomplished in my invention by providing for the admission into each end of the compressor alternately of jets of water at high pressure such admission occurring immediately after its air inlet or suction valve is closed, thereby bringing the water into intimate contact with the air and so cooling it and thus dispensing with the necessity for water jackets intercooling and second stage compression.

Water under pressure admitted into the air cylinder has been proved to be the most effective means of keeping down the temperature of air during compression, but in consequence of no effective means being devised up to the present of getting rid of the water at the termination of the stroke of the compressor piston, said principle has not been practically applied, hence in my compressor means are provided for releasing the said water without any shock before the piston has completed its travel to each end of compressor while also means are provided for releasing the air from cylinder immediately it is compressed to the desired pressure, and for passing it therefrom to the receiver.

The compressor has no delivery valves and admits air and water, and closes the air and water valves automatically that is without any mechanical attachments to the steam engine or other motive power driving same, further there are no springs or other gearing required for said valves.

Movable internal cushion ends arranged in the compressor become balanced when the working pressure therein is reached and consequently no resistance is offered to the release of air or water. These cushion ends take the place of delivery valves and the circumferential length of compressor will be available for the delivery ports or passages.

The free air is admitted into compressor by means of cylindrical valves at bottom thereof, having ports for the admission of air and for the discharge of water thereby preventing the atmospheric air on entering the cylinder coming into contact with the discharging water. The air inlet ports to compressor form a reservoir for holding the water forced by a pump or the like into the compressor and by the air in said ports being expelled it becomes compressed and passes into the receiver, consequently there will be no clearance in this compressor between the piston and the movable cushion ends and hence every particle of air is expelled. Provision is also made for slowing down the driving engine automatically when the pressure of air rises beyond the required working pressure and further effective means for lubricating the moving parts within the compressor and if necessary its driving engine are provided.

This invention will now be more fully described aided by a reference to the accompanying sheet of drawings in which:—

Figure 1 is a general plan of the compressor and its water pump, and Fig. 2 a half side elevation and a half central vertical section of same the latter showing the air inlet port open and the piston being at the end of its stroke having just expelled the air, while Fig. 2ª shows by a section on line *b*—*b* Fig. 4 the end part of compressor with the movable cushion end over the air delivery port thus closing it in readiness for the compression of air within the compressor. Fig. 3 is an end view of the compressor. Fig. 4 a vertical section on line *a*—*a* Fig. 1 through the air cushion chamber and air and water release valves. Fig. 5 a vertical section on line *c*—*c* Fig. 2 through the air inlet valve. Fig. 6 a sectional view on line *d*—*d* Fig. 2ª showing the water jet plate and the annular delivery port or channel. Fig. 7 a general side elevation of compressor and showing the valve mechanism and the water trap. Figs. 8 and 9 are enlarged detail side and end views respectively of the releasing and locking mechanism for placing the valves in and out of action. Fig. 10 a plan of the suction valve box end of the water pump attached to the side of compressor, and Fig. 11 an end view

of same, while Fig. 12 is a section on line *e*—*e* Fig. 13. Fig. 13 a vertical section on line *f*—*f* Fig. 15 through water pump end. Fig. 14 a vertical section on line *g*—*g* Fig. 13 through cushion chamber, and delivery port of water pump, and Fig. 15 a vertical section on line *h*—*h* Fig. 13 and showing the angular water supply port leading to the balancing chamber for the movable end. Figs. 16 and 17 are plan and vertical section respectively of the oil cylinder.

In this invention a compressor cylinder 1 is provided with end covers 2 furnished with the usual stuffing boxes and glands to make an air tight joint about the water tubes 4, lantern packing rings 5, being placed inside the stuffing boxes to allow a free water way through them from water way 5^a to the ports 4^a in tube 4 leading to water chamber 6 in the hollow moving cushion end 7 which works freely upon the piston rod and which cushion ends are located one at each end of compressor in a chamber which lies between it and the covers 2 and said movable cushion ends and their chambers are formed with two diameters, that is they are stepped, the lesser diameter being larger than the bore of compressor so as to allow a sealed joint being formed between the rim of cushion end and the end of cylinder and so as to open and close a way connecting with an annular delivery chamber 13 leading to the usual air receiver or reservoir containing the compressed air. The main piston 8 is of ordinary block type secured to a piston rod 19 in the usual way and furnished with spring rings or other known means for making a working fit.

On the inner face of each movable cushion end 7 and facing the main piston 8 jet plates 9 are secured which have a number of spray nozzles 9^a secured therein and which nozzles are in free communication with the hollow chamber 6 through holes 6^a receiving the spraying or atomizing water and which latter when the compressor is at work is brought into intimate contact with the air during the compression stage, a sufficient number of jets being provided to allow water to pass through same at the requisite pressure sufficient to fill up the air inlet port 10.

In the contacting faces of movable cushion ends 7 and in the ends of compressor 1, are semi-annular grooves 11 which are connected with the pump or any high pressure water service by nozzle or branch 12 to admit water and form a water seal when the faces are together and so prevent the possibility of air escaping into or from the compressor.

The larger diameter of each stepped cushion end chamber between the movable cushion ends 7 and the covers 2 forms cushion chambers 3 which are connected to the air receiver by pipes 2^a attached to covers 2. By the greater diameter of the movable cushion ends 7 being exposed to the receiver pressure it will cause said moving cushion ends to follow the piston 8 on its return stroke in consequence of the increased area exposed to pressure in cushion chamber 3 and so close the way to the annular delivery port 13 leading to the air receiver as shown in Fig. 2^a. Between the two diameters of said movable cushion ends 7 and their chambers a water space 15 is formed which is connected to the high pressure water service by a port 58 Fig. 15 shown by dotted lines in Figs. 12 and 15 and which is connected to the port 57 leading to the pump hereinafter described, said space 15 being used as a balancing chamber for each moving cushion end, so that immediately the water pressure, which is nearly double that of the air pressure, is fed to chamber 15 it will compensate against the pressure on the larger outer area of movable cushion end 7 in cushion chamber 3 and hence when the air in the compressing cylinder 1 reaches the working pressure the moving cushion end 7 will be balanced and offer no resistance to the air passing into receiver through annular chamber 13. Immediately the main piston 8 comes into contact with the moving end 7, and which latter is thus forced back, at same time the water pressure will be liberated from chamber 15 by the opening of valve 16, and the water passing thereinto through port 15^a while valve 16 is attached by a rod 16^a to a lever 16^b on spindle 17 controlled by the moving end 7. Instead of ports 58 pipes communicating between pump delivery port 57 and balancing chamber 15 may be employed and said pipes will be furnished with stop cocks.

To allow the water to escape freely from chamber 15 through valve 16 a specially designed return air valve 18 Figs. 3 and 4 is attached to the top of balancing chamber 15 which will admit and release the air but close immediately when the water pressure is applied. The air return valve 18 consists of a vertical casing provided with a hollow floating plug 18^a which is closed top and bottom, but provided with air ports 18^b in its periphery just above its lower end and in the top of same. Under the cover of said valve a seating 18^c is provided through the center of which is an air hole 18^e which is open to atmosphere. The air passes in and out of ports 18^b when water in the balancing chamber 15 is being discharged, but when said chamber is being charged the water strikes the bottom of plug 18^a and lifts it up to its seating 18^c and cuts off communication with atmosphere again when the water pressure is removed the plug 18^a drops and allows free passage for the air.

On the outer end of each water tube 4 is a

stuffing box 20 furnished with a gland to take piston rod 19 and on each stuffing box lugs are cast to take rods 21 which are secured to the stuffing box of cylinder cover 2, said rods prevent the water tube 4 from revolving. To said rods 21 spiral starting springs 22 are attached and which may be compressed as shown at one end in Fig. 1 to overcome the resistance of moving cushion ends 7 when starting the compressor should there be not sufficient air pressure in cushion chamber 3 to keep the faces of the moving cushion end 7 and the face of cylinder together in the form of a sealed joint as shown in Fig. 2ª. The tension on said springs may be removed by slackening the nuts on rods 21 when there is sufficient air pressure in cushion chamber 3 to force the moving end 7 into sealing contact with end of compressor.

On each water tube stuffing box 20 a lug is formed to which is attached an adjustable tappet bolt 23 which is designed to contact with a roller or tappet 23ª on end of a lever 24 secured on a cross spindle 17 which operates the air inlet valves 25, water supply valve 26, and water release valve 16 at the end of each stroke of the piston 8 through the medium of levers and connecting rods hereinafter described. Said valves at each end of cylinder being so connected together that when the set of valves at one end are being opened the set at the other end of compressor are being closed.

The double ported water supply valves 26 shown in Figs. 2, 3 and 7 are only necessary when the high pressure water service for compressor is obtained from an independent source other than from the pump 55 shown. Said valves 26 consist of a cylindrical valve 26ª carried on rod 26ᵇ attached to lever 24 and said valve has ports in it to admit water through ports 26ᶜ to passage ways 5ª.

The aforesaid spindles 17 for operating the valves are supported by bearing arms 29 secured to lugs formed on cylinder or to brackets on the base plate of same.

The casing 30 of the air inlet valves 25 may be cast on cylinder as shown or cast separately and bolted thereto. Said valves are double ported, those marked 10ª leading through valve to ports 10 which are the air inlet ports, while those marked 10ᵇ are the water discharge ports which lie at the bottom to prevent the air on entering the cylinder coming into contact with the water discharge which passes into a chamber 43ª formed in base plate 43. Said valve spindle 31 passes through the cover at one end and is secured to valve 25 and enters cover 33 where a pressure screw 34 bears against the spindle and forces the end of valve 25 up against a washer joint between end of valve 25 and cover 32.

By the piston 8 covering valve port 10 in compressor before the air valve 25 requires to be operated there will be no friction due to pressure on the valve, when operating.

On each valve spindle 31 is a lever 28 which corresponds with the lever 35 on end of operating spindles 17. Said levers 35 and 28 being coupled together by adjustable rods 37 (Figs. 1 and 7) for operating the air inlet valves 25. Said connecting rods 37 are connected together near their center by a releasing and locking joint 38 for putting valves out of action, (Figs. 1, 7, 8 and 9) and which consists of toggle links 38 connected together as shown each joint being provided with distance washers which together with the eyes of rods are designed to contact with, and be operated by a double cam 39 (Figs. 8 and 9) which is secured to a stud or pin 40 in one end of a vibrating lever 41 which works on a stud pin 42 attached to base plate 43. On said cam spindle or stud 40 is attached a weighted starting and stopping lever 44 which passes through and is attached by link 44ª to a vertical guide weight 45 (Fig. 7) the lower end of which is attached to a pneumatic ram 47 which enters a ram casing 48 connected to the air receiver. Should the air rise above the ordinary working pressure the ram 47 which has the receiver pressure under same will rise and carry the weight 45 with it and at same time open the locking joint 38 and put the valves out of action allowing the free air to pass in and out of compressor, this is accomplished by lengthening the connecting rod 37 so that tappets 23 cannot come into contact with tappet or roller 23ª on end of operating lever 24, at same time it will raise the starting and stopping lever which is also attached to a controlling valve on steam pipe and slow down the engine driving the compressor. Said starting and stopping lever is also provided with a balance weight 46.

When the air is reduced to its working pressure in receiver the aforesaid ram and weights will fall and again put the valves into action and turn on steam. Guide pillars 49—for guide weight 45 are provided—attached to ram casing at bottom and may be attached to cylinder at top.

To allow any water to escape that may get into delivery chamber 13 a communication is formed by means of pipes 51 which lead to a water trap 50 see Fig. 7 which may be arranged below the compressor and furnished with a water gage 53 and dribble cock 54. The compressed air passes out through branch 52 on the top of compressor to the receiver.

The water is forced into the compressor by means of a double acting or other pump 55 which may be attached to side of air compressing cylinder as shown in Figs. 1 and 3, and secured by studs 60ᶜ and worked from

cross heads at each end of piston rod 19. The cubical contents of water at each stroke of pump must be equal to the area of inlet ports so as to expel the air in said ports when inlet valve is closed.

The water passes from the pump into port 57, part of which is in cylinder 1, through supply port 59[a] leading through cylinder cover 2 into water tube 4 through ports 4[a] and thence to water chamber 6 in moving end 7. The water for balancing chamber 15 is also taken from said port 57. The water supply is cut off when the plunger 60[a] of pump is within say from 3″ to 4″ from end of its stroke, the plunger will then pass over the inlet port 60[b] and force the cushion end 60 back into the cushion chamber 59 to end of stroke. Should said water pump be fixed about the tail rod of piston the delivery will have to be connected by pipes to water port 5[a] in compressor cover 2 or to water supply valve 26, by pipes 27 but it is considered preferable to attach the water pump 55 to cylinder 1 as shown in Fig. 1 and dispense with the valve 26 as otherwise the piston tail rod would have to be extended a considerable length.

For the purpose of lubricating the various working parts of this compressor so as to prevent, as far as possible, the oil from polluting the compressed air a new means of oiling is provided as shown in Fig. 2. Main piston 8 is provided with an oil groove 61[a] formed around its periphery and a recess 61 formed to receive a ball valve 62 while an oil hole 63 is bored from ball valve chamber 61 communicating with an oil passage 63[a] in center of piston rod.

The end of piston or tail rod 19 is provided with a stuffing box and gland 64 which surrounds an oil tube 65 fitted inside the tail rod 19 and forming a connection with oil passage 63[a] said oil tube 65 passes through stuffing box and gland 64 and is attached to an oil cylinder 66, which will be about double the capacity required for containing the necessary oil, and provided with cover and an air cock 67.

For the purpose of oiling the moving cushion ends 7 an oil tube 68 is connected to cylinder 66 connecting oil boxes 69 which are placed so as to lead the oil on to the moving ends in any desired two places, holes being drilled at any desired position through body of cylinder into the chamber 3 of cushion ends and so connecting same with the oil boxes 69.

A regulating pressure relief valve, not shown, will be attached to top of oil cylinder 66 while the latter will be secured to the compressor by a stay bolt 70 or by other known means.

When the compressing piston 8 is at the front end of cylinder 1 the air valve 67 on oil cylinder will be shut and on the return of the piston rod the air in oil cylinder 66 will be compressed and so force the oil into the channels around piston 8, moving cushion ends 7, and when properly lubricated the air valve 67 will be opened and allow the oil to follow the piston rod in and out.

When requiring to clean out the oil channel around piston the compressor is at half stroke so that the groove around piston will be directly under plug 1[a] to which is attached an air or steam pipe for blowing through said channel and which finds exit through the plug hole 1[b] at bottom of cylinder. The oil channels around moving cushion ends will be similarly cleaned out by attaching steam or air pipes to oil tube 68.

When the air compressor is worked from the tail rod of a steam engine a communication can be formed through the rod to piston of steam cylinder and the oil tube extended so that the steam cylinder and other working parts of engine can be lubricated simultaneously with and in same manner as the air compressor. Or a similar means of oiling can be applied to any steam engine direct.

To use the compressor as a liquid pump the water valves 16, pump 55 which supplies the water for the spraying appliance in moving cushion end, will be dispensed with as will also the spraying appliance, while all passages leading into and out of moving ends 7 will be closed up so that there will be no communication into cylinder through same. The air inlet valves 25 then become suction valves and the water is delivered through the branches 52 at top of cylinders through annular chambers 13. The moving cushion ends 7 and chambers 3 will be still maintained and also the air pressure in said chambers. The valves 25 would be operated in the same manner as for the compressor.

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

1. In an air compressor, a cylinder having a stepped chamber at each end thereof, a movable water end fitted in each stepped chamber and furnished with nozzles connected by passages to the interior of the water end, means for moving the water ends for controlling the entrance and exit of fluid to the compressor, and means for delivering water to the interior of the water ends whereby water in a fine spray is introduced into the cylinder through the nozzles to reduce the temperature of the air during compression, substantially as described.

2. In an air compressor, a cylinder having a chamber at each end thereof, a movable water end in each chamber furnished with nozzles connected to the interior of water end, means for moving the water ends to

control the entrance and exit of fluid to the compressor, and means for introducing water to the interior of said ends whereby water is injected in a fine spray to reduce the temperature of the air during compression, and a combined air delivery cock and water discharge cock for admitting air to the compressor and discharging water therefrom substantially as described.

3. In an air compressor, a cylinder, a piston and rod therein, said cylinder having an enlarged stepped chamber at each end thereof, a movable water end cushioned on air under pressure in said chambers, said water end having nozzles on its inner face through which water is sprayed to the cylinder, and the stepped parts of said water end and its chamber forming a water balancing chamber having inlet and outlet passages, said cylinder having at each end at its bottom part an air and water port and at its upper part an air outlet port, substantially as described.

4. In an air compressor having movable water-ends the combination therewith of a cylindrical valve arranged one at each end of the cylinder and provided with ports connected with the compressor, an air supply connected with said ports and a water discharge cistern, also connected with said ports, and levers and rods controlled by the stroke of compressor for operating said valves, substantially as described.

5. In an air compressor, a piston and rod, a hollow movable water-end having a front nozzle plate and a stepped chamber, a water supply tube attached to said end and passing out of the compressor about the piston rod, said tube having ports in it, a water supply valve connected with said ports and means for so governing said valve as to admit a supply of water at every stroke of the piston, substantially as described.

6. In an air compressor having a stepped chamber at each end, a movable water-end for each chamber, an air cushion chamber between the back of the cushion end and the compressor cover, and an annular balancing chamber between the stepped parts of said chamber and the cushion end, means for supplying said air chamber with air under pressure and the balancing chamber with water also under pressure, substantially as described.

7. In an air compressor, in combination a cylinder, a piston therein, a piston rod, an enlarged stepped chamber at each end of the cylinder, movable air cushioned and water balanced ends working in each of said chambers, water spray nozzles arranged on the inner faces of said movable ends, means for supplying said nozzles with water under pressure, said cylinder having at its bottom part air and water inlet and outlet ports, a cylindrical valve for controlling said ports and said cylinder having an outlet port for air at the top part thereof, and an air receiver connected with said port, substantially as described.

8. In a compressor, a cylinder, movable water-ends therein, the meeting surfaces of the cylinder end and rim of movable water ends having grooves therein, and means for delivering water under pressure to said grooves in order that when the meeting surfaces are together a water joint or seal is formed, substantially as described.

9. In a compressor, the combination of the valve gear connecting rod having a releasing and locking joint consisting of toggle links at its center, air inlet and water discharge valves, a water supply valve and the water release valve, levers for operating said valves, a tappet for operating all said levers simultaneously and moving ends on the compressor operating the tappet, substantially as described and shown.

10. In a compressor, in combination a rod having a releasing and locking joint consisting of toggle links, a cam engaging with said toggle links, a weighted lever centered on the cam spindle and operating the cam when the air in the receiver has reached the requisite pressure and means connected to said rod for preventing compression in the compressor when the joint is released, substantially as described and shown.

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

JOHN DELBRIDGE.

Witnesses:

BEDLINGTON WODYCOMB,

W. J. S. THOMPSON.