No. 813,301. PATENTED FEB. 20, 1906.

F. S. HYDE.

STEAM ENGINE.

APPLICATION FILED SEPT. 9, 1903. RENEWED JULY 13, 1905.

Fig. I

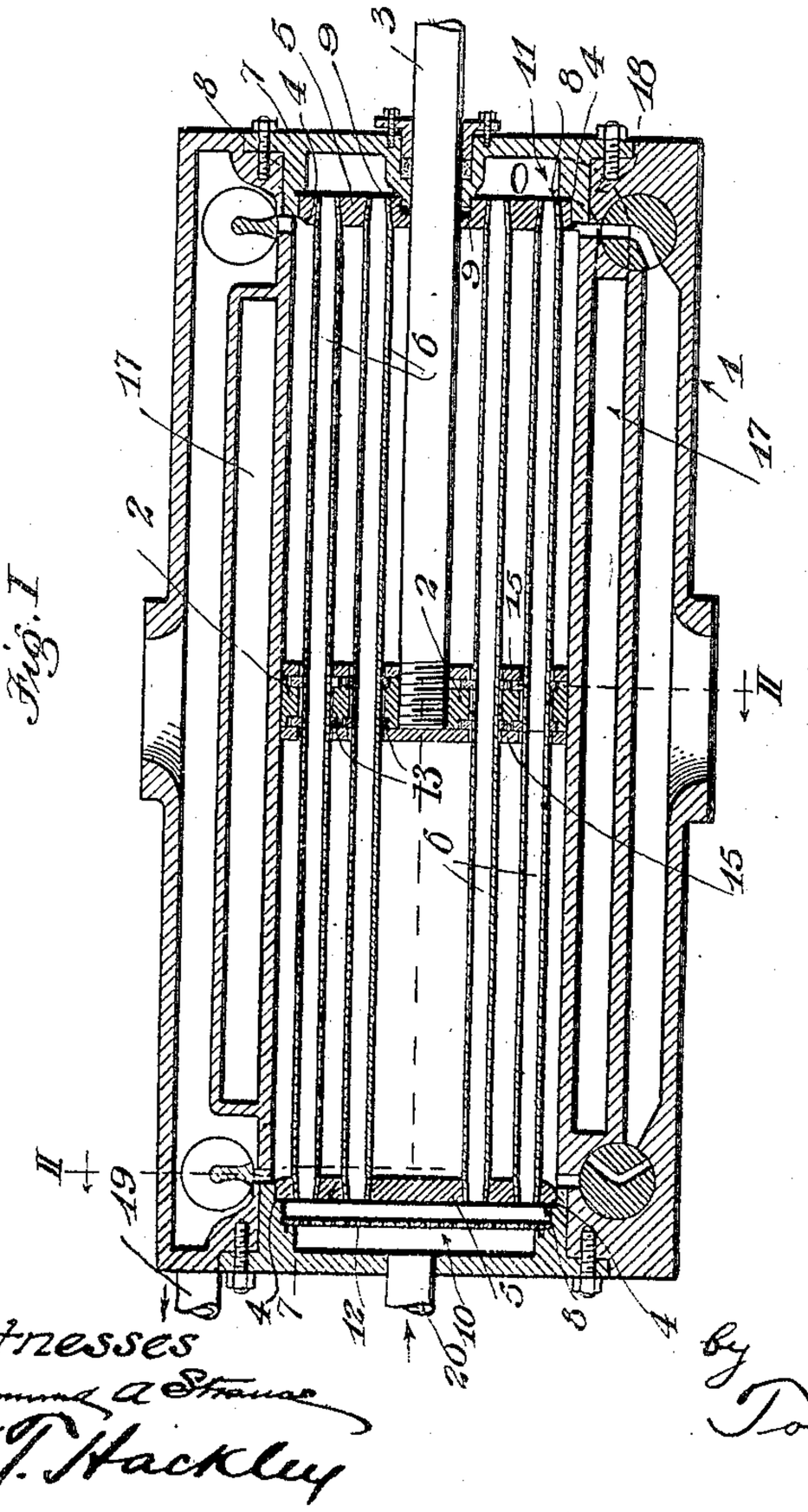


Fig. II

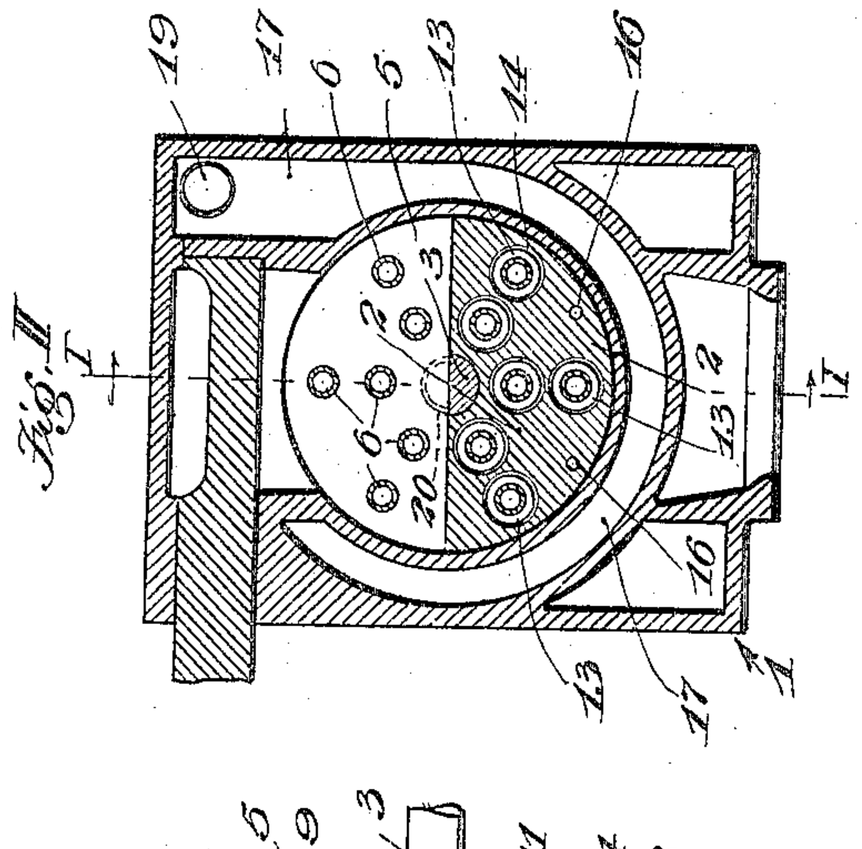


Fig. III

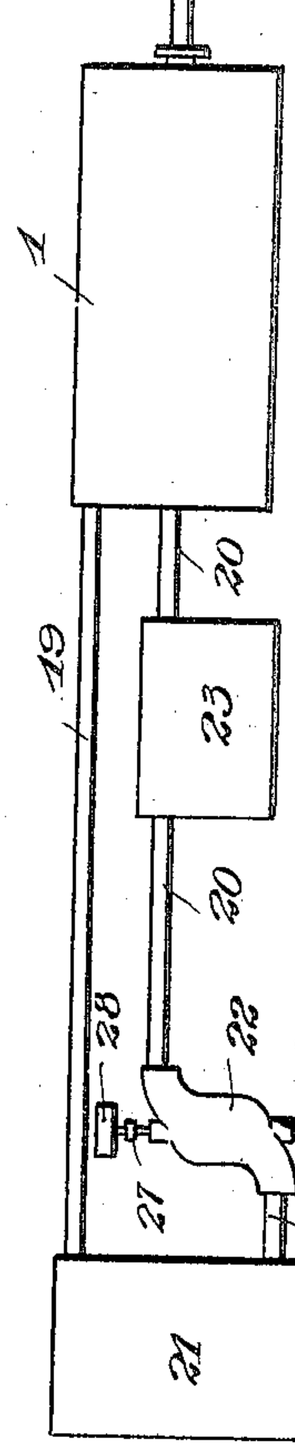


Fig. IV

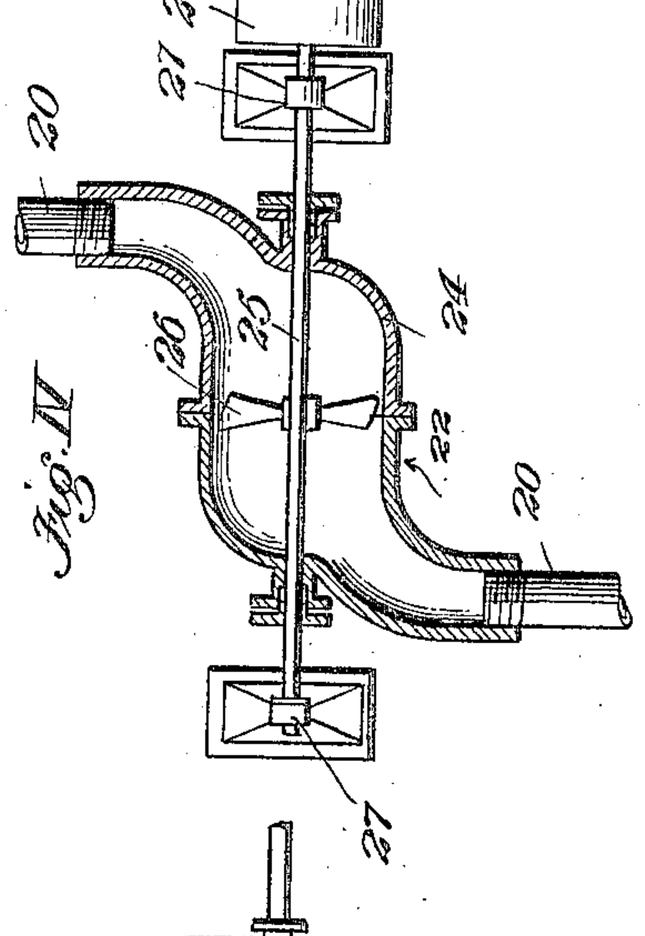
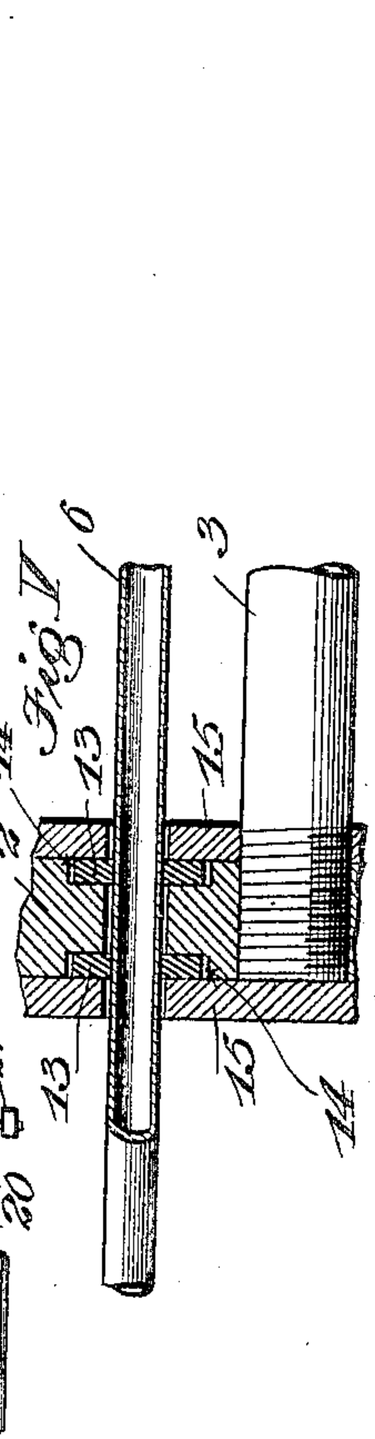


Fig. V



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UNITED STATES PATENT OFFICE.

FRANK S. HYDE, OF RIVERSIDE, CALIFORNIA.

STEAM-ENGINE.

No. 813,301. Specification of Letters Patent. Patented Feb. 20, 1906.

Application filed September 9, 1903. Renewed July 13, 1905. Serial No. 269,571.

To all whom it may concern:

Be it known that I, FRANK S. HYDE, a citizen of the United States, residing at Riverside, in the county of Riverside and State of California, have invented new and useful Improvements in Steam-Engines, Air-Compressors, and the Like, of which the following is a specification.

This invention relates to means for securing greater effectiveness in the operation of steam-engines, air-compressors, and the like.

One object of the invention is greater economy of power.

Another object is to secure a definite mean effective pressure in the working cylinder of the engine and to make it possible to employ an earlier cut-off.

In steam-engines there is considerable loss in efficiency from the condensation of steam within the cylinder. This loss is commonly from twenty to thirty per cent. In quadruple-expansion engines it may be as low as ten per cent., and in simple condensing-engines with a high degree of expansion it has been known to exceed fifty per cent. As is well known, a large portion of this loss is caused before the cut-off by the entering steam coming in contact with the inner surface of the cylinder, which has just been cooled by the exhaust-steam and by radiation. A further loss of steam is occasioned by condensation after the cut-off due to loss of heat during expansion while doing work.

One of the main objects of the present invention is to provide means preventing loss from condensation in steam-engines.

Another object is to provide means for increasing the effective pressure of the steam within the cylinder and for so heating the steam within the cylinder throughout the stroke that before cut-off the pressure of the steam within the cylinder is somewhat greater than it would otherwise be and after cut-off the pressure of the steam within the cylinder is considerably increased during expansion. Therefore with this invention a greater economy of steam results, for the reason that in securing a definite mean effective pressure a much earlier cut-off can be used.

Another object of the present invention is to accomplish what has heretofore been aimed at by the use of superheated steam without the disadvantages which have heretofore resulted in using superheated steam—that is, deterioration and leakage of valves, which have a rubbing action and are excessively heated by the superheated steam.

The temperature of the steam being maintained throughout the stroke, all the benefits of isothermal expansion may be realized. With present engines it is not economical to carry the ratio of expansion in any one cylinder beyond three to four, because of excessive condensation due to the drop in temperature of the expanding steam, the condensation loss rising rapidly with light loads and early cut-offs. With my invention the limiting factor to prevent the full theoretical expansion from initial to minimum exhaust-pressure is the load only. It follows, therefore, that the greatest economy of steam will result with light loads, which is not true of present engines. This is an especial advantage in such engines as are seldom run under full load. It also permits a degree of expansion in one cylinder which can only be economically obtained at present by compounding in two or three cylinders. With a compound engine of two cylinders and long stroke my invention will enable a degree of expansion to be economically used far beyond that now obtained by quadruple-expansion engines. In addition to obviating the condensation losses the use of the invention results in a much greater economy of steam because of the increased expansion, a lessened first cost of engines, and a decrease in the engine friction because of the less number. The full advantages of higher steam-pressures may also be utilized because of the greatly-increased expansion which is rendered practical and economical.

The invention is also applicable for extracting heat from cylinders, and is especially valuable for air-compressors. In air-compressors, especially those having large cylinders, but a comparatively small amount of air is in contact with the cylinder-walls near the water-jacket, the greater bulk of the air within the cylinder being uninfluenced to the degree which might be desired, and the present invention when applied to air-compressors will cool the entire body of air within the cylinder in a uniform manner, so that the air in the center of the cylinder is as cool as the air which lies next the water-jacket, the entire amount of air contained within the cylinder having a uniform temperature throughout.

In liquid-air apparatus the invention is es-

pecially valuable, as the resultant cooling effect reduces the heat arising from the extremely high pressures used in such apparatus, varying from two thousand to four thousand pounds per square inch. By use of the present invention it is possible to compress air to a much higher point than heretofore and to do this with less apparatus and a less expenditure of power than has heretofore been required, thus making a great saving and accomplishing an important advance in the art of liquefying air.

Obviously the invention is equally applicable and valuable for use with air-motors in the same manner as with steam-engines, the invention being adapted for use to either increase or decrease the heat of any expansive confined fluid.

The accompanying drawings illustrate one form of my invention.

Referring to the drawings, Figure I is a vertical longitudinal section taken through a cylinder of the Corliss type equipped with my invention. Fig. II is a vertical transverse section taken on line II II of Fig. I. Fig. III is a plan view of the invention complete. Fig. IV is a horizontal longitudinal section taken through the circulating device. Fig. V is a fragmental sectional detail showing the packing around a tube where the tube passes through the piston.

Briefly, the invention comprises, in combination with a cylinder or other chamber for confining an expansive fluid, means within the cylinder or chamber through which a heating or cooling agent may be passed to influence the temperature of the expansive fluid within the cylinder or chamber.

The invention further comprises means for maintaining a circulation of such temperature-influencing agent through said means within the cylinder.

The invention also further comprises means for increasing or decreasing the temperature of the said temperature-influencing agent, the said means comprising either superheating or supercooling means.

In the drawings and description I have shown my invention as applied to a steam-engine cylinder for increasing the temperature of the steam within the cylinder, the cylinder being provided with a series of longitudinal tubes which communicate with circulating-pipes for conveying water from a boiler or water-heater through the tubes which extend through the cylinder.

Referring to Fig. I, 1 designates a cylinder of the Corliss type which is provided with the usual steam inlets and outlets and inlet and outlet valves.

2 designates a piston having the usual piston-rod 3. Each end of the cylinder is provided with shoulders 4, against which lie heads 5. Each head 5 is provided with perforations, preferably tapered, which receive correspondingly-tapered ends of tubes 6. The heads may be held in place by caps 7, which may be bolted to the ends of the cylinder, as shown, suitable gaskets 8 being interposed between the caps 7 and the heads 5. The piston-rod 3 passes through the center of one of the heads 5 and a packing 9 is provided in that head around the piston-rod 3. The head end of the cylinder is provided with a chamber 10, formed between a head 5 and cap 7, while the crank end of the cylinder is provided with a chamber 11, formed between a head 5 and a cap 7, a screen 12, within the chamber 10, being attached to the cap 7.

The piston 2 is perforated to receive the tubes 6, and suitable annular packing-rings 13 encircle the tubes 6, each packing-ring 13 being nested in a recess 14, each recess 14 being sufficiently large to permit of a slight amount of lateral movement of the packing-ring. The perforations through the piston which receive the tubes 6 are somewhat larger than the tubes, providing sufficient clearance for any deviation in the alinement of tubes. There may preferably be two series of packing-rings 13, one series being on each side of the piston, and the packing-rings 13 may be held in place by plates 15, which are secured to the piston in any desired manner—for instance, as by means of screws (not shown) which take into tapped holes 16. (See Fig. II.) The tubes 6 may preferably be constructed of a material the expansion of which is equal to the expansion of the cylinder when heated, so as to prevent buckling or loosening of the tubes. A desirable material for constructing the cylinder and tubes would be nickel-steel. The cylinder is provided with an annular chamber 17, which communicates at the crank end of the cylinder by means of one or more passages 18 with the chamber 11. At the head end of the cylinder the chamber 17 communicates with an outlet-pipe 19. An inlet-pipe 20 communicates with the chamber 10.

Whether the invention is used for raising the temperature of the expansive fluid within the cylinder or whether it is used for lowering the temperature of the expansive fluid within the cylinder the same generic elements are employed, and, referring to Fig. III, 1 designates the cylinder for containing the expansive fluid, 21 designates the means for supplying a circulating agent at a desired degree of temperature, 22 designates means for circulating the agent, and 23 designates means for increasing or decreasing the temperature of the circulating agent. When the invention is applied to a steam-engine, the means for supplying a circulating agent at a definite temperature may comprise a water-heater, conveniently a steam-boiler, while the means for increasing the temperature of the circulating agent may comprise any desired form of superheater 23, while the means for circulating

the agent may comprise a circulator of the design shown or it may comprise a centrifugal pump or other device for maintaining a circulation or passing the agent through the cylinder. For whichever purpose the invention is applied the means for supplying a circulating agent at a definite temperature may be connected by the pipe 19 with the cylinder, while the pipe 20 may connect the means for supplying the circulating agent with the circulator 22 and with the means for increasing or decreasing temperature of the circulating agent 23 and the cylinder 1, the elements 22 and 23 being connected in series, as shown, the pipe 20 being preferably connected with the boiler at such a point as to obtain water at the maximum temperature from the boiler.

It is obvious that the superheater may be omitted where the temperature of the waste gases is sufficiently above the maximum desired in the water or where the heater is itself placed in contact with the furnace-gases. As high a temperature as the construction of the engine will permit should be given the circulating water in order to increase the temperature and pressure of the steam after cut off. Heat applied after cut off increases the pressure in direct ratio to the increase in absolute temperature and is a most direct means of converting heat into mechanical energy.

One advantage of an independent circulating system is that a high temperature may be given the circulating water without increasing the pressure in the boiler.

In the present embodiment the circulator 22 comprises a chamber 24, through which a shaft 25 extends, carrying a propeller 26. The shaft 26 is supplied with suitable journals 27 and may be driven through a medium of a pulley 28, which is connected with any suitable source of power. The two sections of the piping 20 communicate with opposite ends of the chamber 24.

The superheater or supercooler 23 may be used or not, as desired, and while I have shown it connected by the piping 20 in the system it should be understood that I not do limit myself to the employment of the superheater or supercooler.

In operation it will be assumed that the superheater 23 is not employed. As the circulator 22 is operated it draws the hot water from the boiler and forces it through the pipe 20 and thence into the chamber 10. The water on entering the chamber 10 comes into contact with the screen 12, which causes an effective distribution of the water throughout the chamber 10, so that it enters all of the tubes 6, flows through the tubes into the chamber 11, thence through passage 18 into the chamber 17 and back to the head end of the cylinder, then out through the pipe 19 and back to the boiler. The cylinder-walls and interior of the cylinder are substantially heated by the hot water to a uniform degree nearly equal to the temperature of the hottest water in the boiler. Therefore as the steam enters the cylinder it does not become chilled as ordinarily, but retains its temperature, and as it expands, driving the piston before it, its temperature is maintained substantially constant throughout the stroke, owing to the circulation of the hot water through the tubes 6 and cylinder-walls, although the temperature of the steam will drop somewhat obviously. The circulation around the cylinder-barrel and the inner heads prevents radiation from the steam outward in present practice. By reason of the temperature of the steam within the cylinder being increased to this extent its pressure accordingly is increased, and it therefore permits of cutting off the steam very early in the stroke, thus economizing in the consumption of steam and enabling the same mean effective pressure to be secured with a smaller amount of steam than is obtained in steam-engines as ordinarily constructed. The amount of heat imparted to the steam from the hot water is transformed into energy in a very direct manner, thus promoting the efficiency to a considerable degree, the increase in pressure of the steam being in proportion to the increase in its absolute temperature, and the hot water having lost but little heat is quickly raised to the maximum temperature after it reënters the boiler. A higher degree of efficiency is attained by maintaining a rapid circulation of the hot water.

If desired, in order to obtain a greater efficiency the superheater 23 may be employed. This will result in raising the temperature of the hot water above that which it has attained in the boiler and will cause a correspondingly-increased temperature of the steam and consequent increased pressure of the same in the cylinder; but the evil which ordinarily results from using superheated steam is avoided, for the reason that the steam in the present case does not become superheated until it has passed through the valves and entered the cylinder, and the constant passage of steam at the normal temperature through the valves prevents the valves from becoming excessively heated.

The invention is applicable to compound engines, and the arrangement is very simple, the hot water being conducted from one cylinder to another, from the high-pressure cylinder to the low-pressure cylinder; but the drop in temperature of the steam as it expands and passes through the cylinders is much less than the drop in temperature which the steam would have were the hot-water tubes not employed. Therefore the efficiency of the respective cylinders is increased accordingly. By conducting hot water from the circulator through several pipes to the respective cylinders, so that each cylinder would receive hot water at the same high temperature, there

would result a greater efficiency than by conducting the hot water from the circulator through the cylinders in series.

The invention is especially valuable for air-compressors, and when so used cold water is forced through the circulating-tubes to decrease the temperature of the air within the cylinder. Where air is compressed to a very high degree, as in liquefying air, the value of this invention is obviously very great. A supercooler may or may not be used. If the supercooler is used, water as delivered from the source of supply at ordinary temperature may have its temperature reduced nearly to the freezing-point. With slow piston speed and long stroke the air is better cooled, because it comes in contact with the cooling agent for a longer time, while it is important to also maintain a rapid circulation of the temperature-influencing agent through the tubes.

I do not limit myself to the particular temperature-influencing agent employed. Instead of using hot water steam, hot air, or the exhaust from a gas-engine or other products of combustion could be passed through the tubes in the cylinders. Neither do I limit myself to returning the temperature-influencing agent to the source of supply after passing through the tubes.

In air-compressors it is often most convenient to take the cold circulating water from a pressure system, and it is obvious that in such cases no closed circulating system nor mechanical means for insuring a circulation are required. In like manner the closed system of circulation and a circulator would not be required for steam-engines where waste gases under pressure could be utilized as from gas-engines or other sources of hot fluids under pressure.

While I have shown and described the preferred embodiment of my invention, it should be understood that various changes may be made therein without departing from the spirit of my invention.

While I have shown this invention as applied to a cylinder of the Corliss type, it may be used with a cylinder of the slide-valve or other type. Puppet-valves or valves of any other type may be employed.

What I claim is—

1. In combination with a chamber for confining an expansive fluid, and a movable wall therein, of means for passing a temperature-influencing agent in segregated paths traversing the chamber.

2. In combination with a chamber for confining an expansive fluid, and a movable wall therein, of means for passing a temperature-influencing agent in segregated paths traversing the chamber and through the walls of the chamber.

3. In combination with a chamber for confining an expansive fluid, and a movable wall therein, of a stationary tube extending through the chamber and the movable wall exteriorly of the piston-rod for conveying a temperature-influencing agent.

4. In combination with a chamber for confining an expansive fluid, and a movable wall therein, of means for conveying a temperature-influencing agent in segregated paths traversing the chamber, and means for causing a circulation of the said agent through the conveying means.

5. In combination with a chamber for confining an expansive fluid, and a movable wall therein, of a series of tubes extending through the chamber, and means for introducing a temperature-influencing agent to the tubes.

6. In combination with a chamber for confining an expansive fluid, and a movable wall therein, of a series of tubes extending through the chamber and through the movable wall, and means for introducing a temperature-influencing agent to the tubes.

7. A cylinder, a piston therein with its piston-rod, and a stationary tube lying in the cylinder exteriorly of the piston-rod.

8. A cylinder, a piston therein, and a series of tubes extending through the cylinder and piston, exteriorly of the piston-rod.

9. A cylinder, a piston therein, and a series of tubes extending through the cylinder and piston and suitable packing around the tubes where they pass through the piston.

10. A cylinder, a piston therein, a series of tubes extending through the cylinder and piston, the cylinder-wall having a chamber communicating with the tubes, and means for circulating a temperature-influencing agent through the tubes and chamber.

11. A cylinder, a piston therein, heads in the ends of the cylinder having tapered holes, and a series of tubes with tapered ends supported by the heads.

12. A cylinder, a piston therein, detachable heads in the ends of the cylinder having tapered holes, and a series of tubes with tapered ends supported by the heads.

13. A cylinder, a piston therein, an end of the cylinder having a chamber, a series of tubes extending through the cylinder and piston and communicating with the chamber, a supply-passage for said chamber, and a screen between the supply-passage and the ends of the tubes.

14. A cylinder, a piston therein, a series of tubes extending through the cylinder and piston, said piston being perforated to receive the tubes and having annular recesses around the perforations on each side of the piston, annular packing-rings nested in the recesses, and plates secured to the piston and confining the packing-rings.

15. A cylinder, a piston therein, a series of tubes extending through the cylinder and piston, said piston being perforated to receive the tubes and having annular recesses

around the perforations on each side of the piston, annular packing-rings nested in the recesses, plates secured to the piston and confining the packing-rings, the recesses being larger than the packing-rings to allow side movement of the same.

16. A cylinder the head end of which has a chamber, an inlet-pipe for said chamber, a piston in the cylinder, a series of tubes extending through the cylinder and piston, the cylinder having a chamber in the crank end, the tubes communicating with both said chambers, the cylinder having an annular chamber which communicates with the chamber in the crank end, and an outlet-pipe in the head end of the cylinder communicating with the annular chamber.

17. In combination, a chamber for confining an expansive fluid, a movable wall therein, means for conveying a temperature-influencing agent through the chamber, means for supplying a temperature-influencing agent connected with the said conveying means, and means for circulating said temperature-influencing agent.

18. In combination, a chamber for confining an expansive fluid, a movable wall therein, means for conveying a temperature-influencing agent through the chamber, means for supplying a temperature-influencing agent connected with the said conveying means, means for circulating said temperature-influencing agent, and means for increasing or decreasing the temperature of the said agent.

19. In combination, a cylinder, a piston therein, a series of tubes extending through the cylinder and piston, a water-heater, and piping connecting the water-heater and tubes.

20. In combination, a cylinder, a piston therein, a series of tubes extending through the cylinder and piston, a water-heater, piping connecting the water-heater and tubes, and a circulator connected between the water-heater and tubes.

21. In combination, a cylinder, a piston therein, a series of tubes extending through the cylinder and piston, a water-heater, piping connecting the water-heater and tubes, and a circulator connected between the water-heater and tubes comprising a chamber, and a propeller in the chamber.

22. In combination, a cylinder, a piston therein, a series of tubes extending through the cylinder and piston, a water-heater, piping connecting the water-heater and tubes, a circulator connected between the water-heater and tubes, and a superheater intermediate the water-heater and tubes.

23. In combination, a cylinder and its piston, means for conveying a temperature-influencing agent in definite paths through the space in the cylinder at either side of the piston for promoting uniformity of temperature.

24. In combination, a cylinder and its piston, a series of tubes traversing the space in the cylinder at either side of the piston.

25. A working cylinder, a piston therein, tubes fixed to the cylinder and extending therethrough and through the piston, and means for moving heat-conducting fluid through said tubes.

In testimony whereof I have hereunto signed my name, in the presence of two subscribing witnesses, at Riverside, in the county of Riverside and State of California, this 2d day of September, 1903.

FRANK S. HYDE.

Witnesses:
W. A. PURINGTON,
LYLA PALMER.