

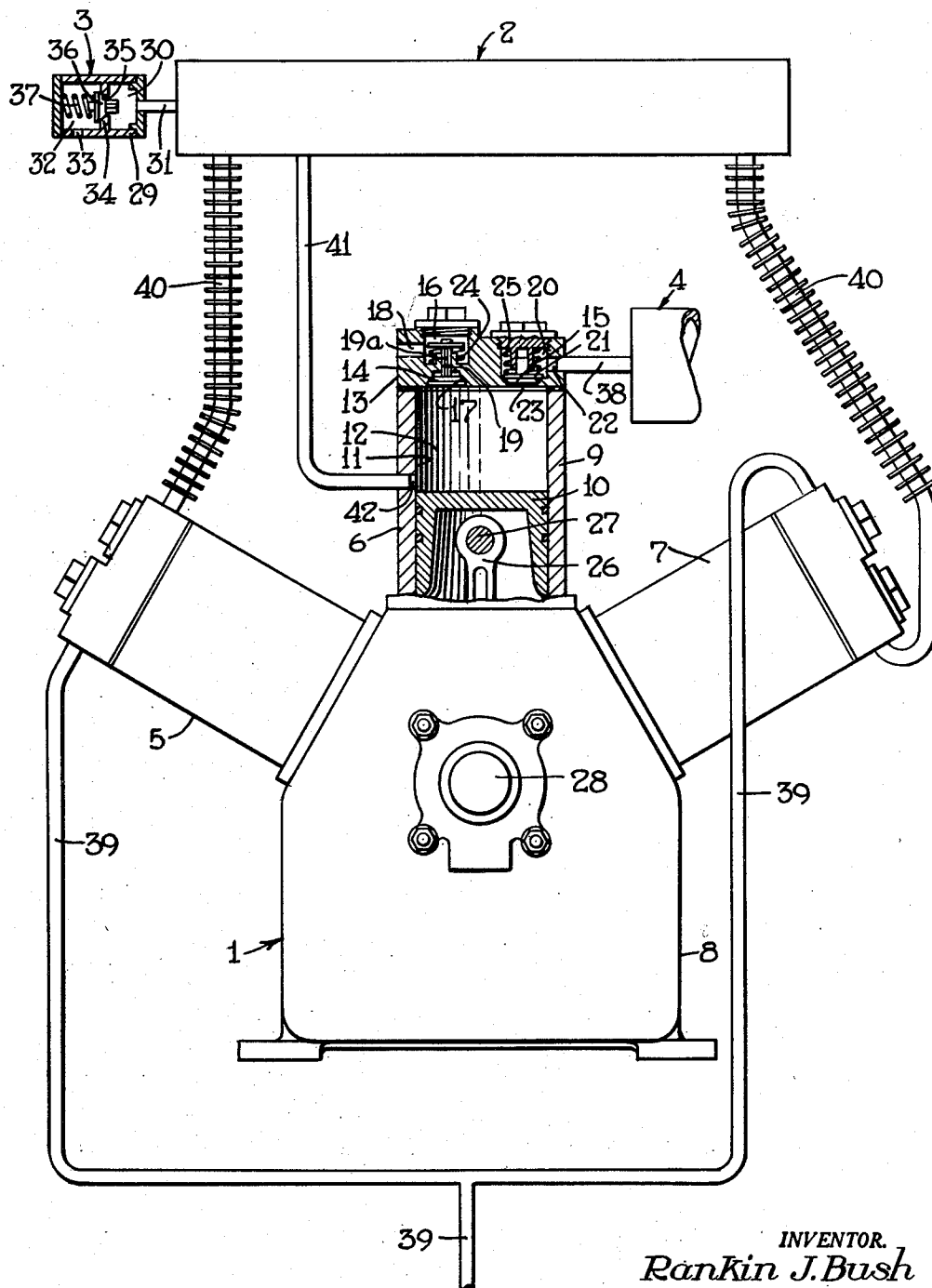
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AIR COMPRESSOR

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AIR COMPRESSOR

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This invention relates to air compressors and more particularly to means for controlling the operating temperature and output thereof.

In operation of certain air compressors of the multiple cylinder type, certain of the cylinders may be employed as air exhausting cylinders and certain other cylinders as air compressing cylinders. The air compressing cylinders draw air from the atmosphere and compress same for discharge and use while the air exhausting cylinders withdraw air from a containing volume to be exhausted and discharge the withdrawn air to the atmosphere with consequent waste thereof.

In view of the foregoing it is one object of the invention to provide means whereby such otherwise wasted discharge of air from the air exhausting cylinders is employed to increase the output of compressed air from the air compressing cylinders.

In the operation of air compressors, excessive discharge temperatures, resultant from heat of compression, tend to damage or otherwise cause faulty operation of the discharge valve mechanism either as a direct result of such heat or as an indirect result of carbonized oil deposits, in view of which, it is another object of the invention to provide a means and method whereby the temperature of operation of an air compressor may be reduced from that otherwise obtaining.

Other objects and advantages will become apparent from the following detailed description of the invention.

In the accompanying drawing, the single figure is a schematic view of a multiple cylinder air exhauster-compressor device embodying a preferred form of the invention.

Description

Referring to the drawing, the air exhauster-compressor apparatus embodying the invention comprises an air exhauster-compressor device 1, a receiver 2, a pressure relief valve device 3, and a storage reservoir 4.

For sake of illustration, the air exhauster-compressor device 1 may comprise three cylinders 5, 6 and 7 mounted on a base or casing member 8 common to each. Each of the cylinders 5, 6 and 7 (referring in particular to the cylinder 6 shown in cross-section in the drawing) comprises the usual hollow casing 9 having the usual piston 10 reciprocable therein in sliding sealing engagement with the usual inner cylinder wall 11 formed in the casing. In the well-known manner, the piston 10 serves as a movable abutment defining one end of the usual cylinder chamber 12, the opposite end of which chamber 12 is closed by a pressure head 13 containing the usual inlet and discharge valves 14 and 15, respectively, which control admission and release of fluid to and from the cylinder chamber 12, respectively; inlet valve 14 being arranged for cooperation with a valve seat 17 to control communication between an inlet port 18 in pressure head 13 and the cylinder chamber 12 via an inlet chamber 16 constantly connected to port 18 and a bore 19 in which a fluted valve stem 19a attached to inlet valve

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14 is slidably guided, and exhaust valve 15 being disposed in a discharge chamber 20 and arranged for cooperation with a valve seat 21 to control communication between discharge port 22 and the cylinder chamber 12 by way of the valve chamber 20 and a port 23. A light compression spring 24 disposed in the inlet chamber 16 is arranged to cooperate with the fluted stem 19a to bias the inlet valve 14 toward its seated position, in which it is shown in the drawing, closing off the cylinder chamber 12 from the inlet port 18, and a similar compression spring 25 disposed in the discharge chamber 20 is arranged to bias the discharge valve 15 toward its seated position, in which it is shown in the drawing, closing off the cylinder chamber 12 from the discharge port 22.

In the well-known manner, movement of the respective piston 10 in each of the cylinders 5, 6 and 7 through the suction stroke from top dead center position in proximity of the pressure head 13 to bottom dead center position in which it is shown in the drawing in connection with cylinder 6, will cause a suction in cylinder chamber 12 which urges unseating of inlet valve 14 and admission of fluid into said chamber 12 via inlet port 18, inlet chamber 16 and bore 19. Subsequent movement of the piston 10 through its compression stroke in the opposite direction, i. e. from its bottom dead center position to its top dead center position, will cause compression of the fluid in chamber 12 and displacement of such fluid therefrom via port 23, discharge chamber 20 and discharge port 22 by unseating of the respective discharge valve 15.

Each of the cylinders 5, 6 and 7 comprises the usual connecting rod 26 which operably connects, via a pin 27, the respective piston 10 to the usual crank shaft 28 suitably driven by means (not shown) to cause reciprocating movement of the piston in each of said cylinders in well-known manner.

The pressure relief valve device 3, for sake of schematic illustration, may simply comprise a casing 29 having formed therein a chamber 30 constantly open to the receiver 2, as through a pipe 31, and a chamber 32 constantly open to the atmosphere by way of a port 33 through the wall of casing 29. A partition 34, serving to separate the chamber 30 from the chamber 32, includes a central opening 35 extending therethrough from chamber to chamber for conveying fluid under pressure therebetween. A tapered valve seat encircling one end of the central opening 35 in the partition 34 serves to cooperate with a correspondingly tapered valve 36 disposed in chamber 32 for controlling communication through said opening. A compression spring 37, disposed in chamber 32, is arranged to urge the valve 36 toward its seated position, in which it is shown in the drawing, closing off communication between the chamber 30 and the chamber 32 via opening 35 and thus closing off communication between the receiver 2, constantly connected to chamber 30, and the atmosphere to which chamber 32 is constantly open. The valve 36 will be unseated by pressure of fluid in chamber 30 upon attainment of a certain pressure value sufficient to overcome the opposing action of spring 37, whereupon communication is established in device 3 between chambers 30 and 32 via opening 35 to release fluid under pressure from the receiver 2 to the atmosphere via pipe 31, and in device 3 the chamber 30, opening 35, the unseated valve 36, chamber 32 and port 33 to limit the degree of pressure of fluid in the receiver 2, against which the exhauster cylinders 5 and 7 must operate, thus assuring that effectiveness of said cylinders 5 and 7 as exhausters will not be undesirably influenced by such back pressure in receiver 2. Upon resultant reduction in pressure of fluid in the receiver 2 to or below the above mentioned

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certain pressure value, the action of the spring 37 will seat the valve 36 to close the communication between chambers 30 and 32 via the opening 35 and prevent further release of fluid under pressure from receiver 2 to the atmosphere via device 3.

The cylinder 6, for example, may be employed as an air compressing cylinder and as such is provided with a pipe 38 constantly connecting its discharge port 22 to the fluid pressure storage reservoir 4, while its inlet port 18 is constantly open to the atmosphere.

The cylinders 5 and 7 may be employed, for example, to exhaust fluid under pressure from a system via such as a pipe 39 having branches connected to the respective inlet ports 18 in said cylinders 5 and 7, to cause fluid from said pipe 39 to be drawn into the respective cylinder chambers 12 via the respective ports 18, inlet chambers 16 and bores 19 by unseating of the respective inlet valves 17 upon repetitive movement of the respective pistons 10 through their suction strokes from top dead center to bottom dead center of piston travel.

According to a feature of the invention, the respective discharge ports 22 in the cylinder devices 5 and 6 are connected via respective heat exchangers, such as finned pipes 40, to the receiver 2 for storage of fluid exhausted from the pipe 39 and subsequent delivery of such fluid to the air compressing cylinder 6 to increase output of compressed fluid from same, rather than discharging such fluid to the atmosphere as is the usual practice. The fluid under pressure supplied by the exhausters cylinders 5 and 7 to the receiver 2 is admitted to the compressor cylinder 6, as through a pipe 41 and a port 42 in casing 9 of said cylinder 6 opening radially into the respective cylinder chamber 12. The port 42 opens into the cylinder wall 11 of cylinder 6 in the path of travel of piston 10 and is so located with respect thereto as to be covered by said piston substantially during its suction and compression strokes and to be uncovered during final movement of the piston in completing its suction stroke and initial movement of the piston in beginning its compression stroke; covering of the port 42 by piston 10 closing off chamber 12 to the pipe 41 while uncovering of said port 42 by movement of piston 10 past same establishes fluid pressure connection between said pipe 41 and said chamber 12 to allow for admission of fluid under pressure from the receiver 2 thereto. It will be understood that, during operation of the compressor cylinder 6, substantially a full charge of air from atmosphere is admitted to the cylinder chamber 12 before port 42 is uncovered to admit fluid under pressure to said chamber 12 from the receiver 2, and that, therefore, the output of compressed air from the cylinder 6 is increased above that which would otherwise be delivered on atmospheric admission alone, by an amount substantially equal to the amount of pressurized air admitted to chamber 12 in addition to the atmospheric charge admitted during the suction stroke. It will also be apparent, that, since the fluid under pressure discharged from the exhausters cylinders 5 and 7 is normally wasted, feeding such fluid under pressure to the compressor cylinder 6 in addition to its normal atmospheric charge will increase the output of said cylinder and result in an increase in efficiency of operation of the exhauster-compressor device 1.

According to another important feature of the invention, the fluid under pressure discharged from the exhauster cylinders 5 and 7 is preferably cooled substantially to temperature of the atmosphere by passage through such as the finned pipes 40 en route to receiver 2 to remove its heat of compression prior to admission of such fluid under pressure to the compressor cylinder 6. The fluid under pressure at atmospheric temperature thus admitted into the compressor cylinder chamber 12 at the end of the inlet stroke of the compressor cylinder piston 10 as previously described, will mix with the charge of atmospheric air previously admitted to said chamber 12 during such inlet stroke and increase the pressure of the

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initial charge in said chamber 12 to a value substantially equal to that of the fluid in receiver 2, independently of compressive action of piston 10 and consequently at substantially constant temperature. By virtue of such initial pressurization of the compressor cylinder charge, the work required to be performed by the compressor cylinder 6 to raise the initially pressurized charge to the desired discharge pressure is reduced below that which would be required were the initial charge at atmospheric pressure, with the result that the temperature of the compressed fluid discharged from the cylinder 6 is correspondingly reduced. The cooling effect of the receiver air admitted to the compressor cylinder 6 enables same to be operated at a higher discharge pressure than would be practical otherwise due to the adverse effect of excessive discharge temperature on operation of a compressor cylinder.

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

1. In combination with a reservoir for storing compressed air, first, second, and third air compressing means, each of said compressing means including a cylinder and piston, all said compressing means being of substantially the same capacity and all said pistons being connected to the same prime mover for operation thereby, means connected to said first and second compressing means for cooling and storing the outputs thereof, said third compressing means having an inlet and an outlet, said outlet being connected to the reservoir, and means for admitting cooled air from said cooling and storing means to said third compressing means for addition to the air in said last named compressing means admitted through said inlet to increase the output of compressed air from the third compressing means and limit the temperature rise therein resulting from heat of compression to a low value, said first and second compressing means supplying air to said cooling and storing means at a greater rate than it is delivered from said cooling and storing means to said third compressing means to thereby insure that a substantial amount of cooled air at a substantial pressure is always readily available for introduction into said third compressing means.

2. In combination with a reservoir for storing compressed air, first and second air compressing means connected to a prime mover for operation thereby, means additional to said first air compressing means for cooling and storing the output thereof, conduit means connecting said first air compressing means to said cooling and storing means, valve means interposed in said conduit means for preventing air from escaping from the cooling and storing means back into the first air compressing means, said second air compressing means having first and second inlets and an outlet, said outlet being connected to the reservoir, and means connected to said cooling and storing means and to said second air compressing means for conducting cooled air from said cooling and storing means to said second air compressing means for admission thereto through said first inlet and for addition to the air in said second air compressing means admitted through said second inlet from a source other than said cooling and storing means, the capacity of said first air compressing means being substantially greater than the capacity of said second air compressing means thereby providing that air is supplied to said cooling and storing means by said first air compressing means at a substantially greater rate than it is delivered from said cooling and storing means to said second air compressing means and insuring that air remains in said cooling and storing means a substantial period of time and becomes effectively cooled, the admission of the effectively cooled air into said second air compressing means serving to limit to a low value the temperature rise in the air therein resulting from heat of compression.

3. Apparatus according to claim 2 including in addition means operatively connected to the cooling and storing

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means for limiting the pressure of the cooled air therein to a preselected value.

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