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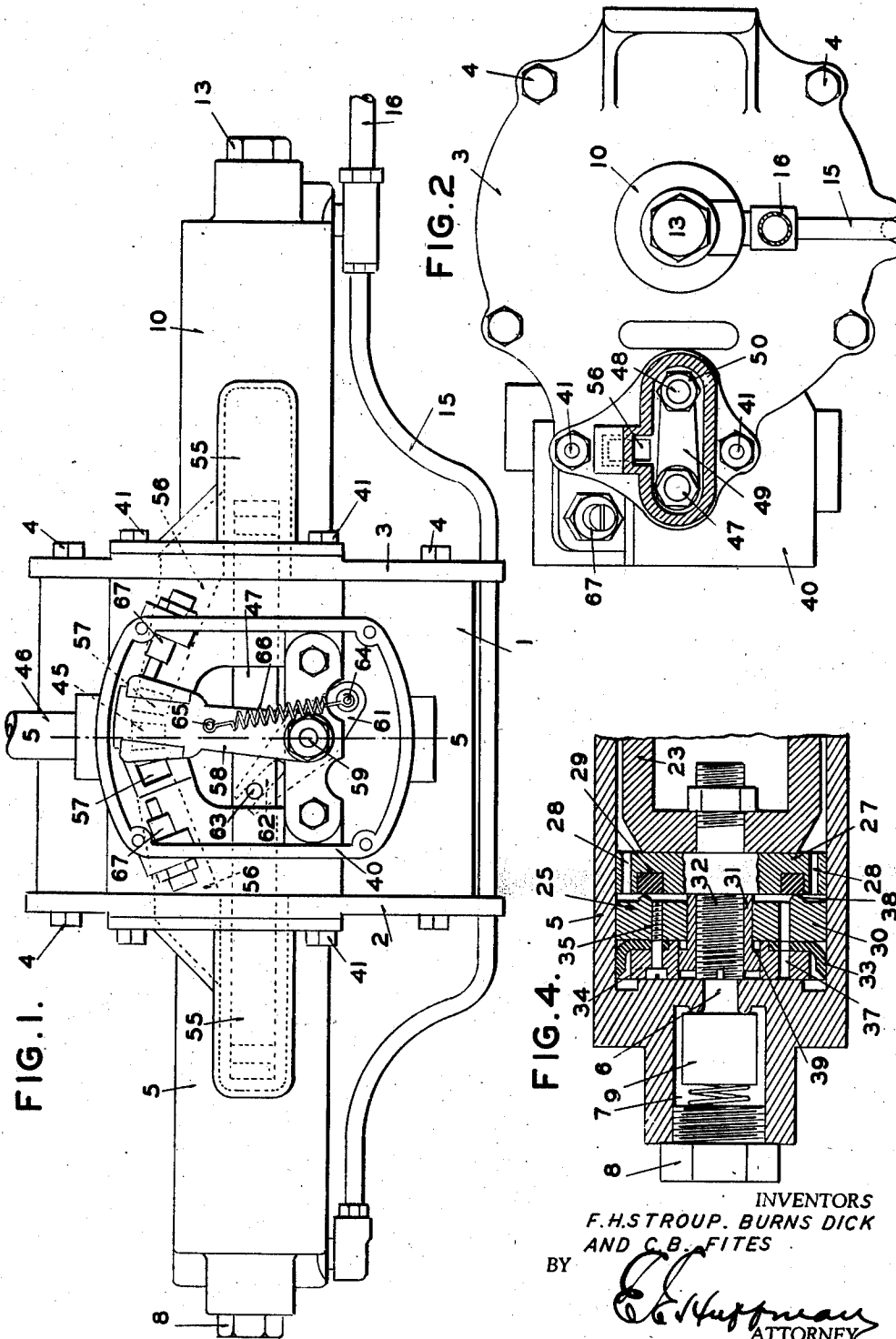
F. H. STROUP ET AL

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AIR COMPRESSOR

Filed June 30, 1937

2 Sheets-Sheet 1



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FIG. 3. 47.

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AIR COMPRESSOR

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Our invention relates to air compressors and more particularly to air compressors which are operated from a source of partial vacuum, as for example, the intake manifold of an internal combustion engine.

One of the objects of our invention is to produce an improved compressor of the type referred to in which all the working parts thereof are totally enclosed so as to be unaffected by dust, dirt or other foreign matter.

Another object of our invention is to provide an improved valve operating mechanism for a vacuum-operated compressor whereby the compressor actuating fluid motor may be alternately placed in communication with the source of vacuum and with the atmosphere.

Still another object of our invention is to so construct a vacuum-operated compressor that the amount of air required to be withdrawn from the fluid motor to cause it to actuate the compressor piston will be a minimum.

Other objects of our invention will become apparent from the following description taken in connection with the accompanying drawings in which Figure 1 is a top view of the compressor with the valve box cover removed to show the valve mechanism; Figure 2 is an end view of the compressor; Figure 3 is a partial cross-sectional view of the compressor, showing the working parts thereof; Figure 4 is a cross-sectional view of the compressor piston and valve mechanism associated therewith; and Figure 5 is a cross-sectional view through the valve box taken on the line 5—5 of Figure 1, the parts being in center position.

Referring to the drawings in detail, 1 indicates the power cylinder of the compressor which is closed by end plates 2 and 3 clamped thereon by means of through bolts 4. The end plate 2 has integrally formed therewith a cylinder 5, the axis of which is in axial alignment with the axis of cylinder 1. The inner end of this cylinder opens directly into the power cylinder and the outer end is provided with an outlet passage 6 which communicates with a small chamber 7 in the extreme end of the cylinder, this chamber being closed by plug 8. Within chamber 7 is a spring-biased check valve 9 which normally closes outlet passage 6.

The end plate 3 is also provided with an integral cylinder 10 in axial alignment with power cylinder 1 and the inner end of this cylinder communicates directly with the power cylinder in the same manner as cylinder 5. The outer end of cylinder 10 is also provided with an outlet passage

11 which communicates with a chamber 12 closed by means of a plug 13. Within the chamber is a spring-biased check valve 14 which normally closes passage 11. The chambers 7 and 12 in the ends of the cylinders are interconnected by a tube 15 which is in communication with another tube 16 leading to a pressure tank or directly to a mechanism operated by the compressed air.

The piston 17 within power cylinder 1 is formed by means of plates 18 and 19 held together by screws 20 and interposed between these plates are the packing elements 21 and 22 which positively prevent air from passing the piston in either direction. The plate 18 is provided with an integral hollow imperforate piston rod 23 which extends into cylinder 5, this piston rod being of an external diameter only slightly less than the internal diameter of the cylinder but of such less diameter that sufficient space is present between the surfaces of the rod and cylinder to permit free passage of air to fill the cylinder during operation of the compressor. Similarly, plate 19 is provided with an integral hollow imperforate piston rod 24 which is of the same diameter as piston rod 23 and extends into cylinder 10.

The outer end of piston rod 23 carries a combined piston and check valve assembly 25 and the outer end of piston rod 24 carries a combined piston and check valve assembly 26. These two combined piston and check valve assemblies are of identical construction and, therefore, only one will be described in detail. Referring in detail to Figure 4, the end of the piston rod has bolted thereon a piston 27 having circumferentially spaced passages 28 near its periphery for permitting passage of air past the piston. The piston carries an annular rubber valve seat 29 which is adapted to cooperate with a movable valve element 30 mounted for limited sliding movement on a sleeve 31 threadably mounted upon the central projection 32 of the piston rod. This valve element carries a packing cup 33 which is held on the valve element by means of a plate 34 and screws 35. The valve element 30, packing cup 33, and plate 34 are each provided with aligned openings 37, these openings being positioned within the outline of an annular rib 38 on valve element 30 and adapted to cooperate with the rubber annular seat 29. The valve element is limited in its movement by means of a shoulder 39 carried by sleeve 31.

It is thus seen by the combined piston and valve assembly just described that when either piston rod 23 or 24 is moved toward the end of the cylinder into which it projects, the rib

of the valve element 30 will be forced against the annular rubber seat 29 and air in the cylinder cannot flow past piston 27 and, therefore, it will be compressed and forced out through the outlet passage in the cylinder. When either piston rod 23 or 24 moves away from the end of the cylinder in which it reciprocates, valve element 30 will be unseated due to the friction between cup 33 and the cylinder wall and, therefore, air will be free to flow through passages 28 in the piston and passages 37 in valve element 30 and the parts carried thereby.

On the top of the power cylinder 11 is mounted a valve casing 40 which is also clamped between end plates 2 and 3 by means of through bolts 41. The interior of the casing is in communication with the atmosphere at all times by means of a port 42 and this port has associated therewith an air cleaner 43 (Figure 5). The top of the casing is closed by a cover plate 44. The valve casing is also in communication with a suitable source of suction by means of a port 45 and a conduit 46, which source of suction may be that found in the intake manifold of an internal combustion engine or a special vacuum tank connected to an independently driven suction motor.

A reciprocable rod 47 extends through the valve casing and projects on each side thereof. Each end of the rod has secured thereto a finger 48 which is positioned below the reciprocable rod and connected thereto by means of an arm 49, this arm being clamped to rod 47 by means of a nut 50 and screw-threaded at its lower end to receive the threaded end of finger 48 which is adjustable with respect to the arm and held in adjusted position by the lock nut 51. The ends of the fingers are adapted to project through openings 52 in the adjacent end plates 2 and 3 in order that they may cooperate with piston 17 within the power cylinder. The ends carry spring-biased plungers 53 to relieve the shock of contact between the fingers and the piston when the fingers are engaged by the piston at the ends of its strokes. The springs 54 are also provided to yieldably center the reciprocable rod.

The exterior ends of reciprocable rod 47 which carry fingers 48 are covered by caps 55 clamped to the side walls of the respective end plates 2 and 3 by means of through bolts 41 which hold valve casing 40 in position. These caps communicate with passages 56 in the valve casing which communicate with ports 57 positioned on opposite sides of suction port 45 (see Figure 1).

Within the valve casing is an arm 58 mounted on pivot pin 59 and carried on the outer end of this arm is a slide valve element 60 which is relieved or hollowed out on its under side. This valve element overlies ports 57 and the suction port 45 and the hollowed out portion is of such width that it can cover two of the ports at one time, that is, the suction port 45 and either of the ports 57. Also pivotally mounted upon pivot pin 59 is a lever 61 having a slotted end 62 for connection to rod 47 by means of pin 63. The other end of the lever carries a pin 64 and the ends of this pin are connected to the ends of a pin 65 carried by arm 58 by spring 66. The levers 58 and 61 and spring 66 form a snap action mechanism whereby the reciprocation of rod 47 will result in valve 60 being shifted back and forth to alternately connect suction port 45 to one of the ports 57. In order to provide yieldable abutments for valve

element 60 the casing is provided with spring-backed plungers 67 which are threadably mounted on the valve casing so as to permit adjustment.

Referring to the operation of the above described compressor when the parts are in the position shown in Figure 3, valve 60 will be in a position where the suction port is connected with the right-hand port 57 (Figure 1), thus placing the source of suction in communication with the right end of power cylinder 1 through passage 56, cap 55, and opening 52 in the end plate 3. The left end of the power cylinder is in communication with the atmosphere by means of the air intake port 42, the valve casing, the left-hand port 57, passage 56, and opening 52 in end plate 2. Thus the right side of piston 17 will be subject to a partial vacuum and the left side of the piston will be subject to atmospheric pressure. This will cause the piston to move to the right end of cylinder 1. During this movement, the air in the compressor cylinder 10 ahead of the combined piston and valve assembly 26 will be compressed since the valve element 30 will be seated and thus compressed air will be forced out through outlet passage 11, chamber 12, and conduit 16 into the storage tank if such is employed. During the movement of piston 17 to the right the valve element 30 of the combined piston and valve assembly 25 will move away from valve seat 29 due to the friction of packing cup 33 on the cylinder wall. Air will, therefore, be free to pass from the left end of the power cylinder into the compressor cylinder 5 ahead of the combined valve and piston assembly 25. When piston 17 approaches the end of its stroke toward the right end of the cylinder, it will abut against finger 48 carried by the right end of the reciprocable rod 47 and carry this rod with it to the right. Movement of rod 47 to the right will operate lever 61 and when this lever passes the center line, spring 66 will be effective to snap arm 58 from its position shown in Figure 1 to a position on the left side of the center line.

Under these conditions, valve element 60 is now in a position to place suction port 45 into communication with the left-hand port 57, thereby placing the left end of the power cylinder in communication with the source of suction. The new position of valve element 60 also results in the right-hand port 57 being placed in communication with the atmosphere through the valve casing and the atmospheric port 42. A partial vacuum is now effective upon the left side of the power cylinder piston 17 and atmospheric pressure is effective upon the right side of the piston. This will cause the piston to move to the left, resulting in valve element 30 of the combined valve and piston assembly 25 being closed. As the piston moves to the left, air will be compressed ahead of this combined piston and valve assembly and forced out through outlet 6 and chamber 7 into tube 16 leading to the pressure tank. During the movement of piston 17 to the left, valve element 30 of the combined piston and valve assembly 26 will be unseated by the friction between packing cup 33 and the cylinder wall, thus permitting air to pass into the head end of the compressor cylinder 10. Under these conditions check valve 14 will be seated. When piston 17 approaches the left end of the power cylinder, it will engage finger 48 carried by the left end of the reciprocable rod 47 and move this rod to the left. This will now cause

valve element 60 to be snapped back in the position shown in Figure 1 as a result of movement of lever 61 with the reciprocable rod 47. When valve element 60 assumes this position, the operation already described will be repeated. It is thus seen that piston 17 is caused to be reciprocated back and forth in the power cylinder and, as a result thereof, air will be compressed and forced out of first one of the compressor cylinders and then the other and into tube 16 leading to the pressure tank or some other mechanism which is desired to be operated by the compressed air. If tube 16 is connected to a storage tank when the pressure of the compressed air in this storage tank becomes as great as the pressure of the air which is being compressed by the action of the power cylinder, the power cylinder will become stalled and discontinue its operation. When any of the compressed air is removed from the storage tank, the compressor will immediately begin to operate and replace this air by additional compressed air from the compressor cylinders.

By having piston rods 23 and 24 of a diameter nearly as great as that of cylinders 5 and 6, it is seen that the volume of air which must be withdrawn from one of the ends of the power cylinder during each stroke of the power cylinder will be reduced to a minimum. This materially increases the efficiency of the compressor since by having less air to be withdrawn during each piston stroke, the rate of reciprocation of the piston will be increased. This is a very important feature, especially when there is a heavy drain on the storage tank and it is necessary for the compressor to operate at a maximum capacity to keep the air storage tank continuously filled with compressed air.

Also, by having the ends of reciprocable rod 47 which carries fingers 48 enclosed within caps 55, all the parts are protected from dirt, grease, dust, and other foreign matter. Furthermore, this construction permits the use of caps 55 as part of the conduit means between the source of suction and the end of the power cylinder or between the atmosphere and the end of the power cylinder, depending upon the position of valve element 60. Thus it is not necessary to construct separate tubes between ports 57 and the ends of the power cylinder. Furthermore, by using caps 55 as part of the conduit means, it is unnecessary to employ any packing around fingers 48 which project into the power cylinder, thus providing a better seal for the power cylinder and increasing its efficiency. It is also to be noted that by having the compressor cylinders integral with the end plates of the power cylinder, the numbers of the parts are decreased, thereby facilitating assembly and disassembly of the compressor. Also, by having piston rods 23 and 24 of larger diameter, they may be of hollow construction and integrally formed with plates 18 and 19 forming the body of piston 17, thus decreasing the weight of this assembly.

Being aware of the possibility of modifications in the particular structure herein described without departing from the fundamental principles of our invention, we do not intend that its scope be limited except as set forth by the appended claims.

Having fully described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In an air compressor, a relatively large power cylinder, a smaller compressor cylinder in axial alignment with the large cylinder and

opening directly into said large cylinder, a piston in the large cylinder, an imperforate piston rod carried by the large piston and extending into the compressor cylinder, said piston rod being of a diameter substantially the same as the compressor cylinder but of such smaller diameter as to permit the free passage of air between the surfaces of the rod and the cylinder, a compressor cylinder piston carried by the piston rod and capable of slight relative axial movement with respect to the rod, check valve means for permitting air to flow from the power cylinder and by way of the space between the piston rod and the compressor cylinder to the compressor cylinder ahead of the piston during the retractile stroke thereof, said check valve comprising a valve seat on the end of the piston rod and a valve element carried by the compressor piston and other valve means for alternately connecting the power cylinder with a source of partial vacuum and with the atmosphere.

2. In an air compressor, a relatively large power cylinder, a smaller compressor cylinder in axial alignment with the large cylinder and opening directly into said large cylinder, a piston in the large cylinder, an imperforate hollow piston rod closed at its outer end and integrally united at its inner end with the large piston and extending into the compressor cylinder, said piston rod being of a diameter substantially the same as the compressor cylinder but of such smaller diameter as to permit the free passage of air between the surfaces of the rod and the cylinder, a compressor cylinder piston carried by the piston rod and capable of slight relative axial movement with respect to the piston rod, check valve means controlled by the relative movement of said piston and piston rod for permitting air to flow from the power cylinder and by way of the space between the piston rod and the compressor cylinder to the compressor cylinder ahead of the piston during the retractile stroke thereof, and other valve means for alternately connecting the power cylinder with a source of partial vacuum and with the atmosphere.

3. In an air compressor, a relatively large power cylinder, two smaller compressor cylinders in axial alignment with the large cylinder, each of said compressor cylinders being associated with an end of the large cylinder and opening directly into said large cylinder, a two-part piston in said large cylinder, each of said parts having an integral imperforate hollow piston rod closed at its outer end and extending into a compressor cylinder, each of said piston rods being of a diameter substantially the same as the diameter of the compressor cylinder into which it extends but of such smaller diameter as to permit the free passage of air between the surfaces of the rod and cylinder, a compressor cylinder piston carried by the end of each piston rod, a check valve associated with each piston for permitting air to flow from the power cylinder and only by way of the space between the piston rod and the compressor cylinder to the compressor cylinder ahead of the piston during the retractile stroke thereof, and valve means for alternately connecting the power cylinder on opposite sides of its piston with a source of partial vacuum and with the atmosphere.

4. In an air compressor, a relatively large power cylinder, two smaller compressor cylinders in axial alignment with the large cylinder, each of said compressor cylinders being associated with an end of the large cylinder and opening

directly into said large cylinder, a piston in said large cylinder, imperforate piston rods carried by opposite sides of the piston and extending into the compressor cylinders, each of said piston rods being of a diameter substantially the same as the diameter of the compressor cylinder into which it extends but of such smaller diameter as to permit the free passage of air between the surfaces of the rod and cylinder, a compressor cylinder piston carried by the end of each piston rod, a check valve carried by each piston for permitting air to flow from the power cylinder and by way of the space between the piston rod and the compressor cylinder to the compressor cylinder ahead of the piston during the retractile stroke thereof, valve means for alternately connecting the power cylinder on opposite sides of its piston with a source of partial vacuum and with the atmosphere, said valve means comprising a reciprocable rod positioned exteriorly of the power cylinder and having a reciprocable movement less than that of the piston in the power cylinder, two coaxially pivoted levers, a valve element carried by one of the levers, means for connecting the other lever for oscillation by the reciprocable rod, spring means connected between the levers for moving the valve carrying lever to opposite sides of a center line when said other lever is oscillated, and means comprising a member at each end of the power cylinder and engaged by the power cylinder piston for reciprocating the rod.

5. In an air compressor, a power cylinder, a reciprocable piston therein, a compressor cylinder in communication with the power cylinder, a piston in the compressor cylinder and connected to the power cylinder piston for movement therewith, a valve casing provided with a port in communication with a source of suction and a port in communication with the atmosphere, a reciprocable rod mounted in the valve casing and projecting therefrom, means carried by the exterior end of the rod and extending through an opening in the power cylinder for cooperation with the piston therein whereby said rod will be moved longitudinally at the end of the piston stroke, a valve mechanism operable by the reciprocable rod for placing the ports in communication with each other, and conduit means including a detachable casing member associated with the end of the power cylinder and enclosing the exterior end of the reciprocable rod

for placing the atmospheric port in communication with the power cylinder.

6. In an air compressor, a power cylinder, a reciprocable piston therein, a compressor cylinder at each end of the power cylinder, a piston in each compressor cylinder, piston rods connecting the compressor pistons to the power cylinder piston, a valve casing in communication with the atmosphere, a source of suction, a reciprocable rod extending through the valve casing, means carried by the exterior ends of said rod and extending through openings in the ends of the power cylinder for cooperating with the power cylinder piston whereby said rod will be moved longitudinally at the end of each piston stroke, a detachable casing member enclosing each exterior end of the rod, said valve casing and the last mentioned casings being provided with independent passages for placing the ends of the power cylinder in communication with the valve casing, and valve means in the valve casing and operable by said reciprocable rod for alternately placing said suction source in communication with the passages.

7. In an air compressor, a power cylinder, a reciprocable piston therein, a compressor cylinder at each end of the power cylinder, a piston in each compressor cylinder, piston rods connecting the compressor pistons to the power cylinder piston, a valve casing in communication with the atmosphere, a source of suction, a reciprocable rod extending through the valve casing, means carried by the exterior ends of said rod and extending through openings in the ends of the power cylinder for cooperating with the power cylinder piston whereby said rod will be moved longitudinally at the end of each piston stroke, a detachable casing member enclosing each exterior end of the rod, said valve casing and the last mentioned casings being provided with independent passages for placing the ends of the power cylinder in communication with the valve casing, valve means in the valve casing for alternately placing said suction source in communication with the passages, and means for controlling said valve means by the reciprocable rod and comprising two coaxially pivoted levers and a spring interconnecting the levers to provide a snap acting mechanism.

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