April 12, 1960 D. J. PEEPS 2,932,285

AIR MOTOR FOR A COATING MATERIAL PUMP

3 Sheets-Sheet 1

Original Filed April 20, 1956

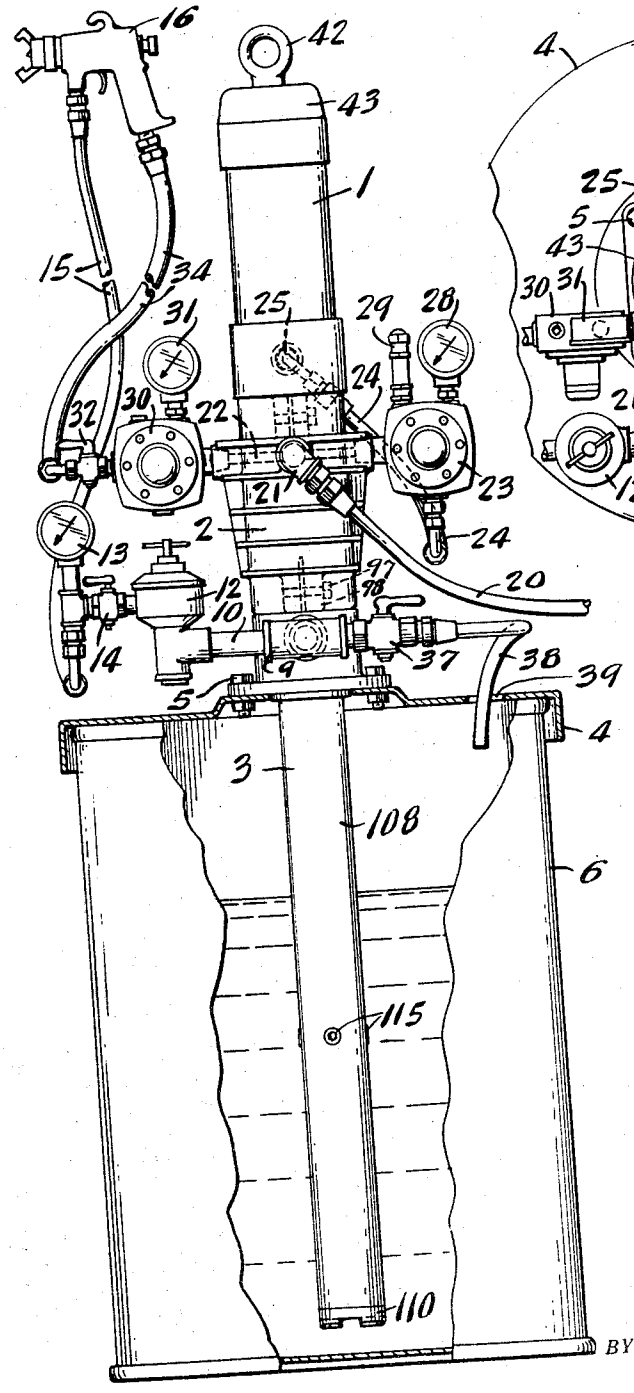


FIG-1-

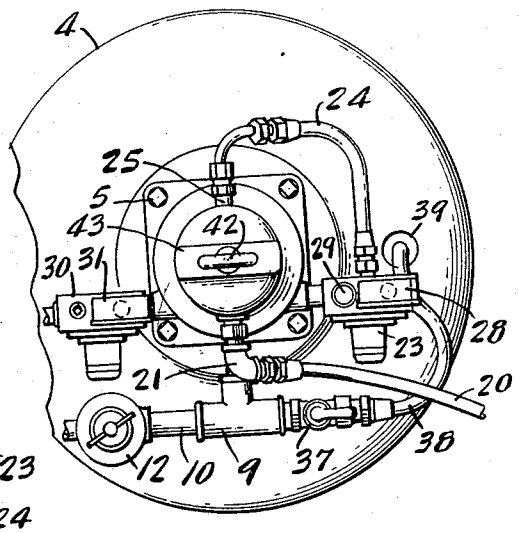


FIG-2-

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Original Filed April 20, 1956 3 Sheets-Sheet 2

FIG-5-

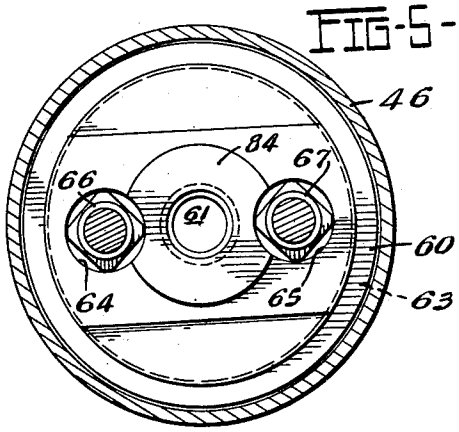
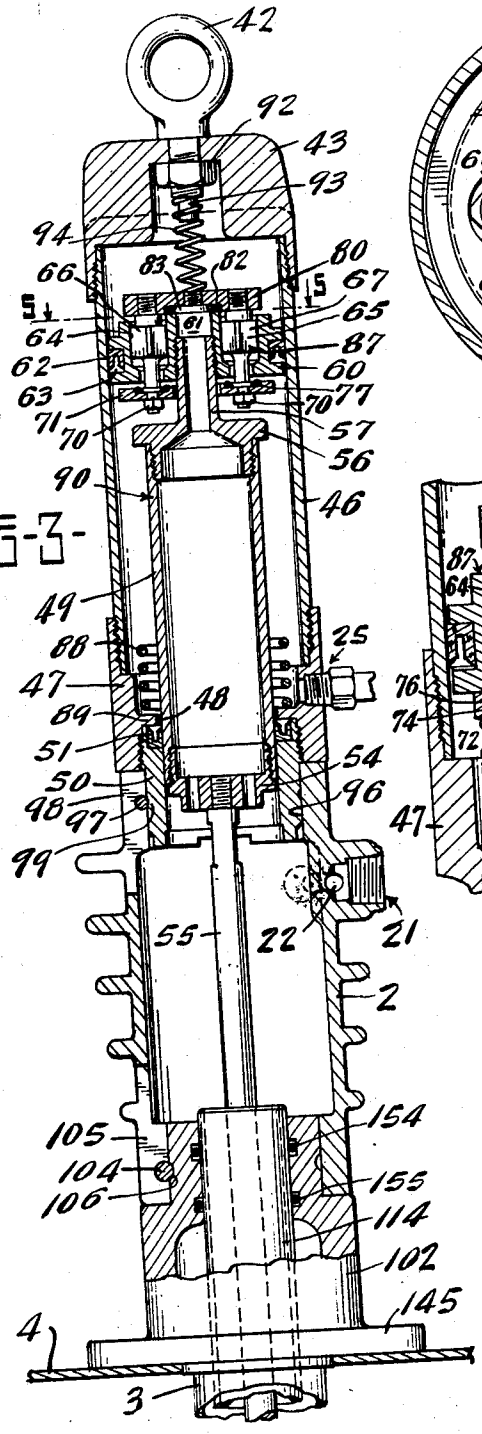


FIG-3-



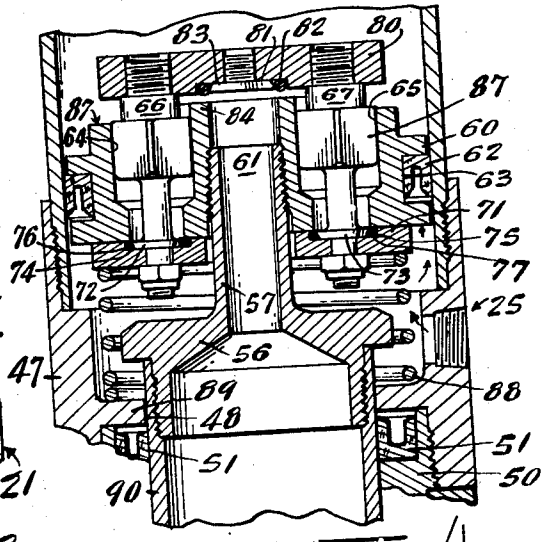


FIG-4-

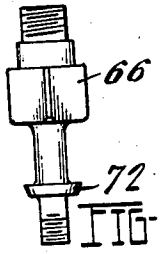


FIG-6-



FIG-7-

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AIR MOTOR FOR A COATING MATERIAL PUMP

Original Filed April 20, 1956 3 Sheets-Sheet 3

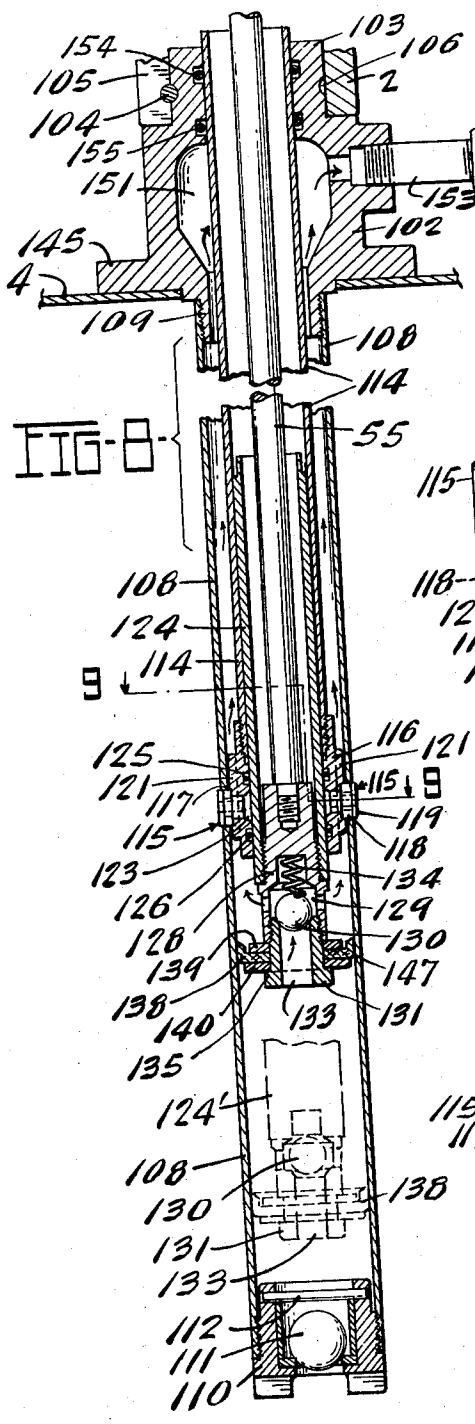


FIG-8-

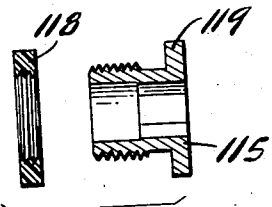


FIG-11-

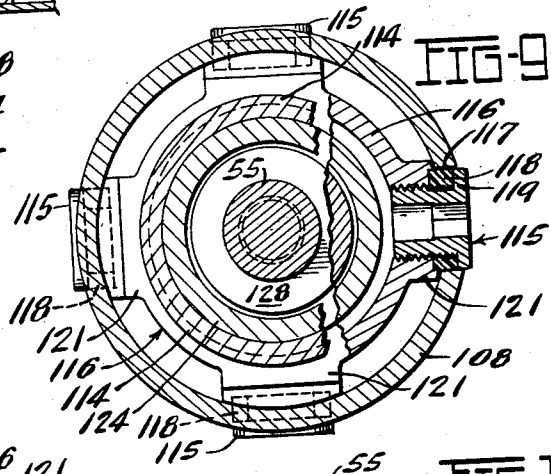


FIG-9-

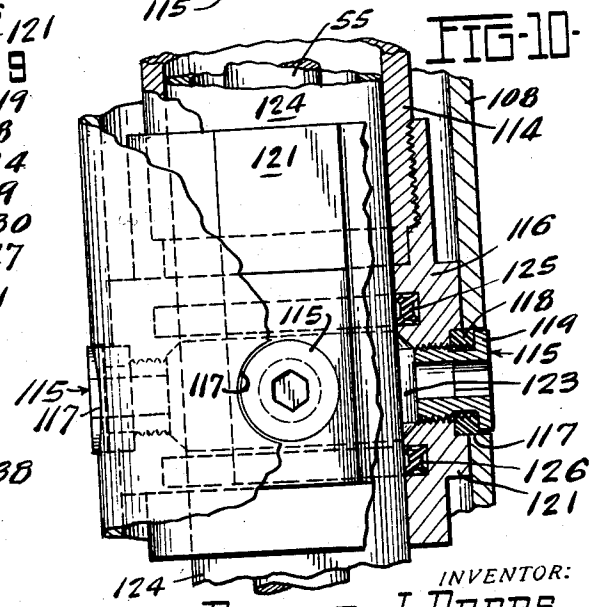


FIG-10-

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2,932,285

AIR MOTOR FOR A COATING MATERIAL PUMP

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Original application April 20, 1956, Serial No. 579,648, now Patent No. 2,895,421, dated July 21, 1957. Divided and this application September 23, 1957, Serial No. 685,753

6 Claims. (Cl. 121—164)

This invention relates to an air motor for a reciprocating pump for delivering coating materials and similar liquid compositions under constant, regulatable pressure and continuous flow and is a division of application 579,648, filed April 20, 1956, now Patent 2,895,421, issued July 21, 1957. More particularly, it relates to an air motor driven pump capable of handling material of high viscosity in substantial volume and under considerable pressure.

Due to pigments in coating materials as well as their high viscosity much difficulty has been experienced with pumps for dispensing such products. Sealing elements have been inclined to deteriorate rapidly causing leaks which lower the pressure and the volume of the coating material being delivered. The consequent shut-down for repairs may disrupt the production schedule and thereby add extra costs. Abrasive action upon valves and valve seats also have frequently put them out of commission with resultant failure of the pump and interruption of operations while replacement of parts is being made.

Also, earlier pump designs did not have valve mechanism fully capable of conveying high viscosity coating materials at satisfactory rates. Another reason pumps available heretofor proved inadequate is that the power developed by the air motors was less than that required to build up the necessary fluid pressure for certain operations.

A principal object of this invention is to provide a pump which alleviates the aforementioned difficulties and shortcomings.

More specifically, an object of my invention is to provide a compact pump in which the air motor and the pumping unit are vertically stream lined and are connected by a common piston rod.

Another object of my invention is the provision of an internal valve mechanism for the air motor which is sturdy and quick acting.

Another object is the provision of a pump having an easily separable air motor and a coupling casting between the air motor and the pump unit serving secondarily as an air manifold.

These and other object and advantages of the invention will become apparent upon perusal of the following description and referring to the drawings in which:

Figure 1 is an elevation of a pump assembly embodying my invention with the pump attached to a cover of a special material drum;

Figure 2 is a plan view of the embodiment of Figure 1;

Figure 3 is a vertical section of the air motor of the pump embodied in Figure 1;

Figure 4 is an enlarged vertical section of the valve assembly and associated parts of the air motor;

Figure 5 is a horizontal section taken on the line 5—5 of Figure 3;

Figure 6 is an enlarged elevation of one of the valve stems;

Figure 7 is a similar view of the retainer of the exhaust valve O-rings;

Figure 8 is an enlarged vertical section of the pump unit;

Figure 9 is a still further enlarged horizontal section taken on the line 9—9 of Figure 8;

Figure 10 is an elevation with parts broken away of the portion of the pump unit in the area adjacent to the line 9—9 of Figure 8; and

Figure 11 is a vertical section of a tube locating and drain plug and its plastic sealing ring.

Referring to the drawings in more detail, the pump embodying this invention has an air motor 1 fixed upon the coupling casting 2 which in turn is fitted to the top of the pump unit 3. The pump assembly is supported upon the lid 4 to which it is secured by bolts 5. The lid 4 fits loosely over a special form of material drum 6.

As shown in Figures 1 and 2 coating material is drawn from the drum 6 by the pump and delivered to a T connection 9 on the side of the pump and hence to nipple 10 leading to a fluid regulator 12. From the regulator which has a pressure reporting gauge 13 the coating material proceeds through a shut off valve 14 and a flexible hose 15 to a manually operated spray gun 16.

An air supply hose 20 is fastened to the inlet nipple 21 of an air manifold 22 within the wall of the coupling casting 2. Air for operation of the air motor 1 passes from air manifold 22 into regulator 23 and through hose 24 to the air inlet opening 25 of the air motor. Upon regulator 23 are mounted a pressure gauge 28 and a safety valve 29.

Atomizing air for the spray gun leaves manifold 22 from the left hand outlet entering pressure regulator 30. The gauge 31 shows the pressure established by regulator 30. A flexible hose 34 carries the atomizing air from the shut off valve 32 attached to regulator 30 to the spray gun 16.

A valve 37 is fastened to the other branch of coating material T connection 9. When desired for agitation or cleaning purposes this valve is opened to permit return flow of the coating material drawn up by the pump back to the drum 6 by way of tubing 38. The end of the tubing projects through an opening 39 in lid 4.

A supporting ring 42 at the top of air motor cap 43 is provided for raising or lowering the pump assembly by means of a block and tackle. This is useful when a drum becomes empty and is to be replaced with one carrying a fresh supply of coating material.

In Figures 3 through 7 the interior structure of the air motor is depicted. As shown, the air cylinder 46 is closed at its upper end by the cap 43. The casting 47 threaded to the lower end of the cylinder has an axial opening 48 for the tubular lower piston 49. The piston 49 is guided in the cylindrical bearing 50, a depending member of reducing diameter fixed to casting 47. A packing 51 of U shape is held around piston 49 in an annular chamber between the adjoining ends of casting 47 and its threadedly joined bearing member 50. A ported bushing 54 is threaded into the lower end of piston 47 and connects the piston to shaft 55 serving as a common piston rod or drive shaft between the air motor and the pump unit.

At the upper end of lower piston 49 is closure 56 with an integral upwardly projecting nipple portion 57. Firmly threaded upon the nipple 57 is upper piston 60. An axial bore 61 in this piston forms with the nipple an air passage communicating with the interior of lower piston 49. A packing ring 62 of U form in a peripheral groove 63 in upper piston 60 seals the piston against the inner surface of cylinder 46.

Two vertical air passages 64 and 65 extend through piston 60 on opposite sides of the axial bore 61. Reciprocably suspended in these passages are valve stems 66 and 67. The lower ends of the valve stems protrude

below piston 60 where they are rigidly secured by nuts 70 to a valve carrier annulus 71.

The annulus 71 is held by the nuts 70 against flanges 72 and 73 on stems 66 and 67. The flanges rest in shallow circular recesses 74 and 75 on the upper surface of annulus 71.

The periphery of each flange flares upwardly and clamps O-ring valve elements 76 and 77 against the cylindrical rims of their associated recesses. The O-rings, having a thickness greater than the depth of the recesses 74 and 75, project slightly above the carrier annulus 71 to present closure surfaces for sealing contact with valve seats composed of the flat under surface of the piston 60 surrounding the lower outlets of air passages 64 and 65.

The upper ends of the valve stems 66 and 67 are firmly threaded to valve carrier plate 80. Centrally located on the underside of plate 80 is a circular indentation 81. An O-ring valve 82 is held against the cylindrical border of indentation 81 by the downwardly flaring edge of the head of bolt 83, threaded into plate 80. The lower face of O-ring valve 82 seats against the flat top of annular ridge 84 around the outlet of axial bore 61 in upper piston 60.

The valve stems 66 and 67 with the O-ring carrier annulus 71 and valve carrier 80 compose an integral valving unit 87 movable as one piece.

A spring 88 rests upon annular shoulder 89 within end casting 47 of air cylinder 46. When assembly 90, composed of the upper and lower pistons, travels downwardly carrying with it valving unit 87, spring 88 is in the path of the carrier annulus 71 of the valving unit 87 and the unit is moved upwardly in relation to the piston assembly upon meeting the spring. This action brings the O-ring valve elements 76 and 77 of carrier annulus 71 against their seats upon the underside of the upper piston 60 as illustrated in Figure 4.

The supporting ring 42 at the top of the air motor is an eye bolt with a threaded stem projecting within cylinder cap 43. A nut 92 holds the eye bolt to the cap. The stem has a reduced unthreaded end portion 93 upon which a spring 84 is frictionally held.

On upward travel of the piston assembly 90, the valve carrier plate 80 of the valving unit 87 strikes spring 94 and the valving unit 87 is consequently stopped and shifted downwardly in relation to the piston assembly. This seats O-ring valve 82 against annular ridge 84 and forces O-ring valve elements 76 and 77 away from their seats on the under side of upper piston 60.

The bearing member 50 which serves as a guide for the lower piston 49 fits within the cylindrical bore 96 at the upper end of the coupling casting 2. The air motor is held attached to the casting 2 by a bolt 97 threaded to pull together vertically split portions 98 of the upper end of the casting while partially disposed within a complementary groove 99 in the side of member 50.

With reference now to the showings of Figure 8 and subsequent figures, the head member 102 of the pump unit has a reduced cylindrical projection 103 fitting into the lower end of the coupling casting 2. It is fixed thereto by a bolt 104 extending through split portions 105 of the lower part of casting 2 and lodged partially in a groove 106 of the side of the cylindrical projection 103.

A cylindrical pump casing 108 is supported by the head member 102 to which it is threadedly joined over a nipple extension 109. At the base of the casing 108 is a ported insert 110 providing an entry passage to the pump for the coating material. Back flow of material is prevented by a foot check valve 111 held loosely within the insert by a cross pin 112. The lower side of the insert 110 is slotted to provide channels for the material should the insert rest against the bottom of a supply container.

Concentrically within casing 108 is a stationary tubular cylinder 114. This cylinder is secured in place by four hollow plugs 115. The latter are threaded into a sleeve 116 on the lower end of the cylinder 114, which they

reach through holes 117 in casing 108. The holes and the threaded connections between the plugs and sleeve are sealed by plastic gaskets 118, compressed between the flanged heads of the plugs and recesses in vertically elongated bosses 121 on the sleeve 116. The plugs have broached bores of a hexagon cross section so that an Allen set screw wrench may be used for screwing the plugs in or out.

The passages through the plugs communicate with a lantern chamber 123 extending around the reciprocating pump piston 124 and located between two X packings 125 and 126 in internal grooves of the sleeve 116.

Threaded into and closing the lower end of tubular piston 124 is a stopper and plunger carrying member 128. The common piston rod or drive shaft is connected to the upper end of member 128. The lower portion of said member is hollow to provide a chamber 129 for a ball check valve 130.

A bushing 131 retains the valve 130 in the chamber and has an axial passage 133 flaring at its upper end to serve as a seat for the check valve. A spring 134 inclines the valve to its seating position.

Between a shoulder 135 on the bushing and the lower end of member 128 a plunger leather 138 is held with supporting washers 139 and 140 on opposite sides.

In preparing the pump for operation the pump with a lid attached may be placed over an open top drum such as that illustrated. In case the supply drum is a closed shipping type a special lid 4 is not necessary and the casing 108, enclosing the pump unit, is inserted through the bung hole of the drum with the assembly supported upon the cover by the lower flange 145 of the pump head member 102. Because of the narrow width of the casing 108, derived from the compact pump design, the bung hole need be no larger than two inches in diameter.

The air supply hose 20 is then connected to the inlet 21 of the air manifold formed in the wall of the coupling casting 2.

The atomizing air hose 34 is then connected to valve 32 on the outlet side of the regulator 30 which receives air from air manifold 22.

The hose 15 for delivery of coating material to the spray gun 16 extends from the valve 14 attached to regulator 12.

With the attachment of the hose to the spray gun, air is slowly introduced to the air motor by turning the knob of regulator 23. This air passes into the interior of air cylinder 46 from inlet 25. With the valving unit 87 in the position illustrated in Figure 3 the air flows through passages 64 and 65 and thereby reaches above as well as below upper piston 60. This equal pressure on both sides of piston 60 neutralizes its action. This restricts the effective force of the air pressure to the lower piston 49.

Consequently, the piston 49 is forced downwardly driving ahead of its piston rod or shaft 55. The plunger carrying member 128, fixed to the lower end of shaft 55, moves downwardly with it as does pump piston 124 threadedly mounted on member 128.

Coating material which has entered casing 108 past foot valve 111 is then forced by the descending plunger 147, of which plunger leather 138 is a part, to pass upwardly through passages 133 and past check valve 130. This material is then directed into the annular space disposed at its lower end between pump piston 124 and casing 108 and extending upwardly between the stationary tubular cylinder 114 and casing 108. As this annular space has no more than half the capacity of the full cylindrical space within the casing 108 below plunger 147 the displaced material is forced to a height double its original level.

The downward stroke of plunger 147 is terminated and its return upward initiated when the air valving unit 87 carried by upper air piston 60 strikes spring 88 and is

moved upwardly in respect to the piston. This impels O-ring valve elements 76 and 77 to their seats on the underside of piston 60 interrupting the flow of air through passages 64 and 65 to the upper side of piston 60.

At the same time the valve carrier plate 80 having raised away from piston 60, O-ring valve 82 has moved from its seat on annular ridge 84 permitting the compressed air above the piston to flow down axial bore 61 to the interior of piston 49. This air is vented to the atmosphere by traveling through the ported bushing 54 at the bottom of lower piston 49 and into the interior of casing 2 from which it escapes through the saw cuts between vertically split portions 98 and 105 at the top and bottom respectively of the coupling casing 2. These separate restricted outlets from the interior chamber of the casting cooperate with the chamber in substantially silencing the staccato discharge of the exhaust air.

With the compressed air above the upper piston 60 thus dissipated the force of the compressed air is applied only to the underside of this piston. As the area of the upper piston 60 is slightly more than twice that of the lower piston 49 the piston assembly 90 is then driven upwardly with at least the same power utilized in its downward thrust. In view of the weight and friction involved in the up stroke it is desirable that somewhat greater force be exerted in order that the net pumping power of the up and down strokes be approximately equal.

As the drive shaft 55 is pulled upwardly another increment of coating material is drawn past foot valve 111 into the lower portion of casing 108 by the rising plunger 147.

The coating material of the first increment now above the plunger is impelled into chamber 151 within the pump head member 102 and hence into outlet nipple 153 and T connection 9. At the start of the operation of the pump the spray gun is held open in order that air in the coating material line from the container to the gun may be expelled. With the line thus unblocked the coating material advances from T connection 9 through regulator 12 and hose 15 to the gun.

The coating material discharge rate from the spray gun may be measured by letting the material flow unatomized, into a small container of known capacity and recording the filling time. As the discharge rate is proportional to the air pressure actuating the air motor it may be varied by adjustment of air regulator 23.

With the use of a single spray gun a fluid pressure regulator such as 12 is not ordinarily required. When two or more spray guns are being supplied by the same pump some fluctuations in pressure may occur. These are usually not of sufficient magnitude to be objectionable in the application of waterproofing, structural and mill paints. However, when several spray guns are operating from a single pump and are utilized in high quality production finishing, maintenance of exact material pressure is important and the use of a regulator for each spray gun is advisable.

As piston assembly 90 reaches the limit of its up stroke the valving unit 87 is thrust downwardly in respect to the piston assembly by the meeting of spring 94 with the top of valve carrier plate 80. This restores the elements to the position presented in Figure 3 with O-ring valve 82 on its seat closing entry to the venting bore 61 and O-ring valve elements 76 and 77 depressed below their seats leaving passages 64 and 65 open. Again upper piston 60 has air on both sides and becomes ineffective and air pressure upon lower piston 49 forces the piston assembly and the drive shaft 55 downwardly for a start of the second pumping cycle. As long as coating material is being consumed the reciprocations of the air motor and pump elements automatically continue.

With cessation of the spraying operation the dead pressure of the coating material in the system instantly brings the pump to a stop as there is no space into which additional material may be forced and the material itself is practically non-compressible. At the same time the desired pressure is maintained on the coating material as static air pressure under the selected regulated pressure continues to exert moving force on the air piston assembly.

In the particular embodiment selected for illustration the net effective air piston area is twice the net effective area of the pumping plunger 147 and the pump piston 124. Accordingly, if the air pressure admitted to the air motor is set at twenty pounds, the coating material is dispensed under a pressure approaching forty pounds. However, friction naturally diminishes the ratio when the material pressure is measured at the spray gun, particularly when long stretches of hose and hose of limited diameter are involved.

Features of the invention it is wished to emphasize particularly include the valving mechanism of the air motor. The solid, integral valving unit 87 comprising the valve element carrier annulus 71, the valve stems 66 and 67, and the valve carrier plate 80, moves as one piece with no looseness between the parts. This assures no wearing contact between the elements and maintains their correct relative positions. It leaves no question in regard to the open status of O-ring valve 82 when O-ring elements 76 and 77 are closed on the up stroke or of the reverse condition on the down stroke.

The short distance of travel of the valves effects quick reversal of the piston assembly 90 as it reaches the end of each stroke. Contributing to this fast action are the ample dimensions of air passages 64 and 65 which permit unimpeded flow of air to the top side of the upper piston. Assisting the easy air flow are the wide proportions of the valves and their face contact with their seats.

The valving unit is not only guided by the square cross sections of valve stems 66 and 67 but also by the upwardly projecting nipple 57 on closure 56.

Special importance is given the functions and structure of the coupling casting 2. Its cylindrical ends insertable in the air motor and pump unit, to which it is tied by easily removable cross bolts 97 and 104, assures axial alignment while also permitting quick disassembly. For removal of the air motor the upper bolt 97 is withdrawn and the air motor is raised to expose the connection between shaft 55 and lower air piston 49. Flats on adjoining areas of these parts are wrench engageable for unscrewing the connection.

The interior of casting 2 and the slots between the split portions 98 and 105 in its side wall serve as a final path for the air exhausted from above the upper piston 60. The size of the chamber within the casting 2 and the two separate restricted slot outlets act to muffle the pulsating noise of the air exhaust. Built integrally in the casting is the air manifold 22 for distributing the supply of compressed air to operate the air motor and for atomizing the coating material discharged by the spray gun. An air line oiler should be placed in the air line to the air motor. This may be fastened directly to the air inlet of the air motor. While important from a practical standpoint, it is not considered an essential element of the invention.

While I have illustrated and described a single form of my invention, it is to be understood that various modifications may be made therein without departing from the spirit of the invention and the range of the following claims.

What I claim is:

1. In an air motor, a vertically reciprocable piston assembly, said assembly including an upper piston and a lower piston of reduced diameter attached to the upper piston, a vertically reciprocable valving unit carried by the upper piston and coaxial therewith, said valving unit including a valve carrier plate above the upper piston, a valve carrier annulus below the upper piston, and valve stems extending through the upper piston between the annulus and the plate and being rigidly attached to the

annulus and plate, means supplying compressed air between the upper piston and the lower piston, air passages through the upper piston in which the valve stems reciprocate, valve elements on the annulus constructed to seat around the lower ends of the passages, means forming an air exhaust passage from the top side of the upper piston axially down through the upper piston and the lower piston, and a valve on the underside of the plate disposed to close the inlet of the exhaust passage, and means moving the valve unit upwardly in respect to the piston assembly to seat the valve elements carried by the annulus, and to unseat the valve carried by the plate at the limit of downward travel of the piston assembly, whereby, with the valve elements seated, the compressed air supplied between the upper and lower pistons acts on the upper piston to drive the piston assembly upwardly from the limit of downward travel of the piston assembly and means moving the valving unit downwardly in respect to the piston assembly to unseat the valve elements carried by the annulus, and seat the valve carried by the plate at the limit of upward travel of the piston assembly, whereby, with the valve elements unseated to allow the compressed air to the upper side of the upper piston, the compressed air supplied between the upper and lower pistons acts upon the lower piston to drive the piston assembly downwardly from the limit of upward travel of the piston assembly.

2. An air motor according to claim 1 in which flat surfaces constitute the seats for the valve elements and the valve, and the latter are O-rings with one side only exposed to form an annular seating face.

3. An air motor according to claim 1 in which the valve stems have portions of polygonal cross section of which the flats provide passing space for air within the cylindrical air passages and the corners having guiding contact with the interior walls of the air passages.

4. An air motor according to claim 1 in which there are bearing surfaces in the air passages vertically guiding the valve stems of the rigid valving unit, and an axially located nipple connection between the upper and lower pistons has vertically guiding contact with the axial bore of the carrier annulus of the rigid valving unit.

5. An air motor having an upright cylinder, a piston within the cylinder adapted for vertical reciprocation, said piston having an axial bore, a tubular mounting casting for the air motor attached to the lower end of the cylinder, said casting defining a large, generally enclosed inner chamber, means providing an air exhaust passage from the cylinder to the chamber, said means including the axial bore of the piston, and means forming a restricted outlet from the chamber to the atmosphere, whereby the chamber acts to muffle the sound of exhaust air leaving the cylinder.

6. An air motor according to claim 5 in which there is an air supply line leading to the cylinder and an air manifold in the wall of the tubular casting constituting a portion of said air supply line.

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