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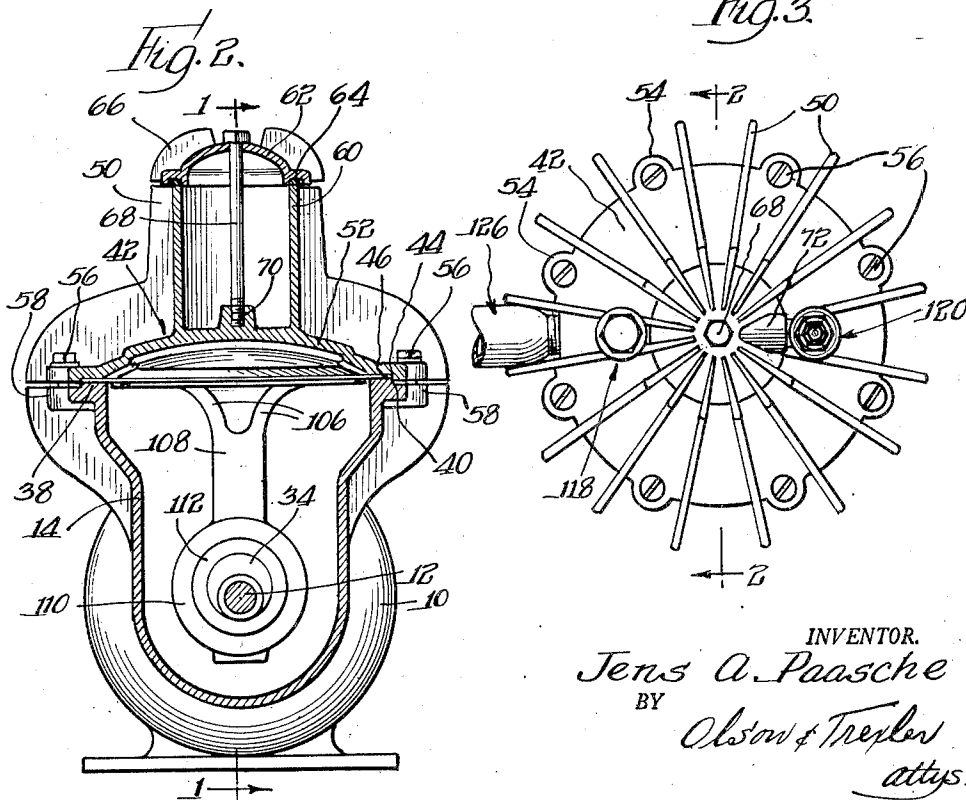
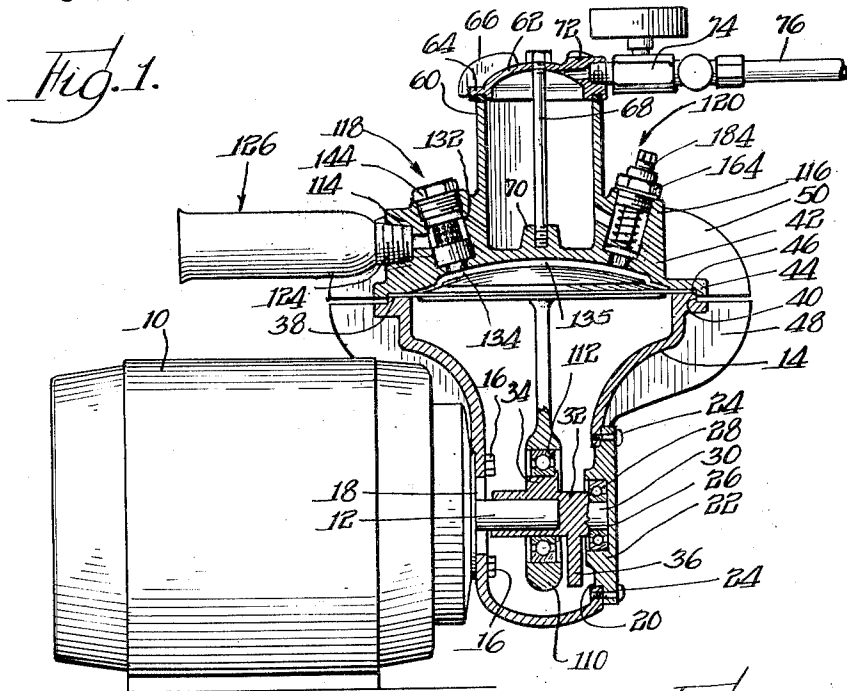
J. A. PAASCHE

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DIAPHRAGM COMPRESSOR PUMP

Filed Aug. 13, 1953

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

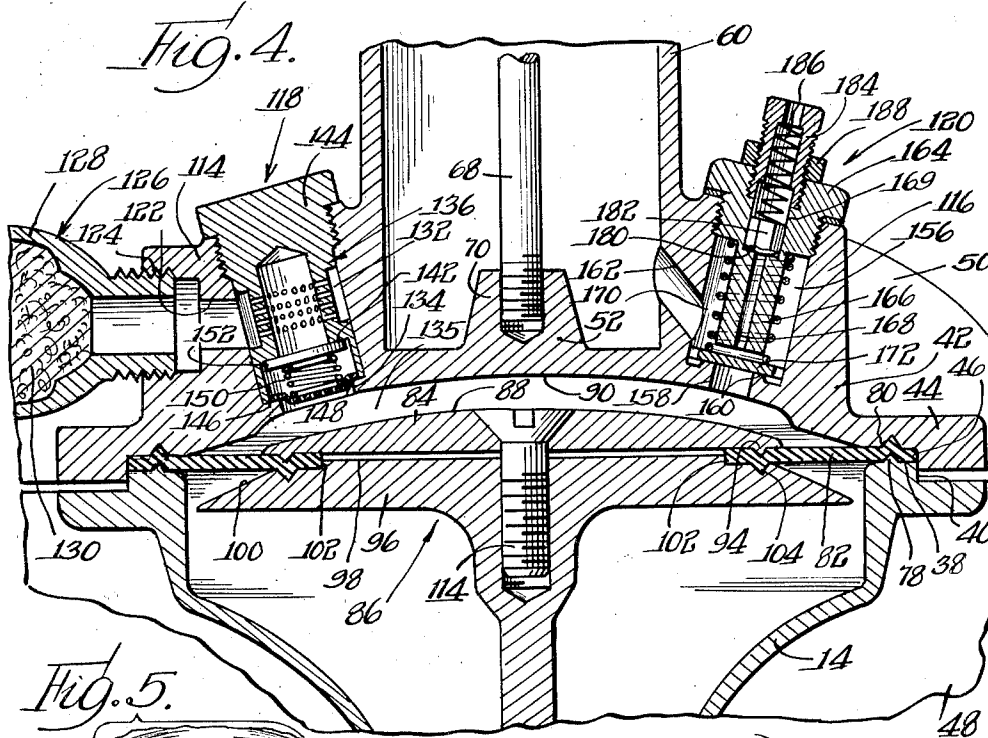


Fig. 5.

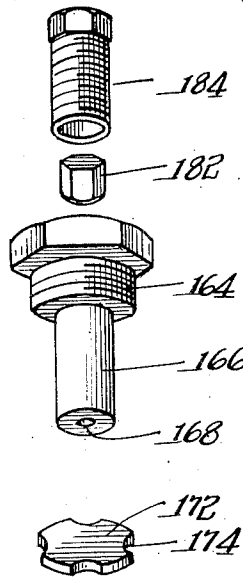
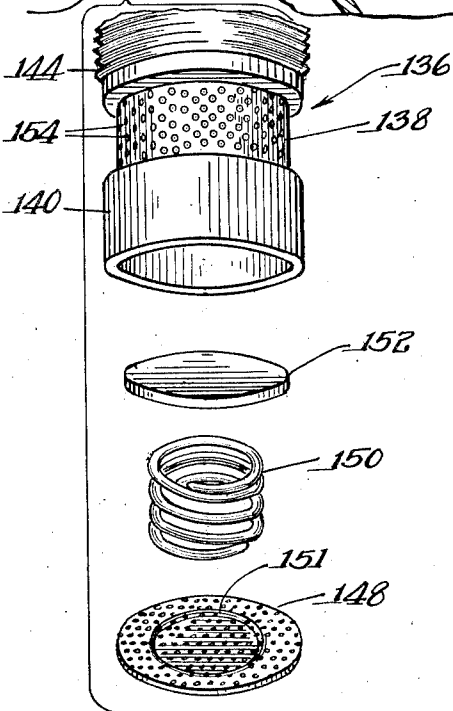


Fig. 6.

INVENTOR.

Jerus A. Paasche

BY:

Olson & Trepner
attys

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DIAPHRAGM COMPRESSOR PUMP

Jens A. Paasche, Chicago, Ill., assignor to Cline Electric Manufacturing Company, Chicago, Ill., a corporation of Illinois

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7 Claims. (Cl. 230—170)

This invention is concerned generally with airpainting, and more particularly with a unitary air reservoir and an aircompressor of the diaphragm type.

Airbrushes require a steady supply of air at a constant pressure for satisfactory and even airpainting. For certain types of industrial applications, relatively large sizes and a certain amount of noise may be tolerated in the air supply apparatus, but in other applications, such as artists' work, small size and the utmost possible silence are essential.

In order to supply air at constant pressure, it is common practice to provide a compressor and a reservoir for air compressed by the compressor. With many types of compressors, such as piston compressors, it is necessary to use a large reservoir to prevent pulsations in the air supply line from the reservoir to the airbrush. However, it has been found that a small reservoir may be used in connection with a rapidly acting pump having a fairly small displacement per stroke, a diaphragm type pump being illustrative. The rapid action of such a pump requires rapid valve action, and heretofore noise has been associated with rapid valve action.

Accordingly, it is an object of this invention to provide an aircompressor and reservoir which is quieter in operation than heretofore thought possible.

More specifically, it is an object of this invention to provide, in an aircompressor and reservoir, substantially silent valves.

A further object of this invention is to provide an aircompressor and reservoir which is of great rigidity to prevent flexing of parts and accompanying noise.

More specifically, it is an object of this invention to provide an aircompressor and reservoir having unitary parts for the greatest possible rigidity.

Still another object of this invention is to provide an aircompressor having a new or improved diaphragm mounting.

Other objects and advantages of the present invention will be apparent from the following description when taken in connection with the accompanying drawings wherein:

Fig. 1 is a view partly in vertical section showing a unitary aircompressor and reservoir constructed in accordance with the principles of my invention, the section being taken along the line 1—1 of Fig. 2;

Fig. 2 is a cross-sectional view taken substantially along the line 2—2 of Fig. 3;

Fig. 3 is a top view of the compressor and reservoir;

Fig. 4 is a fragmentary view showing a part of Fig. 1 on an enlarged scale;

Fig. 5 is an exploded perspective view of the inlet valve; and

Fig. 6 is an exploded perspective view of the operational parts of the outlet valve and relief valve.

Referring first to Fig. 1, there is shown an electrical motor 10 of any suitable type having an output shaft 12. In a specific illustrative embodiment of this invention,

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the motor 10 is rated at 1/2 horsepower. A pump casting 14 of modified conical form is bolted onto the end of the motor as at 16 with the motor shaft 12 projecting into the casting through a suitable aperture 18 in the side thereof.

The casting 14 is provided with a larger opening 20 across from the opening 18 and a plate 22 is held in this opening by means such as screws or bolts 24. The plate 22 is recessed as at 26 on its inner face to receive a ball bearing 28 journaling a stub shaft 30 of an eccentric 32 mounted on the motor shaft 12. The eccentric 32 includes an active or cam portion 34 and a counterweight 36.

The casting 14 is provided with an upper peripheral surface 38 having an external shoulder 40. A reservoir casting 42 is provided with a lower peripheral flange 44 forming an internal shoulder 46 interfitted with the shoulder 40 of the pump casting 14. Both the pump casting 14 and the reservoir casting 42 preferably are cast of aluminum and they are provided respectively with substantially vertical flanges 48 and 50 respectively which are spaced arcuately about the castings to impart the utmost rigidity to them and for cooling purposes.

The reservoir casting 42 comprises a dished basal portion 52 carrying the peripheral flange 44 and also carrying a plurality of radially extending, spaced apart ears or lugs 54 through which bolts 56 or the like are passed and threaded into similar ears or lugs 58 on the pump casting for connecting the two castings together. A cylindrical reservoir tank 60 extends upwardly from the dished out base 52 and is formed integral therewith. The cooling and rigidifying ribs or fins 50 extend over the sides of the cylindrical wall 60 as well as over the dished out base 52 as may be seen in Fig. 2.

A somewhat cup-shaped reservoir cap 62 is provided with an annular flange having a seat 64 for receiving the upper edge of the cylindrical reservoir wall 60. This seat preferably is provided with a resilient gasket for tight sealing. The cap 62 provided with fins or ribs 66 for cooling and stiffening the cap, and a bolt 68 is passed through a hole in the center of the cap and is threaded into the aperture in an upstanding boss 70 on the base 52 and integral with the remainder of the reservoir casting. The cap is provided with an internally threaded outlet or coupling 72 adjacent one edge for connection to an airpressure gage 74 connected to an air supply line 76 for supplying compressed air to an airbrush or any other air operated tool.

As may be seen in Fig. 4, the top surface 38 of the pump casting 14 is formed with an annular ridge 78 having a sharp upper edge. The lower surface of the reservoir casting is formed with a complementary groove 80. The ridge and groove cooperate tightly to grip a flexible diaphragm 82 near the periphery thereof when the two castings are bolted together. The diaphragm 82 is of ring-like configuration with a relatively large central opening. The inner edge of the diaphragm is gripped between a diaphragm washer 84 and a diaphragm bearing connector 86. The washer 84 is formed of relatively rigid material with a convex upper surface 88 complementary to the concave under surface 90 of the base 52. It is apparent that if the washer were allowed to flex, it would generate noise, and it further is apparent that if the washer were unduly heavy, it could cause bearing noises in the connection shortly to be described whereby the washer and bearing connector are reciprocated. The under side of the washer 84 is formed near its periphery with a V-shaped ridge 94 similar to the ridge 78 for biting into the diaphragm near the inner edge thereof.

The bearing connector 86 is formed with a head 96 having a flat upper surface 98 substantially engageable by the under surfaces of the washer near the edge there-

of, this under surface likewise being flat. The upper surface of the head is rounded off at 100 adjacent the periphery thereof, and this rounded off portion meets the flat portion at a shoulder 102 for positioning the inner edge of the diaphragm 82. A V-shaped annular groove 104 is provided adjacent the shoulder 102 and cooperable with the ridge 94 for tightly gripping the diaphragm near the inner edge thereof. Both of the ridges and grooves provide for extremely tight and aggressive clamping of the diaphragm, and additionally completely prevent fluid leakage along the face of the diaphragm.

The head is connected by means of a pair of diverging arms 106 (Fig. 2) to a connecting rod 108, all of these parts being integral and comprising a diaphragm bearing connector. The diaphragm bearing connector further is provided with an integral ring-like lower portion 110 carrying a ball bearing 112 in which the active portion 34 of the eccentric 32 is journaled for reciprocating the diaphragm bearing connector. The diaphragm washer 84 is mounted on this connector by a screw 114 (Fig. 4) passing through the washer and threaded into the connector, the head of the screw 114 preferably being countersunk in the washer to allow the washer to approach the base 52 as closely as possible.

The reservoir casting 42 includes a pair of diametrically spaced enlargements or shoulders 114 and 116 (Figs. 1 and 4) respectively carrying an inlet valve 118 and an outlet and relief valve assembly 120. The inlet valve is connected by a conduit or channel 122 with a threaded fitting 124 for receiving an air filter 126 in the form of an enlarged pipe 128 in which is housed a filter material 130.

The inlet valve 118 includes a cylindrical chamber 132 into which the conduit or channel 122 opens. The chamber 132 opens through a channel or conduit 134 into the air chamber 135 between the base 52 and diaphragm washer 84. A valve cylinder 136 is received in the cylindrical chamber 132 and comprises (Fig. 5) a cylindrical central body portion 138 and an axially extending end flange 140 of slightly greater diameter than the body portion 138 and forming a shoulder 142 therewith. Integral with the upper end of the body portion 138 is a plug portion 144 threaded into the upper end of the cylindrical chamber 132 and clamping the valve cylinder down against a shoulder 146 formed at the bottom of the chamber 132. A perforated centering disc 148 also seals on the shoulder 146 and a coil spring 150 bears against this perforated disc and forces a valve disc 152 up against the shoulder 142 of the valve cylinder 136. The perforated disc is provided with a depressed central portion 151 for receiving and centering the lower end of the spring.

The central body portion 138 of the valve cylinder 136 is provided with a plurality of small perforations 154 or ports spaced therearound. When the bearing connector 86 and diaphragm washer 84 are lowered to increase the size of the air chamber 135, pressure of the outside air forces the disc 152 down against the spring 150 to allow air to flow around the disc and enter the chamber. Air passing through the filter 126 into the valve chamber 132 enters the valve cylinder 136 through the perforations 154. Such entrance of air into the cylinder provides a quiet air flow that would not be possible with a single aperture as air passing through a single aperture necessarily would impinge against the surface opposite the aperture.

The outlet and relief valve assembly 120 includes a cylindrical chamber 156 communicating with the air chamber 135 by means of an opening 158 having at its upper end an annular flange 160 forming a valve seat as will be apparent hereinafter. The chamber 156 communicates through a lateral conduit or channel 162 with the interior of the reservoir 42. A plug 164 is threaded into the reservoir casting 42 above the cylindrical chamber 156, and a stem 166 is integral with the plug and

projects into the chamber. The stem is provided with an axially extending bore 168 which communicates between the free end of the stem and an enlarged bore 169 in the plug for the purpose described below.

A coil spring 170 is centralized by the stem 166 and bears against a valve disc 172. This valve disc is of generally circular configuration with four relatively small semicircular recesses 174 formed in its periphery. When the diaphragm bearing connector 86, washer 84, and diaphragm 82 are moved upwardly to compress the air in the chamber 135, the disc 172 is forced from the seat 160 against the action of the spring 170 so that air may pass past the disc into the cylindrical chamber 156 and from there into the interior of the reservoir. The four recesses or scallops in the periphery of the outlet valve disc 172 provide for an even flow of air around the disc, thus keeping air noise at a minimum, and preventing flutter of the disc. Flutter would be noisy and hence objectionable. The stem 166 adjustably limits the upward movement of the disc 172.

As will be understood, the inlet valve disc 152 is held seated against the lower shoulder 142 when the diaphragm bearing connector rises and the outlet valve disc 172 is held against its seat 160 when the diaphragm bearing connector is lowered.

In order to prevent air pressure from building up in the reservoir to a dangerous point, pressure relief valve means is provided. This means includes a valve seat 180 formed at the junction between the bores 168 and 169 in the stem 166 and plug 164 respectively. A valve 182 is slidably disposed in the bore 169 and is provided with a rounded bottom end adapted to cooperate with the seat 180. As shown best in Fig. 6 the side walls of the valve 182 are non-circular in shape so as to permit the passage of air when the valve is raised from the seat 180. In the particular embodiment illustrated the body of the valve 182 is hexagonal in shape so that the corner of the valve body may engage the circular walls of the bore 169 to guide the valve. A hollow stem 184 is threaded into the upper end of the plug 164 and encloses a spring 186. The spring acts between the valve 182 and a shoulder formed on the stem 184 to press the valve against the valve seat. In the event air pressure becomes too great, the valve 182 is raised against the action of the spring 186 to permit air to escape until the pressure is reduced to the desired level. It should be noted that the relief valve communicates with the cylinder 156 rather than directly with the reservoir whereby any excess air pressure building up in the cylinder may be relieved before a substantial excess pressure build up occurs in the reservoir thereby preventing any possible injury to the reservoir. It is obvious that by adjusting the hollow stem 184 the spring 186 may also be adjusted to vary the maximum air pressure in the reservoir. The stem 184 is locked in position by a jam nut 188.

It will be seen that the construction disclosed herein provides an air compressor and reservoir which is extremely quiet. The plurality of ports or air passages spaced around the inlet and outlet valves insures a quiet air flow while those of the outlet valve disc prevent this disc from fluttering. The rigidity of the castings, particularly as effected by the stiffening ribs thereon, prevents flexing of the various parts of the apparatus and prevents noise which would be generated by such flexing. The unitary construction of the pump casting, and of the reservoir casting including the top of the air chamber, the reservoir chamber, and the valves further provides rigidity and precludes looseness and noise between parts, and additionally simplifies construction.

The ridge and groove arrangement for gripping the edges of the diaphragm assures tight connections which positively prevent air leakage and attendant noise, and which afford a high operating efficiency.

It is to be understood that the example herein shown and described is for illustrative purposes only. Various

structural modifications are possible and are to be considered a part of my invention insofar as they fall within the spirit and scope of the appended claims.

I claim:

1. Air supply apparatus comprising a base, a reservoir unit, a reciprocable diaphragm, cooperable with said reservoir unit to provide a variable capacity chamber, means mounting said diaphragm between said base and said reservoir unit, means securing said reservoir unit on said base, means connected with said diaphragm for reciprocating said diaphragm, said reservoir unit comprising a casting having a centrally located upstanding open-ended storage tank and inlet and outlet valve chambers offset laterally of said tank, passageway means connecting said inlet valve chamber with said first mentioned chamber and with the exterior of said casting, other passageway means connecting said outlet valve chamber with said first mentioned chamber and with said tank, means closing the open end of said air storage tank, a one-way inlet valve means in the inlet valve chamber for passing air into said first mentioned chamber when the diaphragm is moved to expand the first mentioned chamber, and a one-way outlet valve means in the outlet valve chamber for passing air from said first mentioned chamber into said storage tank when said diaphragm is moved to collapse said first mentioned chamber.

2. Air supply apparatus as set forth in claim 1 wherein each valve means is provided with a plurality of separated air paths for quiet operation.

3. Air supply apparatus as set forth in claim 1 wherein the means closing the open end of the air storage tank comprises a cup-like cap for enlarging the capacity of said tank, said cap having radially disposed cooling and stiffening ribs thereon, and further including a stud passed through the center of said cap and threaded into said reservoir unit for holding said cap on the open end of said tank.

4. Air supply apparatus as set forth in claim 1 wherein the one-way inlet valve means comprises a cylinder disposed in said inlet valve chamber and having a reduced central portion providing an internal shoulder, said reduced central portion having a plurality of angularly spaced ports communicating with the exterior of said casting through a portion of said first mentioned passageway means, a disc between said shoulder and said first mentioned chamber and adapted to seat on said internal shoulder, and a spring pressing said disc against said shoulder.

5. Air supply apparatus as set forth in claim 1 wherein the one-way outlet valve means comprises a valve seat, a

disc adapted to seat against said seat, and a spring urging said disc against said seat, said disc having a plurality of relatively small generally semi-circular recesses angularly spaced about its periphery for promoting even air flow and preventing flutter and valve noises.

6. Air supply apparatus, comprising means defining an air chamber and including shiftable means for increasing and decreasing the volume of said chamber to pump air therethrough, a one-way inlet valve into said chamber, a one-way outlet valve from said chamber, a pressure reservoir, said outlet valve communicating with said reservoir, said outlet valve including a valve seat and a valve member yieldably biased against said valve seat, means disposed adjacent said valve member for limiting movement of said valve member away from said valve seat, said last mentioned means having an air passageway therethrough and communicating with the discharge side of said outlet valve, and pressure relief valve means disposed within said passageway for preventing excess air pressure being built up in said reservoir.

7. Air supply apparatus as defined in claim 6 in which includes a cylinder outside of said reservoir, and air conduit means connecting said cylinder with the reservoir and wherein said outlet valve is disposed in said cylinder and said passageway communicates with said cylinder so as to relieve air pressure in the cylinder before excess pressure has been substantially transmitted to the reservoir.

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