United States Patent [19]

Rosen et al.

[11] 3,827,339

[45] Aug. 6, 1974

[54] DOUBLE ACTING HYDRAULIC PUMP

[75] Inventors: **Samuel R. Rosen**, Lorain; **Alvin A. Rood**, Westlake; **Donald R. Scharf**, Amherst, all of Ohio

[73] Assignee: **Nordson Corporation**, Amherst, Ohio

[22] Filed: **May 17, 1971**

[21] Appl. No.: **144,055**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 809,235, March 21, 1969.

[52] **U.S. Cl.** **92/152**, 92/169, 417/554

[51] **Int. Cl.** **F01b 7/00**

[58] **Field of Search** 92/181, 152, 52, 169; 417/545, 554

[56] **References Cited**

UNITED STATES PATENTS

530,350	12/1894	Rosenkranz	417/554
623,357	4/1899	Evans	92/152
1,097,632	5/1914	Holmes	92/169
1,601,472	9/1926	Gates	417/554
1,785,834	12/1930	Kilgore	417/554
1,925,444	9/1933	Grieshaber	92/152
2,178,822	11/1939	Upton	417/554
2,835,005	5/1958	Green	92/169
3,302,535	2/1967	Procter et al.	92/52
3,543,682	12/1970	Farrow	417/554

FOREIGN PATENTS OR APPLICATIONS

169,018	9/1921	Great Britain	417/554

Primary Examiner—Charles J. Myhre
Assistant Examiner—R. H. Lazarus
Attorney, Agent, or Firm—Bosworth, Sessions & McCoy

[57] **ABSTRACT**

A double acting hydraulic pump and air motor therefor including means for controlling the inlet and exhaust of air to and from the opposite sides of the piston in the air cylinder. The pump has a stepped diameter housing including an upper pump cylinder defining an outlet chamber for liquid and a lower pump cylinder received within the upper pump cylinder and defining an inlet chamber for liquid. A pump piston reciprocates in the two cylinders and is slidably received in two axially spaced stationary packing sleeves having a resilient spacer sleeve interposed axially therebetween. The spacer sleeve is formed of metal sheet adapted to deflect resiliently under load. The upper end of the upper pump cylinder is received within a recess in the lower end of the air motor housing. A retainer plate connected to the lower end of the air motor housing is provided with an opening to allow passage of the upper end of the upper pump cylinder and a pair of radially extending ears thereon. The pump housing is rotatable about its own longitudinal axis to align or misalign the ears and the opening and retain the pump housing to or release it from the motor housing.

2 Claims, 6 Drawing Figures

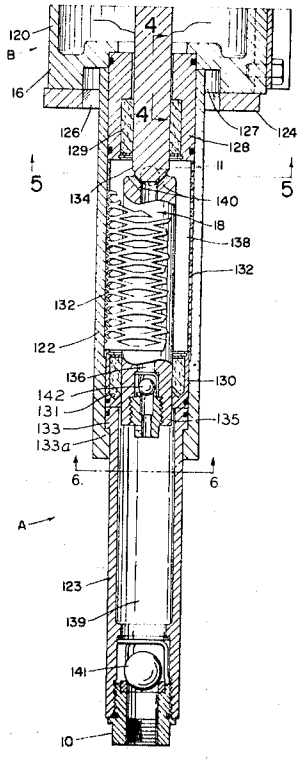
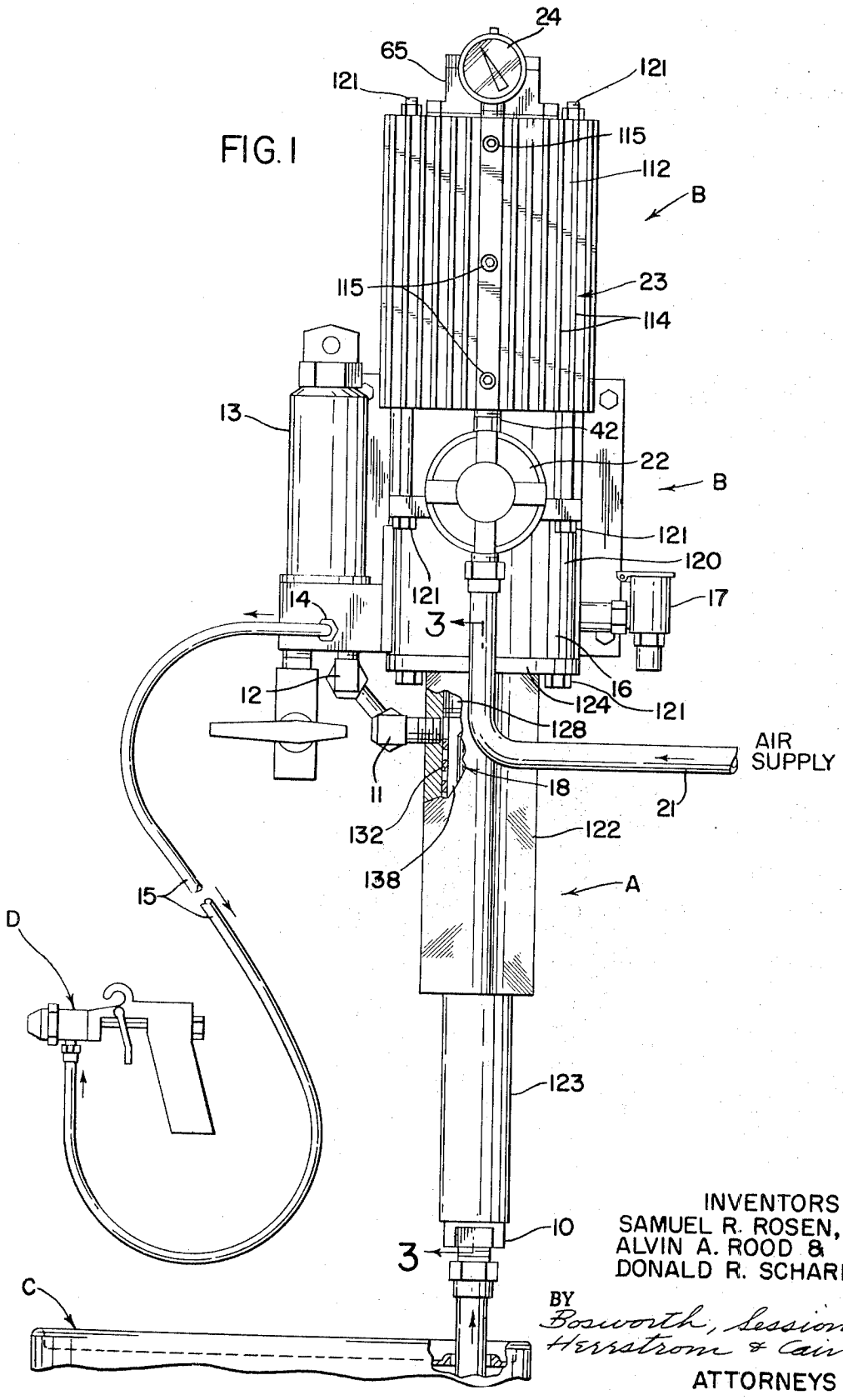


FIG. 1



INVENTORS
SAMUEL R. ROSEN,
ALVIN A. ROOD &
DONALD R. SCHARF

BY
Bosworth, Sessions, Herrstrom & Cain
ATTORNEYS

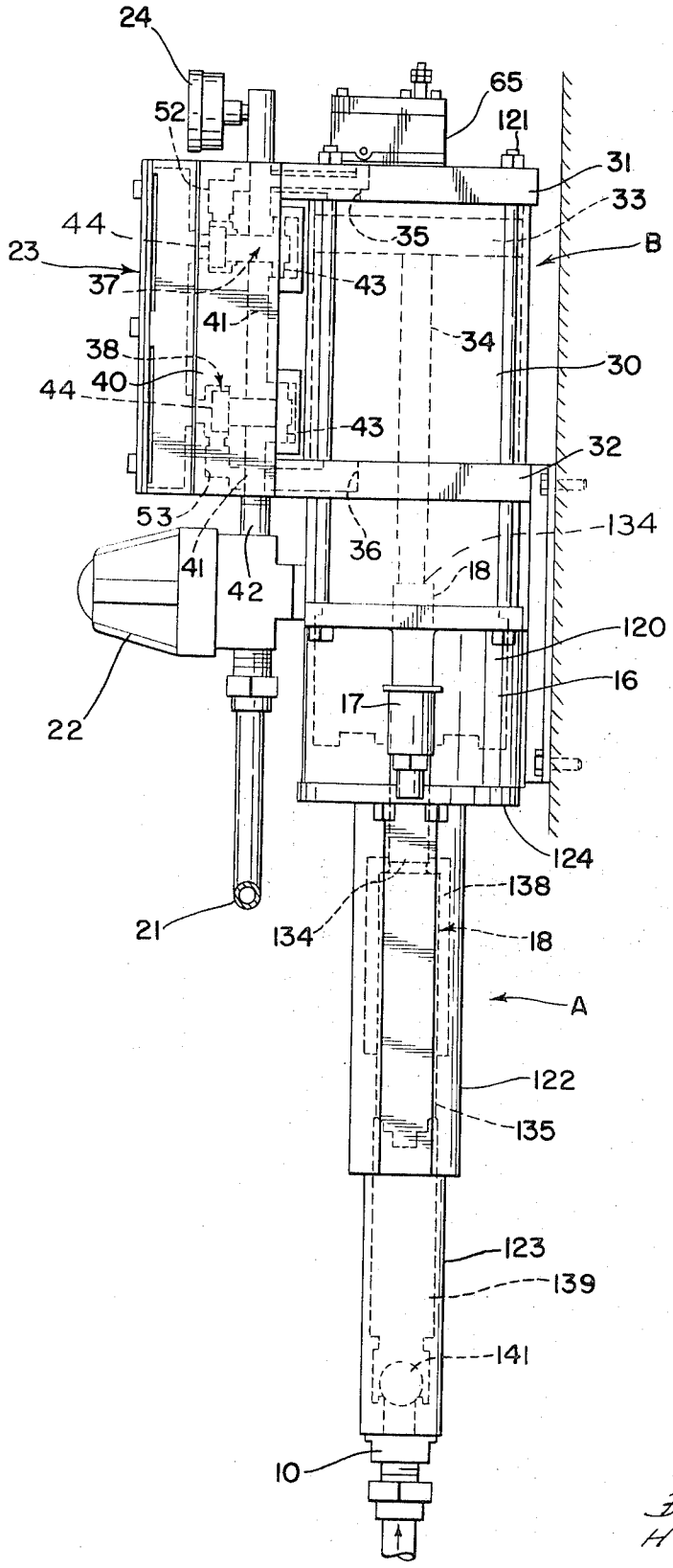


FIG. 2

INVENTORS.
SAMUEL R. ROSEN
ALVIN A. ROOD &
BY DONALD R. SCHARF
Bosworth, Sessions,
Herrstrom & Cain
ATTORNEYS

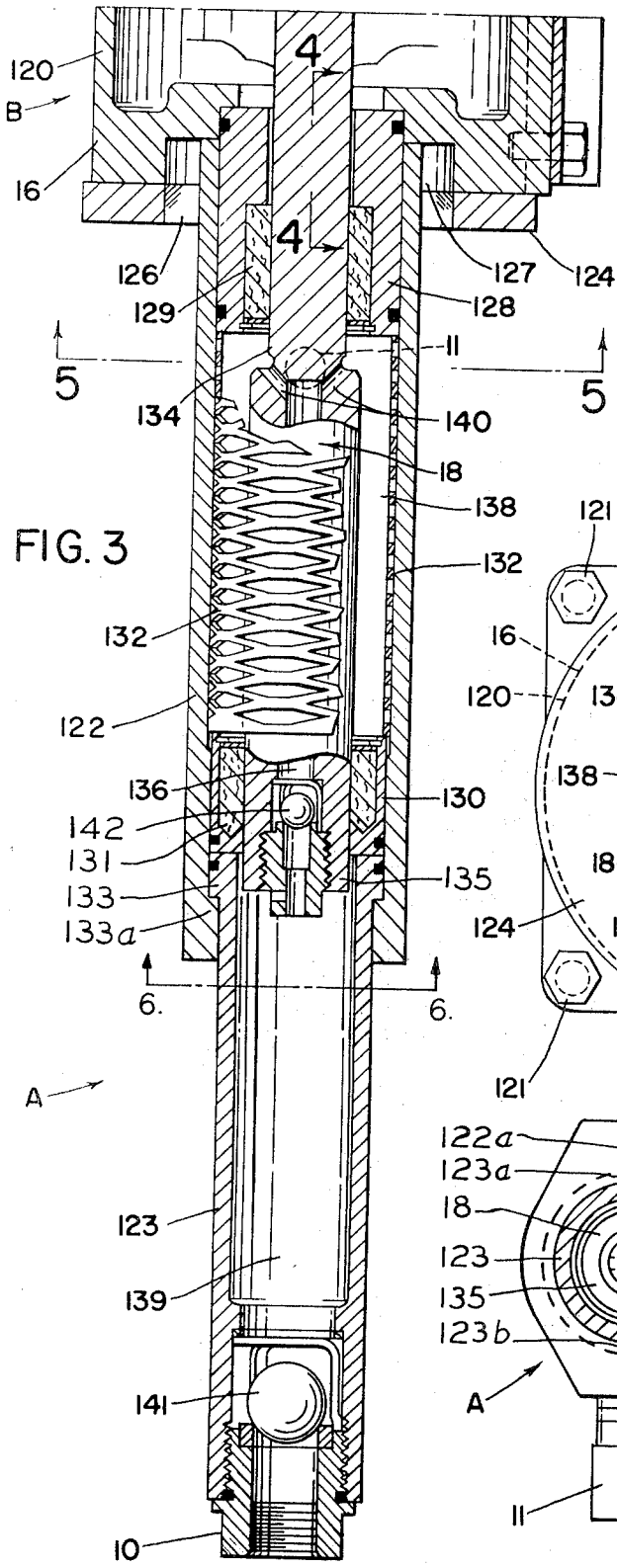


FIG. 3

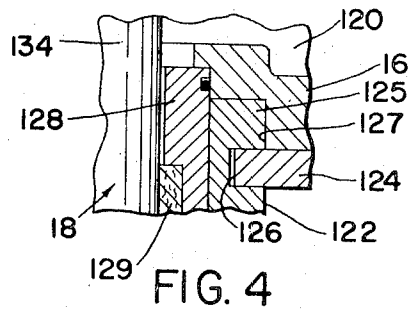
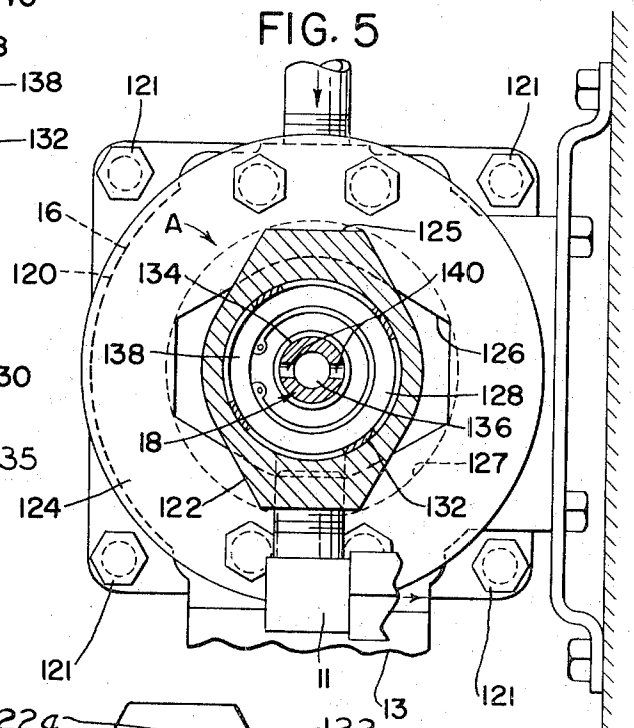


FIG. 4

FIG. 5



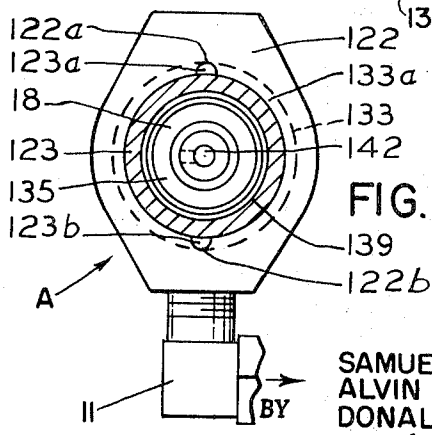


FIG. 6

INVENTORS.
SAMUEL R. ROSEN,
ALVIN A. ROOD &
DONALD R. SCHARF
BY
Bosworth, Sessions,
Herrstrom & Cain
ATTORNEYS

DOUBLE ACTING HYDRAULIC PUMP

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of applicants' copending application Ser. No. 809,235, filed Mar. 21, 1969.

BACKGROUND OF THE INVENTION

This invention relates to pneumatic motors and double acting improved and especially to such a pump having an im proved construction. One aspect of the invention relates to the manner in which the pump is retained to the air motor.

The invention has particular utility in connection with double acting liquid pumps used to pump liquid paint to a spray gun.

In many applications it is desirable to employ a pump having a stepped diameter housing, that is, a housing having a portion of greater diameter to permit holding packings having a substantial wall thickness through which the pump piston slides and having another portion of smaller diameter to obtain minimal clearance volume for the piston. Such minimal clearance volume is desirable to facilitate priming and positive charging on the intake stroke. The stepped diameter housings have, in the past, been made as one piece and when rebuilt require special tools to remove the packings.

Another problem in the art to which our invention relates is that of providing appropriate spacing means between axially spaced packing sleeves through which the pump piston slides in reciprocating within the pump cylinder. The friction of the piston in sliding through such packings may generate an axial force thereon tending to displace them. It is desirable to maintain the packings in their proper position without any such shift. Ordinary fixed length spacers between the packings are generally used but are somewhat unsuitable because the accumulation of tolerances on the lengths of the parts precludes a precise fit of the spacer. A fixed spacer may thus be used to reduce the clearances between the packings but not to eliminate such clearances. In some applications a spring may be effective to eliminate the clearance but in most cases the space available for the spacer is not readily adaptable to use of a coiled spring and, in addition, such springs usually require a high preload to render them sufficiently rigid.

Still another problem in the art to which our invention relates is that of making the pump and driving air motor easily and conveniently connectable and disconnectable for maintenance and repair.

As indicated above, the invention has particular utility in connection with pumps used in conjunction with air motors for pumping paint or hot paint in the so-called hot airless method of spray painting. This method is disclosed and discussed in detail in U.S. Pat. Nos. 2,754,228 and 2,763,575 of James A. Bede. In this method the paint, whether hot or cold, is projected from a small orifice nozzle under high pressure and the continuity of an even pressure is most desirable to obtain the best results.

SUMMARY OF THE INVENTION

A general object of this invention is to provide a hydraulic pump that overcomes the disadvantages noted above in prior pumps of the type described.

A particular object is to provide a hydraulic pump having a stepped diameter housing that is constructed in two pieces to facilitate machining of the pieces and to eliminate the need for tools to remove packings when the pump is rebuilt.

Another object of the invention is to provide a resilient spacer sleeve for use between two axially spaced packings in a pump cylinder that is sufficiently resilient to eliminate clearances between the spacer sleeve and the packing sleeves while being sufficiently rigid to prevent excessive deflection of the packings as the pump piston reciprocates therein.

Another object of the invention is to provide a hydraulic pump and a pneumatic motor for driving the pump in which the pump and driving air motor are easily connected and disconnected to facilitate maintenance and repair of each.

Finally, it is an object of this invention to provide a single piston double acting hydraulic pump that is efficient, easily maintained, easily repaired and rugged in construction and economical to make and maintain.

These and other objects and advantages are accomplished by the provision of a hydraulic pump having a piston reciprocable within a cylindrical housing of stepped diameter. The housing includes an upper pump cylinder, closure means defining a sealing path for the piston at the lower end of the upper pump cylinder, and a lower pump cylinder of lesser diameter than the upper pump cylinder received within the upper cylinder in sealing engagement with the closure means. Means are provided for retaining the lower cylinder within the upper cylinder in sealing engagement therewith. The pump piston passes between the upper and lower cylinders in sealing contact with the closure means.

According to another aspect of the invention there is provided, between two axially spaced packing sleeves through which the pump piston passes, a spacer sleeve of metal sheet that is resiliently deflectible under load.

According to still another aspect of the invention the hydraulic pump is combined with an air motor having a housing and a piston adapted to be drivingly connected to the piston of the pump. The motor housing has a recess in the lower end thereof to receive the upper end of the pump housing which has outwardly extending projections at its upper end. A retainer plate is connected to the bottom of the motor housing and has an opening therein to allow passage of the upper end of the pump housing and the outwardly extending projections thereon. The pump housing is rotatable about its own longitudinal axis to align the projections with the opening in the retainer plate to allow passage of the projections and is also rotatable to misalign the projections and the opening to retain the pump housing connected to the motor housing. In this manner the air motor and hydraulic pump may be easily connected and disconnected for maintenance and repair of either.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation of a double acting liquid

pump and associated single cylinder, double acting air motor embodying the invention;

FIG. 2 is a side elevation of the pump and air motor of FIG. 1;

FIG. 3 is a broken cross-sectional view of the pump of FIGS. 1 and 2, drawn to an enlarged scale and taken on the line 3—3 of FIG. 1;

FIG. 4 is a fragmentary sectional view taken on the line 4—4 of FIG. 3;

FIG. 5 is a cross-sectional view taken on the line 5—5 of FIG. 3; and

FIG. 6 is a cross-sectional view taken on the line 6—6 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawings and initially to FIGS. 1 and 2 there is shown a paint spraying apparatus for use in spraying liquid paint according to the so-called airless method described above in the "Background of the Invention." The apparatus comprises a double acting hydraulic pump A, driven by a double acting air motor B, and adapted to pump paint from a paint pail C to a spray gun D.

Paint from the paint pail C which may be, for example, a standard size drum, enters the hydraulic pump A through an inlet fitting **10** located at the bottom thereof and exits through an outlet fitting **11**. From the outlet fitting **11** the paint is directed to another fitting **12** on a paint filter **13** mounted on the pump A. The paint filter **13** serves to filter out solid particles within the paint that may be too large to pass through the nozzle of the spray gun D.

The paint from the filter **13** exits through an outlet fitting **14** to a flexible hose **15** which extends to the spray gun D. The hose **15** is of sufficient length and is made of flexible material so that it will provide some dampening effect in case of variable pressure output from the double acting pump A. The hose **15** being resilient and flexible, absorbs some energy at the peak pressure periods and thus gives a smoother more uniform pressure output to the spray gun D. The hydraulic pump A cycles at a rate typically about 40 cycles per minute and in a typical instance would have about a 4 cubic inch displacement.

Located at the upper end of the pump A is a solvent chamber **16** and an associated filler cup **17**. The chamber **16** maintains a bath of paint solvent around the upper end of the pump piston **18** to dissolve any paint which may accumulate thereon and which when dry could seriously damage the packing through which the upper end of the pump piston **18** slides during its pumping travel.

Air pressure for operating the air motor B is supplied by an air pump (not shown) through a pressure line **21** which is connected to a pressure regulator valve **22** secured to the air motor B. Air is exhausted from the air motor B through a muffler **23** which serves to attenuate the noise of the escaping air. A pressure gauge **24** is located at the top of the air motor B (FIG. 2).

The double acting air motor B shown somewhat diagrammatically in FIG. 2 comprises an air cylinder **30** mounted between an upper cylinder head **31** and a lower cylinder head **32**. The heads **31** and **32** are preferably formed of cast aluminum while the air cylinder **30** is of aluminum tube stock which has its interior surface hard anodized to accomodate frictional loads and to minimize wear. Within the cylinder **30** is a piston **33** mounted on a tubular piston rod **34**.

Operating air enters the cylinder chamber and is exhausted therefrom in opposite phase through inlet-exhaust passages **35** and **36** located in the upper cylinder head **31** and lower cylinder head **32** respectively. The control of the inlet and exhaust of air from the respective ends of the cylinder chamber is accomplished by upper and lower poppet type operating valves **37** and **38** respectively.

The valves **37** and **38** are located in an operating valve housing or block **40** bolted at one end to the upper cylinder head **31** and at the other end to the lower cylinder head **32**. The block **40** has a central air supply passage **41** extending therethrough, which receives operating air from the pressure regulator valve **22** through an inlet fitting **42**. Each of the valves **37** and **38** is pilot operated, and has a control head **43** and an operating head **44**.

The valves control the inlet and exhaust of air to the cylinder through inlet-exhaust passages **52** and **53** respectively formed in the valve block **40** and which communicate with the inlet- exhaust passages **35** and **36** respectively in the upper cylinder head **31** and lower cylinder head **32**.

The position of the operating valve **37** is controlled by a pilot valve while the position of the operating valve **38** is controlled by a pilot relay valve (not shown). The pilot and pilot relay valves are housed in a pilot valve block **65** which is bolted to the top face of the upper cylinder head **31** with suitable seals interposed therebetween.

The control system for the pneumatic motor including the poppet valves **37, 38** and the pilot and pilot relay valves is more fully described and is claimed in applicants' copending application identified above.

The construction of the pump A is best illustrated in FIGS. **3** through **6** and it includes the solvent chamber **16** as well as the pumping cylinder itself. The solvent chamber **16** is formed in part by the lower cylinder head **32** of the air motor B and by a matching solvent chamber block **120**. The block **120** and the lower cylinder head **32** have a sliding fit with one another and are held in axial position by flange bolts or tie rods **121** which extend up to the upper cylinder head **31** and serve to secure the air cylinder assembly and block **120** together.

A solvent enters the solvent chamber **16** through the filler cup **17** and is most advantageously maintained near the top of the filler. The solvent serves to dissolve any paint which may collect on the surface of the piston **18** and which could dry thereon and by abrasive action seriously damage the packings through which the piston **18** slides.

The pumping action is accomplished within a cylindrical housing including an upper pump cylinder **122** and lower pump cylinder **123**. The upper end of the upper pump cylinder **122** is secured to the solvent chamber block **120** in a circular recess **127** in the bottom thereof by a retainer plate **124**. The upper pump cylinder **122** has a pair of radially extending ears **125** adjacent its upper end and the retainer plate **124** has a central opening **126** contoured to receive the upper end of the upper pump cylinder **122** and the ears **125** when in one condition. However, the upper pump cylinder **122** when inserted is rotated 90° so that the ears are retained by the retainer plate **124** in the recess **127**

(FIG. 4). This manner of retaining the pump housing to the air motor allows for very easy assembly and disassembly for maintainance and repair.

Located within the upper pump cylinder **122** is an upper packing sleeve **128** which seals and guides the piston **18** by means of a packing assembly **129** carried therein. Another packing sleeve **130** is mounted in the lower end of the upper pump cylinder **122**, the sleeve **130** also having a packing assembly **131**.

The spacing between the packing sleeves **128** and **130** must be accurately fixed and the packing sleeves prevented from excessive movement axially as the piston **18** reciprocates. A solid spacer sleeve would therefore require extremely accurate dimensioning and would not accommodate dimensional variations in other parts such as the packing sleeves themselves.

The pump of the present invention however has a resilient expanded metal spacer sleeve **132** which maintains proper spacing between the packing sleeves **128** and **130** while at the same time being resilient enough to accommodate some dimensional variations in other parts. The sleeve **132** is formed of expanded metal which after being expanded according to practices well known in the art is rolled into a flat sheet form. The sleeve may also be formed of sheet metal that is perforated in a regular pattern to render it axially deflectible. The rolled sheet is then cut to size and formed into a cylinder which may or may not have its lateral surface abutted. Accordingly, the spacer sleeve **132** can be compressed while still exerting sufficient force to maintain the packing sleeves **128** and **130** in spaced apart relation and prevent axial movement thereof as the piston **18** slides therethrough. While a round wire coil spring could serve the same purpose, it would require excessive space to provide the same force and rate and thus would be undesirable.

The lower pump cylinder **123** fits within the upper pump cylinder **122** in the manner shown in FIG. **3** with its upper end resting against the bottom of the lower packing sleeve **130**. The lower pump cylinder is retained within the upper pump cylinder as shown in FIGS. **3** and **6**. A flange **133** on the lower pump cylinder **123** rests upon a ledge **133a** on the inner walls of upper cylinder **122**. Lower pump cylinder **123** is provided with a pair of projections **123***a*, **123***b* below flange **133** which align with correspondingly shaped openings **122***a* and **122***b* in ledge **133***a*. The lower pump cylinder is inserted downwardly into the upper pump cylinder with the projections **123***a*, **123***b* in registry with the openings **122***a*, **122***b* until the flange **133** of the lower pump cylinder comes to rest upon ledge **133***a* and the lower pump cylinder is supported thereby. The lower pump cylinder then will not rotate while attaching fittings and or hose to intake of the pump.

Several advantages result from the two piece construction of the pump housing. No special tools are required to remove the packings when the pump is rebuilt. Removal of packings can be accomplished merely by telescoping the lower pump cylinder **123** within the upper pump cylinder **122**. Also, the two smaller pieces of the pump housing facilitate machining operations during making of the housing and, because a lower number of critical dimensions occur on each of the upper and lower cylinders, the rejection rate of pieces can be lowered.

The piston **18** has an upper end **134** of smaller diameter which travels entirely within the upper pump cylinder **122** and the solvent chamber **16**, and also a tubular lower end **135** of enlarged diameter with an axial passage **136** located therein. The upper end **134** of the piston is connected to the lower end of the piston rod **34** of the air cylinder at a threaded connection indicated at **137** in FIG. **2**.

The upper pump cylinder **122** and lower pump cylinder **123** define an outlet chamber **138** and an inlet chamber **139** respectively, the passage **136** within the lower end **135** of the piston **18** being in communication with the outlet chamber **138** through ports **140** at the upper end thereof. A ball check **141** is located at the inlet fitting **10** to the pump inlet chamber **139** and a second ball check **142** is located in the passage **136** at the lower end **135** of the piston **18**.

Considering reciprocating movement of the piston **18** beginning with the piston extended downwardly to the lower end of the pump housing, the beginning of the upward retraction movement will open the ball check **141** and close the ball check **142** and liquid paint will be drawn into the pump inlet chamber **139**. This continues until the piston **18** reaches its retracted or raised position shown in FIG. **3**.

During the same upward retraction movement, liquid paint located in the pump outlet chamber **138** will be forced out through the outlet fitting **11**. The volume pumped out through the outlet fitting **11** during this movement is one-half the volume drawn into the inlet chamber **139**.

During the downward extension movement of the piston **18** the ball check **141** will close and the ball check **142** will open so that paint in the pump inlet chamber **139** will be forced through the axial passage **136** in the lower end **135** of the piston **18** and into the outlet chamber **138**.

Since essentially all of the liquid paint in the inlet chamber **139** will be displaced during the downward extension movement and since only one-half the volume of the inlet chamber **139** is displaced out the port, the other half remaining in the chamber **138**, one-half of the volume paint which is pumped out of the inlet chamber **139** will also be pumped out of the outlet chamber **138** through the outlet fitting **11**.

Accordingly an equal volume of paint is pumped during both extension and retraction movement of the piston **18** so that a generally uniform output of liquid paint is supplied to the spray gun D, the only interruption in pressure output occurring at the instant that the piston **18** reverses its travel.

The transient variation in output occurring at the instant of piston travel reversal however, is dampened out in the supply hose **15** from the filter **13** to the spray gun D_1 which is generally **25** feet or longer to provide a dampening effect due to the resilient character of the hose.

While the invention has been shown and described with reference to a specific embodiment thereof this is for the purpose of illustration rather than limitation and other modifications and variations will be apparent to those skilled in the art upon reading of the specification, all with the intended spirit and scope of the invention. Accordingly the patent is not to be limited to the form specifically illustrated and described not in any manner that is inconsistent with the extent to which the

progress in the art has been advanced by the invention.

What is claimed is:

1. A hydraulic pump comprising an upper pump cylinder defining an outlet chamber for liquid, a ledge on said cylinder projecting radially into said outlet chamber at the lower end thereof, a lower pump cylinder defining an inlet chamber for liquid of lesser diameter than said outlet chamber, said lower cylinder having a radially outwardly extending flange seated on said ledge to connect said lower cylinder to said upper cylinder, a pair of axially spaced packing sleeves sealing the upper and lower ends of said outlet chamber, the lower of said packing sleeves being seated on said flange in sealing engagement therewith and closing the lower end of said outlet chamber, means holding said packing sleeves in spaced relation, and a piston of slightly smaller diameter than said inlet chamber and substantially smaller diameter than said outlet chamber reciprocable within said upper and lower cylinders and adapted to pass from one to the other of said chambers in slidable sealing contact with said lower packing sleeve to pump liquid into said inlet chamber and out of said outlet chamber.

2. A pump as claimed in claim 1 wherein said spacing means includes a resilient spacer sleeve in said outlet chamber interposed axially between said packing sleeves, said spacer sleeve being formed of metal sheet adapted to deflect resiliently under load.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,827,339 Dated August 6, 1974

Inventor(s) Samuel R. Rosen, Alvin H. Rood and Donald R. Scharf

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, delete the first sentence of the "Background of the Invention" and insert therefor --This invention relates to pneumatic motors and double acting liquid pumps, and especially to such a pump having an improved construction.--

Signed and sealed this 8th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

ORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE 1969 O—366-334