

Dec. 8, 1970

S. ZAHRADNIK

3,545,896

RECIPROCATING PUMP

Filed Nov. 13, 1968

Fig. 1

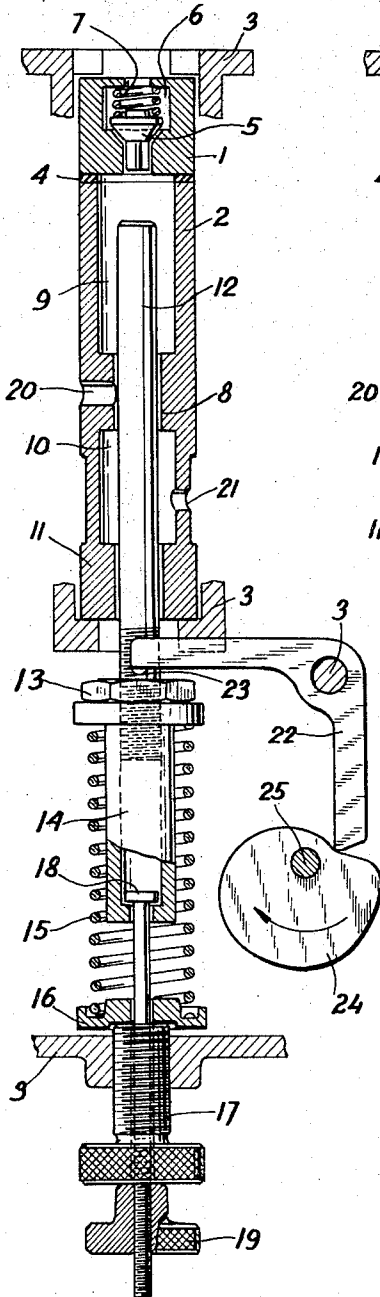


Fig. 2

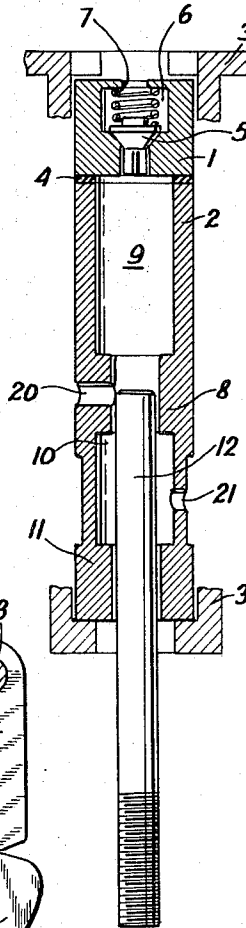
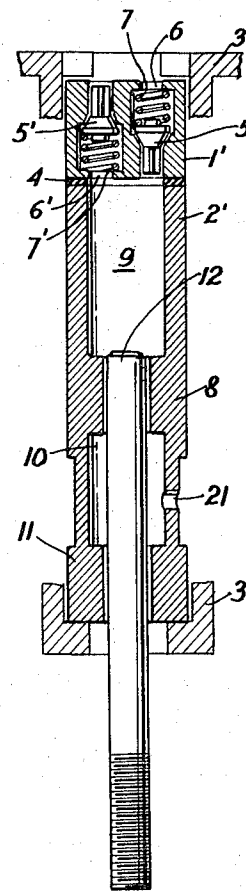


Fig. 3



INVENTOR
Stanislav Zahradnik
BY
Richard C. Wright

1

3,545,896

RECIPROCATING PUMP

Stanislav Zahradnik, Roztoky u Jilemnice, Czechoslovakia, assignor to Elitex, Zavody textilního strojírenství, generalni reditelství, Liberec, Czechoslovakia

Filed Nov. 13, 1968, Ser. No. 775,374

Claims priority, application Czechoslovakia,

Nov. 15, 1967, 8,083/67

Int. Cl. F04b 29/00

U.S. Cl. 417—471

7 Claims

ABSTRACT OF THE DISCLOSURE

A pump for discharging air in pulses of precisely controlled volume, velocity, and timing has a cylinder divided by an annular collar into a working chamber and a lubricant chamber. A plunger passes through a cylinder end wall into the lubricant chamber and thence through the collar into the working chamber to draw air into the latter, and to compress the air and discharge it through suction and pressure valves respectively. The plunger is guided in axially short, conforming bores of the collar and of the end wall which are protected against dust by the lubricant which is held in the lubricant chamber under a pressure normally higher than that of the working chamber.

BACKGROUND OF THE INVENTION

This invention relates to reciprocating pumps, and particularly to pumps suitable for discharging precisely timed pulses of compressed air having a closely controlled velocity and volume.

Pumps of the type described are employed in shuttleless jet looms for blowing a weft thread through the shed of warp threads. The precise operation of the pumps which produce the jet of air is essential to the operation of the loom, and deviations of the air jets or pulses from prescribed values in any of their properties cause misweaves.

It is not normally practical to employ piston rings in such a pump. The piston is precisely ground and polished to match the bore of the pump cylinder. The discharge stroke of the piston is brought about by the rapid expansion of a spring compressed during intake, a more positive drive of the piston being unsuited for the intended purpose.

The spring drive, however, is very sensitive to changes in the frictional resistance of the piston. An increase in the piston friction reduces the velocity at which air is discharged from the pump. Even when an air filter is employed, it is unavoidable that small, solid particles are airborne into the known pump and are lodged where they increase piston friction. Moreover, minute metal particles are dislodged by wear from the slidingly engaged surfaces of the piston and pump cylinder, and further contribute to friction. It is therefore necessary in known pumps frequently to adjust the spring tension in order to compensate for increasing friction, and to replace the pumps after relatively short operation periods for a thorough cleaning and overhaul. If a burdensome maintenance schedule is not maintained, the spring may become unable to move a sticking piston in the required manner, and costly defects may be caused in the woven material.

The known pumps used in jet looms also are quite sensitive to temperature. They do not perform in the same manner immediately after start-up when cold and after warming up, and only a careful and experienced operator can avoid misweaves resulting from variation in operating temperature. The temperature sensitivity of the known pumps is enhanced by the presence of accumulated solid contaminant particles in the pump cylinder.

2

The primary object of the invention is the provision of a pump for a jet loom which, in effect, purges itself of solid contaminant particles, and whose frictional resistance to the operating force of a spring does not change materially over an extended operating period regardless of the temperature of the ambient atmosphere or the pump itself.

SUMMARY OF THE INVENTION

With this object and others in view, the invention provides a pump whose cylinder cavity is axially divided into two chambers by a collar having a central bore. One of the chambers, hereinafter referred to as lubricant chamber, is axially bounded by an end wall of the cylinder formed with an axial bore therethrough. A plunger conformingly engages both bores for axial sliding movement. The two free axial ends of the plunger are respectively exposed in the other chamber of the cylinder cavity, hereinafter referred to as the working chamber, and outside that cavity. The plunger is reciprocated by the pump drive inward and outward of the working chamber, whereby the contents of the latter are alternately compressed and expanded.

Suction and discharge valves on the cylinder are normally closed, and open respectively in response to the outward and inward movements of the plunger for admitting fluid to the working chamber and for releasing the fluid. A lubricating system feeds lubricant to the lubricant chamber, the term "lubricant" being limited to a material having a viscosity greater than that of water. The lubricant pressure in the chamber is held substantially above that of the ambient atmosphere.

The frictional resistance of the piston to its operation by a spring drive is held to a practically constant very low value by the afore-described use of a lubricant chamber and by specific dimensional relationships between the portions of the plunger which are confined in the bores of the collar and of the end wall, and those which are exposed in the two chambers. For reasons which will be more fully explained hereinafter, the surface area of the plunger exposed in the two chambers should not be substantially smaller than the surface area confined in the two bores in any operating position of the plunger during the reciprocating movement of the same. At the end of the compression stroke, at least, the exposed surface area should be substantially greater than the confined area. More specifically, the axial length of the exposed surface should be much greater than the axial length of the confined surface at the end of the compression stroke. For best results the axial length of the bore in the collar must be substantially smaller than the axial length of the working chamber.

Other features, additional objects, and many of the advantages of this invention will readily be appreciated from the following detailed description of preferred embodiments when considered in connection with the appended drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 shows a reciprocating pump of the invention in elevational section at the end of its discharge or compression stroke;

FIG. 2 shows the pump of FIG. 1 at the beginning of its discharge stroke in a fragmentary view corresponding to that of FIG. 1; and

FIG. 3 shows a modified pump of the invention in a view corresponding to that of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIG. 1, there is seen the pump of

3

the picking mechanism in a jet loom. The head 1 and cylinder 2 of the pump are mounted between stationary elements of the loom frame 3, not otherwise shown, and a gasket 4 seals the head 1 to the cylinder 2. A conically tapering check valve 5 is biased by a spring 7 to close a bore 6 in the head 1, which connects the cavity of the cylinder 2 with the ambient atmosphere, the valve being arranged to open under a pressure in the cylinder cavity which exceeds atmospheric pressure by an amount determined by the characteristics of the helical compression spring 7.

An internal, annular, integral collar 8 divides the cavity of the cylinder 2 into a working chamber 9 and a lubricant chamber 10. The bore of the collar 8 has the same diameter as a bore in the end wall 11 of the cylinder 2 remote from the head 1. A cylindrical plunger 12 has a free end in the working chamber 9 and passes in conforming engagement through the bores in the collar 8 and the end wall 11. The free end of the plunger 12 outside the cylinder 2 carries a threadedly adjustable abutment ring 13, and extends inward of a cup-shaped, coaxial pusher member 14.

The rim of the member 14 is held in axially abutting engagement with the ring 13 by a strong, helical compression spring 15, partly coiled coaxially about the pusher member 14. The other axial end of the spring 15 rests on a washer 16. The axial position of the washer may be adjusted by means of a bushing 17 threadedly received in the loom frame 3 and coaxially engaging the washer 16 under the pressure of the spring 15. The head of a long and slender bolt 18 is retained in the pusher member 14. Its shank passes freely through a central opening in the bottom of the member 14, the washer 16, and the bushing 17, and its free end threadedly engages a nut 19 which is normally held against the bushing 17 by the spring 15.

A radial bore 20 passes through the wall of the cylinder 2 and the collar 8. Another radial bore 21 in the cylinder wall terminates in the annular free space of the lubricant chamber 10. A rocker 22 is pivoted on the loom frame 3. One arm of the rocker 22 carries a spherically rounded stop 23 axially aligned with the free radial face of the ring 13. The other arm follows the cam face of a radial cam 24 whose drive shaft 25 is coupled to the loom drive. The cam face of the cam 24 extends approximately in an Archimedes spiral about the axis of rotation, the two circumferential ends of the spiral being connected by a straight cam face portion which is almost radial.

The illustrated pump operates as follows:

When the continuously rotating cam 24 moves clockwise from the position shown in FIG. 1, the plunger 12 is slowly retracted from the chamber 9 by the rocker 22 toward the position seen in FIG. 2 in which the free end of the plunger clears the bore 20, the air intake port of the pump. Withdrawal of the plunger 12 from the working chamber 9 creates a partial vacuum in the chamber which is broken when the plunger opens to port 20.

The pressure of the rocker 22 on the ring 13 also causes the spring 15 to be compressed. When the rocker 22 reaches the practically radial face portion of the cam 24, the spring 15 is suddenly released and pushes the plunger 12 inward of the working chamber 9 until the bottom of the pusher member 14 strikes the head of the bolt 18 while the nut 19 abuts against the bushing 17. The port 21 is closed as the plunger 12 begins its inward stroke, and the suddenly compressed air in the working chamber 9 lifts the valve 5 from its seat in the head 1, and a brief blast of air is discharged through the bore 6 until the spring 7 can again close the valve 5, whereupon another cycle begins.

The lubricant chamber 10 is normally filled with lubricating oil under positive pressure, the bore 21 providing a lubricant port normally connected with other elements of the pressure lubrication system of the loom,

4

conventional in itself and not otherwise illustrated. The moving plunger 12 maintains a lubricant film in the closely fitting bores of the collar 8 and of the end wall 11. Dust unavoidably entering the port 20 even if the latter is provided with an air filter, not shown, is carried with lubricant into the working chamber 9 by the leading edge of the plunger 12, dispersed there in a large excess of air, and harmlessly discharged through the valved bore 6. No solid particles can enter the lubricant film in the bore of the end wall 11 from the atmosphere against the lubricant flow.

The friction of the plunger 12 in the guiding cylinder bores is practically constant. It is changed only by the slow surface wear of the plunger 12 and the cylinder 2. With mating surfaces ground and polished, as is usual in pumps of this type, the wear is very slow, and the metal particles released from the frictionally engaged surfaces are harmlessly carried off by the lubricant. The spring 15 need be adjusted very infrequently to maintain uniform performance of the pump. It is virtually impossible for the plunger 12 to be stuck in the cylinder 2 with a resistance that cannot be overcome by the spring 15, because the plunger engages the cylinder 2 over only a small fraction of its axial length and the corresponding axial length of the chamber 9.

In actual use, pumps substantially identical with that shown in FIGS. 1 and 2 have been found to operate reliably over extended periods at varying temperatures of the ambient atmosphere and of the working parts of the pump. The temperature of the plunger 12 is kept close to ambient temperature by contact of its large exposed surface in the chamber 9 with the pumped air. The surface area of the plunger which is in contact with the pumped air and with the lubricant in the chambers 9, 10 respectively is much greater than the surface area confined within the bores of the collar 8 and of the end wall 11 in most operative positions of the plunger, and is not substantially smaller than the confined surface in the thermally most unfavorable position at the end of the suction stroke shown in FIG. 3.

The pump of the invention illustrated in FIG. 3 differs from the embodiment described in detail hereinabove by a cylinder 2' lacking an intake port, and by a cylinder head 1' having two check valves 5, 5', the latter being biased by a spring 7' to block a second bore 6' in the head 1' during the discharge stroke only, while opening the bore 6' during the intake stroke.

It will be understood that the bores 6 of both illustrated embodiments are normally connected to nozzles positioned to propel a weft thread through the shed of the loom, as is conventional. The volume of the air blast can be adjusted by means of the nut 19, and its velocity by means of the bushing 17 and by suitable selection of the spring 7. The spring 7' need only be strong enough to balance the force of gravity acting on the valve 5'. The lubricant pressure in the chamber 10 should be higher under all operating conditions than ambient atmospheric pressure and is preferably never significantly lower than the maximum pressure prevailing in the working chamber 9 of the pump.

FIG. 3 illustrates only one of the many variations in the pump illustrated in FIGS. 1 and 2 which will readily suggest themselves to those skilled in the art, and which do not materially affect the mode of operation of the apparatus described in more detail, nor the advantages thereof.

I claim:

1. A reciprocating pump comprising, in combination:
 - (a) a cylinder defining a cavity therein and having an axis;
 - (b) a collar having a central bore and axially dividing said cavity into two chambers connected by said bore, the cylinder having an end wall spaced from said collar, said end wall axially bounding one of said chambers and being formed with an axial bore there-through;

5

- (c) a plunger conformingly received in said bores for axial sliding movement, the plunger having a terminal axial end portion exposed in the other one of said chambers and a free axial end portion extending outside said cavity;
- (d) a radial aperture formed in said collar and having a first orifice in said axial bore and a second orifice exterior of said cylinder, said terminal portion of said plunger normally obstructing said first orifice;
- (e) drive means for reciprocating said plunger in said cylinder inward and outward of said other chamber, whereby the contents of said other chamber alternately compressed and expanded and to move said plunger from said other chamber to clear said first orifice for admitting a fluid under suction to other chamber;
- (f) discharge valve means on said cylinder, said discharge valve means being normally closed and opening in response to inward movement of said plunger into said other chamber for releasing fluid from said other chamber; and
- (g) lubricating means for feeding a lubricant to said one chamber.
2. A pump as set forth in claim 1, wherein the area of the surface of said plunger exposed in said chambers in any operating position of said plunger during the reciprocating movement of the same is not substantially smaller than the area of the surface of the plunger simultaneously confined in said bores.
3. A pump as set forth in claim 2, wherein said exposed area is substantially greater than said confined area in at least one of said operating positions of the plunger.
4. A pump as set forth in claim 3, wherein the axial length of said exposed surface is substantially greater than the axial length of the confined surface in said one operating position, said plunger in all operating positions thereof defining in said other chamber an annular space with an inner axial wall of said cylinder.
5. A pump as set forth in claim 4, further comprising a lubricant having a viscosity substantially greater than that of water and filling said annular space, and means for maintaining in said lubricant a pressure higher than atmospheric pressure.
6. A pump as set forth in claim 1, wherein the axial length of each of said chambers is substantially greater than the axial length of said central bore.
7. A reciprocating pump comprising, in combination:
- (a) a cylinder defining a cavity therein and having an axis;
- (b) a collar having a central bore and axially dividing

6

- said cavity into two chambers connected by said bore, the cylinder having an end wall spaced from said collar, said end wall axially bounding one of said chambers and being formed with an axial bore there-through;
- (c) a plunger conformingly received in said bores for axial sliding movement, the plunger having two free axial end portions respectively exposed in the other one of said chambers and outside said cavity;
- (d) drive means for reciprocating said plunger in said cylinder inward and outward of said other chamber, whereby the contents of said other chamber are alternately compressed and expanded, said drive means including a drive member, a spring biasing said plunger inward of said other chamber, means for continuously rotating said drive member, and motion transmitting means interposed between said drive member and said plunger for cyclically moving said plunger outward of said other chamber against the restraint of said spring, and for thereby stressing said spring, for thereafter releasing said plunger for movement inward of said other chamber under the force of said spring, when said drive member is rotated;
- (e) suction valve means on said cylinder, said valve means being normally closed and opening in response to outward movement of said plunger from said other chamber for admitting a fluid to said other chamber;
- (f) discharge valve means on said cylinder, said discharge valve means being normally closed and opening in response to inward movement of said plunger into said other chamber for releasing fluid from other chamber; and
- (g) lubricating means for feeding a lubricant to said one chamber.

References Cited

UNITED STATES PATENTS

Re. 25,849	9/1965	Smith	103—213
1,864,195	6/1932	Holl	103—213

FOREIGN PATENTS

796,608	1/1936	France	103—153
390,226	7/1965	Switzerland	103—153
154,244	4/1956	Sweden	103—153

HENRY F. RADUAZO, Primary Examiner

U.S. Cl. X.R.

92—153, 138; 417—493