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(54) Motor piston compressor unit.

(57) A motor-compressor set (1) has a compressor crank case (4) containing two, opposed and rigidly connected piston heads (23 and 24). Each has a central poppet valve whose disc (33) occupies most of the area of the piston. The rim of the piston has a flexible seal (32) which does not require lubrication and seals against the piston wall during the piston's compression stroke, and allows air to flow past the piston during the aspiration close when the piston poppet valve is also open. The compressor is driven by an electric motor 2 having its stator (6) keyed to the crank-case wall and cooled by separate air flow paths provided by two fans (14, 16) leading to a common discharge orifice (15). The set has a high efficiency and is capable of providing non-polluted compressed air at pressures up to 150 p.s.i. Because it is light, it is also readily portable.

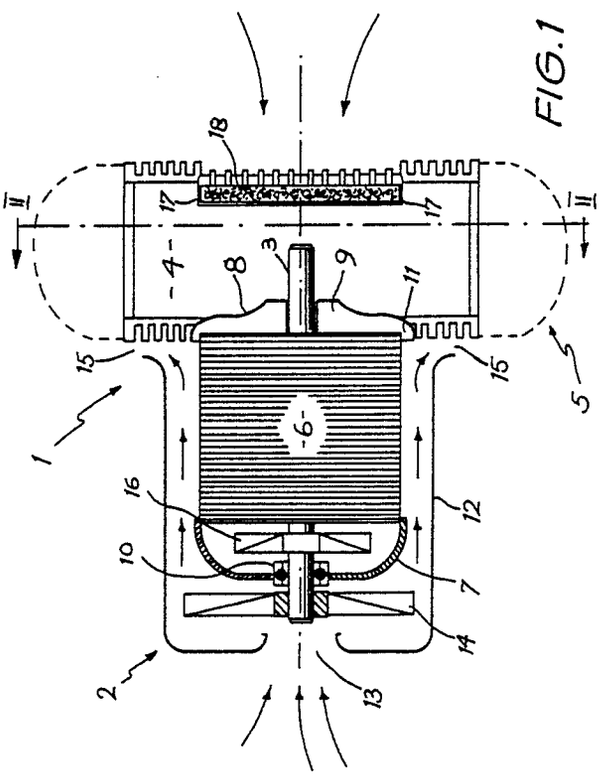

FIG.1

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FIELD OF THE INVENTION

THIS INVENTION relates to a motor-compressor set sufficiently small and light to be capable of being carried by one person, and able to provide clean compressed air at a pressure of up to 1000 Kpa.

There are many applications for a motor-compressor set of the above kind. One of them is the provision of compressed air for pneumatically-operated tools. The compressed air supplied must be clean in the sense of being free from dust and oil vapour. It should also not be at an elevated temperature.

STATE OF THE ART

Compressor technology is nowadays at a sophisticated level. However, many compressors are static installations or rely on oil lubrication for their operation. This prevents them being applied in the many fields of the present invention which calls for a light, relatively efficient source of clean cool compressed air.

OBJECT OF THE INVENTION

An object of this invention is the provision of an improved motor-compressor set.

THE INVENTION

In accordance with the present invention a motor-compressor set for supplying a stream of cool, compressed air at pressures up to 1000 Kpa and uncontaminated by dust or oil, comprises a compressor crank-case having two central apertures one of which is screened by an inlet air filter and the other of which supports one end of a stator of an electric motor which has its drive shaft extending into the crank-case to a mechanism which converts rotational movement of the rotor into reciprocation of two aligned and rigidly connected, opposed piston heads working in respective cylinders disposed on diametrically-opposite sides of the motor shaft, each piston being surrounded by a flexible, friction-resistant sealing washer which seals against the cylinder during the compression stroke of the piston but allows air to flow past it during the aspiration stroke of the piston, the major part of the area of the piston being occupied by a disc closure of a poppet valve mounted in the piston head and which opens during the aspiration stoke of the piston, to allow parallel streams of air from the central zone of the crank-case to flow respectively past the piston head and through the valve into the cylinder chamber; and, a second poppet valve, mounted in the crank-case, has its closure disc opposite and parallel to the piston valve closure disc and is arranged to open during the compression stoke to allow compressed air to flow to a discharge outlet, and to close during the aspiration stoke so that air enters the chamber from the central zone of the crankcase.

ADVANTAGES OF THE INVENTION

The above invention relies on a combination of features which, together give the motor-compressor set the sought-for characteristics. The mounting of the motor stator in one end of the crank-case reduces the weight and size of the set, while increasing its rigidity and robustness. It also assists cooling of the motor by the crank-case providing a heat sump for the motor stator at one end. The large air inlet ensures a minimum air pressure drop for air entering the crank-case, and the use of a filter ensures that dust is filtered from the incoming air. Once the air is inside the central zone of the crank-case, it flows past and through the aspirating piston head. The two parallel paths provided by the open poppet valve in the piston head and the annular orifice provided around its periphery, ensure there is a relatively small pressure drop past the piston during the aspiration stoke so that little work is done in pumping air into the cylinder before the next compression stroke. This reduces the power losses in operating the compressor and enables a smaller, and therefore lighter motor to be used. Also the flow of air past the piston head during the aspiration stoke maintains the lining of the cylinder cool which reduces wear on the sealing washer during the subsequent compression stroke.

During the compression stroke the crank-case poppet valve opens providing a large annular orifice through which air is pumped from the cylinder. As the discs of the poppet valves at each end of the crank-case are very close to one another at the top dead-centre position of the piston head, almost all the air is driven from the cylinder during the compression stoke and the large outlet orifice, provided by the edge of the crank-case valve disc, minimises the pressure drop at this point to improve still further the efficiency of the motor-compressed set.

PREFERRED FEATURES OF THE INVENTION

Preferably each of the rims of the poppet valves is of frusto-conical shape and seals against a complementary sealing surface when the valve is closed. This produces a large orifice through the open valve defined between the two opposed frusto-conical surfaces which separate during opening movement of the poppet valve.

Conveniently the motor cooling circuit provides two separate streams of cooling air. One stream flows around the outside of the stator and out through an orifice adjacent the crank-case. The other stream is sucked from the interior of the crank-case by a second fan on the motor shaft, and flows via the rotor-stator gap to the fan which directs it through holes in the stator laminations opening into the outlet orifice adjacent the crank-case. The two streams merge in the orifice and may be directed past cooling fins on the crank-case to maintain the outsides of the cylinders cool.

INTRODUCTION TO THE DRAWINGS

The invention will now be described in more detail, by way of examples, with reference to the accompanying partly-diagrammatic drawings, in which:-

FIGURE 1 is a side elevation, partly in section, of a motor-compressor set, a piston assembly used in the compressor being omitted.

FIGURE 2 is an end-elevation, partly in section and partly broken-away, of the compressor with the piston assembly in position, as viewed in the direction of the arrow 'A' in figure 1.

FIGURE 3 shows in perspective, an alternative arrangement of piston assembly together with its drive mechanism which is shown in exploded form.

FIGURE 4 shows in section a piston head used in the assembly of figure 3;

FIGURE 5 is a perspective and partially broken away view of a second form of drive mechanism for the piston assembly.

FIGURE 6 is a side elevation of the motor compressor set;

FIGURE 7 is an end elevation; and

FIGURE 8 is the other end elevation.

DESCRIPTION OF PREFERRED EMBODIMENT

Figure 1 shows a motor-compressor set 1 driven by an electric motor 2 having drive shaft 3 which extends into a crank-case 4 of an air compressor 5. The compressor 5 is designed to provide 5 1/Sec of clean air per minute, unpolluted by oil vapour or droplets, up to a pressure of 1000Kpa per square inch. The motor is a 1120 watt electric motor having a shaft drive speed of 1428 revolutions per minute. The compression ratio of the compressor is six to one. The total weight of the unit is currently 22kg and its dimensions are: length 350 mm; width 200 mm; height 370 mm.

The motor is designed to be portable and may be provided with a handle (not shown).

The shaft 3 carries a rotor (not shown) mounted within a laminated stator 6 held in position by being keyed at one end into a central circular aperture 11 provided centrally in one wall of the crank-case 4. End covers 7 and 8 are respectively provided at opposite ends of the stator 6 and support bearings for the shaft 3. One of these bearings is shown at 10.

The stator 6 is mounted within a cowl 12 attached to the crank-case and containing an air entry 13 at one end through which air is sucked by a first fan 14 attached to one end-portion of the shaft 3 protruding through the cover 7. This fan drives air around the outside of the stator laminations to maintain them cool, the air discharging through an annular outlet orifice formed between the outside of the crank case and the adjacent end of the cowl 12.

The shaft 3 carries a second fan 16 inside the cover 7 and which draws air from the interior of the crank-case 4 by way of a central opening 9 in the cover 8 and the rotor-stator gap of the motor. The fan 16 forces the air through axially extending holes (not shown) in the stator which open outwardly into the discharge orifice 15. The air discharged from the orifice 15 flows past cooling fins on the outside of the crank-case to assist its cooling, as shown.

The crank-case 4 is formed, diametrically opposite the motor cover 8, with a second central circular aperture 17 containing a removable air filter 18 through which air enters the interior of the crank-case 4.

As shown in figure 2, the crank-case 4 provides two lineraly opposed co-axial cylinders 20, 21. A piston assembly 22 has at its opposite ends respective piston heads 23, 24 which reciprocate in the cylinders, respectively, and are interconnected by an articulated frame 25. A mechanism driven by the shaft 3 reciprocates the frame in the direction of the axis of the cylinders.

The mechanism for converting the rotational movement of the shaft 3 into reciprocating movement of the pistons comprises an eccentric crank 26 mounted on the end of the shaft 3 and fitting within a ball-race 27. The outside of the race 27 is formed by a big end 28 of a connecting rod 30 which is connected at its little end by a transverse gudgeon pin 31 to the frame 25. Rotation of the

shaft 3 reciprocates the rod 30 back and forth, and this movement is transferred by the gudgeon pin 31 to the frame 26 and piston heads. The gudgeon pin 31 is able to rotate about its axis to accommodate the sideways throw of the big end 28 on the crank 26.

The rims of the piston heads 23, 24 are spaced radially inwardly of the inside walls of the cylinders and each is provided with a radially-flexible, friction-resistant, annular cup washer 32 made from a reinforced plastics material of high thermal capacity and available in Australa under the Trade Mark UNASCO 808. The washer 32 has a 'feathered' upper edge. The washer 32 slides against the inside wall of the cylinder which is case hardened by anodising and "Teflon" coated, to make an air-tight seal therewith during the compression stroke of the piston.

During the following aspiration stoke, the washer lies against the side rim of the piston to leave an annular orifice through which air from the central zone of the crank-case can flow into the cylinder. This air flow assists cooling of the cylinder walls which is important as no lubricating oil is used, and too high a temperature of the cylinder lining could soften and damage the washer 32.

The bulk of the area of the piston head 23 is formed by a closure disc 33 of a poppet valve. The valve has a stem 34 which passes through a gland 35 in the piston head. The piston head is provided with a set of through ports, not shown, arranged around the gland 35 and beneath the poppet disc 33. A nut 36 screwed onto the underside of the stem 34, limits its movement in the valve-opening direction. The edge of the disc 33 is bevelled and mates with a complementary bevelled valve seat provided in the piston, when the valve is closed. The compression of the air in the cylinder during the compression stroke of the piston head 23 holds the valve closed. During the aspiration stoke the poppet valve opens to allow air to flow through the valve ports and peripheral orifice of the valve, into the compression chamber of the cylinder.

The ends of the crank-case are closed by cylinder heads 40, 41. Each contains a poppet valve 42 having a closure disc 43 provided with a bevelled edge, and a stem 44 which passes through a gland 45. The movement of the disc in the valveopening direction is limited by a nut 47 on the stem 44.

The marginal edge of the disc 43 is bevelled to provide it with a frusto-conical peripheral edge. An annular air-outlet orifice in the cylinder head 40 is formed between the edge of the disc and a complementary frusto-conical seat 50 formed in the head 40. This orifice is closed and opened by the movement of the poppet valve, and provides a compressed air outlet of relatively large cross-section and therefore relatively little impedance. The outlet leads to a compressed air discharge connector 51.

As is apparent from figure 2, the piston head 23 and the opposite face of the disc 43 almost touch one another when the piston head is in its top dead-centre postion. This ensures that almost all of the compressed air in the cylinder is discharged through the discharge connection 51. The cylinders 20, 21 are lined preferably with hardened aluminium and the sealing washers 32 on the piston heads are made preferably from a reinforced plastics material and which is relatively friction-resistant. This does not need lubrication when running on hardened aluminium.

DESCRIPTION OF FIRST MODIFICATION

Figures 3 and 4 show a modification of the piston assembly used in the crank case 4. Here the rotational drive of the motor shaft 3 is converted into reciprocating movement of the piston heads by a mechanism which comprises a balanced eccentric 55 to which is bolted a ball race 56 seating inside one part of a two-part slider, 57, 58. The piston assembly comprises a flattened bar 60 having a piston head 61 at each end. A rectangular slot 62 extends through the centre of the bar 60 and a plastics cylindrical surface 63 on the slider, having a low co-efficient of friction, is shaped to it within but being slidable along the slot by having its outside diameter substantially equal to the width of the slot 62.

In an unillustrated improvement of the aforesaid slide system, which has exhibited some side play and therefore noise, there is provided a system of two cylindrical slide rails, mounted within slot 62. The end bearing is cast into the frame and this allows ball race 52 to be replaced by a solid pin. In this improvement the slide block is made simply as a cube, and the system decreases wear rates due to the otherwise unfavourable angle of approach of the crank pin to the slide sides.

Figure 4 shows one of the pistons 61. Its rim is provided with a flexible sealing washer 64 corresponding in function to the sealing washer 32 shown in figure 2. The ends of the bar 60 are formed with rectangular windows 66 from each of which an annular bush 67 extends through the end of the adjacent piston head 61. A stem 68 of a poppet valve 69 is slidable axially in the bush 67 and its movement in the valve-opening direction is limited by a nut 70 located in the window 66. A closure disc 71 on the poppet valve 69 has a bevelled edge 72 which seals against a complementary frusto-conical seat on the piston head

when the valve is closed. Four ports 73 allow air to pass through the piston head 61 from the interior of the crank-case 4 and into a cavity 75 located between the valve disc 71 and the piston 61.

DESCRIPTION OF SECOND MODIFICATION

Figure 5 shows an alternative mechanism to that shown in figure 2 for reciprocating the piston assembly. Parts corresponding in function to similar parts of figure 2, are correspondingly referenced but in the hundred series. The distinction between the mechanisms shown in figures 2 and 5 is that the latter mechanism uses an eccentric disc keyed to the motor shaft 3, to drive the connecting rod of the piston assembly, instead of the crank 26. Also, the sides of the frame 125 are provided with respective aligned and parallel slots which allows the shaft 3 to pass through the frame 125 while it is reciprocating. The piston heads are not shown in figure 5 but are attached to opposite ends of the frame 125 and the stems of their poppet valves (also not shown) pass through the hole 101 provided at each end of the frame 125.

OPERATION OF THE EMBODIMENTS

In all the embodiments described, the rotational drive of the electric motor is converted into a reciprocating drive by a mechanism inside the crank-case and used to reciprocate the piston assembly. Air is continuously drawn in through the filter 18 and flows in two streams respectively past and through the piston head performing its aspiration stroke. The low pressure prevailing in the cylinder chamber at this time holds the outlet poppet valve closed. A second part of the air stream entering the crank case flows through the orifice 9 and around the rotor before being discharged via the orifice 15 to atmosphere.

During the ensuing compresson stroke, the piston head poppet valve closes and the cylinder head poppet valve opens. The sealing washer around the piston head expands to seal against the cylinder wall so that virtually all of the air trapped in the cylinder chamber is pumped out through the discharge connector 51.

The motor is maintained cool during its operation, partly by the air sucked from within the crank-case, and partly by the second stream of air circulated around the outside of the stator 6 by the fan 14. Cooling of the crank-case is effected by the flows of air from the orifice 15 on the outside, and travelling past the outsides of the piston heads during their aspiration strokes.

A typical motor-compressor set constructed as described with reference to figures 1 and 2 of the drawings gives a theoretical efficiency of 70%.

Finally, Figures 6, 7 and 8 illustrate the external appearance of the motor-compressor set, generally referenced as in Figures 1 and 2. The set has a carrying handle 76 and is mounted on feet 77.

From the abovegoing it will be appreciated by those skilled in the art that numerous variations and modifications may be made to the invention without departing from the spirit and scope thereof as set out in the following claims.

Claims

1. A motor-compressor set for supplying a stream of cool, compressed air at pressures up to 150 p.s.i. and uncontaminated by dust or oil, comprising a compressor crank-case having two central apertures one of which is screened by an inlet air filter and the other of which supports one end of a stator of an electric motor which has its drive shaft extending into the crank-case to a mechanism which converts rotational movement of the motor rotor into reciprocation of two aligned and rigidly connected, opposed, piston heads working in respective cylinders disposed on diametrically-opposite sides of the motor shaft, each piston being surrounded by a flexible, fricton-resistant sealing washer which seals against the cylinder during the compression stroke of the piston but allows air to flow past it during the aspiration stroke of the piston, the major part of the area of the piston being occupied by a disc closure of a poppet valve mounted in the piston head and which opens during the aspiration stroke of the piston, to allow parallel streams of air from the central zone of the crank-case to flow respectively past the piston head and through the valve into the cylinder chamber; and, a second poppet valve, mounted in the crank-case, has its closure disc opposite and parallel to the piston valve closure disc and is arranged to open during the compression stroke to allow compressed air to flow to a discharge outlet, and to close during the aspiration stroke so that air enters the chamber from the central zone of the crank-case.

2. A set as claimed in claim 1, in which the two central apertures are arranged opposite one another.

3. A set as claimed in claim 1 or in which the stator is spaced within a cowl having an air intake at one end and an air discharge orifice at the other end, and one end of the rotor shaft carries two fans which respectively pump cooling air to the discharge orifice along separate air flow paths, one of the air flow paths extending around the outside of the stator from an air inlet at one end of the

cowl, and the other air flow path extending from the central zone of the crank case to the orifice and including the rotor-stator gap and axially extending through-passages formed in the stator.

4. A set as claimed in claim 1, in which the poppet valves have frusto-conical rims which seal against complementary frusto-conical surfaces provided on each piston head and the crank-case respectively when the valves are closed, and opening of the valves spaces the frusto-conical rims and surfaces from one another so that the valve orifices is provided around the rims of the poppet valves.

5. A set as claimed in claim 1, in which the piston washers are made of a reinforced plastics material of high thermal capacity, and the lining of the cylinders is made from hardened aluminium.

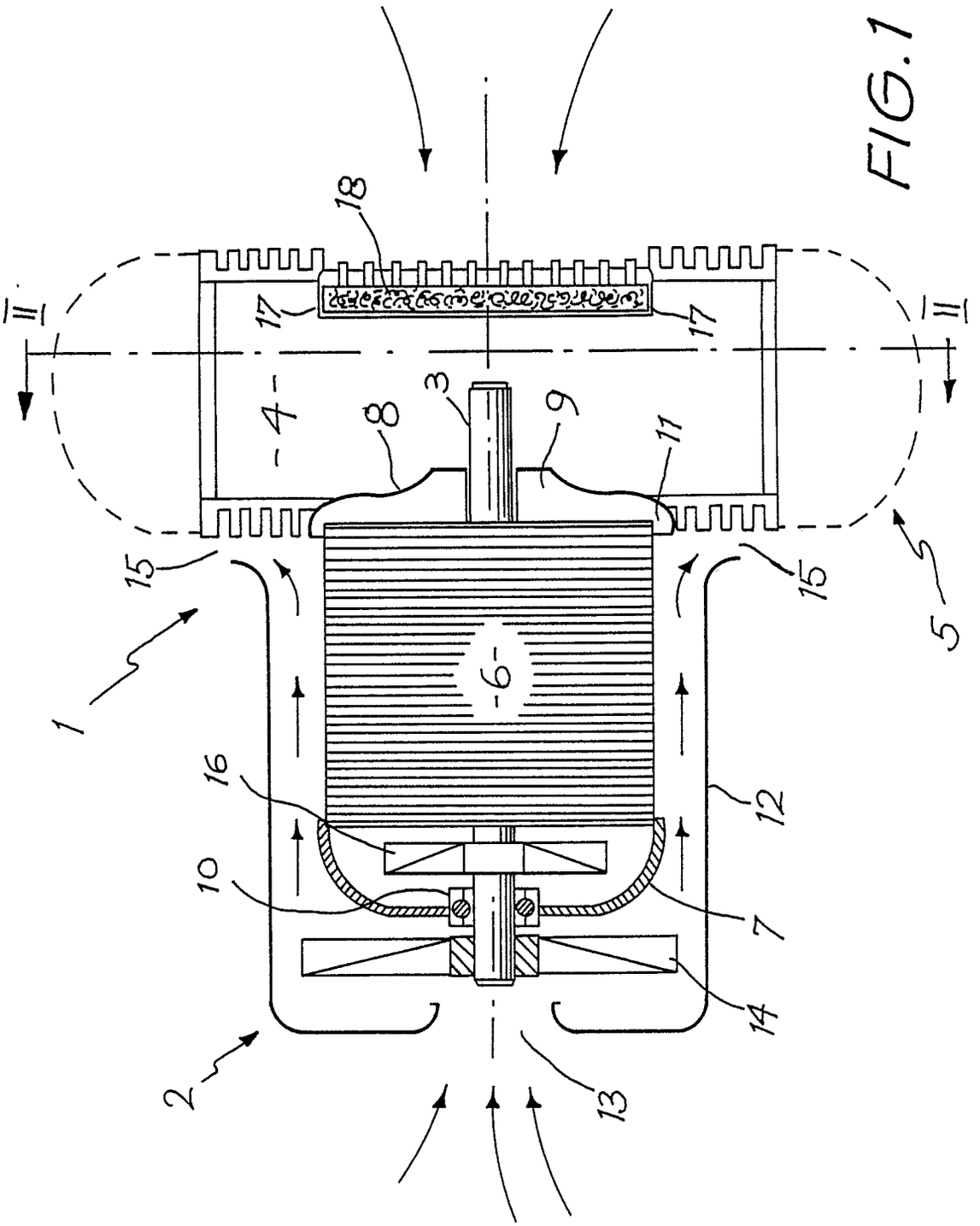


FIG.1

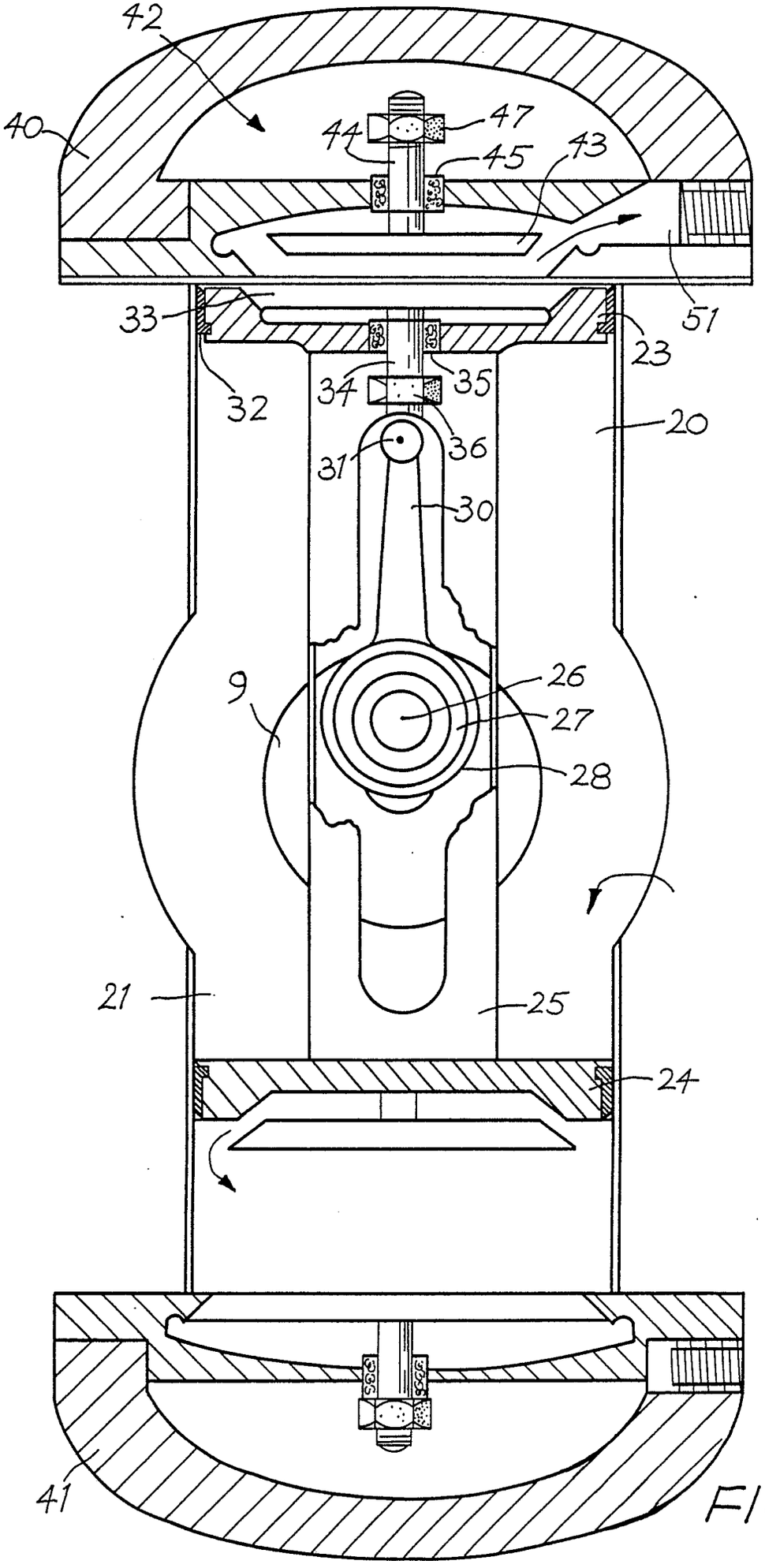
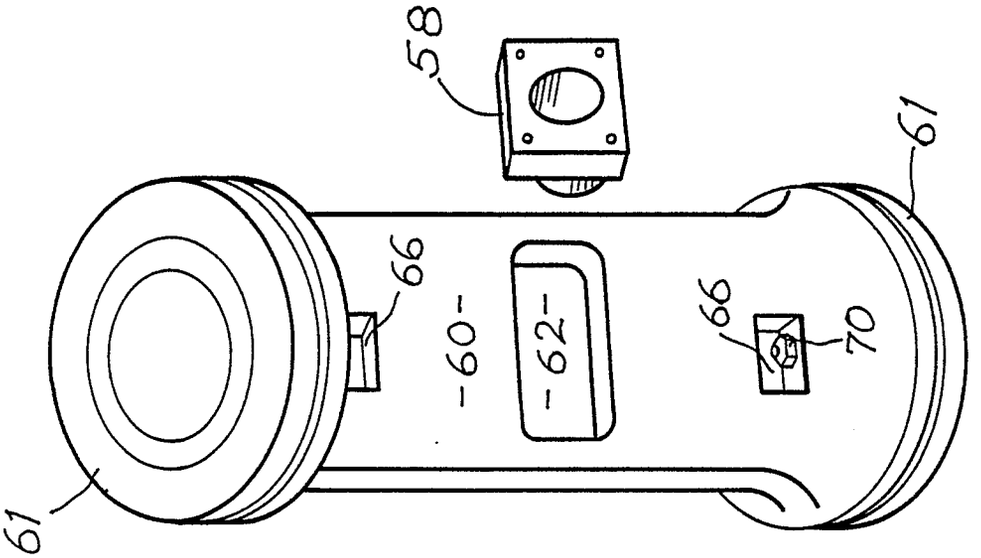


FIG. 2



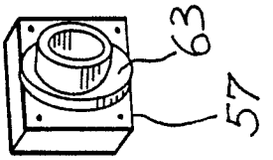
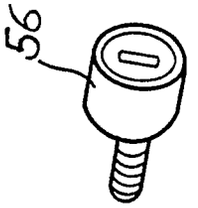
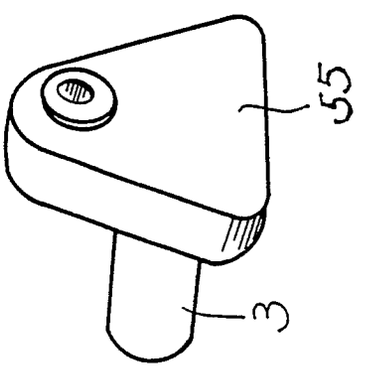


FIG.3





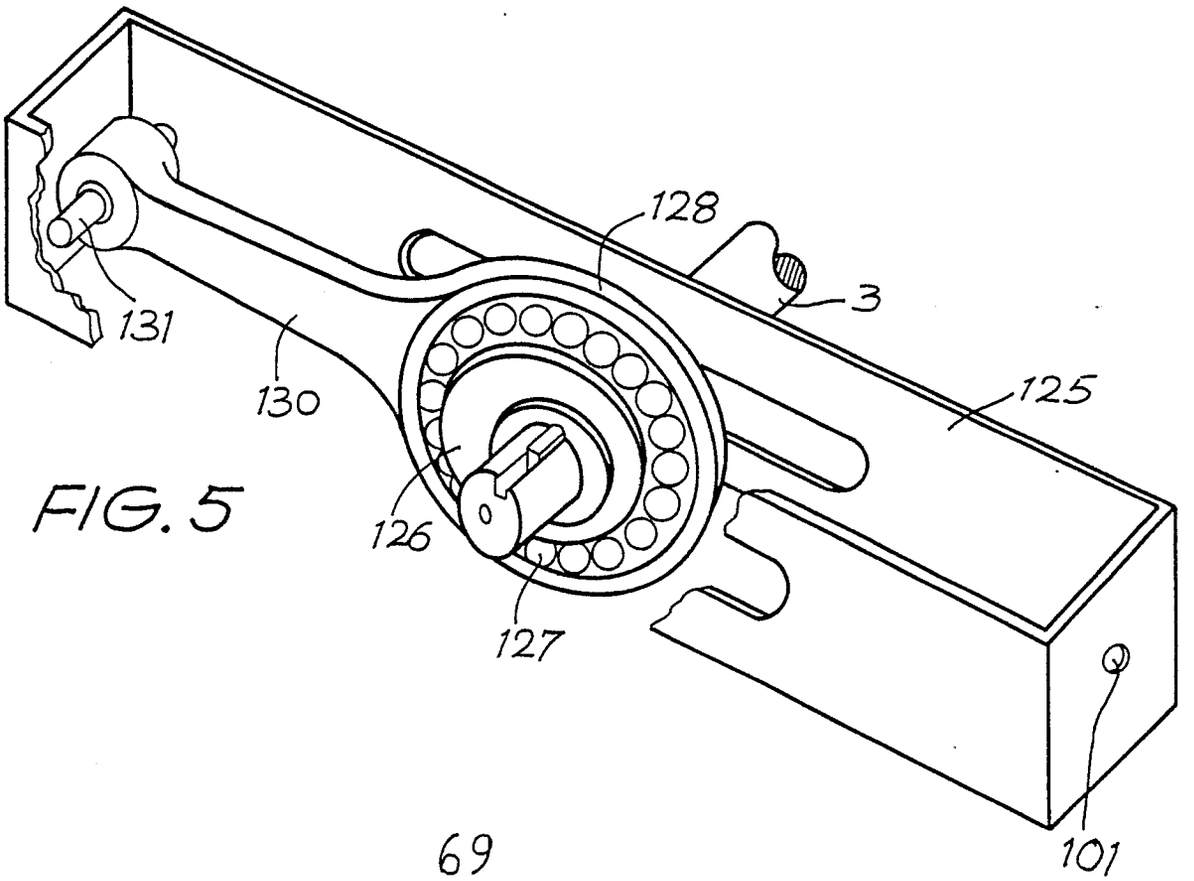


FIG. 5

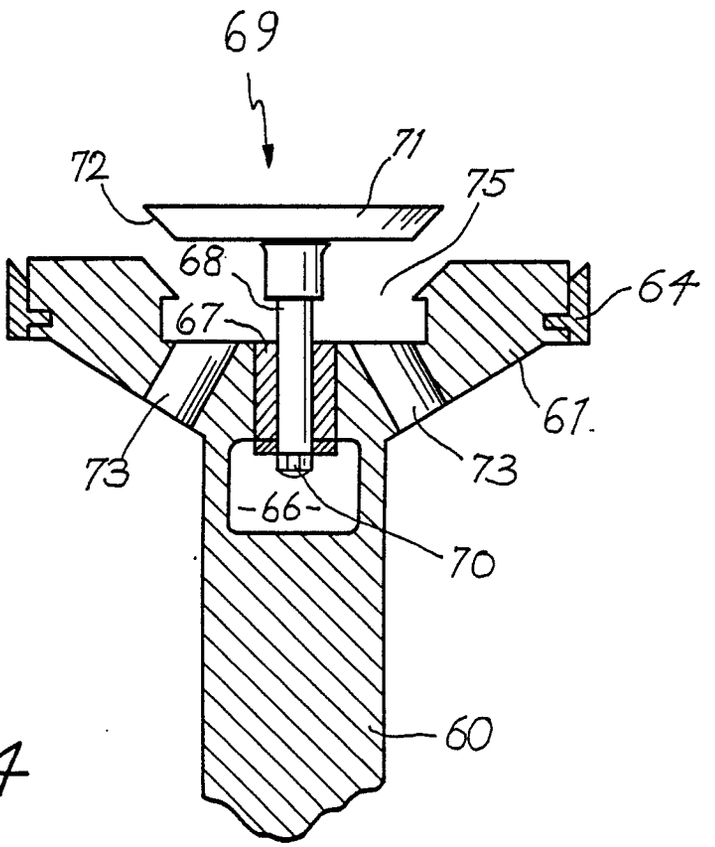


FIG. 4

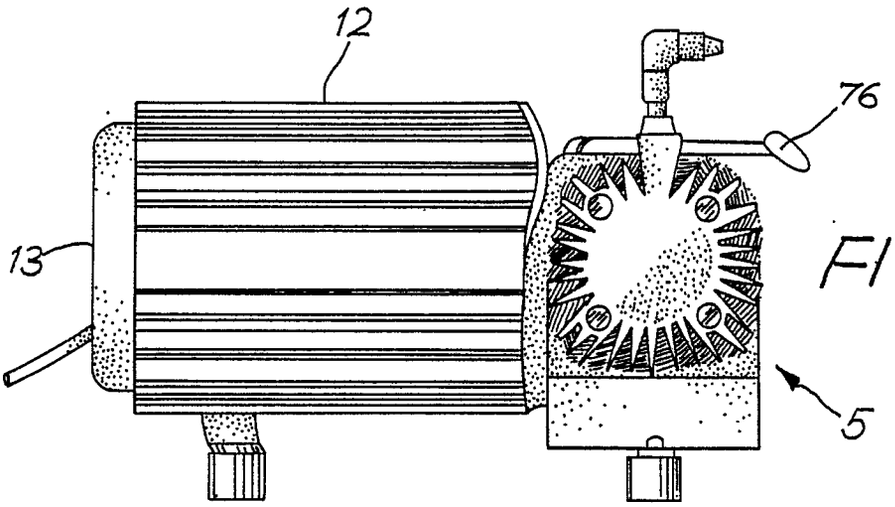


FIG. 6

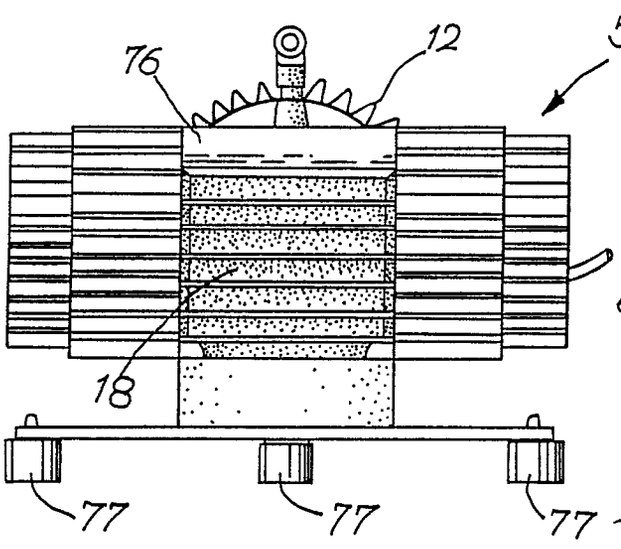


FIG. 7

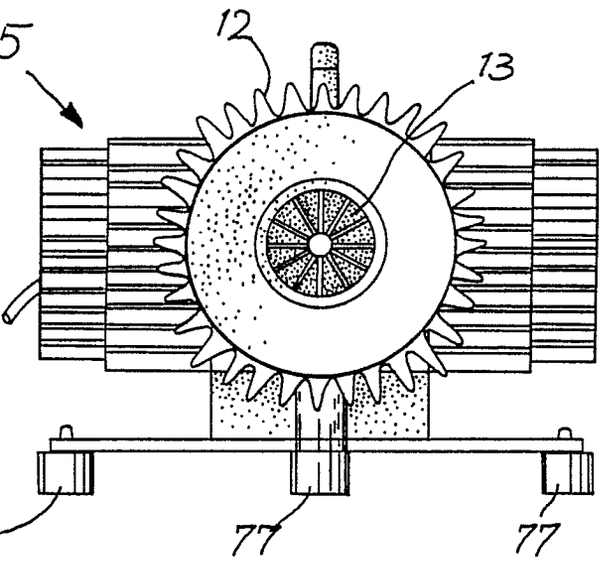


FIG. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 87850245.9

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	WO - A1 - 83/03 640 (THE SCOTT & FETZER) * Totality; especially fig. 3,5 * --	1,2,3	F 04 B 35/04 F 04 B 27/02
A	DE - A1 - 2 821 389 (GRILLINI) * Totality; especially claims; fig. 1 * --	1	
A	DE - A1 - 3 211 318 (GRENCO) * Totality; especially fig. 4,5,6 * --	1,3	
A	US - A - 1 295 529 (LAWHEAD) * Totality; especially fig. 4 * --	1,4	
A	DE - C - 817 013 (BAYER) * Totality; especially page 1, lines 1-19 * --	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4) F 04 B 9/00 F 04 B 21/00 F 04 B 27/00 F 04 B 35/00 F 04 B 39/00 F 04 B 41/00
A	US - A - 4 190 402 (MEECE) * Totality * --	3	
A	EP - A2 - 0 127 585 (AIREL) * Totality * ----	1,3	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	08-03-1988	WERDECKER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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