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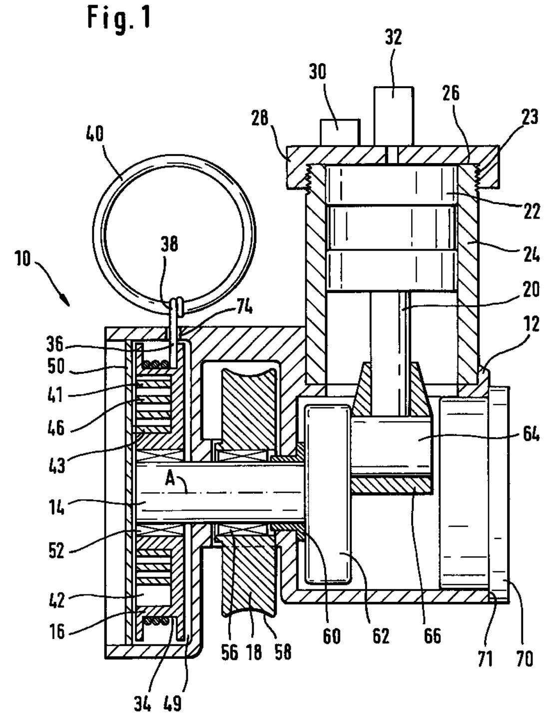
(54) Dual drive compressor

(57) Described is a compressor (10) for compressing gaseous fluids such as air which is adapted to be driven periodically via a rope pulley (16) through pulling on a rope (36) or alternatively is adapted to be driven continuously via a disc or wheel-shaped rotatable body (18). A drive shaft (14) is connected via two overrunning clutches (52, 56) to the rope pulley (16) or the rotating body (18) and the rope (36) can be rapidly rewound by means of a spring actuator. The drive through rotating body (18) enables the use of the compressor (10) with a bicycle, in which the rotating body (18) is frictionally coupled to a tire, in order to fill a compressed air storage container which can subsequently be used, e.g. for pumping up bicycle tires.

Fig. 1



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Description

The invention relates to a compressor in accordance with the preamble of claim 1.

Apparatus for compressing gaseous fluids such as air in enclosed spaces or containers (e.g. balls, vehicle tires) or for removing gaseous fluids such as air from an enclosed space e.g. for creation of a vacuum, work mostly with displacement bodies which either move back and forth (a piston compressor) or rotate (rotating piston compressor) and in so doing are able to withdraw gaseous fluid from a space or force it into a space.

The known compressors normally have as their drive an electric or combustion engine. Their utilization is therefore necessarily dependent on the availability of a power source such as electrical current or fuel for operating the engine. The engine makes the compressor more expensive and makes its utilization dependent on the availability of the power source.

Such problems are avoided if the compressor is driven with muscle power. Examples of this are a bicycle pump and a hand or foot pump to pump up automobile tires. In these a piston equipped with piston rings is moved back and forth within a cylinder, the piston being firmly attached to a rod at whose end a handle or a pedal is mounted. In most cases the cylinder and the piston are made of metal or a plastic, the piston rings are normally made of a polymer compound. The fluid control takes place by means of a simple check- or hand valve.

A muscle-power driven compressor of the known bicycle pump type can indeed be operated without power source, but has the disadvantage that the efficiency and the performance, i.e., the achievable pressure, is relatively low. Connection of such a compressor to an existing mechanical energy source is scarcely possible, because it normally delivers this energy through a rotating shaft and because this rotational movement cannot he used directly for the known hand and foot pumps. Because the force to be applied at a predetermined pressure is proportional to the face area of the piston, this face area is limited in its size. In order to nevertheless be able to displace the largest possible quantity of fluid with a single movement, the cylinders would have to be made relatively large and thereby would make the hand or foot pump impractical. A complete stroke movement cannot be made rapidly because of the great stroke length and, for piston seals or valves which do not operate without leakage loss, a portion of the fluid to be compressed can escape into the ambient even during the compression process. For these reasons the known hand or foot pumps are so limited in their efficiency and performance that pressures of up to 10 bar cannot be generated so that they are unsuitable, for example, for pumping up racing bicycle tires.

The object of the invention is to provide a practical compressor, which is usable independently of an engine having a special power source and is suitable for generation of high pressures.

This object is accomplished in accordance with the invention by the characterizing portions of Claim 1.

The compressor according to the invention can be driven either periodically by muscle power or continuously by mechanical drive and makes it possible to achieve high pressures and a high compression performance with low force application.

If the displacement body of the compressor according to the invention is a piston which is moveable back and forth via the drive shaft and a connecting rod inside a cylinder in the manner known for reciprocating piston compressors, then during each rotation of the rope pulley the working space is filled precisely once and the fluid is compressed in the compression stroke. The number of possible compression strokes from a single pull at a free rope end depends only upon the number of turns of the rope around the rope pulley. If the drive shaft has once been set into rotation, the first overrunning clutch between rope pulley and drive shaft prevents additional rope from being unwound from the rope pulley, simply by virtue of the mass inertia of the moving parts or that rope is again wound up in the opposite direction after complete unwinding. If the compressor takes the form of rotating piston compressor or Roots compressor, then the rotational inertia moment of the moving parts is generally greater, relative to its form as a reciprocating piston compressor and the first overrunning clutch is therefore all the more necessary.

By the addition of the disc- or wheel shaped rotary body, which can be coupled to the drive shaft via the second overrunning clutch, the invention makes it possible to cause the drive shaft to be set into continuous rotation by a mechanical drive. The compressor can therefore not only simply be driven manually, but can also be simply connected to an engine shaft or a wheel. Overrunning clutches of the above described kind are known in themselves, cf German magazine: dhf 12/68 issue, F. Dahmen: Freewheel clutches -- method of operation, design, and possibilities of application pp. 64-69.

Thus the compressor according to the invention is equipped with a dual drive and enables the achievement of high pressures both with manual and with mechanical drive. The compressor according to the invention is therefore usable where known manual compressors such as hand or foot pumps are not adequate because of too low performance. The utilization of a dual drive in an apparatus for pumping up pneumatic tires of bicycles, automobiles, etc. is known in itself, see, for example, Swiss Patent 103362, but not in conjunction with the drive for a compressor via two overrunning clutches, either of which can be utilized.

Advantageous embodiments of the invention are the subjects of the dependent claims.

If in an embodiment of the invention a rope pulley and a housing of the compressor are connected to each other by spring actuator, then the rope unwound through manual pull on the rope end can be rolled up again on the rope pulley by the spring actuator which causes the rope pulley to rotate in the opposite direction. Because the rope pulley is then decoupled from the drive shaft by means of the first overrunning clutch, even a relatively small spring actuator can rewind the rope rapidly on the rope pulley. Thus the time delay between two manual pulls on the free rope end for compressing a fluid can be kept relatively short.

If in a further embodiment of the invention the spring actuator uses a spiral spring, one end of which is connected to the rope pulley and the other end to a housing for the compressor, the spring actuator can be integrated into the rope pulley in space saving manner. The spiral spring can simply be connected at its ends to the rope pulley and the housing, respectively, the wound-up form of the spiral spring making it possible to achieve a plurality of rotations during spring excursion, without the spring force varying much throughout the spring excursion.

If in a further embodiment of the invention the rotating body is a friction roller, then the compressor can be simply driven by pressing the friction roller against a rotating wheel or a rotating shaft.

If in a further embodiment of the invention the rotating body is a spur gear, then the compressor can be simply driven by engaging with it a worm gear on a rotating shaft or by driving the spur gear by means of a chain which can be driven via pedals similarly to a bicycle.

If in a further embodiment of the invention there is provided a holder serving as a stop for holding the compressor in position, which can, for example, be attached to the housing of the compressor, then the compressor can be held in place, for example, by a foot while the free rope end is pulled with one hand.

If in a further embodiment of the invention the free end of the rope is provided with a handle, then the pull on the rope end required for compression can be achieved simply and comfortably with one hand.

If in a further embodiment of the invention the compressor produces high pressure air and the compressor is of small size and an adjustable pressure limiting device is located between the compressor and a compressed air consumer, then the compressor can be comfortably transported and applied anywhere where highly compressed air is needed, with the adjustable pressure limiting device preventing the pressure in the compressed air consumer from exceeding a desired value.

If in a further embodiment of the invention there is provided, as the pressure limiting device, dead space of adjustable size inside the compressor, then the pressure limiting device can be provided simply and reliably. For a given dead space of the compressor a malfunction of the pressure limiting device, in the sense that the actual pressure can exceed the desired pressure, is impossible.

If in a further embodiment of the invention an adjustable pressure relief valve is provided as the pressure limiting device, then there can be used as pressure limiting device an inexpensive standard component which is of compact construction and can be easily connected to the cylinder or a cylinder head.

If in a further embodiment of the invention the holder is a swivel bracket for pivotable attachment of the compressor to the frame of a bicycle, then the compressor can be simply driven by its inward pivoting and by a wheel of the bicycle, most conveniently, for example, during downhill travel of the bicycle.

If in a further embodiment of the invention the compressed air consumer is a tire of a bicycle or a compressed air storage container attached to the frame of the bicycle, then the tire of the stationary bicycle can be pumped up by pulling on the handle or, during downhill travel of the bicycle, the compressed air storage container can be filled without exertion by the cyclist on the bicycle and then the compressed air can be used later to pump up the tire.

Exemplary embodiments of the invention are described more fully in what follows with reference to the drawings. There is shown in

- Fig. 1 a cross-sectional view of a compressor according to the invention in the form of a reciprocating piston compressor,
- Fig. 2 a cross-sectional view of a compressor like that in Fig. 1, but here held in place via a holder by means of a shoe and to whose discharge a compressed air conduit is attached which is connected to a bicycle tire,
- Fig. 3 a front view of a bicycle with a compressor which is connected to the bicycle by a swivel device and whose output is connected by a compressed air conduit to a compressed air storage container on the bicycle, and
- Fig. 4 the use of the compressor according to the invention in a refrigerating plant.

In Fig. 1 there is shown a compressor for gaseous fluids collectively designated as **10**, in a preferred embodiment as a reciprocating piston compressor, which is provided with a crankcase **12** and a drive shaft **14** journaled in the crankcase **12** which can be driven optionally either via a rope pulley **16** or a friction roller **18** and which is connected via a connecting rod **20** with a piston **22** which is moveable back and forth in a cylinder **24** by rotation of the drive shaft **14**. At the head end **26** of cylinder **24** opposite drive shaft **14** a cylinder head **28** is attached on which there is mounted an intake valve **30** and a discharge valve **32**.

On rope pulley **16** a rope **36** is wound up in a groove **34** on the circumference of the rope pulley **16**, with a first, free rope end **38** connected to a handle **40** shaped as a ring and with a second rope end attached to the rope pulley **16**. In a recess **42** in a lateral surface of the rope pulley **16** a spiral spring **46** is wound up, with a first end **41** firmly attached to the rope pulley **16** and a second end **43** via a lid **50** to the crankcase **12**. The rope pulley **16** and the friction roller **18** are connected to the drive shaft **14** by overrunning clutches **52** and **56**, respectively. When the drive shaft **14** is driven by the rope **36**, the friction roller **18** freewheels with it. The friction roller **18** can exert its drive force only in a single direction because in the opposite rotating direction of the friction roller **18** its overrunning clutch becomes effective. The overrunning clutches are so-called ratchet brakes or sleeve clutches of known type.

The peripheral surface **58** of friction roller **18** is concavely curved in order to assure a large contact area, for example when laid against a bicycle tire. A sleeve bearing **60** in the form of a T-bushing for the rotatable bearing of drive shaft **14** is mounted in crankcase **12** and bears with a head end against a crank arm of drive shaft **14**. A crank pin **64** is connected to crank arm **62** of drive shaft **14** eccentrically with respect to the axis **A** of the crank shaft **14**. Rotatably seated on crank pin **64** is a connecting rod end **66** in the form of an eye. The connecting rod end **66** is shrink fitted onto the connecting rod, but the connecting rod end **66** can also be made of a single piece together with the connecting rod **20**. The other connecting rod end is connected to the piston **22** by means of a pivotable connection (not shown). The crankcase **12** is closed by a lid **70** at one head end **71** of the crankcase **12** so that there is formed a space which is completely enclosed by the underside of piston **22**, the inner wall of cylinder **24**, the crankcase **12**, and the lid **70**.

The crankcase **12** in which the drive shaft **14** is rotatably supported by sleeve bearing **60** has at its outer end a chamber **49** which contains the rope pulley **16** and is closed by the lid **15** which is detachably connected to the crankcase **12**. The rope **36** is led to the outside through a passage **74** in crankcase **12**, where its free end **38** is connected to handle **40**.

At the location of the friction roller **18**, which is located on drive shaft **14** approximately midway between the rope pulley **16** and the crank arm **62**, the crankcase **12** is partly open along its circumference, so that the friction roller **18** protrudes here radially, i.e. partly or freely accessible, so that it can be set into rotation through frictional contact with some rotating element (not shown in Fig. 1). The passage **74** is displaced circumferentially by 180° with respect to the exposed portion of friction roller **18**.

When the rope **36** is wound up on rope pulley **16** and is pulled at the free rope end **38** by means of ring **40**, the rope pulley **16** turns in one direction of rotation about an axis **A** of drive shaft **14** relative to the crankcase **12**. The overrunning clutch **52** locks up in this direction of rotation so that the drive shaft **14** also turns about axis **A** with the same rate and direction of rotation. The crank pin **64**, connected to the drive shaft **14** by crank arm **62**, which is connected in rotational linkage to the connecting rod end **66** of connecting rod **20**, has the effect that the piston **22**, which is connected in rotational linkage to the other connecting rod end, moves back and forth inside cylinder **24**.

When the piston **22** is moved toward the cylinder head **28**, the discharge valve **32** opens as soon as the gaseous fluid in the cylinder **24** has a higher pressure than exists on the discharge side. When the piston moves away from cylinder head **28** the discharge valve **22** closes and the intake valve **30** opens as soon as the gaseous fluid in the cylinder **24** has a lower pressure than prevails at the intake valve **30**. In the usual case the pressure prevailing at the intake valve **30** is the ambient pressure.

At the upper dead center of piston **22** there remains a somewhat compressed fluid in a dead space following the compression stroke. If the pressure of the fluid in the dead space following the compression stroke is so high that, in the following suction stroke no additional fluid is drawn in through the intake valve due to the large quantity of the fluid from the dead space, because the pressure no longer falls below the ambient pressure, the compressor **10** no longer delivers. The dead space can easily be varied, e.g. by an adjusting screw thread **23** between cylinder **24** and cylinder head **28**.

If the rope **36** is completely unwound from rope pulley **16** then drive shaft **14** which has been set into rotation can continue to rotate freely due to the overrunning clutch **52**. if, in so doing, no additional corresponding pulling force is exerted upon ring **40**, the spiral spring **46** which was placed under tension through unrolling of the rope, turns the rope pulley **16** in the opposite direction of rotation in which the overrunning clutch **52** does not lock the rope pulley **16** up and thereby again winds the rope **36** up on the rope pulley **16**. The process of winding up and unwinding of rope **36** on the rope pulley **16** can be repeated as often as desired.

The friction roller **18** can be driven by being pressed against a rotating bicycle tire or the like. Basically, any rotating shaft or any rotating wheel can be used as the power source for driving the compressor **10**. Rotation of friction roller **18** drives the compressor **10** via drive shaft **14** in the same way as rotation of the rope pulley **16**, although continuously rather than periodically.

According to Fig. 2 the compressor **10** can conveniently be held in place by shoe **76** via a holder **75** when, for example, the ring shaped handle **40** is pulled away from the compressor by one finger. The discharge valve **32** can be connected to a bicycle tire **78** through a pressure hose **77**. When the handle **40** is pulled, air from the outside is drawn in through intake valve **30** and pumped through discharge valve **32** and pressure hose **77** into the bicycle tire **78**. When handle **40** is no longer pulled, rope **36** is immediately wound back up on rope pulley **16** by the spiral spring **46** so that a further pull on the handle **40** can take place soon. Of course, instead of spiral spring **46** there can also be used a torsion rod, a rubber band, or a coil spring as spring actuator for winding rope **36** back up on rope pulley **16**.

In Fig. 3 the pressure hose **77** is connected to a pressure storage container **82** which is fixedly attached to a bicycle **84**. As a pressure storage container there can also be used the bicycle frame or a portion thereof. The compressor **10** can be displaced by means of a swivel bracket **80** in such a manner that the friction roller **18** is brought into frictional engagement with bicycle tire **78**. Because there is a risk of exceeding the nominal pressure of approximately 10 bar, e.g. while traveling downhill with bicycle **84** in which the friction roller **18** of compressor **10** is in engagement with the bicycle tire **78**, there is provided a pressure relief valve which can be incorporated into discharge valve **32**. Alternatively, the maximum compression and also the nominal pressure of the compressor for a given air pressure can be set via adjustment of the dead space in cylinder **24** which dead space exists when the piston **22** is at its upper dead center. By means of the adjusting screw thread **23** between cylinder **24** and cylinder head **26** the volume of the dead space can be changed and the nominal pressure of compressor **10** varied.

In place of friction roller **18** a spur gear can also be placed on overrunning clutch **56** which can, for example, be driven by a chain, analogously to a sprocket of a bicycle.

If an appropriate pressure relief valve and a correspondingly smaller dead space is provided in the compressor, higher pressures of up to 200 bar can be achieved by means of this compressor. Air at this pressure is used, for example, for pumping up shells such as are used for air guns in sport shooting.

Instead of air, other gaseous fluids can also be compressed so that the compressor described here can also be used as refrigerant compressor in a refrigeration plant.

Fig. 4 shows such a refrigeration plant, consisting of the above described compressor **10**, which is used here as refrigerant compressor, and a condenser **90**, a collecting vessel **92**, an expansion valve **94** and an evaporator **96**. The compressor **10** has no electric connection, but is driven by hand or by external machinery. If it is driven manually until the evaporator in a well insulated refrigerated chamber has reached a temperature below 0° Celsius, then goods can be stored in the refrigerated chamber for at least 24 hours without again having to operate the compressor. Such a small refrigeration plant with hand driven compressor is suitable for remote locations where no electric connection is available, or also for use in automotive vehicles or camping vehicles if the battery is to be saved.

Claims

1. Compressor (10) for gaseous fluids, especially air, having a displacement body (22) driveable by a drive shaft (14) , the drive shaft (14) being permanently adapted to be set into rotation optionally either periodically by means of a rope pulley (16) connectable thereto via a first overrunning clutch (52) by pulling on a rope (36) wound up thereon, or adapted to be set into continuous rotation by means of a disc or wheel shaped rotating body (18) via a second overrunning clutch (56), the rope pulley (16) and the rotating body (18) being mounted compactly side by side on the drive shaft (14) and the drive shaft (14) being mounted in a crankcase (12) for the compressor (10).

2. Compressor according to Claim 1 characterized in that the rope pulley (16) and the crankcase (12) are connected to each other by means of a spring actuator (46).

3. Compressor according to Claim 2, characterized in that the spring actuator (46) is a spiral spring, a first end (41) of which is connected to the rope pulley (16) and a second end (43) is connected to the crankcase (12).

4. Compressor according to one of Claims 1 to 3, characterized in that the rotating body (18) is a friction roller.

5. Compressor according to one of Claims 1 to 3, characterized in that the rotating body (18) is a spur gear.

6. Compressor according to one of Claims 2 to 5, characterized by a holder (75) serving to hold the compressor (10) in position.

7. Compressor according to one of Claims 1 to 6, characterized in that the free end (38) of the rope (36) is connected to a handle (40).

8. Compressor according to one of Claims 1 to 7 for producing high pressure air, characterized by small size and by an adjustable pressure limiting device located between the compressor (10) and a compressed air consumer.

9. Compressor according to Claim 8, characterized in that a size-adjustable dead space of the compressor (10) is provided as the pressure limiting device.

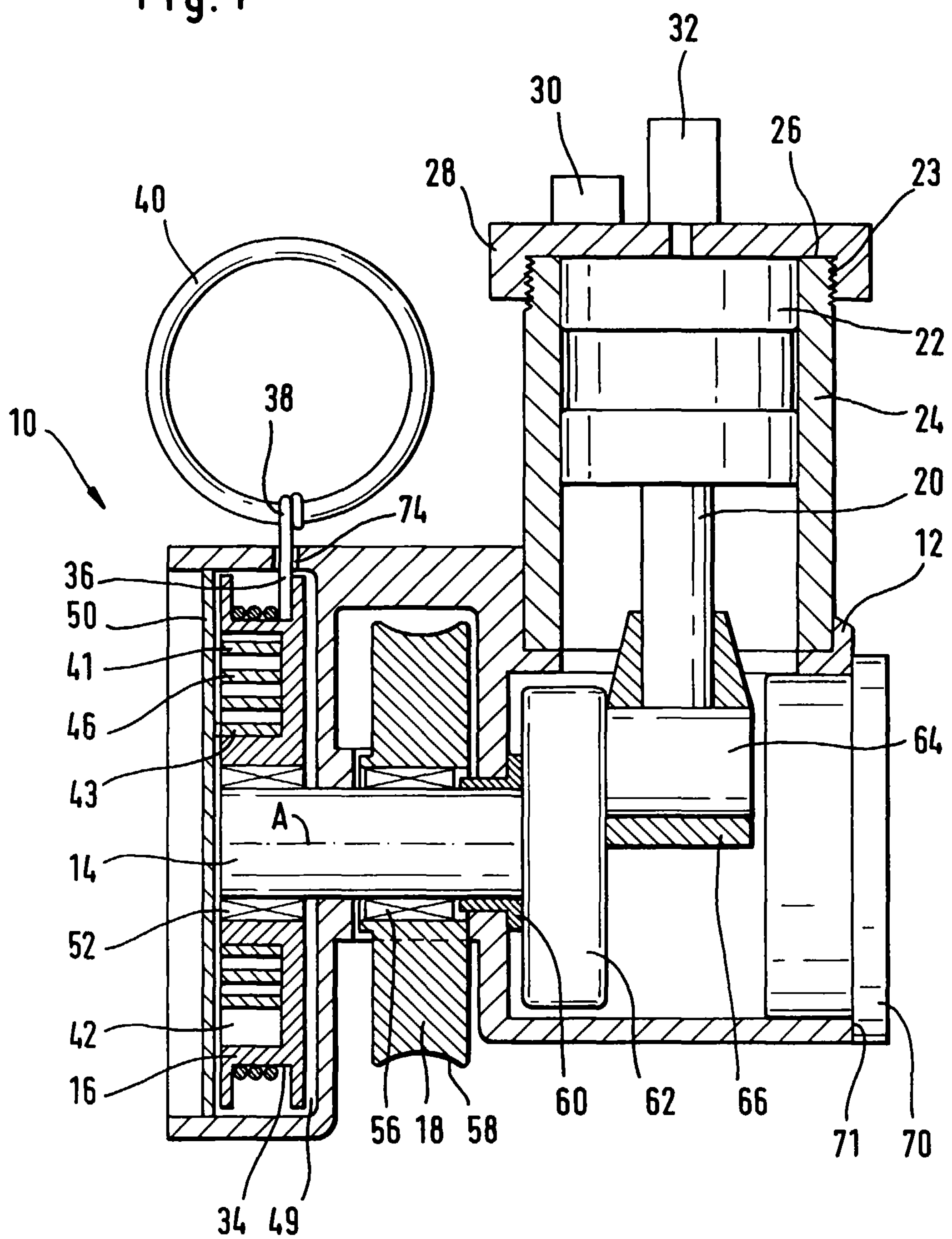
10. Compressor according to Claim 8 or 9, characterized in that an adjustable pressure relief valve is provided as the pressure limiting device.

11. Compressor according to Claim 6, characterized in that the holding device is a swivel device (80) for pivotably attaching the compressor (10) to a frame of a bicycle (84).

12. Compressor according to Claim 8 and 11 characterized in that the compressed air consumer is a tire of the bicycle (84) or a compressed air storage container (82) attached to the frame of the bicycle (84).

13. Use of a compressor according to one of Claims 1 to 7 as refrigerant compressor for a refrigeration plant.

Fig. 1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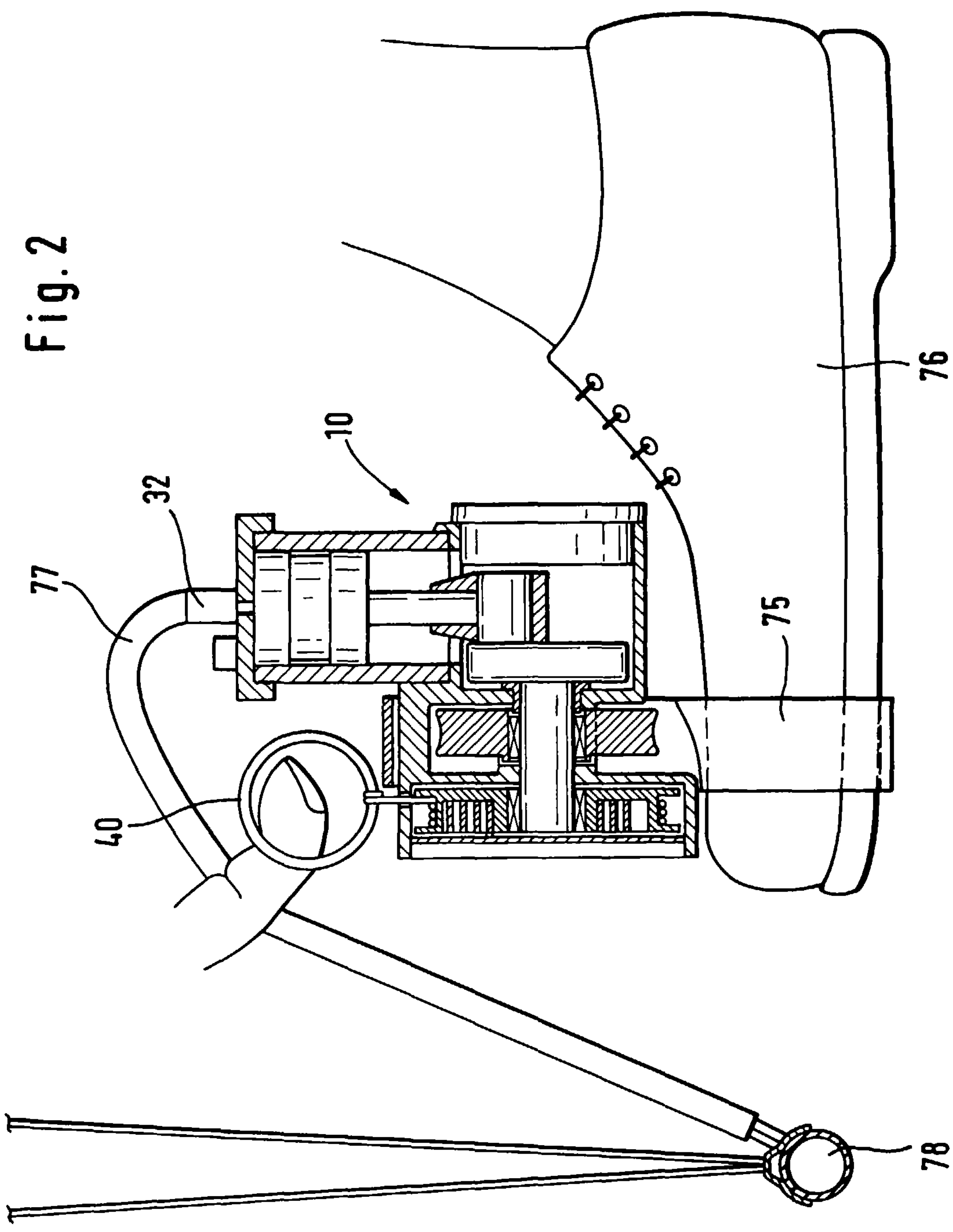

Fig. 2

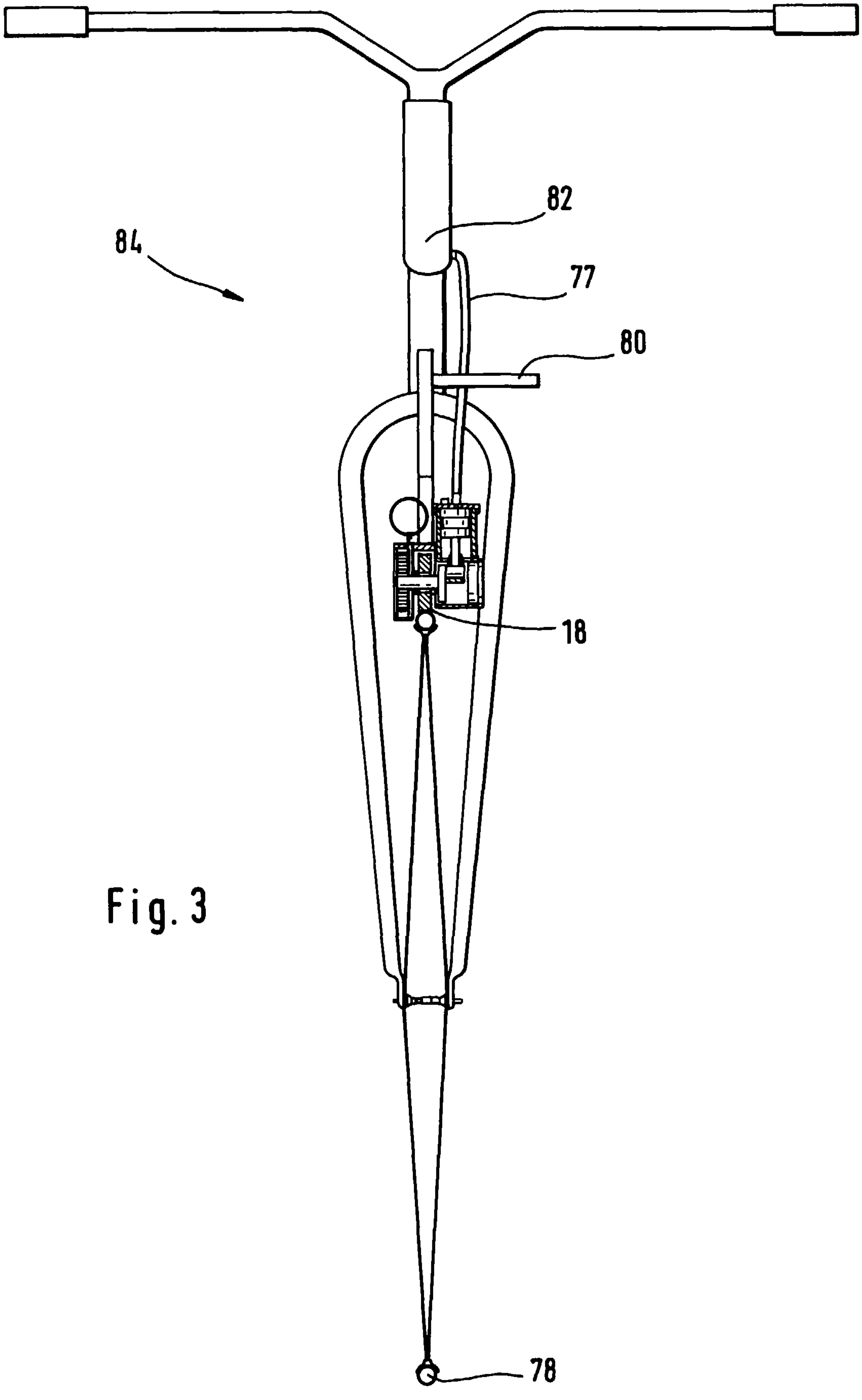

Fig. 3

Fig.4