W. M. INGRAM.

AIR PUMP.

APPLICATION FILED AUG. 6, 1919.

1,389,360. **Patented Aug. 30, 1921.**

2 SHEETS—SHEET 1.

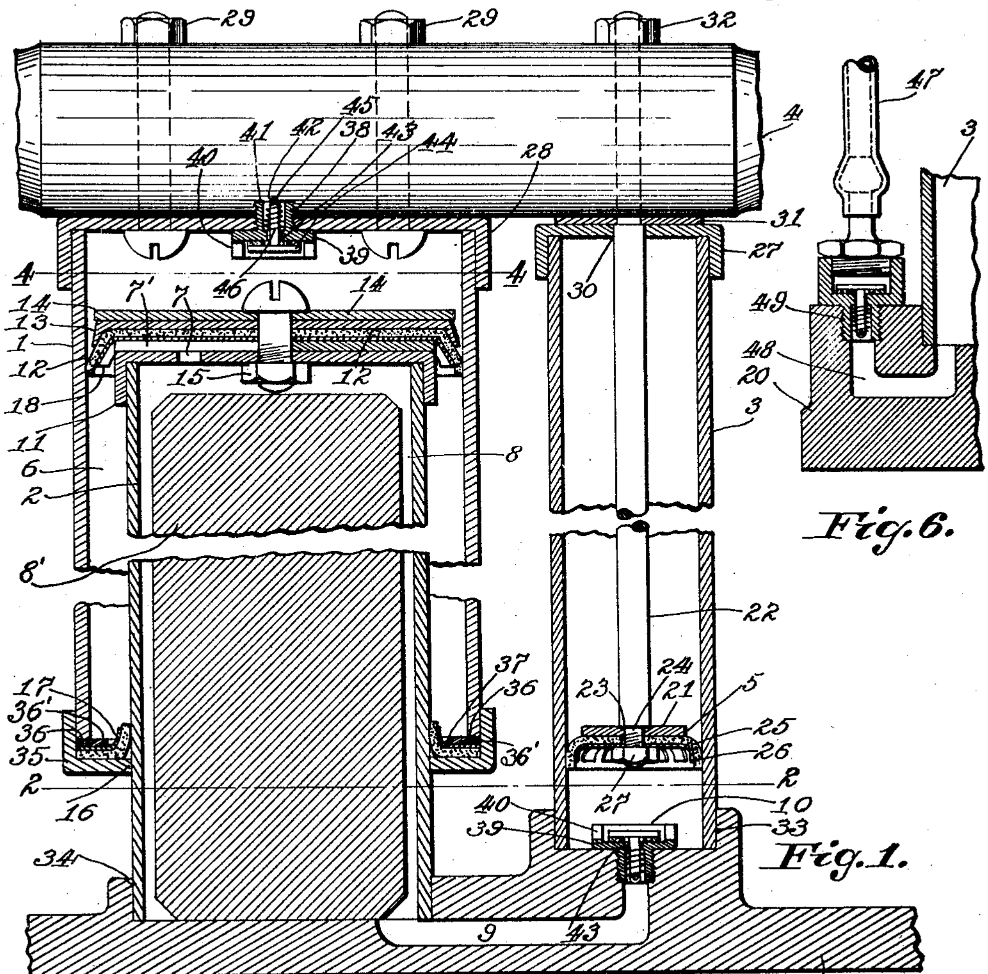

Fig. 6.

Fig. 1.

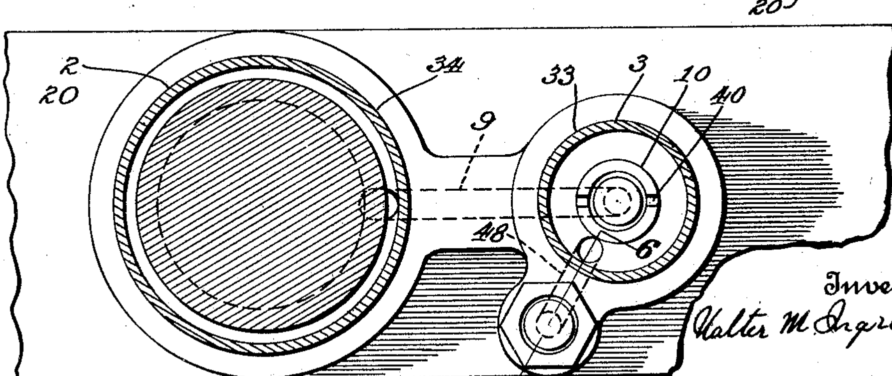

Fig. 2.

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2 SHEETS—SHEET 2.

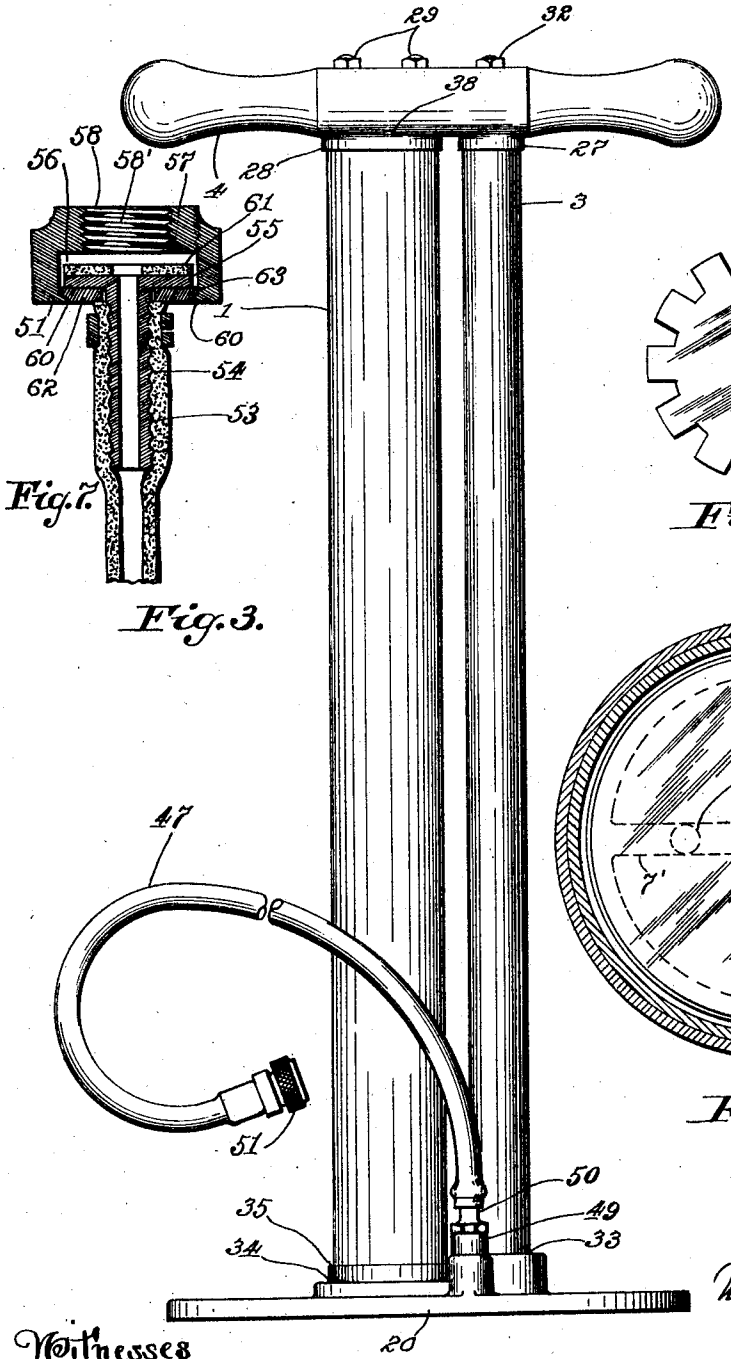

Fig. 7.

Fig. 3.

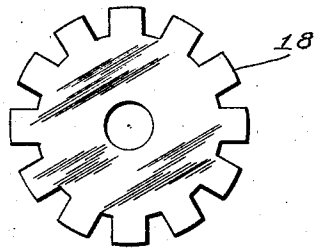

Fig. 5.

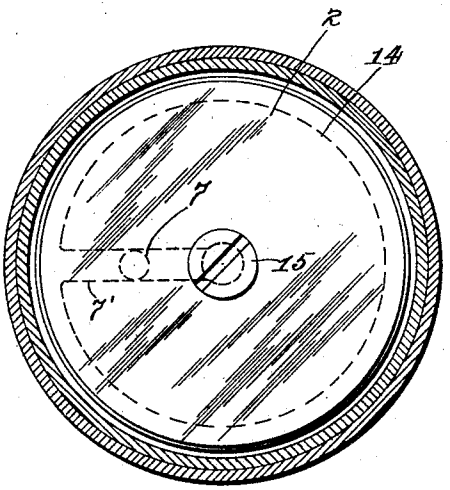

Fig. 4.

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UNITED STATES PATENT OFFICE.

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AIR-PUMP.

1,389,360. Specification of Letters Patent. Patented Aug. 30, 1921.

Application filed August 6, 1919. Serial No. 315,638.

To all whom it may concern:

Be it known that I, WALTER M. INGRAM, a citizen of the United States of America, residing in the city of Baltimore, State of Maryland, have invented certain new and useful Improvements in Air-Pumps, of which the following is a specification.

This invention relates to a compound air pump particularly adapted for use as a manually operated pump for inflating pneumatic tires.

The object of the invention briefly stated is to avoid packed joints or bearings with the consequent excess friction and to achieve the greatest degree of compression with the least expenditure of operating power. In the triple compression compound pump illustrated there is a relatively small plunger in the low pressure cylinder, and the intermediate compression takes place in the annular space in the cylinder around this plunger.

The plunger enters the cylinder through the rear or lower end, and the joint is closed but not packed, loss of pressure being prevented, by means of an annular cupped strip of leather or the like.

Initial compression takes place over the plunger. When the plunger is withdrawn on the up stroke, air is sucked in to the cylinder and on the compression or return stroke this air as it is compressed over the plunger is forced past the head of the plunger passing between the plunger head and the cylinder walls into the annular intermediate compression space about the plunger and within the cylinder. On the return stroke, *i. e.*, the withdrawal of the plunger, the air thus admitted is compressed in the annular space around the plunger between the top of the plunger where there is a suitable non-return member or cup, and the annular strip or washer which surrounds the opening in the cylinder base through which the plunger acts, and as it is compressed it is forced through a suitable passage into the high pressure cylinder.

In this instance the passage is partly in the plunger which is stationary and partly in the base, and is controlled by a non-return valve. The piston in this cylinder moves simultaneously with the stroke in the low pressure cylinder which preferably reciprocates relatively to the stationary piston or plunger. As the high pressure cylinder is single acting, pressure being on one side of the piston only, *i. e.*, opposite the rod, there is no necessity for packing in this cylinder, and in the low and intermediate pressure cylinder, packing is dispensed with as already outlined. Further, the periods of compression in the respective cylinders are so related as to balance to the best advantage and give the least total resistance to the operating force, *i. e.*, the air initially compressed is passed into the intermediate space as it expands, the two actions being simultaneous and the intermediate chamber as it compresses discharges into the high pressure cylinder which is at that time expanding, compression in the high pressure cylinder being accomplished during the intake in the intermediate chamber or cylinder which is simultaneous with initial or low pressure compression, making the total compression by the easiest stages.

Other important features will more fully hereinafter appear.

In the drawing I have illustrated an air pump embodying the features of my invention.

Figure 1 is a vertical central section.

Fig. 2 is a section on the line 2, 2 Fig. 1.

Fig. 3 is an elevation.

Fig. 4 is a fragmentary section on the line 4, 4 of Fig. 1.

Fig. 5 is a detail relating to the piston cup.

Fig. 6 is a fragmentary section on the line 6—6 of Fig. 2.

Fig. 7 is a sectional detail of the valve or swivel connection.

Referring to the drawings by numerals, the pump as shown consists of a low pressure cylinder 1, a plunger 2, a high pressure cylinder 3, the low pressure cylinder 1 and piston 5 of the high pressure cylinder 3 being mounted on the handle or reciprocating member 4, the plunger 2 and the high pressure cylinder 3 being stationary. Between the walls of the low pressure cylinder 1 and the plunger 2 is an annular space 6 of considerable dimension which acts as an intermediate compression chamber or cylinder. This chamber is connected by a passage 7, in the plunger head 8 in the plunger, and 9, in the base 20, with the high pressure cylinder space 3, the passage being controlled by a non-return valve 10. The passage 8, as shown, conforms to the walls of the plunger which is made hollow, of thin sheet metal and filled centrally as by means of a loosely fitting block 8′ the object of which is to reduce the capacity of the passage 8, which

if of excessive size, would cause an important loss of the efficiency of the pump.

The head of the plunger 2 has a cap or cover 11 on which is mounted an inverted leather cup 12 which bears against the walls of the cylinder, having a valve-like action. This cup is held in position by a flanged washer 13 which may be reinforced by a disk washer 14 and is supported beneath by saw-toothed cupped washer 18 resting on a washer 19 which is slotted at 7′ in continuance of the passage 7, the various members being secured to the cap or head 11 by a bolt 15. The plunger 2 slides freely in an opening 16 in the lower end or head of the cylinder, leakage through this opening 16 being prevented by a suction or cupped washer 17. The high pressure piston 5 is also of the cup type.

As shown, it consists of a disk 21 centrally apertured and secured to the lower end of the piston rod 22 which is shouldered at 23 to engage the disk, the reduced portion 24 beyond the shoulder being passed through the aperture. This reduced portion is also passed through the leather cup 25 and the saw-toothed washer 26 which supports the cup from beneath, *i. e.*, on the side opposite to the disk 21. The entire piston thus composed is held by a nut 27 on the end of the piston rod. Both the high pressure cylinder 3 and the low pressure cylinder 1 are closed at the top by means of flanged caps 27, 28, the flanges inclosing the outer walls of the cylinder. The cap 28 is fastened to the pump handle or reciprocating member 4 by means of bolts 29, and the cap 27 is centrally apertured at 30 to pass the piston rod 22. As the top of the high pressure cylinder is not used for purposes of compression, there is no packing at this point, all that is necessary being free sliding of the rod. This rod as shown, is shouldered above the cylinder head and fitted with the washer 31 above the shoulder, the end of the rod being passed through the handle and fastened by a nut 32. The lower end of the high pressure cylinder 3 is seated in a suitable socket 33 in the base 20. The plunger 2 is similarly seated in the base 34 and the lower end of the low pressure cylinder 1 is closed by a head or cap 35 containing the aperture 16 for the passage of the plunger as already described, the cap being flanged at its periphery as are the caps 27 and 28, the flange taking over the outer surface of the cylinder walls, and the cupped washer 17 already described as preventing leakage around the plunger at 16 is held between the lower edge 36 of the cylinder walls and the inside surface of the cap, the cupped washer being further supported by a correspondingly cupped thin metal washer 37 preferably saw-toothed as are the washers 18 and 26, only the washer 17 is serrated and cupped adjacent the opening while the other washers are serrated at the periphery which is turned up to give the cupped effect. The washer 17 is preferably covered as to its periphery by a metal ring or washer 36′ which prevents distortion of the edge of the thin washer 17.

I have already referred to non-return valves admitting air to the upper end of the low pressure cylinder at 38 and to the lower end of the high pressure cylinder, the latter valve being indicated by reference character 10. Each of these valves is composed of a slotted cup or seat 39, the slot 40 being for engagement by a screw driver and a threaded shank 41 which has a central aperture 42 extending from the end of the shank to the cup, the same being shouldered or reduced at 43. This valve seat contains an ordinary puppet valve 44, the stem of which is apertured at its end at 45 and inclosed within a spiral spring 46 which bears against the shoulder at one end and is passed through the shank at the other end so that it tends to keep the valve closed. The shank of the valve fits loosely in the reduced portion of the opening at 43. The valve is opened by the pressure of the inrushing air and closed against return pressure. Delivery from the high pressure cylinder to the tube 47 is by way of a passage 48, see Figs. 2 and 6, controlled by a suitable non-return valve 49 which as shown is like the valves 10 and 39. The tube 47 is connected to the passage 49 by a suitable nipple 50, and is supplied at the other end with a swivel connection 51. This swivel connection is shown in detail in Fig. 7, the same consisting of a sleeve or tube 53 having transverse peripheral ridges 54. This sleeve is thrust inside the end of the tube the ridges improving the engagement. At its outer end the tube 53 has a flat flange 55 which fits within a chamber 56 in a coupling nut 57. This nut has an opening 58 in which is cut a standard thread 58′ to fit the standard valve stem, the chamber 56 being in alinement with the opening. This chamber is adapted to receive the flange 55, which fits loosely. For this purpose the chamber is made with a bead 60 which as formed projects beyond the rear surface of the nut. When the swivel is to be connected, the flange is inserted in the chamber and the bead turned into the position in which it is shown in the drawing locking the flange in this position and making the connection permanent. Forward of the flange there is a flat fiber washer 61 and to the rear of the flange a flat brass washer 62, the same being beveled at 63 on its rear outer periphery to conform to the bead 60. This swivel connection has the advantage over the ordinary type, that the flange 55 and the washers present flat surfaces to the pressure due to the tightening of the connection as compared

to conical surfaces presented by the ordinary swivel connection. The conical surfaces tend to bind wherever there is pressure, while the flat surfaces slide over each other with comparative freedom, making the connection and disconnection with the pump to and from the valve stem comparatively easy.

In a general way the pump consists of a fixed member and a moving member, one said member carrying the low pressure cylinder and the high pressure piston, the other said member carrying the plunger and the high pressure cylinder. The plunger has a considerable clearance in its cylinder, forming an annular space closed at the top and bottom by suitable means as washers 13 and 17 so that this annular chamber acts as an intermediate compression chamber or cylinder the same being for this purpose connected to the high pressure cylinder. The closure member at the top of the plunger has the effect of a non-return valve in that it passes the air from the low pressure space above the plunger to the intermediate pressure annular space, and prevents its return on intermediate compression.

It will be noted that air drawn into the low pressure cylinder by raising the handle which expands the low pressure space, is on the return stroke, passed into the annular space, 6, in which the up-stroke compresses it, forcing it through the passage, 9, to the lower or compression end of the high pressure cylinder. I have referred in the claims to the upper end of the annular space, 6, and to the lower end of the high pressure cylinder, respectively, as the pressure or high pressure ends of these cylinders or spaces.

The operation of the pump has been fully disclosed in connection with the description of the pump structure which is specific and in detail in order that the invention may be easily understood and practised by those skilled in the art; however, the specific terms herein are used descriptively rather than in their limiting sense, the scope of the invention being fully outlined in the claims.

What I claim and desire to secure by Letters Patent is:

1. An air pump having a moving member and a fixed member, a low pressure cylinder and a high pressure piston mounted on one of said members, a plunger adapted to enter the low pressure cylinder and a high pressure cylinder coöperating with the high pressure piston on the other of said members, the plunger having a considerable clearance in the cylinder forming an annular space which serves as an intermediate compression chamber and a passage connecting the compression ends of the intermediate compression chamber and the high pressure cylinder.

2. An air pump having a moving member and a fixed member, a low pressure cylinder and a high pressure piston mounted on one of said members, a plunger adapted to enter the low pressure cylinder, and a high pressure cylinder coöperating with the high pressure piston on the other of said members, the plunger having a clearance in the cylinder, flexible members at the top and bottom of said clearance admitting air from the low compression space to said clearance space, causing the same to act as an intermediate compression space and a passage connecting said space to the high pressure cylinder at the compression end of the latter.

3. An air pump having a moving member and a fixed member, a low pressure cylinder and a piston mounted on one of said members, a plunger adapted to enter the low pressure cylinder with a considerable clearance, and a high pressure cylinder coöperating with the high pressure piston on the other of said members, a flexible member in the low pressure cylinder near the top of the plunger inclined away from the low compression chamber beyond the plunger so that it passes air from the low pressure cylinder into the clearance space but resists the passage of air in the opposite direction, a flexible member at the opposite end of the clearance space and inclined toward the clearance space serving as packing to prevent the escape of air from the clearance space, a passage connecting the clearance space with the high pressure cylinder, near the compression end of said cylinder, and a non-return valve controlling said passage.

4. An air pump having an initial compression cylinder, a plunger therein having a clearance forming an annular compression space, a non-return member on the plunger separating the annular compression space from the space beyond the plunger which forms the low compression space, means closing the opposite end of the compression space, a high pressure cylinder, a piston therein, a passage connecting the annular space to the high pressure cylinder at the pressure end of the latter, means expanding the high pressure space and contracting the annular space simultaneously and contracting the high pressure space and expanding the annular space.

Signed by me at Baltimore, Maryland, this 25th day of July, 1919.

WALTER M. INGRAM.

Witnesses:
ZELLA KUHN,
PORTER H. FLAUTT.