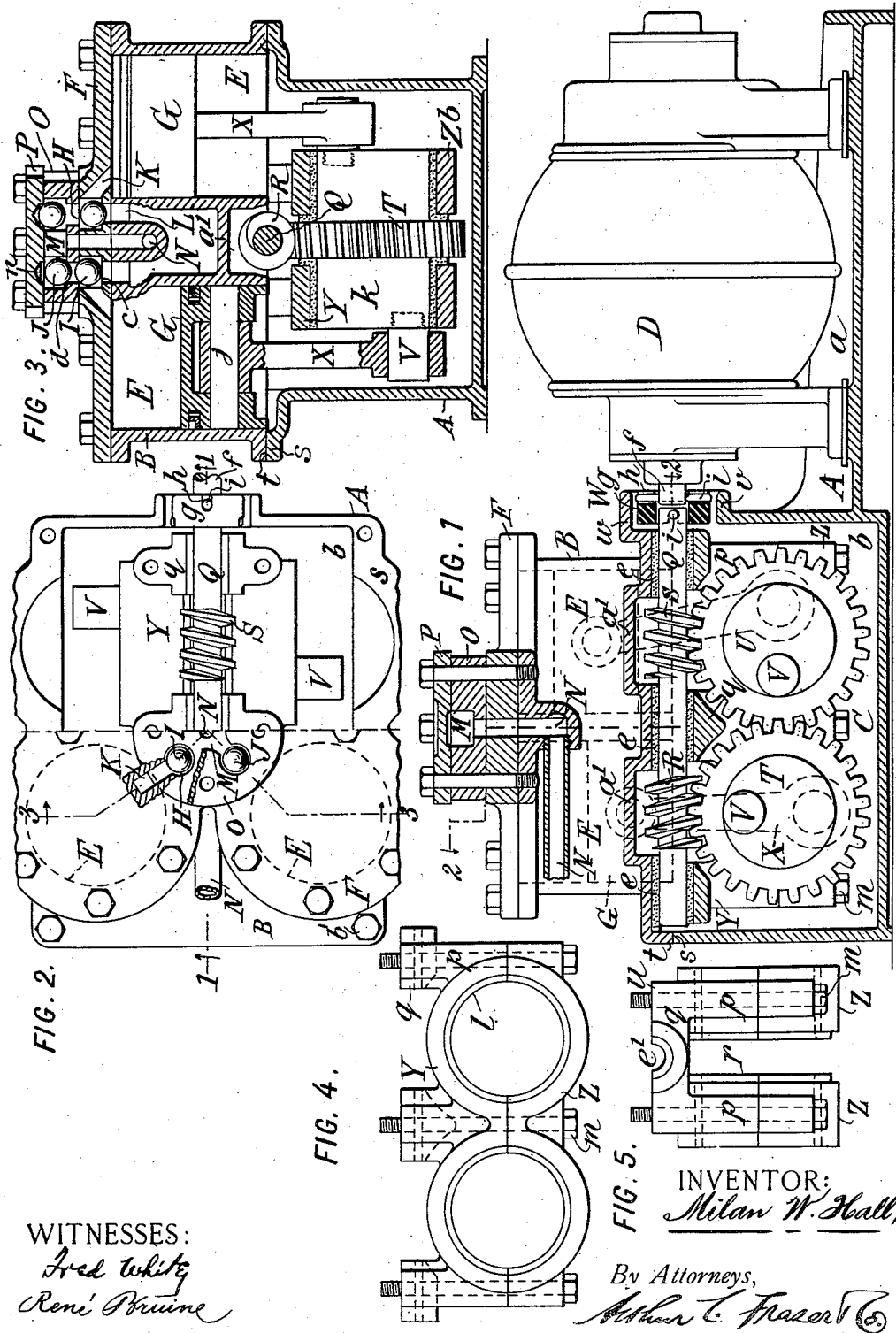


M. W. HALL.
AIR COMPRESSOR AND SIMILAR DEVICE.
APPLICATION FILED MAR. 2, 1903.



WITNESSES:
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UNITED STATES PATENT OFFICE.

MILAN W. HALL, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS,
TO NOISELESS COMPRESSOR AND AIR BRAKE COMPANY, OF NEW YORK,
N. Y., A CORPORATION OF NEW YORK.

AIR-COMPRESSOR AND SIMILAR DEVICE.

No. 853,356.

Specification of Letters Patent.

Patented May 14, 1907.

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To all whom it may concern:

Be it known that I, MILAN W. HALL, a citizen of the United States, residing in the borough of Brooklyn, in the county of Kings, city and State of New York, have invented certain new and useful Improvements in Air-Compressors and Similar Devices, of which the following is a specification.

This invention relates generally to compressors or pumps, and is especially applicable to air compressors.

The invention aims to provide certain improvements which will be hereinafter fully set forth with reference to the accompanying drawings, in which,

Figure 1 is a side elevation partly in vertical mid-section on the line 1—1 of Fig. 2, and looking in the direction of the arrow, of the preferred form of my invention as applied to an air compressor driven by an electric motor; Fig. 2 is a fragmentary plan view thereof, partly in section on the planes of the line 2—2 of Fig. 1; Fig. 3 is a transverse section thereof cut on the lines 3—3 of Fig. 2 and looking in the direction of the arrow. Fig. 4 is a side elevation of the bearing frame and caps removed; Fig. 5 is an end elevation thereof.

Referring to the drawings, A represents the base, B the cylinder casing, C the driving gear, and D an electric motor or other source of power. The base is shown as a casting having a motor bed *a* at one end and gear box *b* at the other end. The casing B is provided preferably with four cylinders E, having parallel vertical axes, opening at their lower ends into the box *b*, and closed at their upper ends by the top F. A single-acting piston G works in each cylinder. A valve chamber H is provided for each cylinder, and each chamber has a suction valve I, and discharge valve J, and each is connected with its cylinder by a single port K. A suction port L, connecting with the outer air between the cylinders, is provided for each chamber H, and a discharge chamber M connects all the valves J, from which chamber the discharge flows downward and away between the cylinders through the duct N. The chambers H are formed partly in the top F and partly in the cover O, the upper part of which is closed by a cap P.

As shown each valve is a ball valve or

sphere, the valves I each working in a cylindrical bore in the top F, which bore is concentric with and slightly larger than the seat *c* of the inlet L, and each valve J works in a similar bore in the cover O which bore is slightly larger than and concentric with the seat *d*, which is drilled through the cover and opens into the adjacent bore in the top. The cap P is drilled with a shallow cavity *n* immediately above and concentric with the seat for each valve J, so that each valve I and J has opposite its seat a circular stop or reverse seat against which the valve may strike when opening. This prevents flattening the valves.

The driving mechanism consists of a worm shaft Q having right hand worm R and left hand worm S, and a right hand worm gear T and a left hand worm gear U, meshing with the worms R and S respectively and also meshing with each other. Each worm gear has a crank V at each side, the crank on one side being shown as diametrically opposite that on the other side, and the cranks of one gear being quartered relatively to those of the other gear. The shaft Q is mounted in central and end bearings *e*, and is driven from the shaft *f* of the motor D through the medium of a compensating joint W consisting of a block of insulating or other material *g*, having notches *h* in its opposite faces, those on one face extending at right angles to those on the other face, in which notches play pins *i* traversing the one the shaft Q and the other one the shaft *f*, the effect being to make a driving connection capable of compensating for slight variations of alinement between the worm and motor shafts and still permitting a quick separation of the motor from the worm shaft without necessitating opening the gear box.

Each piston G is connected with one of the cranks V by a pitman X which fits loosely and unconfined over the crank at one end and is connected to the piston by a pin *j* at the other end. This loose connection enables the crank to slide through the pitman to its proper position and to work therein without throwing the pitman out of line with its piston.

Each worm gear is shown as formed with a large bearing hub *k*, the periphery of which at least coincides with the outer periphery of

the crank V. This gives strength to the crank and simplifies manufacture and operation.

The gears and worm shaft are supported by a frame or journal bracket Y which has in its upper face the lower half e' of the bearings e for the worm shaft and in its lower face the upper half l of the bearings for the gears, the lower half of these bearings being provided in caps Z, while the upper halves of the bearings for the worm are formed in the bottom face of the casing B. Bolts m , traversing the frame and caps and screwing into the casing B, hold the bearings together. The frame Y is a bifurcated hollow casting having sides p , connected by cross pieces q , in which latter the cavities for the bearings e are formed, while between the side pieces p , a space r exists wide enough to receive the toothed portion of the gears T and U. The space r opens up through the top of the frame Y between the cross pieces q , and there constitutes recesses for receiving the worms. All the cavities for the bearings l are formed in the under faces of the side portions p . All bearings may be formed by casting anti-friction metal in the bearing cavities as shown, or in any other suitable way. The bearings for each gear are shown as extending along the hub and against the side face of the gear for holding it against axial displacement. The bearings for the worm shaft permit free axial movement thereof.

The box b has a finished upper edge s making a tight fit with the finished lower face t of the casing B on a plane coincident with that of the axis of the shaft Q, and the frame Y is finished on its upper face u , and fits against the face t of the casing in the same plane when it is clamped thereto by the bolts m . The box makes a leak-tight joint with the casing except at the motor side where it is formed with a flanged opening v coinciding with a similar opening w formed on the casing, these openings receiving and suitably inclosing the coupling W.

The casing B is shown as provided with cavities a' opposite the worms R and S and intermediate of the bearings e . These bearings extend longitudinally of the casing and the cylinders E are disposed equidistantly at each side of the center of the worm shaft, and separated sufficiently to leave an air space between the cylinders on the opposite sides of this shaft. This permits air to flow between the cylinders as well as against all sides of each, which aids in cooling the parts. It also provides room for the suction ports and the discharge duct between the cylinders.

The valves being disposed central of the four cylinders occupy the minimum of space, and this arrangement enables great economy in port and valve chamber clearance, which

is especially important in air compressors. The single top F serves to close all the cylinders and provides the individual valve chambers for each, while the cover O provides the discharge chamber, and the cap P closes this. This attains simplicity of construction, and reduces the number of parts to the minimum while making it easy to get access to the discharge or valve chambers without removing cylinder top. The pistons G are each single castings grooved and provided near their upper ends with suitable packing, as segmental metallic ring or other expansive packing.

In assembling, the compressor, the spur gears or cranks T U are brought into mesh with the cranks of one at 90° relatively to those of the other, and are placed in the frame Y. The worm shaft is placed in the bearings e while the casing B is inverted. The pitmen X are slid over their respective cranks, and the pistons G attached, and the latter are inserted in their respective cylinders as the frame Y is lowered on to the face t of the casing until the gears mesh with the worms. The caps Z are then placed on the hubs of the gears, and the bolts m are inserted and screwed into the casing until the frame, caps, gears, and worm are secured in place. Then the casing with the attached parts is reversed and fastened on the upper edge of the box b by bolts b' or otherwise. The disk g is pushed over the end of the shaft Q until its groove h engages the pin i thereof. The motor D is then placed on the bed a and moved toward the box until the pin i of its shaft engages the outer groove h of the disk, whereupon the motor is clamped to the bed, and the compressor is ready to operate. The parts are taken apart in reverse order.

Should it be necessary to examine the driving mechanism the casing B with the connected parts can be lifted off and these parts can be inspected or repaired without disturbing the motor or the valve mechanism. If the valves need inspection it is simply necessary to lift the cap P, or this and the cover O. Access to the cylinders can be had by lifting the top F without disturbing the cover or cap.

In operation, if the source of power is a high speed motor the worms and gears will be of such ratio as is necessary to reduce the speed of the cranks to that best suited for the work, say for example about 100 revolutions per minute. The worms can be driven in either direction, and will drive the gears in reverse direction so that their intermeshing teeth will travel in the same direction as they revolve. The reverse worms and the intermeshing gears will take up within themselves the thrust incident to their motion and thus counterbalance the worm shaft endwise, avoiding any thrust bearings. The freedom for end movement which the bearings e provide for the worm shaft enables it to move

axially to its normal position relatively to the two gears; and its loose connection through the coupling W enables it to adjust itself irrespective of the motor shaft. This coupling also permits the motor shaft to run out of line with the worm shaft without tending to cramp the latter. The cranks being quartered as shown, as one piston of the crank of the right hand gear completes its working stroke the other will complete its suction stroke, and the one crank of the left hand gear will be in the middle of its working stroke and the other will be in the middle of its suction stroke. Owing to the circular motion of the cranks the well known crank action effect on the pistons will be obtained and the piston traveling will progressively decrease in speed toward the ends of each stroke thus obtaining the minimum of speed during the maximum of compression, and avoiding shock or sudden reversal of piston movement. As one crank of a gear begins its working stroke the other crank of that gear starts its suction stroke, which distributes the work for each gear, and while one gear is performing relatively light work another is performing intermediate work, so by the intermeshing of the gears the load is distributed as far as possible throughout their revolutions, thus attaining comparatively uniform work and reducing to the minimum irregular wear.

By making each piston and its cylinder independent of the others each can perform its own functions regardless of the others, and exact relative positions of the opposite cranks of a gear are not requisite, nor is perfect workmanship necessary. If the cranks are not correctly located the only disadvantage will be a slight departure from the preferred relation of the pistons.

Lubrication of the driving mechanism, pistons, cylinders, and pitmen is attained by making the box B an oil reservoir, the oil in which is raised by the gears into the open ends of the cylinders, which gives complete automatic lubrication without necessitating special attention. Placing the shaft above the gears as shown avoids necessity for a stuffing box around the shaft, saves height, and permits a deep oil reservoir.

It will be seen that my invention provides various improvements which can be readily and advantageously availed of either in whole or in part, either in the form shown, which constitutes the preferred adaptation of my invention, or in such modified form as circumstances or the judgment of those skilled in the art may dictate, and it will be understood that I do not limit myself to the particular details of the construction arrangement or combination set forth as constituting the preferred form of my present improvements.

Air compressors and other devices em-

bodying my improvements secure reliability, efficiency, and durability, and attain smooth and quiet action, with automatic lubrication, and economy of space required. The invention solves the problem of the transmission of the power of high speed devices to compressors and other apparatus where for the sake of durability a moderate speed is desirable. It obtains a practically uniform distribution of the load throughout each revolution of the cranks which is important in order that the natural wear shall be evenly distributed and a uniform resistance be presented to the action of the source of power when for example such source is an electric motor. It provides a durable, reliable, noiseless, efficient, and generally satisfactory device which can be employed to transmit power under a wide range of speed ratios.

It will be understood that cranks need not necessarily form separate parts connected to the worm gears as shown, as either or both sets of cranks can be carried by or driven from the gears in any suitable way to balance the end thrust of the worm.

What I claim is:

1. The combination with right-hand and left-hand worms, of worm gears meshing therewith and with each other, and each having cranks, cylinders corresponding to said cranks respectively, valves for said cylinders, a piston in each of said cylinders, and means connecting each piston with its corresponding crank, substantially as and for the purpose set forth.

2. The combination with right-hand and left-hand worms, of worm gears meshing with said worms respectively, and having means for transmitting the thrust of each to the other, cranks driven by said worm gears respectively, pistons connected to and driven by said cranks, cylinders in which said pistons work respectively, and valves for said cylinders, substantially as and for the purpose set forth.

3. The combination with right-hand and left-hand worms, of worm gears each meshing with and driven by one of said worms, and having means for transmitting the thrust of each worm to the other, reciprocating pistons, cylinders in which said pistons work respectively, valves for said cylinders, and means operated by one of said gears for transmitting reciprocating motion to one of said pistons, and means operated by the other of said gears for transmitting reciprocating motion to the other of said pistons, substantially as and for the purpose set forth.

4. The combination with right-hand and left-hand worms, of worm gears meshing therewith, each of said gears having cranks at its opposite sides, cylinders corresponding to said cranks respectively, valves for said cylinders, a piston in each of said cylinders,

means each connecting one of said pistons with its corresponding crank, and said gears each having means mechanically connecting said gears together to transmit the load from one to the other thereof, substantially as and for the purpose set forth.

5. The combination with a plurality of cylinders, a piston in each of said cylinders, valves therefor, and means for transmitting reciprocatory motion to said pistons, of right-hand and left-hand worm gears disposed between said means and each mechanically connected to one of said pistons for driving the latter, and right-hand and left-hand worms for driving said gears, said worm gears meshing respectively with said worms, substantially as and for the purpose set forth.

6. The combination with four cylinders, of a piston in each of said cylinders, and each independent of those in the other cylinders, valves and valve chambers for said cylinders, a crank opposite each of said cylinders for reciprocating the piston therein, means connecting said several cranks together for driving them in predetermined relation to each other, and for transmitting the thrust of each crank to the others consisting of worm gears having means mechanically connecting them together, and worms connected rigidly together and meshing with said worm gears for driving them, substantially as and for the purpose set forth.

7. The combination with four pistons and means for reciprocating them, of a casing having four cylinders, receiving said pistons respectively, a valve chamber for said cylinders, and having a port connecting with each, and having a discharge outlet between said cylinders, a worm, and a worm gear below said cylinders and beneath and meshing with said worm, and driving said means, substantially as and for the purpose set forth.

8. The combination with a cylinder casing B, having a plurality of cylinders, of a top F closing said cylinders at one end, and having ports K communicating therewith respectively, and a suction port L and a valve seat c for each of said cylinders, a cover O having a valve chamber H and valve seat d for each of said cylinders, ball valves I and J for said seats respectively, a cap P for said cover, pistons in said cylinders, and means for reciprocating said pistons, substantially as and for the purpose set forth.

9. The combination with a casing having a plurality of upright cylinders, valves for said cylinders, pistons in said cylinders respectively, and cranks below said cylinders for reciprocating said pistons, said cranks connected together for transmitting the thrust of each to the other, of a worm gear between and connected to said cranks for driving them, a worm above and meshing with said worm gear for driving it, means at-

taching said cranks and worm and worm gear to said casing below said cylinders, and a supporting base carrying said parts, substantially as and for the purpose set forth.

10. The combination with a casing having a plurality of cylinders, valves for said cylinders, and pistons in said cylinders, of cranks secured to the lower part of said casing for reciprocating said pistons, a worm gear below said casing for driving said cranks, a worm shaft above and meshing with said gear for driving the latter, and a base having an oil chamber inclosing such cranks and connected to such casing independently of said worm gears and worm shaft, substantially as and for the purpose set forth.

11. The combination with a casing having a cylinder open at its lower end, valves for said cylinder, a piston in said cylinder, a crank below said cylinder for operating said piston, of a worm gear below said cylinder for driving said crank, a worm above and meshing with said gear for driving it, and a base supporting said parts and having an oil box below said cylinder and inclosing said crank, worm gear and worm, substantially as and for the purpose set forth.

12. The combination with a casing having a plurality of vertical cylinders, pistons therein respectively, valves for said cylinders, and cranks below and connected to said pistons for reciprocating them, of a base beneath said cylinders, supporting said casing, and having an oil box beneath the latter having an opening through the upper part of said base for receiving and inclosing said cranks, and having a bed portion adjacent to said box, an electric motor mounted on such bed portion, a worm shaft having a worm within said box, a worm gear mounted in said box driving said cranks and meshing with said worm, and means for compensating for variations in alinement between said worm shaft and motor shaft, substantially as and for the purpose set forth.

13. A fluid compressor comprising a plurality of pumping cylinders, reciprocating plungers therein and pitmen respectively connected to said plungers, a pair of crank shafts disposed side by side transversely to the axis of said cylinders with crank arm connections with said pitmen, intermeshing worm gears respectively on each of said shafts and a common worm shaft for driving said gears.

14. In a fluid compressor, a pumping apparatus comprising a plurality of cylinders symmetrically disposed with respect to the central axis of the said compressor, crank shafts transversely disposed one adjacent the ends of each pair of cylinders, plungers within the cylinders and pitmen connecting them respectively with their adjacent crank shafts, intermeshing worm gears one on each

of said crank shafts and a common power shaft for said worm gears having worms engaging therewith.

15. In a fluid compressor, a pumping apparatus comprising four cylinders symmetrically disposed with respect to the central axis of the said compressor, crank shafts transversely disposed one adjacent the ends of each pair of cylinders, plungers within the cylinders and pitmen connecting them respectively with their adjacent crank shafts, intermeshing worm gears one on each of said crank shafts and a common power shaft for said worm gears having worms engaging therewith.

16. In a fluid compressor, a pumping apparatus comprising four cylinders symmetrically disposed with respect to the central axis of the said compressor, crank shafts transversely disposed one adjacent the ends of each pair of cylinders, plungers within the cylinders and pitmen connecting them respectively with their adjacent crank shafts, a pair of intermeshing worm gears one on each of said crank shafts and a common power shaft for said worm gears having reversely pitched worms engaging therewith.

17. In a fluid compressor, a set of four pumping cylinders symmetrically disposed with respect to the central axis of the said compressor, plungers and connected pitmen therefor, in combination with a pair of intermeshing gears centrally disposed between the axes of each pair of cylinders and having crank connections with said pitmen, and a power shaft common to said worm gears having reversely pitched worms in engagement therewith, whereby the strains of said gearing are rendered substantially uniform regardless of the relative positions of the plungers within their cylinders.

18. In a fluid compressor, a plurality of cyl-

inders having reciprocating plungers therein, a shaft common to each pair of plungers and provided with crank connections with each of them, worm gears positively geared together and to said shaft, in combination with a power shaft engaging said worm gears and disposed between the plane of their axes and the ends of the cylinders.

19. In a fluid compressor, a cylinder casting, a reciprocating plunger therein, a journal bracket secured thereto comprising a pillow block and cap plate therefor, said block and plate forming a journal seat, gearing journaled in said seat for reciprocating said plunger, in combination with a power shaft for driving said gearing and a journal seat for said power shaft comprised of complementary recesses in the meeting faces of said casting and pillow block and bolts extending through said cap, pillow block and casting for fastening them securely together and confining the shaft and gearing in the respective journal seats.

20. In a fluid compressor, a cylinder having a plunger provided with a pitman, a crank shaft and gear wheel for driving said pitman, in combination with a support for said shaft and wheel secured directly to the end face of the cylinder, said support comprising a bracket with a central recess for receiving a gear wheel and forked members constituting journal seats for the crank shaft and being also provided with a recess comprising a portion of the journal seat for the power shaft.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

MILAN W. HALL.

Witnesses:

THOMAS F. WALLACE,
FRED WHITE.