No. 636,013

Patented Oct. 31, 1899.

# G. W. TOLLE.

## AIR COMPRESSOR.

(Application filed May 19, 1899.)

(No Model.)

2 Sheets—Sheet 1.

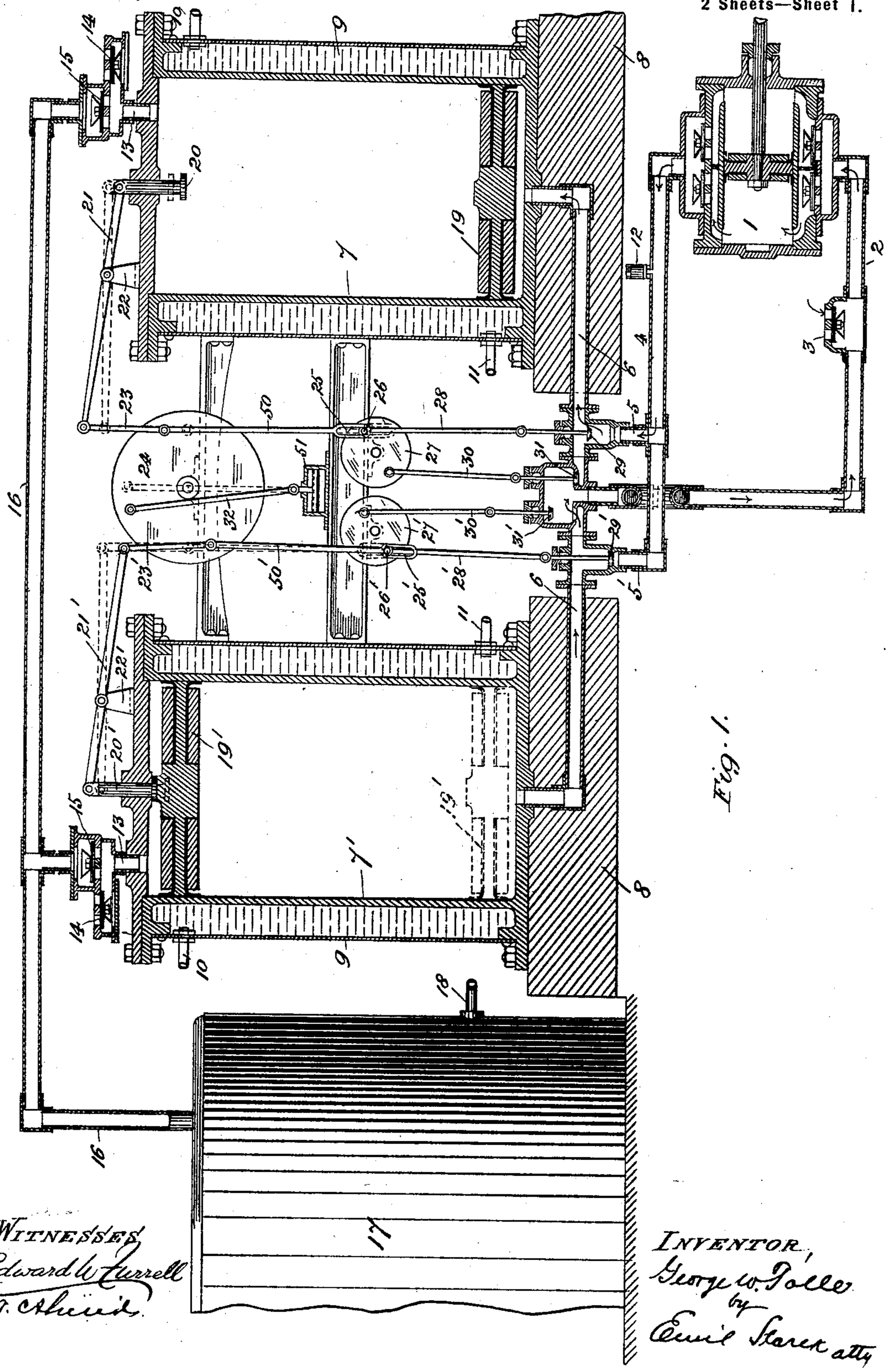

Fig. 1.

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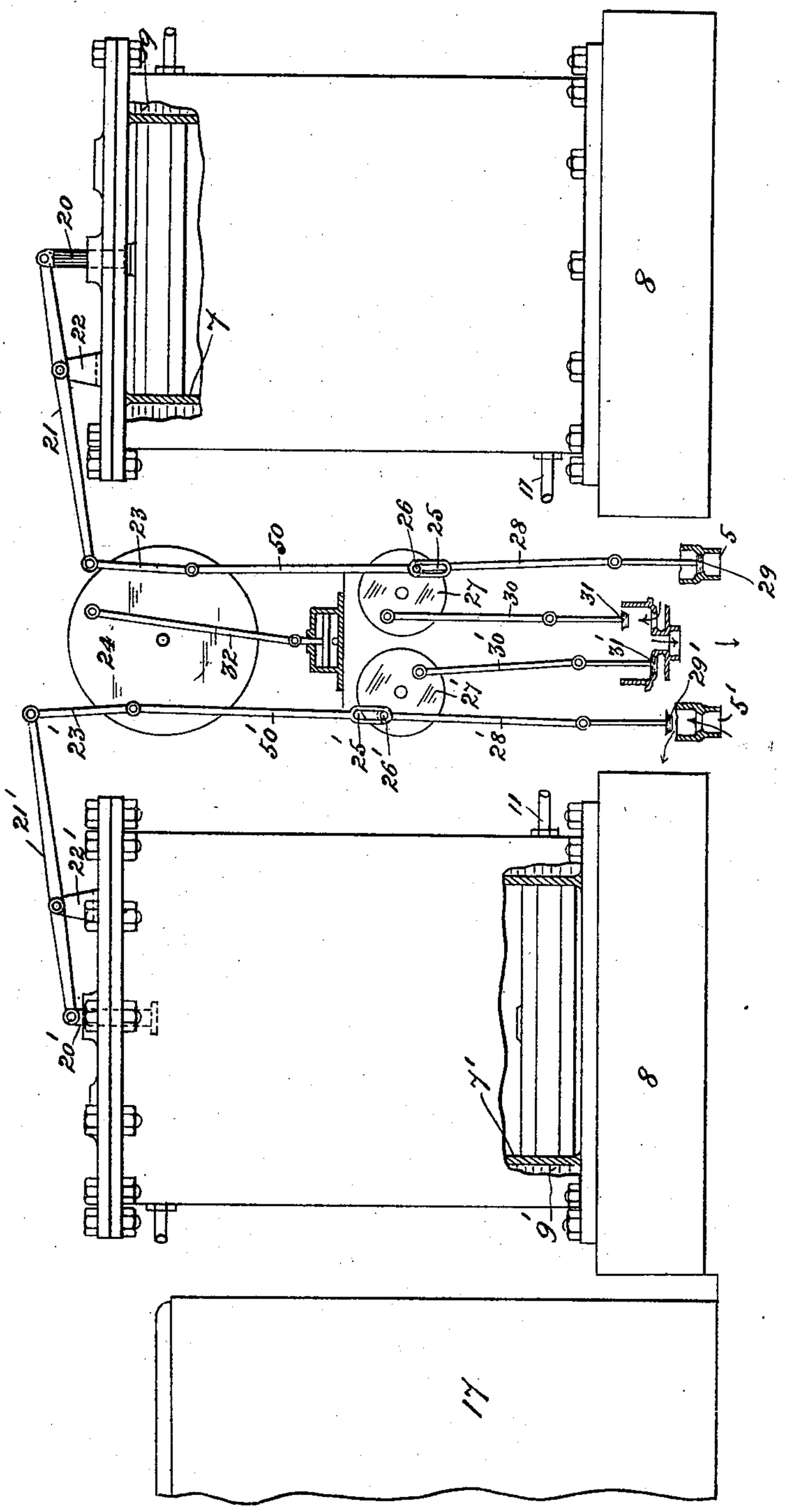
Fig. 2

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# UNITED STATES PATENT OFFICE.

GEORGE W. TOLLE, OF ST. LOUIS, MISSOURI.

## AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 636,013, dated October 31, 1899.

Application filed May 19, 1899. Serial No. 717,443. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE W. TOLLE, a citizen of the United States, residing at St. Louis, State of Missouri, have invented certain new and useful Improvements in Air-Compressors, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part hereof.

My invention has relation to improvements in air-compressors; and it consists in the novel arrangement and combination of parts more fully set forth in the specification and pointed out in the claims.

In the drawings, Figure 1 is a vertical sectional elevation of my apparatus, showing the valves set either for one of the extreme positions of both pistons of the cylinders or for the lowest positions of both of said pistons, this view showing by dotted lines an intermediate position of the several parts; and Fig. 2 is a similar elevational view, parts being broken away, showing the parts in the reverse or second of their extreme positions.

The object of my present invention is to interpose between the air-storage tank (or receiver) and the air-pump of an air-compressing apparatus a series of two (or more) intermediate compressor tanks or cylinders, by the reciprocations of the pistons or movable diaphragms of which the forcing of the air into the storage-tank is accomplished, the pistons themselves being actuated intermittently by the action of the air-pump. In the present invention I utilize the compressed air delivered by the pump in the raising of the piston of one cylinder to subsequently partially raise the piston or diaphragm of the second cylinder and also in a measure to equalize the initial pressure on each side of the air-pump piston as the latter begins the work of raising the piston of said second cylinder to its full stroke, it being understood that the raising of the piston of either compressor-cylinder results in the forcing into the storage-tank of the air above such piston. By thus equalizing in a measure the pressure on each side of the pump-piston during the pumping operation the piston of the air-pump operates in an atmosphere the pressure of which is distributed against each face of such piston, permitting the latter to operate under a minimum amount of resistance no matter what may be the accumulated pressure in the storage-tank, this reduction of resistance resulting in a corresponding economy of driving power, and hence economy of fuel consumed. This will be better apparent from a detailed description of the invention, which is as follows:

Referring to the drawings, 1 represents an ordinary double-acting air-pump actuated from any suitable source of power. (Not shown.) To the cylinder of the pump leads an air-induction pipe 2, provided with an air-inlet or check valve 3, and from the cylinder likewise leads a delivery-pipe 4, the farther end of which connects by means of two connecting-pipes 5 5′ to a pipe 6, whose opposite ends are respectively connected to the bottoms of the compressors or cylinders 7 7′, the latter resting on suitable foundations 8 8, which partially protect the pipe 6. The latter pipe is also connected to the adjacent end of the air-induction pipe 2. Each compressor is provided with a water-jacket 9, as usual, through which cold water may circulate by way of the pipes 10 11, the flanged lower heads of the compressors being bolted to the foundations. The pipe 4 is provided with a pop safety-valve 12 of any approved construction. Leading from the upper head of each compressor is a pipe 13 13, the base of which is provided with an ordinary air-inlet valve 14 and with a check-valve 15, past which the air forced from the compressor must flow to reach the main supply-pipe 16, which supplies air to the storage tank or receiver 17, the latter being provided with a pipe 18, communicating with the throttle or any valve by which steam is admitted to the engine which drives the air-pump, whereby when the pressure of air within the storage-tank exceeds a certain number of pounds the pump may be automatically stopped. Inasmuch as this manner of cutting off the steam (or, in fact, any motive power) is old, I neither claim nor show the construction by which the same is accomplished, as any form of automatic cut-off may be employed.

Each compressor is provided with a reciprocating piston or diaphragm 19 19′, adapted to initially rest at the bottom of the compressor and be forced to the upper end thereof

under the action of the pump, as presently to be seen. Projecting through the upper head of the compressor 7 and extending a suitable distance into the same is a plunger 20, the outer projecting end of which is pivotally connected to the short arm of a lever 21, mounted on a bracket 22 on top of the compressor, the end of the long arm of said lever being pivotally secured to the upper end of a rod 23, which is pivotally connected to a rotatable valve-reversing disk 24, mounted between the compressors. Secured to the disk 24, about the same pivot as rod 23, is a rod or link 50, whose lower end is provided with a slot 25, through which connection is established by a pin 26 with a valve-actuating disk 27, mounted adjacent to the compressor, the pin 26 serving likewise to pivotally connect the disk with the upper end of a connecting-rod 28, whose lower end is connected pivotally to the stem of a valve 29, establishing communication between the upper end of pipe 5 and the compressor 7. Pivotally secured to the disk 27 at a point diametrically opposite the pin 26 is the upper end of a rod 30, whose lower end is pivotally secured to the stem of a valve 31, controlling communication between the pipes 2 and 6. The features enumerated have their counterparts on the opposite side of the machine and are designated in the drawings by 20′, 21′, 22′, 23′, 50′, 25′, 26′, 27′, 28′, 29′, 30′, and 31′, respectively. Mounted between the compressors 7 7′ below the disk 24 is an air-cylinder or dash-pot 51, the stem of the piston of which is povotally connected to the lower end of a connecting-rod 32, whose upper end is pivotally secured to the face of the disk 24 at a point midway between the rods 23 23′. The upper end of the rod 32 is at its dead-center—that is, at the upper end of the vertical diameter of the disk 24—when the rods 23 23′ have been reciprocated under the tilting of their levers 21 21′ an amount to respectively pay out the full lengths of their lower terminal slots 25 25′ against the pins 26 26′. Such intermediate position is shown in dotted lines in Fig. 1.

The operation of the compressor is as follows: Let us assume that both compressor-pistons 19 19′ are at the bottom of their respective chambers or cylinders and that the valve-reversing disk has been set so as to open the valves 29 and 31′ and close valves 29′ and 31. For this position of the valves the air which enters the pump-cylinder by way of the valve 3 is pumped through the pipe 4, branch 5, passing through the right in pipe 6 into the compressor 7, and gradually raising piston 19. When the valves are in the position here indicated, the plunger 20 is in its lowest position and the plunger 20′ is in its highest position. As the piston 19 is raised it strikes the plunger 20, forcing the same upward, thereby forcing the end of the long arm of lever 21 downward, and thus turning the disk 24 to the right (or in the direction of the hands of a watch) and gradually bringing the upper pivoted end of the rod 32 in line with the vertical diameter of the disk 24 or on its "dead-center," compressing the cushion of air above the piston of the dash-pot, but in no wise disturbing the position of the valves, it being understood, as above stated, that the disk 24 has a movement independent of that of either of the valve-actuating disks 27 27′ by reason of the slots 25 25′, formed at the lower ends of the rods 50 50′, and (by a reference to Fig. 1) by the time the disk 24 has been rotated to its dead-center, as just described, the pin 26, which before the movement of the plunger 20, as just pointed out, was at the base of the slot 25, will now be at the top thereof, and the pin 26′, which was at the top of slot 25′, will be at the bottom thereof. A further upward movement of the piston 19 will force the plunger 20 upward its full extent, thereby causing the disk 24 to revolve far enough to the right to pass beyond its dead-center, the elasticity of the air-cushion of the dash-pot positively drawing upon the connecting-rod 32, effecting a sudden further rotation of the disk 24, and from the connections, as described, effecting a sudden reversal of the valves—that is, valves 29 and 31′ are closed and valves 29′ and 31 are open (see Fig. 2) and the plunger 20′ has been depressed. Under these circumstances the piston 19 will gradually drop, the air forced under it from the previous operation being now drawn into the pump by way of the open valve 31 through the pipe 2 and pump 1 and forced through pipe 4, branch 5′, by way of valve 29′, into the compressor 7′, and gradually raising piston 19′ until the air previously compressed under piston 19 has been exhausted, after which the pump will draw the atmospheric air through the valve 3 and force the same under the piston 19′ until it reaches the top of the compressor 7′, it being understood that all the time the piston 19′ is rising it is forcing the air above it into the storage-tank, and while the piston 19 is dropping atmospheric air flows into the cylinder 7 above the piston thereof to be subsequently forced into the storage-tank upon a subsequent upward stroke of the said piston. When the piston 19′ reaches the end of its full upward stroke, the plunger 20′ will have been forced upwardly and outwardly and the valves set to the first or original position, the piston 19′ now being free to descend to the bottom of cylinder 7′, the air from under it passing by way of the now open valve 31′ through pipe 2 into the air-pump and through the latter back again into cylinder 7 by way of valve 29, the piston 19 being again raised as before.

It will be observed that every time either of the pistons 19 19′ is raised the air above the same is forced or compressed into the storage tank or receiver 17. The resistance to the upward movement or stroke of the pistons 19 19′ depends upon the resistance which the tension of the air compressed within the re-

ceiver offers against the movement of said pistons, and while the compressor-pistons necessarily receive the full and direct pressure of this tension during the pumping operation the pump-piston is relieved of a large percentage of such pressure, for the reason that during the descent of either one of the compressor-pistons the compressed air, which is withdrawn from under it to allow for its descent, must pass through the pump-cylinder before it is delivered under the piston of the other compressor. By being caused to pass through the pump-cylinder it equalizes the pressure on each side of the pump-piston, and the only resistance which the latter encounters in its reciprocations is the work it has to perform in forcing into the compressor in which the piston is ascending a sufficient amount of atmospheric air under such ascending piston to effect the discharge of the volume of air above it into the receiver. This work is approximately measured by the difference in the tensions between the compressed atmosphere within which the pump-piston operates and the tension of the air within the receiver which the ascending compressor-piston must overcome to effect its upward stroke. Thus it will be seen that whatever be the tension of the compressed air which flows from one compressor to the other, inasmuch as this compressed air must pass through the pump-cylinder, it exerts the same pressure on each side of the pump-piston, thus balancing the latter and reducing the work the latter has to perform to a minimum. In the ordinary air-compressor one face of the pump-piston is always exposed to only the ordinary atmospheric pressure, the other face receiving the full benefit of the tension of the air stored in the receiver, the pump thereby necessitating a maximum amount of steam or other motive power, and thus consuming a maximum amount of fuel. By the use of my intermediate compressor-cylinders 7 7′ the conditions under which the pump operates are most favorable and a superior fuel-saving air-compressing apparatus results.

It is of course apparent that many changes can be made without departing from the spirit of my invention. For example, the valve-reversing mechanism here shown and described could be entirely changed, the purpose thereof being simply to reverse the valves controlling the flow of air from one cylinder to the other at the proper moment.

Of course where the pump first begins to operate—that is to say, when both of the cylinder or compressor pistons are in their lowest position—the advantage inherent in the present system is not available, since at the first stage of the operation the pump merely forces atmospheric air under the piston of one of the cylinders, such piston in turn driving the air which is above it into the receiver.

Having described my invention, what I claim is—

1. In an air-compressing apparatus, a suitable air-pump, a storage tank or receiver, two communicating cylinders interposed between the pump and receiver, pipe connections establishing communication between the cylinders, and the pump, a piston for each cylinder, pipe connections between the cylinders and receiver, suitable valves controlling the several pipes, the pump being adapted to force atmospheric air under the piston of either cylinder, and subsequently circulating such compressed air alternately from one cylinder to the other, and a check-valve located in the path of the supply-pipe of the pump for permitting the flow through the pump of additional atmospheric air into the cylinders to effect the reciprocation of the pistons and forcing the air in front of such pistons into the receiver, the parts operating substantially as and for the purpose set forth.

2. In an air-compressing apparatus, a receiver, a series of two cylinders communicating therewith, pistons for said cylinders, an air-pump, a pipe connecting the bottoms of the cylinders with the air-pump, an air-induction pipe leading from the pump to said connecting-pipe, an air-delivery pipe leading from the pump and terminating in two branches which in turn communicate with said connecting-pipe, a series of controlling and air valves located in proper positions in said pipes, whereby the pump is adapted to first pump air into one cylinder under the piston thereof, and subsequently pump the air so forced into the other cylinder, and then back into the first, and a check-valve located in the path of the supply-pipe of the pump, for automatically permitting an increase of the initial quantity of air by fresh additions from the atmosphere with the consecutive reciprocations of the cylinder-pistons, the latter in their operations forcing the air which is in front of, or above them, into the receiver, substantially as set forth.

3. An air-compressing apparatus comprising an air-pump, a receiver, two intermediate communicating cylinders, pipe connections between the cylinders and air-pump, valves controlling the communication between said pipe connections and the cylinders, valve-actuating disks for said valves, a valve-reversing disk, slotted links connecting said valve-reversing disk to said valve-actuating disks, a plunger for each cylinder, link or lever connections between the plungers and valve-reversing disk, a piston for each cylinder, suitable inlet and check valves for the several pipes, an air-cylinder or dash-pot, and a link connection between the piston of the dash-pot and valve-reversing disk, the parts operating substantially as and for the purpose set forth.

In testimony whereof I affix my signature in presence of two witnesses.

GEORGE W. TOLLE.

Witnesses:

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