J. F. ALLEN.
Air Compressor.

No. 237,360. Patented Feb. 8, 1881.

Fig. I.

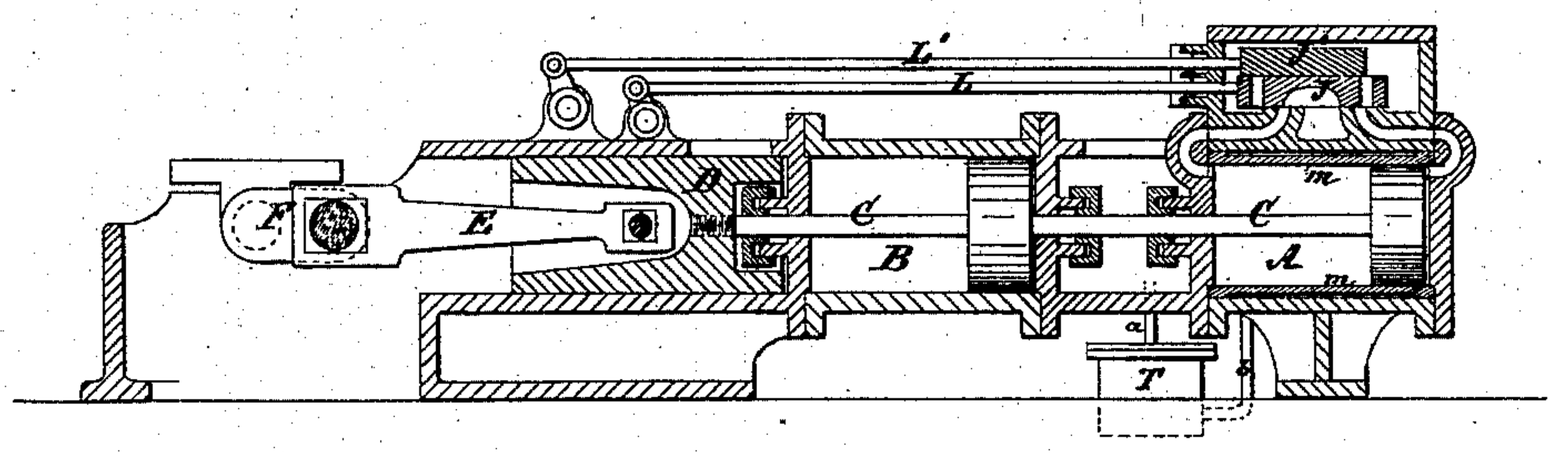


Fig. II.

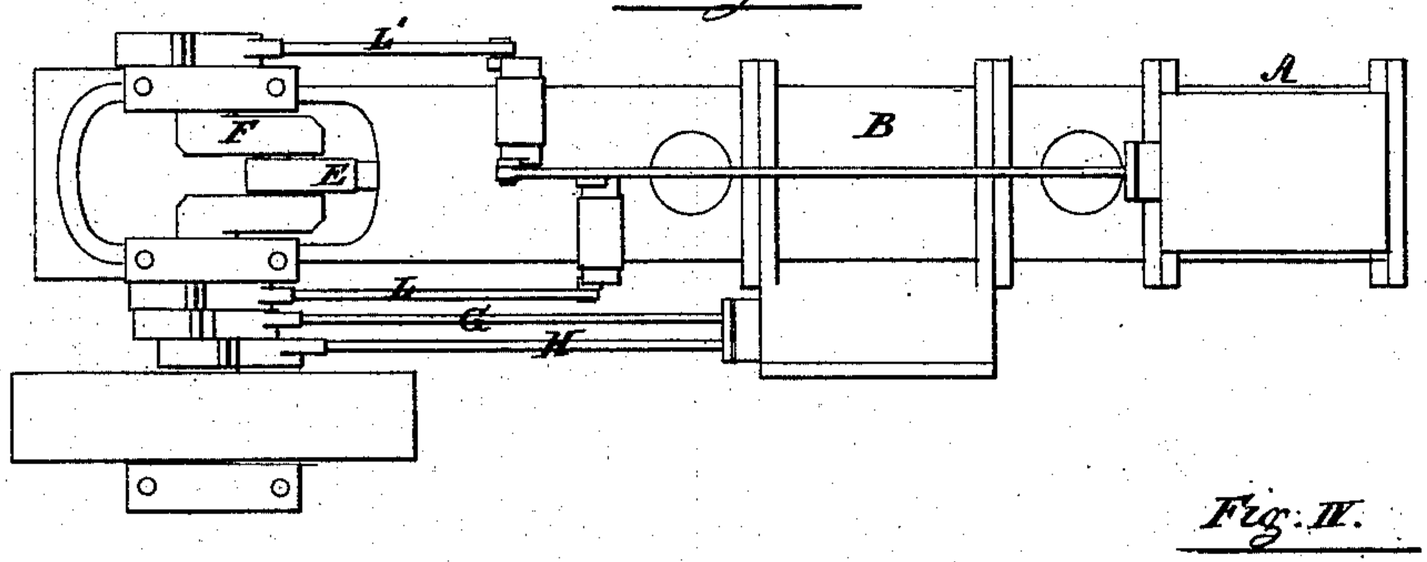


Fig. III.

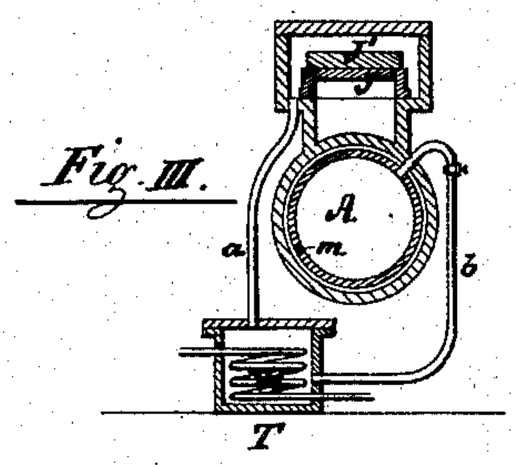


Fig. IV.

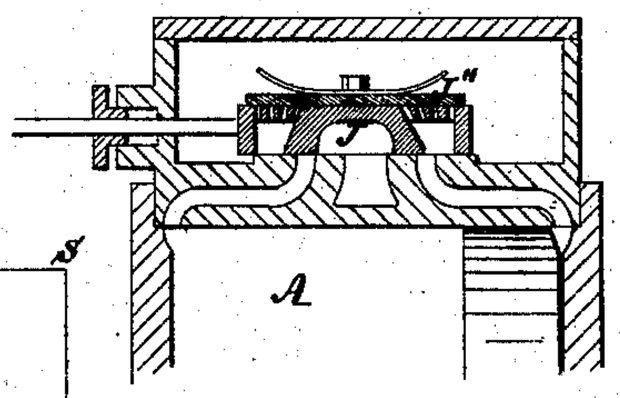
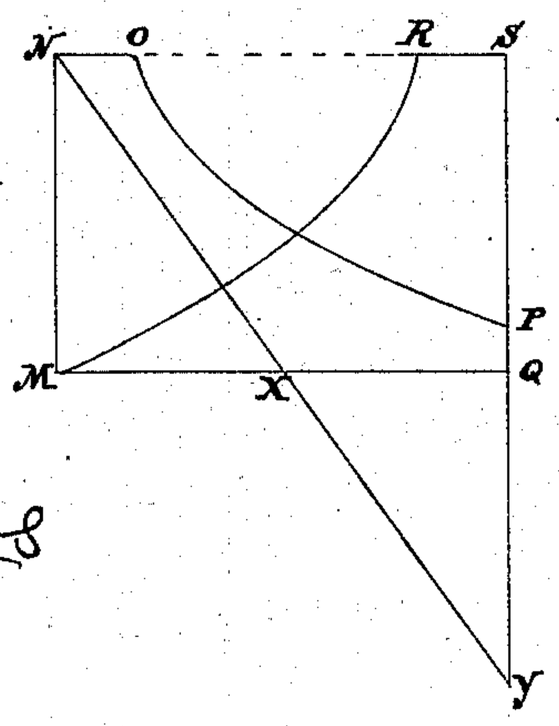


Fig. V.



Witnesses.

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UNITED STATES PATENT OFFICE.

JOHN F. ALLEN, OF BROOKLYN, NEW YORK.

AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 237,360, dated February 8, 1881.

Application filed May 21, 1879. Patented in England September 29, 1879.

To all whom it may concern:

Be it known that I, JOHN F. ALLEN, of Brooklyn, Kings county, and State of New York, have invented new and useful Improvements in Air-Compressors, of which the following is a specification.

The nature of my invention consists, principally, in the combination, with an air-compressing apparatus, of induction and eduction valve or valves controlled in a positive and uniform manner in every part of the movement of such valve or valves by means of a direct connection of such valve or valves with the shaft or a counter-shaft of the prime motor.

It also consists in the arrangement of a heavy reciprocating weight to which the piston-rods of both steam and air cylinders are attached, causing them to reciprocate coincident with each other, their throw being limited by their connections with the crank-shaft; and it also consists in a peculiar arrangement for lubricating and cooling the air-compressing cylinder.

In the accompanying drawings, Figure I represents a longitudinal section of an air-compressor embodying my invention. Fig. II is a top view of the same. The other figures represent details, and are referred to in the following description.

Similar letters represent similar parts in all the figures.

A represents the air-compressing cylinder, and B the steam-cylinder for operating the same. These cylinders are placed one before the other, and the pistons of both cylinders are attached to one and the same piston-rod, C. At the end of the piston-rod C a heavy weight, D, is attached, to which the connecting-rod E connects, the other end of the rod being connected to the crank F. To simplify the construction this heavy weight D is arranged to act as the guide for the end of the piston-rod.

The steam-cylinder B of the prime motor is constructed, in the usual manner, with suitable valves operated through the eccentric-rods G and H.

The air-compressing cylinder A is provided with a slide-valve, J, for the induction of the air and suitable ports for the eduction of the same, and having another valve or valves, J′, arranged on the back face for regulating the eduction of the air. For simplicity and cheapness I prefer to seat this last-mentioned valve or valves on the back of the valve J. These valves receive positive motion through suitable connecting-rods, L L′, which connect the valves directly with the shaft (or it may be a counter-shaft) of the prime motor, the attachment of the rods in this instance to the shaft or counter-shaft of the prime motor being eccentrics.

In all air-compressing apparatus heretofore devised the valves of the compressing-cylinder for the induction and eduction of the air were either of the self-acting kind operated by the pressure of the air acting underneath them, uncontrolled by any positive motion of the machine itself, or else were at a certain portion of the stroke of the piston operated so as to cause them either to open or shut, as the case might require; but at all other times they were wholly uncontrolled by any positive motion, as was the case of the wholly self-acting valves above described. Consequently, when it was desirable to run the compressing apparatus at a high speed, or any speed above the ordinary, the apparatus lost all, or nearly all, control of the valves, especially the induction-valves, through their inertia while at rest and their momentum while in motion, and the air-cylinder would therefore compress less air at a high rate than it would at a low rate of speed.

By the combination, with the air-compressing cylinder, of a positive-motion induction and eduction valve gear the quantity of air that I am enabled to compress is in direct proportion to the speed of the machine, and by the use of heavy reciprocating parts I am enabled to compress the air with a considerable saving of power when the steam-cylinder piston and the air-cylinder piston are upon the same reciprocating piston-rod and the latter is connected direct to the crank-shaft. The part which this heavy reciprocating weight D performs in the economy of power consists in absorbing the force of the steam at the commencement of the stroke, in putting this weight in motion, and returning it at the latter part of the stroke by the momentum of the weight. Where this is done upon the same rod there

will be considerable saving of power, as it avoids the transmission of the load through the shaft and the revolving of the latter while under this load, for if the reciprocating parts have but little weight the whole of the force of the steam will be thrown upon the shaft at the commencement of the stroke to get it into the fly-wheel, and at the latter part of the stroke the fly-wheel throws the load upon the shaft again in compressing the air in the cylinder. The diagram represented in Fig. V will illustrate this point under discussion.

Let M N O P Q represent the steam-diagram, and M R S Q that of the air compressed.

It will be observed that the force of the steam at the commencement of the stroke has very little resistance from the air, and at the latter part of the stroke, where the force of the steam is reduced by expansion, the resistance from the compressed air is greatest. Now, if we have to equalize these forces by means of the fly-wheel, almost all of the steam-force will have to be thrown upon the shaft and the shaft revolve under this load, which even in moderate-sized cylinders will amount to several tons, a large proportion of which would be lost in friction; but by the employment and use of heavy reciprocating parts the fore part of the steam-diagram, equal to N M X, will be absorbed in the acceleration of the part and given out again at the latter part of the stroke, as X Q Y. Then we should have the diagram N O P Y to compress the air, N M X being absorbed in the acceleration, and X Q Y being returned by the momentum of the parts. Engineers will readily observe that by this means heavy fly-wheels may be dispensed with and the shaft may be made to revolve nearly in equilibrium instead of revolving it under the entire load.

The valve J′ to regulate the eduction of the air may be made in a single valve, as shown in Fig. 1, or the same may be divided similar to an expansion-valve in a steam-cylinder. When a single valve is used the line of opening the parts for any desired pressure must be varied either by a link-motion in the valve-gear or by advancing or retarding the eccentric upon the shaft. When separate or a divided valve is used the same may be varied and regulated by a right-and-left-hand screw.

In some cases, where simplicity is desired, the valve at the back of the slide-valve J may be made self-acting, as shown in Fig. IV, where J represents the slide-valve operated by a positive motion, and J″ the self-acting valve, made of leather, india-rubber, canvas, or metal.

When but light pressure is required a single valve with considerable amount of lap may be employed. A valve and valve-gear such as patented by me in 1862 and 1869 may be used to considerable advantage for that purpose.

Fig. III is a cross-section of the air-compressing cylinder, and represents the arrangement of lubricating and cooling the air-cylinder.

T is a reservoir or receiver in which a coil, W, is arranged, through which water is made to circulate. This reservoir is placed at a lower level than the air-compressing cylinder A. This reservoir is made perfectly tight, and the top is connected, through a pipe, *a*, with the bottom of the valve-chest, and a pipe, *b*, leading from the lower part of said reservoir, is connected with the top of the air-cylinder A, or with the eduction-passage.

When the compressor is started a quantity of cooling-liquid, which may consist of oil and water, but preferably water and washing-soda, is introduced into the air-cylinder, together with the entering air, which liquid, after passing through the compressing-cylinder, will be deposited in the reservoir or receiver T, passing through pipe *a*. After a sufficient quantity has been introduced in this manner this liquid may be made to circulate itself by opening a small cock in the pipe *b*, as the liquid in the reservoir T is under the pressure of the compressed air, and the upper end of the pipe *b* is connected either with the induction-passage of the air-cylinder or with the air-cylinder itself. By this means the liquid becomes self-circulating and keeps the compressing-cylinder lubricated, and at the same time cool, as the liquid is cooled by passing over the coil W in the reservoir T, through which a constant stream of cool water is allowed to run; or the reservoir T may be placed into a vessel containing cool water. Another advantage derived from this free and continued circulation of liquid into the air-compressing cylinder consists in the fact that this liquid will fill all passage-ways and clearance-spaces in the cylinder, generally called "lost space." When the compressed air is forced out of the cylinder near the end of said strokes the air will first escape through the valve into its reservoir, while the fluid drawn in at the same time will fill all the spaces, such as at the end of the stroke, between the piston and cylinder-head, as well as the passage-way between the cylinder and the valves, while only the surplus liquid will be forced through the valve J into the valve-chamber and pass again into the reservoir T. This filling of all passages and lost spaces with a liquid at the end of each stroke excludes all compressed air from those parts, which, on the return of the piston, would naturally expand again and partly fill the cylinder and reduce the capacity of the cylinder considerably.

Independent of this above-described arrangement of cooling the cylinder, the same may be lined by lining *m*, made to fit only at each end, leaving a space all around the central part, into which water or other liquid may be introduced and made to circulate. The cylinder-heads close the joints between this lining *m* and the cylinder, and the passages are in this case constructed so as to pass through the cylinder-heads around this joint, as is clearly represented in Fig. 1.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In an air-compressing apparatus, the induction-valve of the compressing-cylinder, connected directly with the prime motor by means of a connecting-rod, so that such valve shall always be moved and controlled in a positive and uniform manner, in combination with a self-acting valve for regulating the discharge of the compressed air, substantially as described.

2. In an air-compressing apparatus, the induction-valve of the compressing-cylinder, connected directly with the prime motor by means of a connecting-rod, so that such valve shall always be moved and controlled in a positive and uniform manner, in combination with a valve to regulate the discharge of the compressed air by opening and closing ports in the back of the former, substantially as described.

3. In combination with the air-compressing cylinder and the steam-cylinder, placed in the same line, so as to have the pistons of both cylinders attached to the same piston-rod, the heavy reciprocating weight D, substantially in the manner and for the purpose set forth.

4. In combination with an air-compressing cylinder, the reservoir T, containing a coil, W, said reservoir connected to the valve-chamber and to the air-compressing cylinder, and arranged to operate, when filled with a suitable fluid, in the manner and for the purpose substantially as specified.

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Witnesses:
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