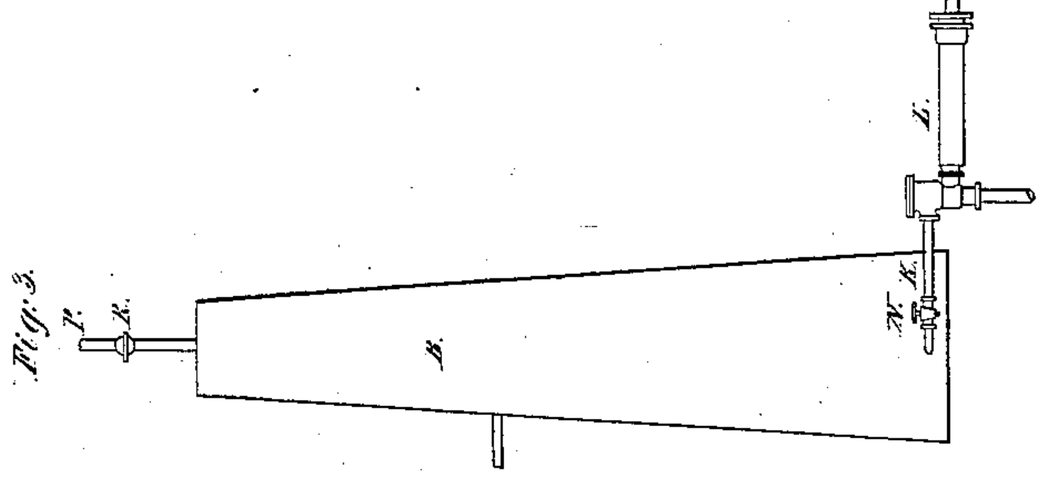
W. Arthur,

Compressing Air,

No. 48,886. Patented July 25, 1865.



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WILLIAM ARTHUR, OF BROOKLYN, NEW YORK.

IMPROVEMENT IN APPARATUS FOR COMPRESSING AIR.

Specification forming part of Letters Patent No. **48,886**, dated July 25, 1865.

To all whom it may concern:

Be it known that I, WILLIAM ARTHUR, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Apparatus for Compressing Air; and I do hereby declare that the following is a full, clear, and exact description of my said invention, reference being had to the accompanying drawings, in which—

Figure 1 represents a plan of an air-compressing apparatus constructed according to my invention. Fig. 2 represents a front elevation of a portion of the same; and Fig. 3 represents an elevation of another portion of my apparatus.

Difficulty has been experienced in compressing air to a high tension, on account of the imperfection of the valves of the pumps employed for the purpose, the necessity of leaving a space for clearance at the end of the air-pump barrel, and the leakage of the piston-packing, because, as the difference between the pressures of the air entering the pump and that leaving it increases by reason of the increase in the tension of the compressed air, the leakages increase and the expansion of the air left in the clearance-space at the end of the stroke of the piston is sufficient upon the return-stroke to fill the pump-barrel to a considerable extent and greatly diminish the quantity of the air drawn in by the movement of the piston. The difficulty in compressing air to a high tension with an ordinary air-pump is, in fact, so great, as I have found by experiment, that it is practically impossible to operate the air-pump so as to raise the tension of the air upon which it acts a much greater extent than eighty pounds per square inch, without an extravagant expenditure of power, unless the air-pump be constructed with much greater nicety than is the practice in machine-shops, which greatly increases the cost of the apparatus, and unless much greater care is exercised in keeping it in working order than can be obtained from the class of operatives by whom such apparatus is generally worked.

The object of my invention is to permit air to be compressed to any desired tension without exceeding a certain predetermined difference of pressure between the air entering and the air leaving the pump-barrel, so that the air-pump is never required to compress the air upon which it acts more than it is capable of compressing it advantageously.

To this end my invention consists in compressing the air methodically by combining the air-pump with two or more air-vessels by means of pipes and stop-cocks or valves, in such manner that the air compressed into one air-vessel may be used to supply the pump when compressing air into one or more other air-vessels to a higher tension. The air entering the pump-barrel is therefore already compressed to a certain tension, and the amount of increase in tension which the pump is required to produce need not exceed that at which it will work advantageously.

My invention consists, further, in constructing the vessel into which the air is ultimately compressed of conical form and combining it with a water force-pump, so that the air may be compressed into the smallest part of the vessel by the action of the water injected into the vessel.

The air-compressing apparatus represented in the accompanying drawings is an illustration of one mode in which my invention may be embodied, and is suitable for compressing air for the purpose of blowing out the pipes of petroleum-wells. The air-pump A used in this example is an ordinary double-acting air-pump fitted with puppet-valves and air-passages, which are contained in a chest, H, above the pump-barrel.

The suction air-passages leading to the entry-valves of the pump are fitted with short pipes, to which stop-cocks G G are applied, so that the entry-valves may be supplied with air from the atmosphere, or may be shut off therefrom by closing the stop-cocks. The suction air-passages of the pump are also connected by a pipe, I, with four of the air-vessels, B' B^2 B^3 B^4, all of which are plain cylinders, while the fifth, B, is of conical form.

The branch pipe leading from the main suction-pipe to each air-vessel is fitted with a stop-cock, F' F^2 F^3 F^4, by means of which the air-vessel to which it appertains may be connected with the suction-pipe of the pump, or may be disconnected therefrom. The discharge air-passage leading from the exit-valves of the air-pump is also connected with the air

vessels by means of a pipe, J, and the branch pipe leading from this discharge-pipe to each of the air-vessels is fitted with a stop-cock, D D′ D² D³ D⁴, by means of which any one of the vessels may be put in connection with the discharge-pipe of the pump, or may be disconnected therefrom. For a reason that will be hereinafter stated, a second discharge-pipe, J′, may be used to connect the last air-vessel in the series with the discharge-passage of the pump. The conical air-vessel B is also connected by means of a pipe, K, with a force-pump, L, suitable for injecting water into it; and as this pump is used to inject water into the air-vessel when the air within it has previously been compressed to a high tension, the area of the pump-plunger should be small enough to enable the motor employed to operate it with ease under the highest tension to which the air is to be compressed.

The main suction-pipe I, the two discharge-pipes J J′, and the injection-pipe of the water force-pump are each fitted with a stop-cock, E C M N, between the air-vessels and the pump-valves. The conical air-vessel is fitted with an exit-pipe, P, leading from its upper end to the place where the compressed air is to be used, and this pipe is fitted with a stop-cock, R.

The mode of operation with such an apparatus is as follows, assuming that the operation is commenced when the air-vessels of the apparatus are filled with air at the pressure of the atmosphere: The stop-cock E of the main suction-pipe I, and those F′ F² F³ F⁴ of all the branch suction-pipes are closed; the stop-cock N of the water injection-pipe, and that M of the supplementary-discharge pipe J′ are also closed; the stop-cock C of the main discharge-pipe J, and those D D′ D² D³ D⁴ of all the branch discharge-pipes are opened, and the stop-cock R of the exit-pipe P is closed; the stop-cocks G G, which connect the suction-passages of the air-pump with the atmosphere are opened. The air-pump is then set to work and air is drawn into it from the atmosphere through the entry-valves and discharged through the exit-valves into the main discharge-pipe J, whence it passes into all the air-vessels. As the pump operates, and barrelful after barrelful of air is forced into the air-vessel, the tension of the air therein is progressively raised, and the operation of the pump is continued until the pressure in all the air-vessels reaches the limit at which it is expedient to work the air-pump—say eighty pounds per square inch. The entry air stop-cocks G G at the suction-passage of the pump are then closed, so as to shut off the connection of the pump with the atmosphere. The stop-cock D⁴ of the branch discharge-pipe leading to the last air-vessel, B⁴, is closed, and the stop-cock E of the main suction-pipe I and that F⁴ of the branch leading to the last air-vesssl B⁴ are opened. By these operations the suction-passages of the pump are put in connection with the last air-vessel in the series, so that the supply for the pump is drawn from this air-vessel, in which the air has already been compressed to a tension of eighty pounds per square inch. The air-pump then operates upon this compressed air and forces it into the remaining air-vessels of the series, and as the work imposed on the pump and the strain incident thereto is to overcome the difference between the pressure of the compressed air entering it from the vessel B⁴ and that in the remaining air-vessels into which the air is discharged, the air may be compressed in the latter to a much greater tension than eighty pounds per square inch above that of the atmosphere before the strain upon the pump reaches the working-pressure of eighty pounds per square inch. Moreover, as the leakages at the valves and the expansion of the air in the clearances of the pump-barrel depend upon the difference between the pressure of the air entering and of that leaving the air-pump, they will not be more injurious under the increased tension in the remaining air-vessels than they were when the air drawn from the atmosphere was first compressed to the tension of eighty pounds per square inch. When the difference between the pressures of the air in the last air-vessel, B⁴, and the remaining air-vessels amounts to the predetermined quantity of eighty pounds per inch, the last air-vessel, B⁴, is disconnected from the pump by closing the branch suction stop-cock F⁴, and the last air-vessel, B³, of those remaining is disconnected from the others, and is put in connection with the entry-valves of the pump by closing and opening the proper stop-cocks. The operation of the pumps is then continued until the difference between the pressure of the air remaining in it and that forced into the other vessels reaches eighty pounds per square inch, as before, when that second vessel is shut off from the pump, and the supply of the pump is drawn from the third vessel of the set, which then becomes the last of the series in connection with the pump.

The operation is carried on until the fifth vessel, B, alone receives the compressed air from the pump, and the pressure of the air in it exceeds by eighty pounds per square inch the pressure in the fourth vessel. Then the connection with the fifth vessel and the air-pump is shut off by closing the stop-cock D, and the compressed air may be permitted to issue through the exit-pipe to the place where it is to act. If, however, a still greater pressure be required, the force-pump L is set to work to inject water into the lower end of the fifth vessel, and the water thus injected, being practically incompressible, compresses the air into the upper part of the fifth air-vessel. The compression thus exerted may be carried as far as the strength of the apparatus and the power of the motor will permit.

After the compressed air has been used, the last vessel in the series might be charged by a repetition of the preceding operations; but,

as the air in each air-vessel is at a different tension, I prefer to commence charging the last vessel, B^4, through the supplementary discharge-pipe J′ with air compressed from the atmosphere, and as soon as the tension of the air in that vessel reaches the tension of the air in the next vessel to open the communication between the two. By proceeding with all the vessels in this manner the loss of the pressure gained at a preceding operation is avoided.

In the apparatus thus described the first four air-vessels are represented as of the same size; but I propose to make the vessels of progressively-larger dimensions from the first, or that receiving the most compressed air, to the last, as the supply of the pump may thereby be kept up longer from the last vessel of the series before the difference in pressures between the air entering and leaving the pump amounts to the predetermined working-pressure in the pump.

The invention is not limited to the number of air-vessels in the series, provided there be at least two, as the number may be increased or diminished, according to the ultimate pressure required and the highest working-pressure at which the air-pump is to be operated. So, also, the invention is not limited to any particular form of the air-vessels; but when the water-force pump is used in connection with the last vessel it should be of conical form, or the sectional area of the upper end of that vessel should be less than that of its lower end.

The apparatus may be employed to compress gases other than atmospheric air, in which case the air-pump must be first supplied with the gas by connecting its suction-passages with the reservoir of gas. So, also, the liquid used to increase the compression in the last vessel need not necessarily be water, but may be any liquid which is suited to the purpose.

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

1. The combination of the air-pump employed to compress air with a series of air-vessels by means of pipes and stop-cocks connecting the air-pump and air-vessels, substantially as hereinbefore set forth, in such manner that the air which has been compressed into one air-vessel may be used to supply the air-pump when compressing the air to a greater extent in another air-vessel, substantially as herein set forth.

2. The combination of the said apparatus with a water-force pump, to increase the pressure of the air in the last vessel, substantially as herein set forth.

3. The conical construction of the vessel of the series into which the air is ultimately compressed, when such vessel is combined with a water-force pump, substantially as set forth.

In witness whereof I have hereunto set my hand this 17th day of December, A. D. 1864.

WILLM. ARTHUR.

Witnesses:

CHAS. E. FROST.

RICHD. B. DUYCKINCK, Jr.,