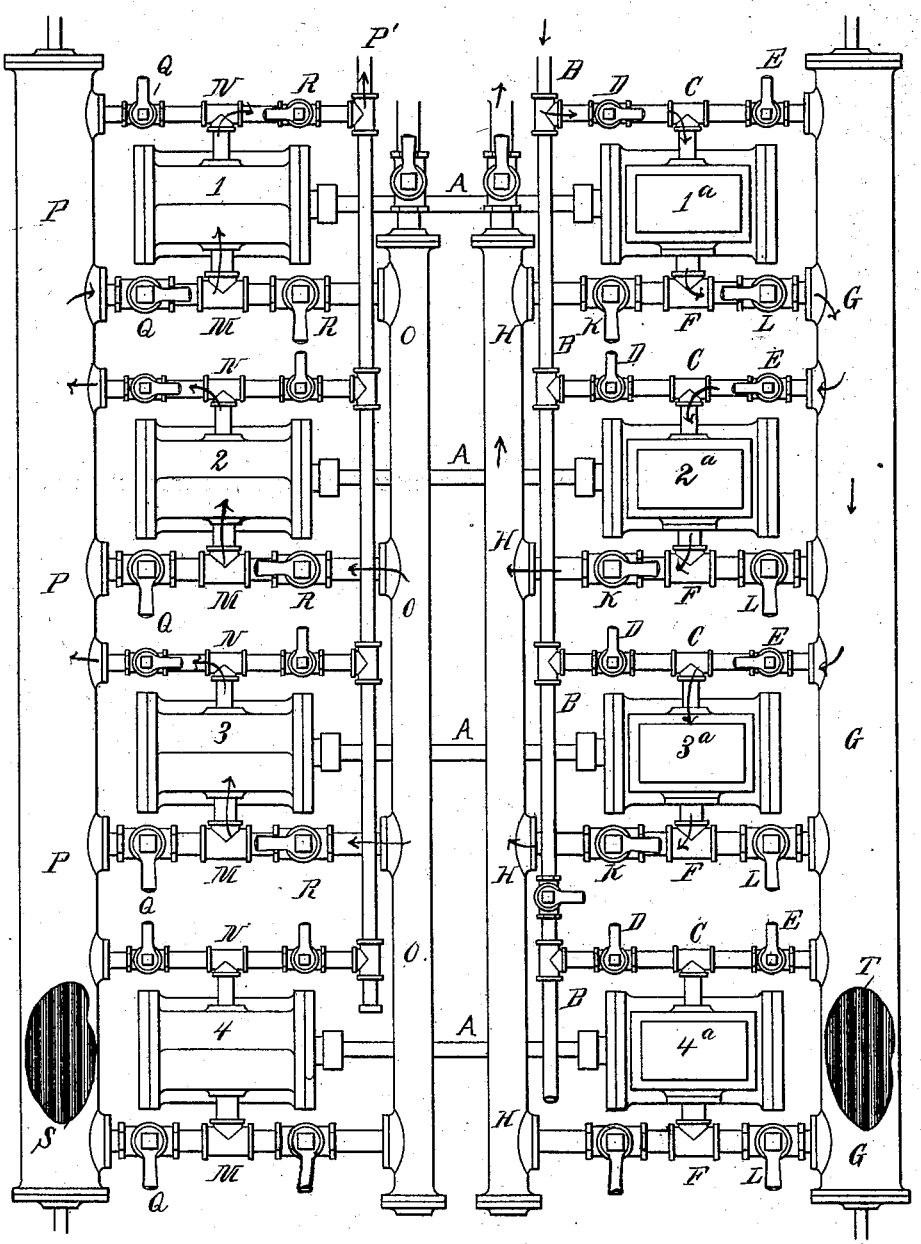
(No Model.)

E. HILL.

AIR COMPRESSING APPARATUS.

No. 261,605. Patented July 25, 1882.



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AIR-COMPRESSING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 261,605, dated July 25, 1882.

Application filed May 16, 1881. (No model.)

To all whom it may concern:

Be it known that I, EBENEZER HILL, of South Norwalk, in the county of Fairfield and State of Connecticut, have invented new and useful Improvements in Air-Compressing Apparatus, of which the following is a specification.

This invention relates to that class of air-compressors in which stage-compression is employed, or in which the air is forced from one engine into another; and the invention also relates to that class of engines in which serial expansion is a feature; and the object of the invention is the compression of the air step by step or by stage-compression with engines that work the steam by serial expansion.

The invention consists, first, in combining three or more air-compressing engines of equal size with each other by suitable connections and with a reservoir in such a manner that the air from a greater number may be forced into a less number, and thence into a reservoir or place for use; or, in other words, if only three compressors be used at once, the air from two will be forced into the third one, and thence to the place to be used, and at the same time the organization of the several parts is such that any one of the three compressors may be used as the first, second, or third, or interchangeably with each other, as will hereinafter appear.

Second, the invention further consists in combining an extra compressor with three or more in the system, or, when three only are used at a time, so combining a fourth one with the others that each or any one of the four may be used alternately and interchangeably, and thereby practically duplicate, or have the effect of practically duplicating, the entire plant or the entire working apparatus, as will hereinafter appear.

Third, the invention also consists in so combining steam-engines of equal sizes, or nearly so, with air-compressing engines, as hereinbefore described, that they are practically duplicates of one another, in such a manner that any one of the set in the system may be operated or remain at rest, or may be used as the first, second, or third, as will hereinafter appear.

In the accompanying drawing is represented a plan of one form of an air-compressing apparatus constructed and combined according to my invention, in which cylinders 1 2 3 4 represent air-compressing engines of equal size, or nearly so, and they are each directly connected to power-engines 1^a 2^a 3^a 4^a, using steam or similar agent as a motor, by piston-rods, as at A, from one to another. All of the compressors and the power-engines are constructed or may be constructed in any of the well-known types of such machines—that is, single or double acting, and with inlet and outlet valves of any suitable form.

The pipe B conducts steam from the boiler and connects with all the engines through branch pipes, as at C, each of which is provided with cocks, as at D and E, to control the flow of the steam.

Each of the engines has also branch pipes, as at F, on the exhaust side to conduct the steam either to an interheater, as at G, which is common to all, or to a common exhaust-pipe, as at H, which may lead to a condenser or to the open air, and these exhaust-pipes are all provided with stop-cocks, as at K and L, to control the direction of the exhaust-steam.

The compressors also have suction and discharge pipes for each one, as at M and N, to connect them to a common supply-pipe, as at O, and also to a common reservoir, as at P, and these branch pipes are all provided with cocks, as at Q and R, to control the direction of the air to and from the compressing-engines. Now, with such an arrangement of the power-engines and the compressors it must be evident that if three of them have sufficient power to do the work required, then one machine can be constantly idle, and also that, as all the machines are of the same size, it is evident that any one of the four can be idle on successive days or at given periods, so that their degree of wearing action will be equalized. The drawing shows that Nos. 4 and 4^a in the set have been selected to remain inactive, as the cocks for the steam and air are represented as closed. If it be assumed now that the throttle of engine No. 1^a is opened, live steam from the boiler through the steam-pipe will operate the power-engine, and it will exhaust into the interheater G through

the pipe F, and thence from the interheater into the engine 2^a, and the third engine, 3^a, will exhaust into the pipe H, connected to the condenser or open air, as the case may be. Now, as these engines are all of the same size, and the first exhausts into the other two, or the common interheater G, the steam will be expanded to double its previous volume in passing from the high to the low pressure. Therefore there is the same net power in the first engine alone as from the other two combined, as on the principle of the ordinary compound engines, where their cylinders have their areas so calculated that the work done in the first cylinder shall be equal to that done in the second. The same principle or law is applicable to the compressing-engines, except that the order is reversed—that is, the atmospheric air is taken into the compressors at 3 and 2 from the common supply-pipe O, and after compression is discharged into the pipe P, or common reservoir for both, which is connected to the compressor at 1 by the inlet-valve Q, which is shown open, and through which the air, partially compressed, is supplied to the compressor at 1, and is thence discharged through cock at R (shown open) to the pipe P′, which is a common discharge-pipe for all the compressors, as either or any of them may be used as the last one in the series; but, as already explained, No. 1^a power-engine does twice as much work as either Nos. 2^a or 3^a. Consequently the power is in each case proportioned to the work required.

To explain the operation in detail, the steam is first introduced through pipe B and cock D to engine 1^a, which exhausts into G through cock at L, and from G the steam drives the two engines 2^a and 3^a, which drive the compressors 2 and 3, which take their air from the outside through pipe O and discharge into P, and which supplies the compressor at 1, as already explained.

As already explained, the Nos. 4 and 4^a engines can take the places in the system of either of the other sets by merely opening and closing the inlet and outlet valves to admit steam and air, as indicated for the others. Consequently in such an arrangement there is perfect uniformity and interchangeability of the various parts, and consequently the failure of any one machine will not destroy the efficiency of the rest, as is the case when the various engines are made with cylinders of varying sizes to be adapted to the various pressures of the work required of them.

Another important advantage in such a system is that the plant is practically duplicated, or the effect is that of duplication, as the entire plant need not be stopped by the failure of any one engine, as the work may be continued with the mere additional expense of a single machine—that is, a power-engine and compressor with their proper connections.

It may be remarked that the air-reservoir and the interheater are both constructed with tubes, as shown at S and T, similar to a surface-condenser, and cold water may be circulated through the tubes in the air-reservoir and live steam from the boiler circulated through the tubes in the interheater, as in similar devices.

It is evident that the parts may be greatly varied in their relations and sizes without departing from the nature of my invention, and other kinds of connections and cocks may be used; but the plan shown gives one of the simplest forms; and it is evident that a plant may be constructed with a greater number of machines in combination.

I therefore claim—

1. The combination, with each other, of three or more air-compressing engines of equal size, attached by suitable connections in such a manner that the first and second compressors, or the greater number, (where more than three are used,) work on separate bodies of air and force it into the third or the lesser number, and thence into a reservoir or place for use, as hereinbefore set forth.

2. In an air-compressing apparatus, a system or series of power-engines effecting serial expansion, and having cylinders of equal capacities, with air-compressors effecting stage-compression, having cylinders of equal capacities, so arranged and constructed as that the high-pressure steam effects the highest compression and the low-pressure steam the initial compression, substantially as described.

3. The combination of a number of air-compressors of equal capacities with a supply-conduit common to each, and a common discharge-reservoir common to each, as hereinbefore set forth.

4. The combination of a number of compressors of equal capacities for performing stage-compression, and a corresponding number of engines of equal size effecting serial expansion, with suitable connections and valves, arranged in a system, so that any one engine and compressor can be interchanged for any other in the system, as hereinbefore set forth.

In witness whereof I have hereunto subscribed my name and affixed my seal in the presence of two subscribing witnesses.

EBENEZER HILL. [L. S.]

Witnesses:

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