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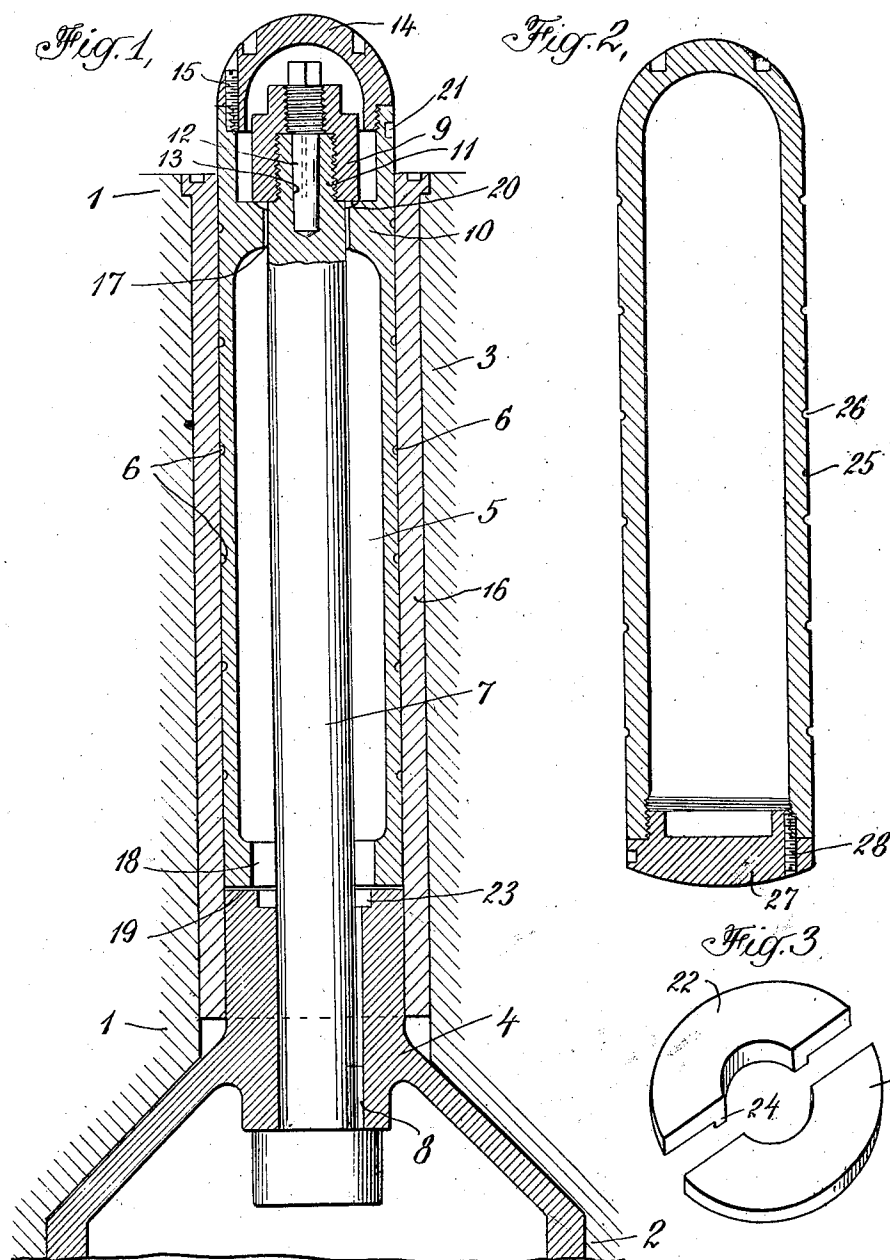
1,520,852

F. T. CABLE

AIR COMPRESSOR PISTON

Filed June 30, 1920

2 Sheets-Sheet 1



Inventor
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 By his Attorneys
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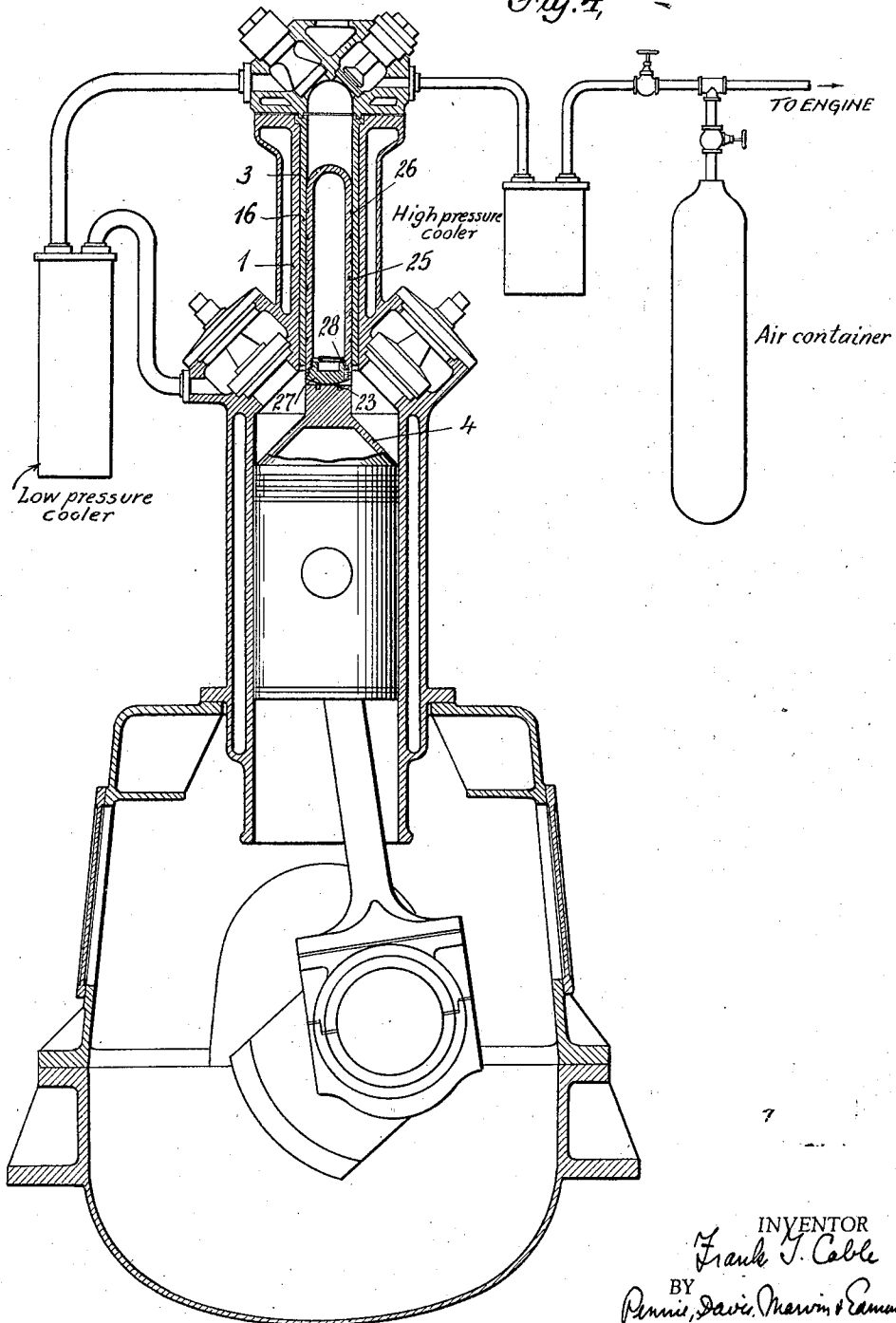
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Fig. 4.



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UNITED STATES PATENT OFFICE.

FRANK TAYLOR CABLE, OF NEW LONDON, CONNECTICUT, ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY.

AIR-COMPRESSOR PISTON.

Application filed June 30, 1920. Serial No. 393,066.

To all whom it may concern:

Be it known that I, FRANK T. CABLE, a citizen of the United States, residing at New London, in the county of New London, State of Connecticut, have invented certain new and useful Improvements in Air-Compressor Pistons; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to two-stage air-compressors, and more particularly to the second-stage pistons used in such compressors.

According to the present practice the first and second stage pistons of two-stage air compressors are rigidly connected. This makes it necessary that the walls of the first and second stage cylinders be exactly parallel and that the two pistons be in perfect alignment. In practice these conditions are difficult to meet, requiring as they do, exact and painstaking workmanship, and as a very slight deviation from exact parallelism between the parts results in rapid wear, particularly in the second stage cylinder, it has been found difficult to maintain a tight fit between the second-stage piston and its cylinder for more than short periods. The wear is taken up in large measure by the snap rings of the piston which must, in consequence, be renewed, sometimes as often as every two or three months. This operation is difficult and costly as the compressor must be entirely dismantled and both pistons removed in order to gain access to the second-stage piston.

It is, therefore, clear that could some means be devised for minimizing this wear and obviating the necessity for such frequent replacements of the second-stage piston rings, a very substantial saving in time and expense could be effected. It is broadly an object of the invention to accomplish this.

Going back to first causes, the origin of the trouble is found in the practical difficulty of getting perfect alignment between the two cylinders which are preferably integrally cast and must be machined with most exacting care. This difficulty has been overcome by the present invention through the simple expedient of doing away with the necessity for such exact alignment. To do this the two pistons are mounted for rel-

ative, lateral and angular play, and thus automatically adjust themselves to any inaccuracies in the cylinder parallelism. In doing this two important results are obtained; first, the wear is minimized, and, second, the need for scrupulous care in machining or grinding the cylinder bores is done away with.

However, a certain amount of wear is inevitable, and as the leakage around the pistons incident upon this wear is more pronounced in the second-stage cylinder than in the first, it still becomes necessary and desirable occasionally to remove the second-stage piston for the replacement of its snap rings or the substitution of a new piston. According to the present invention means have been devised whereby this may be done by simply removing the second stage head and without dismantling the whole compressor.

It has been found advantageous to eliminate piston rings entirely on the second-stage piston and to employ a so-called solid piston having considerably greater surface contact with the cylinder walls than is ordinarily the case, and provided with a series of peripheral grooves or seal rings, such grooves being old in this and analogous arts. As the wear on such a piston and its cylinder cannot be compensated for by the use of a new set of snap rings, nor yet by the substitution of a new piston having the old original diameter, it becomes necessary to bush the cylinder with a removable bushing. The provision of such a bushing is contemplated by the present invention.

To recapitulate, the objects of this invention are:

To minimize wear in the second-stage cylinder and do away with the need for nice alignment between the first and second-stage cylinders and pistons by mounting the two pistons for relative play:

To provide means for withdrawing the second-stage piston through the second-stage head and without entailing a dismantling of the compressor; and

To provide the second-stage cylinder with a bushing which shall be removable in the same manner that the second-stage piston is removable.

A still further object which shall be made clearer from the following description is to provide a self-aligning second-stage piston

which shall have no mechanical connection with the first-stage piston, relying upon air pressure to force it down.

Other and minor objects will be apparent as the description proceeds.

In order that the invention may be more clearly understood reference is had to the accompanying drawings disclosing one specific embodiment thereof, although it is to be distinctly understood that the invention in its broader aspects is not limited to these details of construction.

Fig. 1 is a vertical section through a two-stage air compressor showing the construction of one form of second-stage piston made in accordance with this invention and a part of the first-stage piston connected thereto. As shown in this figure the second-stage head has been removed and the piston moved to a position in readiness for removal;

Fig. 2 is a vertical section of a modified form of second-stage piston designed to have no mechanical connection with the first-stage piston;

Fig. 3 is a perspective view of the two-part collar used in forcing the bushing from its cylinder.

Fig. 4 is a vertical section through a two-stage air compressor showing the second stage piston of Fig. 2 mounted within the second stage cylinder.

In the drawings, 1 represents a two-stage air-compressor. In this compressor, 2 represents the first-stage cylinder, 3 the second-stage cylinder, 4 the first-stage piston, and 5 the second-stage piston, this last being provided with peripheral grooves 6 which fill with oil and serve as seal rings. The walls of the two cylinders are integrally cast and form in effect one cylinder having bores of two different diameters. The two pistons are connected by means of a bolt 7 which passes through the upper end of piston 4, being keyed thereto at 8, and is provided at its upper end with a special nut 9 which bears upon an internal annular flange 10 situated near the upper end of piston 5. This nut is screwed upon threaded end 11 of bolt 7 and locked in position by means of tapered pin 12 which is screwed in the upper end of nut 9 and seated in a tapered and split socket 13 in the threaded end 11 of the bolt. Insertion of pin 12 into socket 13 expands threaded end 11 and fixes the nut 9 tightly in position. Piston 5 is provided at its upper end with a semi-spherical cap 14 locked in position by means of screw 15. Cylinder 3 is bushed by means of a removable sleeve or bushing 16 forming the wearing surface for the piston 5.

Play between the two pistons is permitted by clearance spaces 17, 18 and 19. In a case where alignment of the two cylinders happened to be particularly bad, piston 5 might be twisted so far as to bind at the point

where the edge of nut 9 bore upon flange 10. In order to prevent this the upper face of this flange is dished slightly as shown at 20.

To remove piston 5, the second-stage head is detached and the two pistons moved up to the position shown in Fig. 1. Cap 14 may then be readily removed and then in succession pin 12 and nut 9. With this done it becomes an easy matter to lift piston 5 from its cylinder with the help of a special wrench having a pin which cooperates with a hole 21 drilled in the side of the piston near its upper end.

To remove the bushing, the first-stage piston is drawn down below the lower end of the bushing and the two-part collar 22 shown in Fig. 3 introduced through cylinder 3 and seated upon the upper end of piston 4. An annular groove 23 is bored in the upper end of this piston and is adapted to receive a depending flange 24 on collar 22. The diameter of this collar is greater than the internal diameter of the bushing but less than the external. Upon again moving the piston 4 upward the peripheral face of collar 22 will bear against the lower end of the bushing and force it out of its cylinder a short distance. It is then an easy matter to complete the removal.

By making both the piston and its bushing removable, it becomes possible to replace them with a new pair which have been accurately fitted at the factory. A tight fit is, therefore, assured. Without the provision of a removable bushing it is a difficult matter when replacing worn pistons of this type to attain a perfect fit for the obvious reason that there are no snap rings to take up the wear upon the cylinder walls.

A modified form of second-stage piston is shown in Figs. 2 and 4, the novelty of which resides in the fact that there is no mechanical connection whatever between it and the first-stage piston. This modified piston comprises a cylindrical shell 25 provided with peripheral grooves 26 which act as sealing rings as described before. A case-hardened cap 27 incloses the lower end of the piston and is locked in place by means of screw 28. This cap bears upon the upper end of the first-stage piston. In operation, the compression stroke of the first-stage piston pushes the second-stage piston along its cylinder and thus effects the second compression. Upon the return stroke the air which has just previously been compressed in the first-stage cylinder and is under a pressure of about seventy-five pounds per square inch is led into the upper end of the second-stage cylinder. This pressure is ample to force the loosely mounted second-stage piston downward and keep cap 27 in constant contact with the first-stage piston. This arrangement is even simpler than that shown in Fig. 1;

errors in alignment are automatically taken care of, and the removal of the piston is an easy matter.

Although this invention has been spoken of and described in connection with two-stage air-compressors, it is obvious that the principles involved might easily be applied to compressors operating in more than two stages. It is also obvious that the invention is not necessarily limited to air-compressors, but is applicable to pumps or any other machines which present similar problems in the matter of alignment and removal of parts.

I claim:

1. In a two-stage air-compressor the combination of first and second-stage pistons having no mechanical connection between them.

2. In a two-stage air-compressor the combination of first and second-stage cylinders and first and second-stage pistons in substantial alignment, mounted to reciprocate within their respective cylinders, and having no mechanical connection with each other, contact between them being maintained by the air pressure within the second-stage cylinder.

3. In a multi-stage air-compressor or the like, the combination of a plurality of cylinders of progressively increasing pressure, a plurality of pistons in substantial alignment, mounted to reciprocate within their respective cylinders, and having no mechanical connection with one another, contact between adjacent pistons being maintained by the air pressure within the higher pressure cylinder.

4. A second-stage piston for air-compressors comprising the combination of a cylindrical body portion and a cap at one end thereof adapted to bear upon the end of the first-stage piston.

5. In a two-stage air-compressor, the combination of first and second-stage cylinders, first and second-stage pistons in substantial alignment mounted to reciprocate within their respective cylinders, a removable head on the second-stage cylinder and means permitting separation of the two pistons and removal of the second-stage piston through the outer end of the second-stage cylinder.

6. In a two-stage air-compressor, the combination of first and second-stage cylinders, first and second-stage pistons in substantial alignment mounted to reciprocate within their respective cylinders, a removable bushing or sleeve in the second-stage cylinder, a removable head on the second-stage cylinder, and means for removing both second-stage piston and bushing through the outer end of the second-stage cylinder.

7. In a two-stage air-compressor, the combination of first and second-stage cylinders, first and second-stage pistons in substantial alignment mounted to reciprocate within their respective cylinders, a removable bushing or sleeve in the second-stage cylinder, a removable head on the second-stage cylinder, means for removing the second-stage piston and means cooperating with the upper end of the first-stage piston to move the bushing out of its cylinder.

In testimony whereof I affix my signature.

FRANK TAYLOR CABLE.