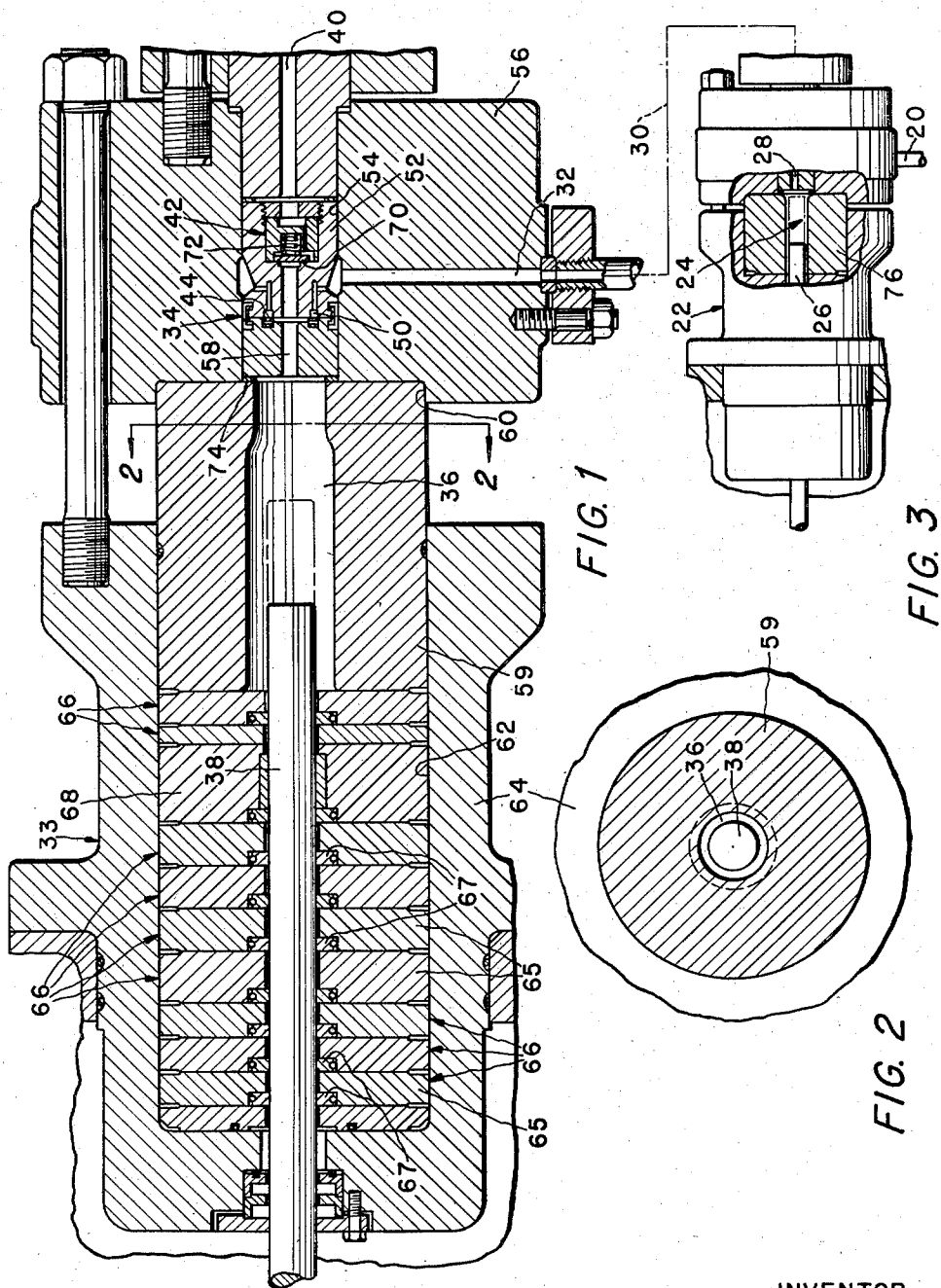


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COMPRESSOR

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COMPRESSOR

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This invention relates to compressors, and more particularly to reciprocating piston type compressors used for compressing air or other gas to a high pressure.

In high pressure installations it is common to use at least a two-stage compressor to raise the pressure of the gas in two steps. In this type of installation gas admitted into the first stage is compressed by the piston to some intermediate pressure and discharged into the compression chamber of the second stage compressor where the gas is then compressed to the higher final pressure by the second stage piston.

Inasmuch as the intake pressure of the first stage is less than that of the second stage, for any given weight of gas compressed the intake volume of gas drawn in per minute into the first stage is necessarily greater than the volume of gas taken in per minute into the second stage. In conventional units the second stage compressor piston and chamber are made with smaller diameters than that of the first stage. This reduction in size of the second stage piston and chamber reduces correspondingly the volume of gas discharged per minute.

There are certain disadvantages associated with this method of matching the two stages. For example, different size casings, pistons and piston rod seals are required for each stage of the compressor. In high pressure installation a great deal of packing, or sealing, material is required to prevent leakage of gas from the compression chamber along the piston, and it is necessary to periodically renew this packing. Thus two sizes of packing must be made and kept available for such renewal.

The present invention eliminates this disadvantage and permits the use of a same size seal casing, piston diameter and other associated parts for each stage of the compressor by the provision of a novel means whereby the capacity of the second stage compressor is made to correspond to that of the first stage.

It is accordingly one object of this invention to provide a high pressure reciprocating piston type two stage compressor in which the piston diameter, seal casing, external diameter of the pressure cylinder and size of other associated parts are substantially the same size for each stage of the compressor.

Another object of this invention is to provide a multi-stage high pressure reciprocating gas compressor in which the seals, and seal housings are interchangeable for at least two of the stages.

A further object of this invention is to provide such a compressor in which means are provided in a higher pressure stage of the compressor to reduce the volumetric efficiency of this stage so as to match the higher pressure stage with that of the preceding lower pressure stage of the compressor to obtain the desired interstage pressure.

Further objects and advantages of this invention will become apparent from the following specification and drawings in which

Fig. 1 is a longitudinal sectional elevation of the sec-

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ond stage of a two-stage high pressure compressor constructed in accordance with the practice of this invention,

Fig. 2 is a cross sectional view of Fig. 1 taken along the line 2—2 looking in the direction of the arrows, and

Fig. 3 is a view, partly in section, of the first stage of the compressor, and shown in a smaller scale than Figs. 1 and 2.

Referring to the drawings the compressor shown embodying a preferred form of the invention is of the high pressure reciprocating piston type gas compressor. Vapor or gas to be compressed is admitted through an intake 20 of the first, or low, pressure stage 22 into a compression chamber 24 and compressed to a higher pressure by the piston 26 and then discharged through the passage 28 and conduit 30 to the inlet 32 of the next high pressure stage of the compressor. This gas, at say for example 13 thousand pounds per square inch, is then admitted through the inlet valve 34 to the compression chamber 36 wherein it is compressed by the piston 38 up to a pressure value, say for example twenty-two thousand per square inch. The gas at this pressure is discharged through the discharge passage 40 and discharge valve 42 to a container (not shown) or to the next higher pressure stage (not shown).

The construction of the low pressure stage, except for a detail to be described hereinafter, is identical to that of the high pressure stage 33. Accordingly, the construction of one stage only, the high pressure stage 33, is shown and described in detail. Referring to Figure 1, the flow of gas under pressure into the high pressure stage 33 is controlled by any conventional high pressure inlet valve 34 operable in response to reversals of pressure differential thereacross. The valve shown comprises a valve element 44 overlying the mouth, or downstream end, of the inlet 32. As illustrated the inlet 32 terminates in the form of an annular passage 50 formed in a valve cage 52 fitted in a bore 54 in a casing 56. Movement of the valve element 44 off its seat permits the flow of gas from the inlet 32 around the valve element 44 to a passage 58 in communication with the compression chamber 36 formed in a pressure cylinder 59.

The pressure cylinder 59 is cylindrical in form with one end mounted in a recess 60 in the casing 56 and having its opposite, or crank, end portion slidably mounted in a chamber 62 in the seal casing 64. The chamber 62 is of considerably greater length than the portion of the cylinder 59 mounted therein for the reception of a plurality of sealing elements 66 comprising packing members 65 housing sealing rings 67. The elements 66 encircle the piston 38 which extends through the chamber 62 and into the compression chamber 36. The piston shown is of the plunger type and is accordingly in the shape of a rod of substantially the same diameter throughout its entire length with the rearward end portion of the rod serving as a piston rod and the forward end portion serving as the piston. Also mounted in the chamber 62 is a bearing element 68 for slidably supporting or guiding the piston 38.

The flow of compressed gas from the compression chamber 36 is controlled by a conventional discharge valve 42 mounted in the valve cage 52. This valve is designed to unseat whenever the pressure in the compression chamber exceeds by some predetermined amount the pressure on the discharge side of the valve. Specifically, the valve element 70 is held on its seat by a spring 72 and the pressure of gas on the downstream side of the valve acting over substantially the entire rear surface of the valve. The valve is unseated by the pressure of gas from the compression chamber acting over a portion of the upstream side, or face, of the valve element 70.

In compressors of this type where the discharge of the

first stage is supplied to the inlet of the second stage, the capacity of the second stage compressor is made to equal substantially the capacity of the first stage compressor. This means that although the pounds of gas per minute pumped by each stage of the compressor is substantially the same, due to the fact that the discharge pressure of the second stage compressor greatly exceeds that of the first stage, the actual cubic feet of air compressed per minute by the second stage compressor is considerably less than that of the first stage. In further-

ance to this end the second stage compressor is provided with a novel means for reducing the volumetric efficiency thereof, as compared to the first, or low pressure, stage to an extent that the desired pressure is maintained for gas passing between stages with the capacity of the second stage corresponding to the capacity of the first stage. More particularly the pressure cylinder 59 of the high pressure cylinder is formed with the compression chamber 36 of substantially circular cross-section with a portion having a diameter substantially greater than the diameter of the piston. It is to be noted that the chamber 36 need not be circular in cross-section, it is necessary only that the chamber be of substantially greater volume than the volume occupied by the piston and rod portion thereof in the compression chamber when the piston 38 is at the end of its discharge stroke (the position shown in dotted lines in Fig. 1). The exact volume of the chamber 36 as compared to the volume occupied by the piston will vary depending on the pressures involved and the type of gas being pumped. The compression chamber shown is of two diameters, the chamber being of reduced diameter at the discharge end thereof, merely to provide a shoulder 74 on which to seat the valve cage 52.

In the low pressure stage, the compression chamber 24 is of substantially the same diameter throughout its entire length and of only slightly larger diameter than the diameter of the piston 26 such that this stage operates at substantially its maximum volumetric efficiency. In the high pressure stage, however, due to the relatively large clearances, a correspondingly larger volume of gas remains in the compression chamber 36 during every compression cycle and is merely compressed and re-expanded. Thus the actual volume of gas pumped by the high pressure stage is relatively small as compared to the low pressure stage for the same stroke of the piston. With this form of compression chamber 36 for the second stage, the volumetric efficiency of this stage is reduced such that the capacity of this stage corresponds to that of the first stage notwithstanding the fact that the size of the pistons and the strokes thereof are the same for both stages.

It is to be noted that although the compression chambers 24 and 36 differ in shape, the external shape and the external diameters of the pressure cylinders 59 and 76 are of the same such that the valve casing and seal casing may be used with either cylinder.

While I have shown and described a specific form of my invention, it is to be understood that various changes

and modifications may be made without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A multi-stage gas compressor comprising a low pressure stage and a higher pressure stage in which each of said stages includes a pressure cylinder, a piston reciprocally mounted in the cylinder, a rod connected to actuate the piston and a casing having a bore for the reception of at least one end portion of said cylinder and adapted to receive a seal for restricting the leakage of gas from the cylinder along the rod, the diameter of the casing bore and the outer diameter of such end portion of the cylinder for the high pressure stage being substantially equal to the corresponding diameters of the casing bore and of the cylinder, respectively, of the low pressure stage of the compressor, and means in the cylinder for the higher pressure stage for reducing the volumetric efficiency thereof as compared to the low pressure stage to obtain the desired interstage gas pressure.

2. The compressor claimed in claim 1 in which the stroke and size of the piston for the higher pressure stage are equal to the stroke and size, respectively, of the piston for the low pressure stage.

3. The compressor claimed in claim 1 in which said means includes a compression chamber in the cylinder which is of substantially greater volume than the volume occupied by the portion of the rod and piston therein when the piston is at the end of its compression stroke.

4. The compressor claimed in claim 1 in which said means includes a compression chamber of circular cross-section and having at least a portion thereof of substantially greater diameter than that of the piston.

5. The compressor claimed in claim 4 in which said portion extends along the entire length of the piston when the piston is at the end of the compression stroke.

6. A multi-stage gas compressor comprising a low pressure stage and a higher pressure stage in which each of said stages includes a pressure cylinder and a piston reciprocable in the cylinder, and means in the cylinder for the higher pressure stage for reducing the volumetric efficiency thereof as compared to the low pressure stage to obtain a desired pressure of gas passing from the low pressure stage to the higher pressure stage, the stroke and size of the piston for the higher pressure stage being substantially equal to the stroke and size, respectively, of the piston for the low pressure stage.

7. The compressor claimed in claim 6 in which said means includes a compression chamber in the cylinder of the higher pressure stage which is of circular cross section and having at least a portion thereof of substantially greater diameter than that of the piston therein.

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