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3,667,874

TWO-STAGE COMPRESSOR HAVING INTERENGAGING ROTARY MEMBERS

Filed July 24, 1970

2 Sheets-Sheet 1

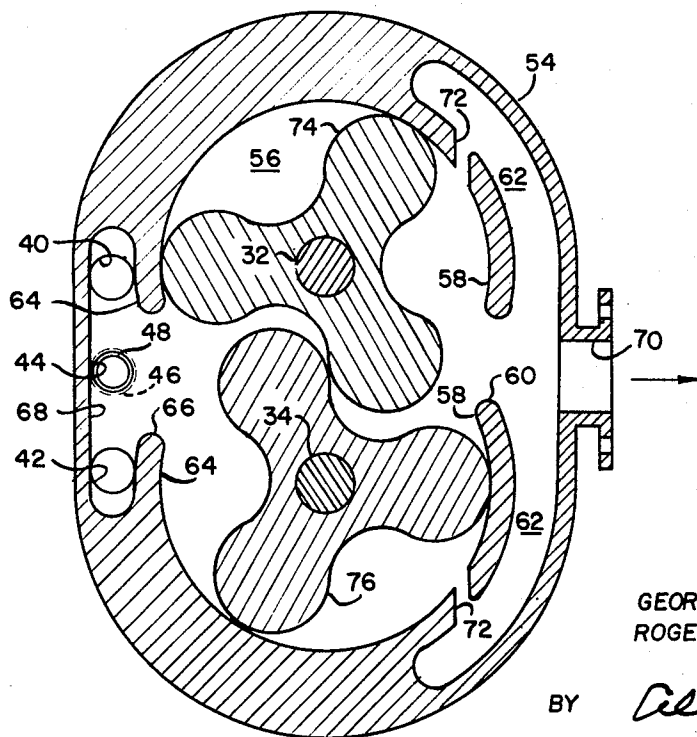
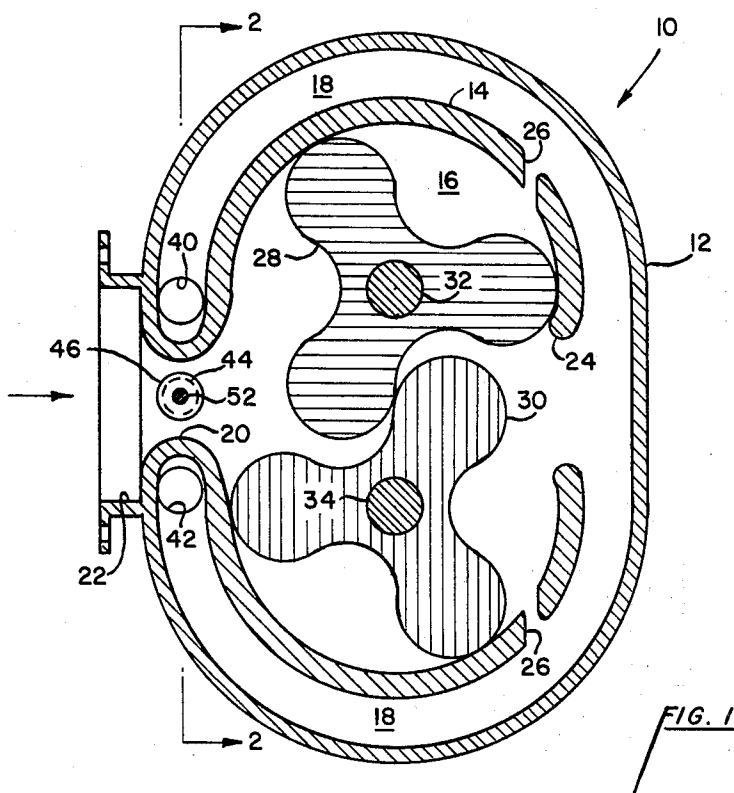


FIG. 3

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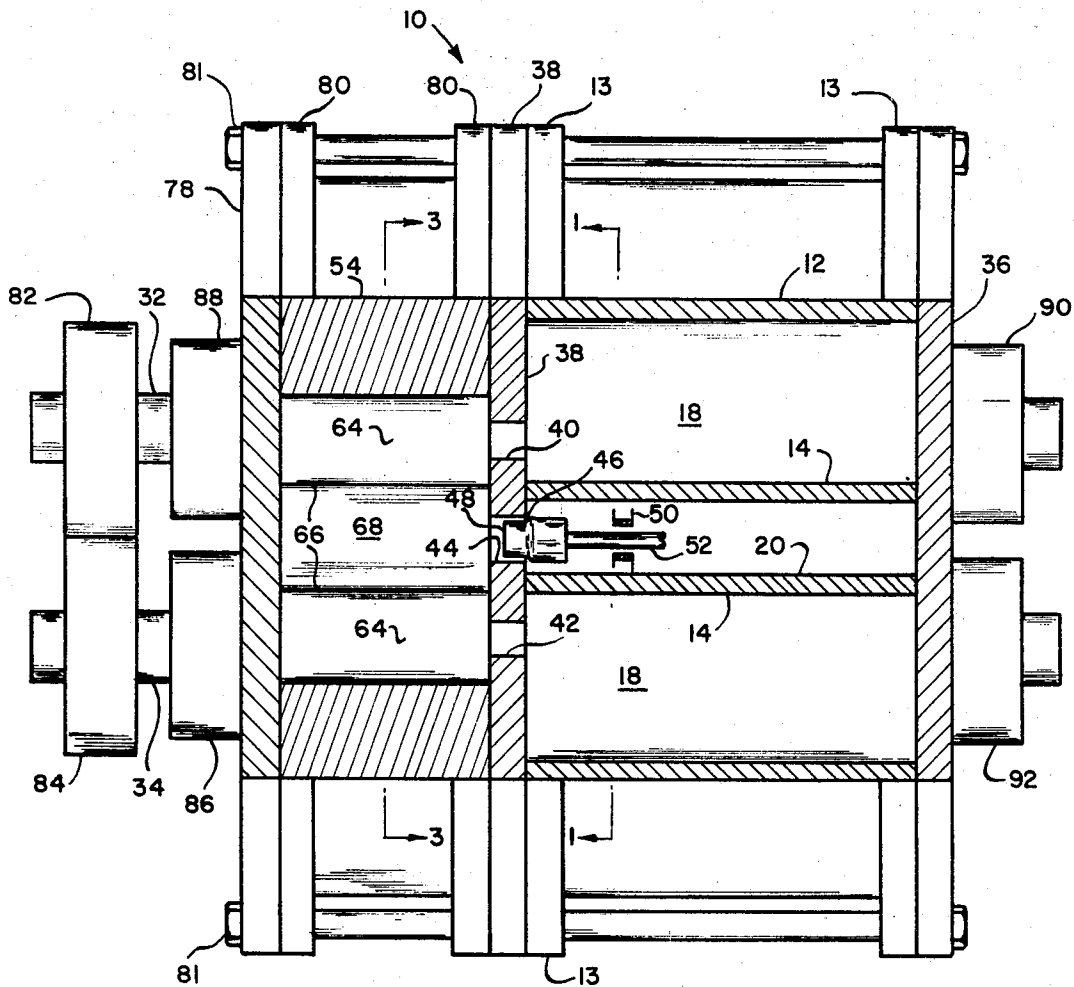


FIG. 2

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TWO-STAGE COMPRESSOR HAVING INTER-ENGAGING ROTARY MEMBERS

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U.S. Cl. 418—9

3 Claims

ABSTRACT OF THE DISCLOSURE

A two-staged Roots type compressor having a housing separated into two compartments by a partition, each compartment containing a working chamber having rotary mating impellers therein, inlets to each chamber and outlets from each chamber, passages in the partition communicating the outlet of one chamber with the inlet of the other chamber, a valved passage in the partition communicating the inlets of each chamber, the impellers of each chamber being mounted on common shafts.

BACKGROUND OF THE INVENTION

Roots type compressors perform satisfactorily at compression ratios below two; however, as the compression ratio increases the efficiency of the compressor decreases significantly. Attempts to increase the efficiency of Roots type compressors by staging two compressors in series are known. Up to a compression ratio of about 3.5 the two staged Roots type compressor's performance is good, however, since multiple housings, timing gears, drive shafts, bearings, external piping and seals are required, the manufacturing costs are extremely high. In addition to being costly the known two stage Roots type compressors are complex and bulky for their capacity.

SUMMARY OF THE INVENTION

The foregoing disadvantages of prior devices are overcome according to the present invention which provides a two staged Roots type compressor having the same number of drive shafts, bearings, timing gears that are normally incorporated in a single stage device.

Additionally, the present invention provides a two stage Roots type compressor structure conduits or piping between the stages wherein all of the connections between stages are internal thereby avoiding the necessity of external conduits or piping between the stages.

The apparatus according to the invention also incorporates valving structure which permits, in a simple and efficient manner, the regulation of the flow rate through the compressor.

Basically, the present invention provides a two stage Roots type compressor having: a first stage housing, defining an interior working chamber, a second stage housing defining an interior working chamber, first stage inlets and outlets communicating with the working chamber of said first stage housing, second stage inlets and outlets communicating with the working chamber of said second stage housing.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the present invention reference should be had to the following detailed description of the same, taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a cross-sectional view of the low or first stage of the compressor according to the present invention and is taken along line 1—1 of FIG. 2;

FIG. 2 is a longitudinal sectional view along line 2—2 of FIG. 1; and

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FIG. 3 is a cross-sectional view of the high or second stage of the compressor and is taken along line 3—3 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, the two stage Roots type compressor according to the invention is generally depicted by the numeral 10 and comprises a generally annular first or low pressure stage housing 12 which may be oblong in section as shown. The housing is flanged at 13. A curved interior wall 14 divides the first stage housing into two sections; an inner working chamber 16 and a surrounding annular discharge chamber 18. Wall 14 joins wall 12 at the curved section 20 which defines an inlet passage thereat which provides communication between an inlet port 22 and the working chamber 16. The opposite portion of wall 14 is open at 24 which provides communication between working chamber 16 and annular discharge chamber 18. Wall 14 may have one or more bypass ports or slots 26 therein for a purpose to be discussed hereinbelow.

A pair of coating multilobed Roots type impeller elements 28 and 30 are mounted on shafts 32 and 34 for rotation in chamber 16. As shown for illustrative purposes only, each impeller has three lobes.

The open ends of chambers 16 and 18 are sealingly closed by an end plate 36 and an interstage partition 38. Conventional sealing rings (not illustrated) may be employed. Partition 38 has a pair of through ports 40 and 42 which communicate with annular discharge chamber 18. Between ports 40 and 42 partition 38 also contains a bypass port 44 which communicates with the first stage inlet passage 20.

A valve member, illustrated schematically in FIG. 2 is adapted to seat on and close communication through port 44. As shown this valve may comprise a frusto-conical head 46, a forward piston portion 48, guides 50 and a stem 52, which may pass through end plate 36 for actuation by a suitable actuator.

A second or high pressure stage housing 54 sealingly abuts partition 38. Housing 54 is similar in exterior configuration to housing 12 and comprises an interior working chamber 56, curved ledges 58 between chamber 56 and casing 54 defining a discharge slot 60 leading to an arcuate discharge region 62, curved lips 64 between chamber 56 and casing 54 opposite ledges 58 which define a second stage inlet slot 66 leading to an arcuate second stage inlet region 68. Ports 40, 42 and 44 in partition 38 are in communication with the second stage inlet region 68. An outlet port 70 is in communication with the outlet region 62. Ledge 58 contains one or more bypass ports or slots 72 similar to slots 26 of the first stage.

A pair of second stage Roots type impeller elements 74 and 76 are mounted on shafts 32 and 34 for rotation in chamber 56. Impeller 74 is located on the same shaft as impeller 30 and impeller 76 is located on the same shaft as impeller 28 and all contain three lobes as illustrated. For a purpose to be discussed hereinbelow, it is important to note that each one of the impellers on each of the shafts is one half cycle out of phase with the other impeller on the same shaft. Thus, impeller 28 is one half cycle out of phase with impeller 74 and impeller 30 is substantially one half cycle out of phase with impeller 76. With three lobes as illustrated the impellers in each stage are 60 degrees out of phase.

An end sealing plate 78 abuts and seals against one end flange 80 of housing 54 and thereby closes one end of chamber 56 and regions 62 and 68, the other ends of which are closed by partition 38. The structure is joined and secured by suitable fastening means illustrated at 81.

A single pair of conventional driving and timing gears 82 and 84 are located on shafts 32 and 34 for driving impellers 28, 30, 74 and 76. Conventional end bearings are provided at 86, 88, 90 and 92.

In operation inlet gas is drawn in through port 22, passage 20 into first stage working chamber 16. The gas is compressed by the action of impellers 28 and 30 and is discharged through opening 24 to annular discharge chamber 18, thence through ports 40 and 42 in partition 38 to the inlet region 68 of the second stage casing 54. From region 68 the gas is drawn into the second stage working chamber 56 through opening 66 where it under goes further compression by the action of impellers 74 and 76 and is discharged through slot 60 to outlet region 62 to outlet port 70 to a point of use.

If it is desirable to reduce or otherwise regulate the flow capacity valve 46 may be actuated to permit turn-down of the compressor by causing a variable portion of the gas entering second stage inlet region 68 to be returned via port 44 to the first stage inlet opening 20. Valve 46 may be operated in response to the speed of the impellers to permit an automatic capacity turndown. Alternatively, any suitable type of actuation could be employed.

As noted earlier, the impellers of the first stage are substantially one half cycle (60°) out of phase with the impellers of the second stage. Thus, the vector relations of loads from the first and second stage impellers are at a 60° angle with respect to each other and as a consequence the maximum load is less than for the case where each impeller is in phase. In addition the variation in torsional loading on each shaft is reduced and the torque requirement in the driving and timing gears is made more uniform. With three lobe impellers as illustrated the ideal phase difference would be 120/2 or 60 degrees. With two lobes the ideal phase difference would be 180/2 or 90 degrees.

The purpose of bypass ports 26 and 72 is to smooth out pulsations, reduce noise and augment the shaft work as disclosed in copending application Ser. No. 742,890 filed July 5, 1968 for Gear Compressors and Expanders, now Pat. No. 3,531,227, and assigned to the assignee of the present invention.

Although a preferred embodiment of the present invention has been described, changes will occur to those skilled in the art; therefore, it is intended that the scope of the present invention is to be limited only by the scope of the appended claims.

We claim:

1. A two-stage Roots type compressor, comprising;

- (a) a first stage housing defining an interior working chamber,
 - (b) a second stage housing adjacent said first stage housing defining an interior working chamber,
 - (c) a thin walled partition intermediate said first and second stage housings,
 - (d) first stage inlets and outlets communicating with the working chamber of said first stage housing,
 - (e) second stage inlet and outlets communicating with the working chamber of said second stage housing,
 - (f) ports in said partition communicating said first stage outlet with said second stage inlet,
 - (g) an annular chamber surrounding said first stage working chamber, one end of which communicates with said first stage outlet, the other end of which communicates with said ports in said partition,
 - (h) a pair of spaced rotating shafts passing through each of said working chambers,
 - (i) mating Roots type impellers mounted on said shafts in said first stage working chamber, and
 - (j) mating Roots type impellers mounted on said shafts in said second stage working chamber.
2. The compressor according to claim 1, further comprising;
- (k) a turndown port in said partition communicating said second stage inlet with said first stage inlet, and
 - (l) a valve coacting with said turndown port.
3. The compressor according to claim 2, wherein;
- (m) the impellers common to each of said shafts are substantially one half cycle out of phase.

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U.S. Cl. X.R.

418—206