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Thayer

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[54] **TUNED EXHAUST FOR HERMETIC COMPRESSOR**

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[51] **Int. Cl.** **F04b 39/00**

[58] **Field of Search** .... 417/312; 181/33 L, 33 D, 181/36 D

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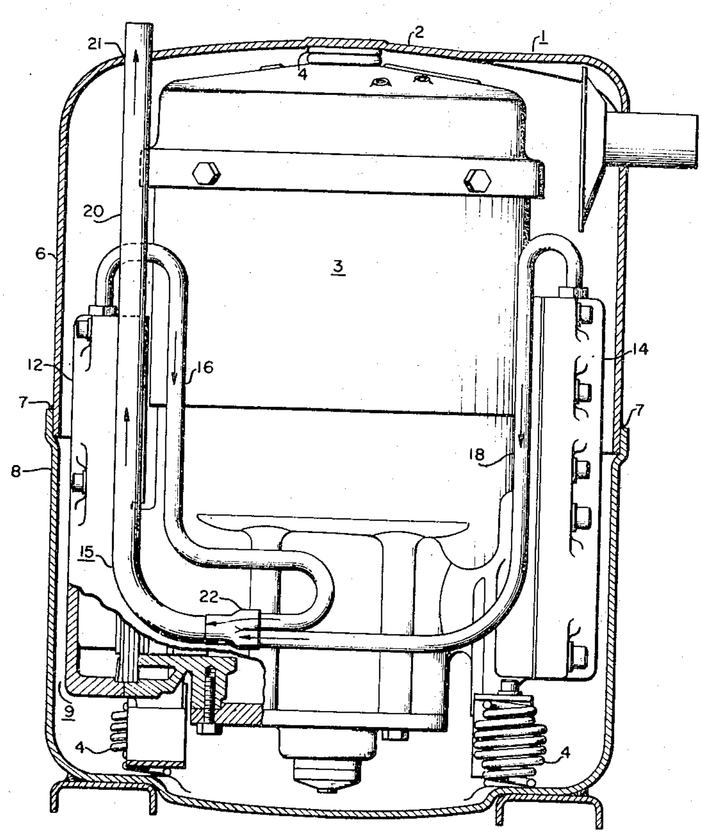
[57] **ABSTRACT**

This invention relates to a discharge arrangement for a hermetic compressor having at least two radially spaced cylinders within the compressor casing. Each cylinder is provided with a respective single discharge tube within the compressor casing. Each of the single discharge tubes is connected in a group at a common joint to a respective common discharge tube. The common joints are positioned at a point relative to the dimensions of the single discharge tubes and to the radial positions of their respctive cylinders such that the discharge pulses in the common discharge lines are evenly spaced which helps to increase the compressor efficiency and also minimizes the need for a muffler. The single discharge tubes are flexible in the assembled relationship and may be arranged in a side-by-side relationship at the common joint to cause an aspiration effect therein, thereby increasing the volumetric efficiency of the compressor.

7 Claims, 3 Drawing Figures



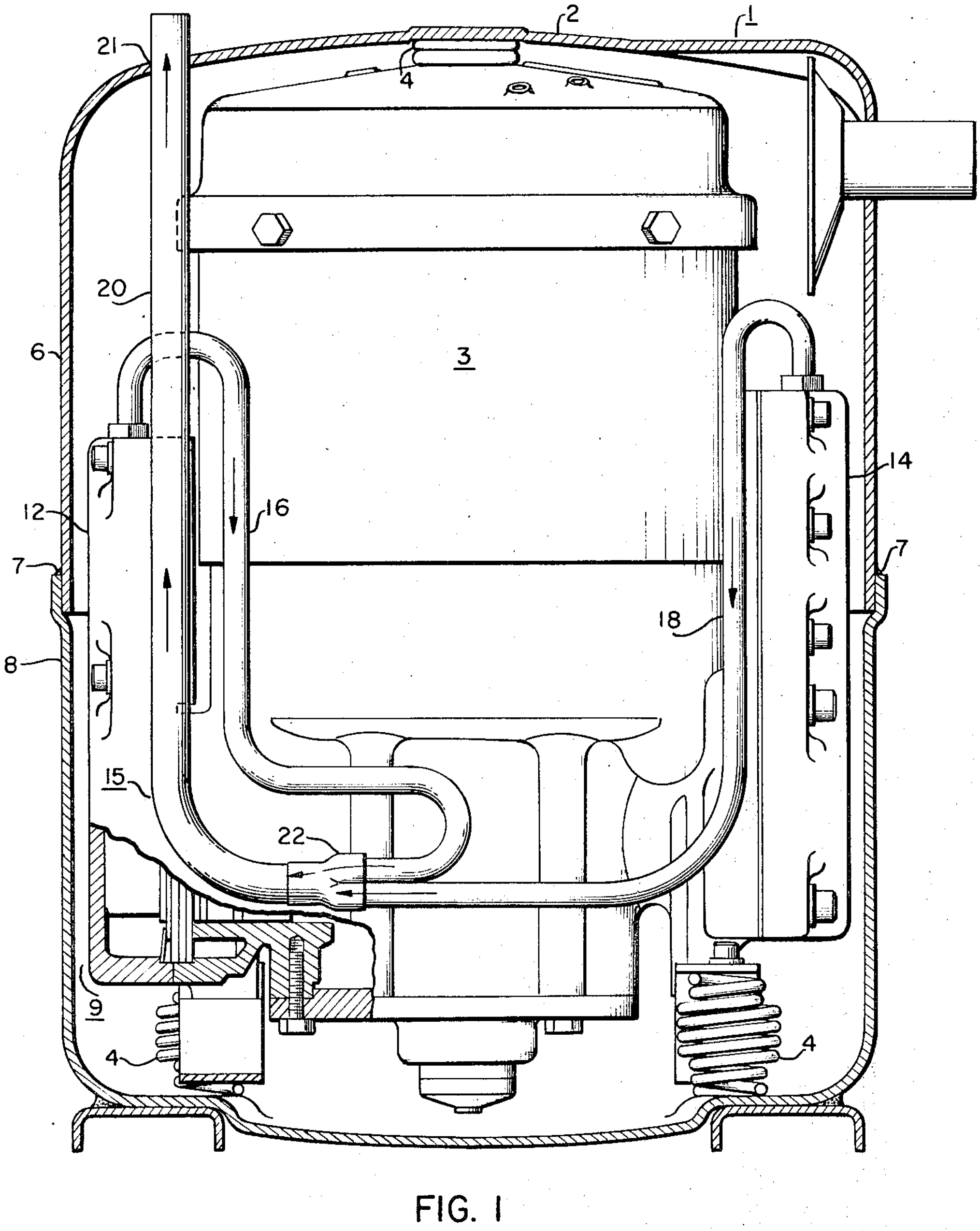


FIG. I

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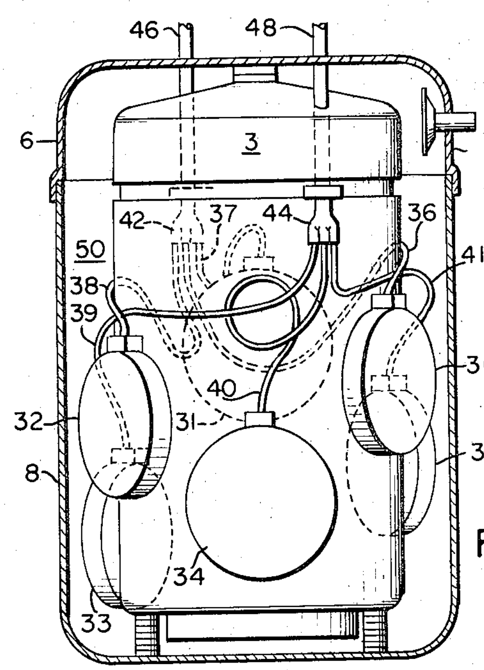

FIG. 2

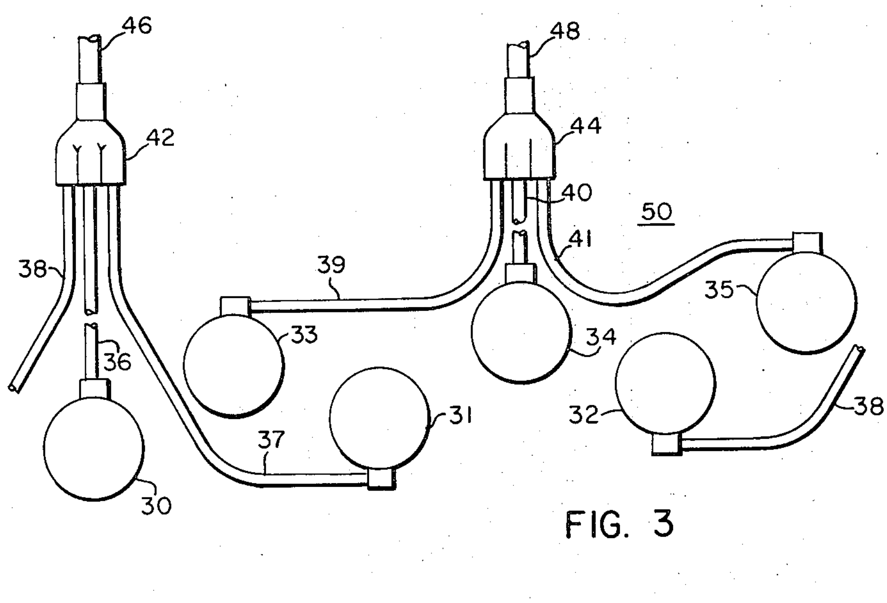

FIG. 3

TUNED EXHAUST FOR HERMETIC COMPRESSOR

CROSS REFERENCES TO RELATED APPLICATIONS

So far as known, this invention is not related to any pending patent applications.

BACKGROUND OF THE INVENTION

It has been customary for hermetic compressor units to employ an exhaust discharge arrangement including some form of a discharge muffler at the outlet of the discharge tubing. These mufflers are needed for reducing exhaust noises and vibrations, but they consume large areas of space within the compressor housing due to the fact that the mufflers themselves take up space and the exhaust tubing between the cylinder heads and the mufflers are of a relatively large diameter. The necessity of using the mufflers also inherently decreases the efficiency of the compressor. It would be more desirable to eliminate noise and vibration while increasing the overall compressor efficiency by improving the hermetic compressor discharge arrangement such that mufflers are not required.

PRIOR ART

No patents are known which disclose a hermetic compressor employing flexible discharge tubes of particular, predetermined lengths to uniformly space the cylinder exhaust discharge pulses as they pass from the cylinder discharge tubes and into a common exhaust line. However, as known to those skilled in the art, gasoline engines, such as those found in automobiles, have employed tuned cylinder exhaust header tubes of predetermined lengths to help increase the power and overall efficiency of the engine, but, as far as known, the tuned exhaust principles of the gasoline engines have never before been applied to discharge arrangements of hermetic compressors.

It has been found that by properly relating the lengths of individual discharge tubes for a respective cylinder of a multicylinder hermetic compressor to the point of common connection with a common discharge line within the hermetic casing, the efficiency of the compressor is greatly increased and the need for a muffler is minimized while at the same time the required flexibility of the tubing within the casing is obtained.

SUMMARY OF THE INVENTION

A hermetic compressor unit is disclosed having at least two radially positioned cylinders and a discharge arrangement which includes one discharge tube that is to be connected to each cylinder for the purpose of providing means for discharging the cylinder exhaust gases. One main discharge line, which extends through the compressor casing, is connected in common within the casing to the respective group of discharge tubes. The connection means for joining each common discharge line to a respective group of discharge tubes may be a hollow joint which has a plurality of inlet openings and a single outlet opening. The length of the discharge tubes are selected to be in a particular predetermined relationship with each other. The relationship is chosen so as to provide uniformly spaced cylinder discharge pulses in the common discharge line. Synchronizing of the discharge pulses helps to increase compressor efficiency and to decrease the noise level which affords better vibration isolation, and at the same time, minimizes the needs for cumbersome muffler arrangements. When the radially positioned cylinders are equi-angularly spaced, the discharge tubes are chosen to be of equal lengths. When the cylinders are not equi-angularly spaced, unequal lengths of tubing may be chosen for the purpose of obtaining evenly spaced pulses in the common discharge line.

By virtue of the uniformly spaced discharge pulses and increased compressor efficiency, the discharge tubes are made to have a relatively small diameter and may be flexible in the assembled arrangement. When the discharge tubes are connected to a common discharge line, they may be aligned in a side-by-side arrangement to cause an aspiration effect within the hollow joint, whereby the pulses being discharged from one of the cylinders assist in withdrawing the gas pulses from the other cylinders into the common discharge line. The result of this aspiration effect is to reduce the watt input and increase the volumetric efficiency of the compressor.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a fragmentary vertical cross section of a two cylinder compressor employing the discharge arrangement of the present invention;

FIG. 2 is a fragmentary vertical cross section of a six cylinder compressor employing the discharge arrangement of the present invention; and

FIG. 3 shows an unfolded view of the discharge arrangement of this invention as employed in the six cylinder compressor of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a two cylinder, hermetic refrigerant compressor 1 of the type having an opposed cylinder arrangement and a vertical crankshaft. The compressor housing 2 is gas tight and comprises an upper half shell 6 and lower half shell 8 welded together at seam 7. Resiliently supported within the compressor housing 2 by coil springs 4 are an electric motor component 3 and a compressor component 9. Radially positioned around the motor crankshaft are the cylinders 12 and 14. Although a two cylinder compressor is illustrated in the present embodiment, the number of cylinders is not by any means limited thereto. Each cylinder 12 and 14 is provided with a single, respective discharge tube 16 and 18 of particular predetermined dimensions for enabling the cylinder gases to be discharged. Each single discharge tube 16 and 18 is connected together inside of casing 2 and to a common discharge line 20 by means of a tubular common joint 22. Common joint 22 is positioned at a point relative to the respective dimensions of each of the single discharge tubes 16 and 18 and to the radial positions of their respective cylinders 12 and 14, as will be explained more fully hereinafter. Common discharge line 20 extends through an opening 21 in the compressor casing upper half shell 6 to provide discharge means for the compressed cylinder gases. Common joint 22 is hollow and is provided with a plurality of inlet openings, one opening being provided for each respective single discharge tube that is to be connected thereto. Common joint 22 has a single outlet opening having a larger diameter than the diameters of the inlet openings, the outlet opening communicating with the common discharge line 20.

Gases that are discharged from the cylinders are in the form of pulse trains having various frequencies. It is known that certain frequencies are apt to cause a turbulent gas discharge flow which results in unwanted noise and vibration. Prior art methods have employed mufflers, silencers, and sound absorbing chambers to cope with the noise and vibration problem. However, these muffling devices may be inherently undesirable, because they decrease the power and overall efficiency of the compressor, consume large areas of space within the compressor casing, and require the use of discharge tubing having relatively large diameters.

By properly selecting the dimensions of the exhaust discharge tubes, unwanted noise and vibration can be kept to a minimum thereby permitting the necessity of prior art mufflers to be minimized. More particularly, by properly choosing single discharge tubes **16** and **18** of particular lengths, the discharge pulsations arriving at hollow joint **22** are evenly spaced and uniformly timed. The lengths of the single discharge tubes are chosen such that when their respective, radially positioned cylinders are equi-angularly spaced, tubes of equal lengths and equal diameters are employed in the discharge arrangement **15.** If the respective, radially positioned cylinders are not equi-angularly spaced, then single discharge tubes of equal diameters but of nonequal lengths are employed for a given direction of rotation of the compressor crankshaft. Whenever single discharge tubes of non-equal lengths are being selected, the lengths must be chosen with regard to the direction of crankshaft rotation to accordingly insure that the discharge pulses from the respective cylinders are evenly spaced when received at common joint **22.**

By virtue of the evenly spaced discharge pulses, a steady and even gas flow can be created in common discharge line **20** whereby the noise level will be substantially reduced and certain frequencies which are known to cause vibration and resonance in the associated mechanical structures will be cancelled. Testing a compressor embodying the particular lengths of discharge lines of the invention, has shown that in compressors operated with a 60 hertz A.C. motor, induced resonant vibrations at 60 hertz and 180 hertz were minimized. (If the compressor were operated by a 50 hertz current, the vibrations at 50 hertz and 150 hertz were found to be minimized.) The effect of properly choosing single discharge tubes so as to cause evenly spaced discharge pulses and the above described cancellations of resonant vibrations at the common joint minimizes the need for prior art mufflers and thereby increases the overall efficiency of the compressor.

With the increased compressor efficiency, the diameters of single discharge tubes **16** and **18** may be reduced. Reducing the diameter of discharge tubes **16** and **18** enables them to be flexible in the assembled discharge arrangement **15,** while the common discharge line **20,** because of its larger diameter, remains relatively rigid. Due to the flexible nature of tubes **16** and **18,** they are adapted to be bent and aligned in a side-by-side arrangement when they are to be connected to hollow joint **22.** The result of aligning tubes **16** and **18** in a side-by-side relationship at their point of connection with hollow joint **22** is to thereby create an aspiration effect within the joint **22,** by which gas being discharged from one of the cylinders actually helps to withdraw the discharge pulses from the opposing cylinder. As a consequence of this aspiration effect at hollow joint **22,** the watt input to the compressor motor can be reduced and the volumetric efficiency of the compressor will also be increased.

FIG. **2** shows a hermetic compressor having six cylinders and employing a discharge arrangement **50** of the present invention. Cylinders **30, 31, 32, 33, 34,** and **35** are radially arranged around the compressor crankshaft. Each cylinder has a respective single discharge tube **36, 37, 38, 39, 40** and **41.** Single discharge tubes **30, 31,** and **32** are joined together in a group and are connected to a respective common discharge line **46** inside of casing **2** by means of a tubular hollow joint **42.** Single discharge tubes **33, 34** and **35** are also joined together in a group and are connected to their respective common discharge line **48** inside of casing **2** by means of a tubular hollow joint **44.** The common discharge lines **46** and **48** extend through hermetic casing **2** in order that the cylinder gas pulses may be discharged. Hollow joints **42** and **44** have three inlet openings, one to accommodate each respective discharge tube, and one outlet opening for communicating with their respective common discharge lines **46** and **48.** The lengths and diameters of single discharge tubes **36–41** are chosen to be equal relative to each other when cylinders **30–35** are equi-angularly spaced.

FIG. **3** shows an unfolded view of the six cylinder discharge arrangement **50** as illustrated in FIG. **2.** When cylinders **30–35** are not equi-angularly spaced, the diameters of discharge tubes **36–41** will again be chosen to be equal, but the lengths of the tubes **36–41** will be non-equal. Regardless of whether the cylinders are equi-angularly arranged or not, the lengths of discharge tubes **36–41** must be chosen to accordingly produce uniformly timed and evenly spaced cylinder gas discharge pulses at common joints **42** and **44** and within common discharge lines **46** and **48.** By virtue of the evenly spaced discharge pulses being produced at the common joints **42** and **44,** a relatively steady and even gas flow will be produced in the common discharge lines, whereby the noise level can be substantially reduced and the need for mufflers minimized, thereby increasing the overall efficiency of the compressor.

With the increased compressor efficiency and the minimized need of mufflers, single discharge tubes **36–41** can be given smaller diameters than what would have normally been required had mufflers been employed. The diameters of tubes **36–41** are smaller than those of the common discharge lines **46** and **48,** which also enable tubes **36–41** to be relatively flexible when assembled in the discharge arrangement **50.** A first group of single discharge tubes **36, 37,** and **38** and a second group of discharge tubes **39, 40,** and **41,** are each connected to their respective common discharge lines **46** and **48** by hollow joints **42** and **44.** Each single discharge tube group is connected to its respective joint with the discharge tubes of that group being aligned in a side-by-side arrangement. As previously described in the two cylinder arrangement of FIG. **1,** this side-by-side aligning of the single discharge tubes causes an aspiration effect to occur at each hollow joint **42** and **44.** The aspiration effect results in a lower motor watt input and increased compressor volumetric efficiency. The fact that the single discharge tubes **36–41** can be of a reduced diameter due to the increased compressor efficiency, results in lower costs and enhances vibration isolation from the casing when used with internally spring mounted compressors.

Various modifications will occur to those skilled in the art. For example, although a two and a six cylinder compressor were illustrated, the discharge arrangement of the present invention could equally well be employed in a compressor having three, four, or more cylinders as long as the lengths of the single discharge tubes are chosen to produce uniformly spaced gas discharge pulses in the respective common discharge line.

It should also be appreciated that should the diameters of the single discharge tubes vary, the lengths of the tubes will be chosen accordingly so as to again insure that uniformly spaced discharge pulses are produced in the respective common discharge lines thereby minimizing the need of mufflers.

Although in the preferred form of this invention the hollow joint is to be positioned inside of the compressor casing, it is to be understood that many of the aforementioned benefits of the invention may also be obtained when the single discharge tubes extend through the casing and are joined to a common discharge line by means of the hollow joint at a point outside of compressor casing.

I claim:

1. A hermetic refrigerant compressor having at least two radially positioned cylinders within the hermetic compressor casing, a single discharge tube for each cylinder, said single discharge tubes having outlet ends directed in the same flow direction and in generally parallel relation into a common discharge line at a common joint, the common joint being positioned at a point relative to the respective dimensions of each of said single discharge tubes and the radial positions of their respective cylinders so that the discharge pulses from each of said single discharge tubes into the common discharge line are evenly spaced, and each discharge pulse causes an aspirating effect upon the succeeding discharge pulses into the same common joint.

2. In a refrigerant compressor of the multiple-cylinder, reciprocating type enclosed within a hermetically sealed casing, a refrigerant discharge line arrangement comprising:

a single discharge tube having an inlet end connected to each cylinder, and an outlet end;

a discharge line having an inlet end receiving the outlet ends of at least two of said discharge tubes at a common joint, the outlet ends of said tubes being directed in the same flow direction and in generally parallel relation into said common joint;

said common joint being so located relative to the lengths of said discharge tubes that the discharge pulses from each of said tubes into said joint are evenly spaced from the discharge pulses from the others of said tubes connected to said joint so that an aspirating effect is provided by each discharge pulse upon the succeeding pulses;

said discharge line exiting through said casing without passage through an intervening muffler.

3. A hermetic refrigerant compressor having at least two radially positioned cylinders with at least one common discharge line extending from within the hermetic compressor casing, a single discharge tube within said casing for each cylinder, a group of said single discharge tubes having their outlet ends being gathered together and directed in the same flow direction and in generally parallel relation into a respective common discharge line at a common joint, the common joint being positioned inside the casing at a point relative to the respective dimensions of each of said single discharge tubes connected thereto and to the radial positions of their respective cylinders that the discharge pulses from each of said single discharge tubes into the common discharge line are evenly spaced, and each discharge pulse causes an aspirating effect upon the succeeding discharge pulses into the same common joint.

4. The invention of claim **3** wherein each of said single discharge tubes is of substantially equal length and diameter and said radially positioned cylinders are equi-angularly positioned.

5. The invention of claim **3**, wherein the groups of single discharge tubes for said cylinders are chosen to be of equal diameters and of non-equal lengths when the respective radially positioned cylinders are not equi-angularly positioned.

6. The invention of claim **3**, wherein said single discharge tubes each has a diameter less than the diameter of said common discharge line.

7. The invention of claim **6**, wherein said single discharge tubes are relatively flexible with respect to said common discharge line.

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