

[54] **METHOD AND APPARATUS FOR
REDUCING EFFECTIVE PUMPING
CAPACITY OF A REFRIGERANT VAPOR
COMPRESSOR**

[76] Inventors: **James D. Bares**, Woodstock Rd.,
Gates Mills, Ohio 44040; **William P.
Burke, Jr.**, 7665 Chesterbrook Rd.,
Chesterland, Ohio 44026

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[56]

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Primary Examiner—William L. Freeh

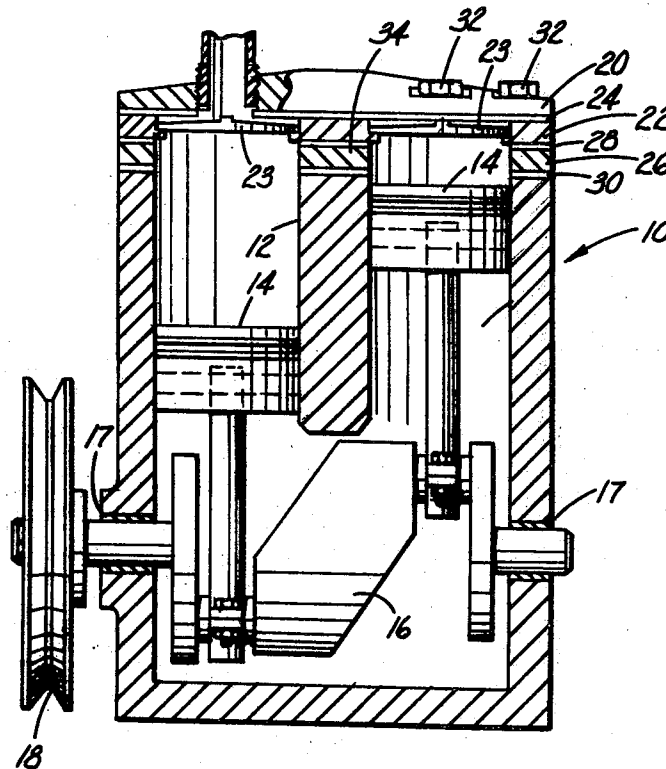
Assistant Examiner—Gregory Paul LaPointe

[57]

ABSTRACT

The effective pumping capacity of a refrigerant vapor compressor is reduced by interposing a spacer plate between the valve plate and the cylinder block.

4 Claims, 9 Drawing Figures



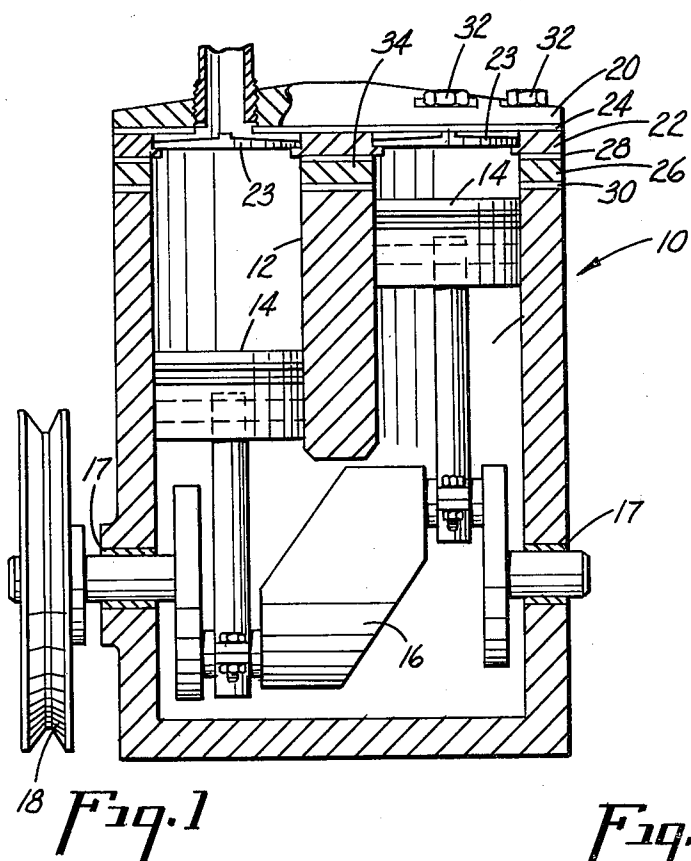
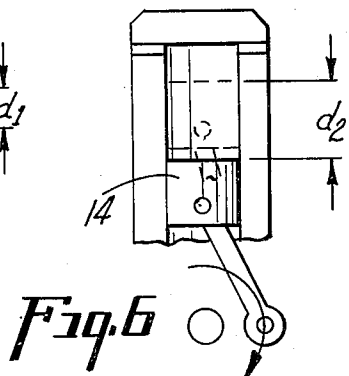
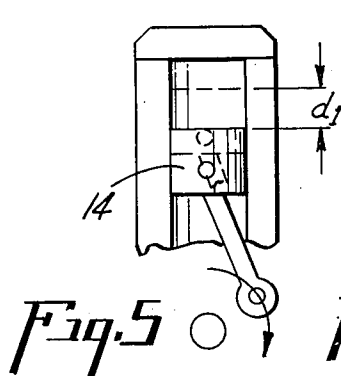
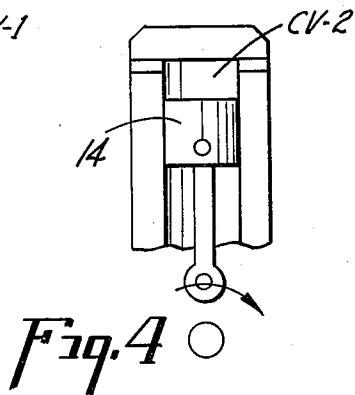
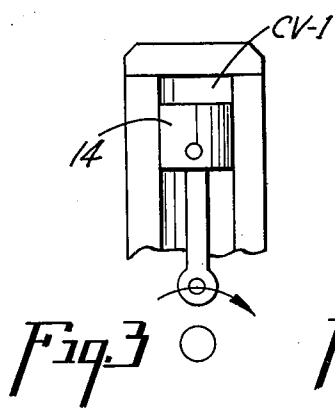
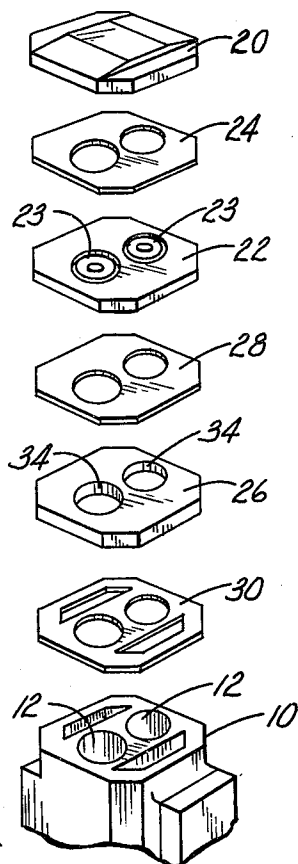
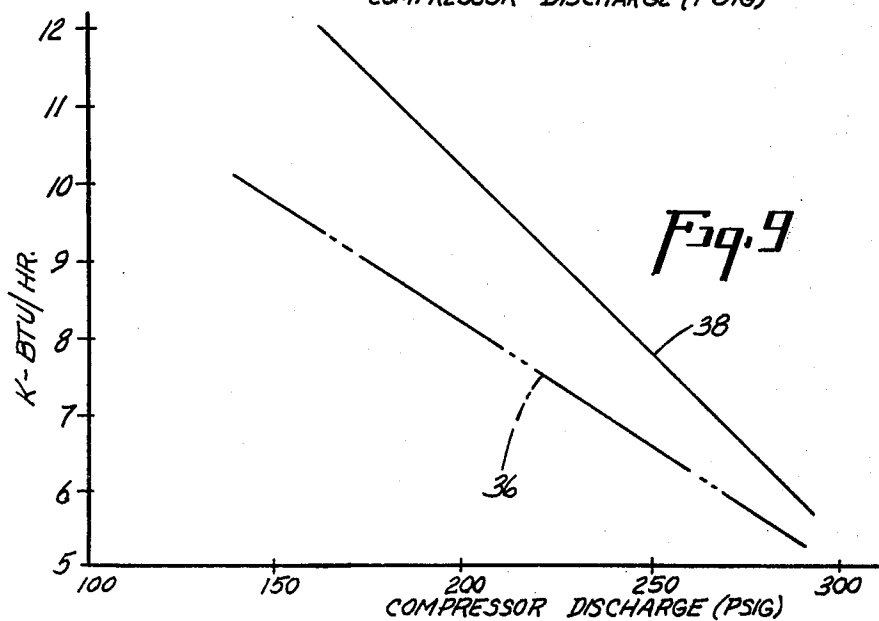
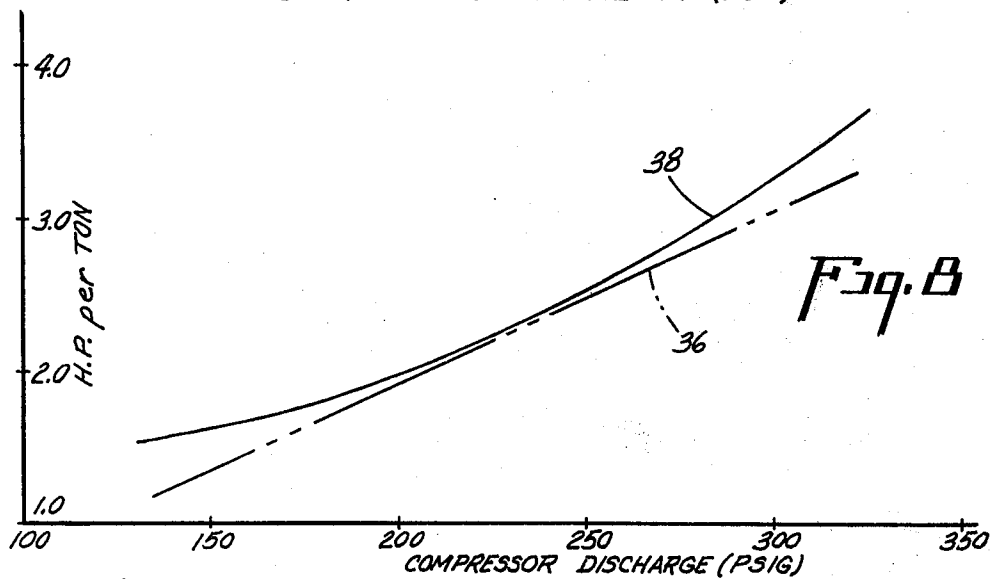
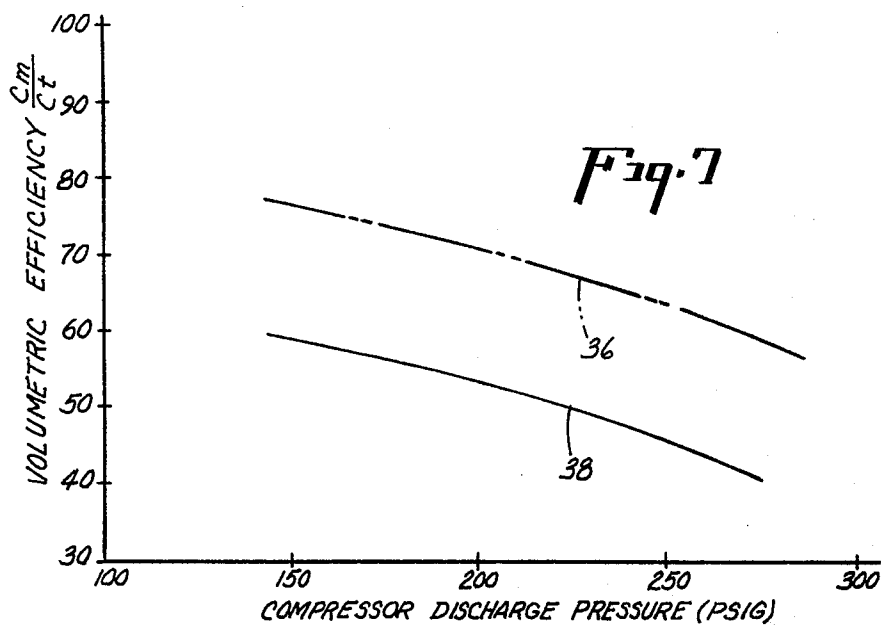


Fig. 2





METHOD AND APPARATUS FOR REDUCING EFFECTIVE PUMPING CAPACITY OF A REFRIGERANT VAPOR COMPRESSOR

BACKGROUND OF THE INVENTION

This invention relates generally to method and apparatus for reducing the effective pumping capacity of a refrigerant compressor, and more particularly to such method and apparatus employing a spacer plate interposed between the block and valve plate to increase the clearance volume of the cylinder bores of conventional refrigerant vapor compressors.

The present invention is especially adapted and suited for use in reducing the effective pumping capacity of refrigerant vapor compressors utilized in automotive compressors for automotive airconditioning and will be described in this context. However, this invention is applicable in any situation wherein it is desired to reduce the effective pumping capacity of a given vapor compressor. In the automotive airconditioning market there has developed several different size, i.e., pumping capacity, refrigerant vapor compressors for use in the various airconditioning systems, each of the several different sizes being utilized in different total systems. Generally speaking, the smaller the size of the effective pumping capacity, the smaller the overall capacity of the airconditioner, and hence the use of the smaller capacity compressors is more common with the smaller size engine, and vice versa.

With the need for various size compressor capacities, there has developed various different size compressors, each specifically designed for a specific capacity airconditioning system and utilized with its specific system. While this is reasonably acceptable in the case of original equipment markets wherein the availability of the various sizes of compressors to be matched with the designed airconditioning systems can be controlled, this variation in size has proved to be a very serious problem in the equipment rebuilding and repair market wherein reconditioned, repaired, and rebuilt parts are provided when repairing airconditioning systems. The problem is one of matching the available capacity compressors for rebuilding with the specific need of the equipment to be repaired and rebuilt. Indeed it has been found that at certain times there is a very serious shortage of the lesser capacity compressors and an overabundance of the higher capacity compressors vis-a-vis the needs of the automotive repairing and rebuilding market for automotive airconditioning. Thus there has arisen a very serious problem of having available necessary small capacity compressors for repair and rebuilding to supply the needs of the repairing and rebuilding trade in the automotive airconditioning market.

SUMMARY OF THE PRESENT INVENTION

According to the present invention, a spacer plate is provided which is interposed between the valve plate and the cylinder block of a refrigerant vapor compressor. The spacer plate has apertures aligned with the cylinder bores thus increasing the clearance volume in the cylinder bores thereby reducing the effective pumping capacity. These spacer plates may be formed to fit various conventional refrigerant vapor compressors to thereby reduce by a given amount the effective pumping capacity of the compressor.

DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal sectional view of a refrigerant vapor compressor employing the spacer plate of the present invention;

FIG. 2 is an exploded perspective view somewhat diagrammatic showing the various components of the refrigerant vapor compressor of FIG. 1;

FIGS. 3, 4, 5, and 6 are diagrammatic illustrations for indicating how the use of a spacer plate increases the clearance volume and thereby decreases the pumping capacity of the compressor;

FIGS. 7, 8 and 9 are graphs comparing the relationship between various parameters of a conventional 6 c i d refrigerant vapor compressor and a 10 c i d compressor modified to an approximately 6 c i d effective capacity by utilizing a spacer plate of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and for the present to FIGS. 1 and 2, a conventional refrigerant vapor compressor modified with a spacer plate according to this invention to reduce its effective capacity is shown. The compressor includes a cylinder block 10 having a pair of cylinder bores 12. A pair of pistons 14 are provided, each mounted for reciprocal movement in one of the cylinder bores 12. The pistons are movable by means of a crank shaft 16 which crank shaft 16 is journaled for rotation in the cylinder block 10 by means of bushings 17. A sheave 18 is provided to allow for a belt from the crank shaft.

The compressor also includes a cylinder head 20 and a valve plate 22 having reed valves 23 operatively associated with each cylinder. The reed valves in a conventional manner will allow intake of refrigerant vapor on the intake stroke of piston when the pressure is below the inlet pressure and allow discharge of the compression stroke when the pressure on the cylinder exceeds the discharge pressure. A gasket 24 sealingly engages between the valve plate 22 and the cylinder head 20.

A spacer plate 26 is also provided which is located between the cylinder block 10 and the valve plate 22 with sealing gasket 28 between the spacer plate and the valve plate and sealing gasket 30 between the spacer plate and the cylinder block. (In the case of all the gaskets these can be formed of separate members or formed as gasket material applied to one or the other of the members with the gasket seals between.) The entire assembly is held together by means of bolts 32.

The spacer 26 is formed of a relatively rigid non-deformable material, preferably metal, and is provided with a pair of through apertures 34, each of which is in alignment with one of the cylinder bores 12. The apertures preferably are of the same size and cross-sectional configuration as the bores 12, thus forming in essence an uninterrupted continuation of the cylinder bore. By providing this increased volume of each of the cylinder bores the effective pumping capacity of each of the bores is reduced thereby reducing the effective pumping capacity of the compressor. This is illustrated diagrammatically in FIGS. 3 through 6.

FIG. 3 shows diagrammatically a conventional cylinder bore and piston without a spacer plate therein while FIG. 4 shows the same piston and cylinder bore extended by a spacer plate. In the case of both FIGS. 3

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and 4, the piston is at the top of its stroke in its full compression mode and has just completed the discharge of the compressed gas at its high pressure. As can be seen, CV-1 (clearance volume) of FIG. 3 is substantially less than CV-2 (clearance volume) of FIG. 4, the clearance volume being defined as that volume remaining in the cylinder bore at the top of the stroke of the piston. At this point with each of the pistons shown in FIGS. 3 and 4, the gas is at high pressure and it is being discharged at this high pressure value; for example, this could be in the order of magnitude of about 200 psig. From this point the piston will move downwardly in response to the action of the crank shaft, and during this downward movement the remaining gas will expand and upon expansion will have a corresponding reduction in pressure. This expansion and reduction in pressure will continue without any gas being added until it reaches the inlet pressure. After this point any further reduction in pressure will cause the reed valve to admit an additional volume of gas in such volume as will maintain the gas at the inlet pressure; for example, this could be around 30 psig. FIGS. 5 and 6 illustrate how the lower pressure value is reached more quickly on the downward stroke of the piston in the conventional device as shown in FIG. 5, as opposed to the modified device as shown in FIG. 6. As shown in FIG. 5, once the piston has moved down a distance D-1, the volume of gas will have expanded until it reaches the inlet pressure, for example 30 psig, after which further downward movement of the piston will result in continuous intake of gas until the bottom of the stroke is reached. Similarly in FIG. 6 the piston will continue downwardly until the inlet pressure, e.g. 30 psig, is reached. However, because of a larger initial volume of gas (CV-2 as compared to CV-1) a longer distance D-2 is traveled before the pressure has reached the inlet value, (e.g. 30 psig). Thus, there will be a longer portion of the downward or intake stroke of the piston that the gas remaining is expanding and hence a shorter period that gas is being admitted which thereby reduces the volume of gas admitted each time and thus reduces the volume of gas discharged each time. Hence the use of the spacer plate actually reduces the effective pumping capacity of the device by reducing the amount of gas admitted and discharged during each cycle of the piston.

FIGS. 7, 8, and 9 show curves comparing the various parameters of a conventional York 6 cubic inch compressor to a York 10 cubic inch displacement compressor which has been modified by a spacer plate according to this invention to be approximately a 6 cubic inch displacement compressor. In each case, the line 36, which is a dot-dash line, represents the standard York 6 c i d compressor, and the solid line 38 is a standard York 10 c i d compressor modified by the use of a spacer plate according to this invention to have approximately a 6 c i d capacity. FIG. 7 shows the volumetric efficiency as compared to the compressor discharge pressure. Volumetric efficiency is equal to cm/ct where cm is measured thermal capacity and ct is theoretical thermal capacity, both in BTU/hour. FIG. 8 shows the

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horsepower per ton as a function of compressor discharge pressure and FIG. 9 shows the BTU's per hour as a function of compressor discharge pressure. These curves illustrate the effectiveness of the device as modified as compared to a conventional device specifically manufactured for the particular discharge size.

As indicated above, the present invention finds particular use in the automotive airconditioner rework or rebuilding market, and this at the present time constitutes the preferred environment and usage for the present invention. However, it is understood that it would be equally applicable to original equipment market in that it would allow the manufacture of a single large size compressor being adaptable to various smaller sizes by utilizing various sizes of spacer plates. For example, it might be desired to manufacture a 10 cubic inch compressor as standard and provide optionally for the use of either of several spacer plates which could reduce the capacity to anything less than the desired 10 cubic inches merely by proper selection of a desired spacer plate.

What is claimed is:

1. A method of reducing the effective pumping capacity of a refrigerant vapor compressor, which compressor includes a block having at least one cylinder bore therein with a piston reciprocally mounted in each bore and each having a predetermined fixed stroke length, a cylinder head, and a valve plate interposed between said head and said block, comprising the steps of providing a spacer plate having through bores therein corresponding to the cylinder bores and forming a continuation of each cylinder bore, said spacer plate being formed of a relatively rigid relatively non-deformable material, and interposing the spacer plate between the valve plate and block, whereby to increase the clearance volume of the cylinder bore and decrease the volumetric efficiency.

2. The invention as defined in claim 1 wherein each of the through apertures have the same size and shape as the cross-sectional configuration of their corresponding cylinder bore.

3. In a refrigerant vapor compressor having a block with at least one cylinder bore therein, and with a piston reciprocally mounted in each bore and each having a predetermined fixed stroke length, said compressor having also a head, and a valve plate interposed between the head and the block, the improvement comprising, a spacer plate formed of a rigid relatively non-deformable material interposed between said valve plate and said block, said spacer plate having a through aperture corresponding to each cylinder bore and each forming a continuation of each cylinder bore, whereby to decrease the effective pumping capacity and volumetric efficiency of the compressor by increasing the clearance volume of the cylinder bore.

4. The invention as defined in claim 3 further characterized by each of said apertures being the same in size or shape as the cross-section configuration of its respective cylinder bore.

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