Oct. 3, 1950 J. S. PALMER 2,524,207

LARGE DIAMETER CRANKSHAFT FOR MOTOR COMPRESSORS

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FIG. 1.

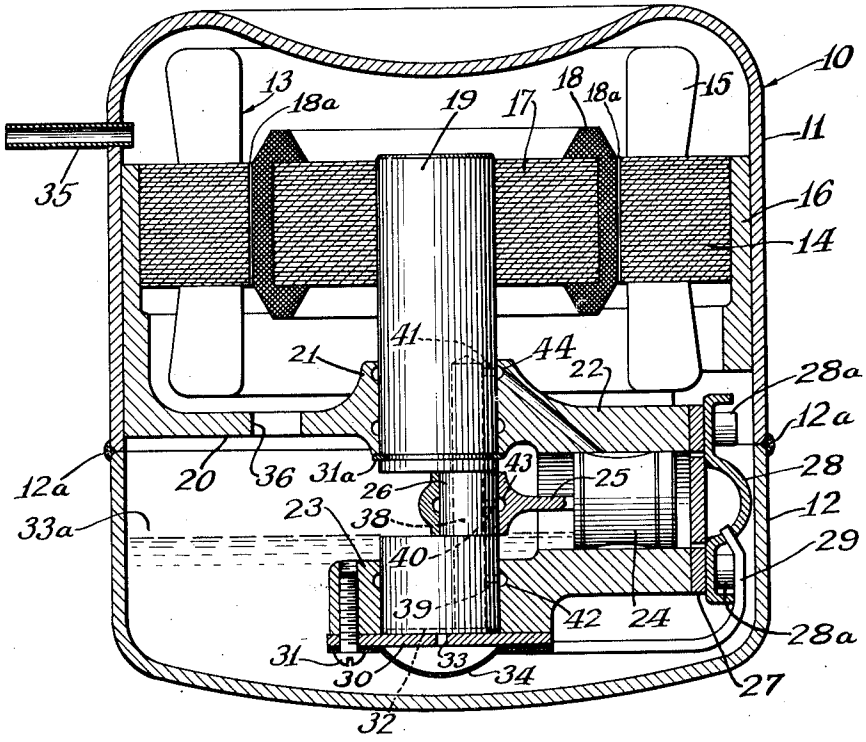


FIG. 2.

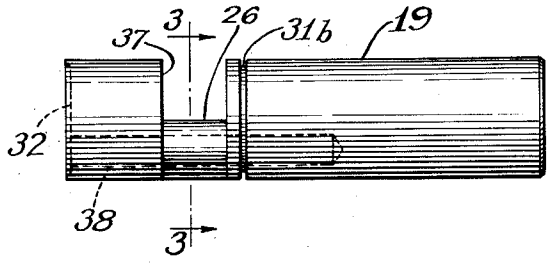
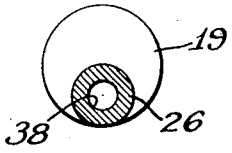


FIG. 3.



Inventor:
John S. Palmer
Paul O. Pippel
Atty.

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LARGE DIAMETER CRANKSHAFT FOR MOTOR COMPRESSORS

John S. Palmer, Evansville, Ind., assignor to International Harvester Company, a corporation of New Jersey

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5 Claims. (Cl. 74—603)

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This invention relates broadly to compressors, but more specifically it is concerned with a new and novel type of crankshaft adaptable for use in compressors associated with refrigeration apparatus, and to the method of fabricating a crankshaft of this character.

In the past crankshafts have been most frequently used as the means best suitable for converting rotary to reciprocatory motion, and vice versa, and the widespread use thereof resulted in the production of many varieties and forms which have been employed with varying degrees of success. Heretofore, however, a device of this type has usually been characterized by designs which followed a rigid adherence to the principle that the most satisfactory method of effecting both static and dynamic balance therein involved the addition of external weights disposed in opposition to the reciprocating or predominating force.

Because of the general acceptance of this practice such devices invariably follow a design pattern which envisages the application of external counter-balancing means in order to compensate for unbalanced forces set up during the conversion of rotary to reciprocatory motion, and vice versa. Usually such counter-balancing is accomplished by the addition of a compensating weight affixed to the crankshaft at a point disposed 180 degrees from the center of the crank throw. In the case of a multiplicity of cylinders, however, this practice usually embraces also a staggered distribution of the various crank throws at spaced intervals about the crankshaft in order to obtain smoother operation. Although both of these methods have been universally employed neither has proven entirely satisfactory. The present crankshafts are much too cumbersome and difficult to fabricate. Occasionally, too, it is difficult to adapt them to a particular machine or apparatus because space limitations therein either restrict, or prohibit, the use of counter-weighting mechanisms. Furthermore, because of its highly complex shape and the intricate and delicate operations involved in its fabrication and balancing it is a very costly item to manufacture; hence, manufacturers are constantly striving toward the simplification thereof with the ultimate hope that such will eventually result in the production of an efficient and much less expensive product.

The present invention, recognizing the limitations and disadvantages of the conventional crankshaft, contemplates the provision of a crankshaft which represents a substantial improvement over the forms presently employed, and, as such, envisages the fabrication of a crankshaft of greatly simplified construction that inherently eliminates many of the objections and difficulties heretofore encountered in connection with the use of the more complex and costly structures presently in use. Accordingly, it is a principal object of this invention to provide a novel, inexpensive, simply constructed and easily counter-balanced crankshaft, adaptable for refrigerant compressors, that has counter-balancing means confined within the perimeter of the shaft.

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It is also an important object of this invention to provide a sturdy, dependable and simplified crankshaft having a crank throw in which the external diameter of the circle described thereby is equal to, or less than, the perimeter of the crankshaft.

Another important object is to provide a crankshaft having a crank throw that describes a circle which may be contained within the perimeter of the crankshaft.

Another object is to provide a crankshaft which may be counter-balanced by the removal of material from its interior thereby avoiding the use of weighting means affixed exteriorly of the shaft for the counter-balancing thereof.

A further object is to provide a crankshaft having one or more crank throws, fabricated integrally therewith, and so positioned that the perimeter of the circle described by any one of the throws will be coincident with or fall within the perimeter of a circle circumscribed about the longitudinal axis of the shaft with a radius equivalent to that of the shaft.

A further important object is to provide a crankshaft that is readily adaptable for insertion endwise through the bearings in a refrigerant compressor employing a unitary-type frame having integrally fashioned single-piece type inboard and outboard bearings.

An additional object is to provide a crankshaft having a crank throw in which the radial distance from the longitudinal axis of the shaft to any point on the perimeter of said throw is equal to, or less than, the radius of the shaft.

A yet still further and important object of this invention is to provide a new and improved method for making a simplified crankshaft.

Other objects and advantages will be understood and will become more apparent from the following description when read in conjunction with the drawings in which:

Fig. 1 is a vertical sectional view of a conven-

tional hermetically-sealed type refrigerant motor compressor unit into which the present invention has been incorporated.

Fig. 2 is a plan view of a crankshaft fabricated in accordance with the teachings of this invention, and

Fig. 3 is a section taken along line 3—3 of Fig. 2.

In the attached drawings a preferred embodiment of the invention has been illustrated in connection with a refrigerant compressor, but it is conceivable that the teachings of the present invention are equally applicable to any one of many machines employed for converting rotary to reciprocatory motion, and vice versa, and the invention, therefore, should not be limited to the specific embodiment shown.

In Fig. 1 a conventional hermetically sealed compressor unit is indicated generally by the numeral 10. A unit of this character may consist of an outer shell fabricated with an upper portion 11 and a lower portion 12 sealed together by any suitable means, such as the welding indicated at 12*a*. An electric motor, indicated in general by the numeral 13, having a stator 14 wrapped with electrical field coils 15 is securely positioned within an annular portion of a unitary frame member 16 which, in turn, is fixedly positioned within the upper portion of the shell 11. Positioned between opposite sides of the stator 14 is a rotor 17 and its associated electrical coils 18. The rotor 17 is spaced from the stator 14, as indicated at 18*a*, in order to provide an air gap in accordance with well known principles, and is further mounted on a crankshaft 19 and the whole rotor assembly adapted for rotation within said stator.

A radially extending partition 20, of the unitary frame 16, provides an inboard bearing 21 for the intermediate portion of the shaft 19, while the opposite side of said bearing merges into one wall of a compression cylinder 22. An additional or outboard bearing 23, proximate the lower end of the shaft 19, is fashioned integral with and extends out from the opposite wall of said cylinder 22. A piston 24, positioned for slidable movement within said cylinder, is connected, by suitable means such as the connecting rod 25, to a crank throw 26 that is fabricated integrally with the crankshaft 19. A valve plate 27 and a cylinder head or collector dome 28, may be affixed, by suitable means such as the fillister screws shown at 28*a*, to one end of the cylinder 22 to seal the end thereof and to provide means for collecting the compressed medium which, after compression, may be exhausted through any suitable outlet such as the conduit 29.

A bearing plate 30, affixed, by suitable removable means such as the screws 31 (only one of which is shown), to one end of the outboard bearing 23, provides a thrust bearing surface for the lower end of the crankshaft 19, while a retaining ring 31*a*, preferably of the split type, positioned in an annular groove 31*b*, in the crankshaft 19 adjacent the marginal edge of the bearing 21, may be provided in order to limit upward thrust motion of said shaft. A recess 32 in one end of said crankshaft, and an opening 33 in said plate, serve to permit the entrance of lubricant indicated by the numeral 33*a* in the lower portion of the shell 12, into the bearings, as will be more fully explained hereinafter. A cup-shaped screen 34 may also be provided to cover the end of the shaft 19 for the purpose of filtering foreign particles out of the lubricant before it passes into the bearing surfaces.

An inlet pipe opening 35, in the upper portion

of the shell 11, provides for the entrance into the compressor unit of the medium to be compressed. In the preferred embodiment illustrated herein this conduit is connected to the suction side of an evaporator in the refrigeration apparatus (not shown) and serves to return refrigerant therefrom. Openings 36 (only one of which is shown in the drawing) fashioned in the radially extending partition 20, of the unitary frame member 16, permit the passage of refrigerant from the inlet 35 into the lower shell portion 12, of the unit 10, where it may be directed through a manifold (not shown) into the cylinder 22 for compressing purposes. Since the flow of refrigerant through the compressor unit is accomplished in conventional fashion, further details relating to the operation thereof are deemed unnecessary to the scope of the present invention.

Since the present invention is, of course, directed primarily to the large diametered simplified crankshaft 19, and to its method of manufacture, a description of the details thereof follows. A conventional circular shaft of relatively large diameter with a shallow recess in one end thereof is first formed, in accordance with any one of the standard practices for fabricating structures of this character, and then machined to predetermined dimensions. Next a portion of the material, represented by the opening 37 (Fig. 2), is cut away in a manner so as to provide a reduced and eccentrically disposed circular section which, when fashioned to dimension, becomes the crank throw indicated by the numeral 26. Although in the present instance only one such throw has been so formed, it will be readily seen that a plurality of similar throws could likewise be fabricated on the shaft, if desired. The external dimensions of the throw, it will of course be understood, should correspond with the interior dimensions of the shaft bearing on the connecting rod 25, while the eccentricity of the throw must be calculated to correspond with the piston stroke desired. Now to counter balance this crankshaft a quantity of material, predetermined by mathematical calculations, is removed from the interior thereof by drilling out a longitudinally extending opening such as is represented by the numeral 38. Such opening may be provided in any one of many locations within the interior of the shaft and may be of varying dimensions depending upon the unbalanced forces which must be compensated. In order to obtain the best dynamic balance, however, it is desirable that a quantity of material be removed from each end section of the crankshaft in lieu of removing all the material from one end only. Upon completion of these operations it will be seen that a sturdy, simplified and effectively counter-balanced crankshaft has been provided. Furthermore, it will also be appreciated that this crankshaft is devoid of external counter weighting means which ordinarily require considerable space in which to operate within a crank chamber. It will be further noted that the crank throw in this crankshaft is constrained in its travel to a circle that is limited to the perimeter of the shaft; hence the crankshaft assembly may be inserted endwise through the compressor bearings. Many of the modern hermetically sealed refrigeration compressor units employ a unitary frame structure, similar to that illustrated herein, which includes supporting means for the motor and compressor assemblies as well as for an integrally fashioned crankshaft inboard bearing and an outboard

bearing cage. A separate outboard bearing supported in a bearing cage is generally utilized in a unit of this character in order to permit the assembly and disassembly thereof when such necessitates the insertion or removal of the crankshaft. It is with compressors of this type that the present invention is particularly advantageous because it permits the use of single-piece bearings, such as is illustrated at **21** and **23** in the drawings, which may be fashioned entirely integrally with the unitary frame member and with a single bore, thus providing substantially perfect and permanent alignment. Since the improved crankshaft may be inserted or removed endwise through the bearings there will, of course, be no disturbance to the alignment thereof during repair or replacement operations. The use of the proposed crankshaft thus greatly facilitates the assembly and disassembly of such a compressor unit for repairs or otherwise. A simplified means for lubricating a unit of this character permits entrance of lubricating fluid **33***a* from its reservoir in the lower portion of the shell **12**, through the opening **33** and into the recess **32** in the lower end of the shaft **19**. The lubricant upon reaching the recess will, because of centrifugal action, be forced in a thin film between the contacting surfaces of the end of the shaft **19** and the thrust bearing plate **30** thereby providing the lubrication required between these surfaces. Since the off-center opening **38** in the shaft is also in communication with the recess **32**, the lubricant will, by centrifugal action, rise in said opening and then be forced through radially extending openings **39**, **40**, and **41** and into annular recesses **42**, **43**, and **44**, respectively, in the bearings after which it will in turn find its way between the contacting surfaces of the rotating crankshaft and its associated bearings.

Although the embodiment selected for illustration herein shows a crankshaft provided with only one crank throw, it will be easily understood that the teachings of this invention are sufficiently broad to embrace other modifications and thus may likewise be applicable when two or more such throws are provided at spaced intervals about a crankshaft.

What is claimed is:

1. As an article of manufacture a rotatable crankshaft, comprising: a circular shaft having a shallow recess in one end thereof, and including opposite end sections of similar diameters, and a crank throw of reduced diameter fashioned integrally and intermediate said end sections; said throw being eccentrically disposed with respect to the longitudinal axis of the shaft, and further fashioned so that the eccentricity thereof is equal to or less than the radius of the shaft; said shaft being further provided with a longitudinally extending recess in the interior thereof that penetrates a portion of both end sections and extends through the interior of the crank throw.

2. As an article of manufacture a rotatable crankshaft, comprising: a circular shaft having a shallow recess in one end thereof, and including opposite end sections of similar diameters, and a crank throw of reduced diameter fashioned integrally and intermediate said end sections; said throw being eccentrically disposed with respect to the longitudinal axis of the shaft, and further fashioned so that the radial distance from the longitudinal axis of the shaft to any point on the perimeter of the throw is equal to or less than the radius of the end sections of the shaft; said shaft being further provided with a longitudinally extending opening of non-uniform diameter in the interior thereof that penetrates a portion of both end sections, and extends through the interior of the crank throw.

3. As an article of manufacture a rotatable crankshaft, comprising: a circular shaft having a shallow recess in one end thereof, and including opposite end sections of similar diameters, and a crank throw of reduced diameter fashioned integrally and intermediate said end sections; said throw being eccentrically disposed with respect to the longitudinal axis of the shaft, and further fashioned so that the radial distance from the longitudinal axis of the shaft to any point on the perimeter of the throw is equal to or less than the radius of the end sections of the shaft; said shaft being further provided with a longitudinally extending recess of non-uniform diameter that extends inwardly from one end of the shaft into the interior thereof and penetrates a portion of both end sections and extends through the interior of the crank throw.

4. As an article of manufacture a rotatable crankshaft, comprising: a circular shaft having an annular groove intermediate the ends thereof adapted to receive a shaft retaining ring, and further including opposite end sections of similar diameters, and a crank throw of reduced diameter fashioned integrally and intermediate said end sections; said throw being eccentrically disposed with respect to the longitudinal axis of the shaft, and further fashioned so that the radial distance from the longitudinal axis of the shaft to any point on the perimeter of the throw is equal to or less than the radius of the end sections of the shaft; said shaft being further provided with a longitudinally extending recess of non-uniform diameter that extends inwardly from one end of the shaft into the interior thereof and penetrates a portion of both end sections and extends through the interior of the crank throw.

5. As an article of manufacture a rotatable crankshaft, comprising: a circular shaft having a shallow recess in one end thereof, and including opposite end sections of similar diameters, and a crank throw of reduced diameter fashioned integrally and intermediate said end sections; said throw being eccentrically disposed with respect to the longitudinal axis of the shaft, and further fashioned so that the eccentricity thereof is equal to or less than the radius of the shaft; said shaft being further provided with a longitudinally extending hollow bore positioned off the longitudinal center of the shaft in the interior thereof and that extends inwardly from one end of the shaft so as to pass through the crank throw and through a portion of each end section.

JOHN S. PALMER.

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