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COMPRESSOR CRANKSHAFT ARRANGEMENT

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Fig. 1

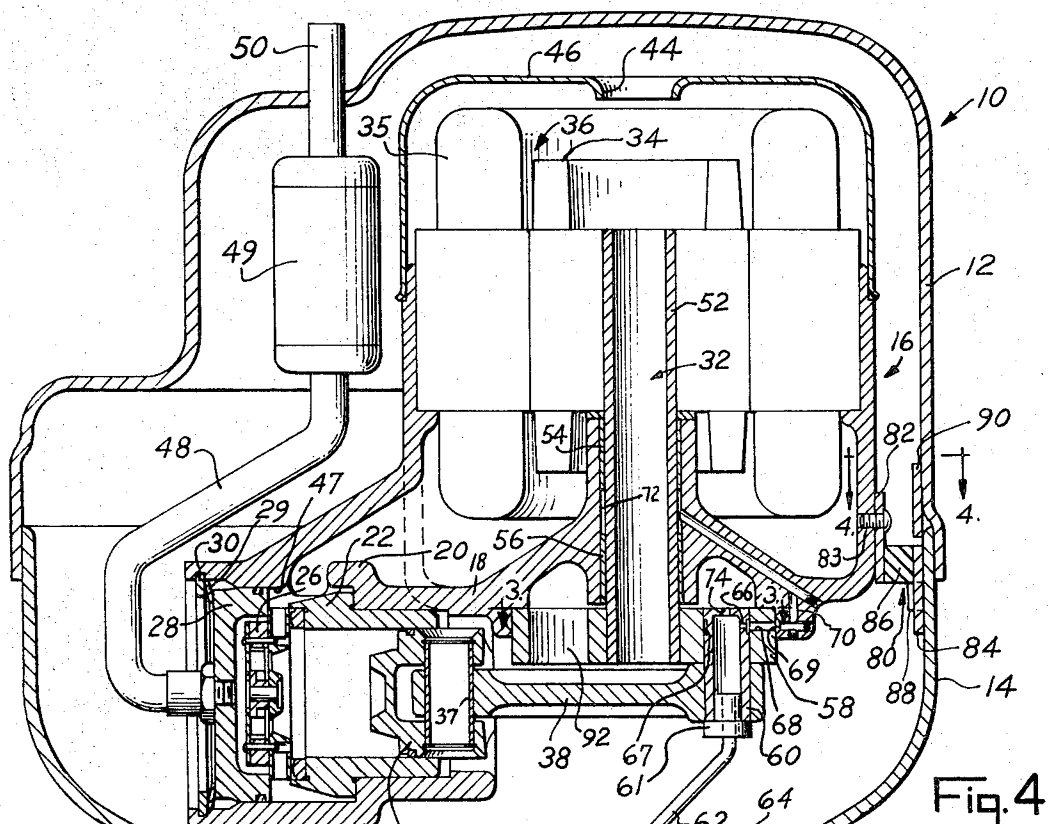


Fig. 4

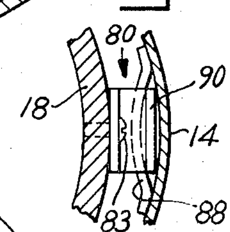
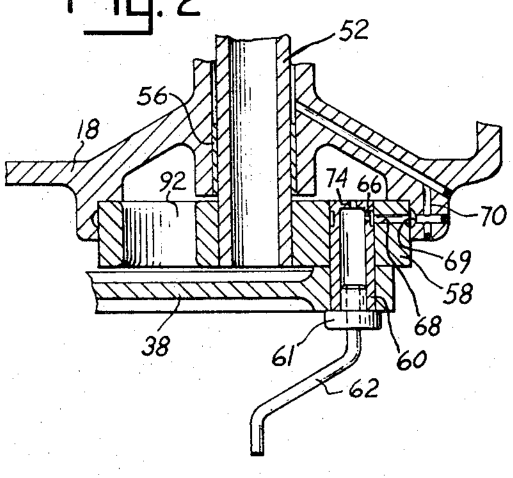


Fig. 2



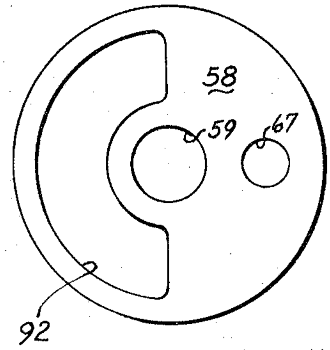


Fig. 3

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COMPRESSOR CRANKSHAFT ARRANGEMENT

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ABSTRACT OF THE DISCLOSURE

A crankshaft arrangement for a refrigerant compressor formed from relatively inexpensive components, including shaft parts prehardened and centerless ground, and then bonded to one another by electron beam welding, rather than being formed in unitary form from a forging or casting as in the prior art.

BACKGROUND OF THE INVENTION

This invention relates to an improved crankshaft arrangement for a compressor.

The crankshaft is one of the more expensive components of a refrigerant compressor, along with the electric-drive motor and the basic casting for compressor block. Prior crankshafts were commonly forged for high strength requirements and cast for lesser strength requirements. After initial forming, the crankshaft is rough ground. Pump passages are then drilled in the crankshaft. The exterior surface of the crankshaft is then coated and a portion of the coating is cut away to expose surfaces to be plated with copper which will prevent heat treatment of such surfaces. The crankshaft is heat treated and straightened. Portions of the exterior surface are then finish ground to the close tolerances required.

Special fixturing is required to grind the crankshaft since the centerline of the eccentric portion of the crankshaft differs from the centerline of the main shaft portion. It is apparent from the foregoing that the manufacture of conventional cast or forged crankshafts is relatively complex, time-consuming and, therefore, expensive.

An object of the present invention is to provide an improved compressor crankshaft arrangement, wherein the cost of fabrication is materially reduced.

A further object of the present invention is to provide an improved crankshaft arrangement for a compressor, including separate relatively inexpensive centerless ground components prehardened, and then joined to one another by electron beam welding without adversely affecting the prior heat treating.

Yet another object of the present invention is to provide an improved method for fabricating an inexpensive crankshaft for a compressor. Other objects and advantages of the present invention will become more apparent hereinafter.

BRIEF DESCRIPTION OF THE DRAWING

There is illustrated in the attached drawing a presently preferred form of the present invention, wherein:

FIG. 1 is a cross-sectional view of a compressor embodying an improved crankshaft of the present invention;

FIG. 2 is an enlarged fragmentary cross-sectional view of the compressor of FIG. 1;

FIG. 3 is a plan view of the flywheel of the crankshaft of FIGS. 1 and 2; and

FIG. 4 is a detail sectional view taken generally along the line 4—4 of FIG. 1 and illustrating a method of securing the compression mechanism within the outer housing of the compressor.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring to FIGS. 1 and 2, there is illustrated a compressor which embodies the crankshaft arrangement of the present invention. The compressor **10** comprises a gas-tight outer housing which includes an upper shell **12** and a lower shell **14** integrally joined to one another, as, for example, by welding. To the bottom of the exterior surface of the lower shell **14** are welded a plurality of suitable supports or legs (not shown) by means of which legs the compressor may be supported in upright position within a condensing unit or an air-conditioning unit.

Resiliently supported within the outer housing or casing of the compressor **10** by means which will be more fully described hereafter is a compression mechanism **16** which includes a compressor block **18.** Formed in the compressor block is a cylinder **20** having a cylinder liner **22** disposed therein for slidingly receiving a piston **24.** The end of the cylinder liner **22** is closed by a discharge and suction valve assembly **26** retained in place within the compressor block **18** by means of a cylinder head **28.** The cylinder head is held in place in the compressor block by suitable means, including a Belleville spring **29** and a retaining ring **30.**

Journaled within the compressor block **18** is the crankshaft arrangement **32** of the present invention. The crankshaft **32** is driven by electric drive motor **36.** The motor includes rotor **34** secured to the upper end of the crankshaft arrangement **32** for rotating same and stator **35** which is inductively connected to the rotor **34.** The stator **35** is fixedly secured within the compressor block **18.**

The means for actuating piston **24** include piston-connecting rod **38** which is affixed to the lower end of the crankshaft arrangement **32.** Upon rotation of the crankshaft **32,** the connecting rod **38** will be moved to reciprocate piston **24** within the cylinder liner **22.**

Suction gas enters the compressor from a suction line and passes into the space between the compressor block **18** and the outer housing **12.** The suction gas flows through the opening **44** in the end cap **46** over the motor **36** for cooling same and through the opening **47** in the compressor block to the discharge and suction valve assembly **26.** During the suction stroke, suction gas is drawn through the suction valve in the discharge and suction valve assembly **26** into the chamber defined between the liner **22,** piston **24** and assembly **26.** On the discharge or compression stroke, the piston **24** forces the compressed gases through the discharge valve in the discharge and suction valve assembly **26** and through the opening in cylinder head **28** into the discharge line **48** and through the muffler **49** in the discharge line to the discharge conduit **50** extending from the top of the compressor. The discharge conduit **50,** which is adapted to be connected in a refrigeration system, forms an extension of the discharge line.

Turning now to a further more detailed consideration of the compressor crankshaft or drive shaft arrangement **32,** it is seen that the crankshaft is fabricated from a plurality of components suitably joined to one another to provide a unique arrangement. The crankshaft arrangement **32** includes a hollow shaft portion **52** which is adapted to be journaled by bearings **54** and **56** within the compressor block **18.** The shaft portion **52** can be made from cold extruded high carbon steel, cut to length, heat treated and then centerless ground to close tolerances. A separate mass or flywheel **58** is secured to the bottom of the shaft **52** by electron beam welding. Such flywheel can be made from powdered metal or may be forged, for example. An opening **92** is provided in mass **58** for reducing the weight thereof, as desired.

The crankshaft arrangement **32** further includes a tubular centerless ground part **60** affixed within an opening **67** in the mass **58** by electron beam welding. The part **60** can also be made from steel, for example, high carbon steel, with the exterior surface thereof being heat treated to harden same. The axis of the tubular part **60** is parallel to the axis of the hollow shaft **52**. Depending from the bottom of the tubular part **60** is a tube **62** which is adapted to be connected to the tubular part **60** through the fitting **61**. Tube **62** and fitting **61** are joined as a subassembly and are connected to part **60** so as to retain an end of connecting rod **38** journaled on part **60**. The free end **62***a* of the tube **62** is adapted to extend downwardly into a lubricant sump **64** defined in the lower end of the compressor casing or shell **14** and is adapted to lie in the axis of the hollow shaft **32**, so as to ingest lubricant from the sump during operation of the compressor. The tubular part **60** is provided with generally transverse or radially disposed openings **66** adjacent the upper end thereof which are in communication with a transverse or radial opening **68** in the mass **58**. The opening **68** in the mass **58** is adapted to communicate with an annular groove or recess **69** defined in the compressor block **18** which groove **69**, in turn, communicates with passage means **70** formed in the compressor block. The passage means **70** may comprise separate interconnected passages drilled in the compressor block, with the ends of the passages then being plugged to provide a continuous passage means communicating the crankshaft passage with annular space **72** between the hollow shaft **52**, the compressor block **18** and bearings **54** and **56**. It will be seen that in normal operation, lubricant ingested by the tube **62** from the sump **64** will pass through the tube **62**, fitting **61**, tubular part **60** and through the opening **68** and passage means **70** into the annular space **72** for pressurized lubrication of the crankshaft bearing surfaces.

A vent opening **74** is provided in the top of the tubular part **60** such that at start-up of the compressor, any refrigerant in the tubular part **60** will be vented through the vent opening **74** into the space between the compressor block **18** and the outer housing. Thus, at start-up of the compressor, lubricant will flow to the bearing surfaces, so as not to starve the bearing surfaces. If refrigerant were carried to the bearing surfaces at start-up, rather than lubricant, it would be possible to damage the bearing surfaces. Also, some lubricant or oil will be emitted from the groove **69** opening **74** during normal operation and will help lubricate the wrist pin **37** which joins the connecting rod **38** to piston **24**.

The drive shaft **32** is readily fabricated as follows. Hollow shaft **52** may be made from cold extruded steel cut to length, heat-treated and then centerless ground to close tolerance. Part **60** is suitably formed and heat-treated. The flywheel portion or mass **58** is forged or can be made from powdered metal. Shaft **52** is inserted into opening **59** in flywheel **58** and electron beam welded into place. Since the heat from such welding is extremely localized the heat-treated exterior surface portions of the shaft **52** are not adversely affected. Tubular part **60** which comprises the eccentrically disposed member for driving connecting rod **38** is positioned in opening **67** in flywheel **50** and electron beam welded in place so as not to adversely affect the heat-treated exterior of part **60**. Part **60** is secured in opening **67** with opening **66** in the part **60** aligned with passage **68** in the flywheel or mass **58**. Opening **67** extends through the mass **58** such that vent opening **74** in the top of part **60** can properly function. The connecting rod **38** is journaled on the part **60** and fitting **61** is secured to the part **60** so as to retain the connecting rod **38** on part **60**.

By this construction the difficult fixturing for grinding of the eccentric portion of a conventional crankshaft is avoided. The surface finishes of a crankshaft made by the present method are consistently better than that of a conventionally formed crankshaft. The components of the new crankshaft are easily formed and are relatively inexpensive. The overall cost of the crankshaft is materially reduced. It is also noted that the electron beam welded joint is strong and that no splined connection is needed to transmit the high torque from the electric-drive motor **36** and shaft **52** to mass **58** and eccentric post part **60** to which the connecting rod **38** is operatively secured.

Referring to FIG. 4, there is better illustrated the arrangement for resiliently supporting the compressor block **18** within the outer housing. The resilient supporting means **80** includes a bracket **82** suitably secured to the compressor block **18** by means of a bolt **83**, a bracket **84** and a resilient block **86** secured between the brackets **82** and **84**. A stirrup-like member **88** which is affixed to the lower shell **14** of the housing receives the bracket **84** and guides same for up and down movement. The member **90**, which is suitably secured to the upper shell **12** provides a stop for limiting upper movement of the resilient supporting means. Thus, it will be seen that the bracket **82** is secured to the compressor block, such that the compression mechanism **16** is affixed thereto. The bracket **84** is movably received within the stirrup **88** which limits downward movement thereof. Upward movement of the resilient means **80** is restricted by the stop **90**.

There has been provided by the present invention an improved low-cost crankshaft arrangement for compressors. The crankshaft is fabricated from inexpensive components that are readily assembled. The parts comprising the crankshaft are joined by electron beam welding so as not to adversely affect the heat-treated exterior surfaces of the hollow shaft or eccentric post part. The components can be separately centerless ground prior to assembly, obviating the need for complex fixturing for grinding the eccentric part of the crankshaft such as is needed in making a conventional crankshaft.

While I have shown and described a presently preferred form of my invention, it will be understood that the invention is not limited thereto, since it may be otherwise embodied within the scope of the attached claims.

I claim:

1. In a compressor, a crankshaft comprising a shaft having separate mass means secured at one end thereof, conduit means secured to said mass means including a tube extending from the mass means, with the free end of the tube disposed in the axis of the shaft and passage means in the mass means adapted to communicate with the tube, there being a vent hole in the mass means communicating with the passage means, and the shaft comprising a hollow tubular member.

2. A compressor as in claim **1**, wherein the mass means includes a flywheel portion, a tubular part secured to the flywheel portion and extending downwardly from the flywheel portion and a fitting affixed to the tubular part for securing the tube to the flywheel portion.

3. A compressor as in claim **2**, wherein the hollow tubular member and the tubular part are made from high carbon steel.

4. A compressor as in claim **2** wherein the exterior surface of the hollow tubular member is heat-treated and is connected to the flywheel portion by electron beam welding so as not to destroy the heat treat of the exterior surface.

5. A compressor as in claim **1**, including a casing having a lubricant sump defined therein, compressor block means for receiving the crankshaft in said casing, bearing means for journaling the crankshaft and passageway in the compressor block means communicating with the passage means in the mass means, the tube being disposed in the lubricant sump, whereby in operation, lubricant is ingested through the tube and passed through the passage means in the mass means and the passageway in the compressor block means to the bearing means for lubricating the bearing surfaces.

6. A method of fabricating a multiple component crankshaft for a compressor comprising affixing a separate mass means having passage means therein to the end of a shaft by electron beam welding, securing conduit means, including a tube, to the mass means with the free end of the tube disposed in the axis of the shaft and with the tube communicating with the passage means.

7. A method of fabricating a crankshaft for a compressor as in claim **6** including forming a vent hole in the mass means communicating with the passage means.

8. A method of fabricating a crankshaft for a compressor as in claim **6** wherein the shaft is hollow including the steps of securing a tubular part in an opening extending through the mass means, with the axis of the tubular part being parallel with the axis of the hollow shaft and affixing a fitting to the tube and connecting same to the tubular part, the tubular part including opening means aligned with the passage means in the mass means and a vent passage at the top thereof.

9. In a compressor, hollow tubular crankshaft means having a heat-treated exterior surface and a fly wheel portion connected to the crankshaft by electron beam welding so as not to destroy the heat treat of the exterior surface, a tube secured to the crankshaft means and extending downwardly therefrom, with the free end of the tube having an opening disposed in the longitudinal axis of the crankshaft means, and vent means in the crankshaft means for venting material within the crankshaft means to exterior of the crankshaft means at startup of the compressor.

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U.S. Cl. X.R.

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