A gas refrigeration compressor with a motor drive enclosed in a single casing, having a primary supporting plate that has an upward projection that receives one of two main bearings that support a rotor shaft for the motor rotor above the main supporting plate, with the stator for the motor being supported directly on the main supporting plate by integral struts projecting upwardly from the plate so that the stator is not supported by the housing, there being provided a centrifugal compressor adjacent the motor and parallel thereto including a back shroud formed integrally with the main supporting plate and a volute formed directly within the main supporting plate behind the impeller to reduce the radial width of the compressor, there being provided an impeller adjacent the back shroud driven by a shaft also supported within the main support plate and drivingly interconnected with the rotor shaft beneath the supporting plate by gearing that includes axial thrust surfaces, so that the unbalanced forces on the impeller are transferred to the large bearings supporting the rotor shaft within the main supporting plate, there being provided an inlet plate on the top side of the impeller bolted to the main supporting plate in a manner to achieve different diffuser widths, with the inlet of the inlet plate facing upwardly toward the motor so that an inlet in the casing serves to both cool the motor and provide inward flow to the compressor, while at the same time reducing the axial length of the unit, there being further provided an outlet from the scroll that is also formed integrally with the main supporting plate.
BOLTED HERMETIC REFRIGERENT GAS COMPRESSOR WITH ELECTRIC MOTOR DRIVE

BACKGROUND OF THE PRESENT INVENTION

Centrifugal compressors have conventionally been used in large sized refrigeration gas compressors for air-conditioning machines, while smaller sized air-conditioners have used reciprocating piston compressors. The reason for this is that it has not been economical to use centrifugal compressors in small air-conditioning units. However, the relative mechanical simplicity of centrifugal compressors compared to reciprocating compressors makes them more reliable and, hence except from the cost standpoint, more desirable even for the smaller sized air-conditioning machines.

It is therefore a primary object of the present invention to provide a small capacity centrifugal compressor and motor drive that may be manufactured so that it is cost competitive with the small size reciprocating compressors.

Rotary compressors combined with electric motor drives have been provided in the past as exemplified by the Johnson U.S. Pat. No. 3,619,086. The Johnson construction represents an example of a costly construction that would not be competitive with reciprocating piston compressors for small refrigeration units. First, the motor stator is supported in the housing requiring the necessity for accurate machining of the housing with respect to the rotor shaft centerline. Furthermore, the compressor itself has its inlet facing away from the motor requiring external plumbing for motor cooling, which is not only more costly but unreliable, and furthermore, adds to the axial length of the entire unit. A still further disadvantage of the Johnson construction is that the centrifugal pump is made in a plurality of separate components, each of which must be accurately machined to mate with the other parts. And, of course, there is no provision for the simple variation of diffuser widths.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, a centrifugal gas compressor is provided, where in all of the basic components are contained within or mounted on a single supporting plate within the compressor housing. The rotor of an electric motor positioned on one side of the plate has a shaft supported in spaced bearings within the plate, and the stator is also supported by the plate through struts extending upwardly therefrom, so that the problem in prior designs of maintaining concentricity between the stator and rotor is eliminated.

All of the noise generating components are structurally connected to the supporting plate, and the casing is isolated from the plate by the proper selection of flange gasket materials.

A centrifugal compressor is provided parallel to, the electric motor rotor shaft with an impeller driven by the shaft, and a diffuser including a back shroud formed integrally with the supporting plate or more specifically machined therein, along with a volute or scroll axially spaced from the back shroud also formed within the supporting plate to reduce machining expenses, as well as part fabrication costs.

Basically, the machining advantages arise from this construction as a result of the main supporting plate being machinable from a casting with several machining operations during one set-up. All of the pertinent dimensions can be related to a common reference line on the casting for the main supporting plate.

An impeller is provided adjacent the back shroud having an impeller shaft also supported within the main supporting plate, and interconnected by suitable gearing with the rotor shaft. There is provided thrust surfaces on this gearing, so that the unbalanced loads on the impeller are transferred to the low speed rotor shaft and carried by bearings supported by the plate. This enables elimination of hydrodynamic thrust bearings of prior designs, which are expensive require lubrication during start-up and often have poor reliability.

An inlet plate is provided above the impeller on the side of the main plate adjacent the motor, so that inlet fluid serves both to supply the centrifugal pump, and to cool the motor. This positioning of the compressor adjacent the motor also has the advantage of reducing the axial length of the overall unit as compared with that of the Johnson patent.

This self-contained suction gas motor cooling system eliminates the need for external piping, and there is no requirement for a gas sealing arrangement between the compressor and the motor. The compressor is therefore less reliant on external factors and may be more easily used in refrigeration applications.

The inlet plate surrounding the impeller is bolted to the main supporting plate. One surface of the diffuser is provided by the main supporting plate and the other by the inlet plate, and for this reason, a variety of diffuser radii and widths can be provided by appropriate machining of the main supporting plate and the inlet plate, while at the same time, using the same basic un-machined parts.

An additional advantage is that the discharge nozzle is also formed integrally with the main supporting plate.

A still further advantage is that the single main supporting plate provides structural strength so that the casing or enclosure merely contains the gas pressure and may be relatively light in weight.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawing is a longitudinal section taken through the present refrigeration gas compressor and motor drive unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawing, a centrifugal compressor and motor combination 10 is illustrated that may be used as a small gas refrigeration compressor unit.

The unit consists basically of a housing or enclosure 11, an inlet 12, an electric motor 14, a main supporting plate 15, driving a centrifugal compressor 18, which delivers gas under pressure to a discharge nozzle 20, connected to suitable outlet piping.

The enclosure 11 consists of two parts, an elongated cup-shaped upper member 22, and a lower cup-shaped member 23 sandwiching the main support plate 15 and connected together by suitable bolts 25. Lugs 26 extending from the support plate orient the supporting plate to the desired location. The housing 11 may be constructed of a relatively lightweight material because it does not provide the support for any of the primary components of the unit.

The main supporting plate 15 has an upward projection 28 carrying a ball bearing 29 which, along with an
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3 other ball bearing 30 in the lower portion of plate 15, support rotor shaft 32 carrying electric motor rotor 33.

The stator 34 of the motor is supported on the main supporting plate 15 by three upwardly extending struts 36 (only one shown in the drawing), which are formed integrally with the main supporting plate 15. This has the advantage of establishing concentricity between the stator 34 and the rotor 33.

The motor rotor shaft 32 drives the centrifugal compressor through step-up gearing 40. The compressor 18 includes a back shroud 42, machined directly within or on the main supporting plate 15, eliminating the requirement for separate components. The compressor includes a volute 43 also formed integrally within the main supporting 15 and communicating with the impeller through vertical passage 45 and a tapered diffuser passage 47. It should be noted that the volute 43, which is circular in cross section, extends radially inwardly of the impeller 46 and is axially spaced below it to reduce the width of the compressor compared to prior compressor designs. A reduction in width of the compressor 18 also results in a reduction in width of the overall unit 10. The size and width of the diffuser passage 47 may be varied by varying the machining operations on the plate 15 without changing the basic casting for the plate 15 thereby affecting substantial cost savings. An impeller 46 is provided adjacent the back shroud 42 and is driven by an impeller shaft 48, mounted in plate 15 by bearings 49 and 50. Shaft 48 is driven by step-up gearing 40 including a large gear 52 affixed to rotor shaft 32 and a smaller gear 53 affixed to the impeller shaft 48. The smaller gear 53 has thrust surfaces 55 and 56 which transfer the unbalanced upward load on the impeller 46 to the main bearings 29 and 30 of the rotor shaft through thrust surfaces 55 and 56, gear 52 and rotor shaft 32.

An inlet nozzle plate 58 is provided, bolted as at 59, directly to the main supporting plate 15.

The inlet nozzle plate 58 may also be machined to vary the width of the tapered diffuser passage 47.

The inlet nozzle 58 has an inlet 60 facing upwardly so that inlet 12 may serve both to cool the motor 14 and also to deliver fluid to the inlet 60 of the compressor 18. This also has the effect of reducing the axial length of the unit 10.

Also formed integrally with the main supporting plate 15 is the outlet 20 whose section shown in the drawings is spaced from the plane of the rest of the unit 10 since outlet passage 62 is tangential to the volute 43.

1 claim:
1. A motor driven centrifugal gas compressor combination, comprising: housing means for surrounding the components of the combination, a support plate extending across said housing, a motor in said housing including a stator and a rotor, said rotor being rotatably mounted in said support plate, said stator being supported on said plate to establish the concentricity between stator and rotor, and a centrifugal compressor supported on said support plate and driven by said rotor.

2. A motor driven centrifugal gas compressor combination, as defined in claim 1, wherein said stator is supported on integral struts extending upwardly from said support plate.

3. A motor driven centrifugal gas compressor combination, as defined in claim 1, including an integral boss extending upwardly from said support plate, spaced bearings in said support plate and boss for supporting the rotor for rotation.

4. A motor driven centrifugal gas compressor combination, as defined in claim 1, wherein said compressor is integral with said support plate and the drive means for said compressor are mounted in the support plate.

5. A motor driven compressor combination, comprising: a housing for the components of the combination, a supporting plate within said housing and fixed therein, a motor within said housing having a rotor shaft journaled in said supporting plate and a stator carried by said plate, a centrifugal compressor in said housing having impeller back shroud means formed integrally with said supporting plate, an impeller, and means driving said impeller from said rotor shaft.

6. A motor driven centrifugal gas compressor combination, as defined in claim 5, wherein said compressor has an annulus formed integrally with said supporting plate.

7. A motor driven centrifugal gas compressor combination, as defined in claim 5, wherein said compressor has a diffuser formed integrally with said support plate.

8. A motor driven centrifugal gas compressor combination, as defined in claim 5, wherein said compressor has an outlet formed integrally with said support plate.

9. A motor driven compressor combination, comprising: a housing for enclosing the components of the combination, a supporting plate extending across the housing, a motor in said housing having a rotor shaft journaled in the supporting plate, a centrifugal compressor in said housing including back shroud means formed integrally with said supporting plate, an impeller mounted for rotation on said supporting plate, and driven by said rotor shaft, an annulus for said compressor, an inlet cover plate over said impeller defining a diffuser passage between the cover plate and the supporting plate, so that the size of the diffuser may be varied by changing the position of the cover.

10. A motor driven centrifugal gas compressor combination, as defined in claim 9, wherein said annulus is formed integrally with said support plate, said annulus is the form of a spiral scroll.

11. A motor driven centrifugal gas compressor combination, as defined in claim 9, wherein said inlet plate faces the motor side of the supporting plate.

12. A motor driven compressor combination, comprising: a housing for enclosing the components of the combination, a supporting plate extending across the housing, a motor in said housing, a centrifugal compressor in said housing driven by said motor including shroud means formed integrally with said supporting member, an impeller rotatably mounted adjacent said shroud means and driven by said motor, an annulus having a portion thereof radially within the radial limits of the impeller to minimize the size of the compressor.

13. A motor driven centrifugal gas compressor combination, as defined in claim 12, wherein said impeller is connected with said annulus by a diffuser passage that extends radially from the impeller and then axially to the annulus.

14. A motor driven centrifugal gas compressor combination, as defined in claim 12, wherein said annulus is axially offset from the impeller.

15. A motor and centrifugal compressor, comprising: a housing for the component parts of the combination,
a supporting plate across the housing, a motor in the housing on one side of the supporting plate, said motor having a rotor shaft journaled in said supporting plate, an inlet for fluid in the housing on the motor side of the supporting plate positioned to cool the motor with inlet fluid, a centrifugal compressor adjacent said motor and supported on said supporting plate, said compressor having an impeller rotatably driven by the rotor shaft, said compressor having an inlet on the motor side of the supporting plate to reduce the overall size of the combination.

16. A motor driven centrifugal gas compressor combination, as defined in claim 15, wherein said inlet extends axially in the direction of the motor and parallel to the axis thereof.

17. A motor and centrifugal pump combination, comprising: a housing enclosing the components of the combination, a supporting plate extending across said housing, a motor on one side of said supporting plate in said housing, said motor having a rotor shaft extending through the supporting plate, rotor bearings carried by said plate in which said rotor shaft is mounted, a centrifugal compressor supported on said supporting plate and including a rotor shaft, first gear means on said rotor shaft, second gear means on said impeller shaft engaging said first gear means, one of said gear means having thrust surfaces so that the unbalanced load on the impeller will be transferred through the rotor shaft to said rotor bearings.

18. A motor driven centrifugal gas compressor combination, as defined in claim 17, wherein said thrust surfaces are on the impeller gear means and the unbalanced thrust acts in an upward direction.

19. A motor driven centrifugal gas compressor combination, as defined in claim 18, wherein said first gear means is larger than said second gear means.

20. A motor driven centrifugal gas compressor, comprising; housing means surrounding the components of the compressor, a supporting plate extending across the housing, an integral projection extending upwardly from said plate, a motor in said housing above said plate including a stator and a rotor, said stator being supported on said supporting plate, said rotor having a shaft journaled in said projection, and extending through said supporting plate, a centrifugal compressor including a back shroud formed integrally with the supporting plate, an impeller mounted for rotation adjacent the back shroud, said impeller having a shaft extending through the supporting plate in the same direction as the rotor shaft, an inlet plate over said impeller and fixed to said supporting plate, said inlet plate having an inlet facing said motor to minimize the length of the housing, and an outlet communicating with said impeller and integral with the supporting plate.

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