Aug. 11, 1959 R. E. SYKES 2,899,130

COMPRESSOR

Filed Dec. 3, 1954 3 Sheets-Sheet 1

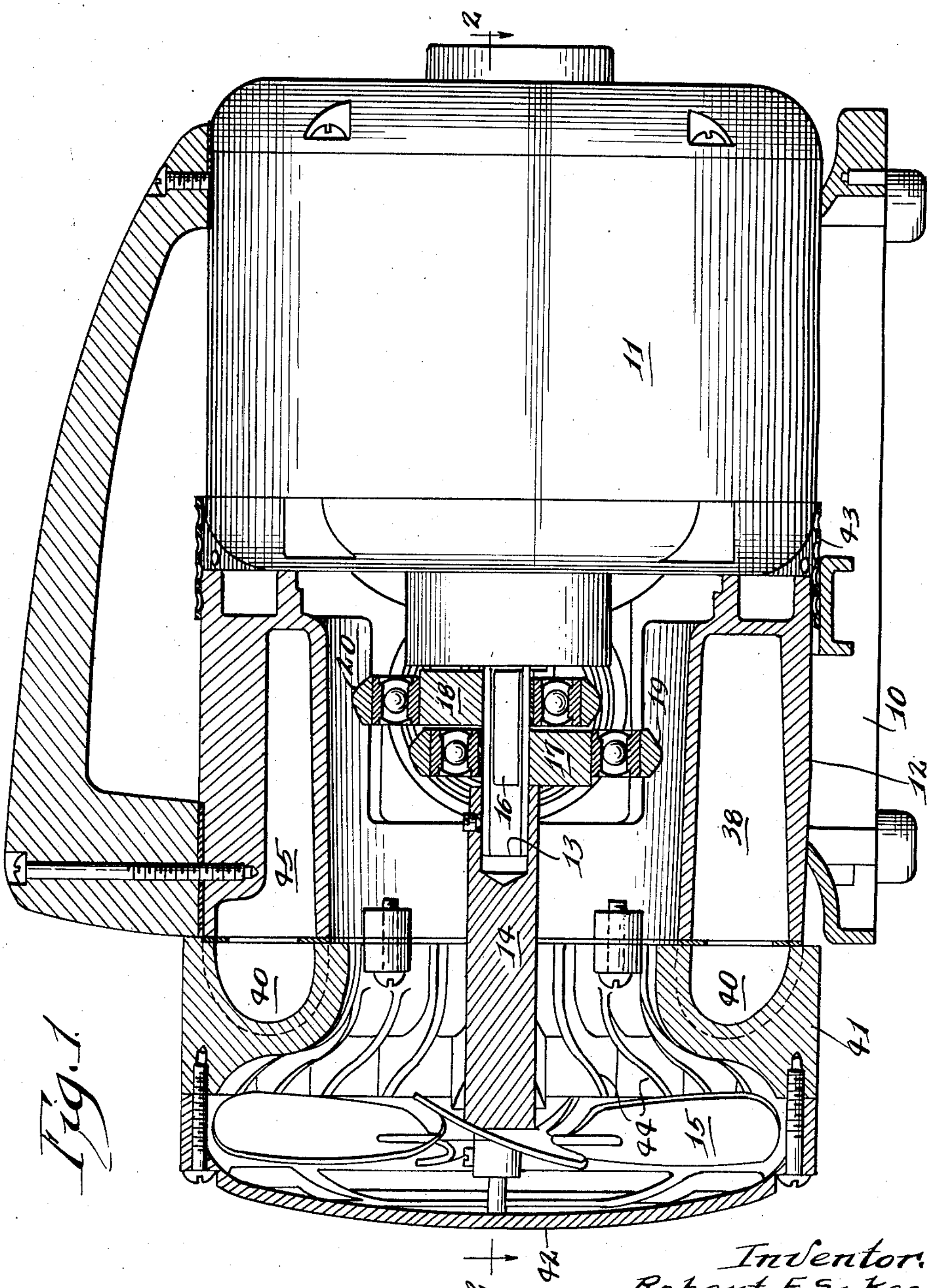

Fig. 1

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Fig. 2.

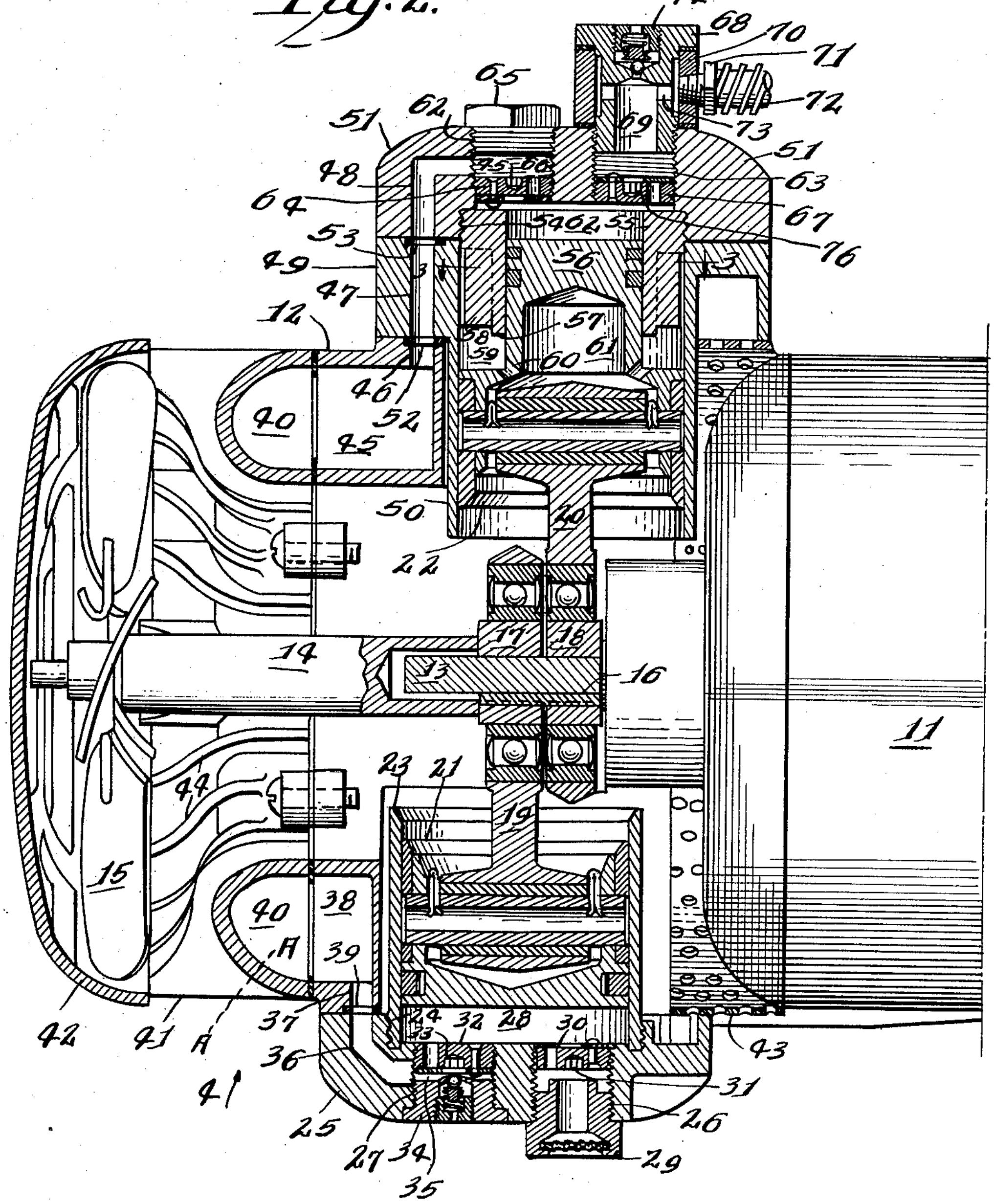

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Fig. 2.

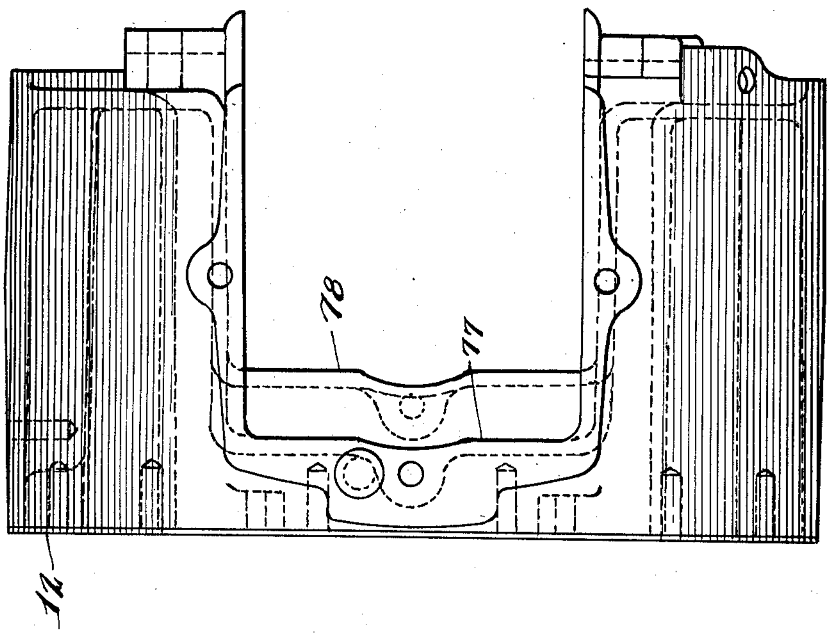
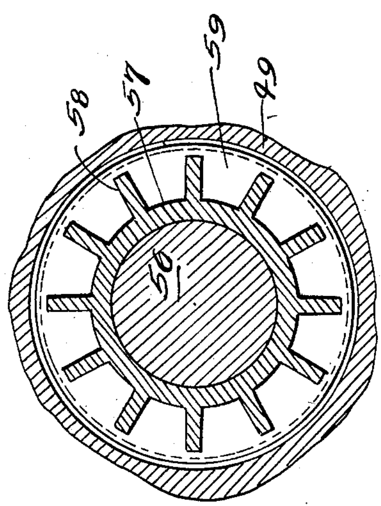


Fig. 3.



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COMPRESSOR

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8 Claims. (Cl. 230—182)

My invention relates to compressors and more particularly to certain design features thereof which are reflected in production and operating advantages.

One object of the invention is to provide a compressor which does not require any gaskets between the cylinder and cylinder head thus enabling good heat transmission between these parts and facilitating cooling thereof by a cooling air stream flowing around and inside the cylinder on the noncompressing side of the piston.

A further object is to provide an electric motor driven compressor of the positive displacement type having a radially disposed piston or pistons mounted in a crank case and in which the motor is axially aligned and drivably connected to the eccentric or crank shaft and to a fan which establishes a cooling air flow through the crank case and into the bell housing at the end of the motor.

A further object is to devise a compressor of the character indicated wherein the crank case includes a chamber that defines and is in heat exchange relation to the cooling air passage through the crank case and in which such chamber serves as an aftercooler for a single or twin piston single stage compressor, or as an intercooler for a two stage compressor.

A further object is to provide a crank case for a compressor as indicated which is constructed and arranged so that the cylinder or cylinders with their associated head or heads may be slipped over the associated piston or pistons after the latter have been assembled to the eccentric shaft and before the crank case is fastened to the cylinder head or heads.

A further object is the provision of a compressor as above set forth having twin, equisized openings in the cylinder head thereof, one opening receiving in superimposed relation a filter assembly and a flapper, inlet valve assembly, and the other opening receiving in like relation a relief valve assembly and a flapper, exhaust valve assembly, thus enabling positioning of these pairs of assemblies in either opening.

A further object is to device a two stage compressor of the positive displacement type in which the guiding portion of the high pressure piston has the same diameter as the low pressure piston and in which the high pressure guiding portion is arranged to direct a cooling flow of air around the high pressure cylinder and connecting rod bearing.

These and further objects of the invention will be set forth in the following specification, reference being had to the accompanying drawings, and the novel means by which the objects are effectuated will be definitely pointed out in the claims.

In the drawings:

Fig. 1 is a side elevation of the compressor, partly in section.

Fig. 2 is a section along the line 2—2 in Fig. 1.

Fig. 3 is a slightly enlarged, detail section along the line 3—3 in Fig. 2.

Fig. 4 is an elevation of the compressor crank case as viewed in the direction of the arrow 4 in Fig. 2.

By way of example and not of limitation, the invention will be described as applied to a two stage air compressor of relatively small size, i.e., one capable of being driven by 1/4 to 3/4 horsepower, electric motors, but it will be apparent that features thereof are applicable to single and twin piston compressors as well as generally to compressors of any size, or multiplicity of cylinders.

Referring to Figs. 1 and 2, the numeral **10** designates a base member which is preferably arcuate shaped on its upper side to receive the cylindrical housing of an electric motor **11** and an axially aligned, cylindrical crank case **12**. The end of the motor drive shaft **13** is received within and is drivably connected to the adjacent socketed end of a fan shaft **14** which is supported by the motor shaft **13**, the fan shaft **14** being coaxial with the motor **11** and crank case **12** and having attached to its opposite end a fan **15**. The motor shaft **13** is secured by a key **16** to juxtaposed eccentrics **17** and **18** which drivably connect through connecting rods **19** and **20** with a low pressure piston **21** and a guide piston **22**, all respectively, each piston being of the trunk type.

In the arrangement shown, the piston **21** constitutes a part of the low pressure side of the compressor and it reciprocates within a sleeve cylinder **23** whose inner end is exposed within the crank case **12** and whose outer end is annularly roughened or corrugated at **24** to facilitate the casting therearound and locking connection therewith of a cylinder head **25**. Preferably, the head **25** is composed of a metal having a relatively high thermal coefficient of conductivity, such as aluminum, while the cylinder **23** is composed of a metal having a relatively low thermal coefficient of conductivity and good wearing qualities, such as cast iron. The head **25** is suitably bolted to the crank case **12** which may also be formed of aluminum and has full metal to metal contact therewith to facilitate heat transmission for a purpose presently explained, except in the region of an exhaust passage as presently described.

Extending through the head **25** are equisized, tapped holes **26** and **27** whose inner ends communicate with a low compression chamber **28** between the head and piston **21**. In the outer portion of the hole **26** is mounted a conventional filter assembly **29** for filtering air flowing therethrough and in the inner portion of the same hole is threaded a conventional flapper, inlet valve designated generally by the numeral **30** and which preferably includes a wrench receiving socket **31** on its inlet side to facilitate mounting and removal thereof. It will be apparent that, during the suction stroke of the piston **21**, the flapper element of the inlet valve **30** will open to admit a charge of air to the compression chamber **28** and will close during the compression stroke of the piston **21**.

In the inner part of the hole **27** is threaded a conventional flapper, exhaust valve **32** which also preferably includes a wrench socket **33** on the exhaust side thereof for the same purpose as noted for the inlet valve **30**, while in the outer part of the hole **27** is threaded a conventional relief valve **34** of the spring loaded ball type which is adjusted to open at a predetermined safety pressure which is higher than the normal operating pressure of the low pressure side of the compressor. The flapper element of the exhaust valve **32** functions in the well known manner at a proper point in the compression stroke of the piston **21** to discharge compressed air into a space between the opposed ends of the exhaust and relief valves **32** and **34**, respectively.

The space **35** communicates through passages **36** and **37** in the cylinder head **25** and crank case **12**, respectively, with a chamber **38** which is parti-annular in shape and extends axially for a major portion of the length of the crank case **12** (see Fig. 1). The mating ends of the passages **36** and **37** are sealed by a gasket **39** which is of such minor area compared to the otherwise metal to metal contact between the crank case **12** and head **25** as not to exercise any substantial restraint on heat transmission therebetween.

The chamber **38** is closed at one end and open at the opposite or left end as viewed in Figs. 1 and 2 in registration with the adjacent part of an annular chamber **40** provided in that face of a ring member **41** which abuts and is appropriately secured to the adjacent end of and functionally is a part of the crank case **12**. Secured to the other face of the ring member **41** is a suitably apertured grill **42** through which air is drawn by the fan **15** to flow through the member **41** and crank case **12** for discharge through a perforated, ventilating band **43** which is located between the adjacent ends of the motor **11** and crank case **12**, respectively. The inner surface of the ring member **41** is provided with a plurality of radially inward and circumferentially spaced ribs **44** which are in heat exchange relation to air in the annular chamber **40**. These ribs extend to the periphery of the member **41** in abutting relation to the grill **42** so that the fan air also flows radially outward between the ribs **44** and externally over the crank case **12**. Preferably, the ring member **41** is composed of a material having a high thermal conductivity, such as aluminum.

The low pressure air discharged into the annular chamber **40** passes into another parti-annular chamber **45** which is generally oppositely disposed to the chamber **38**, the chambers **38**, **40** and **45** together constituting a pulsation chamber. From the chamber **45**, the air flows successively through passages **46**, **47** and **48** provided, respectively, in the crank case **12**, the annularly flanged portion **49** of a sleeve guide cylinder **50** and a cylinder head **51**. Gaskets **52** and **53** having a size comparable to the gasket **39** are interposed between the ends of the passages **46** and **47**, and **47** and **48**, respectively. The guide cylinder **50** through its flanged portion **49** otherwise has metal to metal contact with the crank case **12** and cylinder head **51**. The cylinder head **51** is preferably composed of a good thermally conductive material, such as aluminum, and is cast around and in locking connection with the corrugated, annularly flanged end **54** of the high pressure cylinder **55** whose bore is less than that of the low pressure cylinder **23** and which is formed of material like the latter cylinder.

Reciprocable within the high pressure cylinder **55**, which is generally opposite to but slightly offset from the low pressure cylinder **23**, is a high pressure piston **56** which is preferably integral with or may be otherwise connected to the guide piston **22** that has the same diameter as the low pressure piston **21**. Extending radially from the skirt **57** of the cylinder **55** and in heat exchange relation therewith is a plurality of circumferentially spaced ribs **58** (see Figs. 2 and 3) which extend into an annular space **59** included between the guide and high pressure cylinders **50** and **55**, and the guide and high pressure pistons **22** and **56**, all respectively. The space **59** is closed at one end by the flanged end **54** and communicates at the opposite end through a plurality of ports **60** with the interiors of the guide and high pressure pistons **22** and **56** so that as the composite piston reciprocates, designated generally by the numeral **61** and including the guide and high pressure portions thereof, air flows into and out of the space **59** with a cooling effect on the high pressure cylinder **55** and the bearing of the connecting rod **20**. Also, as shown in Fig. 2, the inner end of the guide cylinder **50** extends within the crank case **12** and the interiors of the high pressure and guide pistons **56** and **22**, respectively, are subjected to the cooling effect of the fan air flowing through the crank case **12**.

The head **51** is tapped to provide a pair of holes **62** and **63** which are sized the same as the holes **26** and **27** and extend therethrough with their inner ends communicating with the high compression chamber **62**. In the inner end of the hole **62** is located a flapper, inlet valve **64** similar to and which may be of the same size as the inlet valve **30**. The inlet side of the valve **64** is spaced from a plug **65** that closes the outer end of the passage **62** to define a chamber that constantly communicates with the delivery end of the passage **48**.

In the inner end of the hole **63** is positioned a flapper, exhaust valve **67** and spaced therefrom in the same hole is a flanged plug **68** having a cavity **69** communicating with the discharge side of the exhaust valve **67**. The flange of the plug **68** sealingly grips a pair of oppositely disposed, thick washers **70** against the cylinder head **51** and in one of these washers is mounted a fitting **71** providing communication between a conventional aftercooler **72** and a port **73** in the plug **68** which connects with the cavity **69**. Also mounted in the plug **68** and providing communication between the atmosphere and cavity **69** is a relief valve **74** similar to the valve **34** but adjusted to a higher pressure. The valves **64** and **67** may also include wrench sockets **75** and **76**, respectively, in their outer portions to facilitate their insertion and removal.

In operation, air is drawn into the low compression chamber **28**, compressed to a determined value and discharged into the chambers **38**, **40** and **45** and from the latter, the low pressure air is drawn into the high compression chamber **62**, compressed to a higher value, and discharged to the aftercooler **72**. During this process, the chambers **38**, **40** and **45** together act as an intercooler due to the heat withdrawing action of the air flowing over the ribs **44** and the interior surface of the crank case **12** and through these ribs and over the exterior surface of the crank case. Moisture condensed in such chambers may be evacuated at intervals through a suitable drain (not shown), but preferably located along the line A—A in Fig. 2.

The air cooling action is also effective over the eccentric bearings, the adjacent end of the motor housing, around the low pressure and guide cylinders **23** and **50**, respectively, which as shown in Fig. 2 have substantial portions of their exteriors spaced from the crank case **12**, and interiorly of the low pressure piston **21** and the composite piston **61**. This construction insures cool operation of the compressor and long life of the parts.

Cooling is further facilitated by the heat transmitting connection arising from the metal to metal contact between the low pressure head **25** and the crank case **12** and low pressure cylinder **23**, respectively, and between the crank case **12**, guide cylinder flange **49**, high pressure head **51** and high pressure cylinder **55** where these parts are severally in contact as shown in Fig. 2.

The equisizing of the threaded holes in the low and high pressure cylinder heads **25** and **51**, respectively, provides certain inventory advantages with respect to the threaded bodies of the several valve and filter assemblies. Moreover, these assemblies may be inserted and removed without disturbing the associated passage or hose connections.

In the two stage arrangement as shown, the construction of the composite piston **61** with its connection between the high pressure piston **56** and guide piston **22** which has the same diameter as the low pressure piston **21** results in a reduction in the stresses and bearing pressures in the composite piston, as well as a utilization of the same size piston pin and connecting rod as for the low pressure piston **21**.

This compressor is characterized by a certain versatility of application with respect to the utilization of its basic components. For example, the compressor as shown in Fig. 2 can be changed to one of the single piston type merely by removing all of the parts associated with the high pressure side and attaching a non-perforated, dummy head (not shown) to the crank case **12** to close the opening therein in what had been the high pressure location. In such a case, the pulsation chamber including the chambers **38**, **40** and **45** serves as an aftercooler for air discharged from the compression chamber **28** and this air may be led from the pulsation chamber at any convenient point thereof.

Further, the compressor may be simply modified to one of the twin piston single stage type merely by substituting for the high pressure assembly shown in Fig. 2 a duplicate of the low pressure assembly shown in the same figure. Both of the pistons then discharge into the pulsation chamber which also serves as an aftercooler due to the cooling action of the fan air. Air would be tapped from this chamber in the same manner as indicated for single piston operation.

Another feature of the invention resides in the arrangement of the crank case **12** (see Fig. 4) which is bifurcated from the motor end thereof and along a transverse diameter to provide generally oppositely related, U-shaped pockets **77** and **78** which are slightly displaced axially from each other. In the two stage design shown in Fig. 2, the low pressure assembly is received within and extends through the pocket **77**, while the high pressure assembly occupies a similar relation to the pocket **78**.

This crank case construction materially simplifies and reduces the cost of assembly. For each pressure side, the piston-connecting rod sub-assembly is mounted on the motor shaft **13** and the associated cylinder with its accompanying parts is slipped over the cooperating piston before the crank case **12** is slipped axially to receive the low and high pressure assemblies in the pockets **77** and **78**, respectively.

All of the foregoing attributes are reflected in a highly efficient compressor having marked cooling qualities, versatility of application while retaining basic components, and which is characterized by certain production advantages.

I claim:

1. In a compressor, in combination: casing means forming a compressor body having the general shape of an annulus to provide an axial air space, said body including radially spaced inner and outer exterior peripheral walls defining a pulsation chamber that is isolated from and extends about the periphery of said space, said body having a pocket opening radially therethrough, a fluid-compression assembly in said pocket and including a cylinder and head therefor carried by said body, a piston reciprocable in the cylinder, and means in said space for actuating said piston, means of communication between said cylinder and said chamber, and means for flowing a stream of air over and in heat-exchange relation with said walls.

2. A compressor unit comprising driving means having a rotatable output shaft, casing means forming a compressor body having the general shape of an annulus to provide a central air space that receives said shaft axially therein, said body including radially spaced inner and outer exterior peripheral walls forming a pulsation chamber that is isolated from and extends peripherally about said space, said body having a pocket opening radially therethrough, a fluid-compression assembly in said pocket and including a cylinder and head therefor carried by said body, a piston drivably connected to said shaft and reciprocable in the cylinder, means of communication between said cylinder and said chamber, and a fan spaced axially from said body and drivably connected to said shaft for moving air axially through said space.

3. The arrangement of claim 1 wherein said compressor body is comprised of mating generally hollow, open-sided ring-like members one of which has one end thereof adjacent said flowing means with said end being provided with radially inwardly extending circumferentially spaced ribs, said ribs being in heat-exchange relation with fluid in said pulsation chamber.

4. A compressor comprising an opposed pair of generally hollow open-sided ring-like members in mating engagement to form a generally annular compressor body having an enclosed annular pulsation chamber bordered by generally concentric radially spaced outer and inner exterior wall portions, said inner wall portion circling and defining a central air space, one of said members having a pocket opening radially and endwise therethrough, a rotatable drive shaft extending axially in said space, a piston receivable in the pocket through the endwise opening region thereof drivably and reciprocably connected to said shaft, a cylinder and head therefor receivable in said pocket through the radially opening region thereof and mounted on said one member in telescoping relation over said piston, and means of communication between said cylinder and said chamber.

5. In a compressor, in combination: casing means forming a compressor body having the general shape of an annulus to provide an unenclosed axial air space, said body including radially spaced apart inner and outer exterior peripheral walls defining a generally annular pulsation chamber that is isolated from and extends about the periphery of said space, said body having a pocket extending radially through adjacent portions of said inner and outer walls, a fluid-compression assembly in said pocket and including a cylinder and head therefor carried by said body, a piston reciprocable in the cylinder, and means in said space for actuating said piston, means of communication between said cylinder and said chamber, and means for flowing a stream of air over and in heat-exchange relation with said walls.

6. The arrangement of claim 1 wherein said cylinder is a sleeve cylinder, said head is separate from and has interlocking connection with the outer end of the cylinder with the head being in metallic contact with both the cylinder and the compressor body, and wherein said means of communication includes inlet and exhaust valves mounted in the head with one of said valves communicating with said chamber.

7. A two-stage compressor comprising casing means forming a compressor body having the general shape of an annulus to provide an axial air space, said body including radially spaced inner and outer exterior peripheral walls defining a pulsation chamber that is isolated from and extends about the periphery of said space, said body having a pair of pockets opening radially therethrough, a low pressure fluid-compression assembly in one of said pockets in discharging communication with said pulsation chamber, a high pressure fluid-compression assembly in the other of said pockets and including a cylinder and head therefor carried by said body, a piston reciprocable in the cylinder and means in said space for actuating said piston, inlet and exhaust valves mounted in the head, means of communication between the inlet valve and the pulsation chamber, and means for flowing air over and in heat-exchange relation with said walls.

8. A two-stage compressor comprising casing means forming a compressor body having the general shape of an annulus to surround and define an unenclosed axial air space, said body including radially spaced apart inner and outer exterior peripheral walls defining a generally annular pulsation chamber that is isolated from communication with and extends about the periphery of said space, said body having a pair of pockets opening radially therethrough, a low pressure fluid-compression assembly in one of said pockets in discharging communication with said pulsation chamber, a high pressure fluid-compression assembly in the other of said pockets and including a cylinder and head therefor carried by said body, a piston reciprocable in the cylinder and means in said space for

actuating said piston, inlet and exhaust valves mounted in the head, means of communication between the inlet valve and the pulsation chamber, and means for flowing air over and in heat-exchange relation with said walls.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,899,130 August 11, 1959

Robert E. Sykes

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 16, for "drivably and reciprocably" read -- and reciprocably drivably --.

Signed and sealed this 23rd day of February 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents