May 17, 1960 H. S. BROOM 2,936,949

AIR COMPRESSOR

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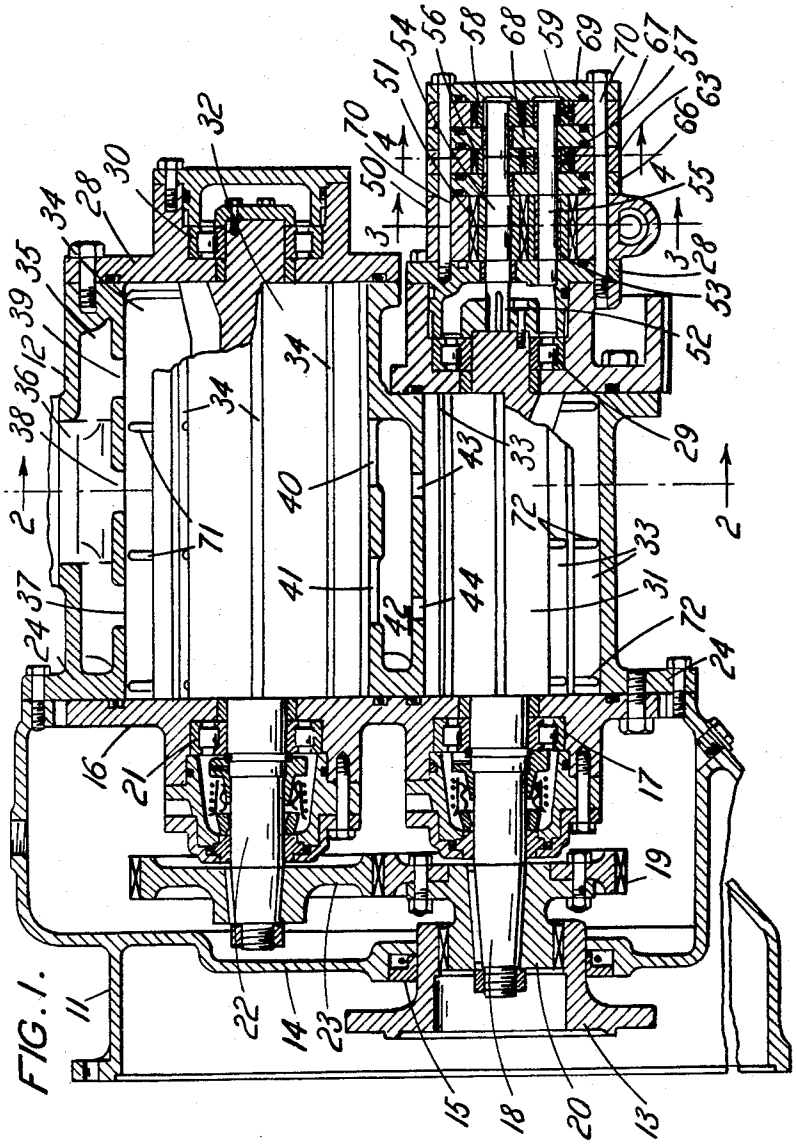


FIG. 1.

INVENTOR
H. S. BROOM
By: Wilkinson & Mawhinney
ATTYS.

May 17, 1960 H. S. BROOM 2,936,949

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FIG. 2.

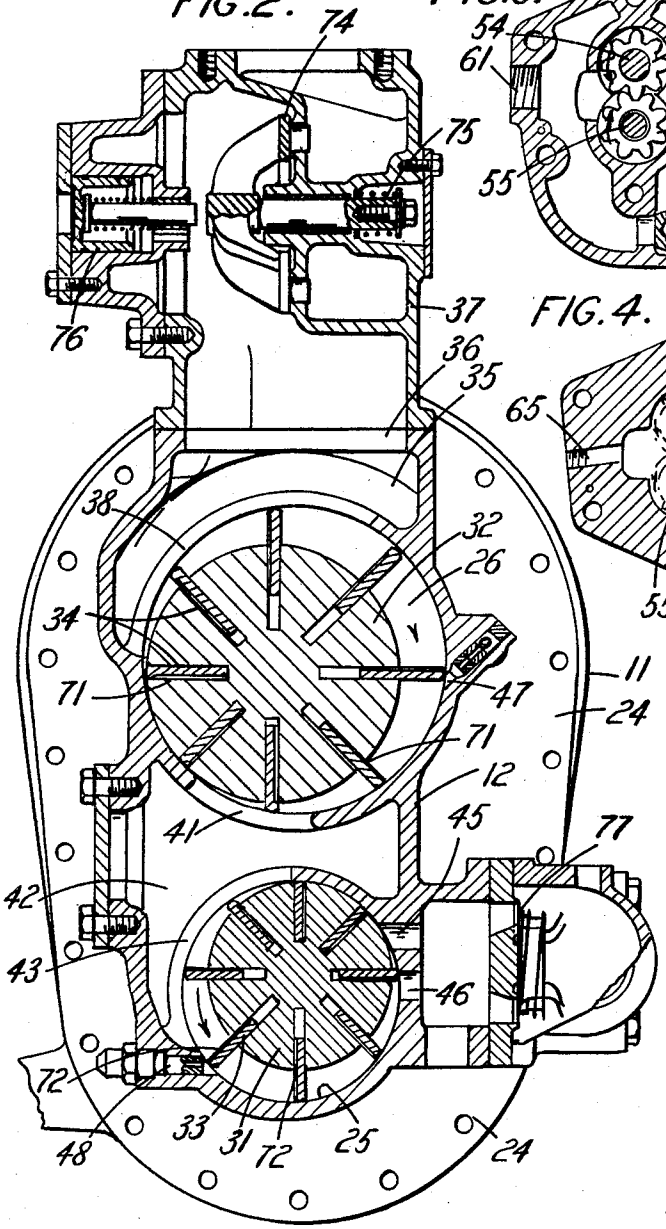
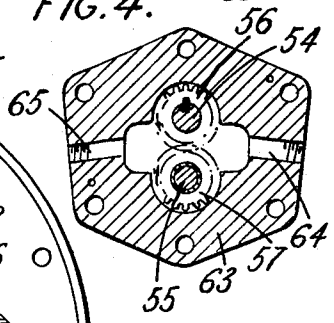


FIG. 3.

FIG. 4.



INVENTOR

H. S. BROOM

BY: Wilkinson & Mawhinney

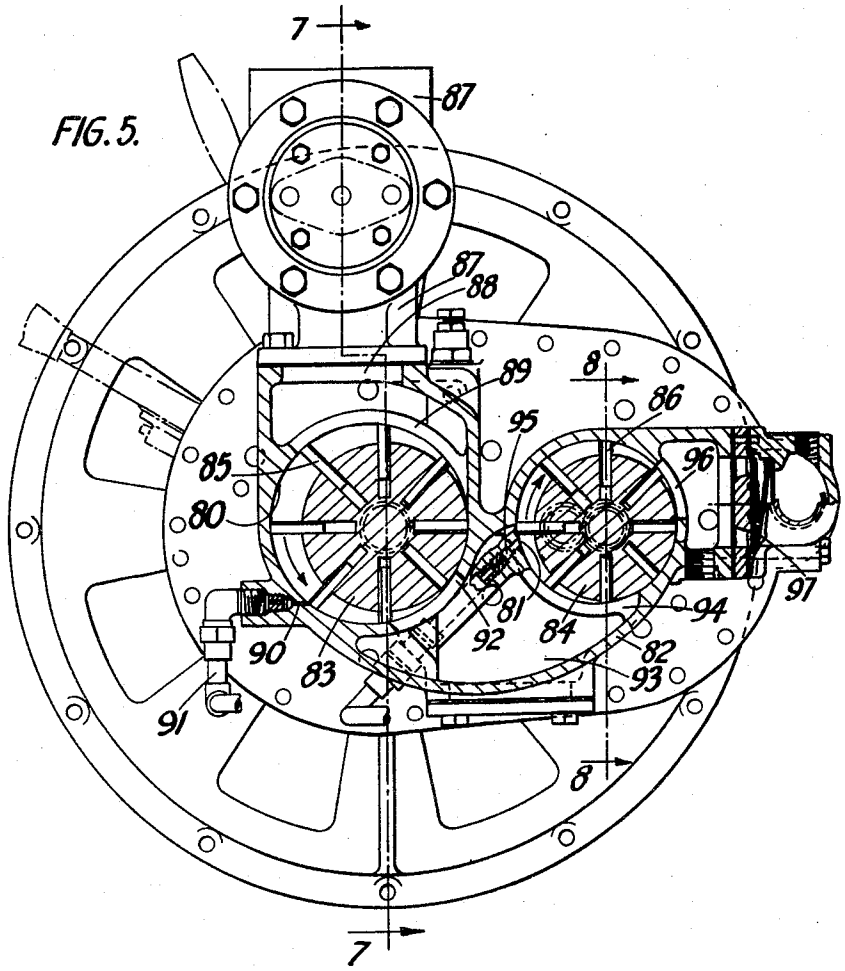
ATTYS.

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AIR COMPRESSOR

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FIG. 5.



INVENTOR

H. S. BROOM

By: Wilkinson & Mawhinney

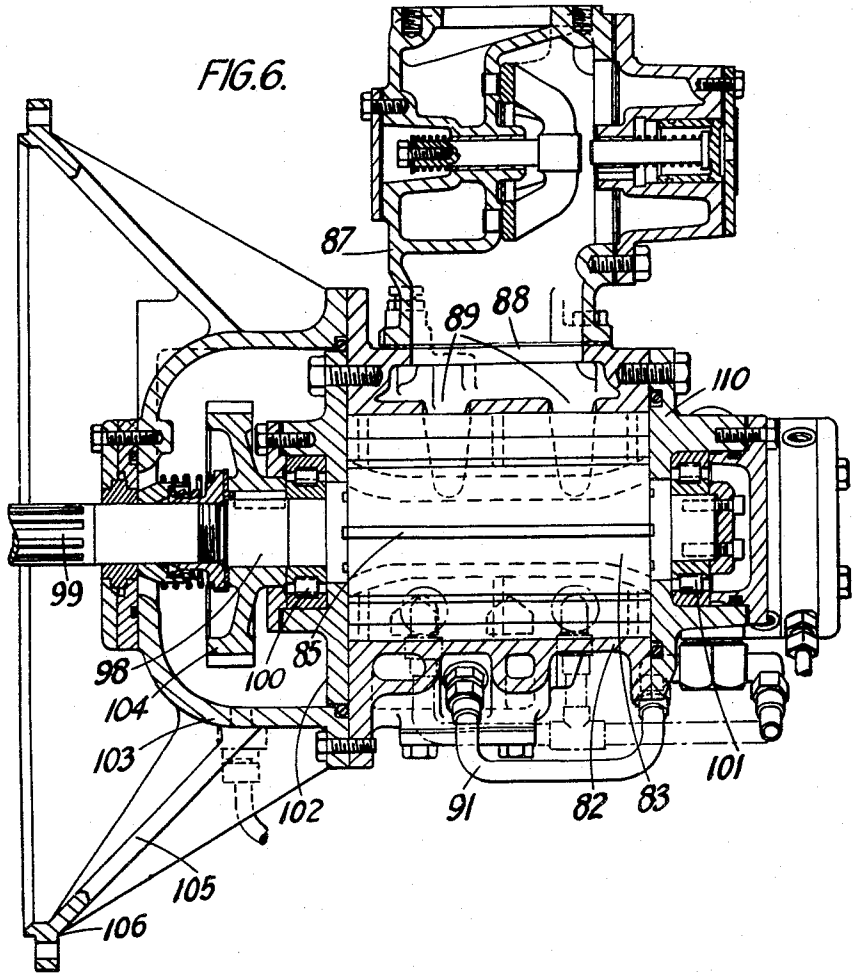
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AIR COMPRESSOR

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FIG. 6.



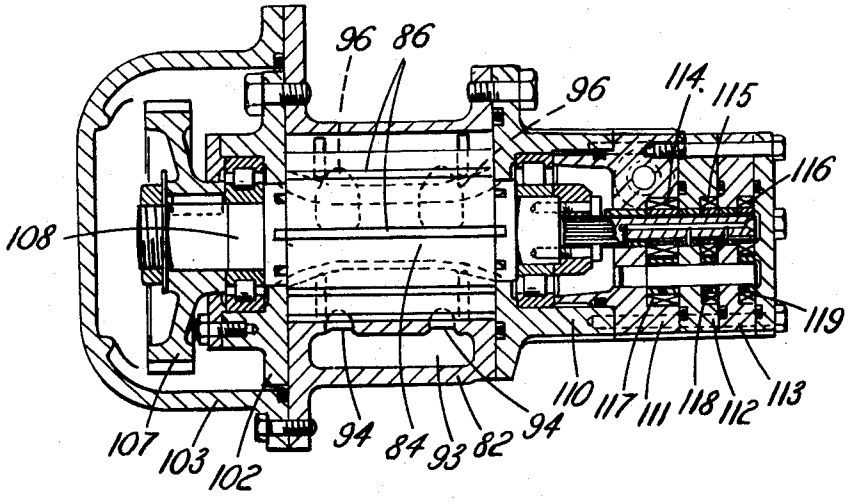
INVENTOR
H. S. BROOM
By: Wilkinson & Mawhinney
ATTYS.

May 17, 1960 H. S. BROOM 2,936,949

AIR COMPRESSOR

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FIG. 7.



INVENTOR
H. S. BROOM
By: Wilkinson + Mawhinney
ATTYS.

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2,936,949

AIR COMPRESSOR

Harry Skeet Broom, High Wycombe, England, assignor to Broom & Wade Limited, High Wycombe, England, a British company

Application May 26, 1954, Serial No. 432,569

Claims priority, application Great Britain May 28, 1953

5 Claims. (Cl. 230—152)

This invention comprises improvements in or relating to air compressors.

It is an object of the invention to provide an improved air compressor of the type in which a vaned rotor is employed to compress the air and in which cooling is effected by oil particles suspended in the air so as to be carried through the compressor with the air flow and subsequently separated from the air under pressure and returned to the compressor for re-use. In a compressor of this type no water jacket is ordinarily required but when air is to be compressed to a pressure of the order of one hundred pounds per square inch or more it is usually necessary to effect the compression in more than one stage. It is an object of the present invention to so design the compressor that the tendency which exists in apparatus of this type to throw the oil out of suspension in the air and allow it to collect in inter-chambers and the like, is obviated or minimised.

According to one feature of the present invention in a compound compressor of the type referred to, a low pressure rotor is located parallel with and close to a higher pressure rotor and the delivery of the lower pressure rotor is arranged peripherally and immediately adjcent to a peripheral intake to the higher pressure rotor so that the air carrying the oil passes directly from the one rotor to the other.

This arrangement minimises the tendency to throw oil out of suspension in the air. It will be understood that the term "air" as used herein is intended to include other compressible gases which are normally compressed in the same kinds of apparatus as air, air itself being the gas which is most frequently compressed.

In one construction, in accordance with the invention, the low pressure rotor is above the high pressure rotor, so that the air carrying the oil descends directly from one rotor to the other. In another construction, the two rotors are arranged side by side.

Preferably, the rotors revolve in opposite directions and the point of contact of the lower pressure rotor with its casing is to one side of the plane containing the axes of the rotors, while the point of contact of the higher pressure rotor is to the other side of said plane, so that the path of the air through the rotors follows a curve free of any sudden change of direction which might tend to throw oil out of suspension by local shock or turbulence or centrifugal effect.

Preferably oil is injected into the casings which contain the vaned rotors by inlets to each rotor located more or less tangentially to the periphery of the casings at a point close to that where the volume enclosed between adjacent vanes commences to contract.

The following is a description by way of example of certain constructions in accordance with the invention:

In the accompanying drawings,

Figure 1 is a vertical longitudinal section through one construction,

Figure 2 is a cross-section upon the line 2—2 of Figure 1 looking in the direction of the arrows,

Figure 3 is a detail of an oil pump in section upon the line 3—3 of Figure 1, looking in the direction of the arrows, and

Figure 4 is a section upon the line 4—4,

Figure 5 is a cross-section of a second construction,

Figure 6 is a longitudinal section upon the line 7—7 of Figure 5, looking in the direction of the arrows,

Figure 7 is a similar section upon the line 8—8 of Figure 5.

The compressor about to be described is intended to be bolted on to the end of the crank case of an internal combustion engine which drives it and the first part of the compressor consists of a casting **11** which forms a bell-housing on the end of the crank case and supports a rotor casing **12**. The bell-housing is large enough to receive the engine flywheel (not shown). To the centre of the flywheel is bolted a sleeve **13** formed with internal driving teeth. The flywheel space is shut off from the rest of the interior of the bell-housing by a partition **14** which is cast integral with the housing **11** and the sleeve **13** projects through an aperture in the partition, which is sealed by an oil seal **15** bearing on the exterior of the sleeve. Within the partition the rotor casing **12** has an end-plate **16** bolted to it, and on the end-plate in line with the flywheel, is a journal roller-bearing **17** for a rotor-shaft **18**. The rotor-shaft **18** extends from its roller bearing towards the flywheel and keyed to it is a spur gear **19** having a hub **20** which extends into the internally toothed sleeve **13** and carries external teeth to enter the teeth in the sleeve and thus to be driven thereby. Above the rotor-shaft **18**, in the end-plate **16**, is another roller bearing **21** for a second rotor-shaft **22**, which carries a spur gear **23** meshing with the spur gear **19** on the first rotor-shaft and of the same diameter, so that the two shafts are driven at the same speed but in opposite directions.

The rotor casing (or "stator") **12** has a flange **24** which is bolted to the bell-housing **11**, and it contains two cylindrical bores **25**, **26** (Figure 2) which are eccentric to the axes of the rotor-shafts **18**, **22** respectively. The outer end of the stator beyond the cylindrical bores is faced to receive cover plates **27**, **28** (Figure 1) one for each bore. The two cover plates contain journal bearings **29**, **30** for the outer ends of the rotor-shafts. Inside each of the bores **25**, **26** in the stator is a rotor (**31** for the shaft **18** and **32** for the shaft **22**) each of which is formed in one piece with the rotor-shaft to which it belongs. The rotors are eccentric to the bores in which they work and are of such diameter as to fit close to them at one side as is shown in Figure 2. Each rotor is slotted longitudinally from end to end to receive eight sliding vanes (marked **33** for the rotor **31** and **34** for rotor **32**).

The upper rotor **32** is somewhat longer than the lower one and is of larger diameter and constitutes a low pressure stage. Above the upper rotor is an inlet chamber **35** with a large port **36** in the top face of rotor casing above which is mounted an unloading valve **37**, shown only in Figure 1. The upper cylindrical bore **26** in the stator has in its upper side where it lies below the inlet chamber three wide slots **37**, **38**, **39** which extend part of the way around its periphery and permit access of air to the upper rotor. On its under side there are two delivery slots **40**, **41** which open into an inter-chamber **42** formed above the lower rotor. The bore of the stator which contains the lower rotor has inlet slots **43**, **44** immediately below the delivery slots **40**, **41** from the upper rotor and it has delivery ports **45**, **46** which open out of the side of the stator approximately on the same level as the axis of the lower rotor.

The upper rotor as viewed endwise has its axis displaced to one side of the bore in which it works and a little below the level of the centre of the bore, so that it

almost touches the interior of the cylindrical bore along the side between the inlet port 38 and outlet port 41 of the bore. The lower rotor is eccentric to its bore, which it approaches at one side of and above the centre of the bore, towards the opposite side of the stator from that which is approached by the upper rotor, the position of nearest approach being located between the inlet port 43 and delivery port 45 of the lower rotor. As the rotors are geared together they move in opposite directions and the direction of rotation in such that each of them moves its vanes across the inlet in a direction away from the place at which the rotor approaches the bore, and then with the vanes sweeps the air down through the underside of the bore and the delivery port. The position at which the lower rotor approaches the bore is nearer to the top of the bore than in the case of the upper rotor in order that the delivery ports 45, 46 may be at one side of the rotor instead of below it. The effect of this arrangement is that air moves downwards into the upper rotor, is carried in a curved path around the upper rotor 32 and given a first stage of compression, coming out of the bottom of the rotor and moving across the interior of the interchamber 42, without any substantial change of direction, to the inlet of the lower rotor. It comes on to the vanes of the lower rotor while moving in the same direction as these vanes and is swept around by them to the outlet 45, 46. This gives the air a path shaped somewhat like an elongated letter S and avoids turbulence or sudden change of direction of movement.

There is an oil inlet 47 to the upper rotor which sprays oil into the same at a point approximately coinciding with maximum distance of the rotor from the casing wall, that is to say at the place where the air is at its least pressure. Oil sprayed in at this position becomes suspended in the air. Owing to the smooth path of the air and to its downward movement there is little or no tendency to precipitate oil droplets out of the air and the whole of the oil with the air is carried around to the delivery port. Moreover by this means the oil pressure required is much less than the maximum air pressure. There is an oil inlet 48 to the lower rotor.

On the back of the cover plate 28 of the lower rotor-shaft there is bolted a casing 50 (Figure 1) for a gear pump for oil. This comprises an upper gear 51 which is driven by a splined connection 52 with the lower rotor-shaft and a lower gear 53 which is driven by meshing with the first. On the pair of spindles 54, 55 which supports the two said gears there are two additional pairs 56, 57 and 58, 59 of narrower gears. The casing 50 has an inlet 60 and a delivery port 61. Between the inlet and the delivery port is a relief valve 62 (Figure 3). The gears 56, 57 work in a casing 63 having an inlet 64 and a delivery port 65. This is separated by a diaphragm 66 from the casing 50. The gears 58, 59 work in a casing 67 which is separated by a diaphragm 68 from the casing 63 and outside the casing 67 is a cover plate 69. All these parts are drawn together by bolts 70.

The larger pair of gears 51, 53 is used to deliver oil at low pressure to the spray point 47 in the bore of the stator 32. The smaller gears collect oil filtered from delivery-air and return it to the system.

The smaller pair of gears 56, 57 is used to deliver oil at a higher pressure to a spray point 48. The pair of gears 58, 59 delivers oil to the journal bearings 17, 21, 29 and 30. The rear faces of the vanes 33, 34 are slotted as shown at 71, 72 to help to carry oil down to the spaces beneath them and to ensure that air pressure behind the vanes is equal to that in the space in which the vanes work against the casing. This permits the vanes to move outwardly freely under the effects of centrifugal force when the apparatus is in motion.

Appropriate pressure seals are located at the various joints.

Above the air inlet to the rotor casing is an unloading valve 74. This takes the form of a double-beat valve urged by a light spring 75 in one direction to close it but opened by the air flow. It is closed under the effects of a piston 76 which is subjected to the delivery pressure.

At the delivery of the pump there is placed a light spring-pressed disc-valve 77 which serves to hold up air pressure in the receiver when the pump is unloaded.

Referring now to Figures 5 to 7, the general relative disposition of the parts is similar to what has already been described, with two rotors arranged parallel to one another, but in this case, the two rotors are in the same horizontal plane. Two cylindrical bores 80, 81 are arranged side by side in a casing 82, and contain two eccentric rotors 83, 84 having vanes 85, 86. There is an inlet unloading valve 87 similar to the valve 37 already described, and from this the air descends through a port 88 into the upper part of the casing 82 and enters the larger or low pressure cylinder 80 by way of ports 89. Oil is injected into this cylinder through a nozzle 90 from a pipe 91, and the oil-laden air passes out through ports 92 into an inter-chamber 93 in the bottom of the casing 82 and thence upwardly through ports 94 into the high-pressure cylinder 81. Here there is a further oil injection nozzle 95 and the air passes out through ports 96 and past a delivery valve 97, which latter corresponds to the valve 77 of Figure 2. The path of the air through this apparatus instead of being shaped like the letter S, as in Figure 2, is more like the letter G but here again as much care as possible is taken to avoid undue or sudden changes of direction.

As can be seen from the longitudinal sections, Figures 6 and 7, the low-pressure rotor 83 forms part of a forging which comprises a driving shaft 98, splines 99 and working-in roller bearings 100, 101. The casing 82 is closed on the driving side, by an end-plate 102, and the bearing 100 is mounted in the end plate. A space outside the end-plate is enclosed by a gear case 103, and within the gear case is a spur gear 104 keyed to the shaft 98. The gear case carries brackets 105 which support a flange 106 for connection to the flywheel casing of an internal combustion engine which drives the compressor.

The spur gear 104 meshes with a second spur gear 107 in the casing 103, the gear 107 being mounted on a shaft 108 which is integral with the high-pressure rotor 84.

On the casing 82 at the opposite end from the end-plate 102, is a cover 110, and the part of the cover 110 which encloses the rotor 84 has secured to it pump casings 111, 112, 113 and an outer pump cover 114. In the pump casings 111, 112 and 113 there operate pump gears 114, 115, 116 which correspond to the gears 51, 56, 58 of Figure 1. These mesh respectively with gears 117, 118 and 119 which correspond to the gears 52, 57 and 59 of Figure 1. The three gear pumps are connected respectively to the low-pressure nozzle 90, to the high-pressure nozzle 95 and to the bearings of the rotors in a similar way to the corresponding connections of Figures 1 to 4.

It is to be understood that if necessary in either of the constructions described, one of the higher pressure gear pumps might be dispensed with and the bearings fed from the same pump as that which supplies the high-pressure rotor cooling nozzle 48 or 95 as the case may be.

Although in the specific embodiment described the design is shown as being suitable for direct drive from an internal combustion engine, it is to be understood that any desired form of drive could be adopted such, for example, as a direct drive from an electric motor, or any other normal form of prime mover, or a belt drive or the like.

I claim:

1. In a compound compressor, a casing having a low pressure rotor chamber, and beside it a high pressure rotor chamber, a low pressure rotor eccentrically disposed in the low pressure chamber and carrying sliding vanes which divide the chamber into spaces which expand and contract upon rotation of the rotor, a high pressure rotor eccentrically disposed in the high pressure chamber

and likewise having sliding vanes, said rotors and their chambers being located parallel and close to one another, means for dispersing oil in the air passing through the low pressure chamber, said low pressure chamber having lateral delivery ports, said high pressure chamber having lateral intake ports, said delivery and intake ports being substantially in alignment in a direction transverse to the axes of the rotors and in direct unimpeded communication with one another free of interposed obstacles so that the air carrying the oil passes directly from the low to the high pressure rotor chamber without impinging on any surface which would baffle its flow, and driving means to drive said rotors at appropriate relative speeds to cause the low pressure rotor vanes to sweep out a greater displacement than the high pressure rotor vanes.

2. A compound compressor as claimed in claim 1 wherein the rotors revolve in opposite directions, and the point of contact of the low pressure rotor with its chamber is to one side of the plane containing the axes of the rotors, while the point of contact of the high pressure rotor is to the other side of said plane, so that the path of the air through the rotors follows a curve free of any sudden change of direction which might tend to throw oil out of suspension by local shock or turbulence or centrifugal force.

3. A compound compressor as claimed in claim 1 wherein the means provided to disperse oil into the air comprises inlets located substantially tangentially to the periphery of both chambers at a point close to that where the volume enclosed between adjacent rotor vanes commences to contract.

4. A compound compressor as claimed in claim 1 wherein the rotor chambers and rotors are side by side substantially horizontally with an interchamber offset downwardly from a point between the chambers, said interchamber communicating with both the delivery and intake ports and having a concave bottom wall curved in a continuous arc from the delivery to the intake ports.

5. A compound compressor comprising in combination a casing having high and low pressure rotor chambers extending parallel with one another and close together, rotors eccentrically disposed in each chamber each carrying sliding vanes to divide the chambers into compartments, means for dispersing oil in air entering the low pressure chamber, said low and high pressure chambers having intake and delivery ports, said delivery ports of the low pressure chamber and intake ports of the high pressure chamber being substantially in alignment with each other in the direction of flow of air from the delivery to the intake ports and said casing providing a passage from the said delivery to the said intake ports free of interposed obstacles, so that the air carrying the oil passes directly from the low to the high pressure rotor chamber without impinging on any surface which would baffle its flow, and means for driving the low and high pressure rotors at appropriate relative speeds.

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