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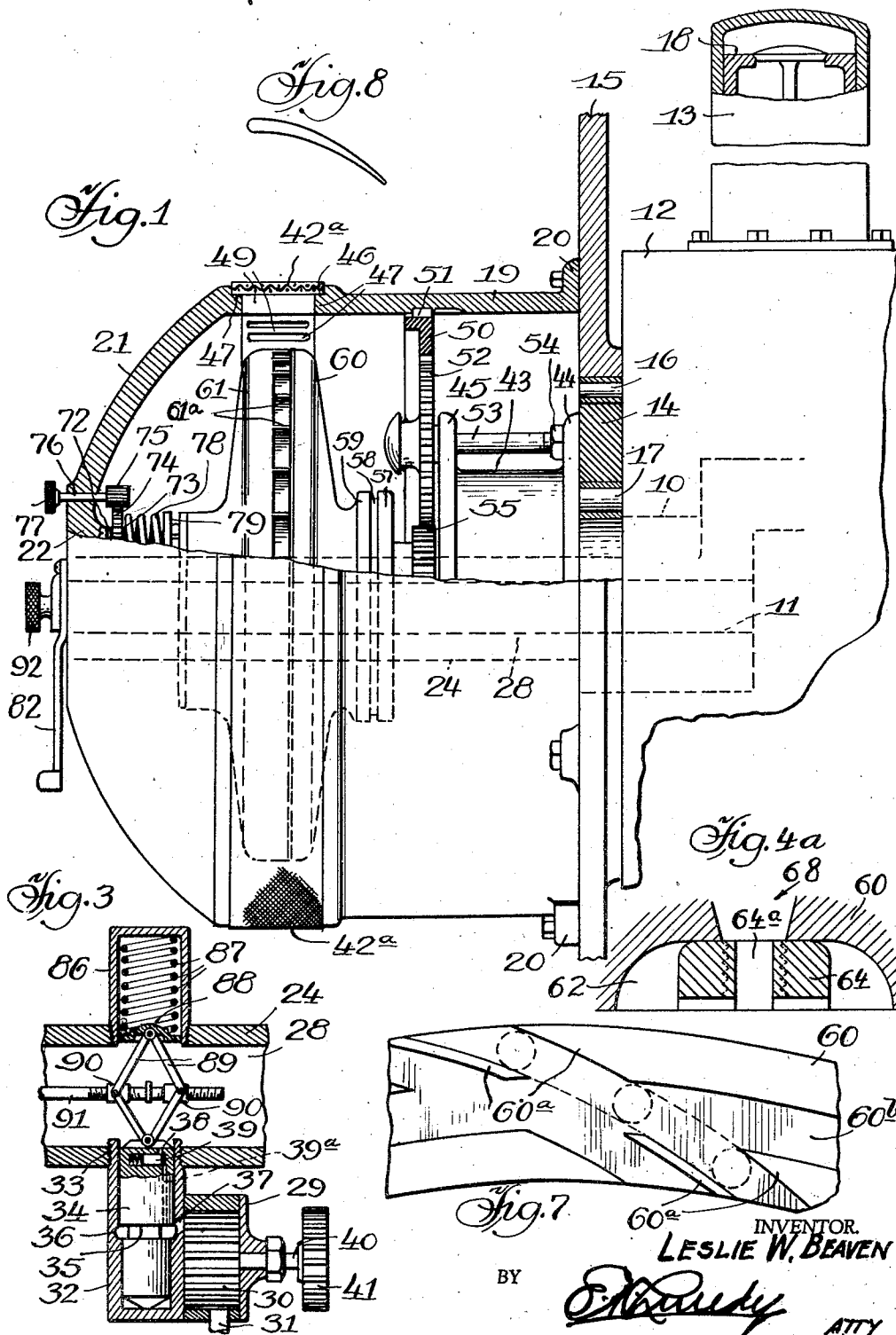
L. W. BEAVEN

2,357,778

SUPERCHARGER

Filed July 29, 1942

2 Sheets-Sheet 1



INVENTOR.
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BY

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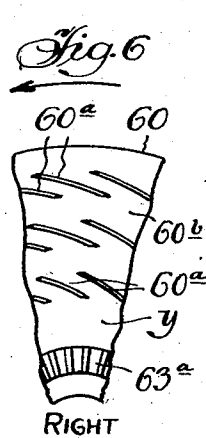
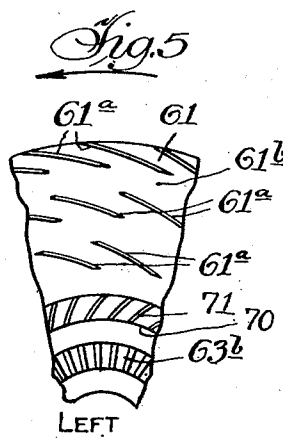
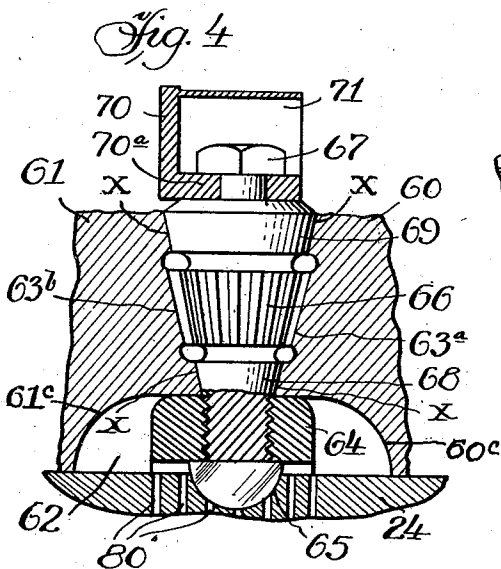
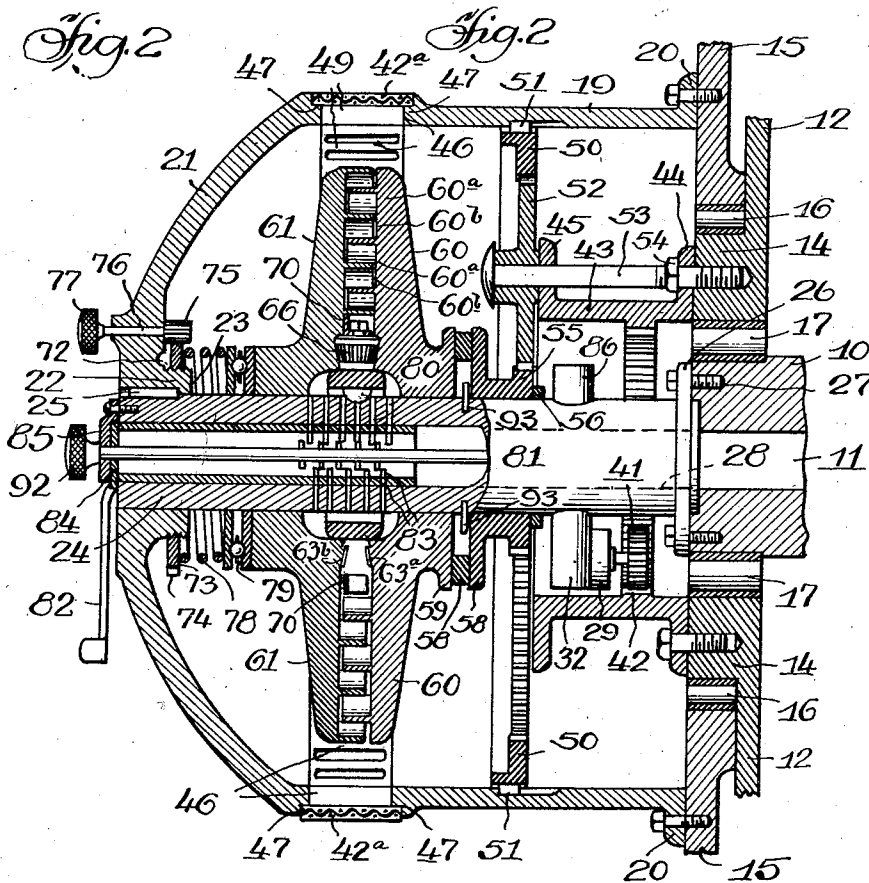
L. W. BEAVEN

2,357,778

SUPERCHARGER

Filed July 29, 1942

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,357,778

SUPERCHARGER

Leslie W. Beaven, Chicago, Ill.

Application July 29, 1942, Serial No. 452,740

11 Claims. (Cl. 230-124)

My present invention relates to devices for feeding liquid or gaseous fuel to an internal combustion engine, and more particularly my apparatus is what is termed a supercharger which contemplates the use of a forced current of air to impel the gaseous mixture or emulsion into the engine cylinders.

Merely for the purpose of convenient illustration, I have herein disclosed my supercharger structure in connection with the "Fuel feed device" which is shown and described in my co-pending application for Letters Patent Serial No. 400,811, and also the "Rotary gas engine" which is shown and described in my co-pending application for Letters Patent Serial No. 398,428; but it will be understood that my supercharger structure is well adapted for use with, and it may be readily employed in connection with apparatus other than those which are embodied in my aforesaid applications.

The present apparatus utilizes and operates upon the principle of a centripetal force, as distinguished from a centrifugal force, by reason of the fact that the novel impeller arrangement which I have employed is especially designed so that the air-currents or pressure created by the impellers are forced backward and forward in such manner as to prevent the creation of a centrifugal force, while at the same time forcing this pressure or air-currents in an inward direction to the fuel feed pipe or conduit that leads to the engine cylinders.

The impellers embody relatively closely fitting confronting members that rotate in opposite or opposed directions so that they are adapted to thereby create a considerable amount of compression while moving at a comparatively slower speed than has heretofore been deemed necessary to generate the desired compression. This obviously results in a material saving of power as well as a reduction in wear of the parts, and vibration is diminished to a minimum. I employ adjustable yieldable means to urge the impellers constantly towards each other in a manner which permits the normal separation or clearance between the impeller members to be automatically increased by further separating said members whenever the pressure rises above the degree to which the yieldable means have been set and thus to release the excess pressure without interfering with the continued operation of the supercharger.

In order to provide for safety, I have incorporated an automatic clutch in my apparatus, said clutch being preferably controlled by the

same yieldable means that are employed for urging the impeller members towards each other. This permits the mechanism to automatically take care of any sudden acceleration or reduction of speed, and it also will prevent damage to the parts of the impeller members in the event any foreign matter accidentally enters the impellers or their associated parts.

A feature of my supercharger is that it is entirely automatic in operation, and since it requires no attention it is well adapted for use in connection with the engines used in airplanes. When used in this manner, if the plane moves into a dense atmosphere, the barometric pressure of such atmosphere will tend to increase the separation of the impellers; and when the plane moves into a thinner or more rarefied atmosphere the impellers will tend to move closer together and reduce the separation or clearance between them which will increase the efficiency of the supercharger by increasing the pressure.

One of the aims of my invention is to provide a supercharger that is of novel construction, and which is adapted to perform its required functions in an effective manner. Another object or aim is to provide an apparatus of the character herein disclosed that is of sturdy construction so that the parts thereof are capable of withstanding heavy duty. The apparatus, as above mentioned, is automatic in operation and therefore requires a minimum of attention from the operator of the engine or motor. The various parts of my apparatus are assembled in compact form and are readily accessible for replacement or repair whenever necessary; the supercharger is more or less economical to produce and it is capable of being quickly assembled with the fuel feed devices of an internal combustion engine of the type mentioned herein or with other types; and it is convenient to adjust whenever such attention is required.

The above-mentioned as well as other objects, aims, and advantages of my apparatus will be obvious to persons skilled in the art after the construction and operation of said apparatus is understood from the following detailed description. It is preferred to practice my invention in substantially the manner hereinafter fully described and as more particularly enumerated in the claims appended hereto, and, for a better understanding of the same, reference is made to the accompanying drawings that form a part of this specification.

In the drawings:

Figure 1 is a view partly in side elevation and partly in section showing my supercharger device

installed upon an internal combustion rotary engine.

Figure 2 is a vertical section taken axially through the supercharger.

Figure 3 is an enlarged detail in vertical section of the fuel feeding devices.

Figure 4 is an enlarged vertical view of one of the motion transmitting pinions with the adjacent portions of the supercharger structure in section.

Figure 4a is an enlarged view, partly in elevation and partly in vertical section, showing the slots in the pinion supporting spider.

Figure 5 is a face view presented in a fragmental manner of the left-hand impeller member shown in Figure 2.

Figure 6 is a view similar to Figure 5 of the right-hand impeller member shown in Figure 2.

Figure 7 is a diagram illustrating the novel manner of forming the blades or fins on the impeller members by means of an automatic milling machine for mass production.

Figure 8 shows an end of an impeller fin or blade of the preferred type.

The accompanying drawings are to be understood as being more or less diagrammatic for the purpose of illustrating a typical or preferred embodiment of my novel supercharger and its various parts, and in these drawings the same reference characters are employed for the purpose of identification of the same parts wherever they appear in the divers views.

The crank-shaft 10 of the engine, which is stationary, is preferably provided with an axial bore 11 through which the combustible fuel is fed to the engine casing 12 and thence to the engine cylinders 13 that are disposed in radial arrangement upon the casing. The casing and cylinders are adapted to rotate upon the stationary crank-shaft 10 and the hubs 14 of the casing are rotatably mounted in a rigid supporting frame 15 of any suitable construction. Anti-friction bearings 16 are interposed between the engine casing hubs 14 and the supporting frame 15, and similar bearings 17 are interposed between the engine casing hubs 14 and the adjacent portion of the crank-shaft 10. The combustion fuel is adapted to pass through the bore 11 of the crank-shaft and into the engine casing 12 where it will enter the inner ends of the cylinders 13 and is admitted into the combustion chambers thereof by means of suitable valved ports located in the pistons 18 which reciprocate in said cylinders and have their pitmans, operatively connected to the eccentric portion of the crank-shaft 10. Other details of the pistons, and associated parts, are fully disclosed in my previously-mentioned co-pending application for Letters Patent Serial No. 398,428, to which specific reference may be made, it being understood that the same is merely typical of the engine structure.

The fuel feed devices and the supercharger apparatus are enclosed within a suitable housing that is mounted on the side of the support 15 which is opposite the engine casing 12. This housing embodies a cylindrical wall or shell portion 19 having lateral lugs 20 by which it is anchored to the adjacent portion of the supporting frame 15 in any suitable manner, preferably by bolts or the like, and the outer portion of said housing is closed by a concavo-convex end wall 21 that is bulged outwardly towards its center where it is thickened or enlarged to provide the inwardly projecting boss 22 that has an axially bored opening 23. The crank-shaft 10 is provided

with an extension 24, the outer end of which enters the opening 23 and is secured therein by a torque key 25, and the opposite end of said extension shaft 24 is provided with an annular outer flange 26 that engages flat against the adjacent outer end of the crank-shaft 10 to which it is secured by bolts 27. This extension 24 of the crank-shaft constitutes a stationary element or fixed shaft upon which the supercharger is mounted for rotational movement relatively thereto, and said extension shaft 24 is provided with an axial bore 28 of suitable diameter that is in axial alinement with the crank-shaft bore 11 to provide a continuation thereof.

The fuel feed device which is assembled upon the inner portion of the supercharger shaft 24 adjacent the flange 26, preferably embodies a structure such as typified by the apparatus disclosed in my previously mentioned co-pending application Serial No. 400,811, and it is adapted to discharge a fuel spray or fog, (preferably a dispersion of air in liquid fuel), into the feed bore 11 of the engine crank-shaft 10. The said device includes a suitable pump chamber 29 in which meshed gears 30 revolve to rapidly and finely churn the liquid fuel, received through an inlet pipe 31, into a finely divided fog or mist which is discharged from the pressure side of the pump into the casing 32 of a control device. Casing 32 is a hollow casting, cylindrical in shape and closed at its outer end, and having its upper open end entered and secured in an opening 33 in the lower segment of the supercharger shaft 24 in communication with the bore 28 thereof. An elongated piston or plunger 34 is reciprocally mounted in the casing 32 and it is of such dimensions that it substantially fills the bore of the casing 32 in both longitudinal and transverse directions. There is a shouldered portion 35 about midway the length of the piston or plunger 34 that is in registry with an annular channel 36 extending around the bore of the casing 32 which receives the dispersion of air in liquid fuel through a passageway 37 communicating with the pressure side of the pump. A spray-port 38 is formed in the upper end of the piston or plunger 34 that is controlled by a spray-valve 39 adapted to be actuated by the pressure of the fuel received from the pump, which fuel is transmitted to the valve 39 by a longitudinal passageway 39a in the upper section of the piston body between the shouldered portion 35 and the chamber in which the spray-valve is reciprocally and yieldably mounted.

The upper end of the piston 34 is exposed to and it is affected by any variations or air-pressure changes which may take place in the passageway or bore 28 of the supercharger shaft 24. The spindle 40 of one of the pump gears projects out of the pump chamber wall and has a pinion 41 secured to it preferably in mesh with an internal annular gear 42 that is secured to the adjacent end face of the engine casing hub 14 so that said internal gear 42 will be rotated with the engine when the latter is in operation with the engine casing 12 and its cylinders rotating upon the stationary crank-shaft 10. This internal gear 42 is upon the inner surface of a cylindrical frame or fitting 43 that has a spool-shape in axial section with annular outwardly extending end flanges 44 and 45, respectively, the inner flange 44 being bolted or otherwise anchored to the hub 14 of the engine casing.

An annular air-fillet opening 46 is made in the outer end portion of the supercharger shell 19, the margins of said opening having seats 47 to

receive a hoop-shaped or annular filter-pad 47a of any type that may be found desirable, for the purpose of filtering the air that is admitted through said opening, whereby to prevent dust and other foreign matter entering said shell which might interfere with the operation of the supercharger and other elements. Said inlet opening 46 is preferably bridged at spaced intervals by transversely disposed stays or ribs 49 that are separated from each other suitable distances to strengthen this open portion of the shell and also to prevent the filter-pad 47 being sucked or drawn into the shell by the current of air passing inwardly through said opening 46.

Within the shell there is an internal ring gear 50 that is suitably anchored to the inner surface of the shell by keys 51 or otherwise, and said ring gear embodies one of the members of a suitable gear train that is employed to drive the impeller members of the supercharger. A plurality of planetary gears 52, (preferably two or more), in mesh with the internal ring gear 50 are mounted upon spindles 53 that are elongated to pass through the flanges 44 and 45 of the spool-shaped fitting or frame 43 that rotates with the engine casing. As shown in detail in Figure 2, the ends of the spindles which are remote to the gears 52 are threaded to screw into the end of the engine casing hub 14 and they are locked in place by nuts 54. The central or sun-gear 55 of the planetary gear train is rotatably mounted upon the stationary supercharger shaft 24 and it is in mesh with the planetary gears 52. There is a thrust-bearing or annular stop 56 secured to the supercharger shaft to prevent movement of the sun-gear 55 in an inward direction towards the engine casing. This sun-gear 55 has a clutch disk 57, preferably formed with it, that is provided with a friction ring 58 of any suitable substance for engagement with the other or opposing disk 59 of the clutch device.

The impeller member 60 of the supercharger which is adjacent the clutch just before described, is preferably formed as a part of the clutch disk 59, or it may be a separate element that is attached thereto. The impeller member 61 of the supercharger confronts said member 60 and it is yieldably urged towards said member 60 so that the elements of the clutch will normally be frictionally engaged with each other to rotate the impellers 60 and 61 upon the extension shaft 24 through the medium of the planetary gear train when the engine is being operated in a rotative manner upon its crank-shaft 10. It will be here stated that the impellers are rotated in directions that are opposed to each other, so that the required amount of compression is secured at one-half the usual speed. The instrumentalities for performing this function, as well as the devices which yieldably urge the clutch members into frictional engagement, will be fully described in a subsequent portion of this specification.

The impellers comprise the circular plates 60 and 61 that are provided with concentric rows of arcuate blades or fins 60a and 61a, respectively, the said rows on one plate 60 being disposed in alternate arrangement with respect to the rows of blades on the confronting plate 61, and in order to accomplish this arrangement, the rows on each plate are separated from each other by channels or grooves 60b and 61b that are each of proper width and depth to intimately accommodate the opposing row of blades with

close clearances between the parts. As shown in Figure 2, the clearances between the interfitting elements have been intentionally exaggerated for the purpose of avoiding confusion in the drawings.

The blades are of segmental or arcuate cross-section, preferably of an aerofoil section such as illustrated in detail in Figure 8 of the drawings, wherein it will be observed that the trailing portions of said blades curve inwardly and are closer to the rotational axis of the impeller than are the leading edges which plow or cut into the air in the manner of the wing of an airplane. The individual blades are spaced apart from each other the proper distances to permit the air to readily pass between them, and, since the confronting impellers rotate in directions opposed to each other, the air is forced in a somewhat zigzag or back and forth course towards the axis of rotation of the impellers, thus creating centripetal force as distinguished from the centrifugal principle upon which it has heretofore been customary to operate supercharger devices. The opposed directions of rotation renders it possible to revolve the impellers of my supercharger at a relatively slowed-down speed as compared with the very high speed at which the present types of superchargers are rotated, with the result that wear and vibration is reduced to a minimum without affecting the operation of my apparatus or reducing the pressure to be attained. Furthermore, the impeller members which I have devised are capable of being rapidly produced in large quantities on automatic or semi-automatic machines due to the fact that confronting faces are alternates of each other, and the curvature of a blade in one row is, or could be, a continuation of the curvature of a blade in the next succeeding row on the same impeller member. This permits an impeller blank, after the channels or grooves 60b or 61b have been turned therein, to be mounted in a standard lathe with an automatic cross-feed and individual power-driven milling cutters to form the faces of a plurality of blades during each sweep thereof in the manner suggested in Figure 7 of the drawings. Since the material used is preferably an aluminum alloy or the like, the impellers may be machined at a very high speed and in mass production for large quantities.

The impeller members 60 and 61 have axial openings whereby said members are mounted for rotation upon the stationary supercharger shaft 24, and around these openings I have provided facing recesses 60c and 61c, which together provide an annular central chamber 62 next to the shaft 24 to receive the compressed air which has been driven centripetally inwardly by the blades 60a and 61a and also to provide for the mounting of motion transmitting devices that are operable between the impellers. Toothed annular racks 63a and 63b are formed upon the impeller members 60 and 61 respectively, which said racks extend around the margins of the central chamber 62 and confront each other in spaced relation. A ring-shaped spider 64 surrounds the stationary supercharger shaft 24 to which it is anchored by a feather-key 65 that has a rounded bearing surface to arrest rotation of the spider ring. A plurality of radially disposed beveled pinions 66 are carried by the spider so that they are in mesh with the teeth of the racks 63a and 63b, said pinions being rotatably mounted upon the smooth shanks of radially disposed bolts 67 that are screwed into the body of the spider 64.

The spider ring 64 is preferably provided with longitudinal slots 64a, which extend between the pinions 66 to insure passage of the centripetally driven current to the annular chamber 62. The surfaces of the impeller members 60 and 61, upon each side of the annular racks 63a and 63b are tapered inwardly towards each other as shown at x in Figure 4, and the inner and outer end portions 68 and 69 of the pinions are smooth and correspondingly tapered, this providing for positive bearings and for guiding said pinions 66 in a dependable manner. By means of the structure above described it will be obvious that whenever the engine casing is rotating, the movement thereof will be transmitted through the planetary gear train and the clutch to the impeller member 60 and thence through the rack 63a and the beveled pinions 66 to rack 63b, thereby moving the other impeller member 61 in a direction opposed to the direction of movement of the confronting impeller member 60.

The innermost row of impeller blades, in which the curvature of the blades is substantially the same as those of the other blades, may have a tendency to spin the air into a whirlpool, creating centrifugal force opposing the centripetal force that has been created by the device, and in order to resist this tendency, and in order to continue to force the air in an inwardly radial path, I have provided suitable means adjacent said innermost row of impeller blades for preventing a circular path of the air and thus continue the centripetal force which has been created. These means comprise what I term a drift baffle which embodies a stationary annulus or ring 70 that has lugs 70a secured to the spider 64 through the medium of the bolts 67. There are arcuate baffles 71 on this ring or annulus 70, which said baffles curve somewhat sharply inwardly towards the axis of the supercharger at a different tangent than the blades of the impellers 60 and 61 and in opposite directions thereto. In order to accommodate this drift baffle, the innermost channel or groove of the impeller 60 is made wider as at y opposite the innermost channel or groove of the confronting impeller 61, thus providing an annular recess in which said drift baffle is disposed.

As previously stated, the impellers 60 and 61 are normally urged towards each other in a yieldable manner, and control means are provided for making any desired adjustment should such be required. For the aforesaid purpose the inner portion of the inwardly projecting boss 22 is provided with threads 72 upon which a bored and threaded disk 73 is screwed, and the peripheral edge of said disk is provided with rack teeth 74 that are meshed with the teeth of a relatively small pinion 75 that is preferably manually rotated to turn the disk 73 and move it longitudinally upon the threaded portion of the boss 22. The pinion 75 is carried upon the inner end portion of a spindle 76 that passes through and is journaled in the adjacent portion of the wall 21 of the supercharger housing, and upon the outer end of said spindle there is a handle or hand-grasp 77 for manually turning the same. A coiled expansion spring 78 surrounds the supercharger shaft 24 between said disk 73 and an annular thrust-bearing element 79 surrounding the shaft 24 at the hub of the impeller member 61. This arrangement permits the operator to adjust the tension of the spring 78 to suit conditions and requirements even though the supercharger is in motion.

Throughout the width of the chamber 62 the supercharger shaft 24 is provided with a plurality of transverse drilled apertures 80 that establish communication between said chamber and the interior passageway or bore 28 of the shaft, thus allowing the centripetally compressed air to discharge into the said bore. The throttle for controlling this discharge of air through the apertures 80 is preferably a cylinder 81 of proper outside diameter to fit snugly into passageway or bore 28 and be rotatably mounted therein so that it may be moved by the throttle lever 82 that is secured to its outer end outside the supercharger housing. A plurality of transversely extending slots 83 are made in the wall of the throttle, which said slots are adapted, upon movement of the throttle lever 82, to be registered to a greater or lesser degree with the apertures 80 in the shaft and thereby admit more or less air into the passageway 24 that leads past the fuel feed devices. The outer end of the throttle is closed by a transverse wall 84, and said throttle is maintained in position by a cupped friction plate 85 that is anchored to the adjacent end of the supercharger shaft 24.

Above the fuel feed device and spray port there is a small hollow dome 86 which houses a coiled expansion spring 87 the tension of which is adapted to be adjusted and which has its lower end seated on a follower disk 88, in the lower open end of said dome 86. This spring is for the purpose of exerting pressure upon the piston or plunger 34 of the fuel feed devices which are axially aligned with the axis of said dome 86. This spring pressure is transmitted through the medium of an adjustable toggle device 89 that has its upper and lower ends engaged respectively with the follower disk 88 and the upper exposed end of the plunger 34. The intermediate hinged portions of the toggle are provided with right-hand and left-hand threaded nuts 90 that are respectively engaged by the correspondingly threaded end portions of a feed-screw 91 that extends through the outer end of the throttle cylinder 81 and the retainer cup 85 where it is provided with a handle 92 for operating the same. Rotation of the feed screw 91 will further separate or draw closer together the nuts 90 at the intermediate hinges of the toggle and thus make the desired adjustment of tension on the spring 87 to control the flow of fuel through the spray-port 38 into the path of the compressed air current which is moving past the spray-port in transit to the engine casing and cylinders.

It will be seen from the foregoing, that the type of compressor shown is particularly suited to aeronautics, especially military, where quick dives and climbs subject the engine to rapid fluctuations of air density, under such stress to the personnel that manual control of the supercharger is much less satisfactory than that which is automatic. The centripetal action is well suited to coordinate the physical shape of the air passages with an important requirement of compression, the progressively increasing confinement. It permits a reduction in speed of the impellers of more than fifty percent (50%). It permits dual function of the impellers, as compressor members and as diaphragm or piston members, which, because of their large area, make the device delicately sensitive to pressure changes and quick to relieve excess pressure, with minimum movement. This feature is also

useful in graduating the degree of compression without transforming the energy of excess motion into heat. Also, injury or breakdown of the supercharger will not stop the engine but only the supercharging and the slipping clutch will become disengaged when a predetermined portion (about one-half) of the lining is worn away. This latter is accomplished by providing several stops or pins 93 that project from the shaft 24 between the clutch faces and preferably close to the face of disk 57. After the friction lining 58 has worn down sufficiently, the other disk 58 will engage the pins 93 so that further clutching function will cease and the supercharger stop without damage to it.

In both the centrifugal and centripetal types, the air is plowed by the impeller blades to move it in the direction desired, but the essential difference between the two motions is that one is tangential, and the other is radial, and the secret of preventing development of centrifugal force is the prevention of circular motion in the air. This is accomplished in my device by moving the air plows in opposite directions. The design of the blades makes it easy to precision machine, cast or otherwise form every surface of the airfoils and channels to the precise angle, shape and clearance that will give maximum efficiency, graduating the angle of each row of blades to suit the requirements that are due to relative velocities of air and blade and directions of approach and recession, all of which are very desirable features in air compressing devices.

While I have described my invention in detail in its present preferred form or embodiment, it will be obvious to those skilled in the art, after understanding my invention, that various changes and modifications may be made therein without departing from the spirit and scope thereof. I aim in the appended claims to cover all such changes and modifications.

What I claim as my invention is:

1. A supercharger embodying a stationary hollow support; confronting impellers rotatable in opposite directions on said support and adapted to drive air centripetally inwards towards their axes; means for admitting the centripetally driven air into said support; a driving gear train; means for actuating said gear train; a clutch operatively connecting said gear train to one of said impellers; motion transmitting means interposed between said impellers; and means yieldably urging said impellers into intimate relation to each other.

2. A supercharger embodying a stationary hollow support; confronting impellers rotatable in opposite directions on said support and adapted to drive air centripetally inwards towards their axes; means for admitting the centripetally driven air into said support; annular racks on facing portions of said impellers; a stationary ring spider interposed between said impellers; pinions rotatably mounted on said spider in mesh with said racks, whereby movement of one of said impellers is transmitted to the other impeller; and driving means having operative connection with one of said impellers.

3. A supercharger embodying a stationary hollow support; confronting impellers rotatable in opposite directions on said support and adapted to drive air centripetally inwards towards their axes; means for removing the centripetally driven air through said support; annular racks on facing portions of said impellers; a stationary

ring spider interposed between said impellers; pinions rotatably mounted on said spider in mesh with said racks, whereby movement of one of said impellers is transmitted to the other impeller; a driving gear train; means for actuating said gear train; and a clutch operatively connecting said gear train to one of said impellers.

4. A supercharger embodying a stationary hollow support; confronting impellers rotatable in opposite directions on said support and adapted to drive air centripetally inwards towards their axes; means for admitting the centripetally driven air into said support; annular racks on facing portions of said impellers; a stationary ring spider interposed between said impellers; pinions rotatably mounted on said ring spider in mesh with said racks, whereby movement of one of said impellers is transmitted to the other impeller; a driving gear train; means for actuating said gear train; a clutch operatively connecting said gear train to one of said impellers; yieldable tensioning means normally urging the other impeller towards the impeller which is clutched to said gear train; and devices for adjusting said tensioning means.

5. A supercharger embodying a stationary hollow support; confronting impellers rotatable on said support and adapted to drive air centripetally towards their axes; means for admitting said centripetally driven air into said hollow support; and a throttle controlling said air admitting means.

6. A supercharger and the like embodying confronting members adapted for rotation in opposite directions; a stationary support upon which said members are rotatably mounted; blades on the adjacent faces of said members, said blades disposed in a plurality of concentric rows on the respective members, the spaces on the face of one member adapted to receive the rows of blades on the face of the other member; yieldable means normally urging said members towards each other to maintain intimate relationship between the respective rows of blades; and driving means operatively connected to and adapted to rotate said confronting members.

7. A supercharger and the like embodying confronting members adapted for rotation in opposite directions; a stationary support upon which said members are rotatably mounted; blades on the adjacent faces of said members, said blades disposed in a plurality of concentric rows upon each member with annular spaces between adjacent rows on the respective members, the spaces on the face of one member adapted to receive the rows of blades on the face of the other member; yieldable means normally urging said members towards each other to maintain intimate relationship between the respective rows of blades; and driving means operatively connected to and adapted to rotate said confronting members, said driving means embodying a gear train, and a clutch operatively connecting said gear train to said members.

8. A supercharger embodying a hollow support; confronting impellers rotatable in opposite directions on said support and adapted to drive air centripetally towards their axes; means for admitting the centripetally driven air into the bore of said support; a tubular member movable in the bore of said support and adapted to throttle said air admitting means; and driving mechanism for rotating said impellers on said support.

9. A supercharger for internal combustion engines and the like, embodying a stationary shaft

provided with a fluid passage therethrough, a pair of confronting members adapted for rotation upon said shaft, there being a communication between said passage in said shaft and the space between said members, means maintaining said members in proximity to each other, a plurality of blades carried by the proximate faces of said members and concentric with the axis of said shaft, all of said blades being obliquely disposed to a radial position, the blades of one series being of opposite obliquity to those of an adjacent series, means for rotating said members in unison in opposite directions, means for uniformly and simultaneously supplying fluid to the space between said members at their peripheries and throughout the entire circumference of the space between said members, and means for controlling at will the said communication between the passage in said shaft and the space between said members.

10. A supercharger and the like, embodying confronting members adapted for rotation in opposed directions and about the same axis, blades on the proximate faces of said members and disposed in a plurality of concentric rows on the respective members, all of said blades adapted to plow the fluid inwardly, the blades on each member rotating in the spaces between the blades on the other member, means normally urging the

said members towards each other to insure a predetermined fluid pressure between said members, the last recited means being yieldable under increased pressure between the members, means for adjusting the last said means at will, whereby the said predetermined pressure between the members may be varied, and means for rotating said confronting members.

11. A supercharger and the like, embodying confronting members adapted for rotation in opposed directions and about the same axis, blades on the proximate faces of said members and disposed in a plurality of concentric rows on the respective members, all of said blades adapted to plow the fluid inwardly, the blades on each member rotating in the spaces between the blades on the other member, means normally urging the said members towards each other to insure a predetermined fluid pressure between said members, the last recited means being yieldable under increased pressure between the members, means for adjusting the last said means at will, whereby the said predetermined pressure between the members may be varied at any time during the cycle of operation of said confronting members, and means for rotating said confronting members.

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