

Oct. 8, 1935.

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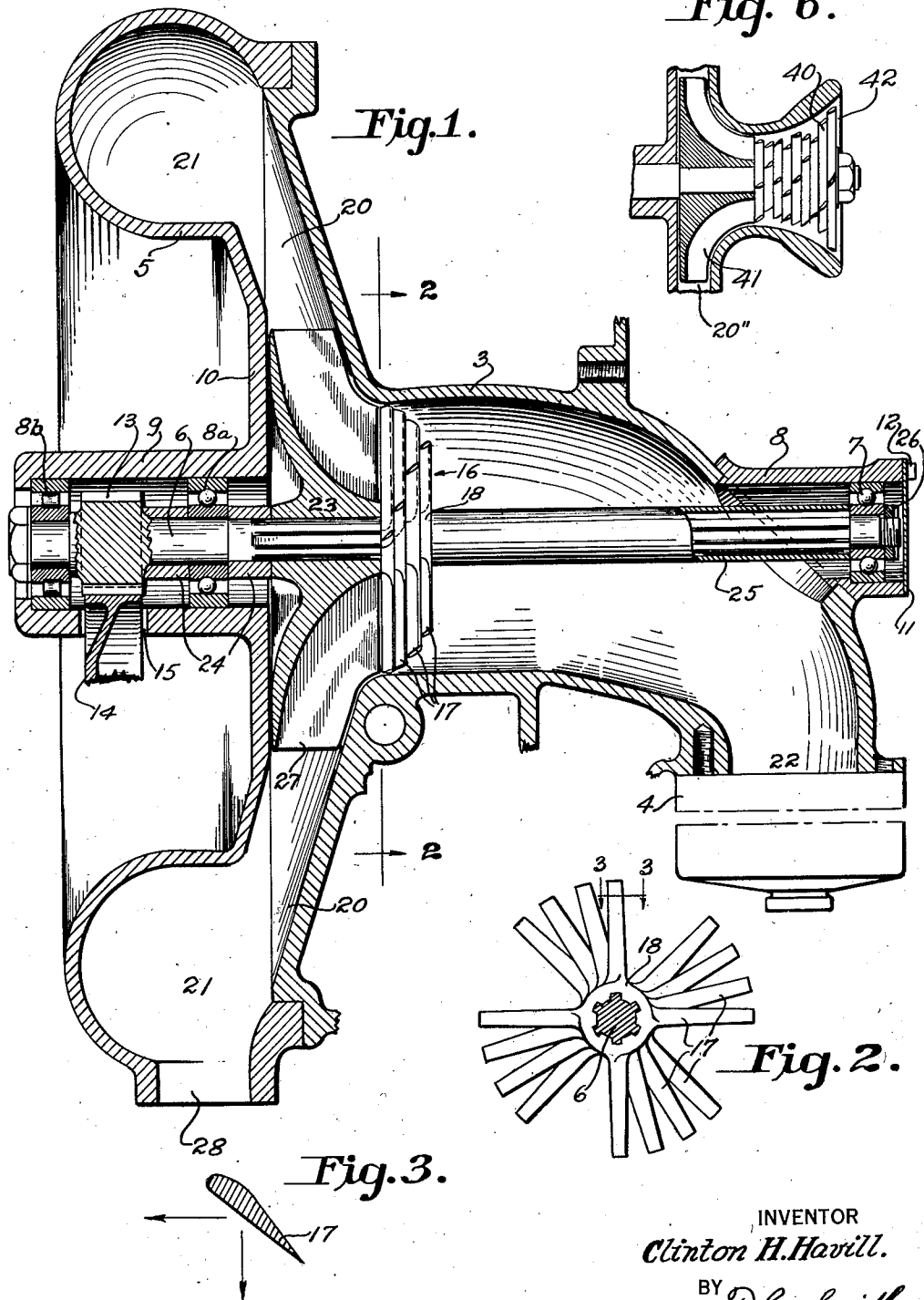
2,016,831

FLUID PUMP

Filed Oct. 30, 1930

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Fig. 6.



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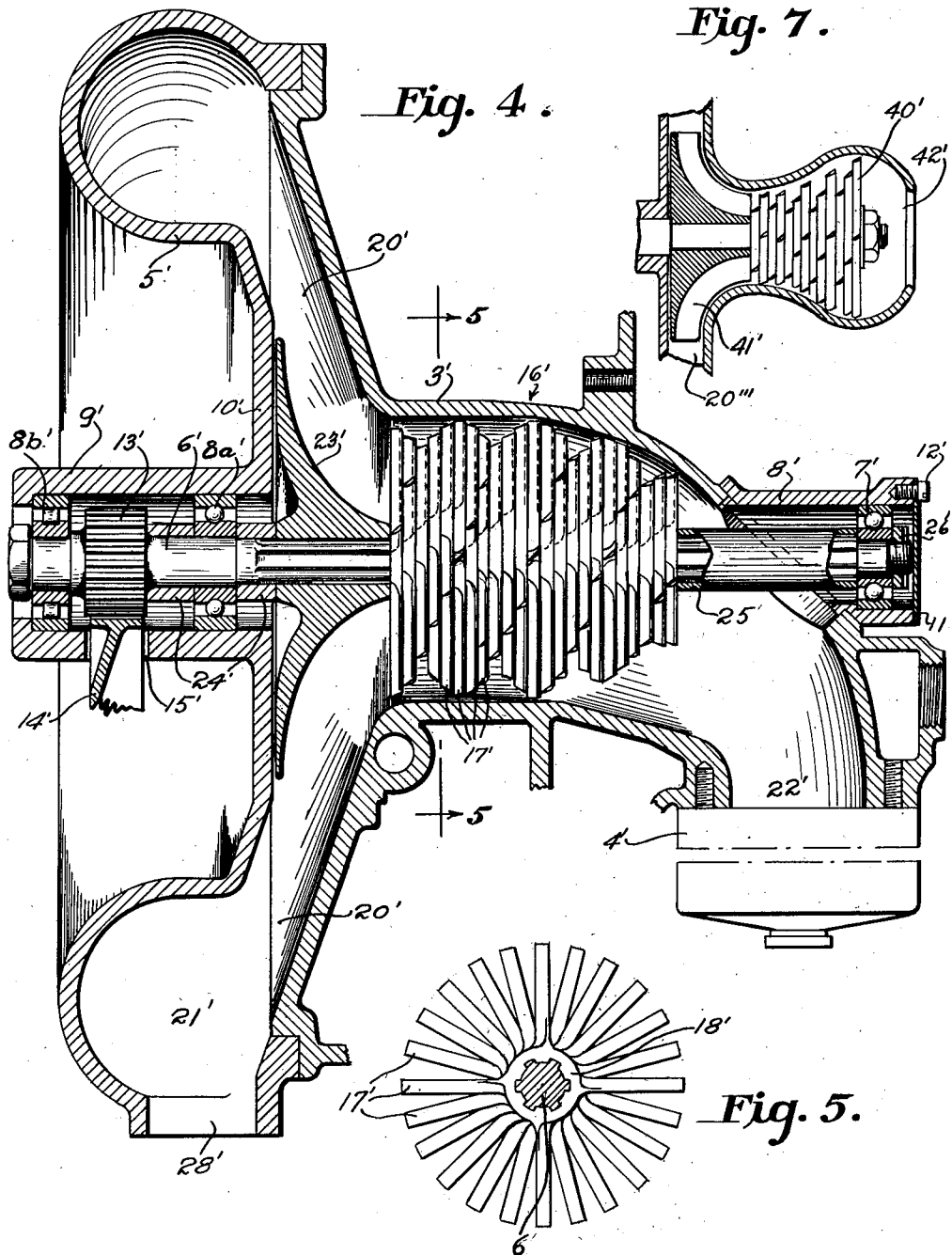
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2 Sheets-Sheet 2



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2,016,831

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Application October 30, 1930, Serial No. 492,298

4 Claims. (Cl. 230-119)

This invention relates to fluid pumps and compressors, and more particularly to pumps capable of use as superchargers for delivering quantities of fluid under pressure, as for example, the delivery of compressed air to an engine.

One of the objects of the present invention is to provide novel means for delivering large quantities of fluid at relatively high pressures.

Another object is to provide a novel unitary device of light weight and small bulk, which, when applied to an internal combustion engine, is adapted to perform the combined functions of a diffuser and a supercharger with a high degree of efficiency.

A further object is to provide a novel type of supercharger applicable to internal combustion engines and which not only delivers the motive fluid to the engine at high pressures and thus increases the amount of fuel supplied to and the power delivered by the engine at any particular throttle opening, but also thoroughly atomizes and mixes the fluid received from the carburetor before delivering it to the intake manifold.

A still further object is to provide in a device of the foregoing character, a novel form of multi-stage supercharger, each of the stages of which serves as a velocity imparting and pressure increasing means.

Another object is to provide a multi-stage supercharger one of the stages of which comprises a plurality of component members disposed in tandem relation along the path of movement of the fluid and another of which comprises a member disposed adjacent the point of exit of the fluid from the preceding stage of the supercharger.

Still another object is to provide in a device of the character described, a combination of impellers at least one of which is of the screw type and at least one other of which is of the centrifugal type.

A still further object is to provide a supercharger constituted by a novel arrangement of parts adapted to combine in a single unit the functions of a velocity imparting propeller, a screw type compressor and a fluid mixing device.

These and other objects will appear more fully in the detailed description of the invention which follows. Although four embodiments of the present invention are illustrated in the accompanying drawings it is to be expressly understood that these drawings are for the purpose of illustration only, and are not to be construed as defining the scope of the invention, reference be-

ing had for this purpose to the appended claims.

In the drawings:

Fig. 1 is a side elevation, partly in section, of one embodiment of the present invention;

Fig. 2 is a view taken on line 2-2 of Fig. 1;

Fig. 3 is a transverse sectional view along line 3-3 of Fig. 2;

Fig. 4 is a side elevation of another embodiment of the invention;

Fig. 5 is a sectional view taken on line 5-5 of Fig. 4;

Fig. 6 shows a further embodiment of the invention, and Fig. 7 shows another embodiment.

Referring now to the drawings, wherein like reference characters indicate like parts throughout the several views, and more particularly to Figs. 1 to 3, the embodiment of the present invention illustrated therein comprises a multi-stage supercharger located between the carburetor and the intake manifold of an internal combustion engine, and having a novel form of impeller which combines in a unitary structure the functions of a multi-bladed propeller and a helical or screw type compressor. As shown, a confining casing 3 of suitable size and form is located between the carburetor, which is diagrammatically illustrated at 4, and the intake manifold 5 of an internal combustion engine, and forms a passageway through which a motive fluid or mixture for the engine is supplied from the carburetor, and in which said fluid is thoroughly mixed and given an increase in pressure and velocity before being supplied to the cylinders of the engine.

Suitably housed and supported within casing 3 is the rotatable assembly of the supercharger including a pair of impellers in sequence relation, the mounting means for which, in the form shown, comprises a shaft 6 rotatably supported in any suitable manner, as, at one end, by a ball bearing 7 mounted and retained with a housing 8, projecting from and removably secured to casing 3, and at the other end, by a pair of bearings 9a and 9b which may be of either the ball or roller type, and which are supported and retained within a cylindrical boss 9 projecting centrally from web 10 of the intake manifold 5. Both bearing housing 8 and boss 9 are open at their outer ends in order to facilitate assembly of the supercharger, and housing 8 is provided with a cover plate 11, secured thereto as by screws 12, for the purposes of preventing leakage of the mixture out of, or of air into, the supercharger casing.

Shaft 6 may be rotated in any suitable manner either by a train of gearing driven by some rotat-

ing part of the engine, the gear ratios being selected so as to give the desired rate of rotation to the shaft for supercharging, or by a separate source of power such as a small electric motor.

In the form shown, a portion of shaft 6 between bearings 8a and 8b is provided with a set of teeth which constitute a pinion 13, said pinion being driven by a gear 14, a portion of the periphery of which extends through an opening 15 in boss 9 to engage pinion 13. Gear 14 preferably constitutes an element of a gear train which is actuated by a rotating member of the engine.

The first impeller or velocity producing element of the supercharger, indicated generally by the reference character 16, consists of one or more multi-bladed propellers 17 which are assembled on shaft 6 in series relation, closely adjacent one another, and each having its blades staggered. As shown, each propeller comprises a hub 18 and a plurality of blades, preferably, though not necessarily, four in number, each hub 18 being internally splined so as to engage a correspondingly externally splined portion of shaft 6 when the propellers are assembled thereon.

Although the plan form of the blades shown in Fig. 2 uses substantially parallel leading and trailing edges, it should be understood that the invention is not limited to such a form but that any desired plan form may be utilized. In general, in accordance with conventional aircraft propeller practice, the blades may have their greatest width at a point approximately six-tenths of the distance from the hub to the tip in order to move large quantities of air or other fluid at relatively low rotative speeds.

Each propeller is designed to meet the conditions of fluid speed, revolutions per minute, and horse power required, much in the same manner as aeroplane propellers are designed with the result that the propellers 17 are in themselves highly efficient in moving large masses of air or other fluid and imparting a high velocity thereto.

Preferably in designing the propellers, the pitch of each blade is so selected as to fit the fluid flow with regard to velocity distribution using an efficient angle of attack for the aerofoil section used, an example thereof being shown in Fig. 3. In general, the pitch of the blades of each successive propeller slightly increases from the inlet to the discharge end of the impeller, if more than one propeller is used. In addition, each blade may have a different pitch at the tip relative to that near the hub in order that the velocity of the air or other fluid, as it passes each succeeding propeller, may be increased more near the tips of the blades than it is at the hubs in accordance with the laws of continuity of flow whereby the same mass of fluid must be caused to pass each section of the blade. The air or other fluid entrapped near the centre of the blades with its reduced velocity is caused to move by the pitch of the helix formed by the staggered blades. It is thus possible with an impeller casing of uniform or increasing diameter from inlet to discharge to give each particle of air or other fluid a uniform acceleration and increase in velocity through the casing.

Suitable means for imparting a final acceleration and velocity increment to the fluid and at the same time, where the invention is applied to an internal combustion engine, diffusion thereof, so that the mixture upon entering the intake manifold of the engine will be possessed of maximum combustion qualities, will now be described.

At the discharge end of the impeller assembly

16 there is provided, keyed to the shaft 6 so as to be rotatable therewith, a second impeller 23 of the centrifugal type having a plurality of blades 27 of suitable shape and structure, and located preferably directly adjacent the propeller 17 or the termination of the series of propellers. In the design of blades 27 the shape and relative disposition is such that the fluid stream on striking the blades will be moved radially outward into the diffusing chamber 20 at a considerably accelerated velocity and at a pressure greater than that attained during passage through the first impeller element 16.

Suitable means are provided for maintaining the members of the rotatable assembly of the supercharger in their proper relative positions upon shaft 6 and within the casing, said means comprising in the present embodiment a pair of spacing sleeves 24, which, together with the inner race of ball bearing 8a, maintain impeller 23 in its properly spaced relation with respect to web 10, and another spacing sleeve 25, which together with the inner race of ball bearing 7 and the lock nut 26 threaded on the outer end of shaft 6, maintain propellers 17 in contact with one another and with the impeller 23.

On operation, the motive fluid to be supplied to the engine, such as a mixture of air and a hydrocarbon fluid, enters casing 3 through inlet 22 from carburetor 4, being drawn in at a high rate of speed due to the suction created in inlet 22 by the rapidly rotating propellers 17 driven by shaft 6 through gear 14 and pinion 13. Since each propeller 17 is aerodynamically designed to be an efficient means of moving a fluid, the incoming mixture will be given a large axial velocity, depending upon the pitch of the blades and the speed of rotation of shaft 6. By assembling propellers in juxtaposition and by staggering the blades an approximate helix is formed. Since a helix rotating in a surrounding shell operates as a fluid transmitting device, it is evident that by making the pitch of the helix less than that of the propeller blades, and bearing a definite relation thereto for the best efficiency under any given set of conditions and by mounting the propellers closely adjacent one another, a portion of the velocity imparted to the mixture by the individual propellers is converted into pressure due to the difference in pitch between the blades of said propellers and that of the helix, with the consequence that the mixture is delivered against impeller 23 with not only increased velocity but also at considerable increase in pressure. Further increases in velocity and pressure occur as the gases are drawn past the impeller 23, by virtue of the construction of the blades 27 and chambers 20 and 21 as above explained.

The gases, in passing through impellers 16 and 23 have also been thoroughly mixed so that a uniform mixture of air and fuel is delivered to the intake manifold and any particles of liquid fuel which might have come through the carburetor in the air stream have been thoroughly atomized by the action of the blades.

Upon leaving impeller 23, the gases are deflected radially outward into passages 20 and 21 where the well known diffusion action takes place and the pressure of the mixture is increased. The high pressure mixture which is thus delivered to the interior 21 of intake manifold 5, is then distributed to the cylinders of the engine through suitable ducts or intake passageways indicated at 28.

The embodiment of the invention shown in Figs. 4 and 5 comprises a multi-stage supercharger including an impeller and a deflector which, in the form shown, are housed and supported in a manner similar to that shown in Fig. 1. In this embodiment, however, in place of the single group of propellers shown in Fig. 1 there is preferably provided a plurality of groups in series, closely adjacent one another, each group being similar to that shown in Fig. 1, but there being preferably a variance in the sizes of the blades in each group, corresponding generally to the variation in cross-section of the casing 3. As shown there are three sizes of the propellers, the smallest being located adjacent the intake 22 from the carburetor and the largest adjacent diffusing passageway 20.

The variations in sizes just referred to correspond (as has been stated) to the variations in cross-section of casing 3. These variations are in turn dictated to a large extent by the size and location of the passageway 22 and the member 4. In cases where conditions will permit, it may be found more advisable to employ an entering passageway of a shape somewhat as indicated at 42 in Fig. 6, and to vary the size of the propellers accordingly, as indicated at 40 in Fig. 6, to be described hereinafter.

By the use of the larger number of propellers shown in Fig. 4, a substantial increase in velocity and pressure is attained, which increase makes it possible, in many installations, to eliminate the centrifugal impellers shown at 23, in Fig. 1, the deflector 23' being substituted therefor in the embodiment of Fig. 4. When this is possible, an important saving in manufacturing costs is effected since the cost of making an impeller such as that shown at 23 is much greater than the cost of making the blades 17' which can be cut, stamped, or formed in other suitable manner of sheet or other material.

This deflector 23' comprises a frusto-conoidal shaped member, keyed to the shaft 6 so as to be rotatable therewith, and serving to deflect the fluid or mixture leaving the impeller blades with high axial velocity radially outward into diffusing passageway 20, from whence it passes into intake manifold 5.

The advantage of the arrangement shown in Fig. 6 is that a relatively large inlet is provided, the cross-sectional area decreasing as the fluid is propelled inwardly toward the member 41 (corresponding to the member 23 in Fig. 1, or the member 23' in Fig. 4). There is thus obtained a Venturi effect which insures a relatively high increase in velocity. At the same time it is preferable to vary the pitch of the successive blades in such manner that the inflow will be directed along the best possible path for effecting the maintenance of proper velocity during the passage into the narrower portion of casing 42. The construction indicated in Fig. 6 may of course be employed with the embodiment of Fig. 1 or that of Fig. 4.

At Fig. 7 is illustrated a form of entrance differing from that of Fig. 6 in that it provides a chamber 42' wherein the incoming fluid may build up a reserve volume and pressure ahead of the first propeller 40', thereby insuring against too great a decrease in flow or pressure as a result of a sudden unusually great draft exerted through the supercharger. Thus the chamber 42' is in effect a pressure reservoir which compensates for fluctuations in the flow.

It has been found desirable to locate the pro-

pellers 40' as shown; that is, with the largest blade positioned first, and at a point where maximum benefit, as regards velocity and pressure, can be obtained.

In Figs. 4, 5, 6, and 7 it may be seen that the adjacent propellers are spaced 15 degrees apart and that as each individual propeller has four blades, any two propellers which are separated by five intervening ones have their blades lying in the same radial plane. This arrangement of the propellers in sets of six provides a helical path between the ends of the propeller blades and the tubular entrance casing, as is best seen in Fig. 4, and the sets of propellers have an Archimedean screw action in forcing fluid toward the impeller.

There is thus disclosed by the present invention a novel form of fluid pump or compressor which is adapted to deliver large quantities of fluid at relatively high pressures. The invention is especially well adapted for use as a supercharger for internal combustion engines, since it provides in a unitary structure, light of weight, compact and easily assembled, a device which performs the combined functions of a diffuser and a supercharger with a high degree of efficiency, and which includes a novel combination of impellers as well as a novel and inexpensive form of impeller assembly which mixes, imparts a velocity to, and increases the pressure of the fluid mixture received from the carburetor. It is also adapted for use in ventilating and hydraulic systems.

It will be obvious that the invention is not limited to the form shown in the drawings but is capable of a variety of mechanical embodiments. For example any suitable type of drive for the shaft of a supercharger may be substituted for the specific arrangement shown, and if desired, as pointed out above, the plan form of the propeller blades may be different from that disclosed in the drawings. Moreover, it is to be understood that the term propeller as used herein is to be construed sufficiently broadly to cover any means for effecting or facilitating the movement of the fluids, and the propeller may, if desired, be so formed as to have one or any suitable number of blades and may in certain instances be limited to the use of a single propeller. It will also be understood that the fluid pump or compressor, when used with an engine, may be located in the intake system at other than the point illustrated, as for example between the carburetor and the air inlet.

Various other changes which will now appear to those skilled in the art, may be made in the form, details of construction and arrangement of the parts without departing from the spirit of the invention, and reference is therefore to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A fluid pump comprising a chamber having a tubular fluid entrance casing, a shaft within said chamber and extending within said tubular casing, an impeller on said shaft arranged to direct fluid radially of said shaft, and a plurality of more than two sets of staggered contiguous propellers on said shaft arranged within the entrance casing, said propellers having only slightly less length than the diameter of the tubular casing and arranged to have each propeller of one set fall within the same radial plane as a corresponding propeller of another set, whereby a helical fluid path is formed between the ends of the propellers and the interior of the casing.

2. A fluid pump comprising a chamber having a tubular fluid entrance casing, an impeller hav-

ing a shaft rotatably supported in the chamber, a plurality of staggered multi-blade contiguous propellers in said tubular casing, each propeller being angularly displaced in the same direction
5 from its adjacent propeller and the number of the propellers being great enough to cause at least three propeller blades to lie in the same radial plane, the blade at the discharge end of the casing having a greater pitch than the blade
10 at the inlet of the casing, and means for driving said impeller and said propellers.

3. A fluid pump comprising a chamber having a tubular fluid entrance casing, an impeller in the chamber, a plurality of staggered multi-blade
15 contiguous propellers in said tubular casing, each propeller being angularly displaced in the same direction from its adjacent propeller, the pitch of the respective propellers being different and increasing toward the discharge end of the casing
20 and the number of the propellers being great

enough to cause at least three propeller blades to lie in the same radial plane, and a shaft common to the impeller and each of the propellers for rotating the same.

4. A fluid pump comprising a chamber having a
5 tubular fluid entrance casing, an impeller having a shaft rotatably supported in the chamber, a plurality of more than two sets of contiguous propellers in the entrance casing, said propellers each having a plurality of equally spaced blades,
10 said propellers being angularly displaced in sequence and having the pitch of each propeller increased as they progress toward the discharge end of the casing, the angular displacement being constant and having a value such that the product
15 of the angle by the number of propellers in each set is equal to the angle between individual blades on each propeller, and means for driving the impeller and the propellers.

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