PATENT SPECIFICATION

591,048

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COMPLETE SPECIFICATION

A Power Unit for Aircraft and the like

We, THE FAIREY AVIATION COMPANY LIMITED, a British Company, of North Hyde Road, Hayes, in the County of Middlesex, and ARCHIBALD GRAHAM FORSYTH, a British Subject, of "Venlaw", Burdon Lane, Cheam, in the County of Surrey, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a power unit for aircraft and the like, and comprises an internal combustion engine, a variable pitch propeller, a supercharger for said engine, a compressor, a series of combustion chambers surrounding said compressor and connected to be supplied by said compressor, each of said combustion chambers terminating rearwardly in a propulsion jet, means for clutching said propeller to be driven by said engine, and drive means connecting said engine with the drive shafts of said supercharger and said compressor.

With such a unit the aircraft may be driven by the propellers alone, or by the propellers and also by jet propulsion, or by jet propulsion alone, in which latter instance the propellers may be declutched and fully feathered.

In the accompanying drawings:—

Figure 1 is a side elevation of one form of the invention;

Figure 2 is front elevation thereof on a larger scale;

Figure 3 is a central vertical longitudinal section taken through the front end thereof also on a larger scale;

Figure 4 is an enlarged vertical longitudinal section taken through the central part thereof and showing the engine supercharger and the clutching arrangement;

Figures 5 and 6 are enlarged sections taken on the lines 5—5 and 6—6, Figure 1;

Figure 7 is an enlarged section taken on the line 7—7, Figure 4, through the clutching device;

Figure 8 is an enlarged longitudinal section through the compressor and showing one of the surrounding combustion chambers;

Figure 9 is a view similar to Figure 8, but showing a modified form of combustion chamber;

Figure 10 is an enlarged vertical longitudinal section through a modified form of compressor; and

Figure 11 is a diagrammatic representation of the compressor blade action.

Figure 1 shows the general arrangement of the various mechanisms which comprise the unit. In this Figure, A indicates an internal combustion engine of the **H** type. Mounted forwardly of the engine and secured thereto is a housing B containing gearing and clutch means by which a propeller C may be clutched or declutched from the engine.

The propeller C is of the variable pitch type, and the arrangement includes pitch changing mechanism D which may be actuated by an electric motor E or the like.

The shaft of the engine A, at the rear, drives a supercharger F and the engine shaft may also be clutched or declutched by a clutching device G to a compressor H (see Figure 4 also). The compressor H is adapted to supply air under pressure to a plurality of combustion chambers I which surround the compressor H, and which discharge their exhaust gases through propulsion jets J against the atmosphere to effect a propulsive force.

The compressor H may be of the type in which one set of blades is rotatable and the other set stationary, or selectively, both sets may be rotatable and in opposite directions. To effect this selective action of the compressor blades, a clutch device K is provided.

As shown in Figures 1, 2 and 3, the housing B, secured to the front facing of the engine A, encloses a hollow shaft 10 mounted in bearings 11 and 12 for rotation about its longitudinal axis. The engine end of the shaft 10 is flanged as at 13 and the flange is formed with a ring gear wheel 14 having teeth on its inner periphery. This ring gear wheel 14 is engaged by planetary pinions 15 which also engage teeth on the end of the engine drive shaft 16 (see Figure 3), rotation of which will through the pinions 15 and ring gear wheel 14, drive the hollow shaft 10.

A propeller hub 17 is mounted by bearings 18 and 19 for rotation about the hollow shaft 10. The forward face of the propeller hub 17 is provided with a ring gear wheel 20 teeth on the front face of which may be engaged by teeth 21 on the rear face of a cap member 22 splined on the forward end of the hollow shaft 10. The teeth on the cap 22 and on the ring gear wheel 20 may be caused to engage or disengage by means of a hydraulic clutch arrangement which comprises a cylinder 23 disposed within the hollow shaft 10 and enclosing a piston 24 having a shaft 25 which extends forwardly within the hollow shaft 10 and is secured at its forward end to the cap 22. The piston 24 is movable within the cylinder 23 by fluid under pressure supplied through conduits 26 and 27 leading to a source of supply (not shown).

It will be apparent that movement of the piston 24 in one direction will declutch the cap 22 from the hub ring gear wheel 20, and that movement of the piston in the other direction will cause these two parts to be clutched. When clutched the propeller hub 17 will thus rotate as one with the hollow shaft 10 driven by the engine.

The propeller C is of the variable pitch type. The pitch changing mechanism *per se* forms no part of this invention and is here merely indicated by the reference letter D as driven by a small electric motor E. The pitch changing mechanism should be capable however at least of fine, coarse and feathering positions and preferably also of being adjusted for braking or reverse position.

The engine A, as previously indicated, is provided with a supercharger F. Directing attention now to Figures 1 and 4, it will be noted that the supercharger F comprises a jacketed casing 28 and central rotor 29 rotatable from the engine shaft 16. The casing 28 is provided on its inner surface with a plurality of spaced radial compressor blades 30 rigidly secured thereto and the rotor 29 is provided with a series of radial blades 31 secured thereto. The blades 30 and 31 are disposed in the space between the casing 28 and the rotor 29 in alternating relationship.

The supercharger is fed with air which enters by an inlet 32 controlled by a butterfly valve 33 or the like, and then passed to the space between the casing 28 and rotor 29 where it is compressed by the blades 30 and 31 and is then delivered through conduits 34 to the intake manifold of the engine A.

The shaft of the rotor 29 is adapted, through a clutching device G to drive a compressor H. As shown in Figure 4, this shaft at its rear end, is formed with a bevel gear wheel 35 forming one side of the clutch device G, the other side of the clutch device being connected to drive the shaft 36 of the compressor H. The clutch device G is of known type but for purposes of identification a section therethrough is shown in Figure 7. It comprises two sets of annular discs 37 and 38 which may be caused to engage each other frictionally by any suitable means (not shown). Also included in the clutch device are a number of bevel gear wheels 39 which mesh with the bevel gear wheel 35 and also with a bevel gear wheel 40 on the shaft 36. The device is such that, when the discs engage frictionally, the bevel gear wheels 39 are restrained against rotation about the axis of the shaft 36 and consequently the rotor 29 will drive the shaft 36. When the discs 37 and 38 are not engaging the bevel gear wheels 39 are free to rotate about the axis of the shaft 36 and rotation of the rotor 29 will not drive the shaft 36 of the compressor.

The compressor H comprises a cylindrical tubular member 41 (Figures 5, 8 and 9) and a central rotor shaft 42 coaxially disposed with respect to each other. The member 41 is spaced outwardly from the rotor shaft 42 and the space therebetween is a compression space. Compressor blades 43 secured to the inner wall of the member 41 project radially inwards and are evenly spaced along the member, while the rotor shaft 42 has secured to rotate therewith, a series of spaced blades 44 which project radially outwards and occupy the spaces between the blades 43, as shown in Figure 8.

Air may enter the compressor space from the rear through an inlet pipe 45 (Figure 1) having an opening 46 facing forwardly in the direction of flight. The inlet pipe 45 is valve controlled by a butterfly valve 47 or the like (see Figure 6).

Air compressed by the compressor blades 43 and 44 in its passage through the compressor is directed by the curved passages 48 (Figure 8) to the combustion chambers I.

The combustion chambers I are of special design, as shown in Figure 8. The principal portion of each has a cigar-shaped interior and the entrance to each is controlled by an inlet valve 49.

A pair of jets 50 and 51 are provided to inject a fuel which mixes in the combustion chamber. A sparking plug 52 is employed for causing the explosion, especially when the device is first operated and before it becomes hot.

Each combustion chamber I terminates rearwardly in a propulsion jet J and the passage connecting the two is formed as a Venturi 53.

It will be noted from Figure 8 that the combustion chambers I and their joined propulsion jets J are provided with cooling jackets 54 for a cooling fluid.

The manner of operating the inlet valves 49 for the combustion chambers I forms no part of this invention. Any suitable system may be employed such as that shown in the Specification of Letters Patent No. 548,898.

Figures 5 and 6 are vertical sections through the compressor and surrounding combustion chambers and serve to show more clearly the disposition of these elements.

The operation of the arrangement should now be fairly clear. Operation of the internal combustion engine A may (through the clutching arrangement in housing B) drive the propeller C. The engine A is supercharged by the supercharger F and through the clutching device G may drive the compressor H, thus furnishing the combustion chambers I with compressed air for mixing with fuel. The products of combustion are ejected through the Venturi connection 53 of the propulsion jets J and thence to the atmosphere where they exert their propulsive effect.

With the two clutching devices, the one for the propeller C and the other for the compressor H, it will be noted that several operative combinations are possible. The engine A may drive both the propeller and the compressor so that the craft will be propelled both by the propeller C and by jet propulsion, Or, the engine may drive the propeller alone, the compressor H being declutched. Or the propeller may be declutched (and feathered by the variable pitch mechanism D) and the craft propelled by jet propulsion alone with the engine driving the compressor only.

A further modification in operation is also possible. It has been mentioned that the compressor H is provided at its rear end with another clutching device K (see Figure 1). As will be described more clearly in connection with another embodiment, this clutch K makes it possible to drive the compressor rotor blades 44 alone, the blades 43 secured to the member 41 remaining stationary with the member 41. Alternatively, the member 41 may also be driven, and in an opposite direction, thus effecting two steps of compression.

A modified form of combustion chamber I is illustrated in Figure 9. This differs from that shown in Figure 8 only in that the Venturi passage 53 between the chamber I and the propulsion jet J is controlled by an outlet valve 54^a. Here again the means for actuating this valve 54 forms no part of the invention, but reference may be had to the Specification of Letters Patent No. 548,898.

Finally, in Figure 10 there is illustrated an alternative form of compressor and combustion chamber arrangement. The compressor portion illustrated is the same as that employed in the embodiment shown in Figures 1 to 8, inclusive, and, since the illustration in Figure 10 is more complete, a brief description thereof will be given.

A tubular outer member 55 is provided with inwardly directed radial compressor blades 56 rigidly secured to the tubular member.

A rotor shaft 57, driven from the engine, has outwardly projecting radial blades 58 secured to rotate therewith. Each set of blades 56 and 58 is evenly spaced and the blades 56 and 58 are disposed in alternate relationship to each other in the compression space between the tubular member 55 and the rotor shaft 57.

Both the rotor shaft 57 and the tubular member 55 are mounted for rotation with respect to each other about their common longitudinal axis. For this purpose the bearings 59, 60, 61, 62, 63 and 64 are provided.

The rotor shaft 57 extends rearwardly of the compressor to the rear side of the clutch device K where it is splined to a clutch bevel gear wheel 65. The tubular member 55 is joined by spiders 66 to a sleeve 67 which extends rearwardly to the forward end of the clutch device K, the rear end of the sleeve 67 being formed as a clutch bevel gear wheel 68.

The clutch device K is of known type similar to the clutch device G already described. In the present connection its operation is such that, when it is declutched, the engine will drive only the rotor shaft 57, the tubular member 55 and its blades 56 then remaining stationary. This provides a first compression step. It is diagrammatically illustrated in the upper portion of Figure 11.

When, however, the clutch device K is clutched, the engine will drive the rotor shaft 57 and, through the clutch device K, the tubular member 55 and its blades 56 will be rotated in the opposite direction. This provides a second compression step. This is diagrammatically illustrated in the lower portion of Figure 11.

As in the embodiment shown by Figures 1 to 8, inclusive, air enters the compressor H from the rear through an inlet pipe 69 controlled by a valve 70. The compressed air leaves the compressor at the forward end and is directed by curved passageways 71 to the combustion chambers I.

The combustion chambers I shown in Figure 10 are generally similar to those already described, but their rear ends are not constricted. They are provided with fuel injecting nozzles 72 and may have cooling jackets 73, and are connected with any suitable type or rearwardly projecting propulsion jets (not shown). The jets may be similar to those illustrated in some of the other Figures.

The engine A may be of the **H** type (as shown) with a 10—1 compression ratio and with fuel injection supercharged to, say, 40,000 feet. It will be noted that the engine is directly coupled with the uniflow supercharger F and also (through clutch device G) with the uniflow compressor. It will be noted that the throttles are fitted to the intakes of the supercharger and compressor. It is intended that the throttle for the supercharger will be controlled by the boost control, and that the compressor throttle can be fully closed thereby allowing the rotor of the compressor to be driven by the engine as fractional power. Consequently, if desired, the clutch G between the engine and the compressor could be eliminated.

The operation of different mechanisms of the unit during different flight conditions should perhaps be mentioned by way of example.

During take-off the propeller is in operation and the engine at take-off boost, with or without having the jets in operation.

During climb both the propeller and jets may be in operation.

During level flight, at low altitude, the propeller only need be in operation. At higher altitude, either the jets alone may furnish the propulsive power, or both the jets and the propeller may be in operation.

Normal cruising would be carried out on propeller only, thus making full use of the low compression engine.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A power unit for aircraft and the like comprising, an internal combustion engine, a variable pitch propeller, a supercharger for said engine, a compressor, a series of combustion chambers surrounding said compressor and connected to be supplied by said compressor, each of said combustion chambers terminating rearwardly in a propulsion jet, means for clutching said propeller to be driven by said engine, and drive means connecting said engine with the drive shafts of said supercharger and said compressor.

2. A power unit for aircraft and the like as claimed in Claim 1, wherein the propeller, engine, supercharger and compressor are in alignment and are connected in the order named.

3. A power unit for aircraft and the like as claimed in Claim 2, wherein the internal combustion engine is a low compression engine.

4. A power unit for aircraft and the like as claimed in Claim 3, wherein the supercharger is driven directly by said internal combustion engine.

5. A propulsion unit for aircraft and the like comprising, an internal combustion engine, a gear and clutch housing secured to the front facing of said engine, a variable pitch propeller carried by said housing, clutch means in said housing for selectively clutching the propeller to be driven by said engine, a housing secured to the rear facing of said engine, a multistage engine supercharger mounted within said housing and connected to be driven by said engine, a housing secured to the rear end of said supercharger housing, a multistage compressor mounted within said last named housing, clutch means between said supercharger and compressor for selectively clutching the compressor shaft to the shaft of the supercharger, a plurality of elongated combustion chambers surrounding said compressor and terminating rearwardly in propulsion jets, and passage means connecting said compressor and said combustion chambers to enable the latter to be supplied with gases under pressure from said compressor.

6. A propulsion unit for aircraft and the like as claimed in Claim 5, wherein the compressor has two sets of blades and means for rotating said sets of blades in opposite directions, and wherein a housing is secured to the rear end of said compressor, and a clutch is provided in said rear housing for said blade rotating means, whereby one of said sets of blades may be caused selectively to remain stationary.

7. A propulsion unit for aircraft and the like as claimed in Claim 6, wherein the propeller, clutch housing, engine, supercharger, compressor and rear clutch

housing are all mounted in tandem in the order named.

Dated this 1st day of May, 1945.
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Fig. 1.

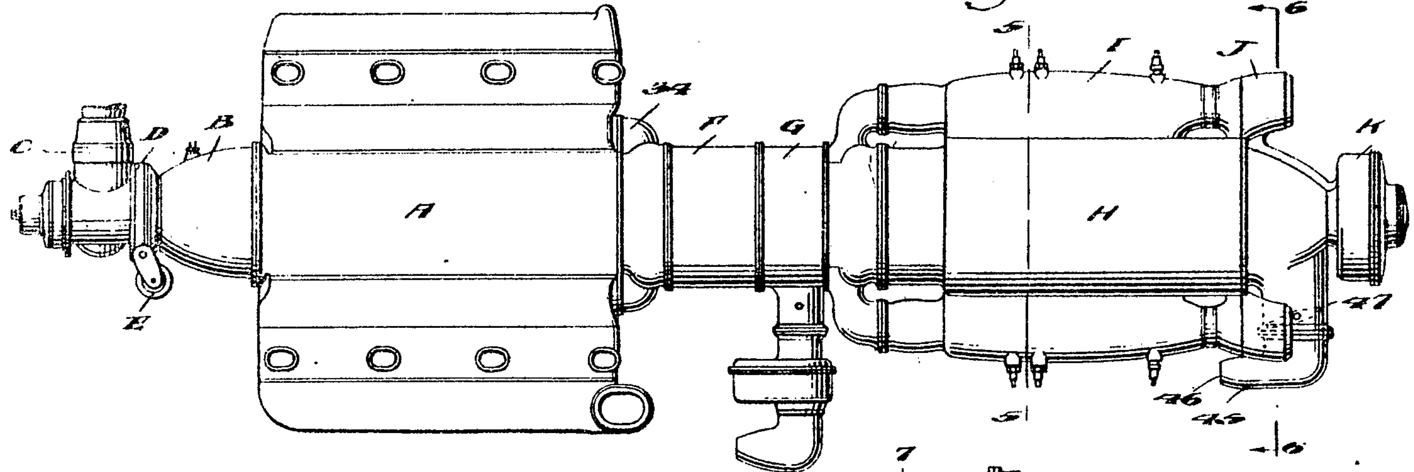
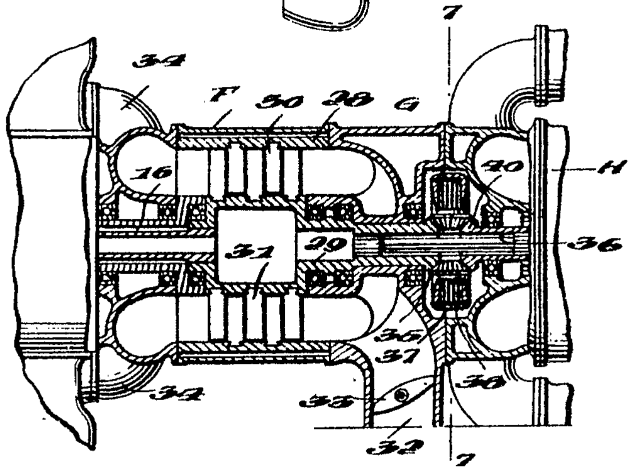
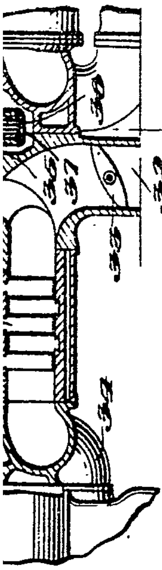


Fig. 4.





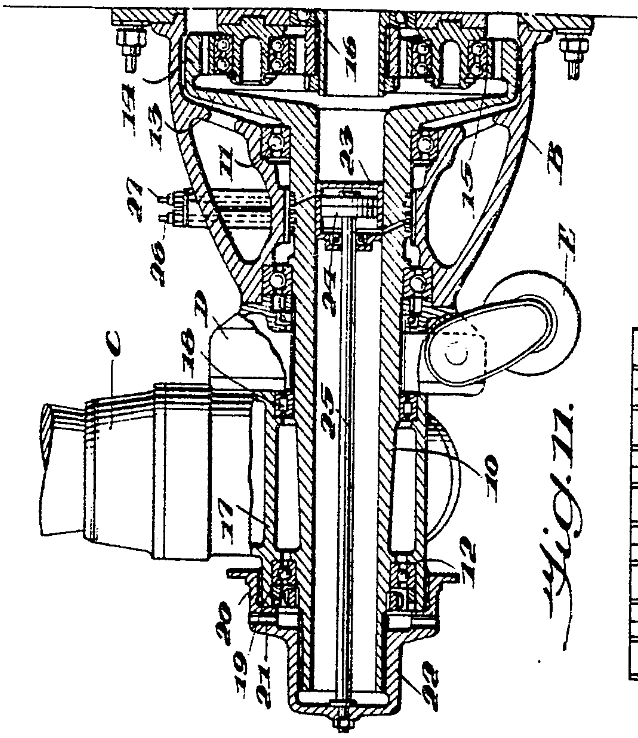


Fig. 3.

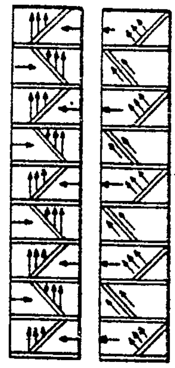


Fig. 11.

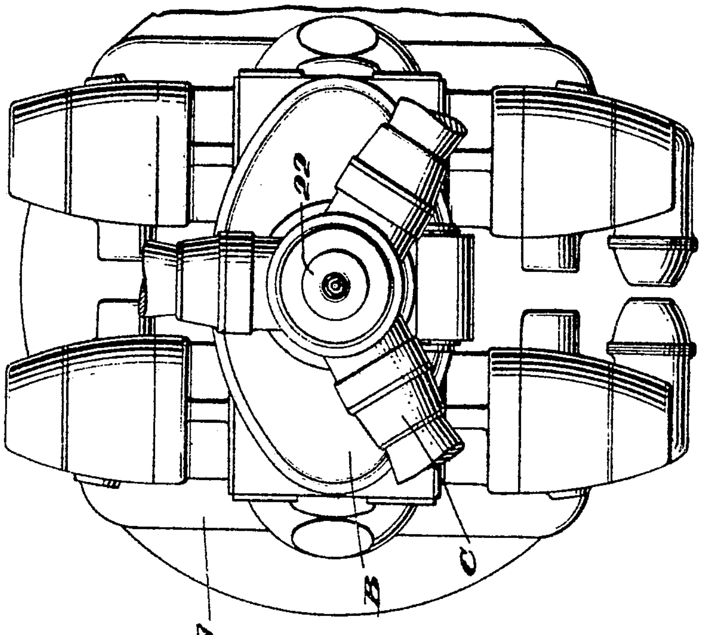


Fig. 2.

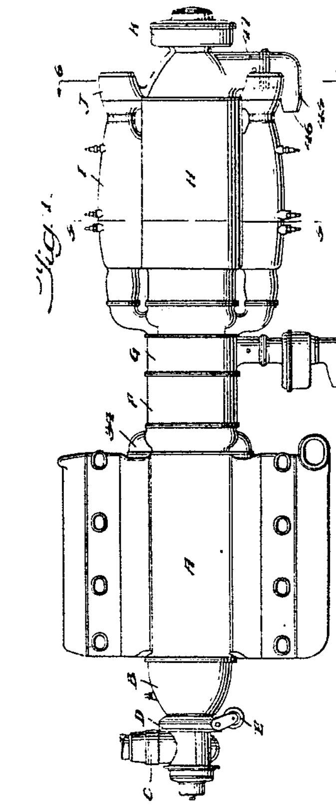


Fig. 1.

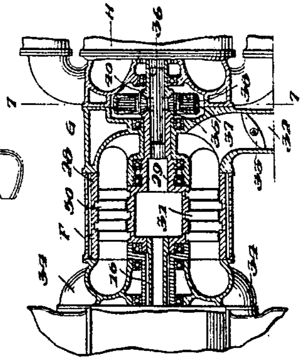


Fig. 4.

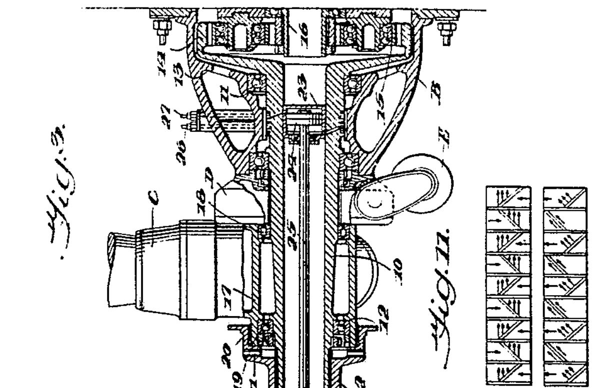


Fig. 3.

Fig. 11.

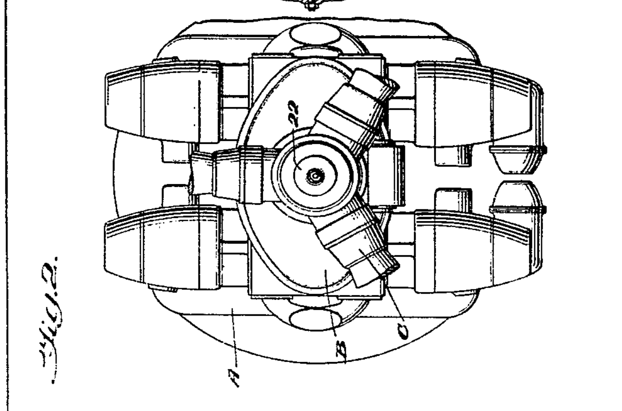


Fig. 2.

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Fig. 5.

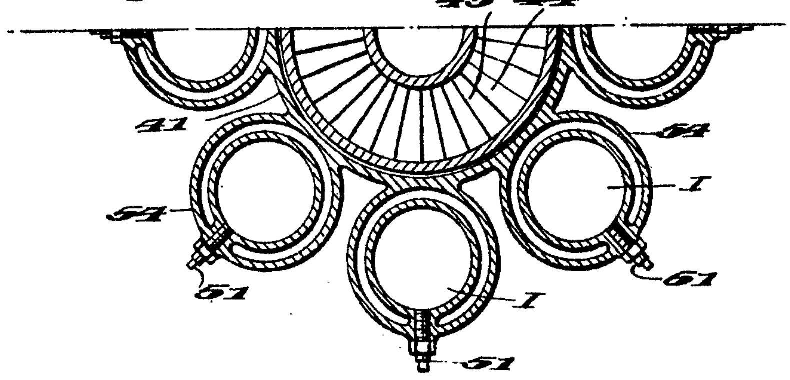
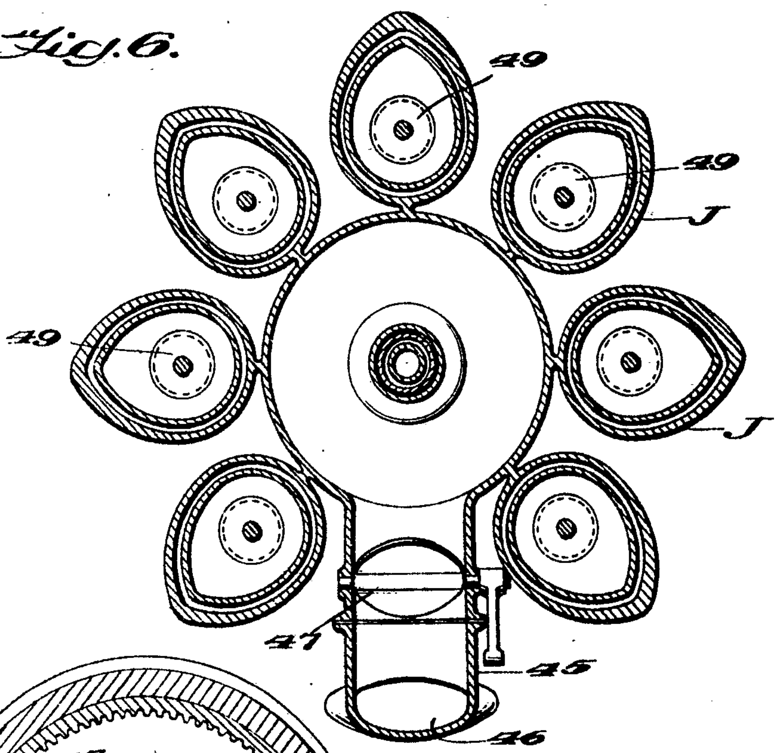


Fig. 6.



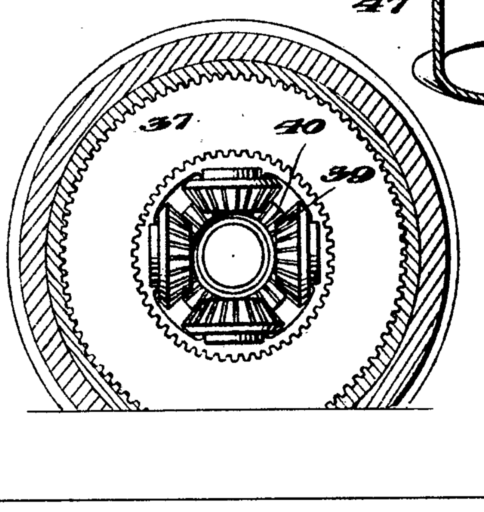


Fig. 7.

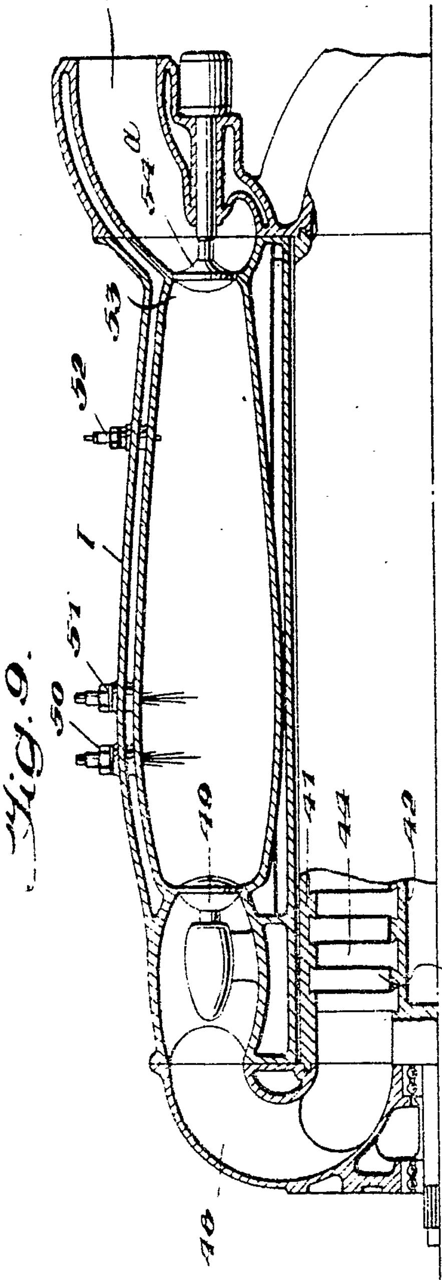


Fig. 9.

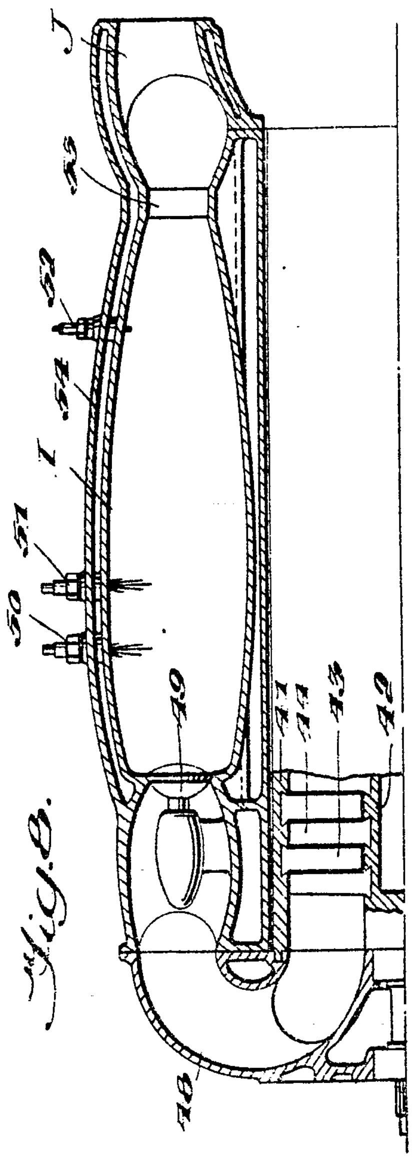


Fig. 8.

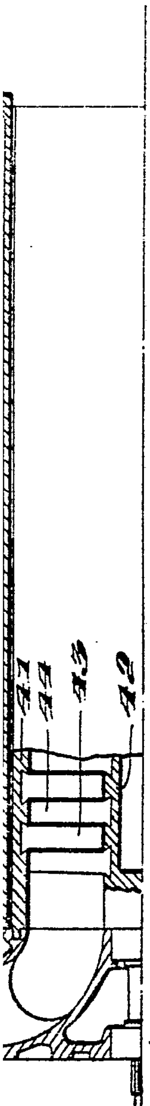
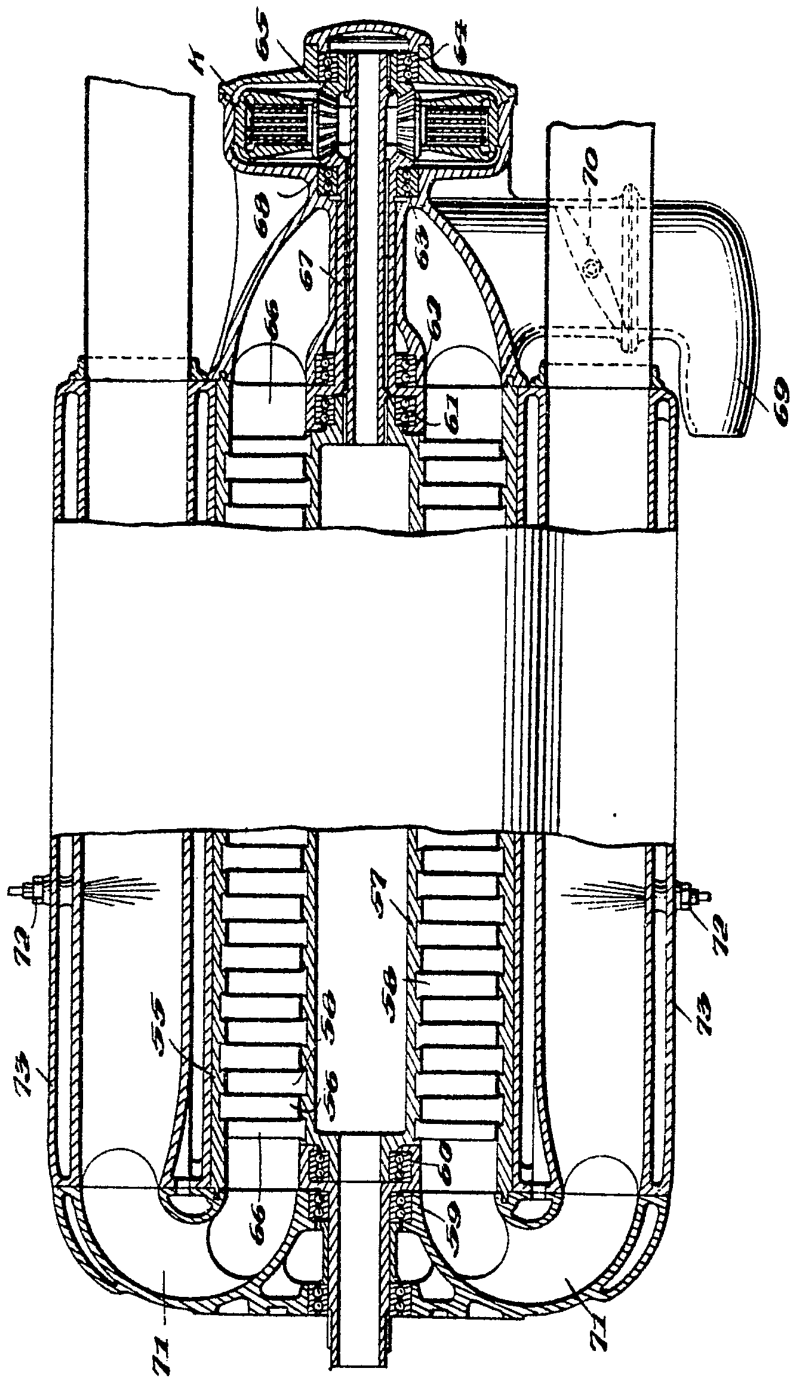


Fig. 10.



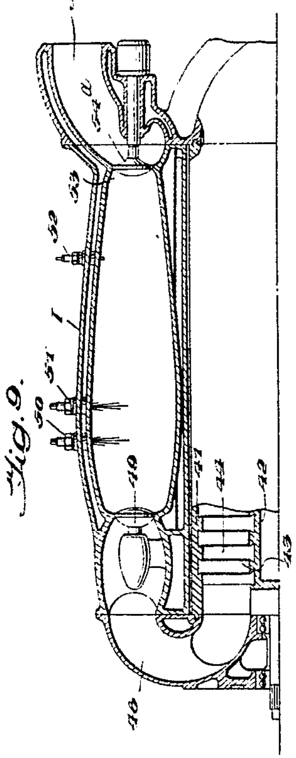


Fig. 9.

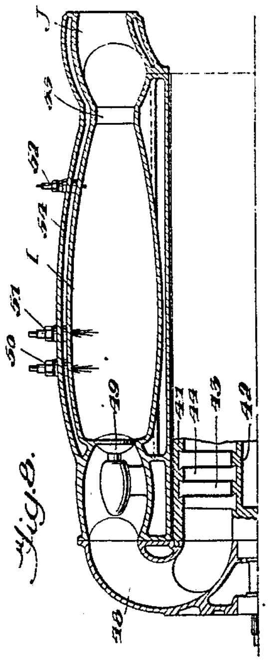


Fig. 8.

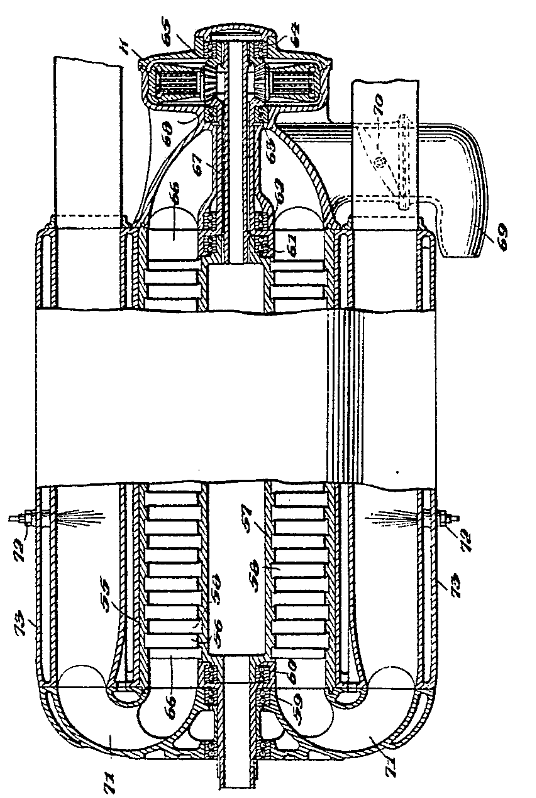


Fig. 10.

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