PATENT SPECIFICATION

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387,617

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Complete Accepted: Feb. 9, 1933.

COMPLETE SPECIFICATION.

Improvements in Apparatus for Generating Combustion Gases Under Pressure.

I, JOSEF CERNOCH, of Prague-Brevnov 409, Prague, Czecho-Slovakia, Czecho-Slovakian citizen, 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 generator of combustion gases under pressure comprising combustion chambers arranged annularly around a valve which controls the inlet to and the exhaust from the chambers.

According to the invention, the valve is stationary and some or all of its passages which conduct the pressure gases out of the combustion chambers into one or more exhaust nozzles common to all the combustion chambers, open into the combustion chambers at such an angle to the radial direction that the chamber structure automatically rotates under the reaction of the pressure gases issuing from the chambers. The passages of the valve and the inlet and outlet openings of the combustion chambers are so relatively arranged and proportioned that the issuing combustion pressure gases have an approximately constant kinetic energy, which is moreover promoted by there being in addition to a primary nozzle, one or more secondary nozzles, which are successively presented to the gas issuing with diminishing pressure from the primary nozzle.

The apparatus is particularly suitable as a reaction engine for vehicles and aircraft instead of rockets which have recently been suggested as driving means for vehicles and the like. It is superior to such means by its reliability and substantially uniform discharge. It is also superior to the normal reciprocating internal combustion engines on account of its simplicity and low weight.

An apparatus embodying the invention, with a fixed valve and a rotary casing, is illustrated diagrammatically by way of example on the accompanying drawings, in which:—

Fig. 1 is an axial section, and

Fig. 2 is a plan view of the casing, partly in section on the lines II—II and II^1—II^1.

Fig. 3 is an axial section, and,

Figs. 4 and 5 are plan views of the valve, viewed from below and from above, respectively,

Fig. 6 is an axial section of the valve on the line VI—VI in Fig. 7, at right angles to the section in Fig. 3.

Figs. 7 and 8 are sections on the corresponding lines VII—VII and VIII—VIII in Fig. 6, the section on the line VII—VII being viewed from below.

Fig. 9 is an axial section of the complete apparatus on the line IX—IX in Fig. 10, with the central portion of the valve broken away.

Fig. 10 is a plan view of Fig. 9, and

Fig. 11 is a diagram showing the relative positions of one of the chambers in the casing, and the ports and passages in the valve and the casing, during one cycle of the apparatus.

Referring now to the drawings, and first to Figs. 9 and 10: 21 is a tapered valve which is shown partly broken away in Fig. 9. A casing 1 is mounted to rotate on the valve with a tapered seat 4. The tapered seat 4 has a port 13 in its upper and a port 14 in its lower portion for each chamber of the casing 1 which will be described below. 31 is a tubular extension at the lower end of the valve 21 on which the casing 1 is supported by a ball or other bearing 18. 2 is a chest which is secured on the upper end of the valve 21, a flange 37 being provided on the valve and a flange 3 on the chest, with bolts 38 for connecting the two flanges. The chest is equipped with a discharge nozzle 35 for the products of combustion.

Referring now to Figs. 1 and 2, which show the casing 1 separately, 10 are chambers in the casing which are connected to slots 13 and 14 in the tapered valve seat 4 of the casing 1. Eight chambers 10 are provided in the example illustrated, and each chamber is sub-divided into a combustion space 10^1 and a compression space 10^{11} by a hollow partition 11. 12 is a comparatively narrow clearance by which the combustion and compression spaces of each chamber are connected across the partition 11. In each chamber, the combustion space 10^1 is connected to a port 13 in the valve seat 4, and the compression space 10^{11} is connected to a corresponding port 14. 15 is an inwardly-projecting flange at the bottom of the casing, with an opening 16, and 17 is a seat for the ball bearing 18 below the flange 15. 20 are radiator fins on the casing 1.

Referring now to Figs. 3 to 8, the valve 21 in its upper portion has a flat axially arranged passage 22, as best seen in Figs. 3, 5 and 6. The passage 22 which is the primary passage, opens into the chest 2 at its upper, and into a transverse ignition passage 23 at its lower end. The ends of the ignition passage 23 are at the level of the ports 13 in the valve seat 4, the positions of which are indicated in dotted lines in Fig. 3. 24 are two oppositely directed reaction passages, also in the upper portion of the valve. The reaction passages, as best seen in Fig. 7, are inclined to the corresponding radius of the valve and their walls are equivalent to the blades of a turbine. They open into the outer face of the valve 21 at the level of the ports 13 in the valve seat 4, Fig. 3, and their inner ends are connected to subsidiary passages 25 which extend parallel to the axis of the valve and are arranged at opposite sides of, and in line with, the axial passage 22. 34 are two bent suction passages in the upper portion of the valve 21 which connect the chest 2 to diametrally opposite openings at the level of the ports 13, Fig. 6. 47 are starting passages, also bent, each of which is arranged at the side of one of the reaction passages 24, with its upper end connected to the chest 2. The starting passages 47 also open at diametrally opposite points at the level of the ports 13, and their lower portions extend parallel to the corresponding passage 24, as best seen in Fig. 7, so that the reaction of the starting fluid in the passages 47 causes rotation of the casing 1, similarly to the action of the flow in the reaction passages 24.

In the lower portion of the valve, an ejection passage 26 is provided which exends at right angles to the ignition passage 23, with its ends positioned at diametrally opposite points in line with the ports 14, Fig. 6. 28 are two curved transfer passages the openings of which are arranged at the level of the openings of the ejection passage 26, as best seen in Fig. 4. One opening of each transfer passage is just below the corresponding opening of the ignition passage 23 and its other opening is between that of the ignition passage 23 and the opening of the ejection passage 26.

27 is a riser which extends from the ejection passage 26 to the upper end of the valve, as best seen in Fig. 6.

29 is a sparking plug which is inserted in the tubular extension 31 of the valve. The sparking plug extends through an annular partition in the ejection passage 26, Fig. 3, and its electrodes are just above the bottom of the ignition passage 23.

30 is a wire or cable through which current is supplied to the sparking plug 29.

The lower end of the tubular extension 31 is screw-threaded at 32 and nuts 19 are mounted on the threaded portion for holding the valve, the ball bearing 18, and the casing assembled, Fig. 9. 33 is a bore in the wall of the tubular extension 31, Fig. 6, which supplies lubricant to the ball bearing 18 and to the valve seat 4. In addition to the lubrication effected by the lubricant from the bore 33, lubricant for the valve seat 4 may be supplied with the fuel.

It is not necessary that the valve and the seat 4 should be tapered as shown, but tapered members are preferred because they make up for temperature expansion while maintaining the tight fit of the members. The valve is entirely relieved of frictional resistance which is transmitted to the ball bearing 18.

The nozzle 35 which extends from the chest 2, Fig. 9, is triangular at its lower end, Fig. 10, and at this end is connected to the openings of the primary passage 22, the secondary passages 25 and the riser 27. The upper end 39 of the nozzle 35 is elongated into substantially rectangular shape, Fig. 10. 40 are two diametrally opposite mixture chambers in the chest 2 which are connected to the suction passages 34 in the valve. The mixture chambers 40 are supplied with air for combustion through bores 42 in their sides, and with fuel through passages 41 in their upper end walls.

A circulation of cooling liquid is effected in the cavities of the valve 21 and the chest 2 by means of two passages 43.

The starting passages 47 are supplied with starting air through pipes 45 one of which is visible in Fig. 9, and check valves 46 with valve springs 36. Starting air may be taken from any suitable source, for instance, from a steel flask.

When it is desired to start the engine, starting air is admitted to the starting passages 47 past the check valves 46 in the manner described. The reaction of the starting air on the portion on the passages 47 which extend parallel to the reaction passages 24, causes the casing to rotate. Assume now that one of the chambers 10 is in the position 10A in Fig. 11 and that the casing 1 rotates in the direction of the arrow, i.e., from the left to the right. In the position 10A, the chamber 10 contains a charge of compressed mixture ready for ignition, as will be described. Upon further rotation of the chamber toward 10B, its port 13 is connected to one of the openings of the ignition passage 23 where the mixture is fired by the sparking plug 29. The ignited gases expand into the ignition space 10^1 on the one hand and into the primary passage 22 on the other hand, and are discharged through the opening 39 of the nozzle 35 under high pressure. When the chamber 10 is in the position 10B, its slot 14 connects the compression space 10^{11} to one of the transfer passages 28 and a portion of the products of combustion in the chamber 10^{11} expands into the following chamber 10 which is at 10C at the time, and is filled with a charge of uncompressed fresh mixture. This mixture is now compressed without, however, mixing with the products of combustion. This is prevented not only by the partition 11 but also by centrifugal action, for the clearance 12 is at the outer perimeter of the casing 1 and, as the mixture in the chamber at 10C is heavier than the products of combustion, it blocks the clearance 12 against access of the lighter products of combustion. In this manner the mixture in the chamber at 10C is compressed to the volume of the compression space 10^{11}. By suitably controlling the supply of mixture it can be compressed to such an extent that preignition occurs in the clearance 12, which may be desirable.

The chamber now arrives at 10D. In this position it partly lays open one of the reaction passages 24, the transfer passage 28 is closed, while the ignition passage 23 is still partly open. The products of combustion partly flow to the nozzle 35 through the primary passage 22 and partly through the subsidiary passage 25 which is connected to the reaction passage 24. The flow of the products of combustion through the passages 24 causes the reaction which in turn rotates the casing 1. Upon further rotation of the casing 1, the ignition passage 23 is disconnected from the combustion chamber and the products of combustion which are still present in the chamber, are discharged only through the subsidiary passage 25 under reduced or medium pressure. When the chamber has arrived at 10E the reaction passage 24 is closed and the ejection passage 26 is connected to the chamber. The residual products of combustion now flow to the nozzle 35 through the ejection passage 26 and the riser 27 under low pressure. At 10F, one of the suction passages 34 is connected to the chamber. The products of combustion have now been completely discharged from this chamber but the nozzle 35 is immediately supplied with products of combustion from another chamber which is between the positions 10A and 10D at the time, so that the flow through the nozzle 35 is practically uniform and the product of the discharge velocity and the weight of the discharged products is substantially constant. The products of combustion leaving the primary passage 22 under high pressure, exert suction on the products leaving the subsidiary passages 25, and the products leaving the subsidiary passages 25 under medium pressure exert a similar action on the products leaving the riser 27 at low pressure. The suction in the riser 27 draws mixture from one of the chambers 40 into one of the chambers 10 through one of the suction passages 34. In the position 10G, the suction passages 34 of the ejection passage 26 are full open so that suction is very intense and a correspondingly effective scavenging of the combustion space 10^1 is brought about. In the position 10H the ejection passage 26 is closed and only the suction passage 34 is exposed, mixture flowing into the chamber 10 and filling it completely by its inertia. At 10C the mixture is compressed by one of the transfer passages 28 tapping products of combustion from the chamber at 10D, in the manner described. The mixture flows in heat exchange proximity with the cooling liquid and is preheated thereby.

The casing 1 is rotated continuously by the reaction of the products of combustion flowing into the inclined reaction passages 24 from the chambers 10.

It should be noted that the valve has a double set of passages so that one-sided pressures are eliminated. Two ignitions occur in each chamber 10 per revolution of the casing 1.

Means (not shown) may also be provided for injecting the fuel into combustion air which has been heated to ignition temperature by compression. Energy for compressing the air is preferably supplied by the rotating chambers themselves.

Instead of supplying starting air through the starting passages 47, a portion of the products of combustion might be led to an auxiliary engine (not shown) through the passages 47 and the casing 1 be rotated by such engine.

The arrangement of the passages etc. in the valve 21, and the free sectional areas of the passages etc. and of the ports 13 and 14 in the valve seat 4 of the casing 1, are so determined that the kinetic energy of the gas issuing from the opening 39 of the nozzle 35 is substantially constant, and this action is favored by the arrangement of the conduits 25 with respect to the axial passage 22.

The apparatus, as mentioned, is particularly suitable as a substitute for the rockets which have recently been suggested for driving vehicles and aircraft, on account of its simplicity, reliability, compactness and low weight. As compared with a reciprocating internal combustion engine rotating a screw propeller for an airplane, its weight is only about 1/8 of the weight of the reciprocating engine.

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

1. An apparatus for generating combustion gases under pressure having combustion chambers arranged annularly around a valve which controls the inlet to and outlet therefrom, in which the valve is stationary and some or all of its passages which conduct the pressure gases out of the combustion chambers into one or more exhaust nozzles common to all the combustion chambers, open into the combustion chambers at such an angle to the radial direction that the chamber structure automatically rotates under the reaction of the pressure gases issuing from the chambers.

2. An apparatus for generating combustion gases under pressure as set forth in claim 1, in which the outlet nozzle consists of one primary nozzle (22), into which the primary combustion products at the highest pressure are led through suitable passages (23) of the valve, and of one or more secondary nozzles (25), into which combustion gases at a lower pressure are led through suitable passages (24) of the valve, and of the outlet end of a passage (27) through which the exhaust gases at low pressure from the combustion chambers are led away and against which the gas streams from the first mentioned nozzle react, through which fresh gases, preheated by a cooling medium circulating around the passages of the valve, are drawn in after removal of the exhaust gases.

3. An apparatus for generating combustion gases under pressure as set forth in claim 1 or 2, in which each combustion chamber (10) is divided by a partition (11) into a combustion space (10^{I}) and an exhaust or compression space (10^{II}), the partition presenting an opening (12) at the point most remote from the centre of rotation for avoiding mixing of the lighter combustion gases with the heavier combustible mixture or air.

4. An apparatus for generating combustion gases under pressure as set forth in claim 3, in which the valve (21) has, at the level of the compression spaces (10^{II}) of the combustion chambers, a transfer passage (28) which transfers a portion of the pressure gases from the chamber in which ignition has just occurred, directly into the chamber filled with combustible mixture for compression and eventual ignition thereof.

5. An apparatus for generating combustion gases under pressure as set forth in claim 2, 3 or 4, in which the passages of the valve are so arranged relatively to the outlet openings of the combustion chambers that each chamber is connected immediately after ignition only with the primary nozzle (22), and progressively with the decrease of pressure inlet to the secondary nozzle or nozzles is opened in such manner that the product of issuing velocity and mass remains approximately constant.

6. An apparatus for generating combustion gases under pressure as set forth in claim 2, 3, 4 or 5, in which an ignition device (29) common to all the combustion chambers is arranged in the passage (23) of the valve through which the highest pressure gases are led to the primary nozzle.

7. An apparatus for generating combustion gases under pressure as set forth in claim 2, 3, 4, 5 or 6, in which the body (35) of the ejection nozzle is secured to the valve and covers the mouths of the primary nozzle (22), the secondary nozzle or nozzles (25) and the exhaust passage (27), and has mixing chambers (40) into which the combustible and air for combustion are introduced and which are connected to suction passages in the valve, and connections (45) with valves (46) adapted to be connected to a source of pressure fluid and connected to starting passages (47) in the valve and opening obliquely into the combustion spaces, and also supply conduits (43) for a medium for cooling the valve.

Dated this 3rd day of September, 1932.

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Agents for the Applicant.

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Fig. 1.

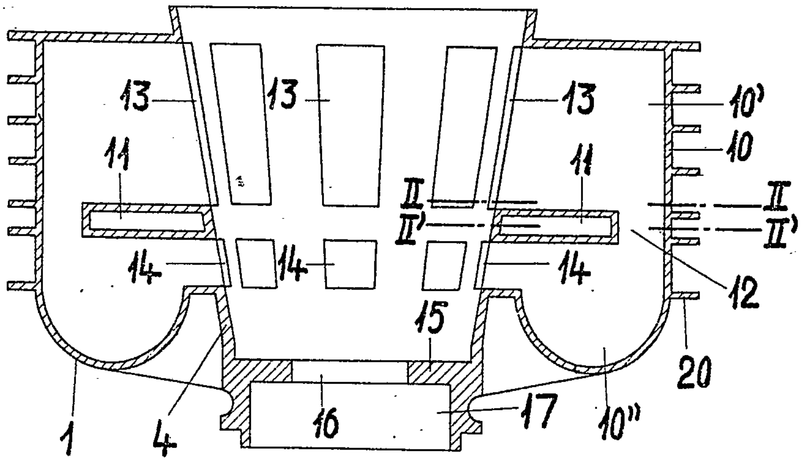
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Fig. 2.

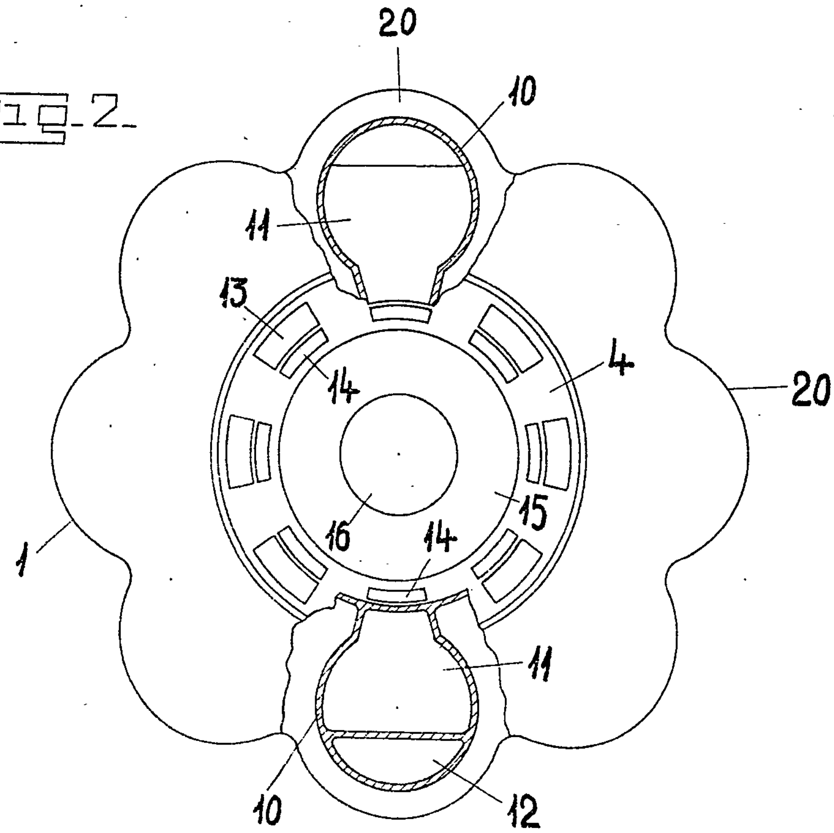
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Fig. 3.

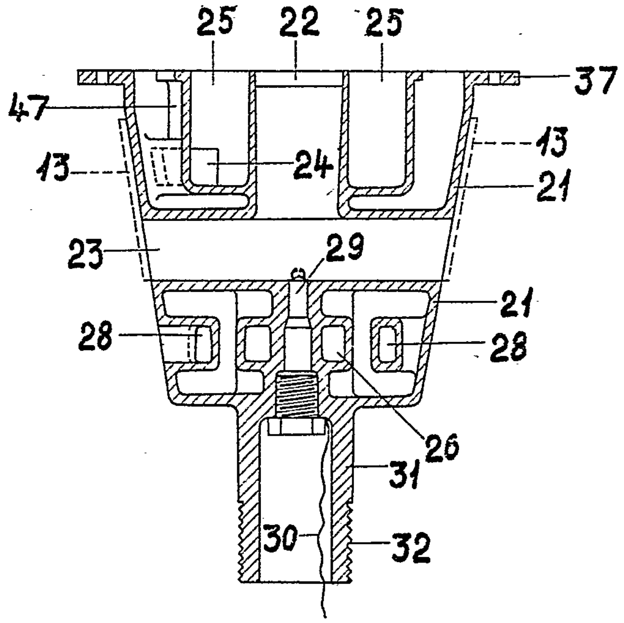


Fig. 4.

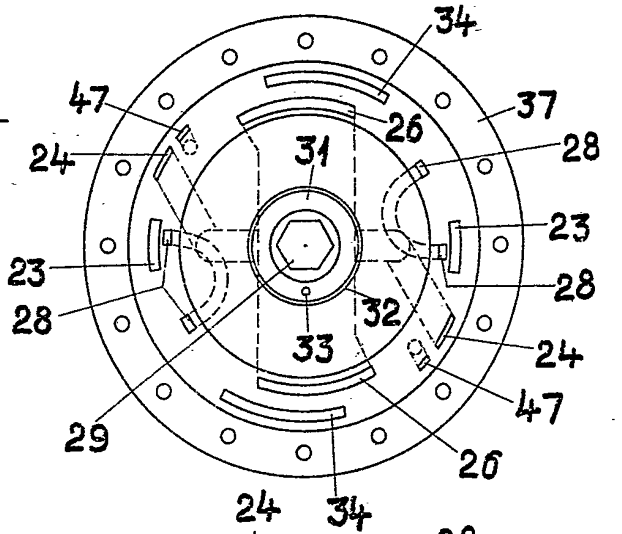
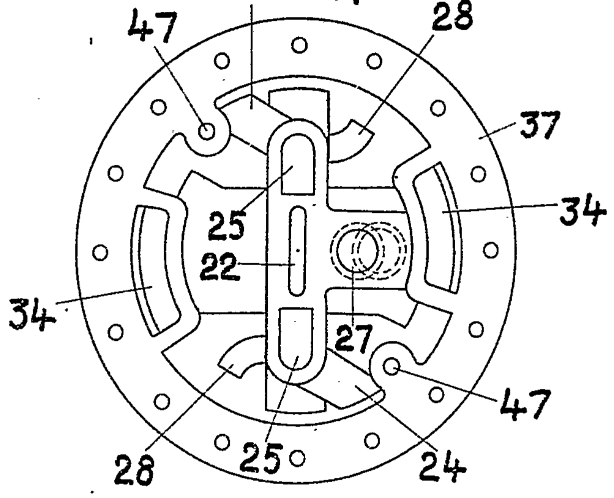


Fig. 5.



SHEET 1

Fig. 1.

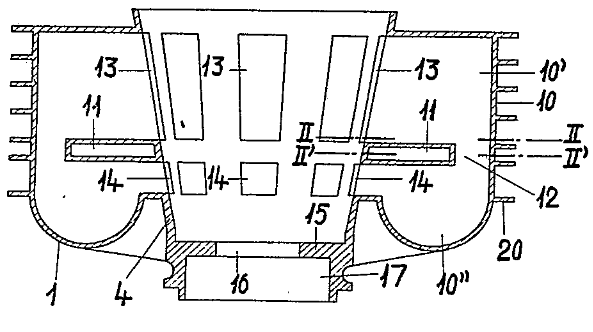


Fig. 2.

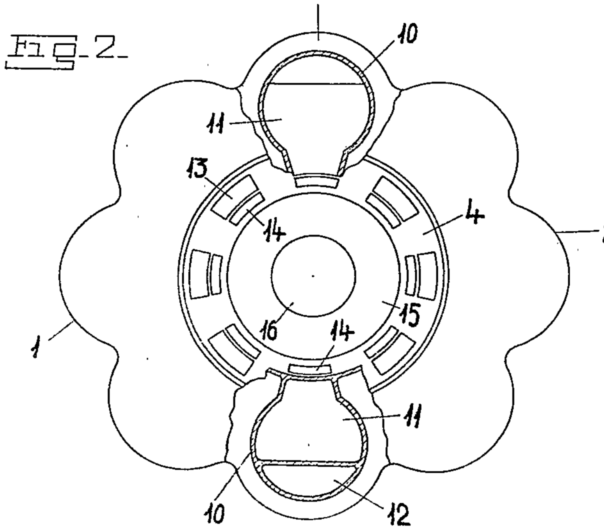


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Fig. 3.

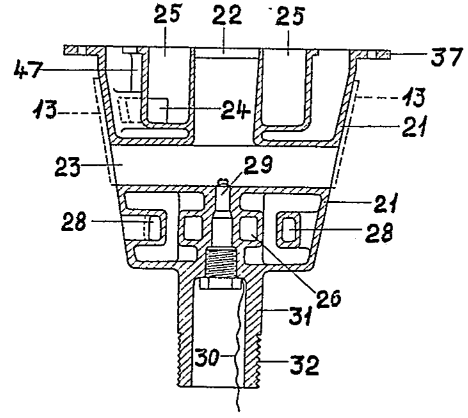

Fig. 4.

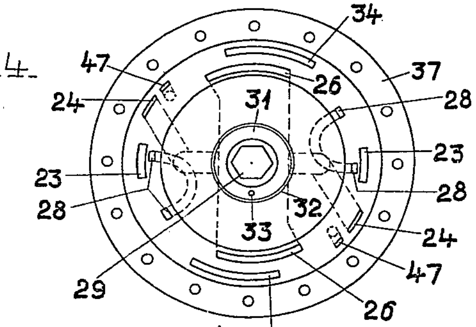

Fig. 5.

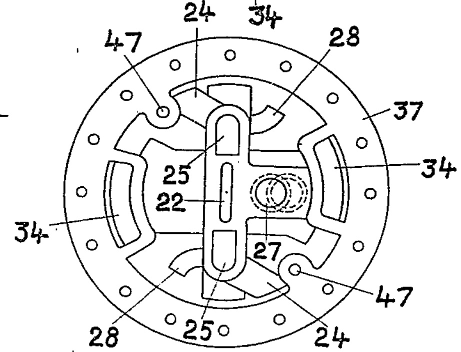

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Fig. 6.

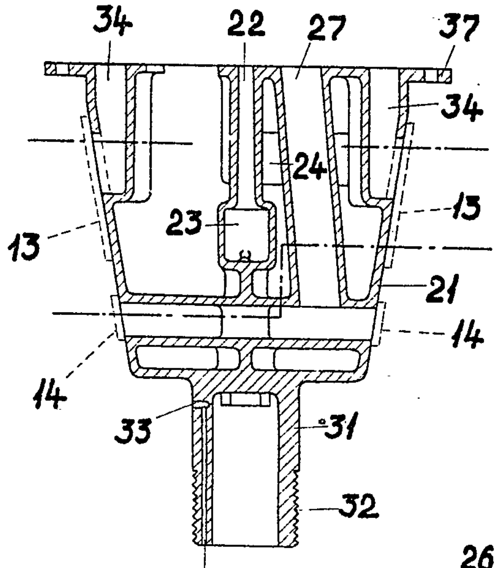
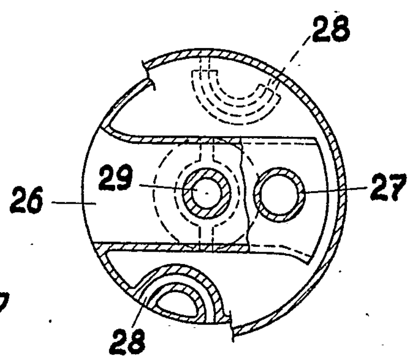


Fig. 8.



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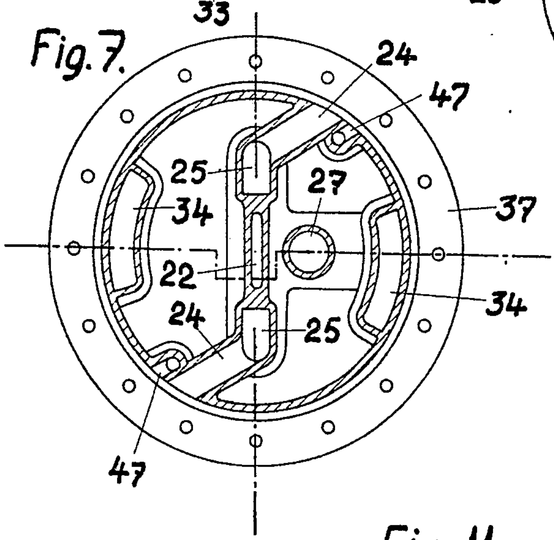

Fig. 11.

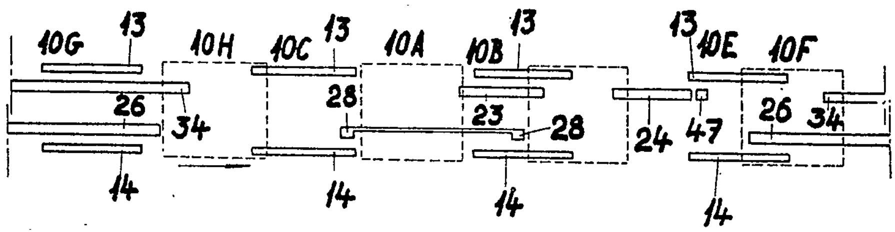

Fig. 9.

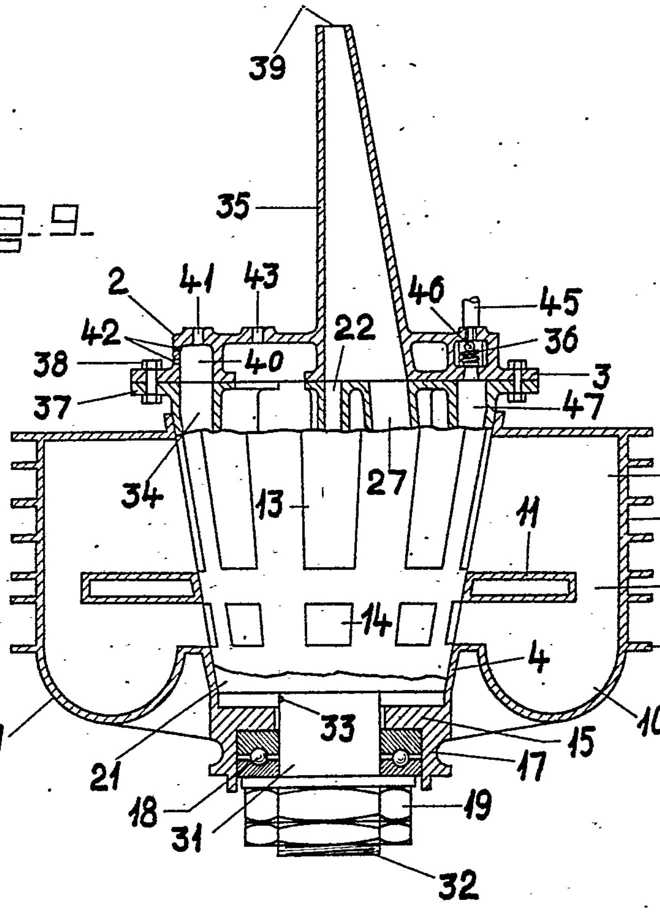
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Fig. 10.

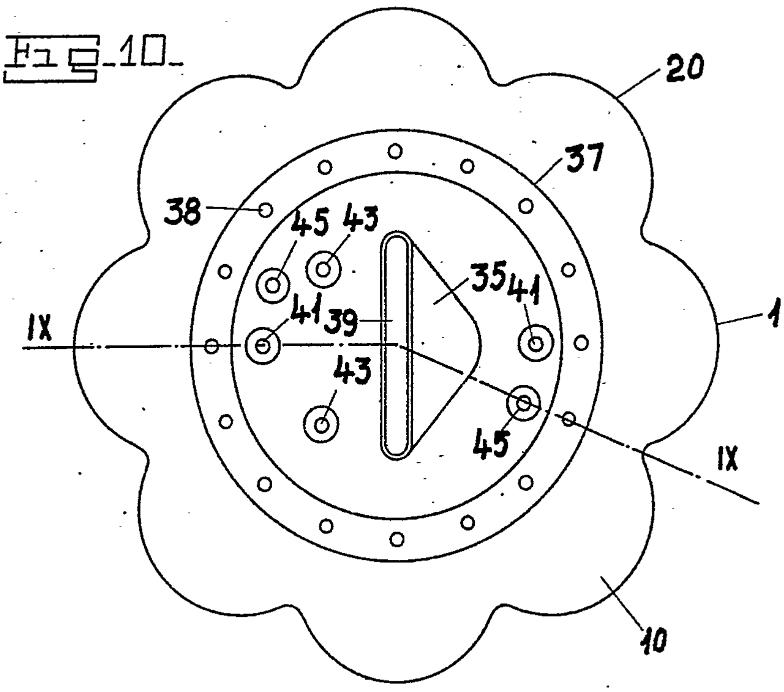
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Fig. 6.

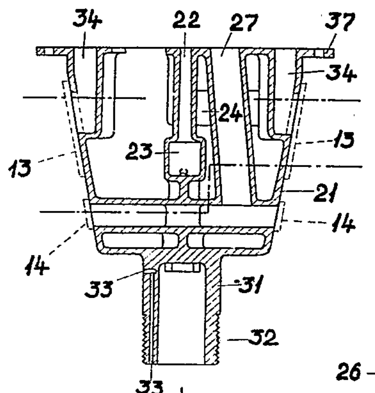


Fig. 7.

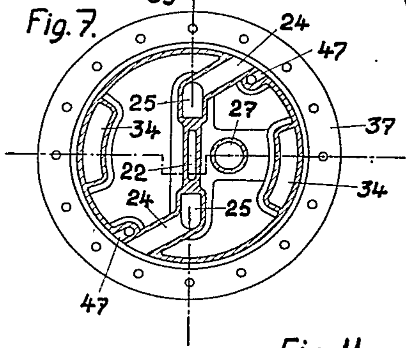


Fig. 8.

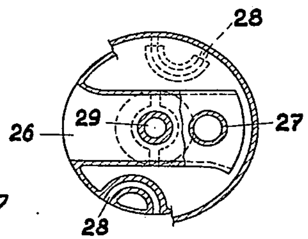


Fig. 11.

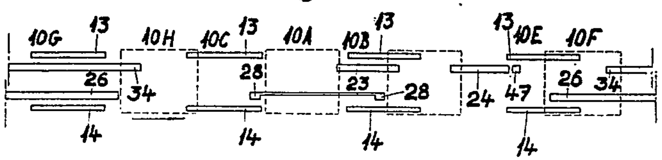


Fig. 9.

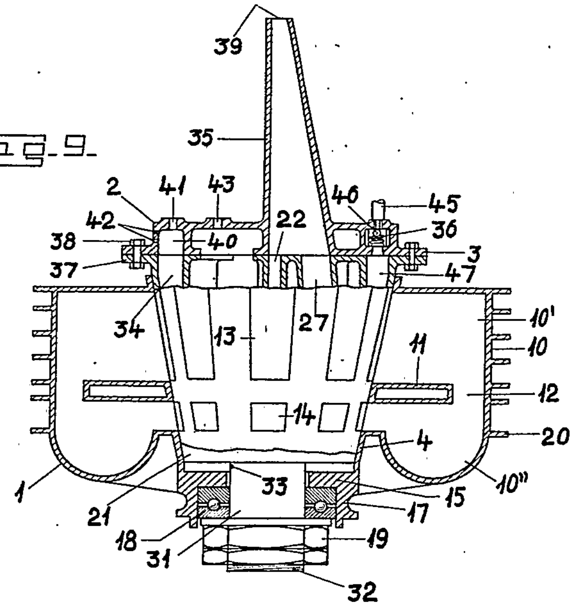
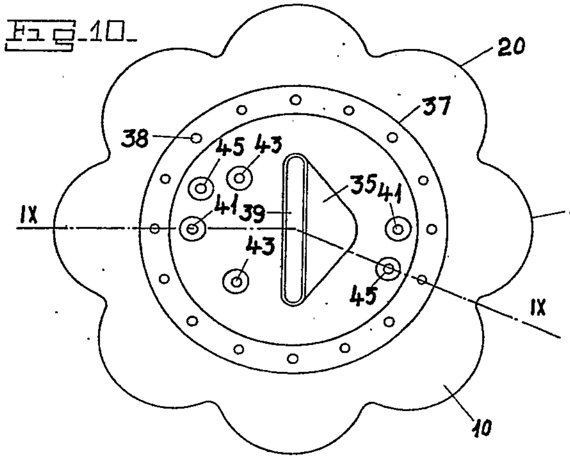


Fig. 10.



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