Feb. 18, 1964 G. C. CROSBY ETAL 3,121,311

LIQUID PISTON TURBINE ENGINE

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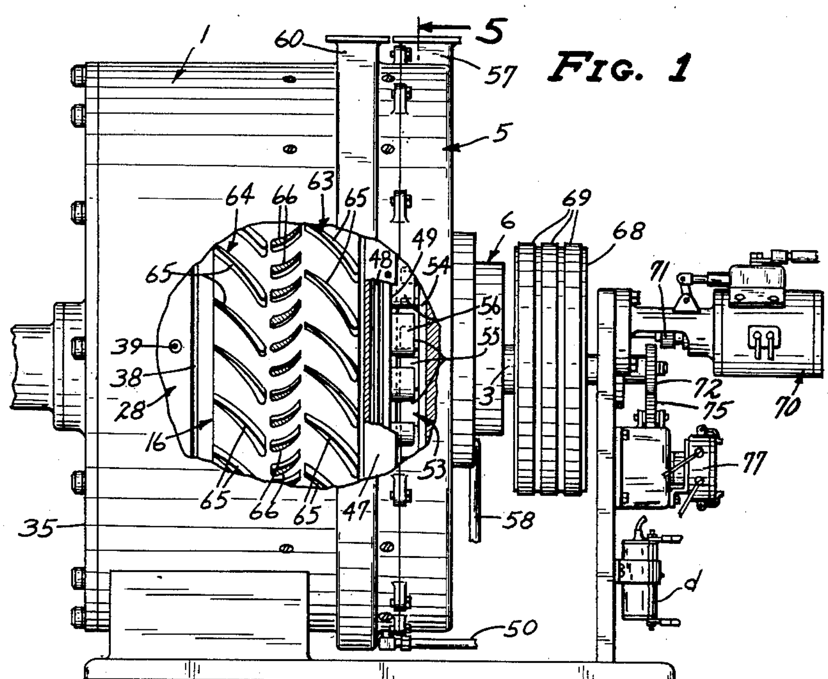

FIG. 1

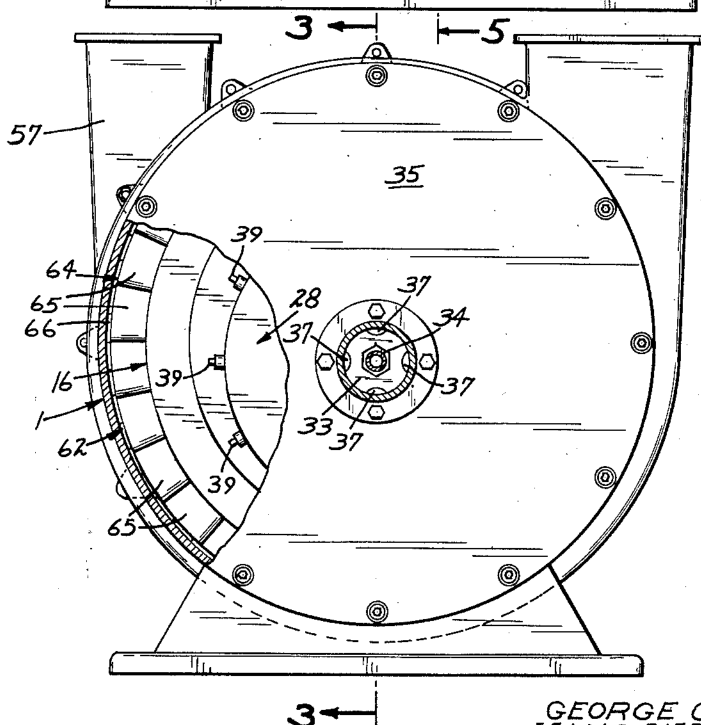

FIG. 2

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LIQUID PISTON TURBINE ENGINE

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FIG. 3

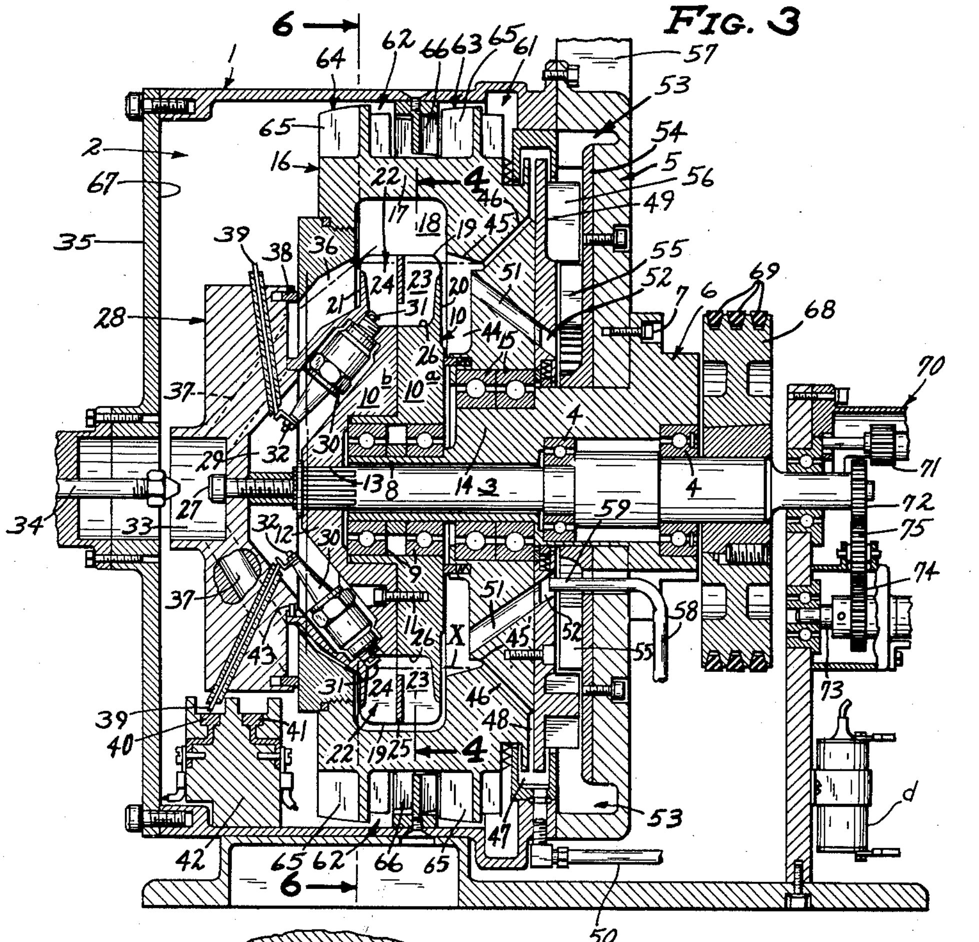

FIG. 4

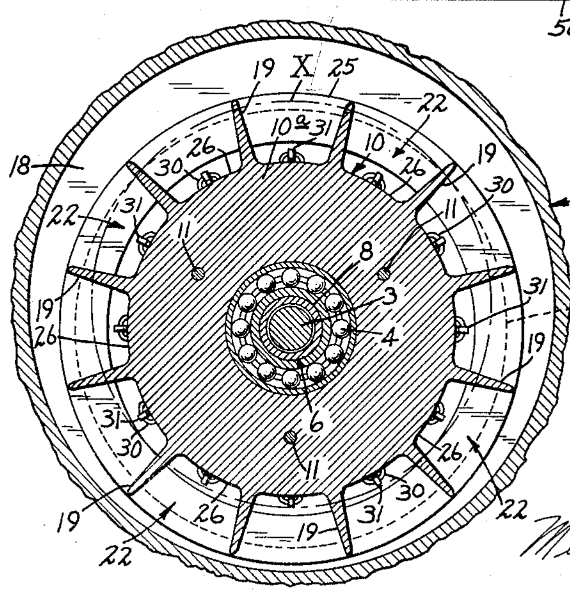

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FIG. 5

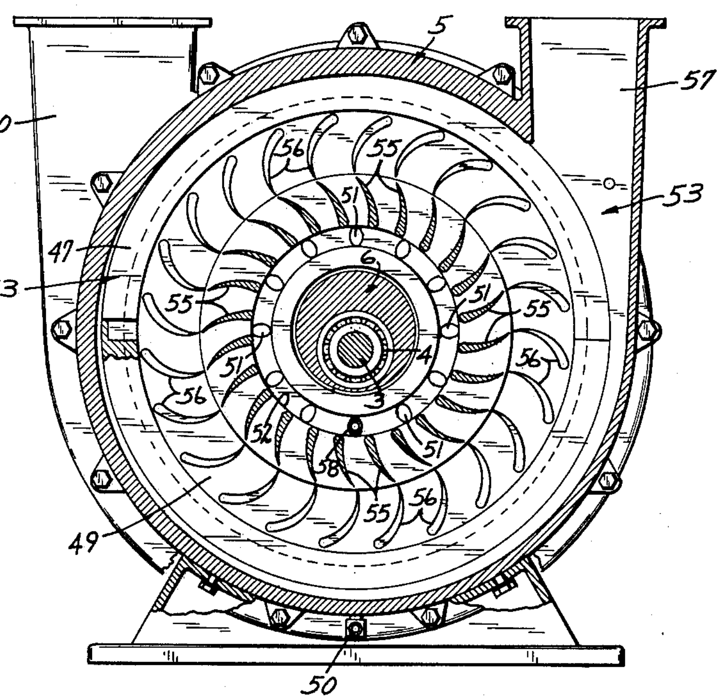

FIG. 7

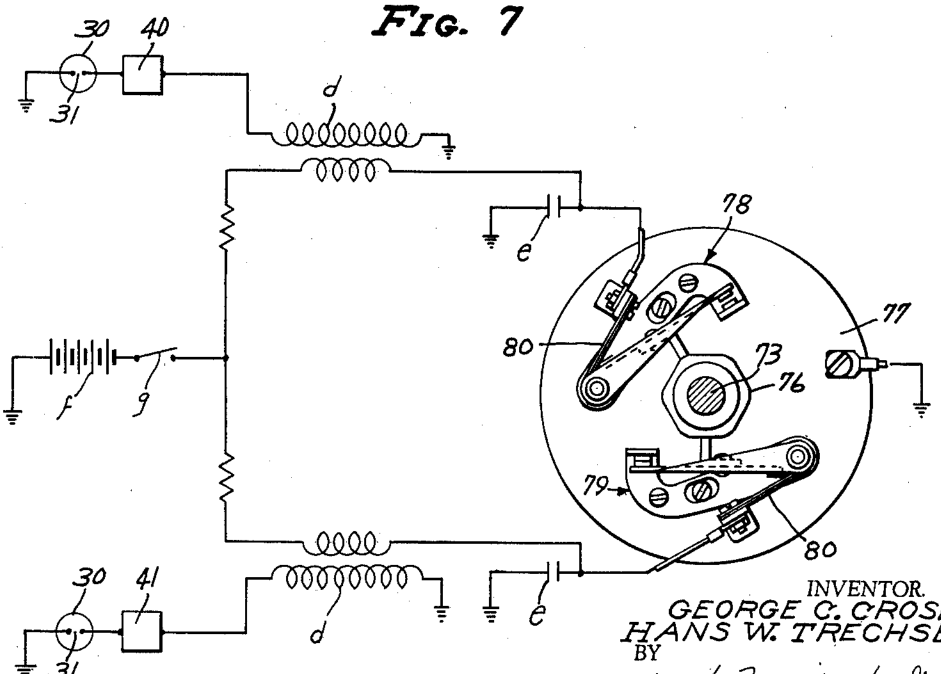

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FIG. 6

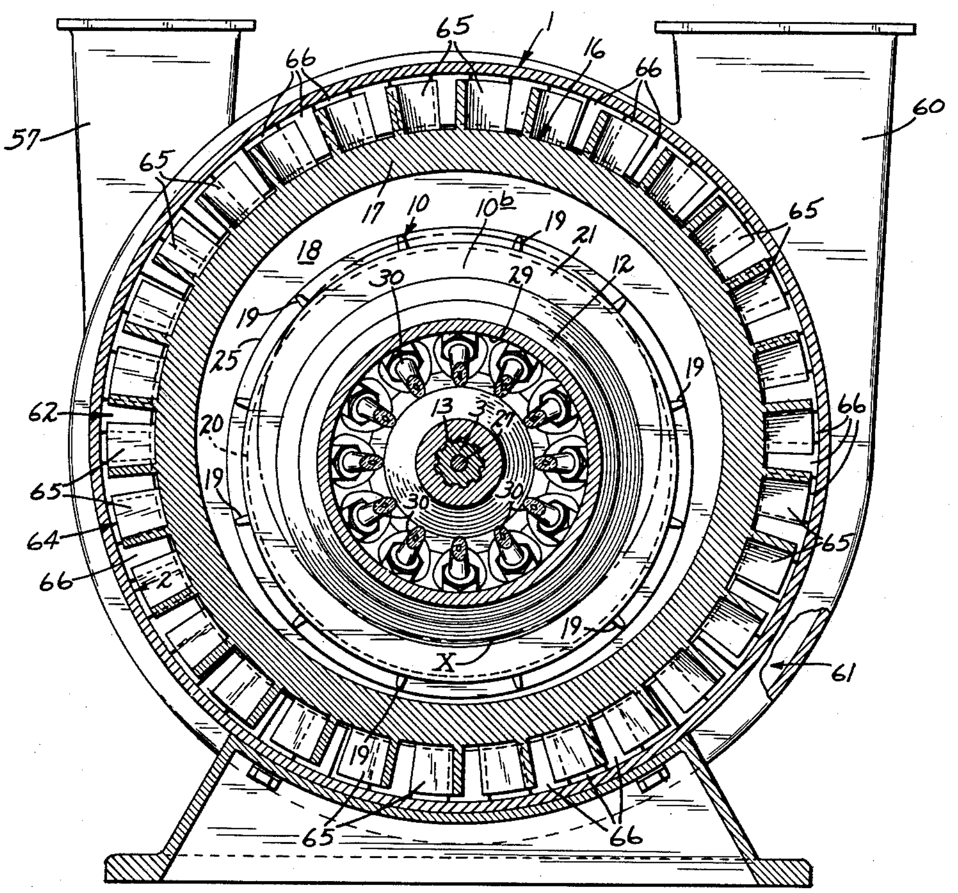
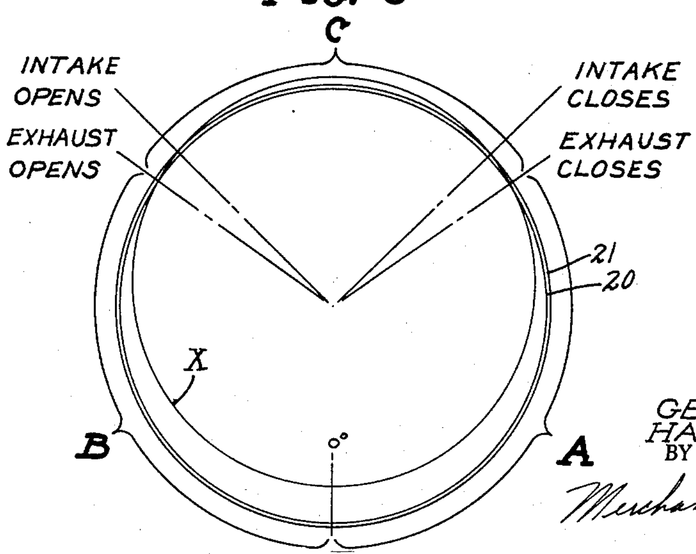


FIG. 8



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3,121,311
Patented Feb. 18, 1964

3,121,311

LIQUID PISTON TURBINE ENGINE

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Filed Sept. 6, 1962, Ser. No. 221,826
6 Claims. (Cl. 60—39.34)

Our invention relates broadly to internal combustion engines and more particularly to rotary internal combustion engines of the turbine type.

Still more specifically, our invention relates to improvements in two-cycle turbine engines of the type in which power impulses are delivered to an output shaft by liquid pistons.

The primary object of our invention is the provision of an internal combustion engine of the type immediately above described in which friction is reduced to a minimum and whose has a considerably greater efficiency than gas turbines heretofore developed.

A further object of our invention is the provision of an engine of the class above described which is capable of developing considerable torque at 1200 to 1500 r.p.m., at slightly higher than the idling speed of a high compression automobiles engine.

A further object of our invention is the provision of an engine of the class immediately above described which has considerably greater range of useful power output than engines heretofore developed.

A still further object of our invention is the provision of an engine of the type above described which has an extremely high power-to-weight ratio.

A still further object of our invention is the provision of an engine as above described which incorporates a minimum of working parts and requires a minimum of lubrication.

A still further object of our invention is the provision of a device of the class above described which is not unduly expensive to produce and which is extremely easy to maintain and service.

A still further object of our invention is the provision of an engine as above described which is so well balanced as to substantially eliminate vibration.

A still further object of our invention is the provision of an internal combustion engine of the type above described which, by virtue of unique design, utilizes the gasses of combustion as a power booster.

A still further object of our invention is the provision of an internal combustion engine of the type above described which, by virtue of unique design, supercharges the incoming air supplied to the combustion chambers.

The above and still further objects of our invention will become apparent from the following detailed specification, appended claims and attached drawings.

Referring to the drawings wherein like characters indicate like parts throughout the several views:

FIG. 1 is a view in side elevation of our novel engine, some parts being broken away and some parts shown in section;

FIG. 2 is a view in front elevation of the structure shown in FIG. 1;

FIG. 3 is a view in vertical axial section as seen from the line 3—3 of FIG. 2;

FIG. 4 is a view in vertical section as seen from the line 4—4 of FIG. 3;

FIG. 5 is a view in vertical section as seen from the line 5—5 of FIG. 1;

FIG. 6 is a view in vertical section as seen from the line 6—6 of FIG. 3;

FIG. 7 is a diagrammatic view of the ignition system utilized in our novel engine; and

FIG. 8 is a diagrammatic view illustrating the areas of intake, exhaust, compression and combustion.

Referring with greater particularity to the drawings, the numeral 1 indicates, in its entirety, a housing or block which defines a cylindrical chamber 2. An output or drive shaft 3 is suitably journalled by bearings 4 eccentric to the axis of the housing 1 in a detachable end wall 5. Specifically, this is accomplished through a sleeve-like member 6 detachably secured, as by machine bolts or the like 7, to the removable end wall 5.

Mounted on a materially reduced inner end portion 8 of the output sleeve 6, through suitable bearings 9, is an internal rotor 10 which preferably, and as shown, comprises axially spaced sections 10*a* and 10*b* which are retained in operative relationship by means of bolts or the like 11. As shown, the rotor section 10*b* is provided with an offset portion 12 which is splined, as indicated at 13, to the inner end of the upper shaft 3 so as to rotate as a unit therewith.

Mounted for rotation within the housing 1 on a diametrically enlarged portion 14 of the sleeve 6, through the medium of bearings 15, is an external rotor identified in its entirety by the numeral 16. As shown, the external rotor 16 is concentric to the axis of the housing 1, but eccentric to the axis of the internal rotor 10. The peripheral portion of the external rotor 16 is axially offset as at 17 to define a radially inwardly opening annular fluid-receiving channel 18 of a diameter greater than that of the internal rotor 10 and adapted to receive in varying degrees the peripheral portion of the internal rotor 10.

As shown, the peripheral portion of the internal rotor 10 is provided with a plurality of circumferentially spaced radially outwardly projecting vanes 19 which cooperate with radially outwardly projecting axially spaced side wall portions 20, 21 of said internal rotor 10 to define circumferentially spaced radially outwardly opening combustion chambers 22. Side wall portion 20 is slightly smaller in diameter than side wall portion 21, for a purpose which will hereinafter be explained.

Carried by the vanes 19 and dividing the combustion chambers 22 into axially spaced compartments 23, 24, is an annular partitioning ring 25. The outer peripheral edge of the partitioning ring 25 projects radially outwardly beyond the axially spaced side wall portions 20, 21 for a purpose which will hereinafter be explained; whereas the radially inner portion of said ring 25 is spaced from the bottoms 26 of the combustion chambers 22 to permit communication between the compartments 23, 24 thereof.

Rigidly but detachably secured within the housing 1 to the inner end of the output shaft 3, through the medium of a bolt 27 or the like, is an intake manifold 28. As shown particularly in FIG. 3, adjacent portions of the internal rotor 10 and intake manifold 28 cooperate to define annular cavity means 29 which extends angularly generally radially outwardly and axially inwardly from the projected axis of the shaft 3 toward the radially inner portions 26 of the combustion chambers 22. Circumferentially spaced conventional spark plugs 30 extend between the radially outer limits of the cavity means 29 and each of the combustion chambers 22, the spark gap creating points 31 thereof being received within the chambers 22 and with the radially inner connector-providing ends 32 being projected axially outwardly from the internal rotor 10.

At its central portion the intake manifold 28 is formed to define an axially outwardly opening throat portion 33 into which carbureted fuel under pressure is adapted to be delivered by a suitable nozzle-equipped fluid line 34 mounted in the detachable end wall 35 of the housing

1. Adjacent side wall portions of the internal rotor 10 and external rotor 16 cooperate to define an annular air intake passage 36 which communicates at its axially outer end with the throat 33 through the medium of generally radial passages 37 in the manifold 28. To prevent escape of carbureted fuel from the passage 36, suitable sealing means is provided between the adjacent portions of the external rotor 16 and the manifold 28. Such sealing means may well take the form of a yieldingly biased carbon ring 38.

Projecting generally radially outwardly through the intake manifold 28 are a plurality of circumferentially spaced insulated electrical lead wires 39. At their radially inner ends said lead wires 39 have yielding contact with the radially inner connector-providing end portions 32 of the spark plugs 30. As shown, the outer ends of the lead wires 39 project radially outwardly from the intake manifold 28, alternate ones of which being axially staggered for brushing engagement with suitable contacts 40, 41 mounted in suitable insulating block 42 carried by the housing 1 within the chamber 2.

In order to insure yielding engagement between the radially inner ends of selected ones of the spark plugs 30 and their cooperating lead wires 39, as well as to insure properly timed brushing engagement of the radially outer ends of the lead wires 39 with respect to the axially spaced contacts 40, 41, the intake manifold 28 is keyed, as indicated at 43, to the internal rotor 10.

Formed by adjacent portions of the internal rotor 10 and the external rotor 16 in axially opposed relationship to the intake passage 36 is an annular exhaust chamber 44, the radially outer portion 45 of which is radially inwardly spaced with respect to the radial outer limits of the fluid-receiving channel 18. As shown, said radially outer portion 45 of the exhaust chamber 44 is in the nature of an undercut to define a liquid level maintaining channel 45′ of greater axial depth than that of the primary exhaust chamber 44 of which it forms a part. Communicating with the bottoms of these channels 45′ and extending angularly radially and axially outwardly through the external rotor 16, are a plurality of circumferentially spaced overflow passages 46 which, at their radial outer ends, communicate with an annular fluid collection channel 47, by way of an annular groove 48 formed between adjacent surfaces of the external rotor 16 and a detachable plate identified by the numeral 49 secured to the side of the rotor 16. From the annular collection channel 47 the fluid is returned to a reservoir, not shown, through conduit means 50 by gravity.

Extending angularly radially inwardly and axially outwardly from the exhaust chamber 44 (immediately radially inwardly of the axial wider end portions 45 thereof) are a plurality of circumferentially spaced exhaust passages 51. At their axially outer ends the passages 51 terminate in an annular groove 52 which is concentric to the axis of rotation of said external rotor 16, and preferably and as shown, is formed in the plate 49 carried by the rotor 16. Groove 52, in turn, communicates with the radially inner extremities of a volute exhaust chamber 53 formed between adjacent side surfaces of the external rotor 16 and the removable end wall 5 of the housing 1. As shown particularly in FIGS. 3 and 5, the end wall 5 through the medium of a detachable plate 54 is formed to define a plurality of circumferentially spaced stator blades 55 immediately radially outwardly with respect to the groove 52. Immediately radially outwardly of the circumferentially spaced stator blades 55, and within said volute chamber 53, the side edge of the external rotor 16 is formed through the medium of the plate 49 to define a plurality of circumferentially spaced rotor blades 56. The outlet to atmosphere defined by the housing 1 is identified by the numeral 57.

As shown particularly in FIGS. 3 and 5, a fluid inlet conduit 58 has its inner end projecting axially through the detachable end wall 5 and plate 54 carried thereby and terminates at its extreme inner end 59 in the groove 52.

The air inlet opening to the chamber 2 of the housing 1 is identified by 60, the same forming the outer extremity of a volute air inlet chamber 61. Air inlet chamber 61 communicates with an annular air inlet passage 62 defined by the radially outer limits 17 of the external rotor 16 and the housing 1. As shown particularly in FIGS. 3 and 6, the external rotor 16, within said annular air inlet passage 62, is formed to define a pair of axially spaced rows 63, 64, of circumferentially spaced rotor blades 65. On the other hand, the housing 1 within said air inlet passage 62 is formed to define a single row of circumferentially spaced stator blades 66 intermediate said rows 63, 64 of stator blades 65. At its axially inner end said air inlet passage 62 communicates with a generally annular compressed air chamber 67 defined by the housing 1 and the air intake manifold 28. Compressed air chamber 67, as shown particularly in FIG. 3, has constant communication with the throat 33 of air intake manifold 28.

Adjacent its outer end the power output shaft is shown as having secured fast thereto a suitable pulley 68 for transmitting power by means of flexible V-belts or the like 69.

Operation

As a first step in the starting of my novel engine above described, rotation is imparted to the output shaft 3 through the medium of a starting motor identified in its entirety by the numeral 70, and cooperating gears 71 and 72 carried respectively by the motor 70 and shaft 3. Rotation in the neighborhood of 200 r.p.m. may prove to be desirable or necessary, depending upon the type of sealing ring forming fluid, hereinafter immediately to be described, which is utilized. At this point fluid from a reservoir, not shown, is forced to enter the chamber 18 through the inlet conduit 49, groove 52, passages 51 and exhaust chamber 44, where, under the action of centrifugal force, it obviously is deposited in said channel 18. When a desired level of such fluid is achieved, namely that of the broken line showing of FIGS. 3 and 4, as indicated at X, the excess is carried away and returned to the reservoir through overflow passages 46, annular groove 48, collection chamber 47 and return pipe 50.

The sealing ring forming fluid forms no part of the instant invention and may vary considerably in chemical and physical make-up. However, as presently viewed, mercury (Hg), may well prove to be satisfactory. It is obvious that in the event that a low melting-point metal is used, that same must be placed in the liquid stage while in the reservoir, and the portions of the motor which come into contact with such metal must be maintained at a temperature to keep the metal in such molten state.

As above indicated, when the liquid has achieved the broken line showing as indicated at X, the vanes 19 and partition member 25 are constantly immerged in the fluid X; whereas the radially outer portions of the side walls 20—21 are immerged in said fluid X for the greater part only of each revolution of the internal rotor 10 of which they form a part, namely for a distance considerably greater than 180 degrees. Because, as above pointed out, the radial vanes 19 are constantly immersed, in varying degrees, within the sealing ring fluid X, frictional engagement between the fluid X and the walls of the channel 18 will cause the internal rotor 10 and the external rotor 16 to rotate simultaneously at a substantially equal rate. This arrangement and combination of elements, as shown in FIGS. 4 and 8, creates substantially matching areas of compression and combustion, as represented by the brackets A, B, respectively, in FIG. 8, and an area of combination intake-exhaust represented by brackets C. Thus, atmospheric air which has been compressed within the annular compression chamber 67 by means of the combined stator-rotor blades 66, 65, combines within the throat 33 with the fuel from the nozzle-equipped fuel line 34, from whence it is carried to the annular fuel-intake chamber 36 through the medium of the passages 37. In this manner, the carbureted fuel is constantly introduced into the combustion chambers 22 exposed to the area of intake C. Obviously, simultaneously, any gases of combustion within the combustion chambers 22 would be driven out the opposite side of the chambers 22 and exhausted to atmosphere through annular exhaust chambers 44, passages 51 and exhaust chamber 53.

It should here be noted that the partition member 25, which divides each of the combustion chambers 22 into axially spaced compartments 23, 24, not only assures complete exhausting of the gases of combustion from the chambers 22 during exposure to the area C, but also assures that said chambers 22 be completely filled with carbureted fuel immediately prior to their entering into the compression area A. As the combustion chambers 22 enter the area of compression A, it will be seen particularly by reference to FIG. 4 that the carbureted gases therewithin are progressively compressed by virtue of the rising level of the fluid X therewithin, due to the eccentricity of the internal rotor 10 with respect to the external rotor 16. Thus, the fluid X acts in the manner of a liquid piston. Likewise, the converse is true as the chambers 22 enter and pass through the area of combustion B.

As above indicated, the compressed carbureted gases within the combustion chambers 22 are ignited by virtue of the ignition system comprising the spark plugs 30, alternately staggered lead wires 39 and axially spaced electrical contacts 40, 41. Because of the relatively high r.p.m. rate of engines of this character, independently timed ignition systems illustrated diagrammatically in FIG. 7 are utilized. Referring specifically to FIGS. 3 and 7, a cam shaft is identified by the numeral 73. Rotation is imparted to cam shaft 73 in a one-to-one ratio by means of a gear 74 fast thereon and having meshing engagement with an idler gear 75 which, in turn, has meshing engagement with the gear 72, fast on the outer end of the power output shaft 3. As shown in FIG. 7, a six-lobe cam 76 is mounted on the cam shaft 73 and is contained within a distributor housing 77. Mounted within the housing 77 are independent pairs of circuit making and breaking contact points identified in their entireties by 78, 79, which are conventional in character and include means 80 for yieldingly biasing the same towards a circuit-making relationship. The element 79 is offset 30 degrees with respect to element 78, so as to bring about a circuit-making relationship of one pair while the other is in a circuit-breaking relationship.

The reference character *d* identifies a pair of coils; *e*, a pair of condensers; *f*, a battery; and *g*, a switch—all conventional in character and completing the circuitry between points 78, 79, and the spark plugs 30.

Inasmuch as the timing system here involved forms no part of the present invention and is conventional in nature, and hence well understood by those skilled in the art, a more specific explanation and description of the parts utilized is deemed unnecessary. It suffices to state that in order to bring about proper timing of the high voltage supply to the electrical contacts 40, 41, the distributor housing 77 is merely rotated in the conventional manner whereby to advance or retard the make-break of the points 78, 79, as the combustion chambers 22 enter the area of combustion B.

With respect to the effect of the successive explosions of the compressed, carbureted fuel within the combustion chambers 22 as they enter the area of combustion B, it suffices to state that, as in all engines of this general type, each successive explosion creates an independent impulse or thrust in the direction of rotation. These successive impulses are obviously the primary source of power. However, a secondary means of imparting rotation to the external rotor 16 (and hence of enhancing the over-all thrust delivered by our novel motor) is achieved by causing the exhaust gases to pass through the chamber 53 where they are deflected by the circumferentially spaced stator blades 55 into rotating engagement with the rotor blades 56 carried by the external rotor 16, all as more particularly described above.

While we have shown and described a preferred embodiment of our invention, we wish it to be specifically understood that same is capable of modification without departure from the spirit and scope of the appended claims.

What is claimed is:

1. In a two-cycle turbine engine of the type in which power impulses are delivered to an output shaft by liquid pistons:

(*a*) a housing,
(*b*) an output shaft rotatably mounted in said housing parallel but eccentric to the axis thereof,
(*c*) an internal rotor mounted fast on one end of said output shaft,
(*d*) said internal rotor defining a plurality of circumferentially spaced radially outwardly opening combustion chambers about its periphery,
(*e*) said chambers being formed by circumferentially spaced radial vanes and radially outwardly projecting axially spaced side wall portions of said internal rotor,
(*f*) an external rotor having an inwardly opening fluid-receiving annular channel radially outwardly disposed with respect to said chambers and rotatably mounted with its axis parallel and concentric to the axis of said housing,
(*g*) sealing ring forming fluid means in said channel in an amount wherein the radially projected ends of said vanes are constantly immersed in varying degrees therein during rotation of said rotors,
(*h*) annular circumferentially extended partition means between said vanes and dividing said chambers into axially spaced compartments,
(*i*) the radially outer limits of said partition means projecting radially outwardly beyond the radially outer limits of said side wall portions of said internal rotor and also being constantly immersed within said fluid during said rotation,
(*j*) the radially inner limits of said partition means being spaced from the bottoms of said chambers whereby to provide constant communication between the compartments thereof,
(*k*) the radially outer limits of the side wall portions of said internal rotor being immersed in said sealing ring forming fluid means for more than 180° of rotation to create successive and substantially matching areas of progressive compression and expansion,
(*l*) the radially outer limits of the side wall portions being emersed from said sealing ring forming fluid means for less than 180° of rotation and creating an area of fuel intake and exhaust,
(*m*) intake manifold means introducing carbureted fuel successively to each of said combustion chambers as they enter said fuel intake and exhaust area,
(*n*) means for progressively igniting said carbureted fuel within each of said chambers as they enter said expansion area,
(*o*) and means for exhausting the gases of combustion from said combustion chambers,
(*p*) said first-mentioned means including an intake manifold carried by said internal rotor and mounted for rotation on one end of said output shaft,
(*q*) said intake manifold including an axial throat portion communicating with a source of fuel under pressure,
(*r*) one side wall portion of said internal rotor and an adjacent portion of said external rotor defining an annular intake passage which communicates with the chambers of said internal rotor in said area of intake and exhaust,

(s) and circumferentially spaced generally radially outwardly extending passages between the throat portion of said manifold and said annular intake passage,

said means for exhausting the gases of combustion from said combustion chambers comprising,

(t) an annular exhaust chamber formed between adjacent portions of said external rotor and said internal rotor and communicating with said combustion chambers in said area of intake and exhaust,

(u) a volute chamber axially outwardly from said annular exhaust chamber and formed between adjacent portions of said external rotor and said housing,

(v) and circumferentially spaced passages between said exhaust chamber and said volute chamber,

(w) said housing within said volute chamber defining a plurality of circumferentially spaced stator blades,

(x) said external rotor within said volute chamber being formed to define circumferentially spaced rotor blades which are radially outwardly spaced with respect to said stator blades and in the path of travel of gases deflected by said stator blades.

2. The structure defined in claim 1 in which

(a) the circumferentially spaced passages between said annular exhaust chamber and said volute chamber extend angularly radially inwardly and axially outwardly from said annular exhaust chamber and which terminate at their outer ends in an annular groove formed in said external rotor,

(b) and in further combination with a fluid conduit carried by said housing and having an inner end portion received within said groove.

3. The structure defined in claim 2 in which

(a) said annular exhaust chamber radially outwardly with respect to the circumferentially spaced passages leading therefrom is provided with circumferentially spaced angularly radially and axially outwardly extending fluid overflow passages,

(b) said overflow passages at their outer ends communicating with an annular collection channel formed in said housing.

4. In a two-cycle turbine engine of the type in which power impulses are delivered to an output shaft by liquid pistons:

(a) housing,

(b) an output shaft rotatably mounted in said housing parallel but eccentric to the axis thereof,

(c) an internal rotor mounted fast on one end of said output shaft,

(d) said internal rotor defining a plurality of circumferentially spaced radially outwardly opening combustion chambers about its periphery,

(e) said chambers being formed by circumferentially spaced radial vanes and radially outwardly projecting axially spaced side wall portions of said internal rotor,

(f) an external rotor having an inwardly opening fluid-receiving annular channel radially outwardly disposed with respect to said chambers and rotatably mounted with its axis parallel and concentric to the axis of said housing,

(g) sealing ring forming fluid means in said channel in an amount wherein the radially projected ends of said vanes are constantly immersed in varying degrees therein during rotation of said rotors,

(h) annular circumferentially extending partition means between said vanes and dividing said chambers into axially spaced compartments,

(i) the radially outer limits of said partition means projecting radially outwardly beyond the radially outer limits of said side wall portions of said internal rotor and also being constantly immersed within said fluid during said rotation,

(j) the radially inner limits of said partition means being spaced from the bottoms of said chambers whereby to provide constant communication between the compartments thereof,

(k) the radially outer limits of the side wall portions of said internal rotor being immersed in said sealing ring forming fluid means for more than 180° of rotation to create successive and substantially matching areas of progressive compression and expansion,

(l) the radially outer limits of the side wall portions being emersed from said sealing ring forming fluid means for less than 180° of rotation and creating an area of fuel intake and exhaust,

(m) intake manifold means introducing carbureted fuel successively to each of said combustion chambers as they enter said fuel intake and exhaust area,

(n) means for progressively igniting said carbureted fuel within each of said chambers as they enter said expansion area,

(o) and means for exhausting the gases of combustion from said combustion chambers,

(p) said first-mentioned means including an intake manifold carried by said internal rotor and mounted for rotation on one end of said output shaft,

(q) said intake manifold including an axial throat portion communicating with a source of fuel under pressure,

(r) one side wall portion of said internal rotor and an adjacent portion of said external rotor defining an annular intake passage which communicates with the chambers of said internal rotor in said area of intake and exhaust,

(s) and circumferentially spaced generally radially outwardly extending passages between the throat portion of said manifold and said annular intake passage,

(t) a volute air inlet chamber in said housing,

(u) an annular compressed air chamber defined by said housing and said air intake manifold and communicating with the throat of said air intake manifold,

(v) and an annular air inlet passage defined by a radially outer portion of said external rotor and said housing and extending between said volute air inlet chamber and said compressed air chamber,

(w) said external rotor within said air inlet passage defining a pair of axially spaced rows of circumferentially spaced rotor blades,

(x) and said housing within said air inlet passage being formed to define a plurality of circumferentially spaced stator blades intermediate said rows of rotor blades.

5. The structure defined in claim 3 in which said annular exhaust chamber, radially outwardly with respect to the circumferentially spaced passages communicating therewith and said volute exhaust chamber, is axially enlarged to define an axially inwardly opening liquid level maintaining channel, said overflow passages communicating at their axially inner ends with the bottom of said level maintaining channel.

6. In a two-cycle turbine engine of the type in which power impulses are delivered to an output shaft by liquid pistons:

(a) a housing,

(b) an output shaft rotatably mounted in said housing parallel but eccentric to the axis thereof,

(c) an internal rotor mounted fast on one end of said output shaft,

(d) said internal rotor defining a plurality of circumferentially spaced radially outwardly opening combustion chambers about its periphery,

(e) said chambers being formed by circumferentially spaced radial vanes and radially outwardly projecting axially spaced side wall portions of said internal rotor,

(f) an external rotor having an inwardly opening fluid-receiving annular channel radially outwardly disposed with respect to said chambers and rotatably mounted with its axis parallel and concentric to the axis of said housing,

(*g*) sealing ring forming fluid means in said channel in an amount wherein the radially projected ends of said vanes are constantly immersed in varying degrees therein during rotation of said rotors,

(*h*) annular circumferentially extended partition means between said vanes and dividing said chambers into axially spaced compartments,

(*i*) the radially outer limits of said partition means projecting radially outwardly beyond the radially outer limits of said side wall portions of said internal rotor and also being constantly immersed within said fluid during said rotation,

(*j*) the radially inner limits of said partition means being spaced from the bottoms of said chambers whereby to provide constant communication between the compartments thereof,

(*k*) the radially outer limits of the side wall portions of said internal rotor being immersed in said sealing ring forming fluid means for more than 180° of rotation to create successive and substantially matching areas of progressive compression and expansion,

(*l*) the radially outer limits of the side wall portions being emersed from said sealing ring forming fluid means for less than 180° of rotation and creating an area of fuel intake and exhaust,

(*m*) intake manifold means introducing carbureted fuel successively to each of said combustion chambers as they enter said fuel intake and exhaust area,

(*n*) means for progressively igniting said carbureted

fuel within each of said chambers as they enter said expansion area,

(*o*) and means for exhausting the gasses of combustion from said combustion chambers,

(*p*) the means mounting said output shaft, said internal rotor, and said external rotor for rotation with respect to said housing comprising an axially elongated sleeve-like element carried by one end wall of said housing and projecting generally axially into the chamber defined thereby,

(*q*) said sleeve-like element adjacent said one side wall defining a bearing element which is concentric to the axis of the housing and upon which said external rotor is journalled,

(*r*) said sleeve-like element axially inwardly from said first-mentioned bearing element defining a diametrically reduced second bearing element which is eccentric to the axis of said first-mentioned bearing element and upon which said internal rotor is journalled,

(*s*) the interior of said sleeve-like element journalling the intermediate portion of said output shaft substantially in the plane of said one end wall of said housing,

(*t*) and means rigidly connecting the inner end of said shaft to said internal rotor for common rotation therewith.

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