Oct. 19, 1943. A. H. NEULAND 2,332,106

ENGINE

Filed May 14, 1941 2 Sheets-Sheet 1

Fig. 1.

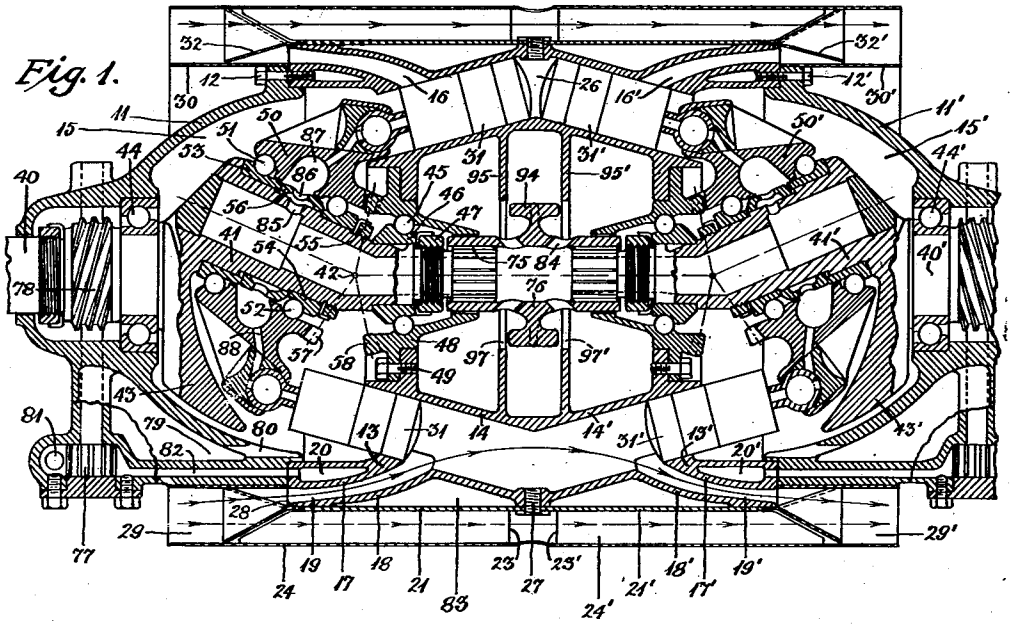
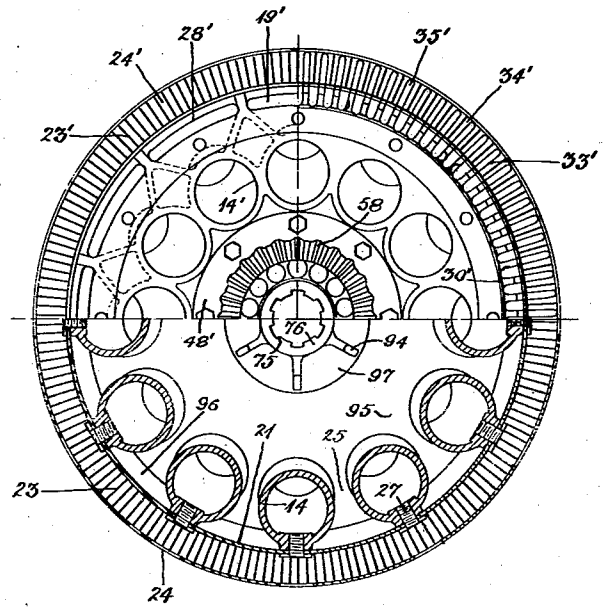


Fig. 2.



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ENGINE

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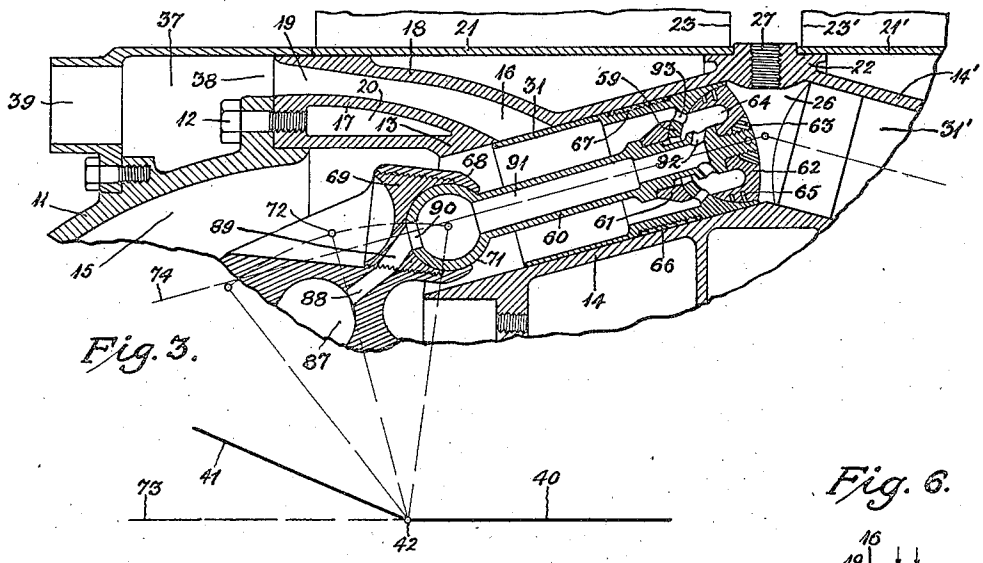


Fig. 3.

Fig. 6.

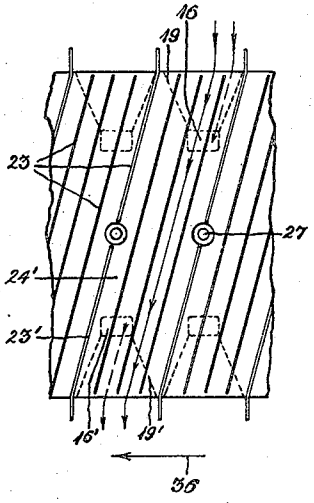


Fig. 4.

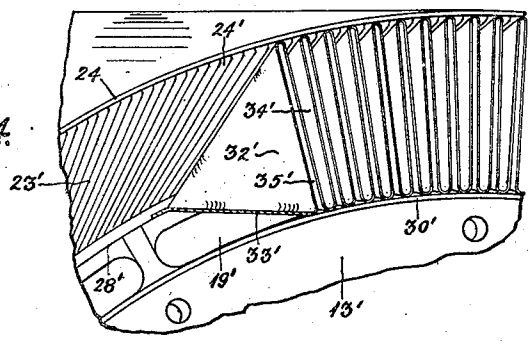
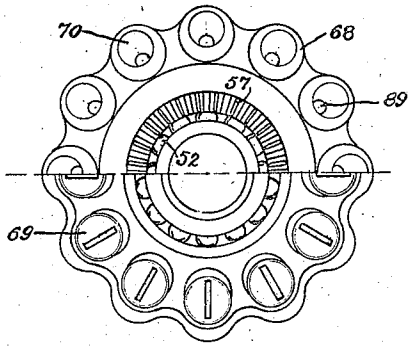


Fig. 5.



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Patented Oct. 19, 1943 2,332,106

UNITED STATES PATENT OFFICE

2,332,106

ENGINE

Alfons H. Neuland, Cleveland, Ohio

Application May 14, 1941, Serial No. 393,308

13 Claims. (Cl. 123—58)

This invention relates to engines and especially to engines having laterally arranged cylinders, sometimes referred to as barrel engines, and relates particularly to internal combustion engines of this type.

In my co-pending application Serial No. 387,227, filed on April 7, 1941, I have described a barrel engine which includes among other objects the provision of an engine capable of operating with high cylinder pressures, an improved mechanism for transmitting pressure developed in the cylinders to a shaft and means for securing greater uniformity of temperature within the engine.

One object of the present invention is to further increase the efficiency and power of engines. Another object is to provide an improved power transmitting mechanism for transforming the pressure developed in the cylinders into torque at the shaft. Other objects are to provide an engine capable of operating with a high cylinder pressure and at a relatively high but uniform temperature and to provide coordinated cooling of pistons and cylinders and a piston adapted to operate with a high pressure and with a small working clearance. Another object is to provide an engine that effectively utilizes the kinetic energy of the exhaust gas and that is inherently self-cooling and self-charging without the use of external auxiliary devices. Still another object is to provide an engine of simple and compact construction capable of developing high power and suited for rapid production and assembly at low cost.

My invention resides in novel features of construction and in the arrangement and combination of certain of its component parts. The foregoing and other objects and advantages will appear in the following description and from the drawings showing one embodiment, and my invention will hereafter be more fully defined in the appended claims.

Fig. 1 is a vertical section of an engine embodying my invention having lower end portions cut away to show the circulating pumps.

Fig. 2 is partly an end elevation of the cylinder block with the end bracket and crankshaft assembly removed, and is partly in transverse section taken through the center of the cylinder block.

Fig. 3 is an enlarged sectional view of the piston, showing its construction and relation with associated parts, and includes a modification of the engine body.

Fig. 4 is a view of the inductor for linking cooling air with the working fluid, showing its undulating form.

Fig. 5 is an elevation of the oscillator, the upper portion showing the inner side and the lower portion the outer side.

Fig. 6 is a diagrammatic developed view of the outer periphery, showing the skew in the cooling elements.

The embodiment of my engine shown in the figures comprises a stationary cylinder block which, with brackets 11, 11' secured to its ends by bolts 12, 12', forms the engine body. The cylinder block is preferably cast in one piece and includes a pair of annular portions 13, 13', and a plurality of cylinder barrels or cylinders 14, 14' extending laterally between the annular portions which serve to tie the portions together. The annular portions 13, 13', with brackets 11, 11', secured to one of their sides, form a pair of chambers 15, 15', which will hereafter be referred to as crank chambers, and the cylinders extending from the crank chambers on the other side of the annular portions are arranged to incline with respect to the axis of the engine body and to diverge outwardly to form elbows. The cylinder block also includes inlet working fluid conduits 16 and exhaust or outlet working fluid conduits 16' for conducting the working fluid through the engine. The conduits 16, 16' are formed integral with the annular portions 13, 13' by inner and outer walls 17, 18 and 17', 18' respectively, extend laterally, and form oblong passages or openings 19, 19', having their short axes arranged to extend radially and their long axes disposed along the outer periphery and in close proximity to the crank chamber, but preferably separated therefrom by the jacket spaces 20, 20' to provide cooling, particularly for the exhaust conduits.

I provide partition means 21, 21', associated with the outer walls 18, 18', preferably formed separately from the engine body but in liquid-tight relation therewith. It may be arranged to extend between outer walls 18, 18' as shown in Fig. 1, or between the outer walls and the central portion of the block as in Fig. 3, when the elbows are tied together by a web 22. The partition means, on the inner side, forms a jacket and contains a liquid coolant for the cylinders and on its outer side is provided with a plurality of closely spaced cooling elements 23, 23' which may consist of metal strips forming laterally extending fins provided along their outer periphery with closure means 24, forming a plurality of cooling air conduits 24' for the flow of a lateral

stream of cooling air past the cooling elements. With my construction and arrangement I secure close spacing of the cylinders at the crank chamber end and a compact crank chamber, a greater spacing at the elbows and cooling passages 25 between cylinders along their outer portions and, in the apex of the cylinders, combustion chambers 26 of inherently favorable shape having a relatively large section near the injector or spark plug opening 27, and a decreasing section away from the opening, adapted to aid smooth combustion. This arrangement facilitates the manufacture of the cylinder block since, without the outer jacket, molding is easily controlled, permitting the use of relatively thin walls and making it possible to cast the block from ferrous metal without excessive weight, or when extra light weight is desired to cast the block from non-ferrous metal, in which case the cylinders may be fitted with liners in any well known manner, not shown. It also facilitates the manufacture of the cooling means. For instance the separately formed partition means 21, 21' may be formed from a thin walled metal tube and the cooling elements may be formed simply by a large number of thin metal strips of high heat conductivity, such as copper, closely spaced along the outer periphery of the partition and held in place by suitable means for hard soldering in a furnace, to provide a substantial heat conducting joint between each metal strip and the tube. The assembly forms a unit of great heat dissipating capacity which may be shrunk over the outer walls 18, 18', or in any other suitable manner joined in liquidtight relation with the engine body.

From the figures it will be seen that the oblong passages 19, 19' are arranged radially between the crank chambers and the cooling air conduits and that each inlet conduit 19 is arranged to converge flatwise with one end of a cooling air conduit to form therewith a line of convergence 28, and a joint inlet passage 29, preferably formed by an extension of the closure means 24 and by the sheet metal tube 30. Each of the outlet conduits 19' is arranged to converge flatwise with the other end of a cooling air conduit to form therewith another line of convergence 28', and a joint outlet passage 29', also formed by an extension of the closure 24 and by a tube 30'. This construction and arrangement provides a smooth and substantially unobstructed path for the passage of the cooling air through the cooling air conduit and for the passage of the working fluid through the cylinder when the reciprocating inlet and exhaust pistons 31, 31' respectively, are in their outer positions, as shown in the lower part of Fig. 1, the piston 31' being arranged to uncover the exhaust duct 16' before the piston 31 uncovers the inlet duct 16.

I provide means for coupling the cooling air with the working fluid whereby the kinetic energy of the exhaust gas is effectively utilized to draw cooling air through the cooling air conduit at high velocity, and whereby the kinetic energy of the high velocity cooling air stream is made to deliver air under pressure to the induction inlet. This means comprises an inlet inductor 32 fixedly arranged within the joint inlet passage 29, and an outlet inductor 32' fixedly arranged within the joint outlet passage 29'. In the illustrated embodiment the inlet and outlet inductor are exactly alike and their shape and combination with the cooling air and working fluid conduits is particularly shown in Fig. 4. Each inductor consists of a series of preferably closely spaced separators or plates 33', arranged crosswise with respect to the line of convergence 28', which extend radially between the walls of the joint passage 29' and have a portion of their edges joined together to form a wavy or undulating partition. The separators are shaped to form a series of flatwise adjacent, wedge shaped ducts arranged with their apexes facing in the direction of the line of convergence and with their open bases facing in the opposite direction, and so that alternate ducts 34' connect with cooling air conduit 24' and intermediate ducts 35' connect with working fluid passage 19'.

With this construction and arrangement and the arrangement whereby the inlet duct 16 is not uncovered by piston 31 until after the exhaust duct 16' has been uncovered by piston 31', and assuming that fuel is injected through opening 27, the burnt working fluid or exhaust gas, exhausting through the passage 19', as piston 31' uncovers duct 16', enters the inductor 32' and is split up into a series of flatwise parallel and closely spaced streams. Emerging from alternate ducts 35', the exhaust gas streams spread until adjacent streams substantially meet and bridge the intervening spaces, and tend to establish a vacuum in the intermediate air ducts 34'. The inductor 32' also directs the cooling air from conduit 24' into the ducts 34', forms it into a series of thin streams, and conducts it into the series of intervening spaces formed by the exhaust gas streams. The action of the exhaust gas streams on both sides of the air streams, and their flatwise association with one another establishes a long line of contact between exhaust gas and cooling air, and operates to effectively couple the streams together and to transfer a substantial portion of kinetic energy from the exhaust gas to the cooling air, and to draw the cooling air through conduit 24' at high velocity. The inductor 32 in the joint inlet passage operates similar to inductor 32', except that its action is reversed. Cooling air flowing through conduit 24' is drawn in through the joint inlet passage 29, and flows into the open bases of the ducts of inductor 32 at high velocity. The inlet inductor splits the incoming air into a series of thin, flatwise adjacent streams, and directs alternate streams into conduit 24' for cooling the engine, and directs intermediate streams into intake passage 19 to serve as working fluid, to be mixed with fuel and compressed in the cylinder, and so to form an explosive mixture. The high velocity with which the incoming air is drawn into the joint passage by the kinetic energy of the exhaust gas and is made to impinge on the inlet inductor, causes it to develop a velocity pressure head in inlet conduit 16. The long line of contact between cooling air and working fluid streams at the point of their formation into separate streams, and the close flatwise association between streams operate to greatly minimize the formation of eddy currents, which would tend to oppose the development of pressure in the inlet duct 16. In this manner the energy of the burnt working fluids is utilized to impell or induce a flow of the cooling air through the cooling air conduit at high velocity, and thereby to effectively cool the engine, and the cooling air flowing into the joint inlet passage 29 at high velocity is made to impell and compress the inflowing working fluid, and thereby to charge or supercharge the engine cylinder. In instances where only mod-

erate cooling or charging is required, one or both of the inductors 32, 32', may be omitted. In such instances the formation of the working fluid into radially thin but peripherally wide streams and their flatwise association with the cooling air flowing into or out of the joint passages 29, 29', induces a flow of fluid through the engine as heretofore described. However the degree of cooling or charging is thereby substantially reduced.

While in Figures 1 to 4, in order to avoid undue complication of the drawings, I have shown the cooling elements 23, 23', arranged parallel to the axis of the engine, I prefer to arrange them askew as diagrammatically indicated in Fig. 6, showing a developed fragment of the outer periphery of the cylinder block, and but a few of the cooling elements. In this figure the inlet and exhaust passages 19, 19', respectively, are shown by the dotted lines, and assuming that the engine shaft rotates in the direction shown by arrow 36, the cooling elements 23 are skewed to trail at their inlet ends, and preferably, so that the ends of the cooling air conduits converge with working fluid passages belonging to angularly displaced or adjacent cylinders. With this arrangement the higher suction developed during the first stage of the exhaust in one cylinder, is made to develop a relatively higher degree of compression in an angularly distant cylinder during the latter part of the induction stage. The fins 23, just intermediate the working fluid conduits, may be extended and shaped as shown in Fig. 6, so as to abut the inductor, and thereby to aid the formation of a high degree of vacuum, and a correspondingly high induction pressure. While the induction pressure is moderate while the engine operates at low speed, it increases as the engine speeds up, because of the greater number of impelling or flow inducing impulses and the increased velocity of the cooling air which accompanies it, and when the engine attains a high speed the impelling impulses follow one another in rapid succession, and establish a substantially uniform vacuum in the cooling air conduits, and a substantially constant flow therethrough.

The engine may be operated in other ways than above set forth. For instance, the working fluid may be supplied to the cylinders by a carburetor with the aid of a compressor. In such an instance the inlet inductor 32 is omitted, and the front bracket is modified as shown in Fig. 3, to form an annular induction chamber 37, communicating through openings 38 with the inlet passages 19. The chamber is provided with an opening 39, to which a carburetor or compressor may be connected in an obvious manner, not shown. It is seen that my construction and arrangement eliminates cumbersome external manifolding usually employed, to connect a series of cylinders with a carburetor or compressor. The induction chamber is formed at least partly but preferably wholly within the bracket, and the connection of the chamber with all the cylinders is accomplished, by merely bolting the bracket to the cylinder block. If desired, the exhaust gas may be conducted from the engine apart from the cooling air, in which case the outlet inductor 32' is omitted, and a bracket formed as just above described is fitted to the exhaust end of the cylinder block, the chamber 37 now serving to collect the exhaust gas and to expell it through the opening 38, to which an exhaust pipe may be fitted. From the drawings it is seen that the arrangement for conducting the working fluid through the engine, either jointly with or apart from the cooling air, leaves the path of the cooling air stream unobstructed.

The aggregate stroke bore ratio in the illustrated engine is 3.5 to 1, which is well suited for operation of the engine with a high compression pressure, and with compression ignition, well suited for the development of a high combustion pressure. I provide improved means for transforming the high pressure developed in the cylinders into torsional power. This means includes a pair of shafts 40, 40', one for each crank chamber, each shaft being provided with a crank element 41, 41' arranged to substantially incline with respect to the rotational axis of the shaft. The crank element may be of substantial diameter, and take the form of an eccentric, but is preferably of relatively small diameter to form a crank pin as shown in the drawings.

It should be noted that the parts within the crank chamber 15 at the left end, are identical with the parts in the crank chamber 15' at the right end, and that in order to avoid congestion of numerals in the drawings, the prime mark has been applied to some of the numerals, to indicate that such numeral will be found identifying a part at the right end which is identical with a corresponding part at the left end. The crank element is preferably formed integral with the shaft and so that one end converges with a main portion of the shaft, and so that its bearing axis converges with the rotational axis of the shaft, to form a point of convergence or intersection 42, which will hereafter also be referred to as the apex. The diverging end of the crank element is connected with another main portion of the shaft, by means of a crankarm as shown. Each shaft is provided with a counterweight 43 arranged opposite the crank arm, and is operatively supported on both sides of the crank element by an anti-friction thrust bearing 44 within the bracket 11, and by an anti-friction bearing 45, having an inner race 46, secured to the shaft by the locknut 47, and having an outer race element 48, secured to the cylinder block by bolts 49.

Arranged within the crank chambers and operatively associated with the crank elements, I provide a pair of non-rotating but oscillatable annular elements 50, 50', which will also be referred to as oscillators. The oscillators are preferably made from steel, and each is shaped to form a pair of raceways provided with rolling bodies 51, 52, operatively associated with inner race elements 53, 54, respectively, which are secured to the crank element 41 by the locknut 55 and spacer 56.

Each oscillator is provided with fulcrum means for transferring torque between oscillator and engine body comprising a pair of bevel gears 57, 58, fixedly associated with the oscillator and engine body respectively. The gear 58 is arranged concentric with shaft 40, and within the circle of cylinders, and in the present instance is formed by teeth cut directly in the face of race element 48, and the gear 57 is arranged concentric with the axis of race elements 53, 54, and is formed by teeth cut directly in the face of the oscillator. Both gears have teeth of the same pitch and are formed to have identical pitch cones. The gears are arranged to mesh along one side of their pitch cones, with a slight working clearance between teeth, and so that the centers of their pitch cones converge to form a vertex, and

are further arranged so that the vertex converges with the apex point 42. In this manner the lateral thrust exerted by the pistons on outerly portions of the oscillator, is effectively transformed into rotation of the shaft. As the shaft rotates, the oscillator gear 57 rolls or weaves with respect to gear 58. The gears, at all times, maintain line contact at one point of their pitch cones, and form a progressing but nevertheless powerful fulcrum between oscillator and engine body. The moderate diameter of the gears and their moderate angle of relative inclination, results in smooth and quiet operation even at high speed. While the gears in the drawings, for the sake of simplicity have been shown with straight teeth, it will be understood that some other practical tooth form may be employed, such as the spiral bevel gear type, when especially quiet and smooth operation is desired.

I provide means for efficiently transmitting the power developed by the high pressure in the cylinders to the oscillators. This means, shown in detail in Fig. 3, consists of a piston for each cylinder, comprising a sleeve 31, having an inwardly extending rim or flange 59, provided on the side facing the combustion chamber, with a concavely spherical bearing surface, which will be referred to as a concave, and on the other side provided with a convexly spherical bearing surface, formed concentric with said concave, which will hereafter also be referred to as a convex. One end of the piston rod 60 extends through the flange 59, and is provided with a collar 61, which may be formed integral with rod 60, but is preferably made separate therefrom, and provided with a substantial spherical surface arranged to bear against the convex in flange 59. The protruding end of piston rod has an expanded end portion 62, also preferably formed separately and secured to the end of the rod by suitable means such as the locknut 63, which forms a piston rod head. The head 62, on one side, is exposed to the interior of the cylinder, and on the other side is provided with a spherical surface in operative bearing contact with the piston sleeve flange concave, and is shaped to form a cooling chamber 64, having a substantial cooling surface in close heat conducting proximity to the exposed side of the head. Thus the bulk of the high pressure developed in the cylinder, is made to thrust directly against the expanded end of the piston rod, and since only a narrow edge of piston sleeve 31 is exposed to the interior of the cylinder, the thrust on the piston sleeve 31 and on the collar 61, is relatively small. Although the diameter of the piston rod head is nearly that of the cylinder bore, its movement or weaving with respect to the sleeve flange 59 is inconsiderable, for reasons which will hereafter be more fully described. Expansible sealing rings 65 between sleeve 31 and head 62, and an expansible sealing ring 66 between sleeve 31 and the cylinder bore is provided. The width of ring 66 is preferably made to exceed the width of the port, formed by the terminal of conduit 16, insuring the free passage of the ring over ports having substantial angularly extending openings. The ring 66 on its inner side, is provided with a plurality of grooves 67, which are preferably tapered and may be formed separate from one another, or may be cut in the ring like an internal single or multiple thread, the grooves in the piston sleeve 31 being shaped to match, so as to form a tongue and groove like multiple seal. During operation, gas pressure against the side of the ring forces the tongues in the ring 66 against the grooves in sleeve 31, and thereby prevents compressed gas from working under the ring, and excessively pressing the ring against the cylinder wall. The concentric shape of the piston sleeve 31, permits it to be machined all over, and to be formed with very thin walls. The construction lends itself to the production of light weight pistons made from a strong metal, having the same heat expansion characteristics as the cylinders, such as iron or steel, and permits fitting the pistons in the cylinders with a small working clearance, without the risk of seizure. The construction of the piston and sealing ring is not claimed herein but forms the subject matter and is claimed in my copending patent application for Engine, Serial No. 403,190 filed July 19, 1941.

The oscillators 50, 50', are formed as shown in the figures, and particularly in Fig. 3 and Fig. 5. The outer portion of each oscillator beyond the gear 57, is formed with bosses or arms 68, preferably arranged to extend into the cylinder as the shaft rotates, and provided with spherical bearing sockets formed partly by the bearing plugs 69, screwed into threaded openings of the oscillator, as shown in the lower half of Fig. 5. The free end of the piston rod extends into the socket of the oscillator through the opening 70, and is shaped to form a spherical journal 71 fitted within the socket.

The sockets in the oscillators are positioned so that their centers, when in the intermediate position indicated by the point 72 in Fig. 3, form axes, with the apex point 42, that incline from the perpendicular with the shaft axis 73, toward crank element 42, and are perpendicular to the inclined cylinder axis 74, thus causing only moderate articulation of piston rod 60, with respect to piston sleeve 31.

With this construction and arrangement of cylinder block, oscillator and associated parts, I secure an oscillator of relatively small diameter and light weight, a close spacing of the sockets and concentration of the piston thrust toward the thrust bearing 44, substantially in a straight line particularly during the period of their maximum thrust, when in the position particularly shown by the upper half of Fig. 1. The combination forms a compact mechanism of great rigidity and power, it permits the positioning of the counterweight 43 between crank element and thrust bearing, and its inclusion in the crank chamber, and makes possible the use of a bracket shaped to withstand a powerful thrust without undue distortion. The concentration of the thrust towards thrust bearing 44, also operates to reduce deflection of the crank element, as well as the load on the pilot bearing 45.

The shafts 40, 40', are rotationally connected to operate as a unit, in fixed circumferential relationship with one another. This is accomplished by an axially slidable joint 75, formed by splines cut in the ends of the shafts. The splines may be formed to mesh with each other, but are preferably formed to mesh with splines in an intermediate shaft 76, arranged to join the shafts as shown. The shafts are preferably connected, so that one crank element is in the lead, and operates to uncover the exhaust conduit 16' before the inlet conduit 16 is uncovered. With my construction and arrangement, assembly and disassembly of the engine can be quickly and easily effected; for instance, removal of the bolts 12 permits the withdrawal of bracket 11, together

with the shaft, oscillator and pistons, facilitating rapid inspection or replacement of these or associated parts. It is also seen that my construction of the crankshaft and associated parts, makes the use of an integral oscillator possible, and the use of anti-friction bearings not only on the main shaft but also on the crank element, because of its inclined position and convergence with the shaft, which permits the bearing races and locknut to be slipped into position over the small end, the counterweight being arranged at the other end of the crank element.

It should be noted that the transmission mechanism, that is the improved means for transforming the high pressure developed in the cylinders into torsional power including the means for transmitting the pressure in the cylinders to the oscillators, as well as the construction and arrangement of the shafts facilitating assembly, are not claimed herein but form the subject matter and are claimed in my copending patent application for Engine, Serial No. 403,190, filed July 19, 1941.

As heretofore mentioned my engine includes means for coordinating the temperature of the pistons with that of the cylinders, so as to maintain a uniform working clearance between cylinders and pistons, under varying conditions of operation. This is accomplished by the provision of a liquid coolant in the jacket of the cylinder block, which is capable of serving as a lubricant, such as oil, and by circulating the same coolant around the cylinders and through the piston cooling chambers 64. For this purpose each bracket is provided with a pump 77, driven by a worm gear 78, secured to the engine shaft. Coolant from the bottom of bracket 11 flows into reservoir 79 through duct 80, is drawn into the pump through duct 81, and through duct 82 is forced into the cylinder block jacket 83, subjecting the interior of the jacket to a moderate pressure. The pressure forces the coolant into the interior of the hollow shafts through the ducts 84, and as it reaches the ducts 85 in the crank element, and the duct 86 in the spacer, rotation of the crankshaft increases the pressure on the coolant, and impells it into the annular chamber 87, in oscillator 50, clearly shown in Fig. 3, which serves to distribute it to the cooling chambers 64 in the pistons, by way of the duct 88 in the oscillator, duct 89 in the bearing plug, and ducts 90, 91 and 92, in the piston rod, to be expelled from the cooling chamber through ducts 93, and after accumulating at the bottom of the bracket or the reservoir 79, to return to the pump. I further provide an impeller 94, in uniform proximity to all the cylinders driven by the crankshaft, shown as part of the intermediate shaft 76 in Figs. 1 and 2, which impells the liquid between webs 95, 95', and through the communicating ducts 96 at the top of the web, shown in Fig. 2, circulates it around the cylinders and past the inner surface of the partition means 21, and returns it to both sides of the impeller through the openings 97, 97'. Thus variation in the temperature of the coolant affects cylinders and pistons alike, and causes both to expand or contract simultaneously, and thereby under changing conditions of operation, to maintain a predetermined working clearance between cylinders and pistons. Excess heat from the pistons and cylinders is transferred to the coolant and the coolant, with the aid of impeller 94, effectively transfers the heat to the partition 21, which in turn conducts it to the cooling elements 23, to be carried away by the stream of cooling air.

The lubricating coolant in the jacket, also operates to lubricate and cool the bearings and gearing. The mild pressure in the jacket forces coolant through the working clearance separating shaft 76, and bearing race 48, toward bearing 45 and gear teeth 58. Coolant is also forced through working clearances formed by race elements 53, 54, and the oscillator, and serves to cool and lubricate the rolling bodies 51 and 52, and gear teeth 57.

From the foregoing it will be seen that my engine is inherently self charging, self cooling and self lubricating, and that in many instances it requires no external auxiliary devices. It requires substantially no external plumbing, and forms a compact and self contained unit that can be installed in a small space, and is well suited for the efficient production of high power.

It should be noted that various changes may be made in the details of construction and combination of the various parts of my device, and that one or more of the features disclosed herein may be used in the illustrated or other embodiments without departing from the spirit of my invention, and I desire to cover by my claims such changes and other embodiments which may reasonably be included within the scope of my invention.

I claim as my invention:

1. In an internal combustion engine of the class wherein a pair of axially spaced brackets are associated with a rotatable crankshaft, pairs of oppositely positioned laterally reciprocable pistons are arranged about the axis of the crankshaft, and are provided with cooling chambers, and a transmission mechanism connecting the pistons with the crankshaft: the combination of a cylinder block secured to said brackets providing therewith a pair of crank chambers and an engine body, and formed to provide elbow shaped pairs of inclined cylinders arranged to converge toward said crank chambers, and further formed to provide inlet and outlet working fluid conduits extending in laterally opposite directions from the inclined portions of the cylinders for conducting working fluid into and out of the cylinders; an annular heat transfer unit comprising partition means in liquid tight association with outer portions of, but formed separately from the engine body, providing on its innerly side a jacket for the cylinders, and on its outerly side provided with separately formed heat conducting elements, providing a laterally extending cooling conduit serving to conduct engine cooling air past said elements, for the transfer of heat from the partition means to the cooling air, said cooling conduit having an inlet arranged to converge with said working fluid inlets, and having an outlet arranged to converge with said working fluid outlets; a liquid within said jacket adapted to serve as a coolant and as a lubricant; means associated with the engine body, crankshaft, transmission mechanism and pistons, for circulating said liquid between the piston cooling chambers and the jacket, serving to transfer heat from the pistons to the liquid; means for circulating said liquid within the jacket, serving to transfer heat from the cylinders to the liquid, and from the liquid to the partition means; and means for utilizing the energy of the burnt working fluid for inducing fresh working fluid into the cylinders, comprising a joint outlet housing connected with

said converging outlets, and an outlet inductor associated with the outlet housing, and converging outlets shaped to join the burnt working fluid with the engine cooling air in numerous thin flatwise alternating streams, and a joint inlet housing connected with converging inlets, and an inlet inductor associated with the inlet housing, and converging inlets shaped to separate the incoming cooling air and working fluid from each other in numerous thin flatwise alternating streams.

2. In an internal combustion engine of the class wherein a cylinder block comprises laterally extending cylinders arranged about a rotatable power shaft, provided with ports adapted to be uncovered by oppositely reciprocable pistons, and inlet and outlet working fluid conduits are connected with said ports for conducting working fluid into and out of the cylinders: the combination with said cylinder block of means for cooling and charging the cylinders, said means comprising partition means forming on one side a jacket containing a fluid for cooling the cylinders, and provided on the other side with cooling elements, and closure means forming cooling air conduits having inlets and outlets arranged to converge with said inlet and outlet working fluid conduits respectively, and to form therewith an inlet juncture and a joint inlet housing, and also to form an outlet juncture and a joint outlet housing, a stream forming inlet inductor within the inlet housing, and a stream forming outlet inductor within the outlet housing, each inductor being arranged to extend from a corresponding juncture, and shaped to form an undulating partition providing a series of narrow flatwise adjacent and edgewise expanding ducts communicating edgewise and in alternating relation with said cooling air and working fluid conduiits, and extending edgewise substantially across the interior of said housing whereby the working fluid and cooling air in the housings are formed into a series of thin flatwise alternating streams, and the flow of working fluid from the outlet conduit causes cooling air to be drawn into the joint inlet housing, and thereby to induce a flow of working fluid under pressure into the inlet conduit.

3. In an internal combustion engine having an inlet conduit and an outlet conduit for conducting working fluid into and out of the engine, and having a cooling air conduit in heat conducting relation with the engine provided with an inlet and an outlet for conducting the engine cooling air into and out of the cooling air conduit: the combination with said conduits of means for coupling the cooling air with the working fluid, comprising a joint inlet housing connected with the inlets of said conduits, and provided with an inlet stream forming inductor, and a joint outlet housing connected with the outlets of said conduits and also provided with a stream forming inductor, each inductor being shaped to form the working fluid and the cooling air into a series of thin flatwise adjacent and alternating streams whereby the flow of working fluid from the outlet conduit causes cooling air to be drawn into the joint inlet housing, and thereby to induce a flow of working fluid under pressure into the inlet conduit.

4. In an internal combustion engine of the class wherein an engine body is provided with laterally extending cylinders having inlet and outlet working fluid conduits, and oppositely facing reciprocable pistons in said cylinders are connected with a rotatable power shaft, and an outer portion of the engine body provides a partition and forms a jacket containing a liquid coolant for said cylinders: the combination with said engine body of a plurality of laterally extending but circumferentially skewed cooling elements, and cooling air conduits associated with the outer surface of said partition for conducting the engine cooling air, having inlets and outlets arranged to converge with inlets and outlets of the working fluid conduits belonging to angularly displaced cylinders, whereby the burnt working fluid from one cylinder is associated with one end of a cooling air conduit, and the fresh working fluid flowing into an angularly displaced cylinder is associated with the other end of such cooling air conduit.

5. In an internal combustion engine of the class wherein a transmission mechanism operatively connects a rotatable power shaft with laterally reciprocable pistons arranged about the axis of said shaft: the combination with said pistons of a cylinder block provided with inclined cylinders for said pistons, forming diverging and converging ends and radial cooling passages between cylinders, an annular portion associated with the converging ends of the cylinders shaped to form laterally extending inner and outer walls, and between walls to form laterally extending working fluid ducts for said cylinders, having openings arranged radially between the converging and diverging cylinder ends, a partition associated with said outer wall forming on its inner side a jacket containing a liquid for cooling said cylinders, and provided on its outer side with closely spaced laterally extending cooling elements adapted to be cooled by a stream of cooling air, and to transfer heat from the partition to the cooling air, and an inwardly extending open centered web associated with said cylinders positioned to axially divide said radial passages and spaced from said partition to form lateral passages; and a rotatable impeller connected with said shaft and arranged on one side of the web within the jacket in substantially uniform proximity to the cylinders, adapted to circulate the liquid past the cylinders, and partition for the transfer of heat therebetween.

6. In an internal combustion engine wherein an engine body is provided with a crank chamber, a plurality of cylinders and a jacket adapted to contain a liquid for cooling said cylinders, reciprocable pistons in the cylinders are provided with cooling chambers, and a rotatable shaft is arranged within the crank chamber and is connected with said pistons: the combination of a liquid within said jacket adapted to serve as a lubricant and as a coolant; means associated with said shaft, pistons and engine body for circulating said liquid between the piston cooling chambers and said jacket, serving to lubricate the pistons and to transfer heat from the pistons to the liquid; and means for circulating said liquid within the jacket, serving to transfer heat from the cylinders to said liquid, including a rotatable impeller arranged within the jacket.

7. In an internal combustion engine wherein a cylinder block is provided with laterally extending cylinders arranged about the axis of a rotatable power shaft spaced one from another to form radial cooling passages between cylinders, an outer partition forming a jacket, and a liquid within the jacket for cooling the cylinders: the combination with said cylinder block of an inwardly extending open centered web associated

with the exterior of said cylinders, positioned to axially divide said radial cooling passages, and spaced from said outer partition to form lateral passages; and a rotatable impeller connected with said shaft and arranged on one side of the web within the jacket, in substantially uniform proximity to the cylinders, for circulating the liquid around the web through said radial and lateral passages.

8. In an internal combustion engine wherein a plurality of cylinders form a cylinder block, and are provided with a jacket containing a liquid for cooling said cylinders: the combination with said cylinder block and liquid of a rotatable impeller arranged within the jacket, in substantially uniform proximity to all the cylinders for agitating the liquid within the jacket.

9. In an internal combustion engine of the class wherein a rotatable power shaft is associated with a bracket, and is connected with laterally reciprocable pistons arranged about its axis: the combination with said bracket, pistons and power shaft of a cylinder block comprising inclined cylinders for said pistons, arranged to form diverging and converging ends, an annular portion formed integral with the converging ends of the cylinders, and shaped to provide an inner wall secured to said bracket and to provide an outer wall, and between said walls to provide working fluid ducts extending from the inclined portion of the cylinders, and having openings arranged radially substantially between the converging and diverging cylinder ends, and a partition associated with said outer wall forming a jacket adapted to contain a liquid coolant for said cylinders.

10. In an internal combustion engine of the class wherein a transmission mechanism connects a rotatable power shaft with laterally reciprocable pistons arranged about the axis of said shaft: the combination with said power shaft and pistons of an engine body provided with inclined cylinders for said pistons, forming diverging and converging ends, an annular portion integrally associated on one side with the converging ends of the cylinders, and shaped to form laterally extending working fluid ducts for said cylinders, having openings arranged radially between the converging and diverging cylinder ends, and a bracket separably associated with the other side of said annular portion, forming on its inner side a chamber for said transmission mechanism, and forming on its outer side a working fluid chamber communicating with said working fluid ducts.

11. In an internal combustion engine of the class wherein a rotatable power shaft is associated with a bracket, and is connected with laterally reciprocable pistons arranged about its axis: the combination with said bracket, pistons and power shaft, of a cylinder block comprising inclined cylinders for said pistons arranged to form diverging and converging ends, an annular portion formed integral with the converging ends of the cylinders, and shaped to provide an inner wall secured to said bracket, and to provide an outer wall, and between said walls to provide working fluid ducts extending from the inclined portion of the cylinders, and having openings arranged radially between the converging and diverging cylinder ends, said cylinder block and bracket forming an engine body; and an annular heat transfer unit comprising partition means in liquid tight association with, but formed separately from the engine body providing on its innerly side a jacket adapted to contain a liquid coolant for said cylinders, and on its outerly side provided with separately formed heat conducting elements, and a laterally extending cooling conduit serving to conduct engine cooling air past said elements, for the transfer of heat from said partition means to the cooling air.

12. In an internal combustion engine of the class wherein a transmission mechanism connects a rotatable power shaft with laterally reciprocable pistons arranged about the axis of said shaft: the combination with said pistons of a cylinder block provided with cylinders for said pistons, an annular portion formed integral with one end of the cylinders, and a separately formed annular partition in liquid tight association with said annular portion, forming a jacket for said cylinders adapted to contain a liquid.

13. In an internal combustion engine of the class wherein a transmission mechanism operatively connects a rotatable power shaft with laterally reciprocable pistons arranged about the axis of the shaft: the combination with said pistons of a cylinder block providing inclined cylinders for said pistons having diverging and converging portions and laterally extending working fluid conduits connecting with the interior of the cylinders between converging and diverging portions and shaped to provide oblong outer openings having their long axis arranged circumferentially to form the working fluid at said outer openings into radially thin but circumferentially wide streams, partition means associated with said cylinder block forming on its inner side a jacket containing a liquid for transferring heat from said cylinders to the partition means and provided on its outer side with laterally extending cooling elements and closure means forming cooling air conduits disposed about the outer periphery of the partition means adapted to conduct a stream of cooling air and to transfer heat from the partition means to the cooling air, said cooling air conduits being arranged to converge with said working fluid conduits and to form therewith a juncture and a joint passage for the cooling air and working fluid whereby the flow of one is made to induce a flow of the other.

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