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1 600 713

(54) ROTARY OPERATED SLIDE VALVE ARRANGEMENT

(71) We, ALTO AUTOMOTIVE, INC., a Corporation of the State of Illinois, United States of America, of Box 33, Deerfield, Illinois 60015, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a rotary operated valve arrangement for a motor or the like and is an improvement in or modification of the invention described in U.K. patent specification no. 1,548,825.

Patent specification no. 1,548,825 discloses and claims a rotary valve arrangement for a motor or the like, including a flow conduit terminating in a combustion chamber, and a rotary valve mounted in a housing interposed in said flow conduit, rotatable camshaft means; means for rotating said rotary valve in a manner responsive to rotation of said camshaft means; intermittent occluding and sealing means for preventing flow through said flow conduit comprising a sealing surface intermittently positionable across said conduit, and first means, operated by said camshaft means, for moving said sealing surface into stationary occluding and sealing relation with said flow conduit and out of occluding and sealing relation with said flow conduit, said occluding and sealing means being adapted whereby the intermittent occluding and sealing by said surfaces is correlated with the operation of said rotary valve means, to seal said flow conduit when said rotary valve is in closed position, and to be out of said occluding and sealing relation when said rotary valve is in open position, and second means, operated by said camshaft means, for intermittently exerting pressure through said rotary valve housing to press said sealing surface into improved occluding and sealing relation with said flow conduit when said sealing suface is positioned in said occluding and sealing relation.

In accordance with this invention, there is provided a rotary valve arrangement for a motor or the like, including a flow conduit terminating in a combustion chamber, a rotary valve interposed in said flow conduit, a pair of rotatable camshafts positioned on opposite sides of said flow conduit, means for causing synchronous rotation of said camshafts and said rotary valve; valve plate member means positioned between said camshafts, said plate member means being transversely movable relative to said flow conduit to define a sealing surface across said flow conduit in a first position, and to define an open aperture across said flow conduit in a second position; and cam means on each camshaft in communication with said plate member means to cause said plate member means to move between said first and second positions as said camshafts rotate.

The invention also resides in a rotary valve arrangement for a motor or the like including a flow conduit terminating in a combustion chamber, and a rotary valve interposed in said flow conduit, valve plate member means transversely movable relative to said flow conduit to define a sealing surface across said flow conduit in in a first position, and to define an open aperture across said flow conduit in a second position, said valve plate member means defining first and second plate members, said plate members having parallel surfaces and being positioned so that said parallel surfaces abut each other in sealing relationship in the first position, and said sealing surfaces being spaced from each other so that the plate members define the open aperture in said second position, and means for moving said plate members in opposite directions to each other between said first and second positions.

Reference is now made to the accompanying drawings, wherein:

Figure 1 is a transverse vertical sectional view taken through a motor as illustrated in Figure 5 with the valve plates in the open position.

Figure 1A is a fragmentary sectional view, similar to Figure 1, but with the valve plates in the closed position.

Figure 2 is a fragmentary perspective view of a portion of the motor of Figure 1 with valve plates shown in a closed, rather than in an open position.

Figure 3 is an exploded perspective view of the motor of Figures 1 to 10.

Figure 4 is a longitudinal vertical sectional view taken on a line perpendicular to the sectional view of Figure 3.

Figure 5 is a top plan view of Figures 1 through 4.

Figure 6 is an elevational view of the means for connecting the various rotating parts of the engine of Figures 1, through to 5 to rotate in synchronous manner.

Figure 7 is a top plan view of the valve plates otherwise shown in Figure 1.

Figure 8 is a transverse sectional view of a cam follower assembly attached to the valve plates.

Figure 9 is an enlarged plan view, with parts broken away, of part of a plate member as shown in Figure 7.

Figure 10 is a sectional view taken along line 10—10 of Figure 9.

Referring to the drawings, a conventional piston 150 reciprocates in a cylinder 152 which preferably contains flow channels 154 around the cylinder for providing a flow of cooling water, to lower the operating temperature of the engine. The upper portion of cylinder 156 may be constricted in the manner described in UK specification no. 1 548 825. Constricted portion 156 of the cylinder may also define water flow channels 158 for cooking, and laterally mounted spark plug 160 in a spark plug well as in specification no. 1 548 825.

Rotary valve 162 is provided for a function similar to that described in specification no. 1 548 825. Valve 162 is positioned in valve housing 164 which housing loosely fits about valve 162. Housing 164 defines an aperture in which valve 162 fits, which is of slightly oval shape to permit upward and downward reciprocation of valve block 164 by a distance on the order of, preferably, 0.05 to 0.015 inch.

Rotary valve 162, in turn, defines apertures 168 which communicate, respectively, with intake manifold 170 and exhaust manifold 172 in a conventional manner of operation for rotary valves.

A sliding valve assembly positioned between the opening 157 of constricted cylinder portion 156 of the combustion chamber and valve block 164 is defined by a pair of reciprocating valve plates 174, 176, which serve as a replacement for valve plate 34 in specification no. 1 548 825. Valve plates 174, 176 define parallel sealing edges 178, 180 with the valve plates 174, 176 being positioned so that the parallel sealing edges abut each other in sealing relationship when the valve plates 174, 176 are in a first, closed position, as shown in Figures 1*a* and 2, to define a sealing surface 182 to close off the upper end 157 of the combustion chamber.

Valve plates 174, 176 can move in directions opposite to each other into a second, open position as shown in Figures 1 and 3 to define an open aperture through which fuel may be taken in through intake manifold 170 and valve 162, and through which exhaust gas may be expelled through the same rotary valve 162 and exhaust manifold 172.

The motion of valve plates 174, 176 is governed by a pair of rotatable camshafts 184, 186 which are adapted to be in synchronous rotation with valve 162 by belt and pulley system 188, which may be positioned at the front or back of the engine adjacent the ends of the respective shafts. In the embodiment shown, camshafts 184, 186 each carry a pulley 190. Rotary valve 162 also carries a pulley 190. Belt 192 is threaded about the respective pulleys 90 as well as a pulley on crankshaft 194 and two idler pulleys 196, 198. Accordingly, the entire system operates in synchronous rotation, driven by the crankshaft 194.

Each camshaft 184, 186 carries three cams for each cylinder utilized in the motor: cams 200, 202 and 204. Cams 200, 204 on the shafts 186, 184 respectively, bear against cam followers 208, 206 respectively on the ends of plate 174. Similarly, cams 200, 204 on the shafts 184, 186 respectively, bear against cam followers 210, 212 respectively on the ends of plate 176. In each respective camshaft 184, 186, cams 200, 204 are in reversed position to the corresponding cams on the other camshaft, as shown, so that each set of cams 200, 204 positioned on opposite camshafts cooperates to push each plate 174, 176 back and forth between the camshafts to open and close the valve aperture between the plates, as the plates move in opposite directions between the first and second positions.

Plates 174, 176 are positioned in their closed position during the compression and ignition phases of the motor operation, then moving by the action of opposing sets of cams 200, 204 to the open position as shown in Figures 1 and 3 for the exhaust and intake phases of the motor operation. Thereafter, cams 200, 204 move plates 174, 176 back into their closed, sealing position for a new compression and exhaust phase in the engine cycle.

It can be seen that cams 200, 204 perform a function generally similar to cams 48 and 50 in specification no. 1 548 825, although by a different form of mechanical action.

Cams 202 are also opposed to each other on their respective camshafts, and perform a function which is analogous to cams 74, 76 in specification no. 1 548 825. The cams define an off-center circumference of, preferably about 0.015 inch. Bearing member 205 slides against the periphery of each cam 202, being retained by lever arm 209 which is adapted for pivoting about pivot shaft 211, each of which is mounted in pillow blocks 213 by passing through apertures thereof.

Accordingly, as camshafts 184, 186 rotate, cams 202 are positioned so that their longer radius portion engages bearing member 205 while valve plates 174, 176 are in their, closed position, during the compression and combustion phases of the engine cycle. Levers 209 are accordingly raised on the side adjacent cams 202, and lowered on sides 214, pressing on ears 216 of block 164 to force valve block 164 downwardly against the closed valve plates 174, 176. This facilitates the sealing of the combustion chamber at its upper end 157, as in the construction described in specification no. 1 548 825.

When bearing member 205 is elevated by cam action about 0.015 inch, valve block 164 is lowered by approximately 0.005 inch, with about a threefold mechanical advantage, to provide a desired firm pressure against valve plates 174, 176, to prevent leakage of combustion products.

Immediately thereafter, as the shorter radius portion of cam 202 rotates into contact with bearing member 205, the downward pressure on valve block 164 by lever arms 209 is released, to allow valve plate members 174, 176 to move from their first to their second positions for opening the combustion chamber, and then to permit the valve plate members to close once again, prior to reapplication of the pressing force of valve block 164 through the action of cams 202.

Valve plate members 174, 176 may be retained on valve plate bed 218 by bolts 220, which are retained in slots 222. Valve plate bed, in turn is carried by the upper surface of the upper cylinder block 153.

Slots 222 may have beveled edges as shown in Figure 7 so that bolts 220 rest flush within the slot.

The upper end of combustion chamber 157 exits through valve plate bed 218, being surrounded by one or more annular seals 224, which may be constructed in the manner of auxiliary sealing system 94 as disclosed in specification no. 1 548 825.

Figure 4 shows a typical arrangement for the exhaust manifolds 172 and the intake manifolds 170 for a four-cylinder engine having the firing order of the engine disclosed in specification no. 1 548 825. The apertures 168*a* on rotary valve 162 which provide access between intake manifolds and cylinder chambers 156 are shown as indicated. Channels 168*b* provide communication between exhaust manifolds 172 and chamber 156, as can be seen. Manifolds 170, 172 communicate with rotary valve rod 162 through apertures 225 in valve block 164. The flow path is then completed through aperture 165 in the bottom of valve block 164.

An upper annular seal 226 is defined in the lower surface of valve block 164 to provide additional sealing of the interface between the valve block and valve plates 174, 176. Seal 226 may be constructed in a manner similar to that of seals 224.

Oil entry port system 228 is similar to the system of the construction described in specification no. 1 548 825, except that oil line may be pressure-fed in conventional manner. Scraper blade 230 is provided in a manner similar to member 141 of the above specification to remove excess oil from portions of the rotary valve 162 before exposure to combustion chamber 156 (in this embodiment, as in the above specification, rotary valve 162 rotates clockwise).

Other conventional oil lubrication systems may be used in the motor of this invention.

The embodiment of Figures 1 to 10 can be lubricated by free-falling lubricant, falling on and around valve block 164 and camshafts 184, 186. By this, the sliding surfaces adjacent and on valve plates 174, 176 can be lubricated as well. Alternatively, more sophisticated pressurized lubrication systems can be provided in any manner desired.

At least one of the cam followers of each sliding valve plate 174, 176 is a multi-part system to permit adjustment of the length of each valve plate 174, 176 to fit the needs of the particular system, to adjust for wear, and the like.

As shown in Figure 3, each of cam followers 206, 212 comprises an inner member 232 which is attached to its respective plate 174 or 176. Inner member 232 defines an angle other than perpendicular to the plane of the respective plate members 174, 176. An outer member 236 defines a typically flat cam contact surface 237 for contact with its mating cam 204 (or cam 200 as the case may be).

Outer member 236 also defines an inner surface positioned against and parallel to the upstanding end face 234 and correspondingly indicated by that reference numeral as well. Accordingly, movement of outer member 236 upwardly or downwardly along the sliding surfaces 234 correspondingly causes cam contact surface 237 to move inwardly or outwardly to change the overall length of each plate member 174, 176. This permits the adjustment of the plate member by a few thousandths of an inch as necessary to optimize the functioning of the engine.

Figure 8 shows the retention mechanism

utilized for holding outer member 236 in a fixed position with respect to inner member 232. Outer member 236 defines a projection 240 which fits in slot 242 of inner member 232. Inner member 232 also defines a side port 244 which passes through slot or aperture 242. Positioned within side port 244 are a pair of gripping pads 246, positioned to bear against and grip projection 240, impelled by the pressure of tapered bolts 248. The tapered surfaces 250 of bolts 248 drive pads 246 inwardly against projection 242 as bolts 248 are advanced into bolt holes 252, for retention of outer member 236.

To facilitate the sealing between edges 178, 180, one of the parallel sealing edges 178 is defined by a sliding member assembly 254. Assembly 254 comprises a first sliding member 256, as part of plate member 176, and having a forward edge 258. A second sliding member 260 is carried by the first sliding member and defines sealing edge 178, adapted for sealing contact with the other sealing edge 180 of plate 174. The second sliding member is relatively movable in the direction of motion between the first and second positions of plates 174, 176, being retained in plate 176 by the loose fitting of retainer lug 262 of upper sliding member 260 in enlarged aperture 264 of plate member 176.

Pins 266 are carried by lower member 256, and are positioned in slots 268 of sliding valve plate 176 for retention of lower member 256 with valve plate 176.

Spring seals 269 are provided, comprising an arcuate spring member terminated at its ends with enlarged sealing members 270, and positioned at the rear of upper member 260. Lower member 256 also carries a similar spring seal member 272, which is terminated with sealing members 274 and positioned at the rear of lower member 256. Spring member 272 is adapted to bear against a lower portion of plate 176, while spring seal 268 bears against edge 276 of plate 176.

Accordingly, when the valve plates 174, 176 are being moved in opposite directions into the first, sealed position where edges 178 and 180 mate together in a sealed closure over the upper end 157 of the combustion chamber, the apparatus is so proportioned that the sliding member assembly 254 is pushed into closed position with edge 180 through projection 262 and related parts, to cause the second sliding member 260 to move relatively forwardly with respect to the first sliding member 356, to cause edge 178 to project slightly forwardly of edge 258, as shown in dotted lines in Figure 10. This projecting edge forms the seal with edge 180.

Simultaneously, the same closing action causes plates 176 to bear against spring seals 269, 272, correspondingly causing sealing projections 270, 274 to spread outwardly to a slight degree, providing a side seal for sliding member assembly 254 in the first position of the sliding members. As camshafts 184, 186 continue to rotate, and plates 174, 176 begin to move to the open position, the pressure on spring seals 269, 272 is released, causing the side seals 270, 274 to retract laterally inwardly, releasing the side seals. Then, as valve plates 174, 176 begin to move in opposite directions to each other from the first sealing position into the second, open position, projection 262 is pulled by the walls of aperture 264 in plate 176 to cause the entire sliding member assembly 254 to move away from the opening 157 of the combustion chamber. As an initial motion, first sliding member 260 is withdrawn to its position shown in full lines in Figure 10, shielding the edge 178 from the full effects of the blast of exhaust gas being emitted through the open end of combustion chamber 157.

This process repeats itself over and over again throughout the movement of valve plates 174, 176, to provide a significant increase in the sealing capability of the motor of this invention over conventional valve systems.

Additional sealing features of sliding member assembly 254 include projections 276 on first or lower sliding member 256, as well as side seals 281 on both sides of first sliding member 256, one of which is illustrated in Figure 9 by broken away portions and phantom lines. A wave spring 280 is positioned in a slot behind a flat seal bar 282 which, in turn bears, against side edges 284, 286 of valve plates 174, 176 for sealing.

By means of the above construction of a sealing arrangement, rotary valves can be utilized on a long-term commercial and reliable basis. As a result of this, the operating temperature of the engine can be drastically reduced, which, in turn, greatly reduces the amount of nitrogen oxide pollutants produced by the engine. Similarly, engines utilizing the invention disclosed herein can exhibit a great deal of power for their size, coupled with a good "drivability" since, by the use of rotary valves, valve overlap can be minimized. Rotary valves inherently provide much greater efficiency of intake and exhaust than poppet valves, since there is no poppet to impede the flow into and out of the combustion chamber. Also, the engine is expected to operate more efficiently, using low octane fuel if desired.

WHAT WE CLAIM IS:—

1. A rotary valve arrangement for a motor or the like, including a flow conduit terminating in a combustion chamber, a rotary valve interposed in said flow conduit, a pair of rotatable camshafts positioned on opposite sides of said flow conduit, means for causing synchronous rotation of said camshafts and said rotary valve; valve plate

member means positioned between said camshafts, said plate member means being transversely movable relative to said flow conduit to define a sealing surface across said flow conduit in a first position, and to define an open aperture across said flow conduit in a second position; and cam means on each camshaft in communication with said plate member means to cause said plate member means to move between said first and second positions as said camshafts rotate.

2. The rotary valve arrangement of Claim 1 in which said plate member means is positioned between said rotary valve and said combustion chamber.

3. The rotary valve arrangement of Claim 2 in which said valve plate member means comprises first and second, laterally positioned plate members, said plate members having parallel sealing edges which abut each other in sealing relationship in the first position of said plate member means, said sealing edges being spaced from each other to define the open aperture in the second position of said plate member means, said cam means being adapted to move said plate members in opposite directions to each other between said first and second positions.

4. A rotary valve arrangement for a motor or the like, including a flow conduit terminating in a combustion chamber, and a rotary valve interposed in said flow conduit, a pair of rotatable camshafts positioned on opposite sides of said flow conduit, means for causing synchronous rotation of said camshafts and said valve; first and second, laterally positioned plate members, having parallel sealing edges, said plate members being transversely movable in opposite directions, actuated by the camshafts, relative to said flow conduit whereby said parallel sealing edges can abut each other in sealing relationship so that the plate members define a sealing surface across said flow conduit in a first position of the members, and said sealing edges can be spaced from each other so that the plate members define an open aperture across said flow conduit in a second position of the plate members, and cam means on each camshaft in communication with said plate members to cause said plate members to move in opposite directions from each other between said first and second positions as said camshafts rotate, said plate members being positioned between the rotary valve and the combustion chamber; in which one of said sealing edges is defined by a sliding member assembly which comprises a first sliding member as part of one of said plate members and having a leading edge during movement of the plate members towards said first position, and a second sliding member carried by said first sliding member and defining said one sealing edge, adapted for sealing contact with the other sealing edge of the other plate member, said second sliding member being relatively movable in the direction of motion between said first and second positions, and means for causing said one sealing edge to project outwardly beyond the leading edge of said first sliding member in said first position of the plate members, while causing said one sealing edge to retract inwardly behind the leading edge while the plate members move from said first position to said second position, whereby, in use, the one sealing edge is protected from the direct blast of exhaust gas upon opening the seal defined between the plate members.

5. The rotary valve arrangement of Claim 4 in which said second sliding member carries, on its side opposite to said one sealing edge, an arcuate, flexible spring member to resiliently bear against an edge of the plate member which carries said second sliding member, to resiliently urge said second sliding member to a leading position, said spring member carrying enlarged sealing members at its respective ends, said ends being positioned at the sides of said second sliding member to be urged outwardly for sealing as said arcuate spring member is compressed, as said first and second plate members move into the sealed, first position.

6. The rotary valve arrangement of Claim 5, in which said first sliding member carries on its side opposite to said leading edge an arcuate, flexible spring member to resiliently bear against an edge of the plate member which carries said second sliding member, to resiliently urge said first sliding member to a leading position, said spring member carrying enlarged sealing members at its respective ends, said ends being positioned at the sides of said first sliding member, to be urged outwardly for sealing as said arcuate spring member is compressed as the first and second plate members move into said sealed first position.

7. The rotary valve arrangement of any preceding Claim in which a single flow conduit communicates with said combustion chamber.

8. The rotary valve arrangement of any preceding Claim in which said combustion chamber is surrounded by a water jacket to reduce the operating temperature within said combustion chamber.

9. The rotary valve arrangement of any preceding Claim in which a movable valve block is positioned about said rotary valve, second cam means positioned on said camshafts, and lever arm means, actuated by said second cam means, adapted for intermittently pushing said valve block against said plate members, while in said first position, to facilitate the sealing of said flow conduit.

10. The rotary valve arrangement of Claim 9 in which said valve block defines a

pair of oppositely-disposed ears against which said lever arms press.

11. The rotary valve arrangement of Claim 10 as appended to Claim 4 in which said plate members define upstanding cam follower members positioned at each end thereof, at least one of said follower member of each plate member comprising an inner member defining an upstanding end face which is other than perpendicular to the plane of said plate member, and an outer member defining a cam contact surface and an inner surface positioned against and parallel to the upstanding end face, whereby adjustment of said outer member by movement along said upstanding end face results in a change in the length of said plate member, and means for releasably holding said outer member in immovable position on said inner member.

12. The rotary valve arrangement of Claim 11 in which said inner member defines an aperture and said outer member carries a projection, positioned within said aperture; a side port positioned in said inner member communicating with said aperture; and pressure gripping means extending through said side port to engage and rigidly hold the projection within the aperture.

13. A rotary valve arrangement for a motor or the like including a flow conduit terminating in a combustion chamber, and a rotary valve interposed in said flow conduit, valve plate member means transversely movable relative to said flow conduit to define a sealing surface across said flow conduit in a first position, and to define an open aperture across said flow conduit in a second position, said valve plate member means defining first and second plate members, said plate members having parallel surfaces, and being positioned so that said parallel surfaces abut each other in sealing relationship in the first position, and said sealing surfaces being spaced from each other so that the plate members define the open aperture in said second position, and means for moving said plate members in opposite directions to each other between said first and second positions.

14. The rotary valve arrangement of Claim 13 in which one of said parallel sealing edges is defined by a sliding member assembly which comprises a first sliding member as part of one of said plate members and having a leading edge during movement of the plate members towards said first position, and a second sliding member carried by said first sliding member and defining said one sealing edge, adapted for sealing contact with the other sealing edge of the other plate member, said second sliding member being relatively movable in the direction of motion between said first and second positions, and means for causing said one sealing edge to project outwardly beyond the leading edge of said first sliding member in said first position, while causing one sealing edge to retract inwardly behind the leading edge of said first sliding member while moving from said first position to said second position, whereby in use, the one sealing edge is protected from the direct blast of exhaust gas upon opening the seal defined between the plate members.

15. The rotary valve arrangement of Claim 14 in which said second sliding member carries, on its side opposite to said one sealing edge, an arcuate, flexible spring member to resiliently bear against an edge of the plate member which carries said second sliding member, to resiliently urge said second sliding member to a leading position, said spring member carrying enlarged sealing members at its respective ends, said ends being positioned at the sides of said second sliding member to be urged outwardly for sealing as aaid arcuate spring member is compressed, as said first and second plate members move into the sealed, first position.

16. The rotary valve arrangement of of Claim 4, 14 or 15 in which said first sliding member carries on its side opposite to said leading edge an arcuate, flexible spring member to resiliently bear against an edge of the plate member which carries said second sliding member, to resiliently urge said first sliding member to a leading position, said spring member carrying enlarged sealing members at its respective ends, said ends being positioned at the sides of said first sliding member, to be urged outwardly for sealing as said arcuate spring member is compressed as the first and second plate members move into said sealed first position.

17. The rotary valve arrangement of Claim 13, 14, 15 or 16 in which a movable valve block is positioned about said rotary valve, and adjacent said plate members, and means for intermittently pushing said valve block against the plate members, while in said first position, to facilitate the sealing of said flow conduit.

18. The rotary valve arrangement of Claim 17 in which said plate members are moved between their first and second sliding positions by cam means, said cam means being adapted for synchronous rotation in a manner correlating with the rotation of said rotary valve.

19. The rotary valve arrangement of Claim 18 in which second cam means are positioned on said camshafts, and lever arm means, actuated by said second cam means, adapted for intermittently pushing said valve block against said plate members, while in said first position, to facilitate the sealing of said flow conduit.

20. The rotary valve arrangement of Claim 19 in which said valve block defines a pair of oppositely-disposed ears against which said lever arms press.

21. The rotary valve arrangement of any one of Claims 13 to 20 in which a single flow conduit communicates with said combustion chamber.

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1600713 COMPLETE SPECIFICATION

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Sheet 1

FIG. 1

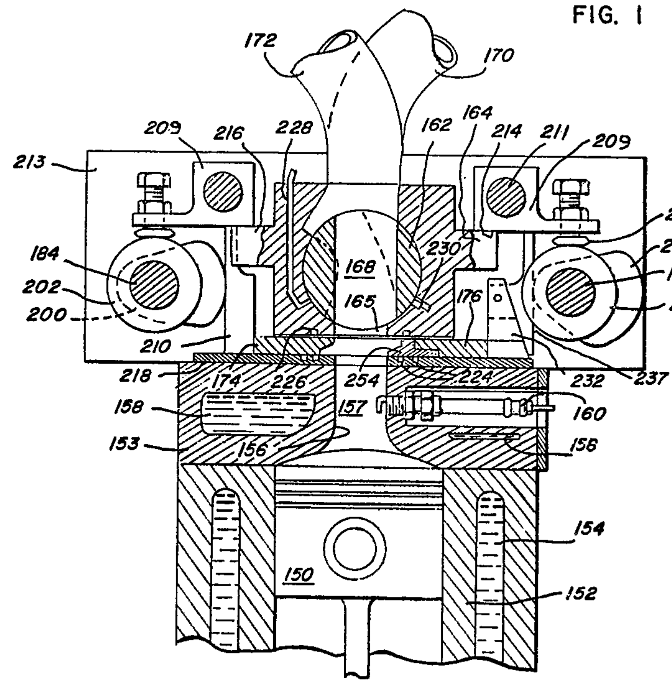


FIG. 1 A

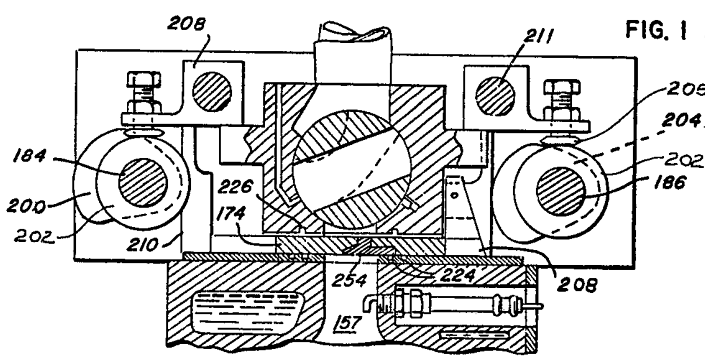
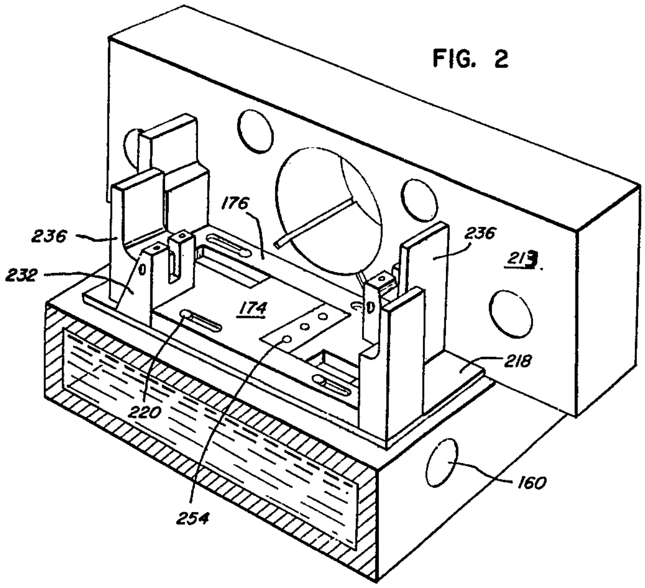


FIG. 2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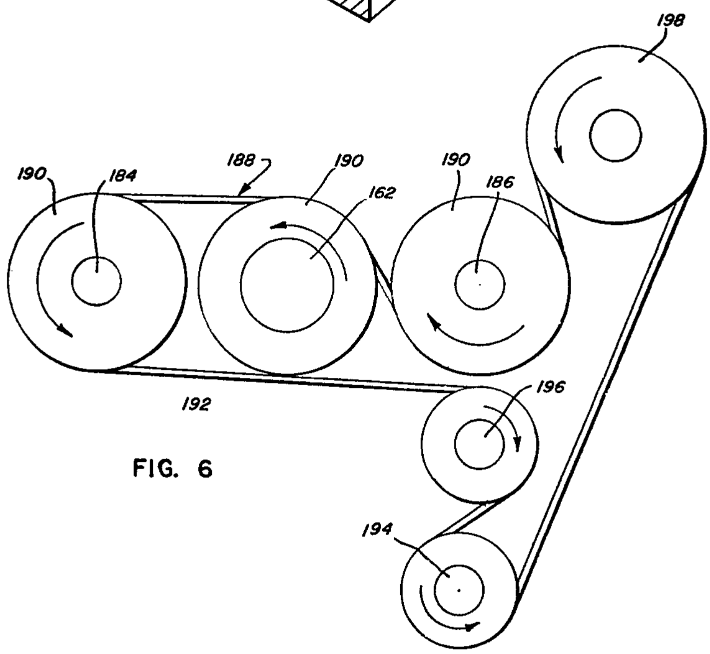
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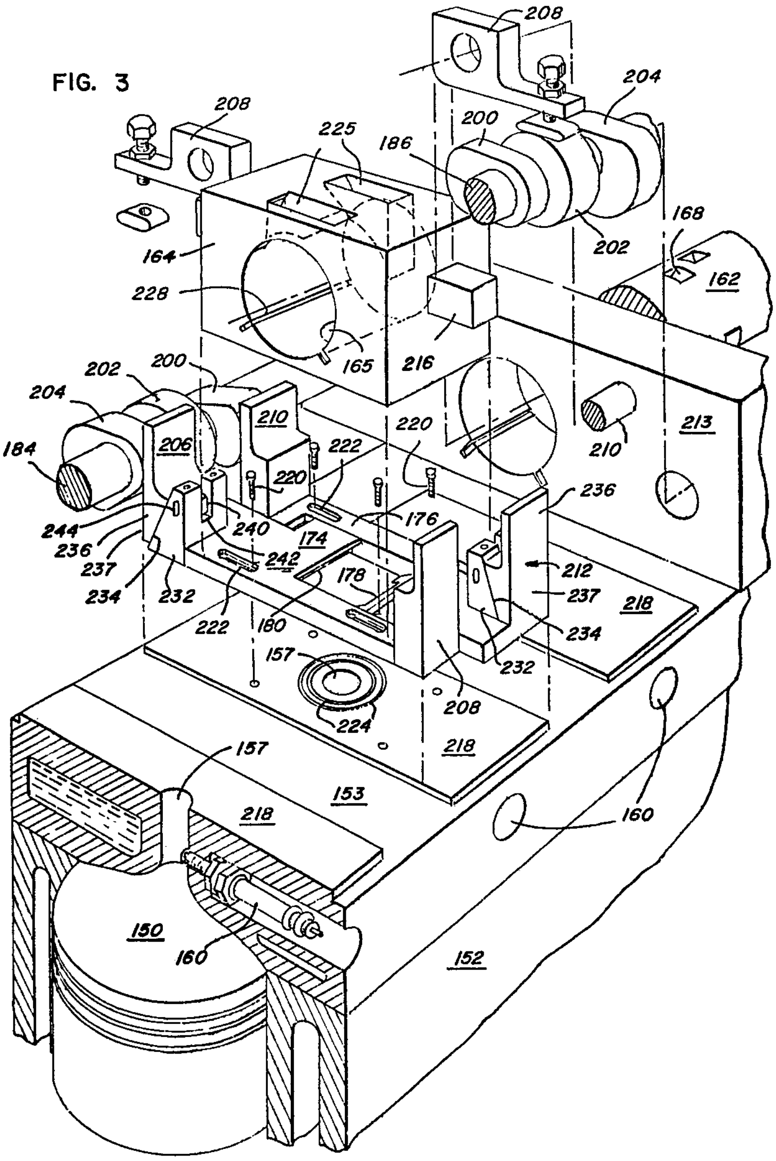
FIG. 6

FIG. 3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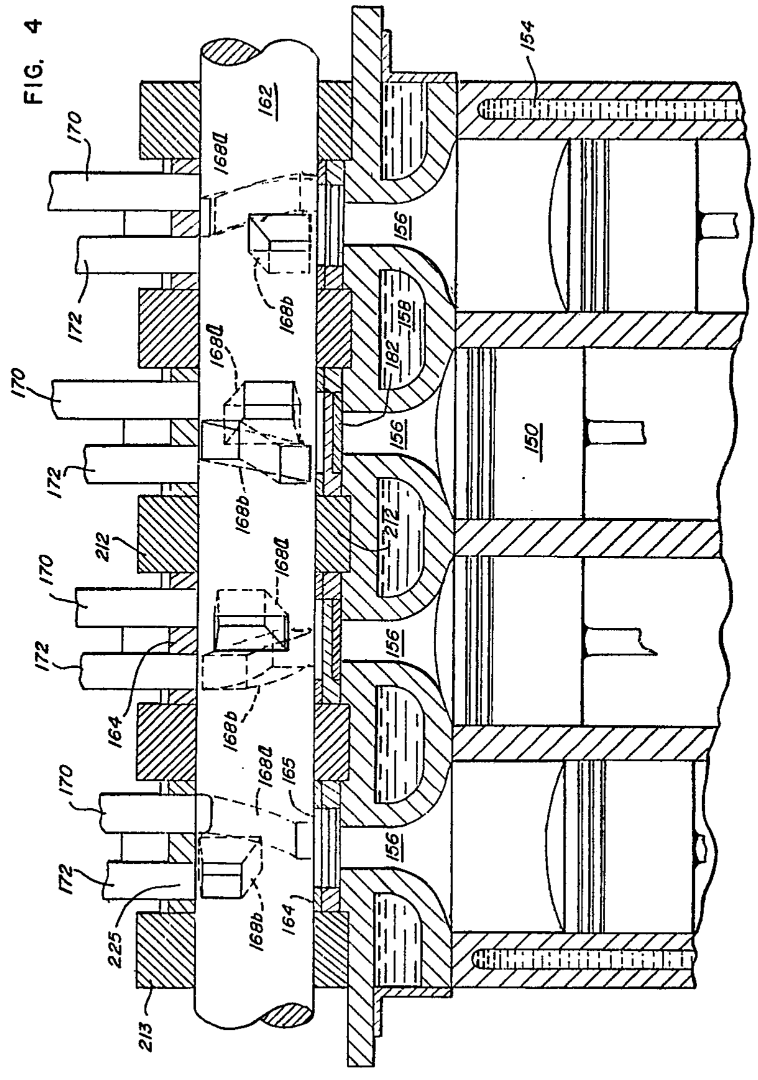
Sheet 4

FIG. 4



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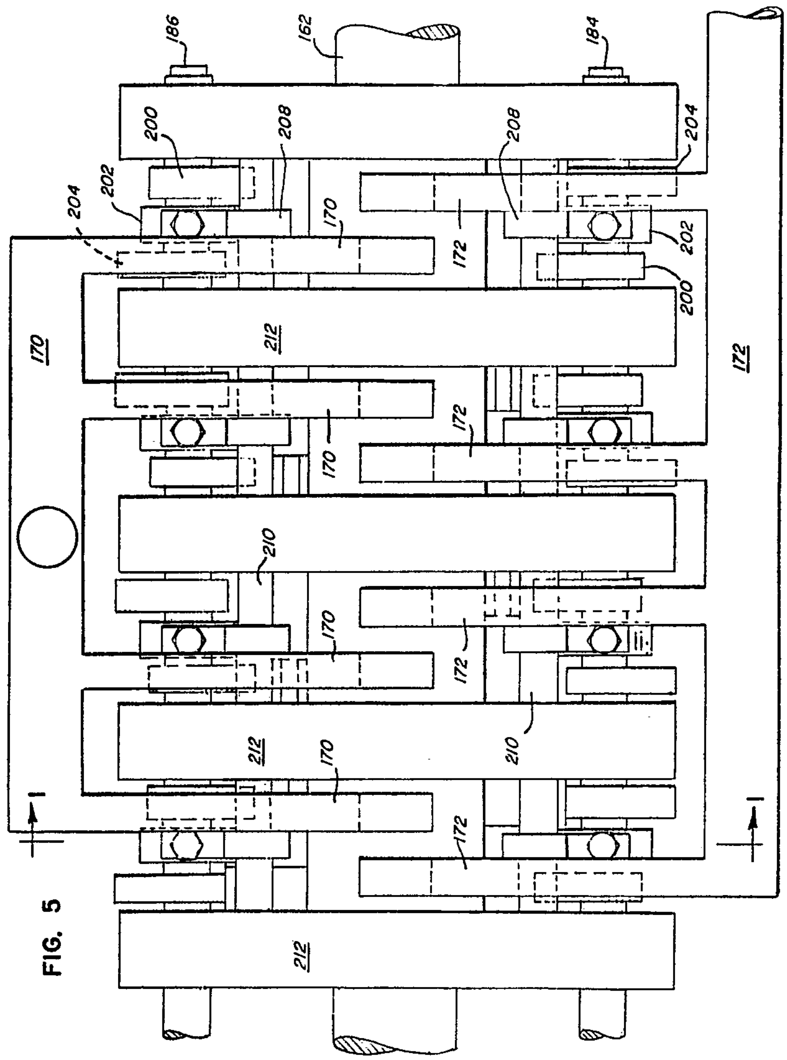

FIG. 5

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Sheet 6

FIG. 7

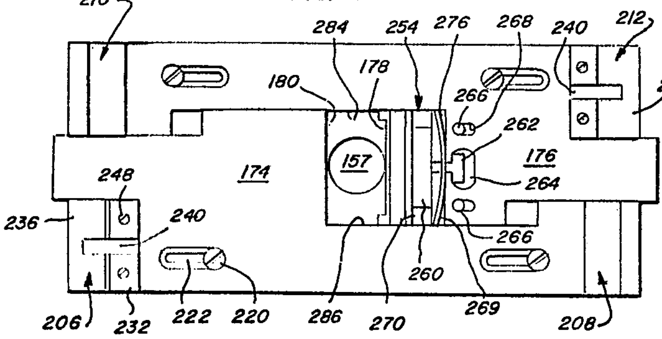

FIG. 10

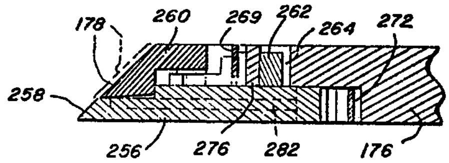

FIG. 8

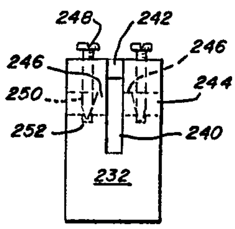

FIG. 9