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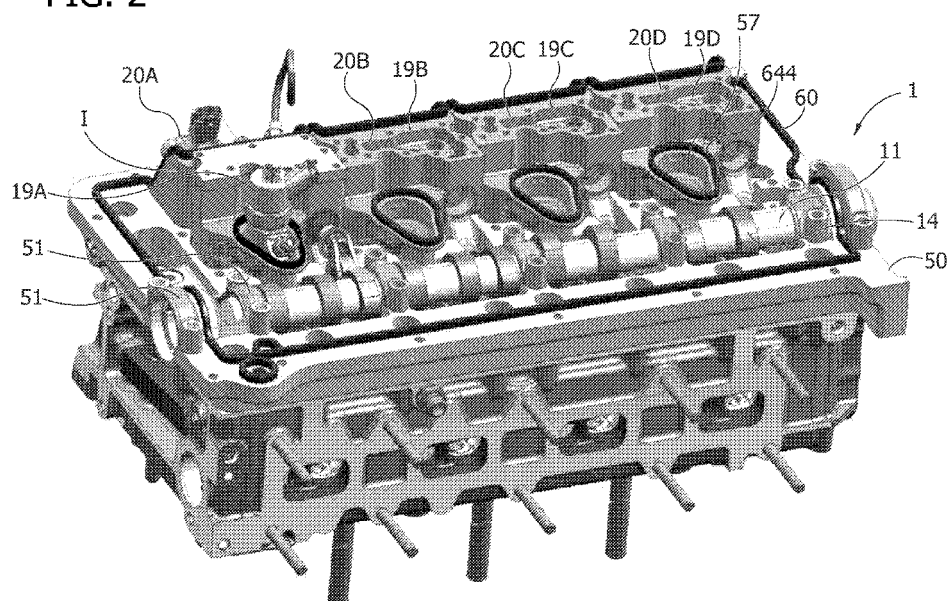
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Amended claims in accordance with Rule 137(2) EPC.

(54) **Multi-cylinder internal combustion engine with a system for variable actuation of the intake valves and an injector housing having a raised sealing edge**

(57) In a multi-cylinder internal combustion engine, provided with a system for variable actuation of the intake valves of the engine, the fuel injector (I) associated to each engine cylinder is surrounded by a sealing casing (57) which is part of a support body (19A-D; 70). The support body (19A-D; 70) is mounted on the engine cylinder head with the interposition of a support (50) surmounting the head and defining the seat in which the

camshaft (11) is received and it defines a sealing peripheral edge cooperating with a sealing cover (58) which is mounted on the cylinder head. The cover (58) has a general base plane sealingly mounted on the cylinder head or on the support (50). The sealing peripheral edge of each sealing casing (57) is arranged in a parallel plane and raised with respect to the general base plane of the cover (58).

FIG. 2

Description

[0001] The present invention refers to internal combustion engines of the type provided with a system for variable actuation of the intake valves of the engine.

[0002] Even more particularly, the invention refers to multi-cylinder internal combustion engines which comprise, for each cylinder:

- a fuel injector,
- at least one intake valve and at least one exhaust valve each provided with respective return spring means which push the valve towards a closed position, for controlling respective intake and exhaust conduits,
- at least one camshaft, for actuating the intake valves of the engine cylinders by means of respective tappets,
- wherein each intake valve is controlled by the respective tappet, against the action of the aforementioned return spring means, by interposing hydraulic means including a pressurised fluid chamber and a hydraulic actuator associated to each intake valve and connected to said pressurised fluid chamber,
- said pressurised fluid chamber being adapted to be connected by means of a solenoid valve with an exhaust channel with the aim of decoupling the intake valve from the respective tappet and causing the quick closure of the valve due to the respective return spring means,
- said hydraulic actuator further being provided with hydraulic braking means for slowing the final phase of the travel for closing the intake valve controlled thereby when the pressure chamber is connected to the exhaust channel,
- electronic control means for controlling each solenoid valve so as to vary the opening and/or closing and/or lift instants of the respective intake valve as a function of one or more engine operative parameters,
- wherein the hydraulic means for controlling the intake valves of the engine and the solenoid valves associated thereto are part of a preassembled unit mounted on the engine cylinder head.

[0003] An engine of the type indicated above is for example described and illustrated in EP 1 338 764 A1 of the applicant.

[0004] Over the years, the Applicant has developed internal combustion engines comprising a system for variable actuation of the intake valves of the type indicated above, sold under the trademark "MLTLTIAIR". The Applicant owns various patents and patent applications regarding engines provided with a system of the type described above.

[0005] According to what is indicated in the document EP 1 338 764 A1 the entire unit for the variable actuation of the intake valves of the engine is integrated in a single

"brick" which can be easily also adapted on an engine initially designed without the system for variable actuation of the intake valves.

[0006] The object of the present invention is that of improving the abovementioned known system, with particular reference to the simplicity of construction and assembly as well as reducing the overall dimensions. One specific problem requiring to be solved in an engine of the type in question lies in providing a sealing casing around each injector of the engine in the limited space available adjacent to each cylinder, due to the presence of the actuators of the intake valves of the engine.

[0007] With the aim of attaining such objects, the invention has the object of providing an engine having the characteristics indicated above and further characterised in that the fuel injector associated to each engine cylinder is surrounded by a sealing casing which is part of a support body mounted on the engine cylinder head such casing defines a sealing peripheral edge cooperating with a sealing cover which is mounted on the cylinder head, and having a general base plane sealingly mounted on the cylinder head. The sealing peripheral edge of each sealing casing is arranged in a plane parallel and raised with respect to the general base plane of said cover.

[0008] Due to the aforementioned characteristics, the sealing around each injector is suitably guaranteed, regardless of the presence - closely adjacent to the injector - of the components of the intake valves actuation system.

[0009] Further characteristics and advantages of the invention will be apparent from the description which follows with reference to the attached drawings, provided by way of non-limiting example, wherein:

- figure 1 is a sectional view of an engine according to the known art, of the type described for example in document EP A 0 803 642 of the applicant,
- figure 2 is a partial perspective view of the cylinder head of a diesel engine according to a first embodiment of the present invention,
- figure 3A is a perspective view, partially transparent, of a single sub-unit for the variable actuation of the intake valves associated to an engine cylinder of figure 2,
- figure 3B is a further perspective view of the support body of the sub-unit of figure 3A,
- figures 4, 5 are sectional views showing the detail of a bracket for locking an injector of the engine of figure 2,
- figure 6 is a perspective view of a cover associated to the cylinder head of figure 2,
- figure 7 is a capsized perspective view of the cover of figure 6,
- figure 8 is a bottom view of the cover of figure 6,
- figure 8A is still a perspective view of a single sub-unit for actuating the intake valves associated to an engine cylinder,

- figure 8B is a sectional view of the sub-unit of the figure 8A,
- figure 9 is a perspective view of a unit associated to the cylinder head of a further embodiment of a diesel engine provided with a system for variable actuation of the intake valves of the engine, which also forms part of the present invention, ,
- figure 10 is an enlarged scale perspective view of a component of the unit of figure 9,
- figure 11 is a sectional view of the unit of figure 9, and
- figure 12 is a perspective view of a bracket for locking an injector of the engine on which the unit of figure 9 is mounted.

[0010] Over the years, the applicant has developed internal combustion engines, petrol or diesel-fuelled, comprising a system for variable actuation of the intake valves of the engine, sold under the trademark "MULTIAIR". The Applicant owns various patents and patent applications regarding engines provided with a system of the type described above.

[0011] Figure 1 of the attached drawings shows a sectional view of a petrol-fuelled engine provided with "MULTIAIR" system, as described in the European patent EP 0 803 642 B 1 of the applicant.

[0012] With reference to figure 1, the engine illustrated therein is multi-cylinder engine, for example an engine with four in-line cylinders, comprising a cylinder head 1. The head 1 comprises, for each cylinder, a cavity 2 formed by the base surface 3 of the head 1, defining the combustion chamber, in which the two intake conduits 4, 5 and two exhaust conduits 6 end up. The communication of the two intake conduits 4, 5 with the combustion chamber 2 is controlled by two intake valves 7, of the conventional mushroom type, each comprising a stem 8 slidably mounted in the body of the head 1.

[0013] Each valve 7 is returned towards the closed position by springs 9 interposed between an inner surface of the head 1 and an end retaining cap 10 of the valve. The communication of the two exhaust conduits 6 with the combustion chamber is controlled by two valves 70, also of the conventional type, to which springs 9 for return towards the closed position are associated.

[0014] The opening of each intake valve 7 is controlled, as described hereinafter, by a camshaft 11 mounted rotatably around an axis 12 within supports of the head 1, and comprising a plurality of cams 14 for actuating the intake valves 7.

[0015] Each cam 14 which controls an intake valve 7 cooperates with the plate 15 of a tappet 16 slidably mounted along an axis 17 which, in the case of the example illustrated in the mentioned prior art document, is substantially directed at 90° with respect to the axis of the valve 7. The plate 15 is returned against the cam 14 by a spring associated thereto. The tappet 16 constitutes a pumping piston slidably mounted within a bushing 18 carried by a body 19, or "brick" of a preassembled unit 20, incorporating all electrical and hydraulic devices as-

sociated to the actuation of the intake valves, according to the description outlined hereinafter.

[0016] The pumping piston 16 is capable of transmitting a thrust to the stem 8 of the valve 7, so as to cause the opening of the latter against the action of the elastic means 9, by means of pressurised fluid (preferably oil coming from the engine lubrication circuit) present in a pressure chamber C to which the pumping piston 16 is faced, and by means of a piston 21 slidably mounted in a cylindrical body constituted by a bushing 22 also carried by the body 19 of the sub-unit 20.

[0017] Still in the known solution described in figure 1, the pressurised fluid chamber C associated to each intake valve 7 can be placed in communication with an exhaust channel 23 through a solenoid valve 24. The solenoid valve 24, which can be of any known type adapted to the function illustrated herein, is controlled by electronic control means, indicated schematically with 25, as a function of the signal S indicating the operating parameters of the engine, such as the position of the accelerator and the number of engine revolutions.

[0018] When the solenoid valve 24 is open, the chamber C enters in communication with the channel 23, hence the pressurised fluid present in the chamber C flows into such channel and thus obtaining the decoupling of the cam 14 and the decoupling of the respective tappet 16 from the intake valve 7, which thus quickly returns to the closing position thereof under the action of the return springs 9. Thus, controlling the communication between the chamber C and the exhaust channel 23, allows varying the opening time and the travel of each intake valve 7 at will.

[0019] The exhaust channels 23 of the various solenoid valves 24 end up in the same longitudinal channel 26 communicating with pressure accumulators 27, only one of which can be observed in figure 1.

[0020] All tappets 16 with the associated bushings 18, the pistons 21 with the associated bushings 22, the solenoid valves 24 and the respective channels 23, 26 are carried by and obtained from the abovementioned body 19 of the preassembled unit 20, to the advantage of an engine that is quick and easy to assemble.

[0021] The exhaust valves 70 associated to each cylinder are controlled, in the embodiment illustrated in figure 1, conventionally, by a respective camshaft 28, through respective tappets 29, even though, in the case of the mentioned prior art document, an application of the hydraulic actuation system also controlling exhaust valves cannot be excluded generally.

[0022] Still with reference to figure 1, the variable volume chamber defined within the bushing 22 and facing the piston 21 (which is illustrated in the minimum volume condition thereof in figure 1, piston 21 being in the upper end stop position thereof) communicates with the pressurised fluid chamber C through an opening 30 obtained in an end wall of the bushing 22. Such opening 30 is engaged by an end nose 31 of the piston 21 so as to provide a hydraulic braking of the movement of the valve

7 in the closing phase, when the valve is close to the closing position, in that the oil present in the variable volume chamber is forced to flow into the pressurised fluid chamber C passing through the clearance present between the end nose 31 and the opening wall 30 engaged thereby. Besides the communication constituted by the opening 30, the pressurised fluid chamber C and the variable volume chamber of the piston 21 communicate with respect to each other through internal passages obtained in the body of the piston 21 and controlled by a check valve 32 which allows the passage of fluid only from the pressurised chamber C to the variable volume chamber of the piston 21.

[0023] During the normal operation of the known engine illustrated in figure 1, when the solenoid valve 24 excludes the communication of the pressurised fluid chamber C with the exhaust channel 23, the oil present in such chamber transmits the movement of the pumping piston 16, imparted by the cam 14, to the piston 21 which controls the opening of the valve 7. In the initial phase of the opening movement of the valve, the fluid coming from the chamber C reaches the variable volume chamber of the piston 21 passing through the check valve 32 and further passages which place the internal cavity of the piston 21, which is tubular-shaped, in communication with the variable volume chamber. After a first displacement of the piston 21, the nose 31 exits from the opening 30, hence the fluid coming from the chamber C may pass directly into the variable volume chamber through the opening 30, now free.

[0024] In the reverse movement for closing the valve, as previously mentioned, during the final phase, the nose 31 enters into the opening 30 causing the hydraulic braking of the valve, so as to avoid impacts of the body of the valve against the seat thereof, for example after an opening of the solenoid valve 24 which causes the immediate return of the valve 7 to the closed position

[0025] In the described system, when the solenoid valve 24 is enabled, the valve of the engine follows the movement of the cam (full lift). An early closing of the valve can be obtained by disabling (opening) the solenoid valve 24, thus emptying the hydraulic chamber and obtain the closing of the valve of the engine under the action of the respective return springs. Analogously, a delayed opening of the valve can be obtained by delaying the opening of the solenoid valve, while the combination of a delayed opening with an early opening of the valve can be obtained by enabling and disabling the solenoid valve during the thrust of the relative cam. According to an alternative strategy, in compliance with the teachings of the patent application EP 1 726 790 A1 of the applicant, each intake valve can be controlled in "multi-lift" mode i.e. according to two or more repeated opening and closing "sub-cycles". In each sub-cycle, the intake valve opens and then closes completely. The electronic control unit is thus capable of obtaining a variation of the opening instant and/or the closing instant and/or the lift instant of the intake valve, as a function of one or more engine

operative parameters. This allows obtaining the maximum efficiency of the engine, and lower consumption of fuel, under any condition of operation.

[0026] In figures 2-12, the common parts or those corresponding to those of figure 1 are indicated using the same reference number.

[0027] With reference to figure 2, a body 50 for supporting the camshaft 11 - in which the seats for supporting the rotation of the shaft 11, on which the latter is held by means of caps 51 fastened on the body 50 - is mounted on the cylinder head 1. the illustrated example refers to the case of a four-cylinder diesel engine. However, the invention is also applicable to a controlled ignition engine and with any number of cylinders.

[0028] In the case of the solution illustrated in figure 2, the pre-assembled unit for the variable actuation of the intake valves of the engine is constituted by four separate sub-units 20A, 20B, 20C, 20D, each comprising a respective support independent body or "brick", respectively indicated with 19A, 19B, 19C, 19D.

[0029] As observable in figure 3A, the body 19A of the sub-unit 20A, and analogously each of the other bodies 19B, 19C, 19D of the sub-units 20B, 20C, 20D carries all the devices intended to allow actuating the intake valves of the respective engine cylinder. In particular, with reference to the sub-unit 20A, the sub-unit carries the pumping cylinder 18 whose stem is actuated by a respective cam 14 by means of a rocker arm lever 52, articulated in 53 to the support body 19A and carrying a roller 54 for the engagement of the cam 14. Furthermore, the support body 19A of the sub-unit 20A carries the two hydraulic actuators 22 respectively associated to two intake valves of the respective engine cylinder. Furthermore, the body 19A carries the body of the solenoid valve 24, which simply rests within a seat arranged in the body 19A and it is locked by means of a locking plate 52 fixed by means of screws to the body 19A. Obviously all ducts required for the hydraulic connection of the system for variable actuation of the valves are obtained within the body 19A. Lastly, an upper cavity of the body 19A (indicated with 56 in figure 3B) is closed by means of a cover 570 fastened on the body 19A.

[0030] What is indicated above with reference to the unit 20A obviously also applies for the sub-units 20B, 20C and 20D.

[0031] The illustrated example, as mentioned, refers to the case of a diesel engine. Figure 2 shows one of the injectors associated to the engine cylinders, indicated with the reference I. Each injector I is mounted in the cylinder head through a cup-shaped casing 57, illustrated more in detail hereinafter and which is made in a single piece with the respective support body 19A of the respective sub-unit 20A.

[0032] The unit for variable actuation of the intake valves of the engine, constituted by the plurality of sub-units 20A-D is closed at the upper part by a cover 58 with the interposition of a sealing gasket 60.

[0033] In the illustrated example, the sealing gasket 60

is received in a corresponding peripheral groove of the cover 58 (see figure 7) and respectively provides sealing on the bodies 19A-D and on the body 50 for supporting the camshaft.

[0034] However, it should be observed that the architecture of the head described above is provided purely by way of non-limiting example. For example, the body 50 for supporting the camshaft could be made in a single piece with the cylinder head, or it could be made in several pieces respectively integrated in the support bodies of the sub-units 20A-D.

[0035] In the case of the solution of figure 2, the sealing gasket 60 has a main portion contained in a general base plane of the cover 58, and a plurality of portions 61A-D arranged longitudinally adjacent to each other along one side of the head and associated respectively to the various support bodies 19A-D of the sub-units 20A-D. Each of said portions 61A-D has two lateral portions 62 which extend in planes parallel and orthogonal to the above-mentioned general base plane, and a central portion 63 which extends in a parallel plane with respect to the abovementioned general base plane and raised with respect thereto. In particular, as observable in figure 7, each of the lateral portions 62 has a rectilinear main section which - at the end - extends in two brief sections one respectively contained in the general base plane of the cover and the other in the plane in which the central portions 63 extend.

[0036] Due to the abovementioned arrangement, the sealing of the fluid of the system for variable actuation of the intake valves (typically engine lubrication oil) at each of the sub-units 20A-20D is ideally guaranteed, even in the area that separates each sub-unit 20 from the one adjacent thereto (also see figure 8A).

[0037] As indicated above, a problem observed in an engine of this type lies in guaranteeing the sealing around each injector I, regardless of the presence of the actuators 22 of the intake valves arranged closely adjacent to the injector. For such purpose, as previously described, each injector is surrounded by a cup-shaped casing 57, shaped extended horizontally, obtained in a single piece with the respective body 19A-D of the respective sub-unit 20A-D. The cup-shaped casing 57 defines an upper peripheral edge for the engagement of a respective sealing gasket 64 arranged within a respective groove in the lower surface of the cover 58 (figure 7). The plane of the upper edge of the cup-shaped casing 57 is parallel but raised with respect to the general base plane of the cover, so that the casing 57 can have the required dimension, without the risk of interference with the actuators 22 associated to the intake valves of the respective cylinder (see figure 3A). Actually, should the sealing gaskets 64 of the casings surrounding the injectors I be in the general base plane of the cover, there would be no sufficient room to receive them in the area comprised between the body of the injector and the body of the aforementioned actuators 22. Therefore, the arrangement described above allows guaranteeing an ideal sealing also at each injector

I.

[0038] Each injector is locked in the seat thereof in the cylinder head (see figures 4, 5) by means of a bracket 640 which has an end resting on a support (in the example the head of a screw 65 which is used for fixing the body 50 on the cylinder head). The opposite end of the bracket 640 is fork-shaped, with two branches 66 which are engaged on two shoulders of the body of the injector. The bracket 640 is pressed in position by means of a screw 67 which engages the cylinder head. The screw 67 traverses the cover with the interposition of sealing rings and it is engaged at the upper end thereof by a nut 68 which presses - from above - the intermediate portion of the bracket 640, to lock the injector I in the seat thereof.

[0039] Figures 9-12 refer to a different embodiment of the invention, also in this case for a diesel engine. Also such embodiment has the characteristic of having cup-shaped casings 57 associated to the injectors of the various engine cylinders and defining an upper sealing edge contained in a parallel plane and raised with respect to the general base plane of the cover (not shown in figures 9-12). Such embodiment does not provide for separate sub-units for the system for variable actuation of the intake valves, but two single longitudinal bodies 70, 71 mounted on the body 50 carrying the camshaft 11. The first longitudinal body 70 closes - at the upper part - the seat for rotatably supporting the camshaft 11 and integrates the cup-shaped casings 57 associated to the various injectors I.

[0040] The body 70, in a different embodiment, can be subdivided into a number of sub-units equivalent to the number of the injectors (i.e. of the cylinders) each integrating the cup-shaped casing 57 and serving or not serving the function of closing the camshaft at the upper part.

[0041] The second longitudinal unit 71 integrates the components of variable actuation of the intake valves of the various cylinders, with the relative solenoid valves 24. Also in this case (see figures 11, 12) each injector is locked in the seat thereof by means of a bracket 65 (figure 12) with fork-shaped end, whose branches 66 engage corresponding shoulders provided for in the body of the injector I. Also in this case each bracket 640 has an end resting on the head of a screw 65 and it is pressed in position by a nut 68 engaged on the upper end of a screw 67 which is fastened in the cylinder head and passes through the body 50, the body 70 and the bracket 640.

[0042] Obviously, without prejudice to the principle of the invention, the construction details and the embodiments may widely vary with respect to what has been described and illustrated purely by way of example, without departing from the scope of protection of the present invention.

Claims

1. Multi-cylinder internal combustion engine, comprising, for each cylinder:

a fuel injector (I),
 at least one intake valve (7) and at least one
 exhaust valve (27) for each cylinder, each pro-
 vided with respective return spring means (9)
 which push the valve (7) towards a closed posi-
 tion, for controlling respective intake and ex-
 haust conduits (4, 5; 6),
 at least one camshaft (11), for actuating the in-
 take valves (7) of the engine cylinders by means
 of respective tappets,

wherein each intake valve (7) is controlled by the
 respective tappet, against the action of the afore-
 mentioned return spring means (9), by interposing
 hydraulic means including a pressurised fluid cham-
 ber (C) and a hydraulic actuator (22) associated to
 each intake valve and connected to said pressurised
 fluid chamber,
 said pressurised fluid chamber (C) being adapted to
 be connected by means of a solenoid valve (24) with
 an exhaust channel (23) with the aim of decoupling
 the intake valve (7) from the respective tappet (15,
 16) and causing the quick closure of the valve (7)
 due to the respective return spring means (9),
 said hydraulic actuator (22) further being provided
 with hydraulic braking means for slowing the final
 phase of the travel for closing the intake valve con-
 trolled thereby when the pressure chamber is con-
 nected to the exhaust channel,
 electronic control means (25) for controlling each so-
 lenoid valve (24) so as to vary the time and/or the
 opening travel of the respective intake valve (7) as
 a function of one or more engine operative param-
 eters,
 wherein the hydraulic means for controlling the in-
 take valves (7) of the engine and the solenoid valves
 (24) associated thereto are part of a preassembled
 unit mounted on the cylinder head (1) of the engine,
characterised in that the fuel injector (I) associated
 to each engine cylinder is surrounded by a sealing
 casing (57) which is part of a support body (19A-D;
 70) mounted on the engine cylinder head and which
 defines a sealing peripheral edge cooperating with
 a sealing cover (58) which is mounted on said cylin-
 der head, said cover having a general base plane
 sealingly mounted on said cylinder head, and **in that**
 said sealing peripheral edge of each sealing casing
 (57) is arranged in a plane parallel and raised with
 respect to the general base plane of said cover (58).

2. Engine according to claim 1, **characterised in that**
 said preassembled unit is formed by a plurality of
 separate sub-units (20A-D) respectively associated
 to the engine cylinders and each having an inde-
 pendent support body (19A-D), mounted on the cyl-
 inder head and carrying said hydraulic means and
 said solenoid valve for controlling the intake valves
 of the respective cylinder, and **in that** the sealing

casing (57) of each injector (I) is part of the support
 body (19A-D) of the sub-unit (20A-D) associated to
 the respective cylinder .

3. Engine according to claim 1, **characterised in that**
 the sealing casing (57) of each injector (I) is part of
 a single support body (70) common for all the engine
 cylinders and which is mounted on the cylinder head
 so as to close at the upper part the seat in which said
 camshaft (11) is received.
4. Engine according to claim 3, **characterised in that**
 the common support (70) is mounted on the cylinder
 head with the interposition of a support (50) sur-
 mounting the head and defining the seat in which
 said camshaft (11) is received.
5. Engine according to claim 2, **characterised in that**
 the abovementioned cover covers said pre-assem-
 bled unit (20A-D) and it has a base peripheral edge
 having a perimeter groove for mounting a sealing
 gasket (60),
 and **in that** said sealing gasket (60) has a main por-
 tion extending in a general base plane of the cover
 (58) and respective portions (61A-D) associated to
 said sub-units and projecting from said general
 plane, in positions arranged longitudinally adjacent
 to each other on one side of the cylinder head and
 each having a three-dimensional development, with
 two lateral parts (62) contained in two planes sub-
 stantially parallel to each other and orthogonal to
 said general plane and a central part (63) contained
 in a parallel plane and spaced from said base plane.
6. Engine according to any one of the preceding claims,
characterised in that each injector (I) is locked on
 the cylinder head by means of a bracket (640) which
 has an end resting on a support (65) fixed to the
 cylinder head and the opposite fork-shaped end, with
 two branches (66) which are engaged on two shoul-
 ders of the body of the injector (I), the intermediate
 portion of said bracket (640) being pressed in posi-
 tion by means of a screw (67) which engages the
 cylinder head.

Amended claims in accordance with Rule 137(2) EPC.

1. Multi-cylinder internal combustion engine, com-
 prising, for each cylinder:
- a fuel injector (I),
 at least one intake valve (7) and at least one
 exhaust valve (27) for each cylinder, each pro-
 vided with respective return spring means (9)
 which push the valve (7) towards a closed posi-
 tion, for controlling respective intake and ex-

haust conduits (4, 5; 6),
 at least one camshaft (11), for actuating the intake valves (7) of the engine cylinders by means of respective tappets,
 wherein each intake valve (7) is controlled by the respective tappet, against the action of the aforementioned return spring means (9), by interposing hydraulic means including a pressurised fluid chamber (C) and a hydraulic actuator (22) associated to each intake valve and connected to said pressurised fluid chamber, said pressurised fluid chamber (C) being adapted to be connected by means of a solenoid valve (24) with an exhaust channel (23) with the aim of decoupling the intake valve (7) from the respective tappet (15, 16) and causing the quick closure of the valve (7) due to the respective return spring means (9),
 said hydraulic actuator (22) further being provided with hydraulic braking means for slowing the final phase of the travel for closing the intake valve controlled thereby when the pressure chamber is connected to the exhaust channel, electronic control means (25) for controlling each solenoid valve (24) so as to vary the time and/or the opening travel of the respective intake valve (7) as a function of one or more engine operative parameters,
 wherein the hydraulic means for controlling the intake valves (7) of the engine and the solenoid valves (24) associated thereto are part of a pre-assembled unit mounted on the cylinder head (1) of the engine,
 wherein said engine further comprises a sealing cover (58) which is mounted on said cylinder head, said cover (58) having a general base plane sealingly mounted on said cylinder head, **characterised in that** the fuel injector (I) associated to each engine cylinder is surrounded by a cup-shaped sealing casing (57) which is part of a support body (19A-D; 70) mounted on the engine cylinder head and which defines a sealing peripheral edge cooperating with said sealing cover (58) which is mounted on said cylinder head, and **in that** said sealing peripheral edge of each sealing casing (57) is arranged in a plane parallel and raised with respect to said general base plane of said cover (58).

2. Engine according to claim 1, **characterised in that** said preassembled unit is formed by a plurality of separate sub-units (20A-D) respectively associated to the engine cylinders and each having an independent support body (19A-D), mounted on the cylinder head and carrying said hydraulic means and said solenoid valve for controlling the intake valves of the respective cylinder, and **in that** the sealing

casing (57) of each injector (I) is part of the support body (19A-D) of the sub-unit (20A-D) associated to the respective cylinder

3. Engine according to claim 1, **characterised in that** the sealing casing (57) of each injector (I) is part of a single support body (70) common for all the engine cylinders and which is mounted on the cylinder head so as to close at the upper part the seat in which said camshaft (11) is received.

4. Engine according to claim 3, **characterised in that** the common support (70) is mounted on the cylinder head with the interposition of a support (50) surmounting the head and defining the seat in which said camshaft (11) is received.

5. Engine according to claim 2, **characterised in that** the abovementioned cover covers said pre-assembled unit (20A-D) and it has a base peripheral edge having a perimeter groove for mounting a sealing gasket (60),
 and **in that** said sealing gasket (60) has a main portion extending in a general base plane of the cover (58) and respective portions (61A-D) associated to said sub-units and projecting from said general plane, in positions arranged longitudinally adjacent to each other on one side of the cylinder head and each having a three-dimensional development, with two lateral parts (62) contained in two planes substantially parallel to each other and orthogonal to said general plane and a central part (63) contained in a parallel plane and spaced from said base plane.

6. Engine according to any one of the preceding claims, **characterised in that** each injector (I) is locked on the cylinder head by means of a bracket (640) which has an end resting on a support (65) fixed to the cylinder head and the opposite fork-shaped end, with two branches (66) which are engaged on two shoulders of the body of the injector (I), the intermediate portion of said bracket (640) being pressed in position by means of a screw (67) which engages the cylinder head.

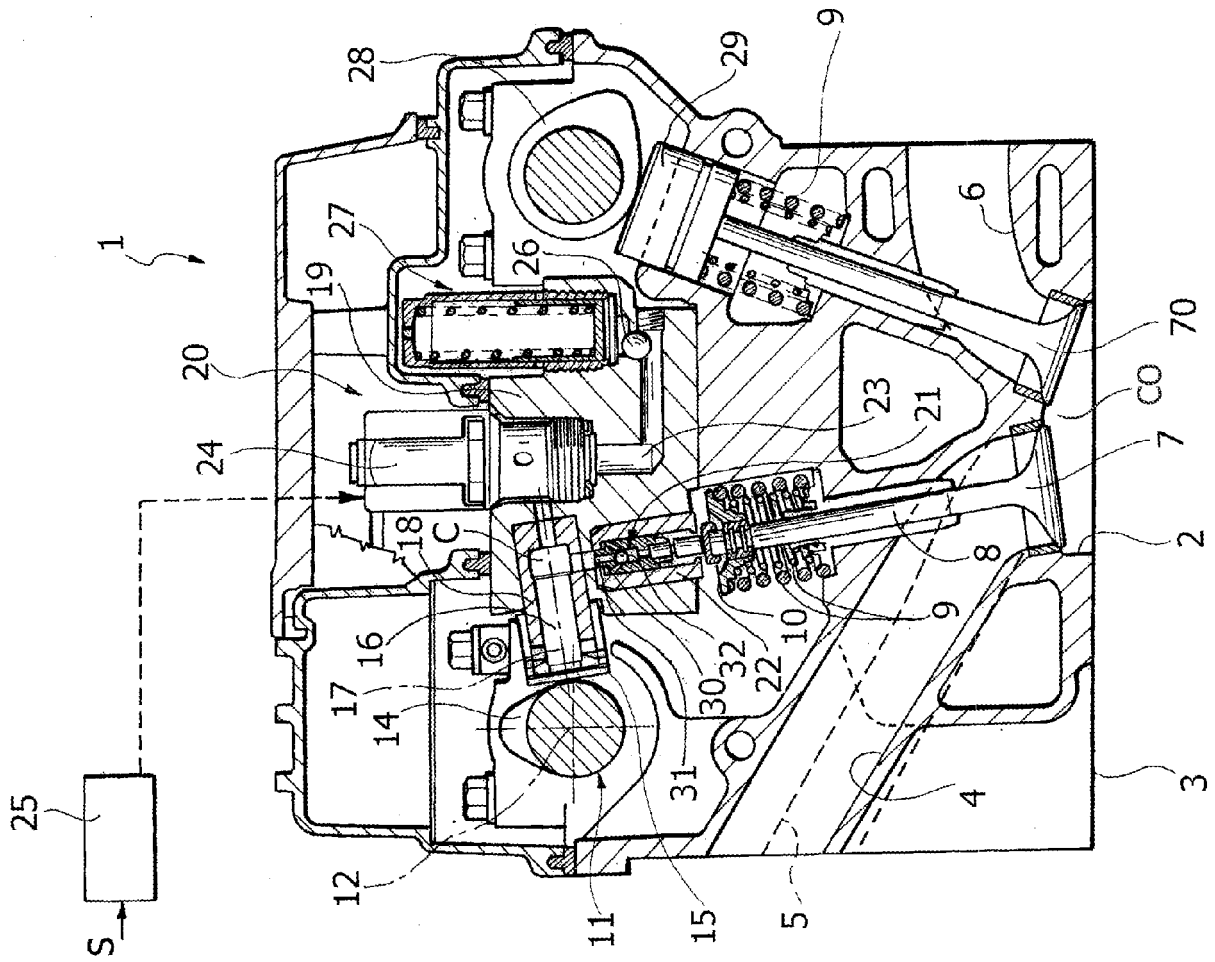


FIG. 1

FIG. 2

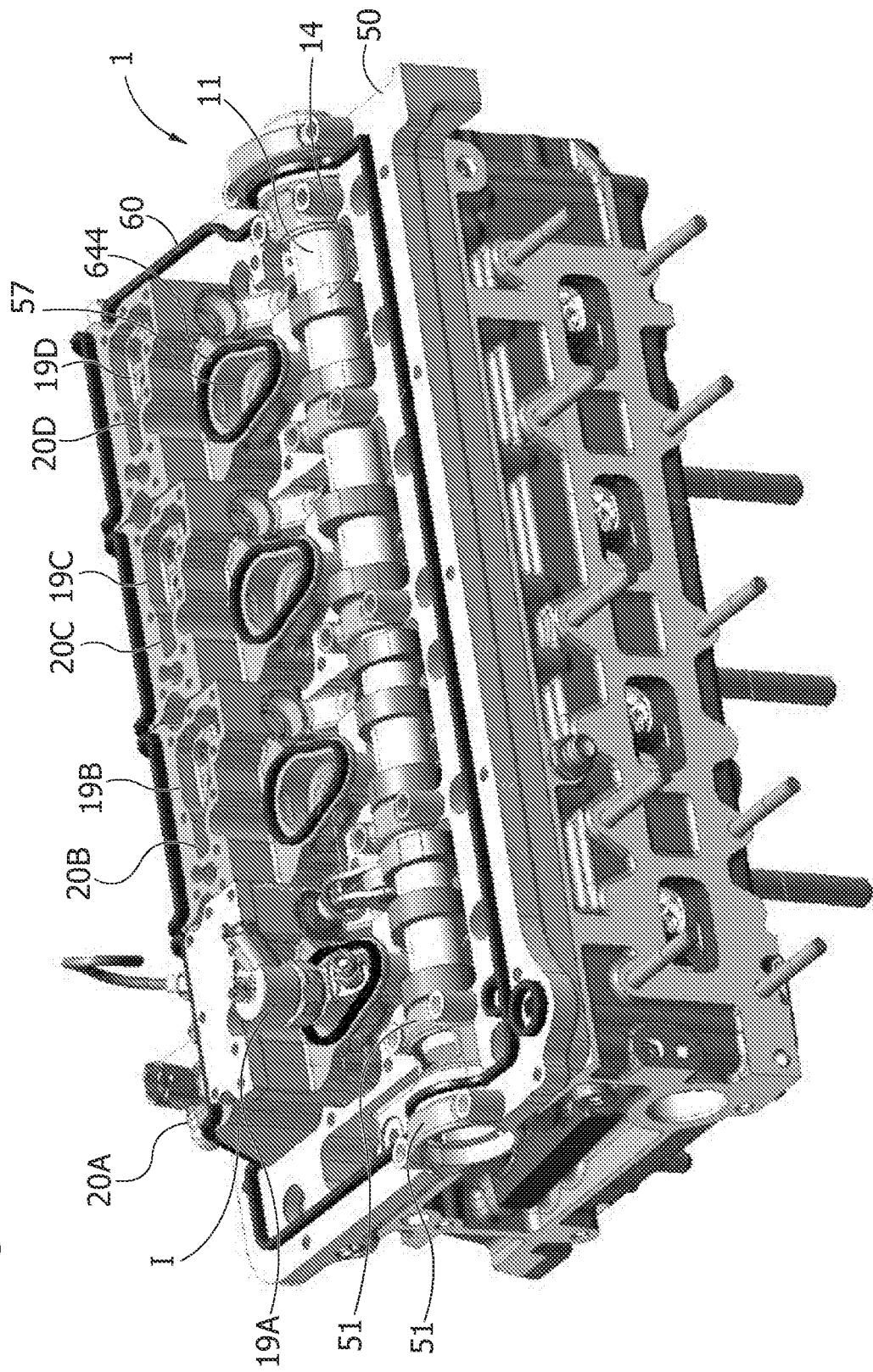


FIG. 3A

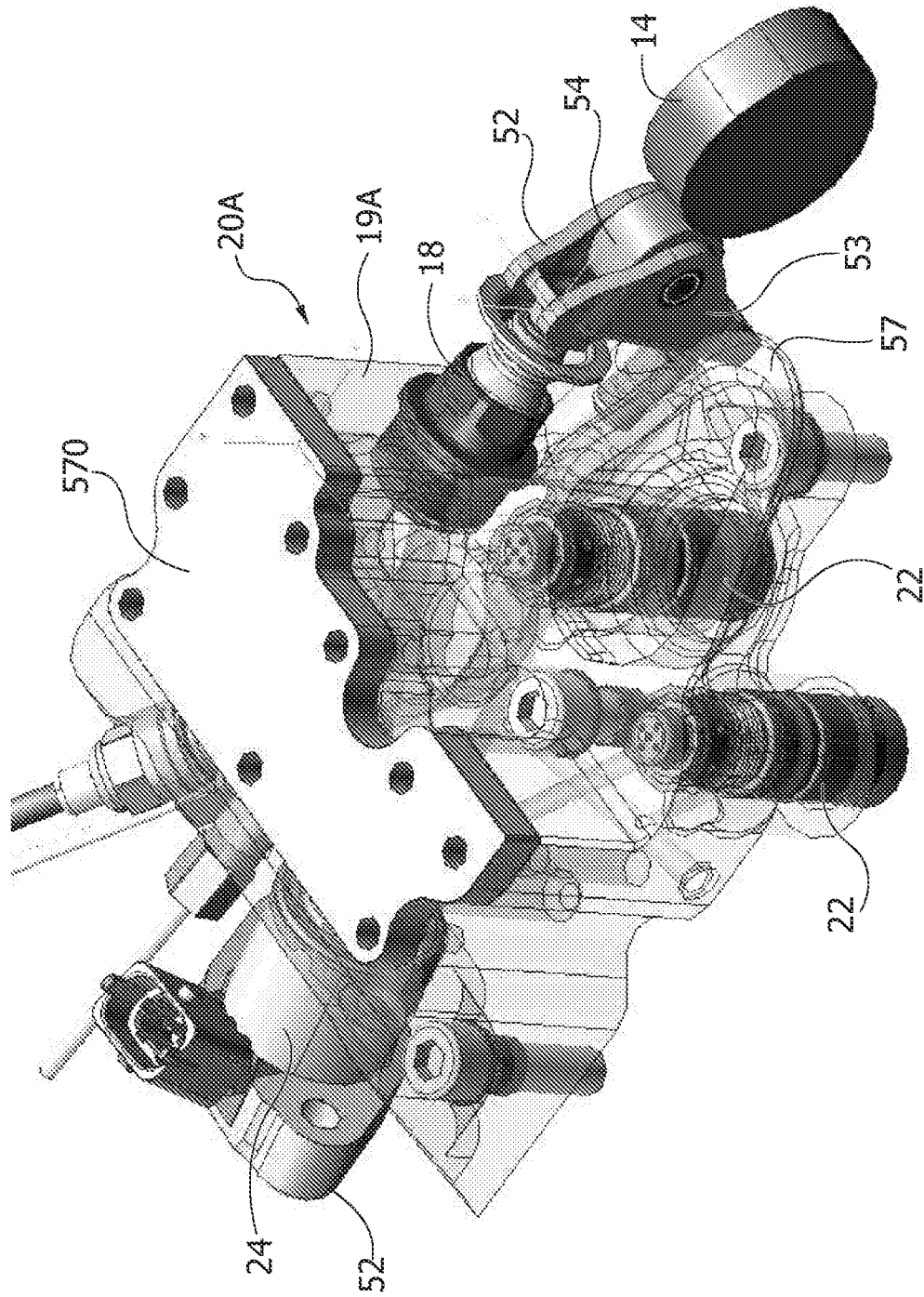


FIG. 3B

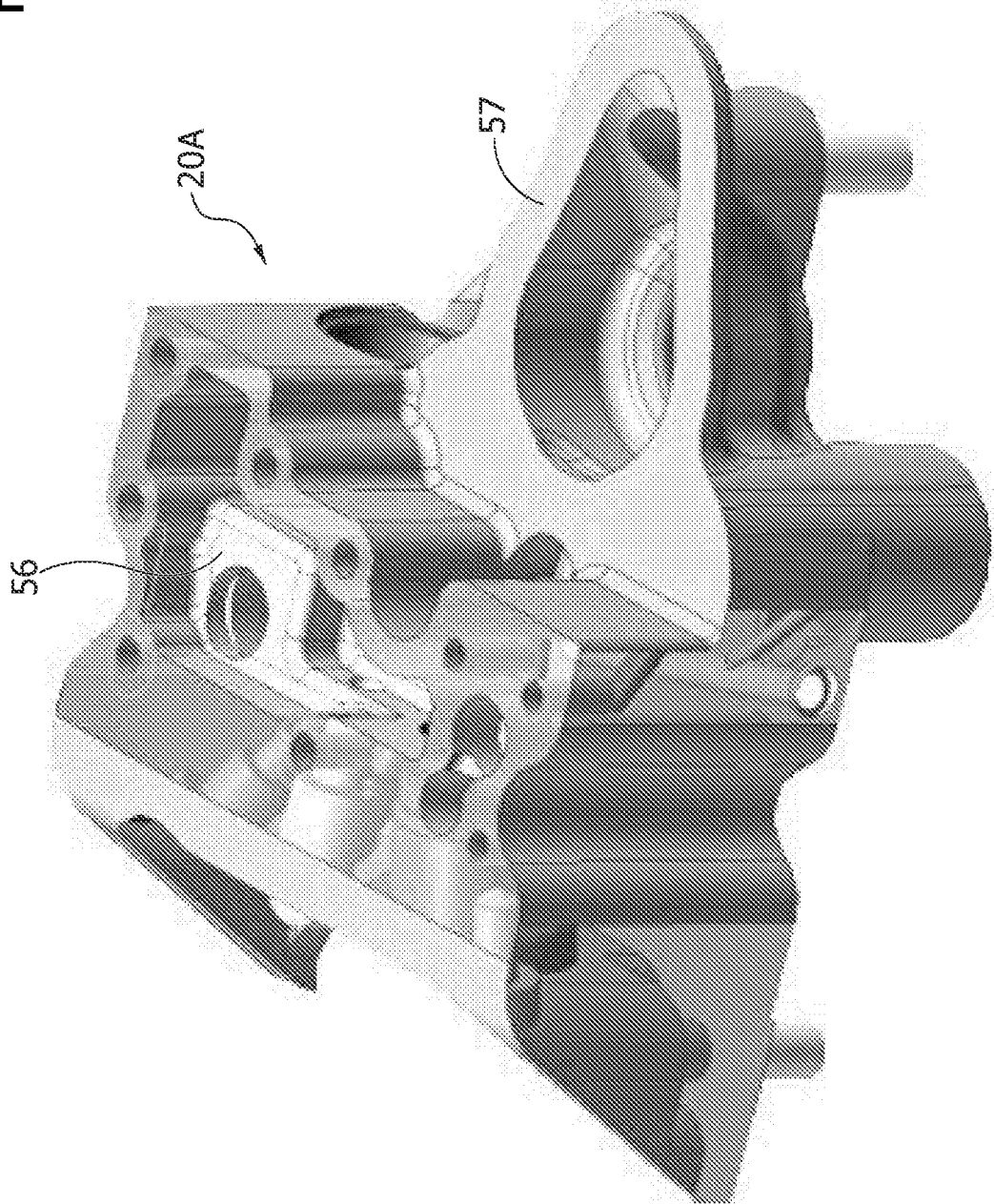


FIG. 4

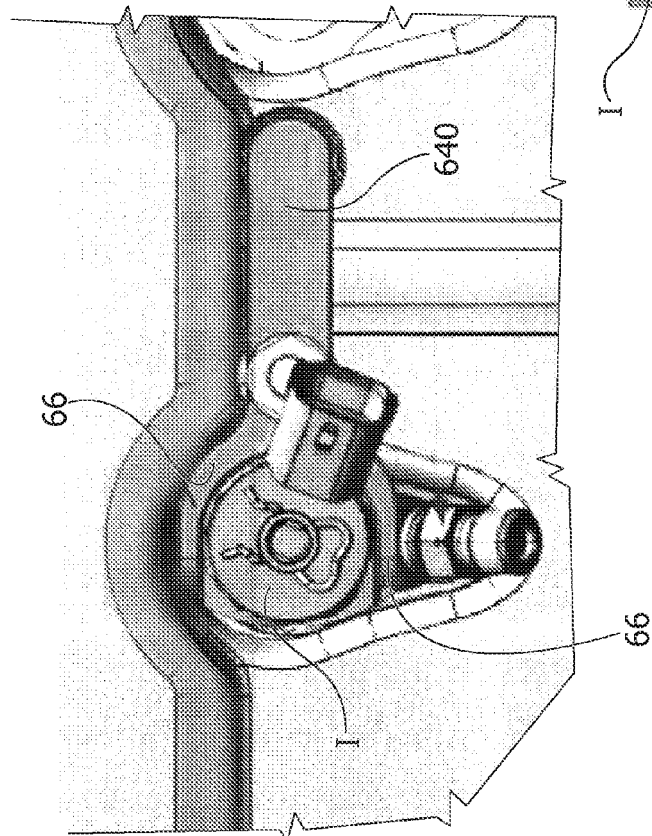


FIG. 5

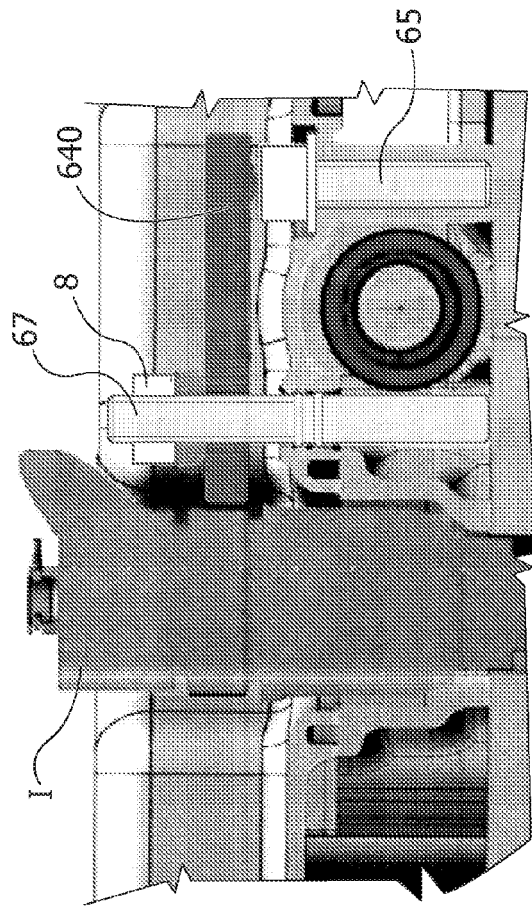


FIG. 6

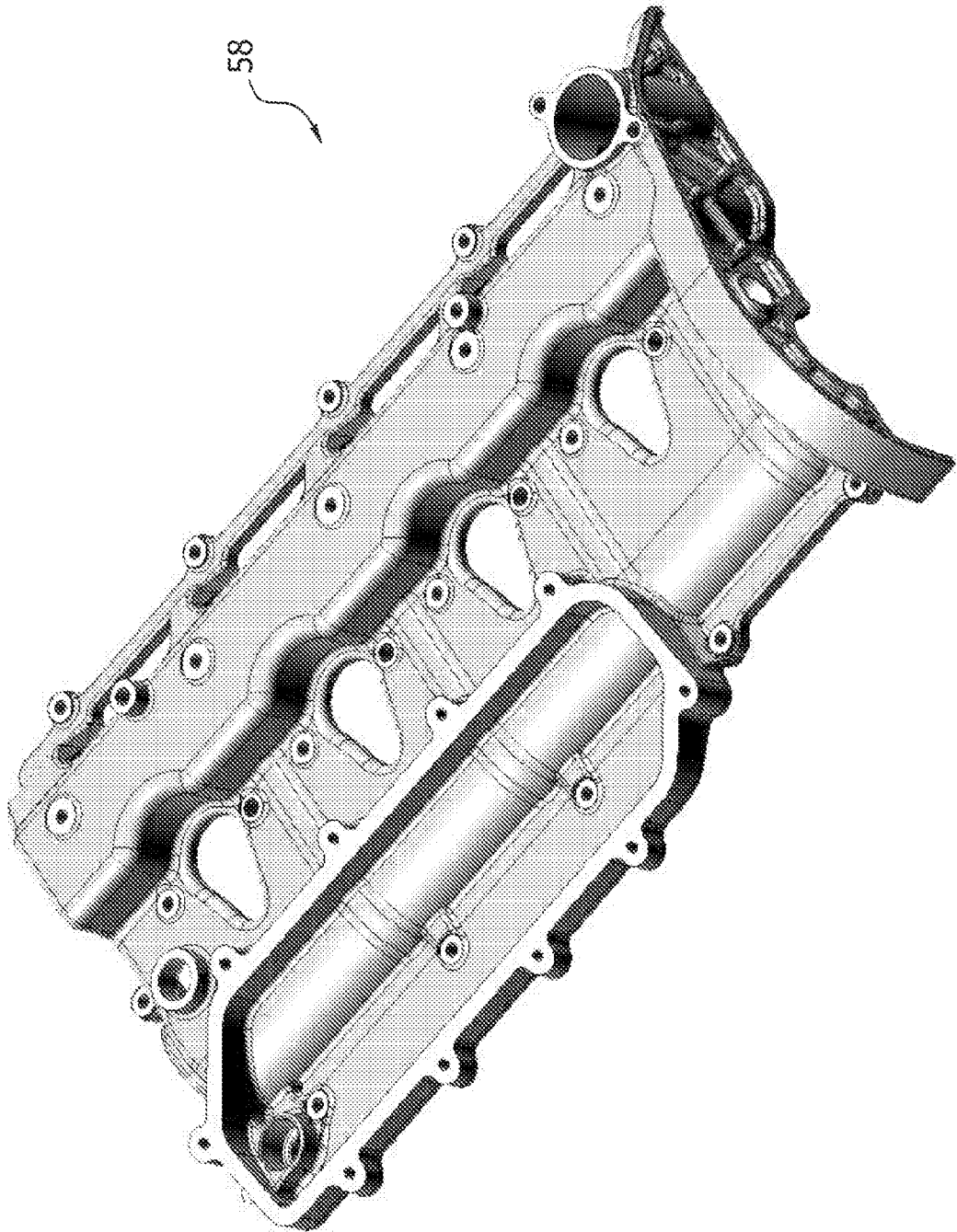


FIG. 7

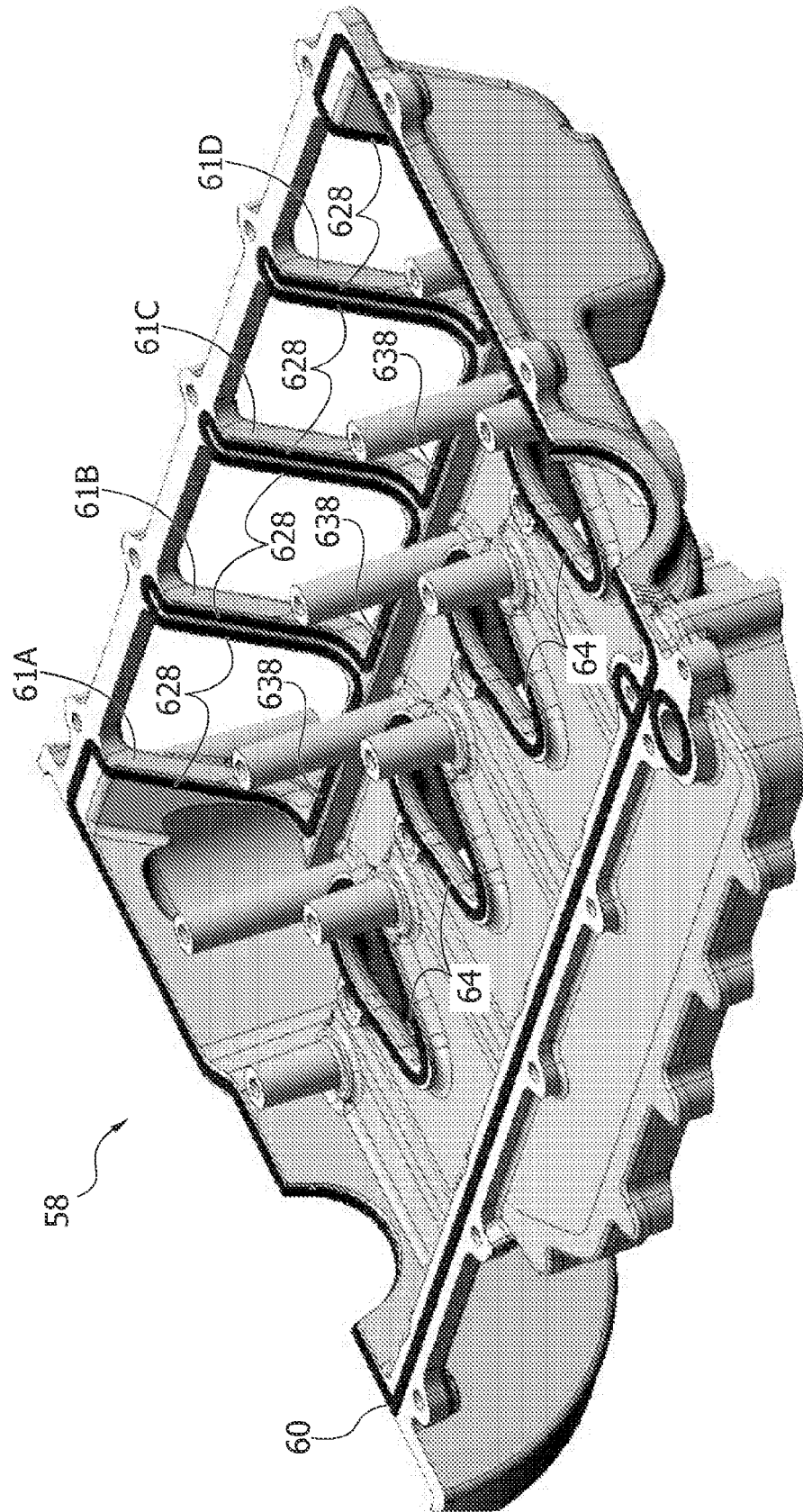


FIG. 8

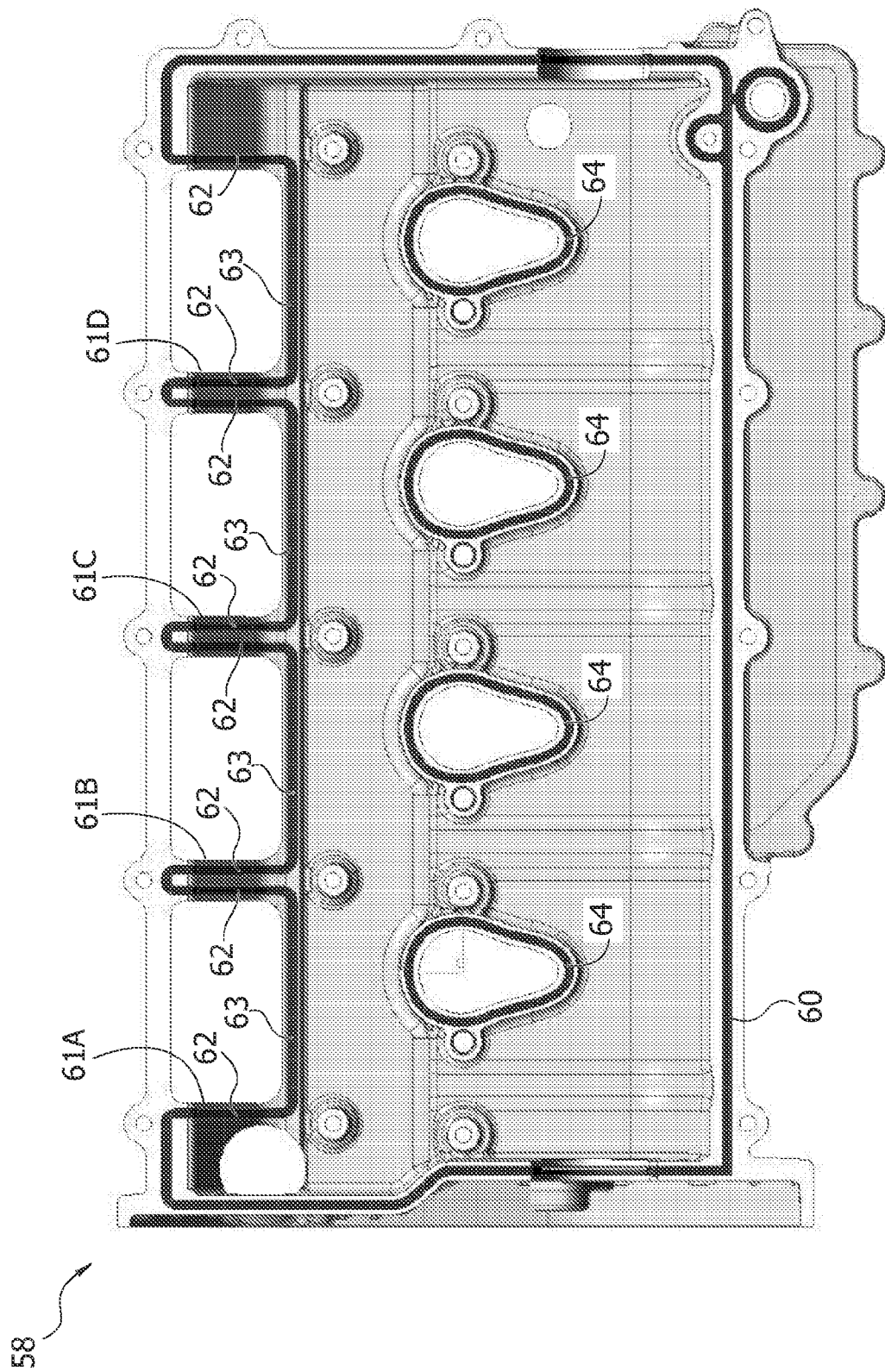


FIG. 8A

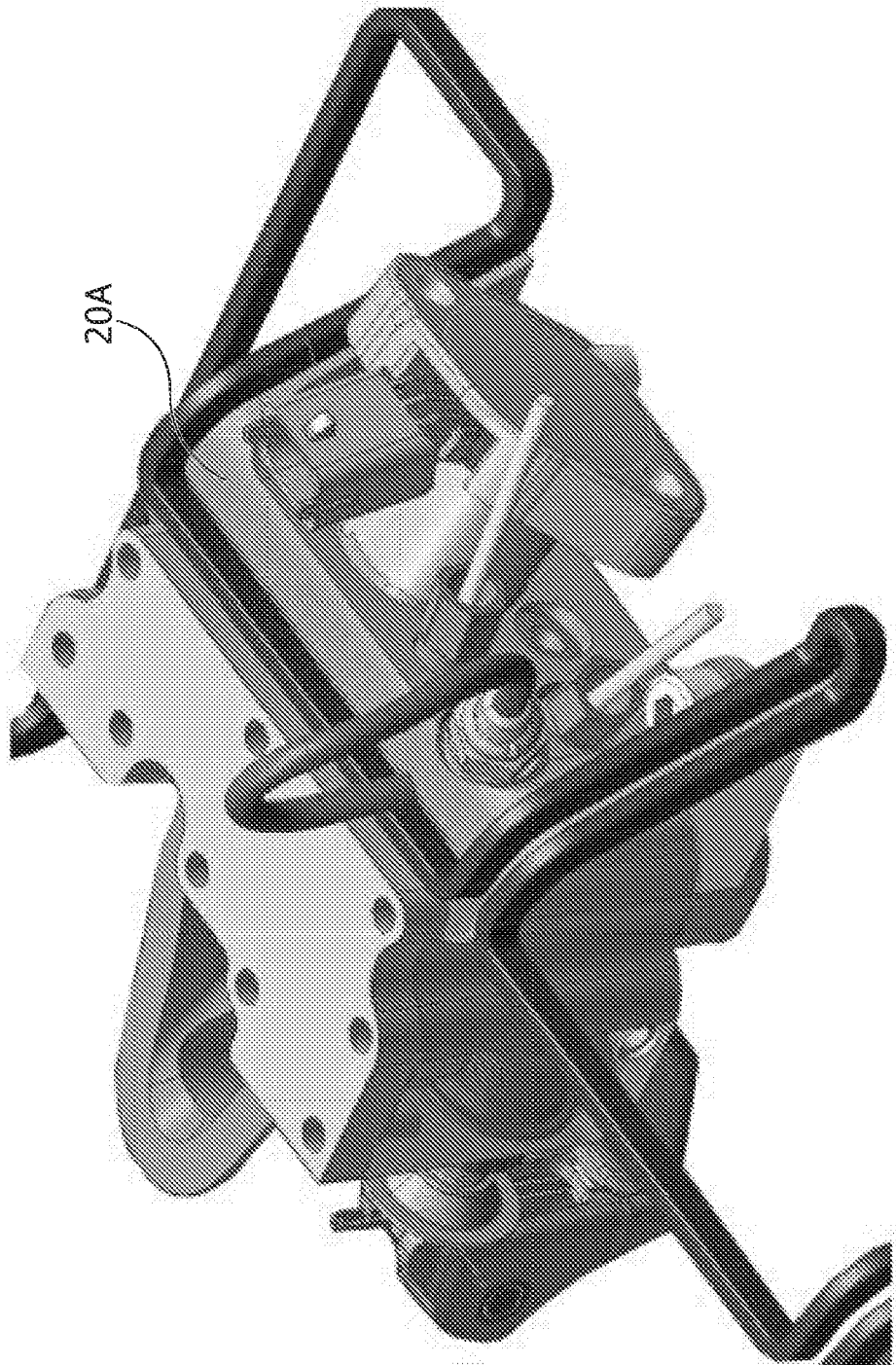
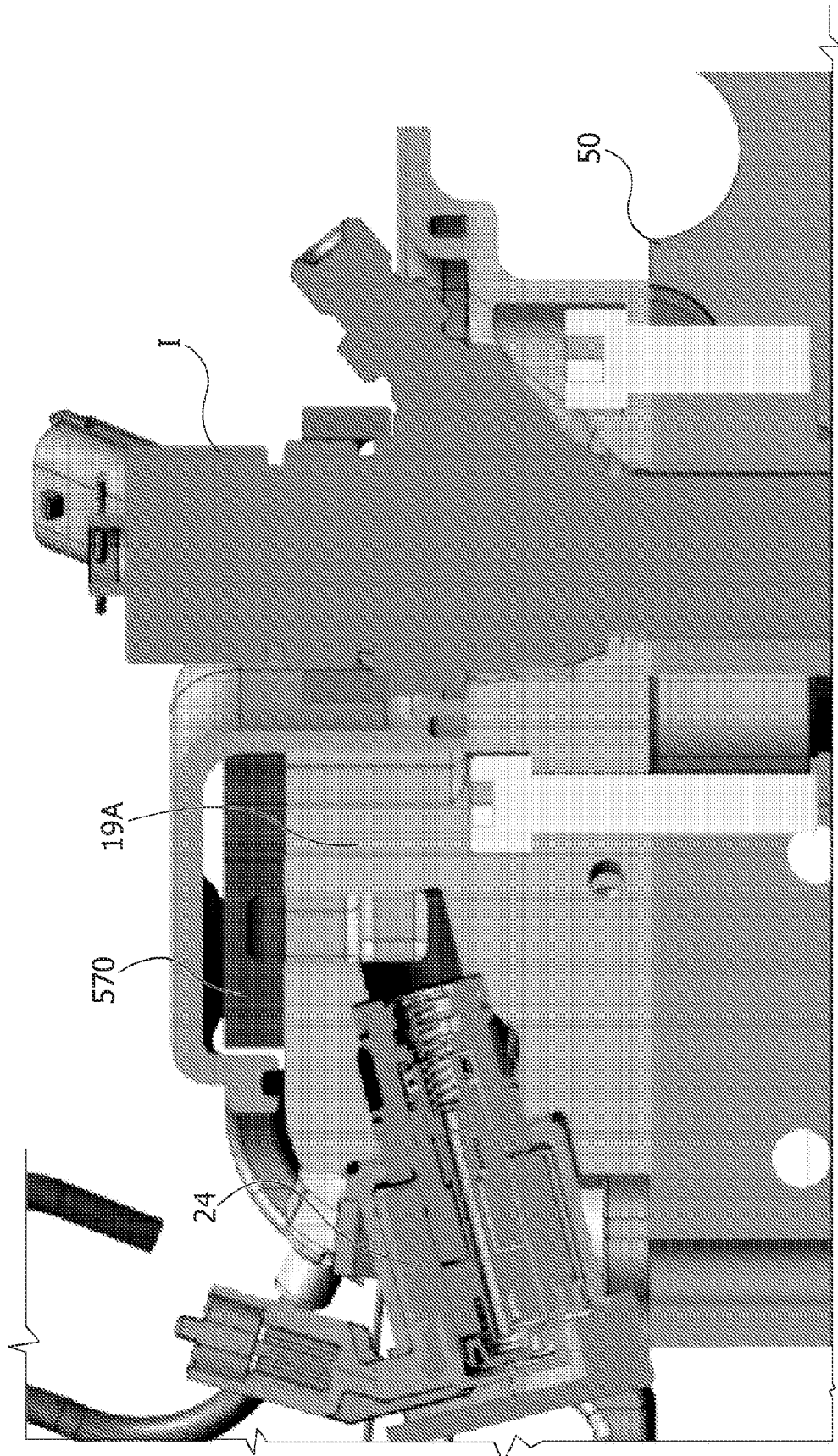
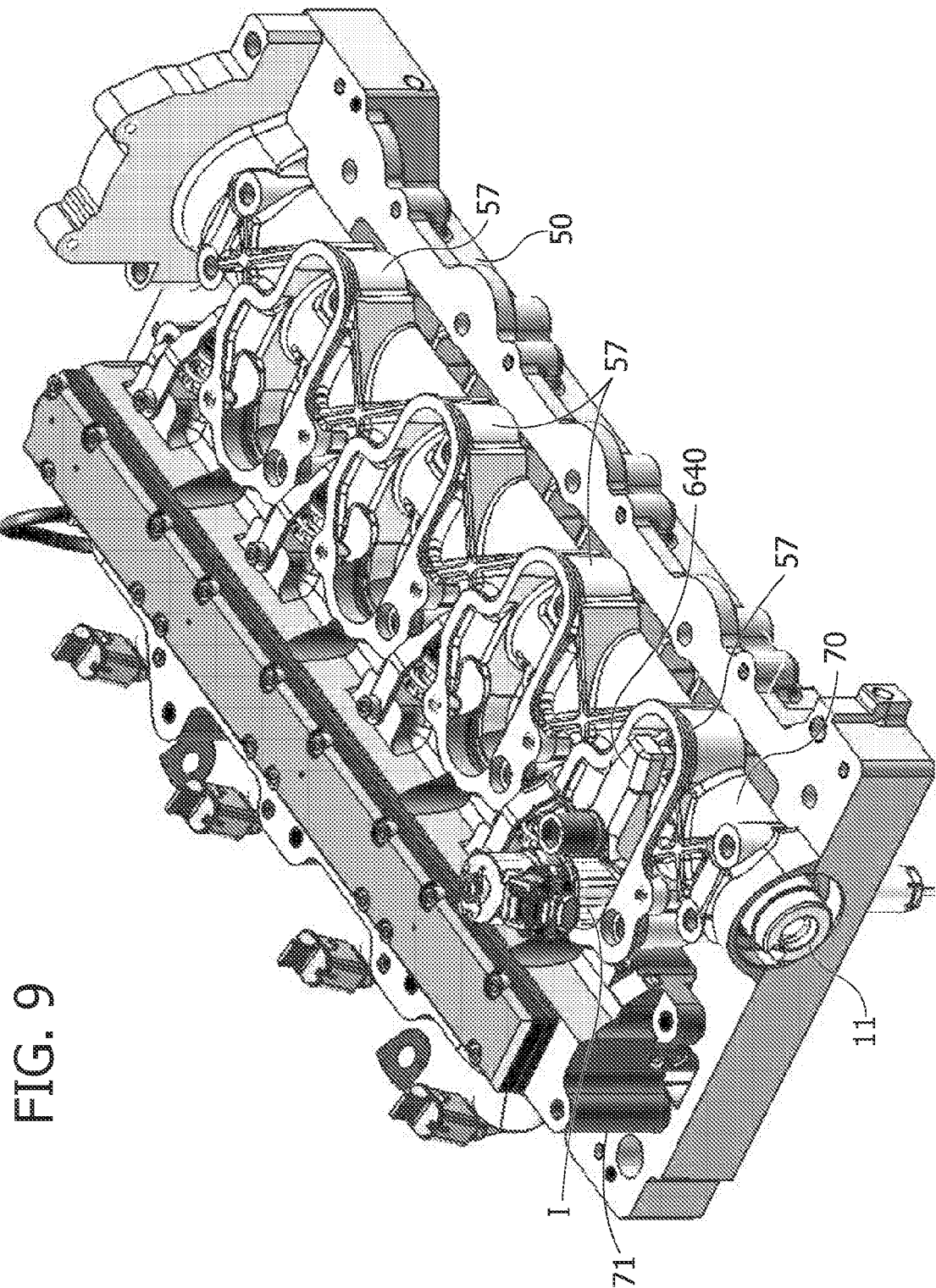


FIG. 8B





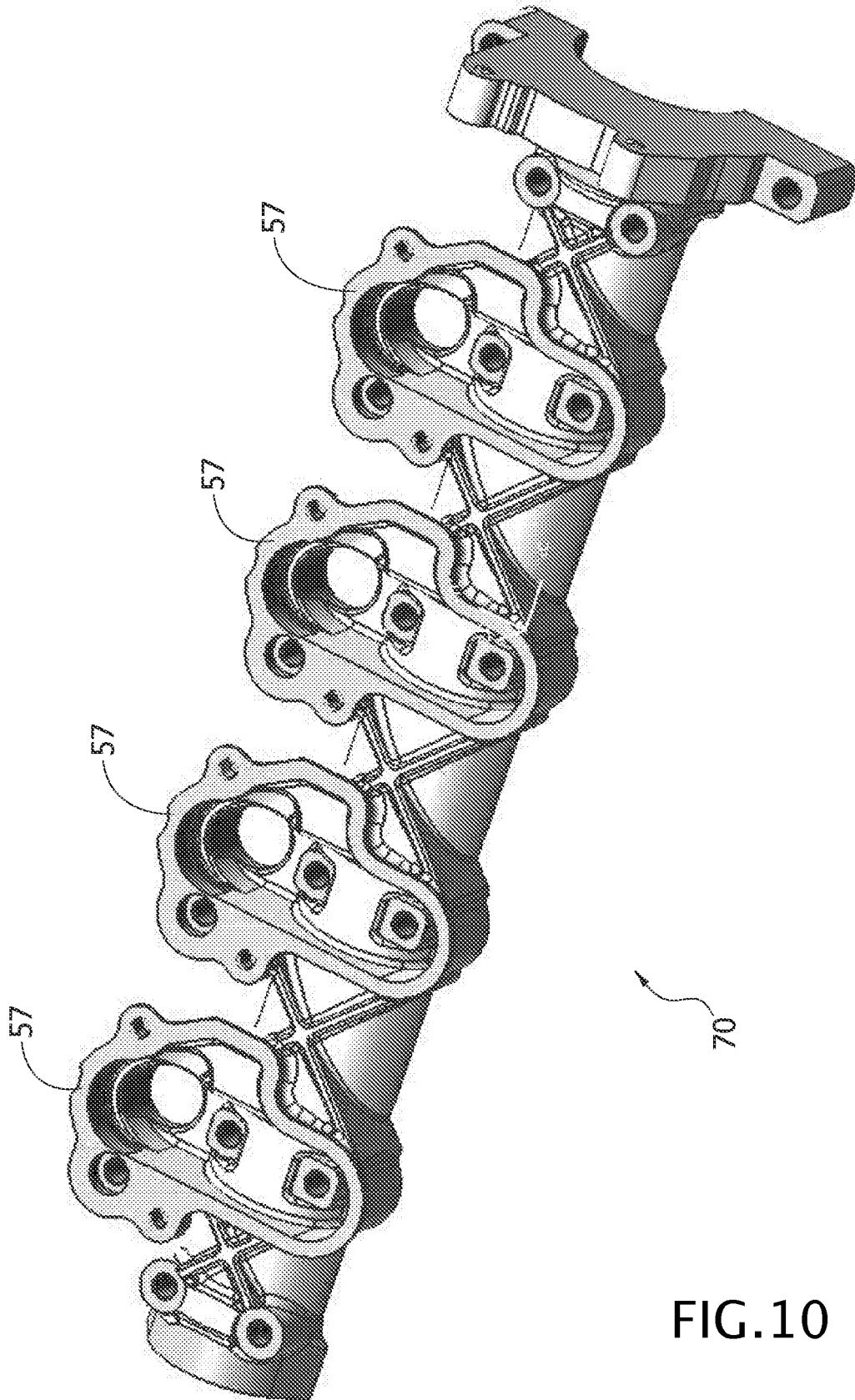


FIG.10

FIG. 11

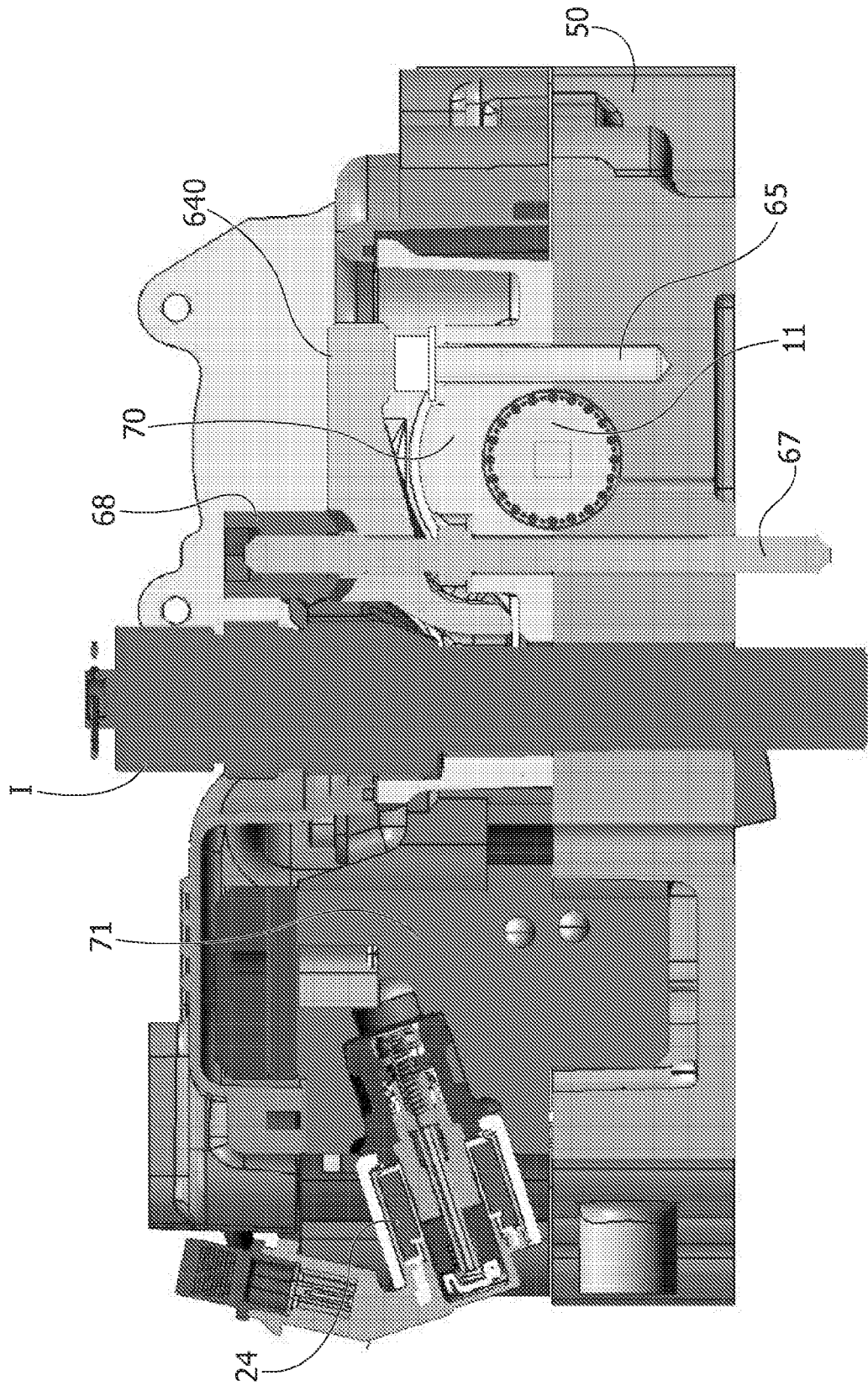
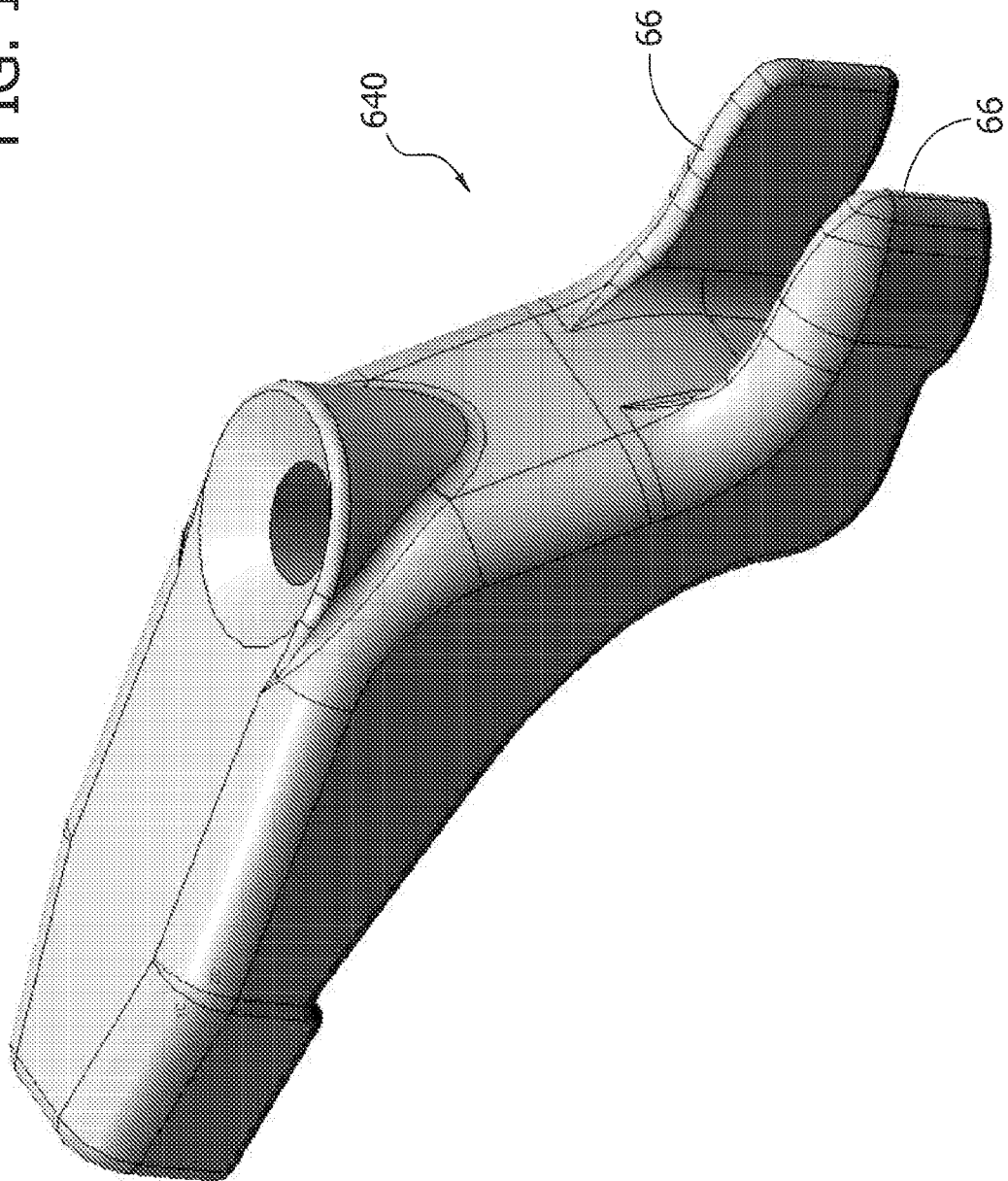


FIG. 12





EUROPEAN SEARCH REPORT

Application Number
EP 11 17 6190

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 11 November 2011	Examiner Klinger, Thierry
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