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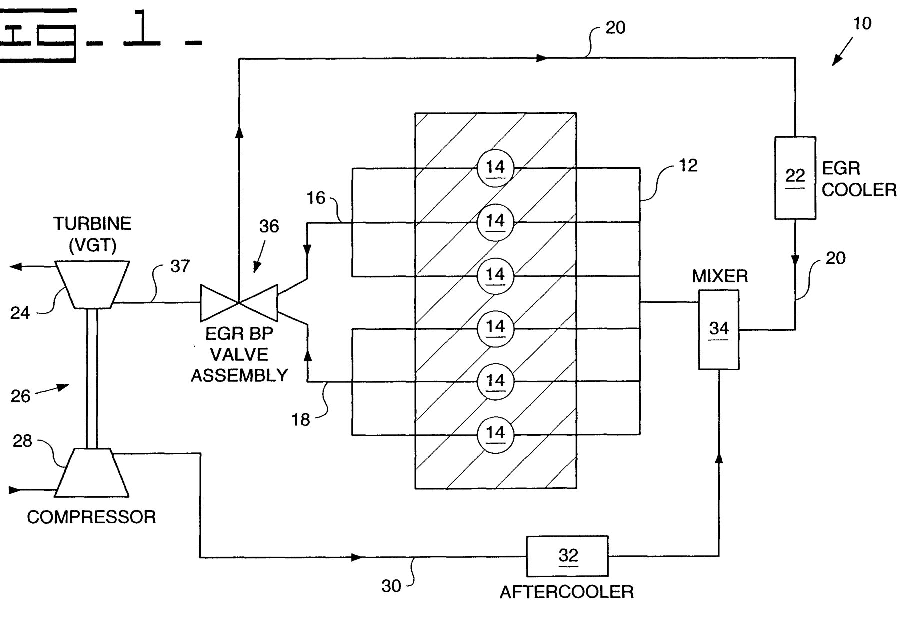
(54) **Open manifold back pressure valve exhaust gas recirculation system**

(57) An internal combustion engine exhaust gas recirculation (EGR) system includes an exhaust gas manifold back pressure valve insert assembly which has an exhaust gas recirculation (EGR) conduit interposed exhaust manifold structure of the engine and atmospheric exhaust structure which includes a scroll element of the turbine stage of the engine turbocompressor, and a valve mechanism disposed within the scroll element and movable between a fully closed position at which all exhaust gases from all of the engine cylinders pass to atmospheric exhaust through the atmospheric exhaust structure, and a fully opened position at which the valve mechanism partially occludes an upstream portion of the scroll element such that a sufficiently large back pressure is developed with respect to the atmospheric exhaust structure such that exhaust gases are forced through the exhaust gas recirculation (EGR) conduit.

Fig. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates generally to internal combustion engines, and more particularly to a valve-controlled system for developing or generating sufficient back pressure within the engine exhaust system so as to force or drive engine exhaust gas toward the engine inlet manifold during exhaust gas recirculation (EGR) operative modes.

Description of the Prior Art

[0002] During exhaust gas recirculation (EGR) operative modes of an internal combustion engine, it is imperative that a flow path be established from the engine exhaust gas manifold toward the engine exhaust gas recirculartion (EGR) cooler such that the recirculated exhaust gas can then be introduced into the engine in-take manifold after having passed through the exhaust gas recirculation (EGR) cooler. It is additionally imperative that sufficient pressure be generated within the exhaust gas recirculation (EGR) system such that a desired portion or proportion of the exhaust gas from the exhaust gas manifold is in fact routed toward the intake manifold so as not to be exhausted or routed through the turbine side of the engine turbocompressor. Prior art systems have utilized pumps, venturis, and/or similar devices to create sufficient pressure, back pressure, and/or differential pressure drops within the respective systems, however, such devices or components comprise considerable expenditures.

[0003] In accordance with the disclosure of the related patent application noted hereinbefore, a back pressure valve assembly is utilized within the exhaust gas recirculation (EGR) system such that the exhaust gases from, for example, the front bank of three engine cylinders and its exhaust manifold are routed into the exhaust gas recirculation (EGR) loop conduit, while the exhaust gases from the rear bank of engine cylinders and its exhaust manifold are routed to the turbine stage of the engine turbocompressor. It has been deter-mined, however, that if the entire engine can be back-pressured by means of a single back pressure valve mechanism, lower exhaust manifold temperatures and lower particulate levels, resulting in better exhaust gas recirculation (EGR) mixing properties or characteristics, will result.

[0004] A need therefore exists in the art for a relatively simple and low-cost control mechanism which can be readily and easily incorporated within the engine exhaust system for use in connection with the exhaust gas recirculation (EGR) system of an internal combustion engine whereby sufficient back pressure is created or generated within the system such that the engine exhaust gas is effectively forced or routed toward the engine inlet manifold so as to properly enable or facilitate exhaust gas recirculation (EGR) operative modes of the engine while at the same time effectively lowering exhaust manifold temperatures and exhaust particulate levels so as to achieve better exhaust gas re-circulation (EGR) mixing properties or characteristics.

DISCLOSURE OF THE INVENTION

[0005] In one aspect of the invention an exhaust gas recirculation (EGR) system is used with an internal combustion engine. The engine has an exhaust gas recirculation (EGR) conduit interposed an exhaust manifold structure of all of the cylinders of the engine and an atmospheric exhaust structure. A valve mechanism is disposed at a juncture defined between said exhaust gas recirculation (EGR) conduit and the atmospheric exhaust structure and is movable between a fully closed position at which an entrance to the exhaust gas recirculation (EGR) conduit is blocked and all exhaust gases from all of the cylinders of the engine pass to atmospheric exhaust through the atmospheric exhaust structure, and a fully opened position at which the valve mechanism opens the entrance to the exhaust gas recirculation (EGR) conduit and partially occludes an entrance portion of the atmospheric exhaust structure such that a sufficiently large back pressure is developed with respect to the atmospheric exhaust structure such that exhaust gases from all of the cylinders of the engine are forced through the exhaust gas recirculation (EGR) conduit.

[0006] And in another aspect of the invention an exhaust gas recirculation (EGR) system is used with an internal combustion engine having a plurality of cylinders. The exhaust gas recirculation system has an intake manifold connected to the plurality of cylinders of the internal combustion engine for introducing air into the plurality of cylinders of the internal combustion engine. An exhaust manifold structure is connected to the plurality of cylinders of the internal combustion engine for conducting exhaust gases out from the cylinders of the internal combustion engine. An exhaust gas recirculation (EGR) conduit is interposed the exhaust manifold structure of all the plurality of cylinders of the internal combustion engine and atmospheric exhaust structure. And a valve mechanism is disposed at a juncture defined between the exhaust gas recirculation (EGR) conduit and the atmospheric exhaust structure. The valve mechanism is movable between a fully closed position at which an entrance to the exhaust gas recirculation (EGR) conduit is blocked and all exhaust gases from all of the plurality of cylinders of the internal combustion engine pass to atmospheric exhaust through the atmospheric exhaust structure, and a fully opened position at which the valve mechanism opens the entrance to the exhaust gas recirculation (EGR) conduit and partially occludes an entrance portion of the atmospheric exhaust structure such that a sufficiently large back pressure is developed with respect to the atmospheric exhaust structure such that exhaust gases from all of the plurality of cylinders of the internal combustion engine are forced through the exhaust gas recirculation (EGR) conduit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Various other objects, features, and attendant advantages of the present invention will be more fully appreciated from the following detailed description when considered in connection with the accompanying drawings in which like reference characters designate like or corresponding parts throughout the several views, and wherein:

FIGURE 1 is a schematic drawing of a high pressure exhaust gas recirculation (EGR) loop utilized in conjunction with an internal combustion engine and having incorporated therein the new and improved exhaust gas manifold back pressure valve assembly constructed in accordance with the teachings and principles of the present invention;

FIGURE 2 is a perspective view of the new and improved exhaust gas manifold back pressure valve assembly constructed in accordance with the principles and teachings of the present invention and attached to the upstream or inlet portion of the scroll element of the turbine stage of the engine turbocompressor so as to be utilized within the exhaust gas recirculation (EGR) loop of FIGURE 1;

FIGURE 3 is a perspective view of the scroll element of the turbine stage of the engine turbocompressor which is shown in FIGURE 2 and which illustrates the casting portion thereof which is integrally formed upon the scroll element of the turbine stage of the engine turbocompressor so as to mount thereon the new and improved exhaust gas manifold back pressure valve assembly constructed in accordance with the principles and teachings of the present invention as shown in FIGURE 2;

FIGURE 4 is a perspective view of the new and improved exhaust gas manifold back pressure valve assembly constructed in accordance with the principles and teachings of the present invention as shown in FIGURE 2 and adapted to be fixedly mounted upon the inlet or upstream portion of the scroll element of the turbine stage of the engine turbocompressor as illustrated in FIGURE 3;

FIGURE 5 is a longitudinal cross-sectional view of the new and improved exhaust gas manifold back pressure valve assembly as shown in FIGURE 1 except that the exhaust gas manifold center section, which is fixedly attached to the inlet or upstream portion of the scroll element of the turbine stage of the engine turbocompressor, has been omitted;

FIGURE 6 is an exploded view of the paddle valve and actuating shaft components of the new and improved exhaust gas manifold back pressure valve assembly constructed in accordance with the principles and teachings of the present invention; and

FIGURE 7 is a partial cross-sectional view of the valve assembly shown in FIGURE 4 specifically illustrating the mounting, fixation, and bearing elements of the valve and actuating shaft components of the valve assembly shown in FIGURE 4.

BEST MODE FOR CARRYING OUT THE INVENTION

[0008] Referring now to the drawings, and more particularly to FIGURE 1 thereof, an exhaust gas recirculation (EGR) loop utilized in conjunction with an internal combustion engine, and having incorporated therein the new and improved exhaust gas manifold back pressure valve assembly constructed in accordance with the principles and teachings of the present invention, is disclosed and is generally indicated by the reference character 10.

[0009] Briefly, it is seen that the internal combustion engine and associated exhaust gas recirculation (EGR) loop 10 comprises an intake manifold 12 fluidically connected to, for example, the six cylinders 14 of the engine, and a pair of exhaust manifolds 16,18 respectively fluidically connected to front and rear banks of the cylinders 14. The pair of exhaust manifolds 16,18 are in turn respectively fluidically connected to an exhaust gas recirculation loop conduit 20 which leads to an exhaust gas recirculation (EGR) cooler 22, and to a turbine stage 24 of a turbocompressor 26 whereby the turbine stage 24 of the turbocompressor 26 drives a compressor stage 28 of the turbocompressor 26 such that intake air is driven toward the engine intake manifold 12 through means of an intake air conduit 30 and an aftercooler 32, while the exhaust gases are ultimately exhausted to atmosphere. Intake air and recirculated exhaust gas from conduits 20 and 30 are mixed together within a mixer 34 before being transmitted into the engine intake manifold 12.

[0010] In order to simply and economically achieve the aforenoted exhaust gas recirculation (EGR) as well as the exhaust gas driving of the turbine stage 24 of the turbocompressor 26, an exhaust gas recirculation (EGR) back pressure valve assembly, developed in accordance with the teachings and principles of the present invention, is generally indicated by the reference character 36. The valve assembly 36 is mounted upon or within the inlet or upstream end portion of the scroll element 37 of the turbine stage 24 of the turbocompressor 26 and is in effect disposed at the junction of the exhaust gas recirculation (EGR) loop conduit 20 and the turbine stage 24 of the turbocompressor 26 so as to selectively route exhaust gas from both the front and rear banks of engine cylinders 14 and exhaust gas manifolds 16,18 into exhaust gas recirculation (EGR) loop conduit 20, or to the turbine stage 24 of turbocompressor 26, depending upon the disposition of the valve element of the valve assembly 36.

[0011] In accordance with the particular teachings and principles of the present invention concerning the new and improved exhaust gas recirculation (EGR) back pressure valve assembly 36, and with particular reference being made to FIGURE 2, the exhaust gas recirculation (EGR) back pressure valve assembly 36 is seen to comprise a substantially T-shaped manifold section 38 which includes a first, horizontally disposed or extending inlet port or tubular conduit section 40 through which exhaust gases from first and second ones of the six cylinders are conducted, and a second, horizontally disposed inlet port or tubular conduit section 42, disposed substantially perpendicular to the first inlet port or conduit section 40, through which exhaust gas from a third one of the six cylinders is conducted. A third, horizontally disposed inlet port or conduit 44 extends parallel to the second inlet port or conduit 42 so as to provide exhaust gas from a fourth one of the six cylinders to the exhaust gas recirculation (EGR) back pressure valve manifold section 38, and a fourth, horizontally disposed inlet port or conduit 46, disposed substantially coaxially with respect to the first inlet port or conduit 40 and substantially perpendicular to the third inlet port or conduit 44, is provided for conducting exhaust gases from fifth and sixth ones of the six engine cylinders into the exhaust gas recirculation (EGR) back pressure valve assembly manifold section 38.

[0012] The underside portion of the exhaust gas recirculation (EGR) back pressure valve assembly manifold section 38 also includes an exhaust section 48 for conducting exhaust gases from the front bank of cylinders, that is, from the first, second, and third cylinders, and from the rear bank of cylinders, that is, from the fourth, fifth, and sixth cylinders, into the turbine stage 24 of the turbocompressor 26 through means of the scroll element 37 of the turbine stage 24 of the turbocompressor 26. As will be more fully described and further appreciated hereinafter, by providing the exhaust gas recirculation (EGR) back pressure valve subassembly, within the upstream or inlet end portion 50 of the scroll element 37 of the turbine stage 24 of the turbocompressor 26, the flow of the exhaust gases from both the front bank of engine cylinders, that is, from the first, second, and third cylinders, and the rear bank of engine cylinders, that is, from the fourth, fifth, and sixth cylinders, can be variably modulated or adjustably controlled such that sufficient back pressure is developed within the system during exhaust gas recirculation (EGR) operative modes.

[0013] With continued reference being made to FIGURE 2, and with additional reference being made to FIGURES 3 and 5, it is seen further that the upstream or inlet end portion 50 of the scroll element 37 of the turbine stage 24 of the turbocompressor 26 is provided with a peripheral flanged portion 52 to which the exhaust section 48 of the exhaust gas recirculation (EGR) back pressure valve assembly manifold section 38 is fixedly attached by means of, for example, a plurality of bolt fasteners 49 threadedly secured within threaded bores 51 defined within the flanged portion 52 of scroll element 37. A similar flanged portion 54 is provided upon a side wall portion 56 of the upstream or inlet end portion 50 of the scroll element 37 of the turbine stage 24 of the turbocompressor 26, and the flanged portion 54 is seen to surround an exhaust aperture or port 58 defined within the side wall portion 56 of the upstream or inlet end portion 50 of the scroll element 37.

[0014] A valve subassembly, additionally disclosed within FIGURES 4 and 7, is generally indicated by the reference character 60 and is adapted to be fixedly secured to the upstream or inlet end portion 50 of the scroll element 37. More particularly, the upstream or inlet end portion 50 of the scroll element 37 is provided with a plurality of bosses 62 within which a plurality of internally threaded bores 64 are provided, and a pair of similar internally threaded bores 64 are defined within peripheral flanged portion 52. The valve subassembly 60 is seen to comprise a substantially rectangularly configured cast base portion 66, for mating with the flanged portion 54 of the scroll element 37, and accordingly, a plurality of bores 68 are provided within cast base portion 66. A plurality of threaded bolts 70 are thus adapted to pass through the bores 68 of the cast base portion 66 and be threadedly engaged within the threaded bores 64 of the flanged portions 52,54 of the scroll element 37 so as to secure valve subassembly 60 to the upstream or inlet end portion 50 of the scroll element 37 as best seen in FIGURE 2. A peripheral gasket 72 is mounted upon the cast base portion 66 of the valve subassembly 60 so as to be inter-posed between the cast base portion 66 and the flanged portion 54 of scroll element 37 when the valve subassembly 60 is secured to scroll element 37 by means of the bolts 70.

[0015] The cast base portion 66 includes an integrally formed upwardly projecting center portion 74 which is surrounded by means of the gasket member 72 as best seen in FIGURES 4 and 7, and the upwardly projecting center portion 74 of the valve subassembly 60 is adapted to be disposed within the exhaust aperture or port 58 defined within the upstream or inlet end of the scroll member 37 of the turbine stage 24 of the turbocompressor 26 when the valve subassembly 60 is secured to the scroll element 37 as shown in FIGURE 2 and as can be clearly seen in FIGURE 5 so as to serve, as will be apparent hereinafter, as a valve seat. An exhaust aperture or port 76 is defined within the upwardly projecting center portion 74 and also extends through the cast base portion 66 whereby, when the valve subassembly 60 is secured to the scroll element 37 as shown in FIGURES 2 and 5, exhaust aperture or port 76 is fluidically connected to the exhaust port or aperture 58 defined within the upstream or inlet end portion of the scroll member 37.

[0016] As also best seen from FIGURE 5, upstream end flanged portion 52 of scroll member 37 defines an upstream inlet aperture or port 78, and cast base portion 66 has integrally formed therewith an exhaust gas recirculation (EGR) outlet scoop 80. Exhaust gas recirculation (EGR) outlet scoop 80 is fluidically connected at its upstream end to the exhaust aperture or port 76 defined within the cast base portion 66 and is fluidically connected at its downstream end to the exhaust gas recirculation (EGR) loop conduit 20. In this manner, exhaust gases from the engine exhaust gas manifolds 16,18 can be routed to the exhaust gas recirculation (EGR) loop conduit 20 through means of the exhaust gas manifold back pressure valve assembly 10.

[0017] In order to control the flow of the exhaust gases from the engine exhaust gas manifolds 16,18 either into the scroll member 37 of the turbine stage 24 of the turbocompressor 26, or into the exhaust gas recirculation (EGR) loop 20 through means of the exhaust gas recirculation (EGR) outlet scoop 80, the valve subassembly 60 further comprises a paddle valve member 82, as best seen in FIGURES 4-7, which is adapted to be pivotally mounted upon the cast base portion 66. As can best be appreciated from FIGURE 5, the paddle valve member 82 is adapted to be pivotally movable between an opened position at which the paddle valve member 82 will partially occlude the upstream entrance portion 84 of the scroll element 37 of the turbine stage 24 of the turbocompressor 26 when exhaust gas recirculation (EGR) of exhaust gases from the engine exhaust gas manifolds 16,18 through exhaust gas recirculation (EGR) outlet scoop 80 and exhaust gas recirculation (EGR) loop 20 is desired and being conducted, and a closed position at which the paddle valve member 82 will cover the exhaust aperture or port 76 defined within the cast base portion 66 such that all exhaust gases from the engine exhaust gas manifolds 16,18 are conducted directly through the scroll element 37 of the turbine stage 24 of the turbocompressor 26.

[0018] As can best be appreciated from FIGURE 7, the cast base portion 66 is provided with a transversely oriented blind bore 86 within which a pair of transversely spaced bearing members 88,89 are disposed. A valve actuating shaft 90 is inserted within the blind bore 86 such that an innermost end portion 92 thereof and an intermediate portion 94 thereof, which is transversely spaced from the inner end portion 92, are respectively disposed within the bearing members 88,89, while the end 96 of the shaft 90 which is disposed opposite the innermost end portion 92 thereof projects outwardly from the cast base portion 66 so as to be operatively connected to a suitable valve actuator, not shown.

[0019] An axially central portion 98 of the valve actuating shaft 90 is interposed between the innermost end portion 92 of the shaft 90 and the intermediate portion 94 of the shaft 90, and is adapted to have the paddle valve member 82 mounted thereon. More particularly, as best seen in FIGURE 6, the paddle valve member 82 further comprises a hinge portion 100 integrally formed therewith, and the hinge portion 100 is provided with a through bore 102 for accommodating the actuating shaft 90. The internal peripheral wall of the hinge portion 100 which defines the upper portion of the through bore 102 within the hinge portion 100 of the paddle valve member 82 is seen to have a flattened configuration as at 104, and the upper external peripheral surface portion of the axially central portion 98 of the actuating shaft 90 is likewise provided with a flattened configuration as at 106 such that when the actuating shaft 90 is inserted within the through bore 102 of the hinge portion 100 of the paddle valve member 82, the shaft 90 and hinge portion 100 are effectively keyed together such that relative rotation therebetween is prevented. Alternatively, in lieu of a keyed connection defined between shaft 90 and hinge portion 100, the two members could be splined together.

[0020] An upstanding wall portion 108 is formed at the end of flattened portion 106 which is opposite innermost end portion 92 of the shaft 90 so as to engage an external side wall portion 110 of the hinge portion 100 of the paddle valve 82 and thereby properly axially seat the actuating shaft 90 within the through bore 102 of the hinge portion 100 of the paddle valve member 82.

[0021] The hinge portion 100 of the paddle valve member 82 is also provided with a transversely extending internally threaded blind bore 112 through which a cap screw 114 is inserted, as best seen in FIGURE 7, such that the innermost end of the cap screw 114 is seated upon the flattened portion 106 of the actuating shaft 90 so as to retain the paddle valve member 82 and the actuating shaft 90 assembled together. The cast base portion 66 is also provided with a recessed socket portion 116, as best seen in FIGURE 7, for accommodating the hinge portion 100 of the paddle valve member 82 in order to permit or facilitate the pivotal movements of the paddle valve member 82. The paddle valve member 82 is also seen to be centered within socket portion 116 by means of inside or internally facing surfaces of the bearing members 88,89.

INDUSTRIAL APPLICABILITY

[0022] With reference now being made to FIGURE 5, the operation of the new and improved exhaust gas recirculation (EGR) back pressure valve assembly 36 which has been developed in accordance with the principles and teachings of the present invention will now be described. When no recirculation of the engine exhaust gases is to take place, the actuator, not shown, is energized such that the valve actuating shaft 90 is pivoted or rotated whereby as a result of the keyed connection defined between the valve actuating shaft 90 and the hinge portion 100 of the paddle valve member 82, the paddle valve member 82 is pivotally moved to its closed position with respect to the exhaust port or aperture 76 and the valve seat 74 defined within the cast base portion 66. Accordingly, all exhaust gases from both the front bank of engine cylinders, and the rear bank of engine cylinders, as transmitted through the exhaust gas manifolds 16,18, are prevented from being conducted through the exhaust port or aperture 76, out through the exhaust outlet scoop 80 and through the exhaust gas recirculation loop 20 toward the EGR cooler 22, and are caused to be exhausted through the scroll member 37 of the turbine stage 24 of the engine turbocompressor 26.

[0023] When partial recirculation of the engine exhaust gases is to take place, the actuator, not shown, is actuated such that the shaft 90 is rotated or pivoted and the paddle valve member 82 is likewise rotated or pivoted such that the paddle valve member 82 is now disengaged from the valve seat 74 whereby a partial back pressure is developed within the upstream portion 84 of the scroll element 37 such that a predetermined portion of the exhaust gases from the engine cylinders is in effect partially deflected through exhaust port 76 of the cast base portion 66, through exhaust outlet scoop 80, and into exhaust gas recirculation (EGR) loop 20 toward the EGR cooler 22 while the remaining portion of the exhaust gases from the engine cylinders is con-ducted through the scroll element 37 toward the turbine stage 24 of the turbocompressor 26. In connection with this partial exhaust gas recirculation (EGR) operative mode, it is of course to be understood that only one example of a partial exhaust gas recirculation (EGR) state has been illustrated. In practice, the actuator, not shown, can of course be programmed or controlled so as to achieve any one of a substantially infinite number of pivotal or rotational states so as to in turn cause a substantially infinite number of partial exhaust gas recirculation (EGR) states.

[0024] When full exhaust gas recirculation (EGR) is to occur, the actuator, not shown, is actuated further such that the paddle valve member 82 is moved to its greatest opened extent. Accordingly, paddle valve member 82 is now disposed at a position which occludes most of the upstream portion 84 of the scroll member 37 of the turbine stage 24 of the turbocompressor to the greatest extent whereby in effect only an annular space remains between the outer peripheral edge portion 117 of the paddle valve member 82 and the inner peripheral surface portion 118 of the upstream portion 84 of the scroll element 37. Accordingly, such occlusion serves not only to physically occlude the upstream portion 84 of the scroll element 37 but in addition, develops a significant back pressure with respect to the scroll element 37 whereby a significant portion of the exhaust gases from the engine cylinders is effectively forced to be conducted from inlet aperture or port 78 of scroll element 37, through elongated exhaust port 74 of the valve sleeve member 64, through exhaust port 58, through exhaust aperture or port 76, and out through exhaust outlet scoop 80 and into the exhaust gas recirculation (EGR) loop 20 and toward the EGR cooler 22 while a remaining portion of the exhaust gases from the engine cylinders is also conducted through the aforenoted annular space defined between the outer peripheral edge portion 117 of the paddle valve member 82 and the inner peripheral surface portion 118 of the scroll element 37 so as to be exhausted into the scroll element 37 and the turbine stage 24 of the turbocompressor 26.

[0025] Thus, it may be seen that as a result of the incorporation of the new and improved exhaust gas recirculation (EGR) back pressure valve assembly within the exhaust gas recirculation (EGR) loop of the internal combustion engine, proper or sufficient exhaust gas recirculation (EGR) is able to be readily achieved in a reliable and low cost manner without the need for separate pumps, venturi mechanisms, or the like. In addition, it is noted that the new and improved exhaust gas recirculation (EGR) back pressure valve assembly is not simply an ON-OFF type valve assembly, but to the contrary, as a result of the provision of a suitable actuator, which may be, for example, an electrohydraulic actuator, a substantially infinite number of open positions of the paddle valve member, for achieving a substantially infinite number of degrees of occlusion of the upstream portion of the scroll element of the turbine stage of the turbo compressor, and therefore a substantially infinite number of exhaust gas recirculation (EGR) states, is able to be achieved. Still further, with the system of the present invention, wherein the exhaust gases from all of the engine cylinders are effectively modulated by the exhaust gas recirculation (EGR) system of the present invention, it is possible to effectively lower exhaust manifold temperatures as compared to a single bank back pressure valve system, and to lower exhaust particulate levels so as to in fact achieve better exhaust gas recirculation (EGR) mixing properties or characteristics.

[0026] Obviously, many variations and modifications of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

Claims

1. An exhaust gas recirculation (EGR) system for use in connection with an internal combustion engine, comprising:

   an exhaust gas recirculation (EGR) conduit interposed an exhaust manifold structure of all of the cylinders of the engine and atmospheric exhaust structure; and

   a valve mechanism disposed at a juncture defined between said exhaust gas recirculation (EGR) conduit and said atmospheric exhaust structure and movable between a fully closed position at which an entrance to said exhaust gas recirculation (EGR) conduit is blocked and all exhaust gases from all of the cylinders of the engine pass to atmospheric exhaust through said atmospheric exhaust structure, and a fully opened position at which said valve mechanism opens said entrance to said exhaust gas recirculation (EGR) conduit and partially occludes an entrance portion of said atmospheric exhaust structure such that a sufficiently large back pressure is developed with respect to said atmospheric exhaust structure such that exhaust gases from all of the cylinders of the engine are forced through said exhaust gas recirculation (EGR) conduit.

2. The system as set forth in Claim 1, wherein said atmospheric exhaust structure including:

a turbocompressor including a turbine stage adapted to be driven by exhaust gases from the engine and a compressor stage for introducing atmospheric air into the engine,
said turbine stage of said turbocompressor being interposed said valve mechanism and said atmospheric exhaust such that the positional disposition of said valve mechanism between said fully opened and fully closed positions determines the amount of exhaust gas transmitted to said turbine stage of said turbocompressor and said exhaust gas recirculation (EGR) conduit.

3. The system as set forth in Claim 2, wherein:

said turbine stage of the engine turbocompressor includes a scroll element; and
said valve mechanism includes a paddle valve member disposed within an upstream portion of said scroll element.

4. The system as set forth in Claim 3, wherein:

said paddle valve member is pivotally movable within said upstream portion of said scroll element; and
an actuator shaft is operatively connected to said paddle valve member for moving said paddle valve member between said fully opened and fully closed positions.

5. The system as set forth in Claim 4, wherein:

said paddle valve member includes an integral hinged member having a flat portion defined thereon; and
said actuator shaft has a flat portion defined thereon for mated engagement with said flat portion of said paddle valve flat portion such that said paddle valve hinged member and said actuator shaft are keyed together wherein pivotal movement of said actuator shaft causes corresponding pivotal movement of said paddle valve member.

6. The system as set forth in Claim 5, wherein:

said hinged member of said paddle valve member has a blind bore defined therein; and
a cap screw is disposed within said blind bore of said hinged member of said paddle valve member for engaging said flat portion of said actuator shaft so as to retain said actuator shaft and said paddle valve member assembled together.

7. The system as set forth in Claim 3, wherein:

an exhaust outlet scoop member is fixedly secured to said scroll element for conducting exhaust gases to said exhaust gas recirculation (EGR) loop, and has an exhaust port for receiving exhaust gases from said scroll element;
said scroll element includes an inlet port for receiving exhaust gases from the exhaust gas manifold structure of the engine, and an outlet port for transmitting exhaust gases into said exhaust port of said exhaust outlet scoop member; and
said paddle valve member is pivotally mounted upon said valve mechanism so as to close said exhaust port of said exhaust outlet scoop member when exhaust gas recirculation (EGR) is not being conducted.

8. The system as set forth in Claim 7, wherein:

said scroll element includes a flanged portion annularly surrounding said outlet port of said scroll element; and
said valve mechanism includes a flanged base portion annularly surrounding said exhaust port of said exhaust outlet scoop member and said paddle valve member; and
bolt fasteners fixedly secure said flanged base portion of said valve mechanism to said flanged portion of said scroll element.

9. The system as set forth in Claim 8, wherein:

said flanged base portion includes a valve seat portion which annularly surrounds said exhaust port of said exhaust outlet scoop member and upon which said paddle valve member is disposed when said paddle valve member is disposed at said closed position; and
said flanged base portion of said valve mechanism, said valve seat portion of said flanged base portion, and said exhaust outlet scoop member include a single integral cast element.

10. The system as set forth in Claim 9, wherein:

said valve seat portion projects away from said flanged base portion so as to project through and be disposed within said outlet port of scroll element when said flanged base portion of said valve mechanism is secured to said flanged portion of said scroll element.

11. An exhaust gas recirculation (EGR) system for use in connection with an internal combustion engine having a plurality of cylinders, comprising:

an intake manifold connected to said plurality of cylinders of said internal combustion engine for introducing air into said plurality of cylinders of said internal combustion engine;
exhaust manifold structure connected to said plurality of cylinders of said internal combustion engine for conducting exhaust gases out from said cylinders of said internal combustion engine;
an exhaust gas recirculation (EGR) conduit interposed said exhaust manifold structure of all of said plurality of cylinders of said internal combustion engine and atmospheric exhaust structure; and a valve mechanism disposed at a juncture de-fined between said exhaust gas recirculation (EGR) conduit and said atmospheric exhaust structure and movable between a fully closed position at which an entrance to said exhaust gas recirculation (EGR) conduit is blocked and all exhaust gases from all of said plurality of cylinders of said internal combustion engine pass to atmospheric exhaust through said atmospheric exhaust structure, and a fully opened position at which said valve mechanism opens said entrance to said exhaust gas recirculation (EGR) conduit and partially occludes an entrance portion of said atmospheric exhaust structure such that a sufficiently large back pressure is developed with respect to said atmospheric exhaust structure such that exhaust gases from all of said plurality of cylinders of said internal combustion engine are forced through said exhaust gas recirculation (EGR) conduit.

12. The system as set forth in Claim 11, wherein said atmospheric exhaust structure comprises:

a turbocompressor comprising a turbine stage adapted to be driven by exhaust gases from the engine and a compressor stage for introducing atmospheric air into the engine,
said turbine stage of said turbocompressor being interposed said valve mechanism and said atmospheric exhaust such that the positional disposition of said valve mechanism between said fully opened and fully closed positions determines the amount of exhaust gas transmitted to said turbine stage of said turbocompressor and said exhaust gas recirculation (EGR) conduit.

13. The system as set forth in Claim 12, wherein:

said turbine stage of the engine turbocompressor includes a scroll element; and
said valve mechanism comprises a paddle valve member disposed within an upstream portion of said scroll element.

14. The system as set forth in Claim 13, wherein:

said paddle valve member is pivotally movable within said upstream portion of said scroll element; and
an actuator shaft is operatively connected to said paddle valve member for moving said paddle valve member between said fully opened and fully closed positions.

15. The system as set forth in Claim 14, wherein:

said paddle valve member includes an integral hinged member having a flat portion defined there-on; and
said actuator shaft has a flat portion defined thereon for mated engagement with said flat portion of said paddle valve flat portion such that said paddle valve hinged member and said actuator shaft are keyed together wherein pivotal movement of said actuator shaft causes corresponding pivotal movement of said paddle valve member.

16. The system as set forth in Claim 15, wherein:

said hinged member of said paddle valve member has a blind bore defined therein; and
a cap screw is disposed within said blind bore of said hinged member of said paddle valve member for engaging said flat portion of said actuator shaft so as to retain said actuator shaft and said paddle valve member assembled together.

17. The system as set forth in Claim 13, wherein:

an exhaust outlet scoop member is fixedly secured to said scroll element for conducting exhaust gases to said exhaust gas recirculation (EGR) loop, and has an exhaust port for receiving exhaust gases from said scroll element;
said scroll element includes an inlet port for re-

ceiving exhaust gases from the exhaust gas manifold structure of the engine, and an outlet port for transmitting exhaust gases into said exhaust port of said exhaust outlet scoop member; and
said paddle valve member is pivotally mounted upon said valve mechanism so as to close said exhaust port of said exhaust outlet scoop member when exhaust gas recirculation (EGR) is not being conducted.

18. The system as set forth in Claim 17, wherein:

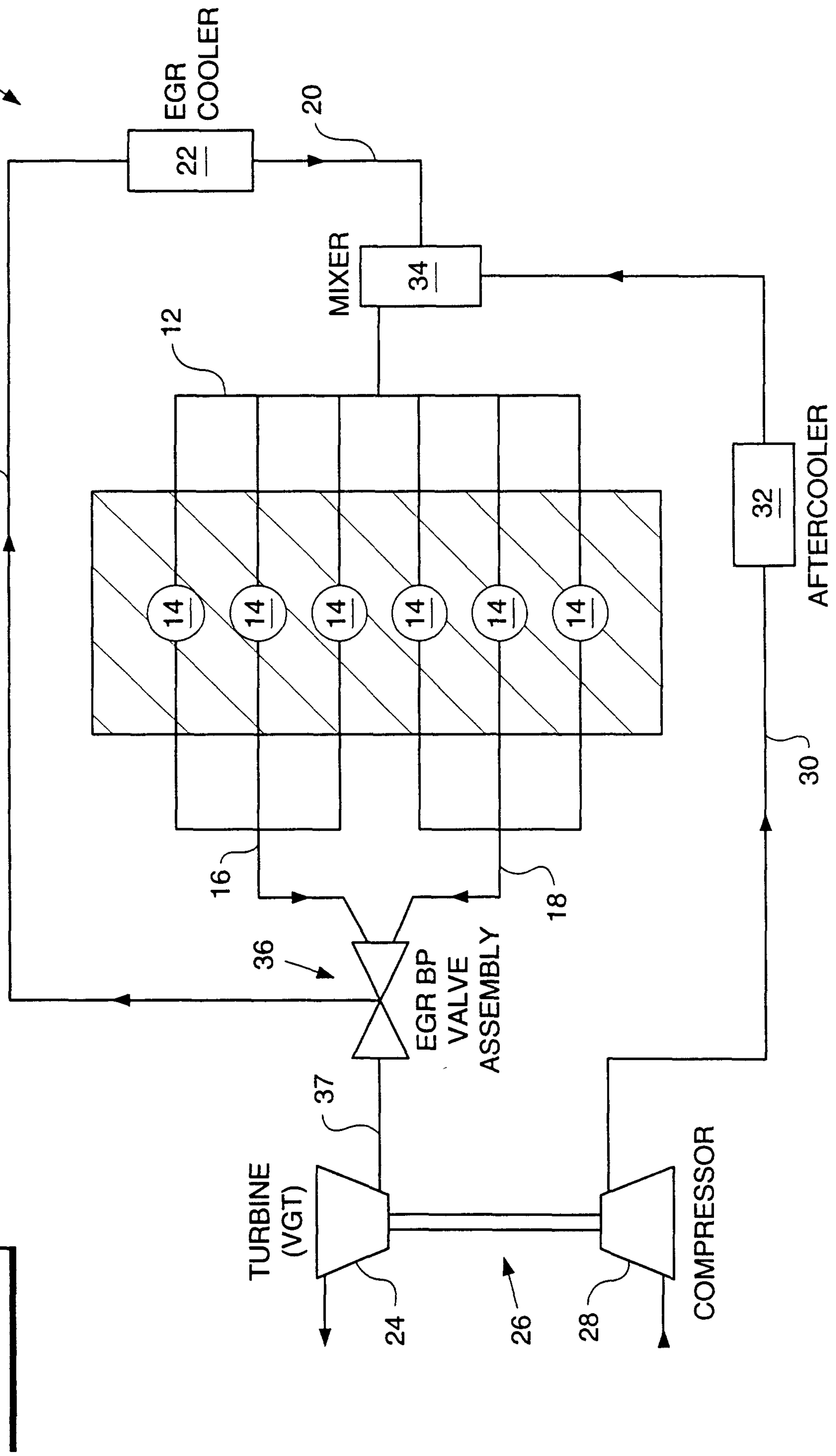
said scroll element includes a flanged portion annularly surrounding said outlet port of said scroll element; and
said valve mechanism includes a flanged base portion annularly surrounding said exhaust port of said exhaust outlet scoop member and said paddle valve member; and
bolt fasteners fixedly secure said flanged base portion of said valve mechanism to said flanged portion of said scroll element.

19. The system as set forth in Claim 18, wherein:

said flanged base portion includes a valve seat portion which annularly surrounds said exhaust port of said exhaust outlet scoop member and upon which said paddle valve member is disposed when said paddle valve member is disposed at said closed position; and
said flanged base portion of said valve mechanism, said valve seat portion of said flanged base portion, and said exhaust outlet scoop member include a single integral cast element.

20. The system as set forth in Claim 19, wherein:

said valve seat portion projects away from said flanged base portion so as to project through and be disposed within said outlet port of scroll element when said flanged base portion of said valve mechanism is secured to said flanged portion of said scroll element.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EGR
COOLER
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MIXER
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AFTERCOOLER
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EGR BP
VALVE
ASSEMBLY
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TURBINE
(VGT)
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COMPRESSOR

FIG-1-

Fig. 2

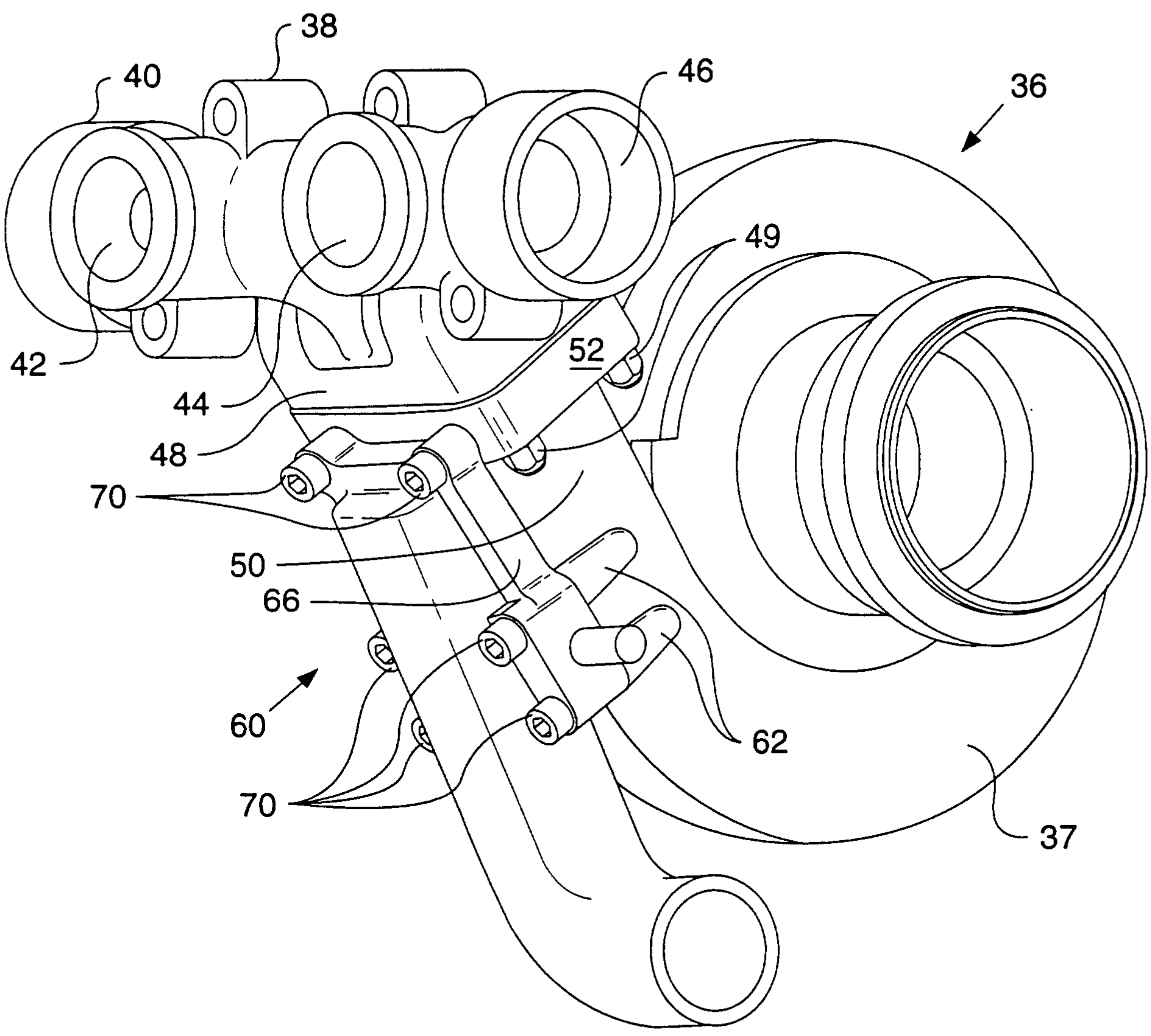


Fig. 3

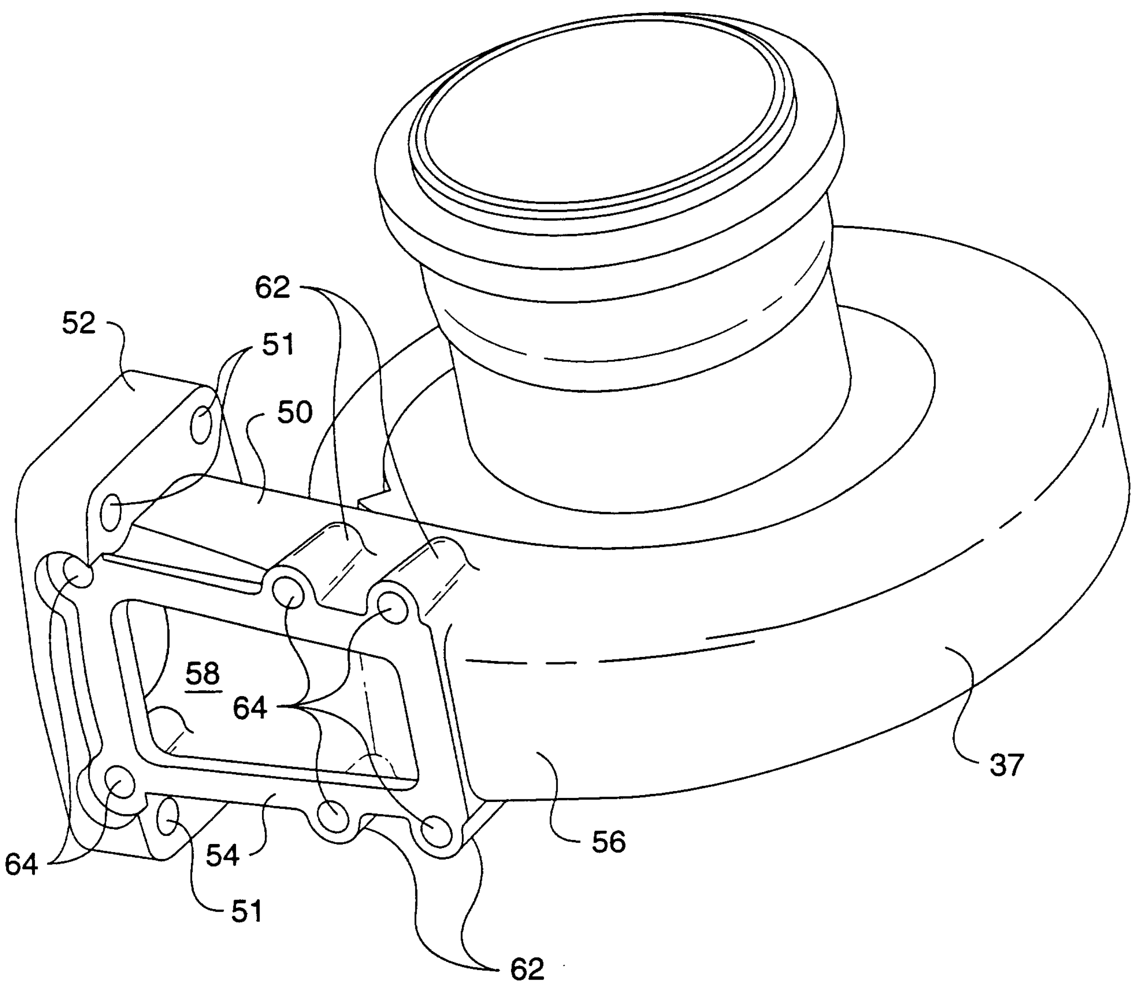
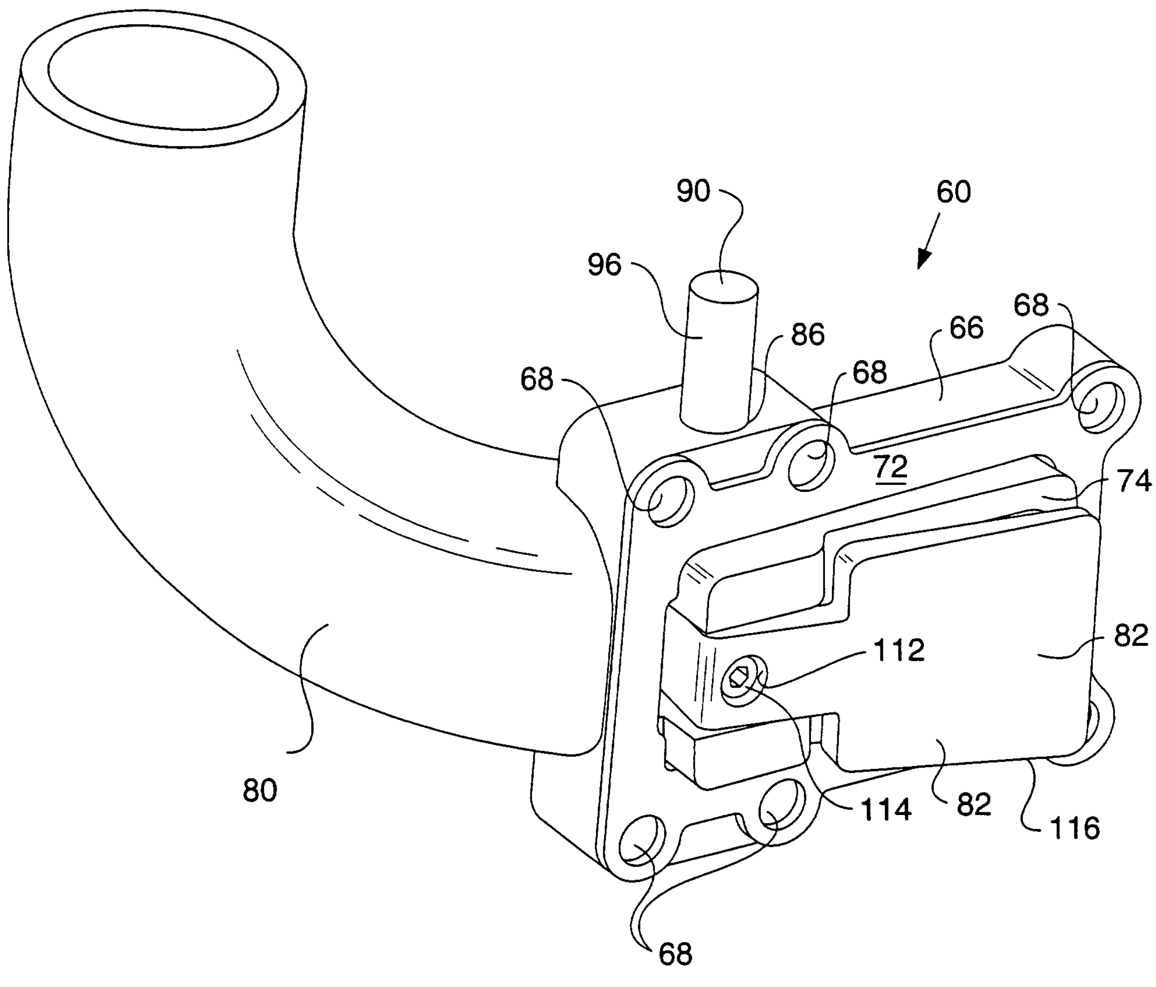


Fig-4-



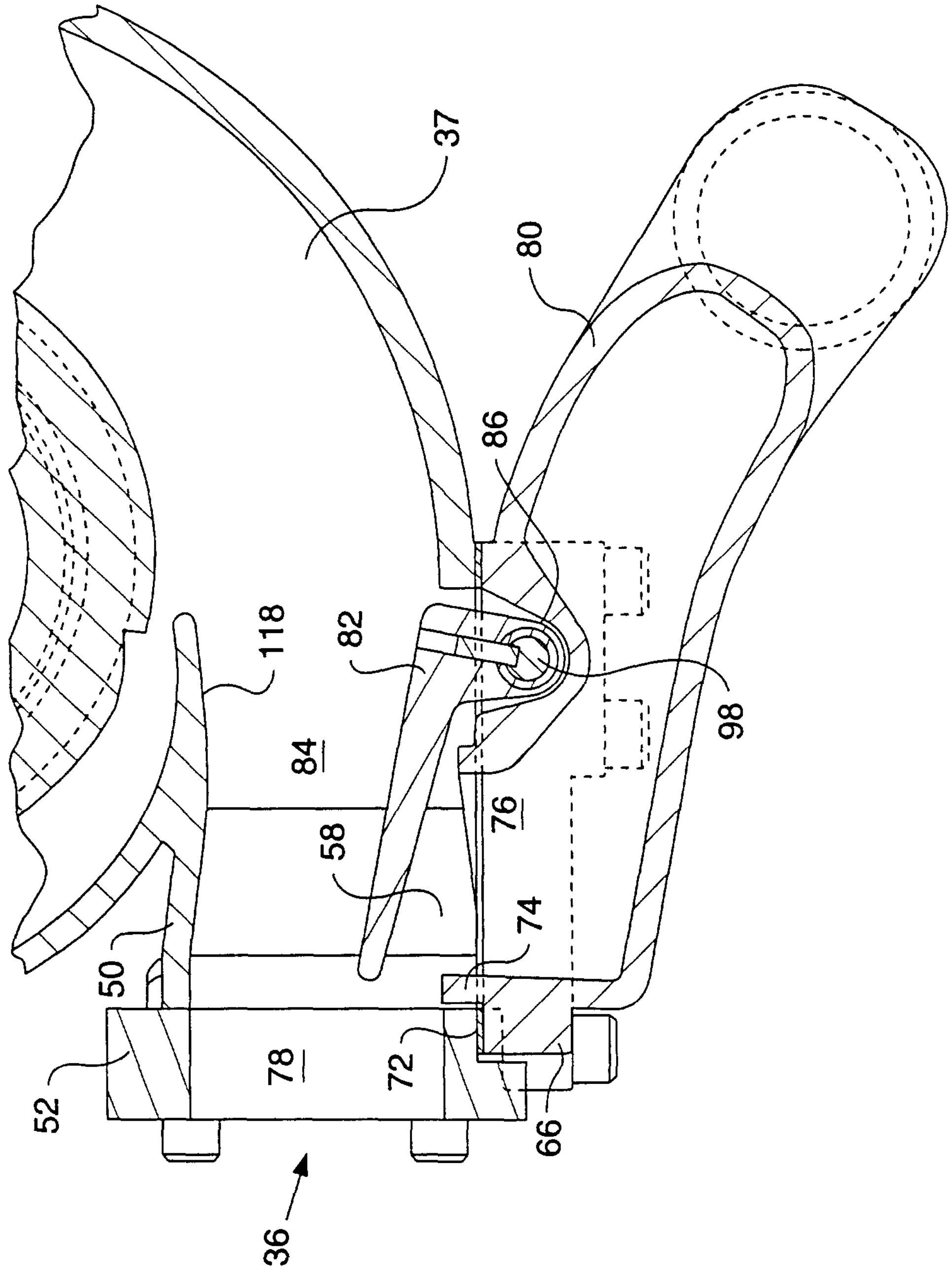


FIG-5-

Fig. 6.

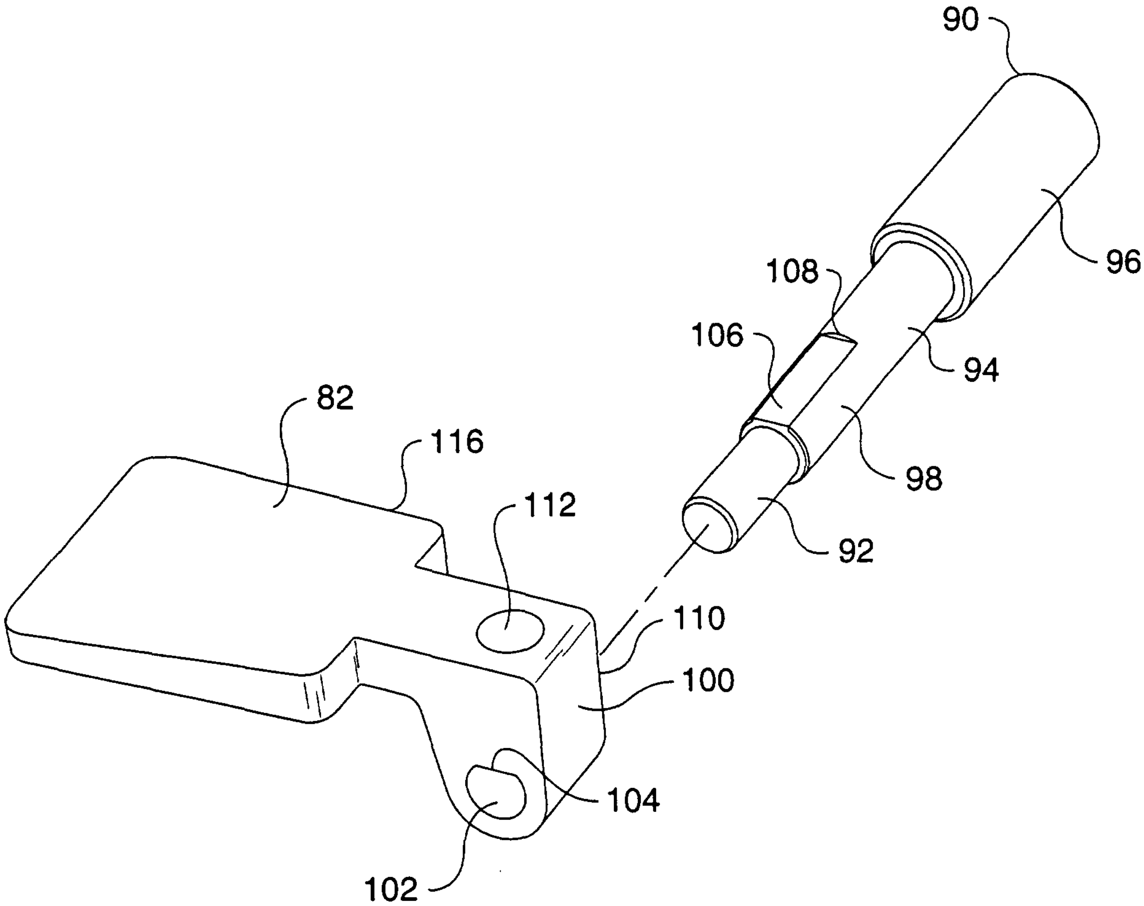
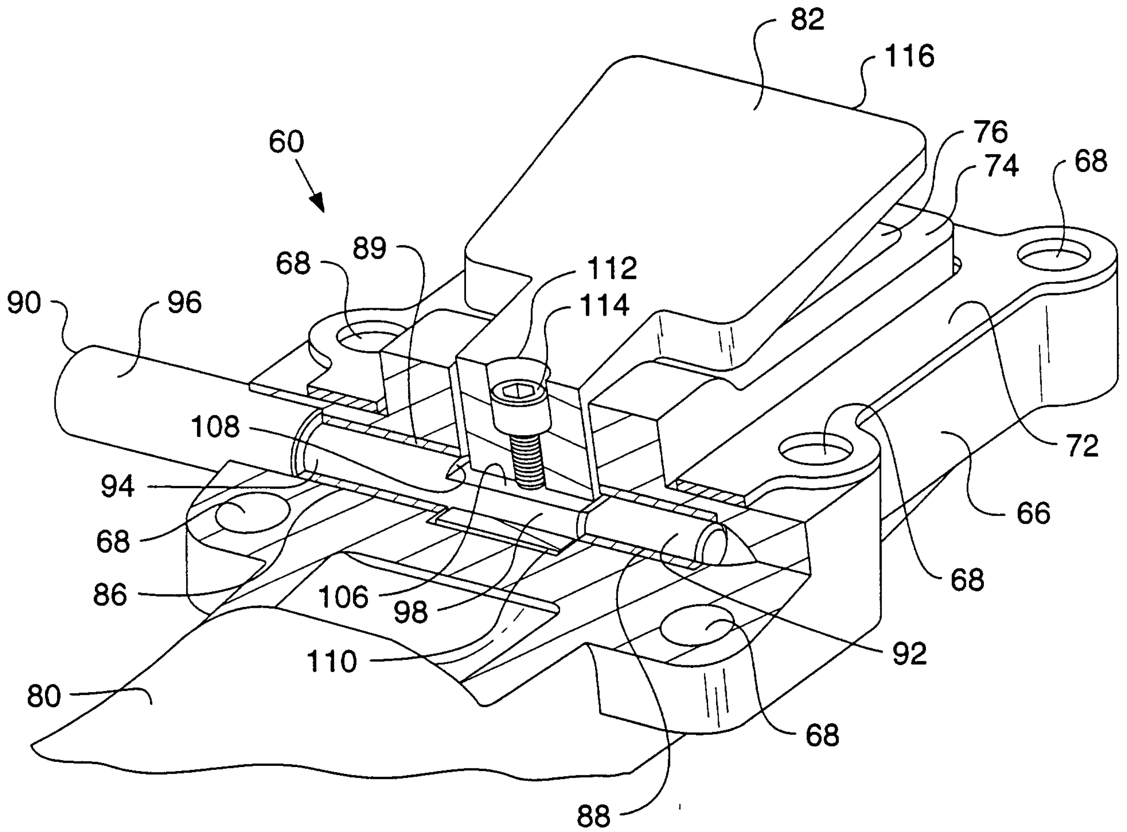


Fig. 7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