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Internal combustion engine with torque converter

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(56) Related Art
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US6793052

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Internal Combustion Engine with Torque Converter

Abstract

An internal combustion engine with a torque converter includes a crankshaft (30) on which the torque converter is mounted. The crankshaft (30) is formed with an oil passage extending along the axis of the crankshaft (30), an inlet hole (35) for supplying a hydraulic fluid from the oil passage to the torque converter, and an outlet hole (36) for discharging the hydraulic fluid from the torque converter to the oil passage. The crankshaft (30) is provided with a shaft bearing (55) for supporting a rotating shaft for the torque converter. The inlet hole (35) is so provided as to contact with the shaft bearing (55). That is, the inlet hole (35) is located at an axial end of the shaft bearing (55). With this arrangement, a flow resistance due to the shaft bearing (55) can be greatly reduced to thereby allow smooth supply of the hydraulic fluid into the torque converter. Accordingly, even when the temperature of the hydraulic fluid is low and the viscosity of the hydraulic fluid is therefore high, a necessary oil quantity and oil pressure in the torque converter can be obtained. The axial end of the shaft bearing (55) corresponds to an axial end positioned near the rotating shaft for the torque converter.

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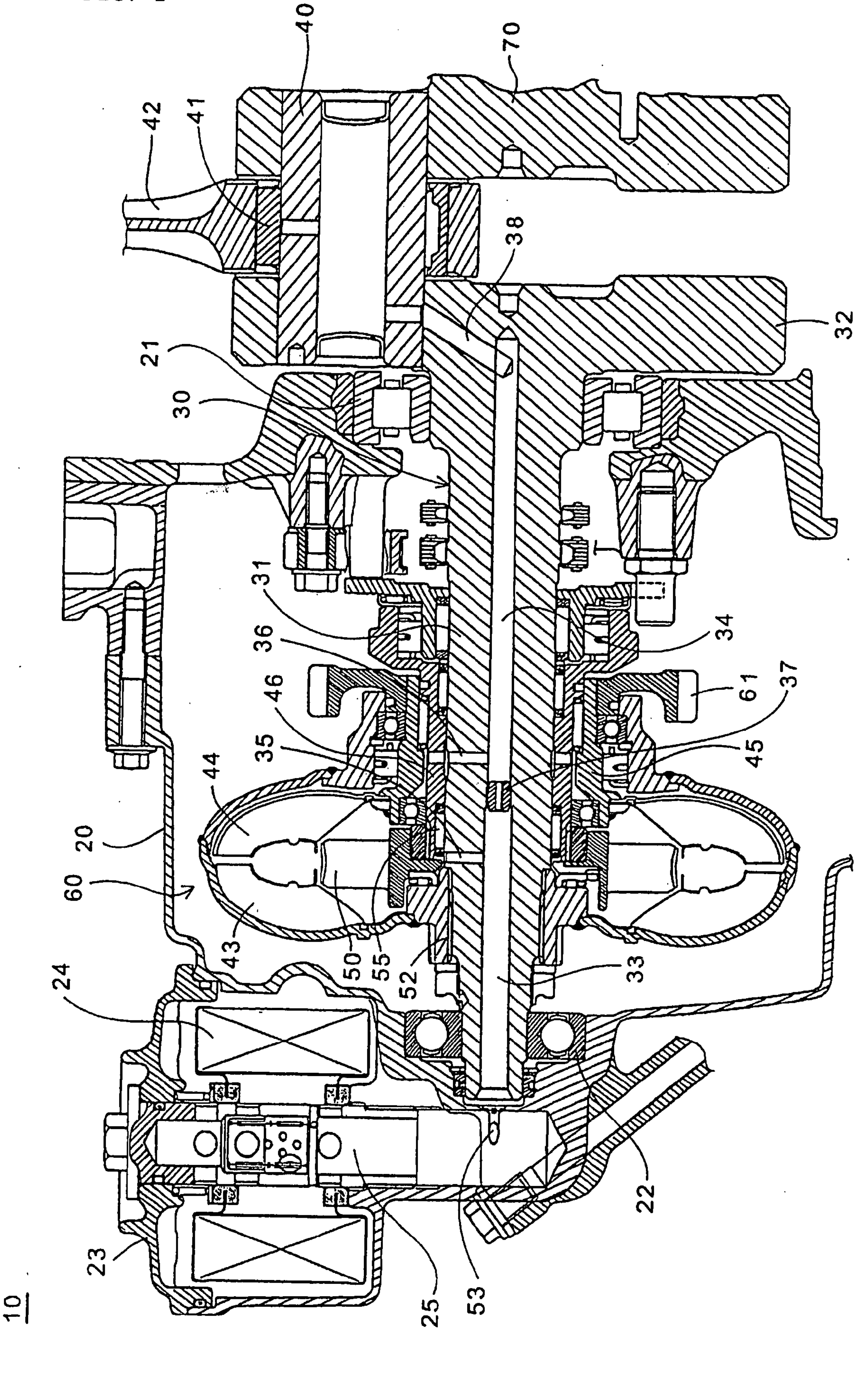
FIG. 1



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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

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Invention Title:	Internal combustion engine with torque converter

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

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Internal Combustion Engine with Torque Converter

Field of the Invention

The present invention relates to an internal combustion engine with a torque converter.

Background of the Invention

It is known that an internal combustion engine with a torque converter uses a common oil as a hydraulic fluid for the torque converter and a lubricating oil for the internal combustion engine. In the case that the hydraulic fluid returned from the torque converter in such an internal combustion engine is not discharged into the oil stored in an oil pan, but directly discharged into the atmosphere in a crankcase, the hydraulic fluid returned becomes a mist at a discharge opening, causing a possible reduction in oil circulation efficiency. However, in the case that an oil passage for the returned hydraulic fluid independent of an oil passage for the lubricating oil is formed to discharge the returned hydraulic fluid into the oil stored in the oil pan, the oil passage for the returned hydraulic fluid becomes complicated in structure, causing an increase in number of production steps.

Japanese Patent Laid-Open No. 2003-328717 discloses an internal combustion engine with a torque converter having an oil passage for the hydraulic fluid returned from the torque converter, wherein this oil passage communicates with an oil passage formed along the axis of a crankshaft, a chamber formed by an oil seal for sealing a shaft bearing provided on the crankshaft, and an oil passage passing through a crankcase and provided with a check valve at an outlet end. With this configuration, the hydraulic fluid returned from the torque converter can be discharged into the oil stored in the oil pan by a simple change in structure. FIG. 5 shows such a prior art configuration, wherein an inlet hole 35a and an outlet hole 36 are formed in a shaft portion 31 of a crankshaft 50, and a hydraulic fluid is supplied through the inlet hole 35a into a torque converter 60 and discharged from the torque converter 60 through the outlet hole 36. The crankshaft 50 is provided with a needle shaft bearing 55 for supporting a rotating shaft for the torque converter 60. The inlet hole 35a is located at the axial center of the needle shaft bearing 55. Accordingly, the oil (hydraulic fluid) introduced from the inlet hole 35a is passed through a space between needle rollers and inner and outer rings of the needle shaft bearing 55, and next supplied to a passage 48.

However, the internal combustion engine with the torque converter disclosed in Japanese Patent Laid-Open No. 2003-328717 has a problem such that when the temperature of the hydraulic fluid for the torque converter is lower than a normal temperature at cold starting or the like and the viscosity of the hydraulic fluid is therefore high, there is a possibility that the hydraulic fluid in the torque converter may not reach a sufficient oil quantity and oil pressure, and a necessary drive force cannot be obtained until the temperature of the hydraulic fluid rises to a certain temperature. This problem is due to the fact that a flow resistance in the vicinity of the inlet hole 35a is increased by an increase in viscosity of the hydraulic fluid, so that the hydraulic fluid is not smoothly supplied into the torque converter.

Object of the Invention

It is the object of the invention to overcome or substantially ameliorate one or more of the disadvantages of the prior art, or at least to provide a useful alternative.

It is an object of the present invention, at least in its preferred form, to provide an internal combustion engine with a torque converter which can extend the temperature range of a hydraulic fluid allowing the function of the torque converter toward lower temperatures.

Summary of the Invention

An aspect of the present invention provides an internal combustion engine with a torque converter mounted on a crankshaft, said crankshaft being formed with an oil passage extending along the axis of said crankshaft, an inlet hole for supplying a hydraulic fluid from said oil passage to said torque converter, and an outlet hole for discharging said hydraulic fluid from said torque converter to said oil passage, said crankshaft having an orifice provided in said oil passage, said inlet hole being located upstream of said orifice, said outlet hole being located downstream of said orifice, said crankshaft being provided with a shaft bearing for supporting a rotating shaft for said torque converter, wherein said inlet hole is located at an axial end of said shaft bearing such that the inlet hole communicates with the axial end of the shaft bearing and the hydraulic fluid also lubricates the shaft bearing,

wherein a first end of the shaft bearing overlaps the inlet hole such that the shaft bearing only partially overlaps the inlet hole,

wherein the shaft bearing is not connected to any outlet holes, and

wherein the inlet hole is only connected to the shaft bearing and an oil supply passage of the torque converter.

More preferably, the axial end of the shaft bearing corresponds to an axial end positioned near the rotating shaft for the torque converter.

Preferably, the inlet hole is located so that at least a part of an opening of the inlet hole exposed to the shaft bearing is not blocked by the shaft bearing.

Preferably, the inlet hole is located in the vicinity of the axial center of the rotating shaft for the torque converter.

Brief Description of the Drawings

A preferred embodiment of the present invention will now be described hereinafter, by way of an example only, with reference to the accompanying drawings, in which:

FIG. 1 is a sectional view of an internal combustion engine according to a preferred embodiment of the present invention;

FIG. 2 is a schematic perspective view of a crankshaft in the internal combustion engine shown in FIG. 1;

FIG. 3 is a sectional view of the crankshaft shown in FIG. 2;

FIG. 4 is an enlarged sectional view of a part of the internal combustion engine shown in FIG. 1; and

FIG. 5 is a sectional view of a crankshaft in the prior art.

Preferred Embodiment of the Invention

A preferred embodiment of the present invention will now be described in detail with reference to the drawings. FIG. 1 is a sectional view of a main part of an internal combustion engine with a torque converter according to the present invention. The internal combustion engine 10 is a four-cycle, single-cylinder engine such that a piston (not shown) is pushed by the explosion pressure of an air-fuel mixture to generate a rotational drive force from a crankshaft 30 and to transmit the rotational drive force to a transmission (not shown) through the torque converter 60 coaxially provided on the crankshaft 30. The crankshaft 30 is rotatably supported through shaft bearings 21 and 22 to a crankcase 20. The crankshaft 30 is composed of a shaft portion 31 and a substantially disk-shaped crank web 32. A crankpin 40 for connecting the crankshaft 30 and another crankshaft 70 forming a pair in combination with the crankshaft 30 is engaged with the crank web 32. A shaft bearing 41 is engaged with the crankpin 40, and a larger end of a connecting rod 42 is rotatably supported to the shaft bearing 41. With this configuration, the reciprocating motion of the piston mounted at a smaller end of the connecting rod 42 in the vertical direction as viewed in FIG. 1 is converted into the rotational motion of the crankshafts 30 and 70.

The rotational drive force generated from the crankshaft 30 is transmitted through the torque converter 60 as a known torque converting device to the transmission for taking out the rotational drive force at an arbitrary reduction gear ratio. The torque converter 60 is composed of a pump impeller 43, a turbine runner 44, and a stator 50. The pump impeller 43 is connected to a support member 52 splined to the crankshaft 30. When the internal combustion engine 10 is started to start rotating the crankshaft 30, the oil (hydraulic fluid) fed under pressure from an oil pump (not shown) is supplied into the torque converter 60. With an increase in rotational speed of the pump impeller 43 rotating integrally with the crankshaft 30, the turbine runner 44 starts rotating so as to follow the rotation of the pump impeller 43 with the aid of the viscosity of the hydraulic fluid. The rotational drive force generated from the turbine runner 44 is next transmitted to the transmission through an output gear 61 connected to a transmitting ring 45.

The internal combustion engine 10 uses a common oil as the hydraulic fluid for the torque converter 60 and the lubricating oil for various parts to be lubricated. A substantially cylindrical oil filter 24 is sealedly fixed through a cover 23 to one end portion of the crankcase 20. The oil fed under pressure from the oil pump is passed through the oil filter 24 to an oil passage 25 and introduced from the oil passage 25 to an oil inlet 53 located at the left end of the crankcase 30 as viewed in FIG. 1. The oil introduced from the oil inlet 53 flows into an oil gallery 33 formed along the axis of the shaft portion 31, and is then introduced to the torque converter 60 through an inlet hole 35 radially extending from the oil gallery 33 to the outer circumference of the shaft portion 31. The oil having operated as the hydraulic fluid in the torque converter 60 is discharged from an outlet hole 36 radially extending like the inlet hole 35 to another oil gallery 34 formed along the axis of the shaft portion 31. The oil flowing in the oil gallery 34 toward the crank web 32 is introduced through another oil gallery 38 formed in the crank web 32 to the outer circumference of the crankpin 40, so that this oil is used for lubrication of the shaft bearing 41 and for cooling of the piston. The remaining oil not used for the lubrication and cooling mentioned above is returned through an oil passage (not shown) communicating with the oil gallery 34 to an oil pan (not shown) of the crankcase 20. An oil flow control member 37 forming a bypass oil passage bypassing the torque converter 60 is provided between the oil gallery 33 communicating with the inlet hole 35 and the oil gallery 34 communicating with the outlet hole 36. The oil flow control member 37 is a pipelike orifice for reducing the diameter of an oil passage where the orifice is located to thereby control an oil flow rate in the oil passage. The inlet hole 35 is located upstream of the oil flow control member 37 in respect of the oil flow in the oil passage formed along the axis of the shaft portion 31. Accordingly, the oil fed from the oil pump is introduced to the inlet hole 35, i.e., to the torque converter 60 more preferentially than to the oil flow control member 37. The shaft portion 31 is supported in the vicinity of the inlet hole 35 by a shaft bearing 55 supported to a shaft support member 46.

FIG. 2 is a schematic perspective view of the crankshaft 30. As mentioned above, the oil introduced from an oil inlet 33a formed at one end of the shaft portion 31 is supplied through the inlet hole 35 into the torque converter 60 (see FIG. 1). Thereafter, the oil is discharged from the outlet hole 36 and then supplied to a crankpin hole 39 with which the crankpin 40 (see FIG. 1) is fitted, so as to lubricate the shaft bearing 41 (see FIG. 1), for example. In this preferred embodiment, the inlet hole 35 and the outlet hole 36 have the same diameter (e.g., 3 mm).

FIG. 3 is a sectional view of the crankshaft 30, and FIG. 4 is an enlarged sectional view of an essential part of the shaft portion 31 in connection with the shaft support member 46. The same reference numerals as those shown in FIGS. 1 and 2 denote the same or like parts. The oil introduced from the inlet hole 35 is supplied through a passage 48 formed in the shaft support member 46 into the torque converter 60. After functioning as the hydraulic fluid in the torque converter 60, the oil is discharged from a passage 47 formed in the shaft support member 46 through the outlet hole 36 to the oil gallery 34. Further, an oil pool 49 is defined between the passage 47 and the outlet hole 36 to temporarily store the oil discharged from the torque converter 60, thereby properly maintaining the oil quantity and oil pressure in the torque converter 60.

The inlet hole 35 is located at an axial end of the shaft bearing 55. With this arrangement, the oil supplied from the inlet hole 35 does not pass through the narrow space between the components of the shaft bearing 55, so that the flow resistance between the inlet hole 35 and the passage 48 can be greatly reduced. Accordingly, even when the temperature of the oil is low and the viscosity of the oil is therefore high, the oil can be supplied smoothly into the torque converter 60, and an oil quantity and oil pressure required for functioning of the torque converter 60 can be obtained. Further, the inlet hole 35 is so located as to communicate with both the axial end of the shaft bearing 55 and the passage 48, so that the function of lubricating the shaft bearing 55 by the oil supplied from the inlet hole 35 can also be ensured.

In comparison with the inlet hole 35a in the prior art shown in FIG. 5, the inlet hole 35 in this preferred embodiment is located in the vicinity of the axial center of the rotating shaft for the torque converter 60. In other words, the axial position of the inlet hole 35 is shifted (e.g., by a distance of 7 mm) from the axial center of the shaft bearing 55 toward the oil inlet 33a (see FIG. 2) of the crankshaft 30. The axial position of the inlet hole 35 corresponds to the axial center of the torque converter 60, so that the oil can be supplied more smoothly into the torque converter 60.

The above described preferred embodiment of the present invention provides the following advantages:

(1) the temperature range of the hydraulic fluid allowing the function of the torque converter can be extended toward lower temperatures by a simple change in structure;

(2) the inlet hole is located at the axial end of the shaft bearing shifted from the axial center thereof. Accordingly, a flow resistance in an oil passage connecting the inlet hole to the torque converter can be greatly reduced by a simple change in structure, so that the temperature range of the hydraulic fluid allowing the function of the torque converter can be extended toward lower temperatures.

(3) the axial end of the shaft bearing corresponds to an axial end positioned near the rotating shaft for the torque converter. Accordingly, the inlet hole is located near the

axial center of the torque converter, so that the hydraulic fluid can be supplied more smoothly into the torque converter.

(4) the inlet hole is located so that at least a part of an opening of the inlet hole exposed to the shaft bearing is not blocked by the shaft bearing. Accordingly, a flow resistance at the opening of the inlet hole can be greatly reduced.

(5) the inlet hole is located in the vicinity of the axial center of the rotating shaft for the torque converter. Accordingly, the hydraulic fluid can be supplied more smoothly into the torque converter.

While the invention has been described with reference to a specific embodiment, it will be appreciated that it may also be embodied in many other forms.

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The claims defining the invention are as follows:

1. An internal combustion engine with a torque converter mounted on a crankshaft, said crankshaft being formed with an oil passage extending along the axis of said crankshaft, an inlet hole for supplying a hydraulic fluid from said oil passage to said torque converter, and an outlet hole for discharging said hydraulic fluid from said torque converter to said oil passage, said crankshaft having an orifice provided in said oil passage, said inlet hole being located upstream of said orifice, said outlet hole being located downstream of said orifice, said crankshaft being provided with a shaft bearing for supporting a rotating shaft for said torque converter,

wherein said inlet hole is located at an axial end of said shaft bearing such that the inlet hole communicates with the axial end of the shaft bearing and the hydraulic fluid also lubricates the shaft bearing,

wherein a first end of the shaft bearing overlaps the inlet hole such that the shaft bearing only partially overlaps the inlet hole,

wherein the shaft bearing is not connected to any outlet holes, and

wherein the inlet hole is only connected to the shaft bearing and an oil supply passage of the torque converter.

2. The internal combustion engine with a torque converter according to claim 1, wherein said inlet hole is located at an axial end of said shaft bearing.

3. The internal combustion engine with a torque converter according to claim 1 or 2, wherein said axial end of said shaft bearing corresponds to an axial end positioned near said rotating shaft for said torque converter.

4. The internal combustion engine with a torque converter according to any one of claims 1 to 3, wherein said inlet hole is located so that at least a part of an opening of said inlet hole exposed to said shaft bearing is not blocked by said shaft bearing.

5. The internal combustion engine with a torque converter according to any one of claims 1 to 4, wherein said inlet hole is located in the vicinity of the axial center of said rotating shaft for said torque converter.

6. An internal combustion engine substantially as hereinbefore described with reference to Figs. 1 to 4 of the accompanying drawings.

Dated 21 July 2011
Honda Motor Co., Ltd.
Patent Attorneys for the Applicant/Nominated Person
SPRUSON & FERGUSON

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FIG. 1

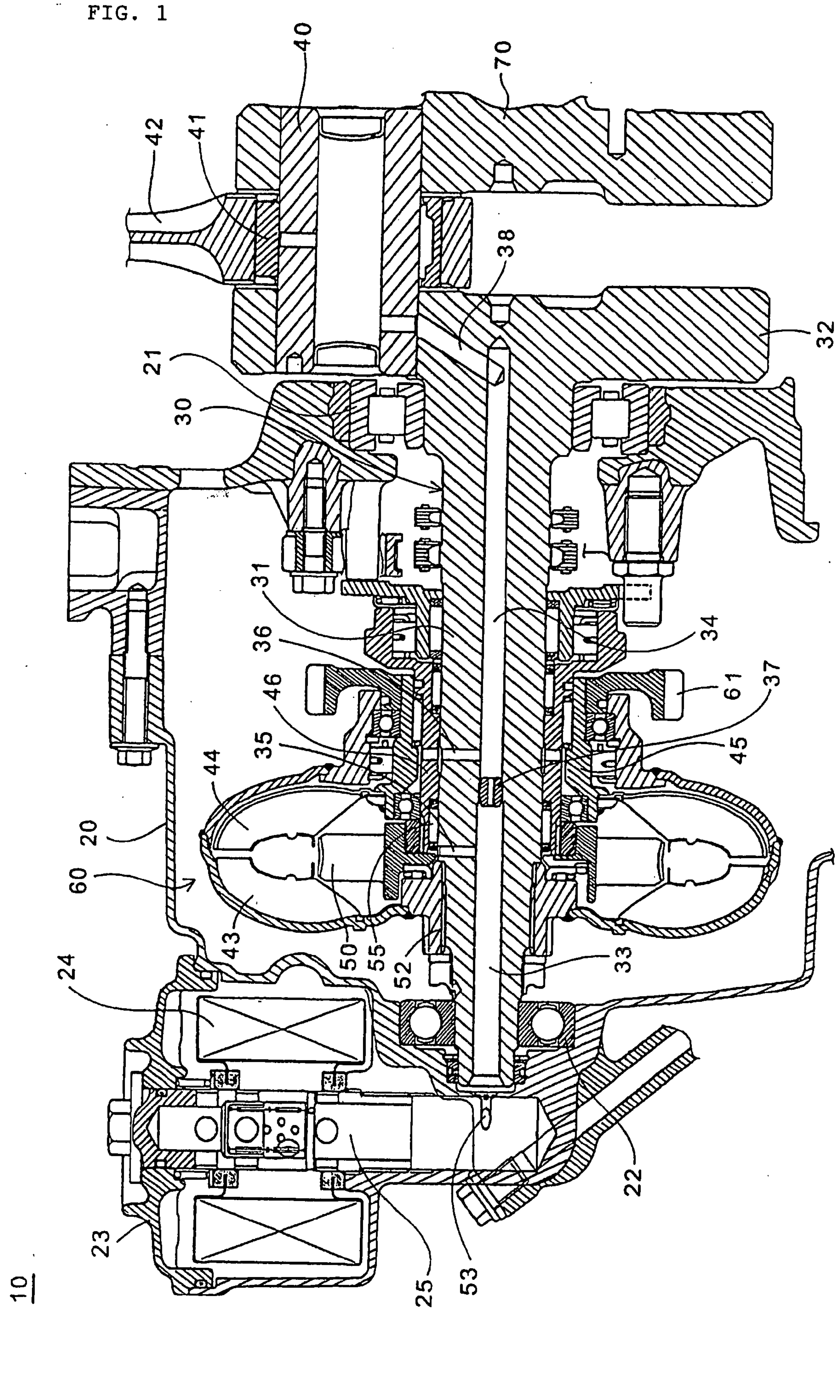

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FIG. 2

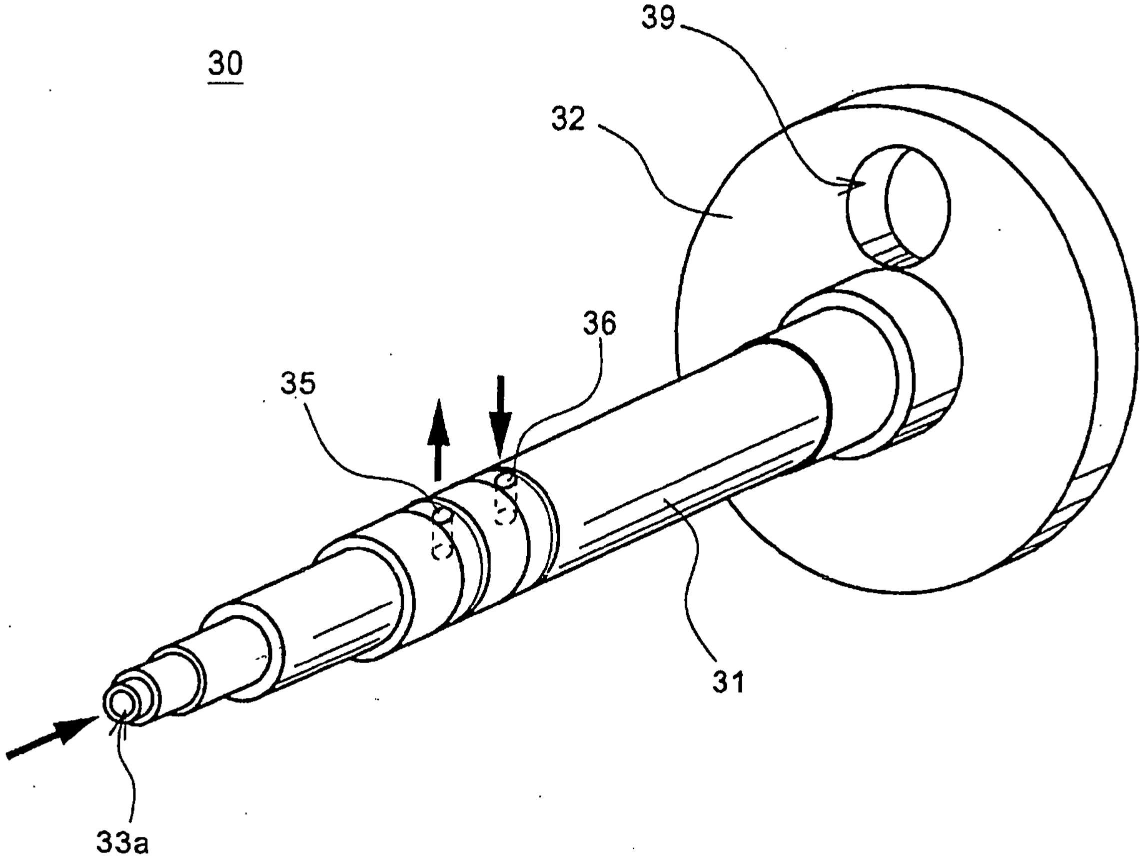

FIG. 3

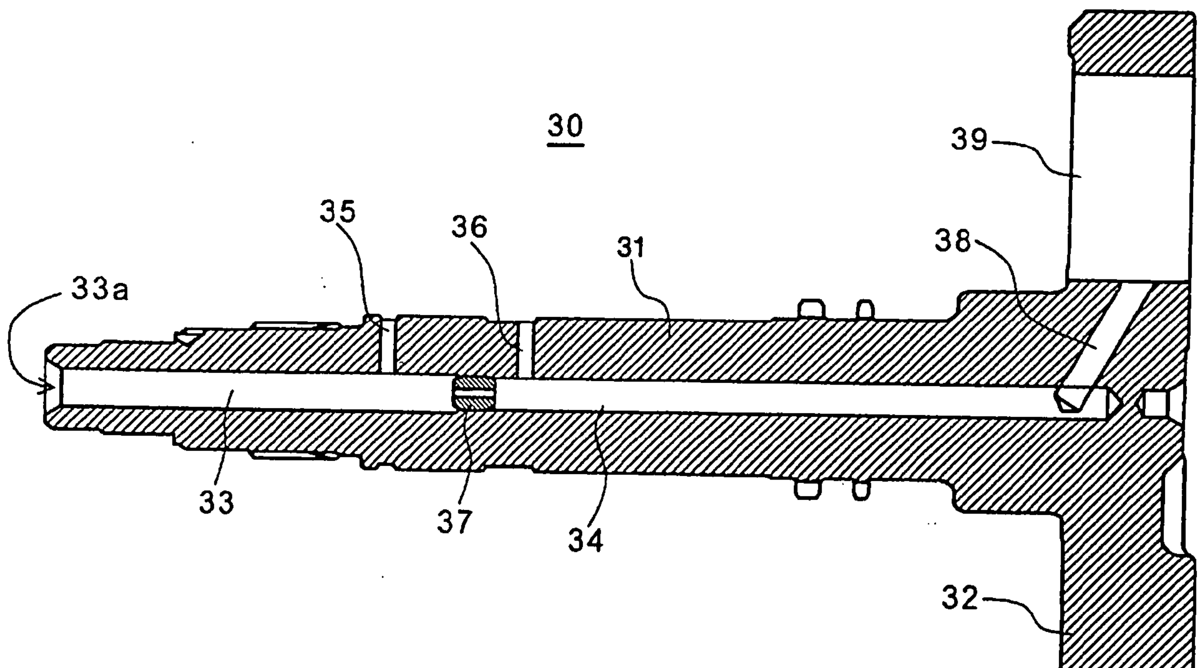

FIG. 4

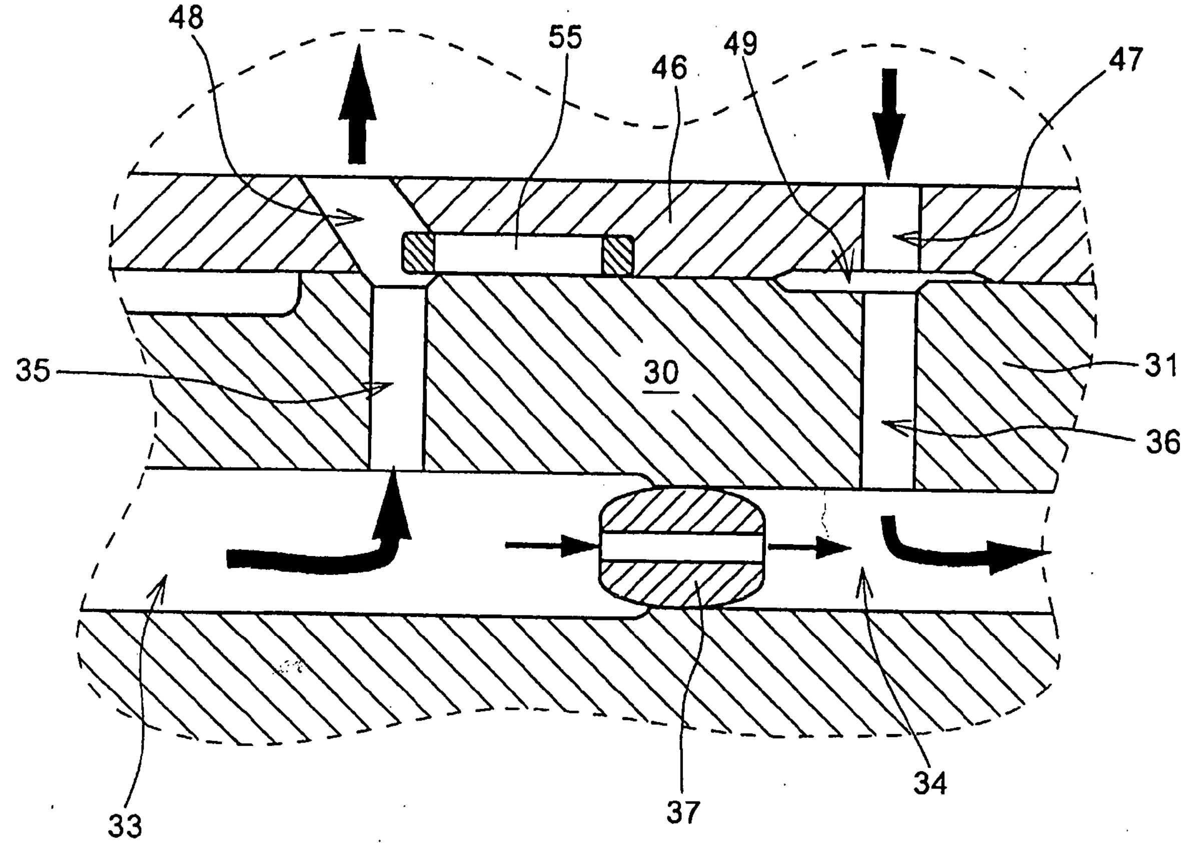

FIG. 5