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Jingu et al.

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[54] CENTRIFUGAL-TYPE INJECTION TIMING ADJUSTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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[51] **Int. Cl.** **F16d 5/00**

[58] **Field of Search** ..... 123/139, 139 AP; 64/25

[56] **References Cited**

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[57] **ABSTRACT**

A centrifugal-type injection advance device for internal combustion wherein a protrusion is provided on each flange pin and a groove is provided in each flyweight to reduce operating noise of an engine and to assure a stable in function.

9 Claims, 6 Drawing Figures

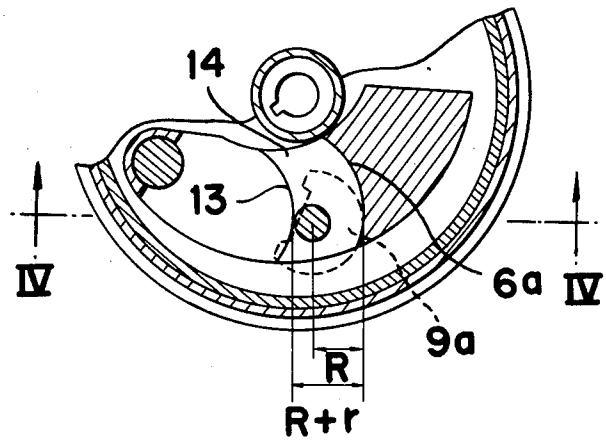


FIG. 1

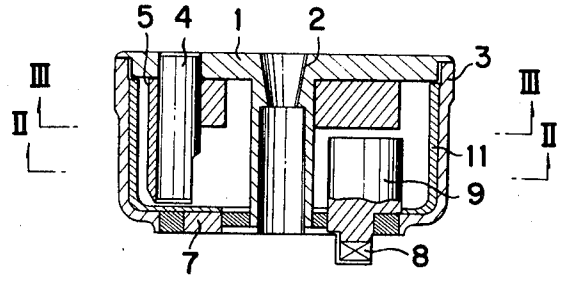


FIG. 2

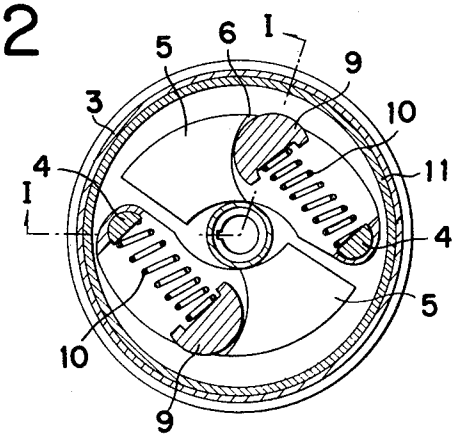


FIG. 5

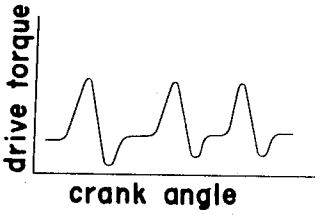


FIG. 3

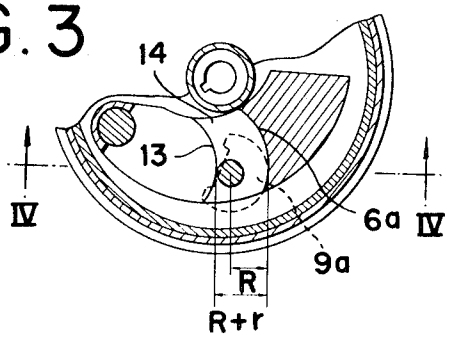


FIG. 6

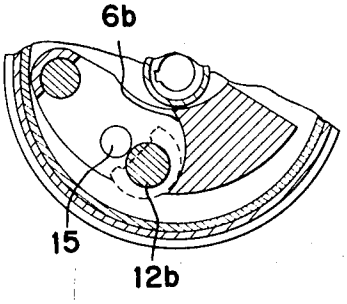
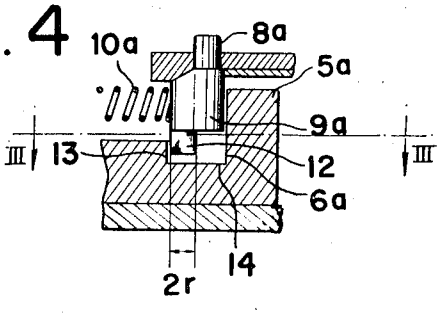


FIG. 4



CENTRIFUGAL-TYPE INJECTION TIMING ADJUSTING DEVICE FOR INTERNAL COMBUSTION ENGINES

The present invention relates to a centrifugal-type injection advance device for internal combustion engines.

Injection advance devices of centrifugal-type (refer to, for example, Patent Publication, TOKU-KO-SHO 30–2909) have long been in use for injection-type internal combustion engines to effect fuel ignition correctly by varying the moment of fuel injection in accordance with revolving speed of engine. The features of construction common to such devices have been that centrifugal weights rotating with the driving (engine-side) shaft are employed together with springs opposing the centrifugal force developed by the weights, that drive torque is transmitted from the driving shaft to the driven (injection pump-side) shaft through the weights and springs, and that the position of equilibrium between the centrifugal force and the spring force changes with the rotating speed of the driving shaft. The phase relationship between the driving and the driven shaft becomes adjusted by this varying equilibrium.

In a device so constructed, however, the absorption by the driven side of transmitted torque changes widely in magnitude because of a number of fuel injections which the pump performs during each rotation. In other words, the torsional resistance of the driven side offers to the driving side fluctuates widely and cyclically, which will present a cyclical wave pattern. The frequency of this fluctuation can coincide with the natural vibratory frequency of the springs and, if such coincidence should occur, a condition of resonance would be set up to induce vibration, thereby disabling the device to adequately absorb the vibratory shocks despite the damping oil in it and causing the centrifugal weights to chatter and make excessive noise so great as to become the major component of engine noise. Moreover, such a vibrating condition would disturb the stability of injection timing.

This invention purports to provide a centrifugal-type injection advance device in which the aforementioned drawbacks inherent in the conventional devices are eliminated to reduce noise during operation and to operate stably.

The invention will be explained by comparing embodiments of this invention with a conventional device with reference to the accompanying drawings, in which:

FIGS. 1 and 2 show a conventional centrifugal-type injection advance device, FIG. 1 being the longitudinal cross section taken on the line I—I of FIG. 2, and FIG. 2 being the transverse cross section taken on the line II—II of FIG. 1.

FIG. 3 shows what corresponds, in a device according to this invention, to the transverse cross section taken on the line III—III of FIGS. 1 and 4.

FIG. 4 is a part of the cross section taken on the line IV–IV of FIG. 3.

FIG. 5 is a graph explaining the drive torque of the fuel injection pump.

FIG. 6 shows another device according to the invention and corresponds to FIG. 3.

The construction and operation of the conventional device are as follows: To a driven shaft, not shown in the drawing, one side of the device is connected by means of mounting hole 2 provided in flyweight holder 1. The holder 1 has screw threads on its periphery, is threadedly connected with case 3 in a pot-like form, and carries two studs 4 for pivotally holding centrifugal flyweights 5, each flyweight to each stud. The flyweights 5 are each capable of turning on the stud and has a curved or cam face 6 against which a flange pin 9 bears. The two pins 9 are rigidly held by flange 7 in the other side of the device. The outer portions of flange pins 9 are so shaped as to act as clutch pawls 8. To the driving shafts and through a flange disc, both not shown, pawls 8 are connected. Pins 9 and studs 4 each have seats for spring 10 interposed between pin and stud to press the pin against cam face 6. Flange 7 is rigidly connected with inner case 11, which is positioned within, and rotatably embraced by, pot-like case 3.

As rotating speed rises during operation, the centrifugal flyweights 5 will spread out by pivoting on studs 4, so that the distance between the flange pin 9 and its corresponding stud 4 diminishes, resulting in increased compression of springs 10 and a twist of the driven shaft relative to the driving shaft. The angular amount of this twist is an angle of advance.

The drawback of the foregoing construction originates in the fact that, if a force other than that due to the spreading movement of flyweights 5 acts on springs 10 for some reason, and if this force happens to be great enough to overcome the expanding force of the springs, flange pins 9 will separate from cam faces 6 to introduce some clearance between pin and cam face. On the other hand, the fuel injection pump cyclically develops momentary high fuel pressure for engine cylinders by the rotation of its cam shaft, so that the torque transmitted from the driving side and absorbed by the pump cam shaft, fluctuates cyclically as shown in FIG. 5. Thus, a frequency of torque fluctuation associated with the number of fuel injections for each rotation of the cam shaft occurs. When the natural vibratory frequency of springs 10 happens to coincide with said frequency of torque fluctuation, a resonant condition occurs in the device. The resultant cyclical force acting on springs 10 is such a force as was mentioned above and, if it should be great enough to overcome the expanding force of the springs 10, a chattering condition would occur between the flange pins 9 and the cam faces 6 to generate chattering noise adding to engine noise or to increase engine vibration.

The improvement which this invention provides over the foregoing construction will be described by referring to FIGS. 3 and 4. The diameter of flange pin 9*a* is indicated as 2R. The flange pin 9*a* has a protrusion 12, concentric with the pin 9*a* and having a diameter 2*r* which is smaller than 2R, at its (flyweight-side) end opposite to the outer end shaped into clutch pawl 8*a*. The flyweight 5*a* is recessed along cam face 6*a* to admit the protrusion 12. One side of this recess or groove 14 is an extension of cam face 6*a* and the other side 13 is a curved surface which is always in sliding contact with the round surface of the protrusion 12. The width of the groove 14 is sized equal to R+*r*. The groove 14 is sufficiently deep so that its bottom will always remain clear of the end face of the protrusion 12. With each flange pin 9*a* and flyweight 5*a* being so shaped, the spreading or expanding movement of the flyweights is not interfered with and the flange pins are restricted by curved surface 13, so that the resonant condition of the springs 10 cannot introduce any clearance between the pin 9*a* and the cam face 6*a* that will cause the pin to chatter against the cam face. This modification of the conventional construction consists in providing a protrusion on each flange pin and a groove in each flyweight, said protrusion and said groove being both so simple that the modification does not reduce the producibility of the device.

In another embodiment of this invention shown in FIG. 6, a cam face of a flyweight is an arc 6*b* of a true circle and a protrusion 12*b* of a flange pin has a larger diameter closer to 2R. If a groove is to be formed in the flyweight in order to admit and restrict protrusion 12*b*, the curved surface corresponding to the surface 13 mentioned above has to be an arc of a much smaller circle. Instead of grooving, therefore, a fixed pin 15 with such a diameter as will present the required small-radius arc is provided on the flyweight to obtain the same effect as that of the groove.

It will be seen from the foregoing description that a device according to this invention is a modified form of the conventional device, involving but simple modifications and having practical advantage in that it reduces operating noise of the engine and assures a stable function of the device to adjust injection timing.

Many variations may be effected without departing from the spirit of the invention. It is to be understood that these, together with other variations in details, are anticipated by the appended claims.

What I claim is:

1. A centrifugal-type injection advance device for an internal combustion engine comprising: first and second opposed casing members rotatable about an axis and adapted to be connected, respectively, to a driving shaft and a driven shaft; a

set of flange pins mounted in the first casing member and extending towards the second casing member, each flange pin having a curved surface of a first radius; a set of flyweights and a pivoting stud connecting each flyweight to said second casing member for pivoting movement of the flyweight about an axis parallel to the said axis; a curved cam surface formed on each flyweight facing its respective pivoting stud, each of said flange pins positioned with its respective curved surface adjacent the cam surface of one of said flyweights; a spring mounted on each flyweight to urge its respective flange pin against its respective cam surface; said flyweights having a curved face formed therein opposing the said cam surface, and each said flange pin including an axial protrusion having a cylindrical surface portion extending axially towards the second casing member and positioned adjacent the said curved face and in sliding contact therewith, said cylindrical surface portion of the protrusion having a second radius less than the first radius, whereby the space between the cam surface and the curved face of each flyweight permits the flyweight to move arcuately outwardly relative to said flange pin while concurrently preventing movement of the flange pin towards the pivot axis of its respective flyweight.

2. A centrifugal-type injection advance device according to claim **1**, said cylindrical surface portion of the protrusion being co-axial with the said curved surface of its respective flange pin.

3. A centrifugal-type injection advance device according to claim **1**, in which the second casing member is a pot-like

member, the first casing member extending generally in a plane closing the open end of the pot-like first casing member, the outer end of each flange pin on the side of the first casing member opposite from the second casing member including a clutch pawl for connection to a driving shaft.

4. A centrifugal-type injection advance device according to claim **3**, wherein each said spring extends from its respective flange pin to its respective pivoting stud.

5. A centrifugal-type injection advance device according to claim **4**, in which the said cylindrical surface portion of each protrusion is co-axial with the curved surface of its respective flange pin.

6. A centrifugal-type injection advance device according to claim **5**, wherein each said flyweight has a curved groove, one side of which faces and is parallel to its respective cam surface, the said one side of the group constituting said curved face.

7. A centrifugal-type injection advance device according to claim **6**, wherein the side of the groove opposite to the said one side thereof is an axial extension of the said cam surface.

8. A centrifugal-type injection advance device according to claim **6**, in which the distance from the said one wall of the groove to the said cam surface is equal to the sum of the said first and second radii.

9. A centrifugal-type injection advance device according to claim **5**, wherein the said flyweights include an axially projecting pin, the outer periphery of which forms said curved face.

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