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PATENT SPECIFICATION

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(54) INTERNAL COMBUSTION ENGINE DECOMPRESSING DEVICES

(71) We, HONDA GIKEN KOGYO KABUSHIKI KAISHA, of 6—27—8, Jingu-mae, Shibuya-ku, Tokyo, Japan; a Japanese body corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to internal combustion engine decompressing devices, particularly for engines for vehicles such as powered bicycles.

When riding a powered bicycle, at the time of changing from pedal power to engine power, the engine crankshaft is driven from the pedals to start the engine and resistance from the compression strokes of the piston is therefore transmitted to the pedals. As a result, if insufficient inertia is given to the crankshaft, the engine is difficult to start and special skill and technique is required. To avoid these difficulties it has been suggested that a decompressing device is provided whereby the pressure in the cylinder can be reduced in the initial starting period of the engine so that the crankshaft may be smoothly rotated in the initial period, this pressure reduction being removed when a sufficient rotating inertia has been reached so that thereafter compression for starting may be easily obtained utilising this inertia. However, further difficulties arise. For example if the decompressing operation is made with a lever operating separately from the mechanism for effecting engine starting and gear changing, it is necessary for the rider separately to perform a decompressing operation and an engine starting operation, so that overall the operation of starting the engine is difficult and complicated. It is also necessary that the lever be returned properly and in due time to its in-effective position so that special skill and technique is required for its operation. Such requirements are undesirable where it is intended that the vehicle should be easily operated by females and children.

According to the present invention there is provided an internal combustion engine decompressing device, comprising a decompression valve spring urged to a closed position; means for switching the engine on and off; a starting shaft for starting the engine; operating means for opening said decompression valve against the spring action operatively connected to and operated in conjunction with said means for switching the engine on and off; and a cam provided on the starting shaft for co-operating with said operating means such that decompressing operation of the decompression valve is controlled by relative movement between said operating means and the cam. In such a device the operations of stopping and starting the engine are related to each other so that at the time of starting the engine there is made, only in the initial starting period, a decompressing operation effected automatically and for a predetermined time to facilitate starting the engine. Such decompression is brought about simply, positively and automatically, without requiring any special operation by the rider, so that no special skill and technique is required to start the engine and the vehicle is therefore suited for use by females and children. The structure of the device can be simple as the operation is regulated by the cam provided on the starting shaft, and the device can therefore be positive and highly reliable in operation. The number of component parts is minimised, as are manufacturing costs, and the device is therefore well-suited to powered bicycles.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 is a side view, partly in section, of an internal combustion engine including a decompressing device, and an associated transmission,

Figure 2 is a cross-sectional plan view of the engine and transmission of Figure 1, parts of the transmission being shown as if they were in the same plane for convenience of explanation,

Figure 3 is a sectional side view of a detail as shown in Figure 1 but drawn to a larger scale,

Figure 4 is a sectional view of part of the detail of Figure 3 as seen in the direction indicated by arrow 4 in Figure 3,

Figure 5 is a view of the detail of Figure 3 as seen in the direction indicated by arrow 5 in Figure 3,

Figure 6 is an explanatory view showing the relationship between the speed-change operating system of the engine and transmission of Figures 1 to 5 and a system for operating the decompressing device,

Figure 7 is a front view of a cam,

Figure 8 is a side view of the cam,

Figure 9 is a side view of a powered bicycle, and

Figure 10 illustrates operation of a speed-change actuating member.

Referring first to Figure 9, the powered bicycle 11 has a body frame 12 mounting a front fork 14 and handle bars 13 at the front. At the rear there is a rear fork 16. The front fork 14 and rear fork 16 support respectively a front wheel 15 and a rear wheel 17. A speed-change actuating member constituted by a hand grip 20 rotatable for effecting speed changes is provided at one end of the handle bars 13. Numeral 18 indicates a rider's seat and 19 indicates a fuel tank. The speed-change grip 20 is connected with a speed changing mechanism of a power transmittion (discussed in detail below) through an operating cable 21.

Turning to Figures 1 and 2, the bicycle has two sources of motive power, namely pedals 30 (Figure 9) and the internal combustion engine 80 having the decompressing device which is operatively connected with mechanism for changing-over from running under pedal power to running under engine power. A starting or drive shaft 31 to which the pedals 30 are fitted has a gear 32 mounted mid-way along its length. This gear is meshed with a gear part 34 of an adjacent intermediate drive shaft 33 having thereon a low speed drive gear 36 and a high speed drive gear 39 which can respectively drive a low speed driven gear 43 and a high speed driven gear 44 on an adjacent output shaft 42, respective one-way clutches 35 and 38 each transmitting power only in one direction being interposed in these two drive paths. The low speed drive gear 36 is rotationally fast with, but axially slidable along, the shaft 33. The high speed drive gear 36 is rotationally free on the shaft 33.

Figure 3 illustrates a low-speed drive condition in which the low speed drive gear 36 drives the driven gear 43, a dogtooth clutch projection 37 carried by the drive gear 36 being disposed clear of a recess 40 in the high speed gear 39. To change to high-speed drive, the low speed drive gear 36 is moved along the shaft 33 towards the high speed drive gear 39 by operation of a first shift fork 49, the gear 36 sliding on splines 41 on the shaft 33, so that the projection 37 engages in the recess 40 and the high speed drive gear 39 is made rotationally fast with the shaft 33 for transmitting drive to the high speed driven gear 44. Rotation of the output shaft 42 in both drive conditions is transmitted through a sprocket 45 secured to the output shaft 42, via a chain, to a sprocket 47 of the rear wheel 17 (Figure 9).

A shift member 52 slid on splines 50 by operation of a second shift fork 31 is provided on the output shaft 42. Recesses 55 and projections 53 forming a dogtooth clutch are provided on the shift member 52 and on a gear 54 rotatably mounted on the shaft 52. In the condition illustrated in Figure 2 the dogtooth clutch is in disengaged condition, a condition adopted when the speed-change grip 20 is in "OFF" position (Figure 10). In this condition the bicycle is motivated by pedal power, rotation of the shaft 31 by pedalling being transmitted to the rear wheel 17 via the low speed drive path described above.

If the speed-change grip 20 is rotated to position "L" in Figure 10, the shift fork 51 is moved towards the gear 54 to bring the projections 53 into engagement with the recesses 55 and, in addition to driving the rear wheel, the pedal power is transmitted to the gear 54 for starting the engine. For this purpose the gear 54 meshes with a gear part 57 of an intermediate shaft 56 provided parallel to the output shaft 42. This shaft 56 is connected through a sprocket 58 provided thereon, via a chain 62, with a sprocket 61 provided on an outer member 60 of a centrifugal clutch 59 provided at one end of a crank-shaft 81 of the engine 80. An inner member 63 of the clutch 59 is provided with clutch shoes 64 of a centrifugally expanding type. A one-way clutch 65 is provided between members 60 and 63 to transmit the pedal power from the outer member 60 to the inner member 63 to drive the crankshaft 81 only at the time of starting the engine. A flywheel and such ignition devices as a magneto and a contact breaker are provided at the other end of the crankshaft 81. The output of the engine 80, once started, is transmitted to the shaft 56 through the clutch 59 and the sprocket chain 62, and then to the output shaft 42 through the gear part 57 and the gear 54 and dogtooth clutch 55/53.

The shift forks 49 and 51 are operated by a rod 67 (Figure 6) which extends out of a case 68 containing the power transmission. A shift lever 69 connected with one end of the cable 21 operated by the speed-change grip 20 is secured to the rod 67 outside the case 68. As shown in Figure 6, the shift lever 69 is in the form of a bell crank lever with the end of one arm connected to a biassing spring 71 and the end of the other arm connected to the cable 21. In the "OFF" position of the grip 20 the shift lever 69 has the position A shown by full lines as in Figure 6. Upon rotation of the grip 20 to the "L" position the shift lever 69 moves clockwise in Figure 6 to the chain-dot line position B. The lever 69 moves further clockwise upon further movement of the grip 20 to the "H" position.

The engine 80 is provided with a cylinder 82, cylinder head 83 and piston 84, which is connected with a crankshaft 81 by a connecting rod 85. A through bore 87 connecting a combustion chamber 86 with the outside is provided in a part of cylinder head 83 and has a small diameter part 89 opening at one end to mark the outside of the cylinder head and a decompression passage 88 consisting of a large diameter part opening at the other end to the combustion chamber 86 with the intermediate portion providing a boundary. A valve seat 90 is provided in the part facing the combustion chamber 86 of the passage 88. The passage 88 communicates with an exhaust port 92 through a communicating passage 91 provided within the cylinder 82.

A decompression valve 100 is provided at the tip thereof with a valve head 101. A rod part 102 of constant diameter extends from the valve head 101 through the bore 87, the part 101 passing through the large diameter part constituting the decompression passage 88 with clearance and being a sliding fit in the small diameter part 89. The valve head 101 cooperates with the valve seat 90. The end of the rod part 102 remote from the head 101 extends out of the cylinder head 83. A spring holder 105, pivoted by a pin 104 to the projecting end 103 of the rod part 102, is channel-shaped in section and bridges the end part 103.

As shown in detail in Figures 4 and 5, a coil spring 110 is associated with the decompression valve 100. The coil part 111 of this spring 110 is extended at one end. The intermediate part of this extension 112 is inserted between the spring holder 105 and the rod extension 103, and is locked with the holder 105. A cut circular locking part 113 is formed at the tip of the extension 112 and is locked to one end of a link 120 (described hereinbelow). The coil part 111 is also extended at the other end to form a continued loop-shaped pressing part 114. A sealing member such as an O-ring 94 surrounding the rod extension 103 and applied to a flat seat surface 93 on the cylinder head 83 is covered by a flanged seat member 95. The loop-shaped pressing part 114 of the spring 110 is applied onto the flange part 96 of this seat member 95 resiliently to press the O-ring 94 against the seat surface 93 to seal it. The loop-shaped pressing part 114 has an extension 115 that contacts a supporting part 97 provided adjacent the sealing surface 93. Thus, the effect of the spring 110 is to close the decompression valve 100 and to ensure sealing of the part through which the rod part 102 projects out of the cylinder head 83.

The locking part 113 of the spring 110 is locked to one end of the link 120 (Figure 1) through a spring receiver 121. The link 120 is pivotably connected at the other end to a lever 122 which is as shown in Figures 1 and 2. In Figure 2, the lever 122 is shown as developed in a sectioned plan so as to be easily understood.

The lever 122 is secured to an extension out of the case 68 of a supporting shaft 125 rotatably carried adjacent the pedal drive shaft 31 and is resiliently pressed in the axial direction outside the case 68 by a spring 126 compressed between the lever 122 and the outside surface of the case 68. The lever 122 has a fork-shaped portion. The link 129 is pivoted at one end to one leg 123 of the fork. The other leg 124 of the fork is an operating piece which, as shown in Figure 6, engages an extended piece 70 formed at one end of the shift lever 69.

Within the case 68 a cam engaging plate 127 is secured to the shaft 125. As shown in Figure 1, this plate 127 has a curved tip part 128. On the adjacent pedal drive shaft 31, a cam 139 is provided axially slidably on the shaft 31, its central hole 135 having an axial groove that receives a positioning pin 136 provided on the shaft 31 as shown in Figure 2. The cam 130 rotates with the shaft 31 and is resiliently pressed against one inside wall surface of the case 68 by a spring 137 compressed between the gear 32 and the cam 130.

Details of the cam 130 are shown in Figures 7 and 8. The cam 130 has two steps in its outside periphery so as to have a large diameter part 131 and small diameter part 134 axially side-by-side. The large diameter part 131 is provided with cam grooves 132. As shown in Figure 8, each cam groove 132 starts from the intermediate portion in the axial direction of the large diameter part 131, inclines towards the small diameter part 134 and joins the surface 133 of the large diameter part that is adjacent the small diameter part. As shown in Figure 7, each cam groove 132 extends over a predetermined angle on the periphery of the large diameter part 131. In the form illustrated there are two cam grooves 132 symmetrically opposed to one another on the periphery of the large diameter part 131. In the pedal-powered condition (grip 20 "OFF") the cam 130 is positioned on the shaft 31 to the left as shown in Figure 1, urged to this position by the spring 137 and, as shown in Figure 1, the tip part 128 of the plate 127 is in contact with, or near to, the starting point of one of the cam grooves 132.

Engine decompression occurs as follows. Figures 1, 2 and 6 depict the state in which the bicycle is pedal-motivated, i.e., the engine 80 is not running and the decompression valve 100 is open so that the combustion chamber 86 is decompressed by being in communication with the atmosphere through the decompression passage 88, the communicating passage 91 and the exhaust port 92. The change grip 20 is in its "OFF" position, the cable 21 is fully tensioned, and the shift lever 69 is disposed in position A in Figure 6. By the rod 67 connected with the shift lever 69, as shown in Figure 2, the second shift fork 51 holds the shift member 52 separated from the gear 54. Thus, only power from the pedal drive shaft 31 is transmitted to the output shaft 42 and the bicycle runs under pedal power, without the engine operating, in the low-speed condition as the shift fork 49 sets the low speed drive gear 36 in mesh with the low speed driven gear 43.

The shift lever 69 when in position A holds the leg 124 of the lever 122, and the lever 122, at its most clockwise disposition (Figure 1) about the shaft 125 as a fulcrum. The plate 127 on the shaft 125 is similarly held and its tip part 128 is on the intermediate part in the axial direction on the outer periphery of the large diameter part 131 of the cam 130. In this position of the lever 122 the link 120 pulls the spring 110 towards the cylinder head 83 and hence the rod 102 of the decompression valve 100, locked as it is in the intermediate part of the extension 112 of the spring 110, is pushed into the cylinder head so that the valve head 101 is held within the combustion chamber 86 clear of its valve seat 90. Thus the combustion chamber 86 is in communication with the atmosphere in the manner described above and is decompressed. For as long as the pedal-powered state is maintained, the decompression valve 100 is kept open, the extension 115 of the spring 110 being acted upon by the supporting part 97 to prevent the spring 110 from lifting.

When it is desired to start the engine, the grip 30 is rotated to position "L". The consequential relaxation of the cable 21 permits the shift lever 69 to rotate clockwise in Figure 6 under the action of the spring 71 to adopt position B. The rod 67 rotates in the same direction. With the rotation of the rod 67, the shift fork 51 moves the shift member 52 to the left in Figure 2 so that the projections 53 engage the recesses 55 of the gear 54. Via the gear 54, gear part 57, sprocket 58, chain 62 and sprocket 61, power from the pedal drive shaft 31 is transmitted to the clutch outer member 60 and the crankshaft 81 is driven through the one-way clutch 65 and the clutch inner member 63.

With this movement of the shift lever 69 the extension piece 70 moves clockwise (Figure 6) and releases the leg 124 of the lever 122. As a result the lever 122 tends to rotate anti-clockwise (Figure 1) under the action of the spring 110, acting through the link 120, but the tip part 128 of the plate 127 mounts the outer periphery of the large diameter part 131 of the cam 130 and rotation of the lever 122, and hence of the shaft 125, is controlled in such manner that at this stage the link 120 is not moved to close the decompression valve 100. This valve remains open and the engine remains decompressed. As pedal driving force is transmitted to the engine, the crankshaft 81 rotates but, as the decompression valve 100 is open, the engine remains decompressed.

The cam 130 rotates with the rotation of the pedal drive shaft 31 and so the tip part 128 of the regulating plate 127 enters one or other of the cam grooves 132. As the grooves 132 are disposed opposite each other, such engagement occurs within pedal rotation drive of not more thai 180°. With movement of the tip part 128 along the cam groove 132, the cam 130 is moved to the right in Figure 2 on the shaft 31 against the action of the spring 137 and, at the termination of the groove, the tip part 128 reached the small diameter part 134. The shaft 125 is released and as bias is applied to the lever 122 by the effect of the spring 110 acting through the link 120, the lever 122 rotates anti-clockwise with the tip part 128 of the plate piece 127 dropping into the small diameter part 124 of the cam 130. The accompanying movement of the link 120 releases the spring 110 and the rod part 102 of the decompression valve 100 is pulled by the spring 110 so that the valve head 101 closes on the valve seat 90, closing the decompression passage 88 and restoring compression to the engine.

Thus, whilst running under pedal power, if the grip 20 is moved from "OFF" to "L" the engine starting system is immediately activated but throughout an initial range of rotation of the pedal drive shaft 31 the decompression valve 100 is automatically kept open by the cam 130 and the combustion chamber is automatically kept decompressed. Thereby opportunity is given to build up sufficient rotating inertia in the crankshaft 81 by the pedal drive, whereafter the decompression is automatically removed, by the effect of the cam 130, for engine starting. After the engine starts, the centrifugal clutch 59 acts so that both engine power and pedal drive may be transferred to the output shaft 42.

If the grip 20 is further rotated to its "H" position in Figure 10, the first shift fork 49 is moved to the left in Figure 2. The gear 36, while remaining in mesh with the gear 43, engages the adjacent high speed driven gear 39 through the dogtooth clutch 37/40; the gear 39 is driven; and the high speed driven gear 44 is driven to drive the output shaft 42. In this condition the gear 33 transmits no drive directly to the gear 43, although these gears are in constant mesh, due to the interposition of the one-way clutch 35.

Upon movement of the grip 20 from either of its "H" or "L" positions (engine-powered running) to its "OFF" position (pedal-powered running), the pedal driven system is cut-off from the engine power system and the lever 122 is moved by the shift lever 69 to pull the link 120 to open the decompression valve 100. Thus the engine is automatically placed in its decompressed condition.

As described above, at the time of starting the engine, the decompression is initially maintained by sliding the cam 130, but it could be maintained by sliding the plate 127 instead. Furthermore, whilst engine starting by pedal operation is been described, a kick starting system can be adopted. In such case, appropriate components of the above described mechanism would be provided on the kick starting shaft.

WHAT WE CLAIM IS:—

1. An internal combustion engine decompressing device, comprising a decompression valve spring urged to a closed position; means for switching the engine on and off; a starting shaft for starting the engine; operating means for opening said decompression valve against the spring action operatively connected to and operated in conjunction with said means for switching the engine on and off; and a cam provided on the starting shaft for co-operating with said operating means such that decompressing operation of the decompression valve is controlled by relative movement between said operating means and the cam.

2. A decompressing device as claimed in claim 1, wherein the decompression valve includes a rod part and a valve head; wherein said operating means includes a lever and a link connected at one end with this lever; and wherein an extension out of a cylinder head of the engine of said rod part of the decompression valve and an end of the link are connected with each other through the spring urging the decompression valve to its closed position.

3. A decompressing device as claimed in claim 2, wherein the spring urging the decompression valve to its closed position is a coil spring having an intermediate portion of an extension of its coil part at one end engaged with said extension of said decompression valve rod part, the end part of this extension of this spring being engaged with said end of the link; and wherein an extension of said coil part at the other end of the coil part is engaged with a sealing means for sealing the cylinder where said rod part extension extends out of the cylinder head; this sealing means being urged into its sealing condition along with the spring action to urge the decompression valve into its closed position.

4. A decompressing device as claimed in claim 3, wherein the cylinder head is flat where said rod part extends out of the cylinder head, the sealing member co-operating with this flat surface and enclosing the periphery of said rod part; and wherein the flanged seat member is urged onto the sealing member by the second-mentioned extension of said spring resiliently to press the sealing member onto said flat surface.

5. A decompressing device as claimed in any one of the preceding claims, wherein the cam is of stepped configuration having large and small diameters, and is provided with cam grooves for guiding an actuating member of said operating means from the large diameter part to the small diameter part, the cam being provided on the starting shaft to be axially slidable thereon but fast in rotation therewith, and being spring-biased to the position in which said actuating member co-operates with the large diameter cam part.

6. A decompressing device as claimed in claim 5, wherein there are two cam grooves symmetrically opposed to one another.

7. A decompressing device substantially as hereinbefore described with reference to the accompanying drawings.

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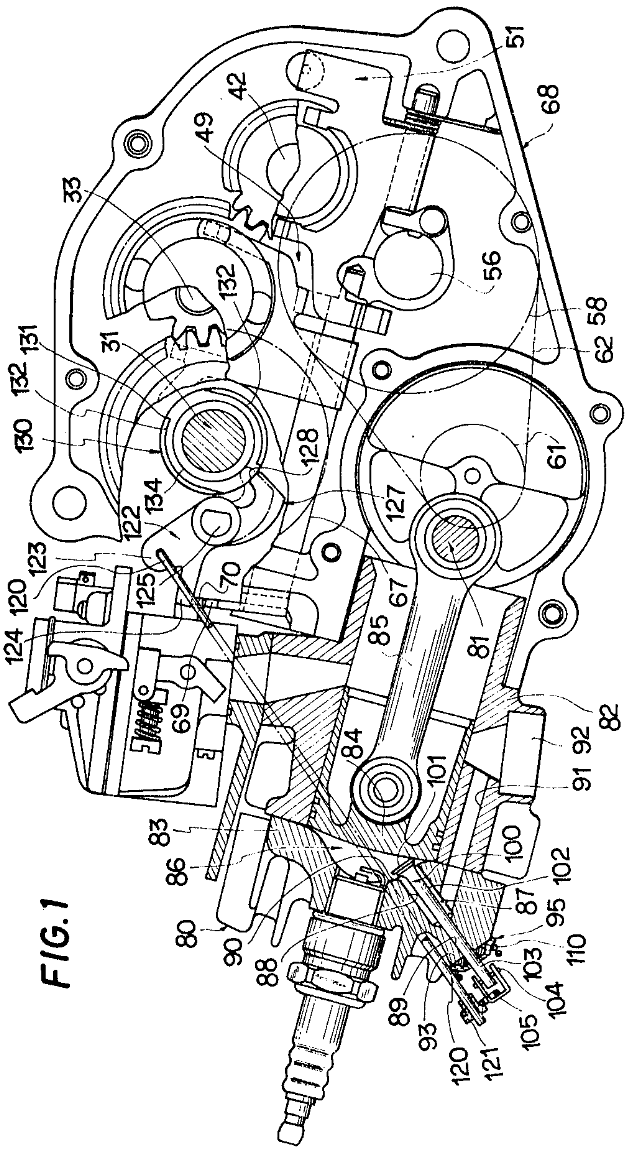
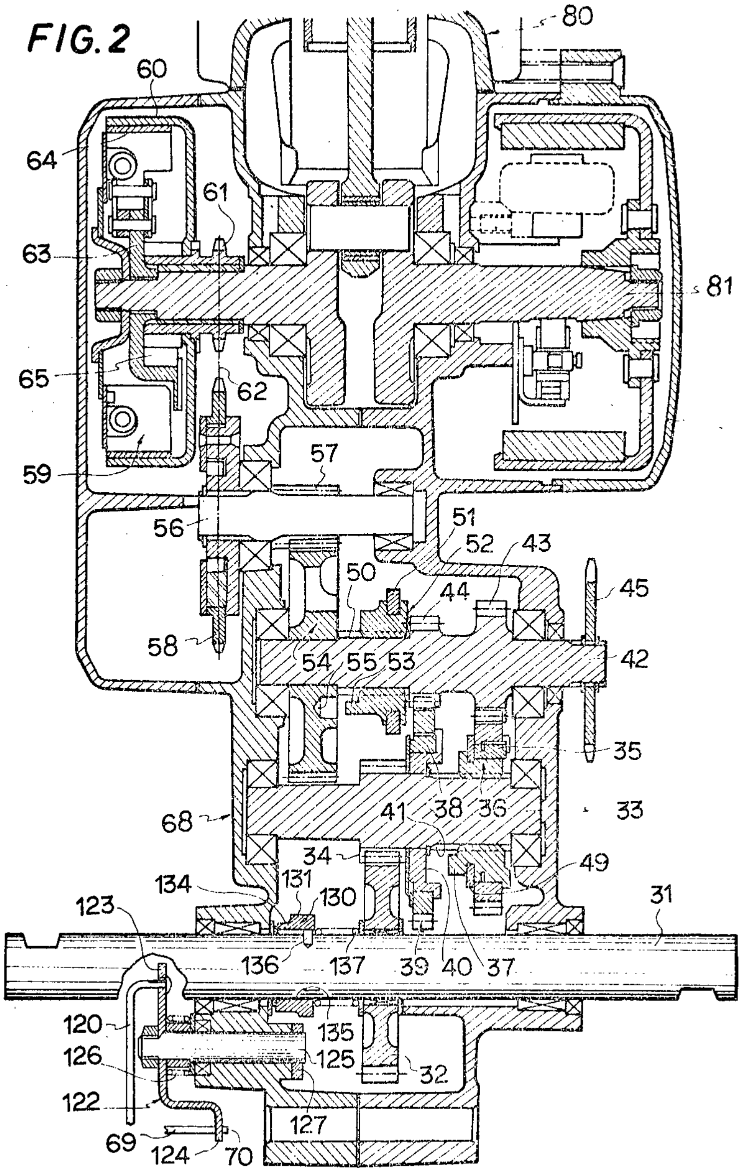


FIG.1

FIG. 2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Sheet 3

FIG. 3

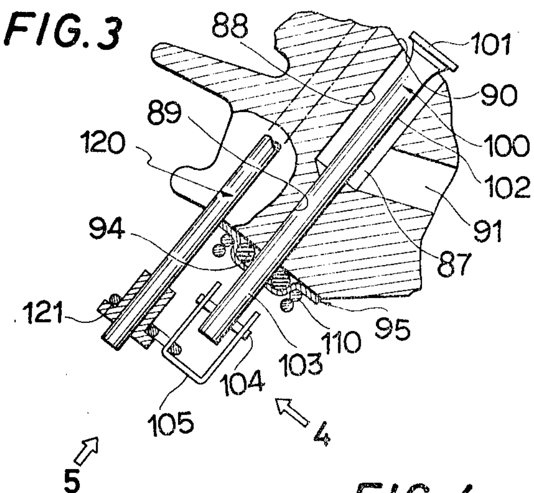


FIG. 4

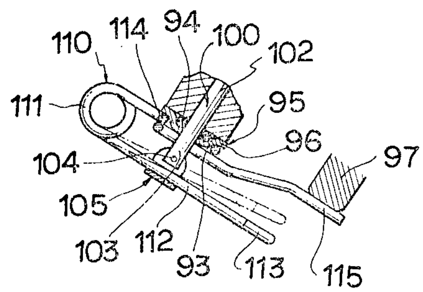


FIG. 5

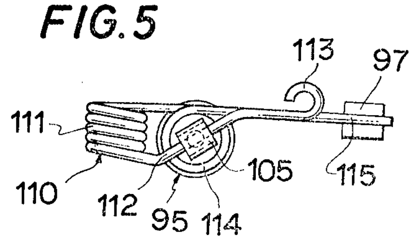


FIG. 6

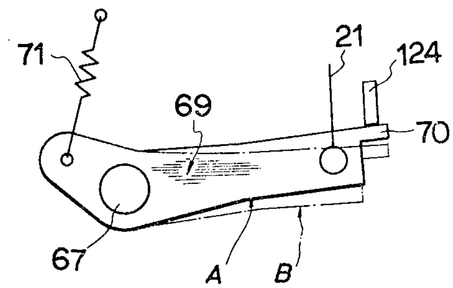


FIG. 7

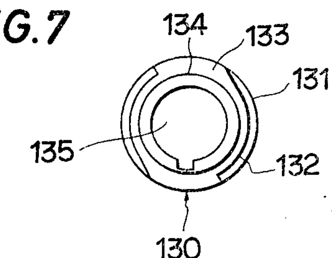
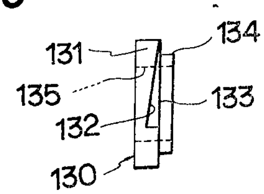


FIG. 8



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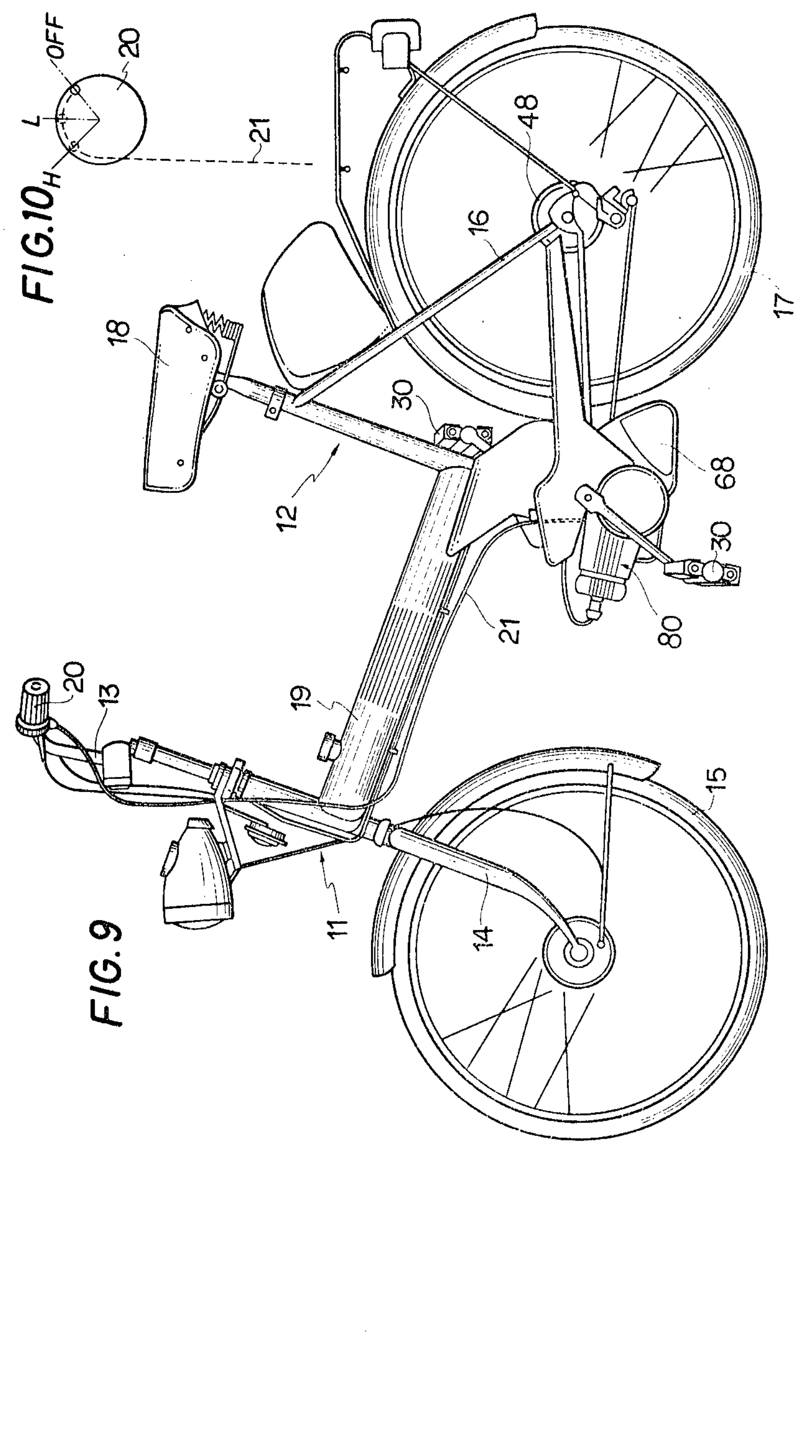

FIG.10

FIG.9