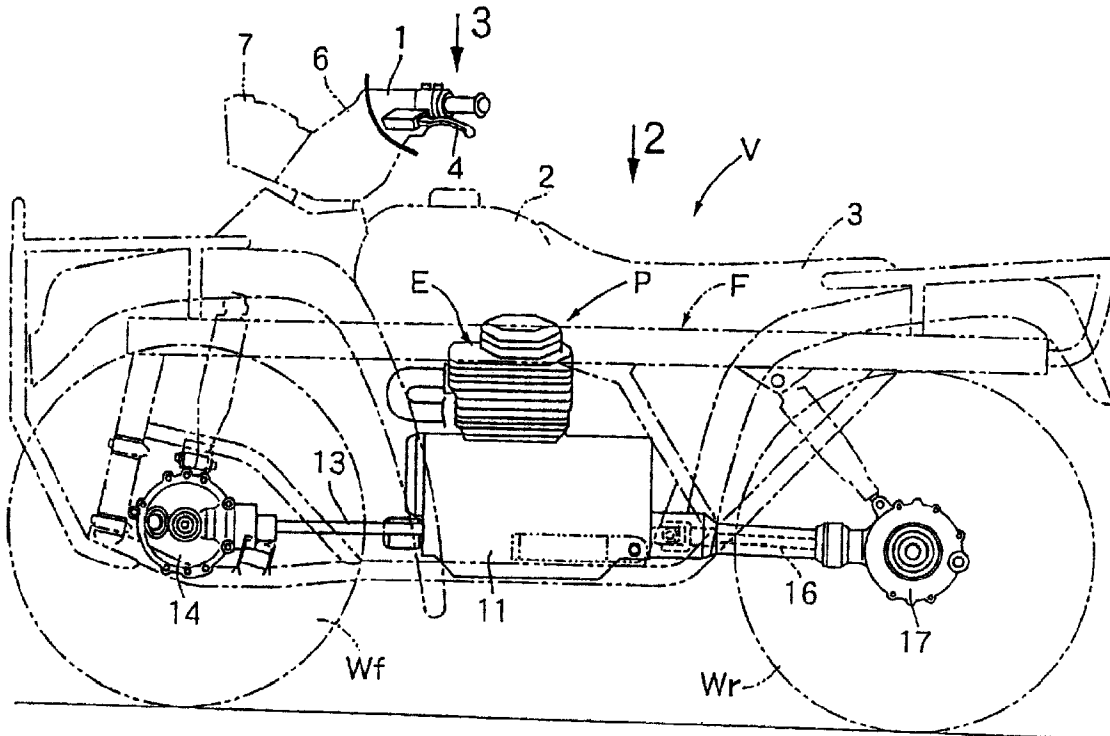




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 (72) Inventeurs/Inventors:  
 NARITA, SATORU, JP;  
 TSUKADA, YOSHIKI, JP;  
 MOHARA, TOSHINARI, JP  
 (73) Propriétaire/Owner:  
 HONDA GIKEN KOGYO KABUSHIKI KAISHA, JP  
 (74) Agent: DENNISON ASSOCIATES

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(57) Abrégé/Abstract:

To be able to perform simple and precise shift changes without using a change pedal and a change lever. In conjunction with the engagement and disengagement of a transmission clutch 39, a shift spindle 51, which revolves a shift drum 81 so as to establish predetermined gear levels, is rotatably driven via moderator gears 62 ~ 67 by a motor 58. By operating a shift up switch or shift down switch not illustrated, the motor 58 rotates the shift spindle 51 in a prescribed direction, the transmission clutch and shift drum operate at a predetermined timing, and the shift change is performed.

**[Document Name]                      Abstract**

**[Summary]**

**[Aim] To be able to perform simple and precise shift changes without using a change pedal and a change lever.**

**[Solution Means]        In conjunction with the engagement and disengagement of a transmission clutch 39, a shift spindle 51, which revolves a shift drum 81 so as to establish predetermined gear levels, is rotatably driven via moderator gears 62 ~ 67 by a motor 58. By operating a shift up switch or shift down switch not illustrated, the motor 58 rotates the shift spindle 51 in a prescribed direction, the transmission clutch and shift drum operate at a predetermined timing, and the shift change is performed.**

**[Selected Drawing]    Fig. 5**

TITLE: POWER TRANSMISSION DEVICE FOR VEHICLEFIELD OF THE INVENTION

5           The present invention relates to a power  
transmission device for a vehicle equipped with a  
transmission provided between an engine and the drive  
wheels, and a transmission clutch provided between a  
power source and a transmission

10

BACKGROUND OF THE INVENTION

          Generally, saddle ridden type vehicles are  
equipped with an integrated engine and a transmission  
15 power unit, whereby shift changes are performed by the  
foot of the rider operating the change pedal provided at  
the side of the transmission.

          In addition, electric motor vehicles wherein a  
20 shift change is performed by intermittently revolving a  
transmission shift drum with a motor are described in  
Laid Open Patent Gazette No. Hei 5-39865.

          However, in above mentioned conventional  
25 transmission devices which use change pedals, as the  
change pedal is operated by the foot of the rider,  
proficiency is required to perform fast shift changes and  
there is a limit to the reduction in the time required  
for shift changes even for proficient riders.  
30 Furthermore, as the transmission clutch is provided on  
the transmission and is operated by the change pedal,  
proficiency is required to smoothly engage the  
transmission clutch and suppress the occurrence of  
transmission shock. Also, as the change pedal always  
35 protrudes from the side of the transmission, problems  
exist such as the change pedal interfering with the floor  
board, and when attempting to confirm the upward and

downward stroke of the change pedal, the transmission is underneath and the lowest road clearance is reduced, etc.

Also, as the transmission in the device stated in  
5 said Laid Open Patent Gazette No. Hel 5-39865 is not  
equipped with a transmission clutch, when performing a  
shift change, it is necessary to synchronize the drive-  
stop of the running motor and the drive of the shift  
change motor, so that not only is the control  
10 complicated, but in the case where the shift drum is  
unable to revolve smoothly, a lost motion mechanism is  
required to prevent excessive loads from being applied to  
the shift change motor.

15

#### SUMMARY OF THE INVENTION

Taking the aforesaid situation into account, it is  
the object of the present invention to provide a shift  
change which can be performed simply and precisely  
20 without proficiency in the operation being required.

In order to achieve the aforesaid object, a power  
transmission device for a vehicle equipped with a  
transmission is provided between an engine and a drive  
25 wheel and a transmission clutch provided between an  
engine and a transmission.

An electric actuator is provided for performing  
the engagement and disengagement of the transmission  
30 clutch based on command signals from the operating member  
operated by the rider.

According to the above configuration, as the  
engagement and disengagement of the transmission clutch  
35 is provided between the power source and the transmission  
is performed by the electric actuator, it is possible for  
an operator to perform simple and precise clutch

operations without proficiency being required. In addition, rapid clutch operations which were previously impossible to perform directly with the hands and feet of the operator are now also possible to perform.

5

In the present invention, as well as engagement and disengagement of the transmission clutch, the motor also performs the transmission gear changes. This is controlled by the operator member.

10

According to the above mentioned configuration, as the same motor is shared for the engagement and disengagement of the transmission clutch and transmission gear changes, the number of parts is reduced, thus contributing to cost reductions.

15

Moreover, in the present invention, the transmission is equipped with a gear column capable of establishing multiple gear levels, a shift fork for changing the mesh of the gear column, a shift drum for driving the shift fork, and a shift spindle for driving the shift drum. Here, the transmission clutch is engaged and disengaged by the rotation of the shift spindle and the motor is feed-back controlled based on the signals from a rotational phase detection means for detecting the rotational phase of the shift spindle.

20

25

According to the aforesaid configuration, as control of the transmission clutch and control of the transmission is performed using a common rotational phase detection means, the number of parts is reduced, thus contributing to cost reductions. Moreover, as the rotational phase detection means detects the rotational phase of the shift spindle near both the transmission shift drum and the transmission clutch that are to be controlled, it is possible to minimize detection errors.

30

35

The power transmission device for a vehicle is equipped with a transmission provided between an engine and the drive wheels and with a transmission clutch provided between an engine and a transmission. The  
5 transmission is equipped with a gear column capable of establishing multiple gear levels, a shift fork for changing the mesh of the gear column, a shift drum for driving the shift fork, and a shift spindle for driving the shift drum. The transmission clutch is engaged and  
10 disengaged by the shift spindle that is rotated by an electric actuator that is operated based on the command signals from the operating members operated by the rider.

According to the aforesaid configuration, as the  
15 engagement and disengagement of the transmission clutch provided between the power source and the transmission is performed by an electric actuator, it is possible for an operator to perform simple and precise clutch operations without proficiency being required. In addition, rapid  
20 clutch operations which were previously impossible to perform directly with the hands and feet of the operator are now also possible to perform.

Further scope of applicability of the present  
25 invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since  
30 various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

#### 35 BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are shown in the drawings, wherein:

FIG. 1 is a side view of the left side of the saddle ridden type vehicle;

FIG. 2 is a plan view of the saddle ridden type vehicle taken in the direction of the arrow 2 illustrated  
5 in FIG. 1;

FIG. 3 is an enlarged plan view taken in the direction of arrow 3 in FIG. 1;

FIG. 4 is a partial enlarged view taken in the direction of arrow 4 of FIG. 2 of the power unit;

10 FIG. 5 is a cross sectional view along line 5--5 of FIG. 4;

FIG. 6 is an enlarged view of the essential parts of FIG. 5;

15 FIG. 7 is a plan view taken in the direction of arrow 7 of FIG. 6;

FIG. 8 is a skeleton drawing of the shift change device;

FIG. 9 is a time chart describing the operation;

20 FIG. 10 is a partially enlarged drawing of the transmission;

FIG. 11 is a view taken along line 11--11 of FIG. 10;

FIG. 12 is a view taken along line 12--12 of FIG. 10; and

25 FIG. 13 is a drawing corresponding to said FIG. 5, and relating to a second embodiment of the present invention.

### 30 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Below embodiments of the present invention are described based on the attached drawings wherein FIG. 1 to FIG. 12 show a first embodiment of the present invention. FIG. 1 and FIG. 2, illustrate a saddle ridden  
35 type vehicle V that is equipped with a vehicle body frame F assembled from welded steel tubes, to the front and back parts of which each of the left and right pair of

front wheels Wf, Wf, and the left and right pair of rear wheels Wr, Wr are suspended. A handle 1, fuel tank 2 and straddle type seat 30 are arranged from the front on the upper part of a vehicle body frame F. A brake lever 4 is provided on the left end of handle 1, and a brake pedal 5 is provided on the right side of the central part of the vehicle body. Handle cover 6 covers the central part of steering handle 1 and meter 7 is provided so as to overhang in front thereof.

10

A power unit P is equipped with an engine E for driving left and right front wheels Wf, Wf and left and right rear wheels Wr, Wr. The power unit P is loaded on the central part of vehicle frame F below the fuel tank 2 and seat 3. The power unit P is equipped with casing 11 divided in two to the front and back combining the crank case and the mission case, and the crankshaft (see FIG. 4) supported by casing 11 is located in a lengthwise direction on the vehicle body.

20

A front propeller shaft 13 extending forwards from the power unit P is connected with the left and right parts of the front axle 15L, 15R via a front part differential 14. A rear propeller shaft 16 extending backwards from the power unit P is connected to the left and right parts of the rear axle 18L, 18R via rear differential 17 so that the four wheels Wr, Wf, Wr, Wr are driven.

30

As is clear from FIG. 3, a dimmer switch 22 for performing the upper and lower switching of the headlights, a lighting switch 23 for switching the head lights ON and OFF, a starting switch 24 for starting the engine E, a stop switch 25 for stopping the engine E, and a shift-up switch 26 and shift-down switch 27 for shifting transmission T up and down, to be described later, are provided near the left side grip 21 of handle

35

1. The shift-up switch 26 and shift-down switch 27  
comprise the operating member of the present invention.

Next, based on FIG. 4 to FIG. 8, the  
5 construction of the shift change device provided on power  
unit P is described. As shown in FIG. 5, the casing 11 of  
power unit P is constructed from front casing 31, rear  
casing 32 connected to the rear surface of this front  
casing 31, a front cover 33 connected to the front  
10 surface of the front casing 31, and rear cover 34  
connected to the rear surface of the rear casing 32.

As schematically shown in FIG. 8, transmission  
T is housed in the inner part of power unit P and is  
15 equipped with a main shaft 35 connected to the crank  
shaft 12 (see FIG. 4) and a counter shaft 36 connected to  
a front propeller shaft 13 and a rear propeller shaft 16  
(see FIG. 2). A gear column 37 for establishing multiple  
gear levels is provided between the main shaft 35 and the  
20 counter shaft 36.

As shown in FIG. 4, an accelerating clutch 38  
formed from an automatic centrifugal clutch which  
automatically engages according to the increase in the  
25 number of engine revolutions is provided on the front end  
of crank shaft 12. A multi-disc type transmission clutch  
39 connected and disconnected by said shift change device  
is provided on the front end of main shaft 35. A  
transmission clutch 39 is equipped with a clutch outer 40  
30 supported so as to be relatively freely rotatable by the  
main shaft 35, a clutch inner 41 is fixed to the main  
shaft 35, a multiplicity of friction plates 42 are  
arranged between the clutch outer 40 and the clutch inner  
41, and a clutch piston 43 is provided for pushing  
35 against the friction plates 42. The clutch outer 40 is  
connected to the crank shaft 12 via an input gear 44  
connected as an integrated unit to the clutch outer 40.

A shaft spindle 51 extending in a length wise direction along the vehicle body is supported by the front cover 33, front casing 31, rear casing 32 and rear cover 34. The shift spindle 51 is supported by the front cover 33 via a needle bearing 52 and O ring 53. The front part of the shift spindle 51 further projects in a forward direction from front cover 32 and is supported by a gear case 54 connected to the front end of the front cover 33 via a ball bearing 55. Furthermore, the front end of the shift spindle 51 is connected to a rotational phase detection means 56 consisting of a potentiometer provided in the gear case 54. The outside of rotational phase detection means 56 is covered by protector 57 connected to gear case 54.

A motor 58 taken as an electric actuator is supported on the outside surface of the gear case 54. A first moderator shaft 60 and a second moderator shaft 61 are supported in a compartmentalized gear chamber 59 between the gear case 54 and the front cover 33. A first moderator gear 62 is provided on the output shaft of motor 58 and meshes with a second moderator gear 63 provided on the first moderator shaft 60. A third moderator gear 64 is provided on the first moderator shaft 60 and meshes with a fourth moderator gear 65 provided on the second moderator shaft 61. A fifth moderator gear 66 is provided on the second moderator shaft 61 and meshes with a sixth moderator gear 67 formed from the sector gear provided on shift spindle 51. Therefore, by forward and reverse driving motor 58 it is possible to forward and reverse drive shift spindle 51. The second moderator gear 63 to the sixth moderator gear 67 are made from carbonized sintered metal.

35

A roller 69 provided on the tip of a clutch arm 68 fixed to shift spindle 51 engages with a groove 71<sub>1</sub> of

a movable cam plate 71 (See FIG. 4) pivotally supported by a spindle 70 provided on the front cover 33 arranged in an extended line from the main shaft 35. A plurality of balls 73 are arranged between a fixed cam plate 72  
5 connected to the spindle 70 and the movable cam plate 71. When the movable cam plate 71 revolves, the movable cam plate 71 moves in the center right direction in FIG. 5 due to the reactive force received via the balls 73 from the fixed cam plate 72. A connecting plate 75 connected  
10 via a ball bearing 74 to the movable cam plate 71 is connected by a bolt 76 to the clutch piston 43. The connecting plate 75 is energized in the center left direction of FIG. 5 by a clutch spring 77 compressed between the clutch inner 41.

15

However, when the motor 58 is forward driven or reverse driven, the shift spindle 51 rotates forward and in reverse via moderator gears 62-67, and as the clutch arm 68 attached to the shift spindle 51 oscillates, the  
20 movable cam plate 71, pushed against groove 71, by roller 69 provided on the tip clutch arm 68, also oscillates. As a result, movable cam plate 71 is moved by the reactive force received via balls 73 from fixed cam plate 72, and as the connecting plate 75 connected to movable cam plate  
25 71 moves clutch piston 43 in resistance to clutch spring 77 in the center right direction of FIG. 5, the friction plates 42 separate from each other and the connection of transmission clutch 39 is released.

30

Shift drum 81 and shift fork shaft 82 are supported in the lengthwise direction of the vehicle by front casing 31 and rear casing 32. Three cam grooves 81<sub>1</sub> to 81<sub>3</sub> are formed on the periphery of shift drum 81, and the bases of the three shift forks 83, 84, 85 engage with  
35 the cam grooves 81<sub>1</sub> to 81<sub>3</sub>. When shift drum 81 revolves, shift forks 83, 84, 85 move in the shaft direction, and a predetermined gear change level is established via said

gear column 37. The revolution position of the shift drum 81, namely, the shift position, is detected by a shift position detection means 91 consisting of a potentiometer attached to the rear end of the shift drum 81.

5

FIG. 10 to FIG. 12 show a shifter gear 113 driven by either of the shift forks 83, 84, 85 supported so as to be freely slidable by transmission shaft 112, and transmission gear 114 connected to the transmission shaft 112 by said shifter gear 113 supported so as to be relatively freely rotatable by the transmission shaft 112. Eight dogs 113<sub>1</sub> protrude evenly spaced around the circumference of the side of shifter gear 113, and the inside end of the radius of these dogs 113<sub>1</sub> are reinforced by being solidly connected to ring protrusion 113<sub>2</sub>. Also, eight dogs 114<sub>1</sub> capable of meshing with the 6 dogs 113<sub>1</sub> of the shifter gear 113 protrude in an evenly spaced manner around the circumference of the side of the transmission gear 114. The outside end of the radius of the dogs 114<sub>1</sub> are reinforced by being solidly connected to ring protrusion 114<sub>2</sub>.

In order to increase the chances of shifter gear 113 and transmission gear 114 meshing and to reduce the time required for shift change, the dogs 113<sub>1</sub>, 114<sub>1</sub> have been miniaturized. However, by reinforcing dogs 113<sub>1</sub> and 114<sub>1</sub> using ring protrusions 113<sub>2</sub> and 114<sub>2</sub>, it has been possible to prevent strength being reduced due to the miniaturization of the dogs 113<sub>1</sub> 114<sub>1</sub>. By doing this, it is possible to perform a precise shift change in a short period of time.

As is clear when FIG. 6 and FIG. 7 are referred to together, the base of change arm 87 equipped with a first opening part 87<sub>1</sub>, a second opening part 87<sub>2</sub>, and a spring receiver 87<sub>3</sub>, formed by bending the inner circumference edge part of a first opening part 87<sub>1</sub>, and a

roller 88 is welded to collar 86 engaging so as to be relatively freely rotatable with the circumference of shift spindle 51. Both ends of a twist coil spring 89 supported by said collar 86 are screwed into the front casing 31 and engage with both side parts of a stud bolt 90 which loosely pass through the first opening part 87<sub>1</sub> and both end parts of the spring receiver 87<sub>3</sub> of the change arm 87. Therefore, when the change arm 87 is in a neutral position and oscillates in either direction to a position where the edge of the first opening part 87<sub>1</sub> engages with the stud bolt 90, the spring receiver 87<sub>3</sub> displaces the twist coil spring 89 and a force is generated to return the change arm 87 to the neutral position.

The tip of an L-shaped connecting arm 92 attached to shift spindle 51 extends inside the first opening 87<sub>1</sub> of change arm 87 and is inserted in between both ends of said twist coil spring 89. Therefore, when shift spindle revolves in either a forward or reverse direction, the tip of connecting arm 92 slips only a predetermined distance inside the first opening part 87.sub.1 of change arm 87. When the tip engages with the internal edge of the first opening part 87<sub>1</sub>, the change arm 87 rotates in a forward/reverse direction. When the tip of connecting arm 92 is slipping, the change arm 87 remains stopped in a neutral position, and during that time the engagement of the transmission clutch 39 is released. Therefore, with predetermined timing from the disengagement of transmission clutch 39, it is possible to begin transmission operations with certainty.

Change plate 93 provided with a slot 93<sub>1</sub> formed at one end, a long hole 93<sub>2</sub> formed at the other end and an opening part 93<sub>3</sub> formed in the middle is arranged between the end face of the shift drum 81 and the change arm 87. The change plate 93 is energized in a parallel direction

to said slot 93<sub>1</sub> and long hole 93<sub>2</sub> by the spring 94 stretched between change arm 87, in a state where slot 93.sub.1 engages with the periphery of the collar 86, and long hole 93<sub>2</sub> engages with the roller 88 of the change arm  
5 87. In this state, the second opening part 87<sub>2</sub> of change arm 87 and opening part 93<sub>3</sub> of change plate 93 are arranged in a position so that they are substantially aligned.

10 A star shaped pin plate 95 is connected by a bolt 97 via a locating pin 96 to the end part of the shift drum 81. A detent arm 99 pivoted by a spindle 98 to the front casing 31 is energized by a spring 100, and a detent roller 101 provided on the tip of this detent arm  
15 99 engages resiliently with either of seven concave parts 95<sub>1</sub> formed on the periphery of pin plate 95. Therefore, shift drum 81 is able to stop stably at either of 7 rotation positions corresponding to 7 shift positions.

20 Seven feed pins 95<sub>2</sub> are arranged at the periphery of the end surface of pin plate 95 in such a manner as to protrude, and a pair of protrusions 93<sub>4</sub>, 93<sub>4</sub> capable of engaging with the feed pins 95<sub>2</sub> and the pair of cam faces 93<sub>5</sub>, 93<sub>5</sub> are formed on the inner periphery of  
25 opening part 933 of the change plate 93. Furthermore, a plate shaped holder 102 pressing against the outer surface of change plate 93 is jointly fastened by said bolt 97 in order to prevent the change plate 93 from falling from the pin plate 95.

30 As shown in FIG. 5, on the rear cover 34, the secondary spindle 103 is supported orthogonally by the shift spindle 51, and an arm 104 connected to one end of a secondary spindle 103 engages with an arm 105 connected  
35 to the rear end of the shift spindle 51. A hexagonal part 103<sub>1</sub> is formed on the other end of secondary spindle 103, and this hexagonal part 103<sub>1</sub> faces the opening 311 of

front casing 31 (See FIG. 4).

The torque of twist coil spring 89 energizing the shift spindle 51 to a neutral position is set greater than the sum of the frictional force of each moderator gear 62-67 and the motor 58 during extreme low temperatures (-25.degree. C.). As the gear chamber 59 is lubricated with a small quantity of grease in order to reduce the frictional force of each of the moderator gears 62-67, if the motor 58 fails, the energizing force of twist coil 89 automatically returns the shift spindle 51 to a neutral position. Also, even if motor 58 fails, by engaging wrenches and other tools 106 (See FIG. 5) to the hexagonal part 103<sub>1</sub> of secondary spindle 103, it is possible to manually operate the shift drum 81.

Assembly of the shift change device of the aforesaid construction is performed in the following order.

20

After inserting the shift spindle 51 from the rear with respect to the previously bolted front casing 31 and rear casing 32, the change arm 87, connecting arm 92 and clutch arm 68 are assembled to the shift spindle 51 from the front. Next, the rear cover 34 which has already been assembled with the secondary spindle 103 is bolted to the rear face of the rear casing 32. The front cover 33 which has previously been assembled with needle bearing 52 and O ring 53, etc., is bolted to the front face of front casing 31. Next, after assembling the first moderator shaft 60, the second moderator shaft 61 and the second moderator gear 63 to the sixth moderator gear 67 to the gear chamber 59 of the front face of front cover 33, the gear case 54 equipped with the integrated motor 58 and rotational phase detection means 56 is bolted so as to overlap the front face of front cover 33 together with protector 57.

The above mentioned shift change device is arranged in a lengthwise direction along the vehicle body so that the axis of shift spindle 51, shift drum 81 and motor 58 is parallel with the axis of crankshaft 12 of engine E, and as the entire shift change device is arranged concentrated below the area between crankshaft 12 and counter shaft 36 of transmission T, the efficient use of space makes it possible to miniaturize the power unit P. Also, as the motor 58 of the shift change device is arranged on the front face of the power unit P, it is possible to effectively cool the motor 58 with running air currents.

As shown in FIG. 3, in addition to signals from the shift up switch 26, shift down switch 27, revolving phase detection means 56 and position detection means 91, signals from vehicle speed detection means 107 and engine revolution detection means 108 are input to electronic control unit C, and the drive of motor 58 is controlled based on these signals.

Next, the operation of the embodiment is described. In the time chart of FIG. 9, when the shift up switch 26 or shift down switch 27 is operated at time  $t_0$ , in the period until  $t_1$ , the motor 58 is driven with a duty ratio of 100%. The drive direction of motor 58 at this time, that is to say, the direction of rotation of the shift spindle 51 is in the opposite direction in the case of shift up and in the case of shift down. When the angle of rotation of the shift spindle 51 reaches 6.degree. 30', the transmission clutch 39 disengages, and the shift drum 81 begins revolving.

The following is a description of the operation at this time. In FIG. 7, when the change arm 87 revolves in the direction of arrow A, the change plate 93

connected via the roller 88 and long hole 93<sub>2</sub> to this change arm 87 rotates in the direction of arrow A, and the under side protrusion 93<sub>4</sub> formed by this opening part 93.sub.3 pushes against one feed pin 95<sub>2</sub> in an upward  
5 direction so as to rotate the shift drum 81 in the direction of arrow A by one pitch. As a result, at time t<sub>2</sub>, when the angle of revolution of the shift spindle 51 reaches 19.degree., the detent roller 101 engages with a new concave part 95<sub>1</sub> of the pin plate 95, and the shift  
10 drum 81 is stopped stably at a new position. Between time t<sub>1</sub> and time t<sub>2</sub>, motor 58 produces a braking force and softens the impact of the inside edge of opening part 87<sub>1</sub> of change arm 87 when engaging with stud bolt 90.

15           Next, between time t<sub>2</sub> and time t<sub>4</sub>, the revolution angle of the shift spindle 51 is maintained at 19.degree., and the shift change is completely ended. In the first half, the time between time t<sub>2</sub> and time t<sub>3</sub> is the time when the dog of the shifter gear driven by shift  
20 forks 81-83 is completely engaged with the dog of the transmission, and in the second half, between time t<sub>3</sub> and time t<sub>4</sub> is the time when throttle operation by the rider is permitted to reduce transmission shock.

25           Next, from time t<sub>4</sub> to time t<sub>6</sub>, motor 58 is driven in a reverse direction. As a result, in FIG. 7, change arm 87 revolves in the direction of arrow B towards a neutral position, and change plate 93 together with change arm 87 revolves in the direction of arrow B,  
30 however, as the under side cam face 93<sub>5</sub> formed by the opening part 93<sub>3</sub> engages with one feed pin and receives a reactive force, the change plate 93 moves in the direction of arrow C due to this reaction force while causing the spring 94 to extend. As a result, the cam 93<sub>5</sub>  
35 overrides the feed pin 95<sub>2</sub> and while the stopping shift drum 81 in said new position, it is possible for change arm 87 and change plate 93 to return to a neutral

position.

During this time, transmission clutch 39 is again engaged. However, during the time from t5 to time  
5 t6 when transmission clutch 39 is engaged, the drive speed of motor 58 is reduced. As a result, it is possible to prevent the occurrence of transmission shock by slowly engaging the transmission clutch 39.

10 Furthermore, when the number of engine revolutions detected by engine revolution speed detection means 108 exceeds a predetermined value (for example 3000 rpm), or the vehicle speed detected by vehicle speed  
15 detection means 107 is above a predetermined value (for example 10 km/h), in order that a sudden load is not placed upon the engine E, neutral to first gear, and neutral to reverse gear is prohibited. Also, when vehicle speed detected by the vehicle speed detection means 107  
20 exceeds a predetermined value, (for example 3 km/h), in order to prevent an interruption of the drive force, a shift change from first gear to neutral is prohibited.

As in the above, in the first half of the shift change, the motor 58 is driven at a duty ratio of 100%  
25 and the transmission clutch 39 is quickly disengaged, enabling the time required for the shift change to be reduced. Also, in the second half of the shift change, by feedback controlling the revolution angle of shift spindle 51 based on the signals from revolving phase  
30 detection means 56, in addition for it to be possible to minutely control the revolution angle of the shift spindle, it is also possible to prevent the occurrence of transmission shock by setting the disengagement speed of the transmission clutch slower than the engagement speed.

35

However, instead of the change pedal and the change lever, by operating using only the shift up switch

26 or the shift down switch 27, as a shift change can be performed with the drive force of motor 58, a smooth shift change can be performed in a short time without requiring proficiency. Furthermore, as the same motor 58 and the same rotational phase detection means 56 are jointly used in the operation of the transmission clutch 39 and the operation of the transmission T, the number of parts is reduced, thus contributing to cost reductions. In this case, as the rotational phase detection means 56 detects the rotational phase of the shift spindle 51 near both driven members driven by the motor 58, namely, the clutch arm 68 and change arm 87, high precision operations are possible.

FIG. 13 shows the second embodiment of the present invention. In this second embodiment, as a heat insulator 111 made from bakelite intervenes between the front cover 33 and the gear case 54, it is possible to prevent the heat from the engine E from being transferred to the motor 58 and the rotational phase detection means 56 by using this heat insulator 111. Also, as the inside of gear case 54, in both the first embodiment and the second embodiment, is lubricated by a small quantity of grease, the insulation from heat from engine E is further enhanced.

In the above, details of the embodiments of the present invention have been given, however, various design modifications are possible without deviating from the scope of the essence of the present invention.

For example, the embodiment shows a four-wheeled saddle ridden type vehicle V. However, it is also possible to apply the present invention to two and three wheeled vehicles.

According to the present invention, as the

connection and disconnection of the transmission clutch provided between a drive source and a transmission is performed by an actuator, a simple and precise clutch operation can be performed by anyone without extensive training or experience, and it is possible to perform a rapid clutch operation that would be impossible in the case where it is directly performed with the operator's hands or feet.

Also, according to the present invention, in conjunction with rapidly performing the transmission clutch disconnection reducing the transmission time, it is possible to slowly engage the transmission clutch, minimizing transmission shock.

Also, according to the present invention, as the same motor is used to engage or disengage the transmission clutch and change gears of the transmission, the number of parts is reduced, thus contributing to possible cost reductions. Also, even if the drive speed of the motor is increased, as the timing of the engagement and disengagement of the transmission clutch and the timing of the gear change of the transmission is always simultaneous, it is possible to perform smooth gear changes in a short time.

Also, according to the present invention, as the control of the transmission and the control of the clutch is performed using a common rotational phase detection means, part numbers are reduced, contributing to possible cost reductions. Furthermore, as the rotational phase detection means detects the rotational phase near to both controlled systems, namely the transmission shift drawing and the transmission clutch, it is possible to minimize detection errors.

The invention being thus described, it will be

obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Although various preferred embodiments of the present invention have been described herein in detail, it will be appreciated by those skilled in the art, that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A power transmission device for a vehicle equipped with a transmission provided between an engine and drive wheels, and a transmission clutch provided between the engine and the transmission, the power transmission device has an electric control unit and associated electric motor for engaging the transmission clutch to produce a shift up or a shift down based on electric command signals from operating members controlled by a rider and wherein the operating members are provided on a left side grip of a handle used to steer the vehicle, and wherein said operating members include a shift switch arrangement connected to and electrically controlling said electric control unit, said shift switch arrangement being operable to produce a shift up electric command signal and being operable to produce a shift down electric command signal; said shift switch arrangement when actuated to produce the shift up electric command signal causing said electric control unit in combination with said electric motor to operate the transmission clutch and produce a shift up and said switch arrangement when actuated to produce the shift down electric command signal causing said electric control unit in combination with said electric motor to operate the transmission clutch and produce a shift down.

2. A power transmission device as claimed in claim 1 wherein said transmission being includes a gear column capable of establishing multiple gear levels, shift forks for changing mesh of the gear column, a shift drum for driving the shift forks, and a shift spindle for driving the shift drum, and wherein said transmission clutch is engaged and disengaged by said spindle made to revolve by said

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electric control unit operated based on command signals from said operating members.

3. A power transmission device as claimed in claim 1 or 2 wherein said electric motor is a reversible motor capable of rotating in a forward or reverse direction with the direction of rotation determining said shift up and said shift down.

FIG. 1

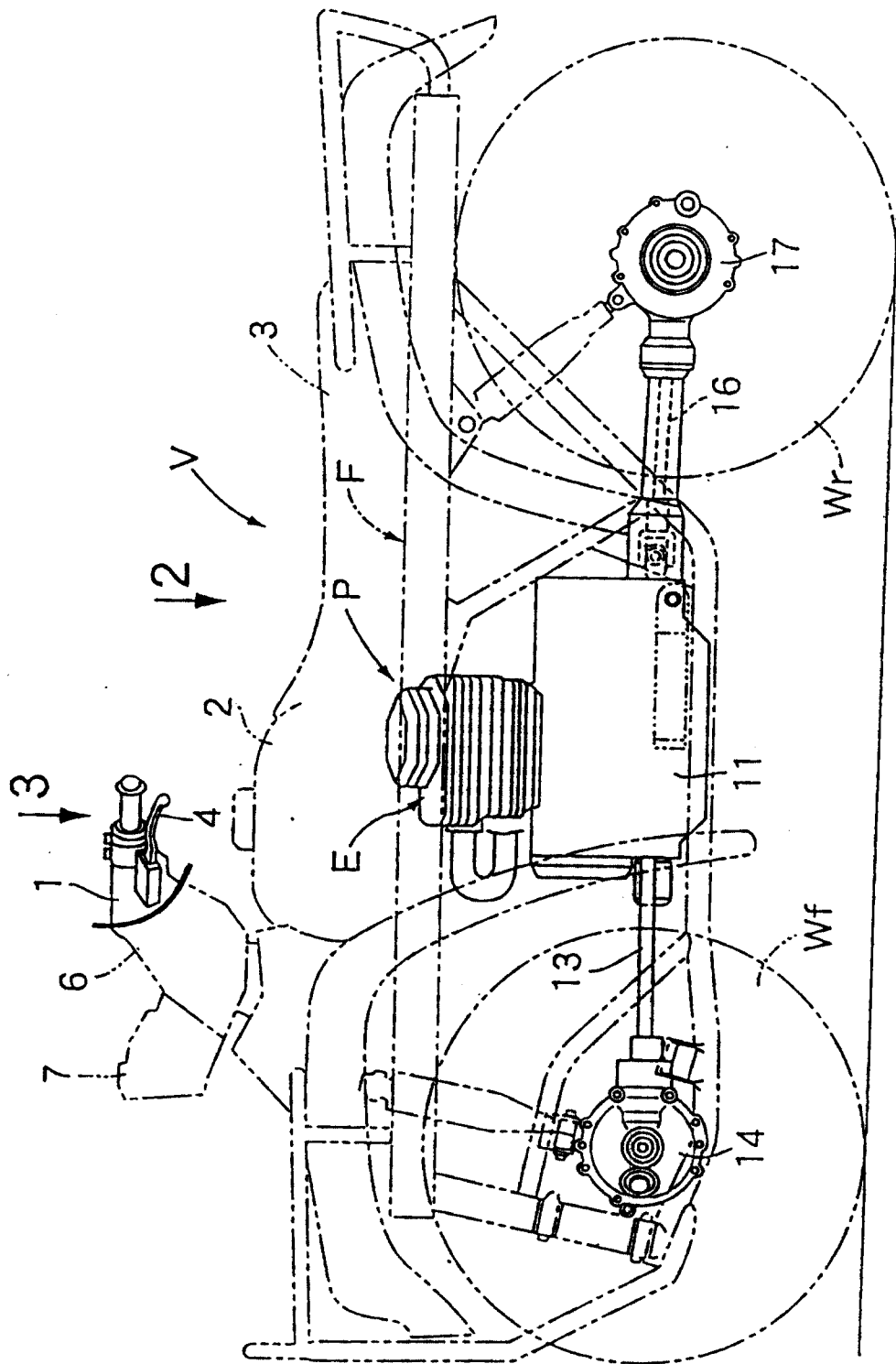


FIG. 2

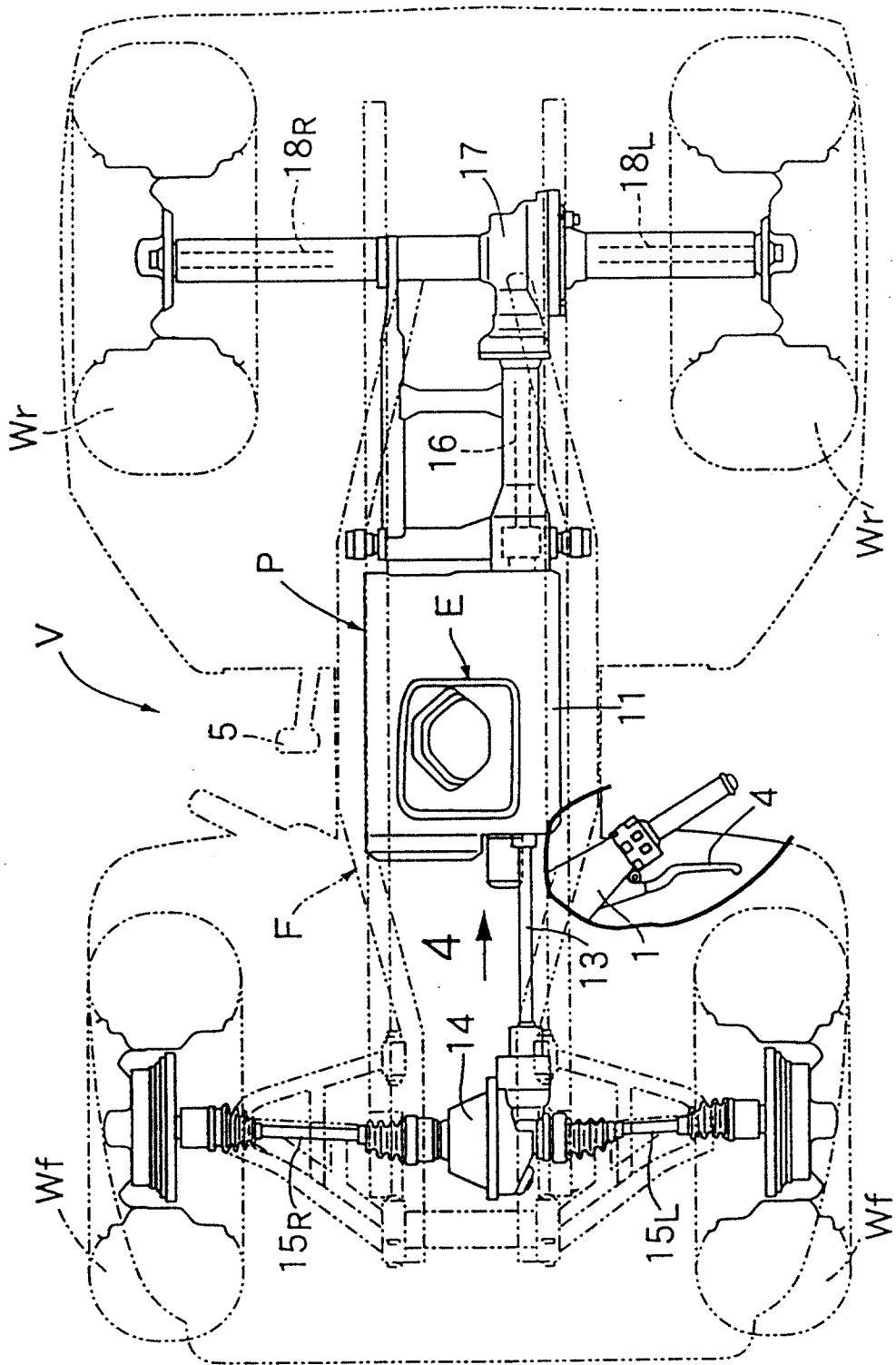


Fig. 3

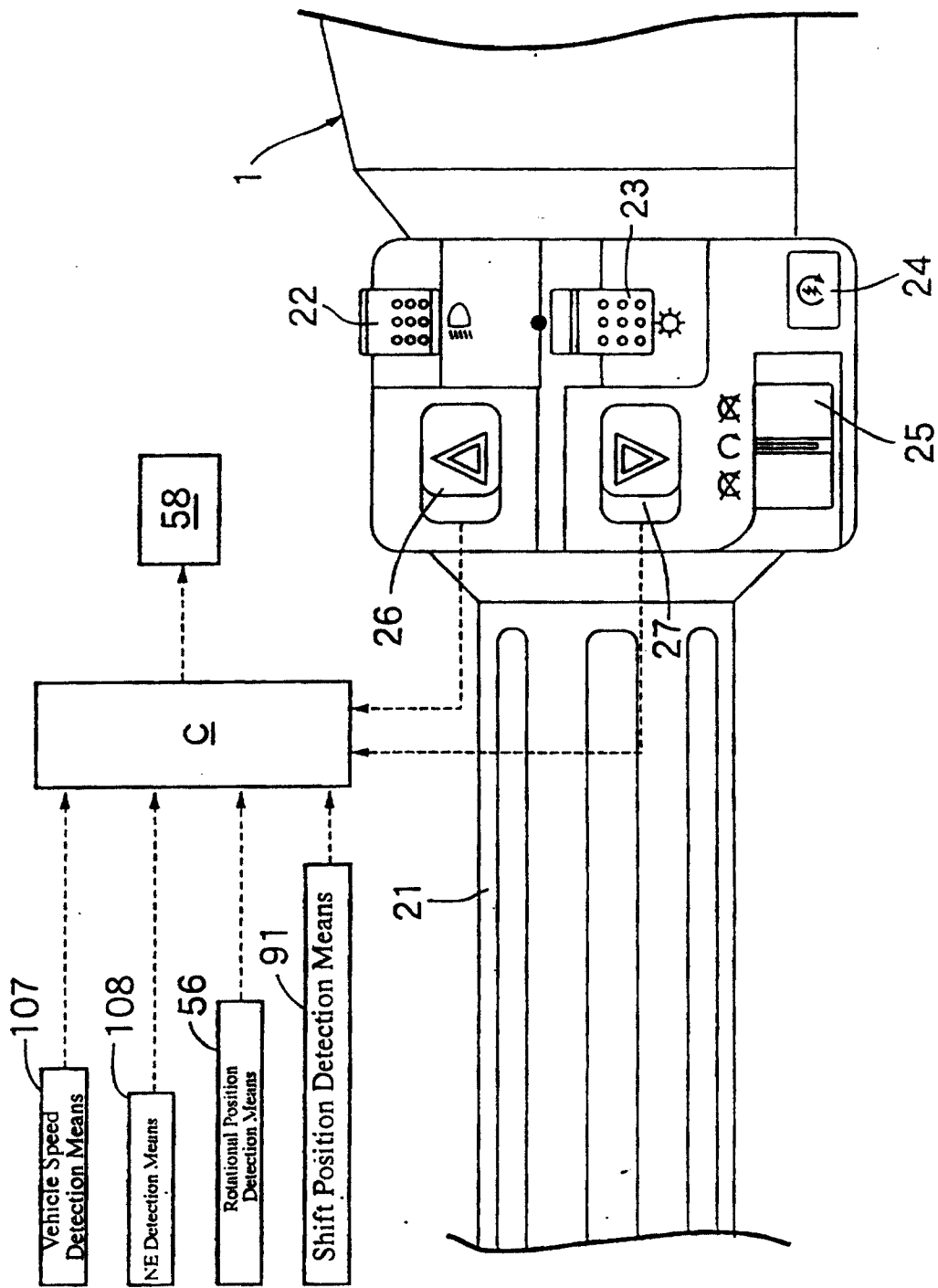


FIG. 4

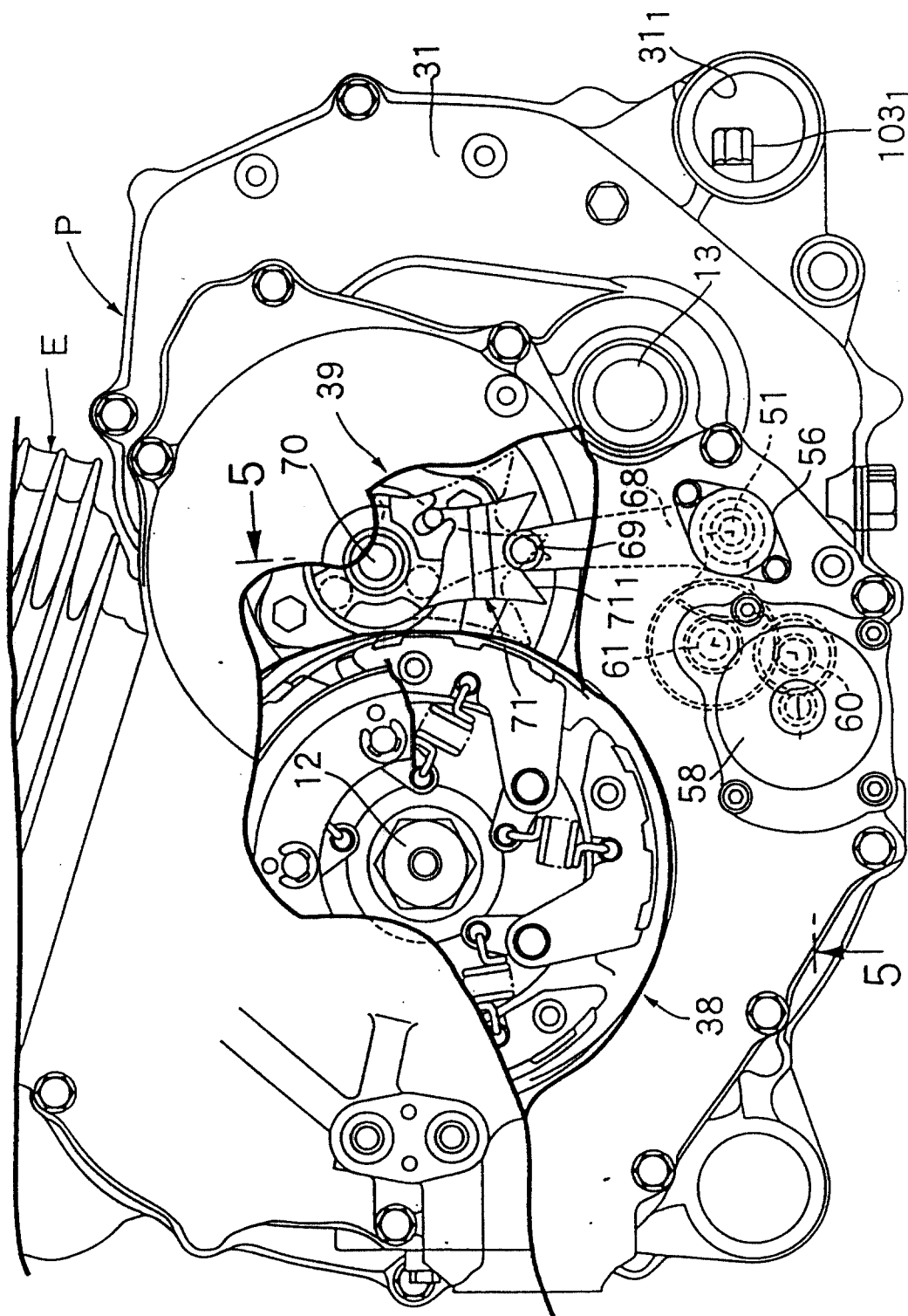


FIG. 5

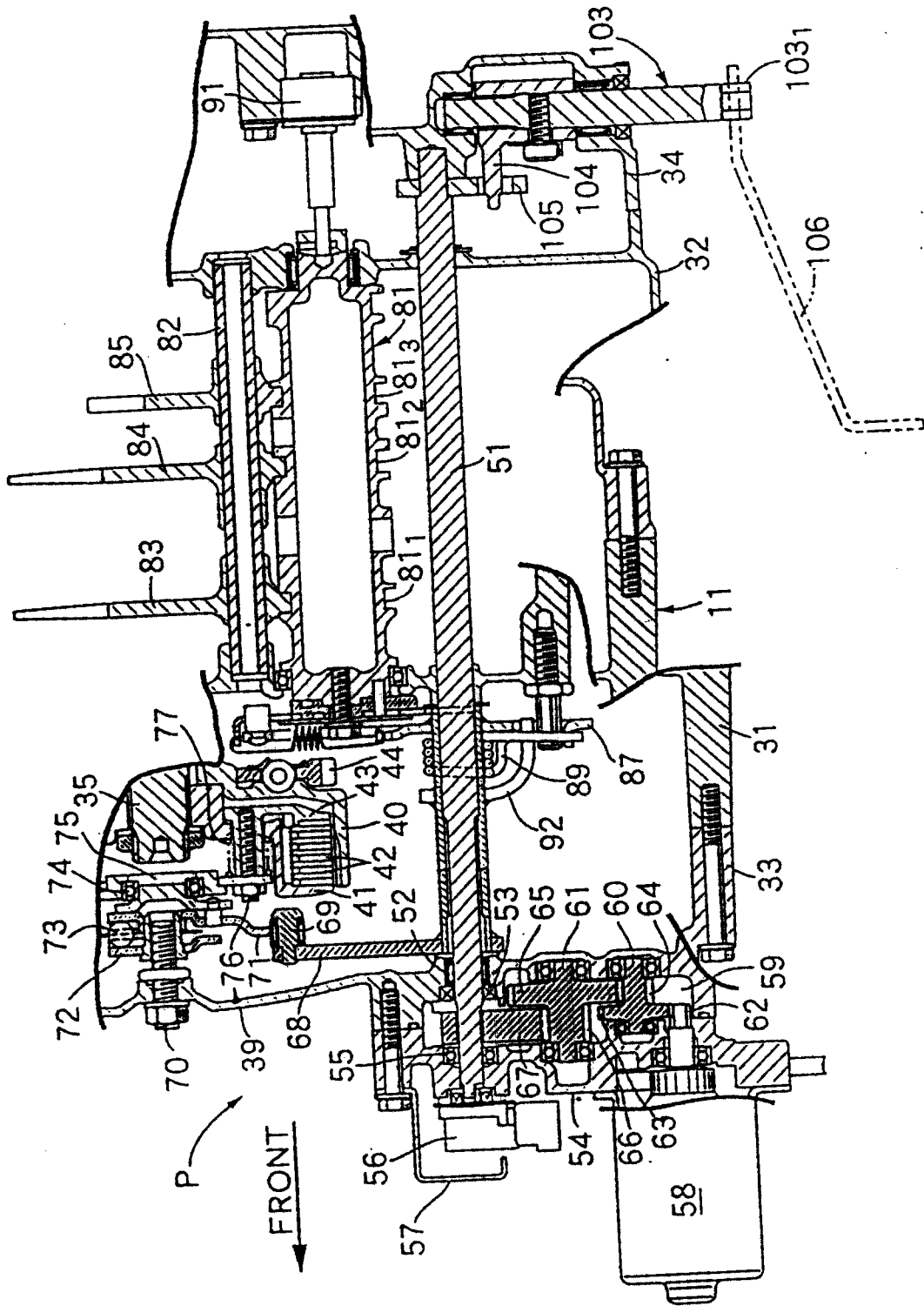


FIG. 6

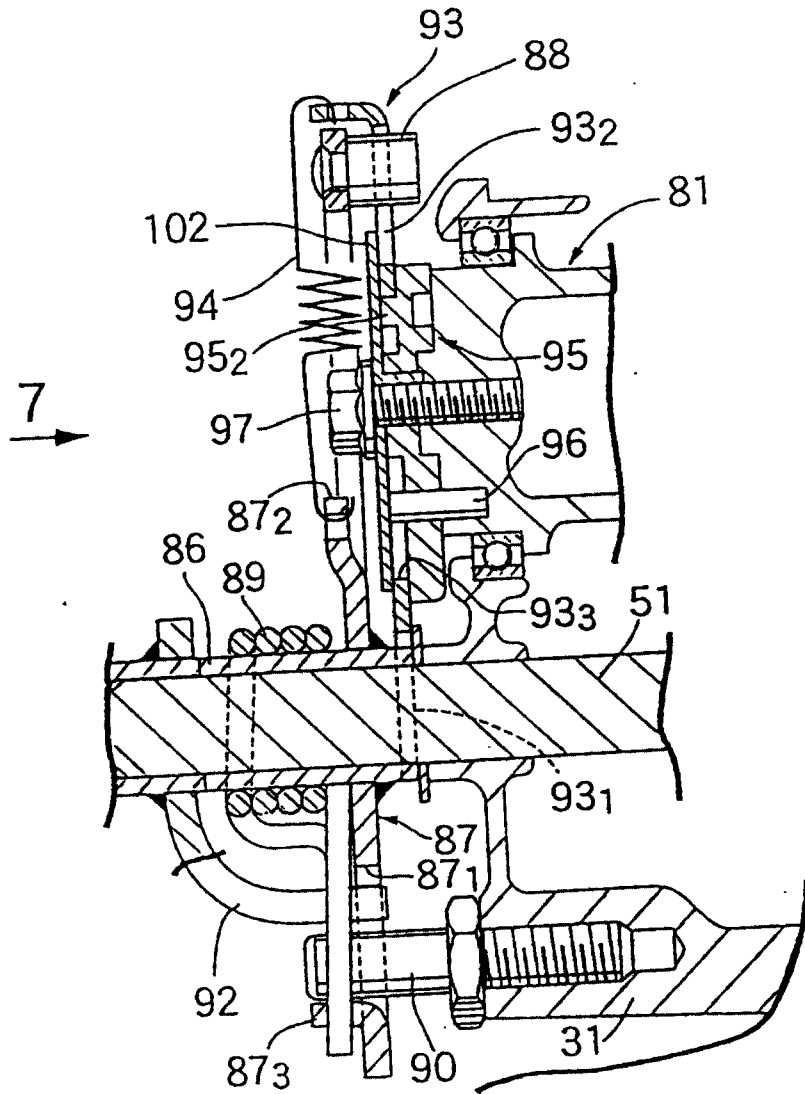


FIG. 7

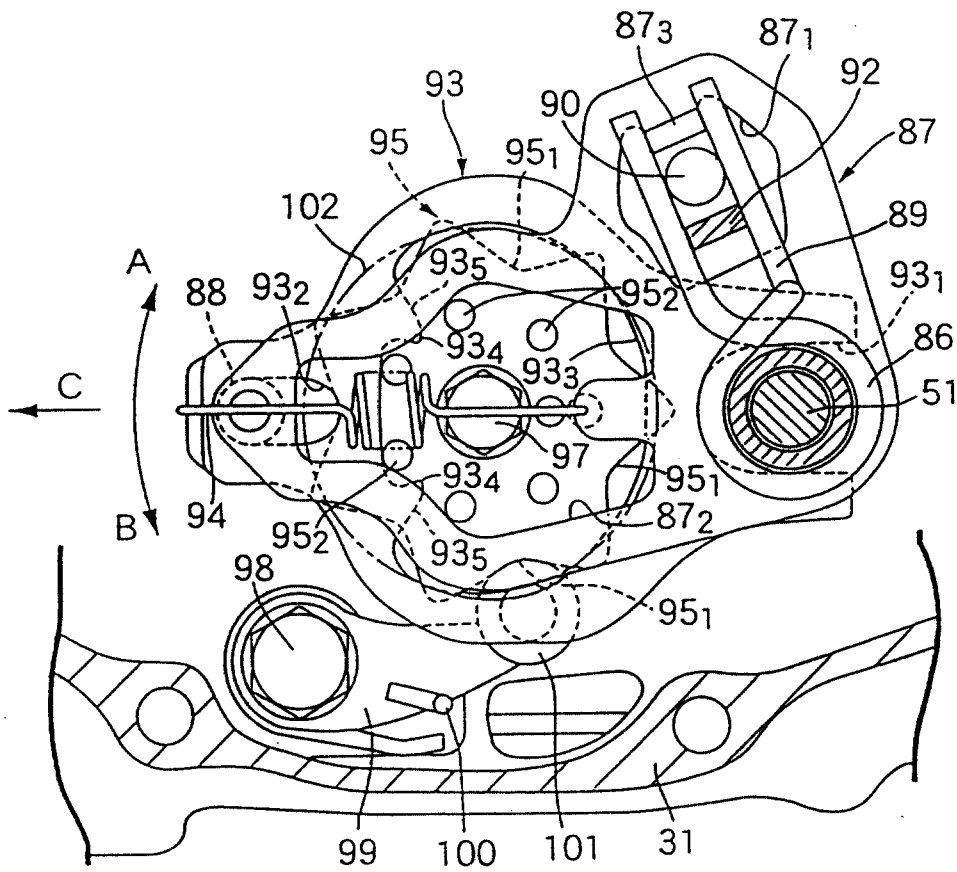


FIG. 8

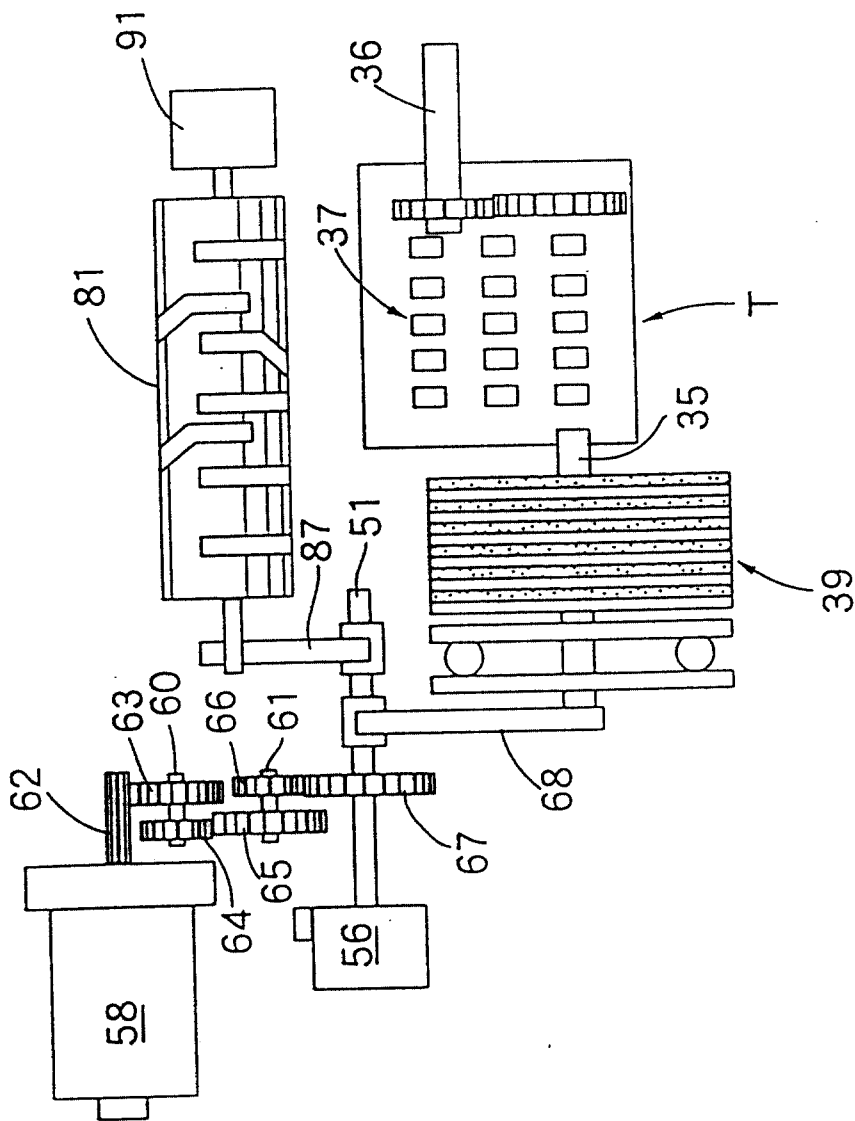


Fig. 9

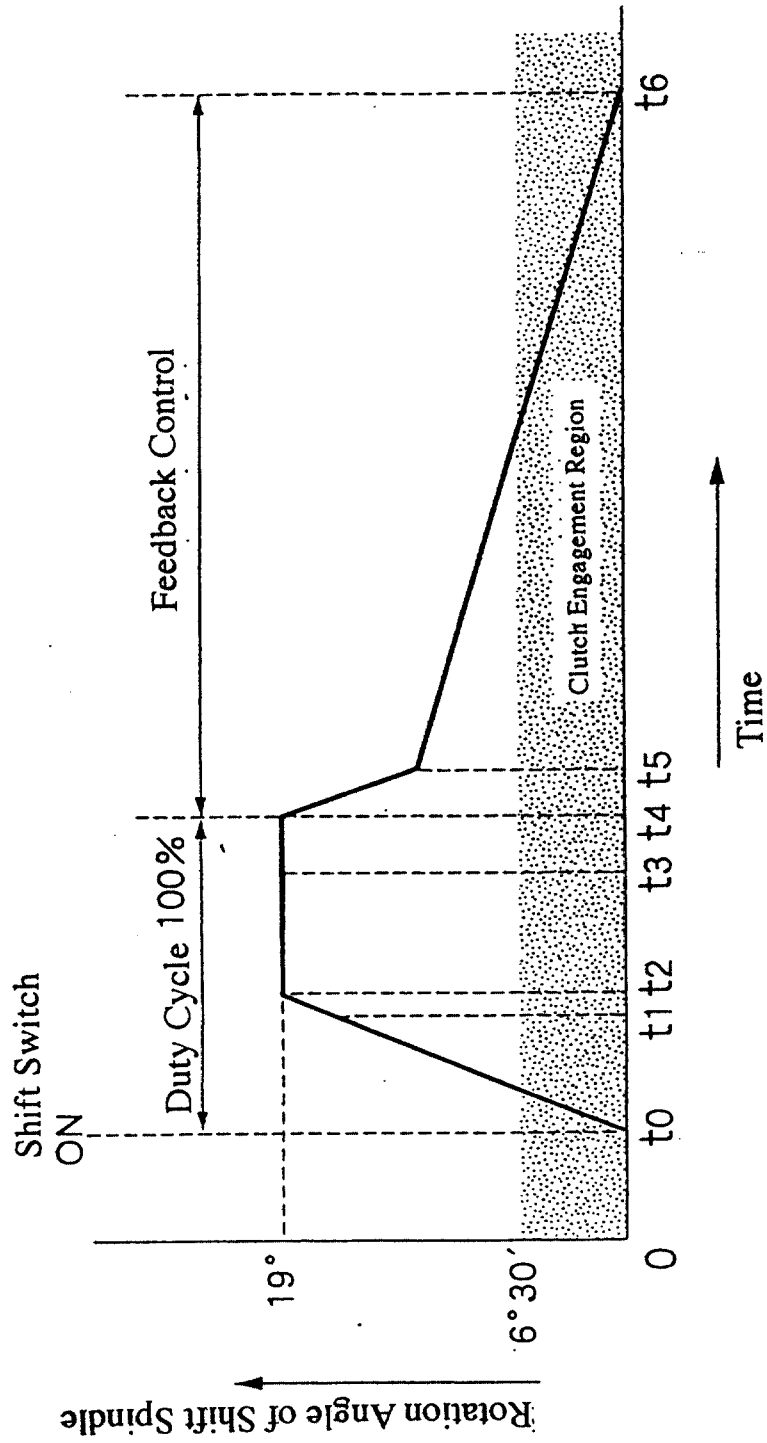


FIG. 10

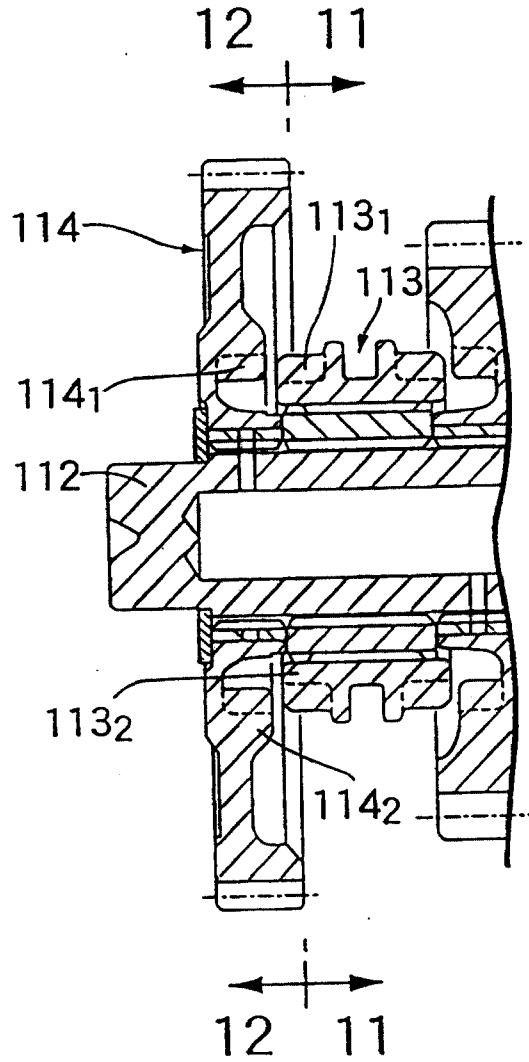


FIG. 11

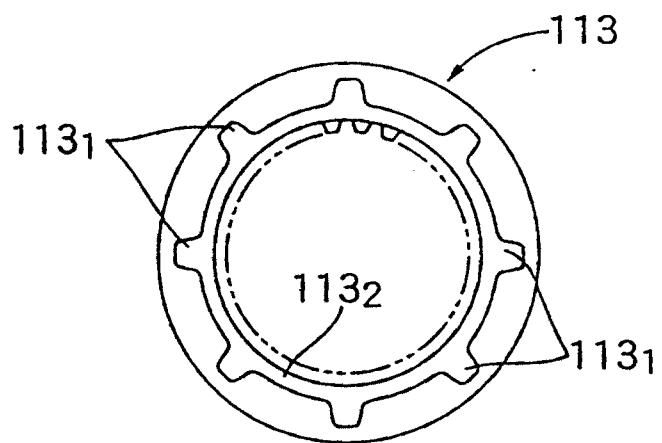


FIG. 12

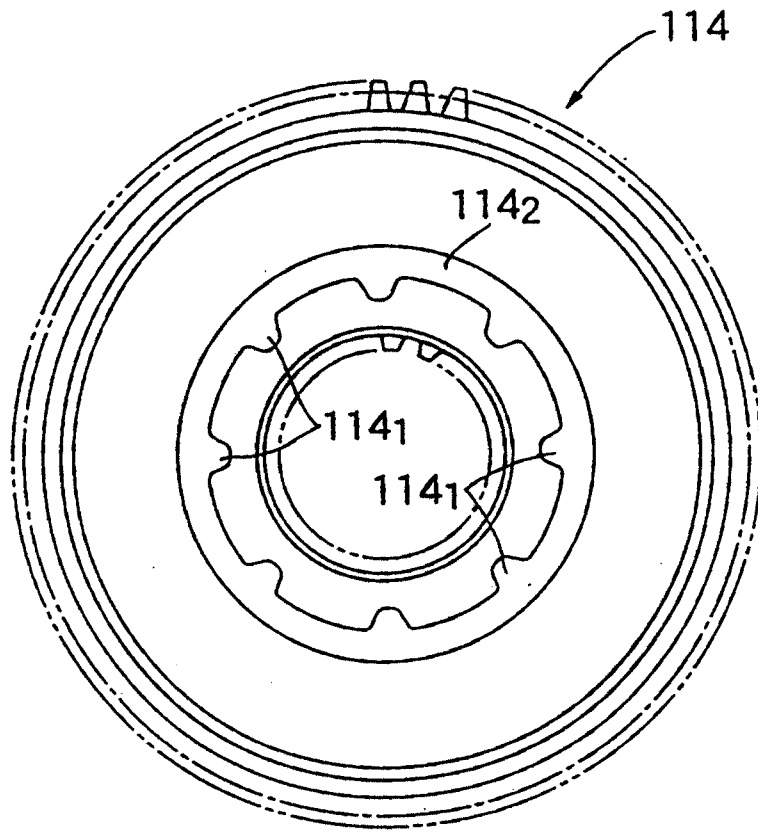


FIG. 13

