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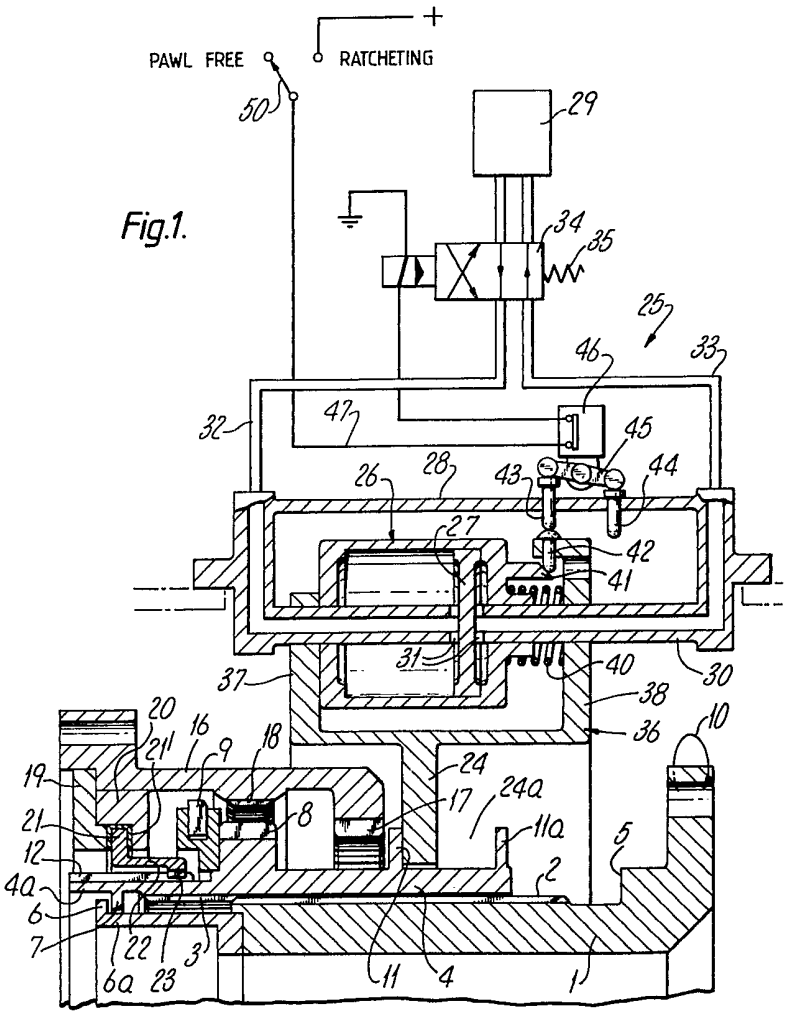
(54) **Pawl and ratchet mechanism**

(57) A pawl and ratchet mechanism, described for use in a synchro self shifting (SSS) clutch, comprises pawls 9 and ratchet 18, a baulking member 4a which inhibits movement of the mechanism from a pawl free condition as shown into a pawl engaged condition unless relative rotation is in the correct direction, and means selectively operable to repeatedly attempt to move the mechanism from the pawl free to the pawl engaged condition against baulking means 4a until the required synchronism is reached. These means comprise a two position main control 34 connected to first movable powered means 26 movable in opposite directions in dependence on the setting of main control 34 and second movable powered means 36 connected to the first powered means via resilient means

Continued overleaf...

Fig.1.



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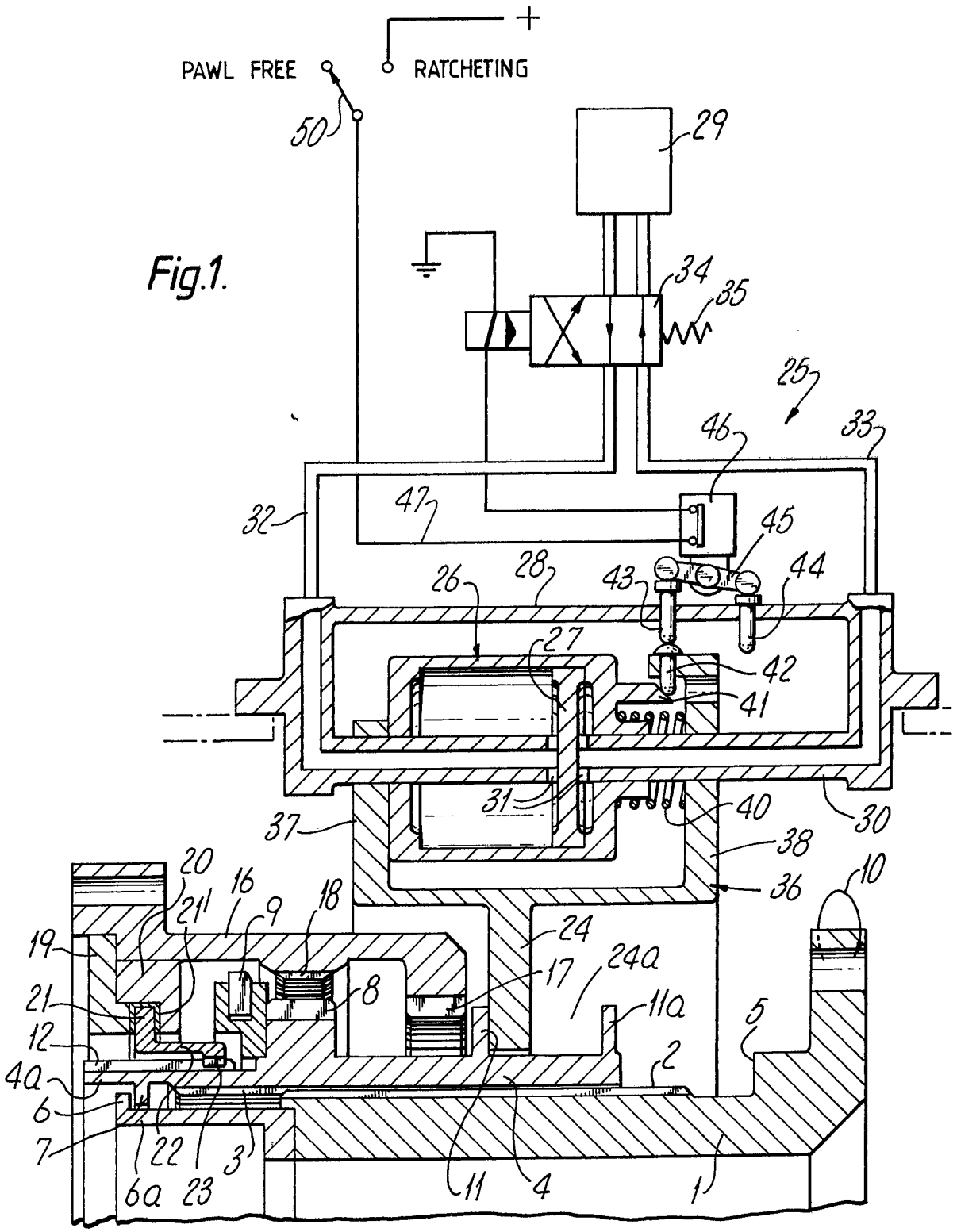
The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

40 permitting relative movement between the two powered means 26 and 36, the relative movement controlling the setting of main control 34.

Fig.1.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PAWL FREE
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26
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11
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Fig.3.

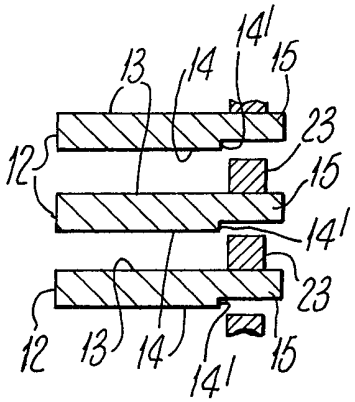
141
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Fig.2.

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11a
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6a
23
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4
1

SPECIFICATION

Pawl and ratchet mechanism

This invention relates to a pawl and ratchet mechanism.

In our British Patent Specification No. 1,291,773 there is disclosed a pawl and ratchet mechanism which may be operated in both a ratcheting and a pawl free condition in which the pawl and ratchet components of the mechanism are respectively in and out of engagement with each other, the mechanism having a movable baulking member which when in a baulking position prevents relative movement of the said components into the ratcheting condition, the baulking member being maintained in said baulking position when the relative rotation of the said components is inappropriate to permit the mechanism to be operated in the ratcheting condition, and movement imparting means for moving the baulking member out of the baulking position when the said relative rotation is appropriate. The baulking member is provided with stepped baulking teeth which, when the baulking member is in the baulking position, are in effect locked in engagement with blocking teeth on a blocking ring, such locking of the teeth together being desirable to prevent their separation as a result of vibration. When, however, the relative rotation of the pawl and ratchet components is appropriate to permit movement of the baulking member out of the baulking position, there is only a small frictional force between the blocking ring and a bearing therefor which tends to effect such movement of the baulking member out of the baulking position. Consequently it has previously been necessary to constantly try to move the baulking member manually out of the baulking position and this could involve a considerable amount of operator time. The object of the present invention, therefore, is to make this operation automatic.

According, therefore, to the present invention there is provided a pawl and ratchet mechanism which may be operated in both a ratcheting and a pawl free condition in which the pawl and ratchet components of the mechanism are respectively in and out of engagement with each other, the mechanism having a movable baulking member which when in a baulking position prevents relative movement of the said components into the ratcheting condition, the baulking member being maintained in said baulking position when the relative rotation of the said components is inappropriate to permit the mechanism to be operated in the ratcheting condition, and movement imparting means for moving the baulking member out of the baulking position when the said relative rotation is appropriate characterised in that the movement imparting means comprises thrust generation means; thrust switching means settable in first and second conditions; a first thrust member arranged to be moved by the thrust generation means in mutually opposite directions in dependence upon the setting of the thrust switching means; a second thrust member which is movable by the first thrust member in a predetermined direction by way of resilient means which permit differential movement between the first and second thrust members, the second thrust member also being movable by the first thrust member in the direction opposite to the said predetermined direction, the second thrust member being in thrust imparting relationship with the baulking member; and adjustment means which adjust the setting of the thrust switching means when such differential movement occurs.

The first thrust member is preferably directly engageable with the second thrust member in each of the said opposite directions.

The adjustment means may comprise a trip switch which is tripped whenever the said differential movement occurs. Thus one of the thrust members may have a cam which adjusts the position of a part carried by the other thrust member whenever differential movement occurs between the thrust members in either of the said opposite directions, the said part being engageable with at least one portion of the trip switch to adjust the latter. The said part may be alternately engageable with spaced portions of the trip switch.

The thrust switching means may be a solenoid valve connected in an electrical circuit which includes the said trip switch, the electrical circuit having a selector switch therein.

The first thrust member may be a movable cylinder of a piston and cylinder unit, the thrust switching means controlling fluid flow to and from the piston and cylinder unit.

The second thrust member may have a control part which is disposed in a recess which is defined between spaced apart flanges on the baulking member, the control part being alternately movable into contact with each of said flanges.

The invention also comprises a synchronous self-shifting toothed clutch of the type comprising a first toothed rotary clutch part, a second toothed rotary clutch part, an intermediate member constrained for helical movement relative to said second clutch part to bring the coacting clutch teeth into at least initial interengagement, and a pawl and ratchet mechanism effective upon passage of the clutch parts through synchronism in one direction of relative rotation to shift the intermediate member into at least initial interengagement of its clutch teeth with the clutch teeth of said first clutch part, wherein the pawl and ratchet mechanism is as described above, the components of the pawl and ratchet mechanism being carried by the first clutch member and the intermediate member respectively.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a partly schematic broken-away view in side sectional elevation of a synchronous self-shifting toothed clutch embodying the invention, the clutch being shown in a pawl free viz. bi-directionally free condition,

Figure 2 is a view similar to Figure 1 but showing the clutch in a baulked condition, and

Figure 3 is a development view of baulking teeth and blocking teeth.

Terms such as "left", "right", "clockwise" and

"counter-clockwise", as used in the description below are to be understood to refer to directions as seen in the accompanying drawings.

Referring to the drawings, the clutch includes a first clutch part or clutch input part 1 formed with external left-hand helical splines 2 with which are engaged internal helical splines 3 in an intermediate member 4, which is thereby constrained for helical movement relative to the clutch part 1, the said helical movement being limited in one direction by an axial stop formed by an annular shoulder 5 on the clutch part 1 and in the other direction by an axial stop formed by an annular flange 6 on a ring 6*a* fixed to the part 1, the flange 6 cooperating with a radially inwardly projecting annular flange 7 in the intermediate member 4. The intermediate member 4 is formed with a ring of external clutch teeth 8, and carries pawls 9 the noses of which point in counter-clockwise direction as viewed from the righthand end of the clutch. The pawls 9 are provided with control springs (not shown) which urge the noses of the pawls radially outwardly. The intermediate member 4 is also provided with a part 4*a* which forms a movable baulking member, the baulking member 4*a* being formed with a ring of external baulking teeth 12, each of which (Figure 3) has a straight flank 13 and a flank 14 which is stepped to form a part 15 of reduced circumferential thickness at one end of the tooth. As seen from the left-hand end of the clutch in Figure 1, the straight flanks 13 of the baulking teeth 12 face in the counter-clockwise direction and the stepped flanks 14 face in the clockwise direction.

A second clutch part or clutch output part is constituted by a sleeve 16 carrying a ring of internal clutch teeth 17 and a ring of internal ratchet teeth 18. The sleeve 16 also carries annular members 19 and 20 shaped so as to provide between them an internal groove, in which is accommodated a ring 21 forming part of a blocking tooth carrier. A white metal bearing 21′ is provided between the ring 21 and the said groove. The blocking tooth carrier also includes a cylindrical member 22 which projects from the inner periphery of the ring 21 and carries a ring of internal blocking teeth 23 which are interengaged with the baulking teeth 12.

With the clutch in an unidirectionally free or ratcheting condition, not shown, the external clutch teeth 8 are out of engagement with the internal clutch teeth 17 and the pawls 9 are in ratcheting relationship with the ratchet teeth 18. With the clutch output part 16 rotating in counter-clockwise direction relative to the clutch input part 1 as seen from the right-hand end of the clutch, the pawls 9 ratchet relative to the ratchet teeth 18 and the clutch over-runs.

The ring 21 forming part of the blocking tooth carrier is rotatably slidable in its bearing 21′. When the clutch parts 1 and 16 are in relative rotation in the over-running direction as above described, the drag on the ring 21 of the blocking tooth carrier, due to the friction between the ring 21 and the bearing 21′, is such that the blocking teeth 23 are maintained in contact with the straight flanks 13 of the baulking teeth 12.

When the direction of relative rotation of the clutch parts 1 and 16 reverses, the pawls 9 engage the ratchet teeth 18 and the intermediate member 4 is thereby shifted helically, to the right in Figure 1, along the clutch input part 1 so as to bring the external clutch teeth 8 precisely into initial interengagement with the internal clutch teeth 17, whereupon the interaction of the clutch teeth 8 and 17 in conjunction with the helical splines 2 and 3 draws the intermediate member 4 into full toothed engagement with the second clutch part 16 and against the axial stop 5, so that the clutch is engaged. When the direction of relative rotation of the clutch parts 1 and 16 again reverses the interaction of the clutch teeth 8 and 17 in conjunction with the helical splines 2 and 3 shifts the intermediate member 4 to the left so as to bring the external clutch teeth 8 out of engagement with the internal clutch teeth 17 and to bring the pawls 9 back into ratcheting engagement with the ratchet teeth 18. During these movements of the intermediate member 4, the baulking teeth 12 slide relative to the blocking teeth 23.

As so far described, the clutch is unidirectionally free, that is to say for one direction of relative rotation of the clutch parts 1 and 16 the clutch overruns with the pawls 9 ratcheting relative to the ratchet teeth 18, whereas upon reversal of the direction of relative rotation of the clutch parts 1 and 16 the clutch engages as above described.

In order to bring the clutch to a condition of bi-directional freedom viz., the pawl free condition, which is shown in Figure 1, the intermediate member 4 is shifted to the left to a position in which the pawls 9 are axially clear of the ratchet teeth 18, as shown in Figure 1. This movement of the intermediate member 4 is effected by operating (as described below) an axially movable control fork 24 engaged with lost motion in an external annular groove or recess 24*a*, in the intermediate member 4, the annular recess 24a being defined between spaced apart flanges 11, 11*a* of the intermediate member 4. During this movement of the intermediate member 4, the baulking teeth 12 move so far to the left that the blocking teeth 23 move on to the parts 15 of the baulking teeth 12 of reduced circumferential width. So long as the direction of relative rotation of the clutch part 1 and intermediate member 4 relative to the clutch part 16 corresponds to the ratcheting direction of relative rotation of the pawls 9 and ratchet teeth 18, as shown by the arrow 10 in Figure 1, the blocking teeth 23 are held in contact with the straight flanks 13 of the baulking teeth 12 (Figure 3) by the frictional drag on the blocking tooth carrier due to the friction between the ring 21 and the surfaces of the bearing 21′ in which it is accommodated. Hence it is possible, by operating the control fork 24, to shift the intermediate member 4 to the right to bring the pawls 9 into ratcheting relationship with the ratchet teeth 18. If, however, while in the pawl free condition, the direction of relative rotation of the clutch parts 1 and 16 is in the direction opposite to the arrow 10, the blocking teeth 23 are held, by frictional drag, against the flanks of the narrow parts 15 of the baulking teeth 12, on the stepped sides 14′ thereof. Hence if an attempt is

made to shift the intermediate member 4 to the right, the steps 14' on the baulking teeth 12 come into axial engagement with the blocking teeth 23 so as to prevent further movement of the intermediate member 4 to the right such as would bring the pawls 9 into contact with the ratchet teeth 18 and cause damage. This baulked condition of the mechanism is shown in Figure 2.

The operator is therfore obliged to wait for the direction of relative rotation of the clutch parts 1 and 16 to reverse before the intermediate member 4 can be shifted to the right.

As so far described, the clutch is constructed and arranged as shown in greater detail in our British Patent Specification No. 1,291,773 to which reference should be made. In such a clutch, however, if the clutch is in the baulked condition, shown in Figure 2, it will not itself "un-baulk" if the direction of relative rotation of the clutch parts 1, 16 returns to that indicated by the arrow 10. This is because, in the baulked condition, the blocking teeth 23 are in effect locked in position in the steps 14', and the frictional force between the ring 21 and the bearing 21' is not sufficient to move the baulking teeth 12 out of their baulking positions. Consequently, in order to get the clutch eventually into the undirectionally free or ratcheting condition (not shown) in which the pawls 9 are in ratcheting relationship with the with the ratchet teeth 18, the control fork 24 has to be shifted repeatedly between its baulked position as shown in Figure 2 and its bi-directionally free position as shown in Figure 1 until the rotational sense is correct for the clutch to pass through to the ratcheting condition, i.e. until the relative rotation of the clutch parts 1, 16 is as indicated by the arrow 10.

This shifting backwards and forwards of the control fork 24 has previously involved constant manual operation of an electro-hydraulic control unit used to move the control fork 24. In the case of the present invention, however, this movement of the control fork 24 is effected automatically by means of an electro-hydraulic control unit 25.

The electro-hydraulic unit 25 comprises a movable cylinder 26 within which there is mounted a stationary piston 27, the movable cylinder 26 being mounted within a casing 28. The stationary piston 27 is carried by an hydraulic conduit 30 which extends through the casing 28 and which has apertures 31 to enable the interior of the hydraulic conduit 30 to communicate with the interior of the movable cylinder 26 on opposite sides of the stationary piston 27. Opposite ends of the hydraulic conduit 30 are respectively connected by pipes 32, 33 to an hydraulic pressure source 29, the flow through the pipes 32, 33 being controlled by a double acting solenoid valve 34. The solenoid valve 34, when de-energised as shown in Figure 1, is urged by a spring 35 towards a position in which a pressure oil feed from the source 29 is connected to the pipe 32, while the pipe 33 is connected to exhaust. In the Figure 1 position of the parts, therefore, the movable cylinder 26 is forced towards its left-most position. When, however, the solenoid valve 34 is energised, it is moved towards the right against the action of the spring 35 and into a position (not shown) in which the pressure oil feed and the exhaust are respectively connected to the pipes 33, 32 so as to urge the movable cylinder 26 towards its right-most position.

The movable cylinder 26 is mounted in part within a thrust shoe 36 having flanges 37, 38. A pre-compressed spring 40 is interposed between the movable cylinder 26 and the flange 38.

The movable cylinder 26 has a cam 41 which engages a plunger 42 carried by the flange 38. The plunger 42 is selectively engageable with spaced plungers 43, 44 carried by a lever 45 of a single pole trip switch 46 having an over-centre operation, the plungers 43, 44 being slidably mounted in apertures in the casing 28 so as to extend therethrough. The trip switch 46 is connected in an electrical circuit 47 in which there is connected the solenoid valve 34, a selector switch 50, and an electrical power source (not shown).

When the clutch is in the bi-directionally free or pawl free condition shown in Figure 1, the selector switch 50 will be kept in its open position shown in Figure 1. In this position, the solenoid valve 34 will be de-energised, the spring 35 will push the solenoid valve 34 towards the left, the movable cylinder 26 will be hydraulically forced towards the left so as to engage the flange 37 of the thrust shoe 36, and the latter will force the control fork 24 against the flange 11 of the intermediate member 4 so as to urge the intermediate member 4 towards the left. The hydraulic pressure will thus maintain the clutch in the bi-directionally free or pawl free condition.

If, with the parts of the clutch in the pawl free condition shown in Figure 1 the selector switch 50 is closed, the solenoid valve 34 will be energised and will move to the right against the action of the spring 35. This will cause the pressure oil feed and the exhaust to be respectively connected to the pipes 33, 32 and the movable cylinder 26 will therefore be forced towards the right. A rightwards force will therefore be imparted to the thrust shoe 36 by way of the spring 40, although at this stage, as resistance to sliding within the clutch is low, the thrust force is insufficient to exceed the pre-compression in the spring 40 so that no differential movement takes place between the movable cylinder 26 and the thrust shoe 36. The control fork 24, however, will be moved into contact with the flange 11*a* and the clutch will therefore be urged towards the ratcheting condition. Accordingly, if the relative rotation of the clutch parts 1, 16 is in the correct sense i.e. in the direction indicated by the arrow 10, the clutch will assume the ratcheting condition without further relative movement of the parts of the unit 25. Thus the trip switch 46 will remain closed.

However, if the rotation of the clutch input part 1 is in the direction of the arrow 10 relative to the clutch output part 16, the intermediate member 4 cannot be moved to the right since it will be maintained in the baulked condition by the engagement between the baulking teeth 12 and the blocking teeth 23. The hydraulic force acting on the movable cylinder 26 will thus force the latter to exceed the pre-compression of the spring 40 and differential movement will take place between the movable cylinder 26 and the thrust shoe 36 so as to cause the movable

cylinder 26 to engage the flange 38 of the thrust shoe 36. This will cause the cam 41 on the movable cylinder 26 to vertically displace the plunger 42 carried by the thrust shoe 36. This in turn will vertically displace the plunger 44 so as to open the trip switch 46. The solenoid valve 34 will therefore be deenergised and will be moved towards the left by the spring 35.

At this particular moment the parts both of the clutch and of the unit 25 will be in the positions shown in Figure 2. As a result, the pressure oil feed and exhaust will be respectively in communication with the pipes 32, 33 and the movable cylinder 26 will be moved to the left. This will first cause the spring 40 to extend and will then bring the movable cylinder 26 into contact with the flange 37, whereby to urge the intermediate member 4 towards the left, so that the clutch will return to the bi-directionally free condition.

However, the trip switch 46 will remain "tripped" when the cam 41 is withdrawn drom the plunger 42 and will not be re-set until the movable cylinder 26 and the thrust shoe 36 have moved relatively to each other so that they are in the positions which they adopt in the bi-directionally free condition. When in this condition, however, the plunger 42 will be moved into contact with and will raise the plunger 43 so as to reset the trip switch 46. This will cause the solenoid valve 34 to be energised again, and the movable cylinder 26 to be moved towards the right with the consequences indicated above.

So long as the switch 50 is closed, the unit 25 will thus sequentially move the thrust shoe 36 leftwards and rightwards over and over again as long as the clutch input part 1 continues to rotate in the direction of the arrow 10 relative to the clutch output part 16.

Once, however,the relative rotation of the clutch parts 1, 16 is in the opposite sense, the clutch will move beyond the baulked condition to the ratcheting condition.

The unit 25 is shown in the drawings as a stationary unit which is separate from the clutch proper. However, the unit 25 may be incorporated in the clutch to rotate therewith if desired. The unit 25 has also been described as an hydraulic unit, but it could of course be pneumatic, electrical or mechanical.

CLAIMS

1. A pawl and ratchet mechanism which may be operated in both a ratcheting and a pawl free condition in which the pawl and ratchet components of the mechanism are respectively in and out of engagement with each other, the mechanism having a movable baulking member which when in a baulking position prevents relative movement of the said components into the ratcheting condition, the baulking member being maintained in said baulking position when the relative rotation of the said components is inappropriate to permit the mechanism to be operated in the ratcheting condition, and movement imparting means for moving the baulking member out of the baulking position when the said relative rotation is appropriate, characterised in that the movement imparting means comprises thrust generation means; thrust switching means settable in first and second conditions; a first thrust member arranged to be moved by the thrust generation means in mutually opposite directions in dependence upon the setting of the thrust switching means; a second thrust member which is movable by the first thrust member in a predetermined direction by way of resilient means which permit differential movement between the first and second thrust members, the second thrust member also being movable by the first thrust member in the direction opposite to the said predetermined direction, the second thrust member being in thrust imparting relationship with the baulking member; and adjustment means which adjust the setting of the thrust switching means when such differential movement occurs.

2. A mechanism as claimed in claim 1 in which the first thrust member is directly engageable with the second thrust member in each of the said opposite directions.

3. A mechanism as claimed in claim 1 or 2 in which the adjustment means comprises a trip switch which is tripped whenever the said differential movement occurs.

4. A mechanism as claimed in claim 3 in which one of the thrust members has a cam which adjusts the position of a part carried by the other thrust member whenever differential movement occurs between the thrust members in either of the said opposite directions, the said part being engageable with at least one portion of the trip switch to adjust the latter.

5. A mechanism as claimed in claim 4 in which the said part is alternately engageable with spaced portions of the trip switch.

6. A mechanism as claimed in any of claims 3-5 in which the thrust switching means is a solenoid valve connected in an electrical circuit which includes the said trip switch, the electrical circuit having a selector switch therein.

7. A mechanism as claimed in any preceding claim in which the first thrust member is a movable cylinder of a piston and cylinder unit, the thrust switching means controlling fluid flow to and from the piston and cylinder unit.

8. A mechanism as claimed in any preceding claim in which the second thrust member has a control part which is disposed in a recess which is defined between spaced apart flanges on the baulking member, the control part being alternately movable into contact with each of said flanges.

9. A synchronous self-shifting toothed clutch of the type comprising a first toothed rotary clutch part, a second toothed rotary clutch part, an intermediate member constrained for helical movement relative to said second clutch part to bring the coacting clutch teeth into at least initial interengagement, and a pawl and ratchet mechanism effective upon passage of the clutch parts through synchronism in one direction of relative rotation to shift the intermediate member into at least initial interengagement of its clutch teeth with the clutch teeth of said first clutch part, wherein the pawl and ratchet mechanism is in

accordance with any of claims 1 to 8, the components of the pawl and ratchet mechanism being carried by the first clutch member and the intemediate member respectively.

10. A synchronous self-shifting toothed clutch substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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