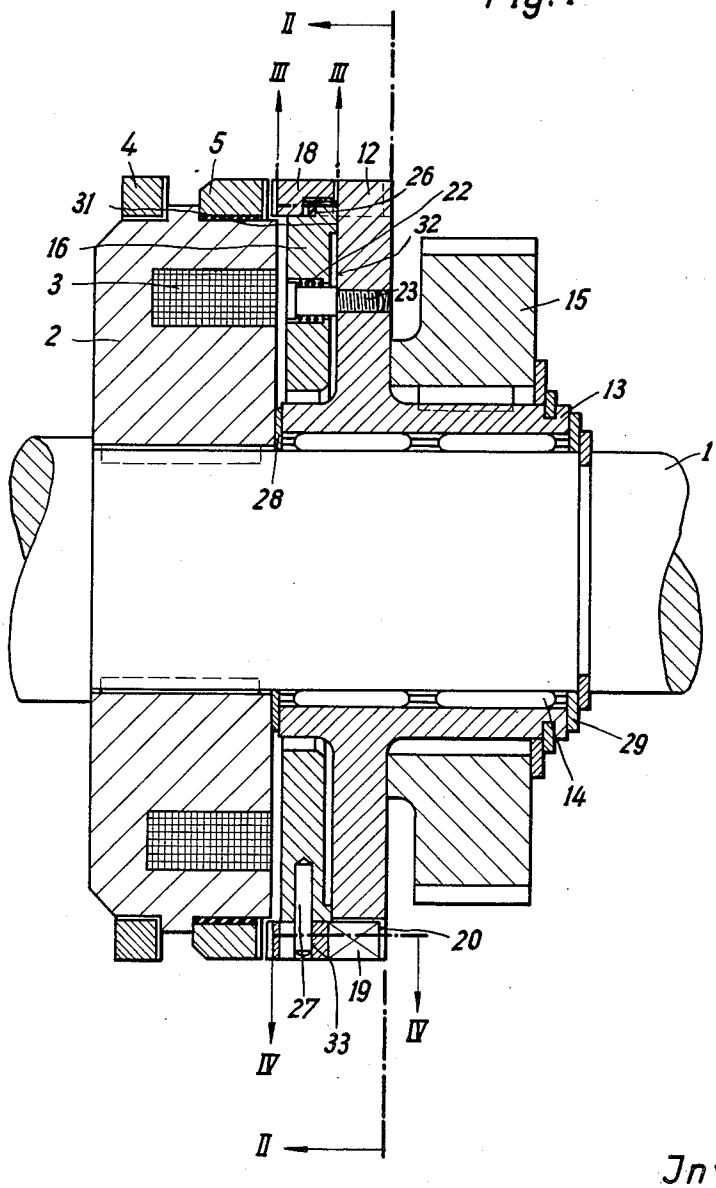
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ELECTROMAGNETIC CLUTCH

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Fig. 1



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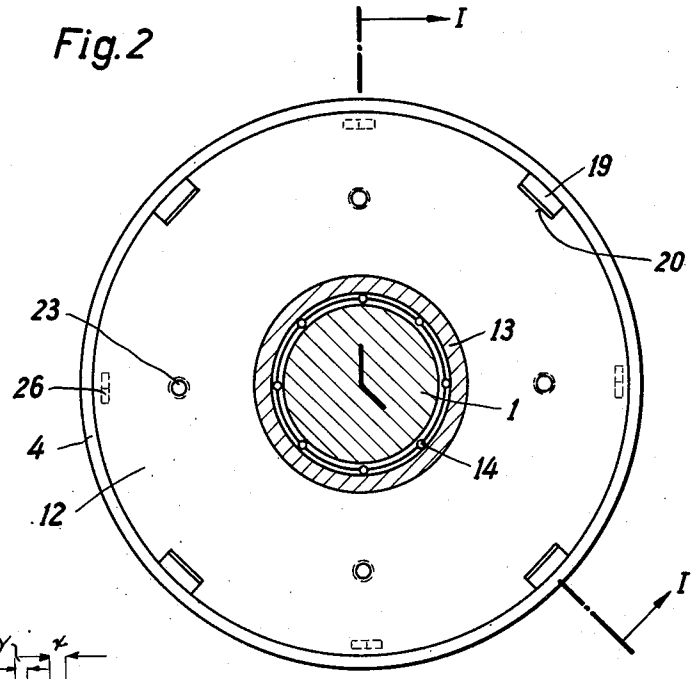
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ELECTROMAGNETIC CLUTCH

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Fig.2



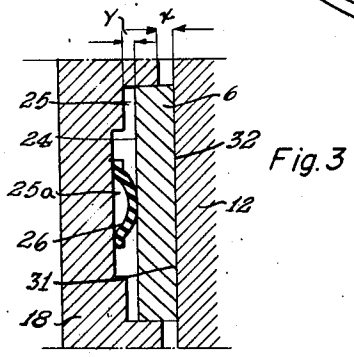


Fig.3

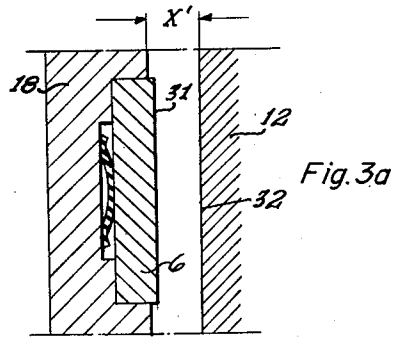
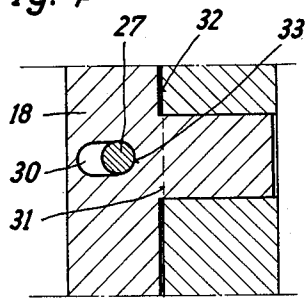


Fig.3a

Fig.4



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ELECTROMAGNETIC CLUTCH

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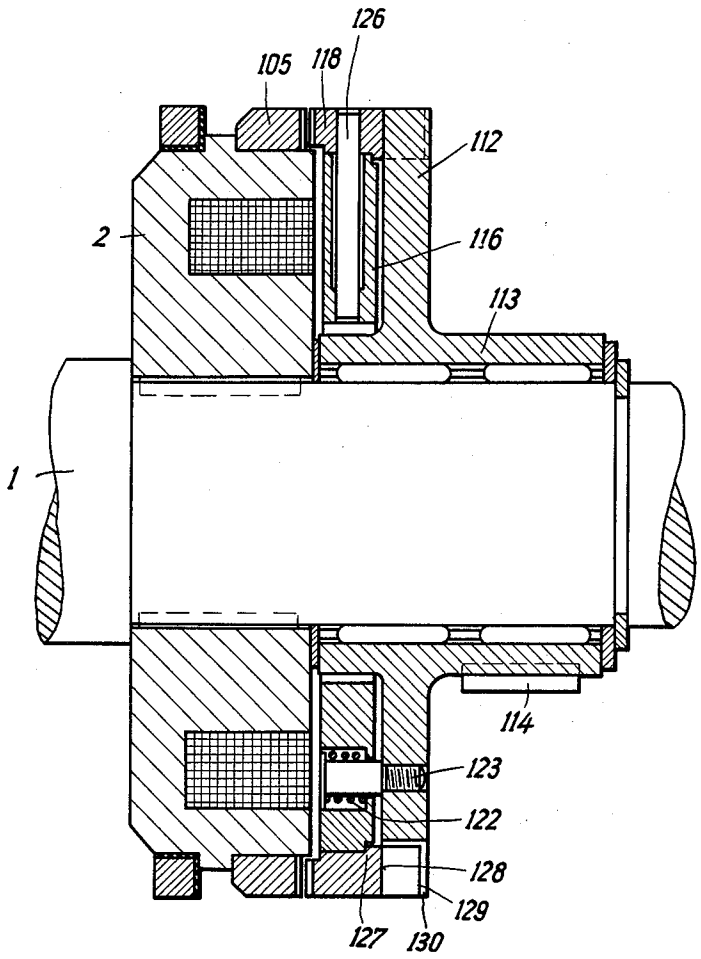


Fig. 5

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ELECTROMAGNETIC CLUTCH

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9 Claims. (Cl. 192—84)

This invention relates to electromagnetic clutches and more particularly to clutches having positively engaging tooth rings.

In prior art clutches, as in the present clutch of the electromagnetic type, a resilient element such as a spring, or a plurality of springs, is inserted between the armature and the magnet body for separating the armature from the magnet body when the current is cut off. It is usually desirable to have quick separation of the armature upon deenergization. In order to effect this, it has been found necessary to use fairly strong springs which bias the armature away from the magnet body. Obviously, the magnet must, therefore, be large enough and be fed enough current to overcome the bias of the springs and to stress the springs in pulling the armature toward the magnet body. In this known arrangement of the spring elements the axial coupling force acting between the clutch elements is diminished by the magnetic force necessary to compress the spring elements. Accordingly, size of the magnet body and the currents required are large and this is an obvious disadvantage.

It is the primary object of the present invention to provide a clutch construction of the general type described wherein, however, quick release of the armature is effected by a strong spring means without requiring the solenoid of the magnet to exert a strong initial pull on the armature to initially stress such spring means.

Another object of the invention is to provide as electromagnetic clutch which will give very rapid separation of armature and magnet body upon deenergization of the solenoid.

A further object of the invention is to provide a clutch having the above features but which will be relatively small, compact, and easily manufactured.

Other objects and features of the invention will be apparent from the description to follow.

Briefly, my invention contemplates providing a solenoid magnet body keyed to a power shaft in the usual manner and carrying one ring of a tooth ring positive drive clutch. The other ring, engageable with the first-mentioned ring, is carried by a torodial armature on the periphery thereof, being itself torodial so that it forms a circumferential ring of the armature. This second-mentioned ring is connected to the armature is such a way as to have a certain amount of predetermined axial motion with respect thereto. The armature itself is carried by a flange integral with a collar having rotative bearing support on the shaft, and to which collar a power gear takeoff is keyed. The armature is connected to the flange is such a manner as to have axial play to a predetermined degree with respect thereto. Both axial play arrangements are effected with spring bias so that the armature is biased away from the solenoid magnet by the spring bias of one set of springs intermediate the armature and the flange and another set of springs intermediate the armature and the tooth ring carried by the armature. The latter set of springs is stronger than the former. Thus, when the armature is attracted upon energization of the solenoid, the pull overcomes the weaker set of springs and the armature can thus be initially pulled with little difficulty toward the magnet. However, on approaching the magnet as the tooth rings start to engage, the stronger springs, intermediate the armature and its tooth ring, are stressed. This occurs at a time when the armature is close to the magnet body and, accordingly the pull of the flux considerably increased. The final movement of the armature effects full engagement of the two tooth rings and during such engagement the stronger springs become full stressed. The armature is then in fully engaged position where it either rests against the magnet body or is extremely close thereto, or, in any event, is in position to have maximum flux exerted thereon to maintain engagement of the tooth rings. When, however, the solenoid is deenergized, the strong springs intermediate the armature and the tooth ring carried thereby exert their bias on the armature to effect a very quick withdrawal thereof from the magnet body. This immediately weakness the magnetic flux between the magnet body and the armature and when the armature has withdrawn to a certain amount, the weaker set of springs intermediate the armature and the flange which carries the armature then exerts its force to pull the armature back into final disengaged position. At that time, of course, the tooth rings are fully disengaged and safely separated to prevent any possible further torque transmission.

A detailed description of the invention will now be given in conjunction with the appended drawing in which:

FIG. 1 is a longitudinal section through a clutch along the line I—I of FIG. 2.

FIG. 2 is a radial section through II—II of FIG. 1.

FIG. 3 is a section through III—III of FIG.1, showing certain clutch elements when the clutch is disengaged.

FIG. 3*a* is a view similar to FIG. 3 showing the same elements when the clutch is engaged.

FIG. 4 is a section taken through IV—IV of FIG. 1.

FIG. 5 is a longitudinal cross section showing a modification of the invention.

Referring now to FIG. 1, illustrating a longitudinal cross section of the clutch in disengaged position, there is shown a power shaft **1** carrying a magnet body **2** with a solenoid **3** keyed to the shaft, there being a collar ring of conventional construction carried on the magnet body. Also carried on and suitably keyed, so as to be integral with the magnet body and rotative therewith, is a tooth ring of generally conventional construction, **5**. The tooth ring **5** is engageable with a tooth ring **18** carried on peripherally or toroidally shaped armature **16**, which armature is carried by a flange **12** integral with a sleeve or collar **13** rotatively mounted as by needle beaings **14** on shaft **1**. The sleeve **13** carries a power gear **15** suitably keyed thereto.

The tooth ring **18** has axial play on the periphery of the armature within the limits of slot (FIG. 4) **30** cut through the ring, the ends of the slot forming suitable limit abutments for a pin **27** integrally carried by and radially extending from the armature, as best seen on FIG. 1. Thus, it will be understood that a plurality of angularly spaced arrangements comprising slots **30** and pins **27** may be provided, the single pin and slot of FIG. 1 being merely exemplary thereof. The tooth ring **18** is keyed to flange **12** by a plurality of extending dogs **19**, one of which is shown in FIG. 1, which dogs pass slidably within respective slots **20** cut into the periphery of flange **12**. See FIG. 4 for the relationship of the dogs **19**, radial slots **20**, and pins **27** and slots **30**. Accordingly, it will be apparent that armature **16** may reciprocate with respect to flange **12** within limits provided by slots **30**, and the distance between the teeth of rings **5** and **18**, for limiting forward motion, that is, motion toward the solenoid body **2**. Intermediate the armature and the flange **12** are a series of springs **22** carried on respective bolts **23**, one example of which is

shown on FIG. 1. Thus, the springs, being compression springs, are stressed between the bolt heads and re-entrant lips of the bores in the armature which peripherally surrounds the bolt shank, as shown. The effect of the springs **22** is to bias the armature toward the flange **12** to the limiting extent effected by radial ears or lugs 6 (FIG. 3) provided on the armature and which ears have surfaces **31** engageable with the surface **32** of flange **12** when the clutch is fully disengaged, and to thus maintain an initial predetermined air gap between the armature and magnet, when the magnet is not energized. Thus, the coaction provides a plurality of recesses for respective ears **6**, which recesses are cut into tooth ring **18** and wherein there is retained in each recess a bowed leaf spring **26**, as seen in FIG. 3. It will be understood from the construction that relative longitudinal movement of the armature toward the tooth ring **18** will cause the surface **24** of the respective lugs to compress the respective springs **26** so as to decrease or flatten them into respective sub-recesses **25***a*. Compare FIG. 3 for the clutch disengaged position with FIG. 3*a* for the clutch engaged position. In other words, for the clutch disengaged position, the space X, indicated by arrows, is the initial spacing between the tooth ring **18** and flange **12**, while space Y is the spacing between the armature and the tooth ring. However, with attraction of the armature space Y disappears and space X expands to the distance X′ as shown in FIG. 3*a*, the springs **26** then being fully stressed for all practical purposes.

It will be noted that flange **12**, being integral with sleeve **13**, is maintained axially fixed on shaft **1** via a retaining ring **29** at one side of the sleeve and a spacer ring **28** abutting magnet body **2** at the other side of the sleeve. Accordingly, the only elements moving with respect to the shaft are the armature **16** and the tooth ring **18** carried thereby, except, of course, for the individual compression and decompression of the two sets of springs **22** and **26**. It will be further noted, as hereinabove described, that the leftward movement of the armature can proceed up to the point where it engages the magnet body, whlie a movement to the right is limited by engagement with pins **27** with respective slot ends **33**. The tooth ring **18** is limited in leftward movement by engagement with tooth ring **5** and is limited in movement to the right by engagement of surface **31** with surface **32** (FIG. 4).

In operation, assuming the elements to be in the position shown in FIG. 1, that is, disengaged, if the solenoid **3** be energized, the armature is pulled thereto, thus compressing the set of springs **22**. The set of springs **22** is weaker than the set of springs **26**. Accordingly, there is no compression of springs **26** at this time and, therefore, no necessity for a strong flux to start the armature on its initial movement toward the magnet body. However, as the armature approaches the magnet body, the flux consequently increases considerably and, at this time, the teeth of the tooth rings commence to engage, and upon such engagement, forming a limit stop for ring **18** in movement toward the left, springs **26** begin to be flattened out, since the armature is still moving toward the magnet body, although now with considerably increased force due to its proximity thereto. Such increased force, of course, readily effects compression of the stronger springs **26** along with continued compression of the weaker springs **22**. The clutch is now fully engaged, the drive being through the two tooth rings from the magnet body to the gear **15**, or vice versa, depending upon mode of use. Now, should the solenoid be deenergized, the strong springs **26** immediately commence to bow, thus pushing the armature away from the magnet body very rapidly and breaking the strong flux pull of residual magnetism on the armature. The armature, thus, in moving toward the right as viewed on FIG. 1, very quickly reaches a point in the flux field where the weaker springs **22** become effective to conduct the armature back to the fully disengaged position. During the course of return movement of the armature, as the tooth rings disengage, the net effect of the combination of springs is to achieve an extremely rapid disengagement of the tooth rings, very important in certain types of controls.

It will, of course, be appreciated that a somewhat different leaf spring arrangement could be used, for example, the springs could be interposed between the tooth ring **5** and the magnet body **2**. The mode of operation, in such case, would still be fundamentally the same as hereinabove described. Further, the principles taught herein may also be used with multiple disk clutches wherein respective additional sets of strong leaf springs could be interposed between an outside disk and the abutting clutch body. It will also be appreciated that an arrangement could be used wherein the magnet body **2** is divided radially into two pieces with springs similar to **26** therebetween. In such case, that portion of the magnet body adjacent the armature would still carry the ring **5**.

FIG. 5 shows an arrangement wherein a different type of spring is used in place of the leaf springs **26**. Thus, in FIG. 5, a shaft **1** carries the magnet body **2** and the sleeve **113**, having a key **114** for connection to a power gear (not shown) and which sleeve has a flange **112** which carries the armature **116** via dogs such as **129** in respective peripheral slots such as **130**. The axial movement of the tooth ring **118** is limited by abutment of surface **128** with the flange, as indicated in FIG. 5. Tooth ring **118** is carried by the armature as in the previous modification and movement of the armature in the right-hand direction with respect to the tooth ring is limited by the shoulder **127** machined into the ring. Movement of the armature toward the left is limited by the solenoid body and, of course, movement of ring **118** toward the left is limited by the coupling ring **105**. The armature is biased rearwardly in a manner similar to that hereinabove described by springs, such as the spring **122**, carried by bolts, such as the bolt **123**. However, instead of using leaf springs, such as leaf springs **26**, as hereinbefore described, a series of angularly spaced, radially aligned flexible pins, such as the pin **126**, are used. Thus the pins **126**, which may be of suitable spring steel or the like, are carried within bores in the armature, their inner ends being suitably secured in the bottom of the respective bores and their outer ends being suitably secured in respective bores provided in tooth ring **118**. Accordingly, in view of the fact that the ends of the pins are in closely confining bores, but that the long intermediate portions of the pins are within over-sized bores, as shown, the pins are capable of bending, at least in the plane of the paper. Thus, when ring **118** engages ring **105**, but armature **116** continues its motion toward the solenoid, a certain amount of bending or flexing of pins **126** takes place, thus affording a powerful reverse motion greater than that afforded by the springs **122**. Accordingly, the springs, being in bent condition when the clutch is energized, but straightened out when the clutch is de-energized, serve to effect immediate return movement of the armature out of the strong flux field upon such de-energization, all as hereinabove described in detail in connection with the functioning of the leaf springs **26**.

Having thus described my invention, I am aware that various changes may be made without departing from the spirit thereof, and accordingly, I do not seek to be limited to the precise illustration herein given except as set forth in the appended claims.

I claim:

1. In a device of the class described, a shaft, an electromagnet mounted on said shaft, a collar having a radial flange mounted on said shaft, an armature carried by said flange and disposed with an initial air gap with respect to said electro-magnet when said electro-magnet is deenergized, a first resilient means for biasing said armature toward said flange, a tooth ring carried by said electro-

magnet, a tooth ring carried by said armature, a second resilient means intermediate said latter tooth ring and said armature, wherein said armature has relative longitudinal motion with respect to said latter tooth ring, said tooth rings being engageable when said armature is attracted to said electro-magnet upon energization thereof, said first resilient means being stressed upon initial motion of said armature toward said electro-magnet, said second resilient means being subsequently stressed upon engagement of said tooth rings when the air gap between said armature and said electro-magnet is substantially less than said initial air gap, said second resilient means having a high resistance to stressing so as to effect an initial rapid reverse movement of said armature in withdrawing from said electro-magnet upon de-energization thereof, said first resilient means effecting final reverse movement of said armature to the position of said initial air gap, said first resilient means having less resistance to stressing than said second resilient mean.

2. In a device of the class described, an electro-magnet, an armature and means whereby said armature is disposed with an initial air gap with respect to said electro-magnet when said electro-magnet is de-energized, a first resilient means for biasing said armature away from said electro-magnet, a toothed clutch element carried by said electro-magnet, a coacting toothed clutch element carried by said armature, a second resilient means intermediate said latter clutch element and said armature, wherein said armature has relative longitudinal motion with respect to said latter clutch element, said clutch elements being engageable when said armature is attracted to said electro-magnet upon energization thereof, said first resilient means being stressed upon initial motion of said armature toward said electro-magnet, said second resilient means being subsequently stressed upon engagement of said clutch elements when the air gap between said armature and said electro-magnet is substantially less than said initial air gap, said second resilient means having a high resistance to stressing so as to effect an initial rapid reverse movement of said armature in withdrawing from said electro-magnet upon de-energization thereof, said first resilient means being operative to effect continued reverse movement of said armature back to the position of said initial air gap, said first resilient means having less resistance to stressing than said second resilient means, said second resilient means being carried by said armature and comprising leaf spring means abutting the clutch element carried by said armature.

3. In a device of the class described as set forth in claim 1, said second-mentioned resilient means comprising a plurality of leaf springs having a normally bowed, unstressed condition, recesses in said second-mentioned tooth ring for accommodating respective leaf springs, said armature having respective ears movable in said recesses for compressing respective leaf springs as said armature moves toward said magnet body subsequent to engagement of said tooth rings.

4. In a device of the class described, a shaft, an energizable magnet body and a support means carried on said shaft, an armature carried on said support means and being movable toward said magnet body, and means whereby said armature has a predetermined initial spacing from said magnet body when said magnet body is de-energized, a tooth ring carried by said armature, a tooth ring carried by said magnet body, said tooth rings being engageable with each other, a first resilient means between the tooth ring carried by said armature and said armature, a second resilient means between said armature and said support means, said first resilient means being

stiffer than said second resilient means, whereby energization of said magnet stresses said second resilient means before said first resilient means until engagement of said tooth rings occurs, which engagement is operative to effect stressing of said first resilient means at a time when said armature is closer to said magnet body than said initial spacing and wherein de-energization effects an initial unstressing of said first resilient means to rapidly thrust said armature away from said magnet.

5. In a device as set forth in claim 4, said first resilient means comprising flexible pins radially disposed and extending from said armature to said tooth ring carried thereby.

6. In a clutch of the class described, an energizable magnet, an armature mounted for movement towards and away from said magnet upon energization and de-energazation thereof, respectively; a clutch means having elements respectively engageable or disengageable by movement of said armature towards or away from said magnet, a first resiliently yieldable means disposed to bias said armature away from said magnet at an initial air gap with respect thereto, a second resiliently yieldable means disposed to bias said armature away from said clutch means, said second resilently yieldable means being stronger than said first resiliently yieldable means so that said first resiliently yieldable means is initially stressed upon energization of said magnet to effect engagement of said clutch elements with reduced air gap between said armature and magnet, and wherein said second resiliently yieldable means is subsequently stressed as said armature further approaches said magnet during movement to a limiting position with respect thereto, whereby, upon de-energization of said magnet said second resiliently yieldable means is operative to effect initial rapid separation of said armature away from said magnet and said first resiliently yieldable means effects final separation therebetween.

7. In a clutch as set forth in claim 6 including a shaft, said magnet being mounted on said shaft in fixed position, a flange mounted on said shaft in fixed position, said armature being carried by said flange, said first-mentioned resiliently yieldable means being connected to said flange and said armature and disposed to urge said armature in a direction away from said magnet, one of said clutch elements compirsing a tooth ring carried on said armature and another of said clutch elements comprises a tooth ring carried by said magnet engageable by said first-mentioned tooth ring, said second resiliently yieldable means being carried by said armature and disposed intermediate said armature and said first-mentioned tooth ring.

8. In a clutch as set forth in claim 7, said second-mentioned resiliently yieldable means comprising a plurality of initially bowed leaf springs.

9. In a clutch as set forth in claim 7, said second resiliently yieldable means comprising a plurality of flexible pins extending between said armature and said first-mentioned tooth ring.

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