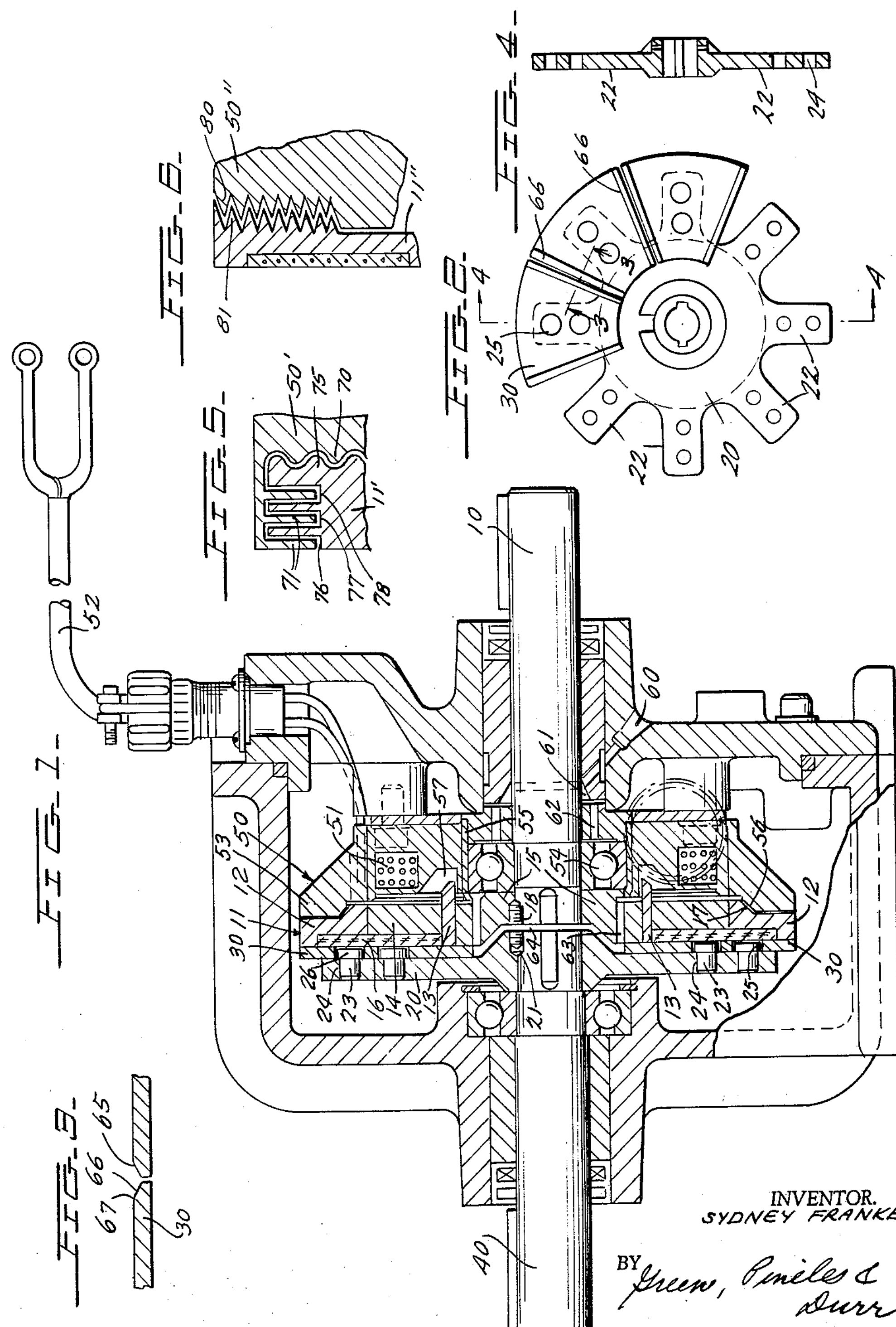
Feb. 27, 1962 S. FRANKEL 3,022,876

MAGNETIC CLUTCH

Filed July 15, 1958



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3,022,876
Patented Feb. 27, 1962

3,022,876
MAGNETIC CLUTCH

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Filed July 15, 1958, Ser. No. 748,660
4 Claims. (Cl. 192—84)

This invention relates to improvements in a magnetic clutch or brake device.

Among the objects of the invention is to provide an improved magnetic clutch.

The type of magnetic clutch to which the invention is related comprises a rotor and an armature which are adjustably held together by a variable magnetic force applied by a stationary magnetic device which surrounds the rotor. At least parts of the rotor and stator are made made of ferromagnetic material so that the attraction between the rotor and armature depends on the magnetic attraction between the two and the latter can be regulated by varying the magnetism of the stationary member. In the conventional type of magnetic clutch, the armature is splined on its shaft so that it can move toward and away from the rotor while still driving its shaft. In such devices there is always a chance that the initial magnetic force applied will be applied unequally or that some other phenomenon will cause the armature to jam so that the desired output force (which is determined by the electrical current in a coil of the stationary magnetic device) is not obtained from the shaft of the armature.

Among other objects of the invention is to provide an improved magnetic clutch of the type described above in which the armature is fixed to its shaft.

Still another object of the invention is to provide a magnetic clutch of the type described with improved sensitivity.

The objects of the invention are attained by fixing the armature of such a clutch to its shaft and interposing one or a series of plates made of ferromagnetic material between the rotor and the armature, said plates being loosely attached to the armature. In such a structure the armature itself may be made of stronger material than usual since at does not have to be of soft ferromagnetic material and it may be made lighter by having those portions cut away which are not necessary for holding the intermediate ferromagnetic plates. The structure already described provides a more sensitive device but the sensitivity may be further improved according to the invention by especially constructing the stationary magnetizing member to fit closely about the rotor.

Various other advantages of the invention will be apparent from the detailed description of the devices below when read in connection with the accompanying drawing in which:

FIG. 1 is a side cross sectional view of the clutch of the invention.

FIG. 2 is a plan view of the armature of the device showing three of the loosely attached plates in place and the others removed.

FIG. 3 is a detail view taken on line 3—3 of FIG. 2.

FIG. 4 is a cross sectional view of the armature without the plates taken on line 4—4 of FIG. 2.

FIG. 5 is a detail view partly cut away of a modified form of magnet-rotor device.

FIG. 6 is a detail view similar to FIG. 5 but showing another modified form of the device.

In the device of FIG. 1, the shaft 10 is the drive shaft and is operated at a desired uniform controlled speed. If shaft 10 rotates at a greater annular speed than shaft 40, the device acts as a clutch whereas if shaft 10 rotates at a lower rate of angular speed than shaft 40 the device is acting as a brake. Fixed to the inner end of shaft

10 is the rotor 11. At least portions of this rotor 11 are made of "soft" ferromagnetic material or in other words, a ferromagnetic material which has high permeability and low retentivity. In the rotor shown the outer ring portion 12 and an inner ring portion 13 are made of the soft ferromagnetic iron, for example, and between the rings 12 and 13 is a non-magnetic metal portion 14. The central portion 15 is also formed of a relatively non-magnetic metal. On the outer face of the rotor 11 a liner layer 16 of oil resistant, relatively compressible material such as the cork is secured. The rotor 11 is attached to shaft 10 by set screw 18, for example.

The armature is made up of a supporting wheel 20 and one or a series of plates 30 mounted thereon. The wheel 20 is secured to shaft 40 by means of a similar set screw 21. This supporting wheel 20 may be made of a skeleton or star shape as shown in FIG. 2. In the wheel shown in FIG. 2, there are eight projections 22 for carrying eight ferromagnetic plates 30 but it is obvious that as few as one single plate or as many plates as desired can be employed without departing from the spirit of the invention. The plates 30 are made of soft ferromagnetic material and are held in position between the face of driving rotor 10 and the driven rotor or wheel 20 by a plurality (two shown for each plate) of studs 23 which fit into apertures 24 of wheel 20 and apertures 25 of plates 30. If desired, a larger plate may be attached to two or more of the projections 22. The studs 23 comprise two portions, a body portion and a head portion 26 with a shoulder therebetween and the diameters of these head and body portions are such that one portion of the stud fits tightly in the aperature 24 or 25 whereas the other portion fits loosely in the opposing aperture. In the form shown the body portion of stud 23 fits tightly in the aperture 24 of the supporting wheel 20 while the head 26 fits loosely in aperture 25 of plates 30 but the same effect can be obtained by reversing the fit of the studs. Thus the plates 30 could be easily removed from the wheel 20 by a pull parallel to the axis of said wheel; when the apparatus is assembled, however, the sectors 30 are held against accidental removal from wheel 20 by the proximity of rotor 11. The amount of play allowed between the head 26 and the aperture 25 does not need to be large; a few hundredths of an inch is sufficient.

The magnetizing means 50 is stationary and comprises an internal coil 51 suitably connected to a two wire line 52 for a source of direct-current electrical energy, and is surrounded by a soft ferromagnetic material 53. Between the ferromagnetic material 53 and the ball bearing race way 54, a non-ferromagnetic sleeve 55 is positioned. Sleeve 55 may be made of bronze, for example. The beveled portions 17 of the rotor 11 and 56 of the magnetizing means 50 fit rather closely together (see FIGURE 1). The ring 13 extends to the rear of rotor 11 and into the slot 57 formed in iron member 53. Thus, the magnetic circuit extends from the outside portion of 53 to the outer ring 12 of rotor 11, to the outer edge of plates 30, along said plates to the inner edge thereof, thence to inner ring 13 of rotor 11 and back across the narrow air gap to the inner portion of 53.

The contacting faces of rotor 11 and armature plates 30 are cooled by circulating oil in a manner similar to that disclosed in my copending application Serial Number 468,692 filed November 15, 1954, now U.S. Patent No. 2,884,107. In the device of this invention oil is supplied under pressure through opening 60, the oil passes through openings 61 and 62 through roller bearings 54 and through a plurality of openings 63 to the space 64 between the rotor 11 and armature 20. From the space 64 the oil passes by centrifugal force through the grooves 65 formed by each two adjacent bevels 66 of plates 30.

The upper edges of the bevels 66 are rounded as shown at 67. With the rounded edges 67 provide an unusual effect in that any slippage between plates 30 and the rotor 11 will cause oil to be drawn in between the contacting surfaces of the same. Since there is substantially always slippage between the rotor and armature in a magnetic clutch of this type, a continuous film of oil is fed between the contacting surfaces thereof. The film of oil is continuously discharged at the outer edge of the contacting surfaces by centrifugal force so that there is a continuous change of cooling film of oil which passes over substantially the entire areas of the contacting surfaces. When the slippage increases, the tendency is to draw more of the oil between the contacting surfaces.

In some devices of this type, it has been common to refer to the plates as moving toward and away from each other depending on the magnetic force applied and it has been stated that the amount of force applied to the armature depends on the amount of slippage. With the oil cooled contacting surfaces of the present invention there is no substantial movement of the plates back and forth and the force applied to the armature is not increased to any great extent when the slippage increases. In the device of this invention the amount of force applied to the armature 20 depends primarily on the amount of magnetic attraction between the rotor 11 and plates 30.

Since the attraction between the plates 30 of the armature and the rotor 11 depends primarily on the magnetization thereof it is important that the stationary magnetizing ring 50 approach as closely as possible to the magnetizing ring 12. The effective magnetization of the ring of the rotor can be further increased by increasing the amount of the adjacent areas between the magnetizing device 50 and the rotor 11. FIGS. 5 and 6 show two methods of doing this. In the device of FIG. 5, the stationary magnet 50′ has a plurality of annular undulating hills and valleys 70 on the face thereof adapted to follow very closely the similar hills and valleys 75 on the rotor 11′. Also, the periphery of rotor 11′ contains tangential grooves 76, 77 and 78 in which the fingers 71 of the magnet 50′ fit.

The magnetomotive circuit of the device of the present invention is substantially the same as in the circuits of conventional magnetic clutches; for example, current applied to coil 51 magnetizes the stationary ferromagnetic member 50 which magnetizes rings 12 and 13 by induction thereby providing a magnetic pull on the ferromagnetic sectors 30 which span the gap between rings 12 and 13. This invention differs from the prior art devices in that, in response to the magnetic force, only the sectors 30 move toward rings 12 and 13, these sectors being loosely mounted on the wheel 20 which is fixed to its shaft 40, whereas in conventional clutches of this type the entire disk (corresponding to the spider wheel 20 plus the sectors 30 of this invention) must move axially on a shaft such as 40 to which it is splined.

In the device of FIG. 6, the stationary magnet 50″ contains a plurality of relatively steep or sharp hills and valleys 80 adjacent the periphery thereof which are saw tooth in cross sectional shape and interfit with similar hills and valleys 81 on rotor 11″. Any combination of the matching projections 70—75, 80—81 or 71—77 may be employed to increase the magnetizing effect of the stationary magnet.

The feaures and principles underlying the invention described above in connection with specific exemplifications will suggest to those skilled in the art many other modifications thereof. It is accordingly desired that the appended claims shall not be limited to any specific feature or details thereof.

I claim:

1. In a magnetic clutch of the type having a magnetizable rotor mounted on a first shaft, an armature having a shaft which is separate from but coaxial with the first shaft, and a stationary magnetizing means adapted to control the magnetic attraction between the rotor and the armature, the improvement in which the armature comprises a supporting wheel which is fixedly attached to the armature shaft, an intermediate ring means comprising at least one plate positioned between the supporting wheel and said rotor in close proximity to the latter, and concentric therewith, stud means for loosely mounting said intermediate ring means on said supporting wheel adjacent the periphery of the latter so that said ring means are loosely retained between the supporting wheel and said rotor, the loose mounting of said stud means providing for axial but not for any substantial amount of angular movement of the ring means with respect to the wheel, said ring means being of relatively soft ferromagnetic material whereby the said plate is adapted to be magnetically attracted to said rotor.

2. The device as claimed in claim 1 in which said rotor comprises a front face adjacent said ring means and a rear face adjacent the stationary magnetizing means, said rotor having at least one annular portion of reduced thickness and increased surface area adjacent the periphery thereof connected to the inner portion by means of a shoulder at the rear face of said rotor, said stationary magnetizing means having a face which closely follows the contour of the rear face of said rotor.

3. The device as claimed in claim 1, wherein said ring means comprises a plurality of separate sector plates with contacting edges to form the substantially complete ring, said plates having beveled edges adjacent the contacting sides thereof, the edge of the bevel at the outer surface of said plates being rounded, and conduit means for feeding oil to the inside portion of the contacting zones between the plates and the rotor.

4. The device as claimed in claim 1 in which said rotor comprises a front face adjacent said ring means and a rear face adjacent said stationary magnetizing means, said rotor having a plurality of concentric annular ridges of undulating cross section adjacent the periphery thereof to increase the surface area thereof, said stationary magnetizing means having a face comprising concentric grooves which closely follows the contour of the ridges of the rear face of said rotor.

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