

RETURN STOP FOR A SELF-STARTING SYNCHRONOUS MOTOR

The invention relates to a return stop for a self-starting synchronous motor which is arranged for driving a load in a given direction of rotation via a shaft operatively connected to the motor, the return stop comprising an inert mass which is supported for rotational movement relative to, and about the axis of, said shaft and which is coupled to the shaft by a helical spring which surrounds the shaft and one end of which is connected to the inert mass for movement therewith.

It is well-known that a self-starting synchronous motor can start arbitrarily in either direction of rotation. In some uses of such a motor it is desired that the motor shall rotate in only one particular direction and a return stop is provided to prevent the motor starting in the undesired direction.

In a return stop of the above construction which is known from DE-PS 2 407 079, in addition to being connected at one end to the inert mass, the helical spring is fixedly connected at its other end to the shaft by means of a clamping member. In the operation of this known return stop, if the motor attempts to start in the undesired direction of rotation, due to the inertia of the inert mass and to the fixed connection of the helical spring to the shaft, the spring tightens around the shaft so that the inert mass is immediately firmly coupled to the shaft and imposes thereon a strong resistance to rotation which prevents the motor starting in this direction. When the motor starts in the other, desired direction, again due to the inertia of the inert mass and to the fixed connection of the spring to the shaft, the spring is initially unwound slightly on the shaft so that there is a delay in the coupling of the inert mass to the shaft, with the result that the motor can start in this direction of rotation because it is not immediately impeded by a strong resistance to rotation from the inert mass.

According to the invention there is provided a return stop for a self-starting synchronous motor which is arranged for driving a load in a given direction of rotation via a shaft operatively

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connected to the motor, the return stop comprising an inert mass which is supported for rotational movement relative to, and about the axis of, said shaft and which is coupled to the shaft by a helical spring which surrounds the shaft and one end of which is
5 connected to the inert mass for movement therewith, wherein the helical spring is arranged to act as a slip coupling between the shaft and the inert mass and has only frictional engagement with the shaft such that in one direction of rotation corresponding to said given direction the shaft can slip relative to the spring
10 while in the other direction rotation of the shaft causes the turns of the spring to contract around the shaft and grip the shaft.

In the operation of the return stop according to the invention, if the motor attempts to start in the undesired direction, due to the inertia of the inert mass and to the
15 frictional contact between the spring and the shaft, the turns of the spring contract and grip the shaft so that the inert mass is immediately coupled to the shaft and imposes thereon a resistance to rotation which prevents the motor starting in this direction. When the motor starts in the desired direction, the frictional
20 contact between the spring and the shaft causes the turns of the spring to expand slightly so that the shaft can slip relative to the spring, with the result that there is only a weak resistance to rotation of the shaft from the inert mass and the motor can start rotating. The slip continues until the inert mass is rotating
25 synchronously with the shaft, by which time the spring will have contracted again to its original diameter and will be rotating with the shaft without slipping. However, due to the fact that the spring has only frictional engagement with the shaft, the latter retains its slip capability in the desired direction of rotation, which is advantageous, for example, if the rotation of the inert
30 mass is inadvertently impeded by undesired influences. In such event the turns of the spring would be opened slightly and allow the shaft to slip so that no damage could occur.

AT-PS 221 168 discloses a return stop in which a helical
35 spring has frictional contact with a shaft and is held fixedly at

one end. In the operation of this return stop, if the motor starts in the undesired direction of rotation, the turns of the spring immediately contract around the shaft, as a result of which the frictional contact is so increased that the motor cannot start in this direction of rotation. In the desired direction of rotation, the turns of the spring are opened slightly so that the shaft can slip relative to the spring, which makes it possible for the motor to start in this direction. However, such a return stop has the disadvantage that in the desired direction of rotation of the motor the stationary spring permanently loads the motor

additionally by the constant slipping of the shaft, which is not the case in the return stop of the present invention. The function of a slip coupling in co-operation with an inert mass is not provided in this known return stop either because the helical spring is held fixedly at one end.

An embodiment of the invention will now be described more fully with reference to the accompanying drawings, in which

Fig. 1 is a sectional view of a synchronous motor constructed in accordance with the invention, and

Fig. 2 is a sectional view taken on the line II-II in Fig. 1.

In Fig. 1, reference numeral 1 designates a self-starting synchronous motor which has a U-shaped stator 2 and a cylindrical permanent magnetic rotor 3. The two limbs of the U-shaped stator 2, of which one limb 4 is shown in Fig. 1, each carry an energizing winding 5. The rotor 3 is enclosed between the free ends of the limbs of the stator, and between each limb and the rotor 3 an air gap is formed which extends along an arc over a predetermined angular range, as a result of which two pole pieces co-operating with the rotor are formed. The rotor 3 is fixed on a shaft 6 which drives an external load (not shown) and is journaled in two bearing members 7 and 8 connected to the stator 2. The rotor 3 in the form of a permanent magnet is magnetized diametrically so that it has at its peripheral surface oppositely arranged N and S poles each co-operating with the two pole pieces of the stator 2. This synchronous motor is thus a bipolar self-starting single-phase synchronous motor having a permanent magnetic rotor which is diametrically magnetized. Such motors are frequently used in small domestic appliances, such as, for example, citrus fruit presses, can openers, knife sharpeners and the like. By shaping the air gaps between the pole pieces of the stator 2 and the rotor 3 in a corresponding manner, when the stator 2 is not energized, a predetermined rest position of the rotor 3 is defined, from which position the rotor can start to rotate in either of the two directions of rotation if the load acting upon it is not too large. The direction in which the rotor actually starts to rotate is not defined but depends upon the instantaneous magnetic field conditions. The fact that such a motor may arbitrarily start in either direction is undesirable for various applications for which a given direction of rotation is required, and this is the reason why such motors are provided with a return stop which permits the motor to

start only in a given direction.

Various forms of such return stops are known. The present return stop is one which utilizes varying load conditions during the operation of starting the motor and which comprises an inert mass 9 which is supported for rotational movement relative to, and about the axis of, a shaft 6 operatively connected to the motor, and which is coupled to the shaft by a helical spring 10 which surrounds the shaft and one end 11 of which is connected to the inert mass 9 for movement therewith. In the present embodiment, the shaft 6 with which the return stop co-operates is the actual motor shaft on which the rotor 3 of the motor 1 is fixed. However, the return stop could alternatively co-operate with a shaft which is operatively connected to the motor shaft proper via a gear provided this gear transmits varying load conditions to the motor shaft in a suitable manner. The inert mass 9 in the present embodiment is constituted by a disk mounted on the shaft 6. The disk is capable of movement relative to the shaft 6 in the rotational direction but is secured in position on the shaft in the axial direction by a shoulder 12 on the shaft 6 on one side and by a ring 13 slid onto the shaft 6 on the other side. Of course, the axial position of the inert mass could be effected in other ways. The end 11 of the spring 10 in the present arrangement is secured in a recess 14 in one side of the disk forming the inert mass 9. Of course, there are alternative means of obtaining a fixed connection between the end 11 of the spring 10 and the inert mass 9, such as, for example, a screw connection.

The helical spring 10 has only frictional engagement with the shaft 6; there is no fixed connection between the spring and the shaft. Thus, while the spring 10 is connected to the inert mass 9 at its end 11, at its other end 15 the spring is not connected to the shaft 6 but has only frictional contact with it.

The operation of the return stop described above is as follows. If the rotor 3 of the motor 1 starts to rotate in the direction which is indicated in Fig. 2 by the arrow 16 drawn in broken lines, the shaft 6 exerts through its frictional contact with the helical spring 10 a force on the turns of the spring which, due to the inertia of the inert mass 9, causes the turns to contract around the shaft and grip it so that the inert mass 9 is immediately coupled to the shaft 6 and prevents the rotor 3 rotating in this direction because the resistance to rotation instantaneously imposed by the inert mass 9 is too strong. If,

however, the rotor 3 starts to rotate in the direction indicated in Fig. 2 by the arrow 17 drawn in full lines, the shaft 6 exerts through its frictional contact with the spring 10 a force on the turns of the spring which expands them slightly so that a certain degree of slip occurs between the shaft 6 and the spring 10, with the result that the inert mass 9 is taken around by the spring 10 but with delay relative to the shaft 6. This means that the resistance to rotation to which the rotor 3 is subjected by the inert mass 9 is now weak so that the rotor can rotate in this direction. As soon as the rotor has begun to rotate in this direction, the inert mass 9 gradually accelerates until it rotates synchronously with the shaft 6 and rotor 3. During this process the slip between the shaft 6 and the spring 10 gradually decreases and the turns of the spring 10 again tighten around the shaft 6 until the original degree of frictional contact is restored. There is then no slip between the shaft 6 and the spring 10 and consequently no additional load on the motor.

The required degree of frictional contact between the helical spring 10 and the shaft 6 is determined on the one hand by the power of the motor 1 and on the other hand by the size of the inert mass 9 so that when the motor starts in the desired direction of rotation the inert mass 9 is rotated by the spring but with delay relative to the shaft 6, the size of the inert mass 9 being so chosen that when the mass 9 is immediately coupled to the shaft 6 by the spring 10 in the undesired direction of rotation, the mass 9 prevents the rotor starting by imposing on it a correspondingly strong instantaneous resistance to rotation. Which of the two directions of rotation is the undesired direction and which the desired direction depends upon the direction in which the turns of the helical spring 10 wind around the shaft 6. The direction of rotation which results in the turns of the spring contracting around the shaft corresponds to the direction in which starting of the rotor is to be prevented.

Such a return stop has a very simple construction because the inert mass together with the helical spring can be disposed on the shaft in a simple manner. Due to this simple construction, also a very high operational and functional reliability is obtained.

Further, due to the fact that the spring 10 has only frictional engagement with the shaft 6, such a return stop acts as a slip coupling between the shaft 6 and the inert mass so that on the one hand slip can occur between the shaft 6 and the spring 10 in the desired direction of rotation of the rotor 3, and on the other hand the inert mass 9 can rotate relative to the shaft 6 in the reverse direction. This has the advantage that, when, for example, the rotation of the inert mass 9 with the shaft 6 in the desired direction is impeded by undesired influences during operation of the motor, no damage can occur because the shaft immediately slips relative to the spring 10 and can therefore rotate relative to the inert mass 9. This is due to the fact that from the end 11 of the spring 10 a force is exerted on the spring which expands the turns of the spring so that slip can occur between the shaft and the spring. This is especially advantageous when the inert mass itself constitutes the external load to be driven by the motor, because in such a case it may happen that rotation of the external load is blocked due to sudden overload conditions. For example, if the inert mass consists of the impeller of a fan, any risk of injury or damage occurring if, for example, a person's hand or a solid object inadvertently enters the path of movement of the rotating impeller, is prevented because the impeller can immediately stop while the drive shaft continues rotating.

Modifications of the above embodiment are possible without departing from the scope of the invention as defined in the following claims. A return stop according to the invention may, of course, also be used advantageously in self-starting synchronous motors of a construction different from that described above, such as synchronous motors comprising multiple stators and rotors or other types of stator and rotor.



CLAIMS:

1. A return stop for a self-starting synchronous motor which is arranged for driving a load in a given direction of rotation via a shaft operatively connected to the motor, the return stop
5 comprising an inert mass which is supported for rotational movement relative to, and about the axis of, said shaft and which is coupled to the shaft by a helical spring which surrounds the shaft and one end of which is connected to the inert mass for movement therewith, wherein the helical spring is arranged to act as a slip coupling
10 between the shaft and the inert mass and has only frictional engagement with the shaft such that in one direction of rotation corresponding to said given direction the shaft can slip relative to the spring while in the other direction rotation of the shaft causes the turns of the spring to contract around the shaft and
15 grip the shaft.
 2. A return stop for a self-starting synchronous motor, substantially as herein described with reference to the accompanying drawings.
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