United States Patent

[11] 3,553,400

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[54] **ZERO-LAG ELECTRICAL SWITCHING ELEMENT FOR MOTORS**
10 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **200/80**
[51] **Int. Cl.** **H01h 35/10**
[50] **Field of Search** 200/80, 166.1, 1A, 153.13

[56] **References Cited**
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ABSTRACT: A single-pole double-throw speed responsive switching mechanism for the starting and running circuits of an electrical motor, in which the contact for the starting circuit is maintained in operative engagement with the pole of the switching mechanism during the transfer which establishes the running circuit of the motor. After the running circuit has been established by the switching mechanism, the starting circuit is opened.

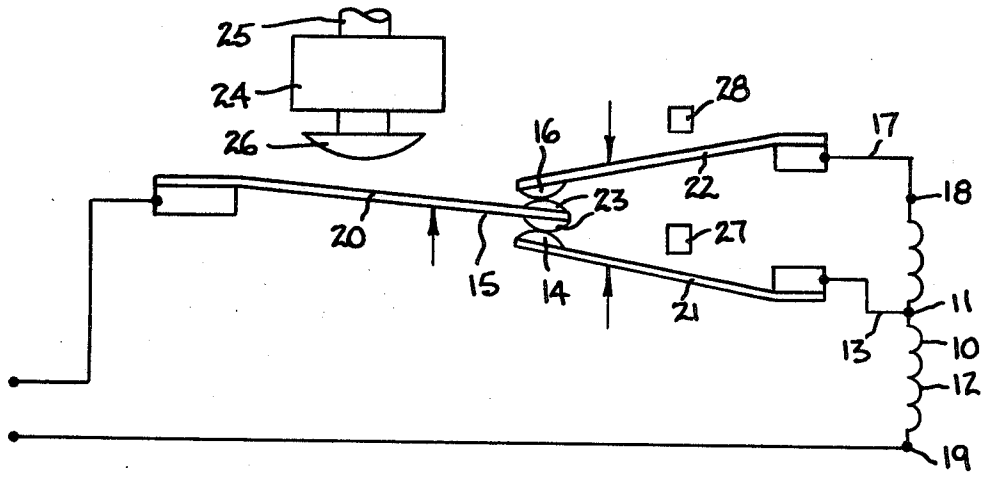


FIG. 1

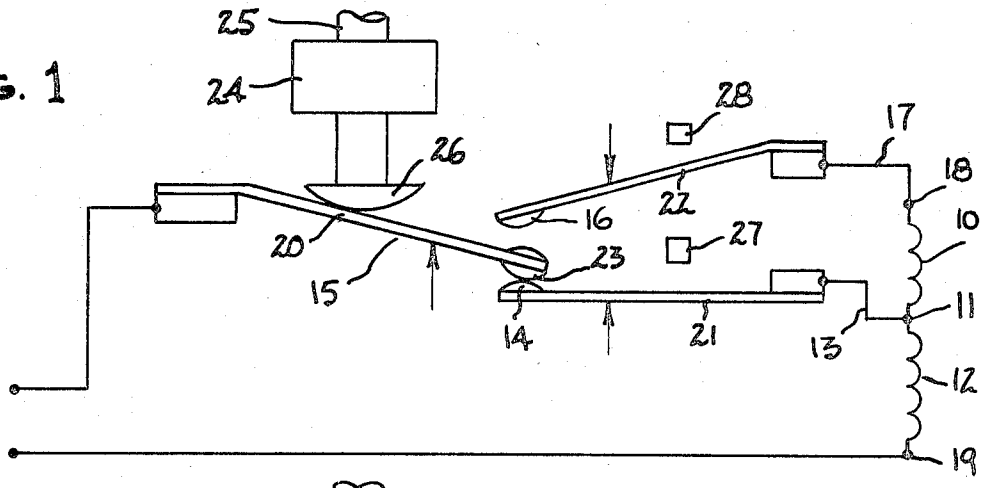


FIG. 2

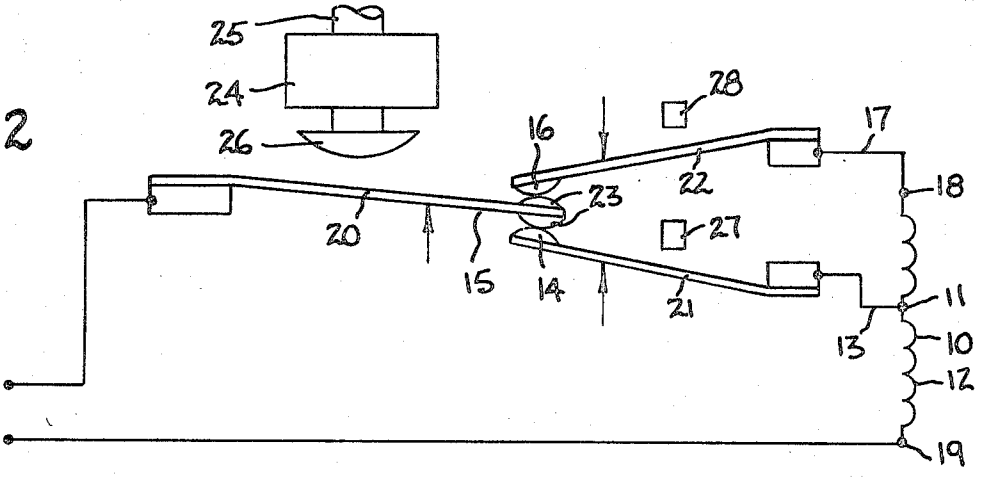
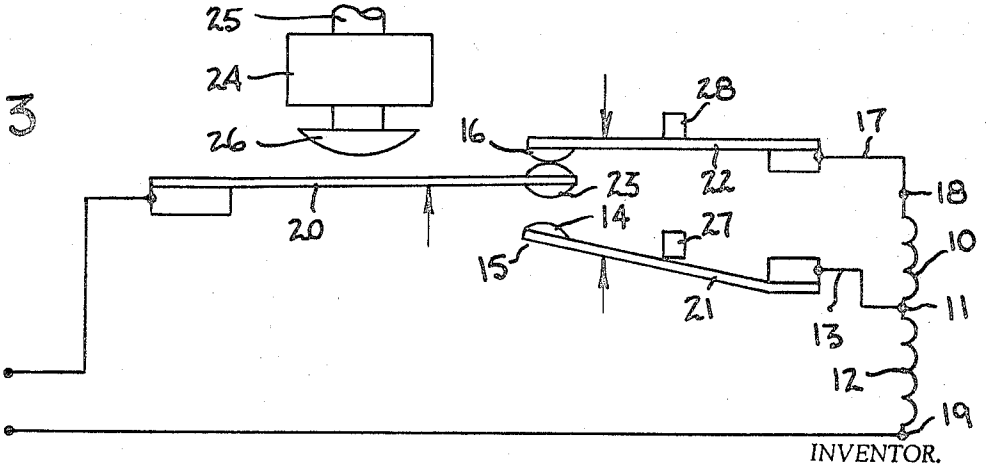


FIG. 3



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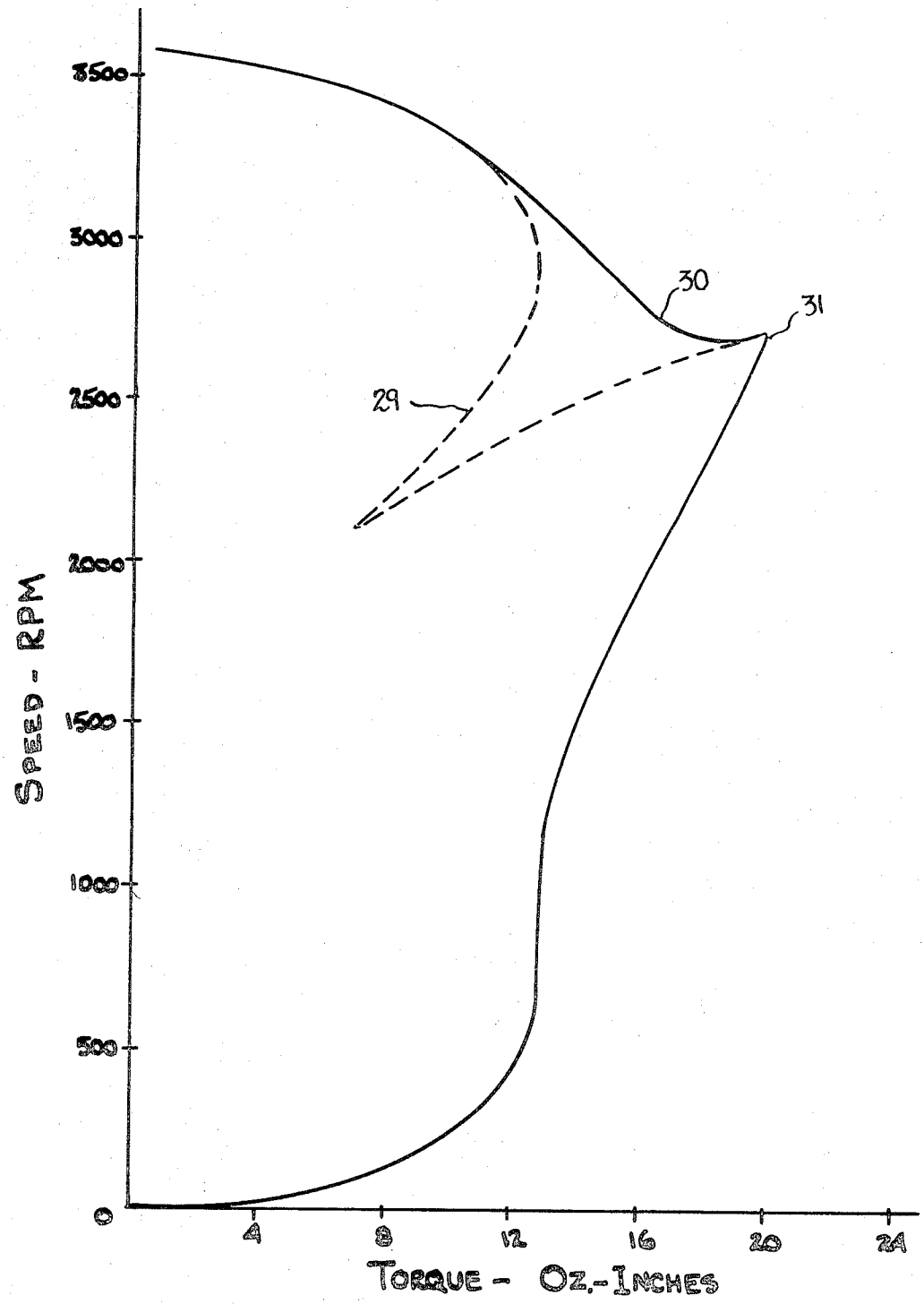

FIG. 4

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ZERO-LAG ELECTRICAL SWITCHING ELEMENT FOR MOTORS

BRIEF SUMMARY OF THE INVENTION

The invention relates to electrical switching means, particularly for use in the starting circuits of electrical motors.

In split phase induction motors, it is customary to utilize a starting winding and a running winding which are connected in parallel by a switch means at the time that the motor is started. A centrifugal speed responsive device is ordinarily utilized to maintain the switch in closed position during the start-up. When the motor approaches running speed and has developed sufficient torque to overcome the start-up load, the centrifugal device disengages or retracts from its holding engagement with the resilient switching element, thus permitting the switch arm to open the circuit to the starting winding which is no longer needed, and the motor thereafter operates on its running winding. For a fuller discussion of the characteristics and operation of such speed responsive switching means, reference is made to my U.S. Pat. Nos. 2,616,682; 2,768,260 and 3,396,251 which describe both the centrifugal speed responsive actuating devices and the stationary switching elements actuated thereby.

In shaded pole motors, it is conventional practice to use only a single motor winding for both start-up and running. The characteristics of the shaded pole motor are such that it produces very poor start-up or pullup torque under load. In order to improve the load-torque characteristics of these shaded pole motors, particularly during the start-up operation, it has been found feasible to tap the magnetic winding of the motor to provide a limited number of turns to act as a starting winding and then, use the centrifugal speed responsive switching means to introduce the total winding into the circuit after optimum torque has been attained and the motor has approached reasonably close to its operating speed.

In accomplishing this, it has been found that the use of the quick-acting snap action type of speed responsive switching arrangement, as described in the foregoing listed patents, which operated quite successfully for the split phase motor, introduced a time lag in transferring from one circuit to the other which resulted in a pronounced and rapid dropoff of torque and speed for the motor during the short interval of the switchover, even though this interval was but a fraction of a second. In order to overcome this undesirable switchover dropoff, the zero-lag stationary switch was devised so that there would be no interruption of the starting circuit of the motor until after the running circuit had been established. In this form of switching mechanism, the switch arm or pole of the switch first establishes the circuit to the starting winding through one contact of the switch. When the centrifugal device attains the switchover speed for which it has been set, it relieves its restraint on the switch arm, thereby permitting the switch arm to move away from the starting circuit contact toward engagement with the running circuit contact. However, during this movement of the switch arm, the starting circuit contact follows the switch arm and maintains the starting winding circuit until the switch arm as engaged the running winding contact and established that circuit. Thereafter, the following movement of the starting winding contact is arrested so that the starting winding circuit is opened and the entire winding is operative to produce the running characteristics of the motor.

The same principle of operation can also be utilized for zero-lag switching from the running circuit to the starting circuit in the event of a sudden temporary overload on the motor during its operation.

By thus improving the starting torque or overload torque of shaded pole motors by means of the zero-lag speed responsive switching mechanism and the tapping of the winding, it is possible to obtain improved operating characteristics for these motors as well as to reduce the size of the shaded pole motor in particular applications where increased torque was required solely to overcome the startup load.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic representation of a switching mechanism embodying the features of my invention in association with the winding of a shaded pole motor, showing the switching mechanism in its starting position.

FIG. 2 is a view similar to that of FIG. 1, but showing the position of the switching mechanism during the period that the transfer from the starting circuit to the running circuit is being effected.

FIG. 3 is a view similar to FIG. 1, but showing the position of the parts after the running circuit has been established and the starting circuit has been opened.

FIG. 4 is a speed-torque graph showing the curves for a shaded pole motor equipped with a circuit interrupting conventional stationary switching device as compared with the speed-torque characteristics of such a motor when a zero-lag switching mechanism is utilized instead.

DESCRIPTION

Referring more particularly to FIG. 1 of the drawings, I have shown the magnetic winding **10** of a shaded pole motor, which may be considered the counterpart of the conventional running winding of a motor. As previously mentioned, conventionally such motors are not provided with a starting winding. However, in order to improve the starting torque characteristics of the shaded pole motor, the magnetic winding **10** is tapped, as at **11**, so as to provide a starting winding **12** which would contain approximately 75 percent of the turns of the winding **10**. The tapped lead **13** is connected to a contact **14** of a single-pole double-throw switch **15**, whose other contact **16** is connected by lead **17** to one terminal **18** of the magnetic winding **10**. The other terminal **19** of the winding **10** is connected to an appropriate power supply, not shown. The switch arm or pole **20** of the switch is also connected to the power supply.

The contacts **14** and **16** are resiliently mounted so as to be yieldably urged toward each other. Preferably, this resilient mounting is accomplished by a leaf spring support arm **21** for the contact **14** and a like support arm **22** for the contact **16** so as to bias the contacts in opposition to each other as indicated by the arrows. It will be understood however that other resilient biasing means such as coil springs or the like could be utilized in lieu of the leaf spring arrangement described.

The pole or switch arm **20** carries a contact **23** which is adapted to engage either the contact **14** for the purpose of establishing the starting circuit through the winding **12** or the contact **16** for the purpose of establishing the circuit through the entire winding **10**. The switch arm **20** is resiliently biased, in the direction indicated by the arrow, by any suitable spring means to normally maintain engagement with the contact **16**. Preferably, this is accomplished by utilizing a leaf spring for the switch arm **20**, which spring should be of slightly greater force than the biasing means **22** which is utilized for the contact **16**.

A centrifugal speed-responsive actuating device, such as the type shown in my previously referred to Pat. No. 2,616,682, is represented diagrammatically and indicated by the reference numeral **24**. The centrifugal device **24** is mounted on the motor shaft **25** for rotation therewith and is provided with a pad or shoe **26** which, in its projected position, engages the switch arm **20** in opposition to its spring action so as to disengage it from the contact **16** and maintain it in circuit making engagement with the contact **14**. When the motor is at rest and until the switchover or transfer speed of the centrifugal device **24** is attained, the pad **26** is in its projected position as shown in FIG. 1. When the switchover speed is attained by the centrifugal device, the pad **26** is retracted by snap action of the centrifugal device, so as to disengage from the switch arm **20** and permit the resilient arm **20** to move away from the contact **14** and toward the contact **16**.

As best seen in FIG. 2 of the drawings, this transfer or switchover movement of the switch arm **20** is followed by the contact **14** due to the biasing of the contact in the direction of

movement of the switch arm by the resilient support arm 21. This following movement of the contact 14 continues until the switch arm 20 has moved to a position where its contact 23 has engaged the contact 16, at which time both the contacts 14 and 16 are in engagement with the contact 23 of the switch arm. Inasmuch as the starting winding 12 offers less electrical resistance to the flow of current than does the entire magnetic winding 10, the current will still tend to flow through the circuit established through the contact 14 even after the contact 16 has been engaged by the switch arm. As the switch arm 20 continues its movement in opposition to the spring action action of the support arm 22, it travels beyond the limit of movement of the contact 14, thereby disengaging the contacts 23 and 14 to open the circuit to the winding 12. Thereafter, the current flow is through the entire magnetic winding 10. The limit of following movement of the contact 14 can be established by the position of the support arm 21 at zero deformation or, more precisely, it is preferably established by disposing an arresting abutment 27 in the path of following movement of the support arm 21 which will prevent any such further movement after the contact 16 has been engaged by the contact 23.

As shown in FIG. 3 of the drawings, the contact 23 is solely in operative engagement with the contact 16 after the following movement of the switch arm 20 by the contact 14 has been terminated and the previously established circuit through the winding 12 has been opened.

In the event there is a sudden temporary overload on the motor causing its speed to momentarily be reduced below the switchover speed of the centrifugal device 24, the device 24 will snap over to project the actuating shoe 26 into engagement with the switch arm 20 and displace it into engagement with the contact 14, thereby reestablishing the high torque starting circuit through the winding 12. The contact 23 will disengage from the contact 16 when the contact 16 has reached the limit of its following movement which, as previously described with reference to the contact 14, can be established by the nondeformed position of the support arm 22. Ordinarily, there would be no need to provide an arresting abutment to precisely control the limit of movement of the contact 16 in following the switch arm 20, as the circuit through the magnetic winding 10 is effectively opened as soon as the contact 23 engages the contact 14, even though the contacts 16 and 23 are still physically engaged. However, it may be desirable to provide an arresting abutment 28 to limit movement of the contact 16 in the opposite direction so as to prevent undesirable overtravel of the switch arm 20 and the support arm 22 when the pad 26 is suddenly retracted to relieve the deformation load on the switch arm 20.

Referring now to FIG. 4 of the drawings, the curve 29 shows the speed-torque relationship of a shaded pole motor with a tapped winding using a centrifugally actuated speed responsive switch means to open the circuit through the winding 12 and establish the circuit through the entire winding 10 with conventional switching mechanism. The curve 30 represents the same relationship utilizing the zero-lag switching mechanism herein disclosed. It will be noted that in both the curves 29 and 30, the torque rises quite rapidly during the start-up period when the speed is below about 500 r.p.m. and then remains fairly constant as the speed increases from 500 to about 1200 r.p.m. Thereafter, the torque again increases at a somewhat lower rate as the speed increases from 1200 to the switchover speed of about 2700 r.p.m. where the pad 26 of the centrifugal device is caused to retract. Up to this point, both the curves 29 and 30 are identical.

As can be seen in the curve 29, the time lag involved in switching from the starting circuit to the circuit through the winding 10 results in a rapid and significant dropoff in torque from a maximum value of 20 to a value of about 7 ounce-inches with a corresponding reduction in speed from 2700 r.p.m. to about 2100 r.p.m. before the speed and torque of the motor pick up again.

By contrast, the curve 30 shows that the use of the zero-lag switching mechanism results in a much less abrupt change in torque and in speed at the point of transfer 31, with the relatively minor change in values being attributable entirely to the circuit change from the winding 12 to the entire winding 10 rather than to any time lag in the switchover between the circuits. The curve 30 shows a temporary reduction in speed from 2700 r.p.m. to about 2600 r.p.m. with a quick recovery toward increasing speed and normally decreasing torque as the running circuit through the magnetic winding 10 becomes fully effective. Thus through the use of the zero-lag switching mechanism, the substantial and significant loss in torque and speed at the switchover or transfer point has been largely eliminated.

I claim:

1. In a speed-responsive electrical switching device for motors having a starting circuit and a running circuit, the combination of a yieldably mounted first electrical contact for one of said circuits, a yieldably mounted second electrical contact for the other of said circuits, a switch arm movably disposed therebetween for circuit-making engagement with one or the other of said contacts, and means for initially maintaining said switch arm in circuit-making engagement with said first contact until completion of movement of said switch arm into circuit-making engagement with said second contact, whereby both of said circuits are energized until the switchover from one to the other is completed.

2. A combination as defined in claim 1, including means for causing circuit-opening disengagement of said switch arm and said first contact after movement of said switch arm into circuit-making engagement with said second contact.

3. A combination as defined in claim 1, including speed-responsive means operatively engaging said switch arm for effecting actuation thereof.

4. A combination as defined in claim 1, wherein said contacts are yieldably biased for movement toward each other, said switch arm is movable between said contacts in opposition to the bias of the contact to be engaged by said switch arm, said first contact yieldably following the movement of said switch arm to provide said means for maintaining said circuit, and an abutment disposed in the path of following movement of said first contact to arrest said following movement thereof after said switch arm has engaged said second contact.

5. A combination as defined in claim 4, wherein said switch arm is resiliently biased for circuit-making engagement with said second contact, and including speed-responsive means for maintaining said switch arm disengaged from said second contact and engaged with said first contact in opposition to the bias of said switch arm.

6. A combination as defined in claim 2, wherein said contacts are yieldably biased in opposition to each other.

7. A combination as defined in claim 6, wherein said first electrical contact establishes said starting circuit and said second electrical contact establishes said running circuit.

8. In an electrical switching mechanism for effecting uninterrupted transfer from a first electrical circuit to a second electrical circuit, a single-pole double-throw switch, said switch having a first contact for making said first electrical circuit, said switch having a second contact for making said second electrical circuit, said contacts being resiliently mounted in opposition to each other whereby one of said contacts is caused to follow said pole and maintain circuit-making engagement with said pole during its transfer movement to engagement with the other of said contacts, and means for arresting said following movement of said first contact to open said first circuit after said second circuit has been closed.

9. A single-pole double-throw switch as defined in claim 8, including means for arresting said following movement of said second contact to open said second circuit after said first circuit has been closed.

10. A single-pole double-throw switch as defined in claim 8, wherein said pole is normally maintained in engagement with said first contact, and including condition-sensing means operatively associated with said pole for actuating circuit-transfer movement thereof into engagement with said second contact.