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1,937,739

PHONIC WHEEL STARTER

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FIG. 1

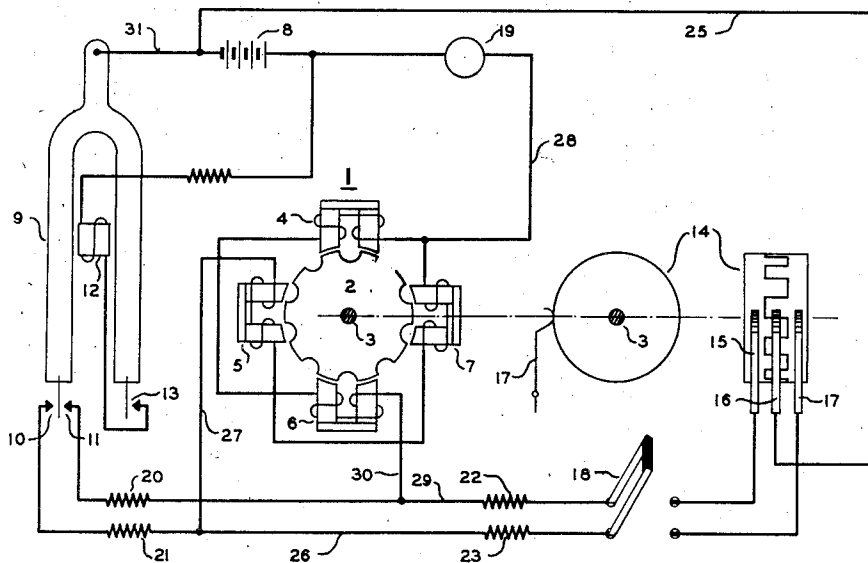


FIG. 2

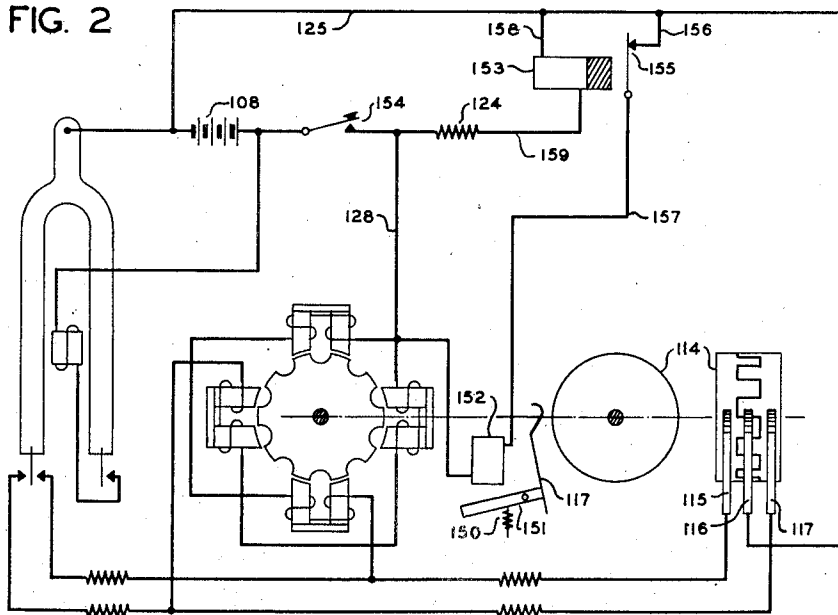
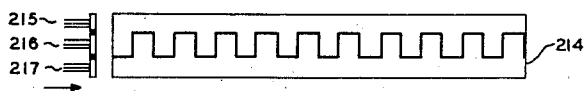


FIG. 3



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PHONIC WHEEL STARTER

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Application March 27, 1931. Serial No. 525,721

8 Claims. (Cl. 172-293)

This invention relates to control systems and in particular to means for automatically starting a LaCour motor, commonly known as a phonic wheel motor, and bringing it into synchronism with its control fork, from a position of rest.

The LaCour motor, which is well known in the art, comprises an armature in the form of a toothed member propelled by a series of magnets which are alternately energized and de-energized to produce the operating torque necessary to cause rotation of the armature. The energization and de-energization of the operating magnets are effected by means of a vibrating member, such as a reed or tuning fork, which can be maintained at a uniform speed.

Several methods of starting LaCour motors have been used. The preferred method has been to revolve the armature by hand or by means of an auxiliary motor until it is thought that the phonic wheel is in synchronism with the fork or travelling at slightly more than synchronous speed. If the wheel fails to remain in synchronism with the fork, further attempts must be made at starting until the motor is properly operated by the fork. A commutator attached to the armature shaft has also been used to place current directly on the operating magnets by means of a switch which is manually reversed to place the wheel in control of the fork when synchronism is attained. The difficulty experienced in connection with the latter method has been that of determining the point of synchronism, and it has been found necessary to use a lamp, operating in conjunction with the fork and the armature, to indicate generally when the motor has attained such a speed. This system demands close attention on the part of the operator until such time as the switch may be thrown to place the wheel under the control of the fork.

It is the object of the present invention to provide an arrangement by which the motor will be automatically brought up to synchronous speed and held at such speed until placed directly under the control of the fork, by the operator.

A further object of this invention is to provide an arrangement whereby, on reaching the point of synchronism, the wheel will be automatically placed in charge of the control fork without further action on the part of the operator.

Figure 1 of the drawing shows a manually controlled LaCour motor starting system.

Figure 2 illustrates an automatically controlled LaCour motor starting system.

Figure 3 shows the commutator in developed form.

In Figure 1 of the drawing, a phonic wheel motor 1 is shown, consisting of an armature 2 mounted on shaft 3, which armature is adapted to be set in rotation by means of suitable mag-

nets 4, 5, 6 and 7, alternately connected. These magnets are adapted to be energized and de-energized in alternate pairs by current passed from current source 8 through fork 9 and fork contacts 10 and 11, thus producing a torque sufficient to rotate the armature. The fork, in turn, is energized by magnet 12 operated from the same source over a circuit completed through fork contact 13, fork 9 and conductor 31.

Mounted on shaft 3 is a commutator 14, which is shown in both side and front view in Figures 1 and 2, and in developed form in Figure 3, as 214. The commutator brushes 15, 16 and 17 are shown in contact with the commutator surface. With switch 18 in its closed position, it will be seen that the commutator will pass current from source 8 directly to alternate pairs of magnets 4 and 6 or 5 and 7 of the phonic wheel 1, the milliammeter 19, placed in the return path of the current, giving visible indication of the attainment of synchronous speed.

In Figure 2, a modified system is shown which is very similar to that of Figure 1. In this figure, brushes 115, 116 and 117 are normally held away from the commutator 114 by the tension of spring 150 on brush carriage 151. Relay 152 operates in a circuit under control of slow-acting relay 153 to bring the brushes in contact with the commutator. Switch 154 is the starting switch for this system.

In view of the fact that the principle of operation of the phonic wheel motor and its control by the tuning fork or reed are well-known in the art, it has not been deemed necessary to go into further detail in regard to the operation of the wheel, particularly in view of the fact that such operation does not form a part of this invention.

The detailed operation of the two systems will now be described:

When the operator wishes to place the phonic wheel of Figure 1 in operation, he closes starting switch 18, thereby causing current to flow from current source 8, over conductor 25, through commutator brush 16, and so to commutator brushes 15 or 17, depending on the position at which said commutator had previously come to rest. If the commutator has come to rest in the position illustrated, then current will be permitted to flow through brush 17, through one arm of the switch 18, and so through conductors 26 and 27 to magnets 5 and 7 of the phonic wheel, and so through conductor 28 and milliammeter 19 back to the source of current. The torque exerted on the armature 2 by the current thus passed through magnets 5 and 7 is sufficient to start the armature in rotation. The rotation of the armature causes the rotation of shaft 3 which, in turn, will rotate commutator 14. As the commutator starts to rotate, current will be

removed from brush 17 and, consequently, from magnets 5 and 7, and will be transferred from brush 16 to brush 15 and thus through the opposite arm of switch 18, through conductor 29 and conductor 30, and so through magnets 6 and 4 of the phonic wheel, conductor 28 and the milliammeter 19 and back to the source of current. The current is, therefore, alternated between alternate pairs of magnets and, as the armature 2 gains speed, the commutator is rotated at a faster rate and consequently the alternation of current between the magnets occurs more frequently. Thus the tendency of the commutator is to rotate the armature at an increasingly high speed.

At the same time that current is being placed on alternate pairs of magnets through the commutator, current is also being passed from source 8 over connector 31, fork 9, contacts 10 or 11, conductors 26 or 29, conductors 27 or 30, and thus through magnets 5 and 7, or 4 and 6, to the current source over conductor 28 and milliammeter 19.

It will be seen that some of the impulses transmitted to the phonic wheel magnets by the fork will tend to accelerate the motor, while other impulses will tend to retard the motor. The resultant effect of the fork control, as the motor is approaching synchronous speed, is therefore negligible.

As the phonic wheel approaches the state of synchronism, however, the fork will tend to hold it at a definite synchronous speed and will, therefore, offset the tendency of the commutator to drive the wheel at a higher speed. As a result, the wheel will be maintained at synchronous speed. The operator may wait until such time as the motor would normally have attained synchronism and then open switch 18, thereby disconnecting the commutator from the motor and leaving the motor in sole control of the fork, or the operator may definitely ascertain the point at which synchronous speed has been reached by reference to the milliammeter 19, the readings of which will become steady when synchronism is obtained, and then open switch 18.

Since the accelerating tendencies of the commutator in effect balance the retarding effect of the fork to maintain the wheel at a synchronous speed, it is important that the accelerating effect of the commutator be not greater than the retarding effect of the fork. This will be determined by the resistances 20, 21, 22 and 23 placed in the circuit. The resistance values for satisfactory operation are not critical, but if resistances 20 and 21 are too high, or resistances 22 and 23 are too low, the fork will be unable to hold the phonic motor in synchronism and the motor will continue to accelerate after synchronism has been obtained. If, on the other hand, resistances 22 and 23 are too high, the phonic motor may fail to reach synchronous speed, or at least will require an undue amount of time to reach such speed.

The principle of operation of the system shown in Figure 2 is identical with that of the system just described. In this system, however, the commutator brushes 115, 116 and 117 are normally held away from the commutator surface by the action of spring 150 on brush rack 151. When the operator wishes to place the wheel in operation, switch 154 is closed. Current is thereby passed from the negative side of current source 108 over conductor 125, conductor 156, contact 155, conductor 157 through relay 152 and so through conductor 128, switch 154 and back to

the positive side of the current source. The closing of this circuit operates relay 152, which places the commutator brushes in contact with the commutator surface and starts the series of events described in connection with Figure 1.

In this system, however, a second new circuit is also closed on the operation of switch 154, viz., from the negative side of current source 108 through conductor 125, conductor 158, slow-acting relay 153, conductor 159, resistance 124 and switch 154 to positive side of current source 108. This places current on slow-acting relay 153, which is so adjusted that it will not operate until such time as the phonic wheel will have had ample time to reach synchronous speed. The relay 153 will then operate to open contact 155, which opens the circuit for relay 152 and permits the commutator brushes to be withdrawn from the commutator by the action of spring 150, thus placing the phonic wheel under the sole control of the fork.

What is claimed is:

1. In a LaCour motor control system and in combination, a LaCour motor, a fork for maintaining said motor at a constant speed, a source of current for operating said motor and said fork, a brush commutator for supplying said current directly to said motor, a switch for disconnecting said commutator brushes and said motor, a milliammeter for indicating a state of synchronism between said fork and said motor, a plurality of resistances between said fork and said motor for limiting the accelerating effect of said fork, and a plurality of resistances between said motor and said commutator brushes for limiting the accelerating effect of said commutator.

2. In a LaCour motor control system and in combination, a LaCour motor, a fork for maintaining said motor at a constant speed, a source of current for operating said motor and said fork, a switch for closing the circuit between said motor and said source of current, a brush commutator for supplying said current directly to said motor, relay means for holding the brushes of said commutator in operative position, slow energizing relay means for de-energizing said first mentioned relay means, a plurality of resistances between said fork and said motor, and a plurality of resistances between said motor and said commutator brushes.

3. In a LaCour motor control system, the combination of a LaCour motor, means comprising a fork, a commutator and circuits therefor connected in parallel for controlling said motor, said fork acting to limit the accelerating effect of the commutator circuit on the motor to a predetermined speed, and means for determining when said motor has attained said predetermined speed.

4. In a LaCour motor control system, the combination of a LaCour motor, means comprising a fork, a commutator and circuits therefor connected in parallel for controlling said motor, said fork acting to limit the accelerating effect of the commutator circuit on the motor to a predetermined speed, and additional means for placing the motor under the sole control of the fork circuit when the motor has attained said predetermined speed.

5. In a LaCour motor control system, the combination of a LaCour motor, means comprising a fork, a commutator and circuits therefor connected in parallel for controlling said motor, said fork acting to limit the accelerating effect of the commutator circuit on the motor to a predetermined speed, and a slow-operating relay for plac-

ing the motor under the sole control of the fork circuit when the motor has attained said predetermined speed.

pulses to said motor for starting said motor, and means for disconnecting said commutator from said motor when the latter attains a predetermined speed.

6. In a LaCour motor control system, the combination of a LaCour motor, a source of current, and means for controlling the motor comprising a vibrating fork and a rotatable commutator connected to said source and parallel connections from the fork and the commutator to the motor over which current impulses produced by the fork and the commutator are delivered to said motor.

8. In a LaCour motor control system, the combination of a LaCour motor, a source of current, a vibrating fork, a rotatable commutator connected to said source, means for causing said fork and said commutator to generate and deliver impulses to said motor for starting said motor, and electromagnetically controlled means for placing the motor under the sole control of said fork when said motor has attained a predetermined speed.

7. In a LaCour motor control system, the combination of a LaCour motor, a source of current, a vibrating fork, a rotatable commutator connected to said source, means for causing said fork and said commutator to generate and deliver im-

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20	95
25	100
30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145