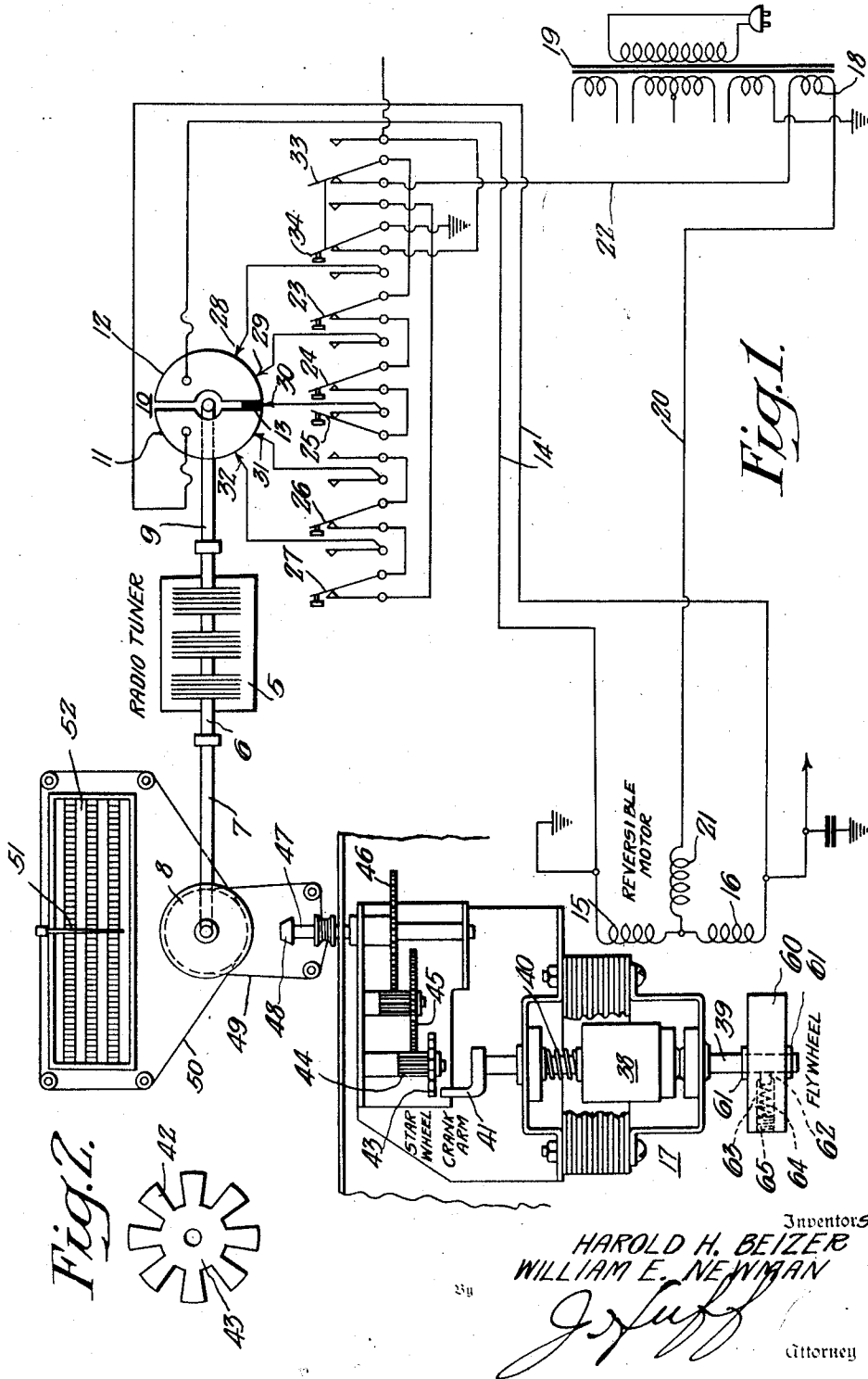


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MOTOR DRIVEN TUNING SYSTEM

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The present invention relates to an electric motor control system particularly adapted for tuning control of radio receiving apparatus and the like, wherein a reversible electric motor is connected to drive a radio tuning device under control of circuit elements for causing the motor to move the tuning means from one to another of several preselected tuning positions.

Motor tuning for radio receiving systems providing for remote control tuning and preselection tuning has gone into more extended commercial use with the advent of recent automatic frequency control circuits which, as is known, permit the oscillator frequency to be adjusted automatically to correct for inaccuracies in tuning adjustment in a superheterodyne receiver.

Automatic frequency control circuits may complicate certain receiving systems and add to the cost more than is desirable. However, accuracy of tuning is important, and it is a primary object of the present invention to provide a motor tuning system for radio receivers, without the use of automatic frequency control circuits, providing a high degree of accuracy in tuning to preselected signals.

The invention relates more particularly to a reversible motor tuning system in which the motor energizing circuit is opened to bring the tuning system to rest at a preselected position when an electrical contact on a reversing commutator device, connected with the tuning control shaft, reaches an insulating segment between two reversing discs or segments of the commutator device.

The accuracy of stopping depends upon the width of the insulator or segment and the radius of the commutator device at the segment and is preferably such that the tuning system may stop for accurate tuning adjustment to within one k. c. of the desired signal frequency.

The matter of speed in tuning is also important and with accurate stopping, the necessity for higher speed in tuning may cause over-travel of the motor at the insulating segment and reversal of the motor and the tuning. Although the over-travel may be small in amount, even with an armature of low inertia in the motor, it has been difficult heretofore to control the stopping for accurate tuning without oscillation or hunting.

It is therefore a further object of the present invention to provide a reversible motor tuning system for radio receivers which may provide relatively high speed tuning movement while at the same time providing accurate tuning adjustment without hunting or oscillation about the stopping

point, whereby the necessity for automatic frequency control circuits, and the like, may be eliminated.

It is a still further object of the present invention to provide an improved reversible motor tuning control system for radio receiving apparatus, and the like, which effectively utilizes the reversing action of the motor means to provide accurate tuning adjustment to preselected tuning positions.

It is an object of the invention, furthermore, to provide a reversible motor tuning control system for radio receivers, and the like, having a reversing commutator device in which the insulating gap or segment of the device between the reversing segments may be made relatively narrow for accurate tuning, while at the same time providing high speed tuning movement by the motor means, without oscillation or hunting about the stopping positions.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing:

Figure 1 is a schematic circuit diagram together with a diagrammatic representation of a tuning system for a radio receiver, embodying the invention, and

Figure 2 is an end view of a mechanical detail of the system shown in Fig. 1, and on an enlarged scale.

Referring to the drawing, a tuning system for a radio receiver or like apparatus is diagrammatically represented by the usual three-gang variable tuning capacitor, indicated at 5, having a tuning control shaft 6 coupled through a shaft 7 to a cord drive wheel or drum 8, and at the opposite end through a shaft 9 to a reversing commutator device 10 comprising two reversing contact segments 11 and 12 and an insulating gap or segment 13 therebetween. The segments 11 and 12 are connected through reversing leads 14, respectively with reversing windings 15 and 16 of a reversible electric motor 17.

The motor is energized from a suitable source of low voltage alternating current, such as a secondary winding 18, on the power transformer 19 of the radio receiver. One side of the secondary 18 is connected through a lead 20 with a main operating winding 21 of the motor, while the opposite side of the secondary is connected through a lead 22 and a series of push-button selector switches 23-27, inclusive, selectively with one

of a plurality of contacts 28—32, inclusive, which engage the commutator device to complete the motor operating circuit through one or the other of reversing windings, depending upon the position of the contact and its engagement with either one of the segments 11 and 12.

As shown in the drawing, the contact 30 is rendered operative to select a tuning position for stopping the motor 17 through the switch 25 which is in the closed position. It will be noted that the switches 23—27, inclusive, are connected in series when in the open position and the series circuit is completed to the potential supply lead 22 through the contacts 33 of a multiple contact switch 34. This series circuit arrangement prevents more than one selector button from becoming effective to operate the motor, thereby preventing overheating of the motor should it receive operating current continuously through more than one selector switch and both reversing windings at the same time.

The motor circuit arrangement is such that while the contact 30 is over the insulating gap or segment 13 the motor circuit is opened and the motor is deenergized following closing of the switch 25. The contact 30 when closed with the segment 11 energizes the reversing winding 16, causing the motor to drive the tuning shaft 7 and the commutator device 10 through a gearing connection hereinafter described, in a direction to restore the commutator to the position shown, with the contact 30 at the gap 13. Contact with the segment 12 causes a similar movement in the opposite direction to restore the commutator to the position shown. Thus the tuning is always brought to the same point of rest for each selector switch.

The contacts 28—32, inclusive, are movable or adjustable with respect to the insulating gap or segment 13 to cause the radio tuning device to stop in any one of a plurality of preselected positions corresponding to desired signals or radio stations to be received. In order to provide a high degree of accuracy in tuning, the segment 13 or insulating space between the reversing segments 11 and 12 must be relatively narrow as are also the contacts 28 to 32.

In a present preferred embodiment of the invention the insulating segment 13 is provided at the periphery of two flat metal plates, in the form shown at 11 and 12, mounted to rotate in connection with selector contacts 28 to 32, inclusive, located at a distance from the center of rotation of from three to four inches, whereby a small degree of angular rotation provides a relatively wide range of movement for the insulating gap.

With this arrangement the width of the insulator or gap has been set at 0.75" and the diameter of the contacts has been set at .059" which permits .008" on either side of each contact when it is centered on the insulator for an exactly tuned-in position of the tuning device.

It has been found that with a relatively small amount of over-travel with an ordinary motor drive and with production tolerances in the insulating gap varying from the values above given, and even when the motor armature has relatively low inertia, it is difficult to control the tuning without excessive oscillation or hunting about the stopping point.

However, the accurate adjustment provided by the narrow insulating gap in the reversing commutator may be maintained and accurate stopping may be provided without oscillation or

hunting if the driving motor is further controlled as will hereinafter appear.

The motor is of the shifting armature type, having an armature 38 mounted on a shaft 39 and axially movable therewith when energized, against a spring 40 to cause a crank arm 41 carried by the shaft to engage between the teeth 42 (Fig. 2) of a star wheel 43 which is mounted on a driving pinion 44. The pinion 44 forms part of a gear train 45—46 connecting the star wheel 43 with a tuning control shaft 47 for manual tuning and having a suitable tuning control knob 48. The shaft 47 is connected with the drum 8 through a cord drive indicated at 49, and a similar cord drive indicated at 50, is also connected with the drum or sheave 8 to actuate a tuning dial pointer or indicator 51, in connection with a tuning indicator dial shown at 52.

When the motor armature is energized the crank arm 41 engages the star wheel 43 by means of the crank pin and drives the gear train 44—45—46 which in turn drives the tuning control shaft 47. The tuning control shaft is connected to the variable tuning device 5 through the cord drive which provides a reduction ratio of 17:1, for example. The reduction ratio from the motor shaft to the tuning control shaft 47 may be substantially 25:1. With this reduction and a present available type of motor, the time required to tune from one end of the broadcast band to the other is approximately three seconds. When the motor is deenergized the armature is thrown clear of the star wheel and pinion by means of the spring 40, the armature itself having axial movement, as hereinafter referred to.

A flywheel 60 mounted on the rear end of the motor shaft 39 between stop washers indicated at 61 is free to rotate on the shaft but is prevented from axial movement with respect to the shaft by the washers. The flywheel provides an inertia weight or device for imparting axial and rotational inertia to the drive system and preferably, as shown, to the motor shaft.

Driving torque is transmitted to the flywheel from the shaft through a friction plug indicated at 62 in a radial recess 63 in the flywheel. The plug is pressed against the shaft by a suitable spring 64. The friction plug may be of leather and the pressure on the shaft is controlled by the screw 65. The action of this flywheel controls the over-travel of the motor and the accuracy of the tuning.

When a station selector button, such as the button 25, is pressed, the motor 10 begins to pick up speed and to rotate the selector disk in the direction of the corresponding station or selector contact such as the contact 30. The motor cannot come up to speed immediately because of the friction load of the slipping flywheel which provides a momentary overload but does so as soon as the inertia of the flywheel is overcome.

When the insulator 13 on the selector disk reaches the station contact 30, for example, both the motor and flywheel are rotating at the same speed and the combined inertia carries the tuning mechanism and the insulating segment past the stop position and the contact 30, thereby causing the motor to reverse.

Because of the momentum of the flywheel which is still rotating in the original direction, and the friction between the flywheel and the shaft, the motor speed in reverse is reduced.

While the motor is rotating at low speed in the reverse direction, the selector contact 30 is again reached by the insulator segment 13. The motor current is thus broken and the tuning device 5 is stopped within the limits of the insulating segment 13 because of the slow rate of travel.

During the forward rapid tuning movement when the contact 30 first traverses the segment 13 a brief interruption of the motor current occurs. The axial inertia of the flywheel 50, together with that of the armature 38, serves to hold the armature in the forward position and to maintain the crank arm in engagement with the star wheel during this brief interruption, thereby preventing declutching and lost motion in the reverse driving action of the motor.

Adjustment of the set screw 65 on the flywheel friction pad controls the amount of over-travel and the accuracy of tuning. In order to ensure that the motor may provide final tuning while rotating very slowly, the drive pinion 44 has been provided with a multiple bladed star wheel, as shown in Fig. 2, which permits the motor to start reversing the tuning shaft immediately before the motor attains speed, which would cause the selector to over-travel the selected contact and hunt or oscillate.

With the reversible motor tuning system described, it will be seen that the reversing commutator may be provided with a relatively narrow insulating segment between the reversing disks or segments and on a relatively long radius providing accurate stopping and eliminating the necessity for automatic frequency control of the oscillator.

Furthermore, the tuning system may be made to operate at a relatively high speed, that is, it may have a relatively high rate of tuning movement, together with accurate stopping with the commutator device above referred to, by providing the tuning motor with a flywheel frictionally connected with a shaft driven by the motor, preferably the motor shaft itself, as shown, which applies a rotary braking effect to the motor when the latter is reversed. The friction between the flywheel and the shaft is adjustable and starts the flywheel spinning in the initial direction so that when the motor reverses because of over-travel at high speed, the motor armature must turn against the friction load of the oppositely rotating frictional flywheel. This provides an overload which causes the motor to start up much more slowly than it would otherwise and the rate of speed increase is controllable by means of the friction load provided by adjusting the set screw 65 on the flywheel. Therefore, it is possible to cause the motor to stop within a much smaller angle and with a much narrower insulating gap in the electrical stopping device.

Furthermore, with the flywheel mounted on the motor shaft between fixed collars or other suitable means, it may not only rotate to provide a friction load on the shaft for controlling the tuning, but it may also provide axial inertia in a shifting armature type of motor sufficient to cause the clutching means to remain engaged during the deenergizing and reversal of current to the motor, as the stopping device contact traverses the insulating gap or segment during the over-travel movement of the tuning operation. This prevents unnecessary axial movement or chattering of the motor armature at each tuning point.

We claim as our invention:

1. In an electric motor control system for radio

apparatus and the like, the combination with a control device of a reversible electric motor having a rotatable drive shaft connected with said device to operate it, said shaft being axially movable in response to the deenergizing of the motor, means carried by said shaft providing a clutch operable upon axial movement of said shaft to disconnect the shaft from said control device, a flywheel frictionally mounted on said shaft whereby said flywheel imparts axial inertia to said shaft tending to resist axial movement and a frictional load on said shaft to reduce the initial speed of rotation upon reversal of said motor by reason of the continued rotation of said flywheel in the initial direction and friction between said flywheel and said shaft.

2. In a motor-driven radio tuning system, the combination of a drive shaft, tuning means having a movable element connected with the shaft and operative at a lower speed than the drive shaft, electrical means including an adjustable device for deenergizing the motor at a preselected position in the tuning movement of said element and for energizing said motor to move said element toward said position from either side thereof, a flywheel device frictionally coupled to and driven by the motor whereby said device is adapted to coast when said motor reverses the direction of rotation, to provide a braking load for and to reduce the speed of the motor in reverse, means providing a clutch in the connection between the motor and the movable tuning element, said clutch having an operating element connected with the flywheel device to move conjointly therewith axially in response to energizing and deenergizing of the motor, whereby the axial inertia of said device tends to resist momentarily the operating movement of said clutch element.

3. In a radio tuning control system, a tuning shaft, a reversible electric motor having a rotary drive shaft which moves axially in response to the energizing of the motor, means providing a restoring force for said shaft against which it moves, means connected with the tuning shaft for reversing the rotation of said motor following over-travel of and for stopping the motor at any one of a plurality of predetermined stopping positions in the rotation of said tuning shaft, means providing a relatively high speed drive connection with said motor shaft for said first named shaft to effect over-travel of said positions and reversal of the motor, a flywheel device providing predetermined axial and rotational inertia rotatably mounted on said motor shaft, means providing a frictional connection between said shaft and said flywheel device whereby the motor is prevented from rotating in reverse with the same initial speed as in a forward direction when energized, by reason of rotating friction load imparted to said motor shaft by said device, thereby to effect exact stopping of said tuning shaft at any one of said positions, and means providing a connection between said device and said shaft for imparting said axial inertia to said shaft.

4. In a motor tuning system for radio receivers, the combination with a tuning shaft, of a reversible tuning motor having a shaft connected therewith, a clutch in said connection, a reversing device for the motor connected with said shaft and comprising two contact elements separated by a relatively narrow insulating gap, at least one adjustable contact element positioned to engage said segments and lying in the path of move-

ment of said insulating gap, said contact being slightly less in width than said gap, a reduction gearing between said motor and said tuning shaft providing a high rate of movement for said shaft such that the gap over-travels said contact causing reversal of said motor, a flywheel providing a frictional load against rotation of said motor upon reversal to reduce the speed of said motor, whereby said contact may be centered accurately on said insulating gap at the reduced speed, said flywheel being mounted on the motor shaft to rotate relatively thereto.

means providing an adjustable friction connection between said flywheel and said motor shaft whereby the initial speed of the motor upon reversal may be controlled, means for operating said clutch by axial movement of the motor shaft, and means providing a connection between the flywheel and the motor shaft for applying the inertia load of the flywheel to the shaft in response to axial movement thereof.

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