Sept. 18, 1956 A. T. BACHELER 2,763,824

FREQUENCY CONTROL SYSTEMS FOR ALTERNATORS

Filed June 19, 1953

Fig. 1.

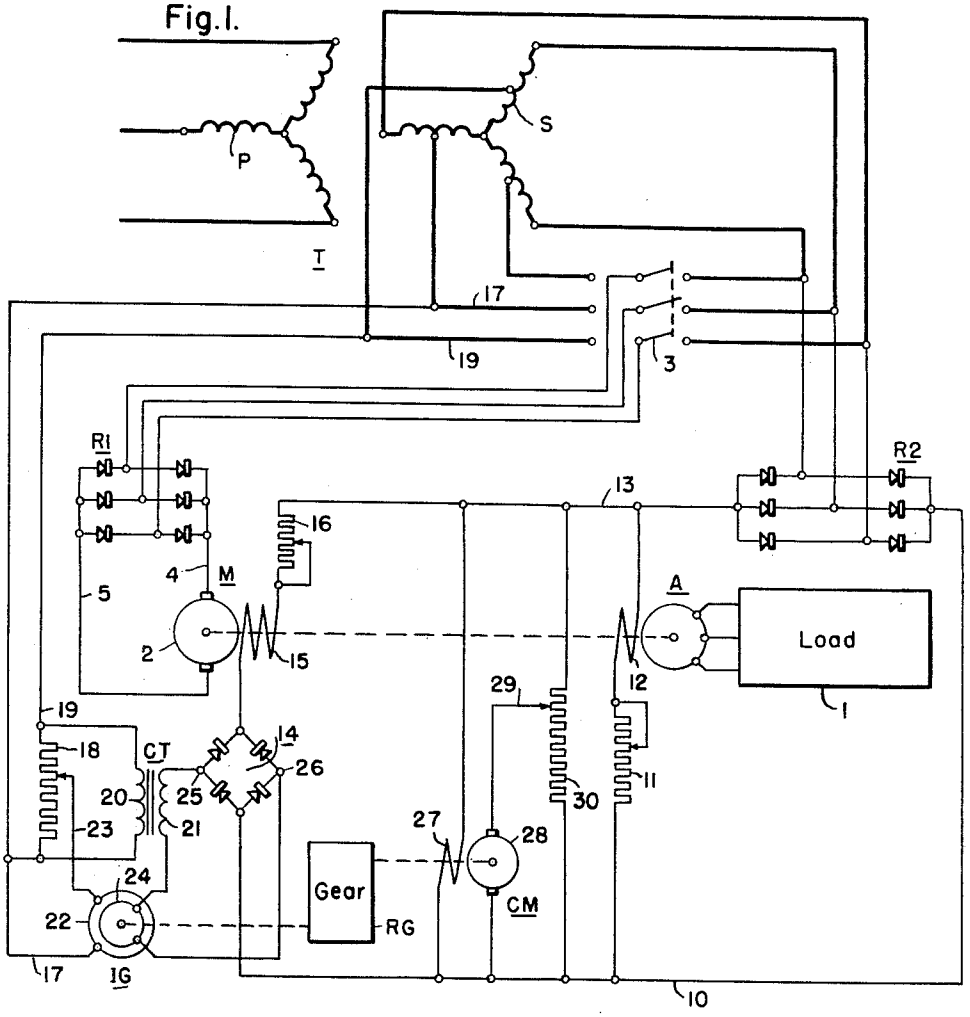
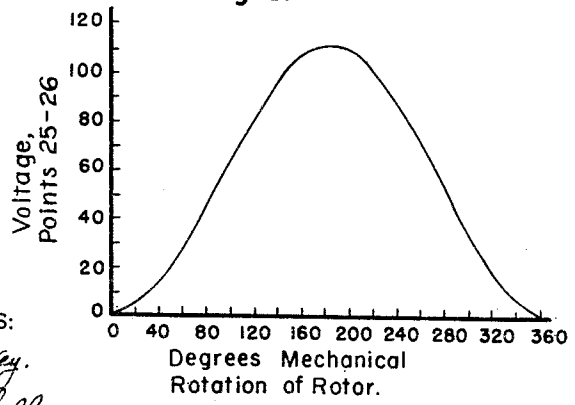


Fig. 2.



WITNESSES:

E. A. McCloskey.

Wm. B. Sellers.

INVENTOR

Albert T. Bacheler.

BY

Paul E. Friedemann

ATTORNEY

United States Patent Office 2,763,824 Patented Sept. 18, 1956

2,763,824

FREQUENCY CONTROL SYSTEMS FOR ALTERNATORS

Albert T. Bacheler, Buffalo, N. Y., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application June 19, 1953, Serial No. 362,871

14 Claims. (Cl. 318—164)

My invention relates to control apparatus for alternators and more particularly to electric systems of control for obtaining an adjustable frequency, adjustable voltage, alternating current power supply.

My invention has general utility but is of special value in the textile industry. Synthetic textile yarns and fibers are spun on multiple position machines, called spinning machines. These machines produce continuous strands of yarn, or thread, which are wound upon bobbins, or spools. On those spinning machines which have surface driven wind-up bobbins, the yarn must be evenly distributed over the face of the bobbin in order to wind an even roll, or package, of yarn. The distribution or traversing of the yarn is usually accomplished by means of a guide driven by a cam built in the form of reversing screw, which is continuously rotated. The yarn guide is driven back and forth across the face of the yarn package by the cam, a projection of the yarn guide running in a groove on the cam. It will be recognized that at certain bobbin diameters, the revolutions per unit of time and the guide strokes per the same unit of time will bear a small whole number relationship to each other. Under these conditions, the yarn turns will pile up on top of each other. This results in the formation of "ribbons" and an unever package of yarn is produced. When the yarn thus gets piled up, or stacked up, in parallel circumferential sectors, many turns fall deep between the stacked up yarn sectors. The unwinding thus becomes a difficult problem. Frequent breakage also occurs during unwinding. The general solution of this problem is to vary the speed of the traverse motion of the guide continuously, according to some form of cycle, or desirable pattern, to break up the undesirable winding pattern and eliminate the formation of "ribbons" in the package.

Modern practice for traverse roll drives involves the use of a squirrel cage type of induction motor for driving several traverse rolls of a multiple position synthetic fiber spinning machine. The speed of the traverse drive motor is set by setting the basic frequency of the power supply for the motor, it being necessary to set the speed at some value in range of approximately six to one in order to take care of the range of yarns produced. The traverse motor speed is varied above and below the basic speed by frequency modulation of the power supply.

A number of methods of operation and the apparatus therefor for obtaining the necessary performance are known in the prior art. One prior art method of attack of the problem is disclosed in the patent to E. R. Swanson, No. 2,036,441. However, the prior art systems all involve sliding parts or reciprocating parts, which by their very nature and the continuous nature of the operation, result in rapid wear, thus providing a short useful life of the equipment, and involving a high maintenance cost. Further, the prior art systems have the disadvantage of interdependence of adjustments for basic frequency, frequency swing, and the frequency of the modulating signal.

One broad object of my invention is the provision of a proper operating cycle, or winding pattern, without the use of any reciprocating parts, or sliding parts.

Another broad object of my invention is the provision of adjustments, for basic frequency, frequency swing, and frequency of the modulating signal, which are essentially independent of each other and which adjustments may be made quickly.

The objects expressed are merely illustrative. Other objects and advantages will become more apparent from a study of the following specification and the accompanying drawing, in which:

Figure 1 is a diagrmmatic showing of my invention as applied to an alternator; and

Fig. 2 illustrates graphically how the excitation of a motor driving the alternator may be varied from a basic excitation.

In Fig. 1 the load **1**, including squirrel cage induction motors, is coupled to the alternator A, the output frequency of which is to be varied. The alternator A is coupled to the direct current motor M. The motor M receives its power, both for its armature winding **2** and field winding **15**, from suitable rectifiers, as selenium rectifiers R1 and R2 connect to the secondary S of the three-phase transformer T.

A better understanding of my invention may be had from a more detailed study of the circuits and elements included and their operation.

In use the primary winding P of the main transformer T is connected to the supply buses of the mill, or plant, and the secondary S is connected to the rectifiers R1 and R2 and to the leads **17** and **19**.

The rectifier R1 may be connected to the low voltage taps of the secondary S by the switch **3** when this switch is in the left-hand position or to the full voltage taps when the switch is in the right-hand position. The leads **4** and **5** may thus be energized, first with a low voltage to effect a selected low speed motor operation for a selected motor field excitation, and second with a higher voltage to effect a selected higher speed of operation of the motor M for the same selected motor field excitation.

The rectifier R2 supplies the leads **10** and **13** with a fixed voltage. Further needed control effects are accomplished by the means discussed below. It suffices to know that leads **4** and **5** may be energized by any adjustable voltage supply, leads **10** and **13** may be energized from any constant potential direct current source, and leads **17** and **19** may be energized from any suitable constant potential single phase alternating current source.

The alternator field winding **12** is energized by the circuit from lead **10** through rheostat **11**, field winding **12**, to lead **13**. The alternator voltage output may thus be adjusted by the rheostat **11** in any suitable manner.

The circuit for the motor field winding **15** may be traced from lead **10** through the rectifier **14**, field winding **15**, rheostat **16** to lead **13**. The basic motor speed, and thus the basic frequency of the alternator A, may thus be selected at will by operation of the rheostat **16**.

There is, however, an important variable motor field excitation component that is received from the alternating current leads **17** and **19**. The potentiometer **18** and the primary windings **20** of the cycle control transformer CT are connected directly across the leads **17** and **19**. This means that the output of the secondary winding **21**, except for a fixed change in phase and a possible change in voltage, is a measure of the voltage at the input leads **17** and **19**. A variable transformer may be used in lieu of the potentiometer **18**.

A single phase induction regulator IG has its primary winding **22** connected across lead **17** and the adjustable tap **23** and has its secondary winding **24** connected in series

with the secondary winding **21**. The induction regulator IG thus may be made to function as a variable transformer.

The tap **23** is in use preferably so adjusted that when the rotor, or secondary winding **24**, of the induction regulator IG is in such a mechanical position that the electrical output of the secondary **24** is in phase opposition to the output of secondary winding **21**, the voltage on the alternating current terminals **25** and **26** will be zero. This is the condition represented at the origin of the showing in Fig. 2.

If the secondary winding **24** is rotated through 360° from the position representing zero voltage on terminals **25** and **26**, then the voltage at terminals **25** and **26** may be caused to vary as indicated in Fig. 2. For the particular showing I make, the direct current component supplied to the motor field winding **15** from this cycling circuit, is made additive to the voltage supplied from leads **10** and **13**. The circuitry could, however, be so arranged that both additive and subtractive effects could be produced.

To provide for the proper rotation of the secondary winding **24**, the secondary **24**, comprising the rotor of the induction regulator IG, is coupled to the cycle control motor CM through suitable reduction gears RG. This cycle control motor has its field winding **27** excited at a constant value, and its armature winding **28** is connected across any selected portion of the potentiometer **30** by the adjustable tap **29**. By shifting lead, or tap, **29** the frequency of the voltage variation, shown in Fig. 2, may be varied at will. This means that the traverse guide for the yarn may have its speed changed so that erroneous build-up of the yarn package cannot result.

While I have shown a cycle control system producing a sine wave output, it is apparent that by the use of a specially distributed winding on the induction regulator, or the use of a special gear transmission as one including elliptical gears, an output characteristic other than a sine wave may be produced.

Essentially independent adjustments may be made as follows:

(*a*) The average frequency is determined by the setting of rheostat **16** when the lead **23** on the potentiometer **18** is set for zero voltage. The magnitude of the excitation of motor M will then be determined by the output of the rectifier **14** and the output voltage component of the cycle control transformer CT.

(*b*) The range of frequency change can then be set by the potentiometer **18**, and the effect of the induction regulator output will be to increase and decrease the motor excitation above and below that set, as above stated under (*a*), so as to produce approximately the same frequency variation below and above that set as above explained.

(*c*) The cycle time is adjusted independently of any other adjustments by the potentiometer **30**.

From the foregoing, it is apparent that my cycle control includes only static and rotating equipment. No actively reciprocating, nor sliding elements are included.

While I have shown but one embodiment of my invention, it is apparent that various adaptations may be made and that changes and modifications may be made or substitutions resorted to which come within the spirit and scope of my invention.

I claim as my invention:

1. In a system of control, in combination, an alternator having a field winding and an alternating current output winding the frequency of which is to be changed, the character of the frequency change is to be altered, and the magnitude of its voltage output is to be changed, means for changing the excitation of the field winding of the alternator, a direct current motor, having an armature winding and a field winding, coupled to the alternator to drive it, the motor field winding being connected to constant potential terminals through means for adjusting the basic field current and a full-wave rectifier, and cycle control means for supplying a changing alternating current potential to the alternating current terminals of the full-wave rectifier, whereby the basic motor speed is changed in accordance with the changes of alternating current voltage applied to the alternating current terminals of the full-wave rectifier.

2. In a system of control, in combination, an alternator having a field winding and an alternating current output winding the frequency of which is to be changed, the character of the frequency change is to be altered, and the magnitude of its voltage output is to be changed, means for changing the excitation of the field winding of the alternator, a direct current motor, having an armature winding and a field winding, coupled to the alternator to drive it, the motor field winding being connected to constant potential terminals through means for adjusting the basic field current and a full-wave rectifier, cycle control means for supplying a changing alternating current potential to the alternating current terminals of the full-wave rectifier, whereby the basic motor speed is changed in accordance with the changes of alternating current voltage applied to the alternating current terminals of the full-wave rectifier, and cycle control means for cyclically altering the character of the change of the changing alternating current being supplied to the alternating current terminals of the full-wave rectifier.

3. In a system of control, in combination, an alternator having a field winding and an alternating current output winding the frequency of which is to be changed, the character of the frequency change is to be altered, and the magnitude of its voltage output is to be changed, means for changing the excitation of the field winding of the alternator, a direct current motor, having an armature winding and a field winding, coupled to the alternator to drive it, the motor field winding being connected to constant potential terminals through means for adjusting the basic field current and a full-wave rectifier, cycle control means for supplying a changing alternating current potential to the alternating current terminals of the full-wave rectifier, whereby the basic motor speed is changed in accordance with the changes of alternating current voltage applied to the alternating current terminals of the full-wave rectifier, and means for adjusting the maximum magnitude of the voltage change of the alternating current applied to the alternating current terminals of the full-wave rectifier.

4. In a system of control, in combination, an alternator having a field winding and an alternating current output winding the frequency of which is to be changed, the character of the frequency change is to be altered, and the magnitude of its voltage output is to be changed, means for changing the excitation of the field winding of the alternator, a direct current motor, having an armature winding and a field winding, coupled to the alternator to drive it, the motor field winding being connected to constant potential terminals through means for adjusting the basic field current and a full-wave rectifier, cycle control means for supplying a changing alternating current potential to the alternating current terminals of the full-wave rectifier, whereby the basic motor speed is changed in accordance with the changes of alternating current voltage applied to the alternating current terminals of the full-wave rectifier, cycle control means for cyclically altering the character of the change of the changing alternating current being supplied to the alternating current terminals of the full-wave rectifier, and means for adjusting the maximum magnitude of the voltage change of the alternating current applied to the alternating current terminals of the full-wave rectifier.

5. In a system of control, in combination, a transformer having a primary winding and a secondary winding, a variable transformer having a primary winding and a secondary winding, one of said windings being rotatable whereby the phase position of the output of

the secondary may be varied, a potentiometer, a pair of terminals energized with alternating current, the primary winding of the first named transformer and the potentiometer being connected directly across said terminals, circuit means for connecting the primary of the second named transformer across any selected portion of said potentiometer to thus vary the magnitude of the voltage output of the secondary of the second named transformer, a pair of terminals energized with direct current, a series circuit connected across said direct current terminals, said series circuit including a rheostat, an electric load unit, and a full-wave rectifier with its direct current terminals connected in the series circuit, said secondary windings of said transformers being connected in series across the alternating current terminals of said rectifier.

6. In a system of control, in combination, a transformer having a primary winding and a secondary winding, a variable transformer having a primary winding and a secondary winding, one of said windings being rotatable whereby the phase position of the output of the secondary may be varied, a potentiometer, a pair of terminals energized with alternating current, the primary winding of the first named transformer and the potentiometer being connected directly across said terminals, circuit means for connecting the primary of the second named transformer across any selected portion of said potentiometer to thus vary the magnitude of the voltage output of the secondary of the second named transformer, a pair of terminals energized with direct current, a series circuit connected across said direct current terminals, said series circuit including a rheostat, an electric load unit, and a full-wave rectifier with its direct current terminals connected in the series circuit, said secondary windings of said transformers being connected in series across the alternating current terminals of said rectifier, and means for rotating the rotatable winding of said second named transformer to change the phase relation of the outputs of the secondary windings with respect to each other.

7. In a system of control, in combination, a transformer having a primary winding and a secondary winding, a variable transformer having a primary winding and a secondary winding, one of said windings being rotatable whereby the phase position of the output of the secondary may be varied, a potentiometer, a pair of terminals energized with alternating current, the primary winding of the first named transformer and the potentiometer being connected directly across said terminals, circuit means for connecting the primary of the second named transformer across any selected portion of said potentiometer to thus vary the magnitude of the voltage output of the secondary of the second named transformer, a pair of terminals energized with direct current, a series circuit connected across said direct current terminals, said series circuit including a rheostat, an electric load unit, and a full-wave rectifier with its direct current terminals connected in the series circuit, said secondary windings of said transformers being connected in series across the alternating current terminals of said rectifier, and means for changing the speed of rotation of the rotatable winding of the second named transformer.

8. In a system of control, in combination, a transformer having a primary winding and a secondary winding, a variable transformer having a primary winding and a secondary winding, one of said windings being rotatable whereby the phase position of the output of the secondary may be varied, a potentiometer, a pair of terminals energized with alternating current, the primary winding of the first named transformer and the potentiometer being connected directly across said terminals, circuit means for connecting the primary of the second named transformer across any selected portion of said potentiometer to thus vary the magnitude of the

voltage output of the secondary of the second named transformer, a pair of terminals energized with direct current, a series circuit connected across said direct current terminals, said series circuit including a rheostat, an electric load unit, and a full-wave rectifier with its direct current terminals connected in the series circuit, said secondary windings of said transformers being connected in series across the alternating current terminals of said rectifier, means for rotating the rotatable winding of said second named transformer to change the phase relation of the outputs of the secondary windings with respect to each other, and means for changing the speed of rotation of the rotatable winding of the second named transformer.

9. In a system of control, in combination, a first transformer having primary and secondary windings, a second transformer of the inductor generator type having a stationary primary winding and a rotatable secondary winding, a potentiometer, a pair of terminals energized with alternating current, said potentiometer and primary winding of the first transformer being connected across said terminals and the primary winding of the second transformer being connected across any selected portion of the potentiometer, whereby the voltage output of the second transformer may be varied at will, a full-wave rectifier, said secondary windings being connected in series across the alternating current terminals of the rectifier, whereby a direct current voltage component appears at the direct current terminals of the rectifier that is a function of the combined voltages of the secondaries, a load circuit, including a source of direct current potential connected to the direct current terminals of the rectifier, and means for rotating the rotatable secondary winding to cause the phase relation of the outputs of the secondary windings to alternately change from a position of full phase opposition to full phase coincidence.

10. In a system of control, in combination, a first transformer having primary and secondary windings, a second transformer of the inductor generator type having a stationary primary winding and a rotatable secondary winding, a potentiometer, a pair of terminals energized with alternating current, said potentiometer and primary winding of the first transformer being connected across said terminals and the primary winding of the second transformer being connected across any selected portion of the potentiometer, whereby the voltage output of the second transformer may be varied at will, a full-wave rectifier, said secondary windings being connected in series across the alternating current terminals of the rectifier, whereby a direct current voltage component appears at the direct current terminals of the rectifier that is a function of the combined voltages of the secondaries, a load circuit, including a source of direct current potential connected to the direct current terminals of the rectifier, means for rotating the rotatable secondary winding to cause the phase relation of the outputs of the secondary windings to alternately change from a position of full phase opposition to full phase coincidence, and means for changing the operating characteristic of the means for rotating the rotatable secondary winding.

11. In a system of control, in combination, a first transformer having primary and secondary windings, a second transformer of the inductor generator type having a stationary primary winding and a rotatable secondary winding, a potentiometer, a pair of terminals energized with alternating current, said potentiometer and primary winding of the first transformer being connected across said terminals and the primary winding of the second transformer being connected across any selected portion of the potentiometer, whereby the voltage output of the second transformer may be varied at will, a full-wave rectifier, said secondary windings being connected in series across the alternating current ter-

minals of the rectifier, whereby a direct current voltage component appears at the direct current terminals of the rectifier that is a function of the combined voltages of the secondaries, an alternator connected to an electric load, a field winding for the alternator, a pair of direct current terminals energized with direct current of a selected voltage value, a rheostat for varying the excitation of the alternator field winding, a motor coupled to drive the alternator, said motor having a field winding, a rheostat for varying the effective resistance of the motor field winding circuit, a load circuit connected across the direct current terminals of the full-wave rectifier, said load circuit including the motor field winding, the rheostat for changing the effective resistance of the motor field winding circuit, and the direct current terminals.

12. In a system of control, in combination, a first transformer having primary and secondary windings, a second transformer of the inductor generator type having a stationary primary winding and a rotatable secondary winding, a potentiometer, a pair of terminals energized with alternating current, said potentiometer and primary winding of the first transformer being connected across said terminals and the primary winding of the second transformer being connected across any selected portion of the potentiometer, whereby the voltage output of the second transformer may be varied at will, a full-wave rectifier, said secondary windings being connected in series across the alternating current terminals of the rectifier, whereby a direct current voltage component appears at the direct current terminals of the rectifier that is a function of the combined voltages of the secondaries, an alternator connected to an electric load, a field winding for the alternator, a pair of direct current terminals energized with direct current of a selected voltage value, a rheostat for varying the excitation of the alternator field winding, a motor coupled to drive the alternator, said motor having a field winding, a rheostat for varying the effective resistance of the motor field winding circuit, a load circuit connected across the direct current terminals of the full-wave rectifier, said load circuit including the motor field winding, the rheostat for changing the effective resistance of the motor field winding circuit, and the direct current terminals, and means for rotating the rotatable secondary winding to cause the phase relation of the outputs of the secondary windings to alternately change from a position of phase opposition to a phase coincidence.

13. In a system of control, in combination, a first transformer having primary and secondary windings, a second transformer of the inductor generator type having a stationary primary winding and a rotatable secondary winding, a potentiometer, a pair of terminals energized with alternating current, said potentiometer and primary winding of the first transformer being connected across said terminals and the primary winding of the second transformer being connected across any selected portion of the potentiometer, whereby the voltage output of the second transformer may be varied at will, a full-wave rectifier, said secondary windings being connected in series across the alternating current terminals of the rectifier, whereby a direct current voltage component appears at the direct current terminals of the rectifier that is a function of the combined voltages of the secondaries, an alternator connected to an electric load, a field winding for the alternator, a pair of direct current terminals energized with direct current of a selected voltage value, a rheostat for varying the excitation of the alternator field winding, a motor coupled to drive the alternator, said motor having a field winding, a rheostat for varying the effective resistance of the motor field winding circuit, a load circuit connected across the direct current terminals of the full-wave rectifier, said load circuit including the motor field winding, the rheostat for changing the effective resistance of the motor field winding circuit, and the direct current terminals, and means for changing the rotating characteristic of the means for rotating the rotatable secondary winding.

14. In a system of control, in combination, a first transformer having primary and secondary windings, a second transformer of the inductor generator type having a stationary primary winding and a rotatable secondary winding, a potentiometer, a pair of terminals energized with alternating current, said potentiometer and primary winding of the first transformer being connected across said terminals and the primary winding of the second transformer being connected across any selected portion of the potentiometer, whereby the voltage output of the second transformer may be varied at will, a full-wave rectifier, said secondary windings being connected in series across the alternating current terminals of the rectifier, whereby a direct current voltage component appears at the direct current terminals of the rectifier that is a function of the combined voltages of the secondaries, an alternator connected to an electric load, a field winding for the alternator, a pair of direct current terminals energized with direct current of a selected voltage value, a rheostat for varying the excitation of the alternator field winding, a motor coupled to drive the alternator, said motor having a field winding, a rheostat for varying the effective resistance of the motor field winding circuit, a load circuit connected across the direct current terminals of the full-wave rectifier, said load circuit including the motor field winding, the rheostat for changing the effective resistance of the motor field winding circuit, and the direct current terminals, means for rotating the rotatable secondary winding to cause the phase relation of the outputs of the secondary windings to alternately change from a position of phase opposition to a phase coincidence, and means for changing the rotating characteristic of the means for rotating the rotatable secondary winding.

References Cited in the file of this patent

UNITED STATES PATENTS

2,001,557	Von Ohlsen	May 14, 1935
2,036,441	Swanson	Apr. 7, 1936
2,320,896	Snyder	June 1, 1943
2,431,501	Phillips	Nov. 25, 1947