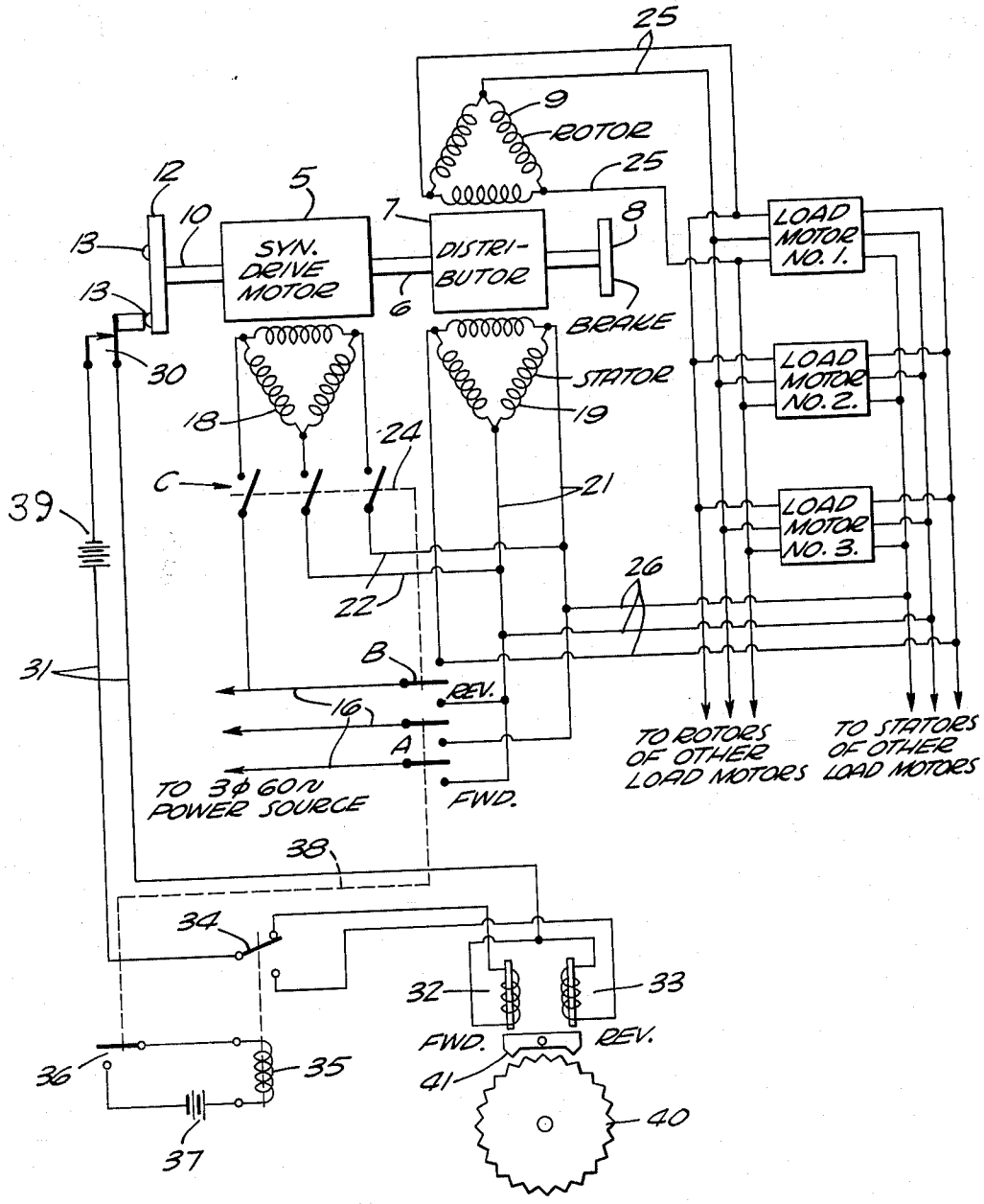
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REVERSIBLE SYNCHRONOUS RERECORDING SYSTEM

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REVERSIBLE SYNCHRONOUS RERECORDING SYSTEM

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This invention relates to a motion picture sound track rerecording system, and particularly to a load motor control to permit forward and reverse advancement of a plurality of films in synchronism at all times. This application is a continuation of application Serial No. 230,220, filed October 12, 1962, now abandoned, entitled "Reversible Synchronous Rerecording System."

The use of selsyn or self-synchronous interconnected motor systems is well known, as evidenced by Kellogg U.S. Patent No. 2,295,664, Miller U.S. Patent No. 2,354,329, Bloomberg et al. U.S. Patent No. 2,445,820, and Hittle et al. U.S. Patent No. 2,833,972.

The general principle of operation of such systems is the use of a three-phase synchronous drive motor mechanically driving a distributor or rotating transformer which has its rotor connected to the rotors of the load motors and its stator connected to the stators of the load motors.

In the production of motion pictures, the picture is usually recorded on a picture film, and the dialogue and music are recorded on a separate sound film which may be a photographic or magnetic recording or a combination of both. Subsequently, other background sounds from photographic or magnetic films are introduced into the dialogue record, such sounds being of different characters, such as hoofbeats, thunder, music, etc., which are used to enhance the depicting of the picture story. Each of the films is reproduced in separate sound reproducers driven in synchronism by individual load motors.

To obtain the proper balance between the amplitudes and positions of the sound sequences of the various sound tracks with respect to one another, the sequences are rehearsed several times. During rehearsal, thousand-foot reels and loops are generally used, seach reel containing a number of sequences.

During the first rehearsal period, certain of the sound records are properly mixed, while others may not be and can be improved. Thus, it is necessary to repeat the undesired combination of sound sequences in order to provide the desired over-all combination. In the past, it has been necessary to run all of the reels out, then rewind the reels and again set their sync mark for a rerun of the entire reels and loops. It is obvious that not only is this time-consuming but provides opportunities for film damage and for errors in previously properly mixed sequences.

The present invention contemplates a system whereby the many motors driving the several sound reproducers, picture projector, etc., may be reversed at any time during reproduction of the various records without losing synchronism. This permits the sequences within the reels to be repeated as often as necessary regardless of their positions within the reels and the length of the reels. After the repeated sequences are satisfactory, rerecording of the remaining sequences in the reels or loops is continued. It is, therefore, unnecessary to run the films to their ends,

rewind and rethread them, which will repeat the satisfactorily mixed sequences, and which is not desired.

To obtain reversal of the drive motor, distributor, and the load motors which have various loads thereon, it is necessary to properly control the energization and deenergization of the drive motor, distributor, and load motors in a special manner. The present invention permits this operation for the first time without losing sync of any load motor with respect to the others regardless of the variation in loads on the load motors.

The principal object of the invention, therefore, is to facilitate the rerecording of multiple sound records into a single record.

Another object of the invention is to provide an improved method of and system for rerecording which permits the repetition of any particular sequences within reels without losing sync with other records being combined to a single record.

A further object of the invention is to provide an improved control for a self-synchronous motor drive system which permits a reversal of all load motors in synchronism together with a counting system which indicates the film footage at all times regardless of the direction of advancement of the various films, the sounds on which are being combined.

A better understanding of this invention may be had from the following detailed description when read in conjunction with the single figure, which is a diagrammatic circuit embodying the invention.

Referring, now, to the drawing, a three-phase synchronous drive motor **5** is connected by a shaft **6** to a distributor or rotating transformer **7**. A brake **8** may or may not be used for increasing the deceleration of the motor **5** and distributor **7**. On a shaft **10** of the drive motor is a cam wheel **12** having three cams **13** spaced 120 degrees apart, although other forms of impulse-producing devices may be used.

Power is supplied from three-phase conductors **16** connected to switch A for one phase of the 60-cycle power supply, and switch B for the other two phases of the power supply.

The synchronous drive motor **5** has windings **18** connectable to the three-phase 60-cycle power supply over switch C, while stator windings **19** of the distributor **7** are similarly connectable to the power supply. Switch A is a reversing switch which when thrown to its lower position will apply energy to conductors **21** of the distributor stator and conductors **22**, which go to switch C, of the synchronous drive motor with a certain polarity. When switch A is thrown to its upper position, these conductors **21** and **22** will be reversed. It will be noted by the dotted lines **24** that switch B is mechanically connected to switch C, and these switches are thus actuated simultaneously to start the motor **5** and distributor **7** in either direction, depending upon the position of switch A.

The rotor **9** of the distributor **7** is connected over conductors **25** to the rotors of load motors No. 1, No. 2, and No. 3, and to the rotors of any other load motors, the number of which may at times be in the neighborhood of from twenty to thirty. The stator **19** of the distributor is connected over conductors **26** to the stators of load motors No. 1, No. 2, and No. 3, and to the stators of any other load motors, which may at times be in the neighborhood of from twenty to thirty motors. Thus, when switch A reverses the distributor conductors **21** and

the synchronous drive motor conductors 22, the phase of the stators of all the load motors will also be reversed.

It is well known that to operate such a system, the speed of the distributor is such that the interlock frequency of the current generated in the distributor rotor 19 is the right frequency to provide the tightest interlock for the particular system. To illustrate for a particular sound recording system of a standard type, this interlock frequency has been found to be 20 cycles per second when the frequency of the power source is 60 cycles per second. In this system, the rotor of the distributor rotates at a speed to generate 40 cycles per second. Thus, the interlocking frequency of the current in the conductors 25 to the rotors of the load motors is 60–40 or 20 cycles per second. This frequency of the interlocking current has been found to be the optimum for such a self-synchronous system and one which will maintain many load motors interlocked even when the loads on the load motors vary considerably.

Such a system can be rotationally reversed by simply reversing only the one phase of the drive motor. However, this action will create an interlocking frequency of 100 cycles per second obtained by adding the 60 cycles of the power source to the 40 cycles of the distributor. This frequency of the interlocking current will not insure the maintaining of synchronism of all the load motors, particularly when the loads thereon vary. However, by reversing the phase of the distributor stator and the phase of the stators of the load motor simultaneously with the reversal of a phase of the drive motor, optimum interlocking current is obtained regardless of the direction of rotation of the system. Although this appears to be a simple modification of the usual type of self-synchronous drive motor system for rerecording, it is one which will permit the reversal of any length of film and the repetition thereof as many times as necessary and at optimums conditions of interlock at all times.

The above system just described is started in the normal manner by first threading the film in the projector and sound reproducer at the editor's sync marks and throwing switch A to its lower position for forwardly advancing the films by their respective load motors. This action will energize conductors 21 and 22 and one phase of the load motors which will align the distributor and load motor rotors in standstill "hold" or "lock-up" positions. After lock-up, the starting position of all film may again be checked. Rotation of the system is then started by closing the switches B and C which will energize the drive motor and the other two phases of the distributor and load motors. The films will then be accelerated in synchronisum until the desired speed is reached and will then remain in synchronism when advanced at uniform speed.

To stop the system, it is only necessary to open switches B and C, which will remove the power from the drive motor and from the two phases of the distributor and load motors while maintaining one phase energized. In this manner, the entire system will coast to a standstill while the load motors will remain interlocked in their original positions. If rerecording is completed, the switch A is opened.

Now, to reverse the system, switch A is thrown to its upper contacts, reversing the conductors 21 and 22 and the phase of the stators of the load motors. The system is then started as described above by closing switches B and C, and all of the motors will rotate in the reverse direction with the same reliability of interlock as when rotated in the forward direction.

Referring, now, to the film-counting portion of the system, a switch 30 is actuated by the cams 13 of the disc 12 three times per revolution of the disc. The switch 30 is connected over conductors 31 and battery 39 to a forward counting relay 32 and a reverse counting relay 33 to the swinger 34 of a relay 35. The relay 35 is actuated by a switch 36 in series with a power supply 37.

The normal position of the swinger 34 is as shown in the drawing which connects the forward counting relay 32 with the switch 30. When the switch 36 is actuated, the swinger 34 is moved to its lower contact which connects the switch 30 to the reverse counting relay 33. The counting relay consists of a toothed wheel 40 and a reversing pawl 41. Thus, the impulse actuation of relay 32 will move the pawl one notch while the actuation of relay 33 will reverse the pawl one notch, the pawl 40 being a unit pawl which may indicate feet or frames, other indicia counting wheels of a normal multiple counter system being connected thereto. Thus, when the motor system is reversed by actuating switch A, switch 36 may be simultaneously actuated, as shown by the dotted lines 38, so that upon reversal of the system, the counter will reverse its counting of the film footage so the operator or mixer knows at all times what point in the reel is being reproduced or the position of the film during reversal.

The counter system may be provided with means for actuating switches B and C at any predetermined point between the ends of the film on the reels and particularly at the ends of the film reels to prevent runouts at either end.

As mentioned above, such a reversal system for a self-synchronous motor driven sound rerecording system permits repeating sequences on multiple films at any point between the ends of the reels with reliability with respect to the loss of sync. Thus, much time is saved as well as reducing the handling of the many films used in rerecording.

We claim:

1. In a system for maintaining synchronism between any combination of a plurality of sound reproducing machines, at least one recording machine, and at least one motion picture projector, said machines and said projector having load motors, a distributor, and a synchronous drive motor for said distributor, each of said load motors and said distributor having stator and rotor windings, said drive motor, said distributor, and said load motors being adapted to be connected to a three-phase power source, connections between said distributor rotor winding and said rotor windings of said load motors, means for simultaneously connecting one phase of said power source to one phase of said distributor stator winding and one phase of each of said stator windings of said load motors, and means for subsequently and simultaneously connecting to said power source, the other two phases of said distributor stator winding, the other two phases of said load motors and the three phases of said synchronous drive motor to drive said load motors in synchronism in one direction, said first-mentioned means being adapted to simultaneously reverse said one phase of said power source as impressed on said one phase of said drive motor, said one phase of said distributor stator winding, and said one phase of said load motor stator windings, said second-mentioned means being adapted to subsequently and simultaneously connect the other two phases of said power source to the other two phases of said distributor stator winding, the other two phases of said load motor stator windings and the three phases of said drive motor, thereby causing said drive motor, said distributor, and said load motors to run in reverse direction to the end that said load motors are driven in synchronism at all times in both directions.

2. A system in accordance with claim 1 in which means are provided for counting the rotation of said distributor and drive motor in both directions of rotation.

3. A system in accordance with claim 1 in which the frequency of the current of said power source is 60 cycles per second, the output frequency of the current from said distributor rotor is 40 cycles per second, and the frequency of the interlocking current between said distributor and load motor rotors is 20 cycles per second during rotation thereof in both of said directions.

4. In a system for maintaining the optimum interlocking synchronous frequency between any combination of a plurality of sound reproducing machines, at least one recording machine, and at least one motion picture projector, said machines and projector having load motors, a distributor, and a synchronous drive motor for said distributor, each of said load motors and said distributor having stator and rotor windings, said drive motor, said distributor, and said load motors being adapted to be connected to a three-phase power source, means for connecting said load motors, said three-phase source to drive said motors in a certain direction, the frequency of said three-phase source providing the optimum frequency of the interlocking current between said load motors and said distributor, and means for driving said load motors in the reverse direction with the same frequency as the interlocking frequency of the current between said load motors and said distributor, said interlocking current being obtained by reversing one phase of said drive motor, distributor, and said load motors.

5. A system in accordance with claim 4 in which the frequency of current of said three-phase source is 60 cycles per second and the frequency of the interlocking current between said distributor and said load motors is 20 cycles per second in either direction of rotation.

6. A system in accordance with claim 4 in which the number of rotations of said distributor is counted when said distributor is rotated in either direction.

7. In a system for maintaining synchronism between any combination of the plurality of movable sound reproducing or recording machines and motion picture projectors when driven in either direction comprising a synchronous drive motor, a distributor mechanically connected to said drive motor, said distributor having stator and rotor windings and said drive motor having three-phase windings, a plurality of load motors, each of which has a stator windings and a rotor winding, means for interconnecting said rotor windings of said load motors and said rotor winding of said distributor to transmit interlocking current of a certain frequency from said distributor to said load motors, means for interconnecting said stator windings of said load motors, said stator winding of said distributor, and the winding of said drive motor, said drive motor windings, said windings of said load motors, and said winding of said distributor being adapted to be connected to a three-phase power source, and switching means for making a said last-mentioned connections, said switching means including a first means for first simultaneously connecting one phase of said three-phase power source to one phase of said distributor stator winding, one phase of said load motor stator windings, and a second means for subsequently and simultaaneously connecting the other two phases of said power source to the other two phases of said load motor stator windings, the other two phases of said distributor stator winding and the three phases of said drive motor, said first means being adapted to reverse the connections of said one first -mentioned phase of said power source to said first-mentioned phase of said load motor stator windings, said distributor stator winding and said first-mentioned phase of said drive motor to reverse the direction of rotation of said drive motor, said distributor and said load motors, said load motors rotating in their original synchronous position at all times in either direction and with an interlocking current of said certain frequency.

8. A system in accordance with claim 7 in which said interlocking current has the same frequency in each direction of rotation of said load motors, said frequency being determined by the difference between the frequency of the current from said power source and the frequency of the current from said distributor, the frequency of said interlocking current being the optimum frequency to maintain synchronism of said load motors in either direction of rotation thereof.

9. A system in accordance with claim 7 in which a rotation counting system is provided, said system including means for connecting said system to said drive motor and switching means for reversing the direction of rotation of said counting system, said means being interconnected with said reversing switching means for said motors.

10. In a system for maintaining synchronism between any combination of a plurality of sound reproducing machines or recording machines and at least one motion picture projector when driven in either direction, a synchronous drive motor, a distributor having stator and rotor windings, a plurality of load motors to be driven in synchronism with each other, each of said load motors having stator and rotor windings, said drive motor, said distributor, and said load motors being adapted to be connected to a three-phase power source, connections between said rotor winding of said distributor and the rotor windings of said load motors, a first switch for simultaneously connecting one phase of said power source through said first switch to one phase of said distributor stator winding and one phase of each of said stator windings of said load motors, and a second switch for subsequently and simultaneously connecting through said second switch the two other phases of said power source to the three phases of said drive motor winding, the other two phases of said distributor stator winding and the other two phases of said load motor stator windings for driving said load motors in synhcronism in one direction, said first-mentioned switch being adapted to simultaneously reverse said first-mentioned phase of said power source as impressed on said one phase of said drive motor, said one phase of said distributor stator winding, and said one phase of each of said load motors stator windings to drive said load motors in synchronism at all times in either the reverse direction or their original direction when said second switch is closed.

11. A system in accordance with claim 10 in which a rotation counting system is provided, said system including a third switch mechanically connected to said first switch for reversing the operation of said counting system.

12. In a system for maintaining the optimum interlock frequency between any combination of a plurality of sound reproducing or recording machines and at least one motion picture projector when said machines and projector are driven in either forward or reverse direction, said machines and said projector having load motors, a distributor, and a synchronous drive motor for said distributor, each of said load motors and said distributor having stator and rotor windings, said drive motor, said distributor, and said load motors being adapted to be connected to a three-phase power source, means for starting said load motors in forward direction by first simultaneously connecting one phase of a three-phase power source to one phase of the stator windings of each of said load motors and to one phase of the stator winding of said distributor having the rotor windings thereof connected in parallel to the rotor windings of said load motors, and means for simultaneously connecting the other two phases of said power source to the other two phases of said distributor stator windings and the stator windings of said load motors and means for connecting the three phases of said power source to the three phase windings of said distributor drive motor, and means for reversing the direction of said load motors in synchronism with the same synchronization of said load motors when driven in said forward direction by first simultaneously disconnecting said three phase windings of said drive motor from said three-phase power source and said two phases of said power source from said two phases of said distributor and load motor stator windings, second simultaneously connecting said one phase of said distributor and load motor stator windings to said three-phase power source in reverse to said forward driving connections, and means for simultaneously connecting the other two phases

of said power source to said other two phases of the stator windings of said distributor and load motors and the three phases of said power source to the three phase windings of said drive motor, one of said three phases to said drive motor being reversed, the frequency of the interlocking current in said rotor windings remaining the same in both directions of rotation of said load motors for optimum interlock in both directions.

13. A system in accordance with claim **12** in which means are provided for continuously measuring the rotation of said load motors in both directions.

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