

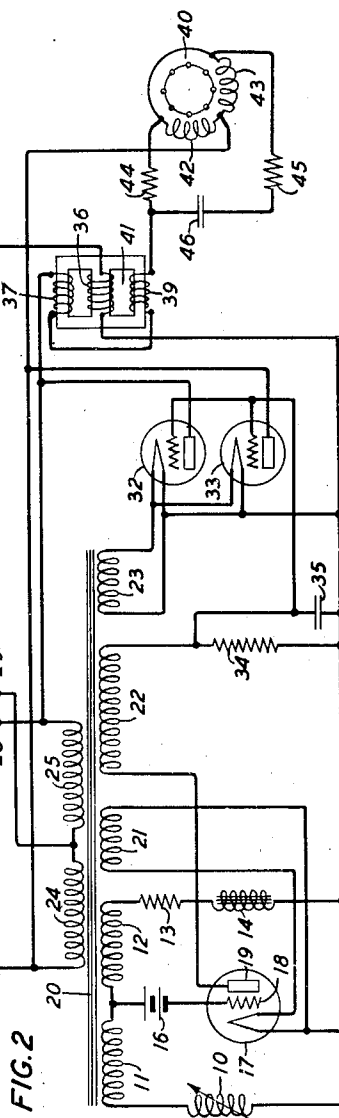
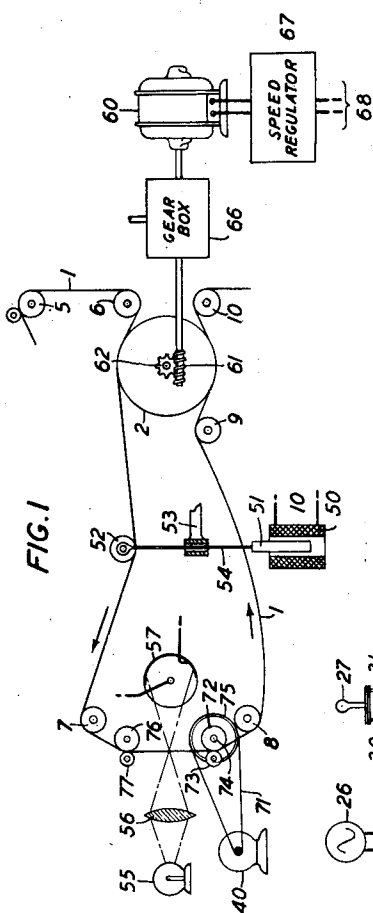
May 10, 1938.

H. M. STOLLER

2,116,586

STRIP FEEDING MECHANISM

Filed May 20, 1936



INVENTOR
H. M. STOLLER
BY
G. H. Nydt.
ATTORNEY

UNITED STATES PATENT OFFICE

2,116,586

STRIP FEEDING MECHANISM

Hugh M. Stoller, Mountain Lakes, N. J., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application May 20, 1936, Serial No. 80,802

17 Claims. (Cl. 271-2.3)

This invention relates to strip feeding mechanism in which separate motors are individual to driving rollers which feed the strip past successive positions in the route of said strip.

5 The invention is particularly useful in combination with strip feeding mechanism in which a plurality of driven members subject to variations in velocity must be synchronously operated. The velocity variations dealt with are mainly the result of irregularities in manufacture of the members, variations in the strip, or variations in load. A true example of a structure of this character is presented in sound picture apparatus and therefore the speed regulating arrangement according to the invention may be suitably applied to this apparatus. The invention, however, applies as well to paper, cloth, or strip metal feeding machinery in which the speed of motors and feed rollers must be regulated for feeding a strip over a route past successive positions for treatments of different character.

10 According to the present invention, as applied to sound picture recording machines, one motor drives all of the apparatus of the recording machine with the exception of the rollers which drive the record carrying strip past the point of sound translation. The latter rollers are driven by a separate motor. In the illustrated embodiment, these rollers are shown belt-connected to the motor and arranged for uniform velocity at a sustained velocity rate equivalent to the average velocity rate at which the film travels past the other rollers. The motor which drives the sound picture apparatus, with the exception of the sound gate rollers, is a constant speed motor carefully regulated by speed regulating apparatus. The motor which drives the film past the point of sound translation is adjusted to an average speed for driving the rollers to feed the film at the same average velocity as it is fed past the other rollers. It is, however, necessary in any mechanism of this character to compensate for velocity variations which may cause the travel of the film at one point to differ slightly from the travel of the film at another. In order to compensate for such variations, special speed regulating apparatus is associated with the motor which drives the film past the point of sound translation. This speed regulating apparatus includes a guide roller which rests upon a length of film extending between feed rollers in the sound picture apparatus and rollers which feed the film past the point of sound translation, the guide roller being linked to an adjustable inductance or impedance coil, with the impedance coil forming one

arm of an impedance bridge. The film between feed rollers is so adjusted as to maintain the adjustable impedance coil in position to balance the impedance bridge. As the length of film between feed rollers becomes shorter or longer, the movable element of the impedance coil is automatically altered by a change in the position of the guide roller which is linked to this movable element. Thermionic means is connected to the impedance bridge and arranged to be actuated by an unbalance of the bridge. In the form of the thermionic control circuit shown, a movement of the impedance coil element in one direction from its average position unbalances the bridge for increasing the speed of the motor and a movement of the impedance coil element in the opposite direction from its average adjustment reduces the speed of the motor. A change in the motor speed changes the speed of the rollers which shortens or lengthens the extent of film between rollers. As soon as the length of film is changed sufficiently to readjust the movable element of the impedance coil to its average position, the bridge is again balanced and the motor and the film feeding rollers again run at normal running speed. The driving elements for feeding the film past the point of sound translation are thus maintained at all times in synchronous relation with the remainder of the driving elements of the sound picture apparatus.

It is not the intention to limit the arrangement of the bridge to an adjustable impedance coil since an adjustable condenser or resistance may be substituted for the solenoid shown. In this case the fixed impedance coil in the opposite arm is replaced by a matched condenser or resistance.

Fig. 1 illustrates an arrangement according to the invention for controlling strip propelling mechanism by the action of a device operated by the variations in a strip loop.

Fig. 2 illustrates the motor speed controlling circuit operatively responsive to variations in the strip loop.

The structure as disclosed in Fig. 1 comprises a film strip 1, apparatus for feeding the strip to various parts of a sound picture machine and apparatus for feeding the strip through a sound translating unit. Motor 60 is operated for moving the film at a uniform sustained rate of travel under the control of well-known speed regulating apparatus shown diagrammatically by the rectangle 67. This motor is connected through gears located in the gear box 66 to the roller or sprocket 2 and also to a majority of the film

feeding mechanism of the sound picture apparatus for synchronizing the overall rate of travel of the film at various points. In order to eliminate substantially all variations in the movement of the film which would cause distortion in the sound translations, the film is fed past the point of sound translation by smooth pinch rollers 72—73 and 76—77, the roller 72 being driven by a separate split phase induction motor 40. A flywheel 75 may be mounted on the shaft with pinch roller 72 to insure uniform motion of the rollers 72—73. A series of guide rollers, such as 6, 7, 8, 9, and 10, are used to properly position the film with relation to the feeding rollers.

The two motors 40 and 60 are designed to drive the film at the same speed but due to imperfections in the film strip and the inherent creep of the film as it passes over the rollers a difference in the speed of travel of the strip occurs and is made apparent by a change in the amount of slack in the strip between the rollers driven by the different motors. Associated with the strip between rollers 2 and 7 is an adjustable device in the form of a sliding core impedance coil under the control of a roller 52 which is connected to the impedance coil core by link 54 extending through the guide member 53. If for any reason there is a difference in the speed of travel of the film over rollers 2 and 7 such as would be caused by a slight difference of the speed of the two rollers or when slippage of the film on the rollers takes place, the slack loop between rollers 2 and 7 becomes smaller or larger which changes the impedance of the coil 10.

Referring now to Fig. 2, it will be apparent that a change in the impedance of coil 10 balances and unbalances a bridge circuit for altering the speed of motor 40. An electric circuit employing an impedance bridge and vacuum tube controlled rectifiers is used to vary the speed of motor 40 in response to variations in the impedance of the coil 10. The power supply for the phase detector tube 17 and the rectifier tubes 32 and 33 and for the primary of the bridge circuit is obtained from a transformer 20 whose primary coils 24 and 25 are connected to a power supply 26 which is preferably 60-cycle alternating current. The bridge circuit comprises three fixed arms 11, 12, 13—14 and one variable arm consisting of the impedance coil 10. Potential is impressed on the bridge through arms 11 and 12 which are secondary coils of the transformer 20. Arm 13—14 is composed of resistance 13 and retardation coil 14. The retardation coil 14 in the arm 13—14 is used in this bridge to exactly balance the impedance of the impedance coil 10 when the movable element is in what may be termed its normal position, i. e., when the slack strip between rollers 2 and 7 is in the normal position shown and, consequently, the strip is running at the same speed past the two rollers. One side of the circuit of the alternating current is extended from source 26 through terminals 30 and 28 of switch 27, coils 37 and 39 of the reactor 41 to the outer terminals of the windings 42 and 43 of the split phase motor 40. The opposite side of the alternating current source is connected to a central point between these windings. The filament of tube 17 is energized by alternating current from the secondary coil 21 of transformer 20 and the filaments of tubes 32 and 33 are energized by alternating current from the secondary transformer coil 23.

In the specific embodiment herein disclosed periodic electric potentials are separately impressed upon the grid 18 and plate 19 of the phase

detector tube 17 which is a half-wave rectifier. These potentials are of substantially the same frequency but of a different phase and magnitude, the phase of the potential on the grid 18 being regulated by the adjustable impedance 10. The grid biasing potential 16 is so adjusted that all values of impressed alternating potential are effective to vary the value of the impulse current that flows in the plate circuit during the half-cycles when positive potentials are impressed on the plate through winding 22 of transformer 20. The current flow over the plate circuit is dependent upon the overlapping periods of the positive potentials impressed upon the grid 18 and plate 19 and, therefore, upon the phase difference of the potentials impressed upon these electrodes. This may be represented by two sine waves of the same frequency with one wave out of phase with the other so that the positive halves of the waves overlap each other. A maximum and minimum position for the grid potential wave may be used to show the duration of the period when the grid and plate are simultaneously positive. When the strip 1 is running at normal velocity with the movable element of impedance 10 in the normal position for balancing the bridge the phase difference is such as to produce a normal current flow through the control circuit and maintain the motor 40 running at a normal speed. As soon, however, as a change in strip velocity takes place, which alters the impedance of coil 10, there results a relative change in phase and magnitude between the two sets of impressed potentials with consequent change in coincidence of positive potentials on the two electrodes which changes the current flow through the associated control circuit.

When the bridge is balanced there is a normal value of direct current pulsations as the plate 19 goes positive within each half cycle of current from the alternating supply. These pulses are stored in condenser 35 producing a comparatively steady direct current potential drop across the coupling resistance 34. This voltage drop is employed as negative C bias on the rectifier tubes 32 and 33 which pass a corresponding normal direct current through the control winding 36 of the saturating reactor 41. Corresponding to this value of direct current is a normal value of alternating current impedance in windings 37 and 39 which controls the current supply to the split phase motor 40. This provides a normal current value for running the motor 40 at the same speed as the motor 60. The output circuit of the full wave rectifier may be traced from the plate of tube 32 through winding 25 of transformer 20, terminals 29—31 of switch 27 winding 36 of reactor 41 to the filament and from the plate of tube 33 through winding 24 of transformer 20, terminals 29—31 of switch 27, winding 36 of reactor 41 to the filament.

Let it be assumed that for some reason such an increase in load or a reduction in line voltage the speed of motor 40 is momentarily reduced or that for other reasons given herein, the slack of the strip is increased between rollers 2 and 7. The movable element 51 of the impedance coil 10 is consequently lowered thereby increasing the impedance of the solenoid 10 to unbalance the bridge circuit. The output potential of the bridge is so poled with respect to the phase of winding 22, which supplies potential to the plate 19, that a decrease in current through tube 17 takes place. The increase in impedance changes the phase of the potential impressed upon the grid 18 suf-

ficiently to reduce the overlapping period of the positive potentials impressed upon the grid and plate. The voltage drop across the coupling resistance 34 is thus reduced which causes an increase in plate current through the rectifier tubes 32 and 33 and, consequently, through the direct current winding 36 of the saturating reactor 41. This reduces the impedance of the alternating current windings 37-39 which causes an increase in the current supply to the motor 40. The speed of the motor is therefore increased sufficiently to shorten the slack in the loop between rollers 2 and 7 and the idler 52 is raised until the movable element 51 of the coil 10 returns to its normal position for again balancing the bridge circuit and restoring the motor 40 to its normal running speed. Conversely, if the speed of motor 40 should be increased or for some other reason the slack loop between rollers 2 and 7 should decrease, the bridge will be unbalanced in the opposite direction to that previously described, since the impedance of coil 10 is reduced by the elevation of the movable element 51. The decrease in impedance causes a phase and magnitude difference in the potential impressed upon grid 18 of such character as to increase the overlapping period of the positive potentials impressed upon the grid 18 and plate 19. This results in an increase of current over the plate circuit and an increase in the voltage drop across the coupling resistance 34 and a decrease in the plate current of rectifier tubes 32 and 33. There is, consequently, a decrease in the current through the direct current winding 36 and an increase in the impedance of windings 37-39 which causes a decrease in the current supply to motor 40. The speed of the motor is, therefore, temporarily reduced until the repositioning of the movable element of the impedance coil 10 takes place for again balancing the bridge circuit.

It is not the intention to limit the invention to the specific embodiment herein disclosed but to apply this control method as described to various systems which require relative motor speed control.

What is claimed is:

1. In a strip feeding system having different mechanically independent speed regulated motors for feeding the strip, a master speed regulator for sustaining one of said motors at a uniform rate of speed and an adjustable speed regulator for another of said motors, said adjustable speed regulator including a balanced impedance bridge circuit with an impedance in one arm adjusted by a device associated with the strip for unbalancing the bridge to create a phase difference in the potentials of the regulator according to a difference in speed of said motors and to create an electric current to compensate for the difference in speed between the motor regulated thereby and the master speed regulated motor.

2. In a strip feeding system having different mechanically independent speed regulated motors for feeding the strip, a master speed regulator for sustaining one of said motors at a uniform rate of speed and an adjustable speed regulator for another of said motors, said adjustable speed regulator including a balanced impedance bridge circuit with an impedance in one arm adjusted by a device associated with the strip for unbalancing said bridge to create a phase difference in the potentials of the regulator according to a difference in speed of said motors and to create an electric current for changing the current flow through the operating windings of the motor con-

trolled thereby to compensate for the difference in speed between said motors.

3. In a strip feeding system having rollers in different positions for feeding the strip and a plurality of electric motors which are mechanically independent for driving the different rollers, different speed regulating apparatus for the separate motors including regulating apparatus for controlling a uniform sustained rate of speed and adjustable speed regulating apparatus, said adjustable speed regulating apparatus comprising a balanced impedance bridge circuit and a phase detector tube controlled by an adjustable impedance in one bridge arm for unbalancing said bridge to alter the phase difference of potentials impressed on the electrodes of said tube and the current flow therefrom, a device associated with the strip between different rollers for adjusting said impedance and means actuated by a change in the impedance of said bridge for altering the driving current for the motor regulated thereby to maintain synchronous relation between said motors.

4. In a strip feeding system having rollers in different positions for feeding the strip and a plurality of electric motors which are mechanically independent for driving the different rollers, different speed regulating apparatus for the separate motors including regulating apparatus for controlling a uniform sustained rate of speed and adjustable speed regulating apparatus, said adjustable speed regulating apparatus comprising a balanced impedance bridge circuit and a phase detector tube controlled by an adjustable impedance in one bridge arm which unbalances the bridge for altering the phase difference of potentials impressed on the electrodes of said tube and the current flow therefrom, a device associated with the strip between different rollers for adjusting said impedance, and means including a saturating reactor actuated by a change in said current flow for altering the driving current for the motor regulated thereby to maintain synchronous relation between said motors.

5. In a strip feeding system having rollers in different positions for feeding the strip past said positions and a plurality of mechanically independent motors for driving the different rollers, means for maintaining synchronous relation in the feeding of said strip past said different positions comprising different speed regulating apparatus for the separate motors including master speed regulating apparatus and adjustable speed regulating apparatus, said adjustable speed regulating apparatus comprising a balanced impedance bridge circuit having potential impressed thereon of the same frequency as the operating potential for the motor regulated thereby and an adjustable impedance in one arm controlled by a loop of the strip for unbalancing the bridge when a nonsynchronous relation in feeding exists for creating a phase difference of the potentials between the input and output terminals of the bridge circuit and altering the current flow in the output circuit and a device responsive to changes in said current flow for regulating the operating current for the motor regulated thereby to adjust its speed in a compensating sense.

6. In a strip feeding mechanism, means for controlling the feeding velocity of said strip including an electric motor, an impedance bridge having an adjustable impedance forming one arm of said bridge, vacuum tube controlled rectifiers actuated in response to variations in the impedance of said adjustable arm and a saturat-

ing reactor responsive to changes in said rectifiers for controlling the current supply to said motor, and means associated with said strip for adjusting said impedance arm for balancing and unbalancing the bridge for controlling the current supply and consequently the speed of said motor.

7. In a strip feeding mechanism, means for controlling the feeding velocity of the strip including a motor and regulating means for altering the speed of said motor, said regulating means comprising a phase detector tube and a balanced impedance bridge having an adjustable impedance for unbalancing the bridge to control the phase relation of potentials impressed on two of the electrodes of said tube for regulating the current supplied to said motor, and means under the control of the strip for adjusting the impedance of said bridge.

8. In a strip feeding mechanism, means for controlling the feeding velocity of the strip including a motor and regulating means for altering the speed of said motor, said regulating means comprising an impedance bridge having an adjustable impedance forming one arm thereof, a phase detector tube, means for impressing potentials of the same frequency over separate paths on two electrodes of said tube, one path being through the bridge circuit, rectifier tubes for regulating the current supplied to the motor, and means under the control of the strip for adjusting the impedance of the bridge to control the phase relation of the potentials on the electrodes of said phase detector tube for regulating the output of said rectifier tubes.

9. In a strip feeding system including an electric motor, means for controlling the feeding velocity of the strip comprising an impedance bridge circuit having potential impressed thereon of the same frequency as the operating potential of the motor and an adjustable impedance in one arm of said bridge controlled by the strip for altering the phase difference of the potentials between the input and output terminals of the bridge circuit and the current flow created by said phase difference and means including a saturating reactor responsive to such change in said current flow for controlling the operating current for said motor.

10. In a strip feeding system means for synchronizing the movement of the strip in different positions comprising a motor speed regulating circuit operated by the current supply for the power windings of the motor, said speed regulator having an impedance bridge circuit actuated by said current supply with an adjustable impedance in one arm which is adjusted by variations in the speed of the strip past different positions, a phase detector tube connected in a manner to transmit current according to the phase difference of the potentials impressed upon its electrodes by the adjustment of the bridge circuit and electrical devices including a rectifier regulated by said transmitted current for controlling the variation in current supplied to the power windings of the motors.

11. In a strip feeding system having different speed regulated motors for feeding the strip, a regulator for sustaining one motor at a uniform rate of speed and an adjustable speed regulator for a split phase induction motor, said adjustable speed regulator including an impedance bridge energized by a power source of the same frequency and phase as the motor controlled thereby and having an impedance in one arm adjusted by a device associated with the strip to create a phase difference to compensate for a difference in speed of said motors.

12. In a strip feeding system including a split phase induction motor, a strip loop-controlled variable impedance connected in a balanced bridge circuit, said bridge when unbalanced by said impedance varying the speed of said motor in a compensating sense.

13. In a strip feeding system including a split phase induction motor, a strip loop-controlled variable impedance connected in a balanced bridge circuit having a phase detector tube, a source of alternating current for actuating said bridge circuit and said motor and means connected with said bridge circuit responsive to an unbalance of said bridge for producing a current for varying the speed of said motor.

14. In a strip feeding system including an electric motor, a strip loop-controlled variable impedance connected in a balanced bridge circuit, said bridge in one directional unbalance creating currents to aid the current flow through the windings of said motor and in another directional unbalance reducing said current flow depending upon the variation in said impedance.

15. In a strip feeding system means controlling the speed of a motor for driving strip feeding mechanism at uniform velocity comprising an impedance bridge circuit with a variable impedance in one arm and a device therein responsive to the balancing and unbalancing of the bridge for maintaining the operating current of the motor normal, above normal and below normal depending upon the variation in said impedance from its normal value and a device associated with the strip for varying said impedance.

16. In a strip feeding system including an electric motor and a source of current supply for operating said motor, a variable impedance connected in a balanced bridge circuit providing a variable auxiliary source of current, a device independent of said motor energized by said auxiliary current for increasing and decreasing the current supply for operating the motor and a member associated with a loop of the strip for varying said impedance to cause an unbalance of said bridge circuit in either direction for controlling said auxiliary current.

17. In a strip feeding system having a motor for driving the strip, a reactance independent of the motor for controlling the current supply to the motor windings and a variable impedance balanced bridge circuit adjusted as to unbalance by variations in a loop of the strip for energizing said reactance.

HUGH M. STOLLER.