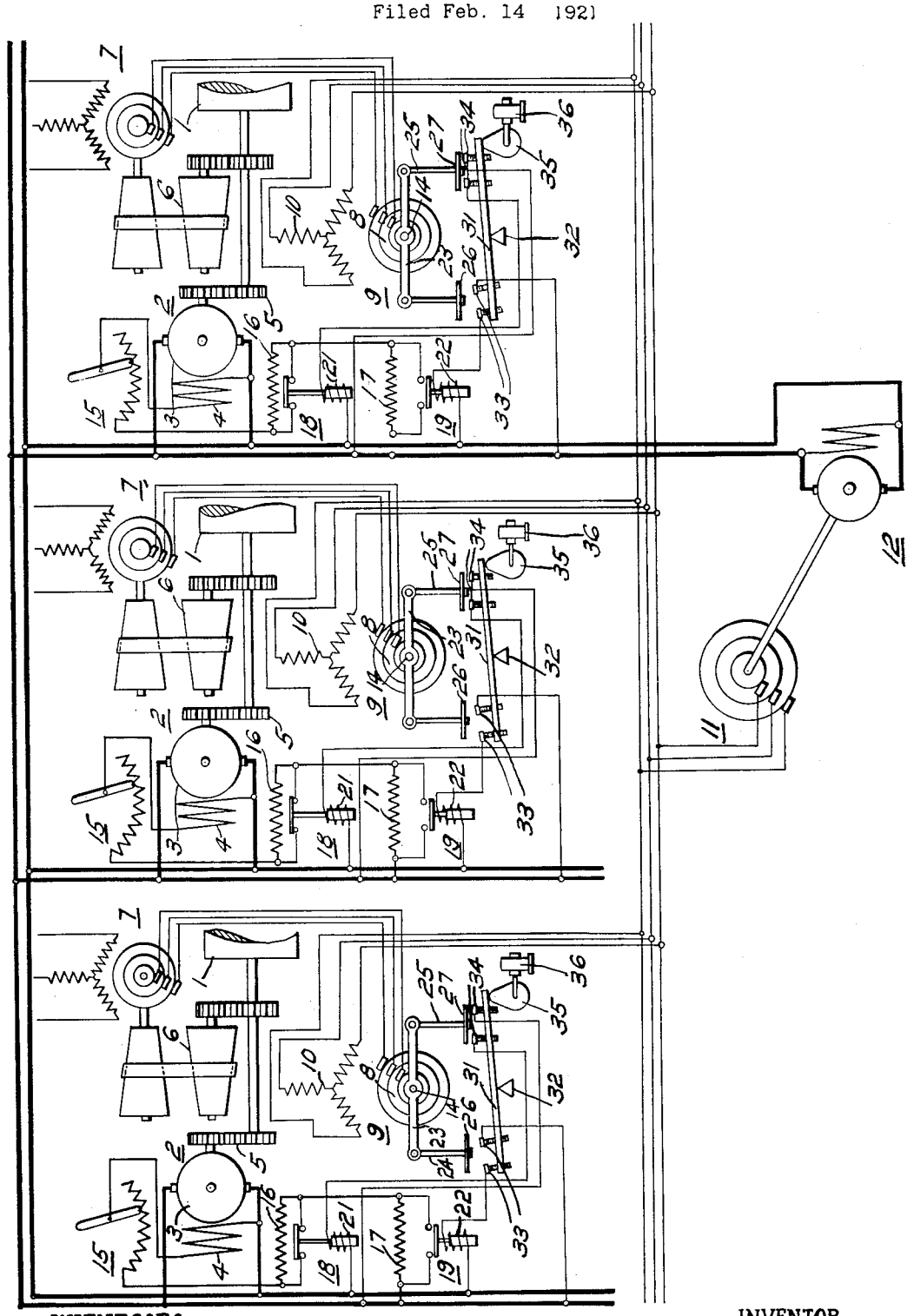
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S. A. STAEGE

SPEED REGULATOR SYSTEM

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UNITED STATES PATENT OFFICE.

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SPEED-REGULATOR SYSTEM.

Application filed February 14, 1921. Serial No. 444,907.

To all whom it may concern:

Be it known that I, STEPHEN A. STAEGE, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Speed-Regulator Systems, of which the following is a specification.

My invention relates to speed-regulator systems and it has special relation to systems adapted to maintain a substantially constant-speed ratio between a plurality of moving members.

One object of my invention is to provide a speed-regulator system of the above-indicated character which shall be efficient and reliable in operation, at the same time shall permit adjustment of the speed of either the individual members, or of all the members as a group.

Another object of my invention is to accomplish the desired results with a reduced number of operating parts and improved apparatus, as compared with previously designed speed-regulator systems.

In my copending application, Serial No. 444,908, filed February 14, 1921, is described a speed-regulator system of the above-indicated character wherein each set of rotatable members is propelled by a variable-speed motor. Each rotatable member operates a speed-changing device which, in turn, operates a frequency changer that is connected to one winding of an auxiliary frequency changer. The other winding of the auxiliary frequency changer is connected to a frequency changer which is common to all the rotatable members and is adapted to supply a constant frequency thereto. Any difference in frequency occurring between the common frequency changer and the individual frequency changer will be recorded by a movement of the auxiliary frequency changer constituting an electric differential or differential relay, to set in motion a train of mechanism that is adapted to correct the propelling-motor speed in accordance with the abnormal load thereupon.

This corrective mechanism includes a motor-operated rheostat in the circuit of the field-magnet winding of the propelling motor. In addition, the field-magnet winding circuit includes two resistor sections, the shunting of which is controlled by electromagnets energized in accordance with the operation of an inertia-responsive device connected to the electric differential. Normally, one resistor is included in the circuit, while the other resistor is excluded therefrom. The purpose of this mechanism is to accelerate the action of the corrective mechanism under certain conditions.

In the present application, the same combination of motors and frequency changers is utilized. However, the shunt field-magnet-winding circuit of the propelling motor herein omits the motor-operated rheostat but retains the electromagnetically-controlled resistor sections. There is provided, of course, a hand-adjustable rheostat for adjustment of the basic speed of the propelling motor.

The control mechanism for the electromagnets herein comprises a double switch lever frictionally mounted upon the shaft of the electric differential, and an unbalanced contact-carrying arm adapted to be rocked by a cam driven from a small motor. Normally, that is, when there is no movement of the differential, the contact terminals will not engage the switch levers. However, upon movement of the differential, one switch lever is raised and, when the associated contacts are lowered, an engagement will be effected with the lever, which engagement will remain undisturbed until the contact-carrying arm is taken out of the plane of engagement. This action will energize the electromagnet associated with the engaged switch terminals to thereby alter the field strength of the propelling motor. When the contact is broken, the resistors assume their normal relation in the circuit.

Obviously, the greater distance the differential moves the contact lever, the longer the switch mechanism will be closed to maintain its associated electromagnet energized to accomplish the correction necessary. Also, in view of the fact that each resistor is of such value that, were it included or excluded from the circuit indefinitely, the field of the motor would be under- or over-excited, it will be apparent that the effective value of these resistors will depend upon the total time each may be included in the motor circuit. This period also depends upon the rapidly vibrating contact-carrying arm.

Accordingly, if the correction has not

been fully attained after the first closing of the switch, the differential will maintain the switch lever in a raised position so that, as the switch contact members again lower, they will again engage the switch lever to further correct the propelling motor in accordance with the load variations.

Referring to the drawing, in which the single figure is a diagrammatic illustration of the circuits and apparatus embodying my invention, as applied to a plurality of rotating units, the present invention will be described with reference to a single rotatable roll and, since the devices for all roll units are alike, the illustrated duplicated parts will be given the same reference numerals.

A roll 1 is driven by a propelling motor 2, having an armature 3 and a shunt field-magnet winding 4, through suitable gearing 5. Also geared to the roll shaft is a speed-changing device 6, connected to one portion of which is a frequency-changer 7. The secondary winding of frequency changer 7 is connected to the secondary winding 8 of an auxiliary frequency changer 9. The primary winding 10 of auxiliary frequency changer 9 is connected in circuit with a frequency changer 11, which is driven by a motor 12 so as to supply a constant frequency to the winding 10. The frequency changer 11 is common to all of the roll units and supplies a constant frequency to each of the primary windings 10.

Thus, the frequency changer 9 constitutes an electric differential, or differential relay, for the reason that, so long as the frequencies upon the primary winding 10 and the secondary winding 8 thereof are equal, there will be no rotation of the shaft of this machine. Should the frequencies vary, a corresponding rotation of the shaft 14 will be produced.

The circuit of the shunt field-magnet winding 4 of the propelling motor includes a rheostat 15 which is adapted to be manually adjustable to determine the basic running speed of the propelling motor. Also, connected in circuit with the field-magnet winding 4 are resistors 16 and 17, which are adapted to be shunted from the circuit by means of electro-magnet switches 18 and 19, respectively. Switch 18 normally completes the shunt circuit for the resistor 16, thus normally excluding that resistor from the field-winding circuit. Switch 19 is adapted to be normally open, and thus, resistor 17 is normally included in the field-winding circuit. The coils 21 and 22 of switches 18 and 19, respectively, when energized, will vary the normal relations of these resistors to the circuit.

Switch mechanism for governing the energization of coils 21 and 22 is operated in accordance with variations in load upon the roll unit 1 by the apparatus about to be described.

A double-acting lever 23 is frictionally mounted upon the shaft 14 of auxiliary frequency changer 9. Carried at the opposite ends of this lever are arms 24 and 25. Slidably and loosely mounted upon the arms 24 and 25 are switch members 26 and 27, respectively.

Co-operating with the switch levers is a switch-terminal carrying arm 31, which is so pivoted at 32 as to be unbalanced. Arm 31 carries, upon opposite sides of the pivot point 32, switch terminals 33 and 34, respectively. Terminals 33 are in circuit with coil 22 of switch 19. Terminals 34 are in circuit with coil 21 of switch 18. An adjustment of the time of engagement between switch members 26 and 27 and terminals 33 and 34 may be obtained by means of the illustrated screw construction of terminals 33 and 34.

Contact arm 31 is adapted to be rocked upon the pivot 32 by means of a cam 35, which is rotated by means of a small motor 36, at such speed that only the average periodicity of the vibrations of the cam 35 will affect the speed of the propelling motor. That is to say, the action of the cam 35 upon the arm 31 produces a regulating effect in the system equivalent to that produced by a pulsatory regulator.

From the foregoing description, it will be apparent that a change in load upon the roll unit 1 will cause a variation in the frequency generated by the frequency changer 7 and thereby cause an operation of the differential frequency changer 9, with a consequent movement of the shaft 14 thereof.

A decrease in load upon the roll unit 1 to cause an increase in the frequency generated by the frequency changer 7 will supply an increased frequency to the differential 9, above the normal constant frequency, to cause a clockwise rotation of the shaft 14. Thus, switch member 26 will be lowered and switch member 27 raised. Accordingly, as the cam 35 presents its smallest radius to the arm 31, the terminals 33 will be brought into engagement with the switch member 26, thereby energizing coil 22 to close switch 19 and thus shunt the resistor 17 from the circuit of the field-magnet winding 4. This action will increase the field strength of the motor 2 to decrease the speed of the roll unit 1. However, when the cam 35 assumes the position illustrated in the drawing, presenting its largest radius to the arm 31, the connection to the coil 22 will be broken, thereby de-energizing switch 19 and reinserting resistor 17 in the field circuit of the propelling motor 2.

It will be apparent that the arm 31 will

be rocked or vibrated upon the pivot 32 rapidly, in view of its direct connection to the motor 36, although this speed may be regulated. Consequently, in the assumed case, the resistor 17 will be included in and excluded from the field-magnet-winding circuit more or less frequently, but the resistor will have an effective value in the circuit of the field-magnet winding corresponding only to the extent that such resistor is included in the circuit over a given period.

It will likewise be apparent that the effective value of either resistor in the circuit will depend upon the displacement of its switch member which, in turn, is proportional to the amount of load variation. In other words, if the load variation is large, the difference in frequency will be correspondingly large and the lever 23 will be moved a great distance. Hence, a longer engagement will be maintained between the switch member and the associated terminals, thereby maintaining the resistor in its abnormal relation to the circuit a greater proportion of time. The natural effect of this will be to cause a quicker correction of the speed of the propelling motor 2.

Of course, what has been said with reference to a decrease in load upon the roll unit 1 will apply equally well to an increase in load thereupon. If such an increase in load should occur after correction has been made for a decrease in load, the movement of the differential will effect the proper movement of the lever 23 for the necessary correction.

Modifications in the system and arrangement and location of parts may be made within the spirit and scope of my invention, and such modifications are intended to be covered by the appended claims.

I claim as my invention:—

1. In a regulator system, the combination with a plurality of rotatable members, a plurality of dynamo-electric machines adapted to be operated at a predetermined speed ratio and a dynamo-electric machine common to all rotatable members, of means jointly controlled by said dynamo-electric machines for governing the speed of each rotatable member comprising a pivoted contact arm and means for vibrating said arm.

2. In a regulator system, the combination with a plurality of rolls, a propelling motor for each roll, a frequency changer associated with each of said propelling motors, a frequency changer common to all the rolls, and an electric differential connected between said frequency changers, of control mechanism for said motors comprising a double-acting switch lever operated by said differential, a pivoted arm co-operating therewith, said arm carrying switch terminals, and a rotatable cam co-operating with said arm.

3. In a speed-regulator system, the combination with a rotatable roll, a propelling motor therefor having a resistor in circuit with the field thereof, and a frequency changer associated therewith, of means co-operating with said frequency changer comprising electroresponsive means co-operating with said resistor and governed proportional to the variations in the speed of the roll and independent means for periodically interrupting the operation of said electroresponsive means.

4. In a regulator system, a motor having a plurality of resistors in circuit therewith, electroresponsive means for controlling the shunting of said resistors governed in accordance with variations in the load upon said motor and independent means for periodically interrupting the operation of said electroresponsive means.

5. In a regulator system, a motor having a resistor in circuit therewith, electroresponsive means for controlling the shunting of said resistor, governing means therefor comprising oppositely-moving switch levers, an unbalanced contact-carrying arm and means for periodically rocking said arm.

6. In a regulator system, a motor having a resistor in circuit therewith, electroresponsive means for controlling the shunting of said resistor, governing means therefor comprising oppositely moving switch levers operated by variations in load upon the motor and an unbalanced vibrating switch-terminal-carrying arm adapted to engage said switch parts to effect motor-speed correction in accordance with load conditions.

7. In a regulator system, the combination with a plurality of rolls, a propelling motor for each roll having a plurality of resistors in circuit therewith, a frequency changer coöperatively associated with each of said propelling motors, a common frequency changer, an electric differential connected between said common frequency changer and each motor-associated frequency changer, of a regulator for each motor comprising electroresponsive means for controlling the shunting of said resistors, actuating means therefor comprising oppositely moving switch levers operated by variations in load upon said motors, and an unbalanced vibrating switch-terminal-carrying arm adapted to engage said switch parts to effect motor correction in accordance with load variations.

8. In a regulator system, the combination with a plurality of roll units, a propelling motor for each roll unit, a plurality of resistors, a portion of said resistors being normally in circuit with a certain motor and

another portion being normally out of circuit with that motor, a frequency changer associated with each propelling motor, a frequency changer common to all the units, and an electric differential connected between said common frequency changers, and each of said motor-associated frequency changers, of a regulator associated therewith comprising electroresponsive means for varying the normal relations of said resistors, and governing means therefor adapted to determine the effective value of said resistors in said circuit.

9. In a speed-regulator system, the combination with a constant-speed motor, a motor to be regulated, and differential means energized in accordance with the respective speeds of said motors, of means for correcting for relative speed variations of the motors comprising a pulsatory circuit-interrupting means.

In testimony whereof, I have hereunto subscribed my name this 5th day of February, 1921.

STEPHEN A. STAEGE.