No. 840,721. PATENTED JAN. 8, 1907.

V. O. STROBEL & A. E. HOGREBE.

VARIABLE SPEED DRIVING.

APPLICATION FILED JAN. 20, 1905.

2 SHEETS—SHEET 1.

FIG. 1.

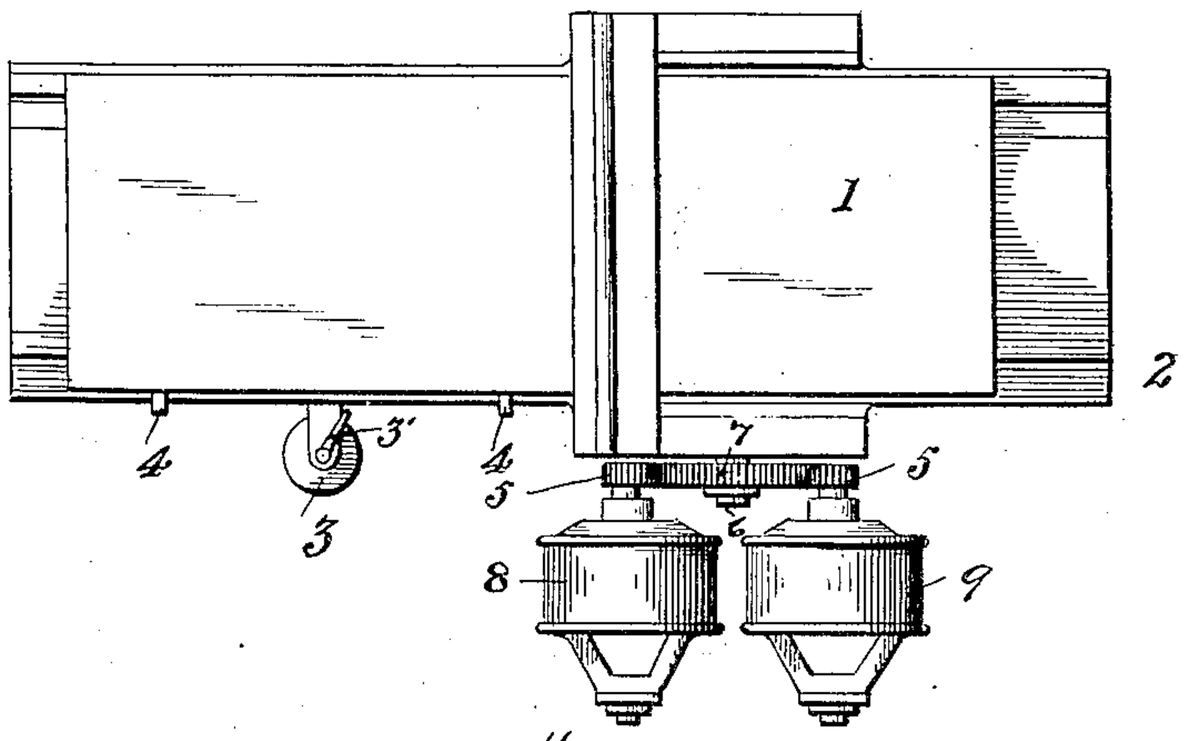


FIG. 2.

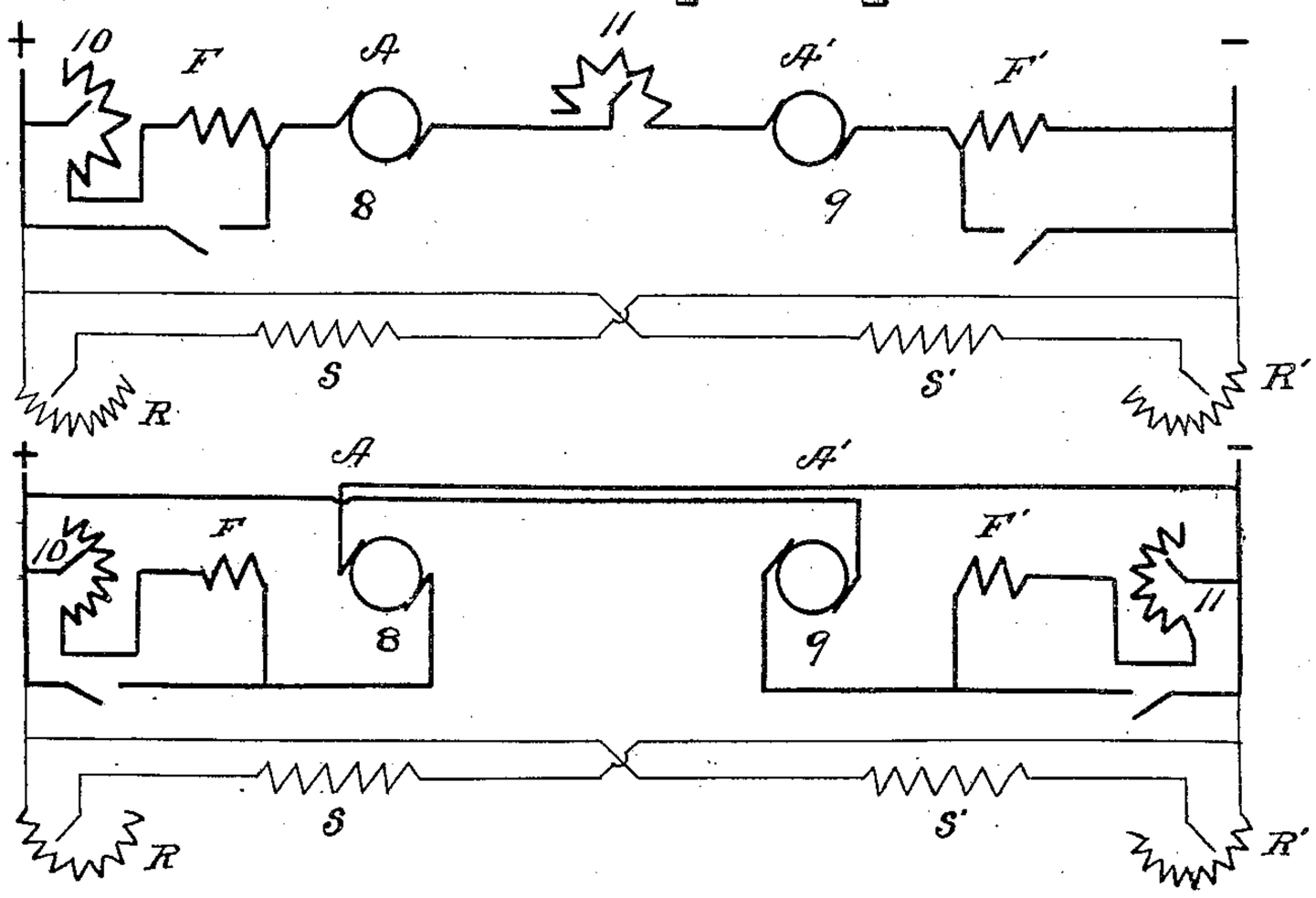
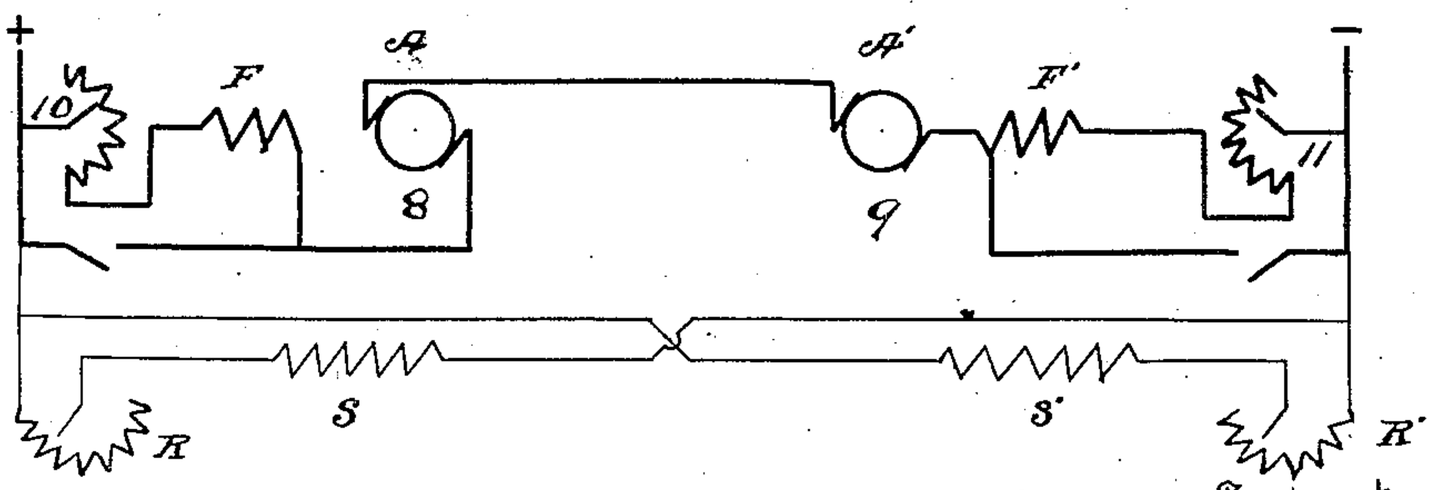


FIG. 3.

FIG. 4.



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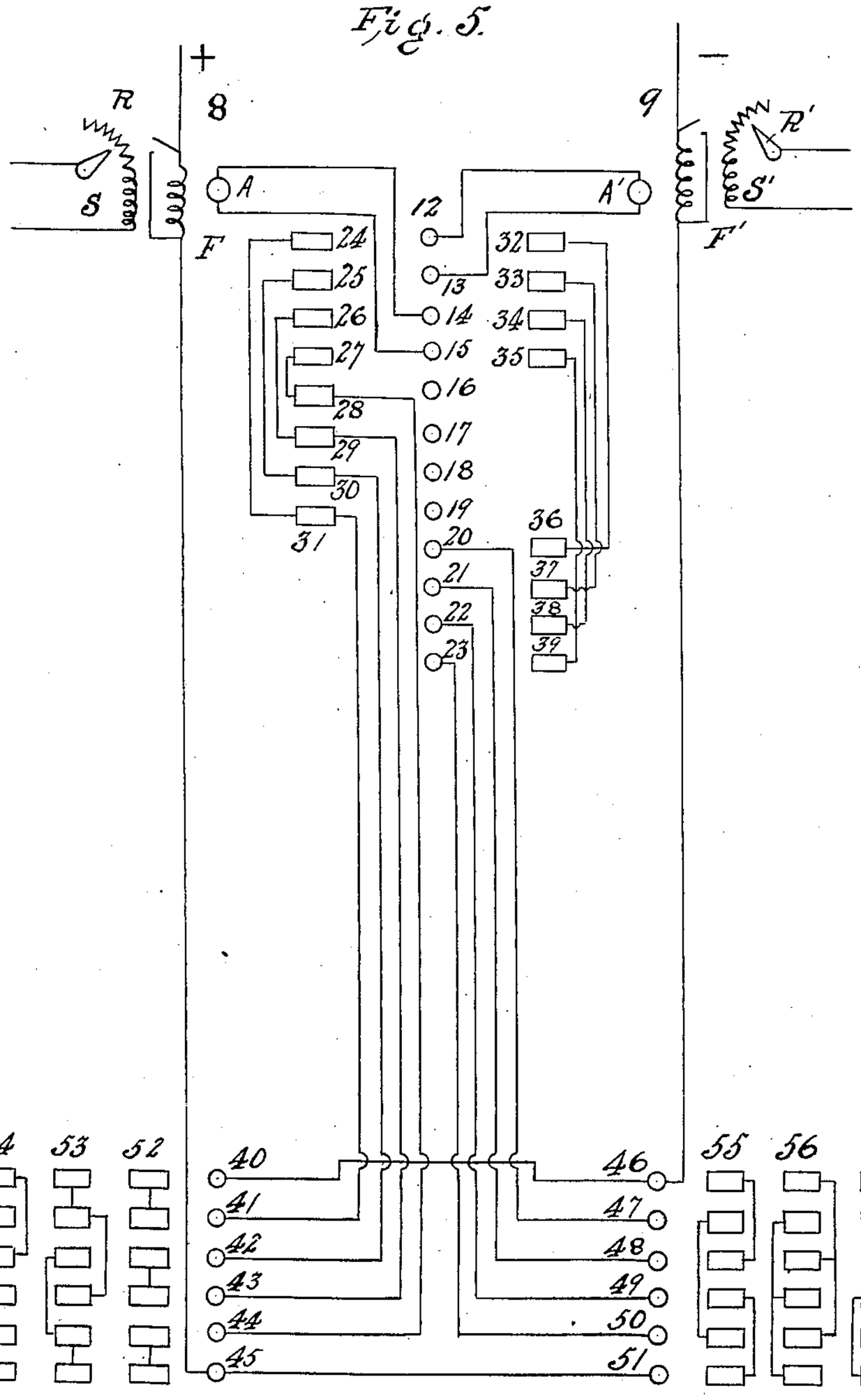
2 SHEETS—SHEET 2.

Fig. 5.



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VARIABLE-SPEED DRIVING.

No. 840,721. Specification of Letters Patent. Patented Jan. 8, 1907.

Application filed January 20, 1906. Serial No. 241,965.

To all whom it may concern:

Be it known that we, VICTOR O. STROBEL and ARTHUR E. HOGREBE, of Philadelphia, State of Pennsylvania, have invented certain new and useful Improvements in Variable-Speed Driving; and we do hereby declare the following to be a full and clear description thereof.

Our improvements relate to variable-speed electrical driving of machines.

The invention consists in the following arrangement and combination, the details of which will first be fully described and the features of patentable novelty then set forth in the claims.

Figure 1 is a plan view of a machine, to which the invention has been applied. Figs. 2, 3, and 4 are diagrammatic views showing the different phases and combinations for securing variable-speed conditions. Fig. 5 is a development of the cylindrical controller 3 shown in top view in Fig. 1.

A plurality of electric machines (preferably two) are employed to variably drive the moving member of the machine. Under certain running conditions both magneto-electric machines act as electric motors, while under other conditions of variable-speed driving one or more of the electric machines is converted from a motor to a generator, as will hereinafter be described. These electric-machines are preferably compound-wound and in series parallel.

The machine selected in this instance to illustrate a concrete application of the invention has a table, platen, or bed 1, reciprocating upon a frame 2. The frame is provided with a controller 3, having a tappet-arm 3′ and adapted to perform the hereinafter-described switching operations. The controller is actuated by contacts 4 on the table 1 engaging tappet-arm 3′. The armature-shafts of the electric machines 8 and 9 are preferably provided with pinions 5 and are located at each side of the power-shaft 6. Shaft 6 has a gear 7 meshing with both pinions 5. Other known means of connecting the electric machines may of course be employed.

It will be understood that all the hereinafter-described makes and breaks in the electrical connections are or may be made automatically by the controller-switch 3. Some of the adjustments of the circuits or the resistances are or may, however, be made manually.

In the switch development shown in Fig. 5 manual provision may be made for adjusting the several shunt fields and rheostats or resistances. The several phases of the variable-speed adjustment hereinafter referred to are, however, performed automatically. The shunt fields and the various resistances may also be controlled automatically.

12 to 23, inclusive, are the contact-fingers of the controller 3.

24 to 31, inclusive, are the controller-drum contacts for the "forward" speeds, and 32 to 39, inclusive, the "reverse-speed" drum-contacts.

40 to 45, inclusive, are the forward-speed connections of the motors, and 46 to 51, inclusive, are the reverse-speed connections to the motors. The three series of connections corresponding to the three phases of variation forward and reverse are shown at 52, 53, and 54 for the forward movements and at 55, 56, and 57 for the reverse movements.

52 and 55 are respectively the forward and reverse connections when the motors are in series, 53 and 56 when the motors are in parallel, and 54 and 57 when one of the motors is converted into a generator in series with the other motor and in series with the generator-supply of current to the line. The connections, for instance, when the first phase forward-speed connection 52 is on and the motors in series may be traced through the + line to field F, contacts 45 52 44 28 16 27 15 to armature A, and thence to contacts 14 26 29 17 43 52 42 30 18 25 13 to armature A′, and thence to contacts 12 24 31 19 41 52 40 46 to series field F′ to complete the circuit. The other connections can be readily traced and need not be gone into in detail. The several phase variable-speed regulation is automatically effected by the mechanical machine-contacts 4 4 at either side of the controller tappet-arm 3′ on the drum-shaft engaging said arm and performing the several switching operations.

In diagram Fig. 2 is illustrated the first phase or the lower range of variable-speed driving of machines. Here both electric machines 8 and 9 run as motors. The motors are compound-wound. The fields F F′ and

the armatures A A′ of the motors are connected in series with an adjustable resistance 10 and 11. The shunts S S′ are connected in parallel. The rheostat R is in series with shunt S and the rheostat R′ in series with shunt S′. After the motors are started the resistances 10 and 11 are gradually cut out, the series fields are short-circuited, and resistances gradually introduced into the shunts, any or all, to suit the maximum degree of acceleration desired. These switching operations are performed by controller 3. The resistances and the field of each motor may be successively or simultaneously operated. The controller also effects the reversal of the motors and introduces in one direction of motion more resistance into one shunt-rheostat than in the other to secure a difference in speed in alternate directions of motion of the motors. Such operation of the controller is well understood and need not be gone into in detail. The degrees of speed acceleration thus obtained in this first phase ranges in the minimum speeds from full resistance in circuit with armatures and fields and no resistance in the shunts to the maximum speeds, where the resistances and fields in the armature-circuits are cut out and the limit resistance in the shunts thrown in.

The intermediate or second phase of the variable-speed driving is illustrated in Fig. 3, showing by diagram the connections of the electrical machines still acting as motors when either the controller 3 (or a manual switch) has thrown the armatures and fields circuit from series into parallel. Here each motor is getting the full line voltage, and the speed of the two motors is thereby largely accelerated. The variations in the degree of the augmented speed of the second phase with the motors in parallel are obtained in the same manner as described in connection with the first phase or series arrangement of motors.

In the final phase of variable-speed driving the controller 3 (or a manual switch) is arranged to convert one electric machine, as 9, which had previously been running as a motor, into a generator by reversing the connections of the armature or field and placing said converted generator in series with the other motor and also in series with the generator or generators supplying current to the line, the shunts remaining in parallel. This conversion may take place with the motors previously in series or in parallel. In this last phase the resistances in the armature and the shunt of the generator or converted motor 9 are adjusted by the controller or manually, together with the short-circuiting of the field, whereby variations in the field density are obtained. The speed variation thus secured ranges from electromagnetic conditions, where generator 9 will generate such limited voltage that it will not augment or assist the pressure from the line-generators, to a maximum safe density and voltage. This higher voltage is added to the line voltage to operate motor 8 at the maximum power of the generators. The motor-speed is then increased from full resistance in the armature and field and no resistance in the shunt to successive increased speeds, ending with no resistance in the armature, a short-circuited series field, and full resistance in the shunt. It will thus be seen that the speed variations obtainable in the use of the two electric machines range through all the accelerations permissible in the series arrangement of the motors, all those obtained by the parallel disposition, and all those secured in the converted motor or generator arrangement added together, or any combination thereof.

While our invention has been described in connection with compound-wound electric machines, yet we contemplate the use of series-wound or shunt-wound electric machines in so far as they may be applicable and operative. More than two electric machines may be used, if desired. The shunt fields may be arranged in series as well as parallel. This system of variable-speed driving will give excellent results by using two commercial non-variable-speed motors.

It will be noted that the present invention provides by simple means a large number of variations in accelerating and retarding motions for driving machines. Each of the phases of acceleration with its variations may be standardized into defined speed ratios. Thus, for example, the range may be systematized into, say, five standard speeds or any other practical manner.

It must be understood that the invention is not confined to the operation of a reciprocating part of a machine before described. This moving part may be rotary—as, for instance, the drive or power shaft of a machine. In the case of a rotary moving member the direction of motion may be in one direction continuously with periods of acceleration, or the direction of motion may be alternately reversed, with variations in speed driving.

By the terms "fields" F and F′ and the "shunts" S and S′ in the specification and claims is meant the series field and shunt field windings on the electric machines 8 and 9, through which the field and shunt control is accomplished as described.

We claim—

1. In mechanism for variable-speed driving, a driven member, two electric machines connected therewith, and means for connecting said machines with a source of electrical power as motors and for connecting one of said machines with such source as a generator and the other as a motor.

2. In mechanism for variable-speed driv-

ing, a driven member, two electric machines constantly connected therewith, and means for connecting said machines with a source of electrical power as motors and for connecting one of said machines with such source as a generator and the other as a motor.

3. In mechanism for variable-speed driving, a driven member, two electric machines mechanically connected together and with said driven member, and means for successively connecting both of said machines with a source of electrical power as motors in series, in parallel, and for connecting one of said machines with such source as a motor and the other as a generator impelled by the first machine to act as a booster.

4. In mechanism for variable-speed driving, a driven member, two electric machines mechanically connected together and to said member, and means for successively placing said machines in series and in parallel as motors and for then connecting one of the machines as a motor and the other as a generator, and for varying the field resistance of said machines in any of these connections.

In testimony whereof we have affixed our signatures in the presence of two witnesses.

VICTOR O. STROBEL.
ARTHUR E. HOGREBE.

Witnesses:
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