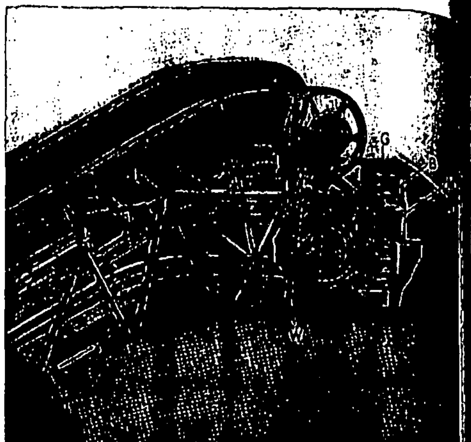
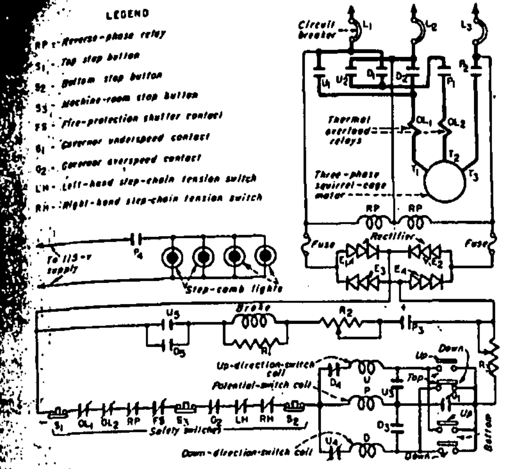
1 Across-the-line-start control for an electric stairway that's driven by squirrel-cage motor



2 This power end of an electric stairway is driven by a vertical squirrel-cage motor M, also a worm-and-gear through a roller-chain drive



3 Straight-line diagram of electric-stairs across-the-line-start control. Direction-switch contacts above motor, reverse-phase relay RP below

Get Moving Stairways Off To a Good Start

To understand how stairs operate, you must know their motor controls. So let's look at two starting methods: (1) across-the-line (2) primary-resistance

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► A MOVING STAIRWAY is a slow, medium-friction, medium-inertia, constant-speed load, and therefore, can be driven by a normal starting-torque motor. Where ac is available, and it generally is, the motor is often a single-speed across-the-line-start squirrel-cage type. Three-phase squirrel-cage motors, with all six winding leads brought for star-delta starting, are used extensively, as is primary-resistance starting on the larger stairways.

Two-Speed Motors. On some applications where the stairway operates at a higher speed during certain periods, 2-speed squirrel-cage motors are used. On high-speed operation the stairway runs 120 ft per min, and on low speed 90 ft per min.

Compared to elevator-motor controls, those for moving stairways are simple. They are usually key-switch-start type, arranged to readily reverse the power unit when necessary and actuate an electric brake. A feature of these controllers is the large number of safety devices that protect passengers and equipment against about every operating hazard.

Power-Drive Unit. Fig. 3 is a wiring diagram of a Westinghouse Type L-1 controller, Fig. 1, for an electric stairway driven by a vertical power unit (POWER, April, p 122). It is designed for mounting in the top-end section of the truss close to the stairway at M, Fig. 2. This unit is powered by an across-the-line-start, 850-rpm, 10- or 15-hp, squirrel-cage motor mounted directly on a worm-and-gear.

A sprocket on the worm-gear shaft connects by roller chain to the step-chain-sprocket drive shaft of the stairway. A service brake B is mounted above the motor with an underspeed and overspeed governor at G above the brake. In addition to the service brake, an emergency one is mounted on the top step-chain sprocket assembly. This brake is applied mechanically by a pawl that drops into a ratchet wheel W if the drive chain should break—which it never does.

Wiring Diagram. At top of wiring diagram, Fig. 3, are the motor, its direction- and potential-switch contacts. The motor is protected by thermal overload relays OL_1 and OL_2 and a reverse-phase relay RP. A contact RP for the latter is in the safety-switch circuit at the bottom of the diagram.

Below the motor is a selenium-disk rectifier that supplies dc for all control and service-brake-coil circuits. This rectifier connects without a transformer direct to the 220-v motor-power supply. Consequently, its dc voltage is always higher than the 115-v required for the brake and control circuits. Excess voltage is absorbed in variable resistor R_1 in the brake-coil circuit and R_2 in the direction- and potential-switch-coil circuits. These resistors permit adjusting the dc voltage to a correct value, whether the motor operates on 208 or 220 v, and also compensates for any decrease in dc voltage due to aging of the rectifier.

Safety Contacts. Four step-comb lights, two for each terminal, are shown at the center of the drawing, separate from the control circuits. The lamps light the approach to the steps at each terminal, operate from a 115-v power supply, and are controlled by contact P_4 on the potential switch P.

Most of the safety contacts are shown connected in series in lower left hand of the drawing. Purpose of each of these contacts is given in the legend in upper left. In lower right are the top and bottom starting-switch stations. These switches are key operated, and are generally located in the newels or on a nearby column. To start the stairway a key is put into the switch, turned to the start position, and held there until the stairway reaches a speed where the governor underspeed contact G_1 closes, at about 80% rated speed.

Starting the Stairway. Assume the stairway is to start in the up-direction from the top terminal. At this station, closing the up-switch completes a circuit from + on the rectifier through R_2, the up-switch, up-direction switch coil U, all the safety-switch contacts to − on the rectifier. This coil closes contacts U_1 and U_2 in the motor circuit, contact U_5 in the brake-coil circuit, U_3 between coils U and P. And the coil opens contact U_4 to break the circuit through coil D.

When contact U_3 closes it completes a circuit through potential-switch coil P, which closes contacts P_1 and P_2 in the motor circuit, and P_3 in the brake-coil circuit. The latter is now complete through contacts P_3 and U_5 so the brake releases. On one line polarity the motor circuit is also complete from, say, line L_1, contact U_1, the motor, contacts P_1 and U_2 to line L_3. The other circuit is from L_3 through P_2, the motor, and to line L_2 as before. Motor starts and when stairway is running at about 80% rated speed, governor closes its underspeed contact G_1 to bypass start switches.

A circuit for coils P and U now goes directly from the rectifier through contact G_1 without going through the top up-start switch so the starting key can be returned to neutral and removed. The stairway will now continue to run until one of the stop buttons S_1, S_2 or S_3 or a safety switch opens. Once the stairway slows down and the governor underspeed contact G_1 opens, it cannot start again except by using the key to close one of the start switches. This prevents the stairway from being started except under absolutely safe conditions.

Reverse Direction. Starting the stairway in down-direction is the same as up, except that either of the down start switches is closed. This completes a circuit through down-direction switch coil D that closes contacts D_1 and D_2 in the motor circuit, D_3 in the brake-coil circuit, and D_3 in the potential-switch coil P circuit. From here, starting operations are the same as for up-direction, except current direction is reversed in motor leads T_1 and T_2.

Resistance Start. Fig. 3 is about the simplest form of a moving-stairway control. For the larger sizes of electric stairways, type S, Westinghouse uses a primary-resistance-start controller. This control is used with a power unit similar to that on a horizontal-shaft worm-and-gear-driven elevator, except it is designed for electric-stairway service.

Fig. 4 is an elementary wiring diagram for a type S stairway's motor control. Even though arranged somewhat differently it has many features similar to Fig. 3. At top of diagram is the up- and down-direction switch contacts U_1, U_2, and D_1, D_2. Below these are the thermal overload relays OL_1 and OL_2, and the potential switch contacts P_1 and P_2. Then, come the 3-phase motor windings M_1, M_2 and M_3 that connect to starting resistors, R_1, R_2 and R_3. These resistors are cut out of circuit by closing contacts SP_1 and SP_2.

Connected to the 3-phase line is a reverse-phase relay RP, as in Fig. 3, and two control-circuit transformers grouped open-delta. These transformers have six sets of terminals (not shown) brought out on them that permit operating on 199-208 to 550-575 v circuits. They provide the correct voltage for the 3-phase copper-oxide rectifier, E_1 to E_6, that supplies dc to the brake-coil and control-circuits.

Assume transformer polarity as shown, then current flows down from + on the transformers through rectifiers E_2 and E_6 to the right-hand fuse. Current flow continues through the control circuits and up through rectifier E_3 and to − between the two transformers. When the center transformer top is + current flows from it through rectifier E_4 and the control circuits as before, through rectifiers E_1 and E_5 to the transformers. Even though current flows reversed in the transformers the rectifiers kept it in the same direction in the control circuits.

Timing Relay. Below the rectifier is the timing relay with coils T and T_1 that control the time when resistors R_1 to R_3 are cut out of the motor circuits. Coils T and T_1 of this relay are connected directly across the rectifier. As long as both coils are energized, con-

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