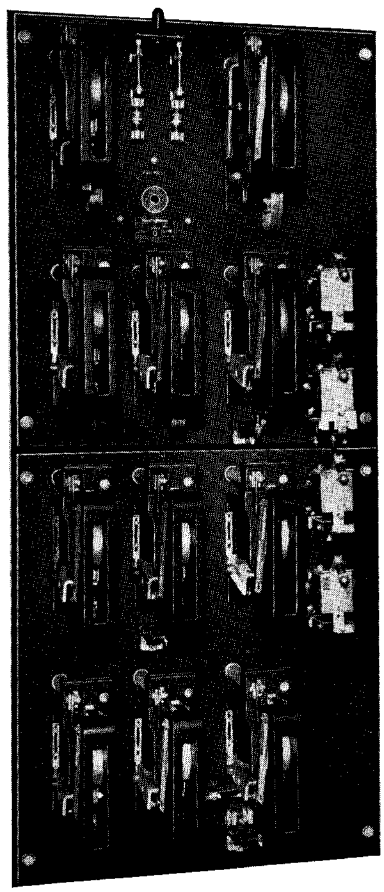
Westinghouse Class 9600

D-C. Magnetic Crane Controllers

For Hoist, Bridge and Trolley Service

INSTRUCTIONS

FOR INSTALLATION AND OPERATION



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be a total of four shims to insure proper alignment of core and armature face. Increasing the number of steel shims increases the time. Increasing spring tension decreases the time. The relays are normally applied with a short circuit connection on the neutralizing coil, which acts as an additional damper. Opening this short makes a slight decrease in time.

8. Timing Potentiometer

This potentiometer is similar in mechanical appearance and electrical design to the well known Westinghouse Type WL 6″ rheostat. It is used to vary the time obtained on the Type TL-11 accelerating relays on the bridge, hoist, and trolley controllers. It does this by varying the neutralizing currents of the relays. All relays on each controller are adjusted simultaneously and any number from one to eight inclusive, may be connected to the potentiometer. In addition to this simultaneous adjustment, each individual relay may be adjusted by its own spring. However, these springs must not be adjusted beyond the limits set by the special adjusting nut construction.

The potentiometer is designed to be operated with a screw-driver. There is a slot in the front end of the shaft for this purpose. The potentiometer is normally mounted on the rear of the panel. A hole through the panel admits the screw-driver to the slot. A dial plate surrounding the hole in the panel indicates the direction of movement to use in adjusting to make the relays operate faster or slower.

An adjustable stop plate is clamped into position by means of a screw through a slot in the back cover of the potentiometer. This stop plate adjusts the limits through which the potentiometer arm may be turned to vary the relay timing. This adjustment is made at the factory during the test on each individual controller and ordinarily should not require any additional attention in the field.

PART IV—ELECTRICAL PROTECTION OF EQUIPMENT (FIGURE 1)

With respect to the location of their protective devices, standard crane panels are classified, into two groups, Class A and Class B.

Class B panels contain neither low voltage nor overload relays, nor main circuit knife switches; instead a separate protective panel (Figs. 1 and 1A) is used. These protective panels contain an overload relay in one side of the line

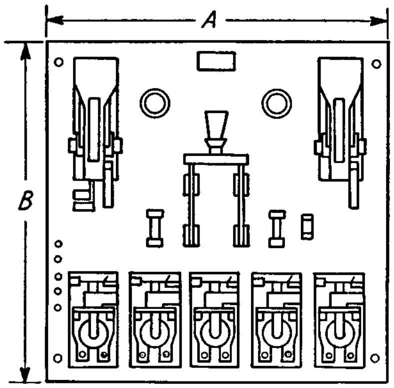

FIG. 1—A TYPICAL 4-MOTOR CRANE PROTECTIVE PANEL

for each motor and a single totalizing overload relay in the other side of the line. The protective panel also contains two contactors which serve as the line contactors for low voltage protection. All power circuits to the motors and control panels are supplied through these contactors. If one of the overloads should trip or the voltage fails, the line contactors will open and remove power from all motors. In order to reset the line contactors, all master switches must be returned to the off position. The protective panel also contains a line knife switch which when opened, removes power from all control and all power circuits. Fuses are mounted in the control circuit, and a fused lamp circuit is provided.

The line contactors are controlled by pushbuttons. These serve as a convenient means of de-energizing all power circuits when the operator leaves the crane cab and again energizing them when he returns. Standard equipment on each Class B control panel includes a control knife switch, which can be opened to deenergize the control circuit on that panel only, when desired.

Class A panels each contain their own protective devices which include: two knife switches for disconnecting motor and control circuits from the line, control circuit fuses, overload relays in each side of the line, and a low voltage relay.

These devices function as described for Class B panels with the exception that devices on each panel are independent of those on any other panel. When a low voltage relay opens for any reason, power is removed from that panel, and it is necessary to return only the corresponding master switch to the off position to reset the low voltage relay, if the overload relay is in the automatic reset position. The low voltage relay operates in the control circuit only and is reset directly through the master switch, reset contacts, no pushbutton being employed.

Fuses are provided in the control circuit as protection against short circuits in the control wiring.

PART V—CONTROLLER OPERATION

Class 9605—Bridge and Trolley Controllers (Figures 2 and 2A)

The circuits of a typical 9605 (Class B) panel are shown in Figure 2A. All contacts are shown in the power-off position. (Master switch in the off position, control switch open.)

A contactor or relay is referred to in this leaflet as being energized whenever power is applied to its coil.

On Class B Panels (Figures 2 & 2A), closing the line knife switch will have no effect with the master switch in

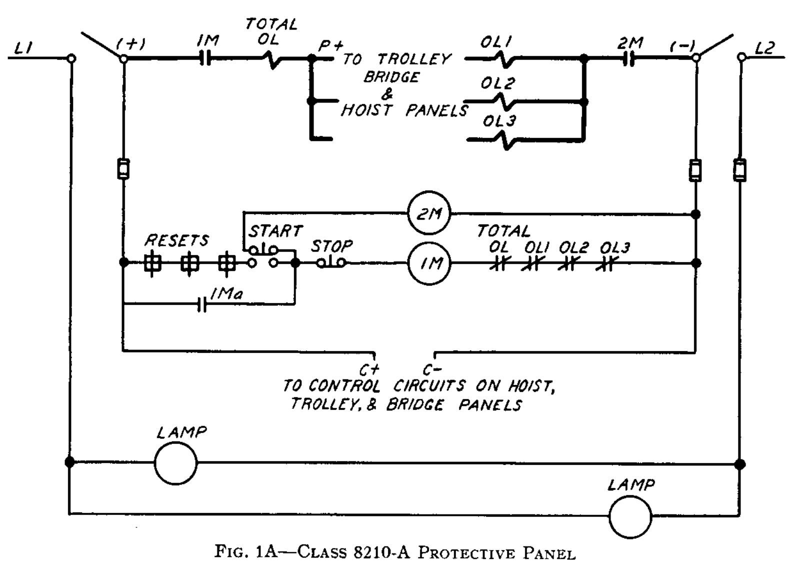

FIG. 1A—CLASS 8210-A PROTECTIVE PANEL

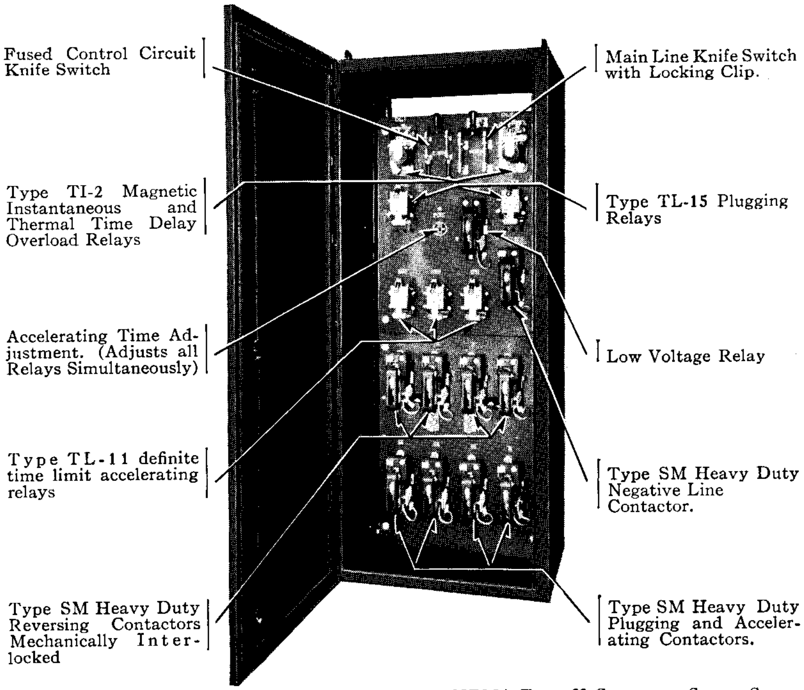

FIG. 2—CLASS 9605-A CONTROLLER, 201 SM SIZE IN NEMA TYPE V GASKETED SHEET STEEL ENCLOSURE. BRIDGE OR TROLLEY SERVICE

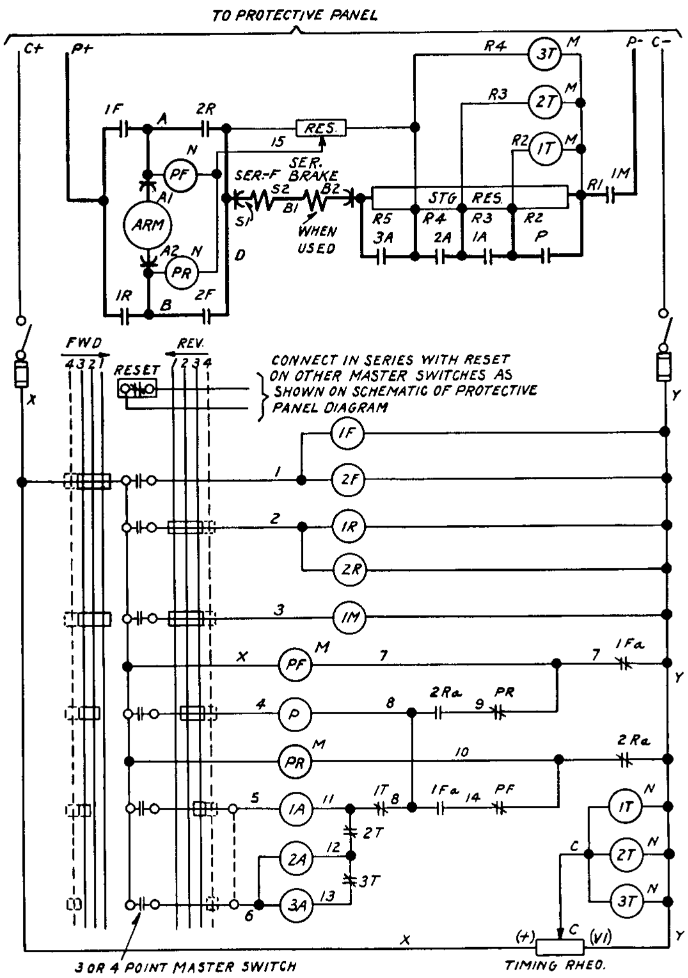

FIG. 2-A—CLASS 9605-B CRANE BRIDGE OR TROLLEY SCHEMATIC DIAGRAM

the off position. Never close the main switch on any control panel unless the corresponding master switch is in its off position. The motor may start at once. Closing the control switch will cause the two plugging relays to pick up. On Class A panels the LV relay will also pick up.

The first point forward energizes contactors, 1F, 2F, and 1M, closing them and connecting the motor to the line with maximum starting resistance in series with the armature. Time relay main coils, 1TM, 2TM, and 3TM, are energized by the voltage drop across the resistor, and their contacts are opened. When 1F closes, normally closed auxiliary interlock 1Fa opens, de-energizing the main coil of PF. The neutralizing coil of PF is energized because of the voltage drop between the armature and the resistor tap, and the direction of current flow in the coil is such that the field produced opposes the residual magnetism of the main coil. The decay of this residual magnetism quickly closes contact PF.

The second point forward on the master switch will close contactor P at once due to the rapid operation of PF. It is not necessary to have any time delay on P in starting from rest. The circuit for closing P is formed by 1Fa interlock, PF contact, and 2Ra interlock. Closing P shorts out the plugging resistance. Motor torque on the first point may be insufficient to start the motor with a heavy load, but the second point should provide enough torque to start the motor under any operating load. When contactor P closes short circuiting the plugging resistance, the main coil of relay 1TM is short circuited, causing contact 1T to close after a brief timing period.

The third point forward will energize contactor 1A when relay 1T has complete timing, and closed its contact. Closing of 1A shorts the first step of the starting resistor which speeds up the motor and starts relay 2T on its timing cycle by short circuiting its main coil. The fourth point will energize 2A after 2T has completed its timing cycle. The second section of the starting resistor is then shorted out and relay 3T begins its timing period. Contactor 3A will close when 3T has closed and the motor is now operating at full speed connected directly across the line.

If the master switch is moved back to one of the intermediate points the portion of the starting resistor corresponding to that point will be returned to the armature circuit slowing down the motor. In cases of light load, the voltage drop across the resistor may be too low to energize the timing relays again. However, if the load is enough to make a timing period desirable on acceleration in order to prevent high current peaks, there will be sufficient voltage drop because of load current in the resistors to energize the timing relays.

It is evident that an identical sequence of contactor operation would occur if the master switch were advanced slowly a notch at a time or if it were moved rapidly to the extreme position, since the circuits to all contactor coils are originally open and can be closed only in series relation after the timing relays close their contacts.

The reverse sequence is the same in all respects as the forward except that the reverse contactors, 1R and 2R, are energized on reverse master switch points to reverse the direction of current flow in the armature. The plugging contactor closes through the circuit composed of 2Ra, PR, and 1Fa.

Plugging Reversing

The plugging reversing controller is almost universally used for bridge and trolley controllers. In plugging, power from the line is used to decelerate the motor. To do this, the armature connections are reversed while the motor is running at full speed. Under this condition, the line voltage is added to the armature voltage producing a voltage across the resistor terminals that is higher than normal line voltage. The resulting current produces a torque to stop the motor. This current would be excessive if external resistance, not required when energizing the motor from rest, were not inserted into the armature circuit. Since the voltage applied to the resistor is higher during plugging than at starting, it follows that the total plugging resistance must be more than the total starting resistance, if the same current peak limits are to be obtained.

Contactor P is used to short out this extra resistance during normal starting sequence. It is controlled by the plugging relays PF and PR which keep contactor P from closing during plugging until the motor has slowed to approximately zero speed. The actual motor speed at which the plugging relays will permit contactor P to close can be varied through a suitable range by adjusting the setting of a potentiometer resistor tube.

The operation of the plugging relays will be more readily understood if the following facts are kept in mind.

1. The main coil of the relay always predominates, picking up and holding in the relay armature whenever it is energized.
2. The neutralizing coil can never pick up the relay armature.
3. After having been pulled in magnetically the relay armature will hold in at least an appreciable time with neither coil energized.
4. After the main coil has been de-energized, the neutralizing coil acts either to oppose the main residual flux and drop the relay armature out, (this condition applies in starting from rest) or to assist the main residual and hold the relay armature in, (this condition applies while decelerating during plugging). The neutralizing voltage required to perform either of these functions is very low (less than 10 volts) compared to full line voltage.
5. It is necessary to distinguish between voltages generated by the motor armature and voltage applied to the motor armature from the line.

Referring to the schematic diagram used (Figure 2A), the plugging sequence is as follows. With the master switch in the off position, PF and PR relays and plugging contactor P are open. When the master switch is moved to the forward position, main contactors, 1M, 1F, and 2F, close. PFM is de-energized; PFN opposes the residual magnetism; and PF closes. P operates and quickly short circuits the plugging resistor. The motor goes through its normal accelerating sequence.

When the master switch is thrown suddenly from forward to reverse position, the main contacts, 1M, 1F, 2F,

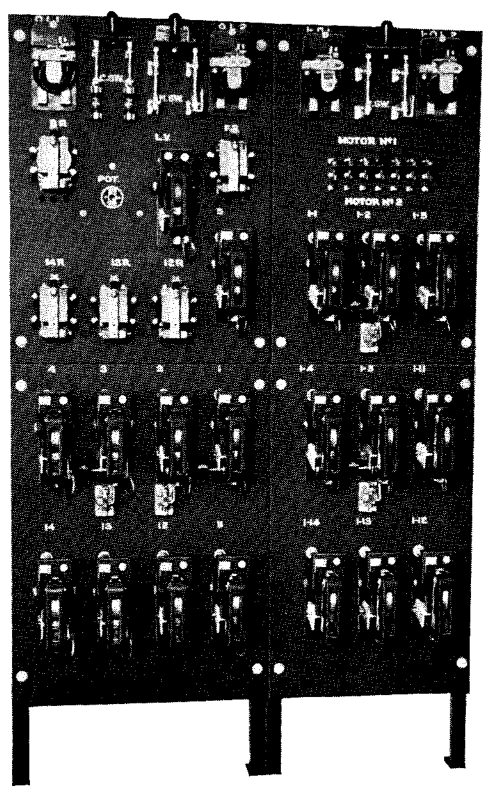

Fig. 3—Class 9605-A Duplex Crane Bridge Controller
Type 201 SM Contactor Size

and P open. PFM is energized and PF contact opens. Contactor 1M recloses, and 1R and 2R contactors close. PRM is de-energized. The counter or generated voltage is now in the same direction as the line voltage. As a result, the potential at point R4 is higher than at point B. The flow of current through PRN is now in such direction as to assist the residual magnetism left by de-energizing PRM, and PR contacts remain open. Contactor P stays open and the plugging resistor is kept in series with the motor armature.

As the motor slows down the armature voltage decreases. When the motor approaches zero speed, the voltage at point R4 becomes less than at point B. The current through neutralizing coil PRN then reverses, opposes the residual magnetism, and permits PR contacts to close. Contactor P operates and the plugging resistor is short circuited. The motor then normally accelerates in the reverse direction. The point selected on the adjusting resistor determines the motor speed at which the plugging contactor will close. In plugging reverse to forward the same principles just discused also apply.

Duplex Panels for Bridge and Trolley Controllers (Figure 3)

Some cranes utilize two motors instead of one on the trolley or bridge, requiring two sets of control which can be operated from one master switch. A duplex panel is supplied for these applications, the panel contains essentially two individual sets of apparatus, but using the same devices for both motors where practicable.

After having become familiar with the single bridge and trolley diagram (Fig. 2A), a brief inspection of the diagram for this panel will bring out the following facts. The duplex controllers are two complete sets of contactors operated by one master switch and from a common control circuit, with the operations of plugging and accelerating controlled by a single set of relays. These relays are connected to transfer switches so that they may be connected to either motor and its resistor for operation with only one motor. For normal operation with both motors, the transfer switch may be thrown to connect the relays to either one of the motors and resistors. Both sets of contactors operate at all times whether both main switches are closed to operate both motors or not. Each

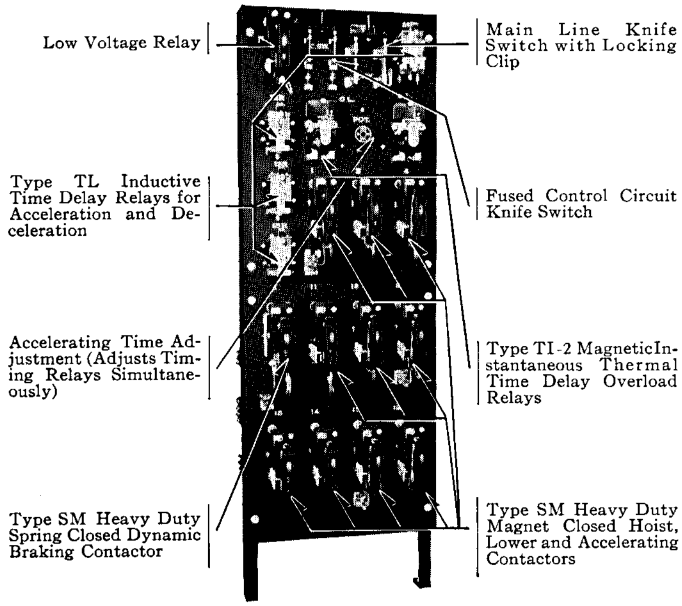

FIG. 4—CLASS 9635-A, HOIST CONTROLLER—202 SM CONTACTOR SIZE

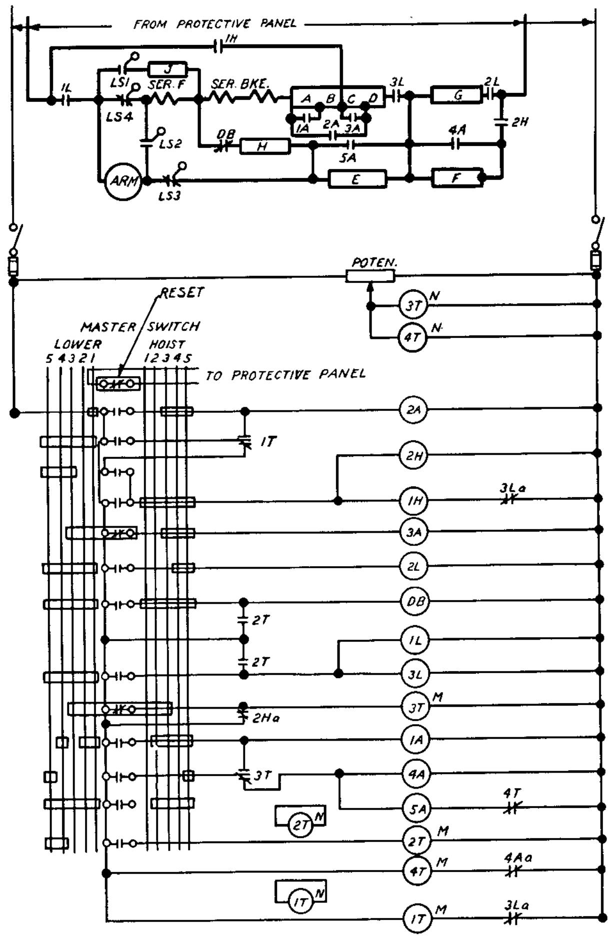

FIG. 4A—CLASS 9635-B CRANE HOIST SCHEMATIC DIAGRAM set of reversers is provided with a set of interlocks to make certain that both sets have operated properly before acceleration may proceed. All overload relays are connected in series so that overload on either motor will trip off the entire control panel.

In making the set-up to operate with only one motor care must be used to make sure that the transfer switch is thrown to connect the relays to the motor and resistor which are to be used. If the relays are connected to the motor whose main switch is out, there will be no time limit acceleration but all contactors may come in at once. Correct set-up may be recognized by making certain that the armatures of the time relays are out, and then placing the master switch on the first point. If these relays immediately pull in their armatures, the set-up is correct.

Forward, reverse, or plugging with one or both motors is similar in sequence to that of the single motor bridge and trolley controller described above.

CLASS 9635 HOIST CONTROLLERS

Hoisting (Figures 4 & 4A)

For hoisting, the motor operates as a straight series wound motor. The inherent characteristics of the motor provide high speeds for light loads and slower speeds for heavier loads.

With the master switch in the off position (Fig. 4A) and the power on (control switch closed), three of the timing relays (1T, 3T, 4T) and one of the accelerating contactors (3A) are energized. On a Class A panel, the low voltage relay would also be energized under the above condition. Fig. 4A is the Class 9635-B for which the low voltage relay is mounted on the protective panel. Closing the main power switch would have no effect provided the master switch remains in the off position.

Moving the master switch to the first hoisting point (see Figure 5) energizes the coils of the hoist contactors, 1H and 2H. The motor is energized with resistor sections, A, B, E, and F, in series with the armature to give a slow hoisting speed. The series brake is released by the flow of motor armature current.

On the second point (Figure 6), contactor 1A will be closed to by-pass section A of the resistor and increase the motor speed.

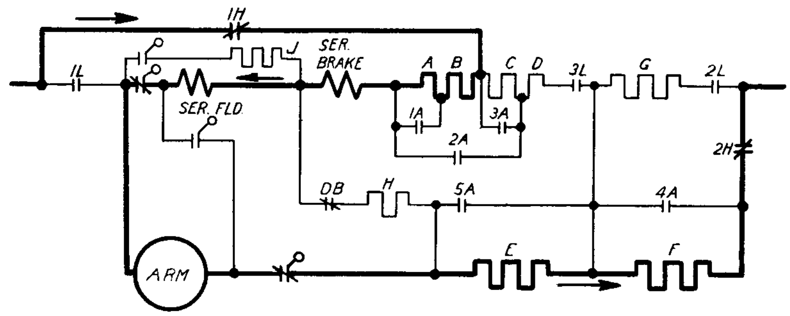

Fig. 5—First Hoisting Point

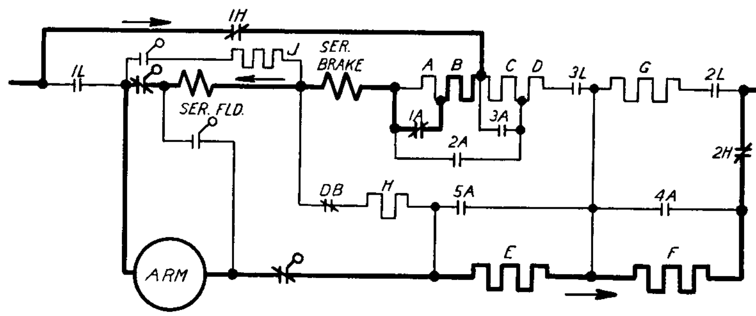

Fig. 6—Second Hoisting Point

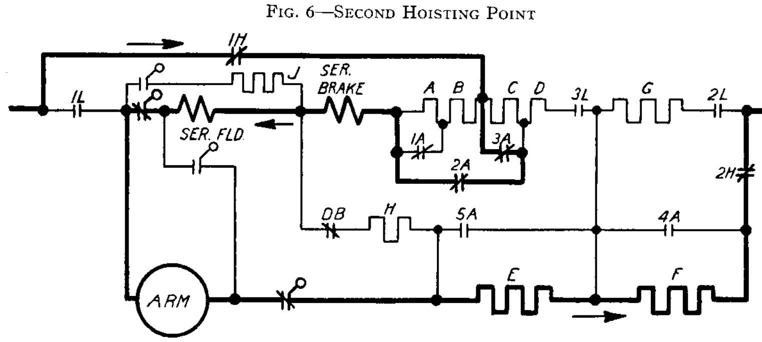

Fig. 7—Third Hoisting Point

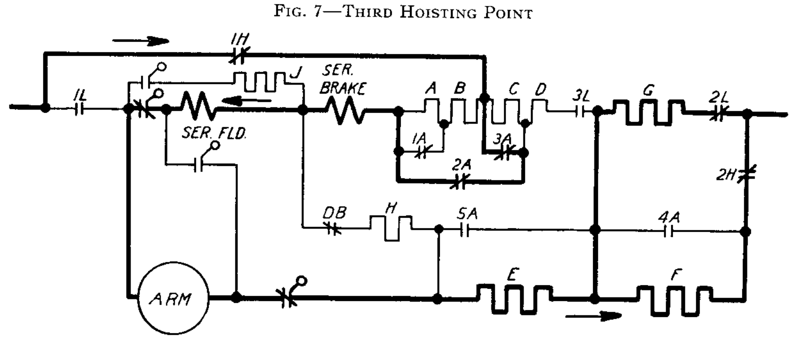

Fig. 8—Fourth Hoisting Point

On the third point (Figure 7), contactors 2A and 3A are closed to by-pass section B of the resistor and increase the motor speed another step.

On the fourth point (Figure 8), contactor 2L will close to parallel sections F and G of the resistor and further increase the motor speed. The timing relay which completes the master switch circuit to contactor 4A will begin its timing period when this fourth point is reached.

The fifth point (Figure 9) of the master switch gives the maximum hoisting speed and controls the action of two accelerating contactors, 4A and 5A. The action of 4A and 5A is also dependent on timing relays. Contactor 4A can close only after the timing relay, whose main coil was de-energized on the fourth point of the master switch, has opened. Closure of 4A shorts the parallel resistor step which was established on the fourth point. A normally closed interlock on

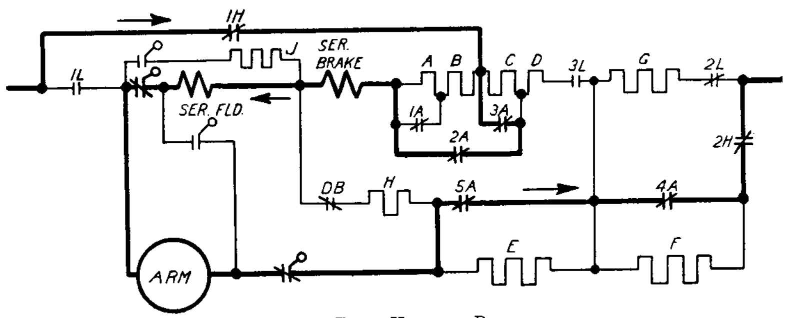

FIG. 9—FIFTH HOISTING POINT

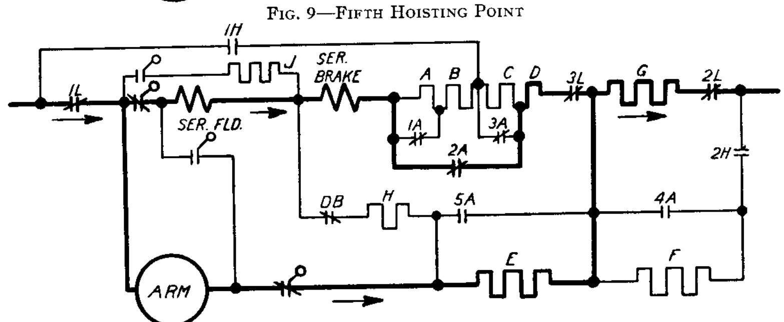

FIG. 10—FIRST LOWERING POINT

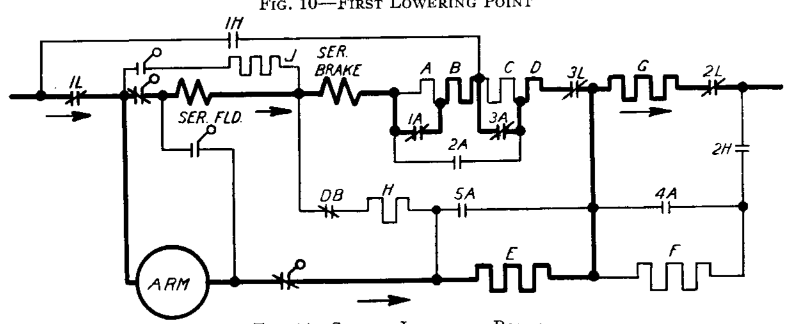

FIG. 11—SECOND LOWERING POINT

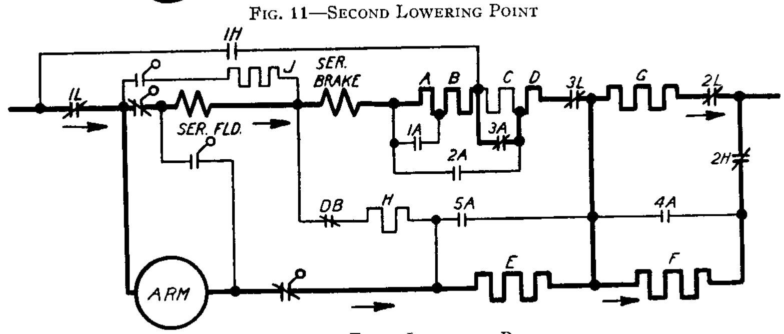

FIG. 12—THIRD LOWERING POINT

4A opens when the contactor closes and breaks the circuit to the main coil of the second timing relay, starting it on its timing cycle. When this timing relay operates, contactor 5A closes to by-pass the final step of resistance and put the motor directly across the line for maximum speed.

If the master switch is moved rapidly from the off position to the fifth point hoist, the sequence would be identical with that obtained by accelerating point by point. The rate of acceleration through the first four steps is controlled directly from the master switch. The last two steps are controlled automatically by the timing relays.

Lowering

In lowering, the series field and the armature are controlled independently to give the motor the characteristics of a shunt machine. This arrangement makes it possible to drive a light hook down and yet to have regenerative braking on overhauling loads. The field, brake and armature circuits are arranged so that, barring a defective resistor, it is not possible to have the brake energized without having a closed armature circuit. This condition is not dependent on any mechanical or electrical interlock.

On the first lowering point (Figure 10), contactors 1L, 2L, 3L, and 1A, 2A and 3A are closed This connects the motor to the line with section D of the resistor in series with the field, section E in series with the armature, and section G in series with both. This connection gives a slow speed, accurate inching point. The braking circuit for an overhauling load is through resistor sections D and E.

On the second point lower (Figure 11), contactor 2A is de-energized and opens to insert section B of the resistor in series with the field. This weakens the field and gives a higher motor speed.

On the third point lower (Figure 12), contactor 1A will open to insert section A of the resistor in series with the field and resistor section B, but contactor 2H closes to place resistor section F in parallel with section G, this combination results in a net resistance which is lower than the value of F alone. This tends to equalize the effect of the added resistance in the field circuit so that field strength will remain constant, but it reduces the net resistance of the armature circuit to raise the armature voltage and give higher motor speed. Overhauling loads will be lowered faster due to the increase in the braking resistance.

On the fourth point (Figure 13) contactcr 1A is again energized and closes. Contactor 3A is de-energized and opens. This exchanges section A for section C (higher value of resistance) of the resistor in the field circuit and increases the motor speed another point. The main coil of timing relay 2T is also energized to close its contacts on this point. (Timing relay 3T is de-energized and operates after a short time delay.)

On the fifth point (Figure 14), contactors, 4A and 5A, will be energized after the timing relays which control them have functioned. Relay 3T which begins timing as soon as the fourth point on the master switch is reached, normally will have opened shortly after the fifth point is reached. As soon as 3T opens, contactor 4A closes to by-pass the parallel resistor section composed of sections G and F. An interlock on 4A will open the circuit to the main coil of timing relay 4T which begins timing and opens after the short timing period has passed. When 4T contact closes, contactor 5A closes to by-pass resistor

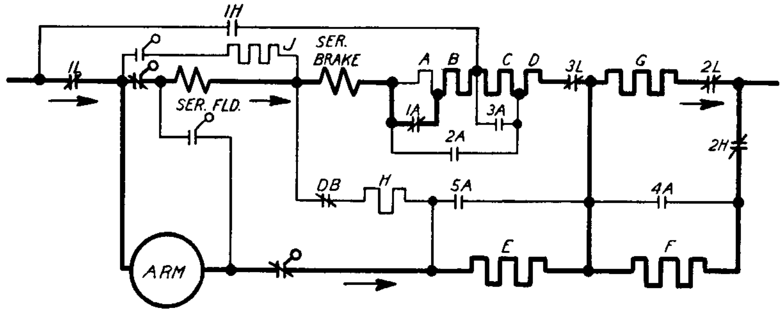

FIG. 13—FOURTH LOWERING POINT

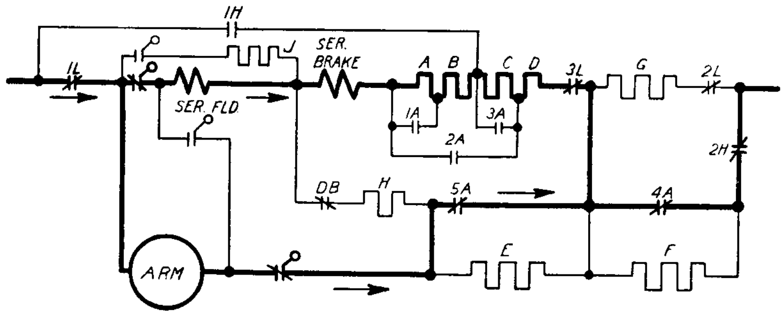

FIG. 14—FIFTH LOWERING POINT

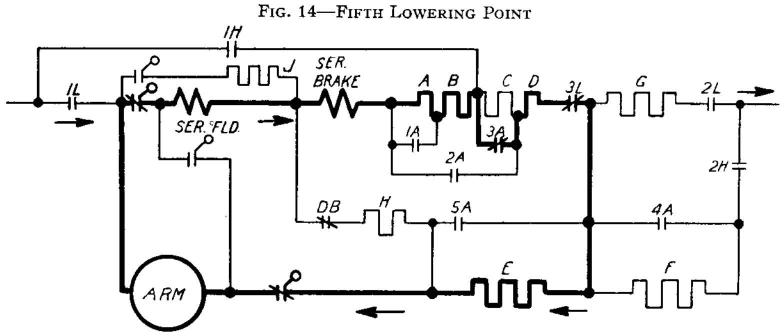

FIG. 15—FIRST STEP DYNAMIC BRAKING

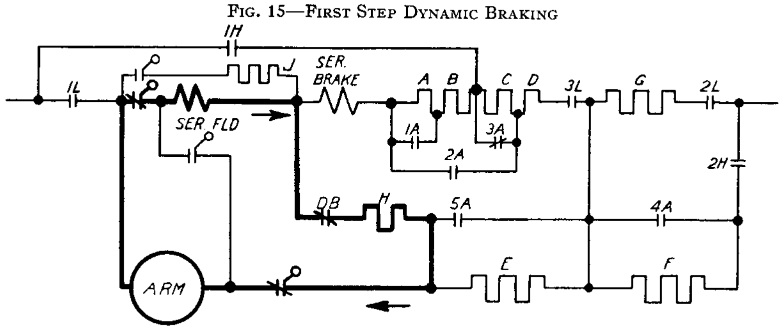

FIG. 16—FINAL STEP DYNAMIC BRAKING

section E and puts the motor armature across the line for maximum lowering speed.

It is necessary for contactor 2A to be closed for a fraction of a second at the start of the lowering sequence in order to insure that the brake will release. This is accomplished, regardless of how quickly the master switch is moved over the first point by the make contact on time relay 1T which is connected to parallel the master switch contact that normally closes 2A on the first point lower. The main coil to relay 1T is opened by an interlock on contactor 3L so that it begins timing as soon as power is applied to the motor (by 3L closing). Thus, when the master switch is moved rapidly beyond the first point lower for rapid acceleration, contactor 2A is closed for a very short period, but this time is sufficient to assure positive release of the brake.

Dynamic Braking

Two steps of dynamic braking are available when the master switch is returned quickly to the off position from the fourth or fifth point lower. The first step (Figure 15) takes place during the timing period of relay 2T.

The main coil of 2T is energized as soon as the master switch reaches the fourth point lower and remains energized as long as the master switch is on the fourth or fifth point. If the master switch is moved from point 4 or 5 to point 1, 2, or 3, the contacts of 2T have no effect on motor speed. If, however, the master switch is moved from point 4 or 5 to the off position, the contacts of 2T will hold DB and 3L energized during a short timing period to provide the first braking step. The braking circuit contains resistance sections, A, B, D, and E, and also the coil of the mechanical brake, so that this brake does not set during this braking time.

The final dynamic braking circuit (Figure 16) is made whenever the master switch is moved to the off position from any hoisting position, lowering positions 1, 2, or 3, or immediately after the nitial breaking period described above is ended by the opening of relay 2T. This braking circuit contains section H of the resistor, (used for braking only) the series field, and the motor armature. This braking circuit does not include the mechanical brake coil ,so the brake sets and helps stop the motor during this final braking condition. There is no electrical braking effect in the hoisting direction except as described under Part VI.

Using the above arrangement insures a safe, rapid rate of deceleration and also reduces brake wear, since the brake is set only after the motor has been dynamically braked to a relatively slow speed.

If the master switch is returned to an intermediate point after the complete starting sequence has been finished (motor running at maximum speed), the motor will slow down to the speed corresponding to that point. To again resume the maximum speed, the sequence would be a duplicate of the starting sequence beginning from that point.

PART VI—LIMIT SWITCHES

A standard limit switch arrangement is shown on the accompanying diagram (Figure 4A). The contacts shown as LS1 and LS2 are normally open, and LS3 and LS4 are normally closed. When the limit switch operates, the contacts all operate simultaneously and take positions opposite to those shown. LS3 breaks the circuit so that current from the line can no longer flow, and this permits the brake to set. Contact LS4 opens the connection between the field and the armature. Contacts LS1 and LS2 reconnect the armature, field, and resistor B3-B4 in a closed circuit, with the residual voltage tending to make the motor excite itself and supply energy to the braking resistor as long as the motor continues to rotate in the hoist direction. This application of both mechanical and dynamic braking produces a very sudden stop.

Note: All standard crane controllers which employ the limit switch in the motor (power) circuit will subject the motor to very rapid acceleration when backing out of the limit switch, because the motor is connected as a straight series motor shunted by the braking resistor J, until the limit switch resets. The circuit is through contactor 1L, armature A2 to A1, LS2 to the series field and brake, and then through the regular lowering field circuit connections to the negative side of the line. Since there is no braking, a high speed may be reached before the limit switch resets with a heavy load on the hook. Dynamic braking will quickly reduce the speed as soon as the limit switch resets. While backing away from the hoist limit the master switch should not be put beyond the first point until after the limit switch resets.

If the master switch connections are made as previously described, there is no danger of "pumping". If, however, a creeping speed is desired on the first hoisting point, a change may be made on the master switch connection to permit the dynamic braking resistance (section H) to serve as a motor shunt, in which case the contactor DB will not be energized and open until the second point is reached. With this connection "pumping" can occur on the first hoisting point after opening the hoist limit, because the limit switch opens the line to the motor but leaves the brake still energized through the motor shunting resistor and contactor. Resetting of the limit switch completes the motor circuit, and the load is hoisted back until the limit switch trips. This action will continue as long as the master switch stays on the first hoisting point after the limit switch trips.

PART VII—TESTS AND ADJUSTMENTS

A. Tests

Make a careful check of the controller without applying power to the motor, to insure that all connections have been properly made. In particular, check as follows without power on the motor. Sequence on the bridge and trolley controllers can not be fully checked without manually operating some of the relays.

1. Does the controller go through the complete sequence properly for each step of the master switch?
2. Trip the overload relay. Does it remove equipment from the line?
3. Do the definite time relays operate properly to energize the accelerating contactors after a definite time?
4. Does the master switch operate the control equipment according to the expected sequence.

After making tests as above, try operation with power applied to the motor and make adjustments and further tests as follows:

5. Check the direction of rotation and correct if necessary by reversing either the armature or the field terminals at the motor. Do not attempt to reverse leads at the panel.
6. Check the limit switch operation to be sure it stops hoist at a point low enough to be safe.

B. Adjustments

Warning: Before attempting adjustments to any apparatus, study carefully the instruction leaflet covering that type of apparatus. See Section III of this leaflet. All circuits should be dead and disconnect switches open when working on apparatus.

Plugging Relays

The successful operation of these relays requires that the main coil will pick up the armature and break the relay contacts whenever it is energized. Another requirement is that the relay armature must never pick up due to voltage on the neutralizing coil alone. If the gap is too short or the spring too weak, the relay will pick up due to neutralizing voltage alone and drop out all the accelerating contactors as the voltage builds up on the armature in starting. The relays are adjusted to pick up at 150 volts on the main coils (cold) and not to pick up below 300 volts on the neutralizing coils (cold).

Theoretically, the plugging relays should operate just as the motor reaches zero speed; but on applications such as a crane bridge or trolley, which are most frequently plugged to a stop, it is sometimes desirable to throw the master switch to the second point or more in reverse, and let the plugging relay and contactor operate while the motor is still operating at a very low speed. This tends to hold a higher braking torque at the low speed. Moving the slider on resistor tube, S1-R4, (Figure 2A) toward R4 increases the speed at which the plugging contactor will operate, and this adjustment may be made at any point to give the result desired on any particular bridge or trolley. The limit of what may be accomplished in this way is reached when the first accelerating contactor comes in before the motor stops. The slider on the resistor tube connected between R4 and S1 should be adjusted so that the plugging relay will drop out and allow the plugging contactor to close at the speed best suited for that particular crane. Although the plugging adjustment described may well be used over a very limited range, it can not take the place of main resistor step adjustments in all cases.

Master Switch

The type SM master switch can be mounted in any position in which its handle is normally vertical. A feature of special importance to the hoist master switch, is the manner in which switch sequence with respect to handle throw can be reversed. If it is desired to reverse the handle movement, change as follows. Set the switch in the off position and carefully remove all the cams. Hold each cam in the same position in which it was mounted on the master switch, turn it about its horizontal axis in the plane of the cam, through an angle of 180 degrees. Replace each cam to the same location on the shaft which it originally occupied.

Timing Relays

It is important to remember that the voltage on the neutralizing coil should never be higher than 30 volts, or lower than 6 volts. The rheostat is calibrated at the factory to give this range of voltages and should not require recalibration in the field.

The timing of the relays with shims can be adjusted by changing the combination of shims employed. Time is increased by using more steel shims or reduced by using more copper shims. There must always be a total of four shims used to insure alignment of armature and polefaces, a brass (non-magnetic) screw must be used to hold the core plug on and never more than three of these should be steel. Care should be taken to prevent any damage to the core plug face, for it must be smooth for satisfactory operation.

STARTING, ACCELERATING, AND BRAKING RESISTANCE

Hoist Panels (Class 9635)

Adjustments in resistor R1-R9 (Figure 3A) will change the time required for the series brake to pick up when starting from rest into lowering. It should be adjusted so that the brake will release positively. Rated full load motor current, or up to 10% more should pass through the brake and field circuit on the first point lowering. Reducing the resistance will give more rapid brake release. However, do not cut out more than 10% of the total resistance in this step.

Never change resistor step R8-R9 or R9-R10.

Alternate Connections

Two alternate connections are possible on the standard hoist controller. One of these will provide a motor shunt on the first hoisting point to give a creeping speed. The other will remove the first step of dynamic braking which is employed on stopping from lowering (having accelerated at least to the fourth point), leaving only the final braking step for operation. Connections for both circuits are indicated on the wiring diagram and can readily and easily be made if desired. If the graduated braking feature is not used, it may be necessary or desirable to increase resistor step R7—R8.

Adjustments in resistor step R3-R4 will change the maximum lowering speed. A **no load** lowering speed at 140% is recommended. The light hookspeed should never exceed 150% of the rated full load motor speed. Decreasing the value of this resistance will reduce the maximum lowering speed.

Trolley or Bridge Panels (Class 9605)

On the trolley or bridge panels, the value of resistor section R1-R2 (Figure 2A) controls the rate of deceleration when the motor has been plugged. Reducing this resistor will decrease the time required for the motor to stop. The value of the resistor should not be decreased below that value, which will limit plugging current to approximately 150% of rated full load current, unless it is necessary to meet some special unusual conditions.

PART VIII—MAINTENANCE

Always disconnect power supply from panel before adjustment or repairs are attempted.

The following items are listed as suggestions for keeping the apparatus in the best operating condition:

1. Periodical inspection at regular intervals of all equipment should be made to insure that all apparatus is in good condition.
2. Contacts becoming badly worn should be replaced. Proper spring pressure should be maintained at all times.
3. Do not oil contactor bearings.
4. Do not use emery paper to smooth contacts. A file, used **sparingly and carefully**, is recommended when necessary.
5. Keep all connections tight, especially the overload heater connections.
6. In replacing coils, make sure that the correct style number or L-number is used. The style or L-number is stamped on a metal tag and taped with the last layer of insulating material. Do not apply any unnecessary force on the coil terminals, for this may injure the insulation between the outside coil layer and the terminal or break the terminal loose from the wire.
7. When replacing or tightening contacts or shunts on contactors, make sure that any copper surfaces bolted together are clean and bright. Silver contacts need not be bright, because they will still make good contact even when they are black. When replacing the contactor arc shields, be sure that they are on straight and that there is no mechanical interference between the shield and moving parts even when the armature is pressed to either extreme toward the arc shield sides. Check condition of the stops on the armature bracket and make certain the stops are not worn thin or the armature travel too long. If these steps are worn too thin, the contactor may fail to close because of magnetic attraction between the armature bracket and the armature. On spring closed contractor make certain that the non-magnetic washers between the moving yoke and the frame are in good condition. If these parts are allowed to touch, the contactor may fail because of attraction between the frame and yoke, setting up unnecessary friction. Inspect and adjust interlocks to be sure that they make good contact with some overtravel but not enough to completely close the coils of the spring.
8. In case of trouble:
   (a) If a control fuse blows, check carefully for shorted or damaged coils or wires; repair equipment and replace fuse.
   (b) If the controller fails to go through the sequence completely:
      (1) Open the power circuit switch and check the operation on all points of the master switch to discover what apparatus is not working:
      (a) If nothing works, check the control fuses first.
      (b) If directional contactors fail to operate, check the wiring to the master switch.
      (c) If a single contactor fails to work, its coil is probably open and should be checked first.
      (d) If a TL relay fails to work, its neutralizing coil may be open. Check this point first. If the coil is all right, check the polarity of the relay coil. It is necessary to have the correct relative polarity between the main the neutralizing coils on both the timing and plugging relays. One top or neutralizing coil terminal is positive with respect to the opposite top terminal. The bottom terminal, on the side having positive polarity at the top, must show negative polarity with respect to its opposite bottom terminal. If this condition is not met, the relay armature will not

leave the pole face after the main coil is deenergized, as it will still be held by the neutralizing coil.

On a controller that has operated properly, troubles due to reversed coils will occur only when new, but faulty, coils are placed on the relays, or normal coils are put on but incorrectly connected.

PART IX—RENEWAL PARTS

When ordering renewal parts, always give the following information:

(1) Name the part. Give its style number if possible and the nameplate reading of the complete units. Reference to the marking of the part on the diagram helps, if other information is not available.

(2) Give the complete controller nameplate reading. S.O. number is absolutely essential.

(3) State whether shipment is desired by freight, express, or by parcel post. Name the route; if by parcel post, state whether the shipment should be insured.

(4) Send all orders or correspondence to the nearest Sales Office of the Company.

Careful observance of these directions is essential for correct shipments and prompt service.

MEMORANDUM

(Use Ink)

MEMORANDUM

(Use Ink)