THE AUXILIARY EQUIPMENT OF THE CHICAGO, MILWAUKEE AND ST. PAUL LOCOMOTIVES

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The auxiliary equipment of locomotives of the nature of the Milwaukee units is considerable, and is of great importance. The present contribution describes the lightning arresters, the voltmeters, the watthour meters, the air compressor circuits, the motor-generator circuits, cab heaters, head lights and the train lighting apparatus.—Editor.

In addition to designing an electric locomotive so that it will exert drawbar pull, there are many other features which have to be taken into consideration; although these features are called auxiliaries many of them are really essential to the commercial operation of the locomotive.

By referring to Fig. 1, an idea may be obtained of the connections of the electrical apparatus which is auxiliary to the main circuits of the locomotive. As both halves of the locomotive are alike the diagram only shows the auxiliary equipment for one-half a locomotive. At times only half a locomotive is used on some of the local passenger trains.

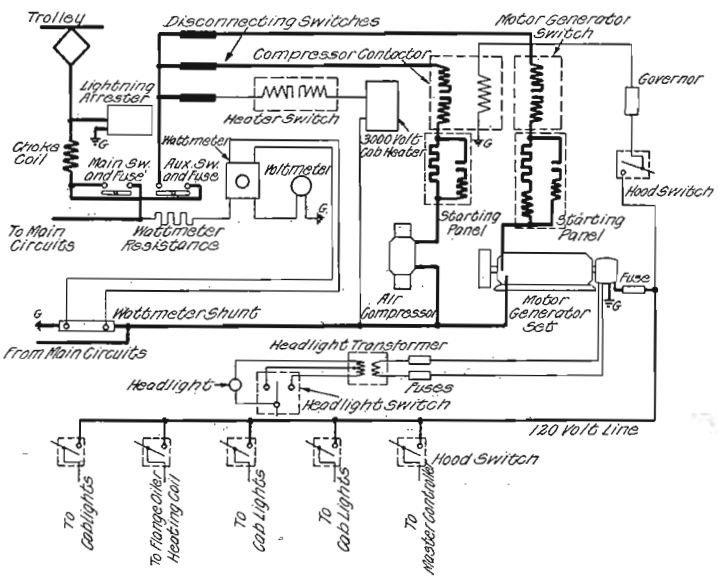

Fig. 1. Connections of Auxiliary Apparatus Chicago, Milwaukee & St. Paul Railway

Lightning Arrester

As an electric locomotive is connected to many miles of trolley wire and transmission line, lightning protection is a necessity. In order to give this protection, an aluminum cell lightning arrester is connected directly to the trolley. This arrester, shown in Fig. 2, consists of a sheet metal box containing twelve electrolytic aluminum cells, each with a balancing resistance across it. When the door is closed a 3000-volt expulsion fuse, held in clips on insulators on this door, makes contact with clips in the small fuse compartment. This fuse thus performs the double purpose of fuse and disconnecting switch.

Voltmeter and Watthour Meter

In order to keep a record of the power used by the different locomotives a railway mercury watthour meter is used. The special feature about this circuit is the extra high resistance which has to be used in series with the potential coil of the meter on account of the high voltage. This resistance, shown in Fig. 3, is similar to the ordinary meter resistance except that it contains more resistance tubes and is made in such a shape that it can be assembled on one of the regular equipment supports. In the low side of this potential circuit is connected a voltmeter with a five kilovolt scale for giving indications of trolley potential.

Air Compressor Circuits

The compressed air required for the pneumatically operated control apparatus and air brakes is supplied by a 3000-volt motor-operated compressor capable of delivering 150 cubic feet per minute at 135 lb. pressure. A 3000-volt double blowout contactor, shown in Fig. 4, is used for opening and closing the compressor circuit. As this contactor is only designed to handle 30 amperes a large number of turns can be used on the blowout coils. This insures a strong blowout which makes it possible to use only one break to open the circuit. The operating coil is supplied with current at 120

volts through a small hood switch and an ordinary governor. The governor then automatically starts and stops the compressor between certain given ranges of pressure.

There is required, of course, a starting set in order to keep down the current while the compressor is starting from rest. This set consists of a resistance and an automatic contactor which short circuits the resistance when the current has dropped to a predetermined value. The resistance is made up of spirally wound coils mounted on mica and porcelain insulation. These units are attached to one side of a narrow panel on the front of which is located, in a covered box, the automatic or series contactor. The contactor is so designed that a heavy current through its coil will hold it open and it will then only close when the current has fallen to a much lower value as the motor speeds up. The starting set, Fig. 5, is all supported by porcelain insulators and can be assembled on the regular equipment supports.

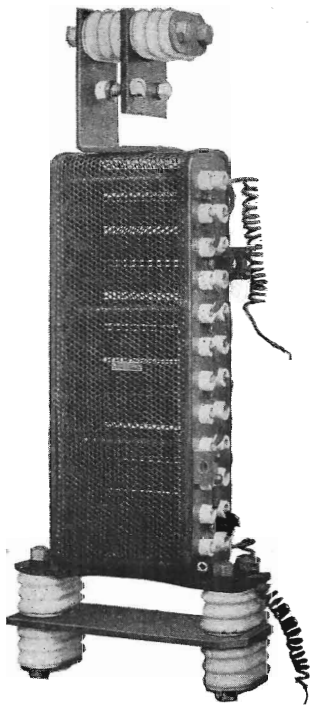

Fig. 3. Special Resistance for Use with Mercury Watthour Meter on 3000 Volts

Motor-generator Circuits

The motor-generator set consists of a 3000-volt motor, a double commutator exciter for use during regenerative braking and for charging batteries on the cars for train lighting, and a 120-volt d-c. generator to furnish low voltage for the control. The blower for cooling the main motors is also connected to the shaft of this set. The motor-generator set is started and stopped by a 3000-volt manually operated contactor or switch. This switch, shown in Fig. 6, is the same as the 3000-volt compressor contactor in Fig. 4, except the operating mechanism. Instead of the electromagnetic coil there is supplied a handle and toggle joint for holding the switch closed. The handle extends through the sheet iron compartment and this eliminates all danger from live parts or flashes from arcs while operating. The same type of starting set is used for the motor-generator as for the compressor.

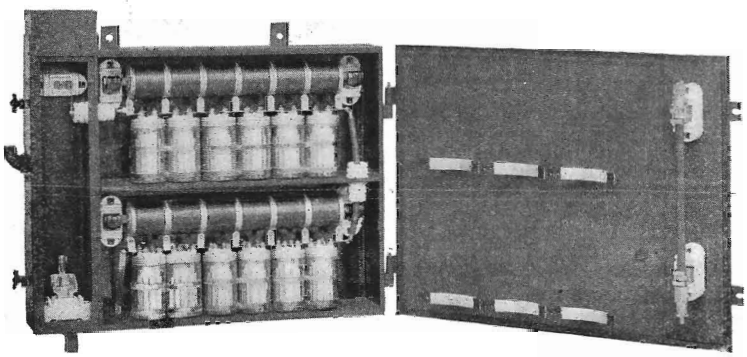

Fig. 2. 3000-volt Direct Current Aluminum Lightning Arrester for Locomotive Service with Series Expulsion Fuse Operating as Disconnecting Switch

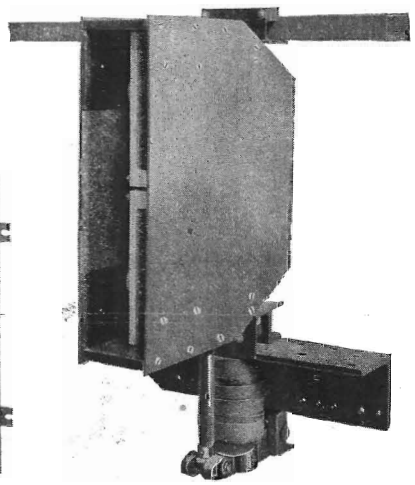

Fig. 4. 3000-volt Compressor Contactor

A feature which helped to simplify the installation of apparatus was the fact that this auxiliary apparatus, namely, the wattmeter

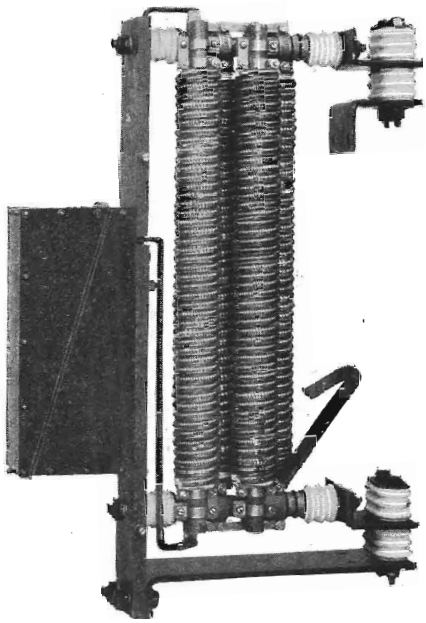

Fig. 5. Starting Set for 3000-volt Compressor and Motor Generator Set

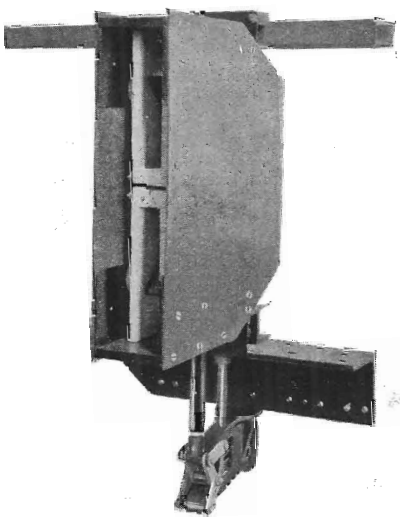

Fig. 6. 3000-volt Motor Generator Switch

resistance, compressor contactor, motor-generator switch and starting sets wer designed to go in the regular six inch spacing of the main contactors on the equipment supports.

Cab Heater

In the winter time the comfort of the engine-men has to be considered, especially in a region like the Rocky Mountains. In each operating cab there is installed a 3000-volt cab heater, Fig. 7. It is made up of ten resistance coils or units, nine of which are in series and the tenth is in parallel with the ninth and has the blower motor in series with it. The motor is connected in this manner so that if the motor circuit should become open circuited at any time there would not be 3000

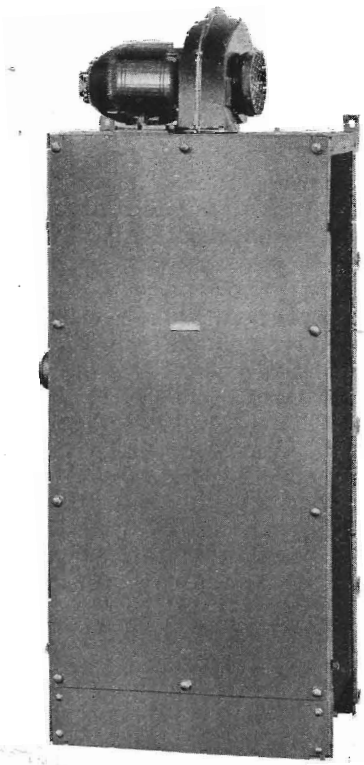

Fig. 7. 3000-volt Electric Cab Heater

volts on the motor. This scheme also allows the use of a low voltage motor in a high voltage circuit. The blower is located on the top of the heater and blows air from the cab down over the units and out at the bottom of the heater case where it is conveyed through ducts to points near the enginemen's feet. The units are designed to withstand the current even should the blower accidentally stop.

Headlight

In order to comply with the Montana law a headlight having 1500 unreflected candle-

power had to be supplied. To produce this high candle-power a 750-watt, 34-volt concentrated filament lamp is used. The power for this lamp is taken from slip rings provided on the control generator for the purpose. The voltage at the slip rings is approximately 96 volts alternating current at anything from 40 to 70 cycles due to the variation in speed of the motor-generator set. From here the current goes through fuses to a small transformer, shown in Fig. 9, where it is stepped down to 34 volts. Fig. 8 shows how the number plates are put on the headlights at an angle so that the numbers can readily be read at the side or from a point directly ahead.

Train Lighting Apparatus

The train lighting system used on the Chicago, Milwaukee and St. Paul Railway is the head-end system with three train lines. One line carries the outgoing current from a generator and is called the generator line. The batteries along the train are connected between the generator line and a second line known as the battery line, while the lamps are connected between the generator line and a third line which is known as the lamp line. An adjustable resistance is provided in the locomotive so that the voltage between the generator line and lamp line may be held

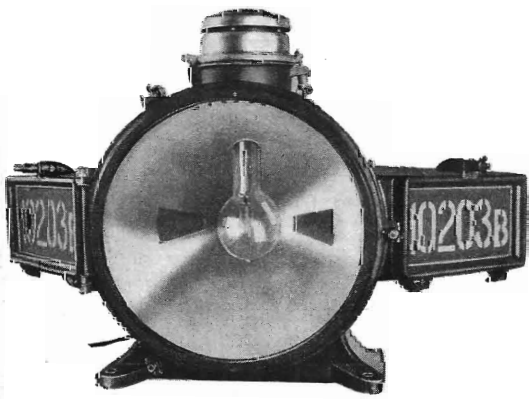

Fig. 8. Incandescent Headlight for Locomotive Service

constant while the voltage between the generator line and battery line is being varied in order to maintain the desired amount of charging on the batteries.

When the trains are being operated by steam locomotives the power for lighting is furnished by a steam turbine driven generator installed in a baggage car at the front of the train and the voltage is controlled there. When in the electric zone, the train lines are coupled up to the locomotive and power for lighting is furnished from the two exciters ordinarily used for regenerative braking, but now connected in series to give the proper voltage.

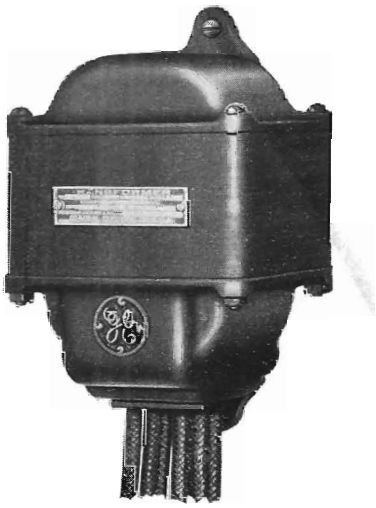

Fig. 9. Small Transformer for Locomotive Headlight

An electro-pneumatic commutating switch is used to change over the connections from braking to train lighting. This switch is very similar to the main reverser but with different sequence of contacts. The connections are so arranged that the engineer always has control of this switch and is enabled to throw it from *lighting connections to braking connections* at any time unless he has opened the small snap switch which controls the commutating switch on the rear half. This commutating switch can never be thrown over to the lighting connections if it is being used by the engineer for braking. The snap switch is provided so that the rear half of the locomotive may be left with train lighting connections while the front half is braking. This is usually the procedure at night except while going through Butte on the 2400-volt section and also on the heavy grade. In the day time, however, the batteries are not on charge unless they are pretty low or there is a lamp load of 20 to 25 amperes.

The control of the battery charging in the locomotive is taken care of at a large panel, shown in Fig. 10. The two lines from the generator armatures, after passing through fuses, lead to this panel. Here the positive lead goes through an ammeter shunt to a

knife blade switch and then to the generator line. The negative lead goes through an overload and reverse current circuit to a knife blade switch and thence to the battery line. The circuit breaker also has a shunt coil which will trip the breaker when relay "A," Fig. 11, is de-energized. This relay is energized only when the batteries are to be charged and when it drops out it short

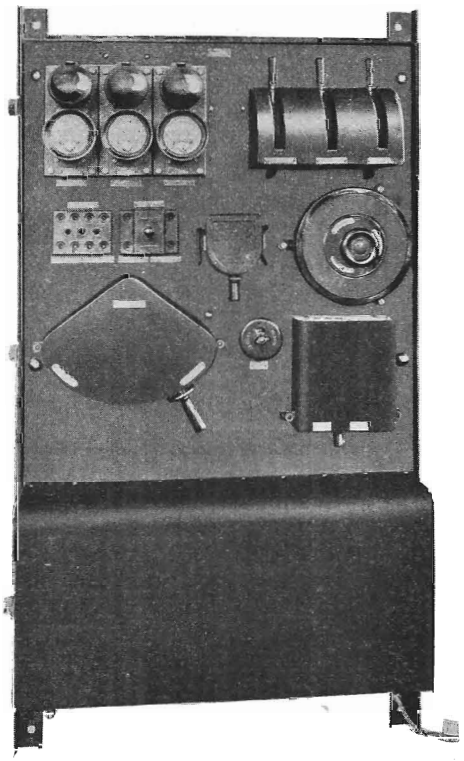

Fig. 10. Battery Charging Panel

circuits a resistance and allows sufficient current through the shunt coil to trip it. In changing back from lighting connections to braking this takes place before the commutating switch throws and thus opens the generator circuit. Between the circuit breaker and battery switch a lead goes through an adjustable resistance, ammeter shunt and knife blade switch to the lamp line. As the voltage of the generator has to be held constant between 75 and 78 volts while charging, this resistance is used to reduce the voltage on the lamps to 62 to 66 volts.

In making the change from steam to electric operation the lamps of the train are thrown directly on the batteries by closing the lamp switch at the panel in the baggage car. This insures having the train lighted during the change of engines.

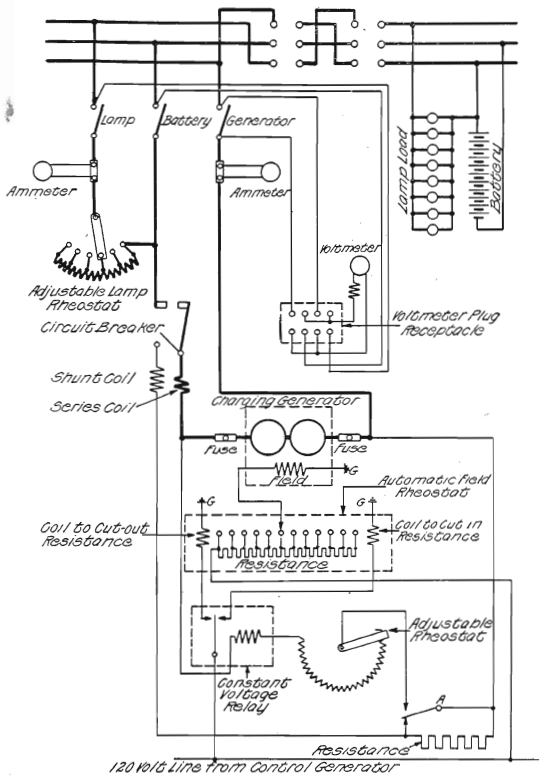

Fig. 11. Connections of Train Lighting Apparatus Chicago, Milwaukee & St. Paul Railway

The voltage is kept at any desired point by means of a constant voltage relay which energizes either the "cut in" or "cut out" coil of an automatic field rheostat in the generator field. The setting of this relay may be varied by means of an adjustable resistance in series with the coil.

This lighting apparatus is only used on the passenger locomotives and a few freight locomotives which are expected to be used at times in place of regular passenger locomotives.