narily be required, because there is ample room for handling the wires through the round opening in the base.

As will be noted in Fig 2, there is a small film or "knockout" of porcelain in the center of the cap. A light blow will serve to knock this out, transforming the "block" into a rosette. Wires can be passed through this opening and fastened at the binding screws, as shown in the upper view of Fig. 1, so that a drop light or switch fixture can be attached.

Another interchangeable feature of this block is that to this same style base a porcelain lamp receptacle

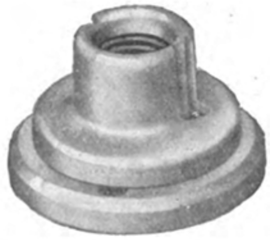

Fig. 3.—Porcelain Receptacle Mounted on Same Interchangeable Base.

(as shown in Fig. 3) can be attached. The heavy lugs shown in the base fit into the recesses molded into both the top piece of the block or rosette and the lamp receptacle base and insure the correct relative position of the parts so that the fastening screws (which also serve as current connections) can be easily and properly fastened.

These devices, designated as list No. 566 for the rosette-connecting block and No. 4122 for the receptacle, are designed for attachment to standard 3¼-inch outlet boxes and to No. 700 Adaptiboxes. They are approved devices.

NEW HIGH-SPEED CIRCUIT-BREAKER FOR HEAVY DIRECT-CURRENT SERVICE.

Unique Apparatus Installed in Substations on the Chicago, Milwaukee & St. Paul Railway Electrification.

High-speed circuit-breakers involving unusual characteritsics have been developed and placed in operation

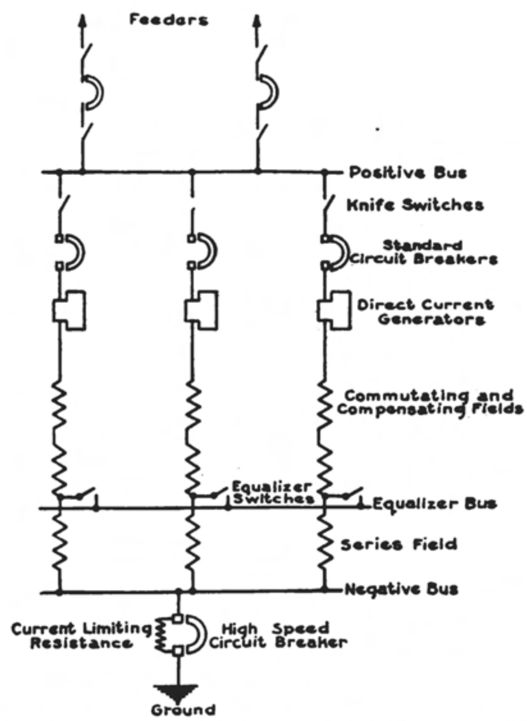

Fig. 2.—One-Line Diagram of Direct-Current Connections for Substations Equipped With Three Motor-Generator Sets Protected by High-Speed Circuit-Breaker Connected Across Limiting Resistance.

by the General Electric Company to protect the generating apparatus in the Chicago, Milwaukee & St. Paul Railway's substations from flashovers resulting from short-circuits near the stations. It is the function of this apparatus to operate with sufficient speed to check the rise in current caused by a short-circuit before damage can be done to the converting equipment. In order to meet this requirement, it is necessary that the rise in current be checked within a few thousandths of a second and the circuit-breaker described below meets these conditions in every respect.

The rate of acceleration on the main and secondary contacts is approximately 8000 feet per second and they are released in a time as short as 0.003 second or less from the beginning of the short-circuit. The time

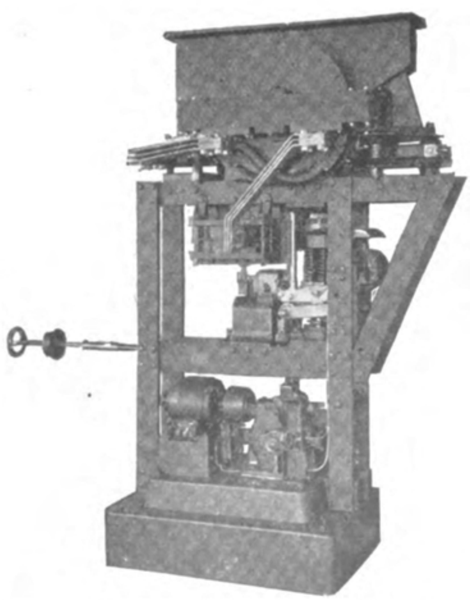

Fig. 1.—High-Speed Circuit-Breaker With Magnetic Blowout for the Chicago, Milwaukee & St. Paul Railway. Type MW, 3000 Amperes, 3600 Volts.

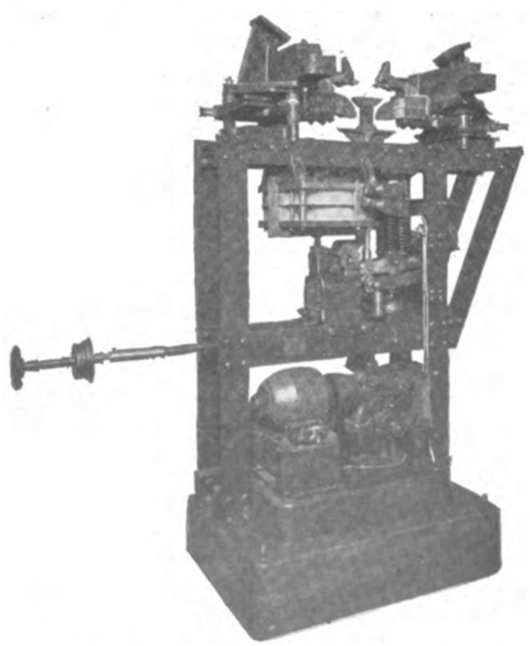

Fig. 3.—High-Speed Circuit-Breaker With Arc Chute Removed.

from the beginning of the rise in current caused by a short-circuit until the secondary contacts part, has shown by test to be of the order of 0.004 second. This compares with about 0.10 to 0.15 of a second, the speed of ordinary switchboard-type breakers. The designers have thus succeeded in building a breaker which will in effect foresee the rise in current caused by a short-circuit and insert sufficient resistance to limit this rise to a safe value.

It has been the practice on many railroads to install a certain amount of feeder as resistance between the substation and the tapping-in point, usually by carrying out the feeders to some distance from the station before tapping in. It was evident, therefore, that if apparatus could be developed to protect the generators from liability of flashover on severe short-circuits, it would permit of the feeders being tapped directly to the trolley at the substation, thus eliminating the losses due to feeder resistance.

Preliminary calculations in connection with the electrification of the Chicago, Milwaukee & St. Paul Railway showed that quite an appreciable amount of power could be saved each year by the elimination of this extra feeder resistance. Work was therefore initiated on the development of an air circuit-breaker which would have such a high speed in opening that it could be used to insert resistance in the circuit soon enough to prevent the short-circuit current from reaching such a value as to cause the direct-current machinery to flashover. This design of breaker required a speed much faster than anything ever before attempted. Careful investigations demonstrated that the device must operate in a shorter time than is required for one commutator bar to pass from one brush to the next or less than one-half cycle for that particular machine.

One of these breakers is installed in each substation and connected into the negative return circuit between the ground and the negative bus. (See Fig. 2.) This location would give the maximum protection, since the return circuit must pass through the limiting resistance in case of a flashover from the positive to ground as all of the negative terminals, bus rigging, etc., are insulated for full generator voltage. To insure complete protection, the high-speed breaker is so interlocked with the regular switchboard type of air circuit-breaker that the high-speed breaker must always be closed before the switchboard breakers.

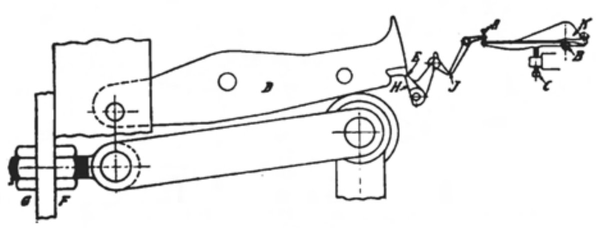

Fig. 4.—Diagram of Levers for Tripping and Resetting the Type MW Circuit-Breaker.

The 14 3000volt direct-current substations on this railway system are equipped with this new type of breaker and the first units installed have been in operation since early in 1917 with very satisfactory results. All substation feeders are tapped to the overhead trolley system directly at the substation, eliminating the resistance losses occasioned by tapping at some distance away. Actual operation has demonstrated that it is entirely practicable to operate direct-current stations in this manner when protected by the high-speed circuit-breaker, even though the voltage of the system (3000 volts) is the highest direct-current voltage used in commercial railway work.

Description of the New Breaker.

This new high-speed circuit-breaker is of the single-pole, magnetic-blowout type rated 3600 volts, 3000 amperes, direct-current. The breaker and mechanism for a self-contained unit are mounted on a structural-iron framework with cast-iron base. The base and framework are in turn mounted on an insulating base to insulate the circuit-breaker from the station floor. The operating mechanism is so arranged that the breaker can be closed either by hand at the breaker, or by a motor controlled from the station switchboard. The closing of the breaker by means of the motor is accomplished by a cam mechanism operated through gears. When closed by hand, a ratchet mechanism is used.

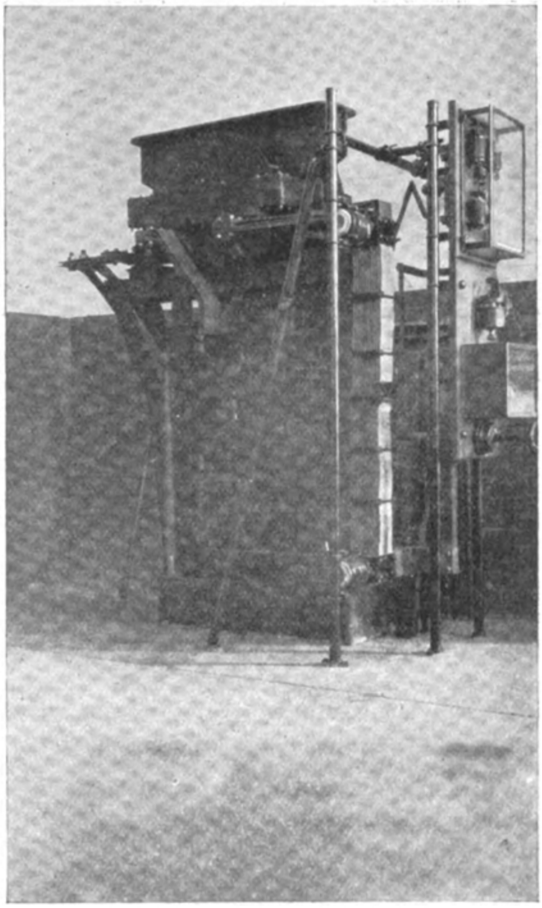

Fig. 5.—High-Speed Circuit-Breaker Installed in Janney Substation, Chicago, Milwaukee & St. Paul Railway.

The main contacts are of the well-known laminated-brush type, the brushes forming the stationary contacts. The movable contact is a solid copper forging which is made as light as possible in order to reduce to a minimum the mass to be moved in operation. Secondary contacts are located above the main contacts and are of very ingenious design to insure their breaking after the main contacts in order to prevent any possibility of burning the current-carrying parts of the main contact. All of the contacts are located in a blowout chute of insulating material designed to withstand the burning incident to the arc. The blowout magnet is of laminated iron of large section. The blowout coils and trip coils are connected in series so that the blowout coils are excited at all times, as the usual arrangement of shunt blowout coils was found to give insufficient speed of blowout. The main and secondary contacts are carried on a lever and this lever is actuated by a nest of compression springs which exert a force of about 8000 pounds when the breaker is adjusted for operation. It was found that this pressure was required to give the rapid acceleration necessitated by the high-speed conditions under which this circuit-breaker is required to operate.

The tripping is accomplished through a train of latches and levers actuated by a solenoid, the magnet frame and core of which are specially laminated to obtain a quick magnetic response to the short-circuit current. The object in using a series of several latches is to allow the mechanism to move the main latch through a distance of 1/8 inch or more by means of a solenoid. This solenoid, in order to act in the time required, is able to move only a distance of about 0.001 of an inch and can exert a force of only about 200 pounds, while the main latch is subject to a pressure of about 4000 pounds transmitted through a lever from the compression spring above referred to.

The calibration in order to take care of the varying number of units in the several stations, is obtained by means of an adjustable tension spring directly opposing the pull of the solenoid. Referring to Fig. 4, the actual tripping takes place at *J*. The levers *A* and *K* are to multiply the movement of the solenoid, which delivers its force at *B* so as to obtain a movement large enough to be entirely definite. The latches from *E* to *J* are special forms of levers which reduce the great pressure at *E* to a value which can be handled by a small bearing surface at *J*.

Upon the opening of the breaker contacts, the resistance becomes increasingly effective due to the resistance of the arc as the breaker completes its operation and after the lapse of about 0.008 of a second or less from the beginning of the short-circuit (see Fig. 6) the resistance has increased to such a value that no further rise of current can take place.

This method of protection has given such satisfactory results that high-speed circuit-breakers have been adopted by the General Electric Company as standard on all 3000-volt direct-current generating apparatus for steam-railroad electrification. Actual service has demonstrated that the high-speed breaker will protect the generating apparatus from all short-circuits experienced, and that it not only prevents damage to the brush rigging, commutator, etc., but relieves the duty on the regular switchboard air circuit-breakers usually installed.

A reference to the oscillograph record shown in Fig. 6 gives a good idea of the remarkably high operating speed of this circuit-breaker and the resulting protection against damage to equipment. It may also be noted that this oscillogram shows the maximum current rise of less than ten times normal which is quickly reduced to well within the commutating capacity of the machine. With this method of protection, none of the effects of the direct-current short-circuits are transmitted through the set to the alternating-current side, thereby preventing such disturbances from affecting in any way the alternating-current supply system.

The breakers were installed by the electrification department of the railway company under the direction of R. Beeuwkes, electrical engineer.

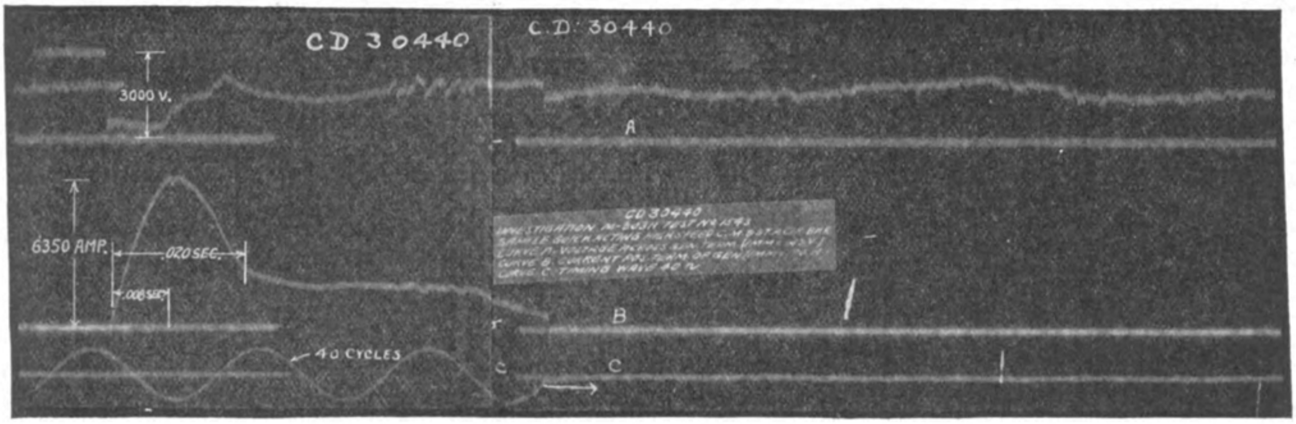

Fig. 6.—Oscillograph Record of Short-Circuit on 2000-KW., 3000-Volt Motor-Generator Set Checked by High-Speed Circuit-Breaker and Standard 3000-Volt Switchboard-Type Circuit-Breaker.

MOTOR-DRIVEN VISIBLE-MEASURE GASOLINE DISPENSER.

The incidental losses in the vending of gasoline are claimed to be eliminated by the use of a visible-measure gasoline dispenser. In a device of this kind known as the Brady dispenser, the pump is driven by a Westinghouse 1/4-hp. motor, entirely enclosed in the base in accordance with the rules of the National Board of Fire Underwriters. The Brady dispenser visibly delivers a full gallon for every gallon ordered. When the wagon delivers gasoline to the garage, the tank gauge shows accurately the full quantity obtained. Every gallon drawn from the tank into the dispenser is shown on the tank register, which can be checked with the tank gauge. Thus, both the public and the garage owner are protected from loss. Furthermore, the oil companies are enabled to make more rapid deliveries than by measuring cans from wagon to garage tank where the Brady dispenser is installed.

SUCCESSFUL BURNER FOR FUEL OIL.

In order to prevent a recurrence of the fuel conditions of the past winter, much study is being given to the fuel situation. One of the suggested means for relief is the more extensive use of fuel oil, with its simplicity in handling, convenience, efficiency, particularly in those sections of the country where it can be easily and cheaply obtained.

The types of burners available for general use have greatly restricted the use of oil. To be successful,