

ENGINEERING REPORT ON CONTROL EQUIPMENT

Section III Page 27

Oct. 1, 1926

LINE BREAKERS

In the process of development of the present day control equipments the matter of wear and burning of controller fingers and segments, as well as platform controller blowups, was given considerable thought and attention. The most likely means of eliminating these troubles was considered to lie in the application of a suitable line breaker, the first designs of which were only partly successful. Continued engineering investigation and improvements in design have brought about the present highly efficient line breaker equipments.

Back in 1905 it was found that some means of protecting platform controllers from the burning and wear incidental to arcing from heavy overloads was desirable. The first step in this direction was the design of the contactor attachment which opened contactors in the line each time the controller turned off, the contactors opening at transition and the off position. This arrangement had its disadvantage in that there were other points in the controller where burning occurred therefore further improvements were necessary.

In order to get the contactors in the line to take more of the burning, that is, to open ahead of the controller at all points, the slip ring was designed. This attachment was found to be unsatisfactory mechanically, and was discontinued.

The ratchet switch, the next step in the development, was a decided improvement as compared with previous designs but it had its limitations in that the controller cylinder was required to move back through one full point before the switch would open. This meant that the controller, being thrown to the off position from the first point, would frequently open ahead of the line breaker taking all the burning on this point. The ratchet switch was the first development which materially decreased controller blowups in the old types of platform controllers.

The Type LB line breaker handle has certain advantages both mechanically and electrically not possessed by any of the previous attachments. It is mounted directly on the shaft above the cap plate and takes the place of the main handle usually supplied with "K" controllers. Backward motion of the handle opens the control circuit of the line breaker before the controller cylinder begins to turn off. This insures practically all arcing taking place in the line breaker thus protecting the fingers and segments of the controller against burning. It also insures all heavy currents being opened under the car. Since adopting this line breaker equipment controller explosion due to opening heavy overloads is a matter of the past. Embodying the control feature in a handle which can be mounted on the outside of the controller permits of making the parts sufficiently heavy and rugged to withstand the rough usage encountered in railway service; it also eliminates the necessity of cutting down clearances inside the controller by adding additional apparatus.

There are two general types of the line breaker handles: One for controlling the line breaker in connection with ordinary platform type of controllers, and the other which has incorporated in it the air brake features of the Safety Car Devices' handle as well as the line breaker control.

The DB-986 and DB-987 line breakers consist of a magnetically operated contactor and overload relay enclosed in a sheet steel case for mounting under the car. The current carrying parts of the line breaker are in their essential details the same as a magnetically operated con-

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tactor in that they are made of a magnet frame, operating coil and removable armature to which is attached a contact tip. This contact tip engaging with a similar fixed tip closes and opens the electrical circuit. A powerful magnetic blowout forces the arc outward through the arc chute to atmosphere.

The arc chute is fitted with arc suppressor plates which greatly assist in reducing the time required for rupturing the arc and protecting the arc chute from burning. The arc chute is so designed that the use of tools for its removal or replacement from the contactor are unnecessary.

The overload relay is so located on the contactor that it not only opens the control circuit to the contactor operating coil but delivers a heavy blow against the contactor armature and exerts a strong pull greatly speeding up the opening.

The curve, Page 29, shows clearly the increase in speed of opening and rupturing the circuit accomplished by the DB-986 line breaker as compared with the previous design. Oscillograph records of test made in the factory brought out the fact that a short circuit applied to either of these line breakers caused the current to rise to 8700 amperes in 0.0145 seconds, at which time the overload relay acted and the line breaker tips began to part. Before the tips opened far enough to reduce the current in the arc, 9300 amperes was reached in 0.019 seconds in the DB-986 line breaker, while the current in the DB-976 reached 9700 amperes in the same time. From this point on the current fell rapidly in the DB-986 until the final rupture of the arc in 0.0392 seconds from the time the short circuit was applied, or 58% of the time required by the older type. It will be observed that in the case of the DB-976 the current rose steadily until the maximum of 11000 amperes was reached in 0.042 seconds and held at this value until 0.048 seconds elapsed, at which time the line breaker tips parted far enough to cause the current to fall rapidly to the point of final rupture; namely, 0.0675 seconds from the time the short circuit was applied.

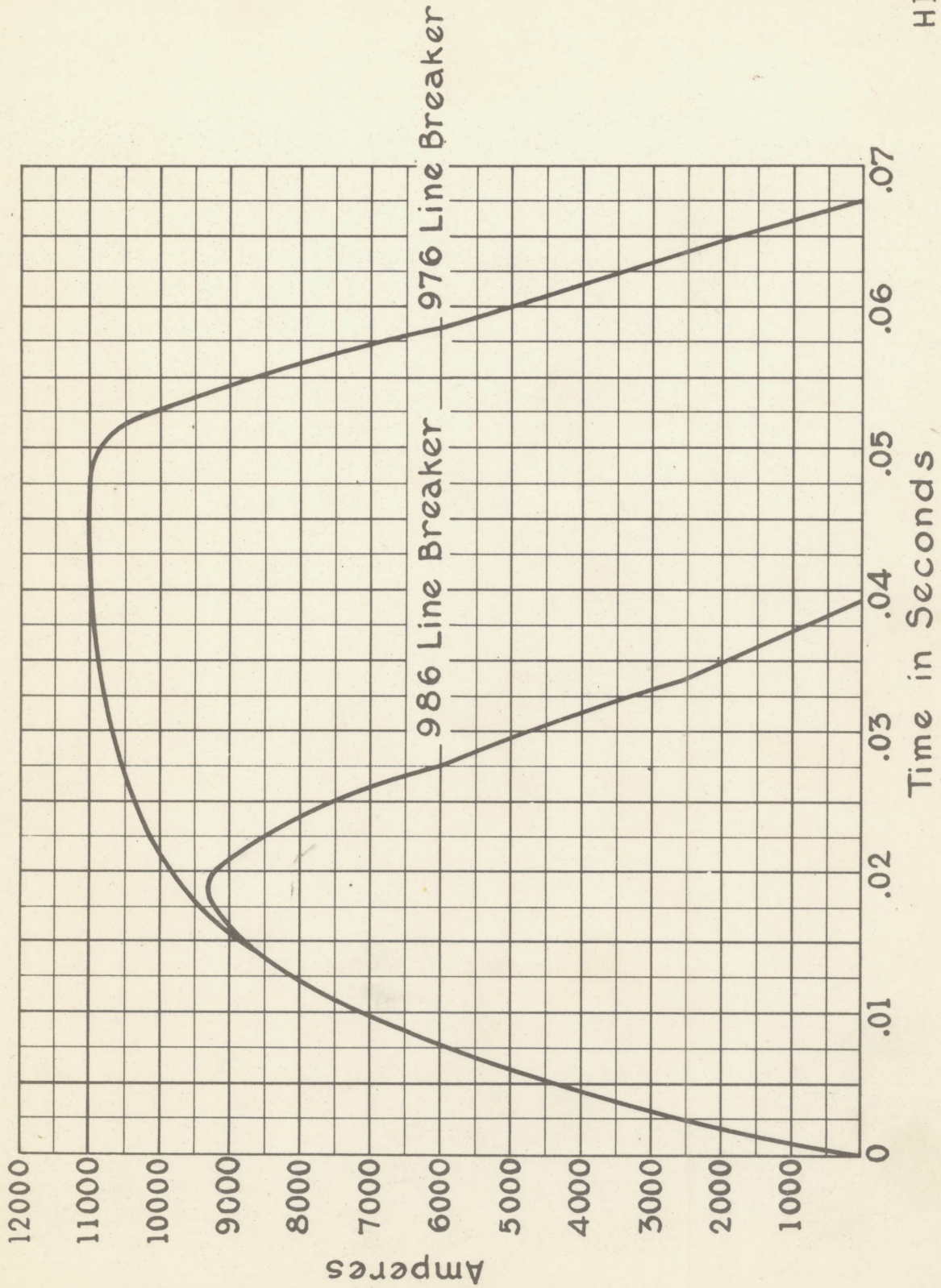
The energy taken from the line before the short circuit on 500 volts was finally opened is represented by the area within the curves and is approximately 75 wathours with the DB-976 line breaker, while under the same conditions the energy taken by the DB-986 was approximately 31 wathours, a considerable saving over the DB-976 line breaker.

The speed of opening of the contactor of the DB-976 line breaker is normal and no more than should be expected for the contactor alone. The contactor of the DB-986 line breaker would be no faster were it not for the design of the overload relay used in this line breaker. In the one case the type of overload relay used merely opens the control circuit of the line breaker and the time required for the tips to open is governed by the time taken from the magnetic flux to die down to the point where the tip pressure springs and gravity will push the tips apart, after the control circuit has been opened. The DB-986 line breaker uses the same general type of contactor as the DB-976. The greatly increased speed at which it operates is due to the fact that the overload relay is so designed and mounted that the energy developed in the series coil, under the high current caused by a short circuit or overload, is employed to exert a powerful force against the armature of the contactor, greatly assisting the tip pressure springs and gravity in opening the tips ahead of the time required for the magnetic flux to die down, after the control circuit has been opened. This feature results in the saving of approximately 42% of the time required to open the circuit by the previous type of line breaker.

The DB-987 line breaker differs from the DB-986 only in the addition of a "kick off" cylinder, to apply to it the emergency air features of the Safety Car Devices' handle.

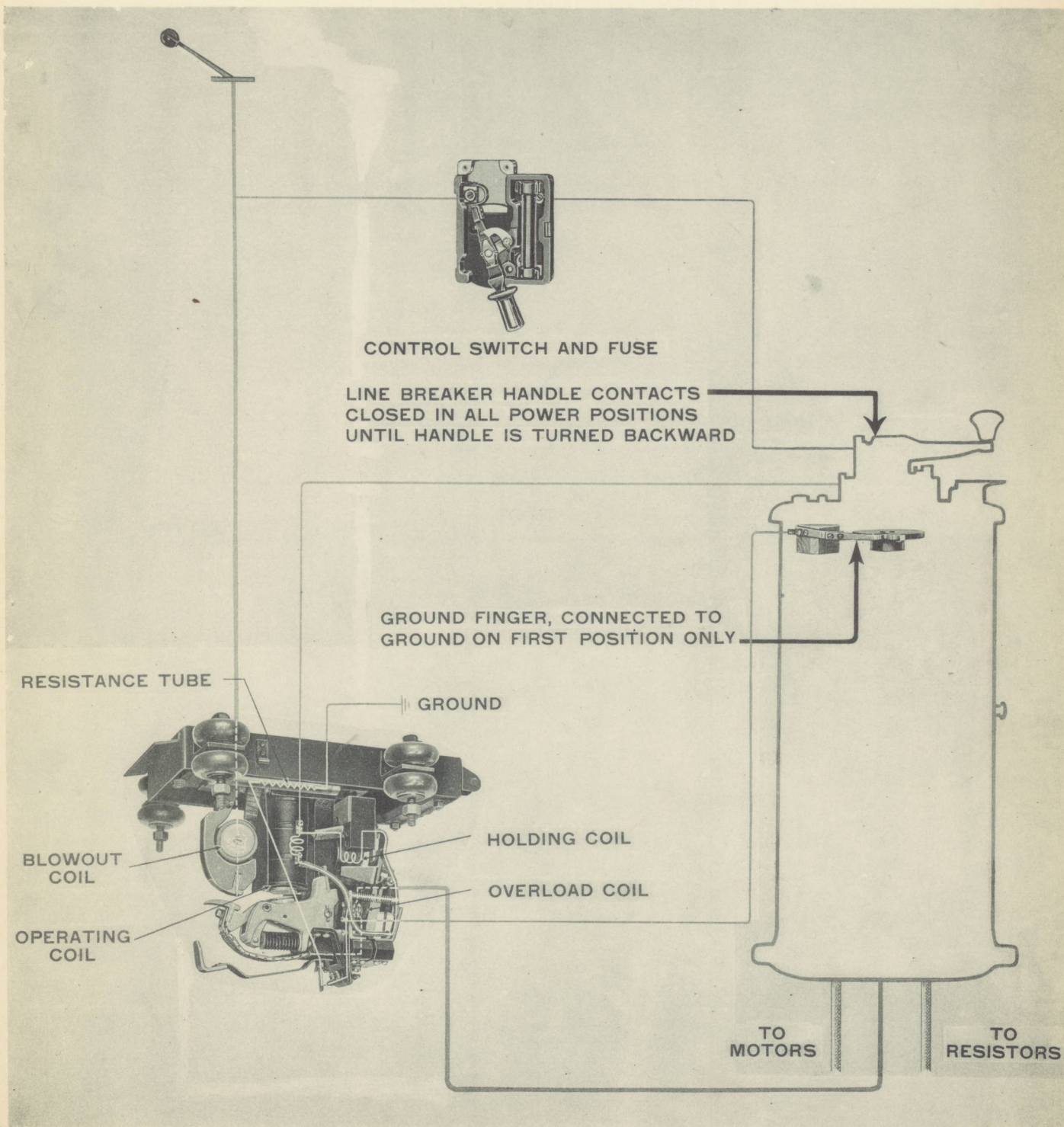
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Speed Curves of DB Line Breakers



Rwy. Equip. Eng. Dept.

**LINE BREAKERS AND OPERATING DEVICES FOR
DRUM CONTROLLERS
CONNECTIONS**



APPARATUS SALES ADVICE No. RY-2 . 79

Department: RAILWAY
Classification: GENERAL
Subject: GE LINE BREAKERS & ACCESSORIES

Schenectady, March 16, 1926

GE line breakers are now operating on 327 electric railways where they are cutting controller maintenance expense by reducing arcing within the controller and hence increasing the life of contact fingers and segments. Carefully compiled records show that on some properties the savings during a single year have offset the additional investment in line breaker equipment.

The DB-986 breaker recently added to the line is the present standard for equipments not employing safety air features. The DB-987 breaker is identical with the DB-986 except that it is equipped with a pneumatic cylinder for tripping the relay armature when the brakes are applied. These breakers supersede the DB-976 and DB-981 respectively for new installations but we will continue to furnish the latter types to those preferring them on account of interchangeability of spare parts. It is expected however that the quicker action, simpler construction and other features of these new breakers will make a strong appeal to the operating department and a special effort should be made to have the new breakers substituted on all orders.

LB-2 and LB-4 line breaker control devices are now available for use with cars equipped with or without safety air features. These devices replace the usual main operating handle of the controller as well as the ratchet switch, slip ring or cam operated contacts previously placed inside of the controller. The new device is bolted to the controller cap-plate. New controllers are furnished with cap-plates drilled and tapped for the reception of these devices and equipped with the required ground finger. For the older controllers a drill jig is supplied for drilling the cap-plate and it is necessary to mount the ground finger furnished as a part of the device inside the controller as with previous types.

The LB-2 control device has a fixed handle and is used in conjunction with the DB-976 or DB-986 line breaker on cars not equipped with air safety features. Prices on complete equipments with line breakers as listed in the Railway Price and Data Book include ratchet switches installed in the K controllers. The LB-2 control device will be furnished if desired in place of the ratchet switch as part of the car equipment without change in price.

(Over)

The LB-4 Control Device combines the functions of the LB-2 device with the safety air features of the Safety Car Device Co's. standard handle and is used in conjunction with DB-981 or DB-987 line breakers. The operating handle is identical with that employed with the safety equipment. With this device as with the Safety Car Devices handle, power circuit is opened and the brakes are applied if the operator removes his hand from the controller handle. For original equipments the LB-4 device will be included in the air brake quotation. It may be substituted in lieu of the Safety Controller Handle Base Portion and Controller Pilot Valve regularly furnished with Air Brake and Safety Car Control equipment at an additional expense of \$22.50 for single end equipments and \$45.00 for double end equipments. In such cases representative should be sure that the ratchet switches are omitted from the car equipment quotation. In all cases where the device is to be substituted an allowance should be obtained from Schenectady for the omission of the ratchet switches.

The LB-4 control device may be purchased with competitive air brake equipments through the Safety Car Devices Co. It is expected that this device will influence the selection of GE air brakes but representatives should make a special effort to have the LB-4 device specified even though the air brakes are to be purchased from a competitor.

Complete price information on line breakers and line breaker equipments sold separately is given in HB-4743. Prices on equipment not there listed are quoted on application to Schenectady. Descriptive Sheet GEA-25-A just issued, copy of which is attached, gives information in convenient form for transmission to customer. Both the LB-2 and LB-4 control devices as well as the DB-986 and DB-987 line breakers are now available for immediate shipment.

A special effort should be made to bring these improved devices to the attention of your customers.

E. P. WALLER,

Manager, Railway Department

DISTRIBUTION:

Sales Office Managers
Railway Representatives