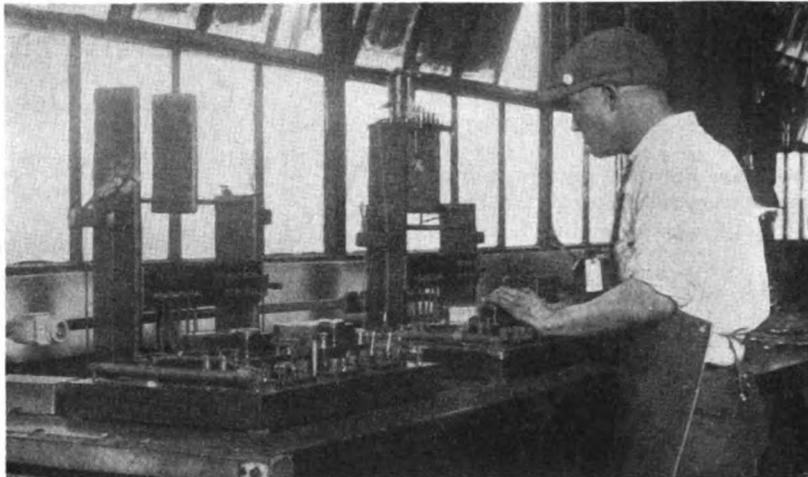


Burlington Develops

Signal Repair Shop

at Aurora, Ill.



Relay test racks

Work for entire system concentrated at one point -- Under supervision of an inspector

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THE signal department of the Chicago, Burlington & Quincy, following the general policy of the management, has developed a well equipped signal shop where the repair and reclamation of signal material is handled, as well as the assembly of some apparatus.

This shop is located at Aurora, Ill., 38 miles west of Chicago, being housed on the third floor of the new general system storehouse. A floor space of 1,260 sq. ft. was allotted for the signal shop which is cut off from the remainder of the floor by steel shelves and bins used for storing parts, tools and apparatus. The mechanical equipment, in addition to specially designed benches and tools, consists of three power drill presses of different sizes, a 10-in. universal lathe, a buffer and a grinder. Power outlets are available with the following range of voltages—42 volts d-c. from a storage battery, and 110 and 220 volts of either a-c. or d-c. A large assortment of electrical instruments are provided to permit making any tests required.

Certain types of work on signaling equipment are sent out to the railroad locomotive shop nearby where facilities are available for welding, nickel or cadmium plating, coil winding and the reconditioning of storage batteries. The signal stock, in charge of a signal stockman, is located on the same floor in the area adjacent to the shop, which reduces delays in dealing with the store department.

How Shop Was Started

No relay or signal repair work had been handled by the railroad up to 1917, at which time a relay inspector

and an assistant relay inspector were appointed and instructed to test relays in the field and make the repairs required, using the maintainers' quarters temporarily as a shop. The increase in this class of work soon required the addition of two more men, the four working in crews of two men each, with the relay inspector in charge.

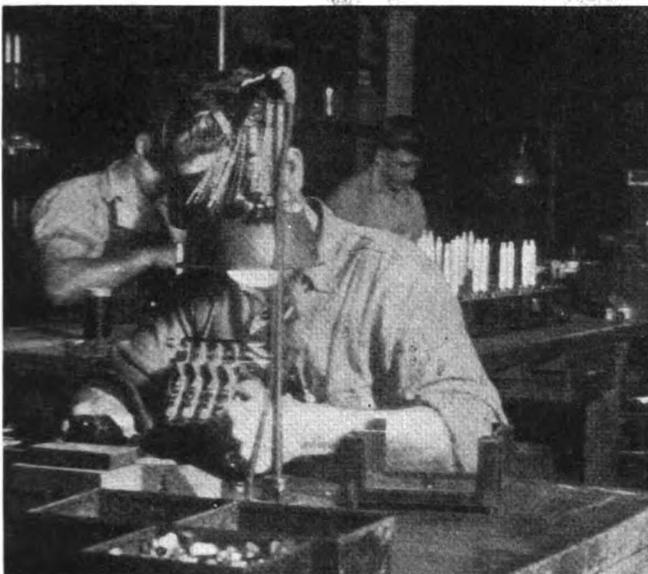
Within a short time a program was adopted to obtain a high degree of signal performance and to reduce failures to a minimum. It was, therefore, decided to establish a small signal repair shop at Aurora, the relays being sent in from the field for repairs. The work at this shop continued to increase until repairs were being made to all types of signal materials used on the road. Another shop was opened at Havelock, Nebr., near Lincoln, which continued to function until 1927, when both shops were consolidated into the present organization at Aurora.

Most repair work consists of overhauling relays, as nominally the relays are rotated in the field on a six-year program. However, as preference is given to relays needing attention, some relays do not get to the shop for a period of more than six years. When relays are received at the shop for repairs, they are examined by the inspector or assistant inspector to determine what repairs are to be made. If the cleaning of contacts and making adjustments is the only attention required, then the work is done by one of the testers. However, if the magnetic values are not up to standard, then the relay is torn down to the necessary point, where new iron and Burlington standard contacts and fingers can be incorporated, which work is done by an assembler who

then turns the relay over to a tester for final adjustment of the air gap, tension, and other adjustments necessary to produce proper magnetic and electric values.

Adjustments are made by laying the relay down on its back with the contacts up and the coils pointing toward the man making the adjustments. A small mirror is placed behind the contacts and the adjustment is made by hand pressure as viewed in the mirror. These mirrors are of several widths but the one used most is one inch by five inches, the width being controlled by the type of relay and available space behind the contacts. This method has proved superior to the usual rack method. After these adjustments are made, the final inspection is made, including meggering and sealing. The use of compressed air to blow out foreign particles has been discontinued, as a soft camel-hair brush is more efficient.

Other repairs are handled in the shop, the general run of material includes switch circuit controllers, rectifiers, switch machines, motors, indicators, signal mechanisms, power drilling machines, transformers, crossing bells, etc. The repair of all signaling equipment is thus concentrated in this Aurora shop with the exception of the repair of centralized control coder relays, which is handled in the field, for two reasons. First, it is not economical to carry an emergency stock large enough to permit rotating these units through the shop, and second, by making repairs in the field, the field circuits and code combinations can be used for testing, thus eliminating the expenditure for testing apparatus in the shop. In case a centralized control relay fails in service, the signal supervisor replaces it with an emergency unit, the super-



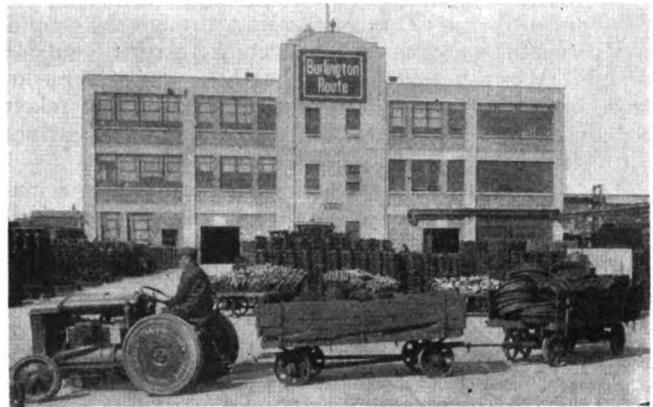
Relay in process of adjustment

visor being permitted to break the seal to make repairs only in case of an emergency. When any of these units fail, the inspector is called out at once to make repairs, test it and seal it again.

A relay inspector, reporting to the signal engineer, has charge of the shop, spending part of his time on the road and the remainder at the shop. In addition, the shop force includes an assistant, who is in the shop at all times, and six relay repairmen, four of whom are capable of dismantling and assembling a relay complete from start to finish. Additional men are employed when required.

Assembly of Burlington Relays

A part of the program outlined when the first shop was established at Aurora was to make a technical study of relays, which resulted in the design and development of a C. B. & Q. relay, made to operate in accordance with the electrical values shown in the accompanying table. Instructions were issued that any relay in the field which did not meet these requirements was to be sent to the shop for repairs and calibration.



The storehouse on the third floor of which the signal shop is located

Arrangements were made to purchase the parts for the new relays in accordance with specifications of the signal department, and the work of assembling and testing the new relays was assigned to the signal shop.

Table Showing Operating Values of Relay

Type	Minimum Release	Maximum Working Current	Contact Resistance of New Relays	Maximum Allowable Contact Resistance In Service
1,000-ohm neutral relay	2.7 volt	6.4 volt	.08 ohm	1.0 ohm
500-ohm neutral relay	2.1 volt	5.8 volt	"	1.0 ohm
4-ohm neutral relay	.037 m.a.	.090 m.a.	"	.8 ohm
2-ohm neutral relay	.052 m.a.	.122 m.a.	"	.8 ohm

The maximum allowable contact resistance .2 ohm.

An accompanying table shows the electrical values adopted for the C. B. & Q. relay as originally developed and as used now. However a few relays have been built to meet the present A. R. A. specification and the new standard values can be adopted at any time. However, due to the fact that the present relay shows a performance of nearly one-hundred per cent, it has not been considered necessary to change the magnetic and electrical values to meet A. R. A. specification.

Since the year 1919, the Burlington has assembled many of the relays of its own design. These include 2-ohm, 4-ohm, and 500-ohm, neutral types, as well as interlocking relays. However, the interlocking relay is of a more recent development. The parts, made according to specifications developed by the railroad signal department, are obtained from various manufacturers. Relays are assembled in lots ranging from 100 to 500, the average being 200. This, of course, is governed by the requirements necessary for new work. The relays are assembled by men called assemblers who make adjustments to approximately the correct values, after which the adjuster makes the final adjustments.

The physical, magnetic and electric characteristics of a Burlington four-ohm relay is shown in an accompanying table. It will be noted that .090 m.a. working current is .020 m.a. higher than A. R. A. specification.

In addition to 2-ohm, 4-ohm, 500-ohm and 1,000-ohm relays, a few for special locations are built, such as 9-ohm, 16-ohm and 250-ohm.

The shop also conducts a certain number of service tests on apparatus and parts. One rack employs a small motor-driven circuit-breaker for testing relays. This apparatus conforms to the A. R. A. Signal Section specification of one complete pick-up and drop-of-armature per minute. Relays being tested are given 200,000 complete operations, the contact resistance and values being measured every 5,000 operations. Approximately one relay out of every 100 relays passing through the shop is tested on this rack, as well as sample relays of outside design. Also different kinds of carbons and silver contacts, different types of fingers and other parts of relays are given this service test, both with and without current through the contacts.

Tests are made when repairing and recalibrating semaphore signal mechanisms. A torque test of seven foot pounds was developed to apply to the lower-quadrant type signals in use. In addition, complete electric and magnetic tests are made.

All work is performed and costs computed under a system of accounting known as a G. A. R. (General Account Requisition), which permits the shop to operate as an independent organization. The store department issues a G. A. R. to repair or assemble a certain number of a certain kind of apparatus. This G. A. R. is given a reference number and copies are furnished the signal shop and to the auditing department. Requisitions for the necessary material are prepared in the shop and are charged to the G. A. R. These requisitions are filled by

Table Showing Characteristics of a Four-Ohm Relay

Resistance for pair of coils.....	4 ohm
Ampere turns per coil.....	950
Working current090 m.a.
Maximum direct pick-up.....	.070 m.a.
Minimum release without spring.....	.016 m.a.
Minimum release with spring.....	.038 m.a.
Physical air gap.....	.013 in.

the store department and priced by the proper branch of the auditing department. The labor in the signal shop is distributed on the payroll to the several G. A. R.'s, and the auditor combines the material and labor cost and adds the overhead which is 3 per cent on material and 2 per cent on labor. These are actual costs and are checked by the signal engineer, and, since they are developed by the auditor, they are official.

When a G. A. R. is completed, the finished article is delivered to the store department where it is taken in stock and applied on requisition, the same as any article that has been bought from outside parties. This system places the signal shop independent in so far as accounting is concerned and also relieves the signal engineer of keeping cost records which would be less official than records compiled by the auditing department, and also leaves the signal engineer free to handle the payroll of the shop, as well as to operate it.

Only a few of the types of work handled in the shop are briefly enumerated here. As many as 14 men are employed at times when the work requires. With a force of 11 men the daily capacity of the shop is 35 new relays, in addition to other work. A total of 16,000 new relays of the Burlington specifications have been assembled since 1919. The major items handled during the 10 months' period January 1, 1929, to November 1, 1929, are reflected in an accompanying list.

This work was done at a considerable saving. The repairs were too heavy to be done in the field, and the

List of Equipment Handled in Shop During Ten-Month Period

1,899 Relays repaired.
1,964 New relays assembled.
70 Interlocking relays repaired.
196 Rectifiers of all types repaired.
32 Power-off relays repaired.
185 Semaphore signal mechanisms repaired.
44 Semaphore signal motors repaired.
26 Tower indicators repaired.
18 Crossing bells repaired.
23 Back locks repaired.
64 ANL approach light relays repaired.
150 Switch boxes of all makes repaired.
5 Wig-wags of the magnetic type repaired.
540 R. S. A. terminal blocks repaired.
12 Power bonding machines repaired.
5 Flasher relays repaired.
132 Resistance units repaired.
7 Mechanical dwarf signals repaired.
16 Semaphore clutch magnets repaired.
5 Time releases repaired.
10 Circuit controllers for interlocking machine repaired.
5 Train control magnets repaired.

apparatus would have been scrapped or sent out for repairs if we had not had a shop. Repairs made outside would have cost much more, and also there would have been freight to add. The principal advantages of operat-



The assembling bench

ing the signal shop have been economy in reclaiming and prolonging the life of apparatus, efficiency in being able to handle repairs quickly and keep ahead of wear and tear of field service, and safety in having the repairs under the supervision of the signal engineer, and also the chance to keep records and make tests resulting in a continuous improvement of apparatus and installation methods.

The development and supervision since the shop was organized have been under Wm. Poole, relay inspector, who not only is foreman of the shop but makes field inspections when necessary.