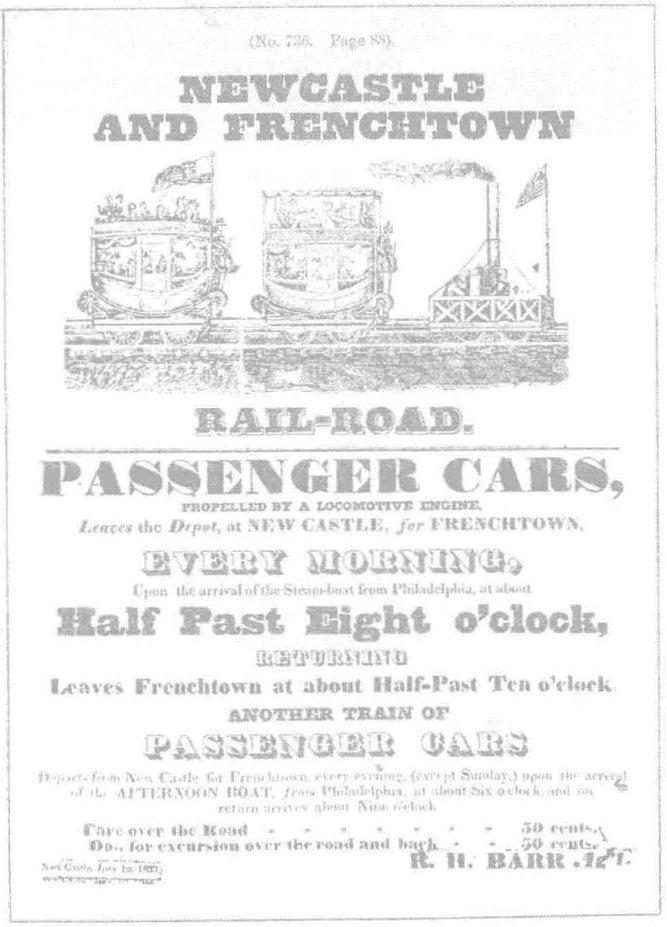
as all three of the tracks are operated in either direction by signal indication.

Next in order is the operation in either direction of *both* tracks of double-track roads by signal indication. The most notable example of this is the double-track section of 119 miles on the Chicago, Burlington & Quincy, described previously. Both tracks are provided with automatic block signals for operation in either direction. Fast trains may easily run around slow moving trains. Other notable installations are as follows: Chesapeake & Ohio, six double-track sections with a total length of 40 miles; Illinois Central, a 20-mile section adjacent to its three-track section; Pennsylvania, the line between New York and Manhattan Junction, eight miles and a double-track section on the Tyrone division of five miles. Either-direction operation on double tracks by train orders is not included in this record.

In certain situations on four-track roads, traffic has taxed the capacity of the four tracks to a point where it has been necessary to operate one or all of the four tracks in either direction. On the Pennsylvania, between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NEWCASTLE
AND FRENCHTOWN

RAIL-ROAD.

PASSENGER CARS,

PROPELLED BY A LOCOMOTIVE ENGINE,

Leaves the *Depot*, at NEW CASTLE, *for* FRENCHTOWN,

EVERY MORNING,

Upon the arrival of the Steam-boat from Philadelphia, at about

Half Past Eight o'clock,

RETURNING

Leaves Frenchtown at about Half-Past Ten o'clock.

ANOTHER TRAIN OF

PASSENGER CARS

Departs from New Castle for Frenchtown every evening, (except Sunday,) upon the arrival of the AFTERNOON BOAT, *from* Philadelphia, at about Six o'clock, and on return arrives about Nine o'clock.

Fare over the Road - - - - - - - - 50 cents.
Do. for excursion over the road and back - - 50 cents.

R. H. BARR, *Agt.*

New Castle, June 1st, 1833.

Poster Advertising New Castle & Frenchtown Railroad Issued in 1833

South Fork, Pa., and Sheridan, westward Track No. 3 of the four tracks is operated for a distance of 11 miles in either direction by signal indication.

The New York Central and the New York, New Haven & Hartford enter New York over a four-track line, five miles long. Heavy traffic indicated the need of additional trackage, but the heavy cost of this was avoided by obtaining a greater use of the existing tracks in 1924, by providing for the use of the westerly track of the four tracks for movements in either direction by signal indication.

The New York, New Haven & Hartford main lines from the north and northeast enter the station at New Haven, Conn., through a cut only wide enough for four tracks which handle 296 trains a day. The two center tracks are now operated in either direction for a distance of one mile by signal indication. At Jersey City, N. J., the Erie has a four-track approach to the station for a distance of two miles, on which all tracks are arranged for either-direction operation by signal indication.

The Direction of Train Movements by Signal Indication Without Written Train Orders

Train operation on single track by signal indication is not new as that method was put into successful use in 1882 on the Pennsylvania at Louisville, Ky., for handling the trains on four roads over the Ohio river bridge which was then a single-track structure. The trains in and out of Louisville over the bridge totaled over 150 a day and to direct train movements by time-tables and train orders was difficult, if not impossible, because standard time had not come into use and each road had a different time standard. The difficulties of the situation brought the space interval method into use; six manual block sections were established on the 5½ miles of single track and 2½ miles of double track covering the bridge and the tracks approaching it. At present the territory controlled by the signals at Louisville handles a daily movement of 325 to 350 trains. The successful operation of the system for nearly half a century has, no doubt, been due to the fact that trains are operated by block signals.

Another early installation of train operation by signal indication was made in 1889 on the Nashville, Chattanooga & St. Louis in the vicinity of Chattanooga, Tenn. The system covered 4.4 miles of single track and 1.6 miles of double track, divided into three manual block sections, all under the control of the dispatcher at Chattanooga. In addition to making a 100 per cent safety record, the system should have credit for having postponed the construction of a second track, thus saving the interest on the cost and the maintenance charges on the up-keep of a second track for 24 years.

The third installation was made in 1907 on 8.6 miles of single track on the Pennsylvania in the vicinity of Huntley, Pa. The controlled-manual block system was used, the signals being controlled by track circuits and by the operators. This installation is still in use with an average daily traffic of 42 trains.

The fourth installation, made in 1909 on the Central New England between Highland, N. Y., and Maybrook, was notable as it relieved traffic congestion which at times taxed the train dispatchers to the utmost. The installation covered 13.2 miles of single track and 7 miles of double track, divided into nine controlled-manual block sections. Trains were moved by signal indication without train orders.

The total net saving for the five-year period in interest charges and maintenance, by deferring the double tracking, exclusive of any saving in operating expenses, amounted to $315,000, equal to 44 per cent of the total cost of the double tracking. The signals not only paid their own way, but helped pay for the double tracking.

The fifth installation, the second on the Nashville, Chattanooga & St. Louis, was between Cowan, Tenn., and Sherwood. The installation covered 11 miles of single track, divided into four controlled-manual block sections with an average daily movement of 34 trains. As no less than 50 train orders per day were eliminated by operation by signals, the delays incidental to operation by train orders were reduced.

The sixth installation, made in 1919 on the Chesapeake & Ohio between Cotton Hill, W. Va., and Cauley,

covers four miles of single track, divided into three controlled-manual block sections.

The seventh installation was made in 1925 on the Missouri Pacific in the vicinity of Kansas City, Mo., and covers 56 miles of single track with 14 passing sidings. Train movements are directed entirely by signal indication under a controlled-manual block system with automatic train control. The daily traffic is 32 to 40 trains. Double tracking estimated to cost at least $2,000,000 has been postponed.

No claim is made that the results accomplished, in the cases cited, were entirely due to the signaling, as many factors usually enter into any improvement in train operation. This is particularly so on single track where coincident with signaling provision is made for better siding facilities and the operation of siding switches.

Summary

The inherent defects in any time interval method and the value of the space interval method are evident, as are also the marked advantages of substituting signal indication for the train order in directing the movement of trains. Efficient transportation is largely dependent upon an efficient direction of train movements and much depends upon the kind of instructions used in directing train movements. Train orders are *written* instructions and must be delivered to the conductor and engineman of the train. They must be correctly prepared, carefully transmitted, and faithfully delivered. Above all, they must be uniformly understood by all concerned, and must not be forgotten. On railroads *not* equipped with block signals, safety of operation depends entirely upon the human element.

Signal indications are instructions given by the aspects of fixed wayside signals. Instructions given by signal indications require less effort in preparation and transmittal than do written instructions. They are delivered to the engineman from block to block through the medium of the signal. The language of the signal is easy to understand and difficult to forget. The signal aspects are few in number and may be regarded as instructions reduced to the minimum in standard form, and hence, there is little opportunity for misunderstanding. The instructions conveyed by the signals are given at the point where they are to be executed and there is no lapse of time in which to forget them.

In conclusion, the case of signal indication versus the train order as the method for directing train movements may be briefly summarized in three points: (1) The science of signaling has now developed far beyond the stage of experiment. Abundant experience has proved that directing train movements by fixed wayside signals is both practical and efficient. (2) The construction, maintenance and operation of a signal system for directing train movements by signal indication can all be carried out by methods that have stood the test of time. (3) Experience in every case has shown substantial economic advantages, an increase in safety, a reduction in train delays, an increase in ton miles per train hour and a decrease in total ton-mile cost.

Testing Caustic Soda Primary Cells

Some Suggestions Relative to the Increasing Need of Simple and Reliable Laboratory Tests Which Can Be Carried Out by Battery Users with Limited Facilities

By L. S. Dunham

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IN common with all other products, caustic soda primary cells are the subject of a certain amount testing. Testing in general is, of course, intended to yield information of value concerning the properties and operating characteristics of the cells. Manufacturers of the product, however, conduct many tests to yield data of special interest to them in the improvement of the cells and in the control of the more or less purely manufacturing details of production. Thus, the testing of caustic soda cells actually embraces quite a wide variety of purposes and becomes, in its full sense, quite a major factor to the producers and users of the material.

In spite of the importance of testing, most users of caustic soda primary cells do not conduct many serious and carefully reasoned tests. This appears to be due to a serious lack of any standard test procedure which is of genuine merit and which is, at the same time, well within the capacity of users to conduct accurately and readily. The only standard test which has a definite standing is that of the Signal section of the American Railway Association. In recent years this test has been extremely difficult for the ordinary user to conduct, largely because of the complex voltage readings required and the rather troublesome temperatures that are specified. In spite of the fact that this test has been a part of the specification under which most primary cells and renewals were bought and sold, it has not appeared that a single railroad has maintained a consistently thorough check up of this detail. Many users of the material recognize this test in a more or less perfunctory way, as by indicating the letters A. R. A. on purchase orders, etc., but this is of greatly reduced effectiveness when, as in the present case, all manufacturers know that the detail of whether or not the material used complies with the specification is not in practice, ever definitely determined by the purchaser.

It might be thought that manufacturers would find little cause for complaint in such a situation. That would be the case except that, for the most part, they have a very positive desire to furnish the best possible material and to become known as so doing. Such a desire is merely good business on the part of any manufacturer who seeks to operate permanently. Thus, well established and responsible manufacturers who have no desire to take advantage of purchasers of their material derive no benefit from a lack of sys-