(i) Locomotive repairs. It seems evident that a reduction in road delay should result in a reduction in the cost of locomotive repairs, particularly if such delay is reduced by reducing starting, stopping and standing (the steam locomotive's hardest service) by the use of proper signaling. Costs per train mile and per trip are therefore reduced 9.33 per cent, which is in proportion to the reduced time the locomotives are on the road. This opinion is verified by master mechanics. Figures in column (h) reduced from column (e) accordingly.

(j) Enginehouse expenses, reduced in the same way as locomotive repairs. This opinion is verified by the master mechanic.

(k) and (l) Enginemen and trainmen. Average wages includes terminal time before road trip is begun and after road trip is completed. See Table 1 for method of computing payroll crew hours for 125 mile trip. If 1.25 hours road delay is saved, the overtime equivalent would be 1.88 hours (1.25x1.5) and total payroll hours reduced from 15.85 to 13.97 hours, a saving of 11.9 per cent. Figures in column (h) computed by deducting 11.9 per cent from figures in column (e).

(m) Fuel. Average cost per freight train mile and per freight train hour includes not only fuel consumption on the road but also includes fuel consumption in enginehouses and at terminals (assumed to be equivalent to 2½ hours average per trip). See Table 1 for method of computing locomotive fuel-burning hours. If 1.25 hours road delay is saved, the fuel-burning hours will be reduced from 15.90 to 14.65 hours or a saving of 7.87 per cent. Figures in column (h) are computed by deducting 7.87 per cent from figures in column (e).

(n) Other supplies (mainly water and lubricants). See item (m) for method of computing figures that are shown in column (h).

TABLE 3.—SAVINGS IN SELECTED EXPENSE ACCOUNTS, UNIT COSTS, BY REDUCING FREIGHT TRAIN ROAD DELAY 3.90 HOURS ON A ROAD TRIP OF 125 MILES

Comparison of 1923 Freight Train service unit costs at average speed of 9.33 miles per hour and unit costs at average speed of 13.16 miles per hour. Difference in speed equivalent to 3.90 hours of road time per 125 train miles

Selected Expense Accounts and Account Numbers (I. C. C.) So-called *"Out of Pocket"* Costs	At 9.33 MILES PER HOUR (a) Cost per			Est. at 13.16 MILES PER HOUR (b) Cost per			
	Freight Train Mile	Freight Train Hour	125 Train Miles in 13.4 hours	Freight Train Mile	Freight Train Hour	125 Train Miles in 9.50 hours	Per cent of Saving
	(c)	(d)	(e)	(f)	(g)	(h)	
(i) Locomotive repairs (308-309-310-311) Freight Locomotives Road Service only	.437	4.08	54.63			38.73	29.1
(j) Engine house expense (400)	.100	.93	12.50			8.86	29.1
(k) Enginemen (392–393)	.283	2.64	35.37			22.32	36.9
(l) Trainmen (401)	.334	3.12	41.75			26.34	36.9
(m) Fuel (394–395–396)	.367	3.42	45.88			34.64	24.5
(n) Other supplies (397–398–399)	.086	.80	10.75			8.12	24.5
Total costs selected expense accounts	1.607	14.99	200.88			139.01	30.8
(o) Car repairs (314-315-316. See Table 1)	.970	9.05	121.25			85.97	29.1
Total costs including car repairs	$2.577	$24.04	$322.13			$224.98	30.2

	With Car Repairs
Total costs for 125 mile trip at 9.33 miles per hour (........... RR.), 1923	$322.13
Total costs for 125 mile trip at 13.16 miles per hour (by cutting out delay of 3.90 hours in 125 miles)	224.98
Savings in unit costs by reducing freight train road delay 3.90 hours on a road trip of 125 miles	$ 97.15

NOTE: Average gross tons per Freight Train, 1923, exclusive of engine and tender, 1610.5.

Signaling at the Age of Maturity

By S. N. WIGHT

Commercial Engineer, General Railway Signal Co., New York

THE Economics Committee has figured that the cost of a freight train delay hour is approximately $25. I am told that a certain railroad estimates an annual saving of about $30,000 on a single division by the use of "19" orders instead of "31" orders. I want you to consider as to the extent to which even "19" orders are required with a properly designed signal system.

Train orders are used for a double purpose, to provide safety and protection and also to create and preserve superiority for the sake of facility. Without signals this dual function is unavoidable; but with a suitable signal system, train orders may well be regarded as having a single purpose—that of facility. Signals afford the required protection, therefore, the only ground for justification of train orders with signals is in the interest of facility, and let us see about that.

Not so long ago automatic block signals on single track were regarded by many as assets of doubtful value. The absolute-permissive system then came to the front and dispelled all doubt. We then had protection—safety. It is now for us to go a little further by making provision so that the signals, may direct and insure superiority and the desired sequence of train movements.

Typical Signaling Arrangements To Eliminate Train Orders

I have prepared some sketches which are designed to show the possibilities of making greater use of our common everyday signaling means on single track. Figure 1 shows an interlocking plant of some sort at every passing siding, which of course requires a man in each instance. This man, we will refer to as the block operator and you will note that he has full control of all of the signals controlling movements through his siding. Furthermore, the signals between adjacent sidings are so interlocked electrically that the block operators at adjacent sidings must co-operate in order to permit movements between adjacent sidings. Such an arrangement involves cost which would not be justified in many cases. The cost would be high not only for the installation of the signaling equipment but also for operation. However, I wonder if anyone will contend for the use of "31" orders along with such complete signal equipment. Then again, how about the "19" orders? What are you doing in your terminal territories today?

A similar arrangement is shown in Fig. 2 except that interlocking plants are shown only at each alternate passing siding, the intermediate sidings being without block operators. The signals, controlling movements between adjacent sidings, are interlocked electrically as before. The block operator at each interlocking plant has full control not only of his own siding but also to the adjacent intermediate siding on either side. I ask you to consider for yourselves the necessity for "31" orders and the extent to which "19" orders would be required with this signaling equipment.

The layout shown in Fig. 3 goes a little farther in that it provides for an interlocking plant only at every third passing siding. The signals, controlling movements between adjacent sidings, are still interlocked electrically as before and the block operator not only has complete control through the next adjacent blind siding on either side, but also controls receding movements to the second siding. For instance, the block operator at Station *A* controls Signal *8*, and block operator *D* likewise controls Signal *13*.

Figure 4 affords protection exactly parallel with that provided by Fig. 3 but does not contemplate any interlocking plants in the sense that we usually use the term; Of course, the same applies with respect to Station *D* and train movements between Stations *C* and *D*.

The automatic operation of the signals is identical with that afforded by the absolute-permissive block system, including the double-distant protection for passing sidings. For example, Signal *4* will give a caution indication whenever Signal *8* is at "stop" except when Signal *8* is held at "stop" by a train moving from left to right, or in other words, from *B* to *C*. This insures adequate distant protection for all meeting points.

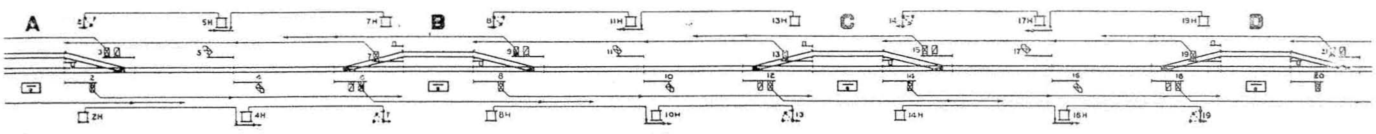


Fig. 1

ALL PASSING SIDINGS INTERLOCKED

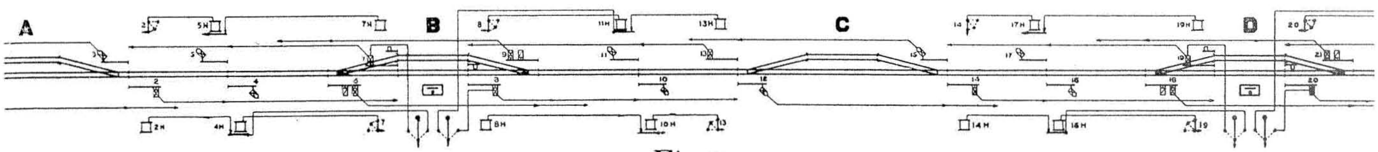


Fig. 2

ALTERNATE PASSING SIDINGS INTERLOCKED

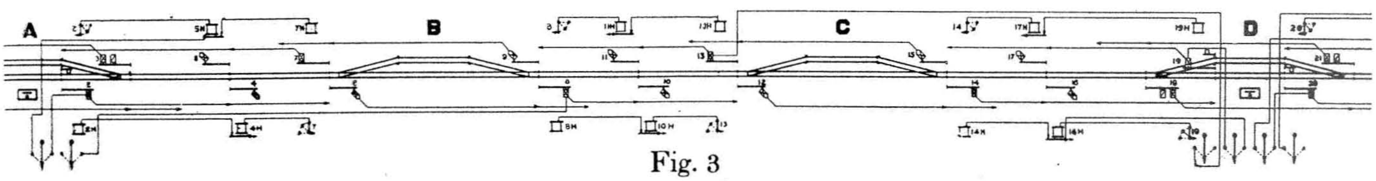


Fig. 3

EVERY THIRD PASSING SIDING INTERLOCKED

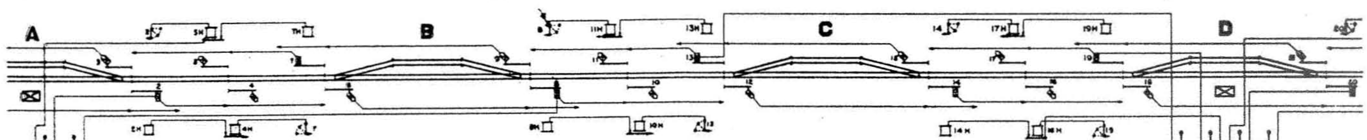


Fig. 4

BLOCK OPERATOR AT EVERY THIRD PASSING SIDING

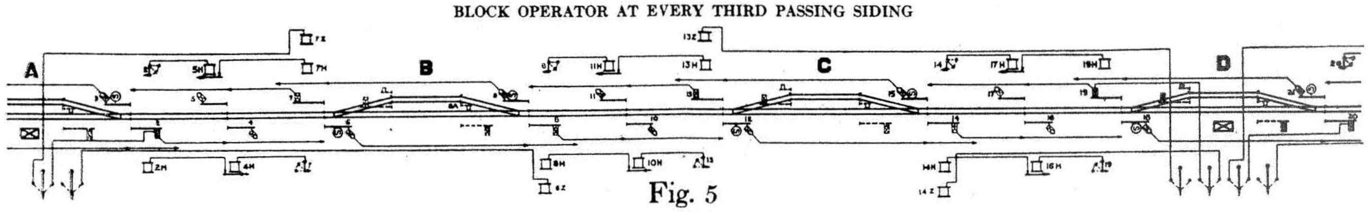


Fig. 5

BLOCK OPERATOR AT EVERY THIRD PASSING SIDING WITH TAKE-SIDING INDICATORS

Various Methods of Single Track Operation by Signal Indication Eliminating Written Train Orders

that is to say, the block operator will not operate any switches; instead these will be operated by the trainmen, but he will have the same degree of control of the signals as in Fig. 3. In other words, less facility is afforded, but the same degree of protection and information is given. Therefore, your conclusions as to the use of "31" and "19" orders might well be the same as in the case of Fig. 3.

For the control as set forth in Fig. 4, the block operators at Stations *A* and *D* must co-operate in order to permit a movement in either direction between Stations *B* and *C*. Saying it another way, block operator at Station *A* controls Signal *8* and block operator at Station *D* controls Signal *13*, and the controls of Signal *8* and *13* are interlocked electrically so that either one must indicate "stop" before the other can be cleared.

Then again, train movements between Stations *A* and *B* are under the control of block operator at Station *A*. Signals *2* and *7* are interlocked electrically so that one must indicate "stop" while the other is clear as before.

In this connection I invite your attention to the entire practicability under these conditions of locating your intermediate signals opposite when local conditions permit. This is permissible even where there is only one pair of intermediate signals between two adjacent sidings, as both of the opposing absolute signals cannot be clear at the same time. This results in some saving in first cost.

How the System Operates

You may question about the transmission of information to trains as to the location of other trains and as to how their own movements will be affected. You are not taking issue with me on the matter of protection. It is that other matter—facility—that is troubling you. May it not be that too much of such information has been given in the past? Should such information be given very long before the signal is required to act? Our problem is that of finding means by which we can: head a train in on a siding, hold it on the main, allow it to proceed after having been held, keep track of its location, and do all this in an economical and efficient manner.

Anticipating that the average signal engineer would want to go along with me all the way, I have prepared Fig. 5. The control and arrangement of signals is the same as in Fig. 4. Take siding indicators have been added at the entering signals, and these will be operated in each instance by the same block operator as has control of the corresponding absolute block signal. You will probably want to move back the absolute block signals, as for instance Signal *8*, to the fouling point and install a dwarf signal to govern movements off from the siding. We will, furthermore, be able to at least make a good start in the matter of "OS"ing trains to the block operator. Now, suppose it is desired that two trains meet at siding *B*; block operator at *A* puts Signal *8* at "stop" by means of his *8Z* relay, and if it is desired that the eastbound train take the siding, displays a take siding indication at Signal *6*. He does this by manipulating his *7Z* relay. Of course, if he wants this train to take the main, he does not display the take siding indicator. He holds the control. Operator at *D* allows Signal *13* to clear by means of his *13Z* relay. When westbound train passes Signal *13*, operator *D* hears the tap of the bell—yes, over his *13Z*. Operator *D* then reports to operator *A*, "train in block." *A* then displays take siding indicator on Signal *9* or not, depending upon his instructions from the dispatcher, by manipulating his *Z8* relay. Then, suppose you had put that eastbound train, we were just talking about, in on the siding at *B*, you would let him go by clearing dwarf signal *8A*. You will select as to the clearing of high signal *8* or dwarf *8A* by manipulating again that *8Z* relay. Had the occasion demanded that the eastbound train remain on the siding at *B* until other trains pass, you would have been caused no embarrassment. Operator *A* holds the control.

Let us imagine a straight through movement from *A* to *D*. Operator *A* clears Signals *2* and *8*, and operator *D* clears Signal *14*. Train passes Signal *6*; bell rings at *A*; train passes completely within siding limits at *B*; same bell rings again; train passes Signal *8*; another bell rings at *A*; train passes Signal *12*; bell rings at *D*; train passes completely within siding limits at *C*; same bell rings again at *D*; train passes Signal *14* and another bell rings at *D*.

Allow me to suggest that the scheme is fully adapted to conditions where there are more than two adjacent blind sidings. The cost, however, goes up in an ascending ratio due to the longer circuits. You require one separate circuit to each end of each passing siding from the nearest block office, in addition to what you now have with your present block signals.

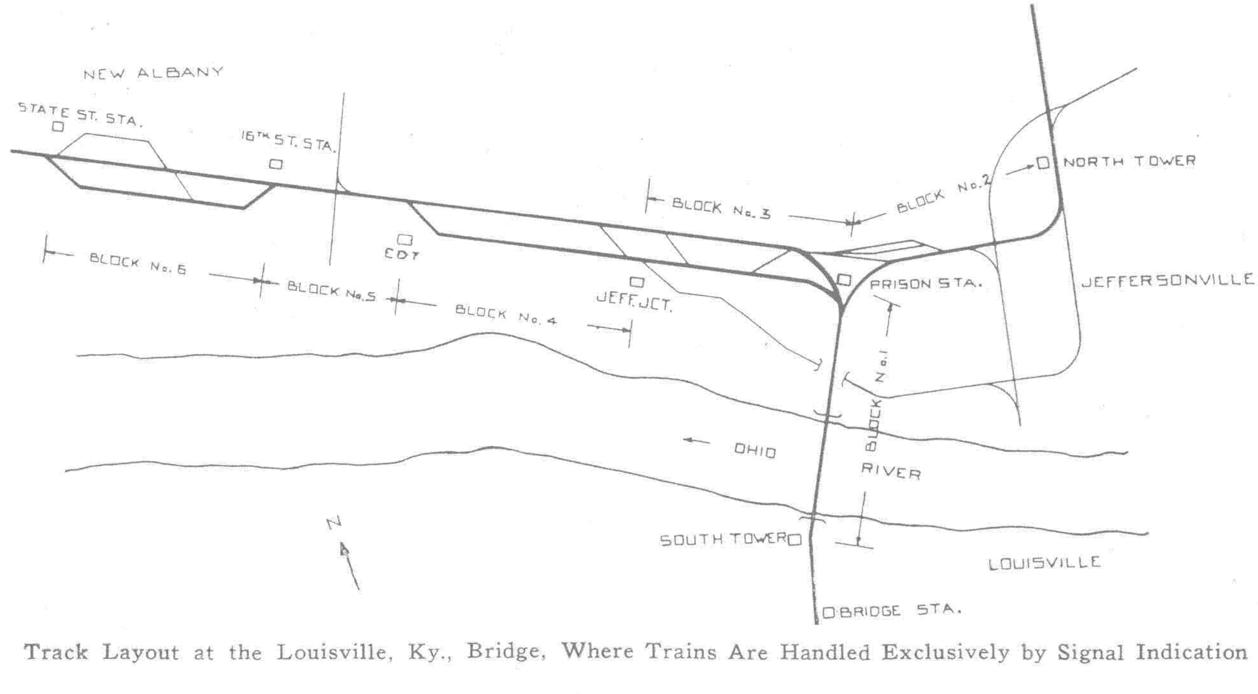
Louisville Bridge Operated by Signal Indications Since 1882

By W. M. POST

Superintendent of Signals and Telegraph, Central Region, Pennsylvania Railroad, Pittsburgh, Pa.

As early as 1882 a manual block system was established on five and one-half miles of single, and two and one-half miles of double track over the Louisville, Kentucky bridge, and east and west of the bridge north of the Ohio river on the Louisville division, formerly part of the J. M. & I. Between 100 and 200 train movements per day were handled over this track by signal indications which superseded time-table superiority, and took the place of train orders. The boldness of this innovation attracted considerable attention at the time. E. W. McKenne, then superintendent of the division, who originated the idea, read a paper before the train dispatchers' meeting at Louisville, Ky., describing the system. Some quotations from this article which are taken from "The Telegraph as Applied to Train Movements" by J. J. Turner, 1885, are given below:

"The number of trains using the road described (less than eight miles in all), is in excess of 120 per day, and



Track Layout at the Louisville, Ky., Bridge, Where Trains Are Handled Exclusively by Signal Indication