"warner" signal scheme of India, a fixed green light being placed at the top of the mast and the "warner" arm being located 7 ft. below it. Green over red signifies caution and green over green proceed. The battery box may be seen just in front of the signal.

Since the signals were placed in service, the track structures for the suburban electrification have been erected. The new 2,200-volt, 3-phase, transmission line for signaling and station lighting will be noted on the top right hand side of each track structure.

# Our Problems in the Economics of Railway Signaling*

*By B. J. Schwendt*

Assistant Signal Engineer, New York Central, Cleveland, Ohio

BY railway signaling is meant signals and interlockings of any and all kinds as may be necessary to produce the desired operating results economically in a given territory. By the term economics we mean the science of business. Modern business comprises all human activities which are directed to the acquisition and expenditure of income. Briefly, the purpose of all railroad business is to deliver maximum service to our customers at a reasonable profit. Economics becomes a science rather than an art because it aims at knowledge rather than skill.

President Coolidge in a recent talk to the Budget Meeting of the Government brought out the point in the following words: "If you at times grow weary of the constant stress put on economy you will see that something more is involved than can be measured in dollars and cents. The spirit of real constructive economy is something higher and nobler. It does not imply so much a limitation as an attempt to be free from limitation. It does not contemplate curtailing ample supplies for worthy purposes and real needs, but it is the enemy of waste and the ally of orderly procedure. It is an attempt to increase and enlarge the scope of the individual and the life of the nation."

By way of service the statistics of 1925 show that the railroads supplied the shippers 99.9 per cent of the cars they wanted when wanted and then moved the loads promptly. By way of service in safety, passenger travel in the way of integrity of signals and enginemen and based on operating statistics of 1924, a passenger would have had to get on a train in the year 476 B. C. and ride continuously up to the end of 1924 A. D. in order to get killed in a train accident due to an engineman overlooking a signal. Generally speaking this does not leave much work for train control to perform.

We should not only defend ourselves against unjustifiable attack but to continue to do and do better what roads have started to do in the last few years, viz.: Make scientific or economic investments and practices, pay higher wages and give better services and thereby make outgo less than income instead of income greater than outgo. Does this not give the same result sought? Is this not unique in that it is good for all parties concerned, good for all labor and personnel, good for the supply man, good for the patrons and good for the stock holders. Does this not also for the first time give the economic spender due credit instead of classing him as a "source of expense and therefore a liability" instead of a source of income and therefore an asset. I think we can all recall having heard of this before in no uncertain terms. In fact, in the past and even in some businesses today those involved in the departments which have to do with producing income are considered as being more valuable than those in the departments which have to do with expenditures. Obviously such conclusions are not correct and as a result are unfair unless given their proper economic weight.

It should be our purpose to deal with the problems of the future profiting by the solution of, and experience with, those of the past. Not long ago our problems were chiefly such as maintaining mechanical interlocking and miscellaneous signals which had been installed without recommendation or voice by the signal department. No one knew how much of an operating asset or liability these appliances represented in money. Today we know ways of determining the economic values of projects. The Railway Signaling Club (predecessors of the Railway Signal Association and at present the Signal section of the A. R. A.) grew out of that period. Its purpose was to standardize practices and parts and advance the art of signaling. Nothing was said about the "science" of signaling. Our purpose, however, today, is the same but on a much large scale of operations. Judging from the size and contents of our manual it would seem that there is less today to be done in the way of standardizing and this would be true except for the increased scope of our work.

The next period added the automatic signal and the power operated interlocking machine, greatly increasing the scope of activity and usefulness of signals. Until a very recent date, the operating limit of a power operated switch was practically less than a mile. Today this limit has vanished and there is, from an operating standpoint, no embarrassing limit on the distance at which a switch may be operated economically by power when handled in combination with proper signaling. This makes it possible for the first time, to develop economically the full operating capacity of single track road. Since about 200,000 miles or 4/5's of the railroad mileage in the United States is single track it follows that the operating and economic possibilities of this kind of signaling are gigantic.

As time went on rumors were heard that the signal department was an expensive luxury. It then became necessary for the signal department to prove the necessity for its existence, i. e., be able to show the operating value in money of the various apparatus and the desirability or non-desirability of them. This is economics.

## Other Responsibilities Added

About the same time the use of electrically operated light signals began to become general as a substitute for electric motor signals. While this simplified matters in some respects it became an increased responsibility

*An abstract of a paper presented before the convention of the Signal Section A. R. A., March 8, as a part of the report of the Committee on Economics of Signaling.

for the signal department to handle through the transition period of substitution which will undoubtedly last for some years. The advent of the automobile and the intensive increase in traffic at highway crossings has necessitated that highway crossing signals be developed and maintained to a standard of excellence and perfection equal to that of railway signaling.

Automatic train control came into being as a recommended second line of defense for the signal system and the burden of this fell to the duty of the signal department on most roads. Last but not least comes the car retarder or track braking systems for use in hump yards as a substitute for hand braking by car riders. It comes to the front and for the first time in combination with power interlocked switches and makes it possible to develop safely the full capacity of a hump yard. The burden of designing, installing, maintaining and operating this additional system also falls to the duty of the signal department.

At the present time it is largely up to the signal department not only to design, install, maintain and operate all of the foregoing, but also to take care of a very practical and most necessary part in advance of all of this work, namely, to prove its worth as an asset or a liability and how much expressed in money.

## Organization Affecting Functions of Signal Department

The problems of proper organization inside of the department determine the personnel, i. e., getting the square peg in the square hole, etc. If our work is to be handled properly it follows that not only the personnel at our command must be properly organized but also the personnel which commands us must be so organized. If the command above us may be so organized as not to function to the best advantage in our relation, we may be reporting to the wrong officer. These relations where wrong are usually the hangover of bygone days when, from the work at hand by the signal department and the peculiar viewpoint of the officer to whom the signal department reported it seemed proper for the signal department to report to others than the vice-president of operation of the general manager. Once brought to their attention, the problems, duties and responsibilities of the signal department added during recent years and, the important work now before us, should make it apparent that any unnecessary steps between the signal department and the management are no longer so-called "stepping stones" but many times may become "stumbling blocks." These are expensive and uneconomical and work against the best interests of the property. The signal department as well as any others should be so organized that it can "go," unhampered by the divergent views of others who by the nature of their work cannot be in the full possession of the facts.

A sample of this is a report in a recent railroad periodical by a prominent official, not in the signal department, stating that "single track signaling" is uneconomical. A similar statement was made by another prominent official of the same rank. Both are misinformed and as such they more or less bother the smooth progress of signaling by disturbing the understanding of others on a subject which they or others do not themselves have time to figure out. This might be a blessing in disguise, let's say it is, for it will force us to look ourselves over occasionally.

## Economy Secured by Co-operation

For economical results we should be co-ordinated with other departments with whom we work and co-operate under the managing officer or vice-president of operation. Otherwise we and the property both work to a disadvantage and a loss. One of the places where the lack of co-ordination shows up continually is in the budget. This may not always be the lack of proper co-ordination but instead heredity of thought and lack of understanding. Thought in the wrong channel and lack of understanding can be overcome if we are given the opportunity to appear before the management on the same basis as other departments to argue our cases on merits. A sample of improper co-ordination is the old story of building more tracks or buying heavier power or both whenever additional road capacity, output, or speed were needed; when, as a matter of fact, many times, less of either or both of them and more signals or something else would produce even better results and better economy.

I have in mind a recent case where a tentative survey and analysis (with an estimate on a conservative basis) showed that on a given piece of road a proposed change from single to double track operation could be postponed for upwards of five years by proper signaling. The required changes to handle it including signaling could be installed in about four months at a cost of $360,000, whereas the required double tracking and signaling to go with it would require much longer time at an expenditure estimated at $2,000,000. On the basis of minimum traffic the time saved by the signaling proposition in this case would pay upwards from 50 per cent a year on the expenditure, not counting the saving per year due to postponing the carrying cost of double track operation.

With the signaling installed the substitution of heavier motive power running at the same average speeds would produce even greater returns but the greater returns of the heavier power could not be realized without the signaling scheme. This is where the matter of operating and dispatching trains enters. The mistake is usually made when handled as a straight engineering matter, i. e., the method of operation is overlooked. Proper co-ordination of the budget would produce the desired results.

There is still work to be done on the matter of train operation and its surrounding rules including manual blocking as outlined in the standard code and also as is explained by various authorities on train rules. This may seem elementary to some but I venture the statement that it is now most important to all in the signal department. Until accomplished the signal department cannot do justice to economical design in signaling because it will be unable to place proper weight on the operating values involved and therefore must guess, which results in many duplications. Obviously the correction of it will cause reduction in the first and annual costs of signaling. We should therefore organize and aim at economical design after full analysis of the problem.

## Signaling Must Be Sold in Operating Terms

The signal department has a big problem in salesmanship. We must not only conceive the correct ideas of the operating results to be accomplished safely and design the system to correspond, but must convince our operating officers and management as to what they are missing by postponing the acceptance of the ideas. To do this properly, we must talk their language. We must know train operation from the same angle as they do. They and the management must, however, talk our tongue in economics in particular as regards the stating of the problem or question, otherwise, they will be apt to "stumble" on the matter of *first cost*. Usually first cost is not the question at all but instead *net return on the investment* is the question. Until we do this we are both handicapped. We, because we lack understanding

and conviction and they because they do not understand the economic possibilities of signaling. It doesn't take long to make a fair minded operating man see the operating advantages, aside from safety, of a proper signaling system if the same language is used.

It therefore seems very important that all concerned in the signal department from the maintainers on up to the chief signal officer know more about train rules, train operation, manual blocking and train orders and also motive power. They can then compare results being accomplished by the written train order process with what can be done with signals, and realize the relative advantages. Signalmen in the fields or in the office are in almost constant contact with such officers as trainmasters, dispatchers, assistant superintendents, superintendents and also motive power men. The opportunity to teach each other is always at hand. All we need to do is to go to work and the results will speak for themselves. Once we accomplish this we will be of value to help the surrounding departments, particularly the so-called "operating men" conducting transportation to reason in terms of signaling as a normal process instead of by written train orders.

Summarizing briefly the whole fabric of the problem of the railroads is interwoven with economic problems, in fact, they are the basis of the fabric and are something to be watched and used constantly. In this the signal department can play a major role. The signal department is no longer a so-called engineering and construction department as most of the titles would indicate. It has grown out of that. If it functions to meet its economic duties it is piece and part of *operation*. It is even more than this because, unlike so-called operating departments as now known, it must design, construct, maintain and also operate. When it is properly co-ordinated with the present operating men, motive power men and track department men it can do more to improve operation economically and make the outgo less than the income than all other departments put together.

# Train Control Inspection Equipment

## Electrical Tests Carried Out at Engine Terminals in the Maintenance Program of the Richmond, Fredericksburg & Potomac

THE difficulties of train control operation arise from two sources. One is the trouble that is involved in getting the right sort of co-operation of the enginemen and the second is the natural troubles which may be inherent in any particular type of train control.

The Richmond, Fredericksburg & Potomac has arranged a simple structure of condulet fittings to simulate the lighting on a locomotive. This device is mounted upon a large board and the various parts are plainly marked so as to make it an ideal means of imparting information to the engineman in a class room.

The R. F. & P. uses the Union Switch & Signal Company's continuous induction system. The locomotive is equipped with two Sunbeam headlight generators. The part of the train control equipment of which the engineman must have knowledge consists principally of what is known as a double transfer switch, and, it is concerning this switch that most of the instruction is given. Although the switch is not particularly complicated there are a number of operations involved in its use which seem to confuse them.

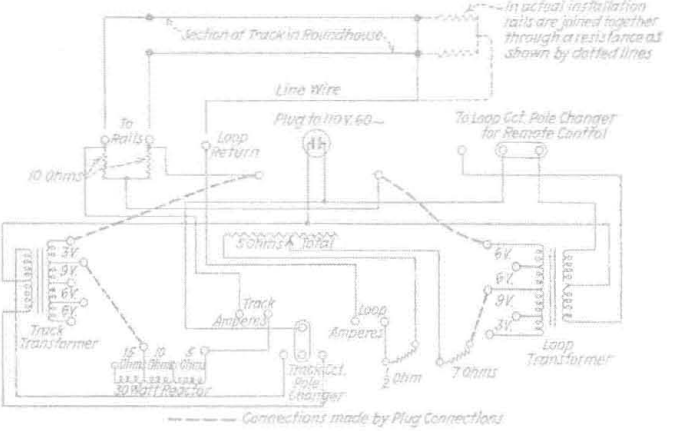
### The Double Transfer Switch

When the compound generators are used this switch is necessary to prevent the train control load from being thrown on to a generator which is not running. When the power is disconnected from the train control terminals the dynamotor which is used for furnishing the high plate voltage will run for several seconds and generate a back e. m. f. If the train control load is thrown on to a generator not running this back e. m. f. forces a current in the reverse direction through the series field of the generator, reversing the residual magnetism. Then when the generator is started it will build up with reversed polarity.

With this double transfer or interlocked switch it is necessary for the engineman to operate the interlock when transferring train control from one generator to the other. The time consumed in operating the interlock is sufficient to insure that the train control dynamotor has stopped before the train control load is connected to the second generator.

The interlock consists of a disk operated by a worm and gear. The disk is slotted at one point so that only one switch at a time can be placed in the "on" position. In order to place the second switch in the "on" position it is necessary to move the disk by the worm and gear until the slot is in such a position that the second switch can be moved. Before the disk can be rotated to this position, however, the first switch must be placed in the "off" position.

In ordinary operation one of the headlight turbines is used for the engine lighting and the other for train control, and the switch which has just been described is used only in event of the failure of one of the turbines.




Wiring Diagram for Automatic Train Control Portable Test Set

### Inspection of Equipment

The inspection of the train control equipment is made at the roundhouse where a number of tracks have been fitted up specially for this purpose. A portable testing set mounted on wheels is used by the roundhouse maintainers in checking up the opera-