stantially reduced the damage to cars and lading, but the damage records are not kept in a way that permits of a segregation of the damages occurring in hump yards. It is estimated that losses on this score have been reduced two-thirds. When the installation of the new type of "skate" machine is completed damages from impact will be further reduced.

Damages resulting from personal injury to the car riders and switch tenders was formerly a serious factor in yard operation. During winter weather when the cars and the ground were covered with snow or sleet serious personal injuries were a common occurrence, and the table shows that damages on this account averaged $2,263 per month for the year ending March 31, 1924. Accidents of this nature were practically eliminated by the installation of the car retarders and automatic skate machines.

In addition to the increased capacity and safer operation resulting from the use of the car retarders a better class of men can be employed. The night hump car rider's job is the most haazrdous and least desirable position about the yards and consequently the one on which new men break in. Obviously the difficulty of getting men of desirable qualifications to enter railroad service at freight car yards is directly proportional to the unattractiveness of this work.

The idea of installing some sort of a braking device at freight classification hump yards to obviate the necessity of employing car riders is not new but it is believed that the development at Gibson is the first practical and successful application of the idea. The entire equipment including car retarder units, tower control equipment and skate-throwing machines is covered by patents held by George Hannauer, vice-president, and E. M. Wilcox, master car builder of the Indiana Harbor Belt.

Signals and the Saving of Fuel*

Cost of Operation Will Be Reduced and Coal Conserved by Eliminating One Train Stop or One Delay Per Trip

By B. J. Schwendt

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ONE year ago at the meeting of this association, R. H. Aishton, president of the A. R. A., established a reputation for "one pound of coal." He suggested that each 1,000 gross ton miles of freight service could be done with one less pound of coal. Such saving aggregated a potential value of $3,165,000 in a year's time. The year has elapsed and you have saved over $29,000,000. Mr. Aishton also cautioned against any ideas for fuel saving which might involve large capital expenditures. However, this reservation must give way in the natural march of events if we are to continue to progress and save not only fuel but labor and all that goes with it.

The almost untouched capital advantages of signals and interlocking in the saving of time in train operation is yet to be considered. In such time saving we automatically save fuel and labor along with many other items, the total money value of which is great enough to not only justify the installation (capital) required but to pay a worth while return on the funds so spent.

Some of the Things Which Make It Possible

In the history of American railroads as a whole the least advancement has been made in the matter of directing train movements. On single track lines and against the current on multiple track lines the trains are generally directed by the written train order system. About four-fifths of the mileage of roads in the United States is single track. By the law of averages, if by nothing else, this advancement and improvement is more than overdue. To safeguard the written train order system, which in itself causes many delays, many roads have superimposed the manual or automatic block signal system. On single track the manual block in particular adds to the complication, delay and expense. One of these block systems, perhaps the automatic, depending upon the nature of the traffic, if properly applied would serve the purpose better.

The proposition is well expressed in the language of Stanton Ennes, formerly general manager of the Baltimore & Ohio Lines East, who said:†

"Running trains by signal indication instead of train orders, substituting signal indication for the train order, presents the biggest opportunity for reducing costs offered the railroads in years. Few people other than those who have had actual experience in moving trains understand or appreciate the intricacy of train rights and the details of advancing by train order.

"Furthermore, and this does not appear in any record, only the train dispatcher knows how often he lets trains lay at sidings because by the time he could get out the order the train could not clear some superior train at the next siding, when again if it could move without this delay he could advance it at least one siding often making several hours difference in reaching the distant terminal.

"Neither do any appreciate that these delays are progressive and that the ratio multiplies faster than the traffic. On light lines the necessity for train orders and the number of orders per train are negligible, but as the number of trains increases, the necessity for train orders increases and at an even greater rate, and so rapidly that in many places double track has been imposed long before the volume of traffic justified the expense."

When it is considered that the boiled down result of the written train order system means approximately one of three things to train movement, that is, *Stop, Proceed* or *Head-in,* and this may be said so easily and safely with signals at the location and time at which action is desired, it is rather singular that the progress of "saying it with signals" is so slow. All the necessary facilities and signals to accomplish the desired result are now in use on railroads and they involve no new or unexplored principles. Many roads are now beginning to avail themselves of the great advantages of signals without written train orders, but the great majority has yet to take hold and develop the thought and the action.

In 1923 we made some road tests with regular pas-

*Abstract of paper presented before the International Fuel Association, Chicago, May 26, 1925.

†Paper presented before Signal section of A. R. A., March, 1925.

senger trains. With the assistance of the traveling fireman we determined that the average of five tests in the stopping of a five car passenger train (about 300 tons trailing load) required an average of 14 scoops of coal more when making the stop and immediately starting than when running through and not making the stop. The highest speeds involved were 45 miles an hour; with heavier trains or higher speeds, necessarily more fuel would be used. At 20 lb. of fuel per scoop and at $3 per ton for fuel on the tender, the fuel cost alone was 280 lb., or 42 cents per stop. One such stop saved per passenger run of 125 miles, approximately a division, would (based on 1924 figures for the U. S.) be in proportion to and at the same rate as 4 lb. of fuel saved for each 1,000 gross ton miles of freight service. Here are 4 lb. instead of 1, our present goal. Many such stops can be avoided by proper signaling.

According to a report of the Signal section of the A. R. A., the cost of making a stop with a freight train of 1,610 gross tons weight, involving a loss of about 15 min., would be about $6.25. This is made up of: Locomotive repairs and enginehouse expense, wages of enginemen and trainmen, fuel and other supplies, and car repairs. The fuel item alone is about 72 cents, which at $3 per ton on the tender means 480 lb. of coal. Based upon the average freight train in 1924 for the United States one stop such as this saved per run over the division would save over two and one-half pounds of coal per 1,000 gross ton miles. Here are two and one-half pounds instead of one. From the same report the money value placed upon the train delay hour reclaimed is about $25.

There are many cases on record where automatic block signals alone, without the assistance of other desirable facilities, have increased the average speed of freight trains (not maximum speed) upwards of two miles per hour by cutting out only the delays. If such an increase is applied to all of the freight trains on Class I roads (average speed during 1924 about 11 miles per hour) it would mean an increase of about 20 per cent which in car supply alone would be the equivalent of 500,000 additional cars. There are many other advantages in additon to the foregoing upon which no money value is being placed by the Signal section in setting up its $25 figure. I suggest you read the report to get the viewpoint.

Other Fuel Savers

How about the handling of passing track switches by machinery and signals instead of by train crews? This will save about two train stops for each train through such passing track. Two such stops saved in a freight train trip of 125 miles, approximately a division, means a saving, based upon the average United States freight train of 1924, of five more pounds of coal per 1,000 gross ton miles. Such installations will pay large dividends and if switch tenders are replaced the dividends will be still larger.

Another item is the arrangement of signals at points where switching is involved. In many places conditions have outgrown themselves. A signal in the right place or the additional of a signal would save a yard engine many hours of useful time (fuel included). The time and fuel saved for other useful work would pay handsome returns on the cost of changing or supplying the signal. There are other similar cases along the main track where a better location might be selected so that trains required to stop by a stop signal can start without difficulty, thereby again saving time and fuel.

There is also the question of requiring the observation of the flag rule in automatic block signal territory just the same as though no automatic block signals were there. The signals fail the wrong way about one time in upwards of 2,000,000 operations. How often does the flagman fail? A number of roads have already eliminated the unnecessary duplication which kept trains waiting while the flagman returned from a distance. They are saving time, effort and fuel.

It is not always necessary that trains stop at an automatic block signal in the stop position, but it is a matter of discipline to insure low speed through the stop block. Some roads are breaking away from this practice by using what is called the "tonnage signal" which permits tonnage trains to pass the stop signal, without stopping, at a prescribed low speed.

If an interlocking plant is at a crossing or junction, the connecting line may be at fault for indulging in practices which unintentionally cause delays to the other roads' trains. I have in mind a case where a connecting line has a water penstock less than a freight train length outside interlocking limits. When one of its trains stops to take water it blocks all three other roads in the plant.

Important Changes That Would Save Fuel

A consideration of the cost of train stops might change the policy of taking certain plants out of service for repairs. A plant out of service for 30 days involving stopping 50 trains a day at $5 each means a loss of about $7,500, approximately 15 per cent of which is fuel. Do all understand the necessity of prompt and exact action in furnishing labor and material to prevent such losses? A substitution in material by the uninformed trying to save a few dollars may result in just such a loss. It may be cheaper to build a new tower than to put up with the increased loss of time caused by an old plant being out of service incident to repairs.

How many interlocking signal stations have you where the operator cannot know at all times just when a train is going to arrive? The signals being normal stop, he cannot clear them prematurely without chancing delay to the other road. A telephone or other means of information would insure that there would be no excuse for unnecessary train stops at such plants.

How many interferences do you have between trains or switching movements in your yards and engine terminals where it may take three or four engines in the course of a day to do the work, yet during part of the day only one can work? This is usually caused by an ineffective track layout, or perhaps a routing of superior trains which requires them to pass through this yard or terminal. I have in mind a recent analysis whereby relatively small changes in track layout and signals indicated a saving of 3,000 yard engine hours, 272 freight train hours and 272 yard cut hours per year, and the elimination of three switch tenders. This amounted to upwards of a 50 per cent net return on the cost of making the change. This may not always involve signals but surely will always involve fuel saving.

Then there is the question of dispatching freight trains from the yard out of their turn. Each operating division is equal to a certain combination of train movements at certain times. If this combination is broken or forced by starting a train when it cannot get through, some train, or maybe several, must wait. This again loses time and fuel. Some roads have made remarkable progress in analyzing road capacity and setting up "pegged schedules."

How many places do you have where under your rules with a two-position manual block signal it is necessary to slow up the train to hand on a caution card to indicate "Caution Block." Why not change the signal to a three-position signal which would avoid writing or handing on a caution card or slowing up the train, thus saving fuel and time by "saying it with the signal." Usually the cost of changing from two to three positions on manual block signals is insignificant.

How many non-interlocked crossings or junctions have you where under the law trains are required to make the safety stop and which stop if avoided by installing proper interlocking or safety device would save upwards of 480 lb. of coal per stop, representing about 15 per cent of the cost of stopping. The annual cost of making these stops is usually great enough to pay all carrying costs of the signals or interlocking plants necessary to avoid the stops and in addition pay a handsome return on the money so spent. I know of cases where the net return on the investment would be over 100 per cent.

There are many improvements in cars, locomotives and track facilities too numerous to mention, yet in general we have the same old system of directing train movements by written train orders dating back almost to the time the telegraph was invented. Permit me to suggest that since the proverbial "one pound of coal" saved has already been more than accomplished that we set a goal of "one train stop or one delay eliminated per trip," continuing this progressively until facilities are installed which will eliminate the last unnecessary train stop or delay. Get rid of these "train crew operated" passing track switches and substitute machines. Get rid of these unnecessary written train orders, substituting the fixed signals, as many roads have now started doing. Give all of enormous capital investment already made a full opportunity to function by putting in the "keystone"—signals.

Private Conference Wire Feature of Railway Semi-Automatic Telephone

A NEW and unique telephone installation that serves the general offices of the Missouri Pacific and the St. Louis terminal, put into service last March, embodies, as one of its component parts, a separate and distinct circuit for use of 25 of the higher officers, exclusively, and which may be used for conference purposes, without interruption by manual operators or from the automatic system which serves all of the general offices and St. Louis terminals.

Telephone experts are familiar with the method of operation of the "semi-automatic private branch exchange" as it now functions in many places throughout the country and which is becoming more and more generally used for inter-department conversation in larger offices. However, in order that some readers may better understand the method of operation of the special circuit telephones used by the Missouri Pacific officers, it is necessary to explain the method of operation of the so-called semi-automatic telephone system. When the receiver is taken from the telephone what is called a dial tone is heard which indicates that the line is ready to receive the number you are calling. When the party calling starts dialing the number desired, this tone is cleared and when the party called answers, the line is free from any interfering noise.

Explanation of Semi-Automatic System

Inter-departmental semi-automatic telephone systems usually work on three numbers. When the receiver is picked up and dial tone heard, it indicates that the switches in the equipment room are ready to operate from the pulses sent out by the dial. When the first number on the dial is operated, the connection is made with the first selector switch, which corresponds on a manual switchboard to the operator plugging in on the line and inquiring, "Number, please." The selector switches respond automatically to the first turn of the dial and select the particular group in which the number called appears.

If the number being called is 542, the first turn of the dial connects with a line switch that automatically connects with the 500 group and connects the calling line through to a connector. The connector switch begins its work at the first turn of the dial and these switches might, very properly, be called silent or mechanical operators. They respond to the second and third turns of the dial and hunt out the number being called from a group of one hundred numbers. These banks are designated as 200, 300, 400 or 500 groups, each containing 100 numbers.

In much the same manner that a telephone operator would try a line to see if it were busy, these conductor switches test the line being called and if it is busy sends back to the party doing the calling a buzz or busy signal which tells the caller to place the receiver back on the hook. If the number called is not busy the third turn of the dial completes the connection automatically and immediately rings the bell at the station called. When the conversation is completed and the receivers placed back on their respective hooks, all of the switches that have been working automatically drop back into normal position and both lines are ready for the next call, sending or receiving calls from either end of the line. This process of making a call on the semi-automatic system, which has taken a great many words to tell about, requires but a few seconds in actual operation. Briefly, it all transpires between the time the receiver is taken from the hook, the dial given three turns and the caller hears the noise that indicates the bell is ringing at the station called. Normally seven seconds are required for the complete operation.

Calls to the city exchange are made from any Missouri Pacific station by dialing "9" and giving the number directly to the city exchange operator, or the railroad's operator may be called by dialing "0" and special calls on the automatic system are provided, for securing the Missouri Pacific's own long distance lines, another call for the city exchange long distance lines, chief operator, etc.

With this explanation of the operation of the semi-automatic system, details of the so-called "600 Group" or officer's conference phones may be more readily understood. The conference line telephone circuit is, in reality a part of the whole system, except that the numbers in that group are all in the 600 bank and only 25 telephones are connected in the group. The 25 higher officers connected on this group of telephones have, usually, an extra telephone on their own desks with no connection to their outer offices. The circuit is so connected that they may call any number in the entire system, long distance or city exchange, from their 600 phone. Conference line No. 1 is reserved exclusively for the use of L. W. Baldwin, president, and conference line No. 2, in