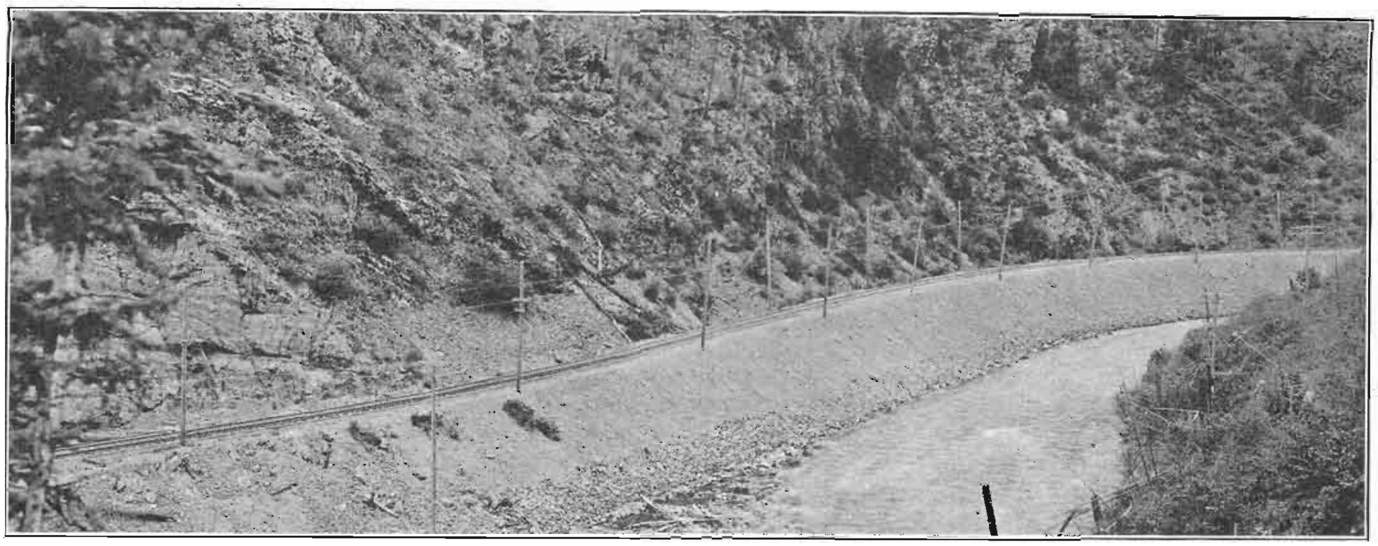

Along the Right of Way of the Chicago, Milwaukee & St. Paul

Electric Motive Power in Freight Train Service*

One C. M. & St. P. Locomotive Handles 2,800-Ton Trains on 0.7 to 1 Per Cent Ascending Grades

By W. S. H. Hamilton
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HEAVY TONNAGE freight trains are not only the most numerous on mountain railroads, but are also the most important and difficult from a train handling point of view. Previous to the electrification of the Chicago, Milwaukee & St. Paul, there were no roads electrified in this country where heavy trains of ordinary merchandise were handled on mountain grades. (The Great Northern electrification at Cascade Tunnel and that of the Baltimore & Ohio at Baltimore are not considered because steam engines are used to assist in starting.) Roads carrying ore or coal entirely have an immense advantage in that the cars are nearly always uniform and usually are all-steel equipment which can withstand rough treatment without injury. On the C. M. & St. P., the cars are of all kinds and descriptions and in rush seasons are often loaded beyond their normal capacity. While an effort is made to keep the weakest cars at the rear of the train, still there are many cars in service which were not designed to transmit the drawbar pull required in modern heavy freight service.

The majority of freight trains do not run on a schedule. True there is a schedule, but it is mostly used for convenience in despatching and trains are not expected to adhere to it closely. To handle freight most effectively, the locomotives should be able to get the trains over the division in about eight hours and yet be able to handle the maximum tonnage possible. To do this they should be able to take advantage of the profile and speed up wherever possible, consistent with safety. On mountain grades it is most economical to use helpers and this usually allows the same train weight to be handled over the entire division.

On mountain grades ascending, the maximum speed permitted by the desirable power input to one train with two locomotives will usually be 15-20 m.p.h. (16 m.p.h. on C.M. & St. P.). When operating on lighter grades, ascending, the locomotive should be able to go faster. The maximum safe speed is probably about 25-30 m.p.h. but again this speed may be limited by the desirable power input to a single train. The maximum safe speed on the level or "water" grades is somewhere between 35 and 45 m.p.h. but this varies considerably depending upon the track.

In descending mountain grades the maximum safe speed is about 15-20 m.p.h. and on the lighter grades 25-30 m.p.h.

The C. M. & St. P. freight locomotives are of the geared motor type shown in one of the illustrations. The full load speed is 16 m.p.h. at 3,000 volts and the maximum operating speed for the gear ratio is 30 m.p.h. The control provides three running speeds, two full field and one shunted. These are shown on the chart together with the speed curves on accelerating resistances. Two regenerating connections are provided, one giving a speed range from about 17-30 m.p.h. and the other about 9-15 m.p.h. The first (parallel) speed is the one generally used. Motor driven exciters are used to obtain the necessary field excitation during regeneration.

Freight Train Handling

The couplers of a freight car are not rigidly fastened to it, but are connected through a friction or spring arrangement or both, which means there is considerable stretch in them when transmitting a large drawbar pull. This is called "slack" and for practical purposes is taken as 1 foot per car. If an 80-car train is started with all the slack "bunched" at the start the locomotive will move 80 ft. before the caboose starts. Those who have ridden freight trains much can best testify to the shock produced if any attempt is made to speed up the locomotive until after the caboose has been started. This "slack" represents the most difficult problem in freight train handling and the first, last and most important rule in freight train handling is to *"properly control the slack."*

Let us consider as the first problem in heavy freight train

*This is the second of a series of three articles on this subject. The first (*Railway Age*, January 21, 1921) dealt with passenger service requirements and passenger train operation and the third will deal with the use of helpers in freight service. The author acted as an instructor to engineers on the locomotives used on the Chicago, Milwaukee & St. Paul, from December, 1915, to August, 1917, and from December, 1919, to April, 1920.

handling, starting a train on an ascending grade of not over .7 per cent with a single locomotive. On such a grade the train will not start back down the grade by simply releasing the brakes. On the C. M. & St. P. one locomotive handles a maximum train of 2,800 tons, about 60 cars, on grades of .7 to 1 per cent. On the Missoula division between St. Regis and Deer Lodge a maximum train of 110 cars, or nearly 5,500 tons, has been handled by one locomotive against a maximum grade of .4 per cent. The first start at a terminal is made after the brakes on the train have been tested. Usually when coupling onto the train, it is pulled out as much as possible before testing the brakes in order to see if it is all coupled and also to detect any short air hoses. These frequently give trouble because of excessive slack in the drawbars and at times a short extension coupler has to be put between cars in the hose line.

Starting a Train on an Ascending Grade Without a Helper

When ready to start, the locomotive is backed against the train enough to bunch the head third of the train and is then started ahead. In starting extreme care must be taken not to get the head portion of the train moving too fast before starting the rear portion as this is liable to set up shocks severe enough to pull out a drawbar. Since the drawbar pull required to start a car from rest is much more than that required to keep it just barely moving, a long freight train has almost to be started car by car and the problem is to keep the locomotive just barely moving until the entire train has been started. If the locomotive is allowed to "stall" while doing this it is usually necessary to start over again.

The engineer, therefore, in starting brings the controller to the first notch and off again once or twice before leaving it there. (This does not mean that the first notch on these locomotives gives too much tractive effort as it provides only enough to just about move the locomotive alone, but if the controller were left in that notch in the beginning the locomotive would speed up too much and pull the slack out of the head cars too quickly.) As the locomotive moves, car after car is started and the engineer watches the ground carefully and also the ammeter and when the locomotive seems to be on the point of stalling brings the controller out another notch. Considerable experience is required to be able to judge just the proper instant, as for best results the controller must be moved just as the locomotive seems to be stalling without actually allowing it to do so. As soon as the locomotive has traveled a distance equal to the amount of slack in the train, the acceleration may be increased to any desired amount which is usually as near the wheel slipping point as it is desirable to go.

In first starting a freight train, especially in cold weather, it is necessary to run it slowly for the first three or four miles out of the terminal in order to warm up the journal boxes gradually. If this is not done hot boxes will result. This is accomplished by accelerating to the series running position of the controller and allowing the locomotive to run there for several miles before going on into the parallel positions. This same precaution must be taken after a train has been standing for some time in cold weather.

In making an ordinary stop where there is no necessity for stopping very quickly, the controller is eased off a notch or two at a time until the 1st or 2nd notch is reached, where it is left until the train stops. The independent brakes are then applied on the locomotive and the controller is shut off. This stops the train without shock and without any interchange of slack. In starting again it is usually necessary to take slack but quite often an attempt is made to start without taking the slack; while this may be successful, it requires a higher value of current. If there are any weak cars ("soft shells") near the head end of the train, this practice should be avoided.

In starting or stopping on an ascending mountain grade with only one locomotive, about the same procedure is followed as on the lighter grade with the exception that it is very difficult to take any slack without excessive shock to the train. However, in such cases the trains are not very long and can usually be started without taking the slack. In one case that the writer is familiar with it was necessary to set a few hand brakes at the rear of the train in order to be able to take enough slack and release them by whistle signal after the locomotive had the train started again.

Comparison of Steam and Electric Operation

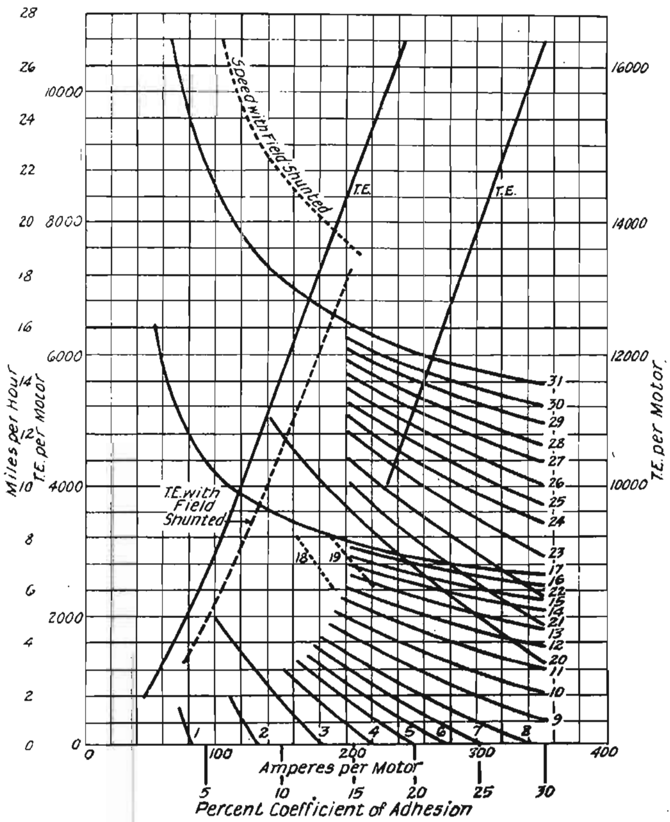
Before considering operation down grade, a comparison may be made between steam and electric locomotives as regards their ability to start a heavy train. The electric locomotive is superior because in the first place the torque on a steam engine is not constant, but varies depending on the position of the cranks. In the second place it is difficult to judge exactly the drawbar pull being developed by a steam engine during the time that the slack is being taken in the train and after the train has just started. Undoubtedly an experienced engineer can tell from the sound of the exhaust how much drawbar pull is being developed by the engine after it is in motion, even at fairly slow speeds, nearly as well as can be told by the ammeter indications on an electric locomotive. During the times referred to, however, the exhausts are so few and far between that they cannot be used as a guide. The effect of the expansion of the steam in the cylinders is variable and difficult to judge while moving very slowly. This point is brought out clearly in wrecking operations where it is desired oftentimes to move a locomotive only a few inches at a time. In such cases it was found to be much easier to do this with an electric locomotive than with a steam engine. The ammeter indication on the electric locomotives is at all times a measure of the drawbar pull being developed and the engineer can tell just how close the locomotive is to the wheel slipping point and thereby judge whether to move the controller another notch or not.

A C. M. & St. P. Freight Locomotive with a 100-Car, 5,000-Ton Train, Eastbound at Thelma on the Missoula Division

After the train is in motion there is practically no difference between the steam and electric locomotives until speeds of 6-8 m.p.h. for Mallets and 10-12 m.p.h. for simple engines are reached. Here the steam engine begins to lose torque in gaining speed while on the other hand the torque of the electric locomotive can be held at full value until speeds beyond 16 m.p.h. are reached. This results in considerable saving in time in starting a train.

Before taking up down-grade operation with electric locomotives, it is well to consider this operation with steam engines and air brakes. When a train arrives at the top of a mountain grade it is stopped and a test of the air brakes is made by applying the brakes and noting that they apply properly on all cars, or at least noting that the gage in the caboose shows a reduction. After this the brakemen go over the train and turn up the retainers on all cars.

The train is then started and as soon as the speed reaches, say, 6-8 m.p.h. a fairly heavy application of the brakes is made. This applies the brakes on all cars. This is held for a few seconds and then the brake pipe is recharged. The next and succeeding applications are lighter (about 10 lb. reductions in the brake pipe pressure), being only sufficient to move the triple valves and insure a fresh supply of air each time to the reservoirs on the cars. The cycle of operations between successive applications requires about 1 minute and is divided about as follows: full release 20 seconds, running position 10 seconds, application 20 seconds, lap 10



Speed-Tractive Effort Curves on Resistance for C. M. & St. P. Freight Locomotives

seconds. Of course these times are only approximate and are varied by the engineer, depending on how the train is holding and the speed. The train crew in the meantime are watching the cars carefully and the retainers are cut out for a few minutes at a time on any cars which show signs of wheels overheating. Stops are made as required to cool the wheels. The brakes on the locomotive driving wheels are kept off during the descent to keep from overheating the tires.

When making a stop a full service application of the brakes is made, the engine driver brakes are allowed to apply, and just before the train comes to rest an additional application is made which is quite necessary. When the first application is made preparatory to stopping and is held on, leakage in the brake pipe throughout the train gradually causes the brakes to apply hardest at the rear of the train and this part of the train has a tendency to stop first and stretch the train out. By making an application just before the train stops, it has the greatest effect on the head end and stops that part first, or at least at the same time as the rear end. Failure to make this final application often causes trains to break-in-two.

When the train is stopped, the brake pipe is recharged and the independent brakes are applied on the engine to hold the train. As the brakes on the different cars leak off the train gradually bunches against the head end and the locomotive, but since this does not occur on all cars at the same time, the cars with the brakes set retard this bunching and thus prevent excessive shocks in the train. This is another very desirable feature secured by the use of retainers and will be referred to again.

With the electric locomotives regeneration is used to control the speed and braking effort on descending mountain grades. On the freight locomotives used by the C. M. & St. P., the controller is so arranged that it is necessary to bring the main handle to either the full series or full parallel running position before the braking handle can be moved to the positions to apply and regulate the amount of regeneration. This makes the application of regeneration when "tipping over" the summit of a grade very easy, as the controller can simply be left on and the braking controller brought on as the speed increases. The regeneration starts gradually and the train bunches as each car in turn passes over the summit. However, when starting on a down-grade the application is not so easy, because of the motoring pulling out of the train slack before regeneration is applied.

The trains stop for an air brake test at the summit; this is done by making a 10 lb. reduction in the brake pipe pressure at the locomotive and noting whether this shows on the gage in the caboose. The conductor then makes a 10 lb. reduction by means of the valve in the caboose and the engineer sees it by means of the brake pipe gage in the locomotive. It is the usual practice to turn up retainers on 25 to 30 per cent of the cars, all at the head end of the train. These assist in controlling the slack in case a stop is made on the grade as previously described.

Starting a Train on a Descending Grade

The train is then started and if it is not all on the down-grade the regeneration is applied as described above. This same method is used on all grades of 1 per cent or less. If, however, the start is made from rest on a grade of 1.5 per cent or over, then the train is started and allowed to run, checking it a little at first by means of the independent brakes on the locomotive. This bunches most of the slack gradually. When a speed of about 17-19 m.p.h. is reached a light application (about 8-10 lb. reduction) of the automatic brakes is made, the independent brakes on the locomotive being allowed to apply. When this application becomes effective the main handle is brought out quickly to the parallel running position and the braking controller is brought on several notches. The independent brakes are released as soon as regeneration commences and the automatic brakes as soon as it has built up to the proper value. This procedure keeps the train bunched while regeneration is being applied and the cars with retainers assist in this, but they soon leak off and do not assist in holding the train after a few minutes.

Frequently one of these locomotives has to take a greater tonnage down a grade than it can hold by regeneration alone. To do this the air brakes have to be used to help hold the train. This condition occurs most often on the 2 per cent grade between Donald and Piedmont. One locomotive can hold back about 2,200 tons, whereas the tonnage down this grade is usually 2,800-3,000 tons. Under these circumstances more retainers are turned up though never on more than on 40-50 per cent of the cars (all at the head end) and after regeneration has commenced additional applications of the air brakes are made from time to time to control the speed, the driver brakes on the locomotive being kept released. The applications are all light (10 lb. or less), being just enough to work the triple valves on the cars, and most of the work is done by the brakes on the cars with retainers up. These, however, do not heat up their wheels enough to bother. This method is entirely successful in operation, but is greatly facilitated by the arrangement provided on the bipolar passenger locomotives, whereby the brakes on the locomotive are automatically kept released while the locomotive is regenerating.

In stopping the train, the regeneration is reduced by moving the brake handle back a couple of notches and a light service application of the brakes is made, the driver brakes being allowed to apply. When the speed has decreased enough so that regeneration has practically ceased, both handles are shut off and such additional applications of the brakes are made as are necessary to stop the train.

Railroad Guaranty Bill Before Congress

WASHINGTON, D. C.

THE WINSLOW BILL, to specifically direct the Secretary of the Treasury to honor certificates of the Interstate Commerce Commission for partial payments to the railroads on account of their six months' guaranty, was favorably reported to the Senate on January 31 by unanimous action of the Senate committee on interstate commerce, after a brief hearing at which Chairman Clark of the Interstate Commerce Commission approved the purpose of the bill. The committee had had an opportunity to study the record of testimony on the bill before the House committee.

As briefly noted in last week's issue, a favorable report on the Winslow bill was filed in the House on January 26 by Representative Winslow. The report said in part:

Regardless of the question whether or not the ruling of the comptroller and the decision of the supreme court of the District of Columbia are in accordance with the terms of the law, there is no question in the minds of your committee (which held full hearings on the subject, at which were heard representatives of the carriers and of the Interstate Commerce Commission, and various individuals representing business interests) that the transportation act should be so amended as clearly to authorize the commission to make certificates in partial payment. If the commission definitely ascertains that a certain amount is due under existing law, no reason is apparent why the payment of such amount should be deferred until a final settlement of all disputed items is arrived at.

Accordingly the bill, the passage of which the committee now recommends, provides that the commission, if not at the time able finally to determine the whole amount due under section 204 or section 209, may make its certificate for any amount definitely ascertained to be due and may thereafter in the same manner make further certificates until the whole amount due has been certified. In order to clarify the bookkeeping processes involved in this payment the bill provides for the allocation among the appropriations already made by these sections of the transportation act of the partial payment warrants authorized by this bill.

The bill also authorizes the commission whenever in its judgment practicable to make a reasonable estimate of the net effect of any deferred debits and credits which can not at the time be definitely determined. When agreed to by the claimant such estimates may be used as a definitely ascertained amount which the commission is authorized to certify for payment, but such estimates so agreed upon are to be binding in final settlement. The principal class of cases covered by this provision are items for loss and damage claims and overcharge claims, which it is impossible to compute with exactness until the courts have settled the liability of the parties.

The testimony of witnesses before the committee represented very generally the railroads, the American Railway Express Company, and miscellaneous railway supply houses.

They all emphasized most forcibly the absolute need for such legislation as is proposed in this bill. They made it very clear that not only were their institutions unable to meet their proper running expenses and maintenance charges, to say nothing of paying their bills, long overdue, or undertaking to make necessary repairs or to provide for any development in order that they may keep up with the need for transportation facilities. It was testified generally that they were unable either to sell new securities or to borrow money temporarily, because of the already too great extension of their credit, on account of which banks and other creditors are demanding payments which the carriers are unable to make. Not only is this condition of affairs working against their day-to-day efficiency, but it is also resulting in the unemployment of tens of thousands of operatives who might, if the government would make payments on account, be immediately and wisely set to work.

The situation is so apparently unbusinesslike as to demand a correction of the present government method of paying its indebtedness to the carriers, etc.

In connection with the report, Mr. Winslow submitted a letter from Chairman Clark of the Interstate Commerce Commission saying that the commission is in full sympathy with the purpose of the bill and is of opinion that conditions and the financial situation are such as to make it highly desirable that the carriers shall have as promptly as possible the amounts due them under the guaranty provisions. It is physically impossible, he said, within a reasonably short time to make final certificates for all the carriers, and in the meantime it seems appropriate that partial payments should be made in so far as the same can be properly certified.

Representative Sims filed a minority report opposing the passage of the bill, both on technical grounds and on the ground that the guaranty was in the nature of a "gratuity" which the railroads are not entitled to ask for in advance of the final ascertainment of the amounts. Mr. Sims said in part:

No property right exists in favor of the carriers, as they were not required to perform any service of any character, or make any sacrifice, or incur any expense in behalf of the government in consideration of the guaranty. This guaranty provision of the transportation act can be repealed; and if repealed, no carrier would have any legal or enforceable cause of action against the government on account of such repeal.

At the time the transportation act was passed and government operation of the railroads ceased every product of the farm was double in market value that it is now. Thus the burden of this gratuity has been doubled. But, notwithstanding this fact, the carriers now ask Congress to amend the law advancing the date of payment of this gratuity so as to require it to be paid at a time when it is impossible for the farmers and producers of the Nation to receive even the out-of-pocket costs to them of their products, which will have to be sold at any price in order to pay the taxes necessary to be paid in order to comply with the unjust provisions of this bill.

The government has already paid during the guaranty period to the applying carriers by way of advances provided for under paragraph (h) of section 209, the sum total of $260,431,874. This vast sum far exceeds the amount that any member of the House or Senate or anyone else supposed or believed would have to be paid the carriers to cover or make good any deficit that would or could possibly be incurred during the guaranty period under honest and efficient management. But we are now confronted with the astounding claim that the deficit for the six months exceeds $600,000,000. That such a deficit could arise during six months (all spring and summer months) with no strikes, no floods, no fires, no let-up in traffic, is so astonishing as to challenge our credulity. This sum is so stupendous that duty to the public demands a congressional investigation and report by a committee of the House of Representatives before another dollar is paid on the guaranty claims of the carriers.

THE RAILROADS are desperately in need of funds. There are already considerable sums due from the government. Why, then, should it be necessary to wait until the last book is balanced before making payments? The Treasury can surely be well protected by a suitable margin. This remedial legislation is advocated by the Interstate Commerce Commission, which recognizes the necessities of the railroads, and has been willing to make certifications on account of the government guarantee. It is a matter in which common sense ought to prevail.—*N. Y. Commercial.*