INSTALLATION.

The railway company furnished and installed in place insulated joints, insulated switch rods and connections and line-wire supports, and the General Railway Signal Company manufactured and installed the signals and signal appliances. Most of the material was delivered by work train. Signals were erected by means of a derrick, which was also used in setting the concrete battery wells. R. L. Latham, chief engineer of the Toronto, Hamilton & Buffalo, had general charge of the installation, which was performed under the immediate supervision of A. A. Hurst, supervisor of signals. A. C. Holden was engineer in charge for the General Railway Signal Company.

INSTRUCTION OF TRAINMEN.

Suitable rules governing the use of the automatic signals were adopted by the railway officers, and were printed in the back of the employees' time table with the operating rules. About the time the signals were ready for service, the railway officers held several meetings for instruction of the trainmen at Hamilton, the division headquarters, at which the signal aspects and indications were elucidated and discussed, as were also the rules governing their use. At these meetings lantern slides of the signal aspects and indications were thrown on a screen to illustrate the explanations, and a model 2-A signal mounted on a short mast, an indicator, a switch-circuit controller and other signaling appliances were operated as if under service conditions, to afford a practical demonstration of the signal system and to fix the essential features firmly in the minds of employees.

MAINTENANCE.

The maintenance of these signals is in charge of a signal supervisor whose force consists of two maintainers, four battery men and two lampmen, who make a daily inspection of the signals and appliances on their respective districts. Each man is provided with a velocipede car on which he carries the necessary maintenance supplies and a kit of tools. Improper operations of the signal system are reported by the maintainer by joint wire to the chief engineer, the superintendent and the signal supervisor. Copies of the report are forwarded by railroad mail to the signal supervisor with full explanation of the cause. The signal supervisor investigates each case personally and works up a record which shows the performance of the entire signal system for a given period.

The signal supervisor also keeps an accurate record of all labor and material chargeable to signal maintenance, so that maintenance costs can be determined for the entire system or any part thereof. The cost of maintenance per mile per month is about $16. Ordinary maintenance supplies are carried in stock at the general storehouse situated at Hamilton, and a few emergency supplies are kept on hand at maintainers' headquarters.

WHAT THE SIGNALS ARE ACCOMPLISHING.

The officers of the T., H. & B. are well satisfied with the results obtained by the automatic signals, summarized as follows: (1) Under proper observance of the indications, the signals provide for opposing, as well as following movements, a definite space interval which reduces the likelihood of collisions to a minimum; (2) misplaced switches, broken rails, or any breaks in the continuity of the track cause the display of a stop indication at the signal governing entrance to the block, thus greatly reducing the likelihood of derailments; (3) the signals increase the traffic capacity of the line, as one train can follow another as soon as the first train passes the signal in advance, which is accomplished in considerably less time than the prescribed time interval of the telegraph block; (4) the signals afford maximum protection at meeting and passing points, serving as a check on despatchers' orders, also as a reminder to trainmen at scheduled meeting and passing points; (5) the signals more than double the safety factor in connection with flagging, as an approaching train would, in most cases, meet a caution or stop indication before the flagman could go out far enough to insure adequate protection; (6) owing to the high degree of protection which the automatic signals afford, "19" orders may be used in many cases where "31" orders would otherwise be required.

COMPENSATION OF PIPE LINES

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Compensators must be placed at the proper points in a pipe line, otherwise the practical operating length will change. Many signal men have found it necessary to adjust pipe lines after every change in temperature, although one or more compensators may have been provided. Inasmuch as there is little change in the temperature in the lower story of the tower, the heating plant usually being located there, the up-and-down rods between the lever and the rocker shaft or vertical crank stand are not taken into consideration in the following examples.

In order to work out any problem in compensation the mean temperature must be known. This, of course, varies with the locality. If the temperature rises to 110 deg. above zero in summer and drops to 10 deg. below in winter, the mean temperature of the locality is 50 deg. above zero. In Fig. 1 is shown a switch 400 ft. from the tower, which can be connected by a straight run if the pipe is cut and laid down when the thermometer is at 50 deg. above zero. Two equal lengths of pipe are cut, one starting from the tower and one from the switch and ending at the middle point with the two ends touching each other. If the temperature rises to 110 deg. each line will expand approximately 1 in., and the straight arm compensator would appear as in Fig. 1a. At 10 deg. below zero, each pipe line should be 199 ft. 11 in. long, as shown in Fig. 1c. Thus, with a compensator at the middle point in a straight run, the practical operating length of the pipe line between the tower and the switch remains the same during all kinds of weather.

For a lazy jack compensator the pipe must be cut to allow for the distance between the ends of the arms, which at mean temperature must be 22 in., regardless of the length of the arms.

Fig. 2 shows one and Fig. 3 two 90-deg. cranks in a pipe line. No change of direction is caused by these cranks in either case and the compensator should be placed at the middle of the entire pipe line, measuring from the tower to the switch. In Fig. 4 there is a change in direction of motion at crank C. The distance between the crank and switch is assumed to be 60 ft. When the 60 ft. of pipe line to the right expands ½ in., it tends to push the crank arm (downward in the illustration), the 60 ft. of pipe to the left of the crank expands ½ in. and permits this movement. The 60 ft. from the crank to the left, marked X in the figure, should be ignored, and the compensator placed at the middle point between X and the tower.

When branch lines lead from the main line the problem is somewhat more difficult. In Fig. 5 there is no change in the direction of movement at crank C. Contraction and expansion on the branch line will therefore have the same effect as in the main line to the right of the connection. In locating the compensator, therefore, the distance between crank C and switch S must be measured, and X located an equal number of feet from crank C to the right. The middle point between X and the tower is the location for one compensator and the middle point between X and the switch Y is the location for the other, two compensators being necessary in lines of this kind.

Fig. 6 shows a similar arrangement, but there is a change in the direction of the motion at crank C. Here, then, after obtaining the distance between the crank and switch S, an equal distance should be measured off from the crank to the left to find the point X. A compensator should be placed at the middle point between X and the tower and another at the middle point between X and switch Y.

In Fig. 7 there is no change of motion at the crank C but there is at crank D, which must therefore be taken as the starting point. Since the distance from D to the end of the line is 100 ft., an equal length of pipe must be measured off to the left of crank D. The cross line being only

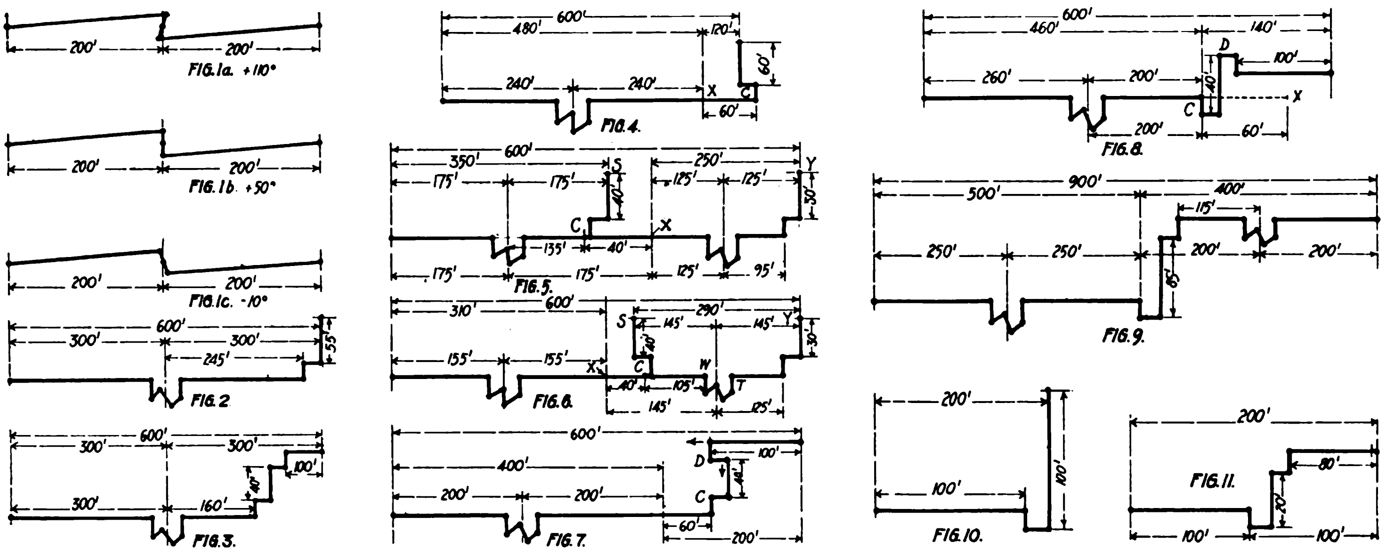
40 ft. in length, 60 ft. of the main line to the left of crank C must be measured off to balance the 100 ft. of pipe. The point X is therefore 60 ft. to the left of point C, and the compensator should be located halfway between X and the tower. In Fig. 8 there is a change of motion at both cranks, so that both must be considered as compensators. The 100 ft. of pipe at the end, in expanding .05 in., tends to force the arms of crank D .05 in. As the 40 ft. of pipe between the two cranks will expand only .02 in. at the same time, the arms of crank C must be given a chance to move .03 in. This amount is equivalent to the expansion of 60 ft. of pipe. Therefore 60 ft. of pipe must be assumed as an extension to the main line to the right of crank C, as shown by the dotted line, to obtain the point X.

Fig. 9 shows a long run of pipe with the crank C connected into it so as to change the motion, but on account of its location near, but not at, the middle point and also because of the length of the pipe line, it is entirely neglected in the scheme of compensation. It is used, however, as the point X to start from, to find the location of the two compensators. One should be at the middle point between the crank and tower and the other at the middle point between the crank and the operating unit. Figs. 10 and 11 show ordinary angle cranks used as compensators. The and then set the arms of all cranks in the line the same distance off center. It is evident in Fig. 3 that the arms of crank C must be set off center to a greater degree than those of crank D.

Another error sometimes fallen into when running a line as shown in Fig. 11 and attempting to gain compensation by means of cranks, is to set the two cranks so as to change the direction of motion at both, with the result that only the pipe between and a few feet on each side of the two cranks is compensated. Practically there is no compensation in this arrangement.

A serious mistake made at times is to attempt to gain or reduce the stroke by drilling back on one of the compensator arms. Unless this is figured on in its location, the compensator will not fulfill its function. For instance, if two equal runs of pipe line are connected to a crank, one with a 14-in. arm and the other with an 11-in. arm, the shorter moves in an arc with a smaller radius. Both arms will tend to expand an equal amount and the smaller arm will not be able to move as far as the other on account of this limitation, so a strain will be set up both in the pipe lines and in the crank.

The question often arises as to what the length of the compensator and crank arms should be. In so far as ease of



Typical Problems in the Compensation of Pipe Lines.

crank must, of course, be placed at the middle point of the line. Other conditions besides those shown in the above examples will be encountered in actual practice, but if the problems given herein are worked out and fully understood, any other arrangement of pipe runs can be properly compensated.

When pipe is cut at the mean temperature, all compensator and crank arms must be set on center regardless of their length, or the extent of the pipe line. When contraction or expansion sets in there is a movement of the arms away from the center line. Therefore, if a pipe is cut and assembled when the temperature is above or below the mean, the compensator arm must be set accordingly and the pipe cut to lengths to suit these positions. In Fig. 4, crank C, the contraction and expansion of 60 ft. of pipe must be considered. If the temperature is at the maximum the arms must be set to the left of the center, and if the temperature is below mean, the arms must be set to the right of the center.

The position of the arms of a crank, at which there is no change in motion, must also be calculated in the same manner. An error often made is to set all compensator and crank arms on center regardless of the temperature at the time the pipe is cut. Another mistake sometimes made is to calculate the position of the arms of the compensator X, operation and maintenance is concerned, the longer the arms, the better. No matter what the length of the arm is, the travel of the pipe lines is the same, other conditions being equal, but the angle through which it must travel varies inversely with the length of the arm. The longer the arm, the smaller the angle, and therefore the less the friction. If short arms are used, the compensation must be calculated and the compensating devices located more accurately, otherwise, especially where turn buckles have been cut into the line, the arms will bind against the stand, on account of extremes of temperature or improper adjustment. In long lines it is imperative that compensators with long arms be used. This is also true of angle cranks unless they are located near the end of the line where the effect of contraction and expansion is small. It must always be remembered that short cranks make greater friction, not only at their pins, but also at the adjacent pipe carrier.

Crank and compensator arms are often caused to bind against the stand by improper or perhaps careless adjustment. A turn buckle on each side of a compensator is often very convenient for making quick adjustments, but it may be the innocent cause of a great deal of trouble. Whenever a turn buckle or any other kind of adjusting screw is used in a pipe line, the adjustment must be made so that it does not throw the cranks or compensator arm out of adjustment.