No. of frog.	Actual lead.	Equiv. radius.	Equiv. degree of curve.
7	60 ft.	410 ft.	14°– 0 ft.
8	66 ft.	573 ft.	10°– 0 ft.
9	75 ft.	702 ft.	8°–10 ft.
10	82 ft.	1,011 ft.	5°–40 ft.

This equivalent radius of 410 feet just about corresponds with the minimum radius that most standard railways are willing to adopt, even for spur tracks and sidings away from the main line, the large switching and main line engines being unable to cope with sharper curves without frequent derailments.

Whatever design for a layout of switches and tracks is considered, the three details given in the table above have to be borne in mind, i.e., the angle of the frog, the lead and the curvature.

The three commonest positions of the switch are in the simple turnout, the crossover and the "ladder." In the design of a crossover the piece of track between the two main tracks and connecting the two frogs is always made straight and the distance in between the frogs is easily obtained, knowing the frog angle and the distance between track centres.

In the case of No. 10 frogs and 13-ft. centres between tracks this distance is 34 ft., thus making the total length of crossover 198 ft.

The design of a ladder requires more consideration, and conditions such as property limits, track capacity, etc., have to be dealt with, but if there are no such limiting conditions a simple straight ladder can be laid out so that the ladder track is at the same angle with the yard tracks as the angle of the frog that is to be used in the switches, in which case the frogs are set at the intersection of the gauge lines of the two rails, as is shown in Fig. 2. If the first frog in the ladder is located it is a simple matter to find the distances between all the frogs on the ladder, e.g., if No. 8 frogs are to be used, and the tracks are 13-ft. centres, the frogs will be $8 \times 13 = 104$ feet apart, so that if there are going to be, say, 7 tracks connected to the ladder the last track will be about 700 feet shorter than the first. This is usually rather a serious situation as it is almost always desirable to get the longest track possible, or at any rate to get the tracks as nearly the same length as possible, but it is readily seen that in order to make the last track longer it is only necessary to increase the angle which the ladder makes with the main yard tracks, the effect of this being to reduce the distance between the frogs, which do not now point in the same direction as the yard tracks, and so have to be placed closer to the first track in order to allow room for the necessary curve between the heel of the frog and the tangent, as is shown in Fig. 3. Now, the maximum angle at which the ladder track can be placed is fixed in this way: the distance from the point of switch to the point of frog (assuming the use of No. 8 frogs) is 66 ft., the standard distance from point of frog to the heel is 9 ft., and the closest distance that the point of one switch can be placed to the heel of the frog of the preceding switch is 3 ft., to allow for the angle plates of the joint, thus we have the minimum distance between frogs is 78 ft., thus giving an angle of 1 in 5.2 for 13-ft. centres or 1 in 6.5 for 12-ft. centres. Using these figures in a yard of 7 tracks there would be an increased length in the last track of about 180 ft. and a proportional increase in the other tracks.

It is not usual in good railway practice to put more than 9 or 10 tracks on the one ladder, as this has been found by experience to be the maximum number that can be efficiently operated by one engine, except in special cases; for instance, where the tracks are used solely for storage purposes. Fig. 4 shows a typical arrangement of tracks with two ladders serving 18 tracks in all.

It is usual to extend the first track in the opposite direction to the yard, to make a switching lead, as shown in Fig. 4; this lead allowing switching engines to make up the various trains without encroaching on the main lines.

In some instances it is desirable to put in even steeper ladders than can be done by the methods described above, especially in cities and towns where land is valuable and must be occupied to the greatest possible advantage. In cases like this a ladder can be used, as shown in Fig. 5.

This ladder, although giving the advantage of longer tracks, has the disadvantage of having the switches on op-

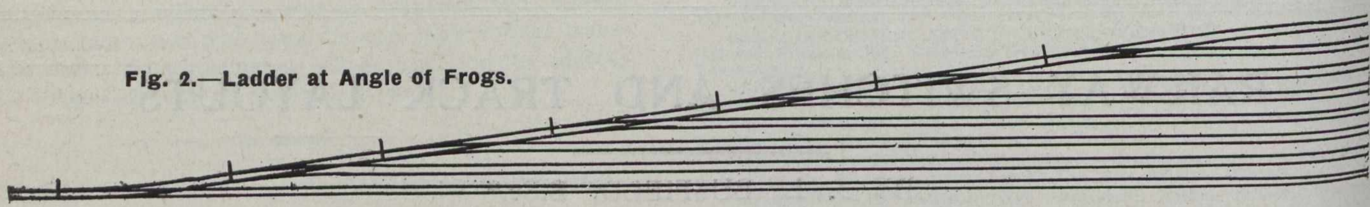

Fig. 2.—Ladder at Angle of Frogs.

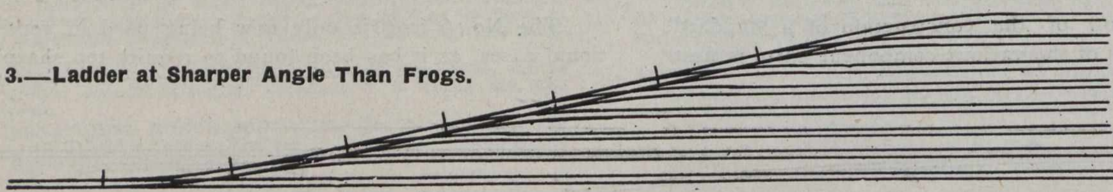

Fig. 3.—Ladder at Sharper Angle Than Frogs.

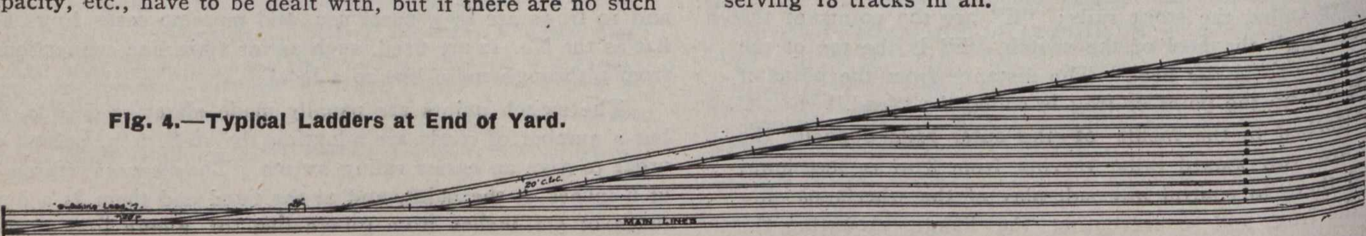

Fig. 4.—Typical Ladders at End of Yard.