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Informal Note #38

YARD HARDWARE - SWITCHES AND CROSSINGS

The purpose of this working note is to discuss devices used to re-route cars on one track to another track, (or to cross another track), such as switches, crossings, turnouts, etc. The types of hardware used for these activities are especially important for railroad classification yards, because the functions of the railroad yard are to disassemble incoming trains and assemble outgoing trains, and therefore, engine and car movements at the yard involve crossing, merging, diverging and turn-back moves.

This note describes:

- Definitions, specification methods, and proper usages of major components, e.g., switches, frogs, and crossings.
- Definition and proper usage of switches and crossings.
- Evaluation criteria of switches and crossings.

Descriptions of switches and crossings and their proper usage are given in the following section. Much of the text was extracted from the AREA Manual for Railway Engineering.

Split Switch

This is a track structure used to divert rolling stock from one track to another. A split switch consists of essentially a two movable point rails with the necessary fixtures. A sample layout of a split switch is given in Figure 1. The specifications of a split switch include:

1. Type of split switch.
2. Straight or curved - for a curved switch it is required to know whether the curved rail is on the left hand or right handside, and the curve alignment is also required.
3. Gage of track.

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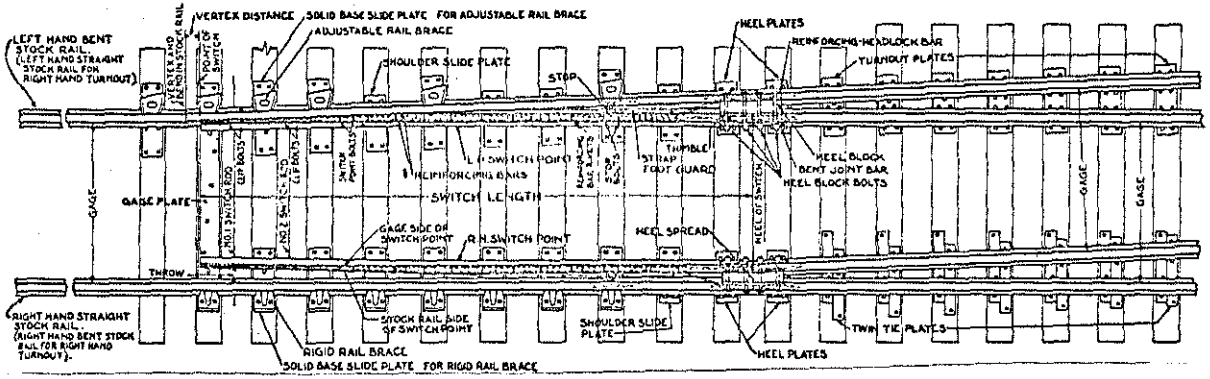


Figure 1 - Plan View Indicating Various Parts of Switch Layouts
(drawn for left hand turnout)

4. Switch point - specified by (a) length, (b) thickness of point, (c) single reinforced or double reinforced, and (d) spacing of holes for the switch clips.

5. Heel spread.

6. Design of switch rods, plates, braces and other special requirements.

7. Weight and section of rail together with the details of joint drillings.

There are a variety of split switches. A brief description of each split switch type is given below:

- Straight split switch - A split switch having straight switch points.

- Curved split switch - A split switch having a curved switch point. For a left hand switch, the curved switch point is the right hand switch point, and for a right hand switch, the curved switch point is the left hand switch point.

- Insulated Split Swtich - A switch in which the fixtures, principally the gage plates and the switch rods, connecting or reaching from one rail to the opposite rail, are provided with insulation so that the electric track circuit will not be shunted.

- Split switch with uniform risers - A split switch in which the switch rails have a uniform elevation or riser plates for the entire length of the switch, and therefore do not have a heel slope, the point rail rise being run off back of the switch in the closure rails.

- Split switch with graduated risers - A split switch in which the swtich rails are gradually elevated by means of graduated raiser plates until they reach the required height above the stock rail, and therefore have a heel slope.

- Spring Switch - A switch in the operating mechanism of which is incorporated a spring device so arranged as to automatically return the points to their original or normal position after they have been thrown over by the flanges of trailing wheels passing along the other track from that for which the points are set for facing movements.

Frog

The frog is a track structure used at the intersection of two running rails to provide support for wheels and passage ways for their flanges, thus permitting wheels on either rail to cross the other. A sample layout of a standard frog is shown in Figure 2. The specification of a frog includes:

(a) Information inherently essential for specifying a frog:

1. Type of frog.

2. Frog number or angle - found by dividing the frog length (L) by the sum of the gage line spreads at the heel (HS) and to toe (TS).

3. Weight and section of rail of which a frog is to be made, together with the details of all joint drillings.

(b) Important information, in addition to the foregoing:

1. Width and depth of flangeways.

2. For standard rigid frog - important measurements such as over all length and heel length from 1/2" point (see Figure 2).

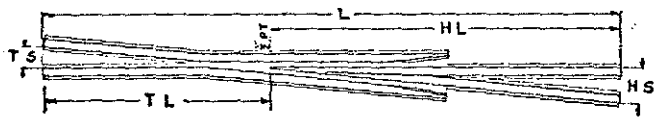
3. For special frogs - important measurements such as, overall length of each side, the length of each leg from 1/2" point. (see Figure 2).

4. For a curved frog - diagram showing direction of curvature and radius or sufficient data to determine the curvature and radius; i.e., the heel spread (HS), toe spread (TS), heel offset (HO) and toe offset (TO). (see Figure 2A).

5. Tie layouts and plates. If special tie plates are wanted a sketch showing the location of ties on which the tie plates are to be located must be given.

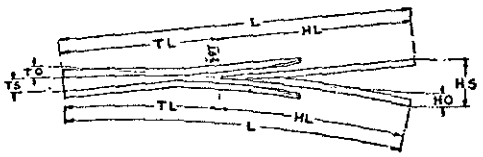
There is a variety of frog types. A brief description and the proper usage of each frog type are given below:

- Spring-rail frog - A frog having a movable wing rail which is normally held against the point rail by springs, thus making an unbroken running surface for wheels using one track, whereas the flanges of wheels on the other track force the movable wing rail away from the point rail to provide a passage-way.



L-Overall length
HL-Heel length from 1/2" point
TL-Toe length from 1/2" point

Figure 2 - Standard Frog Layout



L = Overall length of each leg
HL = Heal length of each leg from 1/2" point
TL = Toe length of each leg from 1/2" point
HS = Heal spread
TS = Toe spread
HO = Heel offset
TO = Toe offset

Figure 2A - Curved Frog Layout

A spring-rail frog may be used in:

A. Main track where traffic is predominantly on the main track side of the frog.

B. Yard tracks, but only when rigid frogs are not available.

- Railbound manganese steel frog - A frog consisting essentially of a manganese steel body casting fitted into and between rolled rails and held together with bolts. Railbound manganese steel frogs should be used only on heavy traffic lines where traffic is approximately equal on both sides of the frog.

- Solid manganese steel frog - A frog consisting essentially of a single manganese steel casting. A solid manganese steel frog may be used as an alternate to a railbound manganese steel frog.

- Self-guarded frog (flange frog) - A frog provided with guides on flanges, above its running surface, which contact the tread rims of wheels for the purpose of safely guiding their flanges past the point of frog. Self-guarded frogs shall be used in yard tracks, and they may be used in main tracks where speed does not exceed 30 mph. (NOTE: Guard rails may be used with self-guarded frogs when conditions justify.)

- Bolted Rigid Frog - A frog built essentially of rolled rails, with fillers between the rails, and held together with bolts. Bolted rigid frogs may be used in yard and industry tracks where traffic is light on both sides of the frog, but only self-guarded frogs are not available, or when it is desirable to utilize available second hand frogs.

Crossing

A crossing is a track structure which is used where one track crosses another at grade, and consists of four connected frogs. A sample layout of crossovers is shown in Figure 3. The specifications of a crossing include:

1. Type of crossing.

2. Angle between intersection of center lines of tracks.

3. Gage of tracks.

4. Direction and radius (or degree) or curvature if any.

5. Mathematical relation of crossings when there is more than one at the location in question. If parallel tracks are involved the distance between their center lines should be given. If there are multiple tracks which are not parallel the distance (chord if track is curved) between intersections of center lines should be given, together with the center angles.

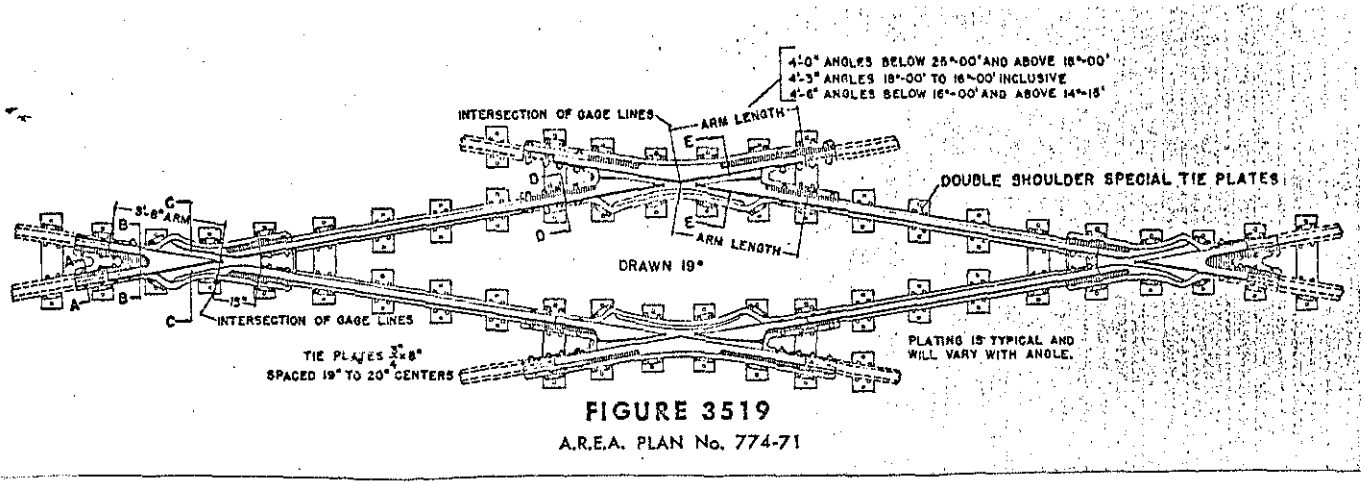


FIGURE 3519

A.R.E.A. PLAN No. 774-71

Figure 3 - Layout of a Crossing

6. Weight and section rail of which (or to fit which) crossing is to be made, together with the details of all joint drillings.

7. A brief description of the design wanted, with suitable reference to one or more AREA or other standard plans. It is well to mention the matter of plating even though the reference plan shows this feature.

8. Width and depth of flangeways.

9. Arm lengths, measured from intersections of gage lines. In the absence of this information it will be assumed that the lengths shown on the reference plan are satisfactory. If any particular location of joints is required for insulation purposes it should be clearly indicated.

10. Tie Layout and Plates. Complete information for the location of ties and/or timbers and details of plating should be shown when other arrangements are wanted than those presented on the AREA plan referred to.

11. Number and details of Compromise Joints or Compromise Rails if needed.

12. Any variation from the construction shown on the reference plan, with specifications covering alternates if wanted.

13. Geographical location of crossing, with names of intersecting railroad, indication as to which track of each crossing is the more important, north mark, directions to division points or terminals, and any other pertinent information. It is well to provide a small scale location sketch on the data plan, showing the general layout and indicating any nearby turnouts and structures such as signal towers, station buildings or platforms,etc.

14. A designating number or letter for each one of a group of crossings or for each frog of an individual crossing, for convenient reference. (In any case the completed crossing should be plainly marked for convenience in installation.)

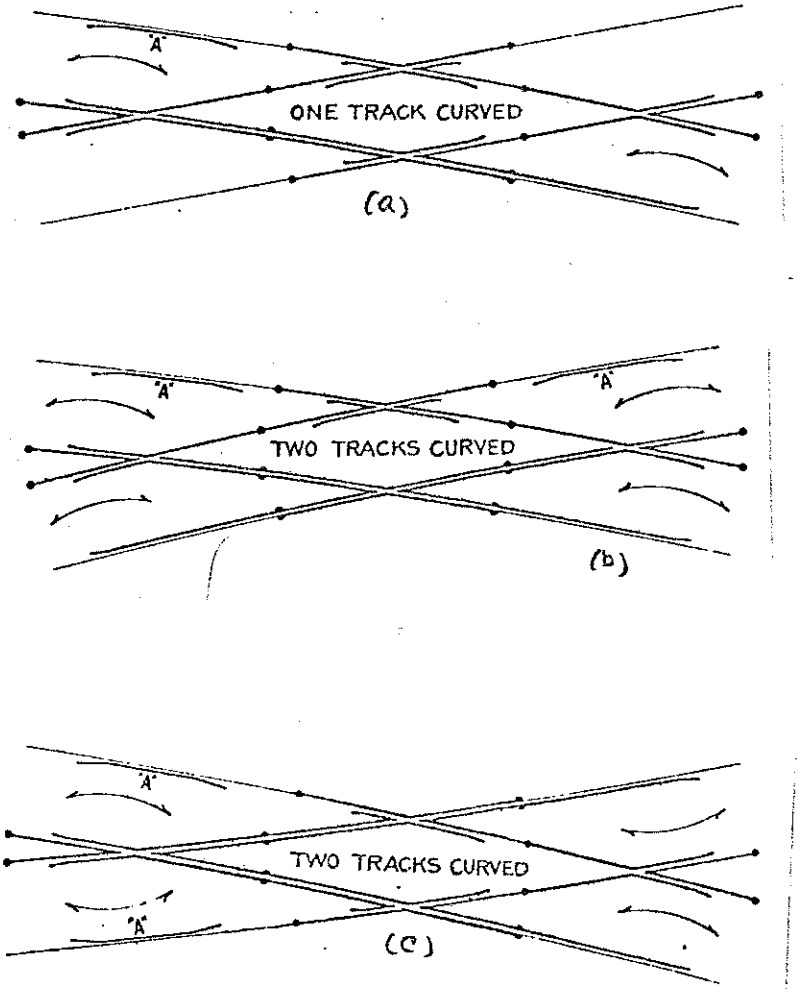
The guarding becomes important for crossings with smaller angles, and crossings on curved tracks. The AREA manual for Railray Engineering specifies the guidelines for guarding at crossings as:

1. The points of end frogs of angles below 50 degrees shall be guarded, and the same requirement shall apply to greater angles if the track be curved in excess of a 6 degree curve. The points of end frogs shall also be guarded on an electric railway track for all angles.

2. If a track be curved through a crossing in excess of a 6 degree curve the inside rail of such curve shall be equipped with a guard rail throughout.

3. Special guard rails shall be furnished with crossing. It is recommended that standard guard rails be used when space permits, but they shall not be furnished with crossing unless specifically called for.

The diagram showing the typical guarding arrangements when the guarding is required on account of curvature is given in Figure 4.



Guard rails marked "A" shall have widened flangeways when required by curvature and shall be furnished with crossing when specified.

Figure 4 - Diagrams showing typical guarding arrangements when required on account of curvature

Movable Point Crossing

A movable paint crossing is a type of crossing for small angles in which each of two center frogs consists essentially of a knuckle rail and two opposed movable center points with the necessary fixtures (see Figure 5). Movable point crossings are recommended by AREA under certain conditions for intersection angles below 14 degrees, 15 minutes. Information on the recommended limitations for crossings with rigid center frogs is given in Figure 6.

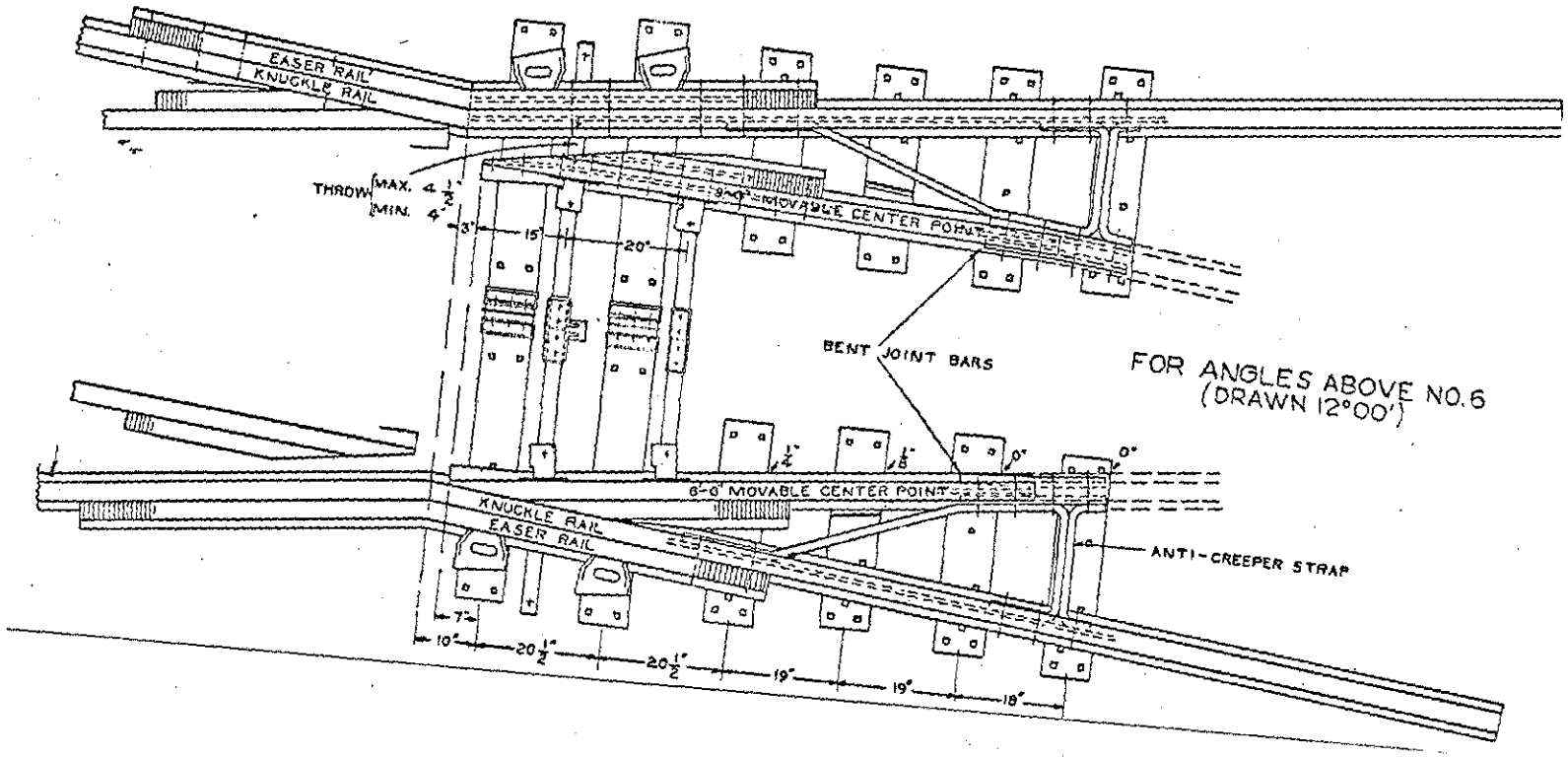
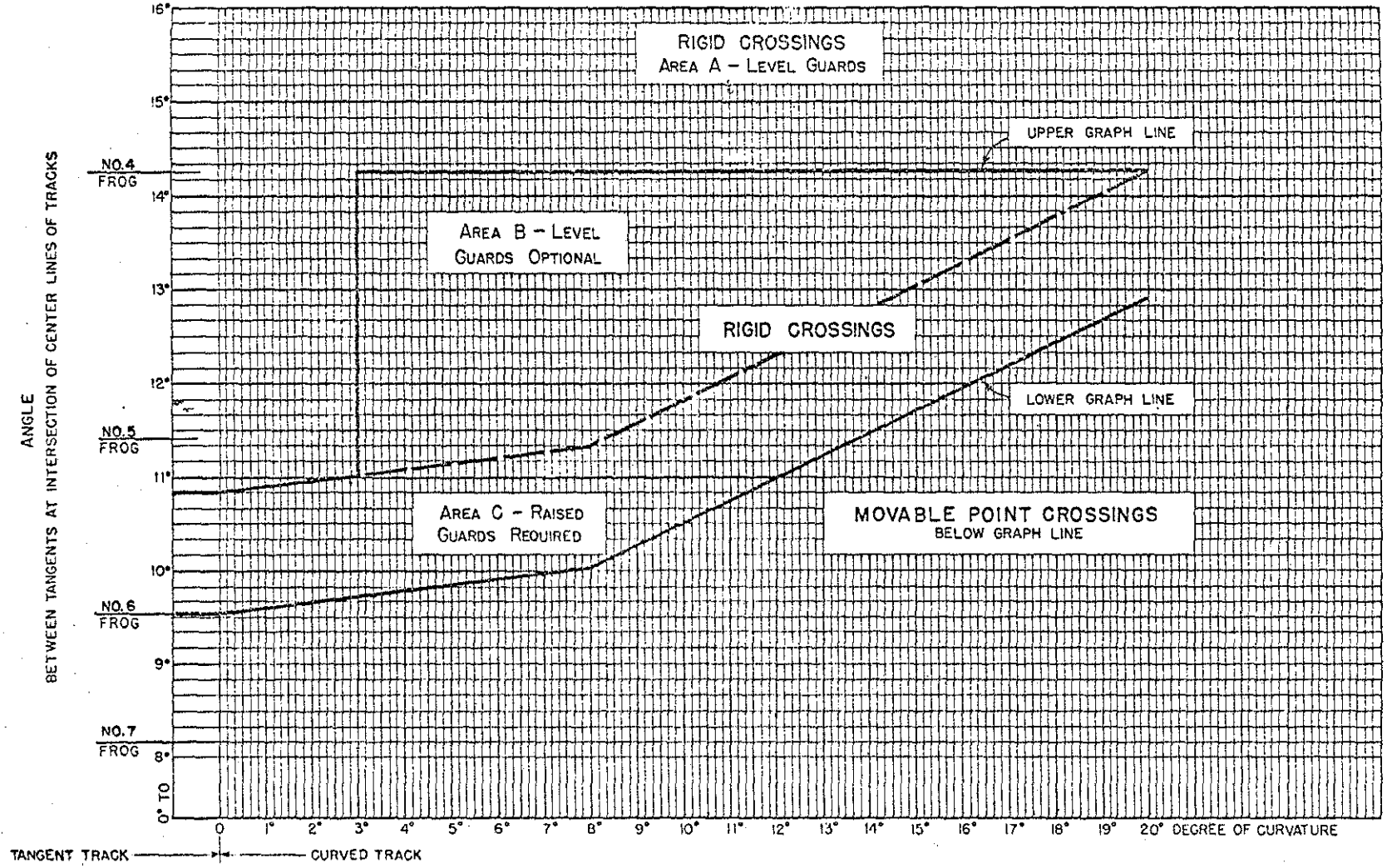


Figure 5 - Movable Point Crossing



NOTES

1.—The graph shows minimum angles between tangents at intersection of center lines of track for which rigid center frogs may be used as referred to on Plan Basic No. 700.
2.—For curved track the center line of track having the greater degree of curvature within the limits of the diamond of the crossing shall apply.
3.—For crossings in the Area C between the lower solid graph line and the dash graph line raised guards are required to provide effective guarding. For crossings in the Area B between the dash graph line and the upper solid graph line, level guards will provide sufficient guarding, but raised guards are recommended to protect the frog points from flange wear. For crossings in the Area A above the upper solid graph line, level guards are recommended.
4.—Where raised guards are specified, the inside guarding face shall be 1" higher than the top surface of the frog.

Figure 6 – Graph Showing Limitations for the Use of Crossings with Rigid Center Frogs

Other Switch and Crossing Types

Lap Switch - A compound switch in which two split switches are in close proximity. It allows one track to fan out into three tracks within a shorter distance than two independent split switches would. A schematic layout of a lap switch is shown in Figure 7

A lap switch is used in order to accomplish a fan out of car flows into three tracks within a short switch distance. A lap switch, because of its complexity, is more difficult to insulate.

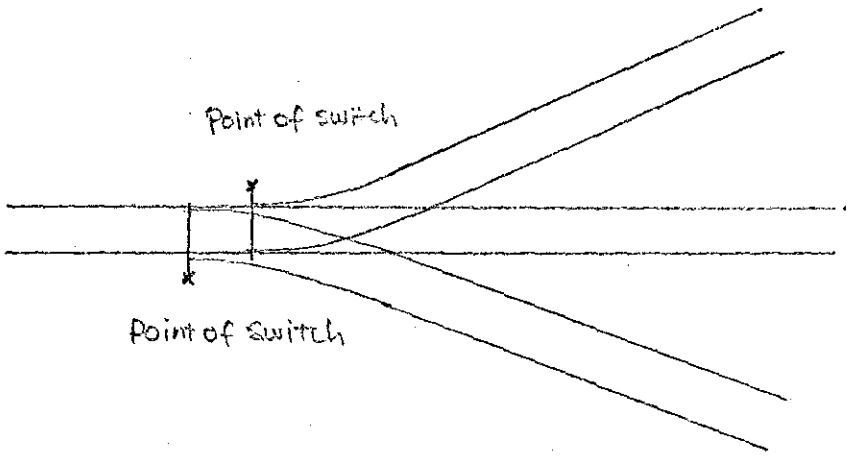


Figure 7 - Schematic Layout of a Lap Switch

Double Turnout (Three throw point) - A type of switch which has a similar geometric configuration to a lap switch. In a double switch the two switch points are so closely located that the two turning flows fan out to these tracks virtually at the same point. A schematic layout of a double switch is given in Figure 8.

A double turnout is used in order to accomplish a fan out of car flows into three tracks at one point. A double switch is more difficult to insulate because of its complexity.

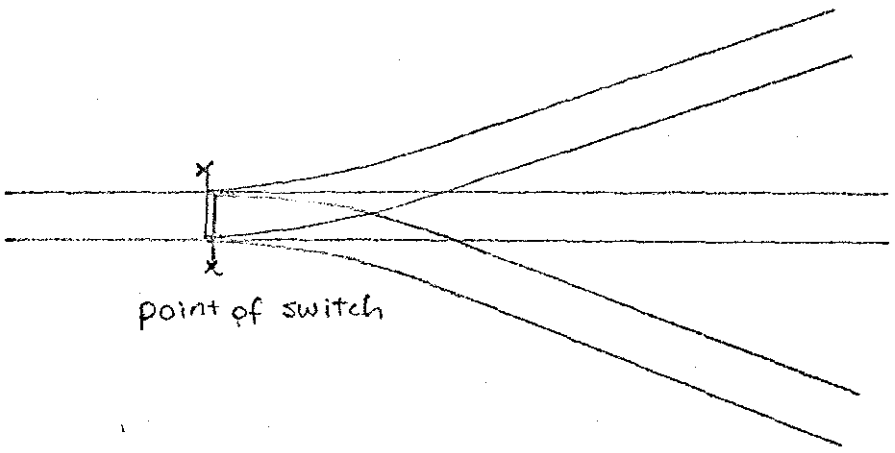


Figure 8 - Schematic Layout of Double Switch

Single Slip Switch - A combination of a crossing with one right-hand switch and curve between them within the limits of the crossing connecting the two intersecting tracks without the use of separate turnout frogs. A schematic representation of a single slip switch is given in Figure 9.

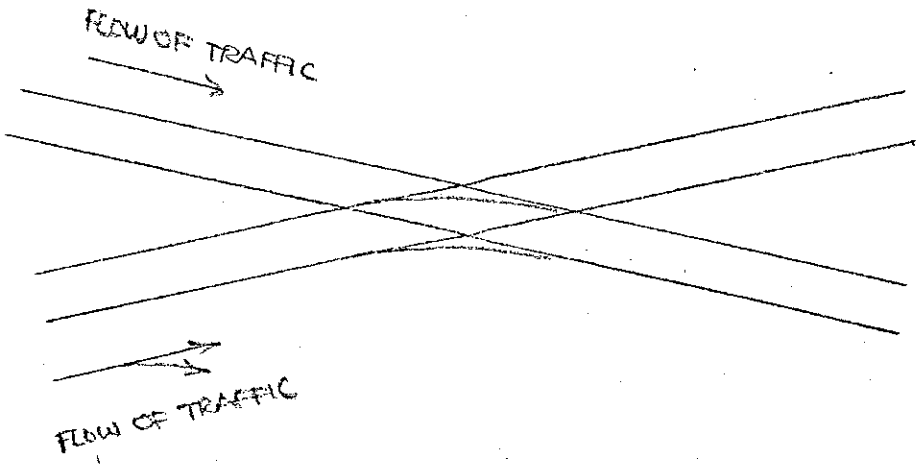


Figure 9 - Schematic Layout of a single Slip Switch

Double Slip Switch - A combination of a crossing with two right-hand and two left-hand switches and curves between them within the limits of the crossing connecting the two intersecting tracks on both sides of the crossing without the use of separate turn-out frogs. A schematic representation of a double slip switch layout is given in Figure 10.

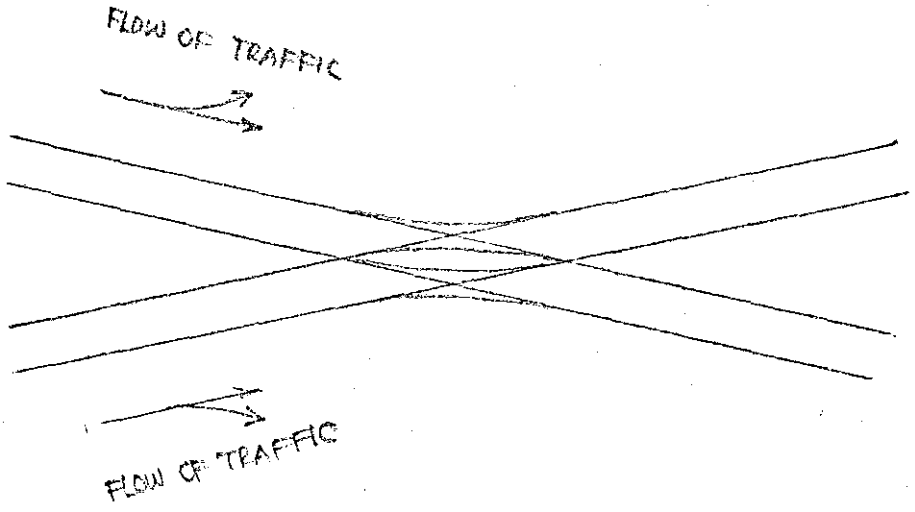


Figure 10 - Schematic Layout of a double Slip Switch

Crossover - Two turnouts with the track between the frogs arranged to form a continuous passage between nearby and generally parallel tracks.

Double Crossover - Two crossovers which intersect between the connected tracks.

Turnout - An arrangement of a switch and a frog with closure rails, by means of which rolling stock may be diverted from one track to another. Two types of turnouts exist. They are:

- Equilateral Turnout - A turnout in which the diversion due to the angle of turnout is divided equally between the two tracks.

- Lateral Turnout - A turnout in which the diversion due to the angle of turnout is entirely on one side of the track from which the turnout is made.

Turnouts are usually specified by turnout numbers, which correspond to the frog number of the frog used in the turnouts. The permissible speeds through turnouts with either straight or curved switch points are given in the AREA manual. The AREA table is presented in Table 1. The table shows that turnouts with curved switch points have higher speed limits than those with straight switch points, and that equilateral turnouts have higher speed limits than lateral turnouts, for the same turnout numbers.

Switch Throwing Mechanisms

Various methods are available to throw switches. Switch throwing mechanisms may be classified as follows:

- Switch stand manual method.
- Power switch machine
  - electric machine
  - hydraulic machine
- Spring switch

The power switch can be thrown by one of the following methods:

- Hand thrown (if necessary)
- Remote control from ground.
- Remote control from moving train

TABLE 1. SPEEDS OF TRAINS THROUGH LEVEL TURNOUTS

TURNOUTS WITH STRAIGHT SWITCH POINTS (AREA)

Turnout Number	*Length of Switch Points*	*Speed in Miles Per Hour*	
		Lateral Turnouts	*Equilateral Turnouts*
5	11'-0"	12	16
6	11'-0"	13	19
7	16'-6"	17	23
8	16'-6"	19	27
9	16'-6"	20	28
10	16'-6"	20	28
11	22'-0"	26	37
12	22'-0"	27	38
14	22'-0"	27	38
15	30'-0"	36	51
16	30'-0"	36	52
18	30'-0"	36	52
20	30'-0"	36	52

TURNOUTS WITH CURVED SWITCH POINTS (AREA)

Turnout Number	*Length of Switch Points*	*Speed in Miles Per Hour*	
		Lateral Turnouts	*Equilateral Turnouts*
5	13'-0"	12	17
6	13'-0"	15	21
7	13'-0"	18	25
8	13'-0"	20	28
9	19'-6"	22	30
10	19'-6"	25	35
11	19'-6"	28	39
12	19'-6"	29	40
14	26'-0"	34	49
15	26'-0"	38	53
16	26'-0"	40	57
18	39'-0"	44	63
20	39'-0"	50	70

For passenger trains completely equipped with cars in which the lean tests show a roll angle of less than 1° 30', trains may operate comfortably through turnouts at 12 percent higher speeds than those indicated in the foregoing.

By considering both switch throwing mechanism and the control method, various combinations are possible.

The analysis of switch throwing mechanisms will be performed in the course of the project and the results will be presented later.

Evaluation Criteria

Specification of switches and crossings involves a set of descriptive parameters such as:

- Type and design of switch/crossing.
- Switching mechanism and control method.
- Material of switch/crossings.

The number of combinations of these parameters can be large, and the selection of a proper switch and crossing requires a proper judgement of an experienced designer.

One way of avoiding misjudgement in switch/crossing selection is to establish a systematic method of evaluation. The evaluation criteria will include items such as:

- Design speed of switch and crossing.
- Switch throwing speed, directionality and other considerations.
- Wear and tear or life-span.
- Operation manpower requirement
- Maintenance manpower requirement
- All weather capability
- Installation Cost

It should be noted that these selection criteria do not necessarily have the same weight. One criterion can dominate the others in some cases and another criterion can dominate the others in other cases.