SIX LEVER MECHANICAL INTERLOCKING MACHINE EXAMPLE

The following diagrams on PDF pages 2 through 18 sequentially illustrate the operation of a theoretical interlocking plant located at a railway junction of a single track main line and single track branch line. A six lever mechanical interlocking machine is employed to operate the switch of the turnout, the facing point lock applied to the switch and the semaphore signals that govern the movement of trains that may approach the turnout from the three directions.

For the signal governing trains approaching the junction from the diverging route two schemes are illustrated the use of either of which is at the discretion of the engineering department of the railway. A third scheme where a one arm dwarf signal is employed instead of a one arm signal on a normal height mast is not illustrated.

The diagram pages are best viewed with the PDF reader set for "one page at a time" mode thereby producing a slide show of the diagram changes as the pages are progressively viewed.

Standard code time table and train order rules and an associated time table and special instructions are considered in effect, and, if implemented correctly, prevents opposing trains from approaching the junction at the same time. Automatic block signals and track circuits are not installed on any of the routes approaching the junction.

The night aspects of the semaphore signals are not illustrated nor are the colors that the semaphore blades may be painted.

The interlocking machine depicted may be described as being of the **direct locking** type as the interlocking action is accomplished by the intended interference that takes place between the tappet bars driven directly by the levers and the cross locking bars that are in turn driven by the motion of the tappet bars. Early interlocking machine designs as well as smaller models produced latter and referred to as **dwarf interlocking machines** generally employed the direct locking scheme. Latter model and larger interlocking machines generally employed a more advanced scheme referred to as **preliminary latch locking** and is described briefly after the series of diagrams.

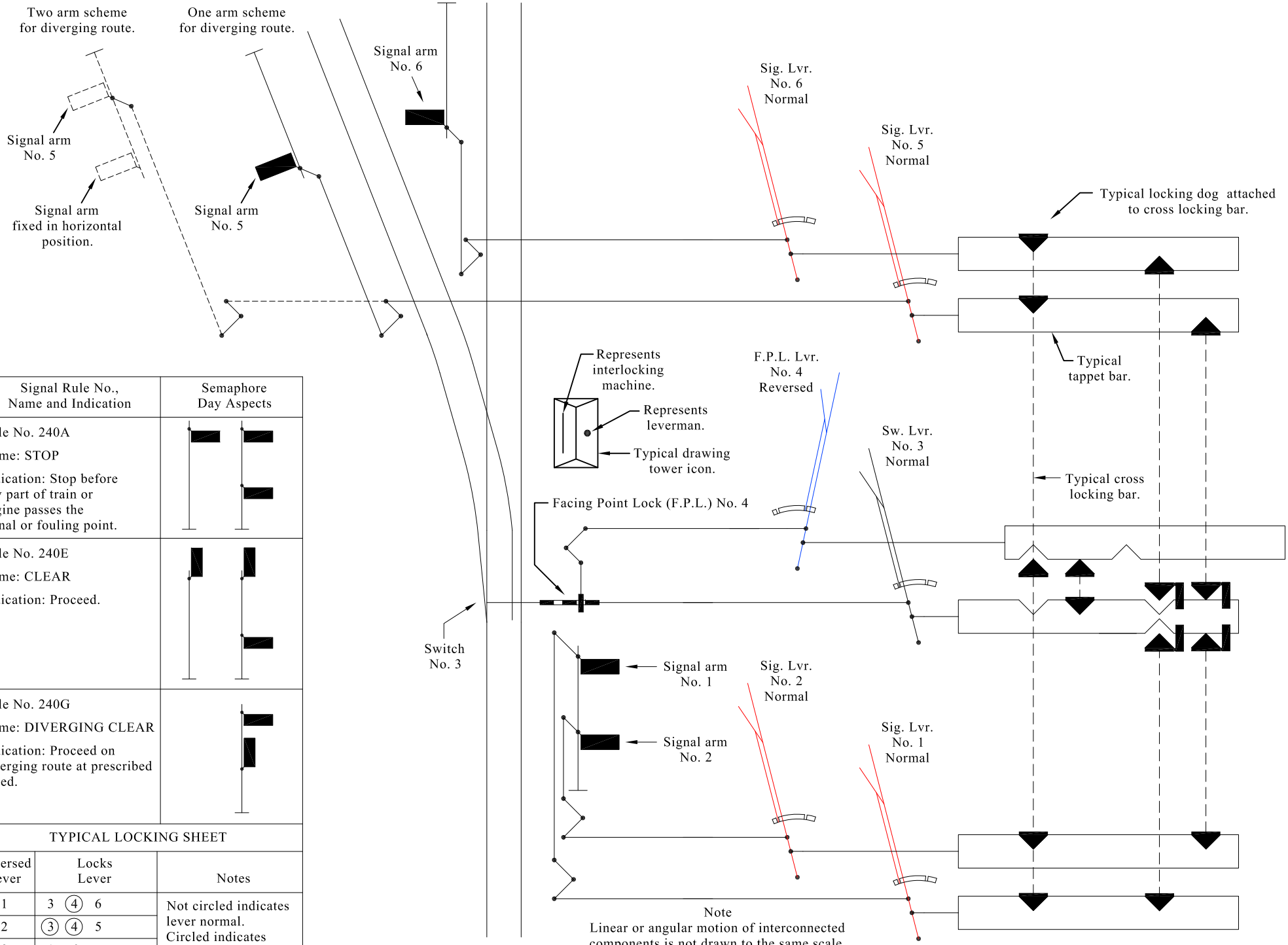
The depiction of the interlocking plant and machine are considered theoretical in that the linear or angular motion of the interconnected components is not drawn to the same scale in order to magnify the motion between the tappet bars and cross locking bars relative to the motion of other components. The depiction of the shape of the foregoing has also been simplified in appearance to those used in actual service. Additional cranks, pipe lines, temperature compensators, etc., etc., that would be required for the actual installation of an interlocking machine and its elevation in a tower are not illustrated.

The means for providing what is referred to as **detector locking** and **time locking** is not included on the diagrams in order to simplify the presentation. The foregoing also described briefly after the series of diagrams.

Additional description continues on PDF page 19.

References.

1. The Railway Signal Dictionary, Second edition, 1911.
2. Maintenance of Way Cyclopedia, edition of 1921.
3. Railroad Operation and Railway Signaling by Edmund J. Phillips Jr., edition of 1942.



Signal Rule No., Name and Indication	Semaphore Day Aspects
Rule No. 240A Name: STOP Indication: Stop before any part of train or engine passes the signal or fouling point.	
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TYPICAL LOCKING SHEET

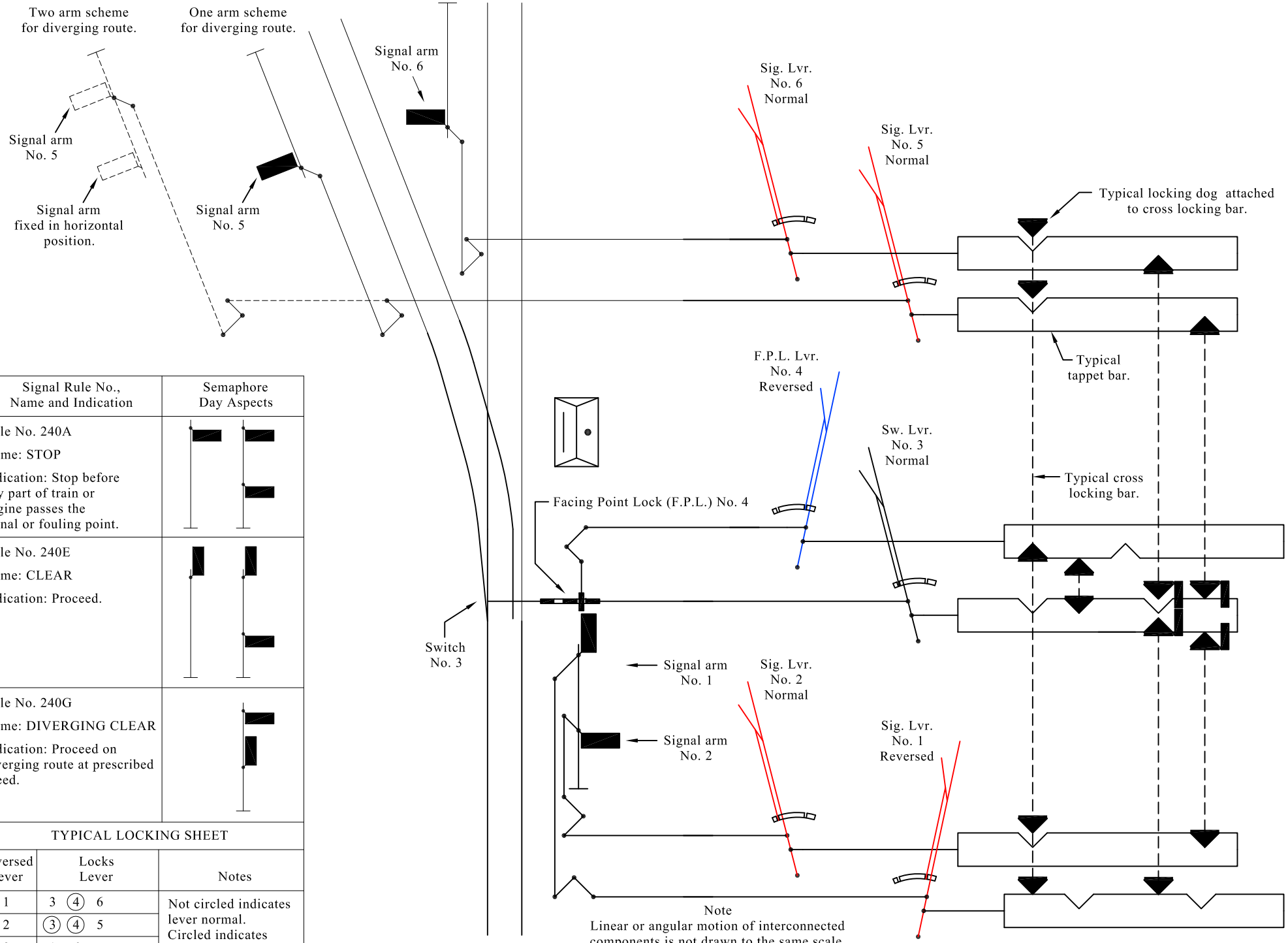
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3	1 6	
4	3 (3)	
5	2 (3) (4)	
6	1 3 (4)	

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Slide 1



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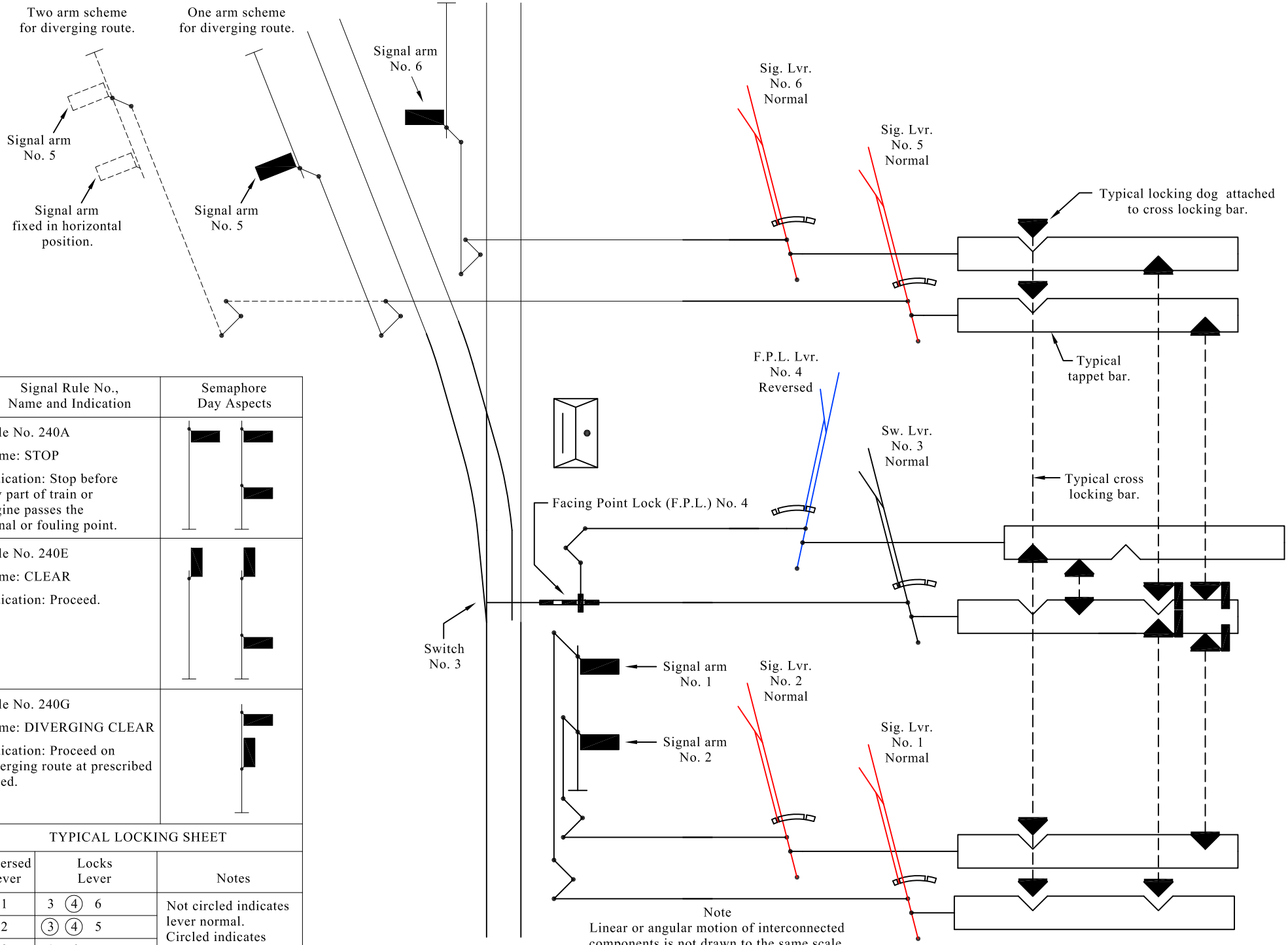
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Slide 2



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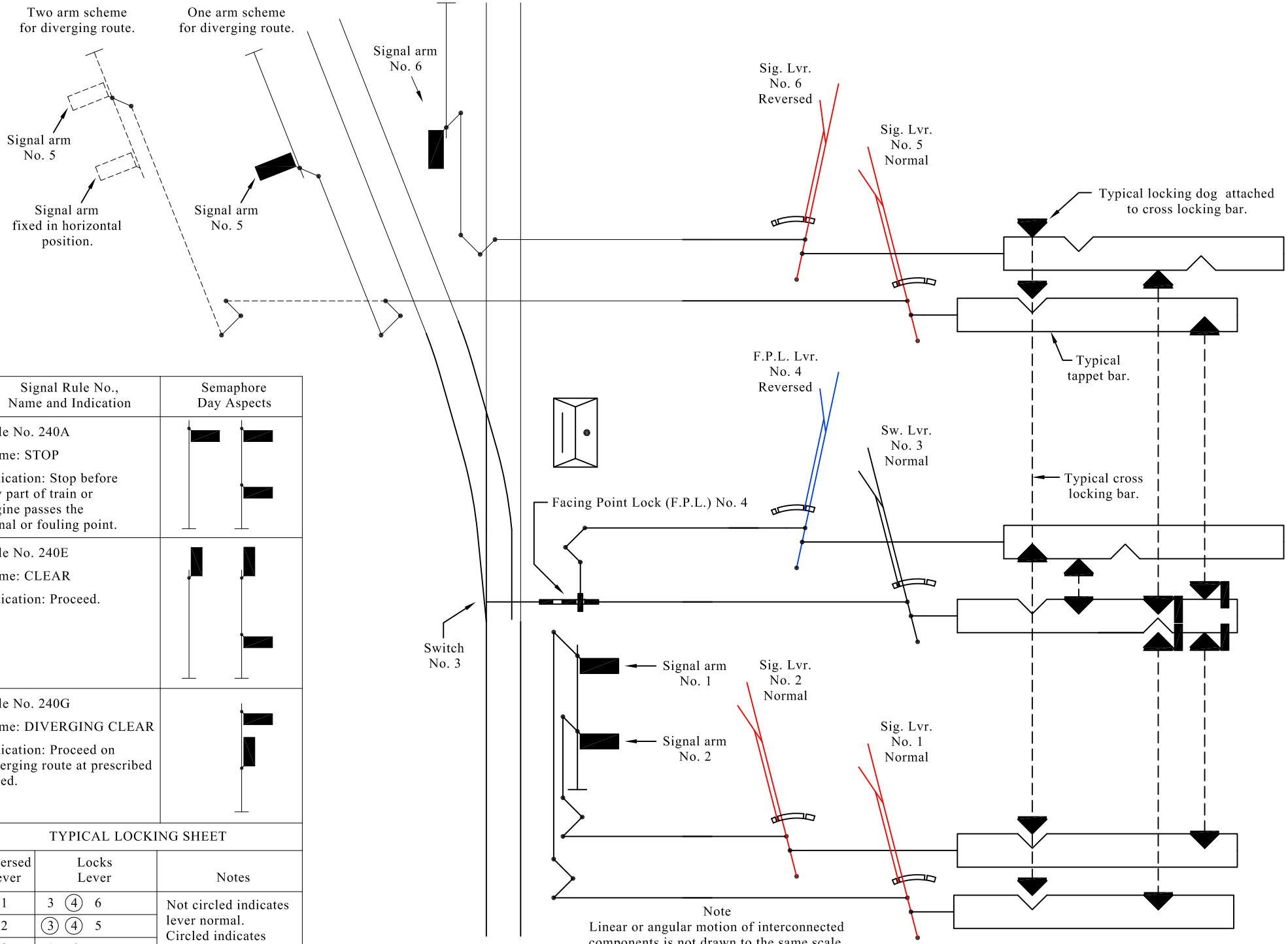
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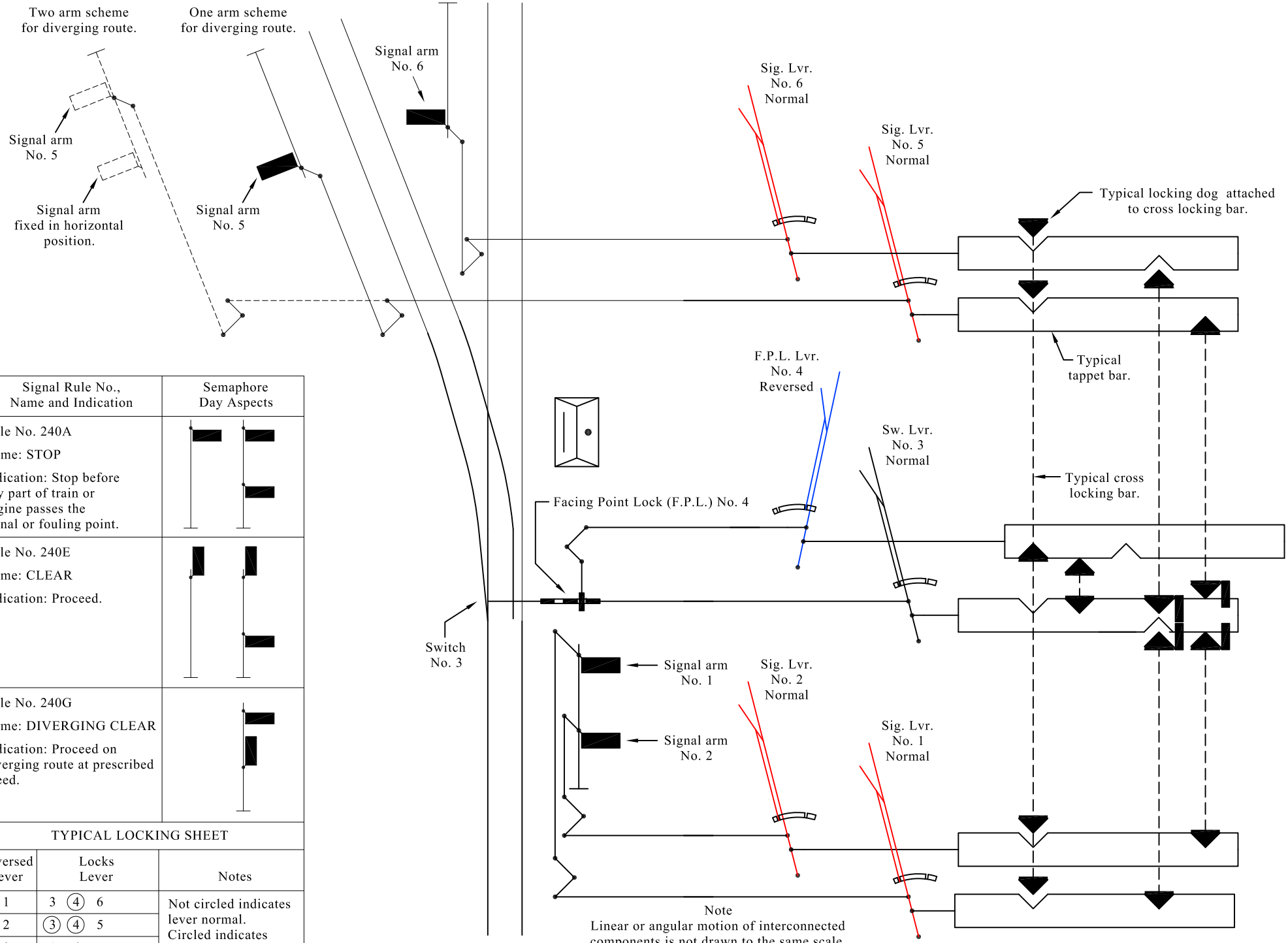
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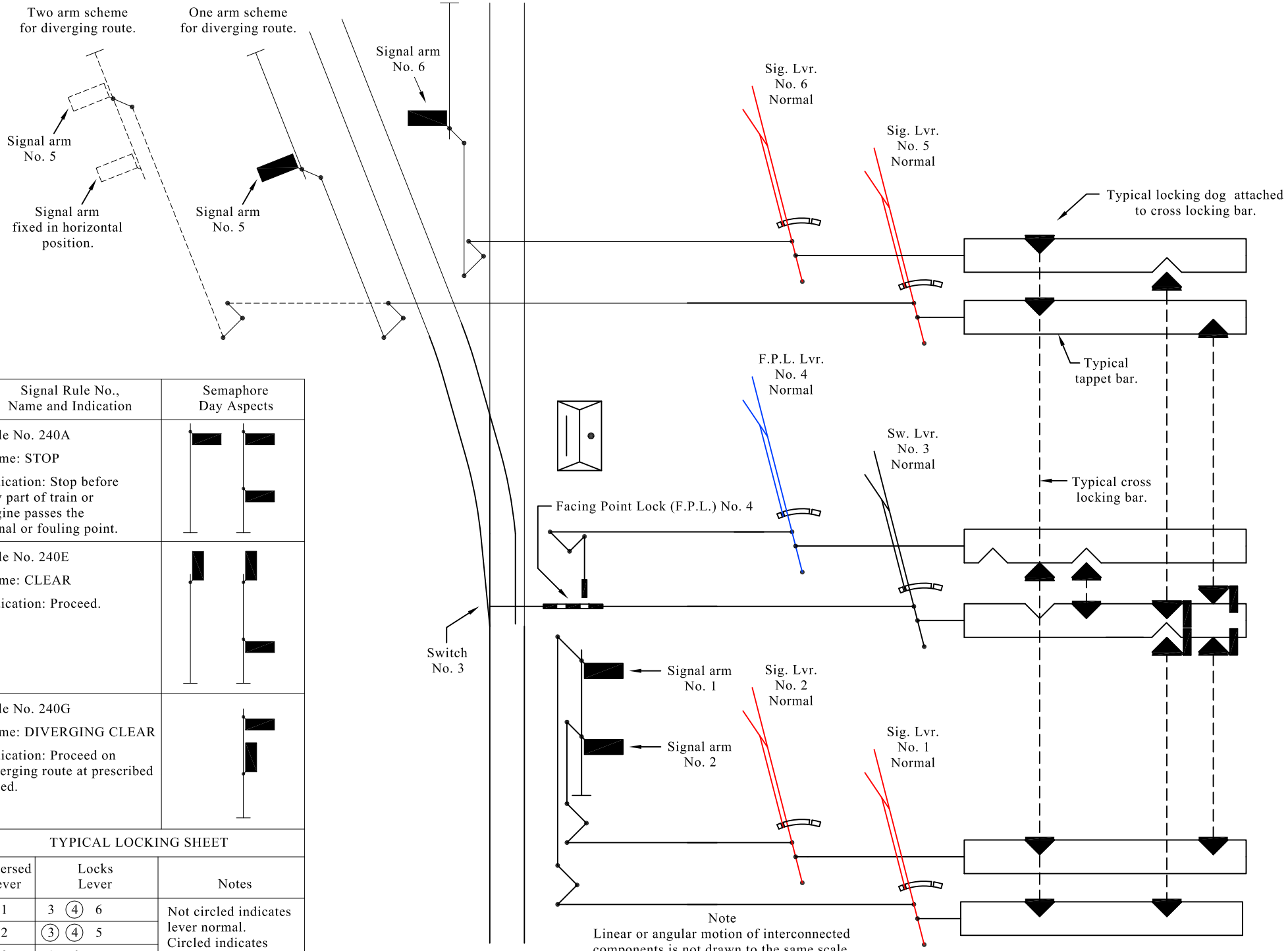
Note
Linear or angular motion of interconnected components is not drawn to the same scale.

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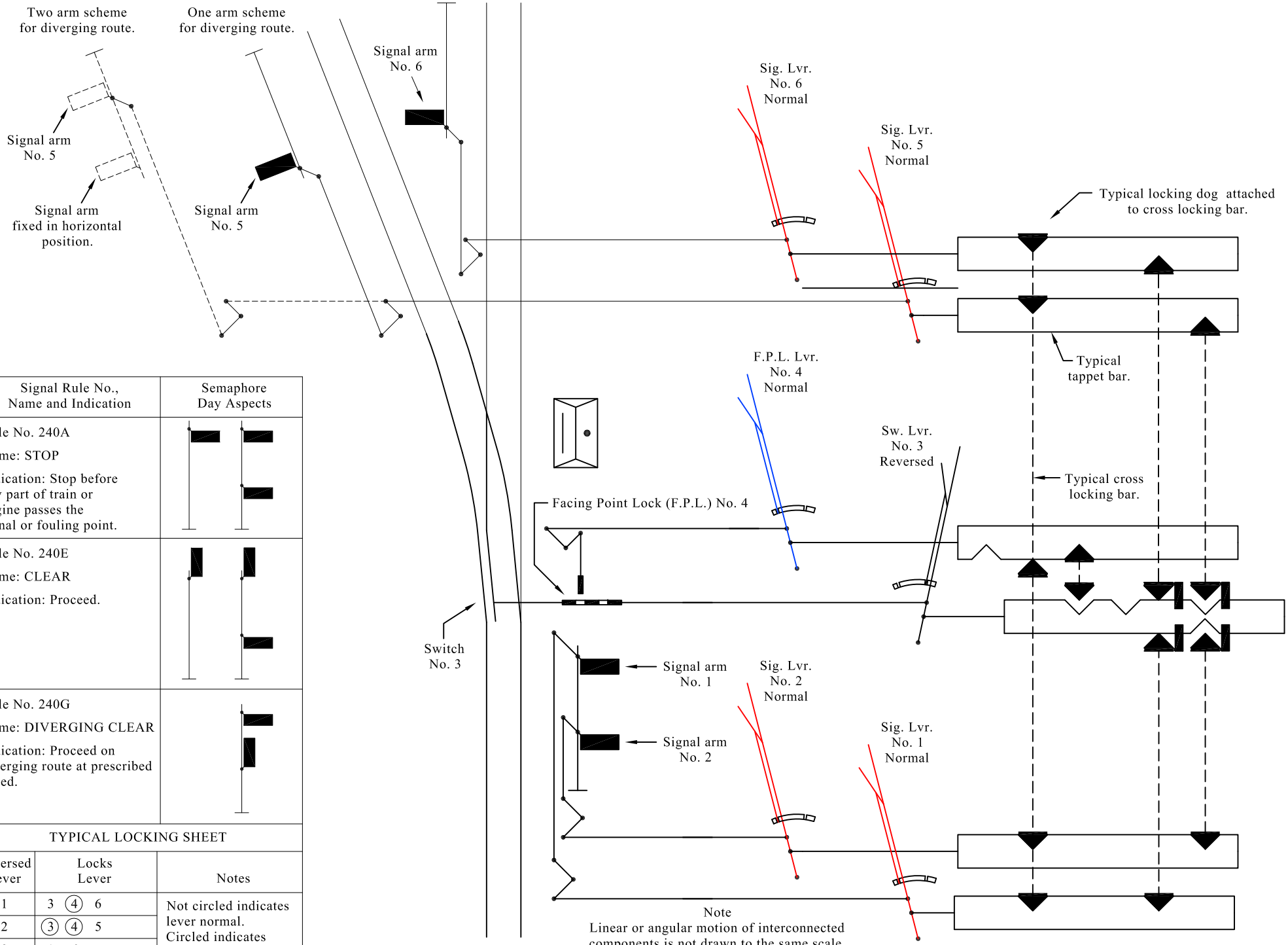
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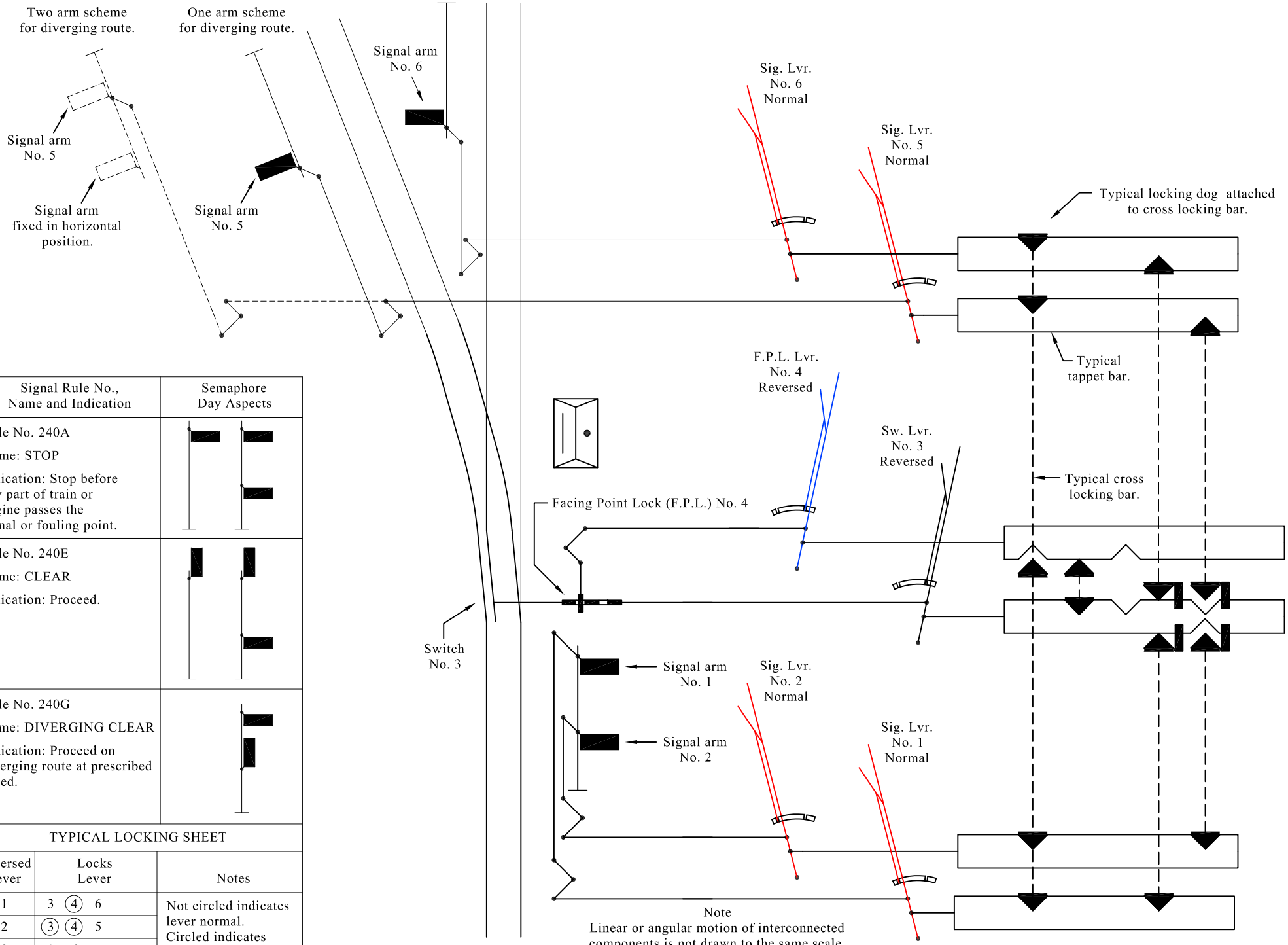
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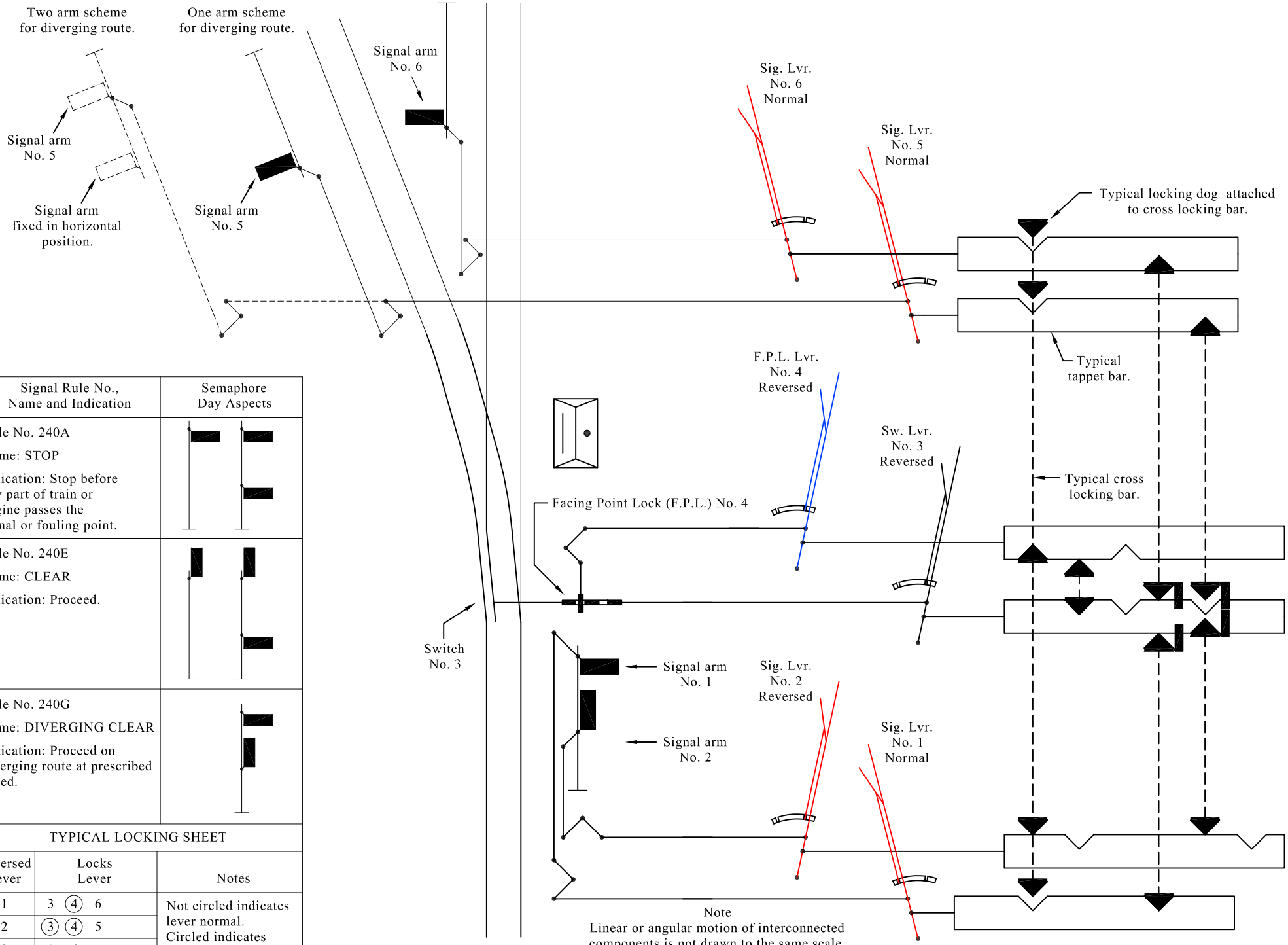
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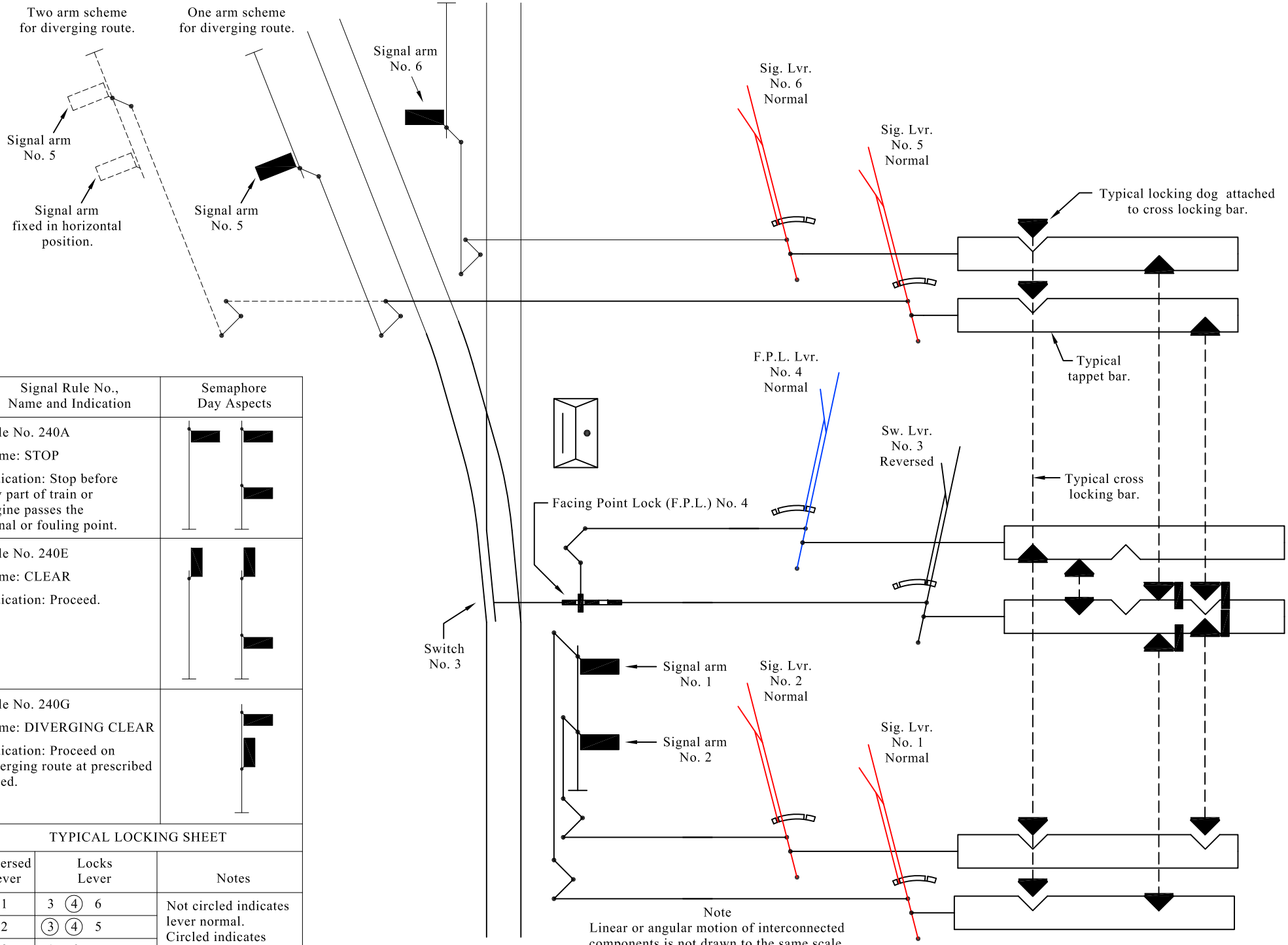
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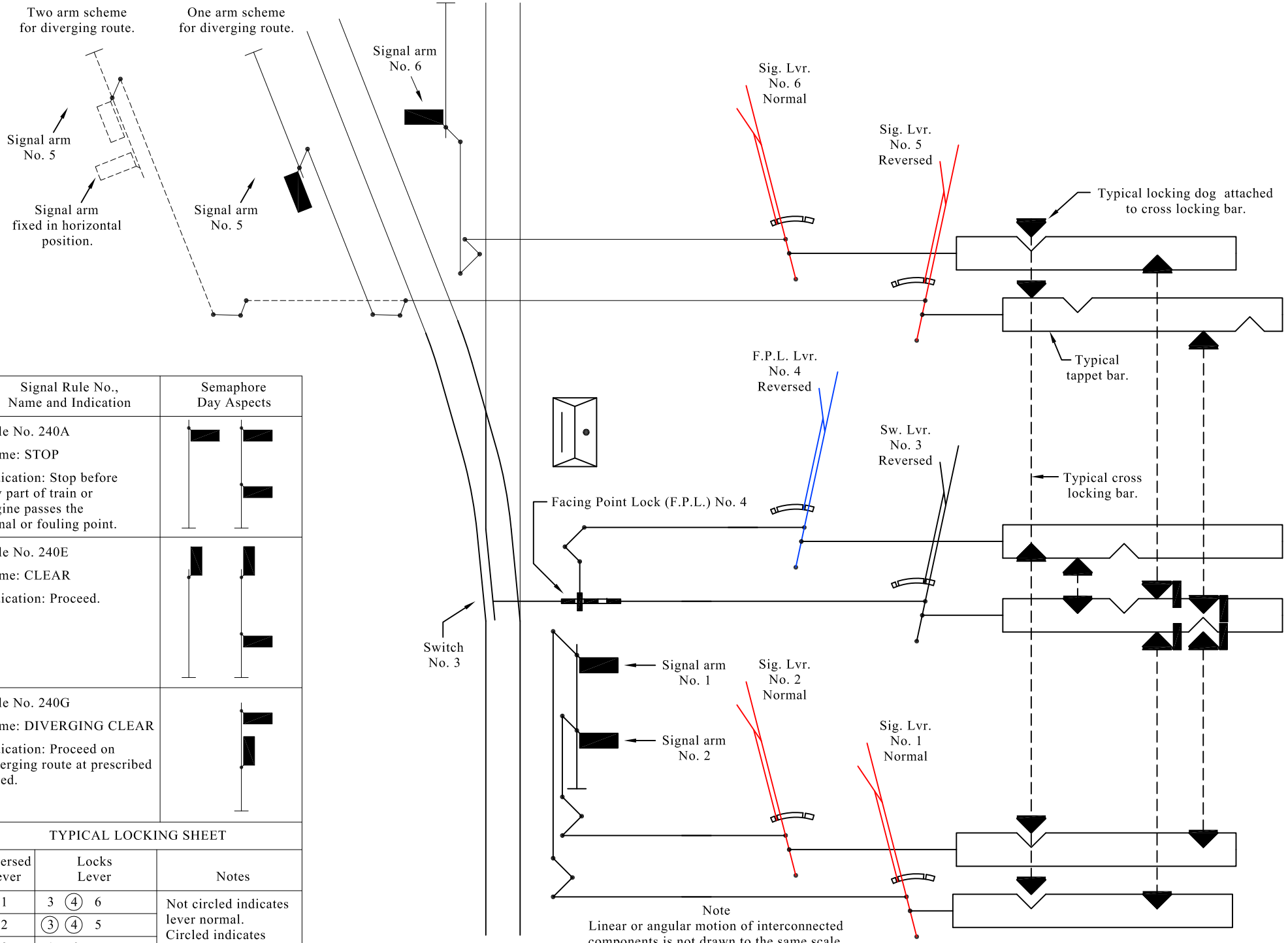
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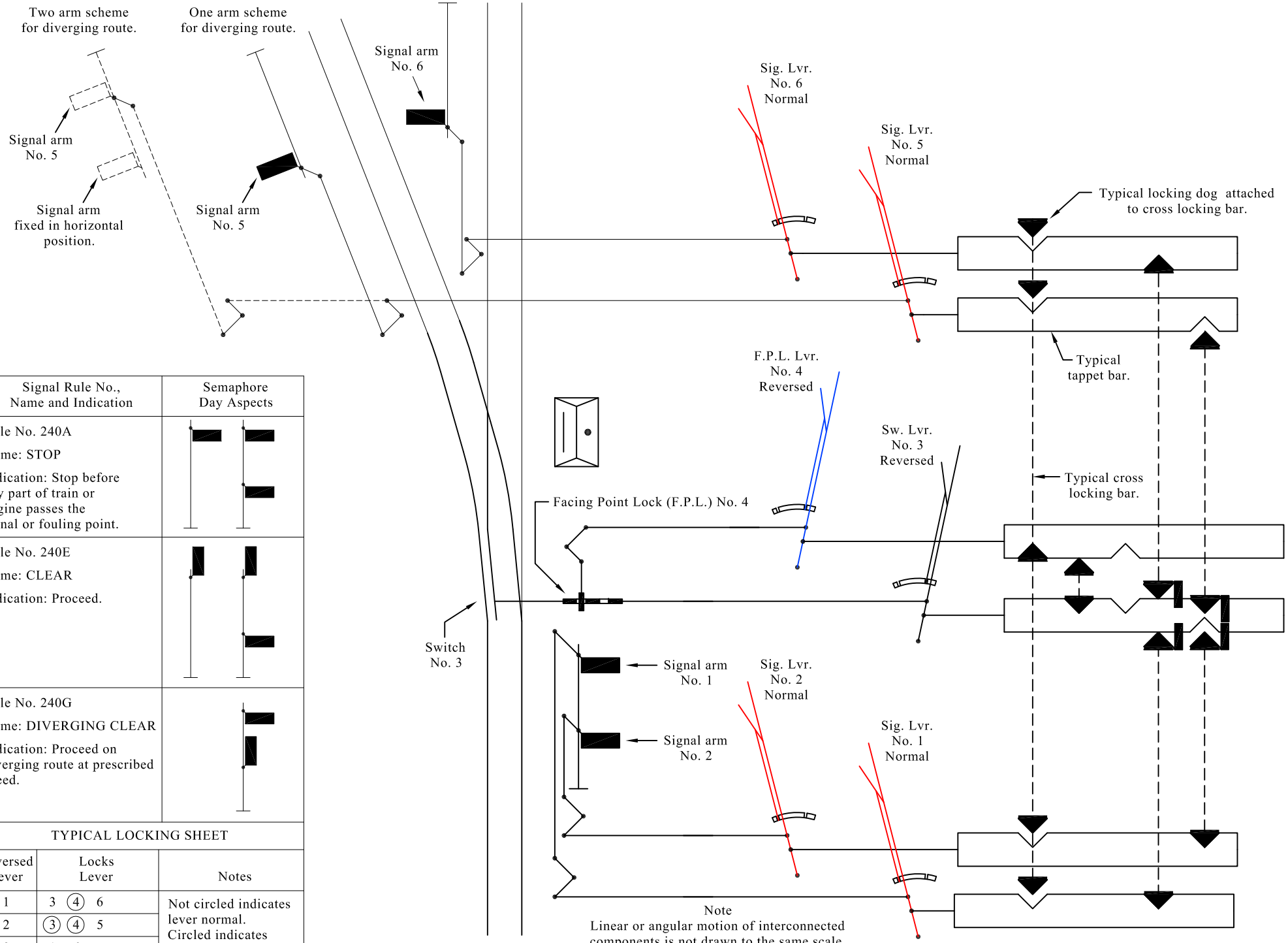
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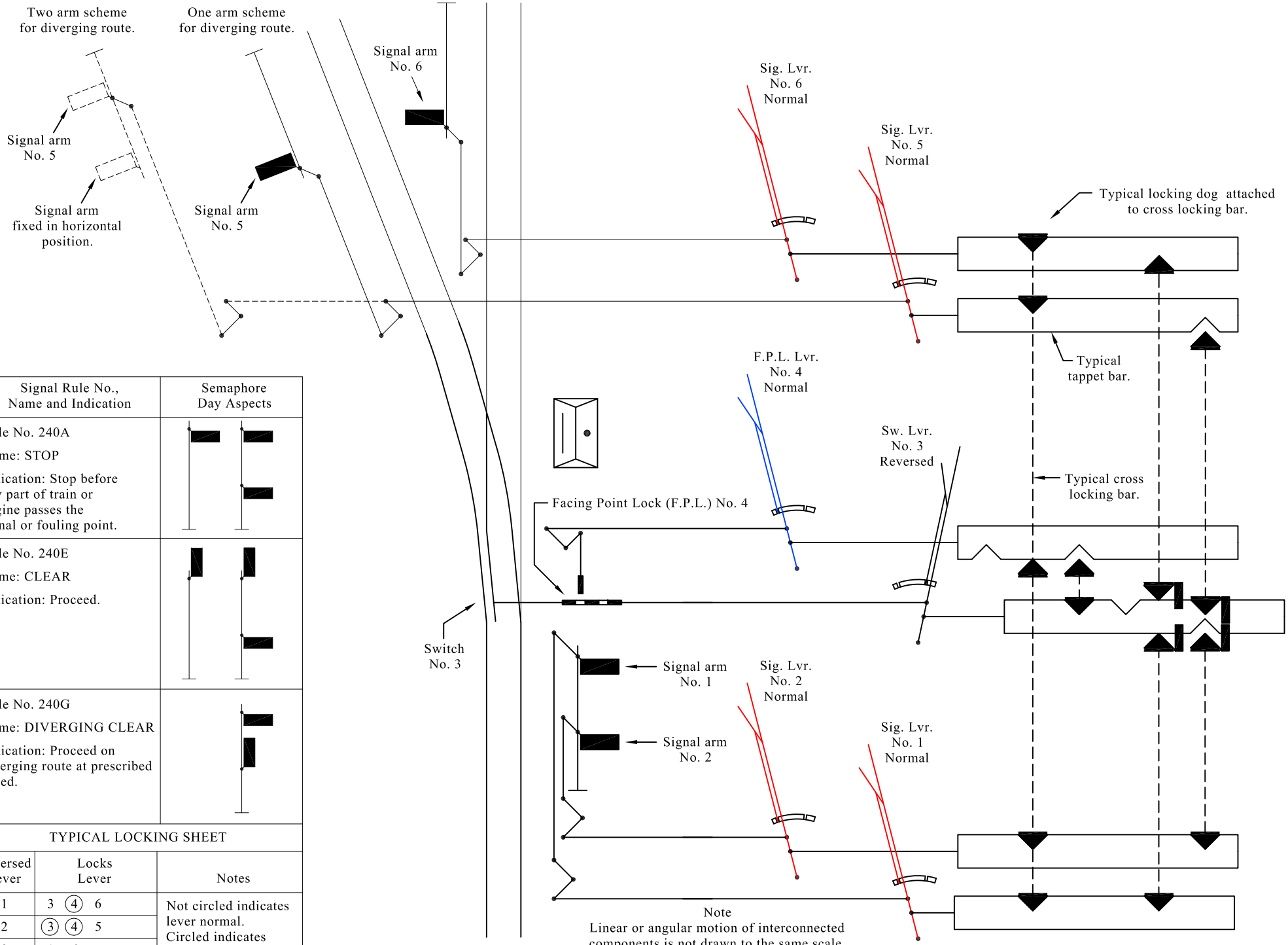
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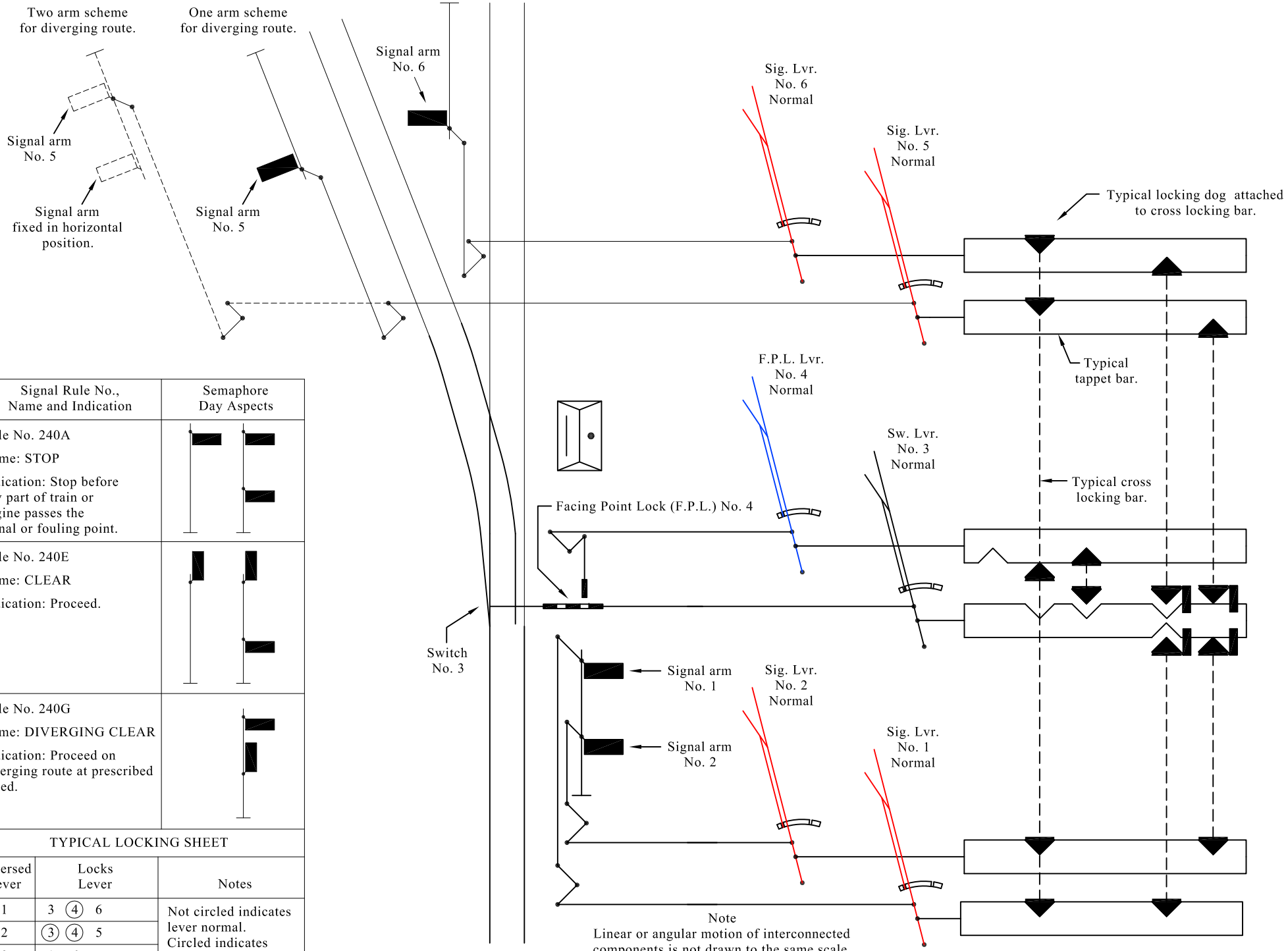
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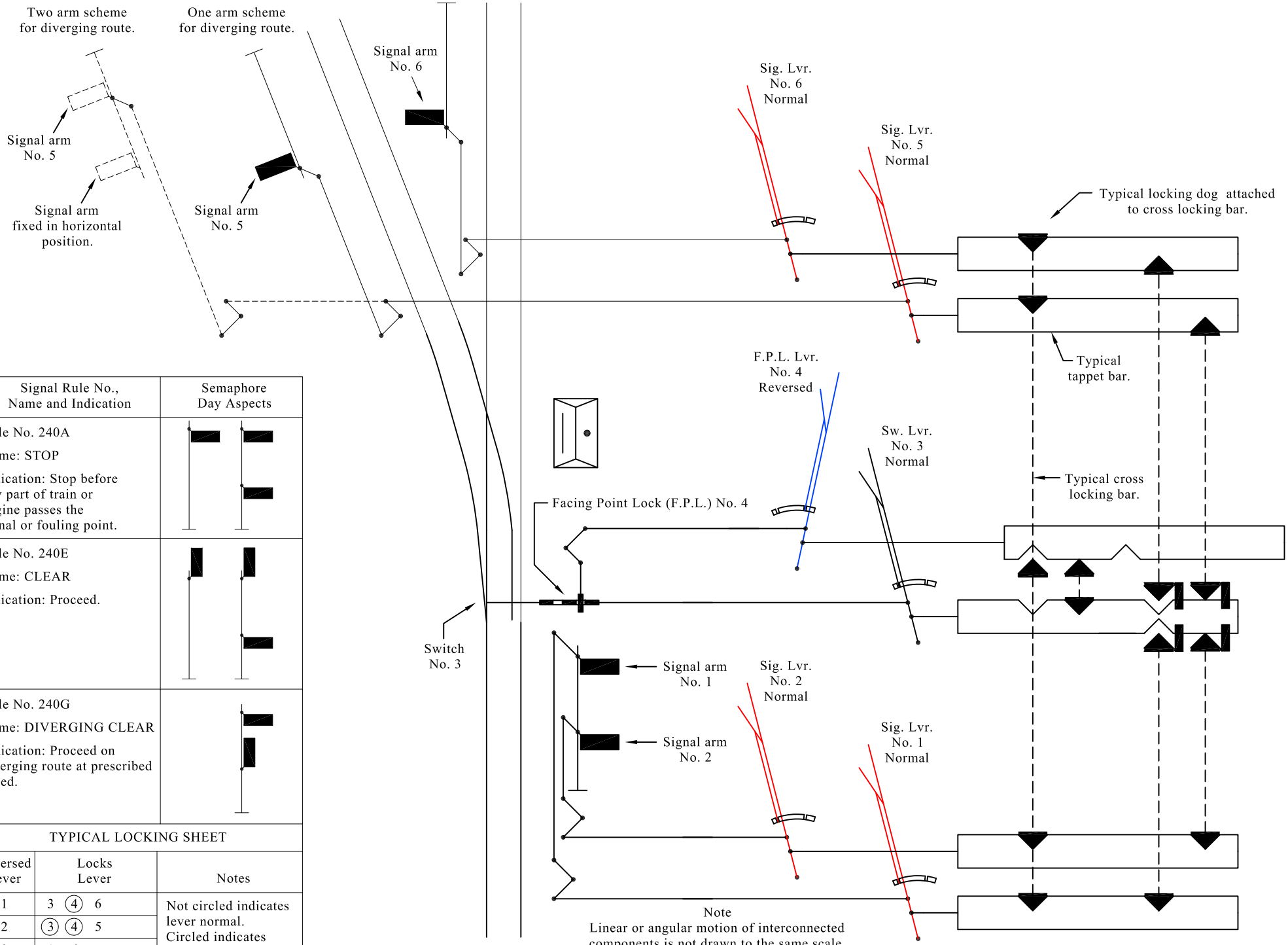
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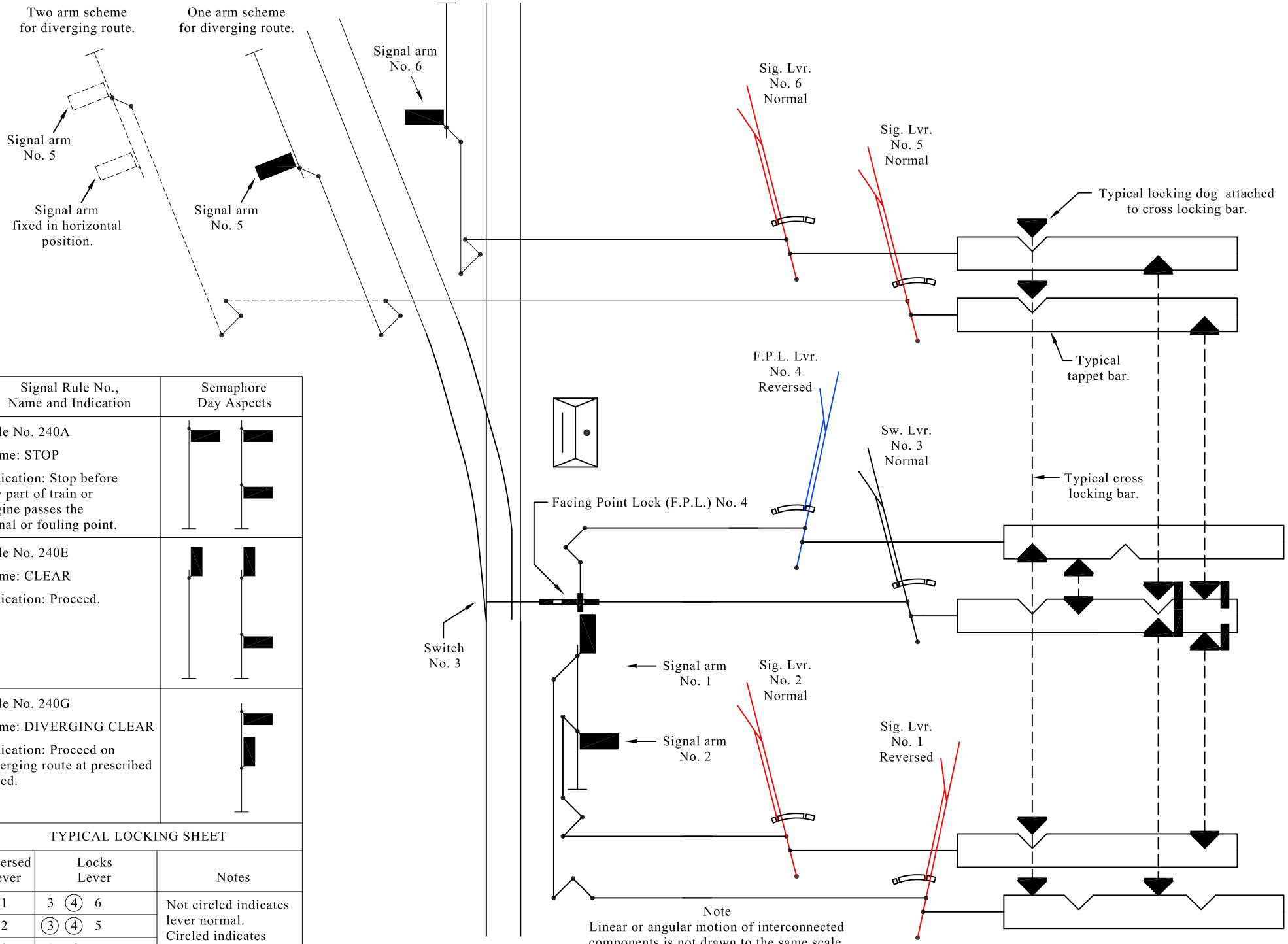
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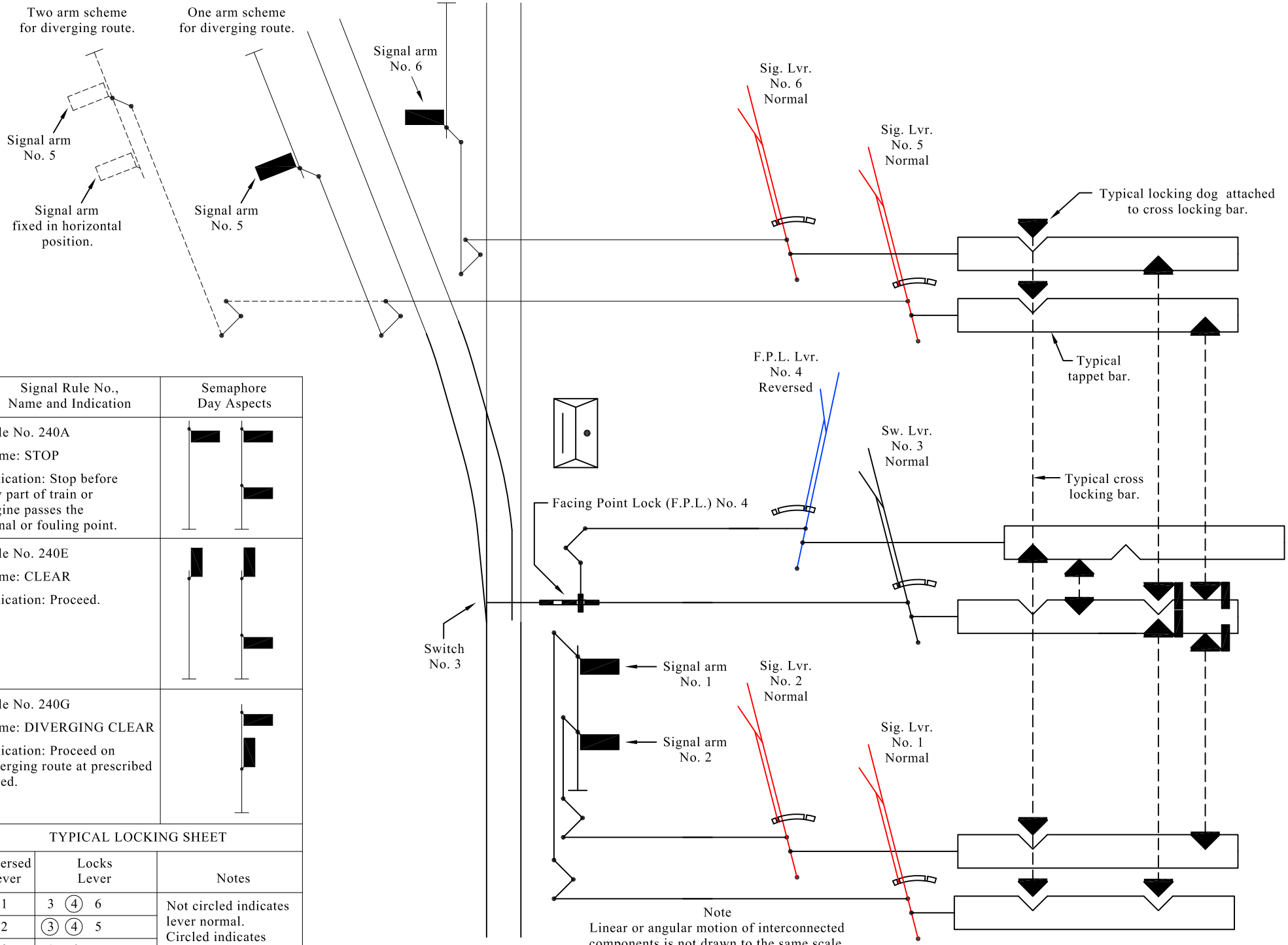
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SIX LEVER MECHANICAL INTERLOCKING MACHINE EXAMPLE

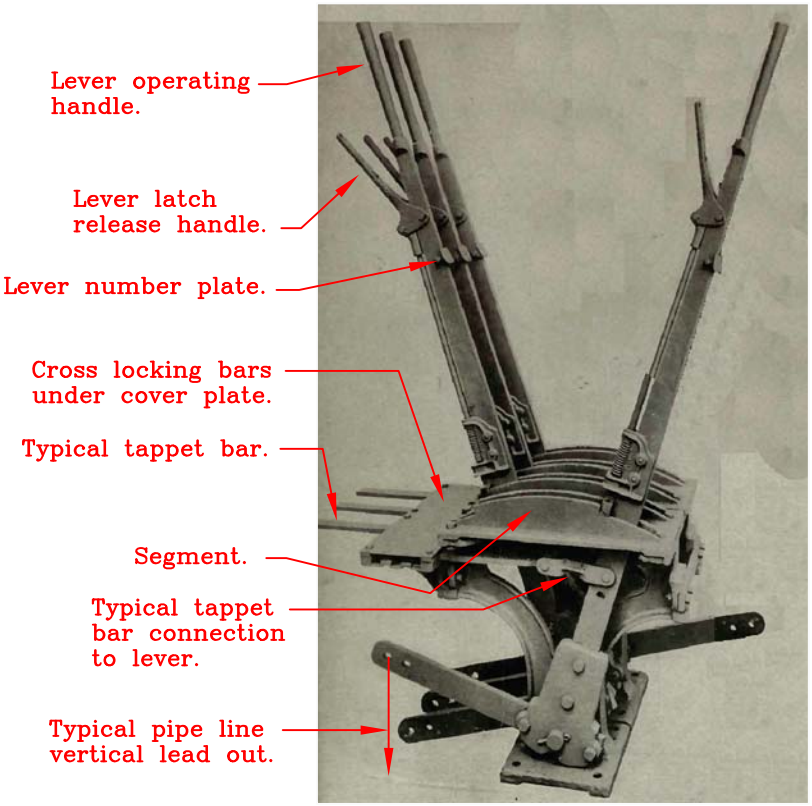
A shortcoming of a direct locking type interlocking machine, as is depicted in the diagrams, manifests its self when the leverman inadvertently operates the lever latch release handle of a lever that is locked by the interlocking action of the machine. Under these circumstances when the lever latch is released from the quadrant, also known as the segment, the full force transmitted from the field device that may be tending to change the lever to the opposite position must be restrained by the interference between the tappet bar and cross locking bar of the machine. In order to minimize the strength requirements and therefore the size of the tappet bars, cross locking bars and other related components, a scheme generally referred to as **preliminary latch locking** was devised where the movement of the lever latch release handle and in turn a rocker mechanism is made to operate the tappet bar instead of the movement of the lever in the quadrant. The locking or prevention of the movement of a lever is accomplished instead by locking or preventing the movement of the lever latch release handle. With preliminary latch locking the tappet bar may be understood as capable of assuming three possible positions, namely lever latched normal, lever unlatched or lever latched reversed. The position lever unlatched is transitional in nature and must always be followed by the position lever latched normal or lever latched reversed. Otherwise the lever is unlatched and it and its associated pipe line to the field device are free to move without restraint.

Note in the image of the Stevens Interlocking Machine the tappet bars and cross locking bars of this direct locking type of machine are located to the left side of the image. The depiction of the theoretical interlocking machine in the diagrams is opposite to this and was done so to provide for a clear distinction between the lever connections to the pipe line lead outs to the field devices and the lever connections to the tappet bars. In both cases the leverman would stand to the right side of the image or the diagrams when manipulating the interlocking machine levers.

Although the tappet bars and cross locking bars ensure that the interlocking machine levers may only be manipulated in the allowed sequences, unless an additional scheme is employed the manipulation of the levers in these sequences may be caused to occur by the leverman regardless of whether rolling stock is closely approaching or directly over a field device such as a track switch or its associated facing point lock.

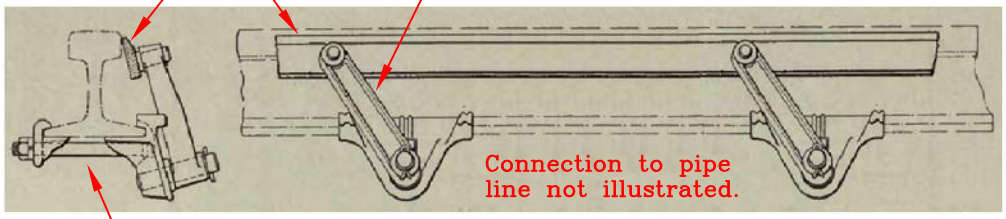
Early schemes to provide protection or locking against the foregoing were generally accomplished mechanically by applying a horizontal bar along the side of the head of the running rail located before or after the points of a switch. The horizontal bar being mounted on multiple levers along the length of the bar such that the angular swing of the levers would cause the horizontal bar to rise above the running surface of the rail. The length of the horizontal bar being some amount greater than the maximum distance between the inside axles of the two trucks of a car. A wheel located on the running rail above such a horizontal bar would prevent it from rising completely and thus the angular swing and motion of the bar would be limited. By suitably connecting the horizontal bar to the same pipe line system leading out from the interlocking machine lever that operated the facing point lock of a switch, the facing point lock would be prevented from being disengaged if a wheel was located above the horizontal bar. The range of motion of the horizontal bar in effect detecting whether a wheel was or was not above it, hence one of the names given such a horizontal bar was that of **detector bar** and the scheme of locking referred to as **detector locking**.

The Stevens Interlocking Machine circa 1910
Direct Locking Type



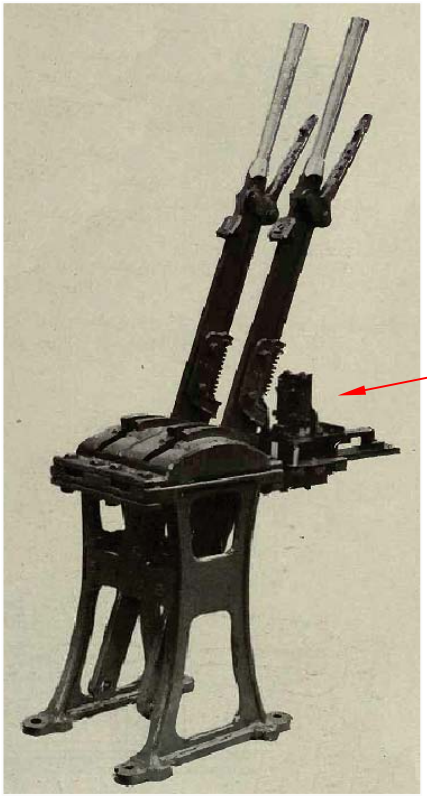
SIX LEVER MECHANICAL INTERLOCKING MACHINE EXAMPLE

With the advent of electrical track circuits and associated equipment used for signaling purposes, detector bar mechanisms could be replaced by electro mechanical locking devices applied directly to the interlocking machine. The name detector locking might still be used even though its result was accomplished electro mechanically. The use of track circuits made possible much longer sections of track for which the occupancy status could be determined than would be practical with mechanical detector bars. Thus the term **section locking** began to be used instead of detector locking.

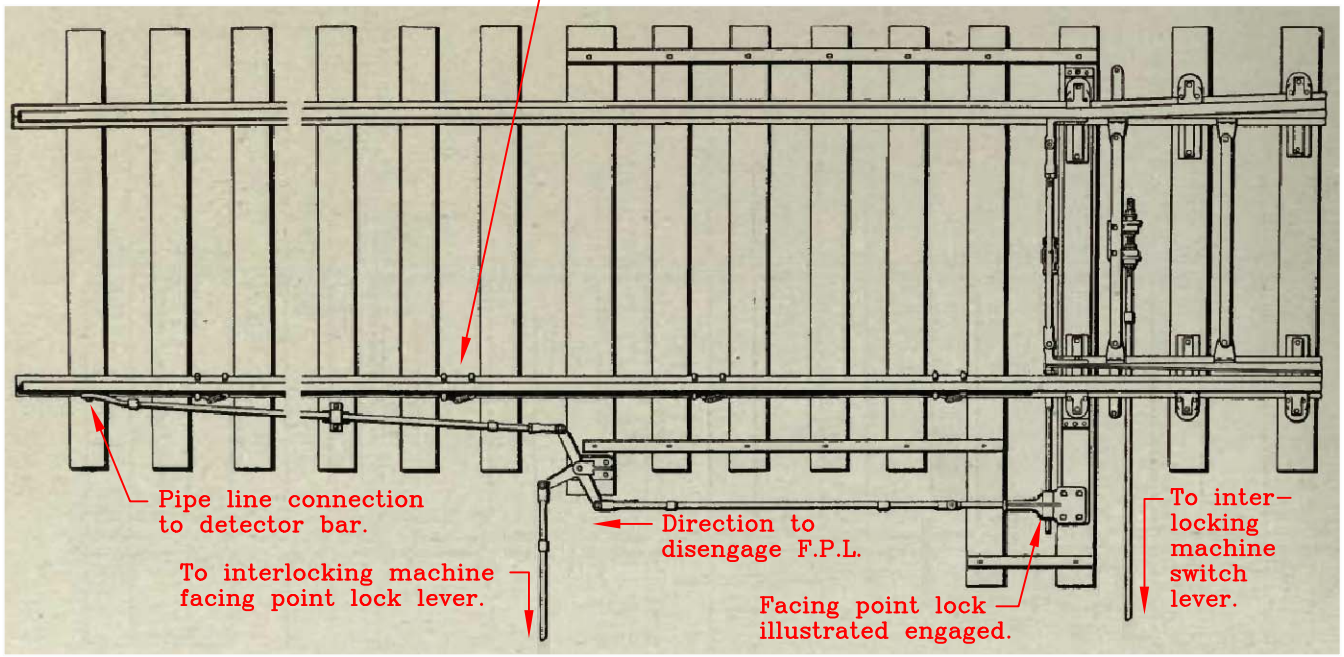


Typical mounting of lever mechanism to running rail.

General Railway Signal Co.
Two Lever Direct Locking
Dwarf Interlocking Machine
circa 1910



Electric lock applied to tappet bars or cross locking bars.



Typical arrangement of field side detector bars placed before the switches of a crossover.

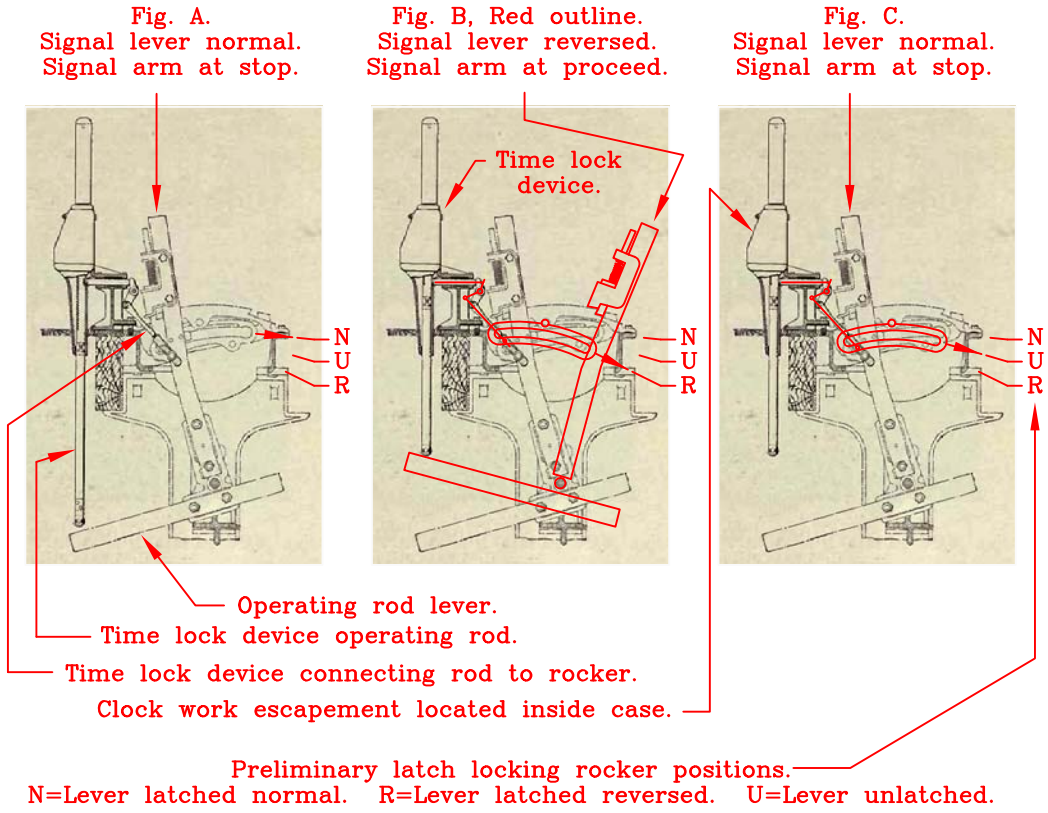


SIX LEVER MECHANICAL INTERLOCKING MACHINE EXAMPLE

Another circumstance that must be considered is the possibility of the leverman manipulating the levers in a sequence allowed by the interlocking machine that results in the movement of a signal lever to display a proceed signal to an approaching train. Then if the signal lever is restored to display a stop signal to the train, a different sequence of lever manipulations may be allowed by the interlocking machine, and if the leverman caused this to occur, might result in the endangerment by derailment or collision or both of the train previously authorized by the interlocking signal to proceed.

One means to avoid the possibility of the foregoing would be for the interlocking machine to be designed such that the manipulation of a signal lever that resulted in the change of a proceed signal to a stop signal was allowed at any moment, although the normally associated change in the relationship between the tappet bar and the cross locking bar(s) of the signal lever were prevented until after a period of time had elapsed sufficient for an approaching train to either stop before the signal or to pass the stop signal and safely traverse the interlocking plant.

Figures A, B and C illustrate the operation of a Union Switch and Signal Co. circa 1910 mechanical time lock device applied to the signal lever of a preliminary latch locking type interlocking machine. For this type of interlocking machine the tappet bar is driven by the motion of the rocker that is in turn driven by the combination of the position of the lever and the lever latch in the quadrant of the interlocking machine.



In Figure A the signal lever, rocker and tappet bar are in the lever latched normal position and the signal is at stop. The time lock devise is released and its connecting rod is disengaged from and has no affect on the position of the rocker or the tappet bar.

In Figure B the signal lever, rocker and tappet bar are in the lever latched reversed position and the signal is at proceed. The operating rod of the time lock device has been raised from its lowest position by the operating rod lever resulting in the time locking device connecting rod engaging with the rocker such that the rocker and tappet bar will be prevented from assuming the position of lever latched normal.

In Figure C the signal lever has been restored to its normal position and the signal is at stop. The time lock device connecting rod being engaged with the rocker has prevented the rocker and tappet bar from assuming the lever latched normal position. The action of the interlocking machine therefore remains the same as if the signal was at proceed. Given the lowered position of the operating rod lever, the operating rod is free to fall by its weight and the rate at which it falls is regulated by the clock work escapement mechanism of the time lock device. When the operating rod nears its lowest point the time lock device connecting rod will disengage from and no longer affect the position of the rocker or the tappet bar allowing the rocker and tappet bar to assume the lever latched normal position as in Figure A. The foregoing scheme accomplishing what is generally referred to as **time locking**.

SIX LEVER MECHANICAL INTERLOCKING MACHINE EXAMPLE

As can be visualized in the cut-away view to the right, operation of the ratchet wheel clutch will allow the operating rod to be moved rapidly upward, as in previous Figure B, without being affected by the clock work gear train and escapement mechanism. When the means used to raise the operating rod is withdrawn, as in previous Figure C, operation of the ratchet wheel clutch will allow the torque from the rack pinion gear, resulting from the downward force of the operating rod rack being free to fall by its weight, to be transmitted to the large gear of the clock work gear train. The rate at which the operating rod lowers controlled by the rate of rotation of the large gear, that in turn is regulated by the frequency of the swing of the pendulum and the effective gear ratio between the escape wheel and the large gear. It is assumed the escapement mechanism is designed such that the swing of the pendulum is self starting when torque is applied to the clock work gear train by the falling weight of the operating rod. Whenever the operating rod is at the bottom of its stroke the time lock device is considered **released**. Whenever the operating rod is not at the bottom of its stoke the time lock device is considered **locked** or not released, hence this type of time lock device may also be known as a **time release**.

Electro mechanical locking devices, similar to those used to replace detector bar locking schemes, that could be applied directly to the interlocking machine and integrated with an electro mechanical timer could be used instead of strictly mechanical time lock devices. If a track circuit was provided on the track approaching an interlocking signal, the associated track relay circuits could be integrated with the electro mechanical timer and locking device such that if the track circuit was not occupied the time locking function would be forestalled resulting in the immediate release of the cross locking bar(s) of a signal lever when it was restored to display a stop signal. The track circuit being of sufficient length given the expected service braking distance of a train approaching the interlocking signal. The foregoing scheme generally referred to as **approach locking**.

Whether time locking is accomplished by mechanical only or a combination of electro mechanical means, the interval of time in which the action of the interlocking machine is to remain locked after a signal lever has been restored to display a stop signal must be established and is related to the braking time or stopping time of a train that is expected to approach the signal. The stopping time being influenced primarily by the speed at which the train is traveling at the moment when a full service brake application is initiated and the rate of deceleration provided by a full service brake application. Conditions also of influence include whether the track is level or on a gradient, wet or frosty rail surface conditions, etc., etc. The time release or delay interval may be selected to be some amount greater than the assumed stopping time in order to provide for a margin of safety.

Union Switch and Signal Co. Mechanical Time Lock Device circa 1910.

