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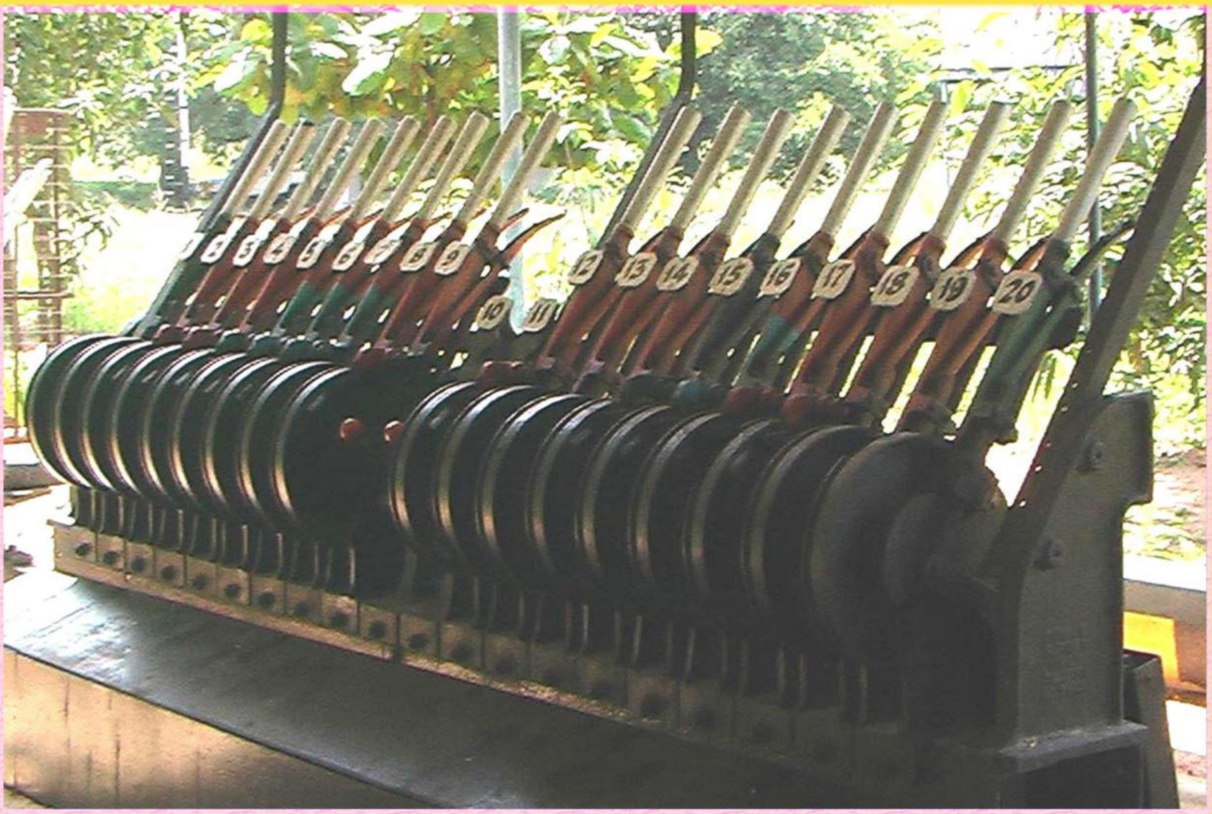
MECHANICAL SIGNALLING DOUBLE WIRE



Indian Railways Institute of
Signal Engineering and Telecommunications

SECUNDERABAD - 500 017

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MECHANICAL SIGNALLING DOUBLE WIRE

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INDIAN RAILWAYS INSTITUTE OF SIGNAL ENGINEERING & TELECOMMUNICATIONS

SECUNDERABAD - 500 017

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MECHANICAL SIGNALLING - DOUBLE WIRE

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CHAPTER 1: INTRODUCTION TO DOUBLE WIRE SIGNALLING

1.1 DOUBLE WIRE TRANSMISSION

Double Wire Signalling as the name suggests employs two wires for the transmission of power from the operating mechanism (e.g. lever) to the operated functions (e.g. points, signals, locks, detectors, etc.). Basically the two wires are connected in the manner of a loop. The operated mechanism and the operated functions are made to form a part of this loop of wire as shown in Fig.1.1.

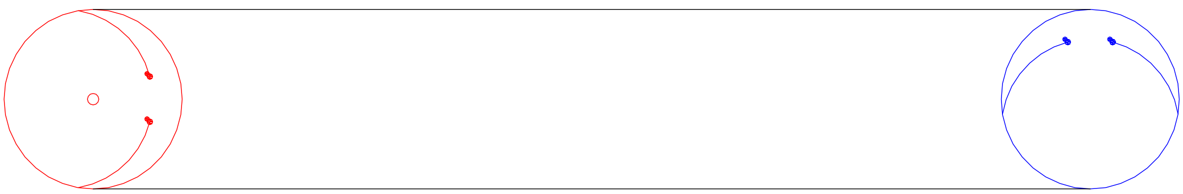


Fig. 1.1

To prevent the wire from slipping on the drum when the transmission is under operation, the ends of the two wires are rigidly attached to the operated and the operating drum as shown.

The operation of drum causes, one of the wires to be wrapped round it and the other to be released from it. The wire that is wrapped round the operating drum causes a pull in the transmission wire and is, therefore, called pull wire while the wire released from it is termed the return wire and sometimes it is release wire or push wire.

Since all the signalling functions are required to be worked from normal to reverse positions and vice versa, the operating drum will have to turn alternately clockwise, and anti-clockwise. A wire that is pulled for one operation will be released during the reverse operation i.e., the pull wire with the operating drum 'N' position will become the return wire when the drum is in its reverse position. Therefore, it will not be enough to term the wire of a transmission as 'pull' and 'push' unless the statement is further qualified by specifying the position of the operating function.

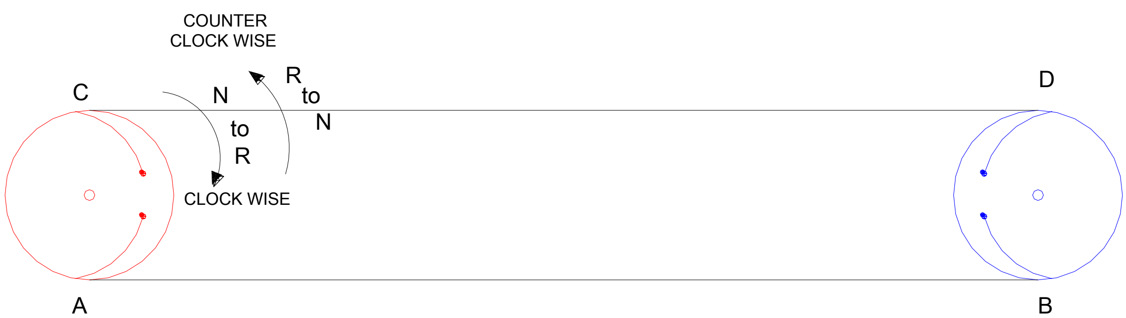
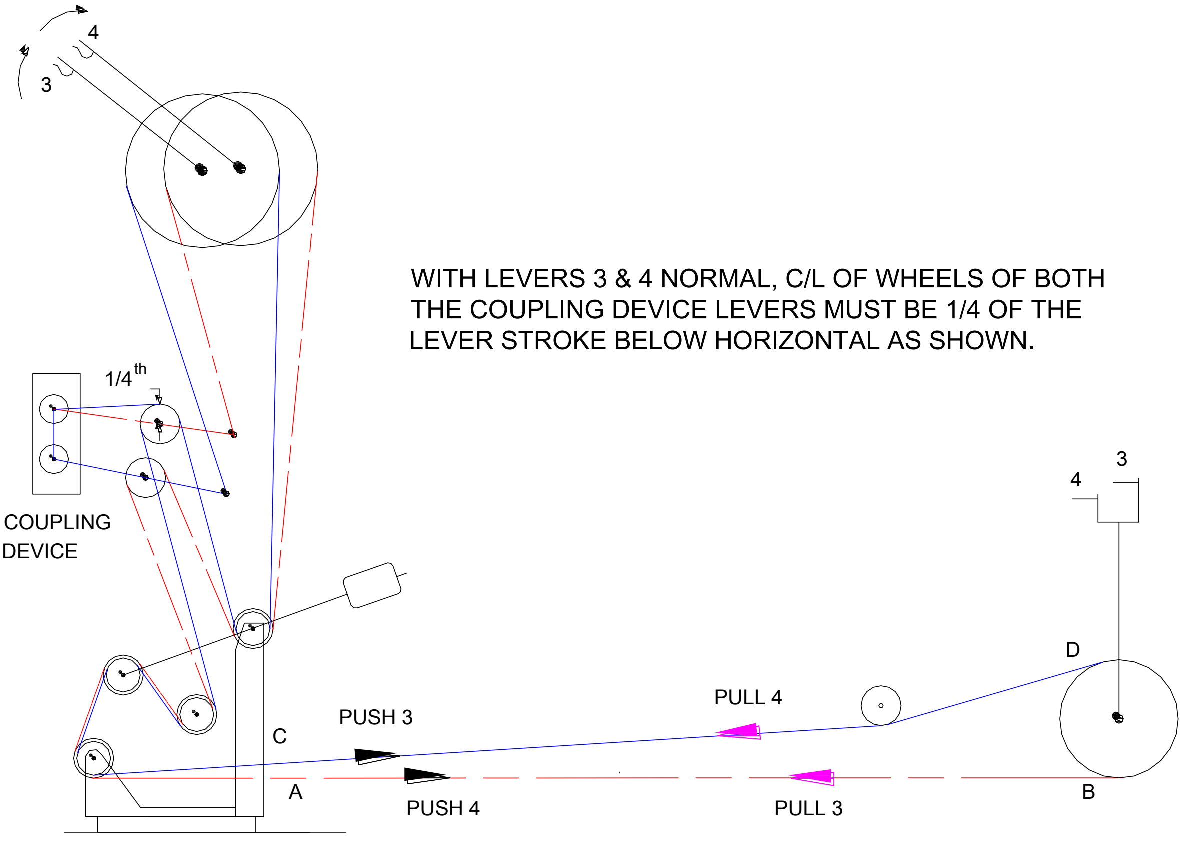


Fig. 1.2

In Fig.1.2, the operating drum rotates clockwise for 'N' to 'R' operation and counter clockwise for 'R' to 'N' operation. The wire AB is wrapped round and the wire CD is released from the operating drum for normal to reverse operation. There fore, AB is called the pull wire and CD the return wire pertaining to the normal position of the drum. However, with the operating drum in the reverse position the pull and return wires alternate and AB becomes the return wire and CD the pull wire.

Another method of distinguishing between the two wires is by describing them as 'last pull' and 'last push' wires. Here the action of the two wires during the previous operation is taken into consideration. For example with the operating drum in the normal position, the last operation was obviously from 'reverse to Normal'. The wire that was pulled during the last operation by the operating drum is termed the 'last pull' wire and the one that was released is called the 'last push' or 'last release' or 'last return' wire. Referring to Fig.1.2 CD is the 'last pull' and AB the "last push" wire with the operating drum in its normal position. With the operating drum occupying its reverse position 'AB' and 'CD' will become the 'last pull' and 'last push' wires respectively.

The terminology 'last pull' and 'last push' does not lend itself to be employee in the case of a push pull transmission. A Push-Pull transmission is that where two conflicting function are operated by the same common transmission but by two different operating drums. The rotation of one drum causes one wire to pull and the other to push. The operation of the second coupled drum causes the wire that was pulled by the first drum to be pushed and vice-versa. In the Fig.1.3 the two operating drums are numbered 3 and 4 and the transmission is so connected that operation of 3 causes AB to pull and CD to push. The 'Pull' and 'Push' wires alternate when no.4 is operated. In the case of this transmission when both the operating drums are in their normal positions the terminology of 'last Pull' and 'last Push wires cannot be employed. Since both the operating drums are in their normal position, it cannot be said as to which was the drum last operated. Therefore, the correct designation of the two wires in the case of a push pull transmission should be 'Pull 3', 'Push 3', 'Pull 4', 'Push 4'. The words 'Pull' and 'Push' followed by the number of the operating functions indicate the wire pulling or pushing the operated function to its 'Reverse' position. Thus 'Pull 3' means the wire that pulls function no.3 to its reverse position when the operating drum is operated from 'N' to 'R'.



TRANSMISSION FOR PUSH PULL WORKING
Fig.1.3

1.2 The Lever

The operating mechanism in addition to the transmission should also cater for the following requirements: -

(a) Convenience of operation

(b) Provision of interlocking between various functions.

(c) Preventing their unintentional operation.

To achieve the objective No.1, a lever handle of suitable length is fixed to the rope drum which facilitates the operation. To the lever is connected a catch handle which through the provision of various links actuates the interlocking and various levers in addition to providing the means of locking the lever in its normal and reverse positions, thus enabling the compliance with the requirement No.2 above. The operating mechanisms incorporating the above features is designated as a lever. In signalling parlance, "a lever is defined as a device for transmitting motion.

1.3 Double Wire Mechanisms

The operated mechanisms contain drums capable of having rotary motion. Operating rods of various signalling functions like signals, points, FPLS require linear strokes. The mechanism of function is, therefore, designed to convert the rotating section of its drum into linear stroke/strokes of the operating is in proper directions and/ or time sequence as required for the working of the function.

1.4 Selection of Double Wire as Transmission **(Need for Double Wire Operation)**

Transmission of mechanical energy involves transmission of not only force, but also its displacement. The latter is also known as stroke and implies physical movement of the transmitting medium under the force. Comparative study of the various media of transmitting mechanical energy should, therefore, be based on the efficiency of transmission of stroke and force as also on the capacity of the medium to handle the maximum amount of energy. The advantages of D.W. transmission over the rodding and single wire transmission are as listed below:-

1.5 Advantages of Double Wire Transmission over Rodding Transmission

(a) Lighter in weight and therefore, is cheaper in cost. Also frictional losses on account of the weight for the transmitting medium are less.

(b) As the wires work only in tension, the spacing between the pulley supports can be greatly increased. This again effects economy in the initial installation and maintenance costs of the transmission. Also as there is no tendency on the part of the transmission to buckle in tension, frictional losses are kept to the minimum possible value.

(c) Loss of stroke due to worn out pins at various joints and connections is absent in D.W. as the transmission works only in one type of stress, viz., Tension.

(d) The transmission can have stroke of unlimited magnitude unlike the rodding transmission where the stroke is limited by the crank arm lengths of various cranks. By increasing the stroke of the transmission, the force transmitted by the wires can be reduced. This considerably economise material of the transmission.

(e) Due to the above factors the required energy can be transmitted over a D.W. transmission without much energy loss. This, therefore, enables the range of D.W. transmission for transmitting mechanical energy to be much higher than that of rodding transmission.

(f) Compensation of D.W. transmission is more perfect than that of the rodding transmission as the latter assumes equality of the variation of temperature in the two lengths of rodding on either side of compensator and which assumption not be true for all places.

(g) D.W. transmission is easier to install in adulatory or otherwise difficult terrain.

1.6 Advantages of Double Wire Transmission over Single Wire Transmission

(a) No need for a gravity or spring bias to return the function to its original position during the reverse to normal operation of the lever.

(b) Due to above, the energy required to be supplied by the lever during an operation need be only what is necessary to work the function either from N to R position or vice-versa. For a given stroke, this results in reduction of the force, required to be transmitted through the D.W. transmission and also the reduction of loss of stroke in the transmission.

(c) By employing pre-tensioning, advantage can be taken of the availability of the return wire, and the force required to be transmitted can be distributed between the two wires to further reduce the force transmitted by each wire and also the loss of stroke.

(d) Automatic compensation is possible and is very satisfactory.

(e) Operation of functions by unauthorised interference is very difficult.

(f) Due to positive action of the transmission on the mechanisms for both N to R and vice versa operation, the working of the functions becomes reliable and independent of the action of gravity or any other bias.

(g) 'ON' and 'OFF' aspects of the signal are stabilised due to proper design of signal cam path, avoiding wrong indication to the driver.

(h) Working of multiple aspect semaphore signal can be easily achieved by the use of D.W. transmission.

1.7 Loss of Stroke

Not fully transmitted to the other end. Loss of stroke is therefore, equal to the stroke completed by the lever minus the stroke completed by the mechanism drum.
The components of stroke loss in a wire transmission are:-

(a) Loss of stroke due to elastic stretch.

(b) Lose of stroke due to sag.

(c) Loss of stroke due to straightening (opening) of kinks, twists and other deviations from the straight of the wire.

1.8 Maximum distance for operation of Points and Detectors

For 500 mm stroke levers, the maximum distance for operation specified by the manual is 500 Mts With a transmission length of 500 Mts and pulley spacing of 15 Mts, a tension difference of 85 kg(186lb.) is caused by a loss of stroke of about 125 mm. As the final stroke of the mechanism drum after the complete operation of points is 103 mm (4 $^{1/8}$ inches) only, it follows that for 500 M length of transmission, the lever may just fail to trip if the clutch spring is set exactly for 28 Kg dynamometer force. It is common experience that for very long transmissions, to effect tripping of point levers with nominal obstruction between the tongue and the stock rails, tripping of the clutch has to be made sensitive by slightly reducing the clutch spring tension.

CHAPTER 2: DOUBLE WIRE LEVERS

2.1 Salient Features

(a) Double wire levers are independent, self-contained units and may, therefore, be installed or removed without disturbing the adjacent levers.

(b) Double wire levers rotate through 180^0, when going from normal to reverse and vice versa.

(c) The interlocking is of the catch handle type. The stroke transmitted to the tappet is 40 mm. When a lever is to be operated from normal to reverse, the catch handle is first pressed and this causes the tappet to move downward by 20 mm when the catch handle is fully pressed, the centre of the locking crank pin coincides with the centre of the rotation of the lever drum and, therefore, during the movement of the lever from normal to reverse, the tappet is stationary; when catch handle is released with the lever in the reverse position, the tappet again moves downwards by 20 mm because in this position the lever is 180^0 out of phase with the normal position. Now, when the lever is to be worked from the reverse to the normal position, the stroke imparted to the tappet by the catch handle will be in the opposite direction.

(d) In double wire frames, miniature levers are employed either for the purpose of interlocking functions, which are not directly controlled from the frame or for the purpose of control of functions by means other than the use of double wire transmission, such as electrically operated points. There are two types of such miniature levers viz., the 2 position and the 3 position. The angular movement of a two-position miniature lever is 13º and 16' while that of the three position miniature lever is 6 deg. and 38' in each direction from its mid-position.

(e) The movement of the tappet in the case of two position miniature lever is 40mm upwards when the lever is operated from normal to reverse position. In the case of 3 position lever, however, the stroke is 20mm upwards from the normal to pull and 20mm downwards from normal to push operation of the lever.

2.2 Type of Levers

The following types of levers are used in double wire signalling: -

(a) Direct lever

(b) Clutch lever

(c) Rack and pinion Lever

(d) Miniature lever

(e) Three to one lever or crank

(f) Auxiliary lever or clutch resetting lever.

2.3 Direct Lever (SA 7512M & SA 7686)

2.3.1 Definition

A lever constructed in such a manner that the drum (or driving disc) is rigidly connected to the lever handle. In case of breakage of wire, the locking is not affected.

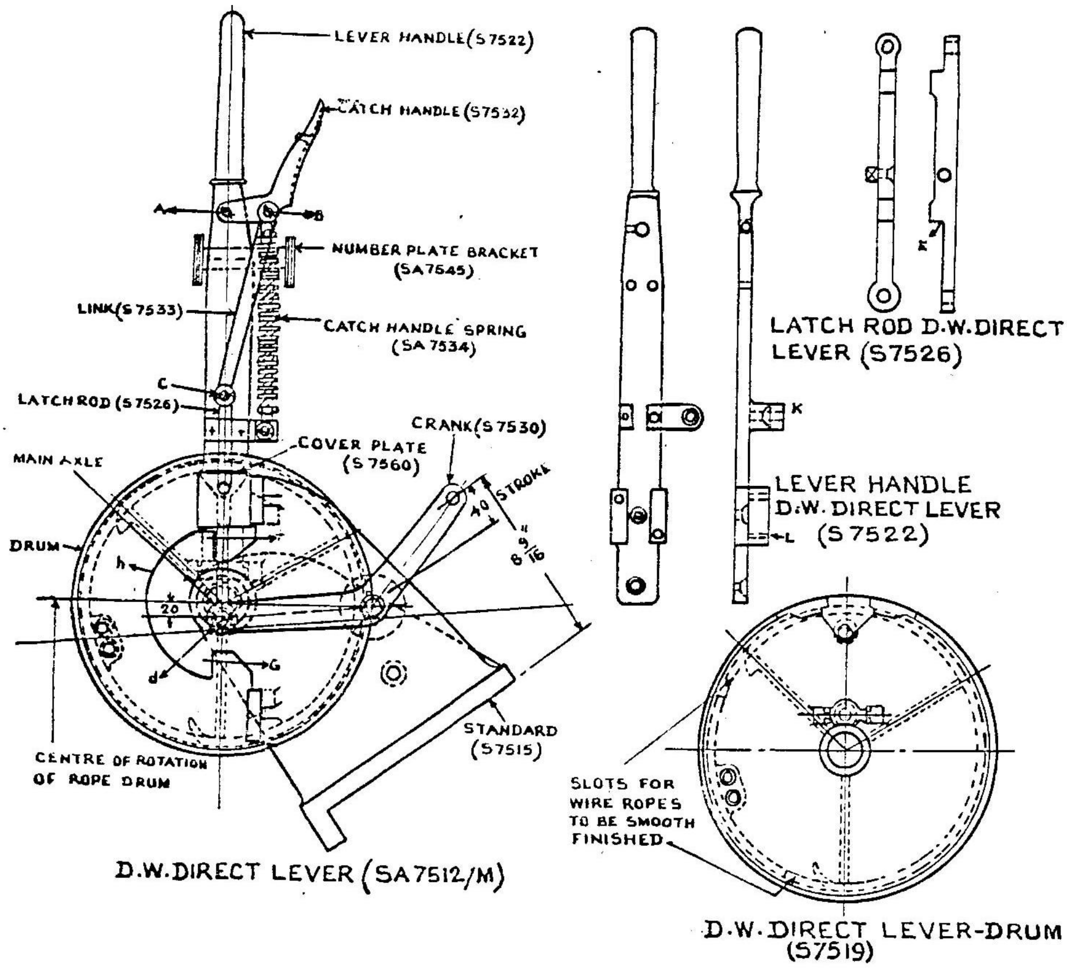


Fig. 2.1

2.3.2 Main parts of the Direct Lever

(a) Rope Drum 500 mm (20") stroke or 600 mm (24") stroke
(b) Lever Handle
(c) Catch Handle.
(d) Link
(e) Latch Rod
(f) Crank
(g) Standard
(h) Catch Handle Spring.
(i) Number plate Bracket
(j) Main Axle.
(k) Crank Axle Ring.

When the catch handle is pressed or released, the latch rod is pulled or pushed causing the crank to turn about the axle thus imparting stroke to the tappet. In this way the lever operation is made dependent upon tappet movement and if the tappet is locked it will not be possible to press the catch handle and disengage the latch rod lug.

2.3.3 Use of Direct Lever

Direct lever is used for working transmission which when obstructed or broken do not leave the gear connected thereto, in an unsafe position. The direct lever is, therefore, employed for working signal transmission without detectors. Such transmission, when broken, will retain or replace the signal to its most restrictive aspect.

A 500mm stroke lever is utilised for working a transmission the length of which does not exceed 1200 M. Lengths greater than 1200 M are worked by a 600 mm stroke lever.

2.4 Clutch Lever (SA 7511/M)

2.4.1 Definition

A lever constructed in such a manner that the lever handle is not rigidly connected to the rope drum, but through a form of clutch permitting the rope drum to rotate independently of the lever with a restricted movement and cause the mechanical locking to be 'fouled' if the lever is forced against an obstructed transmission, obstructed function or if a wire is broken.

2.4.2 Main parts of Clutch Lever (SA 7511M or SA 7685)

(a) Rope drum 500mm stroke or 600 mm stroke,

(b) Lever handle,

(c) Catch Handle,

(d) Link,

(e) Latch Rod,

(f) Crank,

(g) Clutch,

(h) Catch Handle Spring,

(i) Standard,

(j) Main Axle,

(k) Crank Axle Ring,

(l) Number Plate Bracket consisting of the following parts,

(i) Tie plate,

(ii) Number Plate,

(iii) Distance piece,

(iv) Fault Indicator,

(v) Shaft,

(vi) Strip.

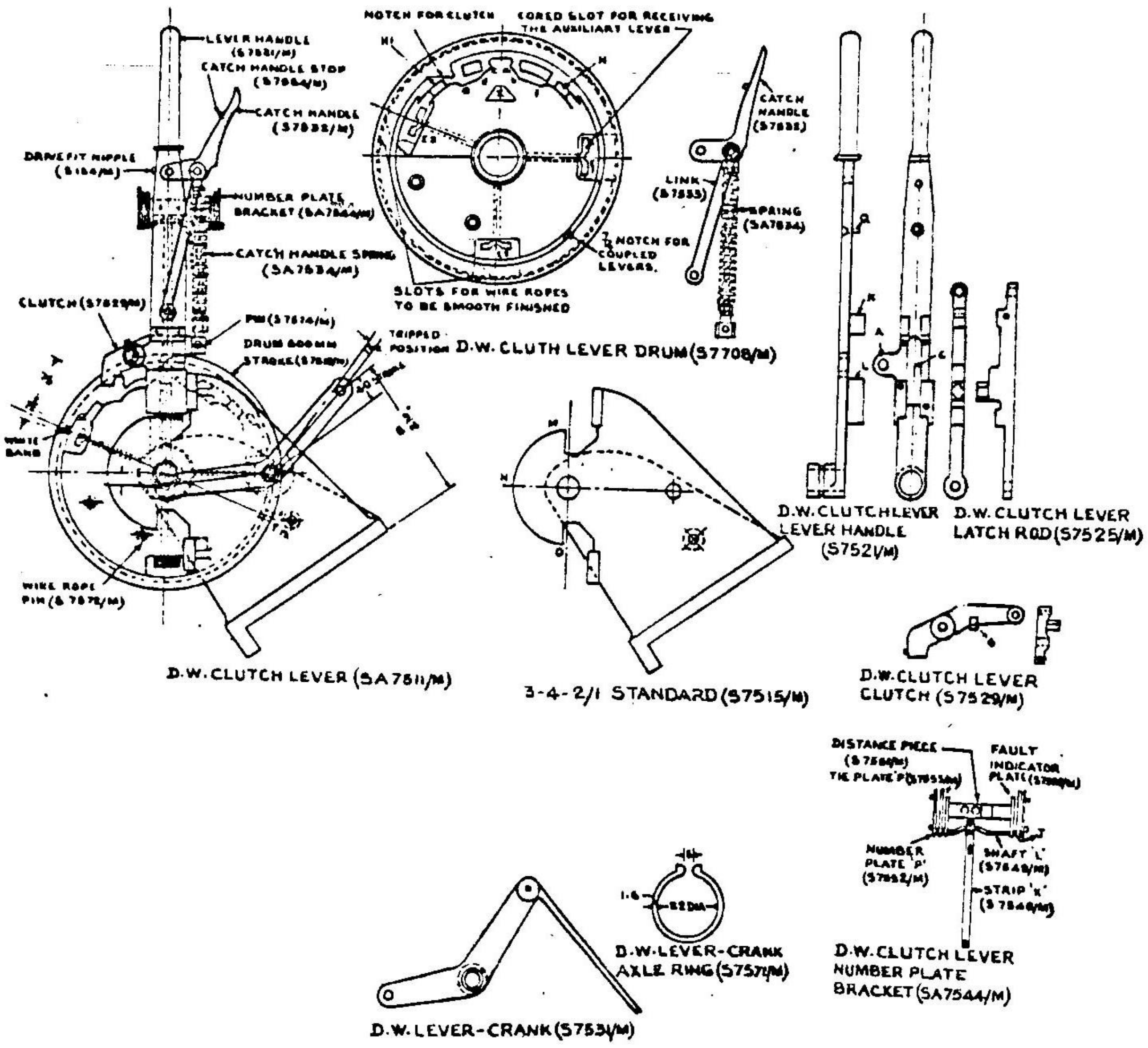


Fig. 2.2

2.4.3 Tripping

Tripping: The restricted relative motion between lever handle and the rope drum of a clutch driven lever caused by a tension difference in the two wires is called the tripping of the lever. The movement of the rope drum should be of such a magnitude that if a lever locked in the interlocking is caused to trip by means of the auxiliary lever, the motion transmitted to the function shall remain within safe limits, i.e., the points should not start working, signal arm should not move etc. This stroke is limited to 75 mm either way clockwise or counter-clockwise.

2.4.4 Essentials of a Clutch Lever

(a) The lever handle and the rope drum should not be rigidly fixed, but the two should be held together through the medium of a spring loaded clutch so that connection between the lever handle and the rope drum can break and the rope drum can move independently of the lever handle.

(b) A tension difference of 85 Kgs in the transmission wires should cause the clutch driven lever to trip while a tension difference of 72 Kgs must not cause the lever to trip and the lift of the nose of the clutch shall not exceed 2.5mm).

A clutch driven lever must not trip during operation of the lever, but should trip only in its full normal and full reverse positions.

(c) The tripping of a clutch driven lever shall cause a visual indicator to be displayed in the cabin thus repeating the faulty condition of the transmission.

(d) The tappet of a lever whose transmission wire broken is locked or back locked tight in the interlocking frame shall cause the fault indicator to appear even though the interlocking prevents the lever from tripping fully.

(e) The tripping of a lever should cause a movement of the tappet, the magnitude of the movement being sufficient to drive a lock fully out of the notch of the tripped lever to effectively and fully foul the locking.

(f) The travel of the tappet due to tripping should be in a direction in which the tappet has last moved, i.e., the tappet should move in opposite directions when the catch handle is pressed in a particular position of the lever and when the lever trips in that position.

(g) The catch handle of a lever that has tripped should not be capable of being pressed so as to keep the lever handle locked against the quadrant.

(h) The rope drum of a clutch lever should have means of conveniently re-clutching the lever when tripped. Slots for receiving the auxiliary lever for re-clutching the lever after it has tripped are provided.

(i) There shall be an arrangement of sealing the clutch so that breakage of the seal will serve as proof of the lever having tripped.

2.4.5 Discussion on the Essentials of a Clutch Lever

(a) Tension difference in a double wire transmission is caused either by:

(i) Wire breakage or

(ii) Over load.

Loss of stroke and wire breakage produces tension difference in the wires and this tension difference is utilised for causing the lever to trip to repeat the faulty condition of the transmission in the cabin. Hence, the necessity of the connection between the lever handle and rope drum being obtained through a spring loaded clutch.

(b) When a lever is operated, a tension difference is changed in the two wires of the transmission and immediately as the lever completes its stroke, the tension difference neutralised since the function mechanism would not have been completed its stroke. This tension difference would cause the lever to trip every time it is operated and would necessitate the frequent use of clutch resetting lever. To avoid this inconvenience, it is stipulated that the lever should not trip with a tension difference of 72 Kgs in the transmission wires. The tension difference exceeds 72 Kgs the loss of stroke causing this tension difference is likely to be of sufficient magnitude so as to leave the gear in an unsafe position. The upper limit of 85 Kgs is, therefore, placed on the tension difference when the lever must trip. Between 72 Kgs tension difference, the lever may or may not trip which is a maintenance margin.

(c) To warn the leverman of the faulty condition of the transmission, a fault indicator appears from behind the number plate when the lever de-clutches giving a visual indication. Fault indicator appears even when the lever is locked or back locked tight in the interlocking and consequently cannot trip.

(d) To get the effect of indication locking when the lever trips, it is imperative that the interlocking of the tripped lever on other dependent levers should not be released. The tripping of the lever should, therefore, cause a movement of the tappet by 12 mm sufficient to effectively foul the locking.

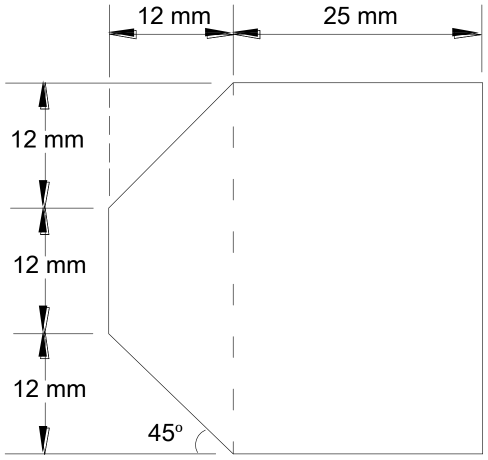


Fig. 2.3

(e) In order to get the benefit of loose locking, the movement of the tappet caused by tripping has to be made ineffective in 'fouling' the locking. This is achieved by cutting the notch 12mm wider in the direction of movement of tappet caused by tripping.

Now if this movement caused by tripping and catch pressed were in the same direction, loose notches will be as shown in Fig. 2.4 and if the movements were in opposite direction the loose notches with respect to the lock dogs will be as shown in Fig.2.5.

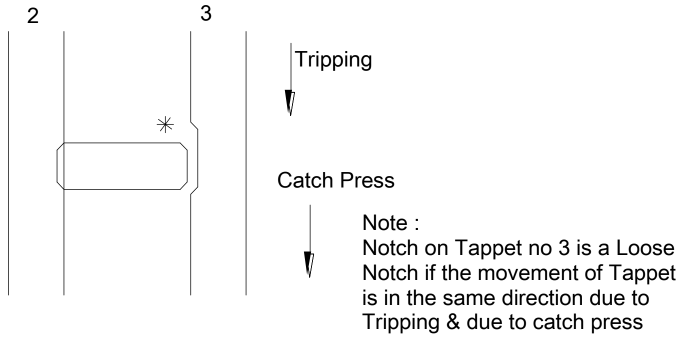
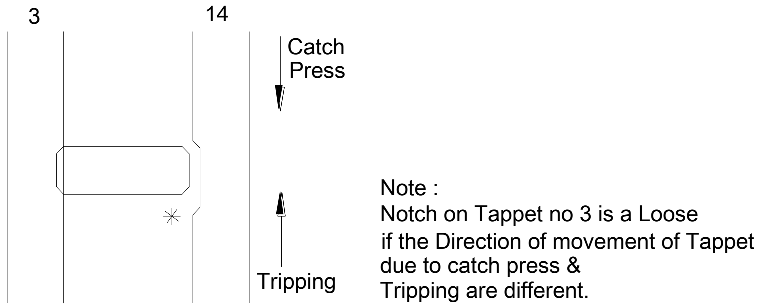


Fig. 2.4



DIRECTION OF MOVEMENT OF TAPPET

Fig. 2.5

It will be seen that in the former case the loose locking will amount to dangerous slack locking because it will be possible to considerably press the catch handle and correspondingly lift the latch rod lug which acts like a catch block and free the lever without actuating the interlocking. In the latter method, however, the extra width of the loose notch does not affect the normal working and affects only when the lever trips. Therefore, the movement of the tappet due to tripping of lever should be in a direction in which the tappet has last moved.

(f) The method of adjusting the spring is to turn it out so that the clutch lifts from the drum. The spring should then be given one or two turns inwards. Generally this adjustment would suffice. The tripping should of course be tested by means of the dynamometer and the three to one lever and the spring adjusted so that the lever trips with a tension difference of 85 Kgs and does not trip when there is a tension difference of 72 Kgs. between the two wires of the transmission.

The lubrication of the nose of the clutch is important in order to ensure uniformity in the declutching force, grease nipple is provided in the nose of the clutch.

(g) The latch rod is provided with a hole for sealing. When the lever trips, the latch rod moves down and the wire loop breaks to indicate to the signal staff that the lever had tripped**.**

2.4.6 Use of Clutch Levers

Clutch levers are used for working these transmissions which when obstructed or broken may leave the gear in or lead it to an unsafe position. Movement of trains under the above circumstances should not be authorised and the tripping action of the lever utilised in causing the tappet to move to lock all dependent levers.

Points: Facing point locks, economical points, lock retaining or holding bars, fouling bars, detectors, signals transmission with detectors are all worked by clutch driven levers.

A 500mm stroke clutch driven lever is used for the following:-

(a) Points transmission upto 500 Mts.

(b) Detectors transmission upto 600 Mts and for the following transmission 600 mm stroke lever is employed.

(i) Point transmission greater than 500 Mts and upto a maximum of 730 Mts.

(ii) Detector transmission greater than 600 Mts and upto maximum of 730 Mts.

2.5 Rack and Pinion Lever

2.5.1 Definition

A lever designed to be erected on a double wire lever frame but required to work function by a rodding transmission.

2.5.2 Main parts of the Rack and Pinion Lever: SA 7730 M (200 mm Stroke)

(a) Pinion
(b) Rack
(c) Lever Handle
(d) Catch
(e) Link
(f) Latch Rod
(g) Crank
(h) Catch handle spring
(i) Standard
(j) Main Axle
(k) Crank axle ring.
(l) Number Plate Bracket

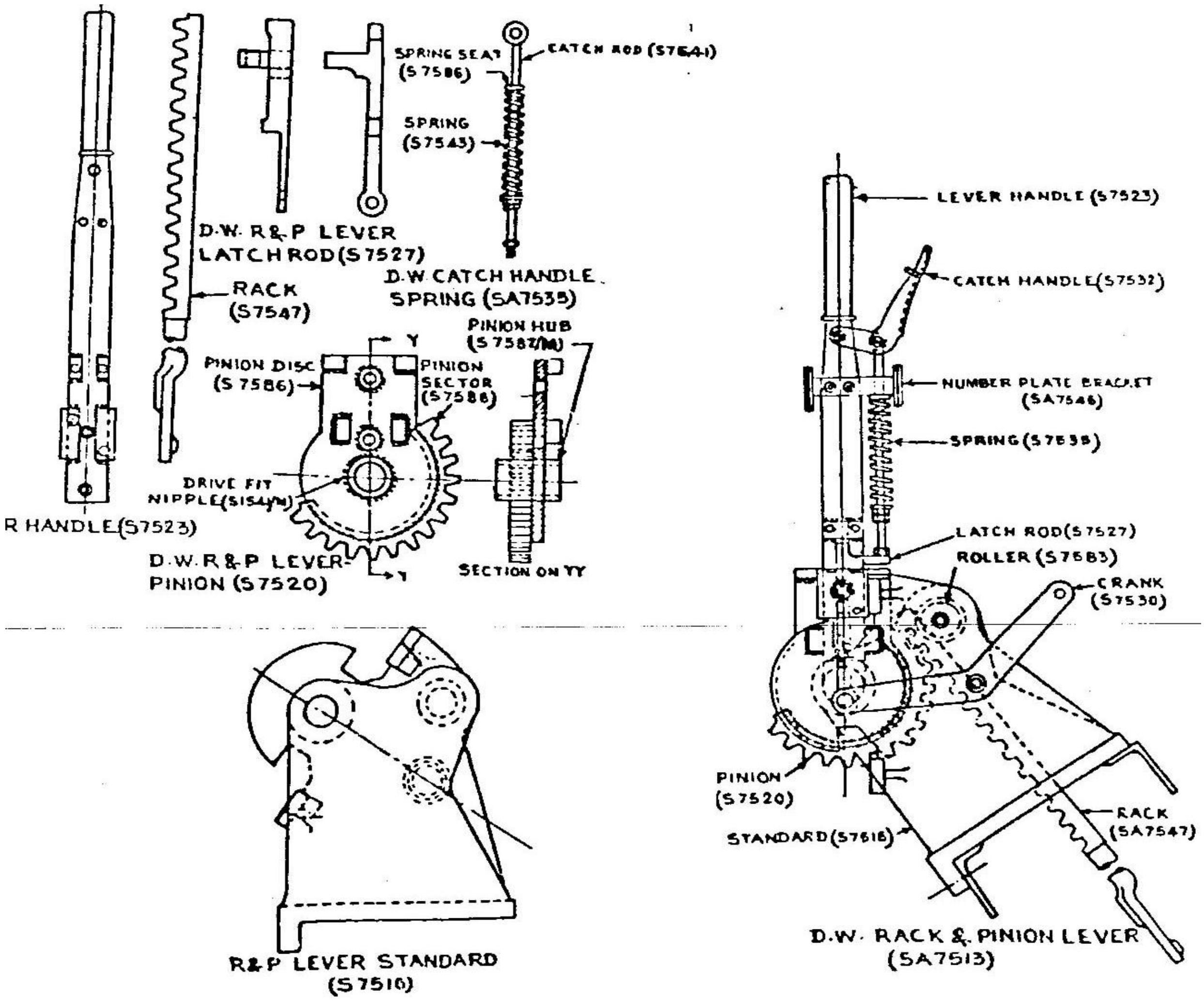


Fig. 2.6

2.5.3 The lever handle is bolted to the pinion in the manner of a direct lever already described. Intermeshed with the teeth of the pinion or the teeth of a rack, so that when the pinion rotates with the movement of the lever the rack gets a rectilinear stroke. To the free end of the rack is connected the vertical crank through the down rod in the usual manner.

Rack and pinion Lever to Drg. No.SA 7730 gives a stroke of 200 mm.

2.5.4 Use of Rack and Pinion Lever

A rack and pinion lever is used for working points EFPL's etc. by a rodding transmission, but from a double wire lever frame. It is not desirable to work points, which are not detected, by a double wire transmission. Because of such a point transmission wire breaks after the signal reading over those pair of points has been taken off the points could be thrown over to the other position in the event of the broken wire lock fails to function, thus diverting the train to a line not intended and perhaps not clear for reception of the train. Where a D.W. detector is provided on a pair of point, it prevents the operation of the points due to wire breakage when the signal is OFF. Such points are, therefore, worked by a rodding transmission and a rack and pinion lever is employed. Example is facing points taking 'off' goods running lines, which need not be detected.

Another use of the rack and pinion lever is for working points in big yards where there is a lot of unsignalled shunting. Incidents of bursted points during unsignalled shunting cannot be avoided and it has been experienced that the bursting of a point provided with a double wire point mechanism causes the casting of the point mechanism drum to break. This necessitates the renewal of the point mechanism which not only costs lot of money, but also requires the signal inspector to have a lot of spare point mechanisms in stock. Wherever a point mechanism is not readily available points have to be clamped to one position alone thus tying down the capacity of yard. Such points if worked by rodding will suffer only buckling of rodding etc. When points are burst, they can be rectified at much less expense and without the necessity of stocking a lot of spares. Rack and pinion levers are also being used by Railways in stations provided with end cabins. Although double wire lever frames are used in these cabins and signals are operated by double wire transmission. The points are worked by rodding as these are within the range of operations.

2.6 Miniature Lever (SA 7514/1-6M)

2.6.1 Definition

A lever not required to work mechanical transmission but adopted to receive or transmit a control like Slot or HKT.

2.6.2 Main Parts of the Miniature Lever

(a) Standard

(b) Lever Handle

(c) Number Plate

(d) Plunger

(e) Index Plate

(f) Pin

(g) Spring

(h) Steel Ball 12 mm dia. hardened.

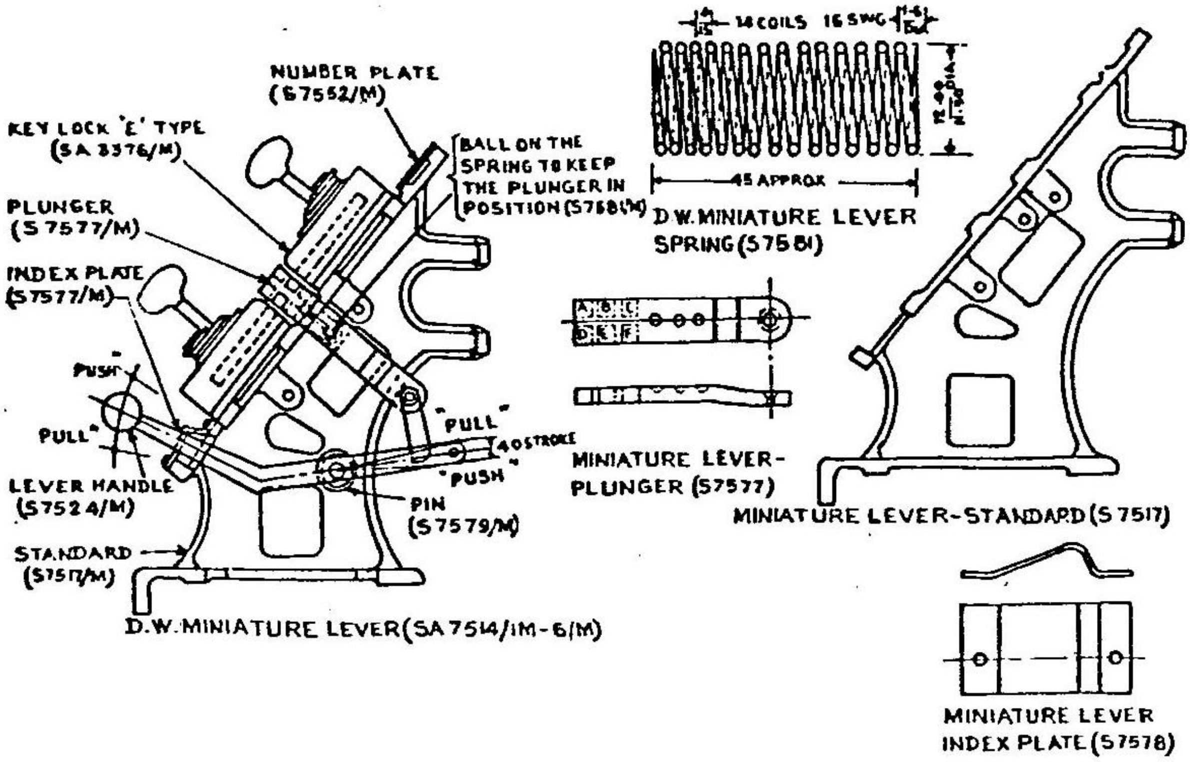


Fig: 2.7

Two types of miniature levers are in use, viz,

(a) Two position miniature lever, and

(b) Three position miniature lever.

Whereas the normal position of a two position miniature lever is up and the lever handle is pressed down to reverse the lever the three position miniature lever normally occupies the middle position from where it can be operated upwards to its 'push' position or downwards to its 'pull' position. The lever is held in its normal (control) position by the "Steel Ball on the spring" arrangement is already discussed. The only difference between the two position and three position miniature lever, therefore, is that the index plate of the former indicates two positions viz., Normal and Reverse and that of the latter, three position viz., Normal, Push and Pull. The stroke imparted to the tappet by two position miniature lever is 40 mm, but the direction of movement is upwards when the lever is operated from Normal to Reverse, and vice versa. A three position miniature lever gives 20 mm upwards stroke to the tappet when the lever is operated from Normal to the 'Pull' position and 20 mm downwards stroke when operated from Normal to its Push position.

2.6.5 Usages of Miniature Lever

A miniature lever is used for receiving or granting control e.g., level crossing gate control, siding control, inter cabin control, SM's control, electrical operation of signal etc. Any control lever is required to perform two functions. Firstly to receive or grant a control from or to a remote location and secondly to actuate interlocking so as to retain the functions in the positions required by the control as long as the control lever is in the operated position.

The control can be received or granted by means of a key for such miniature 'E' type locks can be fitted on the miniature lever. Electrical control can also be affected by circuit controllers and lever locks, provision for fixing of which is also made on the miniature lever. Arrangement for working the locking is achieved by connecting a tappet to the lever handle.

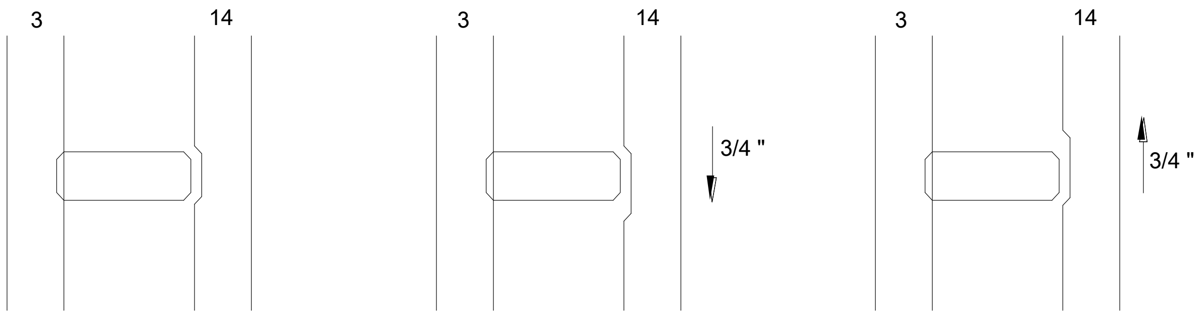


Fig: 2.8

A two position miniature lever is used for only one control. The three position miniature lever is an economical arrangement whereby two controls can be received or granted by the same lever one in its pull position and another when it is operated to its Push position. Two sets of interlocking are required to be actuated and it is so arranged that the Pull movement of the lever does not affect the locking required for the push movement of the lever and vice versa. This is achieved by cutting the notch on the tappet 20 mm longer on the non-locking face side, e.g., 3 Push locks 14 and 3 Pull released by 14 a reference to Fig.2.8 which is self-explanatory will show how this can be achieved.

Three position miniature lever can be used only for conflicting controls, i.e., the controls not required at the same time e.g., it can be used for SM's control (Route Lever) for both up and down directions at a station not provided with simultaneous reception facilities or it should be used for SM's control for reception on the particular line and also for inter-cabin control for reception on the same line in the opposite direction. A three position miniature lever cannot be used as a route lever for both up and down directions at a station provided with simultaneous reception facilities because when simultaneous reception of two trains is to be made both the route levers will have to be operated which is not possible in the case of a single three position miniature lever.

2.7 Three to One Lever: SA 7492 M

Definition:

Lever used for testing the tension difference required to trip a clutch driven lever. As already discussed a clutch driven lever must trip with a tension difference of 85 Kgs. (186 lbs.) in the transmission wires and must not trip when the tension difference is 72 Kgs. (156 lbs.). The clutch spring has, therefore, to be adjusted to the correct value.

Method of Connecting Dynamometer

(SA 7490 and SA 7491): A more convenient method is obtained by employing a three to one lever and a dynamometer (spring balance) reading upto 50 Kgs. A three to one lever is as shown in Figure 2.9 and has a fixed point of application of force. The length of this lever is such that when inserted in the slot on the rope drum of a clutch driven lever, it gives a mechanical advantage of 3. Therefore, with a force of 28 Kgs. on the dynamometer the lever should trip and with a force of 24 Kgs on dynamometer the lever should not trip. Care should be taken to see that the dynamometer is held at right angles to the 3 to 1 lever as shown in the figure.

A three to one lever and a dynamometer reading upto 50 Kgs. should form part of the equipment of each signal Inspector.

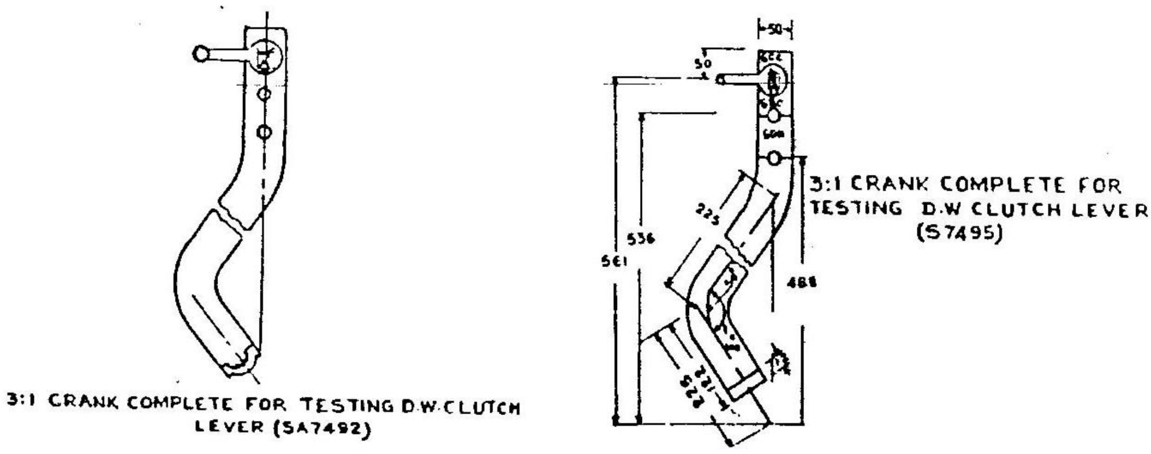


Fig: 2.9

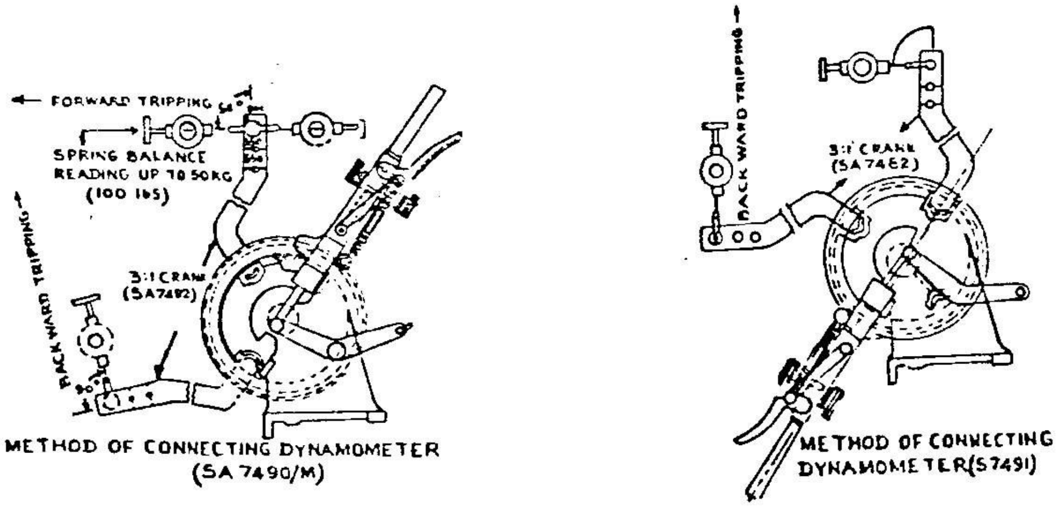


Fig: 2.10

2.8 Auxiliary lever or clutch resetting handle (S7707M)

This is an 'L' shaped lever provided to check while locking testing and used to re-clutch the tripped lever whether a lever is locked or back locked tightly or loose. 3 to 1 and auxiliary lever with special groove are now available.

The auxiliary lever should be kept in the personal custody of the Station Master in a sealed box and its every use to be recorded in the register in SM’s office provided for this purpose to prevent its unauthorised use.

2.9 Double Wire Lever Frame

2.9.1 Double Wire Cabins

Double Wire Cabins should be so designed that the cabin is wide enough to take the compensators in the lower floor of the cabin with sufficient room between the two ends of the compensators and the walls that will permit the maintenance staff to move freely and attend to their maintenance duties. The height of the cabin should be such as to permit the coupling devices working freely without of their being caught up in case of wire breakage as well as provide a clear view of all points and signals.

Whenever locking boxes having more than eight channels have to be used arrangements have to be made to provide false flooring.

Installation of Double Wire Interlocking Frame:-

The most common method of erection of D.W. lever frame is the stanchion method.

The following items are required for erection of a D.W. lever frame by this method.

(a) Lever supporting channel (a) Front Channel 250 x 75 mm

 (i) Front Channel 250 x 75 mm

 (ii) Rear Channel 250 x 75 mm

(b) Separators.

(c) End stanchions with cleats 2 Nos.

(d) Intermediate stanchions - The No. depends upon the size of the lever frame.

(e) Compensator channels front and rear 62 x 125 mm

(f) Two channels for supporting the stanchions and for fixing the coupling device

 75 x 125 mm.

(g) I - Section girder for mounting the travelling trolley and the differential pulley block 100 x 175 mm

(h) Anchor bolts for foundations 25 x 450 mm.

2.9.2 Intermediate Stanchions

Double wire frames mounted on lever supporting channels are supported on stanchions, 2 end stanchions provided for all frames. The normal span is limited to 18 levers (or 19 lever pitches). The number of intermediate stanchions (i.e. intermediate supports) depends upon the size of the lever frame as given below:-

Number of levers	Number of end stanchions	Number of Int. stanchion	Number of spans
Up to 18	2	0	1
20-36	2	1	2
38-54	2	2	3
56-72	2	3	4
74-90	2	4	5

2.9.3 Location of Intermediate Stanchion

The position of the lever under which the intermediate stanchion is to be provided is obtained by dividing the number of levers by the number of spans and adding 1 to the quotient.

i.e., $$\frac{\text{Number of levers}}{\text{Number of spans}} = x \text{ (ignore fractions)}$$

(18 x 1) + 1 = 19 (First intermediate stanchion)

(18 x 2) + 1 = 37 (Second " ")

(18 x 3) + 1 = 55 (Third " ")

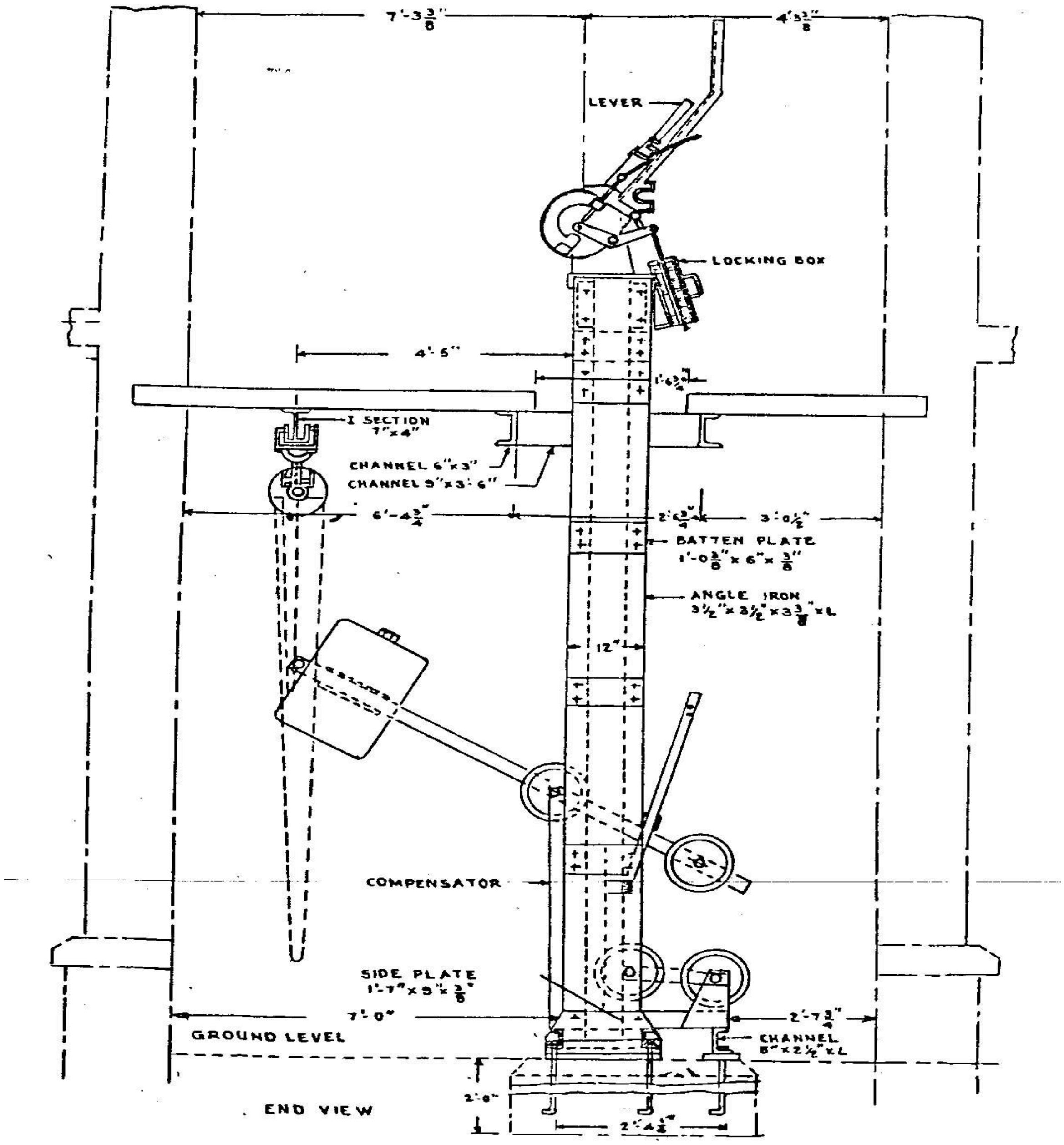
(18 x 4) + 1 = 73 (Fourth " ")

Locking boxes: Locking boxes are available as mentioned below.

6 channels for 4 levers, 8 & 10 channels for 8 levers and 10 levers.

Locking box detailed

S.No	Description	Measurement
1	Pitch of the levers	125 mm
2	Stroke of the tappet	40 mm
3	Stroke of the tappet when tripped	12 mm
4	Pitch of the channel	55 mm
5	Width of the channel	40 mm



ERECTION OF D.W. INTERLOCKING LEVER FRAME

Fig: 2.11

CHAPTER 3: COUPLING OF LEVERS

3.1 Coupling of levers is an arrangement whereby the levers can work two functions or can operate the same signal to display different aspects by a common double wire transmission. the purpose of coupling of levers, therefore, is to achieve economy in the cost of construction and maintenance of signalling installations in addition to facilitating the mechanical working of three aspect signals. By coupling the two levers one transmission is used instead of two and therefore, the expenditure on the following is saved:-

(a) Material of one transmission

(b) Installation of one transmission

(c) Maintenance of one transmission

(d) Material of one compensator

(e) Installation and maintenance of one compensator

(f) One signal mechanism when the two coupled signals are located on the same post.

(g) Installation and maintenance of a signal mechanism.

In the case of a three aspect signal, it is necessary to work it only by one transmission, no means of working such a signal by two transmissions being available. Nevertheless lever working the signal must necessarily be two because the sets of conditions in the yard to be satisfied before displaying either of the two 'off' aspects being different require actuation of different interlocking in the lever frame. The transmission that works this signal mechanism must necessarily be a coupled one.

In the interest of economy, therefore, maximum utilisation should be made of coupling of levers in any double wire signalling installation though for the working of three aspect signals it is an operational necessity.

3.2 Pre-requisites of Coupling

For coupling any two levers it is necessary that:-

(a) The two levers should be adjacent in the lever frame, i.e. bear consecutive numbers.

(b) Length of transmission between the two coupled functions should not be greater than about 73 Mts.

The wires from the two levers to be coupled require to be crossed, i.e., a wire from lever No.1 has to go to the coupling device wheel below lever No.2 and vice versa. If two adjacent levers are coupled, wires can conveniently be crossed, but if there are any other levers in between the two levers to be coupled the wires in crossing would infringe with the transmission and compensators of other intermediate levers.

When two functions are coupled in the same transmission and are located away from each other, it is only one function mechanism that will be at the neutral point and therefore, immune to the effects of temperature variations. The other mechanism will be floating and shall move a distance equal to the variation in length of the uncompensated wire between the neutral point and the floating mechanism.

The greater this distance the greater will be the movement of the floating mechanism due to temperature variations. It is this movement that places a limitation on the length of wires between two coupled functions. 73 Mts. (80 yards) of transmission will vary in length by 44 mm (1.76") between the two extreme temperatures. A movement greater than this would make the signal behave erratically and hence, the distance is limited to 73 Mts.

3.3 Type of Coupling

Levers can be coupled in two manners, viz., 'push-pull' and 'pull-pull'.

3.4 Push-Pull Manner of Coupling

Conflicting functions requiring only one of the two functions to be operated at a time can be coupled in a 'push-pull' transmission.

A push-pull transmission is so connected that the operation of one lever causes one of the wires to be pulled and the other to be released or pushed. With this lever normal if the second coupled lever is to be operated the pull and return wires will alternate i.e., the wire which was pulled during the operation of the first lever will be pushed by the operation of the second lever and vice versa. In consequence, the function mechanism rotates clockwise for one lever operation and counter clockwise for the other.

Example of Push-Pull Coupling:

(a) Two signals located on the same post, but not required at the same time, e.g., L.Q. Main and Loop Line, Home Signals, L.Q. or U.Q. 1st loop and 2nd loop home signals, a starter and a shunt below it, two shunt signals one below the other, a Home Signal and a calling on signal below it, etc.

(b) Two lower quadrant or upper quadrant starters located on different posts provided the length of the transmission between them does not exceed 73 m (80 yards).

(c) Detector transmission, detecting the normal and reverse (conflicting) setting of the same pair of points.

(d) 45^0 and 90^0 aspect of the same MAUQ signal where the two aspects conflict with each other, e.g., 3 position main line starter where the Caution aspect is utilised for shunting Clear for starting.

3.5 Pull-Pull Manner of Coupling

Functions requiring succession working are coupled in the Pull-Pull manner.

A pull-pull transmission is so designed that the operation of one lever causes a wire to be pulled and another to be released and after the first lever is reversed, the operation of the second lever in succession causes a further pull and release on the same wires, i.e., the transmission is given double the stroke in the same direction. The function mechanism moves in the same direction by both the lever operations.

Example of Pull-Pull Working:

(a) Main line Home signal on a multiple aspect signalling where the caution aspect indicates stopping on the main line and clear indicates run through on the main line.

(b) Distance signal on a multiple aspect signalling

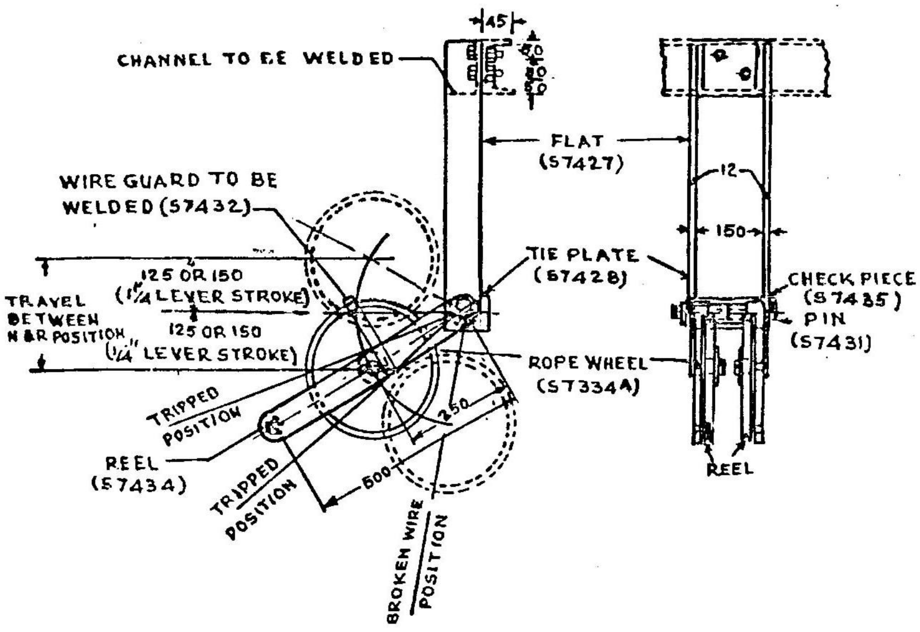
(c) Outer and Warner Signals located on the same post

Some Railways prefer to work distant signal by a pull-pull transmission in preference to a push-pull one while some others work 3 aspect Main Line Home Signals in a push-pull fashion.

3.6 Coupling Device

Coupling device is a contrivance that enables the coupling of two levers in a common transmission.

3.6.1 Indoor type Coupling Device: SA 7426 M



SIDE VIEW FRONT VIEW COUPLING DEVICE (D.W.S) INDOOR TYPE (SA7426)
Fig: 3.1

It consists of two levers hinged on to a bracket as shown in Fig.3.1. Each lever has a reel mounted at its free end and a wheel at its centre as shown.

The coupling device wheels carry a wire rope each in the manner of a draft wheel and therefore, double the stroke and half the tension in the wires. To keep the lever stroke and the tension generated at the lever unaltered in passing through the coupling device, the wheels are placed at the centre of the coupling device lever.

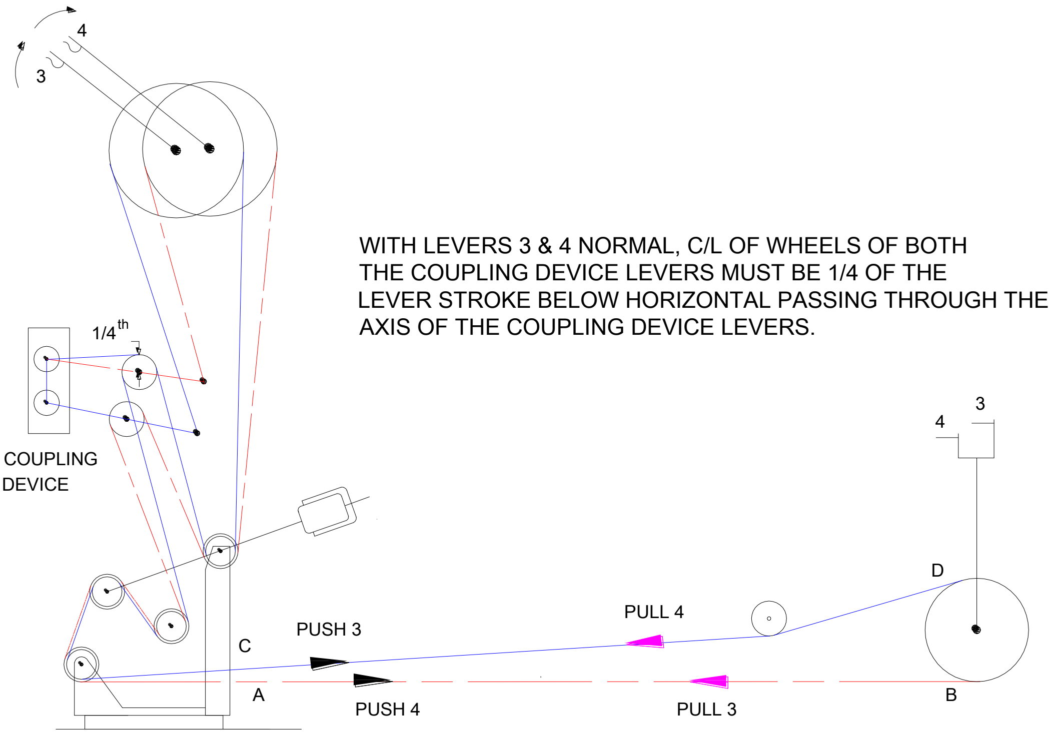
The indoor type coupling device is placed centrally below the two levers to be coupled and is fitted to one of the two longitudinal channels (the channel that the leverman faces while operating the lever) provided in the cabin for preventing the lateral movement of the lever frame.

3.7 Push-Pull Working (See Fig.3.2)

Pull wires from the two levers in their normal positions are terminated at the coupling device wheels which are placed half the lever stroke. 250 mm for a 500 mm stroke lever and 300 mm for a 600 mm stroke lever, below the horizontal passing through the coupling device lever axis. This would mean that the coupling device wheel centres will be 1/4th of the lever stroke, 125 mm for 500 mm stroke and 150 mm for 600 mm stroke lever below the horizontal. The remaining two return wires, one for each lever, form the transmission loop.

These two wires are carried round the vertical wheels of the compensator to the alternate coupling device wheels and through the compensator to the function mechanism/mechanisms. Care is taken to see that the two wires cross i.e., the return wire from one lever should pass over the coupling device wheel below the other lever and vice versa, otherwise no stroke will be given to the transmission loop. The wires are crossed between the lever and the compensator coupling wheel in preference to that between the coupling wheel and the coupling device to reduce the angle of convergence because of the greater distance between the lever and the coupling wheel than that between the coupling wheel and the coupling device.

Push-pull working can also be achieved by keeping the coupling device levers above horizontal and connecting to the wheels the return wires from the lever in their normal positions. This method is not employed because of certain unsafe conditions arising out of breakage of the coupling loop (length of wire between the lever and the coupling device reel) which is discussed later in the chapter on "Broken Wire Protection".



TRANSMISSION FOR PUSH PULL WORKING

Fig.3.2

3.8 Pull-pull working (See Fig.3.3)

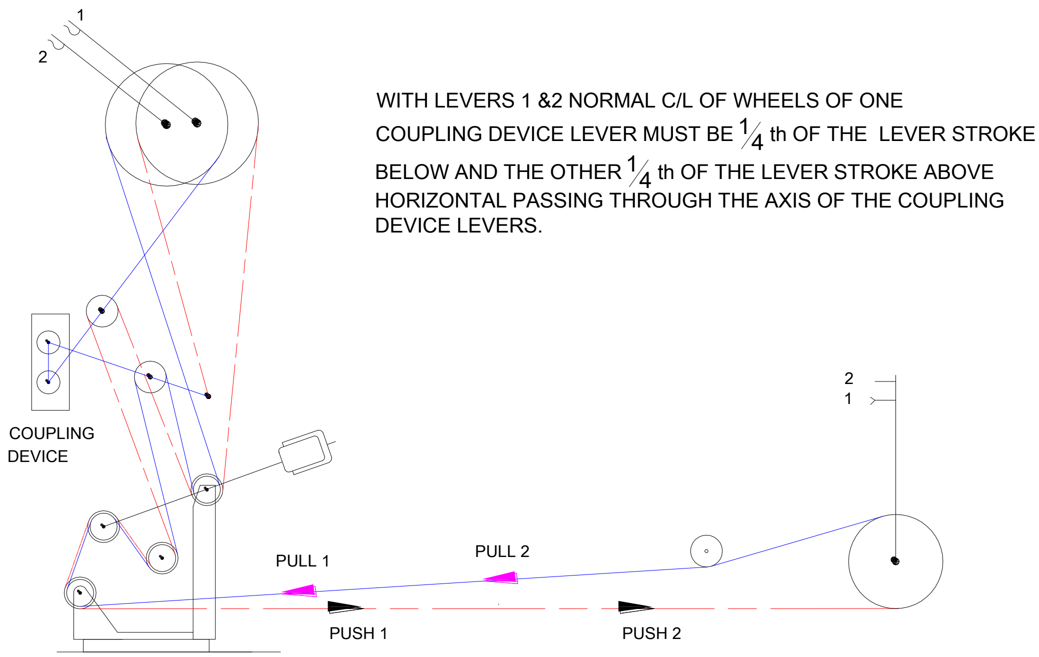


Fig.3.3

Pull wire of the 2nd operated lever in sequence is connected to the reel of a coupling device lever which is kept half the lever stroke below horizontal and return wire of first operated lever in sequence is connected to the reel of the other coupling device lever which is kept half the lever stroke above horizontal. The other two wires from the two levers from the transmission loop in the alternate manner as discussed for push-pull working.

When a lever is operated, say the one the pull wire of which is connected to the coupling device reel, the coupling device lever is lifted giving the pull stroke to the wire passing over the wheel of the coupling device lever. This is the pull wire of the lever at rest as shown in Fig.3.3. After the operation of this lever when the second lever is operated, its pull wire, the wire which was pulled in the previous operation directly transmits the pull stroke. Therefore, the same wire is pulled for either lever operation and similarly the same wire is pushed for both the lever operations thus achieving pull-pull working.

Normally the pull wire of any one lever can be connected to the coupling device lever below horizontal as long as the return wire of the other coupled lever is connected to the coupling device lever above horizontal. However, it is preferable to connect the return wire of the lever to be operated first and the pull wire of lever to be operated last to the coupling device levers so as to get better broken wire protection (Discussed later).

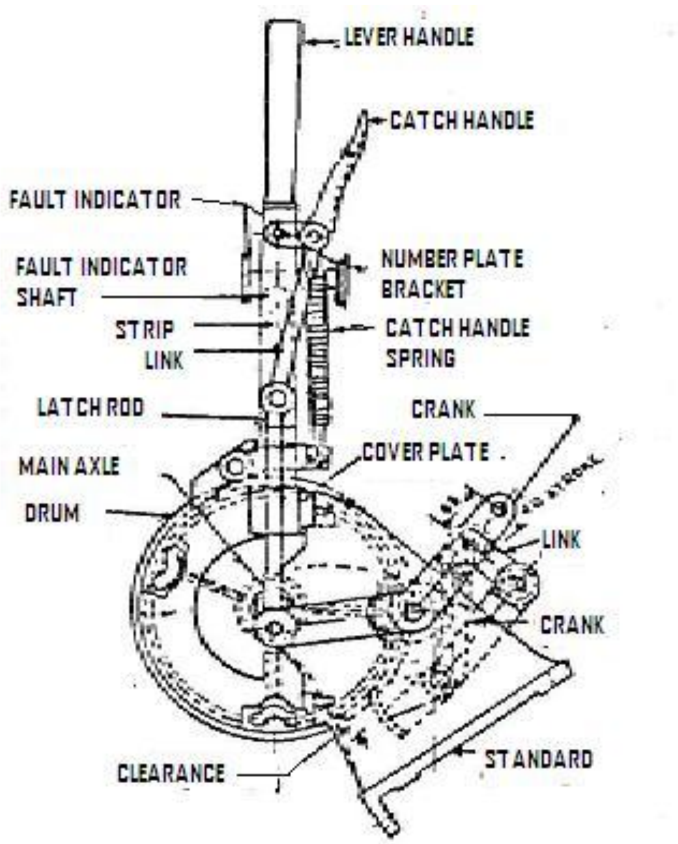
3.9 Hook Lock

It is a device adopted to prevent the tripping of a coupled clutch lever when the other coupled lever, is under operation.

In the case of coupled transmission, the transmission loop is common to both the coupled levers. When either of the levers is being operated, a tension difference is created in the wires which are felt at both the levers. The lever under operation cannot trip because a clutch lever can trip only in full normal or full reverse position. However, since there is nothing to prevent the tripping of the coupled lever which is at rest, this may trip. To prevent the tripping of the lever at rest, the hook lock is employed on clutch lever.

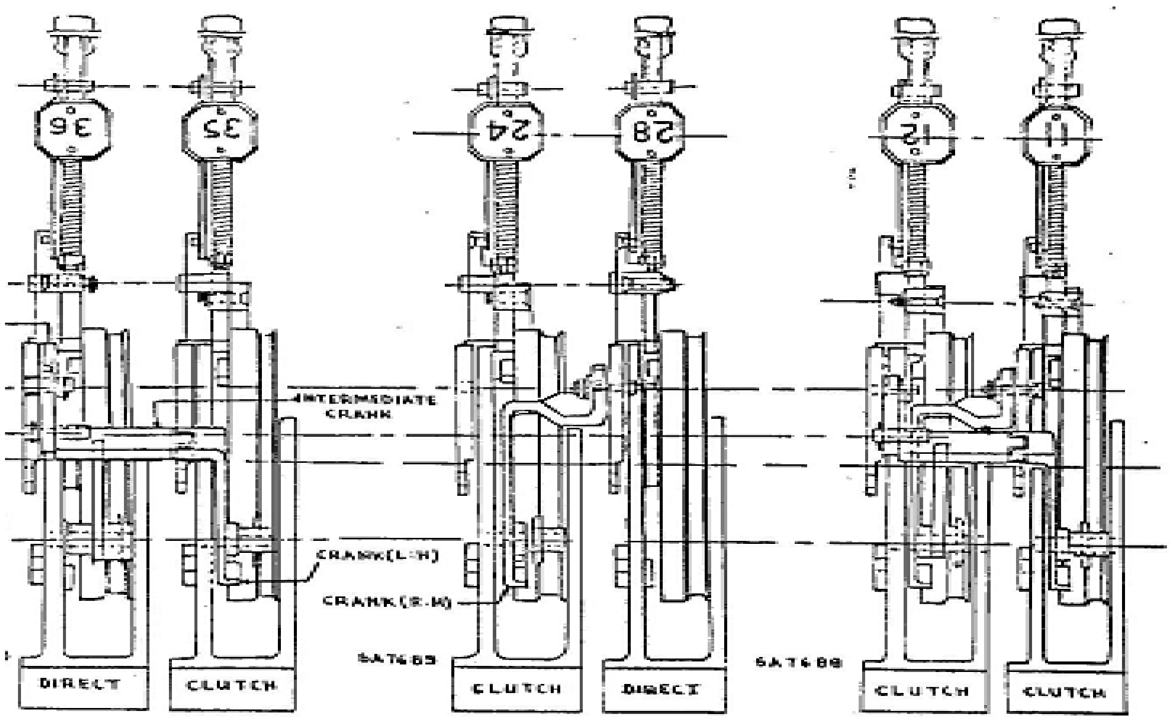
The coupled levers may be both direct or both clutch or one clutch and one direct. When two direct levers are coupled, no hook lock is necessary because a direct lever cannot trip.

The hook lock is available for left hand & right fitting. A notch is out on the rope drum of the clutch lever to receive the wedge. The assembly is shown in Fig.3.4.



COUPLED CLUTCH LEVER (END VIEW)

Fig 3.4



COUPLED CLUTCH LEVER (BACK VIEW)

Fig 3.4

CHAPTER 4: POINTS

4.1 Points are not worked directly by the D.W. transmission, but through a point mechanism. The point mechanism rope drum has a rotary motion but the stroke required on the point throw (operating) rod is rectilinear. The point mechanism, therefore, must convert the rotary stroke of the drum to linear stroke for working the points.

4.2 Economical Point Mechanism (SA 7898 M)

An economical point mechanism, i.e., a mechanism alone working both points and facing point lock with or without lock bar must provide two rectilinear strokes, one for setting the points and the other, (which is at right angles to the former) for locking the points. Points when worked and locked by the same lever and the same mechanism are locked both when the lever is normal and when it is reverse. Therefore, before the point starts moving, the point must get unlocked and after the point has been set it should get locked again. Two methods - the "in and out" and "straight through" are usually employed for this arrangement. In the "in and out" arrangement, the lock plunger moves out of the split stretcher bars, then the points move and finally the plunger moves back to lock the points. For the other arrangement, the lock plunger moves in the same direction, both for unlocking and relocking of the points and continues to move even during the period when the points are moving.

The length of the crank arms required for N.G / M.G. & B.G. for 106 mm & 121 mm stroke are as respectively as follows

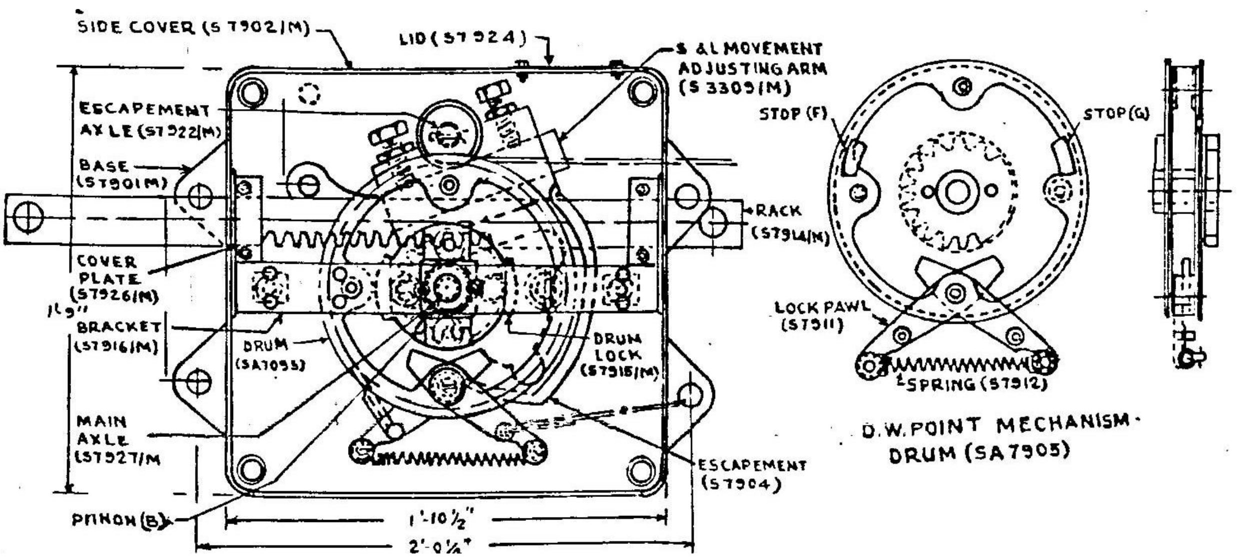
B.G. :

$$\frac{121}{2 \text{ Sin } 18^{o}} = 195 \text{ mm}$$

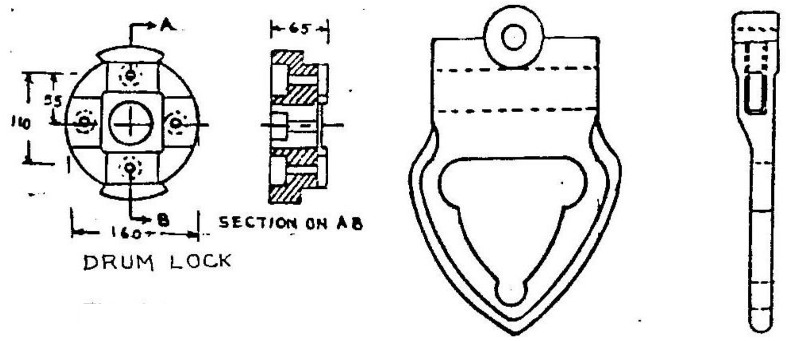
M.G./ N.G. :

$$\frac{106}{2 \text{ Sin } 18^{0}} = 171.5\text{mm}$$

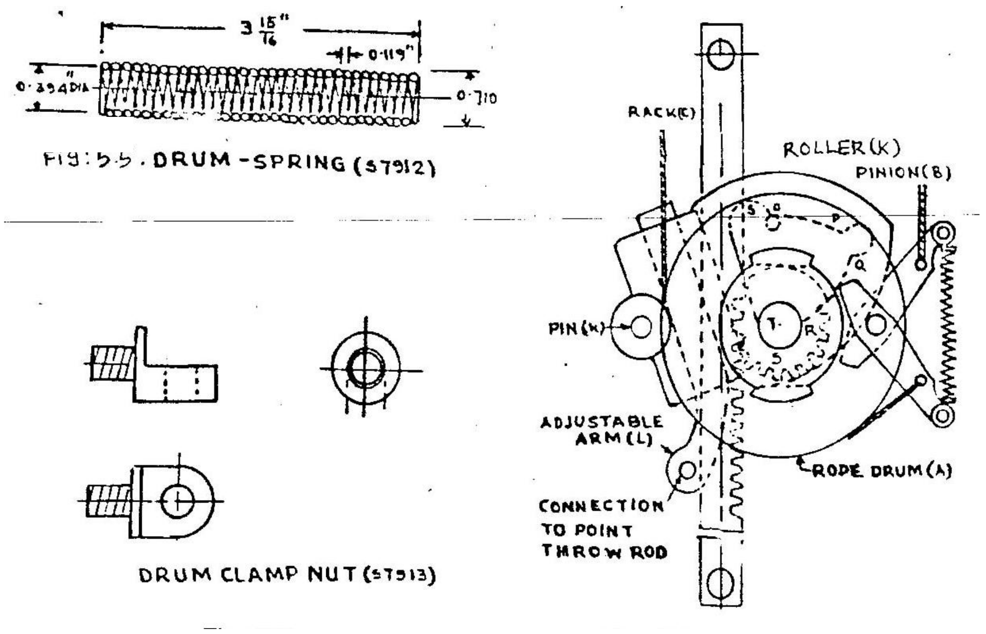
The point mechanism drum has a roller fitted on its underside. The escapement cam 'OP' is concentric with the axis of rotation of the rope drum and the roller normally touches the point ‘O’. Travelling from P to Q the roller has to jump across the gap. Therefore, the rotation of drum during which the roller shifts from position ‘O’ to position ‘Q’ does not impart any stroke to the escapement and therefore, points remain stationary. However, during this period rack moves (rack moves continuously along with the drum) and consequently the facing point lock gets a stroke. This stroke of the F.P.L is called the unlocking stroke. The cam ‘QR’ of the escapement is eccentric the movement of the roller beyond the point Q drives the escapement along thereby imparting stroke to the points. The escapement continues to move with the rope drum till the circular portion strikes against the boss ‘T’ of rope drum. The boss ‘T’ acts as a limiting stop. At this point, the cam 'OR' having moved and occupied the position ‘Q R' becomes concentric and roller shifts from position 'Q' to 'R' points are stationary but the lock plunger moves. This stroke is utilised for locking the points is called the locking stroke as shown in Fig4.2.



D.W. POINT MECHANISM (SA 7898 / M - 7900 / M)

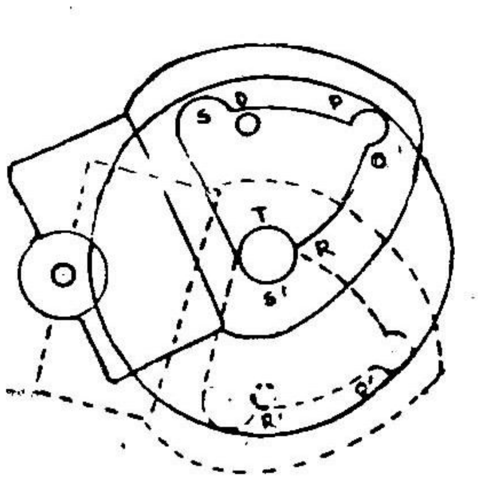


ESCAPEMENT (S 7904)



D.W POINT MECHANISM AND PARTS

Fig 4.1



WORKING OF ECONOMIC POINT MECHANISM

Fig 4.2

The unlocking point setting and relocking strokes are approximately as follows:

Stroke	Rack Movement	Mech. drum movement
Unlocking stroke	51 mm	127 mm
Point setting stroke	107 mm	268 mm
Relocking Stroke	42 mm	105 mm
	200 mm	500 mm

4.3 Non-Economical Point Mechanism & Facing Point Lock Mechanism

Non economical point mechanism & facing point lock mechanism is similar to the economical type described above except that the former does not have a rack and pinion a non-economical point lock mechanism on the other hand, has a rack and pinion, but is without the escapement and the roller.

4.4 Broken Wire Lock

4.4.1 Definition

Broken wire lock is a device adopted to prevent the operation of points in the event of the last pull wire of the transmission breaking.

4.4.2 Necessity

One of the evil effects of pre-tensioning of the transmission wires is the capacity of a wire to move a mechanism when the other wire breaks. This can operate the function and cause it to occupy a position not in correspondence with that of the lever. In the case of point mechanism the last push wire breakage does not affect the position of the points because the stops are always contact and a further movement cannot result. However, the last pull wire breakage causes the stops to move apart and therefore, the points could work. To avoid this, the broken wire lock is employed.

4.5 Broken Wire Test

To prove the motion of broken wire lock of point or lock mechanism, last pull wire must be disconnected at both the lever normal and reverse position. The disconnection must be effected by removing the disconnecting link or wire adjusting screw pin near the lead out. This test must be carried out by each Inspector Incharge of Maintenance of double wire installations at least, once in a year unless otherwise specified.

Broken wire lock pawls must be tested for an easy movement every quarter by lifting the compensator weights. The point mechanism is to be installed on base plate secured to two long sleepers.

4.6 Point Layout

For the operation of points, a point throw rod having a point adjusting screws incorporated in its design is connected between the adjusting arm of the escapement and a lug fitted on the leading Williams stretcher bar connecting the two switches of the points. The locking of the points is done through the following members in order:-

S.No	Description	Qty
1	Mechanism rod having a rod adjusting screw	1
2.	Right angle crank 300 X 300 (12" x 12")	1
3.	Crank Rod	1
4.	Right angle crank 300 X 300 (12" X 12")	1
5.	Long bar driving rod	1
6.	Lock bar 12810(42' - 0")	1
7.	Lock bar clips	12 min.
8.	Lock bar stops and guides	3 min.
9.	Driving attachments	2
10.	Special top stud.	1
11.	Straight crank 8.5/8" X 8.5/8"	1
12.	Short bar driving rod.	1
13.	Plunger driving rod having a rod adjusting screw.	1
14.	Economical facing point lock	1
15.	Split stretcher bars	1 set.

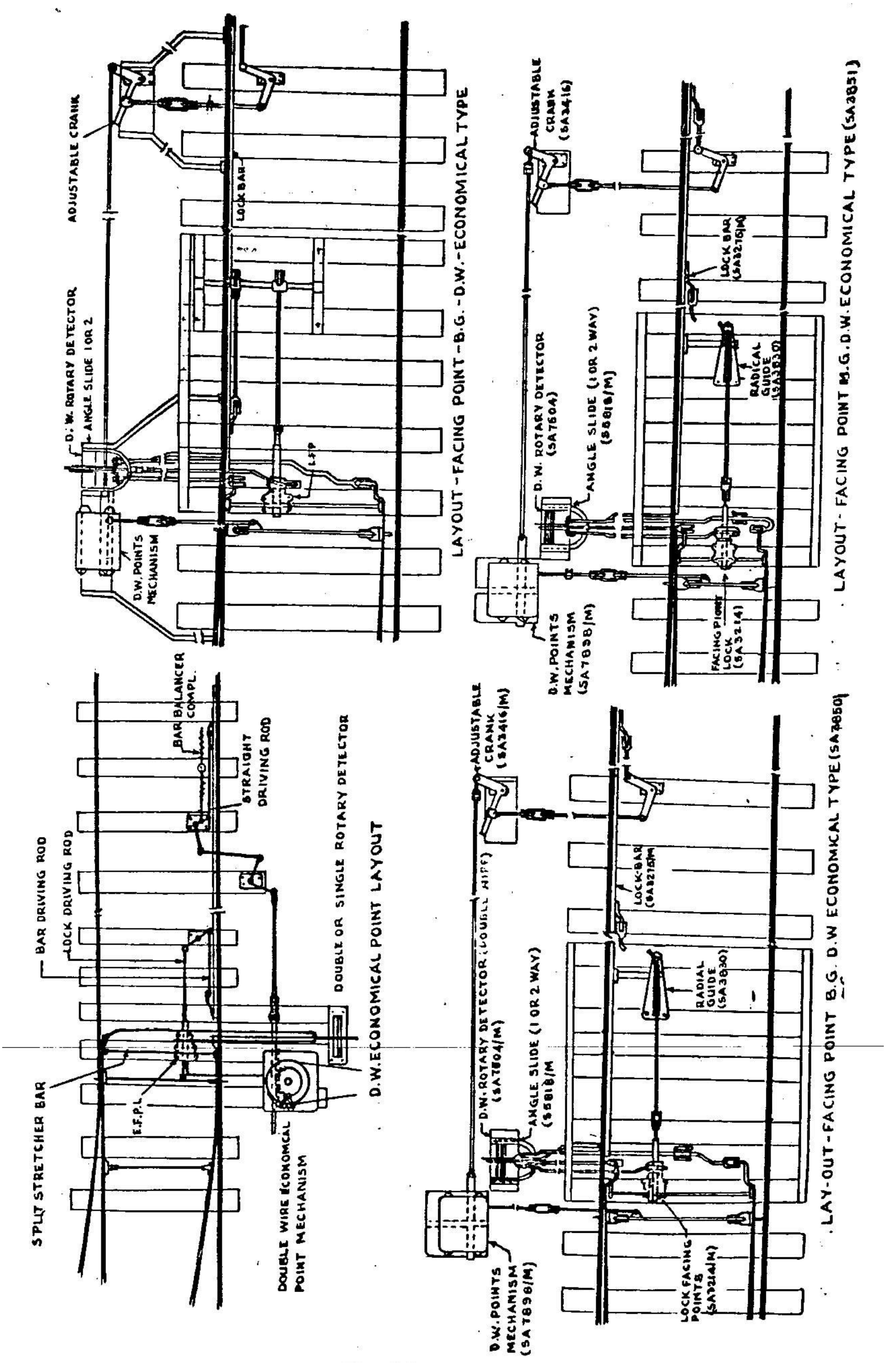

ADJUSTABLE CRANK
D.W. ROTARY DETECTOR
ANGLE SLIDE 1 OR 2
LOCK BAR
D.W. POINTS MECHANISM
LAYOUT - FACING POINT - B.G. - D.W. - ECONOMICAL TYPE
ADJUSTABLE CRANK (SA3416)
D.W. ROTARY DETECTOR (SA7604)
ANGLE SLIDE (1 OR 2 WAY) (S5818/M)
LOCK BAR (SA3275/M)
RADICAL GUIDE (SA3830)
D.W. POINTS MECHANISM (SA7898/M)
FACING POINT LOCK (SA3214)
LAYOUT - FACING POINT M.G. D.W. ECONOMICAL TYPE (SA2851)
SPLIT STRETCHER BAR
BAR DRIVING ROD
LOCK DRIVING ROD
E.F.P.L.
BAR BALANCER COMPL.
STRAIGHT DRIVING ROD
DOUBLE OR SINGLE ROTARY DETECTOR
DOUBLE WIRE ECONOMICAL POINT MECHANISM
D.W. ECONOMICAL POINT LAYOUT
ADJUSTABLE CRANK (SA3416/M)
D.W. ROTARY DETECTOR (DOUBLE WIRE) (SA7804/M)
ANGLE SLIDE (1 OR 2 WAY) (S5818/M)
LOCK-BAR (SA3275/M)
RADIAL GUIDE (SA3830)
D.W. POINTS MECHANISM (SA7898/M)
LOCK FACING POINTS (SA3214/M)
LAY-OUT - FACING POINT B.G. D.W ECONOMICAL TYPE (SA7850)

Fig 4.3

4.7 Facing Point Lock

For B.G. layouts, the facing point lock is fitted off centre to avoid damage due to hanging couplings etc. The C/L of the plunger is usually kept about 500 mm (20") from the running face of the nearest stock rail. The lock is bolted to the sleeper by means of 18 mm (3/4") dia bolts.

4.8 Economical Facing Point Lock (SA 3214/M)

This is fitted in a manner similar to the one described for the facing point lock.

The lock plunger consists of a 49.8 mm wide steel bar fitted when two lock dogs 38mm wide each and placed 158 mm apart. The two lock dogs are stagger as shown in Fig.4.4 by 12 mm Staggering of the dogs is a means of proving the route. The function of an economical point mechanism is to set the points and lock them. This means that unless the points have responded to the lever movement, they should not get locked. Staggering of the lock dogs facilitates this. If the points do not move due to a disconnection in the throw rod, but the plunger moves, the locking dog will recede out of the stretcher bar notches, but the other dog will not be able to enter it because the notch is displaced 12 mm from the alignment of this second dog. Full stroke of the point mechanism cannot be completed under the above circumstances and therefore, when the lever is force latched, it will trip indicating the fault.

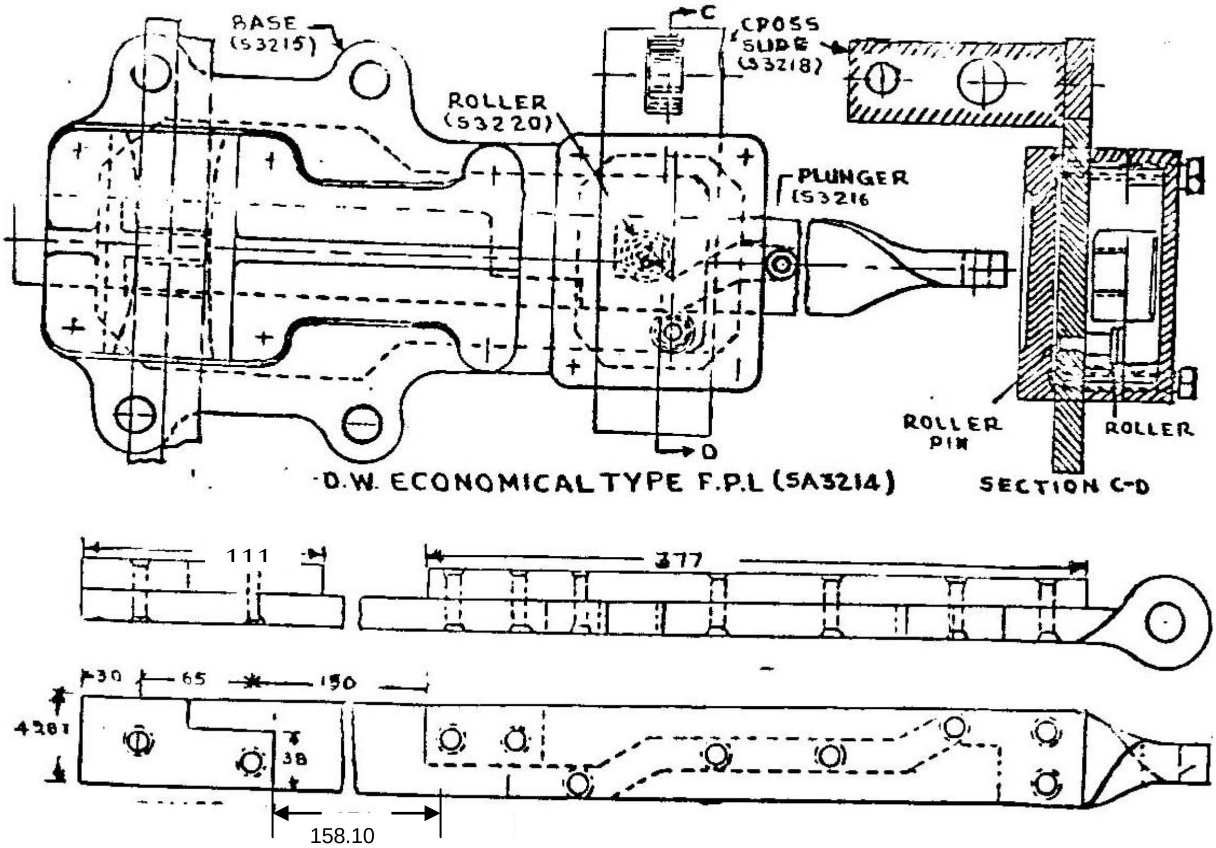


Fig: 4.4 LOCK FACING POINT – PLUNGER (53216)

This 12mm stagger can, however, fail to achieve the purpose under the following conditions. If the point throw rod breaks after the points have just moved, the points might travel 12mm and then come to rest. This may cause the normal notch to come in alignment with the dog locking the point in the reverse position. Lever will be latched without tripping and points would be locked through dangerously gaping. To avoid this a simple thumb rule to ensure this is to see that "with the left hand switch closed", plunger is "IN" and "with the right hand switch closed" plunger is "OUT", with the left hand switch closed, the dog A which is displaced to the right of the dog 'B' and its notch for 'B' further towards the right thereby making it impossible for the dog 'A' to enter the notch nominated for B and vice versa.

4.9 Plunger / Lock Detection

The purpose of plunger/lock detection is to ensure that the points are effectively locked before the signal can be cleared. For this purpose, a cam is fitted on the underside of the plunger. Two roller followers fitted on a cross slide are normally flanking the cam on either side. The cam is designed to give the stroke to the cross slide as follows.

	Movement of plunger		Corresponding movement of cross slide	
	9 mm	3/8"	Idle	Idle
	33 mm	1.5/16"	16 mm	5/8 "
	122 mm	4.7/8 "	Idle	Idle
	33 mm	1.5/16"	16 mm	5/8 "
	3 mm	1/8"	Idle	Idle
Total	200 mm	8"	32 mm	1 ¼"

It will, therefore, be seen that the lock slide gets a stroke initially when the points are getting unlocked and again it gets a stroke in the final stage, when the points are relocked. So that as soon as the points cease to remain effectively locked, the lock slide obstructs the detector and till the points are effectively locked in the reverse position, the reverse notches does not come in alignment with the detector rim.

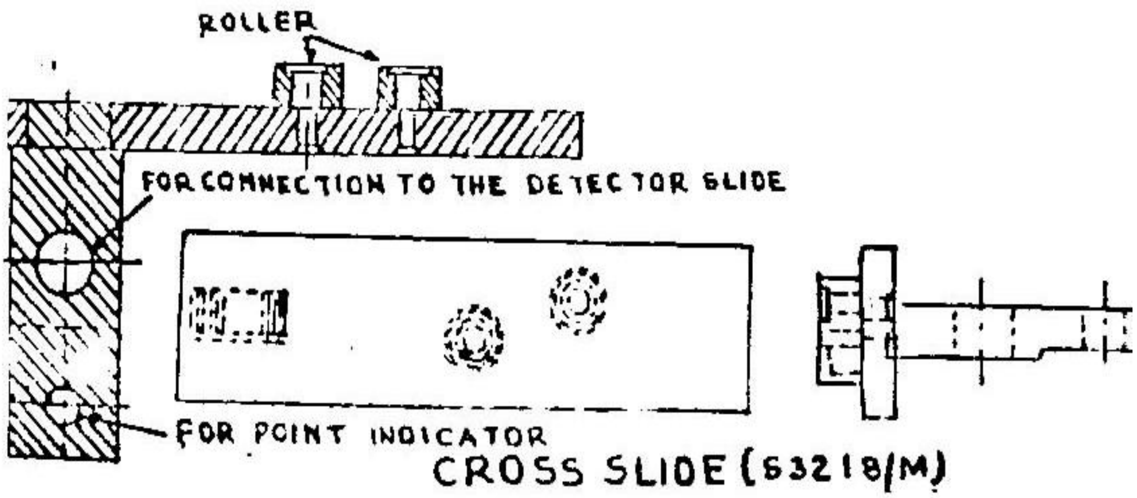


Fig: 4.5

The notch in the lock detector slide is cut 18 mm wide so as to have a clearance of (18-12)/2=6/2=3 mm on either side of the detector rim. This clearance is provided to allow the signal to clear if one of the stretchers (connected to the closed switch) is fully locked and the second split stretcher bar is locked sufficiently to prevent movement of the switches.

Direction of movement of lock slide is opposite to that of point slides. This is done to ensure that, in the event of, the lock detector rod getting disconnected, the point slides, due to friction, cannot carry the lock slide along, thereby permitting the signal to be cleared. Possibility of the disconnected lock slide moving with the point slides is there because all the three slides move in the same opening in the detector stand.

4.10 Essential requirements before Interlocking

Before the interlocking work at points is taken in hand, it must be ensured that the Permanent Way Inspector has

(a) Brought the track to correct level and alignment

(b) Eased off rail joints on either side of points to be interlocked and closed the stock rail joints associated with lock bars.

(c) Fully ballasted and packed all points which are to be interlocked and taken adequate measures to prevent lateral and longitudinal movement of points.

(d) Provided creep and level pillars.

(e) Arranged the sleepers on adjacent track in alignment where rods and wires have to cross.

(f) Seen that the gauge is correct.

(g) Provided and fixed special timbers where required

(h) Provided means to prevent creep in the vicinity of points.

(i) Fitted gauge tie plates correctly.

(j) Made the stretchers of such a length so that the throw of switches is 115 mm at the toe of B.G. and 100 mm at the toe of M.G and N.G points.

(k) Adjusted loose heel switches so that:-

(i) They can be thrown both ways with ease and can be housed against the stock rail by hand and remain there when the pressure is removed.

(ii) The planed surface of the switch rail fully houses against the stock rails for a Sufficient length as per approved drawings.

(l) Adjusted fixed heel switches so that:-

(i) They normally lie in the mid-position and flex equally in the normal and Reversed positions.

(ii) The planed surface of the switch rails fully houses against the stock rails for a sufficient length as per approved drawings.

(m) Fitted flexible stretchers so that they flex equally in the normal and reverse positions.

(n) Provided a stop for the open position of a single switch layout.

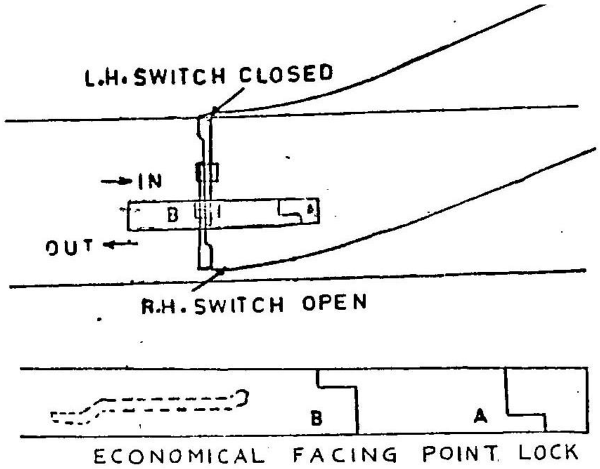


Fig: 4.6

4.11 Adjustment of Point

(a) With the gear disconnected, operate only the point mechanism by the lever and see that the mechanism drum moves from stop to stop both in the normal and reverse positions when the lever is operated, with almost equal smartness.

(b) If the mechanism drum travels upto the stop in one position, but the latching of the lever is hard and in the other position, the mechanism stops stand apart, it is an indication that the two wires of the transmission are out of balance. Usually this adjustment will have compensator weights locked when the lever is latched in one position when the stops butt with each other and the latching is hard. The wires have to be suitably adjusted by means of wire adjusting screws near the point mechanism to see that the mechanism drum travels from stop to stop and that the compensator weights are floating both in the normal and reverse positions of the lever.

(c) When an oversized lever drum 600 mm stroke is used, the wires should first be adjusted so as to cause both the compensator weights to float with the lever normal and the mechanism drum correctly adjusted against the stops. By means of wire adjusting screws near the leadout, the length of pull wire should then be increased by 50mm and that of the return wire shortened by 50 mm. Lever is then operated to ensure that the mechanism travels from stop to stop in both positions.

(d) Operate the lever from normal to reverse and adjust the length of the adjusting arm of the escapement to give a stroke of about (115+6) for B.G. and (100+6) for M.G.

(e) Operate the lever till the rack has moved 51 unlocking strokes + 107/2 point operating strokes (51+54) or 105 mm from its normal position.

(f) By means of a crow bar keep the points at mid position and connect the correct length of the throw rod.

(g) Operate the lever from normal to reverse and reverse to normal and see that the points set correctly in both the positions with equal amount of spring. Spring on the points can be tested by forcing the closed tongue rail by means of a Tommy bar. If the tongue rail falls back to the original position on removing the tommy bar, the spring is correct, otherwise, it is less. Presence of excessive spring can be adjusted by the amount of force required to split the points by means of a tommy bar.

(h) If on operation of the lever, it is found that on one side the points set correctly and on the other side they gap, or that the gaping on either side is unequal or that the spring on the two sides is not the same, it indicates that the stroke of the point mechanism is not in balance. A balanced stroke is divided equally on both sides of the central position. The stroke can be balanced by means of the point adjusting screw provided in the throw rod. Check nuts of the adjusting screw should be tightened.

(i) After the stroke is balanced, it can be increased or decreased by means of the adjusting arm of the escapement. If the points are gaping the effective length of the arm is increased and if they have too much of spring the effective length is decreased. Every time, the length of the arm is adjusted, the studs and the check nuts should be firmly tightened.

(j) Lock bar should then be operated by means of a tommy bar to ensure that it travels full 200mm when moved from its resting on the stop position on the side to its similar position on the other side. If it moves less or more stops should be re-fixed.

(k) Keep the lock bar centre (all the lock bar clips should be vertical) and at the right angle to lock bar and cranks at square (one arm each of the right angle cranks and the straight crank, should be at right angles to the stock rail), connect the long and short driving rods.

(l) Operate the lock bar with hand or tommy bar and see that its working is not unduly hard. If it is hard, it indicates excessive friction on the crank pins, lock bar clips etc. Remove this friction.

(m) Keep the lever centre (rack should have moved 100 mm from its normal position) and lock bar centre and connect the correct length of the mechanism rod. Operate the lever from normal to reverse and vice versa and see that the lock bar rests on the stops in both the positions. Any adjustments needed can be done by means of the rod adjusting screw provided in the mechanism rod.

(n) With split stretcher bars lying midway in the throat of the F.P.L Box, adjust the plunger so that the lock dog not only locks both the stretcher fully, but protrudes 3 mm beyond. With lever normal connect the correct length of the plunger driving rod. The length of this rod can be adjusted to suit by means of the rod adjusting screw provided. Operate the lever from normal to reverse and see that the other lock dog, similarly locks the two stretchers, and protrudes 3 mm.

(o) Place an obstruction 5 mm thick approximately 150 mm from the toe of the switch alternately between each switch rail and its stock rail and operate the lever. See that the lock dog does not enter the notches on the split. Stretcher bars and that the detector cannot be operated.

(p) See that the lever trips when latched. If the lever does not trip, re adjusts the clutch spring to the lower value above 72 Kgs and try again. If the lever still does not trip, lengthening the adjusting arm and the lever latched again should increase the spring of the points. The lever should trip if the transmission wires do not have excessive kinks and twists. If the lever does not trip even with increased spring on the points, kinks and twists in the wires must be removed by means of a wooden mallet. Spring on the points, should however, not to be increased too much because then the broken wire lock starts functioning during operation of the lever causing point failure. If the lever fails to trip even after taking the above precautions, then a 600 mm stroke lever should be employed irrespective of the length of the transmission.

4.12 Broken Wire Test

Disconnect the Return wire with lever normal and Pull wire with the lever reverse, see that the broken wire lock functions to hold the points in the last operated position. It must also be observed that when conducting broken wire tests the clutch lever trip.

The main features of these layouts are as under:-

(a) F.P.lock is fixed at 500 mm from the gauge face in B.G. and at centre in M.G.

(b) Point mechanism and rotary detector are shown fixed on the same side of the track since the wire transmissions will normally be on one side only.

(c) The point mechanism and detectors are shown as fixed on independent and unconnected concrete foundations. The detector is kept floating. The Signal Standard Committee considered the desirability of fixing the points mechanism and detector on extended sleepers or tie plates instead of on separate foundations. While it was agreed that the former arrangement is preferable, it was felt that this need not be standardised due to shortage of long sleepers, want of which may hold up important works.

(d) Radial guide, instead of rocker shaft is standardised, since the latter requires the ballast to be removed for its fixing and also it requires more steel.

(e) Lock slide is detected first to prove the last operation first.

CHAPTER 5: SIGNALS

5.1 Objectives of Signal Mechanism

Signals are not worked directly by the transmission, but one worked through Signal Mechanisms. A signal mechanism should be designed to achieve the following objectives:-

(a) Preventing inaccuracies in the transmission of lever strokes from affecting the display of correct signal aspects.

(b) Providing broken wire protection

(c) Co-relating the down rod movement with that of the mechanism drum during working stroke so as to:-

(i) Make the maximum torque required for signal operation as low as practicable and thereby increase the range of signal operation and the ease of lever operation, and also limit loss of stroke during working stroke, and

(ii) Keep to the minimum the undesirable forces operating on the signal post during working of the signal and thereby reduce the stresses induced in the material of the post and also the intensity of vibration of the post.

(d) Adaptability of the mechanism to work as left hand or right hand, and lower quadrant or upper quadrant signal mechanism.

(e) Simplicity and ease of manufacture of the parts.

(f) Adaptability of the mechanism to work as a single or a coupled signal mechanism.

5.2.1 Concentric Cam Path

The concentric path provides stability to the 'ON' and 'OFF' aspects which is desirable to counteract the effect of:-

(a) Variation in the loss of stroke of the transmission

(b) Variation in the uncompensated length of transmission wire between coupled signals.

(c) Minor maladjustment of the transmission wires.

(d) Outside interference.

From the above considerations, it will be seen that the magnitude of idle strokes should be as much as possible. The limitation on this, however, placed by the magnitude of working stroke which cannot be indefinitely decreased because a reasonable mechanical advantage at the mechanism is necessary to be provided to facilitate its working. The minimum working stroke required to work an upper quadrant, signal by a 31.75 Kgs. force applied on the lever and with a transmission having two 90 deg and four 60 deg diversions other than those at the leadout and the compensator would be 239 mm . The working stroke for the signal mechanism therefore, is generally kept at 250 mm and the remaining 250 mm s divided between initial and final idle strokes since the (ON aspect of signal is more important than its off aspect from the safety point of view, initial idle stroke is kept around 137 mm and final idle stroke is nearly 113 mm).

5.2.3 Broken Wire Protection

To ensure that the signal displays only 'ON' aspect after a transmission wire breaks, it is necessary to join the two ends of concentric portions corresponding to 'OFF' aspect of the signal to the concentric portion correspond to the 'ON' aspect of the signals by a working path which can operate the signal from OFF to ON position and known as overrun working stroke therefore, becomes necessary. The overrun path will have in general similar component parts as these of the stroke working the signal from ON to OFF position viz., initial overrun idle, overrun working and final overrun idle strokes.

5.2.4 Left hand and right hand signal mechanisms

Signal mechanism is termed as left hand or right hand depending upon whether the crank arm connected to the signal down rod is to the left or right respectively of the centre of the mechanism as viewed by an observer facing the cam.

Stroke of down rod is the product of throw of cam and the ratio of the lengths of the down rod arm and the follower arm of the crank. The stroke will, therefore, remain unaltered if with the same mechanism drum the crank is reversed to have the down rod crank arm on the opposite side of the centre line of the mechanism.

With such a conversion of R.H mechanism to L.H and vice versa the correct 'ON' and 'OFF' aspects of the signals are not affected. Point of contact between the roller follower and the cam with the mechanism in normal position must be the same irrespective of whether it is a right hand or a left hand mechanism. But conversion of a mechanism requires changing the position of the roller. Therefore, the mechanism drum has to be rotated so as to make the point of contact in the cam coincide with that on the roller follower. The stops, therefore, also need shifting by the same angle through which the mechanism drum has moved.

5.2.5 Lower Quadrant and Upper Quadrant Signal Mechanism

Working of lower quadrant and upper quadrant signals differ from each other in respect of magnitude and direction on movement of down rod. If the same mechanism drum is to serve for both the purposes, the different amount of strokes has necessarily to be achieved by employing separate cranks with suitable ratio of the crank arms. This however, applies to mechanism working the 0 - 45 deg aspect of the UQ signal only. A lower quadrant signal and a signal working the 0 - 90 deg aspect cannot be worked by the same mechanism because the stroke required for a 'B' type lower quadrant spectacle is 90 mm while that for an upper quadrant signal spectacle to work it to 90 deg. is 216 mm. Similarly the push pull 45^0-0^0-90^0 deg and the pull-pull 0-45-90 deg. UQ signal mechanisms have no corresponding functions in lower quadrant signalling and therefore, separate designs for them also are necessary. The only mechanism that can be common to lower quadrant and upper quadrant signalling is, therefore, the one working the signal to the 45^0. aspect.

Two types of LQ spectacles are in use on the Indian Railways. The 'A' type and 'B' type. Correct lowering of an 'A' type spectacle is 50^0 while that for the 'B' type is 45^0. The strokes required on the down rods for the two types of spectacles to correctly lower the signals are 130 mm and 90 mm respectively. The mechanisms working 'A' type and 'B' type spectacles are similar in all respects excepting that they have cranks of different arm ratios.

5.2.6 Signal mechanism with detectors in their transmission

Single signal mechanism having detectors in their transmission must allow a movement of at least 165 mm on the wrong side to ensure that the detector locks the points in the last operated position in the event of the pull wire breakages. Most of the existing signal mechanisms do not permit any movement on the wrong side. In such cases, the normal stop should be removed and the mechanism is allowed to work only with one stop.

5.3 Types of Signal Mechanisms

5.3.1 Universal signal mechanism has been standardised to provide a single mechanism in all cases when a lower quadrant or an upper quadrant signal has to be worked to 45^0 aspect. Thus it caters for all the lower quadrant requirements and the 0^0 - 45^0, 0^0 - 45^0 and double crank push pull requirements in the upper quadrant. (Refer Drg.No.SA 7256, SA7257, SA7258). The universal signal mechanism gives the following advantages:-

(a) The crank arm associated with the mechanism has three holes so located that the strokes required for 'A' type spectacle B type spectacle and 45^0 aspect of upper quadrant signalling are available.

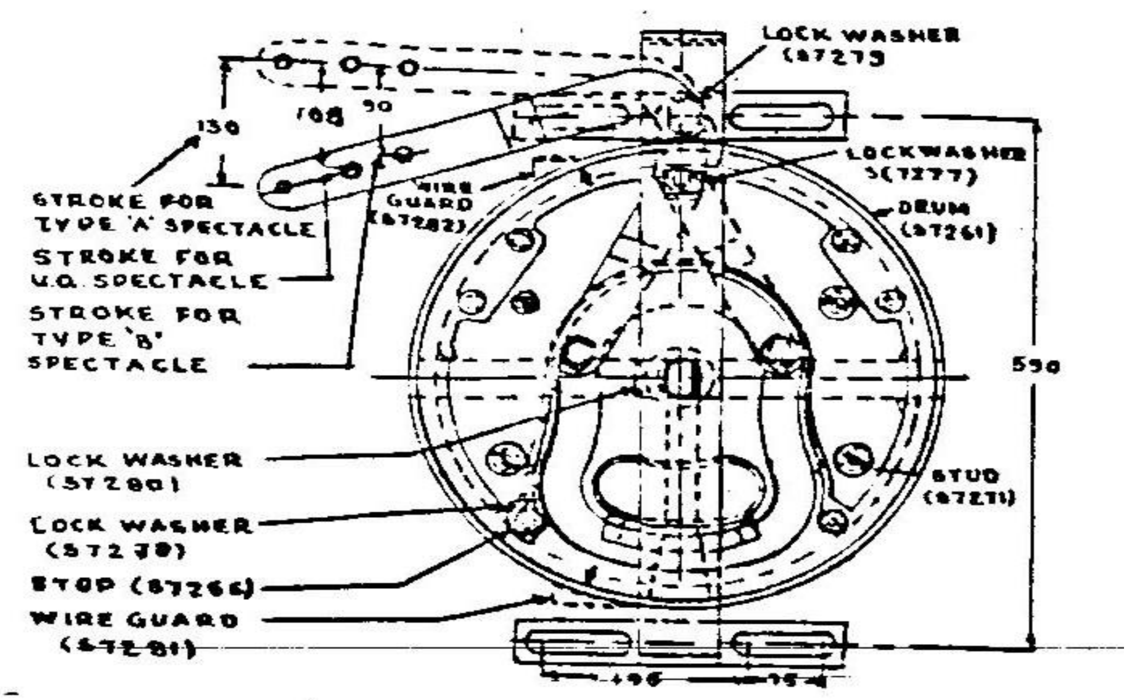
(b) Conversion from left hand to right hand working is simple since the cam paths are symmetrical and the crank can be easily reversed. There is no alternation in stroke. Also since the cranks and bosses have been made separate units, the need for different cranks for right hand and left hand mechanisms is eliminated.

(c) The mechanism can be used in a single or coupled transmission as a single or coupled mechanism by suitably providing or removing the normal stop. (Drum is common with drawing No.S7261).

(d) The normal stop has been so located that it permits adequate movement on the wrong side to ensure that the detector locks the points in the last operated position in the event of pull wire breakage.

While using the universal signal mechanism for Pull-Pull lower quadrant purposes, the mechanism is turned by 500 mm from its normal position. See Fig: 5.1

It may be observed that the broken wire requirements is maximum in this case. At least working stroke 500 mm + locking stroke 500 mm + Total overrun of outer (275 mm) + Total overrun of Warner (275 mm).



D.W.SIGNAL MECHANISM – SINGLE (SA 7256 / M)
Fig: 5.1

5.3.2 Upper Quadrant Signal Mechanism Fig. 5.2

Following types of signal mechanism are used in MAUQ signalling:-

(a) 0^0 - 45^0 signal mechanism (SA7206 RH SA7207 LH)

This mechanism is used for single transmission required to work the signal only to its 45^0 position like loop line Home Signal, loop line starter signal, shunt signal etc. The stroke given to the down rod is 108 mm.

(b) 0^0 - 0^0 - 45^0 Signal Mechanism.

This mechanism is used for one or both of two push pull coupled signals located on separate posts. The signal required to be worked only to its 45^0 position is worked by this mechanism.

There is no difference between 0 - 45^0 and 0^0 - 0^0 - 45^0 signal mechanism except that the first one has two stops, but the second one works only with one stop, by serving the normal stop.

(c) 0^0 - 90^0 Signal Mechanism (SA 7204 RH , SA7205 LH) (SA7290/M).

This is used for working signals to display the 90^0 aspect only like main line starter, advance starter etc. The stroke given to the down rod is 216 mm.

(d) 0^0- 0^0 - 90^0 Signal Mechanism

This is used for working the main line starter to the 90^0 position when this signal is coupled in push pull manner with another signal on a separate post.

The only difference between 0 - 90^0 and 0^0 - 0^0 - 90^0 signal mechanism is that the first one has two stops and the second one only one.

(e) 45^0 - 0^0 - 45^0 Signal Mechanism

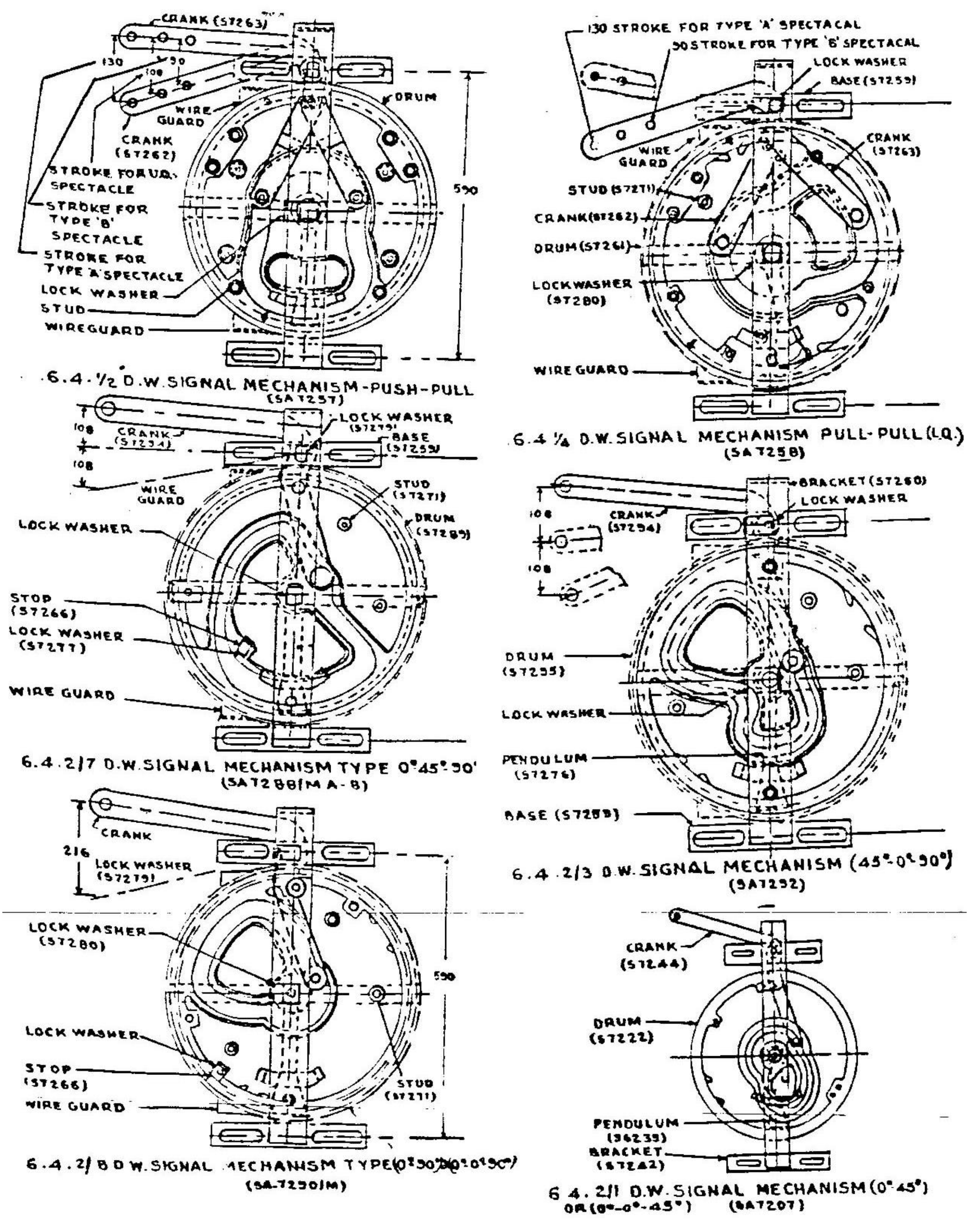
This is a mechanism working only one signal to the same 45^0position, but by two levers. Either of the levers operated works the signal to the 45^0 position.

Use of the mechanism is limited to working a signal reading over two roads. By working the same signal by a different lever for each route simplifies the interlocking and also helps to install a double wheel detector in the transmission for the purpose of route proving.

(f) 90^0 - 0^0 - 90^0 Signal Mechanism:

This mechanism is employed to work the same signal to the 90^0 aspect by either of the two coupled levers.

Its use is similar to that of 45^0 - 0^0 - 45^0 Signal Mechanism except that this can be used only for high speed turnouts where the clear aspect can be allowed to be displayed, for both the diverging roads over which the signal reads.



VARIOUS SIGNAL MECHANISMS

Fig: 5.2

(g) 0^0 - 45^0 - 90^0 Signal Mechanism (SA 7202 RH 7203 LH (SA 7288/M)

This is a pull-pull signal mechanism working the same MAUQ semaphore to the 45^0 position by one lever operation and 90^0 position by the operation of both the levers in succession.

This is used for working 3 aspects main line Home and Distant Signals.

(h) 45^0- 0^0 - 90^0 deg. Signal Mechanism (SA 7200 RH SA 7201 LH) (SA 7292/M).

This is a push-pull signal mechanism working the three aspects of a MAUQ semaphore. The operation of one lever works the signal to the 45^0 position and with this lever normal, operation of the other lever works the signal to the 90^0 position.

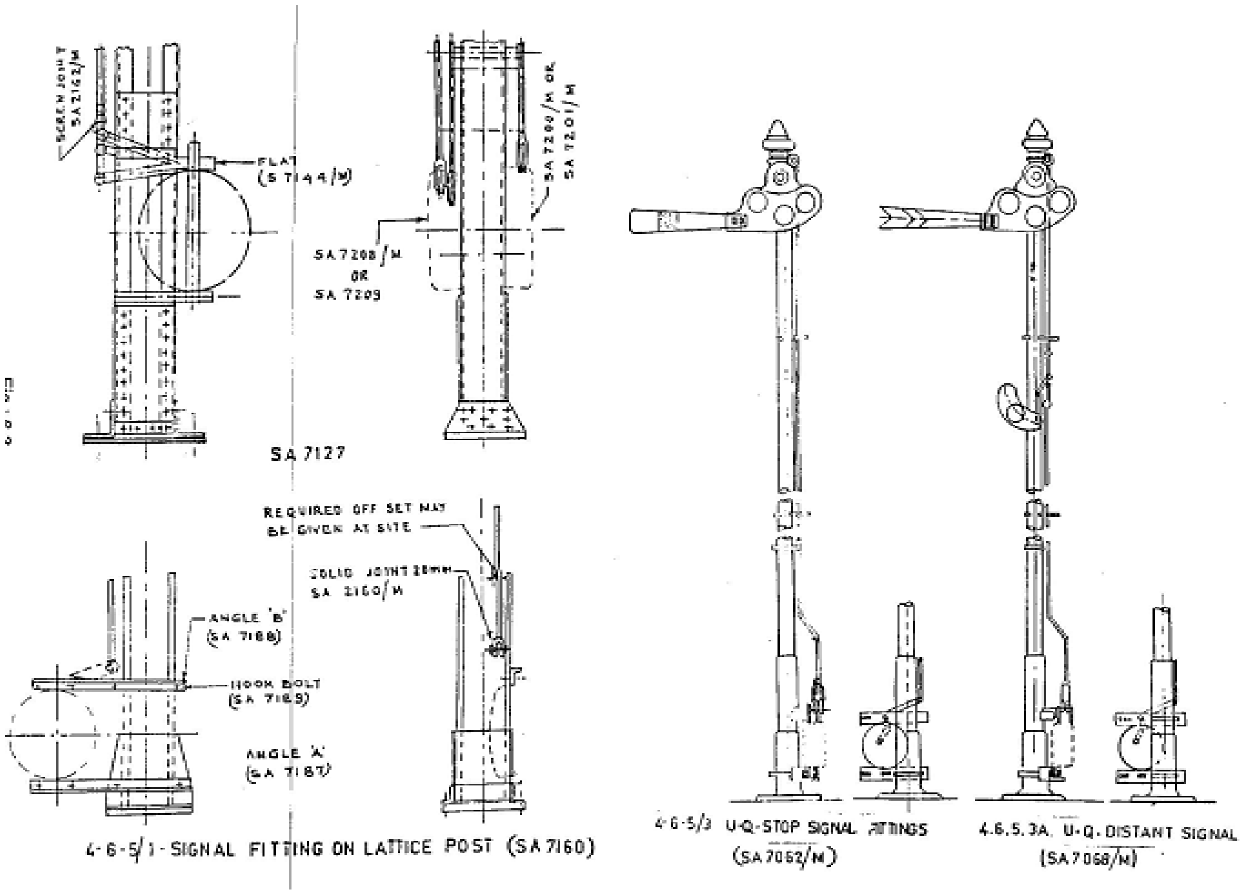
This is used for working a three aspect starter signal and by some railways for working the distant signal.

(i) Push Pull Upper Quadrant Signal Mechanism Double Cranks:

SA 7208 (Adv) for LH

SA7209 (Adv) for RH

This is a push-pull signal mechanism used for two conflicting upper quadrant signals on the same post having 45^0 aspects only. The UP and DN rod in this case imparts 108 mm stroke.



SIGNAL FITTING ON LATTICE / TUBULAR POSTS

FIG: 5.3

CHAPTER 6: DETECTORS

6.1 A detector is a device controlled by facing points and or bolt lock for proving that the point tongue rail or tongue rails and or bolt locks are in their correct positions. A detector is, therefore, a means of interlocking points and or bolt lock with another apparatus generally signals, extended to the actual location of points and or bolt lock. A double wire detector in addition should lock the points in the last operated position.

6.2 Requirements of a Double Wire Detector

(a) To detect the correct position of switch rails with respect to stock rails, i.e., whether the closed switch rail is setting home with its stock rail and the open switch rail is at correct distance away from the stock rail and or whether the points are securely locked by the locking mechanism.

(b) To prove the position (normal or reverse) of the points and thus ensure the correct setting of the route.

(c) To lock the points in their last operated position when

(i) the detector is operated and the transmission is intact.

(ii) the detector is operated and the transmission is broken.

(d) It should be capable of being used in a signal transmission.

6.3 Types

Two types of double wire vertical detectors are in use and they are::-

(a) Double Wire Vertical Rotary Detector - Single wheel SA 7500/M

(b) Double Wire Vertical Rotary Detector - Double wheel SA 7504/M.

The first one is connected in single transmission when a pair of points is required to be detected only in one of its positions (Normal or Reverse) and the semaphore is employed in coupled push-pull transmission to detect a pair of points in both the positions, viz., normal and reverse.

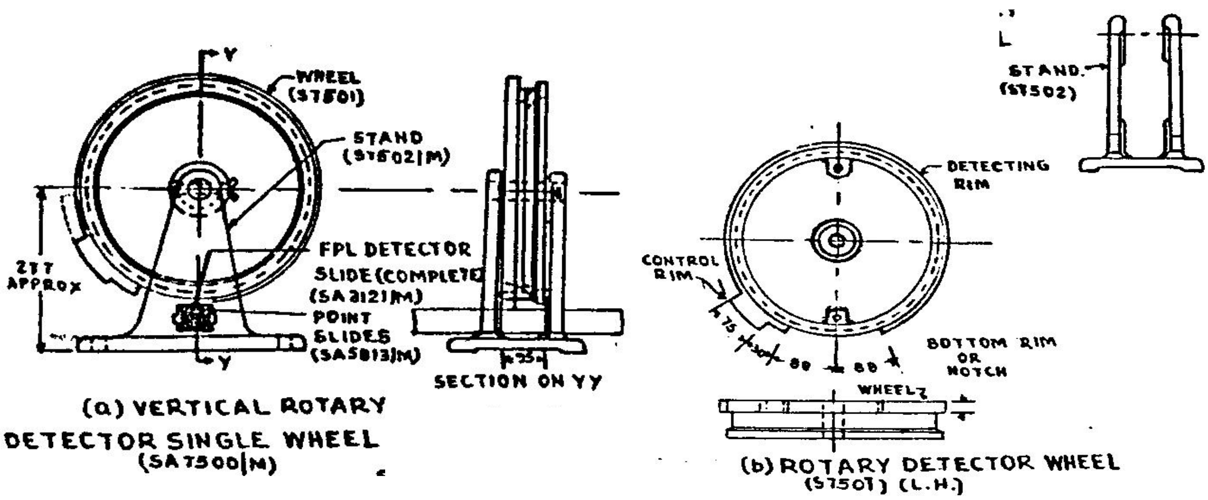


Fig: 6.1

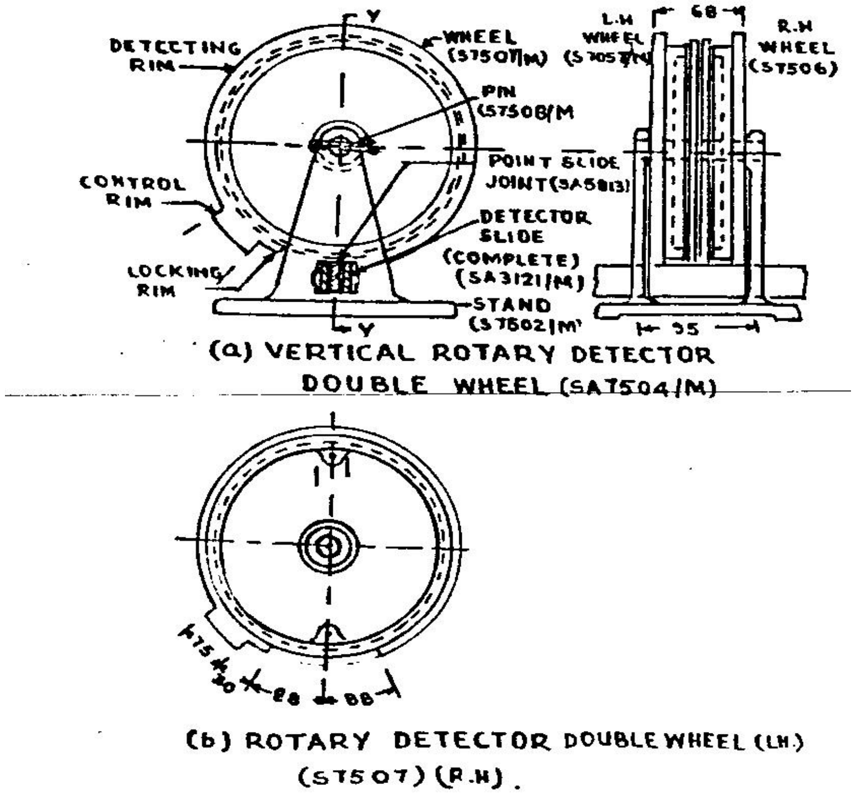


Fig: 6.2

All the detecting, locking, control and bottom rims have a uniform thickness of 12mm the height of the locking and detecting rims is 10 mm each, while the control rim is 25 mm high with respect to the level of the bottom rims. In the case of a double wheel detector, the two detecting wheels are so placed that the detecting, locking and control rim of one wheel are on the left and of the other wheel are on the right as shown in Fig. 6.1. The distance between the centre lines of the rims of the two wheels is 68 mm. The rope drum has a mean circumference (measured at the C/L of the wire rope as wrapped round the drum) of 45 1/2" (360^0 = 1150 mm). The length of the various rims of the detector wheels, in terms of the stroke of the wire rope, is given below:-

Detector Wheel

Description of Rim Name	Length	Thickness	Height wrt. Bottom rim
Bottom rim	176 mm	½"	--------
Locking rim	30 mm	½"	10 mm.
Detecting rim	869 mm	½"	10 mm.
Control rim	75 mm	½"	25 mm.

6.4 Working

As already described, there is a clearance of 1.0 mm between the top of the point, section lock detector slides and the bottom rim. Therefore, the detector can rotate as long as bottom rim is above the point slides. The height of the locking and detecting rims being 10 mm each and that of the control rim 25 mm = 10 -1 = 9 mm (11/32") infringement will be there between the point, lock detector slides and detecting, locking rims and 25 - 1 = 24 mm between the slides and the control rim. lever operation imparts 500 mm (20") stroke to the transmission and therefore, detector must be capable of moving by a like amount notches have to be cut in the point and lock detector slides to permit the locking, detecting and control rims to pass through them thus enabling the detector to operate.

6.4.1 Detecting the correct position of Switch Rails with respect to Stock Rails

Notches in the point and lock detector slides are cut at site. The proving of correct setting of points is achieved by thickness of the detector rims in conjunction with the width of notches. The notches in point slides cannot be cut exactly equal to thickness of the detector rims because of

(a) Preventing friction between detector and the point slides

(b) Preventing a possible failure due to creep of the points.

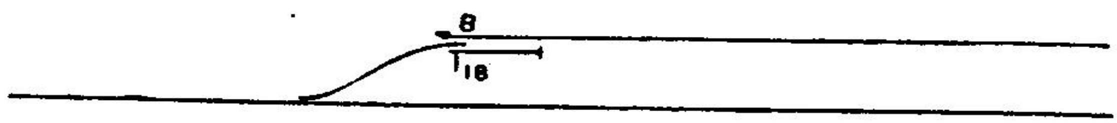
The notches in point slides are, therefore, cut 3 mm wider than the thickness of the detector rims i.e., 12 + 3 = 15 mm and the rims placed centrally over the notch at the mean temperature.

In the case of EFPL, the margin is still wider, cut 6 mm wider than the thickness of the detecting rim i.e. 12 + 6 = 18. This to cater little loss of stroke in lock detection.

6.4.2 Proving the route

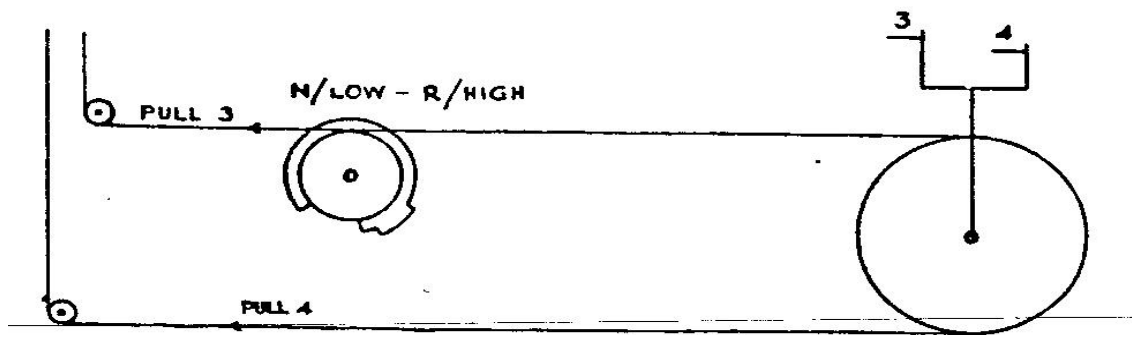
(a) Route proving is an extremely important function of double wire detector. Whereas in any other method of signalling, a disconnection in point transmission will render the points in operative, such a disconnection may throw the points, on break of the last pull wire to the other position. With such condition of the points, the detector should become inoperative so as to prevent the signal being taken off for a road other than for which the points are set.

(b) Points that are required to be detected in one position only i.e., normal or reverse e.g., points leading to sand humps, derailing switches etc., only one notch corresponding to the position of points which is to be detected is cut. Refer Fig. 6.3. If the points throw over due to wire breakage, the point slide will move equal to the throw of the switches and so there will be only notch. Therefore, there will be no notch available for the detector to rotate. It will thus become inoperative thereby proving the route. But route proving assumes importance when points are to be detected both in the Normal and Reverse Positions.



18 DETECTS 8 WHEN REVERSED ONLY. THE POINT SLIDES WILL HAVE A NOTCH IN ALIGNMENT WITH DETECTOR RIM ONLY WHEN THE POINTS ARE IN THEIR CORRECT REVERSE POSITION.

Fig: 6.3

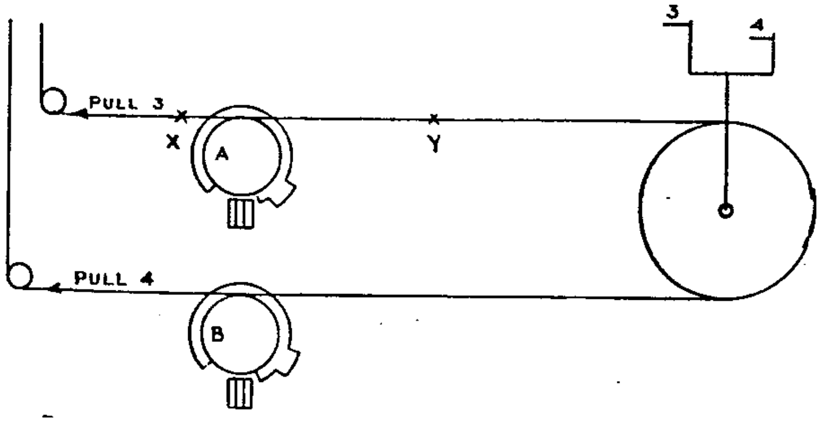


THE ARRANGEMENT NEEDS A LOW NOTCH WHEN POINTS ARE NORMAL AND A HIGH NOTCH WHEN THE POINTS ARE REVERSED.

Fig: 6.4

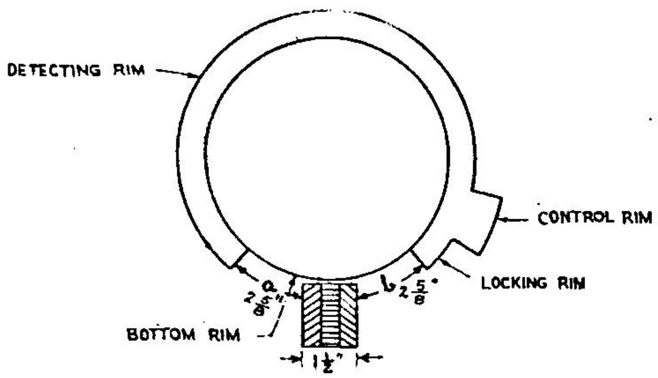
(c) Detection of a pair of points in both the positions indicates that signal movements take place for both the normal and reverse setting of points.

Two levers coupled in push-pull manner are employed for working a detector/detectors detecting both the normal and reverse setting of points. The operation of one lever causes the detector wheel to rotate clockwise but with the first lever normal, the operation of the second lever will rotate the detector wheel counter clockwise. Since the heights of the detecting and control rims are different, notches of different depths are to be cut in the point slides. A 10 mm deep notch cut to permit the detecting rim to move is called a low notch while 25 mm deep notch meant for the control rim is termed the High notch. The point slides will, therefore, have a shallow notch for one setting of the points and a deep notch for the other setting of the points.



Position of Points	Notch for Wheel 'A'	Notch for Wheel 'B'
NORMAL	LOW	HIGH
REVERSE	HIGH	LOW

Fig: 6.5



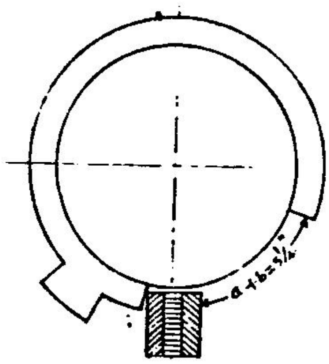


Fig: 6.6 A

Fig: 6.6 B

USE OF DOUBLE WHEEL ROTARY DETECTOR

6.5 Distance between detector and neutral point

A double wire transmission has only two neutral points, one on the lever and the other in the transmission. Neutral point is that point on the transmission the position of which is not affected by the variation in the length of the transmission wires caused by temperature changes. This is that point in a double wire transmission where the length of the pull wire is equal to that of the return wires. Excepting this neutral point, every other point on the transmission moves either away from the compensator or towards the compensator according as the temperature falls or rises. Hence, any gear placed at a position, other than the neutral point will move a distance equal to variation in the portion of the length of wire between this gear and the neutral point.

When the detector is in the normal position the points should be free to be operated. At the mean temperature of 32.5^0 C the clearance between the nearest point slide and locking rim or detecting rim is 70 mm. Therefore, any movement of the detector due to temperature variation in excess of 70 mm will lock the points causing a point failure. This clearance of 70 mm therefore, places a limitation on the distance between the neutral point and the point where the detector can be installed. The linear expansion of the material of wire is 0.01 mm per degree centigrade for one meter. The temperature range is 65 deg C ranging between 2 deg C and 67 deg C. The maximum variation in length of wire of the mean temperature is 70 mm.

Length of the uncompensated wire to be known:
V = Variation in length of transmission = 70 mm: T = Temperature
α = Co-efficient of Thermal Expansion 0.01 mm / 1 MT / 1^0 c

$$V = \alpha\ T \qquad L = \frac{V}{\alpha\ T}:$$

$$= \frac{70}{0.01 \times 32.5} = 215 \text{ m}$$

Which is rounded off to 215 Mts to cater for slight separation of the point and lock detector slides owing to the 3 mm wider notch on the detector stand. If, therefore, there is a distance of 215 mm between the detector and the neutral point, the locking or detecting rims would just touching the nearest point slide at the lowest and the highest temperatures respectively. If the detector is operated under the above circumstances, any slight variation on loss of stroke when the lever operating the detector is put back to normal would cause the detecting or locking rim to keep engaged with the notches on the point slides, causing a point failure. It is, therefore, necessary that some margin is left for the variation of loss of stroke and the maximum distance between the detector and the neutral point reduced suitably.

6.6 Use of detectors in Signal Transmission

(a) If a detector is provided in a Signal Transmission, then the detector control rim, in the event of wire breakage, will knock against a low notch on the point slides thus locking the points either by its detecting rim or by its locking rim. A movement equal to the distance between the nearest point slide and the control rim will result after which the detector will intercept the movement of the signal mechanism. This movement should either be not more than 125 mm (the initial idle stroke on signal mechanism) or not less than 787 mm (the total pull through stroke) so that the signal arm either remaining at or returns to it most restrictive aspect after momentarily taking off.

(b) A detector when connected in a signal transmission is a floating mechanism and moves, due to temperature variation, a distance equal to the variation in length of uncompensated wire i.e., wire between the detector and signal mechanism. Hence, movements of the detector wheel due to wire breakage vary at different temperatures. However, the signal mechanism placed at the neutral point of the transmission remains unaffected by temperature variations. Therefore, the movements of the detector, under the most adverse case of wire breakage, should not be either more than 125 mm or less than 787 mm.

6.7 Installation of Detectors

6.7.1 Requirements

(a) All facing points on passenger running lines must be detected by relative running signals.

(b) Detectors may not be provided on facing points taking off goods lines.

(c) All trailing points on a running line used in the facing direction for shunting movement and not provided with a facing point lock and bar, should preferably be detected by the relative shunt signals.

(d) On all points on the running lines that are fitted with a facing lock, the shunt signal lever should either be released by the facing point lock lever in the cabin or the shunt signal should detect such points.

(e) It is not necessary to detect economical facing point by shunt signals.

(f) Where trains run over the facing points at speeds in excess of 75 kmph (45 m.p.h.) and if a plunger type facing point lock either of the economical type or hand operated type is provided full travel of the plunger should be detected by the relative running signal.

(g) Where trains negotiate the facing points at speeds in excess of 75 kmph (45 mph) full travel of the lock plunger should be detected by the relative running signals if the lock and the switches are operated by the same lever.

(h) It is desirable that plunger detection may also be provided for independently operated facing point locks.

(i) Running signals must detect each switch independently.

(j) Single switch detection is permitted for shunting movements.

6.8 Cutting of Notches

After the point has been connected to the lever and correctly adjusted, the point and lock detector slides should be installed.

After the point and lock slides have been assembled, the detector wheel/wheels should be rotated both clockwise and counter clockwise & mark the impression of the thickness of the detecting and locking rims on the two point slides. Similarly with the points operated to the other position, impressions are obtained on the point slides. Notches should then be carefully cut 3 mm wider than the impression obtained 12+3 = 15 mm with the 3 mm clearance divided equally either side of the impression. The notches be cut square without any bevelling. Shallow and deep notches are cut 10 mm and 25 mm deep respectively.

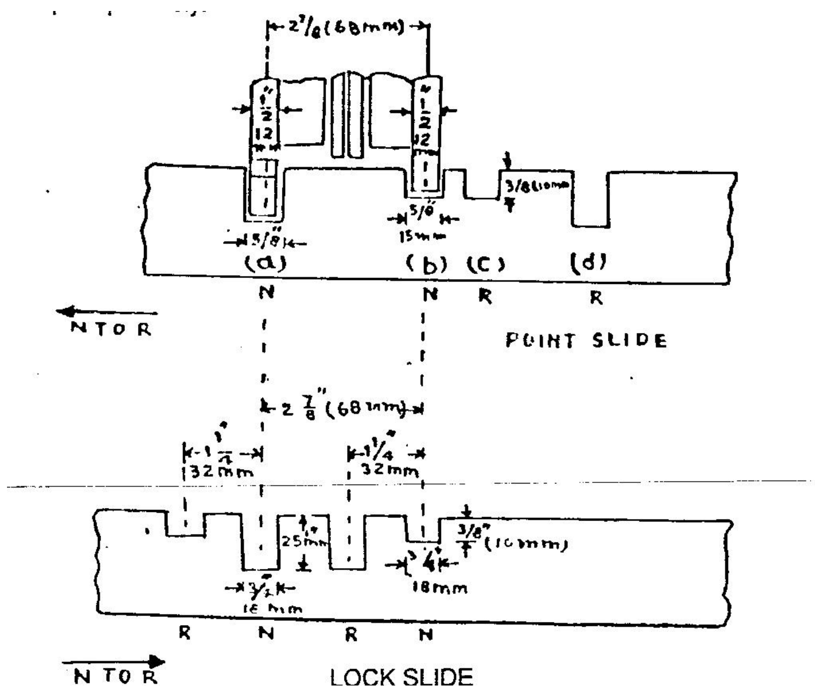


Fig:6.7

Notches on the lock detector slide are marked simultaneously with those on the point slides. The stroke of the lock detector slide is 32 mm and its movement is in a direction opposite to that of the point slides. Notches on the lock detector slides are cut in accordance with Para 6.8.

6.9 Connecting up Detector

Following points should be borne in mind while connecting up detectors:

(a) Wires leading off the detector should be in a straight alignment and should lie in the same plane as that of the detector wheel to avoid unnecessary friction and undue wear.

(b) Single Wheel detectors connected in single signal transmission must be connected in the wire pulling the signal off and should be so connected so as to need a low notch on the point slides (Fig. 6.9).

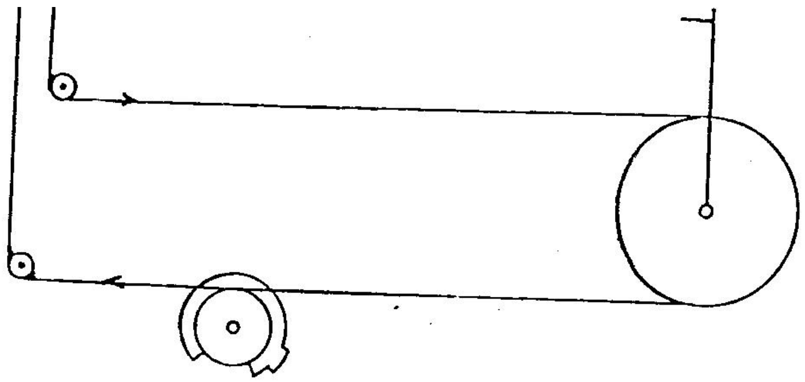


Fig : 6.8

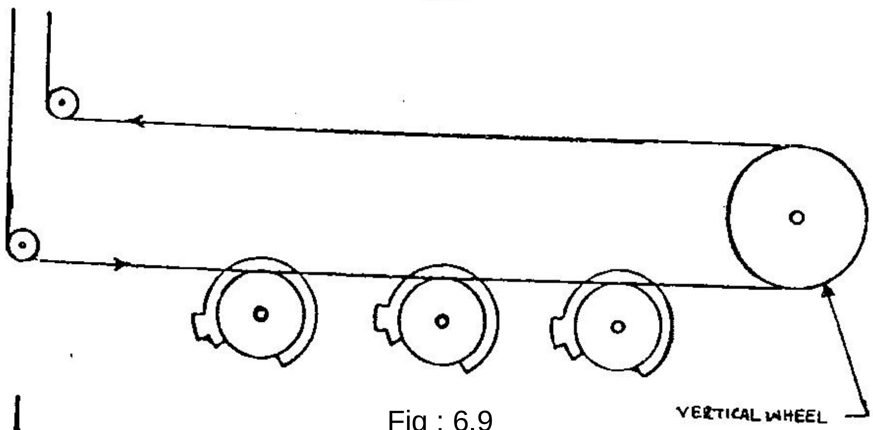
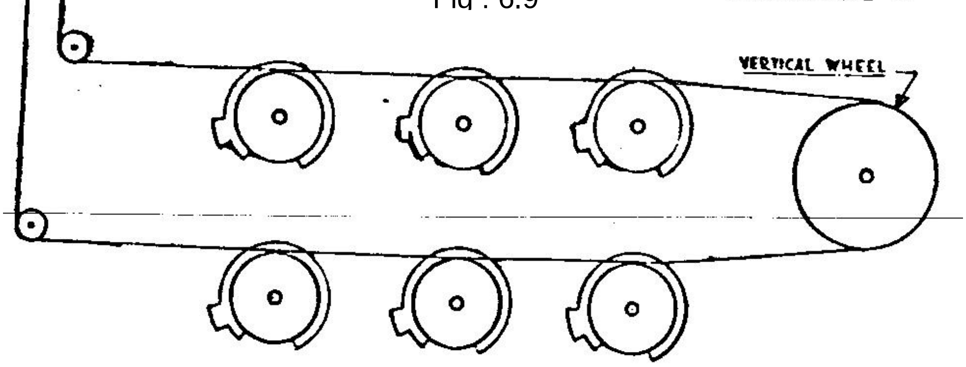


Fig : 6.9



CONNECTING UP OF LEVERS
Fig: 6.10

(c) Double Wheel detectors connected in push-pull signal transmission must be so connected so as to have a detector wheel connected in each of the pull and return wires. The detector wheel connected in the pull wire should need a shallow notch and that in the return wire, a high notch. (Fig. 6.5).

(d) In a single detector lever transmission, the pull wire from the lever in the normal position must first be carried to the end detector, then through each intermediate detector in series and back to the lever as the return wire. All detectors should need low notches (Fig. 6.9).

(e) In a push-pull detector lever transmission double wheel rotary detectors are installed in such a manner that the detector wheel connected in the pull wire proves the route (Fig. 6.10).

(f) In a detector lever transmission the number of detectors must not exceed 3.

(g) Not more than one detector is usually connected in a signal transmission.

6.10 Functions of detector rims

Bottom Rim:

(a) This rim permits the operation of points when the detector is normal.

(b) It permits the detector to be installed at a maximum distance of 215 m from the neutral points.

Detection Rim:

(a) It detects the correct relation between switch and stock rails.

(b) It locks the points in the last operated position when the detector is operated.

(c) It locks the points in the last operated position if the detector transmission wire opposite to this rim breaks.

(d) It permits the detector to be installed in a signal transmission.

Locking Rim:

(a) It establishes correct relation between switch and stock rails.

(b) It locks the points in the last operated position when the wire opposite to this rim breaks.

Control Rim:

(a) It proves the route i.e., normal and reverse setting of points.

(b) It acts as a limiting stop in the event of wire breakage and thereby:--

(i) Helps the locking or detecting rim to lock the points in the last operated position.

(ii) Ensures the tripping of lever.

CHAPTER 7: COMPENSATORS

7.1 Mechanical Signalling transmission media viz., wires and rodding vary in length due to temperature changes. In the case of rodding, the variation in length can cause the points to move and the contraction of wire in single wire signalling can cause the signal to drop or come to off position. These are failures on the unsafe side to obviate of which a compensator is used for rodding transmission and a wire adjuster for single wire working. In double wire signalling, however, the variation in length of the two wires of the transmission cannot cause a movement of the mechanism drum because the wire loop exerts equal and opposite forces (tension in the wires) on the mechanism placed at the end of the transmission when the transmission is at rest. This is so because at the end point the lengths of the two wires are the same and both the wires are exposed to the same temperature changes, therefore, their variation in length is equal with consequent equal increase or decrease in tension. See Figure 7.1.

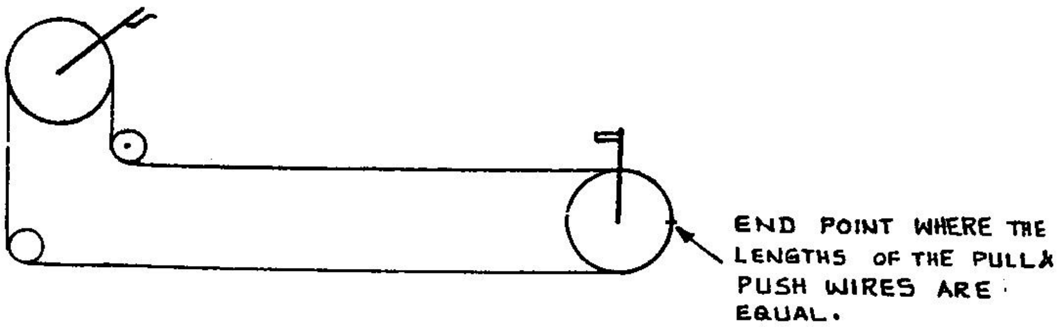


Fig: 7.1

7.2 Expansion or contraction of wires, nevertheless affects the efficient working of gear. In the case of points and signals near the cabin, the expansion may be negligible but for the long distance functions the expansion may be even more than the actual lever stroke. It is obvious therefore, that for long distance functions, perhaps the lever operation will cause no movement or insufficient movement of the mechanisms at high temperatures. In addition, when the wires are slack, the unauthorised pulling of wire can cause the mechanism to move thereby operating the function. This defeats one of the principal advantages of double wire signalling which is to immunise the gear from outside interference, with the transmission that is pretensioned if an external force is applied to operate the function, the force required will have to cause the lifting of the weights in addition to overcome the resistance at the function, such high values of interference forces are not normally met in practice. On the other hand, contraction of wires owing to fall in temperature will increase the tension of the wires. Increase in tension results in greater friction at diversion wheels with the consequent hard working of gear and increased loss of stroke which results in inefficient operation in addition to increase the wear and tear.

Some means of neutralising this variation in length of wires caused by temperature changes is, therefore, necessary in order that the lever operation is equally effective in working the mechanism at all temperatures and that the friction is independent of temperature variation. An apparatus that could keep the wires at a constant tension at all temperatures would, therefore, meet the requirements. Such an apparatus is a double wire compensator which is provided for transmission of the every lever.

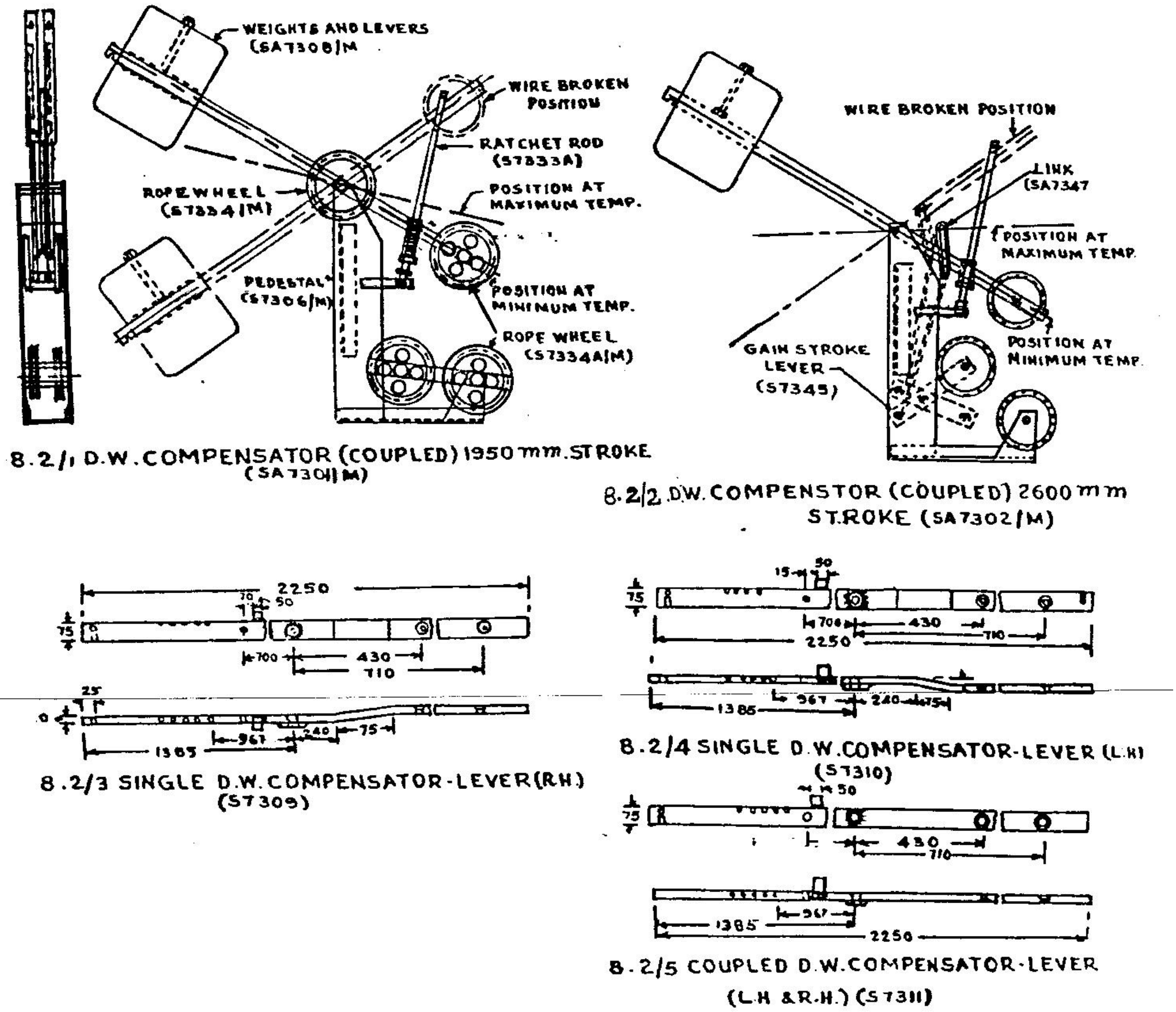


Fig: 7.2

7.3 Requirement of a Double Wire Compensator

7.3.1 A double wire compensator should introduce initial tension of about 68 kgs in the transmission wires and maintain this tension at all temperatures with the transmission at rest.

The necessity of this essential, as already discussed is to ensure efficient operation of the gear at all temperatures and also to minimise the loss of stroke in the transmission and keeping the friction in the transmission to a reasonable value.

The requirement is achieved by attaching a 95 kgs weight on every compensator lever which has a wheel mounted on a 25 mm dia pin at the other end. The arrangement is shown in sketch 7.2. Under the conditions of equilibrium, the wires will have an approximate tension of

$$\frac{95 \times 1017 \cos \theta}{2 \times 710 \cos \theta} = 68.03 \text{ Kgs.}$$

When the wires expand or contract decrease or increase respectively in the tension of the wires results. This destroys the state of equilibrium of the compensator lever, the weight falls the wheel at the other end of the lever correspondingly rises and when the weight rises, the wheel has a corresponding fall. The rise and fall of the wheel results in withdrawing wire from or releasing wire in the transmission. This neutralises the variation of tension of the wires and consequently the weight comes to rest when equilibrium has been re-established, when the wires will have acquired the same initial tension.

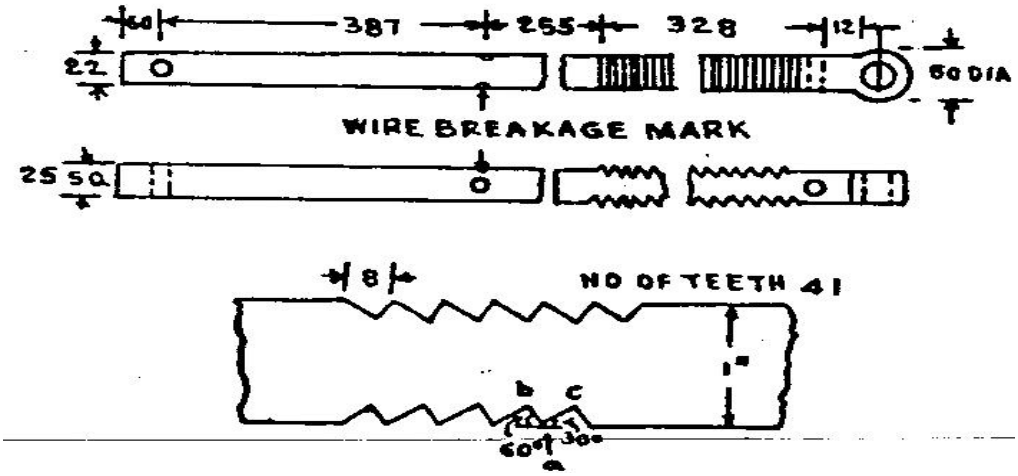
Since the constant tension in the transmission is maintained by the rise and fall of compensator weight, it is necessary that the weights should be able to rise and fall freely with the transmission, at rest.

7.3.2 The Compensator Levers should be locked during operation of the Lever

As already discussed, a weight falls with a decrease in tension and it raises when the tension in the wire increases. During the lever operation tension in the pull wire increases and that in the return wire falls. This would cause one of the weight to fall and the other to rise resulting in all the lever stroke being absorbed in working the compensator levers. No stroke would be imparted to the function. In order, therefore, that the lever stroke be transmitted to the mechanism, the movement of the compensator levers, during operation of the lever, should be restricted. This could be achieved by coupling the two compensator levers together.

To overcome the above drawbacks, to lock the compensator during lever operation, "the ratchet rod and pawl" arrangement is adopted. Two pawls are fitted to the pawl plate which is connected to the two compensator levers through links. The pawl, which are located on either side of the ratchet rod are normally clear of the teeth of the latter; the clearance between the pawl face and the teeth on the ratch rod being 1.5 mm on either side with equal tension in the two wires, clearance enables the weights to fall or rise freely for compensation. When the lever is operated, the wheel over which the pull wire passes is depressed down and that carrying the return wire is lifted up causing the two compensator levers to move in opposite directions, consequently, the pawl engages with a tooth on the ratchet rod and lock the compensator levers.

The Compensator locking stroke should be as small as possible and must not exceed 25 mm measured immediately at the compensator.



RATCHET ROD

Fig: 7.3

7.3.3 A compensator should have sufficient stroke so as not only to allow for the variation in length of wires caused by temperature changes but also to ensure broken wire protection under all conditions.

7.4 Compensating Stroke

Compensating stroke of a compensator is its capacity to compensate for the variation in length of wire caused by the maximum change in temperature so as to keep the transmission wires at rest, at constant tension at all temperatures. Therefore, compensating stroke is the amount of wire that a compensator withdraws from the transmission when it is subjected to the maximum increase in temperature.

7.5 Wire Breakage Stroke

It is the capacity of a compensator to impart sufficient stroke to the mechanism/mechanism under broken wire conditions so as to ensure broken wire protection at all times. Wire breakage stroke is, therefore, equal to the stroke that the compensator must apply to the intact wire to make all the function mechanisms to move to their safe positions under the most adverse case of wire breakage and cause the lever/levers to trip Broken wire stroke is, therefore, a sum of the following strokes.

(a) Stretch in the intact wire when its tension increases beyond 68 kegs due to wire breakage. This is taken as 100 mm for heavy functions like points, but is not added for lighter functions like signals, detectors, etc. For signal transmissions longer than. 730 Mts. however, an allowance of 75 mm should be made on this account.

(b) Max. Movement of mechanism drum under most adverse circumstances.

(c) Tripping of lever/levers.

(d) Allowance for over sized lever drum, if any this is 50 mm for all transmissions other than push-pull one, when 600mm stroke lever is employed. In the case of push-pull signal transmission without detectors, an allowance of 100 mm is necessary on this account.

7.6 Wire Breakage Mark

In order to facilitate inspection to ensure that the full wire breakage stroke is available even at the highest temperature and that it is not reduced by maladjustments of the transmission wires, a dia 6 mm Counter shunk depression is made on every ratchet rod at the beginning of broken wire way. This mark which indicates the extreme compensating position of the compensator is called the wire breakage mark. The guide should not pass the wire breakage mark even when the temperature is the highest (Fig. 7.4). Inspectors and Engineers should pay special emphasis on this point during their inspection because if the wire breakage mark is passed during normal compensation. The compensator will not be retained with sufficient stroke to ensure effective broken wire protection.

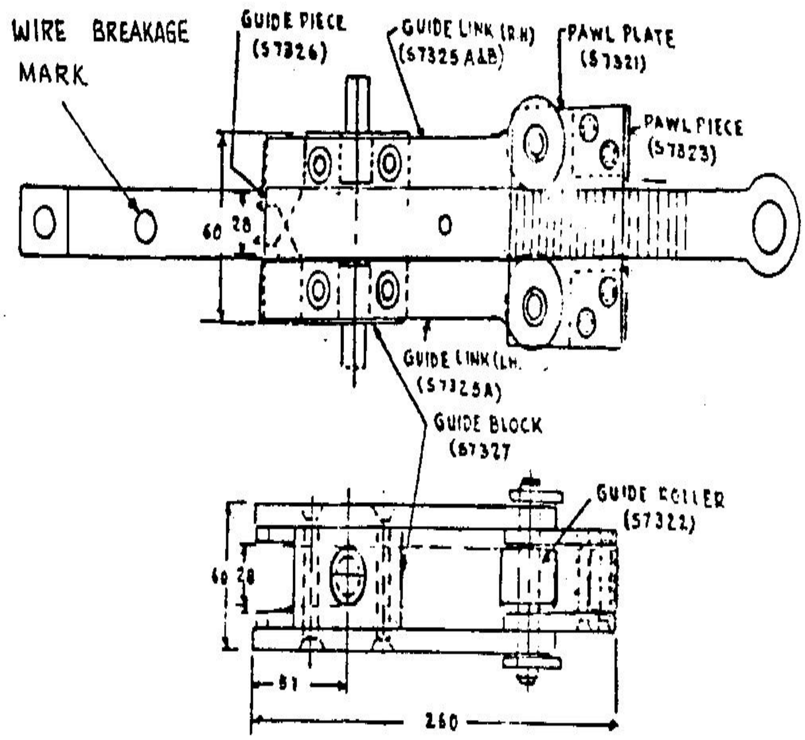


Fig: 7.4 D.W COMPENSATOR PAWL & GUIDE

7.7 Types of Compensators

Following types of compensators are in use:-

S.No	Description	FPS
1	A type single & coupled compensator	56" stroke
2	B type single & coupled compensator	72" stroke
3	C type coupled compensator	92" stroke
		Metric
1	Single compensator	2080 mm. stroke
2	Coupled compensator with out gain stroke lever	1950 mm. stroke
3	Coupled compensator with gain stroke lever	2600 mm. stroke

Feature of the metric compensator

(a) There is only one type of ratchet rod to be used in all cases.

(b) There is only one adjustment table to be used in all cases (details are shown in the annexure).

(c) The co-efficient of linear expansion of steel is taken as 0.000012 per degree centigrade and compensator strokes provided accordingly.

7.8 Difference between a single and a coupled compensator

(a) A single compensator is used for a single transmission and a coupled one for a coupled transmission. A single compensator has, therefore, a narrow pedestal which can occupy the place only below one lever but a coupled compensator has a wider pedestal so as to be below two coupled levers.

(b) Each of the levers of a single compensator has two pins, each fitted on the same side of the lever. One pin bears the wheel while the other has the link of the locking assembly. Keep the angle of diver as low because the two wires passing over these wheels come from the same lever drum. The levers because the ratchet rod is placed between the two levers. The weight levers of coupled compensators, on the other hand have the two pins on opposite sides. One for the link to be inside and the other for the wheel to be outside. The wheels of a coupled compensator are placed 125 mm apart because the two wires passing over the wheels are from two different levers and are required to go to leadout wheels that are placed 125 mm apart.

(c) A single compensator has three pairs of wheels of 300 mm Dia. whereas a coupled one has an additional pair of wheels in which one wheel Dia. Is 275 mm diverting the wires to make them pass over the coupling device wheels without rubbing each other.

(d) The coupled 'C' type compensator has in addition to above differences, the following additional parts for increasing its total stroke:-

(i) Gain Stroke Lever

(ii) Link.

The weight levers of this compensator have an additional for bearing the link.

7.9.1 'A' type compensator single 56" stroke

This type of compensator, which is capable of maximum stroke of 56" is used for the following transmissions:

(a) Points up to 730 Mts (800 yards)

(b) Single signal up to 730 Mts (800 yards)

(c) Detector up to 500 Mts (580 yards)

7.9.2 'A' type compensator - Coupled - 56" stroke:

This is used for the following transmissions:-

(a) Coupled push-pull signal transmission with detectors connected, thereto upto 800 yards in length.

(b) Coupled push-pull detectors transmission upto 500 Mts in length.

(c) Coupled push-pull signal transmission upto 800 yards (730 Mts)

7.10 'B' type compensator, single stroke 72"

This is installed in the following transmissions:-

(a) Single signal transmissions greater than 730 Mts and upto 1400 Mts.

(b) Single detector transmissions longer than 500 Mts and upto a maximum of 730 Mts.

7.11 'C' type compensator coupled 92" stroke

This is used for the following transmissions:

(a) Push-pull Signal Transmission without detector greater than 730 Mts (800 yds). And upto 1400 Mts (1500 yds.)

(b) Pull-Pull Signal transmission upto 1400 Mts (1500 Yds.)

(c) Push-Pull Signal Transmission without detector greater than 730 Mts (800 Yds). and upto 1400 Mts 1500 Yds.

A single compensator is bolted to both the compensator channels by means of 2 Nos. 25 mm Hex. head bolts and nuts, but a coupled compensator requires 4 such bolts and nuts.

Keeping the compensator weights in their highest positions corresponding to the largest temperature connects the transmission wires. To adjust weight levers of each compensator correctly to suit ambient temperature and length of transmission given on the table. Only one adjustment table in metric dimensions for all types of compensators has been issued to Drg.No.IRSS.7339/M.

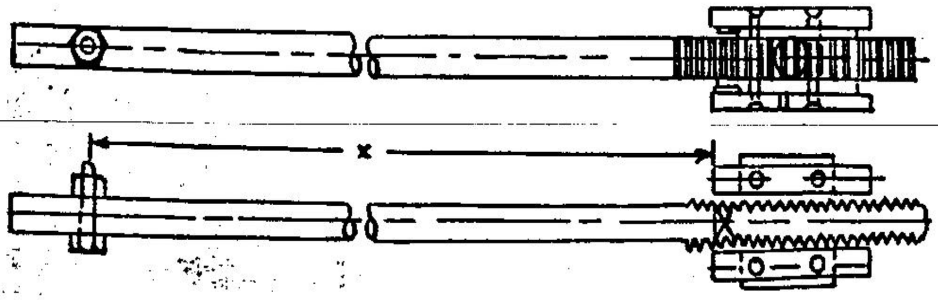
This table shows the temperatures in steps of 5^0 C along vertical rows and length of transmission in metres along horizontal lines in steps of 50 Mts. Read along the horizontal row corresponding to the length of the transmission and vertical column corresponding to the temperature. The square in which the two meet, gives the figures to which the compensator should be adjusted. This figure is the distance between the top stop and the guide piece in mm.

In order to allow for the permanent stretch which occurs during first few weeks after a new transmission is installed, compensator should at first be adjusted to a position about 20mm to 30 mm lower than would be correct for ambient temperature and the length of the transmission. This would allow final correct adjustments to be made later without attempting to cut the wires and making fresh joints.

The figures given on the table relate to the clearance between the bottom stop on the ratchet rod and the reference line b-b on the pawl plate. Wire adjusting screws near the function mechanism should be used for carrying out the compensator adjustment.

Although the range of temperature at almost all places in the country is the same yet the minimum and the maximum temperatures at every place vary. It is not correct, therefore, to prepare the adjustment tables to the actual temperatures. The tables should be modified so as to read the temperatures as a variation off the mean temperature 32^0 C. the table should be reckoned as the mean temperature and all other temperatures as a variation off this temperatures i.e., 37^0 C and 27^0 C on the existing tables should be read as $+5^0$ C and -5^0 C off the mean temperature respectively.

LENGTH OF TRANS-MISSION IN METERS	DISTANCE 'X' IN MILLIMETERS ON RATCHET ROD AT TEMPERATURE IN CENTIGRADE													
	2°	7°	12°	17°	22°	27°	32°	37°	42°	47°	52°	57°	62°	67°
100	551	549	548	546	544	542	540	539	537	535	533	531	530	528
150	557	655	552	549	547	544	541	539	536	533	530	528	525	522
200	564	560	557	553	549	546	542	539	535	531	528	524	521	517
250	570	566	561	557	552	548	543	539	534	530	525	521	516	612
300	576	571	566	560	555	549	544	539	533	528	522	517	512	506
350	583	576	570	564	557	651	645	539	632	526	520	513	507	501
400	689	582	575	567	560	553	546	539	531	524	517	510	503	495
450	595	587	579	571	563	555	547	539	530	522	514	506	498	490
500	602	593	584	575	566	559	548	539	530	521	512	503	494	485
550	608	598	588	578	568	558	548	539	529	619	509	499	489	479
600	614	603	593	582	671	560	549	539	528	397	506	495	485	474
650	620	609	597	585	574	562	550	539	527	515	603	492	480	468
700	627	614	602	589	676	564	551	539	526	513	501	488	476	463
750	633	620	608	539	619	566	652	539	525	512	498	485	471	458
800	639	625	611	596	582	567	553	539	524	510	485	481	467	452
850	646	630	615	600	584	569	554	539	523	508	493	477	462	447
900	652	636	620	603	587	571	555	539	522	506	480	474	458	441
950	658	641	624	607	590	573	556	539	521	504	487	470	453	436
1000	665	647	629	611	593	675	657	539	521	503	485	467	449	431
1050	671	652	633	614	595	576	557	539	520	501	482	463	444	425
1100	677	657	638	618	598	578	538	539	519	499	479	459	440	420
1150	683	663	642	621	601	580	559	539	518	497	476	456	435	414
1200	690	668	647	625	603	582	560	539	517	495	474	452	431	409
1250	696	674	652	629	606	584	561	539	516	494	471	449	426	404
1300	705	679	656	632	609	585	562	639	515	492	468	445	422	398
1350	709	684	660	636	611	587	563	539	514	490	466	441	417	393
1400	715	690	665	639	614	589	564	539	513	488	463	438	413	387



FOR COMPENSATOR			
DRAWING.No.	TYPE	STROKE	COMPENSATION IN mm
SA 7300/M	SINGLE	2080mm	1092
SA7301/M	COUPLED	1950mm	585
SA7302/M	COUPLED	2600mm	1082

FIG: 7.11 D.W Compensator Adjustment Table

No.	Type of Transmission	Compensation Stroke CS = L t	Strecth in the intact wire	Maximum movement of the mechanism	Allowance for tripping	Allowance sized lever drum	Safety margin 9(3+4+ 5+6+7)	Type of compensator type stroke	Remarks.
1.	Point upto 800 yards	800x110x0.2 / 100x10 =17.69 or 18"	4"	20"	3"	2"	9"	A type single compensator 56"	altough A type single compensator is used. for points & signal transmissions & detectors transmissions yet the compensators used for the two will not be identical in all their details. The ratchet rod used will be different with regard to two disposition of wire breakage mark & No. of teeth . Similar remarks apply to other correspomding cases. Total stroke of the compensator has been considered to determine the safety margin; hence, values do not tally with the one mentioned earlier in this chapter.
2.	Single Signals upto 800 Yds.	18"	-	31"	3"	-	4"	A -do- 56"	
3.	Single detectors upto 550 Yds.	550x110x0.2 = 12.1 or 12"	3"	37 1/4"	3"	-	3 3/4"	A -do- 56"	
4.	Single Signals from 800 Yds upto 1500 Yards.	1500x110x0.2 / 100 x 10 =33"	3"	31"	3"	2"	11 1/4"	B -do- 72"	
5.	Single detectors from 550 yards to 800 yards.	18"	37 1/4"	3"	2"	11 1/4"		B -do- 72"	
6.	Push-Pull signals with detector in transmission	18"	-	31"	6"	-	1"	A type coupled compensator 56"	
7.	Push Pull detectors transmission upto 550 Yds.	12"	-	37 1/4"	6"	-	3/4"	-do- 56"	
8.	Push Pull detectors transmission without detectors in the transmission upto 800 Yds.	18"	-	51"	-	-	3"	B -do- 72"	
9.	Push Pull detector transmission greater than 550 upto 800 Yds.	18"	-	37 1/4"	6"	-	10 3/4"	B -do- 72"	
10.	Push Pull signal transmission without detection greater than 800 Yds. and upto 1500 Yds.	33"	3"	51"	-	4"	1"	C -do- 92"	
11.	Pull Pull Signal Transmission	33"	2"	54"	-	2"	-	C -do- 92"	

Various Strokes of D.W. Compensator

No.	Type of Transmission	Compensation Stroke CS = L t	Strecth in the intact wire	Maximum movement of the mechanism	Allowance for tripping	Allowance sized lever drum	Safety margin 9(3+4+5+6+7)	Type of compensator type stroke	Remarks.
1.	Points upto 730 m length (the length of the compensator has been taken as 750 m)	750x110x.00012 x 65 mm OR 585 mm	100 mm	500 mm	75 mm	50 mm	2080 - 1310 =770 mm	DW compensator (Single 2080mm Stroke)	To Drg. No. SA 7300/M
2.	Single detector upto 730 m	585 mm	-	945 mm	75 mm	50 mm	325 mm	-do-	
3.	Single Signals upto 1400 m	1400x.000012x65 = 1092 mm	75 mm	775 mm (only when Clutch lever is Used)	75 mm	60 mm	13mm	-do-	
4.	Coupled Push Pull transmission for detectors 730 m (750 m)	585 mm		945 mm	150 mm	100 mm	270 mm	DW compensator (Coupled 1950mm Stroke)	To Drg. No. SA 7301/M
5.	Coupled Push Pull Transmission for signal with detectors 730m(750m)	585 mm		775 mm	775 mm	150 mm	-	440 mm -do-	
6.	Coupled Push Pull Transmission for signal without detectors (730 m) (750 m)	585 mm			1250 mm		100 mm	150 mm -do-	
7.	- do - 1400 mm	1092 mm	75 mm	1250mm		100 mm	50 mm	-do-(2600mm)	To Drg. No. SA 7302/M stroke) This type of compensator appear unsuitable. Balance can however be placed on the inertia for completing the movement of the signal mechanism even though the compensator fails to impart positively stroke of adequate to magnitude.
8.	Coupled Pull-Pull transmission	1092 mm	75 mm	1430mm		50 mm	47 mm(no Safety margin)		

Various Strokes of D.W. Compensator

CHAPTER 8: TRANSMISSIONS

8.1 A double wire transmission consists of wires supported on pulleys at regular intervals and wire rope round the diversion wheels - Diversions upto 10^0 can be had on diversion pulleys, but these exceeding 10^0 must be laid on horizontal wheels.

8.2 Types of wires and wire rope: [See Table in the page: 60.]

8.3 Use

Wire rope is used round diversion wheels whenever the transmission is required to be diverted through an angle greater than 10 deg . Length of the transmission between lever and the outside lead out is generally wire rope though when the distance between the compensator and the outside leadout is considerable, intermediate closure of solid wire may be inserted.

No.8 SWG wire is, used for signal transmission without detectors connected thereto.

No.6 SWG wire is used for the following transmissions:-

(a) Point Transmissions

(b) E. F.P.L. "

(c) Holding bar and fouling bar transmission

(d) Signal transmissions with detectors

(e) Detector transmissions.

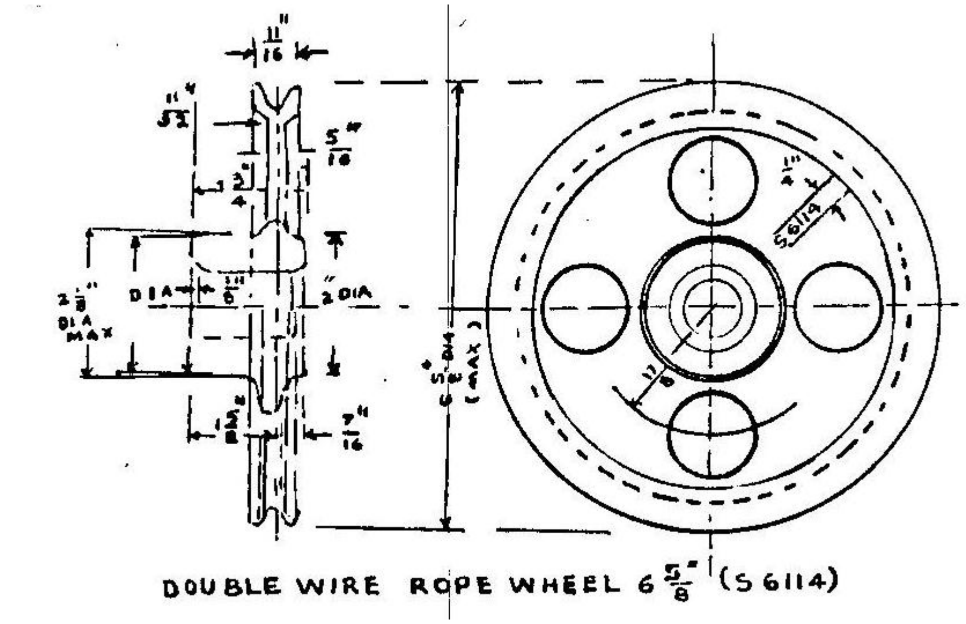
8.4 Running out wire and wire rope

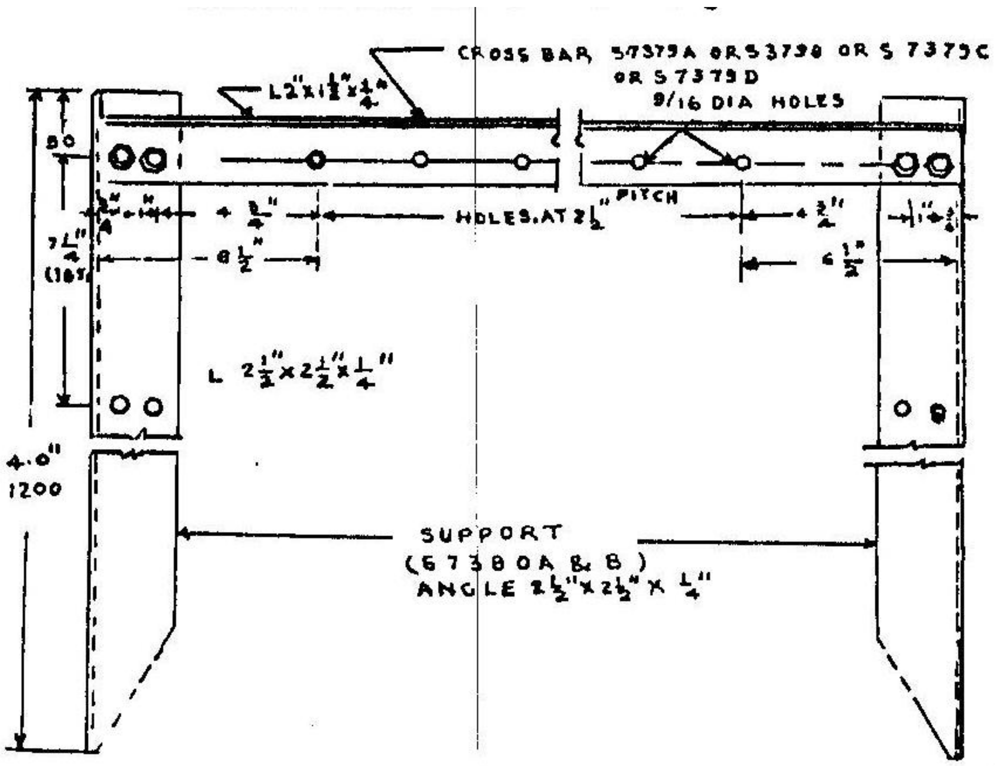
Coils of wire and wire rope must be run out from a drum or reel on a spindle and extra care taken to avoid the formation of kinks and twists. If such damage occurs, that part of the wire must not be used and either a fresh length should be run out or a piece jointed in.

Special precautions should be taken at the time of cutting a length of the wire from a coil. The wire should be held securely by a person or preferably by two persons on either side of the place where the wire is to be cut and then only should the wire be cut by means of chisel and hammer and the two ends of the wire slowly released. If an unsecured wire is cut, the two cut portions of the steel wire act as powerful springs and recoil with a great force. This can cause serious injury to the persons who sets the wire or to those working nearby.

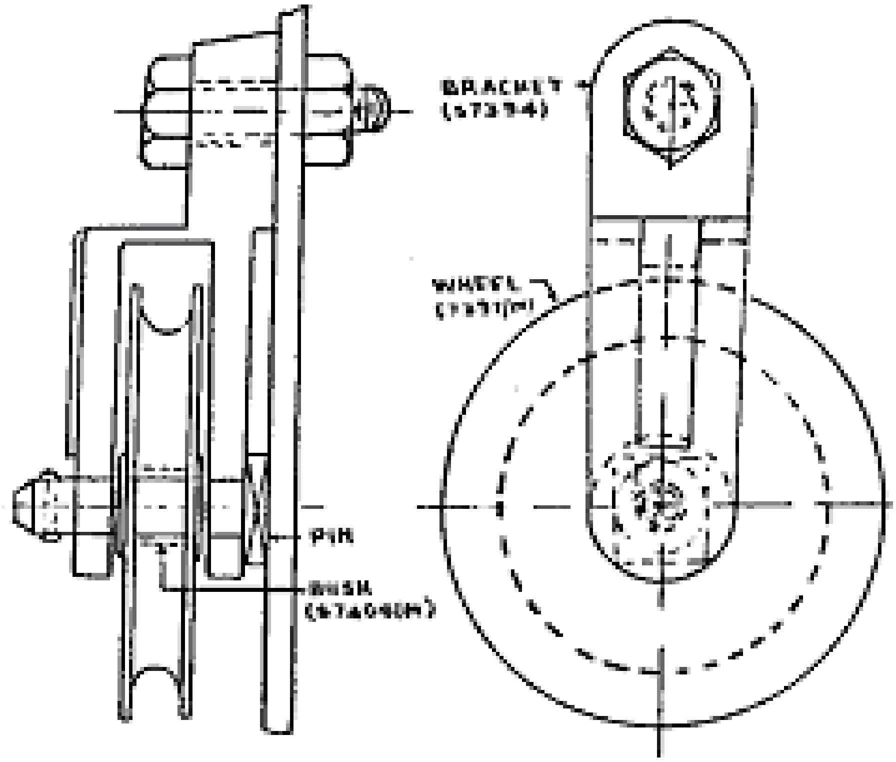
No.	Type of wire and wire rope with construction	where used	IRS specn.	Diameter	Tensile strength	Min. breaking load	Length of wire coil	Weight	Remarks
1.	Wire rope 6 x 19 consists of 6 strands each comprising of 19 Gal. steel wires & a fibre core (Para 4-11 of IRSE manual)	Round the diversion wheels with angle of diversion being greater than 10°	S 11	Nominal 6mm (1/4")	140-160 kgs./sq.m (90-100 tons/Sq. in)	1720 Kgs. (3800 lbs)	365 m (400 Yds.)	49 kgs per coil 4 kg/30 mts. (9lbs/180 ft)	
2.	No. 10 SWG solid steel galvanised signal wire(Para 4-121 of IRSE manual)	For Signal transmission without detector	S 1	3.15 mm (0.128")	96-110 kgs/sq.mm 60-70tons/sq.in	741 kgs. (1730lbs.)	548 m (600 Yds.)	45 kgs. (100 lbs)	
3.	No. 8 SWG solid steel, galvanised signal wire (Para 4.121 of IRSE manual)	- do -	S 13	4 mm (0.160")	95-110 kg/sq.mm (60-70tons/sq,in)	1103 kgs. (2700 lbs.)	450 m (500 Yds.)	46 kgs. (102 1/4 lbs.)	
4.	No. 6 SWG solid steel, galvanised signal wire (Para 4.121 of IRSE manual)	1. Point transmission 2. FPL transmission 3. Holding bar and fouling bar. 4. Signal transmission with detector. 5. Detector transmission.	S 14	5 mm (0.192")	95-110 kg/sq.mm (60-70tons/sq.in)	1770 kgs. (3980 lbs.)	360 m (400 Yds.)	53 kgs. (117 3/4 lbs.)	

Types of Transmission Wires





D.W PULLY SUPPORTING BRACKET, SINGLE TIER
(SA 7377) A-D/M
Fig: 8.1



WIRE PULLEY (DWS) SINGLE (SA 7393)

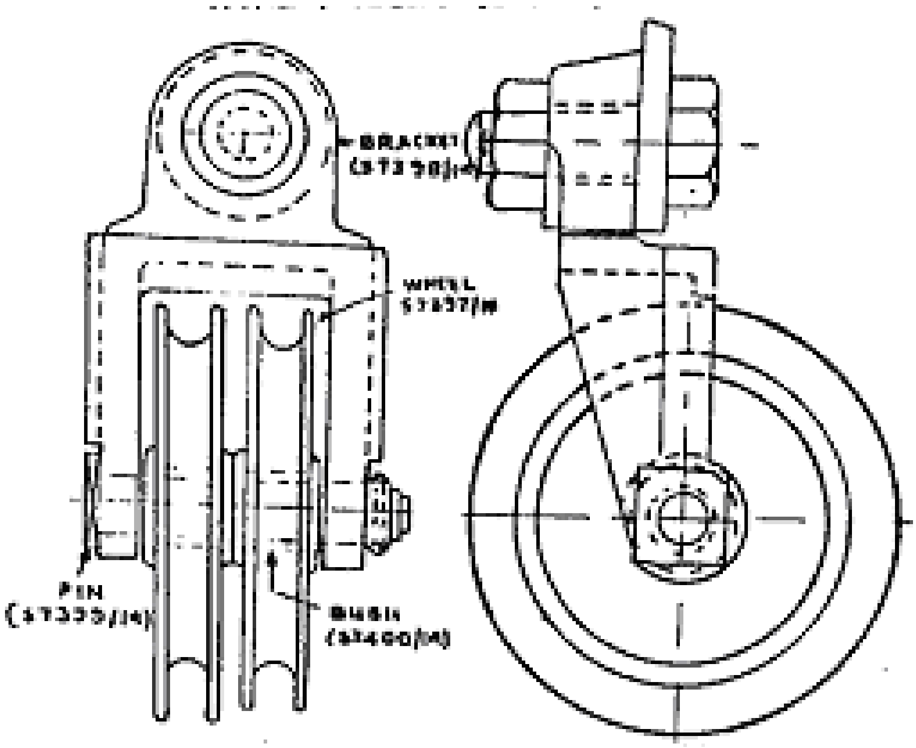


Fig : 8.2 WIRE PULLEY (DWS) SA –7396 STS –S 1008/88

8.5 Pulleys (SA7396/M)

S.No	Type or cross bars (S7381)	No.of supports reqd.	No.of 10mmx5mm bolts and nuts reqd.
1	2 way	One (Single Stake) Note: If a 4 way bracket is reqd. two cross bars can be bolted to the supports in two tiers.	Two
2	6 way	Two (Bridge Stake)	Four
3	8 way	Two (Bridge Stake)	Four
4	10 way	Two (Bridge Stake)	Four
5	12 way	Two (Bridge Stake)	Eight
6	14 way	Two (Bridge Stake)	Eight
7	16 way	Two (Bridge Stake)	Eight
8	18 way	Two (Bridge Stake)	Eight
9	20 way	Two (Bridge Stake)	Eight

(a) Pulleys for points, lock and detector lever transmissions must not be fixed more than 15 m (45 feet) apart.

(b) Pulleys for signal lever transmissions must be fixed not more than 20 m (60 ft). apart on the straight. This distance may be reduced suitably on curves.

(c) When point, signal, detector transmission, etc., run together pulleys must be fixed not more than 15 m (45 feet) apart. It will be seen that the Signal Engineering Manual places the upper limit on the spacing of pulleys. Spacing can be reduced, if required to reduce the loss of stroke due to sag.

Pulleys are supplied in complete units consisting of two pulley wheels on a pin supported in a bracket. Each pulley is fixed to the cross bar by means of a (12 mm x 38 mm) (1/2" x1 ½ ") hex head bolt and nut. Pulleys with self lubricating sintered bronzed bushes reduce the maintenance and improve the efficiency of the transmission.

8.6 Pulley Supporting Brackets (SA 7377A to D/M)

These consist of a cross bar/bars bolted to the support/supports by means of 10 mm x 25 mm BSW, galvanised bolts and nuts. Pulleys supporting bracket support is a 65 mm x 65 mm x 6 mm angle iron stake 1200 mm long. Cross bars can be fitted to the supports in one or two tiers as required. Bridge supporting brackets can be formed by connecting a cross bar or two cross bars in two tires to two supports. Following are the types of cross bars used:-

8.7 Instructions for Fixing Pulleys and Stakes and running the transmission

Following instructions should be followed while fixing pulleys and pulley stakes and running the Transmissions.

(a) Stakes should be rigidly fixed in the ground. If local conditions of soil do not provide adequate rigidity, stakes may be packed round with well rammed ballast or alternatively small concrete Foundations may be provided.

(b) Stake should be properly levelled. Where the length of a stake is not sufficient, it may be bolted to a piece of an old rail of suitable length Pulley brackets must be fixed on alternate sides of the cross bar and bottom of pulley should ordinarily be 300 mm clear of ground.

(c) Runs of stakes, must be installed in one straight line as far as possible. Where straight runs are not possible owing to local conditions, then the transmission should be laid in a succession of straights, using-angle pulleys at the point of diversion. The stakes at the point of diversion must be set in concrete or else they may start shaking.

(d) Stakes should be so fixed that the wire grooves of the pulleys are in alignment with the wire run and the wires lie properly and fully in the groove of the pulleys.

(e) No portion of a stake shall be less than 2135 mm from the C/L of the nearest track. However, if the top of the stake is not more than 203 mm above rail level, pulley stakes may be placed not less than 1600 mm or 1830 mm in the case of tunnels or through semi-through girder bridges from the centre of the nearest track. Whenever an angle pulley is used, the link should rigidly fixed to the cross bar, but the bolt connecting link and the pulley brackets should be left loose. When the transmission is tensioned, the pulley will occupy its correct position as required by the transmission wire alignment. The bolt between the link and the pulley bracket should then be tightened, without disturbing the position of the pulley.

(f) Fixing of stakes in the side drains should be avoided.

(g) Wires and ropes must not scrap against walls protecting covers platform ramps, rails and sleepers. Transmissions passing under rails between sleepers must be protected by channels or other suitable means to avoid damage by permanent way staff and live cinders from engines.

(h) Transmission must not pass near protecting covers. It must be possible to remove any apparatus cover without interfering with passing transmission wires.

(i) Use may be made of RCC troughs and steel cover plates when a transmission is required to cross a level crossing gate.

(j) Wires running under the track should neither drag on the ground nor rub against ballast, base of rails or side of sleepers.

(k) When leading a wire away from the main run or to a horizontal wheel for crossing the change in alignment of level must be gradual. Additional stakes, if necessary, should be provided.

(l) Crossing the wire should be as far as possible, be avoided in leads from the cabin. The top pulleys when cross bars are fixed in two tiers, should carry the wires having the longest run and the pulleys below successive shorter runs.

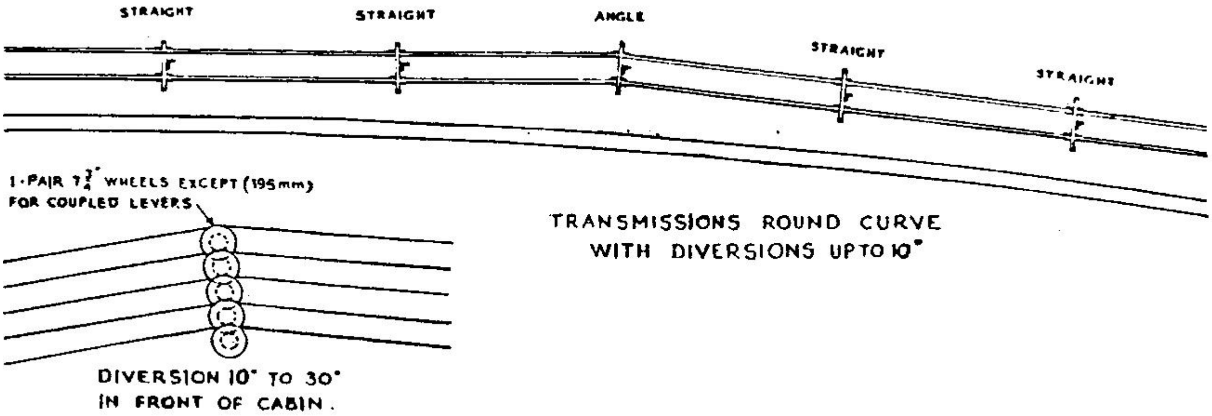


Fig: 8.3

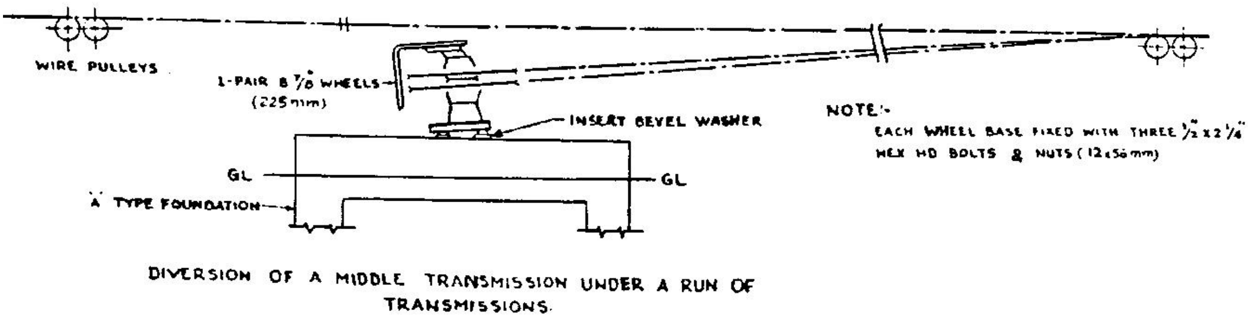


Fig: 8.4

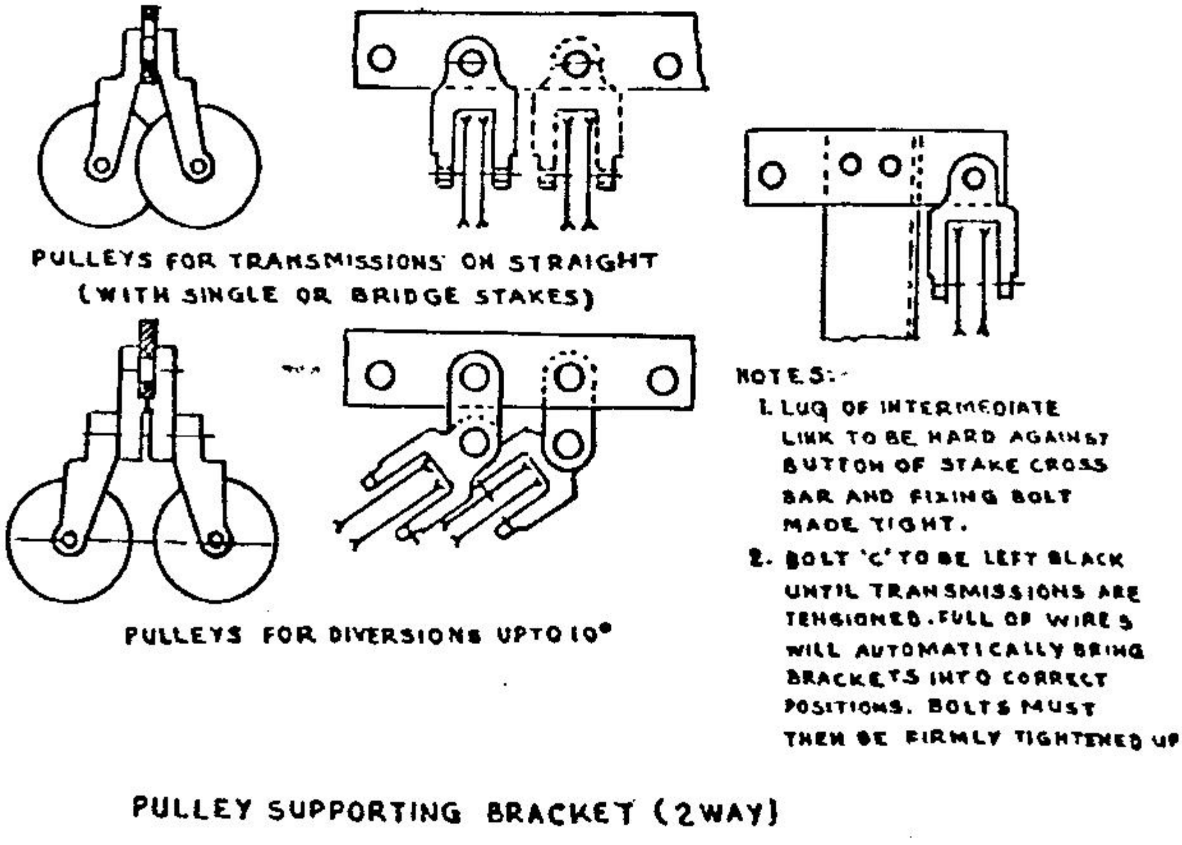
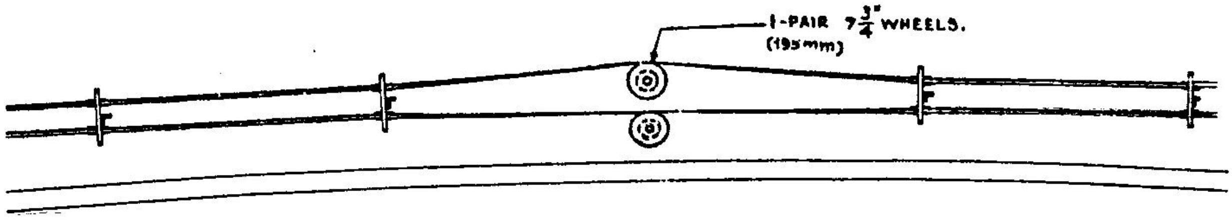


Fig: 8.5

8.8 Diversion Wheels

195 mm dia. wheels are used for diversions greater than 10 deg. and upto 30 deg. For diversions exceeding 30 deg. 225 mm dia .wheels are used. Excepting where the wheels are required in a nest they are bolted to 'A' type foundations 12 x 56 mm hex head bolts and nuts with bolt heads underneath, where the wheels are required to be intermeshed to for a nest e.g., at the outside leadout or when a number of transmissions are required to be diverted at the same place, wheels are mounted on channels by means of 12 x 55 mm hex head bolts and nuts. The channels, in turn, are secured to a type foundations or other approved type of wheels piers through cleats and 16 x 50 mm bolts and nuts as shown in Fig.8.8. The 'A' type foundation is buried in cement concrete except for diversions in a signal transmissions without detector when the foundation may be secured by alternate layers of well rammed ballast and earth.

Diversion wheels are available in single, one pair and two pair assemblies. Single wheels are used when one wire of a transmission is required to be diverted. This is also used at the leadout for coupled transmissions. Single transmissions have a one pair wheel at the leadouts. Two pair wheels are generally not used because experience shows that the pins of these wheels bend in the direction of resultant force on account of the distance between the top wheel and the base of the pin and the additional tension of transmission.



TRANSMISSIONS ROUND CURVE WITH DIVERSIONS EXCEEDING 10^0
Fig: 8.6

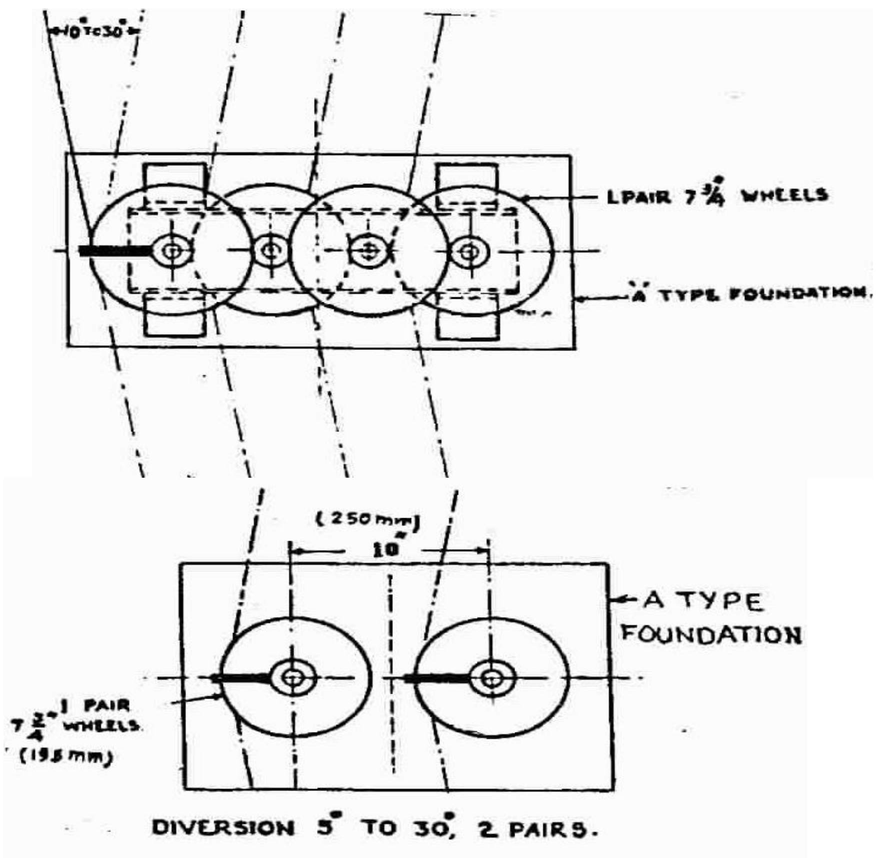


Fig: 8.7

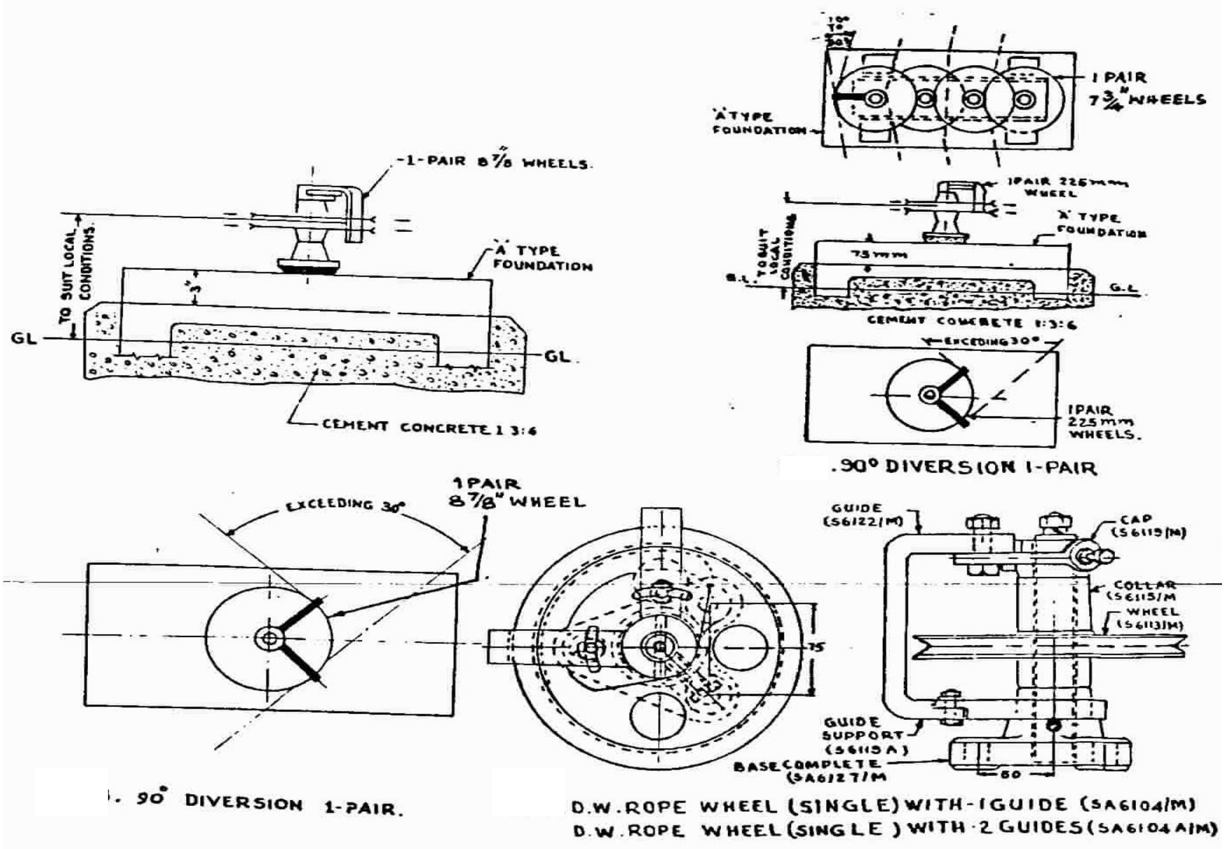


Fig: 8.8 (a)

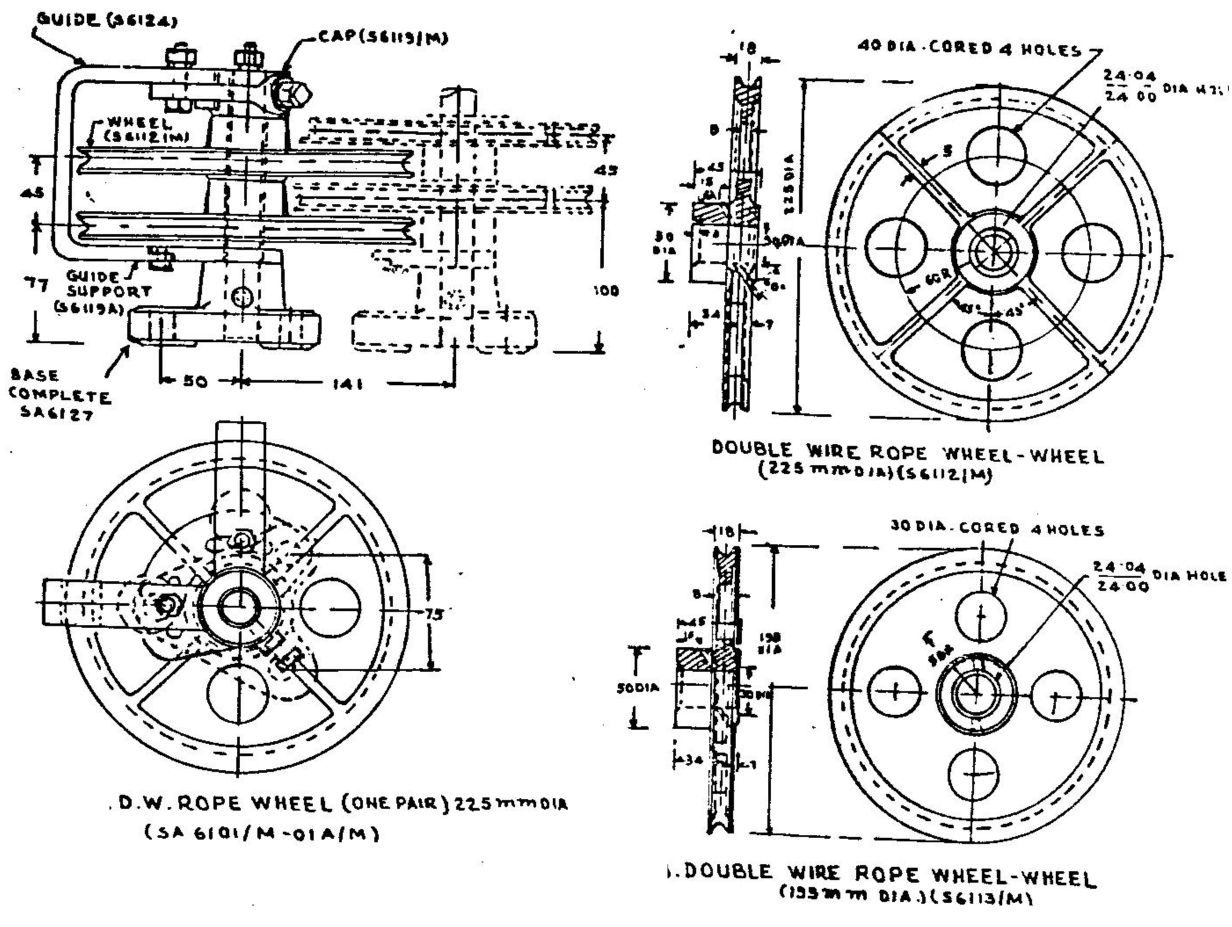


Fig.8.8 (b)

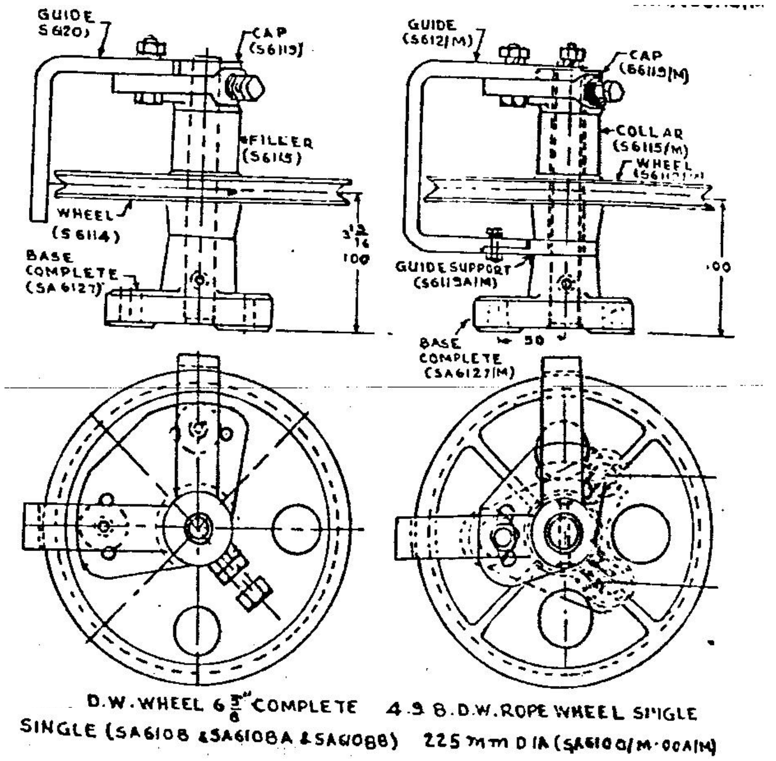


Fig: 8.8 (c)

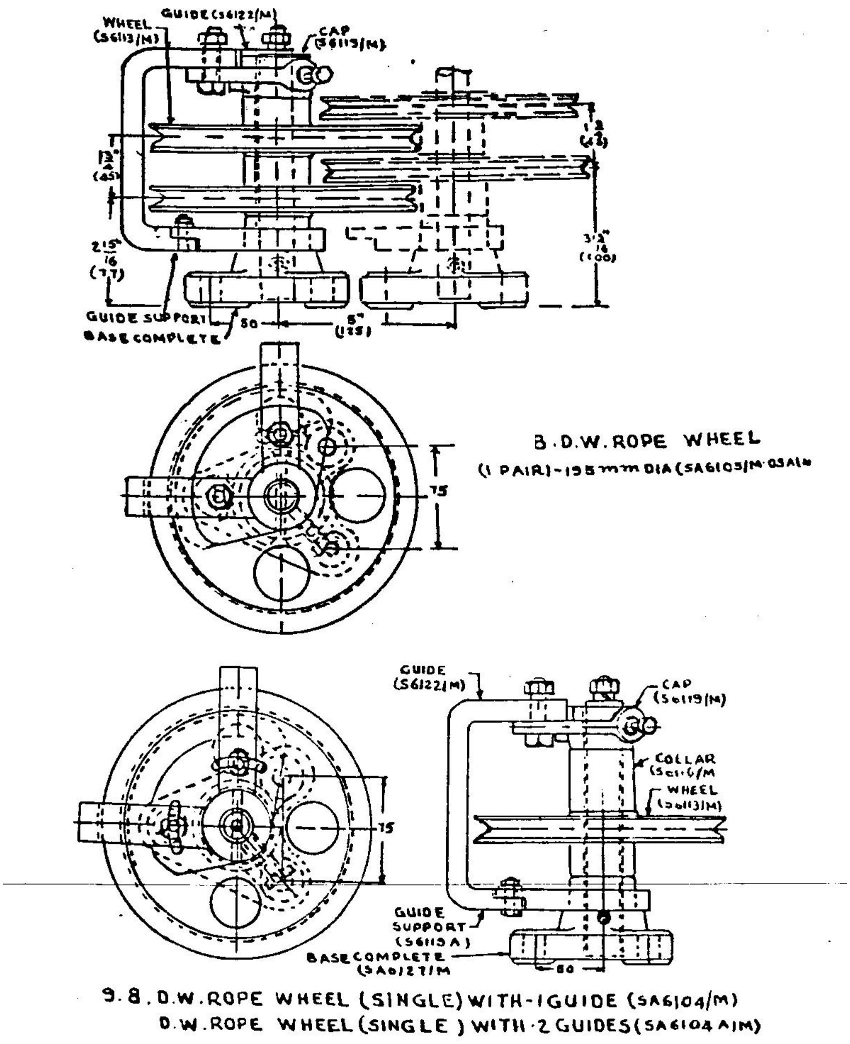


Fig: 8.8 (d)

8.9 Wheel Guides

Wheels in all diversions must be provided with adequate guides to prevent wire ropes escaping from wheel grooves. For diversions upto 25 deg. one guide must be used for each independent set of wheels and one guide for the outside wheels of a nost, the wheel hubs serving as guides for other wheels. For diversions exceeding 25 deg. two guides must be used for each independent set of wheels and two guides for the outside wheels of a rest. The clearance between rim of wheels and guides should neither be less than 1.5 mm nor more than 2 mm.

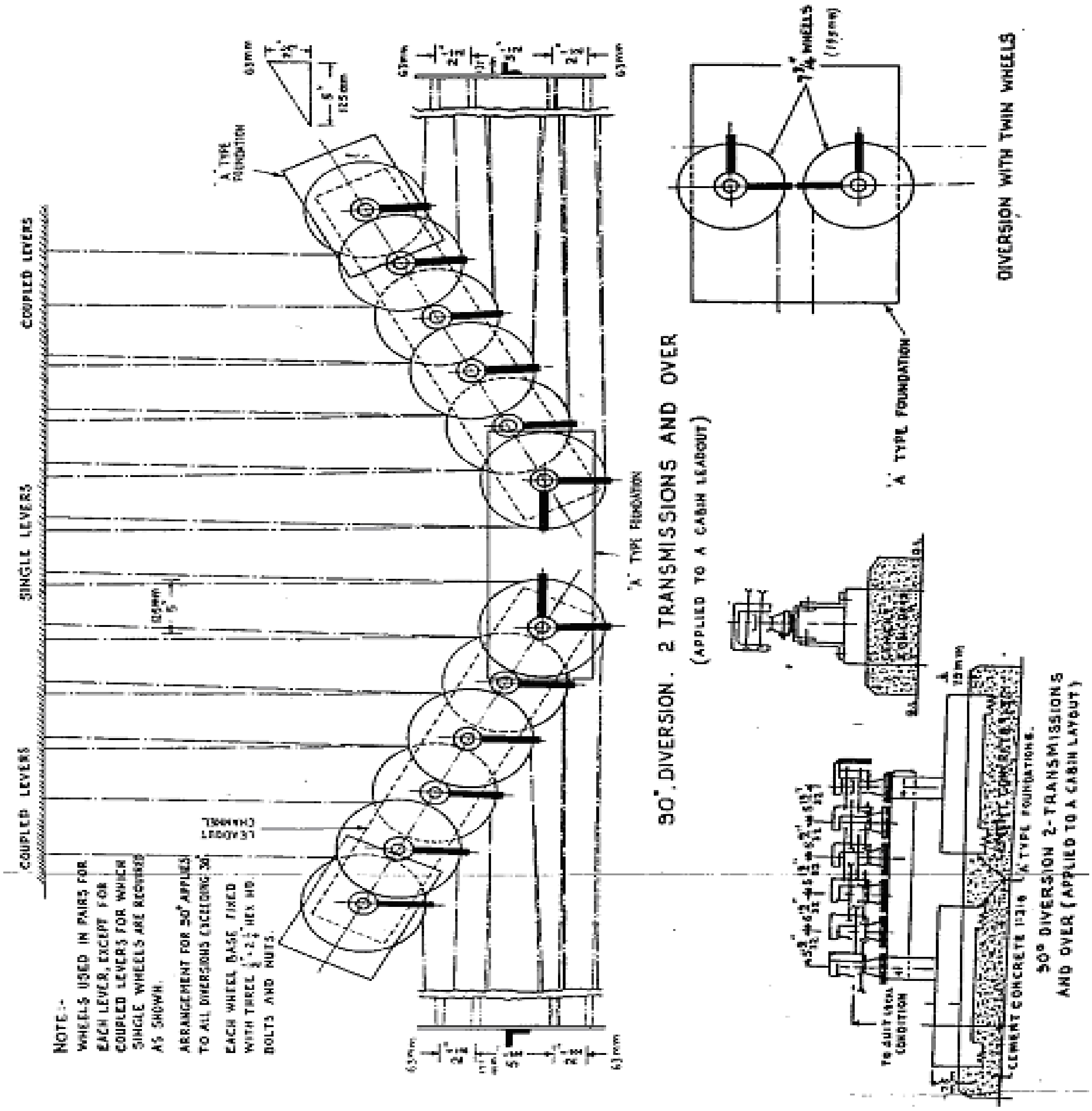


Fig: 8.9 a, b & c

At the outside leadout, accommodating cranks, low medium and high are used in the usual manner for rack and pinion levers. Wire transmissions leading off double wire compensators run at 125 mm pitch but they are to be lead away at the outside leadout at 63 mm pitch which is the clearance between the C/L of any two consecutive pulleys on a pulley supporting bracket. The nest of wheels, therefore, has to be placed in such a way so as to suitably reduce the pitch.

The lead out wheels which are intermeshed to form a nest are bolted to the leadout channels by means of 12 mm x 56 mm Hex. head bolts and nuts, each wheel base requiring three bolts. For a single transmission, one pair wheel is used while a coupled transmission has two single wheels at the leadout.

The lead out channels are mounted on 'A' type foundations or other approved type of wheel pairs by means of cleats and 16 x 50 mm Hex. bolts and nuts.

When the number of transmissions to be carried requires longer than 10 way leadout channels, bolting each of the two channels on to the same ‘A’ type foundation can join the channels. The end 'A' type foundation can be common to the leadout channels for the transmission diverted to the left of the cabin as well as for those diverted to the right as shown in Fig. 8.9(a). Therefore, the total number of 'A' type foundations required for a leadout can be calculated as follows.

One for each of the four free ends - 1 + one for each joint of the leadout channels.

The 'A' type foundations are then embedded in cement concrete. A trench about 600 mm wide & 900 mm deep dug along the full length of the line along which the pin centres of the wheels lie. The 'A' type foundations are placed in this trench at the appropriate level and then the trench is filled up with cement concrete. Standard drawings (SA 8515 to SA8530)

To form a good consistency of concrete cement, fine aggregate and coarse aggregate are mixed in the ratio of 1:3:6 by volume. Stone screenings not larger than 6 mm may be used as fine aggregate or may be mixed with sand. Coarse aggregate must consist of broken ballast of size that 63 mm screen, but will not pass through a 6 mm screen. Finished foundation must be properly cured by keeping it thoroughly saturated with water for, at least 10 days empty bags or old tarpaulin can be used for protecting foundations from Sun. Time that concrete takes to set is about 36 hours after which any form if used for giving shape to the foundation may be removed.

8.10 Double Wire Joints

All joints between wires and wires and those between wires and wire ropes should be soldered joints. The use of thimbles or split links, twisted or sleeve joints is strictly prohibited. Joints should be made in accordance with the following instructions:-

(a) 6 x 19 wire rope used for double wire signalling can be cut without rope unstranding. No soldering or binding is, therefore, required before cutting.

(b) Ends of wires must be levelled before joint is made to avoid sharp corners.

(c) End of wire rope must be cut square and a bevelled extension of sheet metal soldered to rope before joint is made.

(d) For making loop connections for adjusting screws and disconnecting links, make a 150 mm (6") long loop by binding 8 SWG wire round a 10 mm dia. bar. The wire should bent cold, heating may cause the wire to loose its strength and consequently the loop may break in service.

(e) For making loop connections to levers, signal and point mechanisms, the end of the wire rope need not be a bevelled.

(f) For making loop connection to the coupling device lever, remove the reel and bend the wire rope round it. No bevelling of the wire rope is necessary.

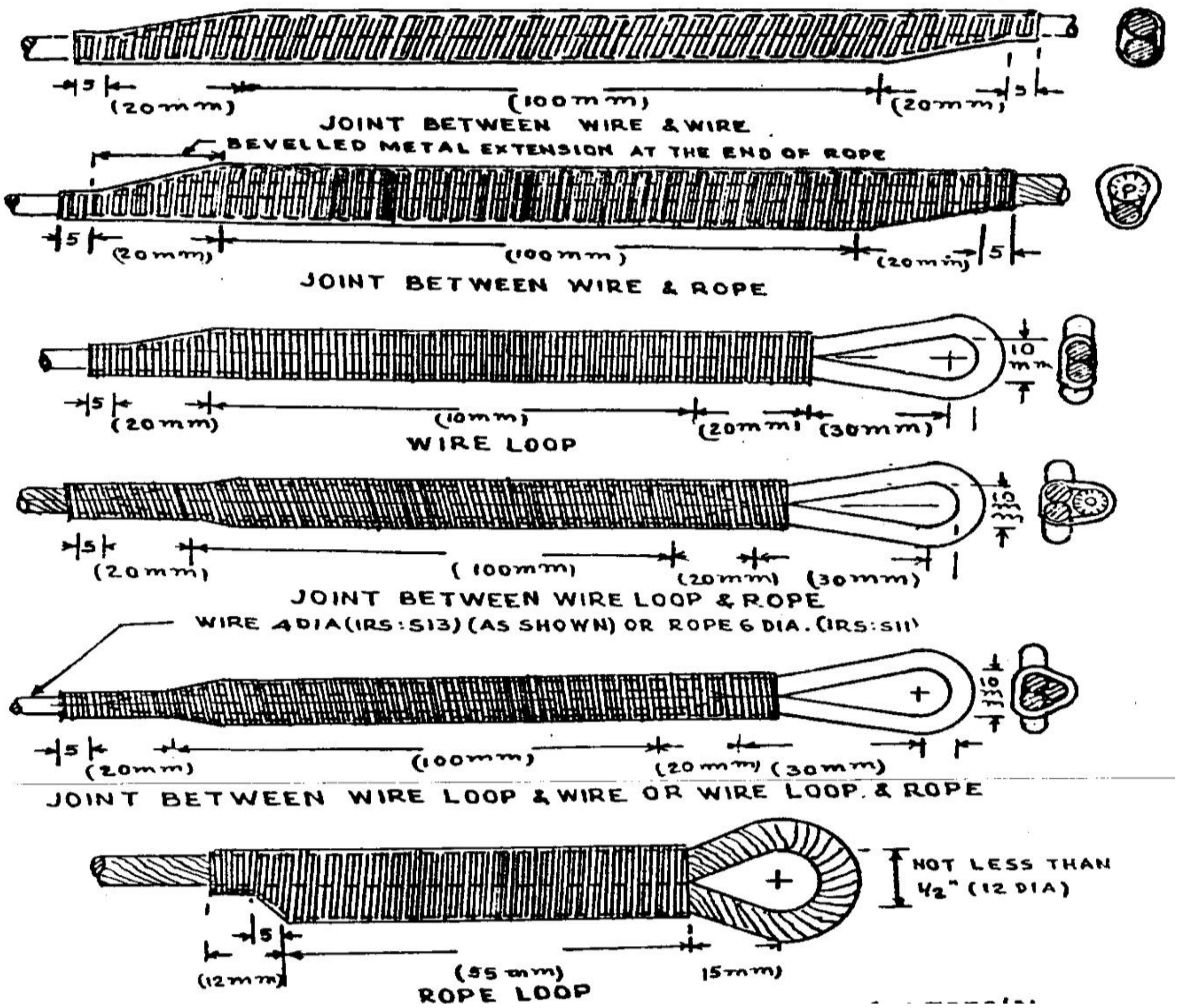
(g) For making loop connections to detectors make loop by bending wire rope round a (5/16") 8 mm dia bar. Ends of ropes need not be bevelled.

(h) Copper head of soldering bit should weight, at least (1 ½ lbs.) ¾ Kg to retain plenty of heat and must well tinned so that solder may run freely.

(i) Ordinary Tinman's solder (Solder Soft) with Muriatic acid or other approved flux should be employed.

(j) Ends of wires must be straightened and thoroughly cleaned, with emery paper to obtain a bright surface.

(k) Hold ends at the middle firmly and closely together in a hand vice with leather faced jaws and connect them with solder. Bind up joint tightly with No.20 SWG soft steel wire galvanised by of the wire binding machine. Care should be taken to see that the binding wire has sufficient form tension. Tension should not be varied during the course of binding a joint.



D.W.TRANSMISSION WIRE JOINTS (SA7370/M)

Fig: 8.10

(l) The bound joint should be sweat up completely. Soldering bit must be sufficiently not to enable the soldering to be done quickly with a single application of heat. Superfluous solder must then be wiped off and finished joint allowed to cool in air.

(m) With the exception of push-pull transmission, joints in the pull wire with lever normal should be painted red and those in the return wire painted black for each identification. Joints for push-pull transmissions may, however, be painted white with the number of lever pulling the wire, when connected from Normal to Reverse.

(n) 40 Nos. of good joints can be made per Kg. of solder soft, 1 litre of muriatic acid and 1 Kg. salammoniac are required for every 200 joints.

8.11 Connecting up Transmissions

All double wire transmissions must be connected in the following manner.

(a) Lift compensator weight levers to their highest position corresponding to the lowest temperature and wedge levers securely in this position.

(b) With the lever normal runout wire rope from the lever to the leadout through the compensator and coupling device if any. The rope from the lever to the leadout should normally be in a continuous length without any joint. Intermediate closures of wire, however, may be inserted between the compensator and the leadout if the distance between the two is considerable. Care should be taken to ensure that the floating wheels on the gain stroke lever of compensator are lifted to the highest position. The end of the gain stroke lever may be firmly tied to the compensator pedestal and the wire rope run out. However, it is imperative that the gain stroke lever is untied as soon as the transmission has been connected: otherwise the stroke of the compensator will be considerably reduced and broken wire protection will not be fully available.

(c) Bearing in mind, the minimum spacing of joints and the clearance between the joints and the wheels (discussed later in this chapter) connect (6") 150 mm long loops to the ends of the wire ropes to make joints for wire adjusting screws and disconnecting kinks.

(d) Run-out wire from the leadout to the function mechanism if there is no diversion in the transmission and upto the near end diversion wheels if the transmission is required to be diverted. From then far end of the diversion wheels, a fresh length of wire is run up to the next diversion wheel or the mechanism. Care should be taken to see that the wire is run out from drum or a creel and that the wire does not form kinks or twists. Wire should be pulled and securely tied at the ends to wheels, stakes, etc., as otherwise if some time elapses between the running of the wire and connecting up the transmission, the wire might form kinks and twists.

(e) Connect loops to the leadout end of wires and insert the wire adjusting screws/disconnecting links between these loops and loops prepared vide para (c) above. Wire adjusting screws should be kept open so as to allow adjustments on both sides. Wire adjusting screw at the mechanism end should, however, be fully closed at the time of installation as to enable the transmission and compensator being adjusted from their lowest temperature position to that corresponding to the ambient temperature.

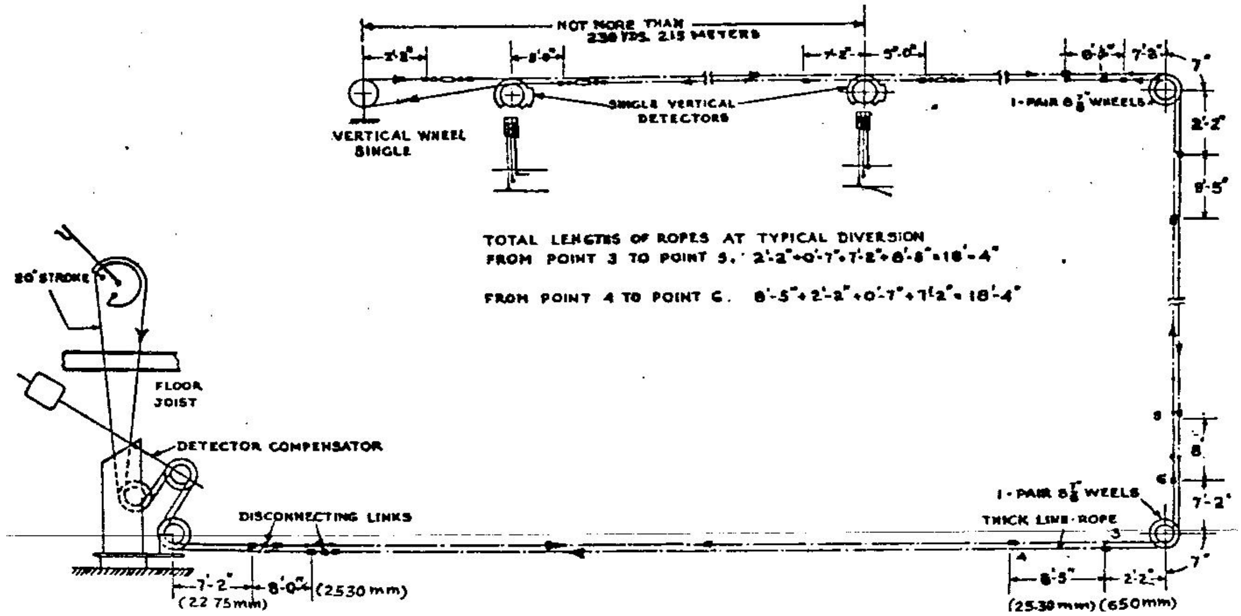
(f) At the diversion wheel/mechanism the wire is brought to correct tension by means of a toggle draw tongs and wire adjusting screw. An experienced Inspector or a Tinsmith can make out the correct tension, by inspection but it is advisable that a dynamometer is connected in the transmission near the toggle and the wire brought the same tension as would be introduced by the compensator. The value of tension caused by the compensator is about 68 kgs.150 lbs. near it, but is gradually reduced on account of friction offered by diversion wheels as we move away from the compensator. Therefore, due allowance for this should be made while measuring tension at the time of connecting transmissions so that when compensator weights are flatted, the position of the joints does not change. Mark off the position of joints on the wire taking care that minimum spacing and direction of movement of joints is correct. Cut the wire and make the joint between wire and wire rope. The same process has to be repeated at every diversion and at the function mechanism.

(g) Wire adjusting screws must be provided in each wire of the transmission as follows:-

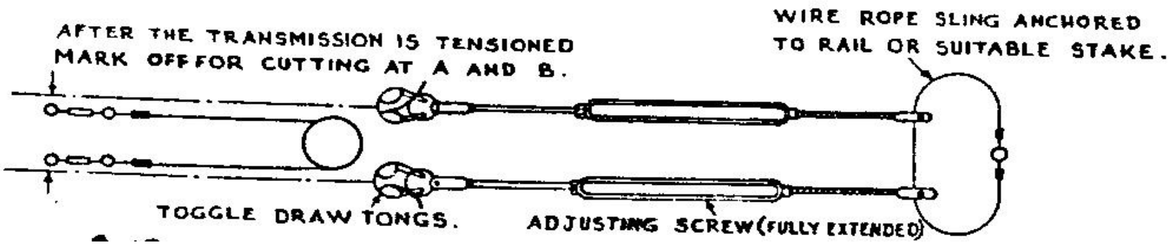
(i) One near the mechanism to be adjusted.

(ii) One near the leadout if required.

One in the wire running between each mechanism where two or more mechanisms are operated by one transmission.



SINGLE DETECTOR LEVER TRANSMISSION
(For Normal or Reverse Detection)
Fig 8.11



TENSIONING TRANSMISSIONS

Fig 8.12

The following causes bring about the movement of joints and hence, all of them should be taken into consideration before the minimum clearance between adjacent joints in pull and return wire or between joints and wheels.

- Temperature Variations
- Adjustment of a transmission to suit the use of an oversized lever drum.
- Lever Operation
- Wire Breakage.

Compensating Stroke: Compensating strokes for the various lengths of transmission are given below:-

Length of transmission upto	550 yds	12"
Length of transmission upto	880 yds	18"
Length of transmission upto	1500 yds	33"
Length of transmission upto	730 Mts	595 mm
Length of transmission upto	1400 Mts	1092 mm

8.12 Effect of Lever Operation

When a lever is operated all the joints in the pull wire move towards the lever and those in the return wire move away from it. The magnitude of this movement is taken to be equal to the stroke of the lever.

8.12.1 Clearance between Adjacent Joints in Pull and Return Wires

Single Transmission: When a lever is operated, the adjacent joints in pull and return wires of the same transmission move towards each other through a distance equal to the lever stroke. Thus the two joints will come closer by twice the lever stroke viz., 500 x 2 = 1000 mm or 600 x 2 = 1200 mm dependent upon whether a 500 mm or 600 mm stroke lever is employed. Therefore, to prevent the joints getting entangled, their nearest ends should be at least the above distance apart with the lever in the normal position. However, to cover errors due to maladjustment etc., a safety margin of 200 mm is added to the figures obtained above. Therefore, the minimum distance between the nearest ends of the two joints should be: Twice the lever stroke + 200 mm See Fig.8.13.

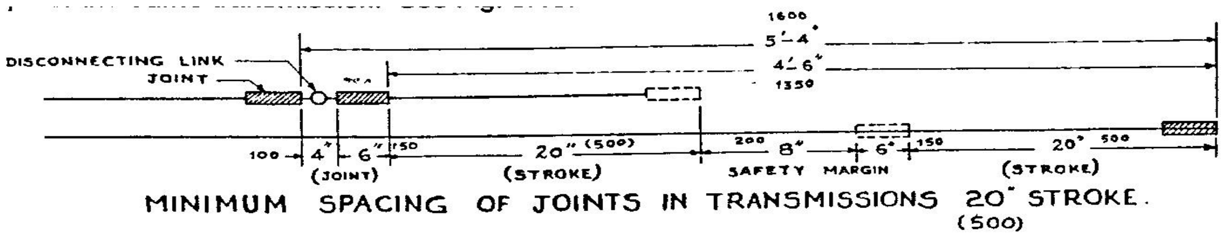


Fig 8.13

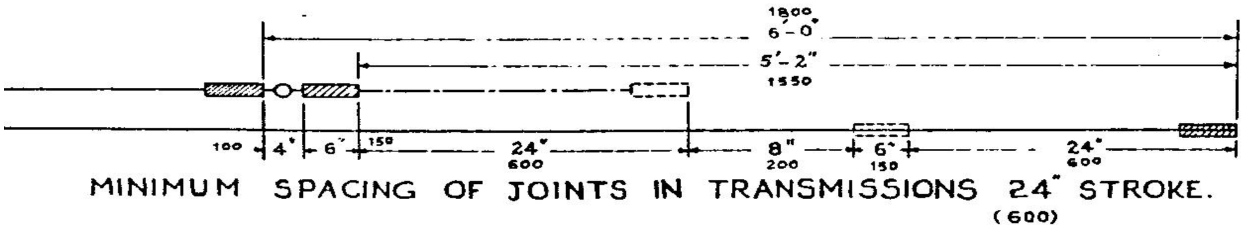


Fig 8.14

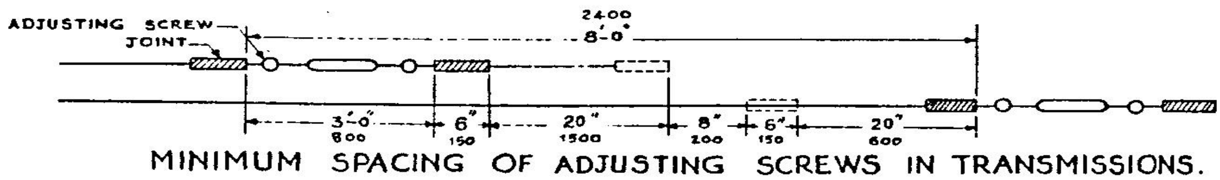


Fig 8.15

(a) Coupled Push-Pull Transmissions:

Distance between joints in adjacent wires for push-pull transmissions is the same as that for single transmissions since only one lever is required to be operated at a time and the joints move towards each other only to the extent of twice the lever stroke.

(b) Coupled Pull-Pull Transmission:

In the case of pull pull transmissions, two levers one after the other are required to be operated so that the joints move towards, each other each by twice the lever stroke and therefore, the distance between the ends of the wire ropes of such transmission shall be four times the lever stroke 200 mm + 150 mm.

(c) Use of disconnecting link and wire adjusting screws:

Here a disconnecting link is provided in the wire rope, the extra length of the longer rope must include100 mm for the length of disconnecting link and another 150 mm and return wire shall be:-

Twice the lever stroke + 200 + 150 +100 +150 for single and push-pull transmission. See figure 8.14 and four times the lever stroke + 200 + 150 +100 + 150 for a pull-pull transmissions.

When a wire adjusting screw is connected in a transmission the distance between the joints must include 900 mm for the length of the adjusting screw when fully opened and 150 mm for the length of the additional joint. The distance between the joints shall be.

Twice the lever stroke + 200 + 150 + 900 + 150 for single for single and coupled push-pull transmissions and four times the lever stroke 200 + 150 + 900 +150 for pull-pull transmissions. See Fig. 8.12.

These clearances, however, can only be provided for those joints, which move in the same direction due to breakage but in opposite directions during lever operation. The movement caused by wire breakage is always more than caused by lever operation. Therefore, joints that move in opposite directions due to wire breakage must cater for the excessive wire breakage stroke to prevent their entanglement in the event of wire snapping.

The only joints in a transmission that move in the same direction. When a wire break occurs are the joints adjacent to the leadout. Of course, this is based on the assumption that the wire rope between the lever and the leadout joint has no probability of breaking. Therefore, clearance between adjacent joints in pulls and return wires of a transmission based on the lever stroke.

(d) Clearance between Joint and Wheels:

Joints in the pull wire on the lever side of wheels move away from the wheel while those on the function side move towards it. Similarly, joints in return wire on the lever side of the wheel move close to the wheel and those on the mechanism side away from it. Therefore, no clearance need be provided for lever operation for joints in the lever side of wheel and those on the function side of wheel for pull and return wire respectively. A clearance equal to the lever stroke is necessary for the other joints. However, since all the joints move with respect to the wheels when wire break occurs and the movement caused by wire breakage being more than that caused by lever operation the former determines the clearance to prevent the entanglement of joints with wheels.

8.12.2 Effect of Wire Breakage

(a) Increase in tension of intact wire:

Clearance between joints and wheels: When a wire break occurs, tension in the intact wire doubles and consequently a length of wire is withdrawn from the transmission by the compensator. This causes the joint in the intact wire and those on the compensator side of break in the broken wire to move towards the compensator by an amount equal to stretch in the intact wire caused by an increase in tension from about = 68 kgs. to about 135 kgs The joints in the broken wire on the function side of break are not adversely affected by this movement. Therefore, allowance has to be made for joints on the function side of wheel only on this account. A uniform extra clearance of 150 mm is provided.

(b) Losses of tension in the broken wire:

(i) Clearance between joints and wheels: - A wire breakage causes a loss of tension in the broken wire and therefore, a shortening in the lengths of the wire on either side of the break occurs. This causes the joints in the broken wire to move away from the break a distance equal to the shortening of the wire. Since a break can take place anywhere in the transmission, all joints whether on the function side of the wheel or the lever side should have an extra clearance to cater for this movement. A uniform allowance of 150 mm is made on this account.

For calculating the clearance between the wheel and the joints however, only 150 mm is added on account of both loss of tension in the broken wire and increase in tension of the intact wire because of any one time, the same wire cannot be intact as well as broken and therefore, the allowance of 150 mm provided is sufficient.

(ii) Clearance between adjacent joints in pull and return wires:- Since the joints only in the broken wire move on this account, on extra clearance equal to this movement would be required between all adjacent joints. An allowance of 150 mm is made on this account.

(c) Movement of function Mechanisms:

(i) Clearance between joints and wheels: - When a wire break occurs and if the function mechanism is free to rotate the two ends of broken wire move in opposite directions each a distance equal to the rotation of the function drum. The intact wire moves towards the compensator by an equal amount. Thus joints in the intact wire and those in the broken wire on the function side of the break move in opposite directions but those in the broken wire on the compensator side of the break move in the same direction as joints in the intact wire.

In the case of single detector transmissions the return wire breakage with lever normal will cause a much greater movement of the wires when a breakage in the pull wire. The actual movements are 939 mm and 100 mm respectively. Therefore, joint in this transmission should have extra clearance as follows:-

Pull Wire		**Return Wire**	
Function Side	939 mm	Function Side	939 mm
Lever Side	939 mm	Lever Side	939 mm

Minimum clearances required between the wheel and the joints for various transmissions caused by movement of the mechanism drum, by a wire breakage under the most adverse circumstances are given below:-

1	Point Mechanism	500 mm
2	Single Signal Mechanism	787 mm
3	Push-Pull Signal Mechanism without detector	1275 mm
4	Push-Pull Signal Mechanism with detector	939 mm
5	Single detector transmissions	
	(i) Pull Wire breakage	100 mm
	(ii) Return Wire breakage	939 mm
6	Pull Signal Mechanism	1350 mm
7	Coupled Push-Pull detector transmission	939 mm

(d) Adjacent Joints in Pull and Return Wires:

As already discussed adjacent joints in pull and return wires move opposite to each other (with the exception of leadout joints) with the wire breaking at one place or the other in the transmission. The distance between adjacent leadout joints remains unaffected but clearance between other adjacent joints reduces on account of the wires moving towards each other. Therefore, to present joints getting entangled when a wire break occurs, the minimum clearance between adjacent joints would with the exception of leadout joints need a clearance equal to twice the movement of the mechanism drum under the most adverse case of wire breakage.

8.12.3 Tripping of Lever/Levers

If the transmission is worked by a clutch lever/levers then the broken end towards the lever/levers is pulled further by 150 mm twice the tripping movement of the clutch driven lever or 300 mm depending upon whether one lever trips or both. In the case of transmission worked by coupled clutch levers, a wire break with both the levers in the normal position will cause both the levers to trip, but a wire break with one lever reverse, will cause only the operated lever to trip the other lever in the normal position having been drum locked. The broken end towards the junction and the intact wire are not affected by tripping movement.

(a) Adjacent Joints in Pull and return wires:

Tripping of the lever causes the broken end towards the compensator only to move, the other end remaining stationary. Adjacent joints on the function side of the break do not move and therefore, their relative positions remain unaffected. Joints on the compensator side of the break move closer. No extra clearance would appear to be necessary for this since joints on compensator side of break move in the same direction due to rotation of the functional drum and the only opposite movement in them is caused by lever tripping. However, if a wire breaks with a lever in the reverse position, the joints would have already moved towards each other each equal to the lever stroke and the tripping movement will cause the joints to move closer. To cater for wire breakage under these circumstances, an allowance of 150 mm needs to be made for the leadout joints only.

Adjacent joints in pull and return wires, other than the leadout ones, if given the greater broken wire clearance, would not need 150 mm extra clearance on this account because the clearance provided will cover this case also. However, for point transmission where the lever stroke and the point mechanism movement due to wire breakage are equal the 150 mm clearance between all adjacent joints in pull and return wires is necessary.

(b) Joints and Wheels:

As already discussed joints in the broken wire move in opposite directions from the point of break and those in the intact wire move towards the compensator if the function drum is free to rotate. Tripping causes only the broken end nearer the compensator to move.

This causes the joint to move closer to the wheels and therefore, sufficient clearance has to be provided to prevent a joint catching up. An extra clearance of 200 mm for single transmission and 300 mm for coupled transmissions should be made for all joints on the function side of the wheel, if the transmission is worked by clutch lever/levers.

(c) Clearance between Joints and Wheels:

Single transmission: (Where the mechanism has a normal stop) and pull transmission.

Joints on lever side of wheel pull wire:

No clearance is required, for the following:-

(i) Temperature variations

(ii) Increase in tension in the wire when the return wire breaks

(iii) Movement of mechanism caused by wire breakage.

(iv) Tripping of levers

(v) Lever Operation.

Clearance is required on the following accounts:-

(i) 50 mm for adjustment for oversized lever drum if a 600 mm stroke lever is used.

(ii) 150 mm for loss of tension when the wire breaks

(iii) 150 mm for length of joints

(iv) 250 mm for safety margin to cover errors due to maladjustments, etc.

(d) Joints on Lever side of wheel/return wire:

The clearance to be provided should be equal to the clearance obtained above for the pull wire plus the clearance between adjacent joints in pull and return wires.

(e) Joints on function side of wheel/return wire:

Clearance is required to be provided for the following:-

(i) Temperature variations equal to the compensating stroke

(ii) 50 mm (2") for the adjustment of transmission for oversized lever drum.

(iii) 150 mm (6") for increase in tension in the wire if the other wire breaks or loss of tension if this wire breaks.

(iv) Movement of the function mechanism due to wire breakage.

(v) 150 mm (6") for tripping movement

– 150 mm (6") for length of joint.

– Safety margin of about (250 mm) 10”.

(f) Joints on function side of wheel/pull wire:

The clearance should be sum of the clearance for return wire as calculated above and that between the adjacent joints in pull and return wires.

(g) Push Pull Transmissions: For Push Pull transmissions distinction between pull and return wires cannot be made because each of the wires is either pull or push according as whether one lever is operated for the other. Therefore, distance between the wheel and the joints in one of the wires is calculated as follows:-

(h) Joints on Lever side of wheel:

No allowance is necessary to be made for the following:-

(i) Temperature variations

(ii) Increase in tension of the wire when the wire breaks.

(iii) Tripping of lever/levers

(iv) Lever Operation

Clearance is determined by the following factors:-

(i) 150 mm for loss of tension if the wire breaks.

(ii) 150 mm for length of joints.

(iii) Movement of mechanism caused by wire breakage.

(iv) 250 mm for safety margin.

The clearance between the wheel and the joint in the other wire on the lever side of wheel is struck by adding the clearance obtained above to the clearance between adjacent joints in pull and return wires:-

(i) Joints on function side of wheel:

The clearance is the sum total of the following movements:-

(i) Temperature variations equal to the full compensating stroke

(ii) 150 mm for increase in tensions when a wire breaks

(iii) Movement of the mechanism due to wire breakage

(iv) 300 mm for tripping movement

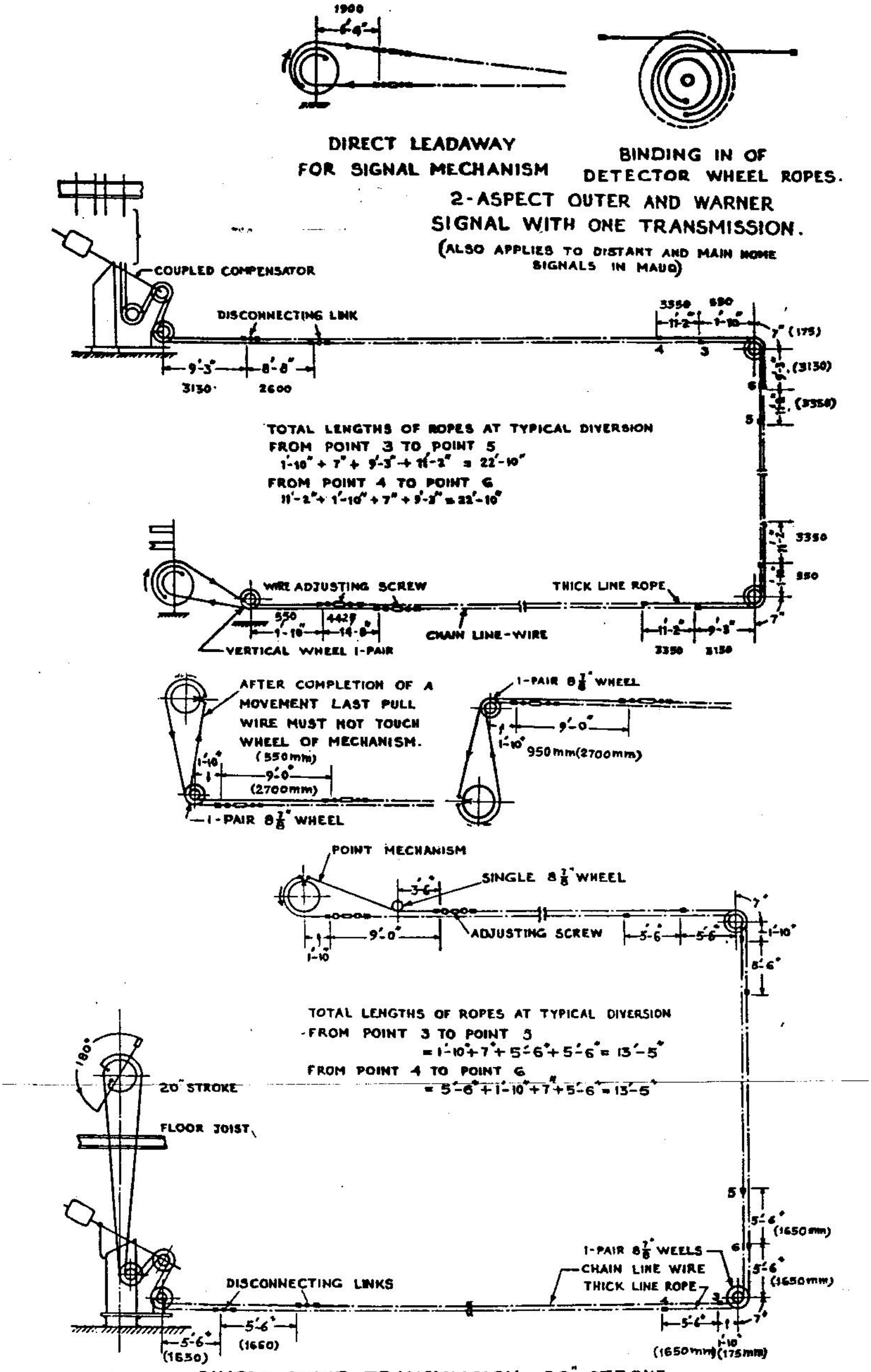
(v) 150 mm for length of Joint.

(vi) Safety margin of 250 mm

Clearance for single detector transmissions are calculated in the same manner as that for push-pull transmissions excepting that the movement of the detector due to breakage in pull and return wires is different.

For reasons of safety, however, wire ropes are installed a few inches longer than is necessary according to the calculations.

Distance between joints in Pull and Return Wires at the leadout:



SINGLE POINT TRANSMISSION 20" STROKE

Fig: 8.16

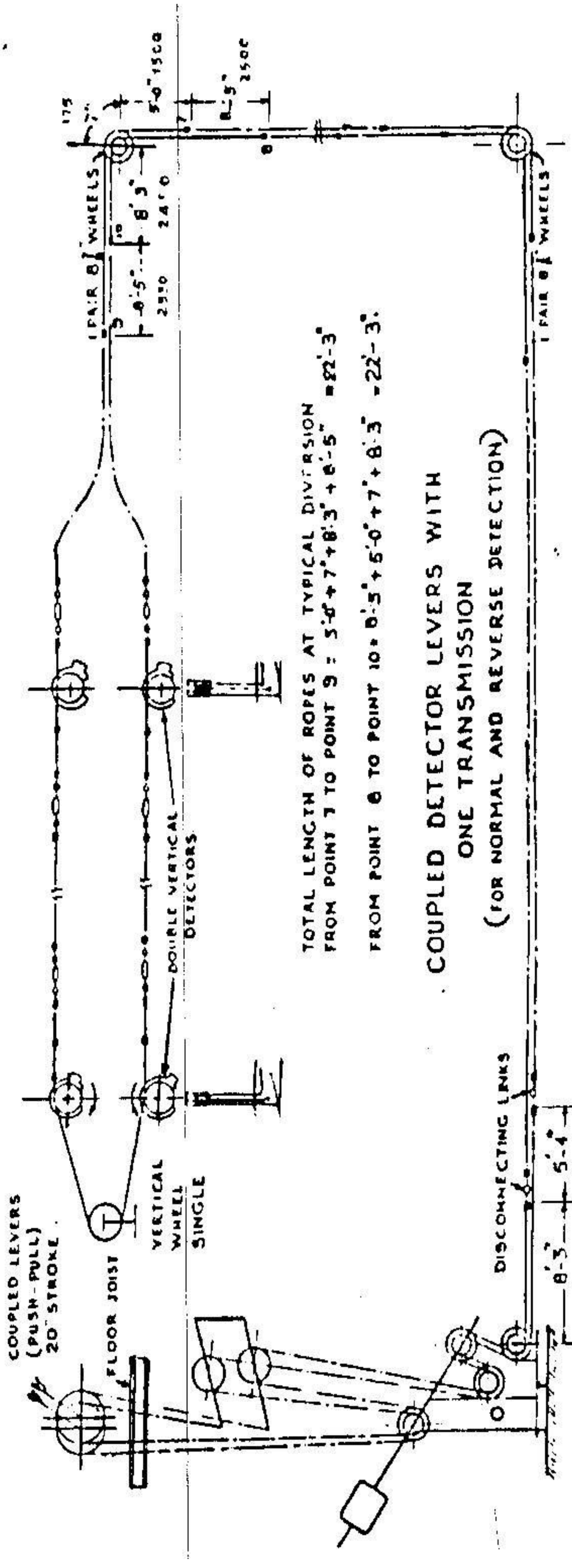

TOTAL LENGTH OF ROPES AT TYPICAL DIVERSION
FROM POINT 7 TO POINT 9 : 5'-0"+7"+8'-3"+8'-5" =22'-3"
FROM POINT 8 TO POINT 10 = 8'-5"+5'-0"+7"+8'-3" =22'-3"
COUPLED DETECTOR LEVERS WITH
ONE TRANSMISSION
(FOR NORMAL AND REVERSE DETECTION)
COUPLED LEVERS
(PUSH-PULL)
20" STROKE
FLOOR JOIST
VERTICAL
WHEEL
SINGLE
DOUBLE VERTICAL
DETECTORS
DISCONNECTING LINKS
1 PAIR 8¼" WHEELS
1 PAIR 8¼" WHEELS

Fig: 8.17

CHAPTER 9: BROKEN WIRE PROTECTION

9.1 Basic consideration involved in Broken Wire Protection

With the Orthodox Mechanical Signalling transmission broken correspondence between lever position and function position is lost only when the lever is operated where under such conditions in Double Wire transmission, however suffers from an additional disadvantage in that the transmission under broken wire conditions becomes active under the influence of pre-tensioning and falling compensator weights and is quite capable of working the mechanism. The function mechanism drum when free to rotate indeed does so under such cases thereby operating the connected function. It is this aspect of working of double wire transmissions calls for special efforts to ensure safety under broken wire conditions.

9.2 General principles governing working of function under broken wire conditions

Broadly speaking to ensure safety at all times essentials of interlocking must be observed even under broken wire conditions. In general, therefore, a signal which is not taken off must be maintained in 'ON' position while any other function (points etc.) must comply with the requirement of route holding. The requirements to be fulfilled by individual functions are detailed below:-

9.2.1 Signals

(a) With its lever normal, the signal must continue to remain in its 'ON' position, momentary movement of the signal towards a less restrictive aspect during a complete pull through being however, accepted.

(b) With its lever reversed, the signal may remain in the last operated position though it is desirable that the signal returns to its 'ON' position. In case, however, the signal remains in the last operated position, it is imperative that the signal goes back to its 'ON' position with the operation of the lever from its reverse to normal position.

9.2.2 Points

(a) Points should remain held in their last operated position.

(b) However, in case this objective is not achieved, the switches must not stand gaping but should completely throw over to the other position.

9.2.2 Detectors

(a) With the lever reversed, the detector must continue performing its function viz., holding the points in the detected position.

(b) With the lever normal, detector is not called upon to do any work.

9.2.2 Clutch Levers

Clutch levers must trip and cause the fault indicator to be displaced. In addition, when the lever is not locked tight its tappet should get a further stroke and actuate the tight locking if any provided on the lever.

9.3 Signals

To distinguish between the lever stroke and the broken wire stroke in the same direction, the latter is made greater in magnitude than the former. The excess of broken wire stroke over the lever stroke called the overrun stroke is then utilised for replacing the signal to its 'ON' position.

9.3.1 Points

To cater for these circumstances the broken wire stroke of the points mechanism drum should completely throw the points to the other position. It should be noted that elimination of broken wire stroke of the point compensators will not result in elimination of the torque applied by the transmission on the mechanism because of the initial tensioning and also of the fact that any compensation capacity not utilised by the transmission will act as broken wire stroke.

9.3.2 Detectors

With the lever reversed and pull wire broken, the detector wheel is caused to rotate by the broken wire transmission torque in the same direction as that caused by the lever operation from normal to reverse position. To enable the detector, therefore, to continue holding the points in the detected position the detecting rim is extended beyond the reverse position of the detected wheel upto the control rim. However, if the return wire breaks the broken wire transmission torque rotates the detector wheel towards its normal position. From the reverse position of the wheel upto end of the detecting rim, the latter holds the points but as in the normal position of the detector wheel the points are free to move. The detector wheel is made to continue to rotate upto the control rim when locking rim again holds the point's slides.

9.3.3 Clutch Levers

Adjusting the maximum tripping tension difference to 85 kgs only ensures tripping of clutch levers. This adjustment allows (137 - 85 = 52 kgs) for frictional losses etc., and makes the tripping action of these levers reliable. It is, however, desirable to keep the maximum tripping tension difference as far as below 85 kgs as feasible so as to achieve better sensitivity of the tripping device.

9.4 Movement of Coupling Device

The coupling device levers are 500 mm long and the wheels are at 250 mm from the fulcrum. In the case of push-pull working both the coupling levers have their ends 250 mm below the fulcrum and therefore, the wheels are 125 mm below. When either lever is operated, the coupling lever connected to its rises so that the wheel is 125 mm above the fulcrum. Hence, if the coupling loop breaks when the lever is normal the wheel drops125 mm , but if the lever was reversed the drop is 375 mm (15") .

9.5 Movement of Wire during a break

The effect of a broken wire between the lever and the compensator on the outside transmission will be considered first. The Figs 9.1 and 9.2 illustrate this.

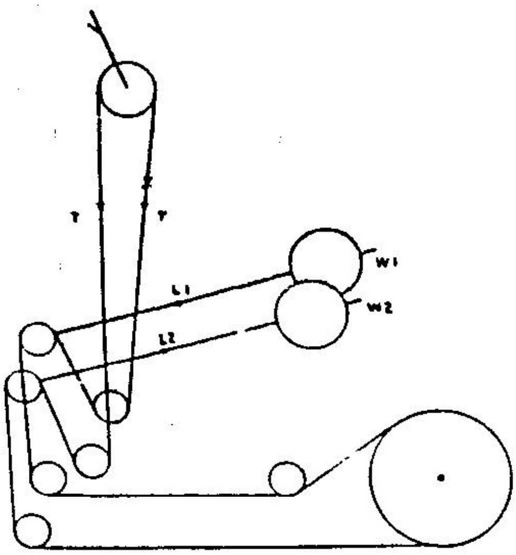


Fig.9.1

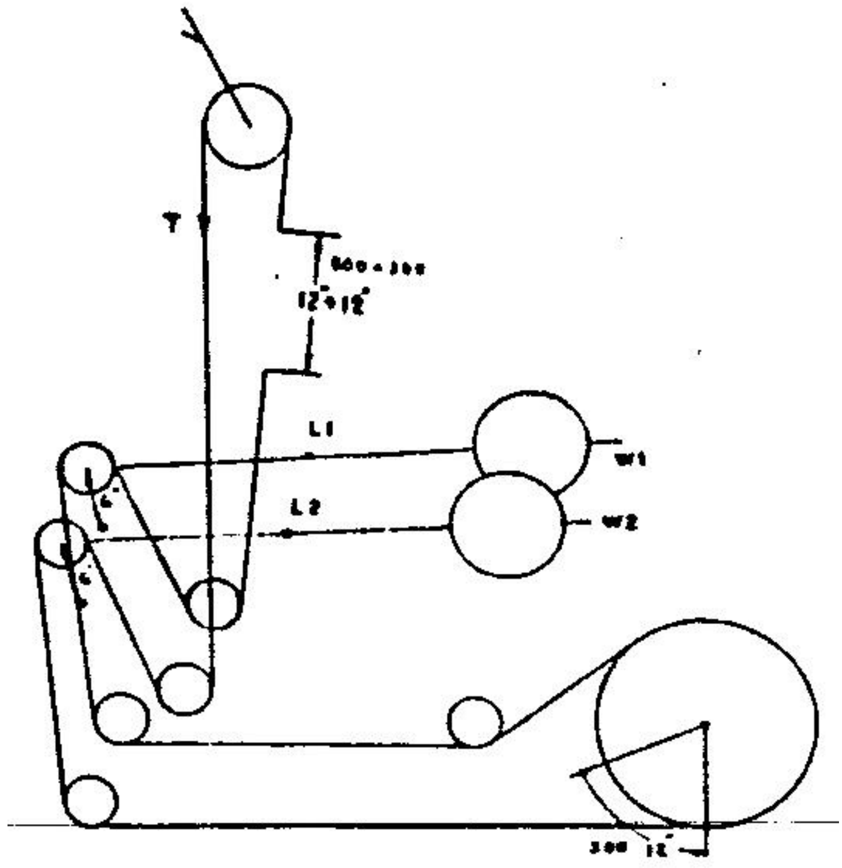


Fig: 9.2

If the return wire breaks at X, the compensator weight on weight lever L1 intends to drop, as in effect it was hung on the return wire. In doing so, it will open, out a gap between the broken ends of wire at X. Supposing it could drop so as to lift wheel W1 through 150 mm the gap at X would be opened by twice this amount i.e., 300 mm, It is, however, impossible for the weight on lever L1 to drop without that on lever L2 dropping at the same time through substantially equal distance, and this in turn will require wheel W2 to rise 150 mm. In order to do so the wheel must pull in 300 mm of wire. Assuming the drum to be locked, it cannot pull any wire from the lever side, but can pull 300 mm of wire right round from the break X. This will have two results.

(a) It will rotate the mechanism through an amount corresponding with 300 mm wire stroke.

(b) It will widen the gap at X by a further 300 mm making it 600 mm in all.

From this analysis it is seen that the movement of wire outside the cabin is only half that of the broken ends between the lever and the compensator and the movement of the compensator wheel upwards is half that of the outside wire in the case of a break in transmission.

The same applies to a system of coupled levers. A break in one of the coupling loops constitutes a break in transmission between lever and compensator, and the resulting movement of the wires outside the cabin will be half that of the wire between the compensator and the point of breakage. In the case of push-pull coupling arrangement shown in Fig 9.3 and 9.4 the drop of the coupling wheel will be 125 mm and the gap between the wires 250 mm which is same as the slackening of the wires passing over the dropped coupling wheel. Consequently, the movement of the signal mechanism will be equal to the drop of this wheel.

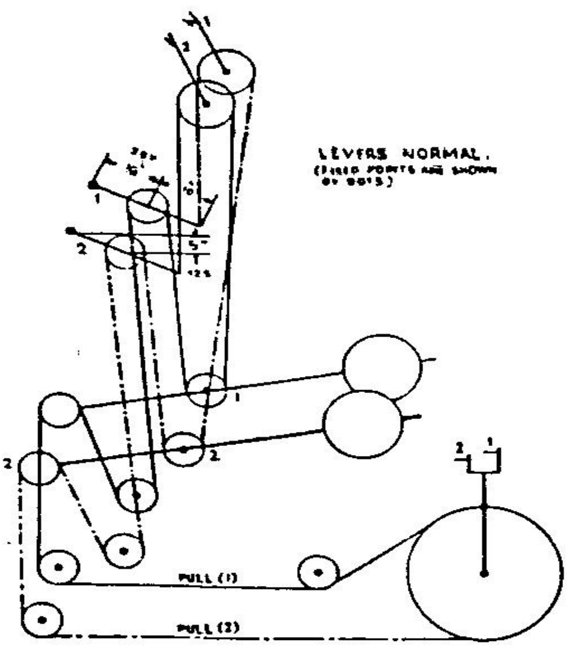


Fig: 9.3

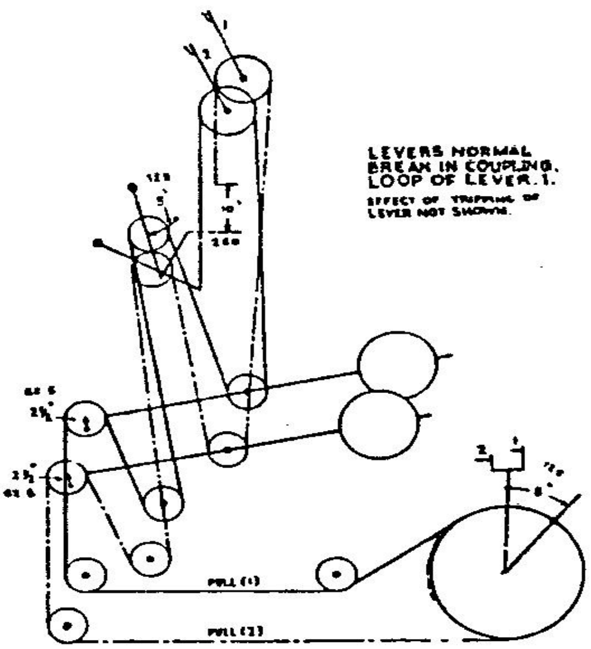


Fig: 9.4

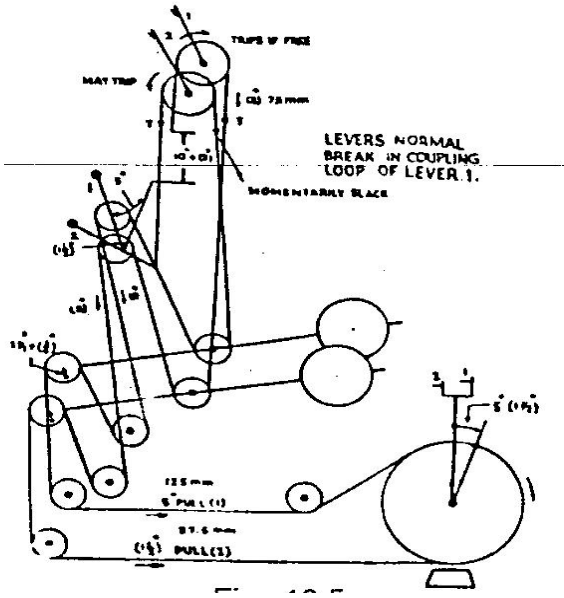


Fig: 9.5

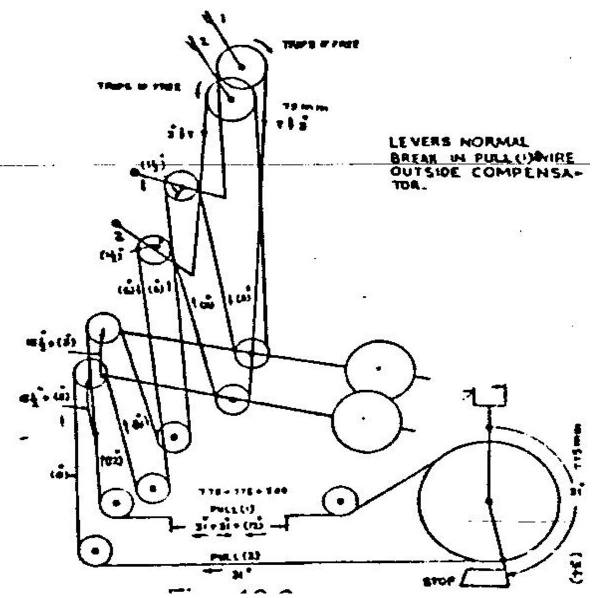


Fig: 9.6

9.6 The Effect of wire breakage on Tripping of Levers

In the above analysis the effect of wire breakage on the tripping of the lever has not been considered. In all cases, the movement of the wire due to tripping is shown in brackets.

A break at X will cause the intact wire to pull the lever downward by a force equal to the normal wire tension. The lever, if free, will, therefore, trip backward. The same thing will happen if the wire breaks at any point in the transmission with signal compensators, i.e., the intact wire will trip the lever, if free, towards it.

In the case of coupled compensators with a break in the coupling loop of lever 1 as in Fig. 9.5 pull (1) wire will hang on coupling wheel 1. Pull (2) wire will exert a downward force T on lever 1 which will therefore, trip forward, if free. On lever 2 there is downward force of T on both sides, but during the time the coupling wheel 1, falls down, the momentarily slackening of pull (1) wire reduce the tension on the front of lever 2. The pull 2 may or may not therefore, trip backward, if free.

However, if the break is at Y as in Fig. 9.5 pull (1) wire will become completely slack and there will be no downward force exerted on coupling wheel 1 and therefore, on coupling loop of lever 1 and the return wire on the front of lever 2. Lever 1 will, therefore, trip forward and lever 2 backwards, i.e., the lever connected to the broken wire will trip backward and the lever connected to intact wire will trip forward.

The effect of a breakage on the transmission having detectors will be considered later along with the complete analysis of the effect of wire breakage on all equipment.

9.7 The effect of Tripping on Movement of Wires

The result of these movements of the lever due to tripping is to impart movement on the signal mechanism or transmission amounting to 37.0 mm in the direction of tripping if both the levers trip opposite to each other, the effect of one lever tripping is added to that of the other end, a 75 mm movement of the wires will result.

As already stated the effect of a breakage between the lever and the compensator is to impart a stroke equal to half the separation of the broken ends to the wire transmission and the compensator wheels rise by half the amount of the movement of transmission during breakage.

The breakage of coupling loop the transmission moves back 125 mm and the compensator wheels rise 64.0 mm. Again due to the tripping of lever 1 the transmission moves forward 37.0 mm making a total backward movement of 87.0 mm. The compensator wheel rise is however, 64.5 + 18 = 82.0 mm. The compensator wheel rise has no relation to the direction of movement of the wire due to breakage and the individual rise due to each cause should be calculated and added up.

If, however, the gripping is due to break in transmission the compensator weights are held at least by one intact wire and the additional stroke of 37 mm if one lever trips, and 75 mm if both levers trip as above will be taken up by the compensator wheels by moving up 37.5 mm and not 18 and 37.5 mm not and respectively, as half the stroke of wire is not taken up by the other compensator wheel. In such a case of breakage outside the compensator, the effect of tripping on the gap between the broken ends is to increase, it by 150 mm for each lever tripped (See Fig.9.6). If, however, the movement of the free wire is restricted beyond 150 mm, then the compensator wheel cannot rise beyond 37.5 mm and this wire will hold the compensator. The net result is the lever connected to this wire may not trip at all, and if both levers trip, it will cause only half the movement of both lever drums.

9.8 Effect of a Detector in the wire run

The only difference between the conditions met with coupled levers with detectors and coupled push-pull levers without detectors are as follows:-

(a) With both levers normal and complete pull through may be prevented by a detector. This depends upon the setting of the points.

(b) With one lever reversed the pulling back of the mechanism beyond the normal position may be prevented by the detector.

Depending on the position of wire breakage different movement are imparted to the signal drum.

9.9 Detailed analysis of wire breakage on Push Pull Signals on the same post

The effect of wire breakage at various points on the transmission on the various equipment operating the transmission will not be considered. Consideration will be given to the position of various signal levers and the point levers at the time of breakage and also the point breakage on the transmission. The levers may be normal or reverse and clutch levers may be free to trip or not, or held by the drum lock. The wire break on the coupling loop or between the lever and the detector or between detector and signal. Various combinations of these will be considered.

In all the following cases, a forward movement of the signal mechanism will clear signal 1 and a backward movement will clear signal 2. The movement of the wire due to tripping is indicated by bracketed figures.

9.10 Break in Coupling Loops

9.11.1 Signals without Detectors

Condition 1:

(a) Both levers normal break in coupling loop of lever 1 (Fig.9.5).

The coupling wheel can fall until the coupling lever is vertical. The drop of the wheel is 125 mm and therefore, the signal mechanism will rotate backward by 125 mm which is insufficient to clear signal 2. The compensator wheels will rise 62.5 mm.

If, however, lever 1 is free to trip forward, the wire will move 37.5 mm forward and therefore, the signal mechanism will rotate back by 87.5 mm only. The compensator wheels will rise an additional 10 mm to make up a total of 81 mm.

Lever 2 may trip back if free due to momentarily slackening of the wire, but it can be reset and lever pulled over taking OFF signal 2. The roller will, however, move in the overrun cam path partly restoring the signal to 'ON' and may trip the lever again. By resetting the lever, it can be returned to 'ON'.

(b) Similar movement takes place if coupling loop of lever 2 breaks.

Condition 2:

(a) Lever 1 reverse, break in coupling loop of lever 1 (Fig. 9.7).

This break will result in the mechanism moving back towards the normal position.

The coupling wheel has been lifted 250 mm When the loop breaks, the wheel drops down a total 375 mm. This is sufficient to return the signal practically fully to danger. The compensator wheels will rise 187.5 mm and the detectors, if provided will lock the points with a movement of 125 mm from normal position. The presence of detector will not, however, affect the working. If lever 1 is free to trip forward, the signal mechanism will rotate forward by 37.5 mm. This means that the mechanism will rotate backward by 375 - 37.5 mm = 337.5 from its reversed position. This will not fully return the arm A to danger, but it will be sufficiently near to the horizontal position to give an unmistakable danger aspect. The compensator wheels will rise 187.6 + 18.0 = 205.5 mm.

Lever 2 cannot trip as it is held by the drum lock.

(b) Similar action will take place if lever 2 is reversed and it's coupling loop breakages.

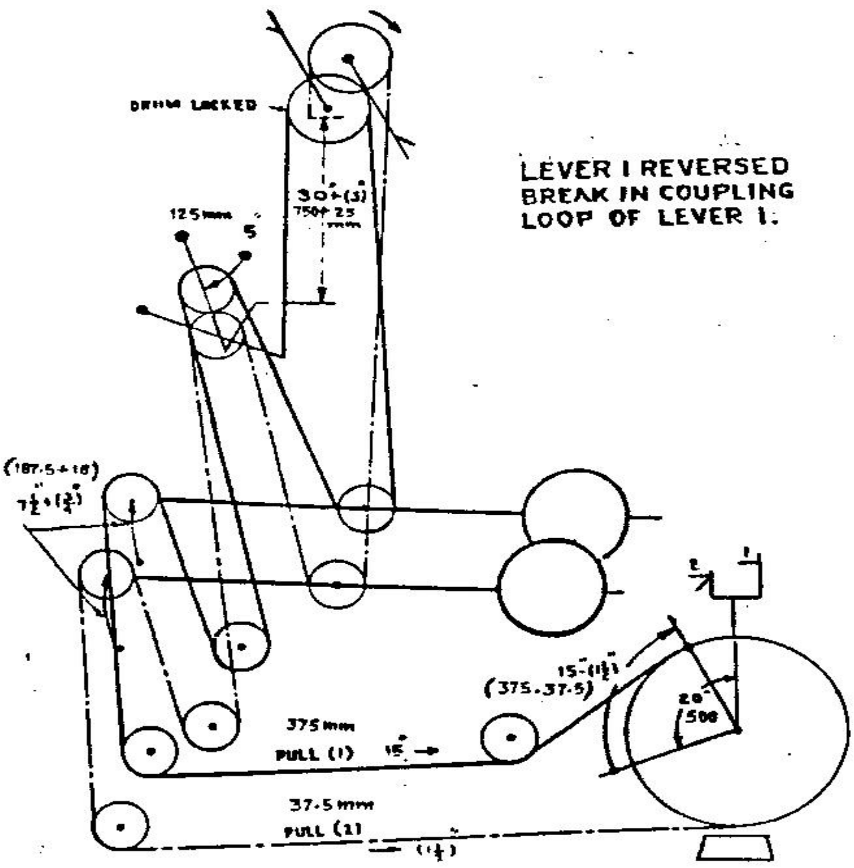


Fig: 9.7

Condition 3:

(a) Lever 1 reverse, break in coupling loop of lever 2 (Fig.9.8).

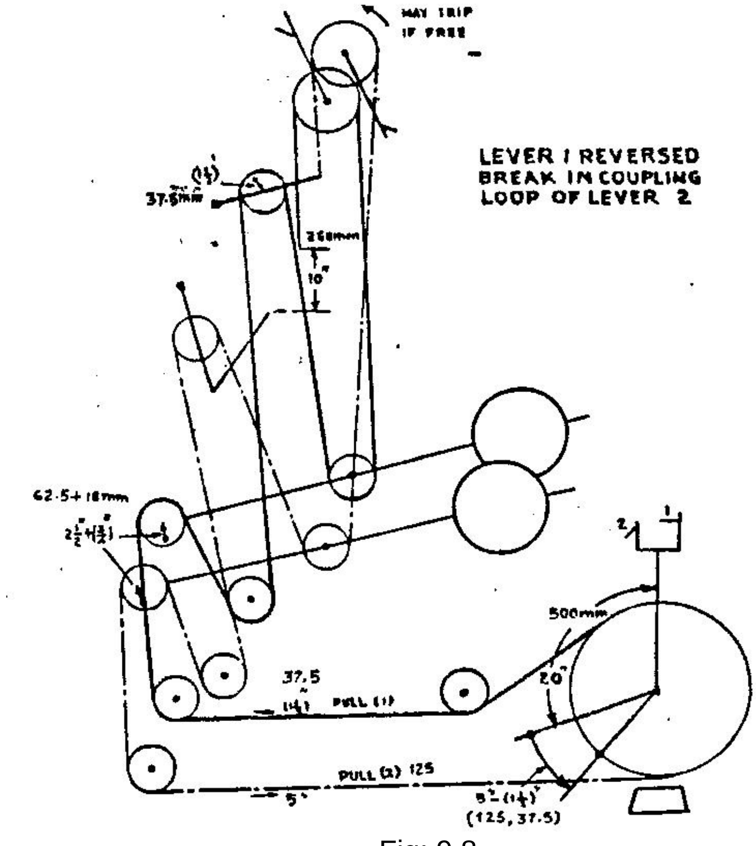


Fig: 9.8

This breaks results in the signal mechanism moving round the overrun direction.

The coupling wheel of lever 2 drops 125 mm and therefore, the signal mechanism will move 125 mm towards the overrun. As the idle overrun is 110 mm and thereafter the signal moves towards 'ON' the net result would be that the signal will return partly to 'ON' but as aspect will still be taken as 'OFF'. The compensator wheel will rise 62.5 mm.

Lever 2 is not free to trip as it is held by the drum lock. If lever 1 is free to trip, it may trip back and the wire will get a backward stroke of 87.0 mm and the resultant movement in the overrun position will be 75 mm only which will not return the signal towards 'ON' position. The compensator wheels will rise 81 mm.

If now lever 1 is returned to Normal, after resetting if it has tripped, the signal will return to 'ON' position, but the roller will be 125 mm inside the initial idle cam path and the points will be partially locked, if a detector is provided in the wire run. Lever 2 will also trip immediately lever 1 is restored to Normal and the roller will move back 37.5 mm towards Normal.

9.11.2 Signals with Detectors

Condition 6:

(a) Points normal both the levers normal, break in coupling loop of lever 1 (Fig.9.5 and 9.9).

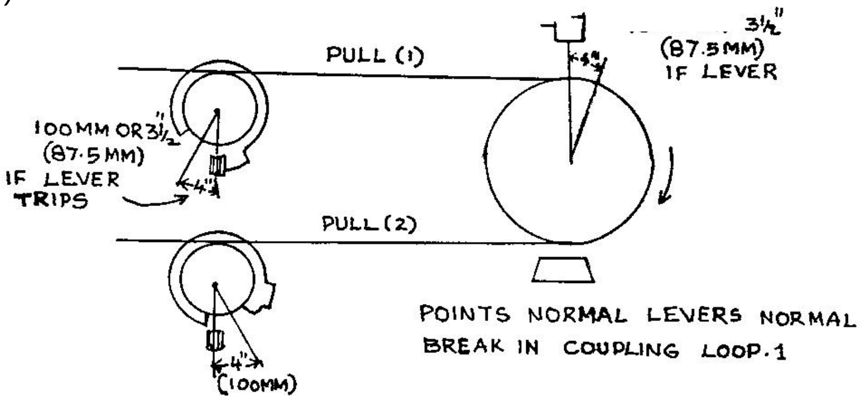


Fig: 9.9

The transmission will move back and the normal detector prevents movement beyond 100 mm. The signal drum will move only 100 mm in the initial idle cam path of signal 2, and the compensator wheel will rise 50 mm with the wire over compensator wheel 1 loose by 50 mm. If lever is free to trip forward the movement of the transmission will be only 87.5 mm and the detector will not come to its stop. The compensator wheels will rise by 81 mm

(b) Similar action takes place if points are reversed and coupling loop of lever 2 breaks.

Condition 7:

(a) Points normal, both levers normal, break in coupling loop of lever 2 (Figs. 9.5 and 9.10).

Normal detector does not prevent movement of the wire and therefore, the action takes place as in condition 1. The detector moves 125 mm (5") or 87.5 mm (3 1/2") locking the points. The presence of detector therefore, does not alter the working.

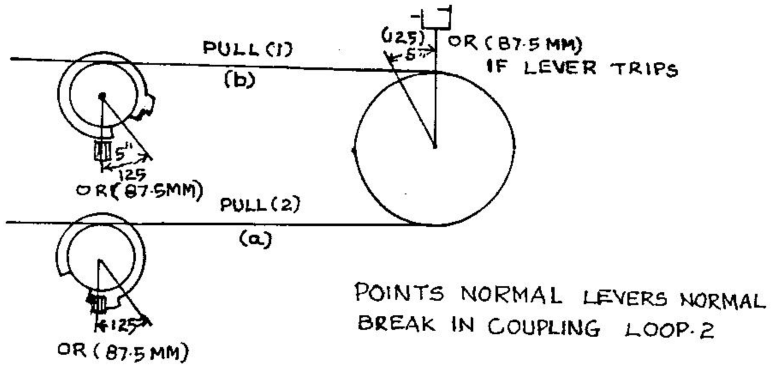


Fig: 9.10

(b) Similar action will take place if points are reverse and coupling loop of lever 1 breaks.

9.12 Break in Transmission

9.12.1 Signals without Detectors

Condition 8:

(a) Levers Normal, break in pull (i) wire (Fig 9.6).

The intact wire will be drawn back 775 mm (31") to step by signal drum. The signal 2 will go to off position momentarily and return to 'ON'. The compensator wheels will rise 387.0 mm (15 ½ "). If levers are free to trip, lever will move forward and lever 2 back and the effect is to give 75 mm (3") stroke to act on pull (2) intact wire but this will be taken by the compensator wheels which will rise a further 75 mm (3") i.e., (to 462.5 mm (18 ½ ") from Normal position. The gap between the broken ends will be 1850 mm (74").

(b) Similar movement takes place if pull (2) wire breaks.

Condition 9:

(a) Lever 1 reversed, break in pull (1) wire (Fig. 9.6 and 9.11).

The intact wire will be drawn back 500 + 775 = 1275 mm (20" + 31 = 51") to opposite stop on the mechanism. The signal 1 will return to 'ON' and signal 2 will momentarily go to 'OFF' and then the 'ON'. The compensator wheels will rise 637.5 mm (25 ½ "). If lever 1 is free to trip, it will move forward and the effect is to give additional 37.5 mm (1 ½ ") stroke on the transmission which will however, be taken up by the compensator wheel rising a further 37.0 mm (1 ½ ") to 675 mm (27"). The gap between the broken ends will be 2700 mm (108").

(b) Similar action takes place if lever 2 is reverse and pull (2) wire breaks.

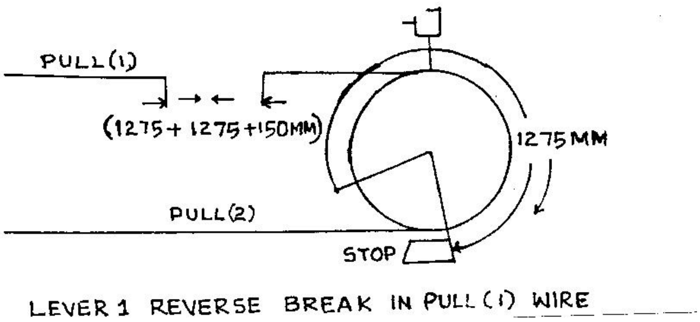


Fig: 9.11

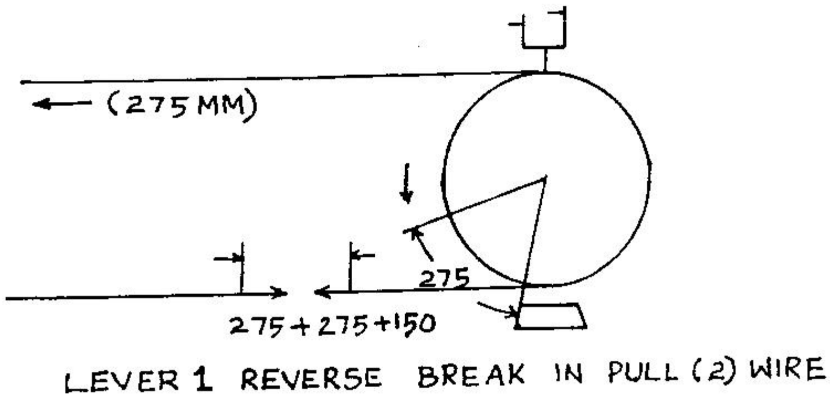


Fig: 9.12

9.12.2 Signals with Detector

Break between lever and Detector

Condition 11:

(a) Points normal, levers normal, break in pull (1) wire between lever and detector (Fig.9.13).

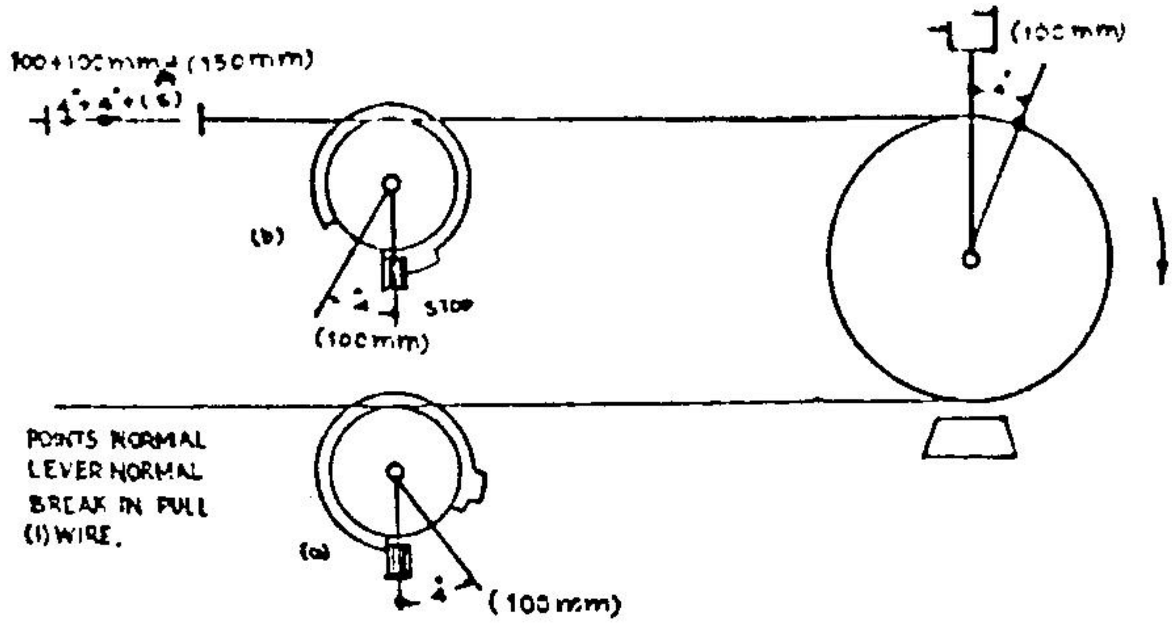


Fig: 9.13

The intact pull (2) wire will be drawn in 100 mm (4") back to stop by high rib of normal detector. Points will be locked by both the detectors and the signal drum moves back (100 mm) 4”. The compensator wheels will rise 50 mm (2"). Levers, if free will trip, lever 1 moving forward and lever 2 moving back. This will cause the compensator wheels to rise a further 75 mm (3") i.e., to 125 mm (5") in all. The gap between the broken ends will be 350 mm (14").

(b) Similar action will take place if points are reverse and pull (2) wire between lever and detector breaks.(Fig . 9.14)

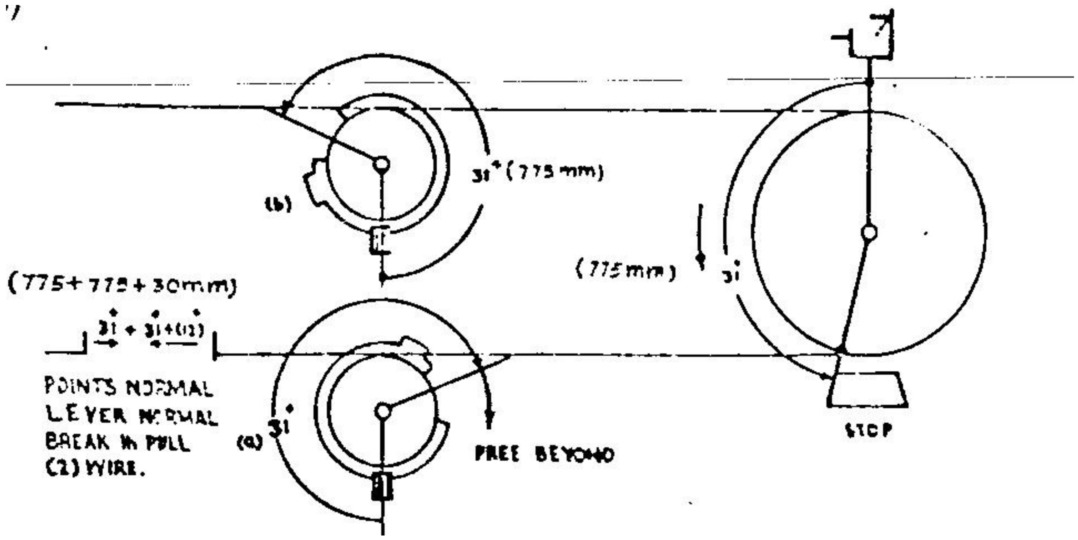


Fig: 9.14

Condition 12:

(a) Points Normal, lever Normal

Break in pull (2) wire as the intact wire will draw the signal mechanism and detector towards normal operation, the transmission will behave as if the detector does not exist. The signal mechanism rotates forward by (31") 775 mm to its stop, taking signal 1 to 'OFF' position momentarily. The reverse detector may continue to rotate due to momentum and stop after unwinding all the rope. The points will be locked by normal detector and possibly by reverse detector also. The compensator wheels will rise (15 ½ ") 387 mm. The levers are free to trip, lever 2 will move forward and lever 1 backwards and the compensator wheel will rise an additional (3") 75 mm. The broken ends will move (74") 1850 mm.

(b) Similar action will take place of point lever is reverse and pull (1) wire between lever and detector breaks.

Condition 13:

(a) Points Normal, lever 1 reversed break in pull (1) wire between lever and detector (Fig.9.15).

The intact pull (2) wire will rotate signal mechanism back until held by normal detector high rim after 600 mm (24") movement. The signal 1 will be returned to 'ON'. Points get locked by both the detectors. The compensator will rise 300 mm (12"). If the lever 1 is free to trip, it will move forward (3") 75 mm and the resultant 150 mm (6") slack in pull (2) wire will be taken up by the compensator wheels raising 75 mm (3"). The broken ends will separate 1350 mm (54").

(b) Similar action will take place if points are reverse: lever 2 is reversed and pull (2) wire between lever and detector breaks.

Condition 14:

(a) Points Normal, lever 1 reversed break in pull Wire between lever and detector (Fig.9.16).

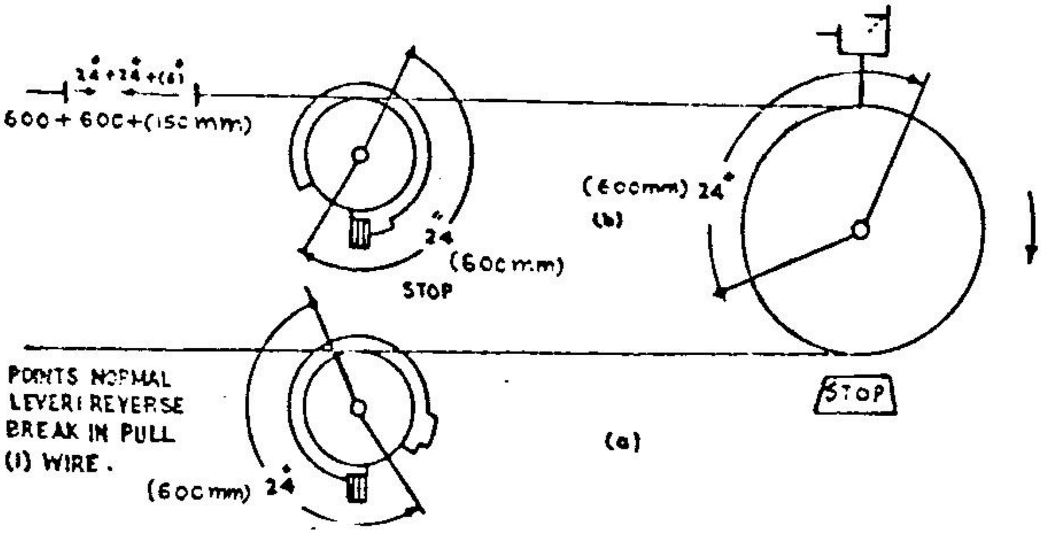


Fig: 9.15

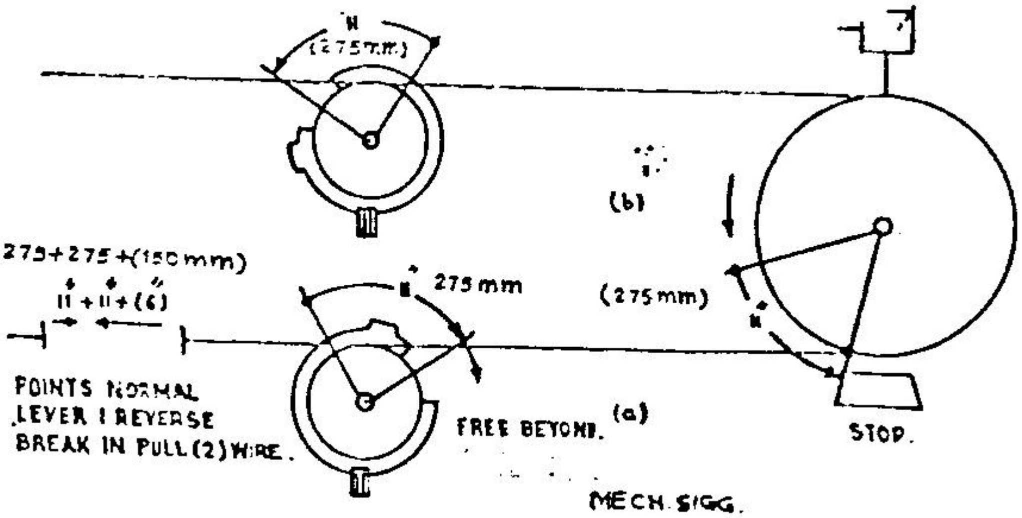


Fig: 9.16

The intact pull (1) wire will rotate forward the signal mechanism by 275 mm (11") until it is held by its stop. The reverse detector may, however, continue to rotate due to momentum until stopped after unwinding all the rope. The points continue to be locked by Normal detector and possibly by reverse detector also. The compensator wheels will move up by 137.5 mm (5 ½ "). If the lever 1 is free to trip, it will move back 75 mm (3"), slackening pull (1) wire by 150 mm (6") which will be taken up by the compensator wheels rising a further 75 mm (3"). The broken ends will move apart 500 mm (20").

(b) Similar action takes place if points are reverse lever 2 reversed and pull (1) wire between lever and detector breaks.

Break between Detector and Signal:

Condition 15:

(a) Points Normal, lever Normal, break in pull (1) Wire between detector and signal (Fig. 9.17).

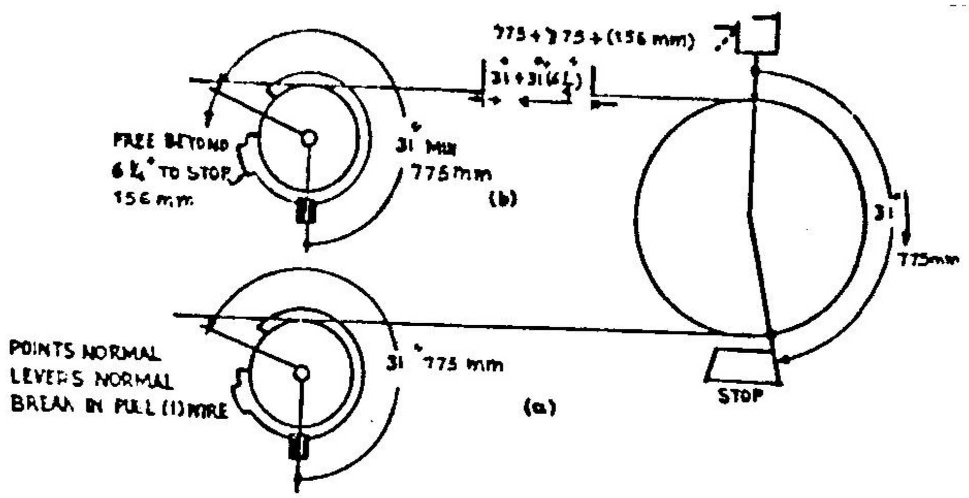


Fig: 9.17

The intact pull (2) wire will rotate the signal mechanism by 775 mm (31") backwards to its stop taking 'OFF', signal 2 momentarily. Points will be locked by both detectors. Normal detector may, however, continue to rotate beyond 775 mm (31") to its stop by high rise after moving 931 mm (37 ¼ "). The compensator wheels will rise 387.5 mm (15 ½ "). If the levers are free to trip lever 1 will trip forward and lever 2 backward. The pull (1) wire will be drawn back 150 mm (6") and pull (2) wire release 150 mm (6"). The normal detector will move up to its stop and take up the slack of pull (1) wire and prevent the compensator wheel rising beyond 3 mm (1/8"). The pull (2) wire will remain slack by 143 mm (5 ¾ ").

(b) Similar action will take place if points are reverse and pull (2) wire between detector and signal breaks.

Condition 16:

(a) Points Normal, lever Normal, break in pull Wire between detector and signal (Fig. 9.18).

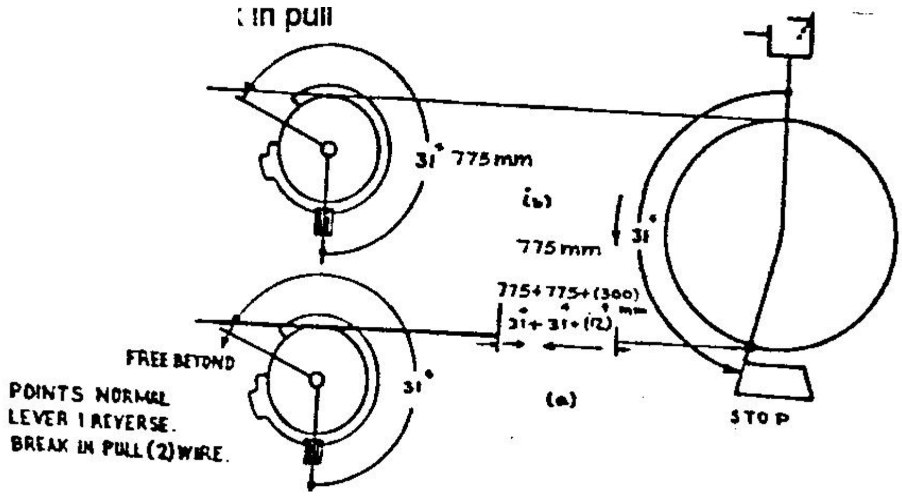


Fig: 9.18

The intact wire will draw forward signal mechanism right round to its stop taking signal 1 to 'OFF' position momentarily. The points get locked by Normal detector but the reverse detector may rotate further until stopped after unwinding the wire rope. The compensator will rise 387.5 mm (15 ½ ") if levers do not trip. If free, lever 1 will trip back and lever 2 forward thus raising the compensator wheels by a further 75 mm (3"). The broken ends will separate 1850 mm (74").

(b) Similar action takes place when points are reverse, and a break occurs in pull (1) wire between detector and signal.

Condition 17:

(a) Points Normal, lever 1 reverse, Break in pull (2) Wire between detector and signal (Fig.9.19).

In this case the compensator can draw up pull (1) wire by 431 mm (17 ½ ") to its stop by high rim of Normal detector which is sufficient to return signal 1 to 'ON'. Pull (2) wire can, however, move 1275 mm (61") to stop by signal mechanism. As the compensator wheels rise by 215.5 mm (8 5/8") to stop the momentum on pull (2) wire may continue to rotate signal mechanism backwards beyond 431 mm (17 ¼ ") to 1275 mm (51"). If due to sluggish working or some obstruction in wire run the stroke imparted to the drum is more than 625 mm (25") and less than 1005 mm (43.4") after returning signal 1 to 'ON', signal 2 may clear and not go back to 'ON'. This condition is, therefore, not satisfactory and special efforts will have to be taken to see that the wire between detector and signal does not break.

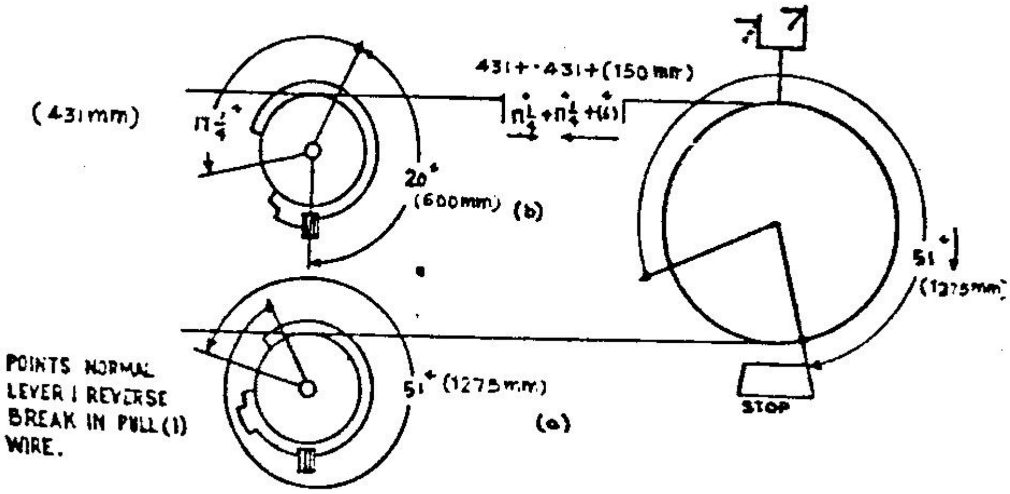


Fig: 9.19

In the case of signals provided with reversers there is, however, no danger as the signal drum movement will not by itself take 'OFF' the signal.

If lever 1 is free to trip, it will move back slackening pull (1) wire by 150 mm (6") which will cause the compensator to move a further 50 mm (2") upwards. Pull (2) wire will, therefore, move back 581 mm (23 1/4") due to the compensator and continue to operate signal mechanism beyond by momentum only.

If the lever is reset and catch lifted, it will fly towards normal position by the action of the compensator weights. For every 25 mm (1") move back, coupling wheel 1 will drop 12.5 mm (1/2") and compensator wheels will rise 12.5 mm (1/2") keeping pull (1) wire stationary and pull (2) wire will be moved back 50 mm (2") , 25 mm (1") due to movement of lever and 50 mm (2") due to compensator taking if any slack in the wire caused by the drum rotating beyond 431 mm (17 1/2") . After the lever is moved back 409 mm (16 3/8") the signal mechanism is rotated to its stop taking signal 2 to 'OFF' and then to 'ON' movement of the lever beyond is prevented by the normal detector and the locking of the compensator. It is evident from this that if the lever is returned to Normal signal 2 will go back to 'ON' but any attempt to do so is brought with danger of injury to the leverman as the lever will fly back due to the compensator weight falling down.

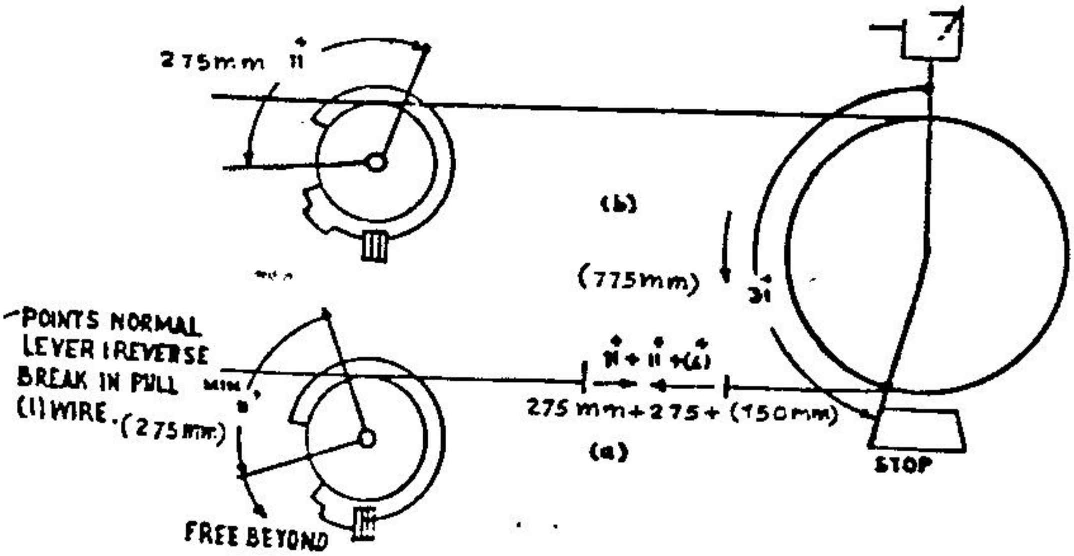


Fig: 9.20

(b) Similar action will take place if points are reverse, lever 2 reversed and pull (2) wire between detector and signal breaks.

Condition 18:

(a) Points normal, lever 1 reversed break in pull (2) wire between detector and signal (Fig. 9.20).

Pull (2) wire in this case can rotate detector back until it is stopped by the unwinding of wire rope. Pull (1) wire is pulled further by 275 mm (11") until stopped by signal mechanism. Signal 1 is returned to 'ON'. Points continue to get locked.

The compensator wheel will fit 137.5 mm (5 ½ ") and if lever 1 trips back, the compensator will rise a further 37.5 mm (1 ½ ") increasing the gap between broken ends by 150 mm (6").

(b) Similar action will take place if points are reverse, lever 2 is reversed and (1) wire between detector and signal breaks.

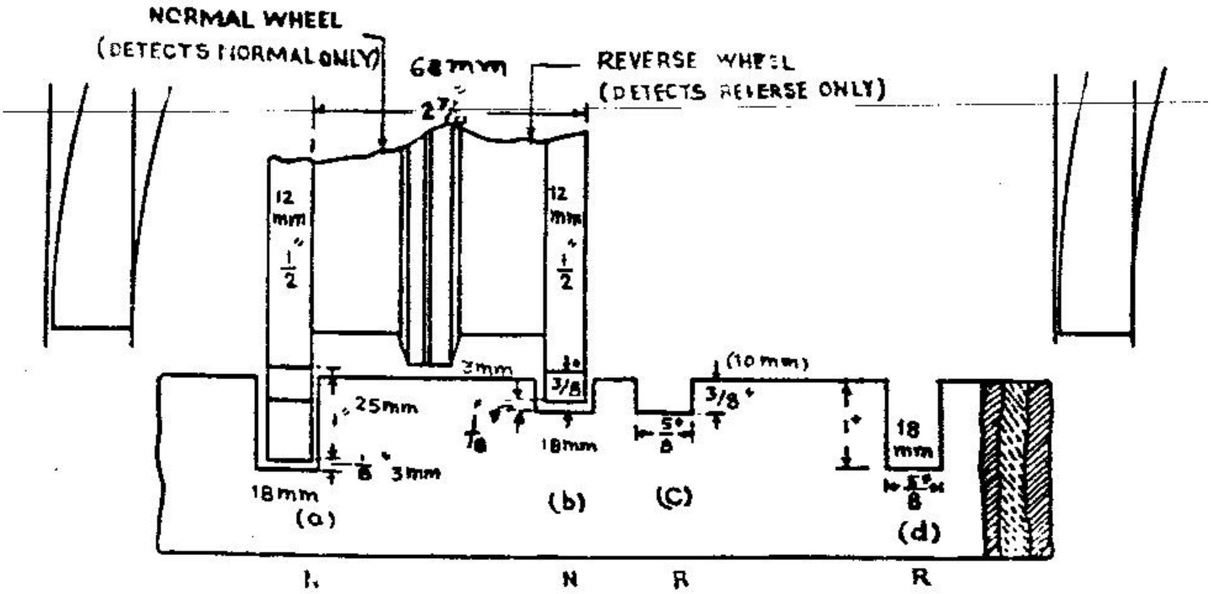


Fig: 9.21

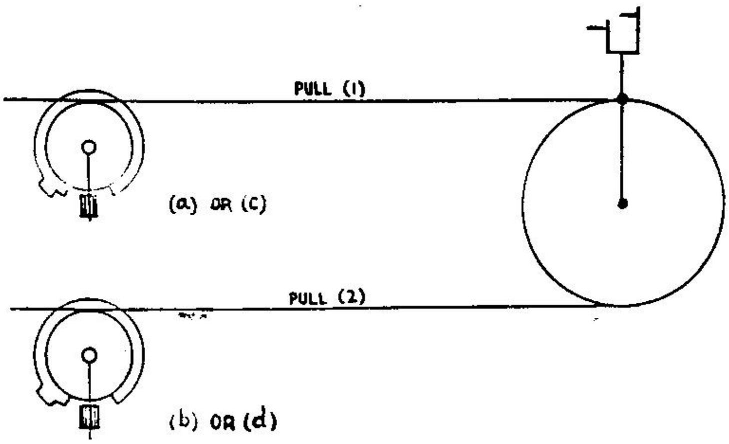


Fig: 9.22

9.14 Detailed analysis of wire breakage on coupled Push-Pull Signals on separate posts

In this case double rotary detector is provided in the wire run, the normal detector detecting the point in the normal position and the reversed detector detecting it in the reversed position. The arrangement of wire run and the method of fixing the detectors will be the same as for push-pull signal on the same post. The only difference is that an additional mechanism provided in the wire run between the two detectors (see Fig. 9.23). All the 18 conditions of the wire breakage given for push-pull signal on the same post apply in this case also excepting that instead of one signal mechanism two signal mechanisms will operate in the same direction to their respective stops.

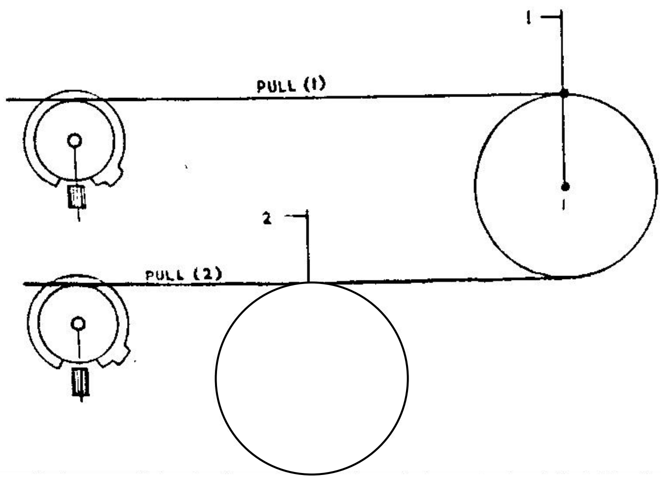


Fig: 9.23

The following additional conditions of wire breakage are met within this case:-

Condition 19:

(a) Point Normal, Levers Normal, break in wire between the signals.

Both the intact wires will be drawn up by the compensator weight falling down and the signal mechanism 1 will rotate forward after taking off signal 1 momentarily to its stop position. Signal mechanism 2 will rotate back to its stop taking signal 2 to 'OFF' position momentarily. Both the wires move 775 mm (31") and the compensator wheels rise 387.5 mm (13 ½ "). The gap between the broken ends will be 1550 mm (62"), the levers may not trip. (ii) Similar action will take place if point lever is reversed when the break takes place.

Condition 20:

(a) Points Normal, lever 1 reversed, break in wire between signals.

Pull (1) wire will move forward 275 mm (11") until stopped by signal mechanism 1. Signal 1 will go to 'ON' position and the points will remain held by normal detector. The compensator wheels will rise 137.5 mm (5 ½ ") pull (2) wire is however, free and signal 2 may or may not go to 'OFF' position as the momentum of the wire may rotate signal mechanism backwards beyond 275 mm (11") upto 1275 mm (51"). The conditions of the wire breakage are similar to that given in condition 17.

This condition is, therefore, not satisfactory, as the signal 2 may go to and remain OFF when the wire breaks and a train from loop line may start and enter the sand hump.

(b) Similar action will take place if points and lever 2 are reversed when the wire breakage takes place. In this case, a train on the main line may start and collide with the train from the loop which has already passed signal 2.

ANNEXURE: I

BOLTS AND NUTS USED IN SIGNALLING FIXTURES

S.No.	Description	Size of bolts& nuts in mm	size of bolts & nuts in inches	No.of bolts & nuts for each unit.
1.	Coupling Device	20 x 60	(3/4x1) (3/4)	Two
2.	D.W. Compensator single	20 x 60	(3/4x1) (3/4)	Two
3.	D.W.Compensator Coupled	20 x 60	(3/4x1) (3/4)	Four
4.	D.W.Compensator Mounting Channel	22 x 91	(7/8x3)	
5.	Leadout channel fixing bolt(1)	20 x 50	(3/4x2	Four
	(2)	12 x 40	(1/2x1 1 1/2)	Eight
6.	Diversion Wheel	12 x 45	(1/2 x 2)	Three
7.	-do- Guide	8 x 40	(5/16x1 1/2)	Three
8.	~~Vertical Crank~~	20 x 60	~~(3/4 x 2 1/2)~~	~~Four~~
9.	Accommodating	20 x 60	(3/4 x 2 1/2)	Four
10	Horizontal Crank	20 x 60	(3/4 x 2 1/2)	Four
11.	Bottom roller stand	12 x 40	(1/2 x 1 1/2)	Two
12.	Trestile Extension	12 x 45	(1/2 x 1 3/4)	Two
13.	Top roller pin (M.S)	12 x 75	(1/2 x 3)	One
14.	Split pin for top roller	6 x 75	(1/4 x 3	Two
15.	Rod Compensator	20 X 60	(3/4 x 2 1/2)	Four
16.	Adjustable Crank	20 x 60	(3/4 x 2 1/2)	Four
17.	Adjusting Sleeve	12 x 40	(1/2 x 1 1/2)	Two full threaded.
18.	D.W. point Mechanism	20 x 60	3/4 x 2 1/2)	Four
19.	D.W. Detector (1) Angle Slide	20 x 50	3/4 x 2)	Two
20	(2) for Detector	20 x 50	(3/4 x 2)	Four
21.	Flange Connecting Rod.	20 x 60	(3/4 x 2 1/2)	Two
22.	Flange connecting rod coupling	12 x 55	(1/2 x 2 1/4)	Two
23.	Split lock stretcher bar.	20 x 70	(3/4 x 3 sq. Hd. Spl.	Two for each bar.
24.	Facing Point Lock (FPL)			
	(1) for Base as per sleeper thickness	20 x 180 20 200	(3/4x7, 3/4x9)or	Four
	(2) Cover	12 x 40	(1/2 x 1 1/2 full threaded)	Six
	(3) Cross Slide Cover	8 x 45	(5/16x1-3/4)	Four
25	Racker Shaft (1) Bracket	20 x 200	(3/4 x	Four for each bracket.
	(2) Bearing	16 x 50	(5/8 x 2)	Two for each bearing.
	(3) Rocker Arm	12 x 40	(1/2 x 1 1/2)	One for each arm.
26.	Horizontal crank for lock bar fixed on sleeper	20 x 180	(3/4 x 7)	Four
27.	Lock bar clip fixed type.			
	(i) Bracket	20 x 60	(3/4 x 2 1/2)	Two
	(ii) Stud	16 x 75	(5/8 x 3) clip	One for each
28.	Lock bar stop (Adjustable type)(Clamp type)	15 x 200	(5/8" x 8)	One
29.	Tie Bar	20 x 180	(3/4 x 7)	As per the Nos. of the bar.

S.No Description	Size of bolts& nuts in mm	size of bolts & nuts in inches	No.of bolts & nuts for each unit.
30 Signal Mechanism (i) Bracket	20 x 50	(3/4 x 2)	Four
(ii) U Clamp	20 x 220	(3/4 x 9)	One
		(3/4 x 10)	One
31. Surface Base (Angle Bolt)	25 x 910	1 x 3	Four
32 Ladder (i) Foundation	12 x 45	(1/2 x 2")	Two
(ii) Supports	12 x 40	(1/2 x 1 1/2)	As per No. of supports.
33. Down rod guide	12 x 45	(1/2 x 2)	Two for each.
34. Signal Arm	12 x 45	(1/2 x 2)	Four
35. Semaphore Bracket	20 x 25	(3/4 x 5)	Four
36. Pinnacle	16 x 40	(5/8 x 1 1/2)	One
37 Roundals Ring	6 x 25	(1/4 x 1)	Four
38. Back light green	12 x 45	(1/2 x 2)	Two
39. Lamp Bracket	12 x 40	(1/2 x 1 1/2)	Two
40. D.W. Pulley	12 x 40	(1/2 x 1 1/2)	One
41. Cross Bar	10 x 25	(3/8 x 1)	Four
42. Bridge Stake	10 x 25	(3/8 x 1)	4 each.
43 Single Wire Pulley Single	8 x 20	(5/16x3/4) common	One each
Single	8 x 40	(5/16 x 1 1/2)	to all
Double	8 x 50	(5/16 x 2)	One
Tripple	8 x 75	(5/16x3)	One
44. Point indicator (i) Base	20 x 60	(3/4 x 2 1/2)	Three
(ii) Indicator	6 x 40	(1/4 x 1 1/2)	Four
45 Unit wire detector			
(i) Angle Slide	20 x 50	(3/4 x 1 3/4)	Two for each slide.
(ii) Detector Base	20 x 60	(3/4 x 2 1/2)	Four
(iii) Cover	20X200	(1/2 x 2)	Four
46. Ground Frame lever	20 x 70	(3/4 x 3)	Two for each
Hand plunger lock	20 x 220	(3/4 x 9) or 10)	Four
HPL split lock stretcher bar	20 x 6	(3/4x2 or 2 1/2)	Two
47. Disengager	20 x 60	(3/4x2 1/2)	Four
48. Rocker Shaft Coupling	12 x 55	(1/2 x 2 8 1/4)	Two for couting.
49. Radial Guide (i) Base Front	20 x 220	(3/4 x 29)	One
(ii) Back Side	20 x 200	(3/4 x 8)	Two
(iii) T-Bracket	12 x 40	(1/2 x 1 1/2)	Two
50 Pins for cranks and compensator.	25 x 65	(1 x 2 1/2)	
51.Pin for flush joint	25 x 65	(1 x 2)	
52. Pin for signal down rod	15 x 50	(5/8 x 2)	

REVIEW QUESTIONS

1. Write advantages of double wire transmission over rodding transmission?
2. Write advantages of D/W transmission over single wire transmission?
3. What are the losses of stroke facing in the double wire transmission?
4. Write the types of d/w levers?
5. Write essentials of clutch lever?
6. Write difference between direct lever and clutch lever?
7. Briefly write about miniature lever and rack and pinion lever?
8. How will you calculate intermediate stanchions?
9. What is the need to provide coupling device?
10. Draw the diagram of push-pull and pull-pull coupling?
11. Explain push-pull working and give examples?
12. Explain pull-pull working and give examples?
13. What is hook lock (or)drum lock? where it is used?
14. Write the procedure for adjustment of d/w point and lock bar with economical facing point mechanism?
15. Explain briefly economical facing point locks?
16. Write essential requirements before interlocking of a point?
17. Explain broken wire test?
18. Briefly explain objectives of the signal mechanism?
19. What is concentric campath?
20. Write the types of mechanisms?
21. Write requirements of d/w detector?
22. Write about various rims and dimensions?
23. Write functions of detector rims?
24. What are the requirements for d/w compensators?
25. What are the types of compensators?
26. Initial adjustments of a compensator?
27. What is wire brackage mark?

28. Write working of compensator?

29. What are the types of wires used in d/w transmission?

30. What are the types of pulleys used in d/w transmission?

31. Write rules for running the transmissions?

32. Write working of functions under broken wire conditions?

Objective:

Q.1. MATCH THE FOLLOWING :

1. Rack and pinion lever	(C)	A)	10 mm.
2. Detecting rim	(I)	B)	Double wire compensator.
3. Clutch lever	(D)	C)	Rodding transmission.
4. Gain stroke lever	(B)	D)	Trips.
5. Miniature lever	(H)	E)	40 mm.
6. Tappet moves	(E)	F)	176 mm.
7. Lock detection slide	(J)	G)	25 mm.
8. Bottom rim	(F)	H)	3-Position.
9. Height of Locking rim	(A)	I)	869 mm.
10. Control rim	(G)	J)	12 mm.

Q.2. Write (T) for True & (F) for False :

1. Input Energy = Out put Energy – Energy Loss (F)
2. In D.W. Transmission Gravity or Spring bias to return the function to original need to be considered. (T)
3. Miniature Lever can not be used as Gate Control Lever (F)
4. Direct Type lever has Rope Drum of size 550 mm (F)
5. 1st Intermediate Stanchion is installed at x X 1 + 1 = x + 1 (T)
   (where x = No. of levers/No. of spans)
6. Width of channel is 40 mm (T)
7. Pitch of channel is 55 mm (T)
8. Pull-Pull coupling may be used for UQ Main Line Home Signal (T)
9. For Coupling of D/W Lever both the lever should have subsequent number (T)
10. Tappet moves by 20 MM when catch handle is fully pressed or released (T)