Electric Point Machines of SEL Design

L 700 H Electrohydraulic Point Machine

By Joachim Karkosch, Ing. (grad.)

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Standard Elektrik Lorenz AG

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Elsner's Railroad Engineering Handbook, 1977 and 1978)
Abbreviations in drawings remain in German.

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1. Introduction

The demands made on rail switch systems have risen steadily with the increase in rail vehicle speeds and the density of rail traffic. The principal factors here were the development of switches with spring blades, larger radii and heavier-gauge rail. Improvements in point machine design and the resulting increase in the switching force (500 ± 50 kp) and the retaining force (700 ± 50 kp) have facilitated the operation of all switches using S 49 rail.

A further increase in switching force is not practicable, since higher switching forces could result in damage to the switch linkage if any obstruction occurs. Higher retaining forces would mean that lightweight rail vehicles would no longer be able to trail the points satisfactorily.

The introduction of switches using UIC rail with or without a movable frog therefore led to efforts to improve the switch movement system and the locking devices in such a way that a point machine would be able to overcome the increased resistance to movement. This in turn led to new designs for the bearing and transmission components and thus to a number of additional forms of attachment. In order to reduce the stocks of components for point machine attachments to a reasonable level despite the large number of switch designs in use, it was laid down that for switches with UIC rails the only point machines to be used were those which could be mounted reasonably simply on a standardized base and connected by means of a unified linkage. Since the L 700 M point machine, which lies parallel to the track, did not satisfy these requirements, SEL has developed a new type of point machine.

2. Development objectives

2.1 Basic requirements

In addition to the above-mentioned requirements concerning point machine mounting and the general conditions referred to in earlier issues of this publication, the new point machine design was required to have the following features:

– *Low maintenance*

  The amount of maintenance and time required were to be as low as possible.

– *Adjustable switching force*

  Provision for adjusting the switching force offers manufacturing advantages, since the same components can be used to produce drive designs with different switching forces, for instance quick-action and slow-action switch mechanisms.

– *Adjustable retaining force*

  As for switching force, similar considerations also apply to retaining force. Accurate adjustment of the retaining force is particularly important from a safety point of view.

– *Trailing force ≅ retaining force*

  While trailing a switch the trailing resistance, which comprises the retaining force and the friction loadings of the moving parts, must be overcome. The value can be brought down to the region of the retaining force if the number and mass of the moving parts are kept small and friction loadings thus reduced. At the same time, this makes trailing the switch less dependent on actual speed.

– *Left and right mounting without modification to point machine*

  Advantages in installation and in parts storage are obtained if the point machine can be employed for left and right mounting without modification to internal components.

– *High efficiency*

  A reduction in the number of moving parts in the point machine yields improved efficiency, which has a positive effect when hard-to-move switches have to be operated from a considerable distance.

2.2 Choice of drive system

One of the methods of constructing a low-maintenance switch drive with fairly good efficiency is to use the hydraulic principle.

This concept was confirmed by the level crossing barrier motors used with good results by the German Federal Railways, and by many other applications within industry and transportation in general.

Hydraulic systems are used for most applications with a pump rotating in one direction only, while a change in the direction of flow in the actual operating unit is obtained by means of mechanically or electrically-operated flow control valves. When designing the hydraulic system for a point machine, the conditions imposed by the existing control circuitry must be taken into account. This led to the choice of a closed oil circuit with reversible pump and no flow control valves.

2.3 Drive layout

The layout and mounting position of the point machine were governed by the requirement to employ standardized throw and detection rods.

As a result, a perpendicular position of the switch throw rod in relation to the rail, and a linear movement within the drive were necessary.

The requirement to employ the point machine without modification for both left and right mounting positions made it necessary to employ a one-piece throw bar with provision for attachment of the linkage at either side.

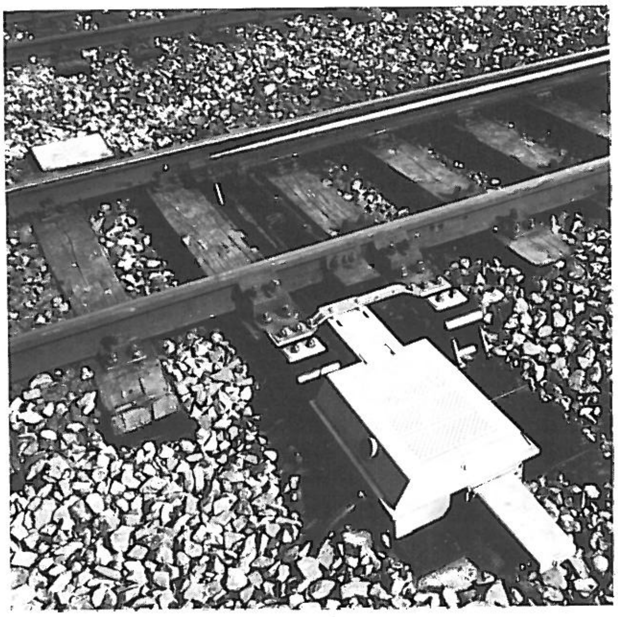


Fig. 1: Position of L 700 H point machines at the switch

3. Development phases

In the summer of 1969 an initial prototype electro-hydraulic point machine with mechanical retention was presented. Trailing tests at Landshut station with speeds between 5 and 40 km/h and a continuous switching test with 2.5 million cycles and a load of 400 kp yielded the first data on the ability of this switch drive to meet the specified demands and wear resistance of the individual elements. In February 1970, 5 prototypes of the electrohydraulic point machine were installed at Kempten station on switches requiring normal and increased drive force. These point machines, which still used individual pipework, proved successful in practice. A pre-production run of 60 point machines was therefore installed experimentally early in 1972 in 5 Federal German Railway operating areas (Fig. 1). On these point machines, a section of the hydraulic circuitry was combined into a block with integrated pipework. From 1974 on, the point machines were more widely applied with a range of technical improvements.

4. Schematic diagram (Fig. 2)

The schematic diagram shows in simplified form the manner in which the drive system operates. The figure reveals that a closed hydraulic circuit is used. This has certain advantages compared with an open circuit, for instance the ability to reverse direction without using flow control valves. The changeover from left to right movement is obtained directly by altering the direction of motor rotation and consequently that of the reversible hydraulic pump. The motor (M) drives the pump (P) through a coupling. The high-pressure oil discharged from the pump is supplied at the same time to the piston face of one hydraulic ram and the piston rod face of the other ram (Z1/Z2). This causes the pistons in the two ram cylinders to move in opposite directions and to exert a torque force on the common angle lever, which exerts leverage on the throw bar of the switch and causes switch movement. Rotary movement of the angle lever thus causes switching movement at the throw bar. The switching force is linear from start to finish of the switching movement, and can be widely varied by means of the pressure relief valves (ÜV).

If any obstacle obstructs switch movement, for instance ballast between the switch blade and the stock rail, the pressure relief valve for the direction of movement concerned opens to prevent damage. The motor continues to drive the pump, which then discharges oil through the open pressure relief valve back to the oil tank. The pressure relief valve is set to the maximum permissible pressure limit. Since the hydraulic rams then cause no further movement and no oil is returned to the suction-side of the pump from the zero-pressure side of the rams, a partial vacuum develops at that point. This vacuum causes the check valve (RV) on the suction side to open so that the pump can draw oil from the tank until a timer installed at the interlocking tower automatically switches off the drive.

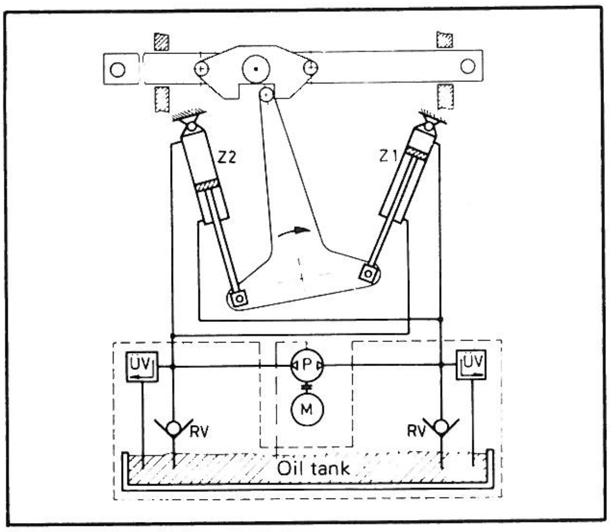


Fig. 2: Schematic diagram

5. Design features (Fig. 3)

The point machine consists of

- A *housing with cover*
- The *drive assembly*: motor with flywheel and manual drive unit
- The *hydraulic assembly*: hydraulic pump, cylinders, hydraulic circuit block, pipework and fluid.
- The *mechanical transmission element*: angle lever, throw bar, spring housing and rocker, detector slide and detector bolt.
- The *electrical control circuitry*: reversal and shut-down devices.

5.1 Housing with cover

The various components are enclosed in a housing with a lockable cover. Since mid-1975 the housing has been

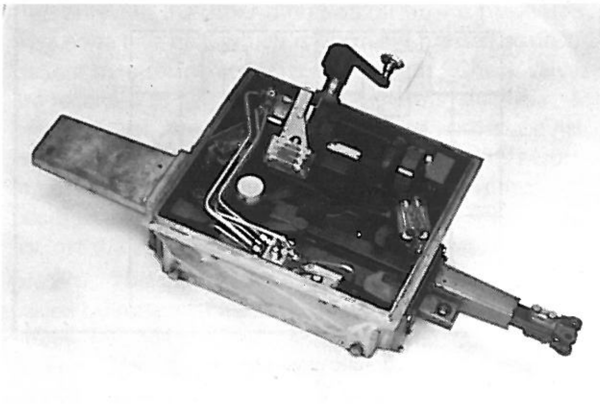


Fig. 3: Point machine with cover removed

manufactured from high-grade Silumin castings instead of gray cast iron, in order to save weight. A tube is bolted to the housing, and protects the free ends of the detector slide and the throw bar against damage. The sheet steel cover is secured to the housing by a built-in lock of standard German Federal Railway pattern (red lock).

5.2 Drive assembly

The force required to operate the switch is derived from a weatherproof, fully-enclosed three-phase 220/380 V motor running at 900 rpm. The power consumption is approx. 700 W. One end of the motor comprises a bearing plate with cast-on socket for the hand crank and bolt-on hydraulic pump. The motor shaft and the pump are connected by means of a cross-slot coupling. The other end of the motor shaft carries a positively mounted flywheel which serves to eliminate hydraulic compression energy at the limits of movement.

5.3 Hydraulic system

5.3.1. Hydraulic pump

The pump selected is notable for its simple, sturdy design which ensures maximum reliability in the arduous operating conditions encountered. The pump is reversible and the discharge and suction sides are interchanged when the direction of pump rotation is altered, so that the previously existing point machine control circuitry can be adopted without modification.

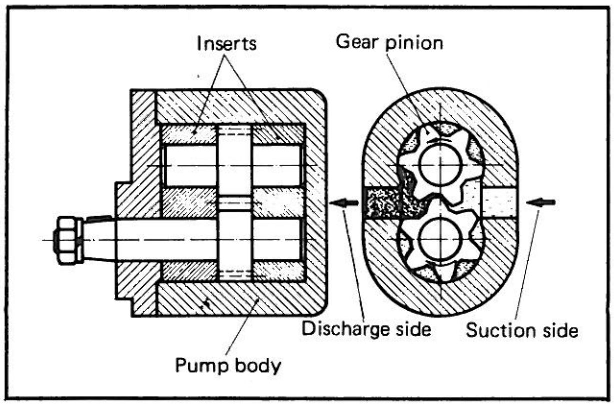


Fig. 4: Schematic of gear-type pump

A reversible gear-type pump for the hydraulic fluid (Fig. 4) was used until mid-1975.

Gear-type pumps consist effectively of two gear pinions in mesh, surrounded by a housing. The hydraulic fluid is trapped in the tooth spaces between the gears and the housing, and moved along the housing wall. The teeth of the contra-rotating gears mesh again at the discharge side and force the fluid into the pump outlet. When the gears no longer mesh, a partial vacuum develops to cause pump suction.

A radial-piston pump (Fig. 5) has now been introduced on account of its improved performance characteristics at low running speeds (for instance when hand-cranked). On this pump (Fig. 5) a 'spider' turns on a fixed control shaft. The spider contains the bores for the pistons.

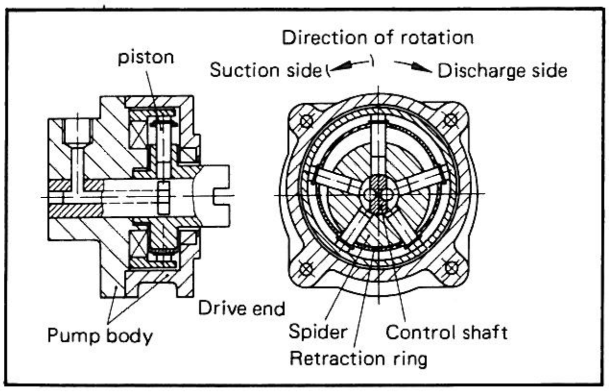


Fig. 5: Schematic of radial piston pump

The pistons are connected together by a retraction ring and supported externally on ball bearings. The ball bearings and the spider are offset eccentrically, so that when the spider rotates the pistons are forced in on one side and out on the other. The fluid displaced in this manner flows into the control slots and through longitudinal passages in the control shaft to the pipe unions. As for the gear type pump, a reversal in the direction of rotation will cause the discharge and suction sides to be interchanged.

5.3.2. Hydraulic cylinders

The hydraulic cylinders convert hydraulic energy into straight-line mechanical movement. A distinction is to be made between the single-acting and double-acting cylinders. The single acting cylinder is supplied with oil at high pressure at the piston face only. Its return movement is obtained by spring loading, the force exerted by a load or similar means. The piston diameter can at this point be almost the same as the piston rod diameter.

The hydraulic point machine uses two double-acting cylinders. Both cylinders operate in either switching direction and enable a low profile unit to be constructed with standard comercially available cylinders and minimum loads on the angle lever pivot bearing.

In contrast to the single-acting cylinder, double-acting hydraulic cylinders must have a piston rod diameter smaller than the diameter of the piston itself, so that a contact face behind the piston is provided for the hydraulic fluid when the cylinder is retracting. This contact face is smaller in area than the piston face on the other side of the cylinder by the amount represented by the piston rod. Accordingly, piston rod speed varies according to the cylinder operating direction, assuming that pump flow remains constant. At constant pressure the force exerted differs. For the hydraulic point machine this characteristic is eliminated by linking the piston face of cylinder 1 with the piston ring face of cylinder 2 in parallel, and vice-versa.

The double-acting hydraulic cylinder consists of the following main components (Fig. 6):

- Cylinder base
- Cylinder barrel
- Guide bushing
- Piston
- Piston rod
- Seals

The cylinder base is welded to the cylinder barrel on most of the cylinder patterns in normal use. The piston is either screwed to the hard chromium-plated piston rod, shrunk on or assembled with some other form of

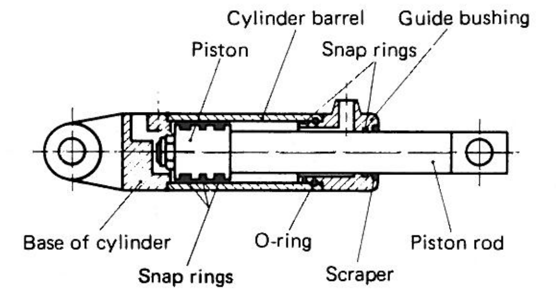


Fig. 6: Double-acting hydraulic ram

joint providing a seal. The guide bushing is either screwed on to the cylinder barrel or retained axially by a wire snap ring in a groove. The seal between the sliding faces is maintained by flexible sealing elements. The following factors govern the choice of seal material:

- Fluid and ambient temperature
- Type of hydraulic fluid

The hydraulic cylinders used in this point machine are commercial products with Perbunan seals. These resist all normally encountered mineral oils at temperatures between – 30 and + 80°C.

5.3.3. Hydraulic circuit block

In most hydraulic assemblies, it is customary for the oil from the pump to pass through a system of pipes, valves, etc., to the load such as hydraulic motor, cylinders etc., depending upon the application.

However, since all of these control units tend to possess a number of unions and thus require careful sealing at each of these points, efforts are made to combine them wherever possible into an integrated

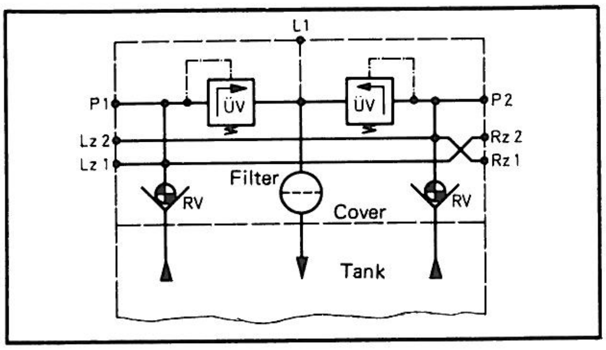


Fig. 7: Schematic of hydraulic circuit block

assembly or control block. The individual units can then be installed as required in the block in the form of screw-in elements linked together by cast-in passages or drillways. This form of space saving construction is easily understood, permits components to be exchanged easily and can be produced at lower cost than individually piped circuits once a certain production volume has been reached.

The hydraulic circuit block for the L 700 H point machine contains the following modules:

2 Pressure relief valves for control of the maximum pressure limit

2 Check valves for the supply of the pump

1 Bypass micro-filter, aperture width 25 μ

1 Flange-mounted oil tank, capacity 1.2 litres, with dipstick, vent and sludge trap magnet

The schematic diagram (Fig. 7) shows the 7 connection points on the block. P1 and P2 lead to the pump as discharge and suction lines, L1 is the oil leakage line which also leads to the pump, LZ1 and LZ2 lead to the left-hydraulic cylinder RZ1 and RZ2 the right-hydraulic cylinder.

Since a closed hydraulic circuit is used, two valves (one pressure-relief valve and one check valve) are each used for left and right movement. The check valve is of rather simple design, and permits oil-flow in one direc-

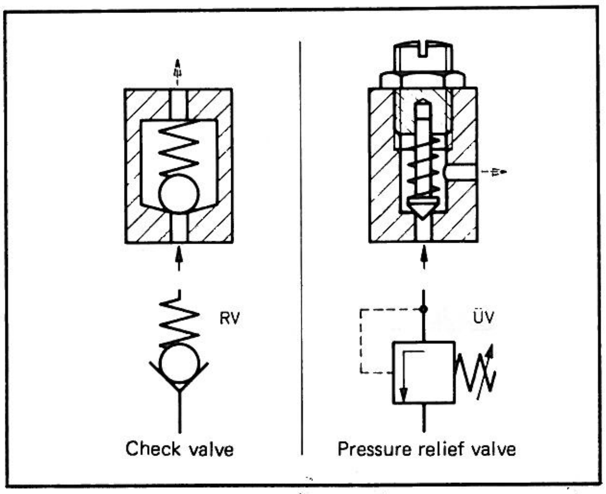


Fig. 8: Check and pressure relief valves

tion only. In the other direction oil flow is prevented by a cone or a ball, which is normally pressed against its seat by a spring or by its own weight. Check valves are regarded as hermetically sealing units, since, as pressure rises, the ball or cone is forced harder against its seat. The pressure relief valve is used to limit working pressure to a pre-determined value. In its rest position a seal is pressed by a poweful coil spring against the aperture at which hydraulic pressure is present. The spring loading acting on the seal can be varied by means of a screw. If pressure in the hydraulic line exceeds the preset spring loading, the seal lifts from its seat. The hydraulic fluid then flows through the resulting annular gap back to the tank (Fig. 8).

5.3.4. Pipework

The reliability of any hydraulic system depends to a considerable extent on the quality of the connecting lines and the threaded union joints. For this reason, only seamless drawn steel pipes with electrolytically galvanized surface and cutter ring unions which have been used successfully on hydraulic equipment for some time are employed. This construction is noted for its high strength, resistance to vibration and hermetic sealing.

The cutter ring threaded unions (Fig. 9) consist of three sections; the stub pipe with external thread and internal taper, the collar nut and the wedge shaped cutter ring.

The pre-formed hardened wedge-shaped cutter ring slides along the inner taper of the stub pipe as the collar nut is tightened. It is thereby forced into a smaller diameter and cuts a visible shoulder into the pipe. In order to complete this seal successfully however, the pipe must be cut off flat and must make contact with the stop of the internal taper, so that a clean cutting action results.

The seamless precision steel pipe can be easily formed when cold, possesses good resistance to vibration and carefully matched levels of tensile strength, elongation and rupture strength. If a suitable pipe bending device is available, no heat treatment is needed.

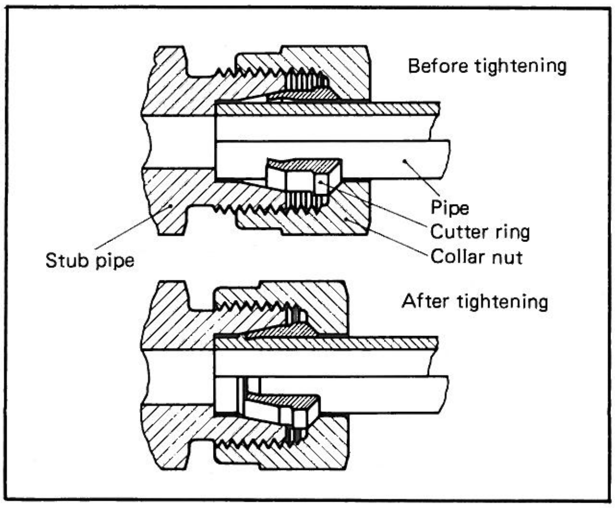


Fig. 9: Sectioned view of threaded union with cutter ring

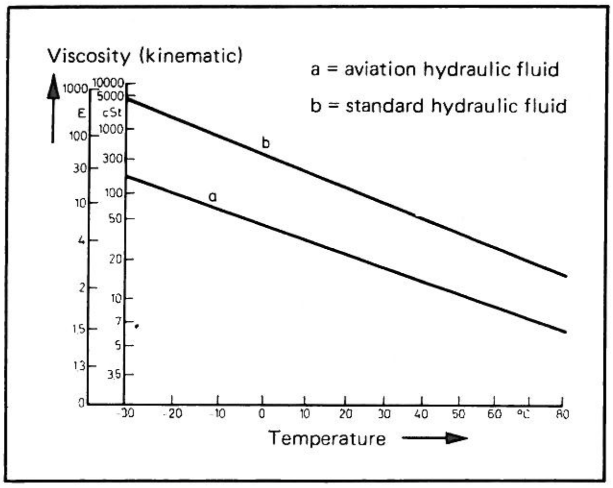


Fig. 10: Viscosity graph

5.3.5. Hydraulic fluid

The satisfactory operation and long service life of an hydraulic system depend on the correct choice of hydraulic fluid. This is required to transmit energy, fill the space between the pump and the load equipment, reduce wear of parts in sliding contact with one another, protect components against corrosion and dissipate the heat generated as energy is converted.

The choice of hydraulic fluid for hydraulic systems operating in the open air depends mainly on the change in viscosity at varying temperatures. The decisive factors are the lowest and highest temperatures encountered at the operating location, with due regard for the optimum viscosities specified by the manufacturer for his equipment, for instance the hydraulic pump. The viscosity of a liquid is the resistance which results when two adjacent flow layers are displaced. It depends on temperature and is quoted by the manufacturer in the form of a viscosity-temperature characteristic. The viscosity-temperature characteristic graph in Fig. 10 shows the kinematic viscosity as the ordinate and the temperature as the abscissa. Both factors are shown on a logarithmic scale, so that the viscosity-temperature graph becomes a straight line. The slope of the straight line is an indication of viscosity change in response to temperature. Good viscosity-temperature performance results when the viscosity changes only slightly within the required temperature range.

The hydraulic fluid is exposed to high locally concentrated surface contact pressures, especially in pumps, for instance at the points where the meshing teeth of gear-type pumps come into contact. To prevent wear, a lubricant film must always be present with adequate lubricating capacity and surface adhesion even at maximum loads.

The hydraulic fluid is also required to be resistant to ageing, that is to say the molecules of the fluid should absorb oxygen only very slowly and thus prevent premature formation of deposits and sludge.

A good hydraulic fluid must also protect the hydraulic equipment components it surrounds against the formation of rust caused by moisture condensate, and should not attack metal components chemically. Generally speaking, mineral-based fluids satisfy all the above requirements.

The above remarks show that the choice of a suitable hydraulic fluid is decisive for the correct operation, long working life and reliability of an hydraulic system. For the electrohydraulic point machine a thoroughly tested high-performance aviation hydraulic fluid is used, which satisfies all requirements.

This hydraulic fluid is listed by the German Federal Railways as service material number 055.11 (NATO H 515).

5.4 Mechanical components

With the exception of the throw bar and the detector slide, all mechanical components such as the angle lever, spring housing with rocker arm and detector bolt are manufactured from high-grade spheroidal graphite cast-iron (Fig. 11). The T-shaped angle lever pivots on a bearing bracket. The hydraulic cylinder piston rods are attached to the two ends of the angle lever. The upper end of the angle lever carries a roller which engages in the spring housing. The spring housing with rocker surrounds the throw bar. The two components are positively connected by means of a cup spring cluster and a spring pin. This positive connection is an important element in the locking arrangement (Fig. 12).

The locking device consists of the cup spring coupling, the rocker arm and the locking hook. The pin of the cup spring coupling presses a roller into a case-hardened recess in the throw bar. This positive connection determines the retaining force. It can be adjusted at a threaded ring which preloads the cup spring cluster. The threaded ring is secured and protected with a lead seal after adjustment. The rocker pivots on the spring housing and has a roller on either side. In the end positions, the rocker arm is positively held against the drive housing with the locking hook, by means of the roller and the desired locking action is thus obtained.

The detector bolts combine all the functions necessary for monitoring and controlling switch movement. They

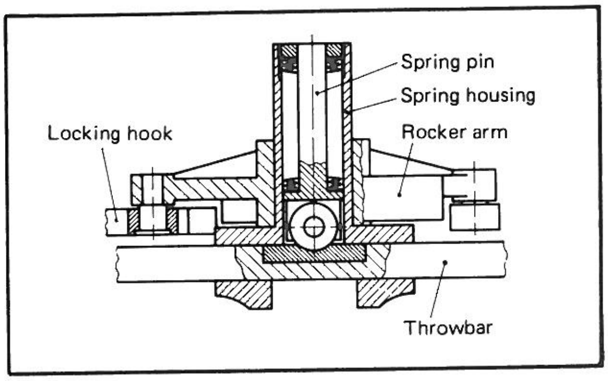


Fig. 12: Locking arrangement

pivot on the drive housing. There is a left and a right detector bolt.
The left detector bolt is fork-shaped and the right detector bolt pin-shaped. The detector slide cutouts are matched to the detector bolts so that an incorrect setting cannot be obtained even if the detector slide should break. Control of the movement of the end contacts is by way of the detector slides and detector bolts.

The throw bar and the test slides are manufactured from bright drawn steel section. They are guided in bearing plates at both sides of the drive housing. The bearing plates are spheroidal graphite castings. Water penetration is prevented by means of oil-soaked felt packing inserted in the bearing plates.

All rotating linkage elements have maintenance-free bearings. The angle lever is supported on both sides by enclosed deep-groove ball bearings with a grease chamber. All other bearing points employ Teflon-coated plain bearings, which have already given good results in many applications. The Teflon-coated bearings used here consist of a multi-layer material. A copper-plated steel backing carries a porous layer of sintered bronze, and the pores of this layer are filled with a mixture of polytetrafluorethylene (Teflon) and lead powder. These dry bearings offer good sliding characteristics on account of the polytetrafluorethylene used in their construction.

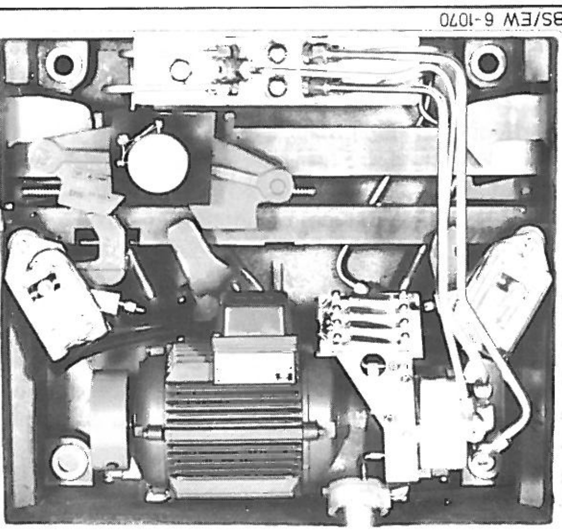


Fig. 11: Top view, showing internal drive components

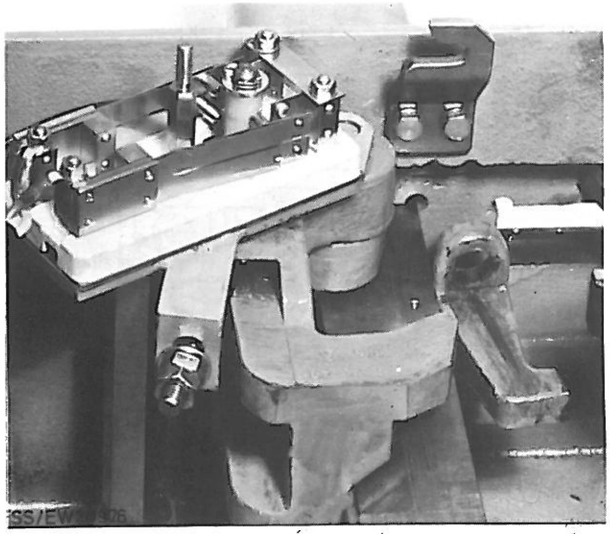


Fig. 13: Detector bolt with contacts

5.5 Monitoring and shutdown devices

The two end positions are monitored by two independent contact assemblies in the drive housing. These are located above the detector slides (Fig. 13). The contacts are positively controlled by the detector slides, according to the switch position, by the use of a fixed pin in the detector bolt and an insulated roller. The contacts, which have already proven successful in the L 700 M point machine, are of double-wiping action, which means that relative movement of the silver-plated contact rivets causes any oxide layers to be rubbed off so that a uniform low contact resistance is assured. The contact units are provided with transparent plastic covers.

The manual drive is enabled by a shutdown device with retainer for the hand crank on the special mounting plate between the drive motor and the pump. It consists of the shutdown ring, linkage and 4-pole contact assembly. The shutdown ring has a groove into which the shutdown key is inserted. When the key is fully turned to the left the shutdown ring is also turned until the hand crank can be inserted to engage with the bevel gear on the motor shaft and the point machine operated manually.

6. Drive operating principle

6.1 Switching action

When the switching action is initiated, the motor rotates the pump by way of the cross-slot coupling in the desired direction, e.g. to the right (Fig. 2).

The pump discharges oil to the upper hydraulic cylinder chamber Z1 and the lower chamber Z2. The oil is drawn in from the lower hydraulic cylinder chamber Z1 and the upper chamber Z2, thus completing the closed circuit. The resulting piston movement turns the angle lever to the right. A projection on the angle lever presses against the right-inclined face of the rocker arm and turns this to the left. This movement lifts the left-rocker roller out of the locking hook. At the same time the detector bolt is rotated, the monitoring contacts change over and the detector slide is released.

As movement continues the angle lever drive roller, which previously idled, engages in the slot of the spring housing and moves the throw bar to the right. Shortly before the limit of movement is reached, the right-rocker roller runs up the inclined face of the locking hook until the end of the hook is reached. At the same time the detector bolt is rotated and causes the rocker roller to be forced behind the locking face of the locking hook. The contact pin operates the contacts as the detector bolt continues to rotate, so that the end position is indicated and the motor switched off.

The detector bolt can engage and cause contact change-over only when the detector slides have also reached the correct end position.

To prevent the mechanism from swinging back after reaching the correct limit position the flywheel mounted on the motor shaft performs serveral revolutions in the same direction of previous rotation so that the built-up pressure in the system is dissipated.

6.2. Control of the switching force

The L 700 H point machine is normally set to a switching force of 450 to 500 kp.

If the switch is hard to move, so that switching resistance increases, the switching force limit comes into effect. The task performed conventionally by the slipping clutch in limiting the switching force is now taken over, depending on the direction of switching movement, by one of the adjustable pressure-relief valves (ÜV). A switching force setting of 450 kp corresponds to an hydraulic system pressure of 90 bars.

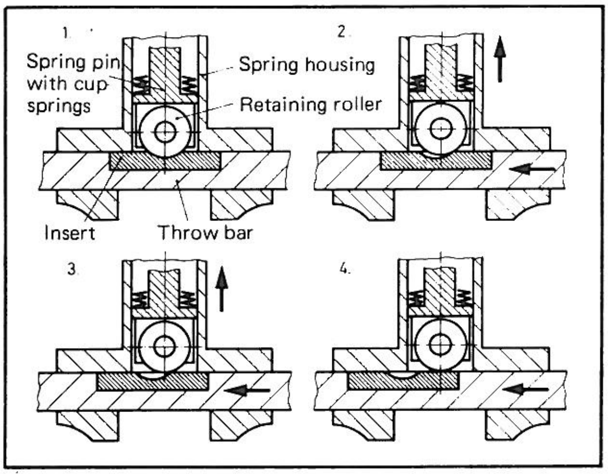


Fig. 14: Locking and release action

6.3. Bursting a switch

When a vehicle runs through or bursts a point, a force is transmitted from the switch to the throw bar. When the preload at the cup spring cluster is exceeded, the trip action will commence. This is shown in Fig. 14.

Drawing 1 in Fig. 14 shows the rest position. The spring housing with rocker arm is anchored firmly against the locking hook (see also Fig. 12). When the switch is run through, the throw bar moves to the left and the roller is forced up out of its recess. This sequence of events is shown in pictures 2 to 4.

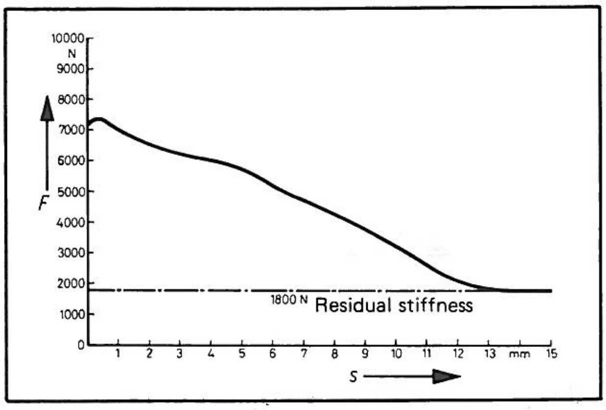


Fig. 15: Effort required during release

The resulting forces are shown in Fig. 15. This represents a purely mechanical action which does not affect the hydraulic system. As a result, no additional stresses need be anticipated as a result of differing run-through speeds.
The movement of the throw bar simultaneously releases the detector bolt, which in turn releases the detector slides, alters the contact setting and thus transmits the 'run-through' signal.

The drive can be reset to the correct position by a normal switch reversal after a run-through has taken place. The spring housing thereby moves along the throw bar until the retaining roller engages in the bar.

6.4. Control circuitry

The point machine is controlled and monitored by means of the four-wire circuit proven for years. Different circuits are used for SpDrL-20/30 and SpDrL-60 installations. On both types of interlockings the end positions of the point machine are monitored via all four wires, although the starting circuits differ.

6.4.1 Control circuitry for SpDrL 60 (Fig. 16)

The point machine is started by applying phases R, S, and T to wires 1,3 and 4.

Winding VY is connected to phase R and via wire 2 to the common. A voltage of 380 V is present between wires 3 and 4. After the motor has run up off-load, contacts 11/12 and 13/14 change over. The drive motor now runs in true star configuration until the opposite end position is reached.

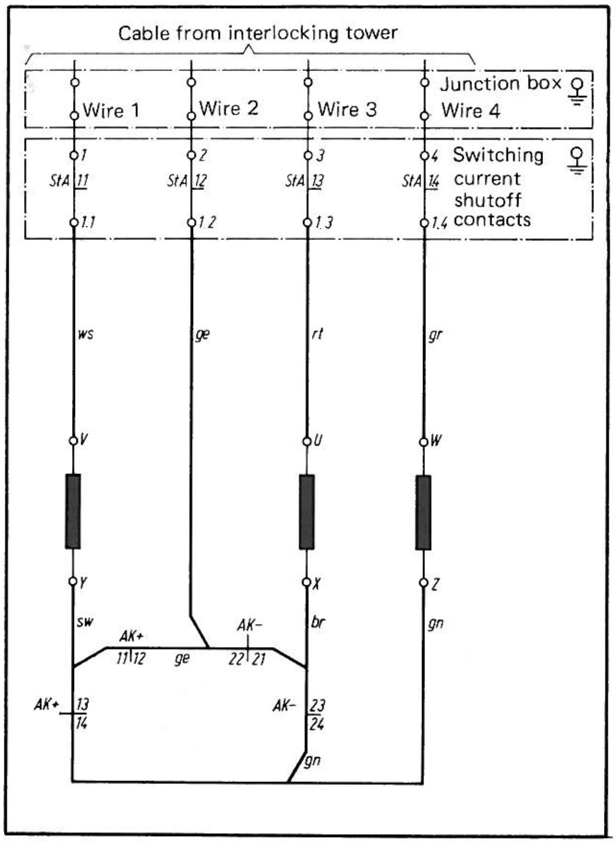


Fig. 16: Drive circuit SpDrL 60

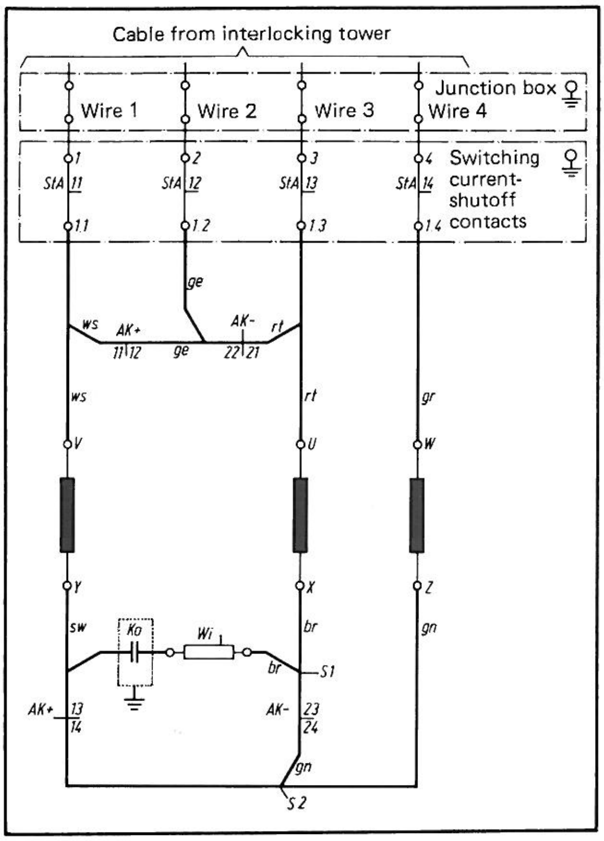


Fig. 17: Drive circuit SpDrL 20/30

Contacts 23/24 and 21/22 are operated by the pin fixed on the test locking bar.

When the contacts switch over, the drive current is switched off and the monitoring circuit for this end position comes into effect.

6.4.2 Control circuitry for SpDrL 20/30 (Fig. 17)

In this circuit, wires 1 and 3 are connected through an R/C-link. This consists of a capacitor and a resistor.

The R/C-link is mounted on the side of the housing next to the motor. It inhibits the DC-monitoring current and assists in starting the motor. As on the SpDrL 60 circuit, phases R, S and T are applied to wires 1, 3 and 4 for starting. The ends of the coils are connected to the center of the star at point S1, with coil VY at wire 1 phase shifted by capacitor Ko. After running-up off-load, contacts 11/12 and 13/14 change over and the R/C-link is shorted out. The drive runs in star configuration (S2) until the opposite end position is reached. Contacts 21/22 and 23/24 then switch over and the monitoring circuit comes into effect.

The circuits described above remain unchanged regardless of whether the point machine is installed left or right. If the drive has to be turned through 180° when installing, compared with the normal position (derailing stop or scotch block), wires 1 and 3 in the cable connecting the junction box to the point machine must be interchanged at the terminal strip (Figs. 18 and 19)

For point machines used in conjunction with separate switch point detector contacts, the control circuitry is modified. Further details will be given in the description of the point detector contact.

6.5 Manual switch operation

Provision is made for inserting a hand crank on the sloping section of the cover, so that the switch can be operated manually. This arrangement has the advantage that the crank can be operated without installing special crank blocks.

The hand crank aperture is provided with a weatherproof sealing cap permanently attached to the housing cover.

The hand crank consists of the lever arm with knob, the drive gears (ratio = 1 : 2) and the engagement section with bevel drive gear (Fig. 20).

In order to reverse the switch manually:

– The sealing cap on the cover is removed

– The key is inserted so that its pin engages in the groove on the shutoff ring

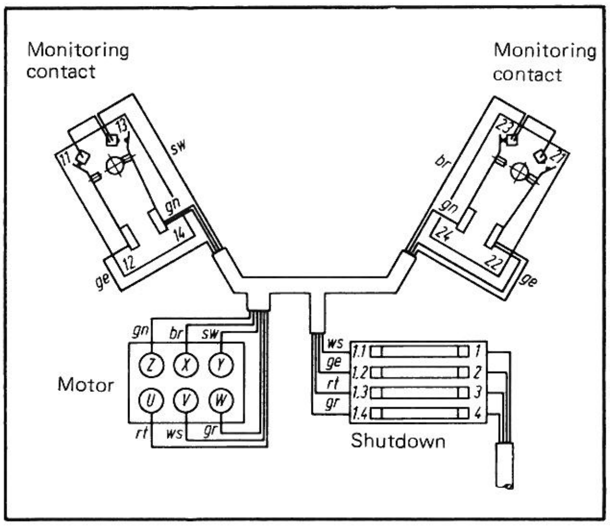


Fig. 18: Wiring for SpDrL 60 installations

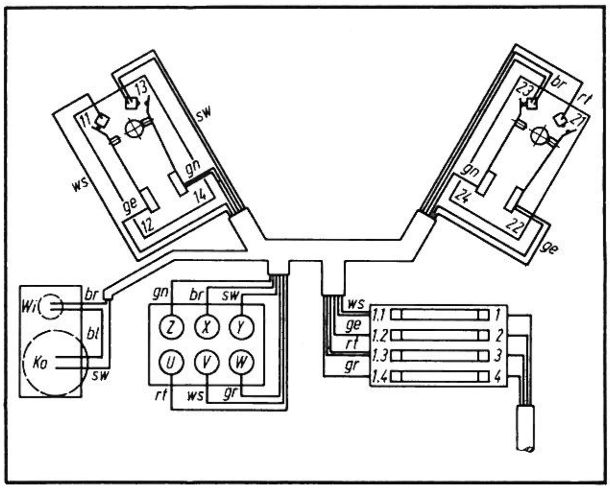


Fig. 19: Wiring for SpDrL 20/30 installations

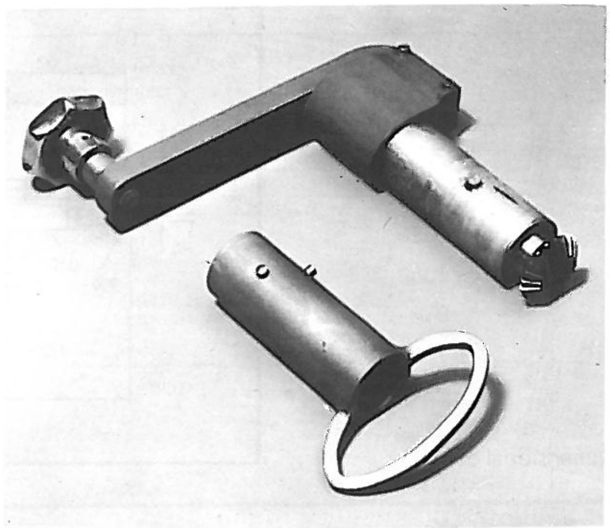


Fig. 20: Hand crank

– The key turned fully to the left (approx. 90°) and then removed. After this operation, the motor switch drive is shut off.

– The hand crank is inserted with the pin on the shaft facing upwards.

– The hand crank is turned in the direction opposite to that in which the switch is required to move. The limit of drive movement is reached when the blade makes contact and the hand crank becomes distinctly more difficult to turn, and when the rocker arm audibly engages.

– The hand crank can be pulled out of the housing after turning the shaft slightly.

– The key is then reinserted, turned fully to the right and pulled out. This re-enables the motor drive.

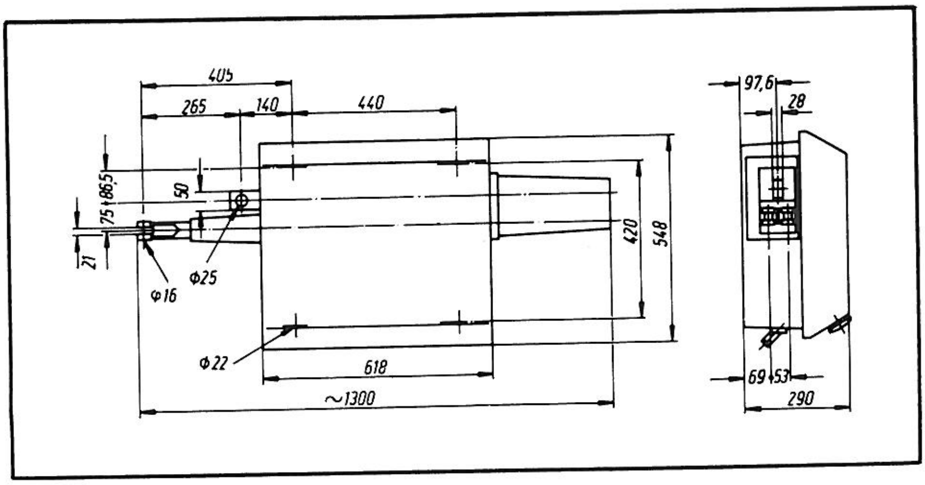
– The sealing cap is installed and secured by turning to the right.

7. Technical data

7.1 Drive ratings and dimensions

Motor	220/380 V, three-phase, 50 Hz
Power consumption	approx. 700 W
Running speed	approx. 900 rpm
Hydraulic fluid	Aviation-hydraulic fluid, DB reference 055.11 (NATO H 515)
Weight	with gray cast-iron housing approx. 160 kp with Silumin housing approx. 135 kp

Dimensional drawing:



7.2. Summary of versions available

Order No.	220/380 V three-phase, 50 Hz	Throwing Stroke (mm)	Operating Time (max.) (sec.)	Retaining Force (N)	Throwing Force (N)	RL per wire (max.)* (Ω)	applicable on switch type Z/H/K	with/ without Point detector	with separate point detector contacts and point detector
82001 01030	SpDrL 60	220	≦ 7	7000±500	5000±500	45	Z	with	
82001 01032	SpDrL 60	220	≦ 7	7000±500	5000±500	45	Z	without	
82001 01037	SpDrL 60	220	≦ 7	7000±500	5000±500	45	Z	with	X
82001 01042	SpDrL 60	220	≦ 7	7000±500	5000±500	45	H	with	X
82001 01045	SpDrL 60	150	≦ 1	7000±500	3300±300	6	Z	without	
82001 01052	SpDrL 60	220	≦ 7	7000±500	5000±500	45	Z	with	
82001 01055	SpDrL 60	150	≦ 6	7000±500	5000±500	45	K	with	
82001 01063	SpDrL 60	220	≦ 2,5	7000±500	3000±400	25	Z	without	
82001 01064	SpDrL 60	220	≦ 2,5	7000±500	3000±400	25	Z	with	
82001 01031	SpDrL 20/30	220	≦ 7	7000±500	5000±500	45	Z	with	
82001 01033	SpDrL 20/30	220	≦ 7	7000±500	5000±500	45	Z	without	
82001 01038	SpDrL 20/30	220	≦ 7	7000±500	5000±500	45	Z	with	X
82001 01043	SpDrL 20/30	220	≦ 7	7000±500	5000±500	45	H	with	X
82001 01046	SpDrL 20/30	150	≦ 1	7000±500	3300±400	6	Z	without	
82001 01048	SpDrL 20/30	220	≦ 4,5	6500±500	4000±400	25	Z	with	
82001 01049	SpDrL 20/30	220	≦ 4,5	6500±500	4000±400	25	Z	without	
82001 01051	SpDrL 20/30	220	≦ 7	7000±500	5000±500	45	Z	with	
82001 01054	SpDrL 20/30	150	≦ 6	7000±500	5000±500	45	K	with	
82001 01061	SpDrL 20/30	220	≦ 2,5	7000±500	3000±400	25	Z	with	
82001 01062	SpDrL 20/30	220	≦ 2,5	7000±500	3000±400	25	Z	without	

* The admissible working distance of the points is referred to be power of the point operating motor.
The maximun admissible working distance of points for the installation depends on the type of interlocking installation.

Abbreviations:
Z: points, crossings, derailer
H: movable point frog
K: special crossings

7.3. Maximum cable length

RL per wire (max.)	Cable length (max.) at wire diameter		
	0.9 mm	1.4 mm	1.8 mm
Ω	m	m	m
45	1500	3800	6500
25	870	2100	3600
6	210	500	870

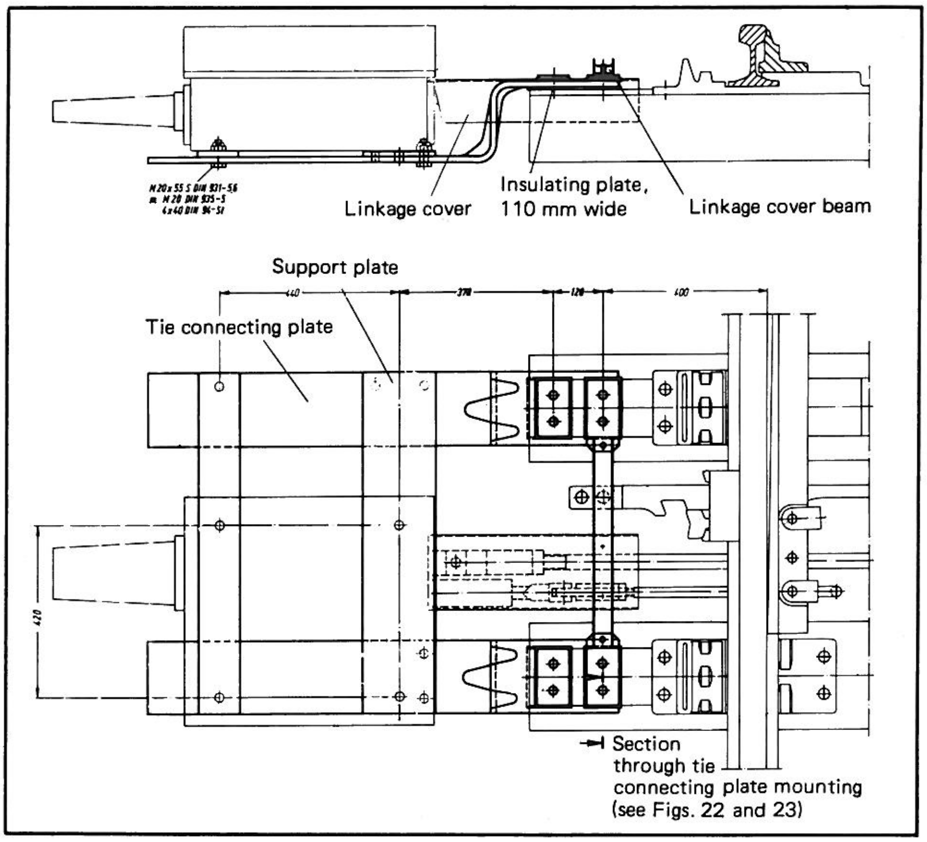


Fig. 21: Point machine mounting

8. Point machine installation

The L 700 H point machine can be attached to all switches, crossings, movable point frogs and diamonds and derailer stops or scotch blocks. Before the point machine is attached, the switch and the point locks must be in good working order.

In this connection check:

- Correct blade contact
- Specified blade contact force
- That both clamp lock housings are at a right angle to the rail track axis (check center punch marks on outside of stock rail)
- That no excessive switch blade tension is present
- That the ballast below the point machine mounting allows water drainage
- That the ties are spaced 650 mm apart, whereby a distance of 242 mm from the center of the lock housing to the center of the next tie is assumed.

8.1. Point machine mounting

A 'fixed mounting' is provided to link the switch with the point machine. Its design is similar to that used for mechanical point machines. It permits modern track maintenance equipment to perform continuous tamping and alignment work between the ties used to support the point machine.

The point machine mounting (Fig. 21) consists of two 15 mm thick, 180 mm wide tie connecting plates with swaged reinforcement in the curved areas, a 180 mm wide mounting plate, a 100 mm wide support plate and the necessary fastenings.

All components are normally supplied pre-drilled and can be easily attached to the switch. The mounting has been designed for use with all new switch drive design used by the German Federal Railways. At slip points where the extended ribbed plates are not parallel to the locking components, the support elements must be modified appropriately. For these installations, non-drilled connecting plates are available. The connecting and support plates form a rigid frame when assembled. The dimensions are such that the space for the switch drive is fixed at 650 mm and the ties are prevented from moving towards this ballastless space. The holes for attaching the connecting plates to the extended ribbed plates are of 32 mm diameter in all cases for insulated attachment. If attached to non-insulated switches, the difference in diameter is compensated for by a bushing. The extended ribbed plates on switches with S 49 rails are 16 mm thick, and those on switches with UIC-60 rails 20 mm thick. The difference in height, if standard tie bolts are used, is compensated for by inserting a 23 mm DIN 1441 washer. The tie bolt (Fig. 24) has in addition, an offset cross-drilling, which permits a retaining cotter to be inserted on insulated (Fig. 22) and non-insulated (Fig. 23) layouts. The connecting plates are insulated with the same components used for anti-vibration mounting. However, the lower outer insulating plate is widened by 20 mm on one side, so that contact with the ribbed plate and breakdown of the insulation is prevented

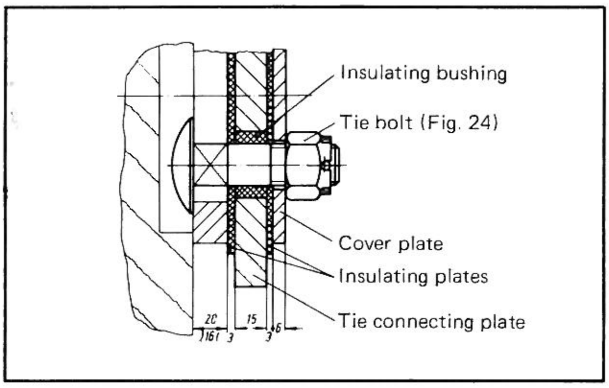


Fig. 22: Section throught tie connecting plate mounting when attached to insulated switch

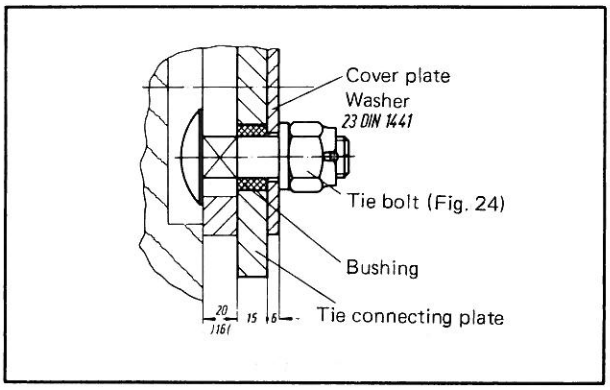


Fig. 23: Section through tie connecting plate mounting when attached to non-insulated switch

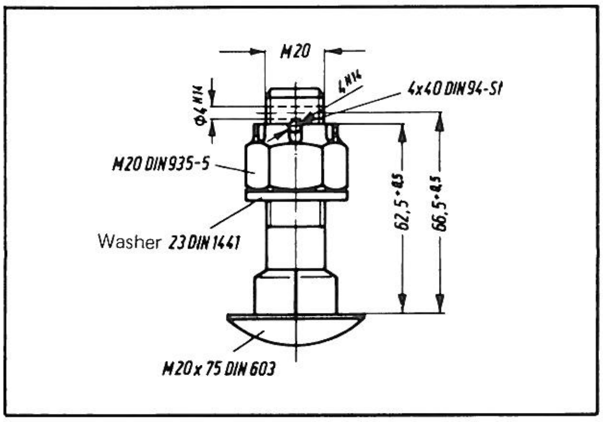


Fig. 24: Tie bolt

even if severe vertical movements of the support plate take place. When installing, care must be taken to ensure that the wider side of the insulating plate faces outwards. It then covers the edge of the extended ribbed plate. The cover plates for the inner mountings are extended towards the space between the ties and carry 30 mm long pins which prevent the supports for the linkage cover from moving out of position.

Normal modern practice is the use of the linkage cover made from glass-fibre reinforced polyester resin, with a fire-resistant sealing layer on the outside. This cover, originally used only on insulated switches, is secured with two polyamide screws to the formed sheet metal support. Cover and support are installed as a single unit, with the support connected to the extended cover plates as described above and the cover supported on the drive housing. The linkage cover can be used for all switch drives of the German Federal Railways.

The same design principle is retained for the mounting of derailer stop drives This mounting, however, has extended support plates designed for a tie spacing of 800 mm. The ties adjacent to the derailer stop are provided with extended ribbed plates. If the motor is located on the side opposite to the derailer stop – this being the preferred standard layout – the result is a particularly satisfactory straight-line control rod arrangement. If the drive has to be located on the same side as the stop for space reasons, a downward-curved throw rod will be necessary to provide space for the derailer shoe.

8.2 Installation sequence

The regulation drawings governing the layout of the various switches, crossings and stops must be complied with in installing the switch drive.

Before installation, the point machine should be prepared to match the switch position. All motors are supplied from the factory prepared for right-hand installation. On right-hand installations, the tube is at the right (Fig. 25), looking from the motor side (hand crank entry point).

The point machine is accompanied by the connecting cable with protective sheath and the accessories needed for assembly of the detector slide (forks, actuators, insulating components and fastenings).

8.2.1. The point machine is to be prepared as follows:

a) Right-hand installation

- Insert the hand crank and move the point machine away from its end position.

  The detector slides can be pulled out in the central position. The detector slides are marked 'O' for top and 'U' for bottom on their end faces, since the upper detector slide must always be installed at the top and the lower detector slide at the bottom, regardless of whether the point machine is installed in the right or left position.

- Bolt the 3 mm thick actuators and the forks with insulating components into position.

  For installation of these components in the correct positions, it is best to place the slides corresponding to the correct installed position (with cutouts facing the motor) on the drive cover. The fork-shaped cutout, which is easily visible from above, must then be at the front, looking from the connection end (Fig. 25).

  Starting from this position, install the forks at the outer ends in each case and the actuators at the inner ends of the slides.

- Tighten the actuator retaining bolts firmly and secure with center punch marks (Fig. 26).
- Bend up the keeper plates to secure the hex. bolts holding the forks (two bends per bolt).
- Grease the sliders lightly on all sides, and install.
- Insert the clamp bushing into the locking bar.

b) Left-hand attachment

- Pull out the detector slides.
- Transfer the tube with M 6 x 40 mm hex. bolts, auxiliary guide with M 6 x 25 mm bolts and the two M 6 x 18 mm scraper plate retaining bolts to the new position.

  When securing these components, make sure that the water drain holes and vent apertures face downwards.

- Insert and screw up the bolts but do not tighten fully.
- Assemble the remaining detector slide components as for right-hand installation.

  Note that for correct assembly the cutout – easily visible from the top – must be at the rear, not at the front as for right-hand installation.

- Grease the detector slide lightly on all sides and install.
- Tighten the auxiliary guide and tube retaining bolts.

  Correct centering of the scraper plate and free slider movement can only be obtained after the detector slides have been installed.

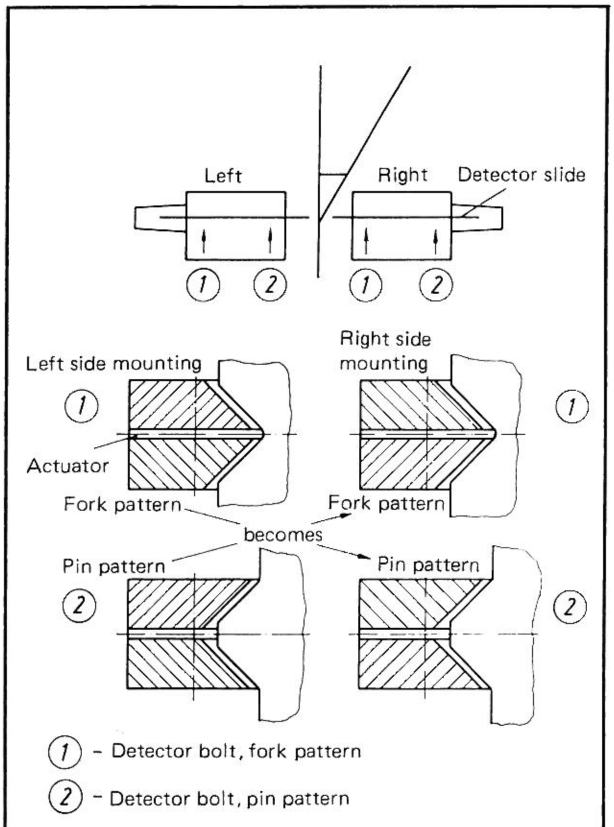


Fig. 25: Detector slide cutout patterns

8.2.2. Support mounting

- Check tie spacing and adjust if necessary.
- Prepare the surface for the connecting tie plates using ballast and gravel if necessary.

  The support level should not be too high, or else rail drop as traffic passes could result in excessive bending moments at the connecting plates.

- Bolt the connecting plates to the ribbed plates. Note the correct sequence of parts assembly for the insulated and non-insulated switch arrangements (Figs. 22 and 23) and the thickness of the ribbed plates (16 or 20 mm). The support plates must be

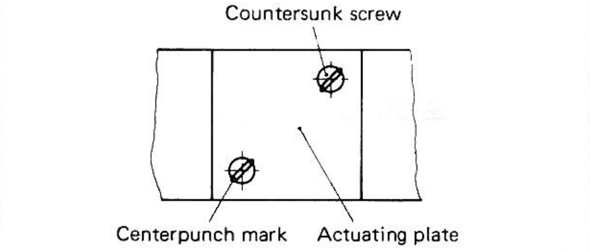
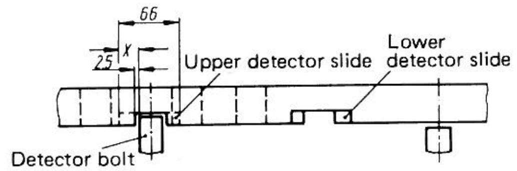


Fig. 26: Attaching the actuator plates

Position of detector slide with:

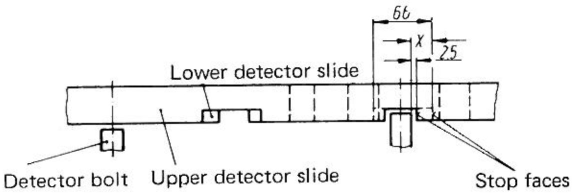
Switch at right, mounted at left



Upper detector slide must always be on top and lower detector slide at bottom, regardless of relative positions of point machine and switch.

Dimension "X" at switch opening travel of:
Z_a = 149 mm;   X = 14 mm[2]
Z_a = 160 mm;   X = 25 mm
Z_a = 169 mm;   X = 34 mm[3]

2) This is the absolute minimum permissible dimension for X. Switch at left, motor mounted at right



When the stop face of the detector slide is in contact with the detector bolt, overlap of ≧ 10 mm must still be available at the switch lock.
The more remote blade must be pressed against the stock rail at the same time. If the overlap is not present, e.g. if Z_a is lower and the overlap thus smaller, use special rails with a cutaway to suit the actual layout.

Fig. 27: Position of detector slide

parallel with one another and run in the same direction as the throw bar.

– Position the support and mounting plates and insert the bolts for the drive and the support plates.

8.2.3 Mounting and connecting the point machine

– Place the point machine on the pre-assembled mounting.

  Four carrying handles are provided so that the motor can be moved. These can be attached to the grounding screws. When moving the motor with a crane or otherwise carrying it, try to avoid aoplying any force to the tube or auxiliary guide.

– Bolt the motor to the support plates, but do not tighten down firmly.

– Align the point machine.

  With the near blade in contact with the stock rail, align the short detector rod and the detector slide.

– Tighten all bolts on the supports and drive mounting.

– Connect the throw rod and detector rod.

  When adjusting the throw rod for symmetrical switch blade contact, or adjusting the detectors, note the test dimensions given in Fig. 27.

– Turn the hand crank to check that the switch drive operates correctly.

– Locate junction box SKV 8/20 close to the point machine.

– Insert the ground cable into the junction box and connect.

– Run the flexible connecting cable between the point machine and the junction box, and connect according to circuit diagram.

  The cable should be run above ground if possible and protected by a weatherproof outer sheath.

8.3. Special arrangements

If the point machine has to be attached to ribbed plates which are not parallel to the throw bar, some adjustment will be necessary. On single slips, double slips and crossings the extended ribbed plates are in most cases not parallel to the slider rod. In this event, use tie connecting plates without pre-drilled support plate holes.

When attaching, the following procedure is recommended differing slightly from the standard version:

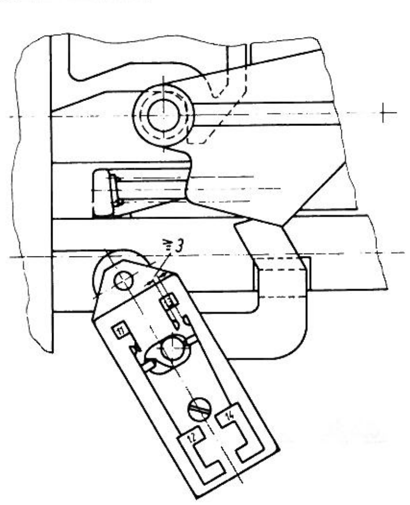
– Bolt the tie connecting plates to the ribbed plates.

– Install the support plates and point machine.

– Bolt the point machine with support plates to those holes which are accessible.

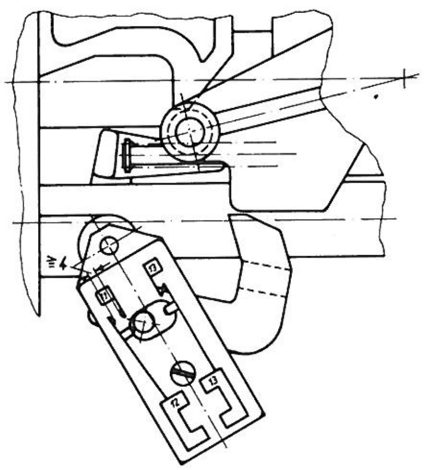
– Align the point machine with the short detector rod. Make sure that the remaining point machine attachment holes are correctly located.

– Secure the unit in the aligned position with hand vises or clamps, and mark the positions of the remaining attachment holes.



Test position: detector bolt engaged, roller engaged (≧ 14 mm)
Contact setting: contacts 13/14 or 23/24 open by ≧ 3 mm

Fig. 28: Checking contact in the end position of drive



Test position: detector bolt withdrawn
Contact setting: Contacts 11/12 or 21/22 open by ≧ 4 mm

Fig. 29: Checking monitoring contact when open

– Make sure that the holes are far enough away from the edge of the tie connecting plate. If this cannot be achieved, drill new holes in the support plates as well.

8.4 Checking point machine after installation

The point machine is to checked after installation as follows:

8.4.1 Intact lacquer and lead seals

Switching force setting

The pressure relief valves in the hydraulic control block are locked at the manufacturer's settings and marked with a paint stripe. If this paint stripe is intact, the original setting has not changed.

Retaining force setting

The pin-headed screw in the spring housing for retaining force adjustment is positively held by two cross-screws to prevent it from moving. If the lead seal and the wire are intact, the original retaining force has not changed.

8.4.2 Contact gaps

Monitoring contacts

The monitoring contact gaps must be as shown in the following table:

Left-hand switch position

Contact number	Contact opening	Fig.
13/14	⩾3 mm	28
21/22	⩾4 mm	29
11/12	closed	30
11/12	⩾2 mm	31*

Right-hand switch position

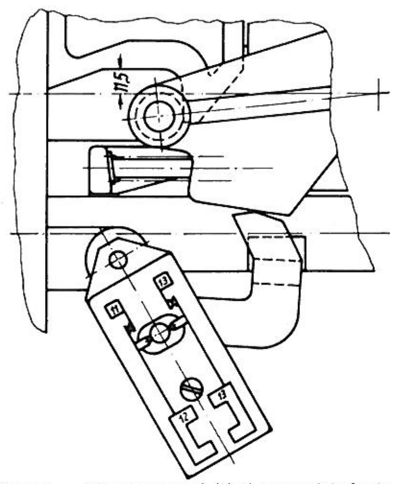
Contact number	Contact opening	Fig.
23/24	⩾3 mm	28
11/12	⩾4 mm	29
21/22	closed	30
21/22	⩾2 mm	31*

Shutoff contacts

When raised, the contact gap must be ⩾ 4 mm.

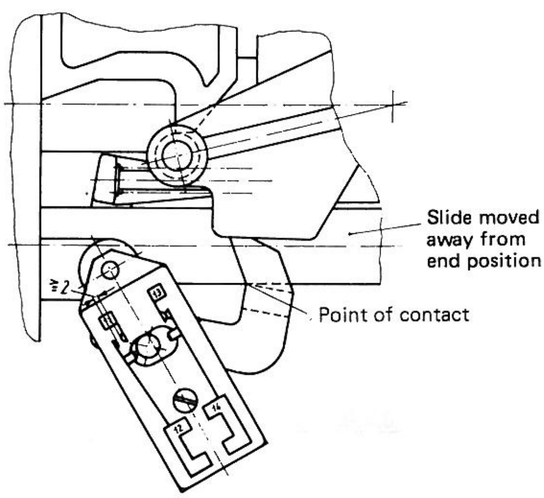
Switched on, reliable contact must be present (contact pressure 2 + 0.8 N).

* Refers only to point machines equipped with detector slides



Test position: Check gap of 11.5 mm with feeler gauge. (Center of roller 4 mm away from end of hook)
Contact setting: Both contacts must be closed. If detector bolt is turned further, contact movement must start

Fig. 30: Checking effectiveness of retention mechanism



Test position: Detector bolt in contact with detector slides
Contact setting: Contacts 11/12 or 21/22 open by ≧ 2 mm

Fig. 31: Checking minimum contact opening gap

8.4.3 Position of detector slide cutouts (Fig. 27)

If the detector rods are correctly adjusted, the following test gaps will be present between the locking face of the detector bolt and the edge of the detector cut outs:

a) In the narrow detector cutout, 2.5 mm at both sides

b) In broad detector cutout, dimension X will depend on switch opening travel, and is obtained from the equation:

X = 25 + ZA (switch opening travel) – 160

or

X = ZA – 135

8.4.4 Switch position

Check that the position of the switch assembly corresponds with the position shown on the monitor in the interlocking box. If a stop is designed to derail vehicles to the right, wires 1 and 3 of the connecting cable must be interchanged at the junction box, since the raised derailer shoe is interpreted corresponding to the right-hand position of the switch.

8.4.5 Checking hydraulic system for leaks

Run the drive several times against a fixed stop, for instance a hammer placed between the stock rail and the switch blade. This will increase the load on the hydraulic system to maximum pressure. Any leaks can then be detected more rapidly, since loss through leakage is proportional to system pressure.

9. Maintenance

Maintenance definitions for signals and communications servicing have been revised. The terms are based on German Industrial Standard DIN 31051 Sheet 1.

9.1 Definition of terms

Maintenance covers all measures needed for the preservation of the desired condition of the equipment, and the determination and evaluation of its actual condition. Maintenance of signalling equipment is divided into the following categories:

9.1.1. Routine maintenance

Routine maintenance comprises:

a) Work performed by auxiliary signal engineers to maintain serviceability (governed by Sig VB 1 – DV 482/1 –)

b) Work performed by specialist signalling officers and their assistants to ensure correct operation (preventitive maintenance, cleaning, lubrication).

9.1.2 Inspection

Inspection work on signalling equipment and individual components thereof is divided into partial and full inspections. Inspection should cover the condition of the entire signalling installation and the correct interaction of the various elements thereof.

Partial inspection

Partial inspection comprises:

a) Determination and assessment of actual condition by visual inspection and with the aid of simple facilities; minor deviations from the desired condition on the components of the system being inspected are to be rectified.

b) Checking individual functions, using the specified test equipment as necessary.

Full inspection

The full inspection comprises all the work and tests performed during the partial inspection, and in addition the recording of all technical data with the aid of test and measuring equipment and its comparison with the specified values.

9.1.3 Repair work

Decentralized repair work on signalling equipment comprises:

a) All urgent work necessary to restore failed equipment to operating condition, including if necessary temporary measures

b) Work needed to restore the desired condition when rectifying defects detected during inspections

c) All remaining work carried out on instructions from the railway directorate with a view to restoring the desired condition of signalling equipment.

9.2 Maintenance work on the L 700 H point machine

On the L 700 H motor the switching movement is obtained from an electro-hydraulic system without gear transmission or mechanical switching force coupling, and using only a small number of moving parts. In accordance with this operating principle, the following work should be performed under the various headings defined above.

9.2.1 Routine maintenance

The point machine requires very little maintenance. For this reason, no preventitive maintenance is called for. Lubrication, oiling and greasing should be performed as required during inspection routines.

9.2.2 Partial inspection

The partial inspection is divided into checking condition and checking operation.

Checking condition takes place in conjunction with the *two-monthly* clamp lock check. It serves to determine and assess unit condition visually.

Check that:

– The interior of the point machine is dry and clean

– The cable assembly is not touching moving parts or the cover

- The cover lock moves freely
- The shutdown device can be operated with the cover in place and moves freely
- Sufficient space is provided for inserting and operating the hand crank
- The drive components show no visible signs of damage
- The drive and its mounting do not move horizontally when the switch is operated
- The throw bars and detector slides are free from rust and correctly greased
- No significant quantity of oil has been lost from the hydraulic system or emerges during switch operation (some oil may appear at the scrapers on the ram piston rods, and need cause no alarm)
- The tube is not blocked with ballast
- There are no visible signs of damage or faults at the fastening or mounting elements
- The cover cannot be raised when the point machine is locked.

Check operation is necessary every 2 years, and includes the work described under 'Checking condition' and 'Testing the point machine' (see Item 8.4).

Check in addition that:

- The rocker arm moves freely with the point machine in its central position
- The rubber sleeve above the rocker arm is not damaged
- The contacts are not severely burned or erroded
- All terminals on the wiring are tight
- The connecting cable and its protective outer sleeve are neatly laid, well secured and free from damage
- Bolts and nuts are tight and secured where necessary
- The oil level in the hydraulic fluid tank is between the two marks on the dipstick
- The drive housing has been connected to the track grounding with galvanized 10 mm diameter steel wire;

On older installations for non-electrified lines, the short-to-ground indicating wire is connected to the contact carrier

- The hooks on the detector bolts move freely;

  Check by applying pressure at limit positions.

- When the switch is moved against its end point, no relative movement is visible between the spring housing and the throw bar (locking).

  All defects detected during partial inspection must be rectified as soon as possible. If defects recur at frequent intervals, they should be reported to the responsible senior official.

9.2.3 Full inspection

At each 3rd partial inspection, the following operating items should be checked on a full-inspection basis:

- Loop resistance in the supply cable
- Correct operation of actuating plates for detector slide .

  The following test routine is to be used:

- Run the switch drive and move away from its limit position (hook on detector bolt released)
- Disconnect the upper detector rod
- Move the upper detector slide towards the drive fully against its stop.

  The detector slide fork must not contact the auxiliary guide when this is done.

- Pull the upper detector rod fully out of the drive
- Insert a screwdriver blade between the detector slides to eliminate play in the guide
- Pull the upper slide firmly outwards. Any further movement must be restricted by the actuating plates.

9.3 Repair work

The repair of point machines can only be carried out by personnel possessing detailed knowledge of the functions of the various drive components. For this reason, only skilled personnel should be permitted to carry out repair work. The point machine performs a key function in efficient operation of the rail system. For this reason, any faults should be rectified as quickly as possible.

9.3.1 Rectifying faults

The summary below shows the correct trouble-shooting routines for various point machine faults. Note that the list does not necessarily contain all possible faults.

Trouble-shooting summary – point machine

Nature of fault	Possible causes	Fault tracing	Remedial action
Motor does not start	Cable broken	Measure voltage in each wire of cable	Replace cable
	Shutoff contacts still open		Turn shutoff ring again
	Switching current fuses blown or missing		Check assembly and frame in interlocking box
Motor buzzes	One wire broken	Check cable	Replace cable
	One wire loose		Tighten terminals
	Shutoff contact sticking	Apply pressure to shutoff contact	Adjust contact
Motor runs but control bar does not move	Broken coupling between motor and pump	Detach discharge line from hydraulic control block and check pressure build-up when hand crank is turned (observe emerging oil)	Replace motor/pump assembly
	Fault in hydraulic circuit block		Replace hydraulic circuit block
	Too little oil in circuit	Check oil level	Add oil
Drive stops in center position, motor continues to run	Switch resistance to movement too high	Measure resistance to movement	Free switch mechanism
	Object trapped between switch blade and stock rail	Check blade closure	Clean and lubricate switch
Throw bar reaches end position but rocker and detector bolt do not engage	Position of detector cutouts and detector bolt do not agree	Check cutout positions	Adjust locking mechanism rods
	Stiff movement between rocker and spring housing	Check free movement of rocker arm and detector bolt	Clean and apply special grease to pivot points
Motor runs in wrong direction	Wires wrongly connected	Check wire connection including at junction box	Connect wires in proper sequence
Drive current fuse blows during switch movement	Momentary short circuit between wires	Measure cable and drive	Replace cable
	Short circuit in motor winding	Check winding resistance	Replace motor/pump assembly
Switch moves in one direction only although motor rotates in both directions	One valve in hydraulic control block has failed	Check pump pressure build-up by detatching discharge lines and turning hand crank	Replace hydraulic control block
	Pump discharges in one direction only		Replace motor with pump

Nature of fault	Possible causes	Fault tracing	Remedial action
Run-through signal is received immediately after switch movement	Angle lever backlash – rocker releases detector bolt	Check that flywheel continues to run after motor is switched off	Free flywheel
	Air in hydraulic system		Bleed drive circuit
	Contact assembly loose	Check attachment of monitoring contacts	Tighten bolts
Oil leaks in point machine	Oil leaking past scrapers piston rods	Clean drive components and threaded unions	No remedial action necessary
	Leak at threaded union joints	Run switch drive against a fixed point and trace oil leak	Take up slack at threaded union (do not overtighten)
	Pump oil seal has failed		Replace motor/pump assembly

9.3.2. Individual repair action at trackside

To rectify faults or eliminate any defects which have been detected, the following components of the L 700 H point machine can be replaced at the trackside.

- Motor pump
- Hydraulic control block
- Pipework
- Contact assembly
- Shutdown assembly
- Wiring harness
- RC-link ('30' units)
- Lock with baseplate, eyebolt and spring
- Tube with auxiliary guide

These repair jobs are described in brief below.

A. Replacing motor/pump assembly

As described in Item 5.3, both gear-type and rotary piston pumps are used. Always install the appropriate motor pump combination.

	Procedure	Tools and other equipment
1.	Switch off the motor. Remove the switching current fuses.	
2.	Unscrew the motor terminal box cover	Small screwdriver
3.	Detach wiring harness from motor	7mm socket wrench
4.	Pull off shut-down unit cover	
5.	Detach wiring harness and connecting cable from shut-down unit	Screwdriver 7 mm socket wrench
6.	Remove the motor retaining bolts	13 mm hexagon socket wrench and 13 mm open-ended wrench (DIN 3112)
7.	Detach oil-leak line from pump	17 mm open-ended wrench
8.	Detach discharge lines from pump, (trapping escaping oil with wadding)	19 mm open-ended wrench
9.	Lift out the motor/pump assembly and install the new unit	
10.	Connect the discharge lines to the pump	19 mm open-ended wrench
11.	Connect the oil-leak line to the pump	17 mm open-ended wrench
12	Bolt down the motor	13 mm hexagon socket wrench, 13 mm open-ended wrench
13.	Attach the wiring harness and connecting cable to the shutdown device	7 mm socket wrench
14.	Connect the wiring harness to the motor terminal board	7 mm socket wrench
15.	Screw on the terminal box cover, not forgetting the gasket	Screwdriver
16.	Install the shut-down device cover	
17.	If the pump contains oil: switch on the drive, insert the fuses and run against a fixed point several times to bleed the circuit.	

Procedure	Tools and other equipment
If the pump is empty : Open the cover at the top swivel threaded union on pump and add oil' Install the cover, tighten down and run the drive against a fixed point to bleed the circuit. Check hydraulic system for leaks	8 mm Allen key with extension, funnel, hydraulic fluid, hammer
18. Clean drive to remove any oil which has escaped	Rag, wadding
Check oil level	

B. Replacing hydraulic control block

2 designs are in use (rectangular and trapezoidal).. Always install the appropriate design.

Procedure	Tools and other equipment
1. Switch off the drive	
2. Detach feed pipes from hydraulic control block	17/19 mm open-ended wrenches
3. Unscrew hydraulic control block from housing (hexagon through bolts) and install new unit. (Note shim washers.)	13 mm open-ended wrench
4. Connect feed pipes to hydraulic control block	17/19 mm open-ended wrenches
5. Check venting and leakage as in A. 17	
6. Check oil level	

C. Replacing pipework

If a threaded union in the hydraulic system still leaks after slack has been taken up, or a pipe is accidentally damaged, the affected pipe or hose must be renewed as a complete unit. Use 17/19 mm open-ended wrenches. The collar nuts should be tightened firmly but not overtightened. If a threaded union has to be renewed in exceptional circumstances, 6 and 8 mm Allen keys will also be needed.

D. Replacing contact assembly

Procedure	Tools and other equipment
1. Switch off the drive	
2. Pull off the cover	
3. Disconnect the wiring harness	7 mm socket wrench
4. Remove the retaining screw	Screwdriver
5. Detach the contact assembly and install a new assembly (note insulating plate)	
6. Insert and tighten retaining screw	Screwdriver
7. Connect wiring harness	7 mm socket wrench
8. Check contact gap	Feeler gauge
9. Press on the cover	

E. Renewing shut-down device

The shut-down device has a set of contacts with contact carrier. Additional individual components which can be renewed are:

Shut-down ring, link rod and terminal strip for 8-pole circuit.

Proceed as follows to renew the shut-down device:

Procedure	Tools and other equipment
1. Pull off cover from shut-off assembly	
2. Remove switching current fuses	
3. Disconnect wiring harness and cable from tower	7 mm socket wrench
4. Unscrew shut-off assembly from motor and install new unit	10 mm open-ended wrench
5. Assemble in the reverse order	

When renewing only the shut-off ring and the link rod, carry out stages 1 to 3 above, then unscrew the shut-off device and replace the damaged component.

The terminal strip for the eight-pole drive supply connection can be re-equipped or replaced (note correct wiring layout).

F. Replacing wiring harness

The wiring harness must always be renewed as a complete unit. Individual wires must not be renewed. A screwdriver, 7 mm socket wrench and 8 mm open-ended wrench are needed. After all renewal work, check that the switch and the signal box or tower settings correspond.

G. Replacing R/C-link ('30' system)

	Procedure	Tools and other equipment
1.	Switch off the drive	
2.	Loosen the hexagon nuts on the assembly plate	8 mm ring spanner
3.	Lift out the assembly plate	
4.	Detach the wiring harness and connect a new R/C-link into position	7 mm socket wrench
5.	Place assembly plate over studs	
6.	Tighten hex. nuts	8 mm ring spanner

H. Replacing detector bolt

	Procedure	Tools and other equipment
1.	Use the hand crank to move the point machine to its central position	Hand crank
2.	Disconnect detector rods	
3.	Pull out detector slides	
4.	Detach contact assembly (but do not disconnect wiring harness)	
5.	Remove M-8 bolt for base plate	Screwdriver
6.	Lift out detector bolt assembly with baseplate, eyebolt and spring and insert new unit	
7.	Screw base plate tightly to studs	Screwdriver
8.	Install contact assembly (note insulating plate)	
9.	Check contact assembly as in 8.4.2	Feeler gauge
10.	Install detector slides	
11.	Test as described in 8.4.3.	

I. Replacing tube and auxiliary guide

After removing the 4 M 6 retaining bolts, the tube can be taken off and renewed. When bolting on, make sure that the vent aperture at the end of the tube faces down.

Renewing the auxiliary guide:

	Procedure	Tools and other equipment
1.	Run the point machine to the central position.	Hand crank
2.	Remove the 4 bolts holding the damaged auxiliary guide	10 mm open-ended wrench
3.	Disconnect the detector rods	
4.	Pull out the detector slides	
5.	Detach the auxiliary guide and install the new unit, but do not tighten bolts yet	
6.	Install detector slides	
7.	Tighten down auxiliary guide	
8.	Reconnect detector rods	

Seven years of excellent results in practice have now confirmed that the development objectives for the L 700 H point machine have been attained in full. Development of the basic type with 220 mm travel can therefore be regarded as concluded. Point machines with a travel of 150 mm or 120 mm, of the quick-acting type, are currently being tested for hump marshalling yard use.

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Standard Elektrik Lorenz AG
P. O. Box 40 07 49 · D-7000 Stuttgart 40 · Federal Republic of Germany · Telephone (49) 71 41/124-0 · Telex 7 2 526 se d · Telefax (49) 71 41/124-95

2841 Scho

Standard Elektrik Lorenz AG Germany