Maintenance of Mechanical Interlocking*

Discussion of Details to Be Watched in Caring for Machines, Signals, Switches, Detector Bars, Etc

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INTERLOCKINGS are installed at points where a number of switches can be controlled from a central point. In mechanical interlocking the signals and switches are connected together by means of movable mechanical connections and their operation is accomplished by manual power. The interlocking machine and a part of the lead out are ordinarily housed in a signal tower. Nothing much can be said in regard to the maintenance of towers themselves further than that immediate repairs of damaged parts should be made and cleanliness and an orderly arrangement of everything should be paramount.

Interlocking Machines

There are several standard types of mechanical interlocking machines, all being similar in appearance and designed with the same purpose in view. The interlocking machine should be overhauled frequently and carefully inspected. It is important that the machine and all its parts be rigid and in proper alinement. Always note that pins and cotters in the rocker link, connecting the lever with the locking bed, are in place to insure that there is no possibility of these having been taken out, resulting in levers being handled in an unauthorized way. The cleaning of the lever handles, rockers and other bright parts of the machine is often left to the leverman. Where this is the rule the leverman will take pride enough in the machine to do this, provided he is furnished adequate tools for the purpose.

While making repairs or adjustments of the apparatus it is often necessary for the maintainer to disconnect a lever temporarily from its ground appliances. Should the lever be thrown in such cases it may result in extra work for the maintainer and cause accidents, owing to the lever not corresponding with the position of the function. In order that the leverman may keep this in mind, a "lever marker" of some kind should be used. Efficient markers include a piece of air hose or a small metal ring slipped over the handle, or a small wooden wedge placed between the handle and the latch. After having disconnected a function the maintainer should keep the connections in such shape that he can make a quick connection again if necessary. As the mechanical locking (dog locking) is the medium which restricts the operator to the manipulation of such levers as will not conflict with routes already set up, no maintainer should ever remove the caps or plates from the locking bed or permit anyone else to do so without authority from the signal supervisor or the signal engineer's office.

A smooth and easy operation of the locking devices will greatly facilitate the manipulation of the levers, and the rigidity and correct alinement of all dogs, tappets and locking bars has much to do with the easy throwing of the levers, besides being of importance to the safe operation of the interlocking. Any loose dog on tappets or locking bars, or any swing dogs showing the effects of a worn trunnion should immediately be taken out or tightened by the use of a pick punch. Some signal departments have found it desirable to use sealed rods to prevent the removal of the locking bracket caps. Where such are not in use, the tap bolts holding the caps should be kept tight and in place.

Always keep the bed-plate clean. Keep everything off the top of the locking and have no obstructions under the rocker links to foul them. See that all locking-bar drivers, all connections between sections of spliced locking bars and all dogs fastened to bars with set-screws are tight. Note that all cotters are in place and properly spread.

The leadout is that part of the mechanical connections which is located within and immediately in front of the tower. It is of importance that all cranks, deflecting bars, chain wheels, rocker shafts, box cranks and pipe carriers constituting the leadout are rigidly and solidly connected and that the floor bolts are tight, as it is here that the greatest part of the strain falls when the levers are manipulated. Inspect the base of the tower weekly and keep the leadout clean and well oiled. All bolts, nuts, pins and cotter pins should be examined at this time. Note in particular the bent and straight arms and the leadout up-and-down rods to detect breaks or stripped threads. Get a ladder under the machine and give all connections a minute examination. See that nothing can foul the bent or straight arms or the shafts. If the leadout is of wood, go underneath and examine it once every six months for evidence of decay in the flooring and timbers, and apply paint occasionally. The up-and-down rods and wires should be given the same consideration as pipe and wire lines. It is often desirable to have the outside part of the leadout protected by a wooden cover. It should be constructed in sections so as to be readily removable and permit easy access to the connections.

All movable parts of an interlocking machine should be oiled frequently and well with a light lubricant, such as a mixture of lard and black oil or a good grade of machine oil. It is important not to overlook the oiling of the main pin in the lever shoe and the front or tail lever pins. As all oiled parts of the machine are likely to collect dust, these parts should be cleaned frequently. The mechanical locking should only be oiled after having been thoroughly cleaned, so that the bars and their guides are entirely free from grit and dirt. The cleaning should be done with a stiff brush and a bellows. After cleaning, it should be lubricated with a good grade of lard oil, dynamo or hydrol oil. If oil lubrication is objectionable, graphite applied with a soft brush may be used.

Canvas cloth is frequently placed over the locking bed or hung in front of the locking to protect it from dirt and dust. In such cases a less frequent cleaning and oiling is needed.

No particular adjustment of levers is necessary in a mechanical interlocking machine. However, when inspecting, try the levers and note if any has too much spring, either normal or reverse, or if any pulls abnormally hard. Too much spring in a lever is caused by too much adjustment in the pipe or wire line connection or in the switch point. A hard-working lever is usually caused by insufficient lubrication or by a tight crank pin. The latter can be located by disconnecting the connec-

*The ninth of a series of articles on signal maintenance. The first, on organization for signal maintenance, was published in the March issue, page 73; the second, discussing tools and instruments for maintainers, appeared in the April issue, page 113; the third, on battery maintenance in signal service, in the May issue, page 145; the fourth, on the adjustment and maintenance of relays, in the June issue, page 174; the fifth, on the essentials of track circuit maintenance, in the July issue, page 211; the sixth, on maintaining line circuits, in the August issue, page 233; the seventh, on the care of lamps, in the October issue, page 306; and the eighth, on automatic block signal maintenance, in the November issue, page 338.

tions outside of the tower at various points until the tight pin is passed. If it appears that a hard-working lever is caused by tightness in the locking bed, no filing of dogs, cross-locking bars or tappets should be attempted until it is proved that these are the cause of the trouble. It might be the locking bars or the longitudinal locking bars that are tight, bent or rubbing against each other. Filing of dogs or tappets results

Temperature in Fahrenheit.	Length of Pipe Line in Feet.							
	100'	150'	200'	250'	300'	350'	400'	450'
120°	5/8"	15/16"	1 1/4"	1 5/8"	1 15/16"	2 1/4"	2 9/16"	2 7/8"
110°	9/16"	13/16"	1 1/8"	1 7/16"	1 11/16"	1 15/16"	2 1/4"	2 1/2"
100°	1/2"	3/4"	15/16"	1 3/16"	1 7/16"	1 11/16"	1 15/16"	2 3/16"
90°	7/16"	5/8"	13/16"	1"	1 3/16"	1 3/8"	1 5/8"	1 13/16"
80°	5/16"	1/2"	5/8"	13/16"	15/16"	1 1/8"	1 1/4"	1 7/16"
70°	1/4"	3/8"	1/2"	5/8"	3/4"	13/16"	15/16"	1/16"
60°	3/16"	1/4"	5/16"	3/8"	1/2"	9/16"	5/8"	3/4"
50°	1/16"	1/8"	3/16"	3/16"	1/4"	1/4"	5/16"	3/8"
40°	Normal.							
30°	1/16"	1/8"	3/16"	3/16"	1/4"	1/4"	5/16"	3/8"
20°	3/16"	1/4"	5/16"	3/8"	1/2"	9/16"	5/8"	3/4"
10°	1/4"	3/8"	1/2"	5/8"	3/4"	13/16"	15/16"	1/16"
0°	5/16"	1/2"	5/8"	13/16"	15/16"	1 1/8"	1 1/4"	1 7/16"
-10°	3/8"	5/8"	13/16"	1"	1 3/16"	1 3/8"	1 5/8"	1 13/16"
-20°	1/2"	3/4"	15/16"	1 3/16"	1 7/16"	1 11/16"	1 15/16"	2 3/16"
-30°	9/16"	13/16"	1 1/8"	1 3/8"	1 11/16"	1 15/16"	2 1/4"	2 1/2"
-40°	5/8"	15/16"	1 1/4"	1 5/8"	1 15/16"	2 1/4"	2 9/16"	2 7/8"

Pipe Compensation Table

in loose locking and lost motion, which will prove a source of danger.

Ground Connections.

The ground connections constitute the pipe and wire lines which connect the signals and switches with the interlocking machine. To insure freedom of movement and safety in operation of the apparatus it is evident that all connections must be tight, no lost motion present and all apparatus forming a part of the connections be securely fastened.

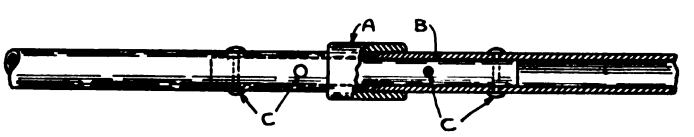
The pipe used in pipe lines is usually 1-in. wrought-iron or galvanized mild steel. It comes in various lengths, although 16 ft. is the most common. A pipe line should be supported or guided by pipe carriers not farther than 7 ft. apart. Pipes running under streets or highway crossings are generally run through a 2-in. pipe, each end of which is fitted with a stuffing box. The 2-in. pipe is filled with crude or non-freezing lubricating oil so that the 1-in. pipe is always submerged in oil. A cock is generally provided to drain the old oil from the outer pipe, after which new oil can be inserted. The joints and stuffing boxes should be tight in order to prevent leakage. Inspect the pipe lines periodically and note particularly that all joints are making good and solid connection. Pipe will more readily break at a coupling or a jaw than at any other place and may only be held by a few threads or by a rivet. A broken joint can readily be detected by gripping the pipe by the hand while shaking it. Broken paint or the presence of rust on the edge of a coupling is a sure sign of a loose coupling or a broken pipe inside of a coupling. Also examine all pipe couplings for loose or missing pipe rivets, stripped threads, and examine the pipe for weak places.

When making repairs of a broken joint do not re-thread the pipe, but cut and set in a new length of pipe. Of course, if in the vicinity of a screw jaw, the pipe can be lengthened—a re-threading of the broken pipe will be all that is necessary. See that all pipes are straight and that they do not rub against each other. Renew immediately broken pipe-carrier sides; replace broken and missing pipe-carrier wheels and top rollers, as a neglect of this may mean a bent, buckled or broken pipe, with serious consequences. It is also important that the rollers move freely and fit properly in the pipe-carrier sides. If too loose, however, they will drop out, and this might be caused by worn rollers or spreading pipe-carrier sides. Foundations may shift and sag, particularly in the early spring, and their straightening at times may be necessary. Bracing, tamping and lining up in a manner similar to the straightening of signal foundations will be required.

To take care of changes in temperature, which tend to lengthen and shorten pipe and wire lines, it is necessary that compensation of some kind be provided where the distance is more than 50 ft. A maintainer need only consider compensation when cutting pipe for repair of a pipe line. The accompanying table shows how much to add to or subtract from the length of a pipe at various temperatures in order to provide for compensation. The normal temperature is taken as 40 deg. and any degree of temperature above this point should be added to and any below should be subtracted from the length of the pipe line. When joining two pipes together, screw the coupling on the end of one pipe and insert the plug one-half its length into the pipe to which the coupling is screwed. Punch and drill holes in the pipe corresponding to those in the plug, and put soft iron rivets (1¼-in. by $1\frac{3}{16}$-in. "button-head" rivets) through the holes and rivet down. The second pipe is then screwed into the coupling tightly, holes punched and drilled and rivets put through. The holes are located by measuring and laying out the distances on the pipes as secured from the plug.

A standard method of coupling pipe is shown in the drawing, part of the pipe being cut away. A is the coupling, B the plug and C the rivets.

When cutting pipe, first determine the length necessary and mark the place with a center punch or chalk, insert the pipe in a pipe vise and apply the pipe-cutter. Two or three turns will be sufficiently deep to break it off readily. Threading is accomplished by the use of a



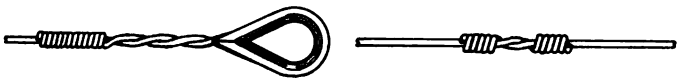
Standard Method of Coupling Pipe

stock and die. When joining the pipes use great care to butt the pipe ends against each other so that enough threads will come inside the coupling for a rigid connection. Although the joining of the pipes may be started by hand, it is necessary to finish with a pipe-wrench to insure a tight connection.

Pipes must be straight, otherwise the proper degree of accuracy in running the connections in the rollers cannot be obtained. To straighten, place over a long timber and pound with a wooden mallet. Bends or offsets in jaws and pipe connections are made by first heating the part in a forge and then bending it over an anvil with a hammer or sledge.

The wire used in wire lines is generally No. 9 B. & S. gage hard-drawn steel and usually furnished in large coils about one-half mile in length. The maintainer should order from the storehouse only the amount nec-

essary for immediate repairs. Wires under streets, highway crossings and platforms are generally run through a ½-in. pipe with a stuffing box at each end, as described for pipe lines. Inspect wire lines to see that the wires rest properly in the wheels, that none rest on the ground, and that the wires do not rub against each other. If the wires have a tendency to rub or twist around each other, place a stake or board in the ground between them. Straighten kinked wires, renew broken wheels immediately and replace or fasten loose wheels. Decayed, broken or loose stakes should either be replaced or repaired, and, if necessary, the ground around the stakes should be tamped, the stake braced or longer stakes installed. Keep wire carriers and chain wheels securely fastened to their foundations or supports and replace broken wheels and those with chipped flanges,



Standard Wire Eye Western Union Wire Joint

as the chain may catch in them. Where a wire line crosses the tracks the wires must not drag on the ground and should not bind against the base of the rail. For this reason guides or braces should be provided if not already installed. The guides should be fastened across two ties in such a way that there will be no possibility of the wires coming in contact with the rails.

When splicing a wire never use a wire eye, but make a standard splice, as illustrated, similar to a Western Union wire joint. The method of making a wire-eye joint for wire ends where connected to chain is also shown in the drawing.

Worn crank and compensator holes and pins will introduce lost motion in the connections and all such places must be closely watched. Enlarged holes or worn pins can be remedied by inserting bushings, larger pins, or new pins; while wobbly and worn cranks can be fixed by placing iron washers at the pin between them and the crankstand. Frequent oiling of all movable parts will reduce wear and facilitate operation, while the proper adjustment is of utmost importance. Watch all bolts, lags and screws used in the fastening of apparatus, as constant manipulation will cause them to wear and work loose.

Whenever wood tops on pipe carriers or other foundations become decayed they should immediately be renewed. Renew one at a time so that there will be no necessity for taking any function out of service. Cranks and compensators covered with platforms should be inspected as frequently as others by removing the cover and observing the condition of all parts. Where a pipe or wire line is run through a pipe provided with stuffing boxes, it is of importance that the pipe be straight and that the joints and stuffing boxes be tightly stuffed with felt packing so as to avoid leakage of oil. It is necessary that the pipes be filled up with oil about four times a year, as a slight leakage is always present. While it is desirable that a non-freezing oil be employed, this is not always possible on account of excessive cost. Crude oil is commonly used, and, as a frost preventative, coarse flake graphite No. 1 mixed with it has proved very effective.

While frequent oiling of all movable parts is necessary to insure free and easy operation, excessive amounts of oil must be avoided. All castings have holes near the pin for the placing of oil. In many cases it will be advantageous to raise the pin slightly and pour the oil under so as to insure a proper distribution. When oiling, it is desirable to use a piece of bond wire, sharpened at one end and bent into the form of a handle on the other. With this the oil hole can easily be scraped clean for oiling. Where anti-friction carriers are used no oiling is required, because where no friction is present lubrication is unnecessary. The wheels and rollers should be oiled, however, where the pipes and wires move.

It is important that attention be given to the perfect drainage of the roadbed. If ditches come too close to foundations, flowing water will tend to wash away the soil and result in a foundation shifting or getting out of line. This, of course, also applies to leadout and tower foundations. Ditches must not be dug around the switch-point ties, as it is of importance that these be well tamped.

Keep all wire and pipe lines free from dirt and cinders, and also see that all wheels and rollers are kept clear from any accumulation which will prevent their free movement. Clean underneath pipes and cranks at least twice each year. Remove grass or weeds which sprout up around pipe lines and apparatus. An occasional raking and clearing of all sprouts in the spring will generally keep a plant free from weeds. Always see that nothing can foul the pipe line, cranks and compensators.

Signals.

Wood, wrought-iron and steel pipe are used as masts for the support of high signals and, in addition, for bracket masts, channel irons with lattice-work are often employed. Signal masts should be given careful attention to see that they are kept plumb. A leaning mast may not only be a source of danger, but will tend to throw the light out of focus. Wood masts have a tendency to warp and may lean, owing to settling of the earth. They are also liable to rot near the surface of the ground and at places where bolts and screws enter the wood. Badly decayed parts can be strengthened by boxing up on all four sides with boards or planks bolted to the mast. Iron masts are straightened by unearthing the foundation, leveling it by blocking well, and then replacing the dirt around the foundation. A simple method of straightening is to drive a wedge block under the base and fill the crevice with a fine mortar mixture. On bracket masts and signal bridges, give careful attention to the decking platforms, as boards will become rotted or get loose and prove a source of danger.

High signal blades are made of wood, pressed steel and iron, while blades for dwarf signals are rubber or wood, with a hinge attachment. Blades should be inspected frequently to see that they are securely fastened on the spectacle castings, as it is of importance that no lost motion be present. They must fit the castings properly and the bolts and nuts holding them be kept tight. Trouble with broken blades is generally occasioned by a loose connection at a spectacle casting, caused by jars and shocks at this point. Drooping blades is another result of insecure fastening. Keep the blades as clean as possible. They should be washed with a solution of washing soda applied with a sponge, then thoroughly wiped with a piece of dry cloth. Enameled blades should be cleaned with oily waste. Experience with certain kinds of paint has proved that soda or any other strong alkaline solution cannot always be used in the cleaning of blades. As a substitute, maintainers use warm water. They dip a sponge in it and squeeze nearly dry; then take up as much of the best kind of whiting as will adhere to the sponge, apply to the blade surface, which, with a slight rubbing, will remove any grease and dirt; afterwards wash with clean water and dry with a soft chamois.

Blades must be repainted periodically because, after frequent washing the paint becomes dingy. It is recommended that they be painted with one coat of paint mixed with turpentine and two coats of coach varnish. With this paint they can be washed frequently without much injury.

The semaphore spectacle casting must be securely fastened to the spindle to insure an even motion when clearing. Loose spectacles can be shimmed with small sheet-iron pieces. Always note that the nut on the spindle is tight and the cotter properly spread in place. This also applies to the up-and-down rod connection. Blank spaces in the spectacle should be filled with sheet-iron disks not only for safety, but also to save roundels.

Semaphore bearings must be kept tight at all times. If loose, it will result in a wabbly spectacle casting which, when moved, may strike the lamp or other parts of the mast. On pipe masts the screws fastening the bearing clamp should be watched on this account. On wooden masts enlarged bearing holes often are the cause of loose bearing. In such cases re-boring or plugging of the hole will be necessary. Inspect the spectacle bearings to see that no water gets in, which will cause rust or freezing of the shaft in cold weather. Worn bearings should be changed out, as they may cause leakage. It is often necessary to drill holes to let moisture out of a bearing. Such holes must be plugged, however, to insure that no dirt or fumes from engines will cause the bearing to rust on the inside. Dwarf signal blades or banners should receive particular attention because, being located close to the ground, they are liable to breakage or bending. Being small and inconspicuous in themselves, the blades and banners should be cleaned and painted more frequently than high signal arms.

Clean roundels and replace cracked and broken ones on lamp-filling days. During snow storms wipe the roundels frequently. At places where considerable dirt, dust and cement has a tendency to collect and trouble is experienced in keeping roundels clean on this account, apply a rag soaked in diluted muriatic acid and afterwards wipe dry with clean waste. This will quickly clean the dirtiest roundels. Paint on a roundel can be removed by the use of a paint or varnish remover. An occasional washing with alcohol will result in bright roundels and is recommended. Never use putty when putting in roundels because the hardening of the putty makes the replacing of broken roundels difficult. Specially-made rubber clips or clips made from the insulation of No. 6 rubber-covered wire should be used, three or four for each roundel. Keep bezel rings (roundel rings) securely fastened to the castings so that the roundels will not rattle. Dwarf-signal roundels are more likely to become broken than those on other signals.

The semaphore spindle must be oiled frequently and examined closely to see that nothing binds or grinds during its operation. At times the spindle should be taken out, cleaned and greased with vaseline. For regular lubrication use a light lard or signal oil. Bearings for unused arms should also be lubricated and greased with vaseline to keep them from rusting and have them retained in good condition for future use. Have up-and-down rod guides lubricated frequently to secure a free working signal and improve the torque of the blade.

Pipe or wire-connected signals should be so adjusted that they will show good lights, that they will not droop when normal and will assume proper positions and correct angles to the pole when cleared. If the blade is not in correct position it may mean a readjustment of the pipe or wire line or a refitting of the blade. Adjust up-and-down rods so that the force of the spectacle casting, when the signal is restored normal, will come on the balance lever casting and not on the semaphore bearing stop. If a signal is not so adjusted the semaphore bearing may be broken by the constant pounding.

Electric or electro-mechanical slots are devices placed on mechanical signals to cause their automatic return to the stop position. Their maintenance is identical with other electric devices described in the block-signaling article.

Switches and Derails.

In the maintenance of switches and derails the proper co-operation of the track forces is very necessary. It is up to them to keep the track to proper gage, the points in good condition and alinement, the switch ties well tamped and the rail braces tight. The ballast in particular must at all times be well tamped around the switch ties. The track will run in the direction of traffic and the points should be closely watched to see that this does not cause the front, head or lock rod to foul on or come in contact with the ties, or twist the lock rod so that it fouls in the switch and lock movement or facing-point lock casting.

Points must fit properly against the stock rails. Always note that points are in proper alinement; replace or have the trackmen notified if a point is chipped, and bent points must immediately be straightened. Watch closely for lost motion in fittings. This is caused by worn pins and bolts which fasten the rods to the switch lugs; worn tie-plates; loose rail braces, or fittings of any kind that are allowed to become worn. Replace such parts without delay. Lost motion in pins does not always mean a worn pin, as the hole also has a tendency to wear. For this reason it is generally necessary to replace a worn pin by a larger pin and if necessary ream out the hole slightly so as to fit the pin.

When oiling switches, first scrape the tie-plates and fittings free from dirt and sand; then clean with a broom and apply oil. Apply oil sparingly on each slide plate and have the leverman operate the switch so that both sides can be oiled. It is necessary to oil shortly after a rain, as the oil washes off. Twice a week is generally considered sufficient for oiling switches under ordinary weather conditions. Keep threads on all adjustable rods well oiled and free from rust. For the maintenance of derails of various types the reader is referred to the discussion of cut-out derails in the block-signaling article.

The chief cause of switches getting out of adjustment are wear in fittings, running or shifting of the track and poor track maintenance. A switch will more readily get out of adjustment during extreme changes in temperature, and at such times it is particularly necessary to test for adjustment. Good maintainers will, however, test a switch for adjustment as frequently as possible, often twice each day. In order to insure that a switch point is properly up against the stock rail, with the switch in either position, there should be some spring in the lever when it is latched. When making switch adjustments care should be taken that the track is to gage and is held firmly in position by the braces and plates. A "switch adjustment" is the means for adjusting and moving the switch points. It is necessary that the operating rod and sleeves or thimbles be adjusted at this place so as to move a greater distance than the switch points in order that a finer adjustment may be obtained by changing the position of the adjustment nuts. This extra stroke on the operating rod, in addition, forces the switch parts against the stock rail. Hence, it is customary to allow about 1 in. or less of play in the switch adjustment. For example, if the switch points have a

4-in. stroke, the operating rod and sleeves should have a stroke of 4½ to 5 in.

A good way to adjust a switch is to first line up the hole for the lock plunger with the point against the rail. Then adjust the front and throw rods so that a throw equal to the distance between the centers of the holes in the lock rod is obtained, with the throw-rod adjustment set to reduce the pipe-line throw to the switch throw. After the adjustment is made, the space between the adjusting nut and the edge of the bracket in the switch adjustment must not be less than ¼ in. and not more than 1 in. Be sure that the jamb nuts are tightened after completing the adjustment. Before commencing to adjust a switch, ascertain that the trouble is not in the ground connections, as loose cranks and compensators will tend to take up all extra stroke in the switch adjustment. For these reasons many times a switch cannot be locked, although it is in perfect adjustment.

Switch Movements, Locks and Bars

A switch and lock movement is a combination of two mechanisms and should have twice the attention of either. It also requires considerable attention because the locking plunger may catch on the lock rod, the escapement crank spread and the lever latch with the switch point open. For this reason the locking plunger should advance at least 1½ in. through the lock rod with the switch point closed. A close watch must also be kept for broken or cracked castings. The pins, slide bar, locking plunger and all parts of the escapement crank should be oiled frequently.

A switch and lock movement should be adjusted so that the position of the detector bar, when the switch point starts to open, is at the full height above the rail. The lever should spring a little before being latched.

In a facing-point lock, always note that the plunger stand is firmly fixed to the ties and that it is not cracked or broken. Tighten lags or bolts at intervals so that the plunger stand will not work loose. The plunger rod should have a squared end, which must not be chamfered, so as to prevent it from being forced through the hole in the lock rod, and the edges of the lock-rod holes should be sharp. The lock rod should have properly centered holes, the distance between them being equal to the travel of the switch point. If trouble is experienced with the locking of the switch, worn parts or changes in the switch gage are generally the cause. Have rail braces rigidly fastened to tie-plates and stock rails, and have track spiked to gage. The holes in the lock rod should not be more than $\frac{3}{32}$ in. larger in diameter than the plunger rod. Keep the lock rod and plunger rod well lubricated so that they will not rust and bind in the stand.

In the adjustment of facing-point locks, it should be observed that when the plunger rod is withdrawn it clears the lock rod 1 in. and has a stroke of at least 7 in. Some railroads specify at least 8 in. and total length of lock plunger must be 19 in. To keep the lock rod in adjustment some maintainers find it necessary to place a lock nut between the jamb nut and adjusting nut.

In bolt locks it is important that the stand or base be rigidly fastened and all bolts and nuts tight. It is desirable that the signal bar connection be equipped with a turnbuckle so as to effect a finer adjustment than is possible with a screw jaw, where at least one-half turn must be made for each adjustment. Keep jamb nuts tight, as they readily jar loose by the vibration of trains. Also keep them oiled. Bolt locks should be adjusted so that the signal bar (slide bar) clears both sides of the notch in the lock rod (switch bar) ⅛ in., and the signal bar should be adjusted so that when the lever is normal the stops on the signal bar bear against the bolt-lock stand, leaving a spring in the lever.

A detector bar works in conjunction with the plunger of the bolt lock and will prevent the unlocking of a switch while a train is passing over the bar. Detector bars must be kept straight and true, both vertically and horizontally. Kinks or bends in a bar are not only dangerous, but will cause a hard-working lever, and as a lock lever with a couple of bars is likely to throw hard under ordinary conditions, they should be made to work as easily as possible. A bar can readily be straightened by laying it on the top of the rail and striking it with a hammer. When badly bent it is necessary to heat the bar before using the hammer. When working on a bar it will often be advantageous to disconnect only one section, as they are bolted together and can readily be taken apart. No part of a detector bar should be left disconnected for any length of time, as this will prove a source of danger to trains passing over the switch or derail protected. When temporary disconnection is urgent notify the leverman. Watch the driving piece closely, as it often becomes loose and will result in lost motion. Also see that the rail clips are tight, because loose clips will cause the motion plates to catch and the links to become twisted. Keep motion plates tight by prick-punching rivets when loose, or put in new rivets when necessary. Where links are used keep them rigid. If they become loose it will cause the bar to lean away from the rail. Watch for broken or bent links, clips and motion plates. Wearing of the rail will force the metal out, roll it over and form burrs. These will interfere with the proper operation of the bar and should immediately be removed with a cold chisel. Snow and ice on or around a bar will cause it to work hard and should be removed with a broom and scraper. Bars should be taken off at least once a year, when all coagulated and gummed oil should be scraped off and the rollers and clips thoroughly lubricated after cleaning. This should preferably be done in the early spring. The bars themselves should never be oiled, but the rollers and motion plates should be oiled sparingly at frequent intervals. Never pour oil over the outside of the clip, but place oil on the roller bearings and in the holes provided for this purpose. Use very little oil on motion plates.

A detector bar should fit up to the rail and be adjusted to travel the required distance so that, where motion plates are employed, the point of incline will be not more than 1½ in. from the center of the rail clip with the bar in normal position. When at rest in the normal or reversed position it should be not more than ¼ in. below the top of the rail, and during the operation it should rise at least ¾ in. above the top of the rail. This is regulated by the links or motion plates working in the rail clips. A bar must not travel too far, as the motion plates will move past the clips. This can be adjusted by means of the screw jaw in the throw rod. If trouble is experienced by the motion plates moving out of the clip, rivet a piece of iron at each end of the motion plates, which will act as a stop for the movement of the bar in either direction.

Painting.

All iron and metal work used in the outdoor apparatus of an interlocking plant is exposed to severe conditions, which tend to cause corrosion and rust. For this reason metal parts should be repainted at frequent intervals. A very efficient and economical preparation can be made of the following combination: 1 lb. lamp black, 1 gal. black oil and ½ gal. kerosene. Pipe lines, detector bars, poles and ladders should be painted at least once a year, and

white poles should be repainted as often as required. Tie-plates, cranks, compensators, switch connections and leadouts should be painted frequently. When painting signal poles, clamps and lamp brackets should be raised or shifted so that all parts can be reached. Do not apply paint in wet weather or on surfaces that are not clean and dry. Before applying, remove any rust, grease or dirt by scraping or otherwise. Old paint and dirt are often removed with an old file. A better method is to use a 5-ft. piece of thin, flat chain, fitted with handles. The chain, when cleaning pipe lines, is wound around the pipe twice and pulled up and down while it is moved along the pipe. For a more expensive and substantial painting of ironwork it is a general practice to apply a priming coat of red lead paint and two finishing coats of the desired color, either black asphaltum or graphite paint being very suitable. All unfinished parts of an interlocking machine should be given one priming and one finishing coat of black japan, while the colored parts are given one priming and two finishing coats of the required color.

On the inside woodwork apply a wood filler before painting, and follow with two coats of hard oil or varnish. On outside woodwork apply at least three coats of lead-and-oil paint. The first coat should be applied thin so that it will soak into the wood. Use pure linseed oil, and not turpentine, to dilute the paint, as the latter will not resist the weather like oil. Before the second coat of paint is applied, putty all nail or knot holes.

General Maintenance.

The integrity of the connections between the levers and the functions is largely dependent upon the maintenance of cotter pins. The importance of cotter pins and keys is not always realized by maintainers. Without regular inspection they are likely to get out of place and cause accidents. In a number of signal departments the maintainer is liable to suspension and also a mark against his record for every cotter pin reported out. Each cotter pin should be inspected at least once a week. A small hand mirror will be found valuable during such inspection, especially when the pin is located underneath a crank arm. It is not sufficient to spread the split ends ⅛ in., as most maintainers think, because experience has proved that a spread of ½ in. is necessary. Most signal departments do not permit the substitution of nails and pieces of wire for cotter pins. The insertion of an old, previously-spread cotter pin is often found difficult. The spread ends may be brought tightly together by placing the head of the cotter pin on a solid surface and striking the ends with a hammer. Cotter pins in cranks are often broken inside of the crank pin without being seen. When inspecting, insert a bond wire in the cotter-pin head and turn the head. As the spread ends should move with the head, a broken pin can readily be discovered.

Rivets are extensively used for fastening parts together. These work loose, however, and maintainers have considerable difficulty in replacing them with new rivets. A loose rivet can readily be tightened by punching a number of dents in its rim by means of a hammer and a prick punch. This will cause the rivet to spread and consequently tighten the loosened parts. If it is desirable to remove a rivet in a motion plate, no filing or chiseling is necessary, as a slim punch can be applied to the center of the riveted side of a rivet. A few hammer blows on the punch will loosen the rivet and it will drop out.

Generally, there is little system in inspecting and testing a mechanical interlocking, due to the fact that the parts are simple and general defects readily apparent. A daily inspection of all apparatus is required of maintainers at interlocking plants. Where there are day and night maintainers, the night man should also make an inspection. In addition to the daily inspections, a weekly inspection should be made of the general condition of the apparatus in order to detect any condition which should be corrected to increase the efficiency and safety of the operation of the signal and switch apparatus. Any such condition should be reported to the foreman in charge or to the supervisor of signals.

During snow storms it is a practice to call out the trackmen to sweep out the switches. At other times during winter it is up to the maintainer to see that the snow is kept away from the switch points so that it will not interfere with the operation of the switch. A few roads box in the pipe carriers and cranks to avoid such trouble. The maintainer should clean away all snow as frequently as possible. The switch adjustment also becomes clogged with snow and ice, thereby preventing the adjustment of the switch. Maintainers generally wrap a piece of canvas around the front and throw-rod adjustment in the fall and when the switch is in need of adjustment this is removed. The canvas used is 2 ft. wide and should be long enough to completely cover the adjustment and part of the rod. Old burlap sacks are also used for this purpose and securely tied in place with a string, while some railroads use specially-constructed iron shields.

Clogging of detector bars and locks also makes their operation difficult. It is often necessary for the maintainer to go over the plant with a hammer to loosen frozen parts, and, in some cases, only by the burning of oily waste can fittings and parts be loosened. During cold weather the functions should be operated frequently so as to avoid freezing. On extremely bad days pintch gas waste (called hydro-carbon) may be carried from switch to switch, poured upon the snow, ice and frozen parts, where it will burn until entirely consumed. A section man should be shown how to pour a moderate quantity of hydro-carbon, just the amount required to melt the snow, in order that ties and trunking shall not be set afire. An indiscriminate use of salt for snow-melting purposes around interlocking apparatus should not be permitted, as it causes rust and corrosion. If the sprinkling of salt is found to be indispensable in keeping switches clear, very small amounts should be used. The removal of ice and snow can also be accomplished by the use of kerosene thawing outfits, of which several successful and reliable types have recently been placed on the market.

Trouble is often experienced with tight pins in cranks and bearings. A little kerosene frequently applied will help to loosen them. It might be necessary in some cases to drive the pin out and clean it before it will work freely. Pipe rivets or cotter pins placed in oil holes in cranks will prove effective in keeping the dirt out and the holes open for oiling. When the lag screws fastening the apparatus get loose and it is impossible to tighten them, put in larger screws. For instance, replace a 4½-in. with a 6-in. screw. To facilitate the work of applying lag screws, fill the holes drilled in the tie with oil or paint before the lag screw is inserted.

In the oiling of switches, derails, detector bars and ground connections, use black oil diluted with 25 to 50 per cent of kerosene. Black oil will need more diluting in winter than in summer. Keep all turnbuckles and adjusting screws well oiled so that the nuts can be readily turned when necessary. It is important that all jamb nuts are tight against the jaws, as they are intended

not only to keep the adjustment intact, but also to prevent the stripping of the threads on the screw jaws.

During repairs or when a switch is out of order, it is of utmost importance that it be disconnected and spiked in the normal position while it is held locked in position by the plunger rod. If the switch is part of a cross-over, also have the other switch spiked in the same position. When spiking a switch, split-point or Wharton derail, place a spike in the two or three ties nearest to the point on the closed-point side. If the switch is operated by a switch-and-lock movement, remove the pin in the tee or right-angle crank. If there is a facing-point lock, remove the pin in the switch connection only. On a split-point or Wharton derail, remove the pin in the operating crank and in the tee crank for the facing-point lock. On a Hayes derail, tie the derail block to the guide-box casting with heavy wire and remove the pin in the crank. If a signal fails to respond to the position of the lever its operation should be discontinued and the signal securely fastened in the stop position until it is repaired. During a storm, and at times when many derangements happen, the maintainer should first give attention to those functions most used.

IN MEMORY OF W. R. SYKES*

ONE of the great pioneers in the art of railroad signaling, William Robert Sykes, passed away on October 2 at his residence, Whitstable, Kent, England. He was in his 78th year and was overtaken quite suddenly by a painful internal complaint. Born in London in 1840, he had to earn his own living at an early age, and at 14 he entered the service of the old Electric Telegraph Company, where he came in contact with men who were famous as pioneers in electrical matters. There he developed a talent for telegraphic and electrical work that remained with him throughout his long career. Eventually he secured an engagement with Shepherd, the chronometer manufacturer, who supplied the government and private companies. In 1862 the London, Chatham & Dover Railroad required the services of a telegraph engineer and Mr. Sykes was engaged. From that time until the last years of his life his whole energies were devoted to the invention and improvement of railroad signaling apparatus. Subsequently Mr. Sykes retired from active service with the Chatham railroad and formed the W. R. Sykes Interlocking Signal Company, of which he was chairman at the time of his death.

W. R. Sykes

Probably his most widely-known invention is the controlled manual block, which was introduced in 1875 and was adopted to a considerable extent in England and also on some railroads in the United States. It was first used on the Chatham line in London. He also experimented with track circuiting very early, putting in a circuit at Brixton in 1864, and in the seventies he installed others on the Chatham line. Mention may also be made of his single-track controlled manual block, which was adopted in Japan, Russia and elsewhere. Mr. Sykes also designed an electric signal slot, signal selector, track instrument and several signal machines, while he was the inventor of the electric fouling bar so much used in England. Operating signals electrically was another of Mr. Sykes' early activities. The signals at each end of Penge tunnel on the L. C. & D. were installed in 1875, and in 1883, at Victoria terminal, no less than 50 electric shunting signals were put in, as has been previously referred to in these columns. Later Mr. Sykes designed the well-known "banner" signal, of which large numbers are now in use. It may also be mentioned that he strongly advocated the upper-quadrant semaphore in the eighties, but nothing was done in this direction at that time in England.

The electro-mechanical interlocking system may also be traced to his work. Its germ lay in the Victoria shunting signals, but its complete development was left till 1901, when the Glasgow & South Western Railroad terminal at Glasgow was fitted up. One of the towers in this plant has 400 electric levers. The same system was later installed at Victoria terminal, London, on the London, Brighton & South Coast, where six towers were in service. Interlocking drawbridges was also a field in which Mr. Sykes was active and several installations designed by him are in use; the first was at Howarden. It is impossible to refer to all the inventions that he was responsible for. At many exhibitions, both in England and abroad, he received high awards. Railroad signaling everywhere bears witness to his influence, and British railways iu particular owe much to his work. His death removes almost the last of the pioneers in British signaling who have done so much to lay the bases of the present-day block and interlocking systems. In Mr. Sykes' active days inventors met with little encouragement, and we who live in a time when a better recognition is given to the signal engineer must ever remember with gratitude those who labored to found the signaling profession, among whom Mr. Sykes was a prominent worker. The wonderful safety of British railroads is in no small measure due to his efforts.

*Written by T. S. Lascelles, assistant to engineer, Sykes Interlocking Signal Company, London, England.

NEW USE FOR TRAIN ORDER SIGNAL

THE illustration serves to emphasize the fact that train order signals may be used to designate a place to give as well as to take orders. The one shown is in service at the entrance of a hotel and restaurant on the main street of Everett, Wash. It is painted the Northern Pacific standard and is reported to look well and work fine. The maintenance force of the Northern Pacific has never had a trouble call from this signal.

Novel Use of a Train Order Signal