Technical Meeting of the Institution

held at

Derby

Wednesday, March 3rd, 1954

The President (Mr. T. AUSTIN) in the chair

Mr. S. Williams opened the meeting by saying how pleased he was that their President had been able to visit Derby and take the chair that evening. He also welcomed the many who attended, including two representatives from the Western Region who were formerly of the London Midland Region.

The President replied that it was with more than usual pleasure that he came to Derby. He had spent a matter of ten years there, and it was there that he had married.

When arranging for a provincial meeting at Derby, he had offered Mr. J. S. Davis a choice of papers, and suggested that one of the local staff might come forward and prepare a paper. It was, therefore, with considerable pleasure that he learned that Mr. H. G. E. Taylor had offered to read his paper on "Testing of Mechanically Interlocked Lever Frames," and he now called upon him to do so. There had been surprisingly few papers dealing with mechanical signalling, and he had no doubt that much would be learnt from the one they were about to hear.

Testing of Mechanically Interlocked Lever Frames

By H. G. E. TAYLOR (Associate Member)

Diagrams—Inset Sheet No. 15

The importance of testing all signalling apparatus, either electrical or mechanical cannot be over stressed, and an efficient signalling system cannot be maintained unless thorough tests are carried out periodically to the many pieces of apparatus employed.

It is considered that the Interlocking Lever Frame is one of the most important pieces of apparatus that has to be main-

tained by a signal and telecommunications engineer and on the L.M. Region of the B.T.C., instructions are laid down for the guidance of all concerned in the proper maintenance of a mechanical lever frame.

These instructions cover :—

(*a*) " Records of examination, cleaning, adjusting and testing of interlocking frame " and state that these operations should be carried out at certain periods according to the type of frame concerned.

(*b*) " That after a lever frame has been overhauled or altered it shall be tested on completion by the locking lineman in charge and also by the supervisor."

To record that these tests are carried out, test certificates are signed by those concerned and forwarded to the responsible officer.

To define the term " testing " as implied in the instructions, means checking or pulling to ascertain that the applied locking between any number of levers agrees with the locking table for the frame under test.

The person carrying out the test should be in possession of a correct locking table which represents what locking should be applied, and as the test proceeds, should suitably mark off the locking tested. Great care must be exercised in this marking off, as a mark over the wrong number would convey that certain locking had been tested, and it may not exist.

The test could of course be made, using only a signalling plan of the layout controlled by the frame, but the risk of overlooking some locking is considerably increased and the practice is not recommended.

Speed, as well as efficiency is also vital when testing, for until the test has been satisfactorily carried out normal working cannot be restored and in consequence greater delay will occur, which in the end means financial loss. In this respect the presence of superfluous locking on the test sheet can cause considerable delay to the tester and it is well worth while to examine the sheet prior to testing and suitably mark all such locking.

It is of course essential for the tester to be familiar with the particular signalling layout and to be able to set up quickly any sequence of levers that will be required.

Broadly speaking testing can be grouped under four headings, depending on the nature of the work under test.

These are as follows :—

(1) Complete test of every lock on the frame.

(2) Complete test of all the locking in a particular locking box or tier of locking.

(3) Testing of new bars or tappets while preparing for an alteration.

(4) (*a*) Spot testing during periodical examination ; *or*
(*b*) after correcting a fault.

Analysing these four types of testing in more detail, Item 1 is the test which will occupy most time, especially if the lever frame is a large one, and the ideal conditions under which a test of this description can be made are :—

(*a*) On a new lever frame prior to it being brought into use and which has no external connections ; *or*

(*b*) On a frame in service which has been entirely disconnected.

The common factor between the two, is to give the person in charge complete possession of the frame, and not to be dependent on permission given by the signalman before a lever can be moved.

It is recommended, where a complete test is being carried out, especially at a busy box to arrange for total disconnection of all points and signals to give this freedom, for the time saved in testing is far in excess of that taken to disconnect and reconnect. Another advantage is that no misunderstanding can arise between testing staff and signalman, which may lead to serious consequences.

It will also be necessary to arrange for all levers to be free of any electrical control, either beforehand, or during the test.

Item 2 can only be applied in certain cases according to the type of frame under test.

On lever frames similar in design to the ex L.N.W. tappet frame, it is possible to localise the disturbance of locking to a particular trough or bracket, so leaving the majority of the locking effective. Hence the test can quite safely be confined to the locking in the trough or bracket that has been disarranged.

As can be realised this is a tremendous help when dealing with large frames, and it is suggested that where frames of this, or

similar types are being overhauled, the work should be carried out systematically, bracket by bracket and the testing confined accordingly.

A part locking table is required for this test corresponding with the locking in each bracket.

This type of test, however, cannot be applied to frames having a common tappet to affect all the locking on one particular lever.

The test outlined in Item 3, is in the main, second nature to a locking fitter, but it is mentioned, because if disregarded it can cause untold delay.

If an alteration is being prepared which necessitates fitting a new tappet or making a new bar, then each lock on the bar, should be tested individually, and each notch cut in the tappet should be tried before it is accepted as finished and laid aside for final insertion.

If these part tests are not carried out before the alteration is brought into use, excessive delay is caused when it is found that a bottom bar is faulty and has to be removed, also it disturbs top locking which may have been tested, and because of the disarrangement the test would have to be repeated.

In many ways the test in Item 4 presents most difficulty to a maintenance lineman because it usually has to be carried out on a weekday, during traffic, without cover of a notice to traffic, and it is under such conditions that the greatest care must be exercised.

In the first case (*a*) at many busy signal boxes, traffic is such that it is impossible to actually test the locking by pulling the levers, as possession cannot be obtained. If the locking has not been interfered with since the last test, then it can be assumed that in the main it is effective, except for locks which have worked loose, or in the case of tumbler frames, racks which have become out of adjustment. In such cases the test becomes one of observation and touch and this is a practice which is not easily acquired.

In the event of a failure to a frame it may be necessary to replace a broken part, which in turn disarranges the interlocking. On completion of the repair, part test would have to be made at the discretion of the person in charge, bearing in mind the extent of the interference to the locking bars.

Method

The method of testing any type or design of lever frame is fundamentally the same and should be carried out, where possible, with the aid of a set of locking figures and not from a layout plan or locking diagram.

If, for example, the frame is to be completely tested, then the object is to test each lock and notch to ensure that the locking figures have been correctly interpreted, and nothing must be left to chance.

Before commencing the test, it is advisable to see, wherever possible that all levers are normal in the frame. When testing levers with catch handle locking the lever is fully normal or fully reverse only when the catch handle is " down " in one position or the other. If the locking is " direct," i.e., the locking is operative as soon as the lever is moved, then the lever is normal when back in the frame, and reversed when pulled.

(See Inset Sheet. For illustration purposes tappet locking only has been used).

Dead Locking

Fig. 1 shows a simple form of dead locking :—

1 locks 2 normal. (Ignore the dotted notch in No. 2 tappet).

The test to be made is to ensure that 1 pulled, locks 2 normal, and that the converse, which is equally as important of 2 pulled locking 1 normal is effective.

The procedure to test would be :—

Pull 1, try 2 which is locked normal.

Replace 1 and pull 2, try 1 which is locked.

It is often thought that the first half of this test is sufficient, but this is not so.

Imagine that a second notch has been incorrectly cut in the reverse position of No. 2 tappet. The first part of the test could be completed, but this only proves that no reverse or conflicting notch has been wrongly cut in No. 1 tappet. It will be seen, that immediately No. 2 tappet is reversed, lever 1 is free to be pulled and as both levers could be reversed together the desired locking is not applied. Hence the importance of trying both the front locks and notches to prove that neither are given away.

This important feature will re-occur throughout all the tests made, either in dead locking or releasing locking and the double test *must* be made each time.

Releasing Locking

Fig. 2 shows one lever released from the normal position by two other levers being fully reversed.

1 released by 2 and 3.

The test would be :—

Try 1, pull 2, try 1 which is locked.

Restore 2 and pull 3, and again try 1 which is locked.

Pull 2, leaving 3 reverse and pull 1.

Test the reverse or back locks on 2 and 3,

(which means trying to restore to normal the releasing levers while the lever which is released is reverse).

At first glance it might seem unnecessary to try lever 1 with only one of the releasing levers reversed, but again this is done to ensure that a notch has not been accidentally cut in the normal position of either tappets on levers 2 and 3.

Both Way Locking

The method of testing the both way locking shown in fig. 3 would be :—

Pull 1 try 2, which is locked.

Restore 1 and pull 2, then pull 1 and try the back lock on 2.

Conditional Locking

Locking is often applied when the position of a lever or levers has to be taken into account. This is known as conditional locking.

The same testing procedure is gone through similar to that already described, but in addition, a test has to be made to ensure that the conditional lever cannot be moved from its relative position while the desired locking is effective.

Fig. 4 illustrates lever 1 pulled locking normal lever 3 only when lever 2 is normal. If lever 2 is reversed then levers 1 and 3 are free to be pulled.

To Test :—(All levers normal).

Pull 1 try 3 which is locked.

Replace 1 and pull 3. Try the converse.

Pull 2 with 3 still reverse and pull 1.

Try the back lock on 2.

The last part of the test is to ensure that with lever 2 reversed the locking between 1 and 3 is inoperative but having reversed

these two levers, it must be established that lever 2 cannot be restored to normal to destroy the condition.

This locking, 1 locks (3w 2n) could be written as a releasing condition, i.e., 1 released by 2 when 3 reversed. The locking could be tested in exactly the same way, but generally the release would be tried first.

Conditional both way locking is tested in a similar way to that for conditional dead locking except that the lever to be locked is tested in either position.

If more than one conditional lever is employed before the locking becomes effective, as shown in fig. 5, then the test would be :—

(All levers normal).

Pull 1 and 3, try 5 which should be locked.

Restore 3, pull 5, try 3 which is locked.

Restore, 1, pull 3 and test the converse.

Pull 2 and 1 with 3 and 5 reverse and try the back lock on 2.

Restore 1 and 2 and pull 4 and 1 leaving 3 and 5 reverse and test the back lock on 4.

Sequential Locking (fig. 6)

This locking is different from previous types mentioned inasmuch that the locks between the two levers are not rigidly connected, but operate by spring. This is necessary of course to enable both levers to be in the reverse position at the same time. Because of this spring connection it is essential to prove that the spring is operating correctly after having been under tension.

To Test :—(Both levers normal).

Pull 1 and try 2 which is locked.

Replace lever 1 to the normal and release the catch handle on 1 to the normal position very slowly. Then try 2 which is free. The slow restoration of the catch handle on 1 ensures that the lock is withdrawn quietly out of 2 tappet.

Then pull 2 and 1.

Replace lever 2 to the normal position and release the catch handle very slowly until full normal, then try the front lock on 2.

In this case the slow restoration of the catch handle on lever 2 proves as far as possible, that the lock is pushed into the tappet

without the help of any vibration which would result if the lever was operated normally.

Full Rotation Figure 7

This form of locking is tested on similar lines to those described for sequential locking, for sequential locking forms part of it, but in addition, there is a dead front lock to check.

This form of locking requires careful fitting when being made to ensure that the chamfers on the lock and tappets are cut correctly and that the gravity lock with lug is " dropping " into the tappet.

In consequence, when testing this form of locking, this should be borne in mind, and all the movements of the catch handles should be regulated accordingly, for if they are moved slowly when the test is satisfactorily carried out there is little likelihood of failure when the levers concerned are operated normally.

To Test :—(Both levers normal).

Pull 1 and try 2, which is locked.

Restore 1 and pull 2, then pull 1.

Put back 2 and try the front lock.

Operate the clasp handle on 1 lever which is in the reverse position, and release it again without moving the lever, try the front lock on 2 again (this is to prove that the sequential locking is doing its work).

Restore 1 and try 2 which is now free.

That completes the test, but when 2 was last pulled this would re-set the gravity lock on that lever and it becomes self locked, therefore, 1 must be operated again.

Detonator Locking

Fig. 8 shows this simple form of locking.

The main feature of the test is to check that the catch handle on the signal lever (No. 2) cannot be put to full normal after having been reverse with the detonator lever (No. 1 reverse).

To Test :—(Both levers normal).

Pull 1 try 2 which is locked.

Restore 1 and pull 2, then pull 1.

Put back 2 and check that the catch handle is "held up."

Restore 1 which frees the catch handle on 2.

With the exception of one or two forms of locking, those dealt with will go to make up a complete interlocking arrange-

ment, and it will be multiples of these types that the person testing will be confronted with.

The larger the lever frames, the more times a particular test will have to be carried out between different levers, but for each type of locking the test will be similar to those described.

DISCUSSION

Mr. J. S. Davis, in opening the discussion, said that the paper would provide a valuable addition to the records of the Institution, and he congratulated the author on the clear and concise manner in which he had dealt with the subject.

He noted that the author stated that it was essential that the tester should be familiar with the particular layout he is testing, but he suggested that it was not necessarily essential, as a person who is not familiar with the layout can impose a functional test, and is therefore, in effect, imposing a check on the locking table itself as well as on the test of the frame to the locking table. The paper suggests that superfluous locking can cause considerable delay to the tester, and that it is well worth while to examine and suitably mark off all such locking before commencing testing. Mr. Davis was in agreement that all such superfluous locking should be marked off, but considered that this work should be done when the locking tables were prepared, and not by the person making the test.

The author had grouped testing under four headings, and he enquired whether a further test should be made to ensure that the locking, as actually fitted, was carried out to the tappet diagram. It would be understood that the frame may test correctly to the locking table, but in actual fact the locking may have been carried out in a different way to that shown on the diagrams and difficulty would be experienced by the locking fitters when any subsequent alteration had to be carried out.

With regard to sequential locking, Mr. Davis was not in favour of springs being used in interlocking, and asked the author if in his opinion, gravity sequential locking would not be preferable.

Mr. W. Dean said that he would like to congratulate the author on the choice of the title for his paper and he agreed with the President's remarks as to this branch of the signalling profession being very much neglected in the past. He knew of few more mentally exhausting tasks than testing a large mechanical

interlocking, particularly as the work usually took place at the end of a long and tiring day for all staff where large alterations were concerned, and he supported the author in stressing the need for great care in the final testing. He did not fully agree on the disconnection of all points and signals for testing, as this was bound to impede traffic movements, particularly at a busy box, and he felt that although this was the ideal conditions for testing a frame, a lot could be done beforehand by asking the operating department to divert traffic or reduce shunting movements to give adequate margins for testing. This was an important side of the work which was often overlooked in planning line occupations, and so forth.

He supported the view for testing a frame from the locking sheet instead of the layout sketch and agreed that the latter method should be used for a spot check only. He also agreed that a thorough knowledge of the layout and numbering was required.

He asked for the author's views on the use of the words "try lever" as distinct from "pull lever" and noted that the former term was used in the paper. Although it was sometimes felt that the man testing the levers should always be asked to "pull," there was a risk of injury if the lever was locked and he himself used the term "try lever" when the lever should be locked.

Mr. V. K. Openshaw said he would like to be associated with previous speakers in congratulating Mr. Taylor not only on his excellent paper, but also for bringing into prominence so important a subject which did not always receive the consideration it deserved, particularly in connection with the training of people in the right methods of testing locking. In this connection it would be appreciated that the difficulties in testing a large lever frame lay in the way in which other locking would interfere with the particular lock being tested, and it was that reason that the tester should be fully conversant with the layout and the complete locking table. He thought it necessary to test all locking with the outside connections attached, particularly in the case of a frame with lever locking as opposed to catch handle locking, but that this could be done by the fitter as each portion of locking was completed, leaving the final test to be carried out with complete disconnection if required. With regard to conditional locking, he found that a useful maxim was "one lock per lever," so that the condition 1 locking 3 when 2 reversed involving

3 levers would necessitate testing three separate locks (or back locks) as shown in the paper. In many cases, however, other locking on the frame might prevent one or more of these locks from being tested directly.

The difficulties over superfluous locking he thought could be overcome by leaving all such locking off the table supplied with the layout plan (which the tester would use) but in showing it distinctively marked on the table attached to the tappet diagram.

Mr. C. G. Derbyshire said there are still those who seemed to think that testing of locking was overdone, and was given an importance above its deserts. He would like to take such people into the shops to see how many pieces go into the making of a locking frame, the omission of any single piece might cause a serious accident. Locking is the foundation of all signalling safeguards and will continue to be so as long as mechanical signalling is used. Regarding the definition of testing, the author sums it up by saying it is to ensure the locking corresponds with the locking table. But each individual lock has to be correctly adjusted, not too tight and not too slack, and he would include in the term "Testing"—testing the locking to the table, also testing to ensure that the signalman has the essential freedom for simultaneous movements. In a complicated layout it is possible to have a number of movements going on at the same time, and difficulty should not be experienced in setting up such movements. When learning to test a frame it was helpful to prepare a table beforehand including all reciprocal locking and ring those locks or reciprocals which cannot be tested.

With regard to the various types of test, he noted that the author, in bringing a new frame into use, spends much time to make the test as thorough as possible. That is very important as no similar opportunity may occur again during the life of the frame.

He thought that the locking tester should be thoroughly conversant with the layout, the frame and the locking. A careful study of the locking chart was useful to the tester as there were several different ways of achieving the same object when preparing the chart. For instance, dead locking must be included with the conditional locking to economise in locking bars. If a layout is under-signalled, more point locking is needed for safety, but where a signal is given for every movement, point locking is not so necessary.

The amount of locking differs from place to place according to the nature of the traffic, and the type of signalling. It is useful for the tester to appreciate all these points before he starts to test.

Mr. T. Guest referred to the author's statement "Before commencing the test it is advisable to see wherever possible that all levers are normal in the frame." To make a satisfactory test it is essential to have all the levers in their normal positions and to have complete possession of the frame. With regard to superfluous locking the presence of any such locking should be exceptional.

He agreed that in the case of busy signal boxes it was an advantage to arrange for total disconnection, if arrangements could not be made with the operating department to divert traffic. Generally possession of the frame had already been obtained to enable the locking lineman to carry out his work. There were occasions, particularly with point levers, that when the lever was re-connected the tension on the lever in the catch caused the locking to be tight, especially on lever frames with direct lever locking.

After the locking had been tested to the locking table it was desirable that a test should be made to the signalling plan. The first test ensured that the locking was in accordance with the locking diagram and that the diagram had been made correctly. The second test ensured that the locking sheet had been made correctly from the signalling plan. This test covered to a certain extent the points of the first test but it was desirable to apply both tests as it was sometimes difficult to thoroughly check the locking from the signalling plan especially in complicated layouts. He agreed that this test alone was not satisfactory.

When testing from the signalling plan it was usual to commence by testing the locking between point levers, facing point locks and then signal levers. A final test being made by setting up routes to ensure that routes which did not conflict were free and that those which did conflict were locked.

Mr. S. Williams said that the author deserved praise for the manner in which he had set out the paper. It was not an easy matter to put one's knowledge into words in a clear and simple form, however well one knew the subject, and he felt sure that all

would appreciate the able way in which Mr. Taylor had dealt with the subject of testing lever frames.

The Author, in reply, thanked Mr. Davis and Mr. Williams for their words of appreciation.

The presence of superfluous locking on the lever frame under test had given rise to quite an amount of discussion, and although on new lever frames such locking should not be there, on old lever frames which had been extensively altered, it was not always easy to remove such locking. If the superfluous locking were positioned on a long bottom bar on a tappet lever frame, it is no mean task to remove such locking, and because of the resultant disturbance to the remaining locking this would lead to additional testing. Having accepted the presence of superfluous locking on the test sheet, it is considered this locking should be distinctly marked.

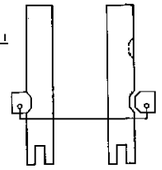
In reply to Mr. Davis. Undoubtedly electrical sequential locking is the complete answer, but it is not always possible to install this form of sequential locking due to the expense involved. Concerning the merits of sequential locking in either "spring" or "gravity" form, on balance I prefer the "spring" sequential locking.

In reply to Mr. Derbyshire. In regard to making a test to ensure that the signalman had the essential freedom for simultaneous movements. Whilst it is agreed that this is a test which can be carried out if the time is available, I consider that this problem should be dealt with in the drawing office when the locking figures are being compiled, and that under actual testing conditions it is not justified to burden the man in charge with this problem.

In reply to Mr. Dean. Regarding the total disconnection of the lever frame during testing, from experience I have arrived at the conclusion that where the size and nature of the work warrants it, the lever frame should be totally disconnected, and I think that we are justified in bringing this to the notice of the operating department who could then make the necessary traffic arrangements for the period whilst the frame is under test.

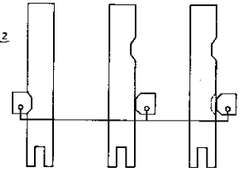
The President said he was sure that it had proved a most interesting and instructive meeting and he proposed a hearty vote of thanks to the Author, which was carried with acclamation.

FIG. 1



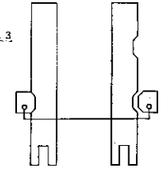
1 LOCKS 2 NORMAL

FIG. 2



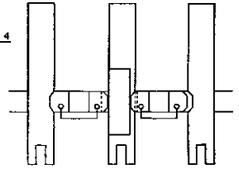
1 REL BY 2 & 3

FIG. 3



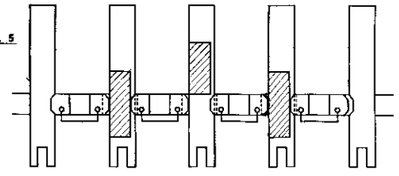
1 LOCKS 2 B/W

FIG. 4



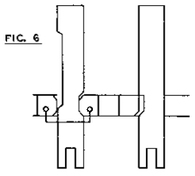
1 LOCKS (3W 2N)

FIG. 5



1 LOCKS (3W 2. 4N 5R)

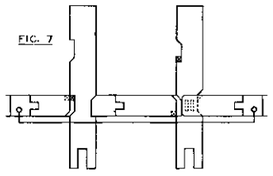
FIG. 6



SEQUENTIAL

1 LOCKS 2 NORMAL

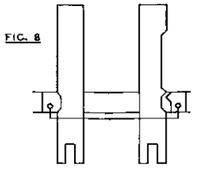
FIG. 7



FULL ROTATION

AFTER 2 - 1 BEFORE 2

FIG. 8



1 LOCKS 2 (DET)