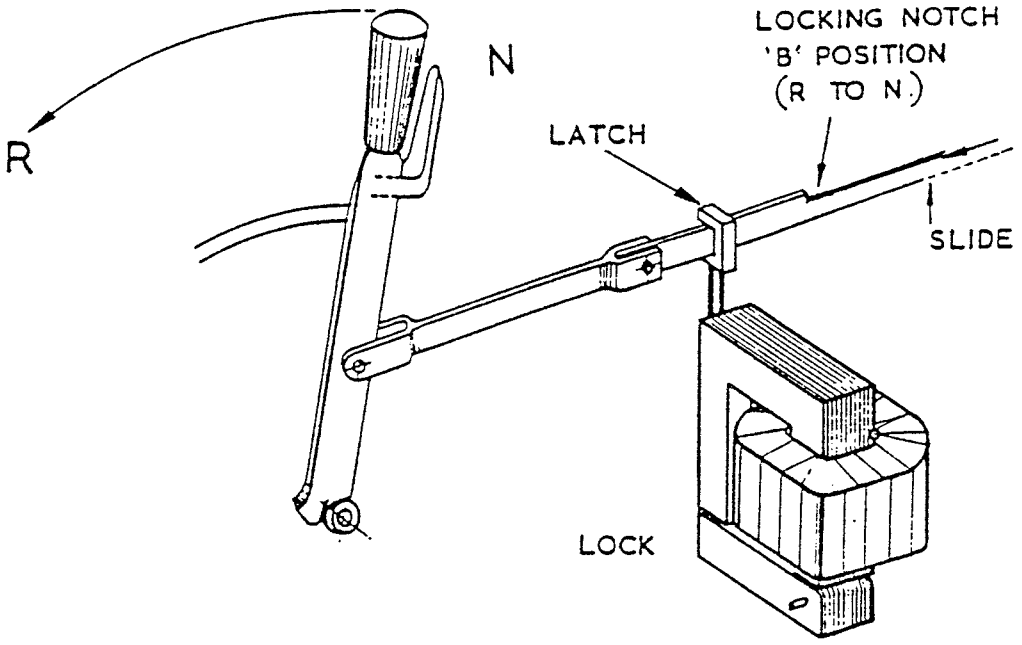
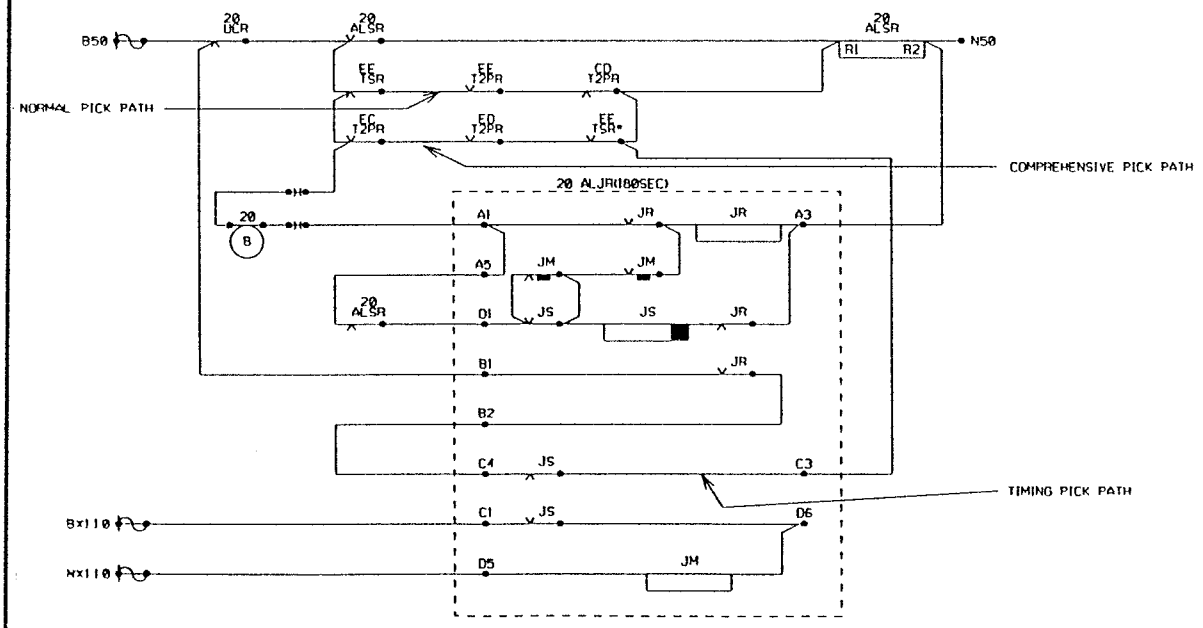
CENTRAL SERVICES
SIGNALLING PROJECTS GROUP

PRINCIPLES AND APPLICATION OF APPROACH LOCKING





PRINCIPLES AND APPLICATION OF APPROACH LOCKING

The Standard Signalling Principle Number 19 states:-

> "The purpose of approach locking is to prevent the change of route ahead of a signal once the driver has seen a proceed aspect at the signal or has seen an aspect at a previous signal that would indicate to him that the former signal is displaying a proceed aspect. Provision must, however, be made for such locking to be released provided a reasonable assurance can be given that any movement, the driver of which has sighted a proceed aspect, will in the event of the signal being replaced to danger, either have come to a stand at the signal or will have run past the signal onto the track circuits which lock the points or level crossing".

Probably the best way to describe why we need to "approach lock" a signal and consequently lock the route ahead of the signal is to consider the sketch on Figure 1 which depicts a converging junction at an electro-mechanically operated signal box.

Examine this situation:- the signalman has set a route from signal 20 to signal 17 from the Up Branch to Up Main, Signal 20 clears to show a proceed aspect for a slow goods train. The signalman then realises he has a fast passenger train due on the Up Main line which will be seriously delayed if he allows the Goods train out in front of the passenger train.

The signalman replaces signal 20 (which will release 21 points in the mechanical interlocking) and is about to move 21 points to the normal position when he sees the slow train approaching signal 20. The driver of the slow train has been running on signals giving him the impression that signal 20 is showing a proceed aspect, but is now at red. Brakes are applied to the Goods train, sparks fly, will the Goods train stop before the signal? or will it over-run onto the Main Line past signal 20? The signalman realised just in time that he could, after replacing signal 20, have moved 21 points to the Normal position and cleared signal 16 to allow the fast passenger train to proceed along the Up Main and possibly colliding with the Goods train which could not stop at signal 20. If the "approach locking" feature had been installed on signal 20 the previously explained action by the signalman could not happen.

So how do we prevent the signalman from immediately changing the route ahead of a signal which has been cleared for an approaching train after a replacement of the signal that is locking the route?

If we consider Figure 1, the approach locking feature would be provided on signals 16, 20, 23 and 24. Each of these signals lock the route ahead when reversed, and when replaced fully Normal, release the mechanical interlocking holding the points.

The method of achieving "Approach Locking" on the signals in this electro-mechanical situation therefore preventing a change of route ahead of the signal is normally by means of a "B" Lock, on each control signal that requires the approach locking feature.

continued

Figure 2A shows a typical sketch illustrating the principle of the "B" Lock.

The lever can move from Normal to Reverse without interruption, however, when moving the signal lever from Reverse to Normal, the lever lock "dog" or "latch" engages into the "notch" in the lever slide when the lever is in the "B" position and prevents the lever from being replaced to Normal. To complete the replacement of the lever to the Normal position we have to satisfy conditions that will energise the "B" lock "dog" and, therefore, allow the signalman to replace the lever Normal. Whilst the lever is in the "B" position the route ahead is locked by the mechanical interlocking until the signal lever is fully replaced to the Normal position, also the action by the signalman of replacing the lever to the "B" position will replace the signal aspect to Red. When is it safe for the signalman to replace this lever fully? How do we energise the "B" Lock to allow the signalman to fully normalise the signal lever?

To answer these questions we must now look at some circuitry and the method of
a) applying approach locking and b) releasing approach locking.

APPLYING APPROACH LOCKING TO A SIGNAL

We shall take signal lever 20 as our example and Figure 2A & 2B shows all the circuitry involved. When the signalman reverses lever 20, 20 UCR energising will de-energise 20 ALSR, 20 ALSR down will now prevent the lever of 20 signal being fully replaced (20 (B)L) back to Normal (if the signalman were to replace the lever) until certain conditions have been satisfied (discussed in releasing approach locking).

With 20 UCR energised and 20 ALSR proved de-energised, 20 HR energises and a proceed aspect will be displayed on 20 signal.

RELEASING APPROACH LOCKING

This means the re-energisation of 20 ALSR to enable the signalman to replace 20 lever fully Normal in the lever frame ie. through the "B" check position. In the case we are considering with 20 signal, there are two ways of re-energising the ALSR after the signal has been restored to danger.

These are :-

1. The train passes through the section in the normal manner occupying EE and CD track circuits and clearing EE track circuit.

2. By the operation of the automatic time release for a pre-determined time.

continued

SSP 19 states :-

Releasing of Approach Locking

After the signal aspect has been restored to danger the approach locking is to be released either:-

i) When the train passes the signal, by the positive operation of train detecting equipment or clearing of all approach track circuits as appropriate, or

ii) by the operation of an automatic time release for which the following settings should be used:-

a. On mixed traffic lines, where signal post to post distance is :-

Not more than 900 yards	- 2 minutes
901 to 1800 yards	- 3 minutes
Over 1800 yards	- 4 minutes

b. On lines normally carrying only passenger traffic, where the signal post to post distance is:-

Not more than 1600 yards	- 2 minutes
Over 1600 yards	- 3 minutes

c. At terminal or bay platform starting signals:-

i) Usually - one minute
ii) Exceptionally where signals can be cleared with long trains standing ahead - 2 minutes.

d. At major through stations and critical junctions where justified by operating considerations:-

i) An additional release after occupation of the berth track circuit (maximum length 300 yards) - 1 minute.
ii) An alternative release after the restoration of a signal which has been displaying:-

a main aspect approach released from red	- 2 minutes
a "delayed yellow" aspect	- 1 minute
a position light aspect associated with a main aspect	- 30 seconds

continued

e. At all shunting signals - 30 seconds

Where shunting signals can be cleared automatically as part of a main route, route locking to be maintained ahead of the shunting signal until the approach locking of the main running signal is released.

f. At main signals leading from a siding - 1 minute.

NOTE In a. and b. above, where there is no separate overlap track circuit the length of the overlap must be added to the signal-to-signal distance to determine the equivalent signal spacing on which to base the length of time delay.

Where the normal equipment of the signal box does not provide a means of indicating the expiring of the time delay, a special indication is to be provided.

With the situation we have in Figures 1 and 2 the signalman is highly unlikely to be involved in frequent changes of route once he has selected the path for an approaching train and SSP19 caters for this case by stating:-

RUNNING SIGNALS - MAIN AND SUBSIDIARY

At locations where re-routing will only occur infrequently and enforced time delay can be tolerated eg. at signals protecting ground frames controlling emergency crossovers, the approach locking to become operative immediately a proceed aspect has been displayed.

Close examination of the circuitry in Figure 2B will show that the energisation of 20 UCR will de-energise the ALSR and, therefore, only the occupation and clearing of track circuits by the train after having passed the signal or an enforced time release, will re-pick 20 ALSR.

The sequence for normal passage of a train along the Up Branch with 20 signal OFF is as follows:-

1. Train occupies EE track circuit, 20 reverts to red (EE TSR down in 20 UCR circuit).

2. Train occupies CD track circuit and clears EE track circuit (EE TSR remains down).

3. In 20 ALSR circuit the conditions to energise the ALSR have been satisfied and the relay energises and sticks.

continued

4. Signalman replaces lever 20 to the "B" check position and because 20 ALSR is now up the lock will pick which enables the signalman to replace 20 lever fully normal which will release the mechanical interlocking between signal and points. (however the points will be locked until route locking TC's holding the points have cleared). The signalman also receives an illuminated indication that the approach locking on the signal is free.

5. With 20 lever fully normal and 20 ALSR energised, EE TSR energises and 20 signal is ready for operation again when the controls in 20 UCR circuit allow.

NOTE: Before a proceed aspect can be displayed on 20 signal you will notice three cases of down proving (refer to Figure 2).

i) 20 LCC's in 20 UCR circuit proving that the lock "dog" has dropped and in the event of the signalman replacing the signal he will have to satisfy the conditions of the approach locking to enable him to fully normalise 20 lever.

ii) 20 ALJR, JR and JS contacts proving that before the UCR can be energised the timing feature of the approach locking is at zero seconds at the start of the timing cycle and, therefore, if the signalman needs to "time-off" the approach locking to release the route ahead of 20 signal he will require to have the lever in the "B" check position for the predetermined time (180 seconds).

iii) 20 ALSR in 20 HR circuit to prove correct sequential operation of circuitry ie. approach locking is operative before signal can be cleared.

The sequence for the situation when the signalman replaces 20 signal in front of an approaching train is as follows:-

a. 20 ALSR will be de-energised with 20 signal showing a proceed aspect

b. Signalman replaces lever to "B" check position, de-energising UCR and 20 signal shows a red aspect.

c. With UCR down and lever in "B" position a B50 feed is directed to the ALJR timing unit and takes the following route:- A1, A5, 20 ALSR down, D1, JM down, through JS coil. JR down, through A3 and to the N50, energising the JS relay which sticks.

continued

d. JS up, operates the synchronous motor from the BX110 supply, the motor commencing operation immediately breaks the JM back contact.

e. After 180 seconds the JM front contact makes and the JR energises and sticks, which breaks the circuit to the JS and this relay eventually drops (slow release to allow JR to energise and stick).

f. With JR up and JS down a B50 feed is directed to 20 ALSR coil through the path B1, JR up, B2, C4, JS down, C3, 20 ALSR front contact arm along to R1 of the ALSR coil, which operates and sticks up.

g. With 20 ALSR up and lever still in the "B" position an indicator illuminates over 20 lever to indicate to the signalman that the correct time period has elapsed and the lever can now be fully normalised and consequently, free the mechanical interlocking between signals and points.

However, in busier and more complex areas where the signalman requires the facility to re-route frequently (without the penalty of an enforced time release) to regulate train movements efficiently, another release path needs to be added to the ALSR circuitry and the creation of this feature to the circuit transforms it into a "Comprehensive" Approach Locking circuit.

S.S.P 19 describes where comprehensive approach locking is to be applied and under what circumstances:-

Running Signals - Main & Subsidiary

To become approach locked once a proceed aspect has been displayed and an approaching train has reached the sighting point of the outermost signal in the rear which would change from a green to a cautionary aspect in the event of the approach locked signal being replaced to danger in the following circumstances:-

i) Where re-routing is likely to occur frequently enough for enforced time delays to be detrimental to the working.

ii) Where the signal can be set to operate automatically.

iii) Where approach locking is provided in connection with a signal protecting a level crossing.

continued

At locations where the sole function of the signal is to protect the crossing and continuous track circuitry does not exist from the point at which a driver could first become aware that it is displaying a proceed aspect, the approach locking to become effective immediately a proceed aspect has been displayed

Figure 3 displays the comprehensive approach locking track circuits for 3 and 4 aspect automatic sequences running up to a control signal. You can see for the 3 aspect sequence with the train approaching 10 signal if the signalman replaces 10 signal whilst the train is in position "A" the driver will receive a correct aspect sequence to bring him down to 10 at red ie. 108G, 106G, 104Y and 10R, therefore, it would be safe to release the approach locking on 10 signal immediately because the driver has had no indication from the aspect sequence that 10 has ever been showing a proceed aspect. If the train is in position "B" when the signalman replaces 10 signal, again the driver will see 106G, 104Y and 10R and it would be safe to release the approach locking on 10 signal. However, if the driver was in position "C" when signal 10 was replaced to red he could see signal 104 revert to yellow from green and under this condition the enforced time release must be satisfied, the same applies if the train is in any portion of the comprehensive approach locking track circuit area when the signalman replaces signal 10 in front of an approaching train. If the driver has seen and passed 104 signal at green and then 10 is replaced to danger he may not be able to stop at 10 and may over-run into the direct/route locking area of signal 10 and the route will be held by the occupation direct/route locking track circuits.

To re-cap in the three aspect sequence if AC and AD are clear and the train is approaching 10 signal (which is showing a proceed aspect), the signal may be replaced and an immediate release of the approach locking is allowed to enable a change of route to take place ahead of signal 10.

The route from 10 diverging to 122 signal (FIG 03) has the comprehensive approach locking feature inherent as the control relay for 10 will not energise until the track circuit AD is occupied (ie. the ALSR will not de-energise until AD is occupied), therefore, the signalman can release the route immediately at any time before the train has reached TC "AD". The driver will not have been given an aspect sequence to inform him that 10 signal is at any other aspect than red and he will be reducing his speed to stop at 10 signal. If, of course, the signalman
replaces 10 to red whilst the train is occupying "AD" track circuit then the normal "timing out" feature will apply.

The four aspect sequence illustrated in Figure 3 shows the "comprehensive" track circuits that require to be clear before the signalman can immediately release the approach locking on 10 signal.

continued

If we now re-examine Figures 1 and 2 and look at the circuit alteration required if comprehensive" approach locking was to be provided on this layout (we will consider 20 signal). The "comprehensive" track circuits in rear of 20 are "ED" and "EC" and these TC's clear must be included in 20 ALSR circuit as shown in Figure 4, at an installation like the one shown in Figure 1 all the running signals would also have the "comprehensive" facility applied to them.

Another example of approach locking is taken from the electro-mechanical installation at Warrington Central where the approach locking is applied directly onto the points required to be held, rather than holding the signal lever in the "B" position and preventing the points from being moved by the mechanical interlocking. This form of applying approach locking can be more economical in practice, rather than providing an electric lock (with slide cut in the "B" position) for every signal reading through the points, an energised contact of the ALSR is placed directly in the points N and R lock pick path as required. If power operated point operation is in use there will be an NBDR lock available on the point lever as standard arrangement. It should be noted that if no train is following (occupying a comprehensive track circuit), 20 ALSR could pick up before 'EE' has cleared and the release would be affected when the last wheel had cleared 'ED', to ensure that the ALSR picks only with 'EE' occupied and cleared, 'CD' occupied when passing the signal a contact of EE TSR energised is placed in the Comprehensive release path as shown (EE TSR cannot be energised until the signal lever is in the normal position and the ALSR has picked).

Referring to Figure 5 the signal we are concentrating on is 3/10 and how the approach locking is provided on the points these signals read through.

Consider the signalman has a train to send along the down main from Signal 3, the points that require approach locking once the control relay has been energised are 11 and 26 in the Normal position. We will now examine the sequence of events ensuring the approach locking feature is applied to the points.

1. Signalman reverses lever 3 which locks levers 11 and 26 Normal (mechanical interlocking).

2. As before refer to Figure 6, 3 lever reversed de-energises the JR in the ALJR circuit and energises 3/10 ALJPZR.

3. With 3 lever reverse and all track circuits and points in their correct state and JR and JS proved down (confirming that if the timer is required to operate it will commence at zero seconds and not some way into the timing cycle) the relay 3 HR energises.

4. 3 HR up, de-energises 3/10 ALSR.

5. 3/10 ALSR down energises 3/10 ALSPZR (proving ALSR has dropped and approach locking has been applied where required).

continued

6. 3/10 ALSR down in 11 and 26 Normal Lock pick path, therefore, approach locking now effective.

7. 3 HR up, 3/10 ALSR down (in the form of 3/10 ALSPZR), 3 UHR energises and 3 signal shows a proceed aspect when controls allow (because there is insufficient braking distance between 3 and 4 signals, 3 cannot show an unrestricted yellow aspect if 4 is at red. With 4 at red 3 signal will be approach released to bring the train "under control" but if 4 is showing a proceed aspect 3 can clear unconditionally).

There are two ways we can re-energise 3/10 ALSR and release the approach locking in our circuitry for the route to down main.

1. By correct sequential operation of track circuits ie.
   T4 and T12 occupied and T4 cleared as the train passes the signal normally.

2. By proving 120 seconds of time has elapsed after
   signal 3 is replaced to danger, meaning there is sufficient time for the train to either:-

   a) come to a stand on the approach side of signal 3
   or b) over-run signal 3 into the "dead locking" track circuit area ensuring the points cannot be moved.

Releasing of the approach locking in the normal way takes the following sequence:-

1. Train passes signal 3 and occupies T4 replacing signal to red.

2. T4 and T12 both occupied, T4 then clears, with this
   condition 3/10 ALSR can energise and then stick.

3. Signalman replaces 3 lever in the frame and T4 TSR energises.

4. 3/10 ALSR up in the points lever lock circuits allow the points to be free to be moved as long as other conditions in the circuit allow (Figure 7).

Releasing approach locking using the timing path with the train on the approach side of the signal (Figure 6).

1. Signalman decides to replace 3 signal to re-route approaching train.

2. 3 lever Normal, HR's down, ALSR down, JS picks over JM back contact then sticks.

3. JS up operates the JM.

4. JM makes timing contact, JR energises and sticks.

continued

5. JR up disconnects JS.

6. JR up and JS down creates pick path to 3/10 ALSR which will energise.

NB JS slow to release to ensure JS stick contact holds up long enough to allow JR to energise and stick (JR up breaks feed to JS). Contact between A5 and D1 of 3/10 ALSR economises timing circuit when approach locking not effective.

The explanation of approach locking in the previous notes has dealt with the electro-mechanical type installation where levers are used. Later in this manual you will be introduced to the Standard Free Wired Interlocking and how the approach locking is applied on an NX panel.

The principle is the same in the SFWI with the ALSR initiating the route releasing to free the points in a route when it is safe to do so.

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PRINCIPLES AND APPLICATION OF APPROACH LOCKING

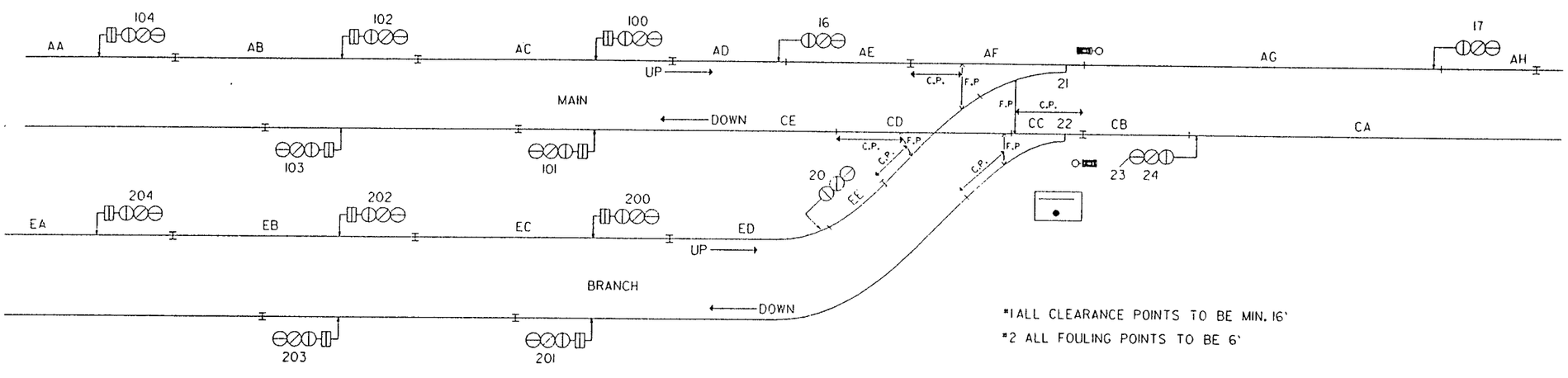

FIGURE 1

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PRINCIPLES AND APPLICATION OF APPROACH LOCKING

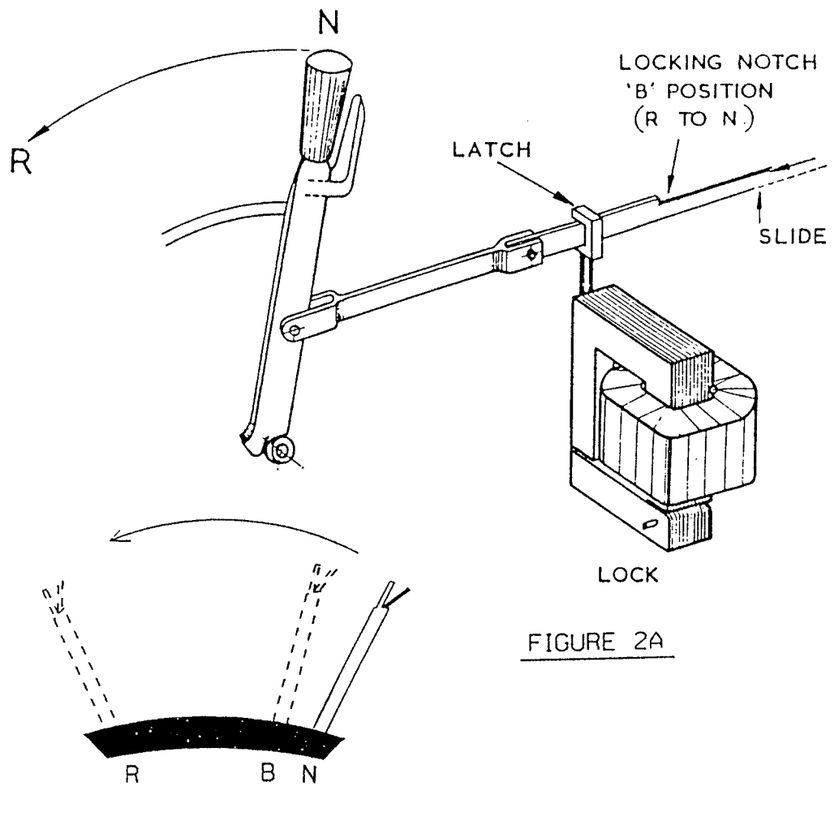

FIGURE 2A

ASSUMPTION :- 21 RELEASED BY 22 IN MECHANICAL INTERLOCKING

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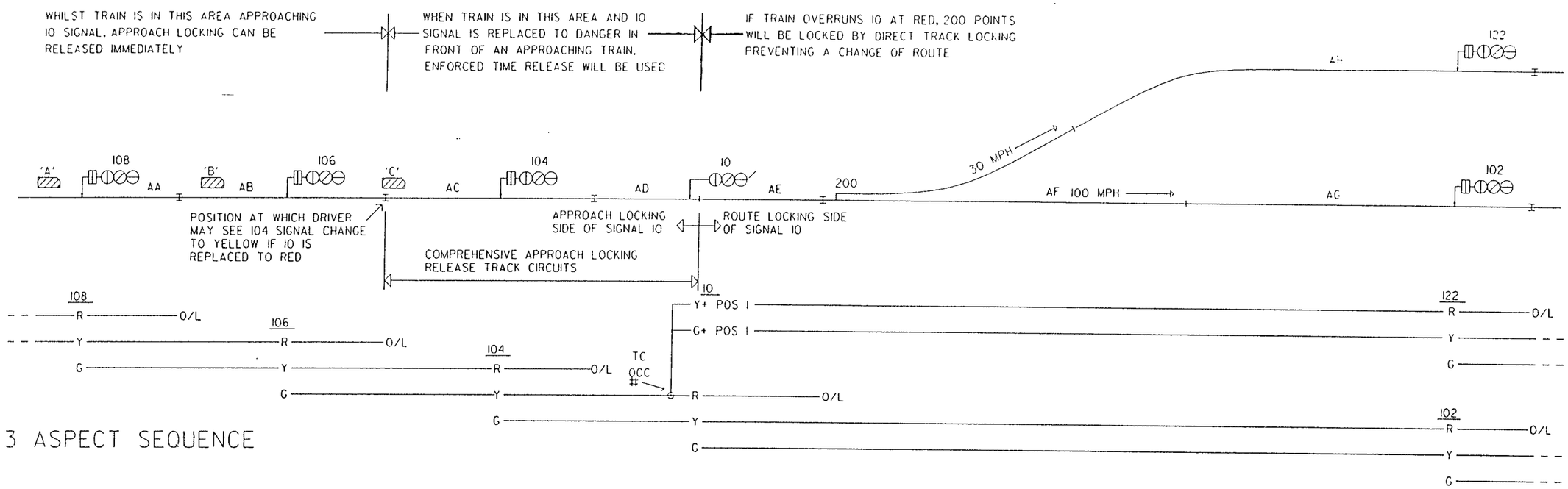
FIGURE 2B

PRINCIPLES AND APPLICATION OF APPROACH LOCKING



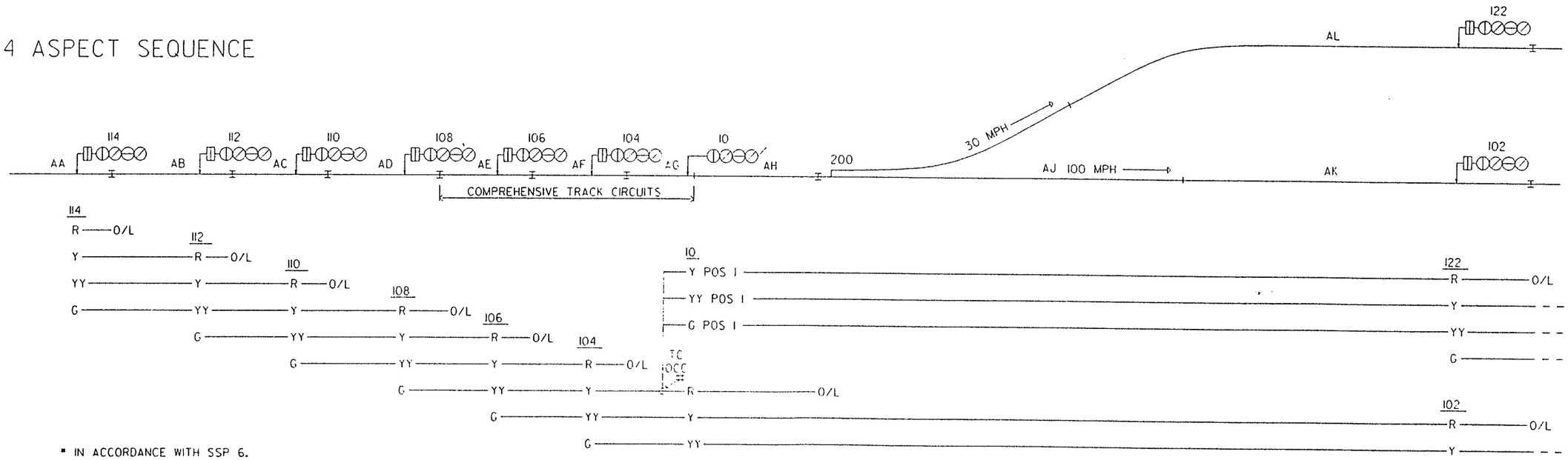


FIGURE 3

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PRINCIPLES AND APPLICATION OF APPROACH LOCKING

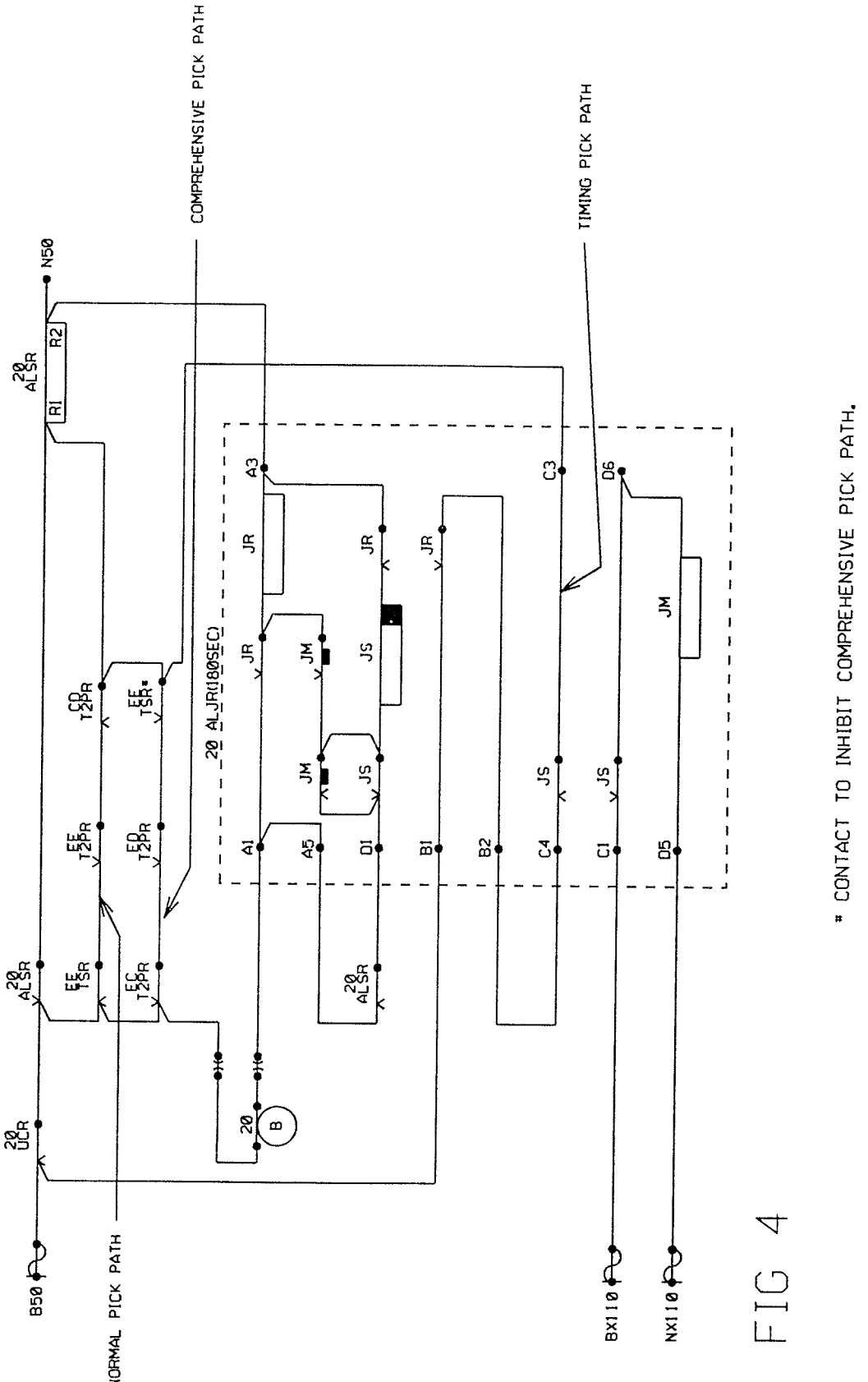

FIG 4

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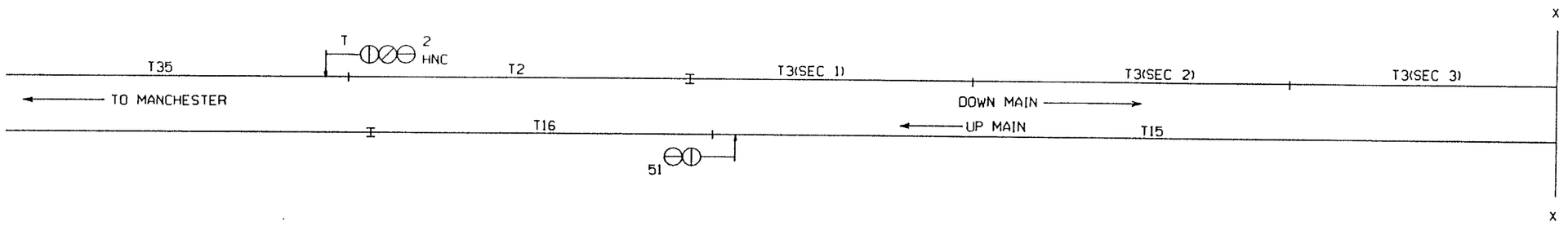
WARRINGTON CENTRAL (W.C.)



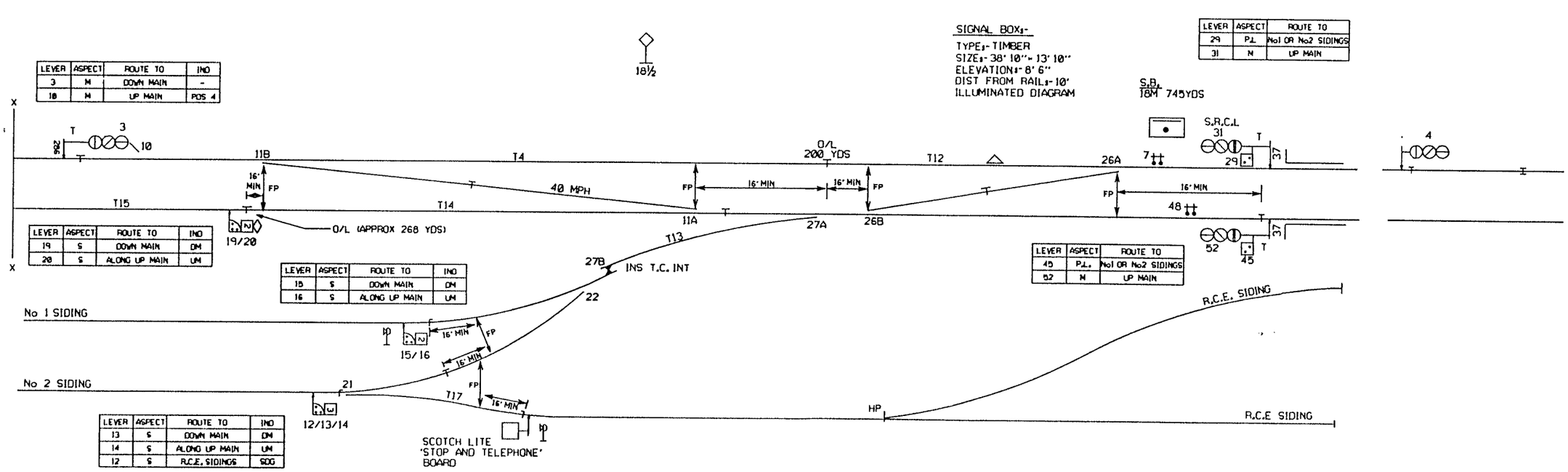


FIGURE 5

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PRINCIPLES AND APPLICATION OF APPROACH LOCKING

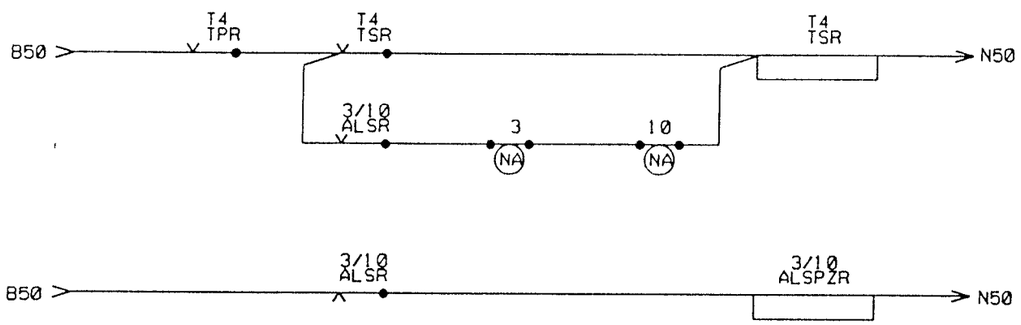
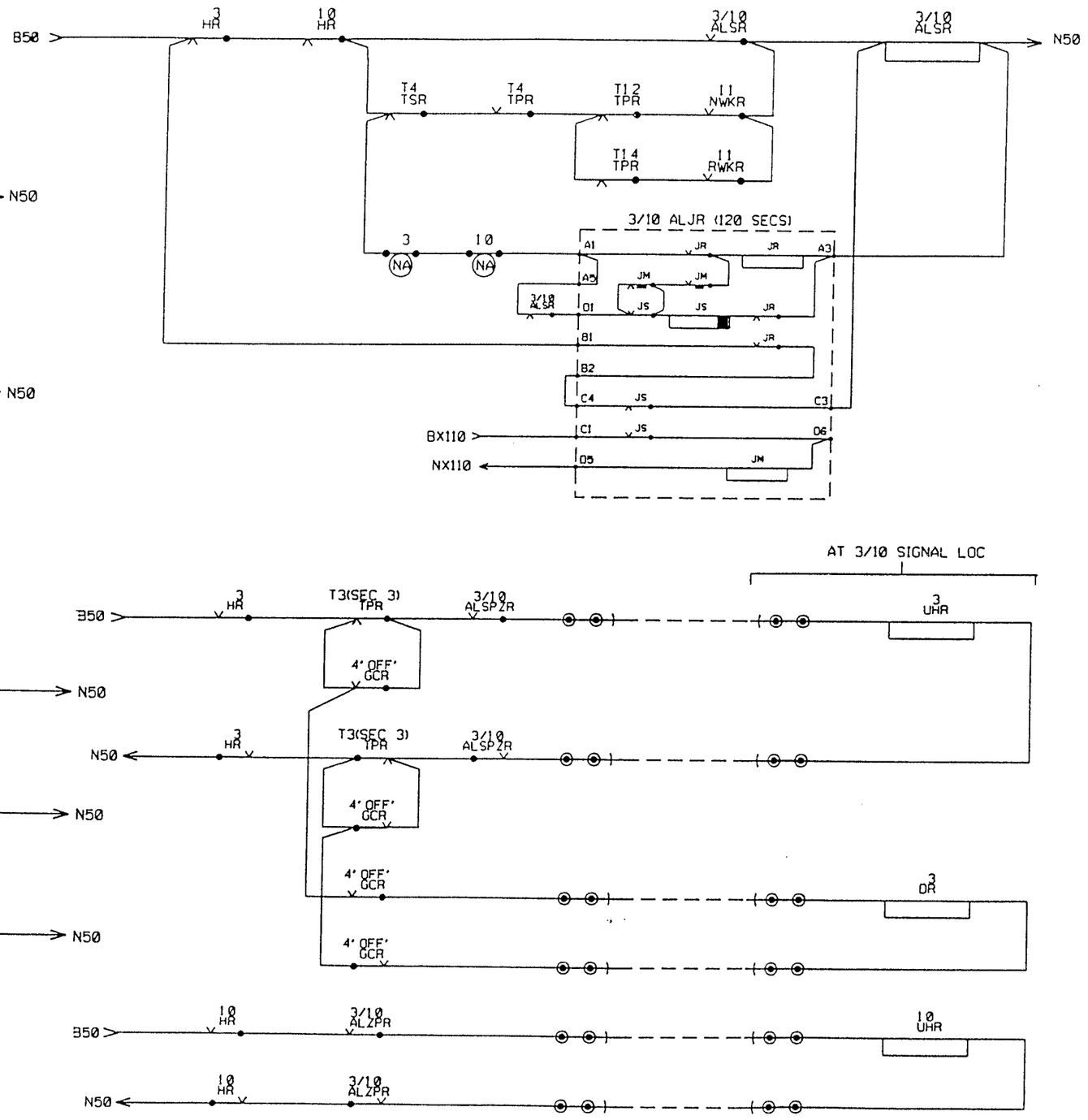


FIGURE 6



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