All-Relay Interlocking Plant for Danish State Railways

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Preliminary tests of all-relay interlocking plants were undertaken by the Danish State Railways in 1948. These tests were successful from the start. A rapid development in relay interlocking plants took place in the next few years, and the Danish State Railways now build no other types. The largest interlocking plant hitherto built in Denmark — and, in fact, in Scandinavia — is that at Odense, which was brought into service in May 1954. It is specially designed for operation in a CTC system to extend from Fredericia to Nyborg, that is to say right across the island of Fyn.

In 1948 the Danish State Railways made the important decision to install all-relay interlocking plants, by way of experiment at certain minor stations. There were no means of predicting at that time whether the experiment would be a success or failure. The only possible course was to construct these plants on the basis of experience from the already existing types of electrical interlocking plants and, to start with, the relays and other material designed for those plants had to be used in the new types.

It is now agreed that the experiments succeeded beyond all expectation, and the all-relay interlocking plants being built to-day by the Danish State Railways are even better fitted to operate efficiently, since the materials now employed — relays, contacts etc. — are designed specifically for such plants.

The object of the experimental plants was to provide experience in regard to the reliability of the relay contacts and to the circuit arrangements, while traffic functions were assigned a second place.

As said, the test plants showed remarkably good results. By 1951 the General Directorate fully realized that the all-relay interlocking plants possessed all the advantages that could be hoped for and that they revealed hardly any weakness compared with the previously used types.

In co-operation with Dansk Signal Industri A/S, therefore, the State Railways started to construct new types of all units in use at that time which were not particularly suited for relay interlocking plants, i.e. such parts as relays, press buttons, indication lamps and cable fittings. The main consideration in this work was to produce apparatus that would improve traffic control with the aim of speeding up and increasing the safety of train and shunting movements and of effecting a saving in staff.

The new equipment was completed by the beginning of 1953, and in June of that year was put into service for the first time in a somewhat larger relay interlocking plant at Glostrup Station. The new relays had, however, already been used in a few other plants. The decision was made at the same time that the very much larger plant at Odense should operate on the same lines as at Glostrup, but that improvements were required in respect to certain units.

Fig. 1 X 4988

The interlocking plant at Odense

The building has sloping windows to avoid the trouble caused by reflection of light. A special type of glass is employed with two panes hermetically sealed together at the sides; the space between the panes is filled with absolutely dry air. One pane is coloured pale green to reduce heat transmission.

Odense Relay Interlocking Plant

The new interlocking plant at Odense, put into service in May 1954, has only one interlocking machine which is contained in the building shown in fig. 1. Thus all train and shunting movements are controlled from this building. The plant comprises:

25 dwarf signals and exit signals on platforms
17 speed, numerical and alphabetical signals
71 train routes
5 shunting routes
76 centrally controlled points
76 track circuits
35 local switches for centrally controlled points

As is seen from the lay-out in fig. 2, the number of dwarf and exit signals is quite large, their primary purpose being to prevent shunting on to train routes. Only signals G2, G3 and E govern shunting routes proper. When the remaining signals are used for shunting work, they show the aspects "stop" and "shunting movements permitted".

Operation of Control Panel

The main features of the control panel shown in fig. 3 are that all switches for points, routes and signals are placed on the track diagram and that they are correctly placed "geographically" in relation to the tracks. The control panel with track diagram is 2 ½ metres in length and is inclined at an angle of about 20° to horizontal. The white lamps on the track diagram serve to indicate both the state of the centrally controlled points and that a track circuit on a locked route is unoccupied. Red lamps indicate that a track circuit is occupied. Finally, the state of signals is indicated by lamps of the same colours as the signal lamps. The various switches are placed as close as possible to the corresponding lamps in the track diagram, so that the signalman can, in fact, not fail to observe the lamps which indicate the correctness or advisability of performing an operation immediately prior to its being carried into effect. All switching operations are done by means of non-locking push buttons which only need to be depressed momentarily — less than one second.

Point Operation

Points are operated by depressing two buttons, one of which is placed beside its particular point on the track diagram, the other being common to a group of points. The object of this two-button method of operation is to eliminate unintentional switching of points. The time at which points should be operated is indicated both acoustically by a bell and visually by the flickering of the lamp corresponding to the new position of the point. The completion of the operation is indicated by the bell ringing a second time and by the lamp

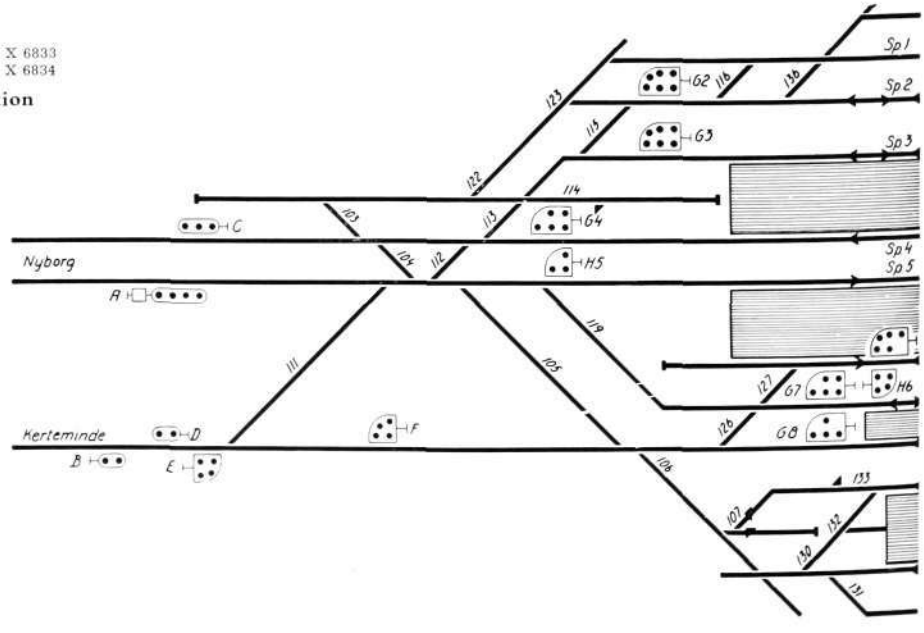


Fig. 2 X 6833 X 6834
Schematic lay-out of Odense Station

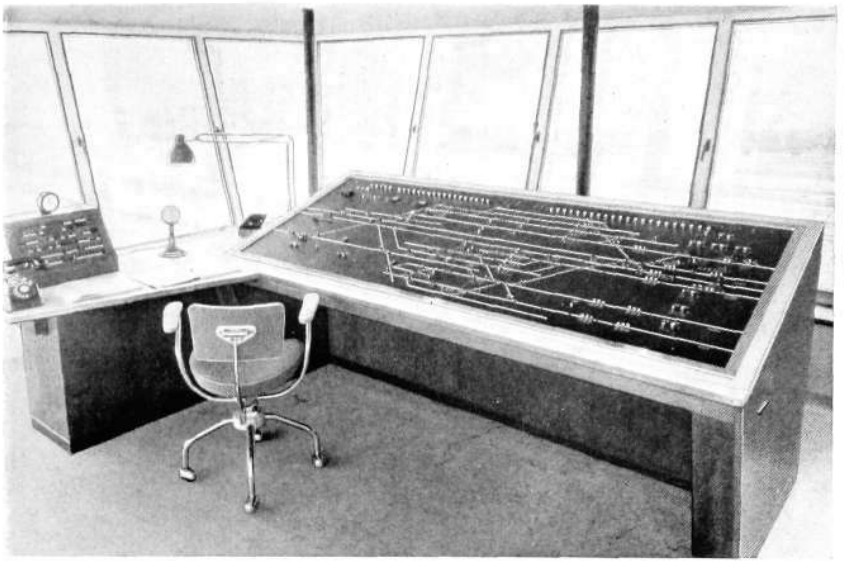


Fig. 3 X 6831

Control panel

On the left is seen the telephone switchboard and loudspeaker microphone

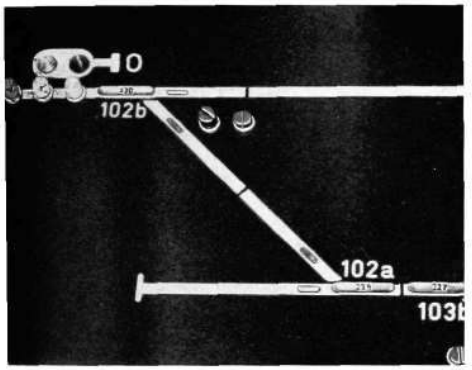


Fig. 4 X 4987

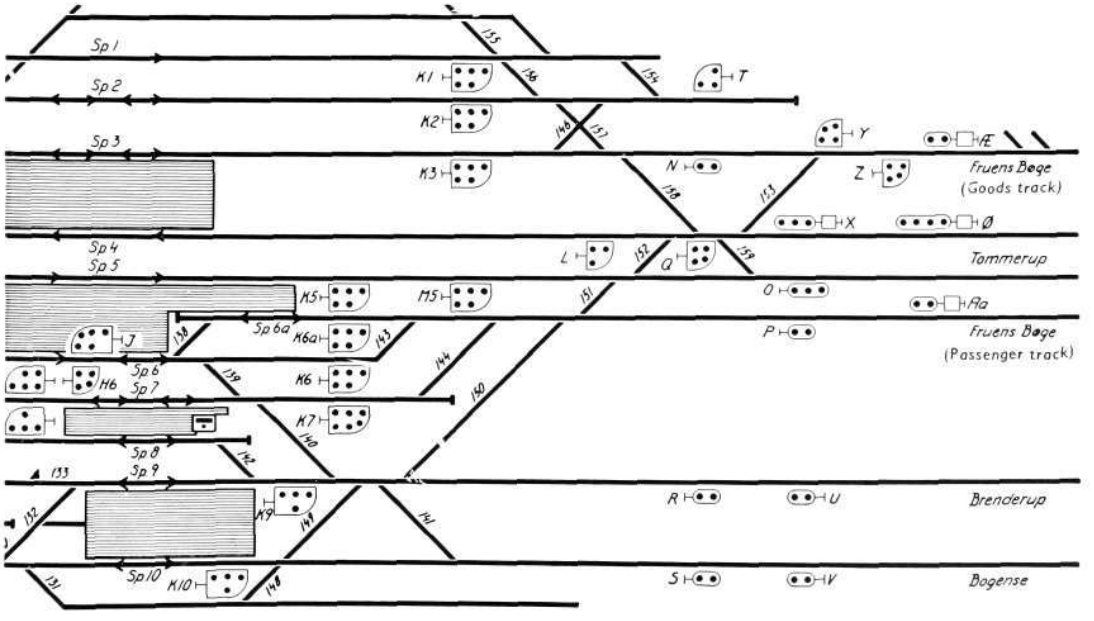
Section of control panel

for the new position of the point remaining continuously alight. The button is used for switching points in both directions. Every point, moreover, is represented by a lamp which is normally extinguished, but can show a red or white light. If the track circuit at the point is occupied, the red lamp lights to warn the signalman not to operate the point. The white lamp lights when the point is in a locked route, the lamp then also serving to indicate that the track circuit at the point is occupied.

To provide for shunting movements and to facilitate the removal of snow from the points, some points have local switching arrangements. The changeover to local operation is done by turning a button (black with white stripe), which is placed beside the ordinary point push-button on the track diagram. Before local operation can take place, any dwarf signals in the group of points must be set to "shunting movements permitted".

Since it may happen, that a point does not fully switch over, especially when operated locally, and that the operator fails to notice the fact, every point is supplied with a time relay which automatically breaks the motor current if the operation is not completed within a time of 15—20 secs.

If the relay of a point's track circuit remains deenergized, the point can nevertheless be operated by depressing a special sealed button (blue with white



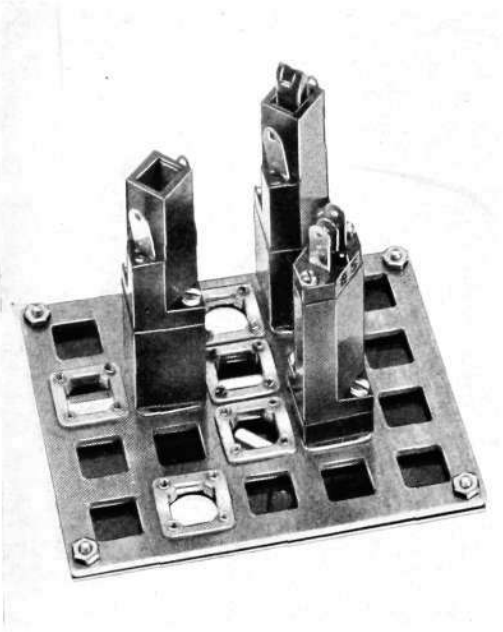


Fig. 5 X 4986

Press-buttons and indication lamps

are mounted in identical fittings on a perforated aluminium plate forming the base of the control panel.

stripe) placed beside the point on the track diagram. The operation of the points is now effected by depressing the individual point push-button in the ordinary way, but this time in association with another button common to a group of points. In this way the staff are reminded that special precautions must be taken every time point-operation of this kind takes place, and a counter records the number of times that such point-operation occurs.

Train Routes

After the points concerned have been laid in the correct position for the route of the train, a signal button (yellow) is depressed on the line track in approach of the respective signal, and also a route button (green) on the platform track. By this means the relay system locks the points on that particular route. The condition is indicated on the track diagram by the lighting of the white lamps of the track circuits. The relay equipment thereupon investigates whether the route is unoccupied. If it is, the "proceed" signal appears.

When the train has entered the station, the route is released in the normal manner after the signalman has indicated that he has observed the train's rear end signal by momentarily depressing a red stop button beside the signal on the track diagram. This operation is not performed for outgoing trains, nor for incoming trains from lines that are equipped with automatic blocks.

Shunting Route

It is intended that shunting routes shall be arranged in order to facilitate the constant shunting movements that occur at some stations and to carry them out with the greatest amount of safety. At Odense, however, there is little need of such arrangements. A shunting route is locked by the simultaneous operation of a yellow signal button beside the appropriate dwarf or exit signal and of a route button at the end point of the route. When the cut passes a track circuit immediately after the signal, the signal automatically switches to "stop". The points in the route are automatically and successively unlocked as the train passes. Unlocking can also be effected by hand by simultaneous pressing of buttons at the beginning and end of the route.

At stations where more extensive shunting takes place than at Odense it is intended that longer marshalling tracks shall be established by joining together a number of shorter tracks.

Automatic Blocks

Until the automatic block installations are brought into service on the Odense—Marslev and Odense—Holmstrup sections, manual blocks are being used on those sections. These manual blocks are specially designed to the replacement of the ordinary block apparatus at Odense by combinations of relays, and the block controls and indication lamps have been placed on the track diagram. This gives signalmen a much better control of train movements than they had previously. At the other stations on the section the normal blocks have been preserved unmodified.

Design of Interlocking Equipment

The track diagram is mounted on a perforated plate on which push-buttons and lamps are secured in fittings as shown in fig. 5. The plate is covered by a multilayer insulating material in which the track system is engraved, with tracks and lamp symbols in white on a black background. The control panel is divided into sections. A bunch of max. 200 wires are connected to each section. There is no direct connection between sections. At the rear are cable boxes and terminal boards. Each of the bunches of wires is taken to a terminal board and to one or two cable boxes. The terminal boards are connected both to one another and to the cable boxes of the other sections.

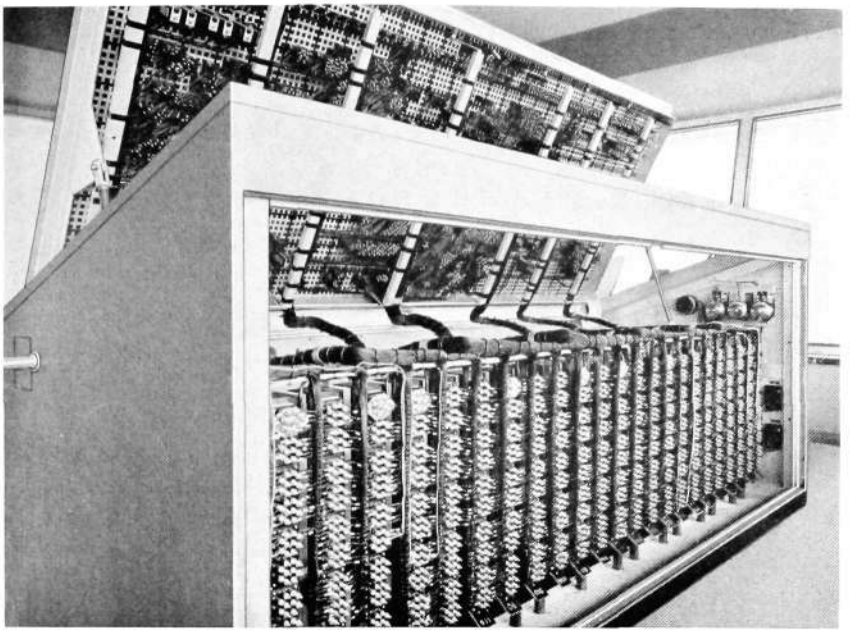


Fig. 6 X 6830

Rear view of control panel

The entire control panel can be wound up into the vertical position by means of a crank acting upon a horizontal shaft

The push-buttons have only one transfer contact, and the contact system is entirely enclosed. The buttons may be of the locking or non-locking type, and different colours and engravings can be arranged.

The control panel rotates about a horizontal shaft running along its front edge. Gearing arrangements are employed for erecting it into the vertical position, fig. 6.

The Relay Racks

The relays are mounted in six racks in a separate room, fig. 7. All relays with the exception of the track circuit relays and certain feed relays are placed in groups, the relays that operate and control the points forming one group and those that operate and control signals another group, and so on.

Every group is built up in six rows, one above the other. The top row, No 0, contains fuses, negative terminals and resistances. Each of the other groups, Nos. 1—15, has two positions in which a relay, resistances or negative terminals can be accommodated. The cable boxes are placed underneath the racks. The Odense interlocking plant comprises some 1 000 relays with about 7 500 contacts, of which roughly 60 % are used. The internal wiring between the various units of the plant is, in round figures, 50 000 metres in length.

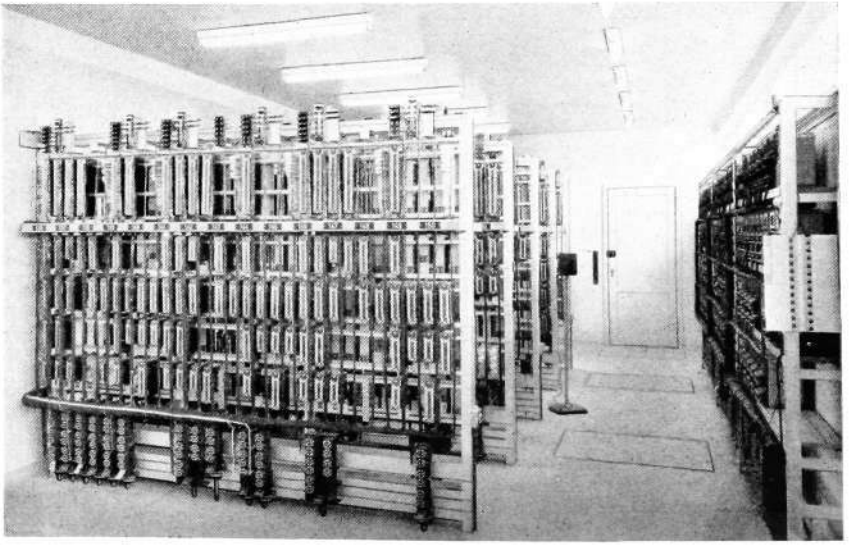


Fig. 7 X 6832

The relay room

(Right.) Track relays, (left) two racks with point relays and three with signal relays.