Interlocking Plant at Fredericia Railway Station

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In order to do away with the train-ferry between Strib and Fredericia established in 1872, a bridge for traffic has been erected over the Little Belt between Jutland and Fyen. One result of this has been that a fairly long stretch of railway line has had to be constructed necessitating a complete new railway station at Fredericia. The new Fredericia station has been provided with an interlocking plant furnished by L. M. Ericssons Signalaktiebolag. The new plant is of much the same type as the interlocking plant recently delivered by Signalbolaget for Aarhus, which is described in Ericsson Review No 2, 1935, but it is, as will be seen, rather more comprehensive. The plant has been very quickly delivered, seeing that woork only began on the site about 1st October, 1935, and it was ready for service in all respects on 15th May, 1935.

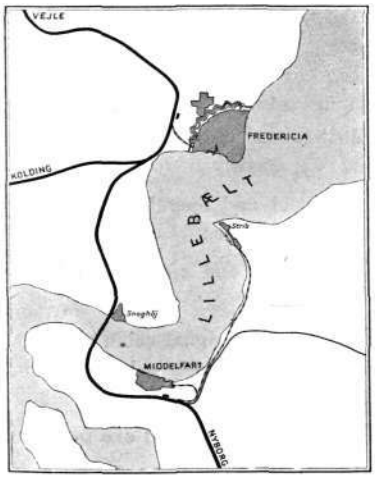

Fig. 1 X 3469
Map showing railway lines meeting at Fredericia

Fredericia is the largest railway junction in Jutland, as the main line through Fyen here joins up with the Jutland lines. Three double tracks meet at the station, namely: that from Nyborg (Copenhagen and Zealand), Vejle (Aarhus) and Kolding (Esbjerg, and Padborg, Germany), see Fig. 1.

Planning

The station covers an area of 70 ha, and the distance between the most northerly and most southerly points, both of which are locked, is about 5.6 km. In consequence of this and other things the interlocking plant is of considerable extent. As will be seen from the signal diagram, Fig. 2, the goods and shunting station is in the northern part and the passenger station at the south. Between them lie the two turn-tables for locomotives. Before the reconstruction there were at the passenger station 10 tracks, 8 of which served platforms while the remaining two, *viz:* track V and track VIII in addition to shunting were used for goods trains running to and from the East, South and West.

Fredericia being a junction for converging lines, incoming trains are for the most part made upp of groups and before the individual groups proceed considerable shunting of the groups from the incoming train must be shunted in the shortest possible time before it goes on. The trains from the East include through coaches for the North, the South and the West, while trains from the North have such coaches for East, South and West, and trains from South and West include through coaches for East and North, seeing that the double track line to Kolding for a large number of incoming trains works as two lines, namely one to the South (Germany) and one to the West (Esbjerg). In addition there is a considerable sorting of post, and quick and express goods traffic.

As this exceedingly intensive shunting is thus fairly well determined beforehand and for a great part also includes passenger coaches, it was decided when planning the interlocking plant that one with dwarf-signals—as that recently installed at Aarhus—would in the circumstances be required to provide safe and rapid handling of the traffic. The plant is therefore supplied with dwarf

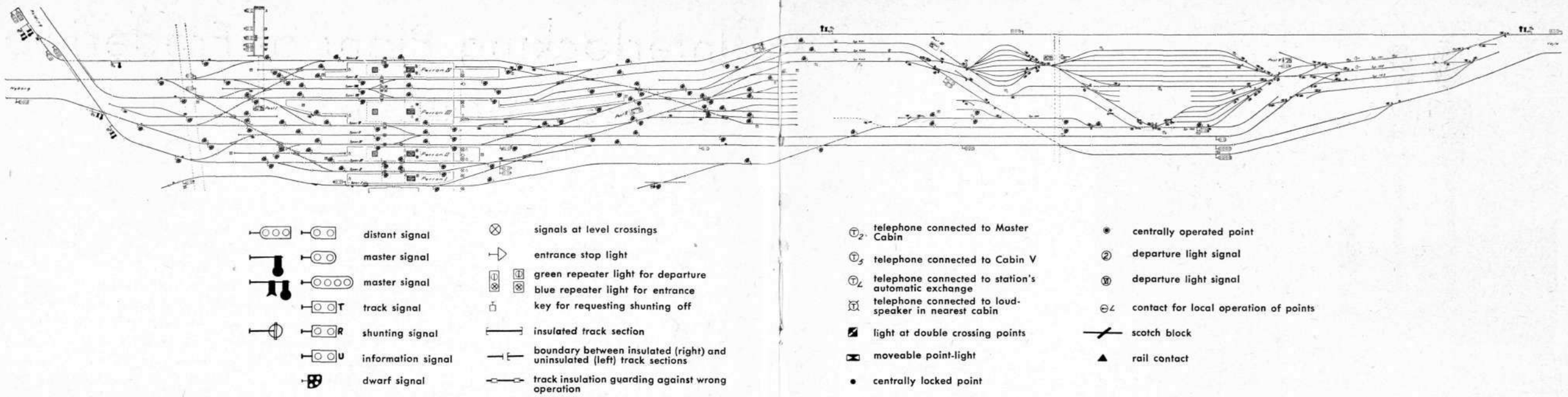

Fig. 2 X 9023
Track signalling plan of Fredericia tation

signals for the passenger station. This also allows the running on blocked lines of locomotives and motor coaches to and from the sheds and sidings, and coaches to an from the coach depot, while in addition goods trains from East, South and West can be directed to the incoming grid by dwarf signal. In the same way the harbour shunting traffic can be directed to the goods station by means of dwarf signals. On the other hand the goods station is provided with general interlocking plant without dwarf signals.

There are at the passenger station 2 signal-cabins (I and II) and at the goods station 3 signal-cabins (III, IV and V), namely:

Cabin I, at the south of the platforms, a signal and operating cabin; the main tracks are subject to release by the master cabin;

Cabin II, at the north of the platforms, a signal and operating cabin as well as control cabin;

Cabin III, at the southern end of the station tracks, a signal cabin and block cabin; the main tracks are subject to release from the master cabin;

Cabin IV, between the station tracks and the shunting tracks, a shunting cabin only from which a number of points in the station yard are operated;

Cabin V, right to the north, between the shunting tracks and the goods entrance tracks, a signal and operating cabin; the main tracks are subject to release from the control cabin.

There are following main tracks:
from Kolding to tracks II, III, V and X and »run through» on track III,
from Nyborg to tracks III, IV, V and VI and »run through» on track IV,
to Kolding from tracks VI, VII and VIII,
to Nyborg from tracks VIII, IX and X,
to Vejle from tracks II, III and IV,
from Vejle to tracks VII, VIII, IX and X and »run through» on track VII to Kolding and on track IX to Nyborg,

while for goods trains there are:
to Kolding from tracks 401 and 402 through track VIII,
to Nyborg from tracks 401 and 402 through track VIII,
to Vejle from tracks 402 and 403,
from Vejle to tracks 101 and 102,
from the passenger station to tracks 102 and 103 (goods trains from East, South and West on track V).

Fig. 3 X 3416
Dwarf signal

Moreover shunting sections have been provided to and from the harbour. Line blocking in the direction of Nyborg has been introduced and same is also to be arranged for the Kolding and Vejle directions.

Signals and points etc. are indicated by three and in some cases four digit numbers, the first digit of which indicates the cabin from which the operation is carried out, while the others indicate the field in which the operating lever is located in the corresponding interlocking apparatus. If a lever can be pulled either to right or left, the number is followed by an *v* or an *l*. For example *271v* indicates that the signal or point in question is operated from Cabin II by pulling to the left the lever in field 71.

Arrangement of Signals

As in the case of Aarhus, the main entrance signals are semaphores, while the remaining signals consist of two types of daylight signals, namely *distant daylight signals* and *position daylight signals* (mostly *dwarf signals).* The distant signals show red, green, yellow or blue light, while the position signals show indications corresponding to the positions of several white lights, Fig. 3.

All the distant signals consists of daylight signals of a type new to Denmark and are set up 800 m in front of the main signal. »Caution» (main signal indicating »stop») is indicated by a yellow flashing light, »clear» is shown by a green flashing light and »run through» by two green flashing lights.

In respect signalling the goods station is chiefly treated as a separate station, as here both incoming and outgoing passenger trains are given »run through». The goods station is provided with the following pole signals, operated from Cabin V:

for *goods and passenger trains from Vejle:* an entrance semaphore with run-through arm and distant daylight signal for through running to the passenger station and entrance to tracks 101 och 102; the signal is provided with direction indicator, see further;

for *goods trains to Vejle:* a daylight signal with run-through indication and further in outside Cabin III two daylight signals for outgoing from tracks 402 and 403; the last-named signals being operated from Cabin III;

Fig. 4 X 3470
Departure signals
with letter frames

for *passenger trains to Vejle:* a daylight signal with run-through indication and distant daylight signal;

for *goods train to goods entrance tracks 102 and 103* (from East, South and West through track V): a daylight signal; for *harbour tracks, etc. to goods entrance tracks:* one shunting signal.

In addition the goods station has two daylight signals, operated from Cabin II, for outgoing goods trains from departure tracks 401 and 402 to both Nyborg (East) and Kolding (South and West). These signals are provided which letter frames which show an *N* for trains to Nyborg and a *K* for trains to Kolding, see Fig. 4.

The passenger station has the following pole signals:
operated from Cabin II:

for *trains from Vejle:* an entrance semaphore with run-through arm. A direction indicator and a distant daylight signal (the direction indicator is a light frame which when the track is set for the direct line shows a vertical illuminated bar and when the track is set for a diverging line shows an oblique illuminated bar, see Fig. 5);

for *trains to Vejle:* three daylight track signals for outgoing from tracks II, III and IV and further out a daylight departure signal;

for *lines leading to and from the harbour to track I:* two pole shunting signals;

operated from Cabin I:

for *incoming from Kolding:* two entrance semaphores before the furthest points, each provided with run-through arm and advanced daylight signal;

for *trains from Kolding* to tracks II, III and V: an entrance semaphore with run-through arm and a distant daylight signal;

for *trains from Kolding* to track X: an entrance semaphore with distant daylight signal;

for *trains from Nyborg* to tracks III, IV, V and VI: an entrance semaphore with run-through arm and distant daylight signal.

On a signal bridge at Cabin I, see Fig. 6, there are set up five daylight track signals, namely:

for *trains to Kolding* from tracks VI, VIII and VIII;

for *trains to Nyborg* from tracks VIII, IX and X;

for *trains to Nyborg and Kolding* two further daylight signals for outgoing to Nyborg or Kolding as the case may be.

Traffic on the level crossing at the north end of the platforms is safeguarded by 8 light signals in all, located at each side of the various points. These signals are normally unlit and allow free passage to the crossing of the track covered by the signal in question. A signal when lit shows a vertical short white streak and is warning that there is danger in passing over the track in question. The lamps are suitably connected to the main signals, dwarf signals and insulated sections and they are for the most part lit and extinguished automatically when the track insulation is passed, by time relays of the requisite size. For through trains there are in addition at the level crossing two loud bells which are set ringing by the trains, Fig. 7. The settings of the incoming and starting signals for trains are repeated by blue and green lights respectively in the platform hall above the corresponding tracks. There are besides on the platforms press-buttons for the nearest dwarf-signals for the platform tracks by which Cabin II or Cabin I as the case may be can be advised that shunting off is wanted. When a button is pressed a light shines on the track diagram of the cabin operating the dwarf signal. The button operates a lamp which shows a white arrow at the dwarf signal to be moved.

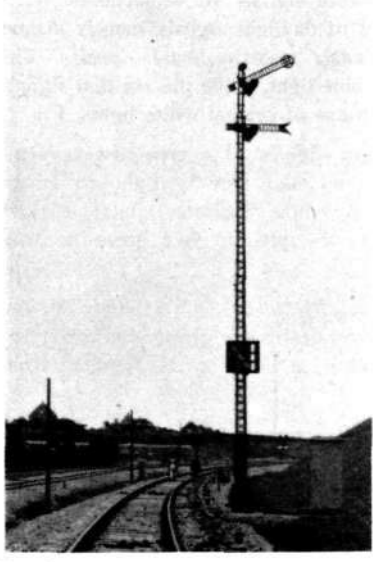

Fig. 5 X 3471
Entrance signal
with direction indicator

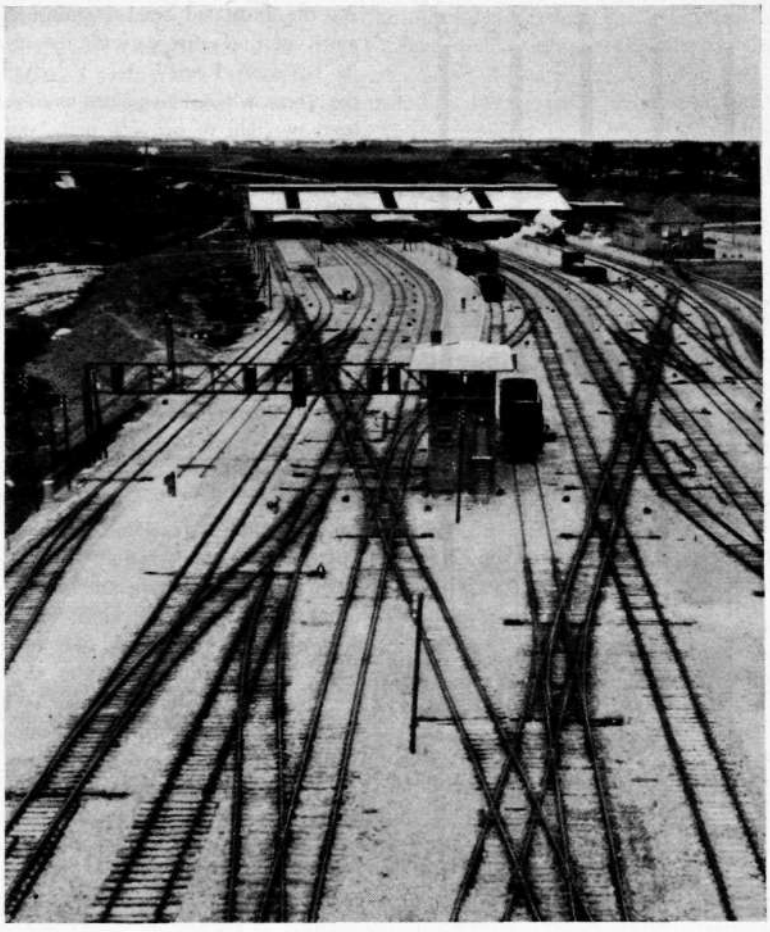

Fig. 6
Southern station area
with Cabin I and signal bridge

X 5220

Insulated Tracks, Dwarf Signals, Shunting Tracks

In regard to Cabin I (but not around point 102) and Cabin II and also, as far as track 100 and 200 is concerned, for Cabin V the installation is — as previously stated — in addition to the main tracks provided with shunting tracks, and the signal system includes dwarf signals which are arranged in connection with the points and insulated track sections. Likewise the tracks for trains to and from Vejle are insulated over the stretch between Cabins II and V.

The track system is divided up into a fixed number of insulated sections and each section is fed with AC which operates a relay. When a coach, a locomotive or the like enters a section the current is bridged by the wheel axles and the relay armature falls. The signals, etc. are connected by contacts with these track relays, and thus a »clear» signal cannot be shown when there is a coach, locomotive or the like in the section. This gives automatic indication whether a section is clear before signal can be given. For all the main sections the blocking is in principle arranged so that train movements take place on definite tracks, while shunting ways comprise all those in the track system, seeing that all movements in this area are directed and controlled from the corresponding interlocking machine. The dwarf signals and daylight signals are in the form of small low signals, though conditions on the spot may require some to be set high. A dwarf signal is placed immediately to the right of the track, it refers to and is not repeated behind. The signal indications are made by two white lights taking up different positions in relation to each other, see Fig. 8, which show four signal indications, *viz:* »stop», »caution», »clear» and »cancelled», the last-named being used to a very limited extent.

Fig. 7
Light signals and bells
for protection of level crossing

X 3472

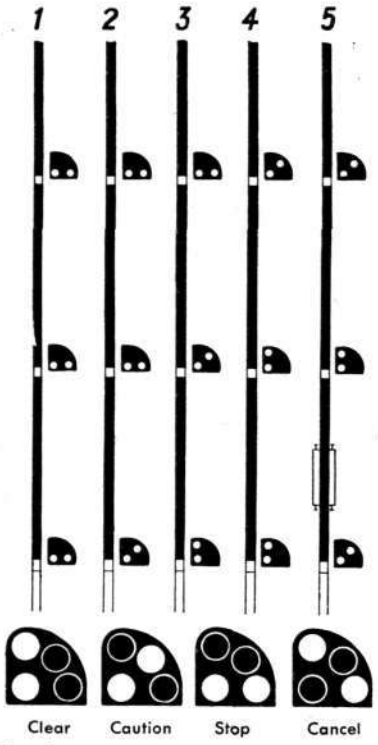

Fig. 8 X 3420
Cooperation of dwarf signals

As the insulated tracks, shunting tracks, dwarf signals, etc. are arranged much in the same way as the new interlocking plant at Aarhus, described in Ericsson Review No 2, 1935, attention is directed to that article. In the areas where the points are protected by dwarf signals, it has in general been possible to provide point signals and block signals at catch-points and scotch-blocks.

There are however variations from this rule, especially places where dwarf signals may be useless. At all those points not protected by dwarf signals and which are included in the interlocking plant, point signals and block signals are provided.

Insulation of the fish-plates and intermediate plates is by means of American fibre layers. The insulated rails are as a rule provided with insulation in both rail ties with the exception of rails, in the fields of Cabins IV an V, insulated against untimely reversal and locking of the tracks, where insulated may be on one side only. Connection within the individual insulated rails is provided by double 5 mm copper wire attached to the insulation by conical spikes. The rails insulated for protection against untimely reversal and locking of the tracks under Cabins IV and V are fed with 34 V DC, while the other insulated rails under Cabin V, together with the insulated rails under Cabins I and II are fed with 110 V AC in conjunction with the track transformers and the reactance coils. Two-phase induction relays (vane relays) are used here. The current feed to the track relay local phase is taken from the 110 V side of a $3\times380/3\times110$ V transformer placed in each signal cabin, while the current supply over the insulated relays to the track phase of the relays is taken from the same transformer over a special track transformer for each single section. The track transformers and the reactance coils are located in cubicles at the station. The track relays are placed in the basement of the signal cabins. The connecting wires are laid in armoured underground cables.

Operation of Points and Signals

The points are operated and locked by drives of Signalbolaget's make. A number of the points are fitted with hook-locks or Voegel-locks and for these are used drives with only one driving rod for the point-lock. For those protected points which are not provided with a special lock drives with built-in locks and two rods one for each point tongue, see Fig. 9, are used.

Double crossing points are operated by two drives, each of which operates and controls two pairs of tongues. All opposite points in the train tracks are control-locked, each corresponding drive being provided with two further control rods, one for each tongue or pair of tongues, in such a way that an independent control of the position of the tongues is obtained from the drive rods. The motors of the drives are fed with 136 V for moving the points. Supervision of the position of the points is carried out in cabins I and II areas by means of three-position vane relays installed in the relay rooms, with local and indicating phase for 110 V AC, 50 c/s. In the area of Cabins IV and V supervision is by 34 DC in the usual way with control magnet but without special relays. In Cabin III area the points are locked by electro-magnetic locks. The most distant points towards Kolding and Vejle are also control-locked by special electric locks.

The semaphores are operated by drives from Signalbolaget for 110 V motor current (DC) and 34 V control current (DC). The daylight signals and the dwarf signals below them are operated by special DC relays located in the signal cabins.

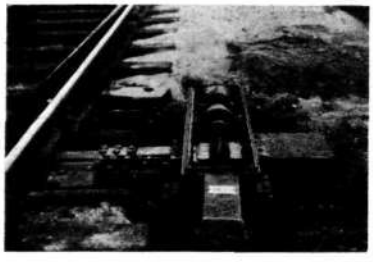

Fig. 9 X 3475
Point drive with enclosed motor and point lock
for distant control and protection of points

Interlocking Apparatus, Relays, Signal Cabins etc.

The interlocking apparatus in Cabins I and II are Signalbolaget's newest type. The point levers each operate one or two points and in normal position lie over to the right, being over to the left when thrown. The angle traversed is 140°. The signal levers normally slope upwards and can be changed

70° to either side. Each lever can thus serve more than two train tracks. Where, for example, the throwing of a lever to the left corresponds to more than one train track, there are placed above the lever track buttons with which the desired train track is selected. The dwarf signal levers also which are operated in much the same way as the general signal levers, can serve for each position (to right or left) several train tracks, but in their case without track buttons. All the tracks on one lever must naturally be mutually opposed. Both for main tracks and for shunting tracks the connection is solely electric (there is no mechanical locking register provided), which is effected partly with the lever magnets armature on contact of the lever with the armature, and partly by means of a large number of relays housed in the basement of the signal cabin. The relays, some for AC and some for DC, are for the most part made with contacts enclosed in glass cases.

Fig 10 shows the interlocking apparatus and the illuminated track diagram in Cabin II (control cabin). Fig. 11 shows Cabin II (master cabin) and Fig. 12 shows the relay room in Cabin II. The design of the interlocking apparatus in Cabins I and II is in essentials the same as described in Ericsson Review No 1—3, 1931. The interlocking apparatus in Cabins III, IV and V are of Signalbolaget's general type. An occupied train section is automatically blocked and is cleared likewise automatically on the passage of the train.

The table below gives an idea of the levers, numbers of train tracks, numbers of points operated, signals, dwarf signals, track insulations, etc. for the various interlocking apparatus.

	Cabins					
	I	II	III	IV	V	total
sections in the interlocking apparatus	88	128	12	24	56	308
point levers	37	42	—	11	31	121
signal or clearing levers	9	20	1	1	5	36
dwarf signal levers	28	37	—	—	4	69
locking levers	1	—	6	—	1	8
spare sections	13	29	5	12	15	74
train tracks	19	13	2	—	7	41
shunting tracks	154	237	—	—	9	400
centrally operated points	53	66	—	11	44	174
centrally operated scotchblocks	1	3	—	—	4	8
semaphores	5	1	—	—	1	7
distant daylight signals	12	9	2	1	8	32
dwarf signals	44	65	—	—	6	115
insulated tracks with lamp on track diagram	57	78	—	—	19	154
tracks insulated only against untimely operation	—	—	—	3	13	16
relays	340	450	10	1	69	870
locked points	1	—	11	—	1	13

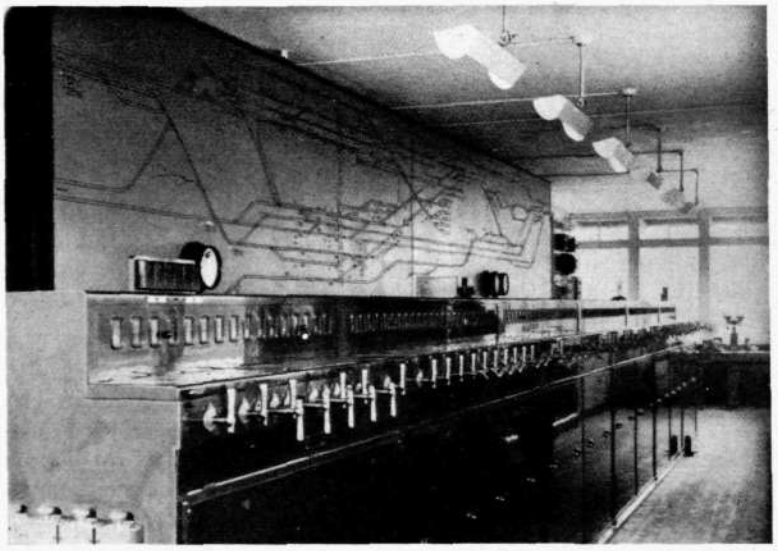

Fig. 10 X 5221
Interlocking apparatus and illuminated track diagram in Master Cabin

Illuminated Track Diagram

As the shunting in the areas of Cabins I and II and part of the area of Cabin V is to be controlled by and directed from the cabins, it is necessary that the operating staff should be able easily to supervise and follow the individual movements. For that reason each of these cabins is provided with an illuminated track diagram for the track system concerned.

On these track diagrams, which are set up separately behind the interlocking apparatus, there are indicated, in addition to the tracks, the main signals (mast signals) and dwarf signals as well as the individual insulated track sections into which the track field is divided. The positions of the signals are repeated on the track diagram by separate coloured lights which show up on the lighting of lamps set behind small coloured windows and which mark the signals. There is a lamp on the diagram for each track insulation in a line of track. The entrance of a train in a section is indicated by the lighting of the lamp corresponding to the section; when the train has left the section the lamp goes out. The lamps are thus not alight when the track is unoccupied. In this way all movements on the track system can be followed on the track diagram.

»Stop» at a dwarf signal is not repeated on the track diagram, while »caution» is shown by a yellow light and »clear» by white light. »Cancelled» is indicated by yellow light lying in a black cross. The positions of the various pole signals are shown by red light for »stop» (train track signal for starting shows yellow light for the position »track not clear for train») and green light for »clear», while the shunting signals are indicated by yellow light for »shunting permitted» and blue for »shunting forbidden».

The traction line signals are repeated in yellow light on the track diagram in Cabin II, when they are lit, see above. The arrangement of the track diagram in the main cabin may be seen from Fig. 11.

In the direction of Nyborg, AC blocking is installed an such is also to be arranged in the directions of Kolding and Vejle.

Power Supply

The plant is fed with current from Fredericia Electric Works which normally furnish AC 3×380 V, 50 c/s, to each of the five cabins. In case the current supply to one of Cabins I, III, IV or V fails, the supply can be obtained from Cabin II over a special cable. In Cabin II there are two cables coming each from its own transformer station, one of which acts as reserve. Finally there is at Cabin II a petrol motor-generator to maintain the supply in case current fails entirely at the Electric Works. In each of the cabins there is a transformer 3×380/3×110 V. Current is taken from the 110 V side for the local phase of the point-control relays and for the local phase of the track relays, for dwarf signals, lighting of semaphore signals, etc.

Through other transformers, 110/110 V, is taken current for the indication phase of the point-control relays. The tension is transformed from 110 V to about 30 V for the daylight signals (mast signals) by transformers or series resistances. The 110 V is transformed for the track-insulation to 12—24 V by special track transformers, and for the lamps of the track diagrams the tension is transformed from 110 to about 12 V.

Fig. 11 X 3473
Cabin II (Master Cabin)

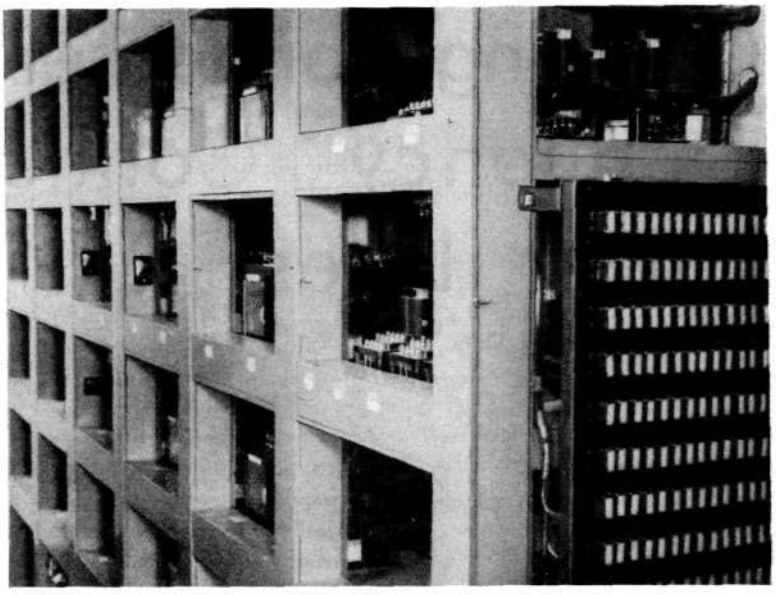

Fig. 12
Relay room in Cabin II

X 5222

The current feed for the point motors (136 V DC) and for the supervising current (34 V DC) is taken from metal rectifiers connected in parallel with floating batteries and connected to the 380 V mains. As reserve for the metal rectifiers there is in each of Cabins I, II, IV and V a motor generating set consisting of a 380 V motor, a 136 V generator and a 34 V generator. Cabin III receives its motor and supervisory current from Cabin IV by a special cable.

Telephone Installation

The plant is provided with a comprehensive telephone installation, since besides the customary connections between telegraph office, signal cabins, platform boxes, etc. which are made over an automatic private branch exchange with about 80 instruments connected, there is a considerable number of instruments at various spots, providing convenient communication with the signal cabin concerned, which is necessary in the cases where shunting is controlled and directed from the signal cabin.

Thus there are telephones at 10 places in the field of the Cabin I connected to a loud-speaking instruments in the cabin. In the same way are 15 place telephones connected to a loud-speaking telephone in Cabin II. Further there is in this cabin a CB exchange for 7 instruments at the main entrance signals. In the field of Cabin V there are 8 place telephones of the CB type served by an exchange in the cabin. Finally there are at the section tracks, the station tracks and the goods departure tracks 7 place telephones in all connected to the local automatic exchange and 3 further place telephones at the goods incoming tracks.