TRAIN MARSHALLING BY RADIO AT ZURICH CENTRAL STATION

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Modern communication media have been installed in the new main train control system at Zurich central station. Brown Boveri radio equipment provides communication between the control room and the shunting engines. It is coupled to the novel track signalling equipment supplied by Albiswerk Zurich AG. The construction, operation and interconnection with existing communication systems are described below.

Scope and Purpose

THE new central train control system at Zurich central station went into service on the 15th of May 1966 and is equipped with new communication apparatus. Part of this is the Brown Boveri radio control equipment for shunting which ensures contact between the shunting locomotives and the central control or the marshalling crew foreman. This comprises 12 mobile and 13 fixed radio sets of type RT 18 with all ancillaries and is closely connected with the other communication media at the fixed end of the control system. To comply with the operating requirements each radio-equipped shunting engine is in communication with its opposite station by its own high-frequency channel in the 400-Mc/s waveband so that the 12 shunting crews can transmit messages simultaneously. A further common channel is unidirectional and transmits the synchronizing signals for the track signalling equipment. Apart from the transmitter end stages the equipment is fully transistorized and of robust and reliable construction.

In addition to the radio-communication equipment, the track positioning requirements can be rapidly relayed to the central train control room with the aid of the track signalling equipment. This information appears in illuminated form on the mimic diagram of the corresponding section (see inside front cover) and gives quick reference regarding the starting track, goal, and the type of traction required by a given vehicles composition. A track signal also closes the RT link. The information remains stored until the despatcher acknowledges and cancels it. A verification device informs the marshalling crew foreman whether his signal has been picked up by the central control or if a repeat is necessary.

The RT system is of the intercommunication type. An audio-frequency selecting device permits the engine driver or the crew foreman to call up a limited number of other receivers. In addition to this the RT unit in the shunting engine is in direct contact with the crew foreman's portable set.

For practical reasons the radio-equipped shunting engines are only required to operate up to 1·6 km from the railway terminus.

Design and Application

Fig. 1 gives an overall picture of the connection between the equipment supplied by Brown Boveri and the existing intercommunication equipment, and shows the following.

The Transmitting Centre

As shown in Fig. 2, this is housed in the top floor of the central train control building and is enclosed in an electrostatic screen for lightning protection. The twelve type RT 18 intercommunication sets which are supplied from the network each have an output of 4 W and are erected on standard frames, as shown on the left, complete with their monitoring

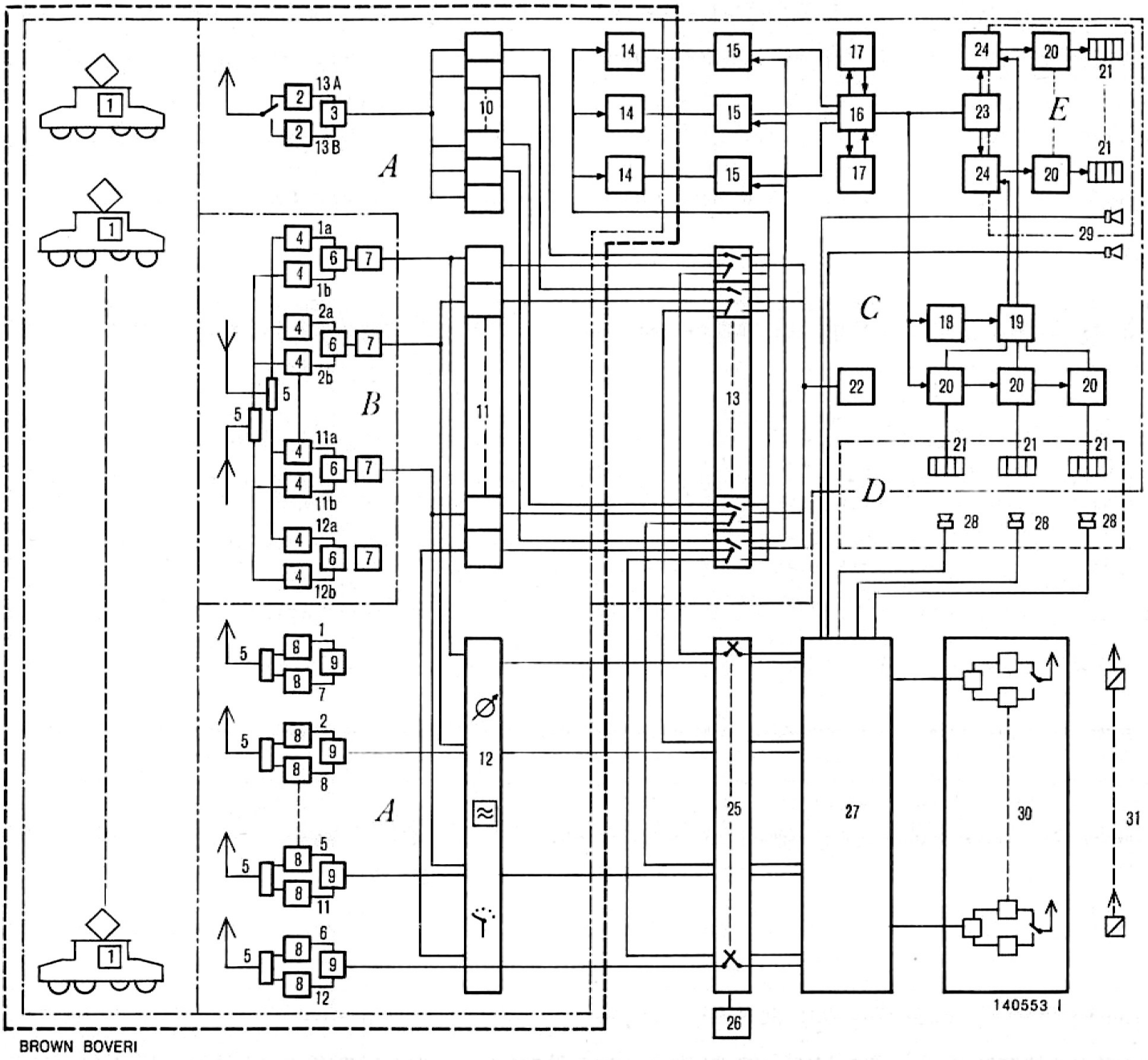

Fig. 1. – Design principle of the Brown Boveri marshalling communication system and its interconnection with the existing communication systems in the central train control

A = Transmission centre
B = Receiving centre
C = Track signalling equipment
D = Control panel
E = Auxiliary control systems
1 = Mobile track signalling and intercommunication equipment
2 = Transmitter for track signaller synchronizing signals
3 = Automatic changeover device
4 = Receiver
5 = Frequency selector
6 = Diversity unit with monitor
7 = Level amplifier
8 = Transmitter for intercommunication
9 = Monitor
10 = Frequency-shift transmitter
11 = Identification signal evaluator
12 = Channel monitoring unit
13 = Channel connection
14 = Signal evaluator groups for scanning
15 = Scanning store
16 = Selector store link
17 = Selector store
18 = Destination evaluator
19 = Indicator
20 = Display store
21 = Visual track indicator
22 = Switching array for the intercommunication equipment
23 = Transmission store
24 = Transmission link
25 = Service number link
26 = Indicator display for service number changeover
27 = Automatic intercommunication system
28 = Loudspeaker-microphone
29 = Extension
30 = Static equipment for portable transmitter-receivers
31 = Portable transmitter-receivers

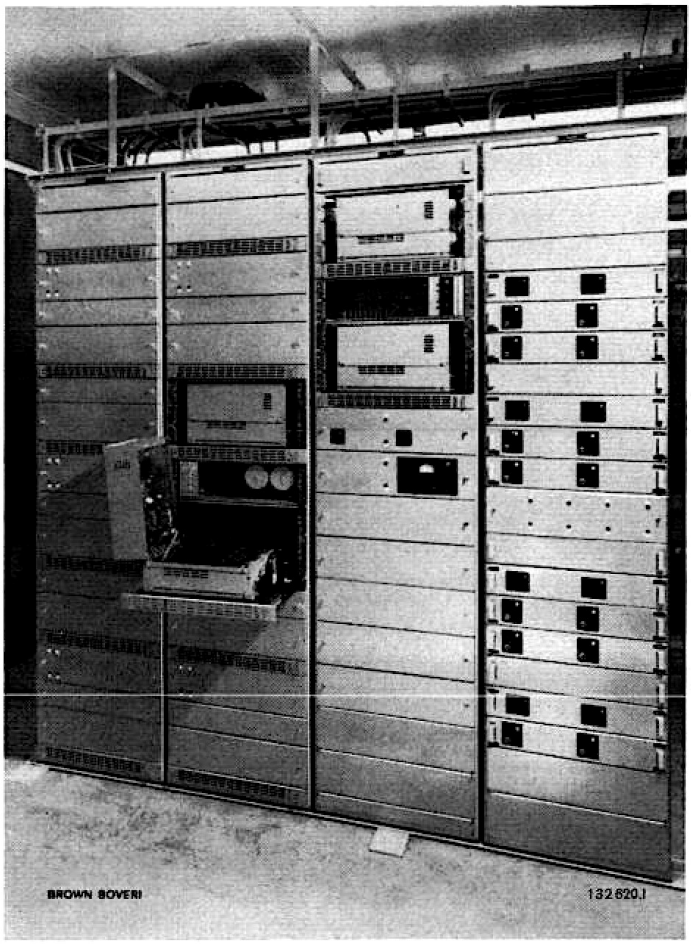

Fig. 2. – The transmission centre on the sixth floor of the control centre. Transmitters 5, 11, 13A and 13B, complete with their monitoring devices can be seen in the second and third frames. The sets are mounted on drawout tiers for ease of access.

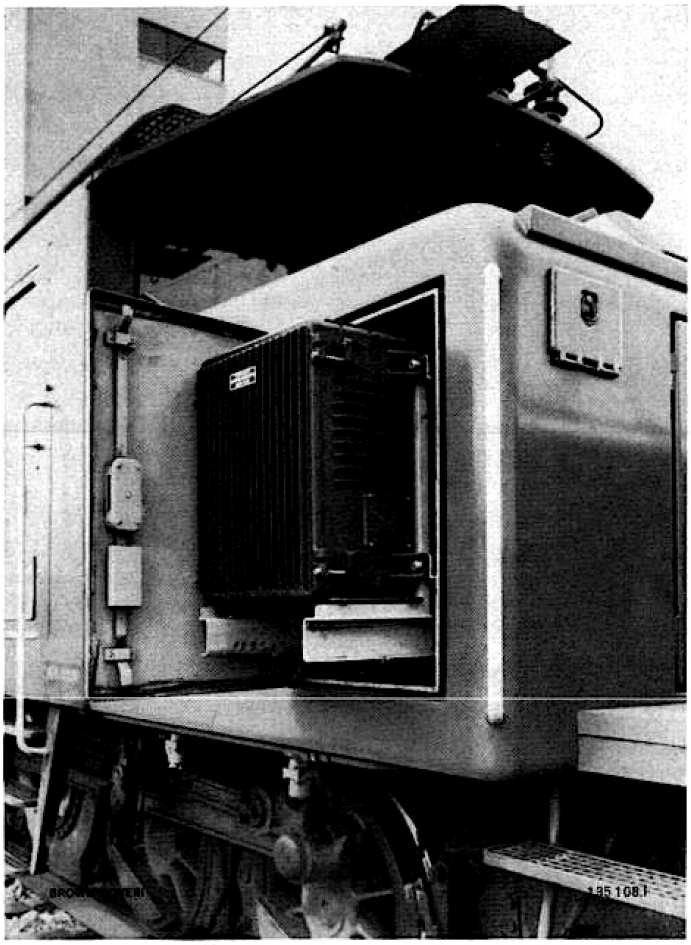

Fig. 3. – Mobile track signalling set fitted to an electric shunting engine and mounted on a pull-out frame which permits very rapid fitting or removal

equipment. Of these there are always two sets in communication with each other via their corresponding aerial with duplex frequency separation. The third frame contains the main and stand-by transmitters for track signalling synchronization. The main transmitter is in continuous operation and is fitted with an automatic change-over device which operates as soon as the modulation or carrier frequency drops and switches on the stand-by set. A monitoring and control unit is connected in the same circuit. This gives a quick reference with regard to the operational readiness of the 12 intercommunication channels. The other tiers contain five signal evaluation sets, each of which contains twelve printed circuit converters for code frequencies 1 to 12. The first set functions as an identification signal evaluator and the next three control the scanning store of the automatic track positioning equipment. The fifth set is only used for testing purposes. The last frame contains 14 frequency-shift transmitters with main and spare feed units. An automatic changeover device safeguards the power supply for this piece of equipment. The signal outputs from the shift transmitters are connected in parallel and modulate the above transmitter for the track signalling synchronization by means of a buzzing signal.

Receiving Centre

The receiving centre is housed in the general office building which is situated about 600 m from the railway terminus. Its equipment comprises two standard racks, each of which are fitted with twelve RT 18 receivers with all their ancillaries. Two receivers are connected together in each channel through

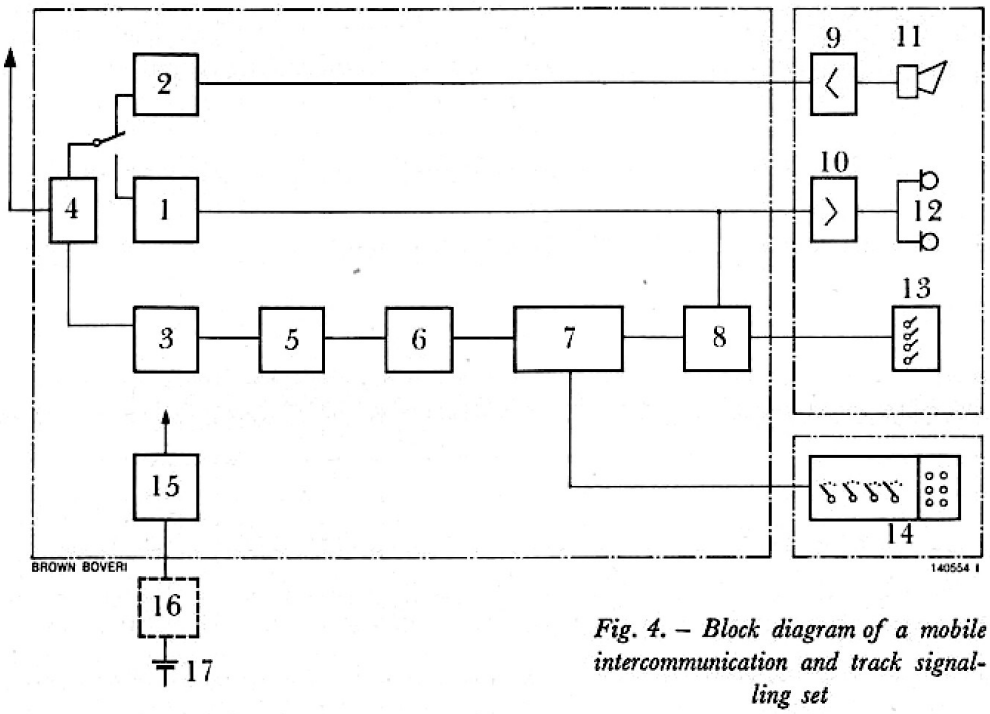

Fig. 4. – Block diagram of a mobile intercommunication and track signalling set

1 = Transmitter
2 = Two-way communication receiver
3 = Track signaller synchronizing receiver
4 = Frequency selector
5 = Selective amplifier
6 = Frequency-shift receiver
7 = Track signaller automatic changeover
8 = 12-tone oscillator
9 = Loudspeaker amplifier
10 = Microphone amplifier
11 = Loudspeaker
12 = Microphone
13 = Two-channel selector
14 = Track signal transmitter with channel selector
15 = 24-V stabilizer
16 = D.C. converter with 110 V input, 36 V output
17 = Battery

an electronic diversity unit and connected with the transmission centre through a signal level amplifier. The installation is supplied from two separate 24-V batteries in such a manner that the receivers of a common channel have access to various power supplies. Basically the same principle applies to the high-frequency side. The use of two different aerials, set apart from each other, gives a good space diversity effect so that even weak h.f. signals can be picked up. Further to this, each channel is fitted with a monitoring circuit which gives an alarm signal as soon as a set stops working. The equipment room is screened with copper as protection against lightning and interference.

Mobile Intercommunication and Track Signalling Sets

Apart from the operating controls these twelve sets are in dust-proof cast iron containers. They can be fitted to any of the 13 electric or 6 diesel shunting engines which are equipped with the necessary facilities (Fig. 3). The equipment contained in the casings performs the following functions.

One RT 18 transmitter-receiver set with a 4-Watt output serves the intercommunication requirements and transmits the track positioning code signals to the control centre. In the opposite direction the synchronizing signals received from the fixed track signalling device through the supplementary receiver are fed to the frequency shift evaluator which converts them into d.c. criteria. These control the automatic scanner and, together with the twelve-tone oscillator, generate the frequency code, i.e. the actual information carriers of the mobile track signalling device.

The power supply for the RT equipment is taken from the ancillary supply of the electric locomotives through a stabilizer whose output is a 24-V supply which is independent of operation. The diesel engines have a 100-V supply and therefore they must be fitted with an auxiliary d.c. converter which reduces the voltage to 36 V.

The basic circuit diagram of the mobile track signalling devices can be seen in Fig. 4. The driver's cab is fitted with two microphones, a loudspeaker and a selector device for the intercommunication system. A set of push-button controls is provided for two-channel selection and combined with the track signal transmitter. This is accessible from the front catwalk of the engine which is the normal position for the crew foreman. The amplifiers for the microphones and loudspeaker are also fitted in the driver's cab.

Establishing Contact

Contact can be established in the following ways:

1. Intercommunication between the central control and locomotives.

Pressing the scanning button of the requisite marshalling crew causes their transmitting channel to be scanned through the service number link and the intercommunication equipment and the vehicle can be called up over its loudspeaker. In the opposite direction the engine driver can call up central control through his two-channel selection device. The individual pulses are limited by a timing device so that no track signals are indicated. Further to this the driver is automatically in contact with the yard supervisor after a track signal has been given. This connection remains until the visual signals have been acknowledged and cancelled.

2. Intercommunication between the driver and the crew foreman.

When starting work the set in the locomotive and that of the crew foreman are interconnected through the service number link at the central control. This is accomplished by inserting marked plugs into the appropriate sockets in the control panel at the engine sheds. In this case the ancillary equipment operates as a relay station. The call is made in both directions through the duplex transceiver. If the crew foreman wishes to make contact with a set other than that of the yard supervisor responsible for that particular section, the call must be relayed through the set in the locomotive as his own portable set has no two-channel selector.

3. Transmitting the track signal information.

The call for a clear route (track signal) is given in the form of a sequence of letters and numbers which is identical to the starting and finishing positions (e.g. A1–C3). This information can be set at the track signal transmitter with the aid of the four selectors provided. Moving the engine control lever to "drive" or "shunt" starts the scanning process and indicates the method of traction (pull or push). The automatic scanner transforms the signal into a frequency code consisting of 14 pulses (Fig. 5). The first pulse is transmitted to the appropriate channel circuit through the identification signal evaluator in the transmitting centre, which, after 3 s occupies a clear scanning store. The information arriving is thus

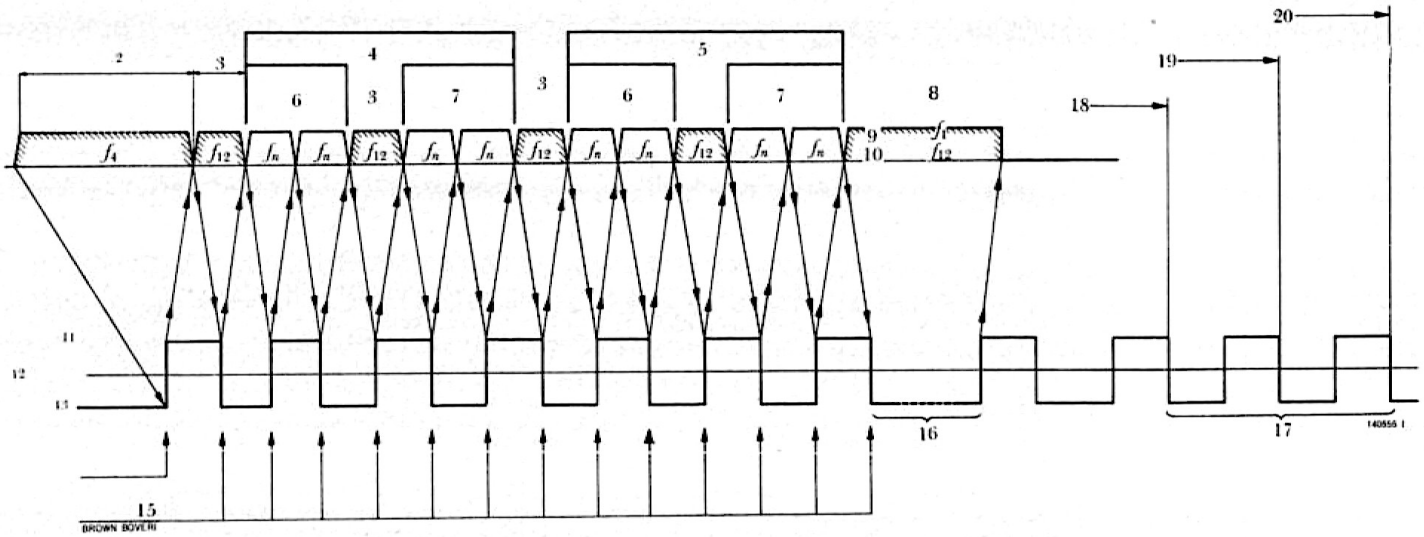

Fig. 5. – Pulse diagram for transmitting the track signal information between locomotive and control centre

1 = Signal code programme for the locomotive set
2 = Verification
3 = Separator pulse
4 = Origin
5 = Destination
6 = Signal code for array
7 = Signal code for track
8 = Type of traction
9 = Travel
10 = Shunt
11 = Working position
12 = Frequency-shift channel
13 = Stopped
14 = Standby
15 = Acknowledge or enquire
16 = Verification from selector store
17 = Return signal
18 = Engaged
19 = Error
20 = Signal arrived
f_n = Signal frequencies f_3 to f_{10}

identified as a track signal. After a starting pulse, which has a frequency of f_1 or f_{12}, there follows a series of four groups of data, each of which has two pulses whose frequencies are independent of the signal contents identifying the origin and goal. Between the groups of data there are check pulses which also have a frequency of f_1 or f_{12}. The frequency of the final pulse establishes the type of traction. Immediately following the end of a message it is relayed through a vacant selector store to the display store indicated by the destination evaluator and indicated by the corresponding visual display so that the scanning store is immediately ready to receive further signals. At the same time there is a return signal to the locomotive on the shift channel which can transmit the following criteria:

1st pulse = Selector store or visual display engaged
2nd pulse = Error
3rd pulse = Signal transmitted

The scanning sequence is so arranged that the signalling channel has to be intact in both directions as each code pulse arriving must be acknowledged by a shift on the opposite channel. If there is a break in contact on the return channel a pulse store circuit in the shift receiver holds the latest pulse until the scanner is released by the signal monitor. The pulse period of the information scanner is not rigidly fixed but depends upon the evaluator and relay time-lags as well as on the state of connection. The track signalling channel has a high degree of protection against incorrect information as the channel frequency, identification signal frequency and shift channel frequency must be matched before a signal can be realized.

Operation and Maintenance

Operational reliability is of particular importance for the installation described above. For this reason a number of measures have been taken to comply with this requirement. A high degree of reliability and freedom from maintenance is achieved in many respects by extensive transistorization. Another safety measure is the alternative sources of power supply for those units which are essential for operation. These are the local mains network and an emergency power supply. The track signalling equipment has standby shift power-packs and h.f. transmitters with automatic changeover devices and the twelve duplex transceivers have two spare units on continuous standby. A defective receiver or power pack in the receiving centre does not cause a break in communications as the standby set is automatically switched over to that channel by the diversity circuit and the monitoring unit gives the appropriate warning. All sets in the transmission and receiving centres are supervised in this manner and connected to the alarm busbar of the control centre.

There are two spare portable sets available in the engine sheds which can be fully operational in a few minutes should one of the twelve in use break down. The act of fitting coded plugs ensures correct channel selection and frequency. A testing device in the control centre permits the mobile sets to be checked on an audio frequency that does not interfere with the corresponding h.f. channel which may be occupied.

Conclusion

The adjacent equipment shown in Fig. 1, particularly the extensive intercommunication and track signalling equipment were not supplied by Brown Boveri and are merely shown for the sake of clarity.

The new control centre has been in operation for six months and has proved itself to be perfectly adequate in every respect, particularly the communication system. The overall design of the installation was carried out by Swiss Federal Railways.

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