SAAB-SCANIA

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TRAIN DISPATCHING SYSTEM

Description ICP-1-79-013

1979-04-04

GENERAL

The Train Dispatching System is designed to perform the transports in the mine in such a way that the capacity of the rolling stock will be optimally utilized in a safe way with a minimum need of manpower. The system is built-up to be flexible to fit different layouts of haulage systems.

The dispatching of the trains is done from a supervisory operator, but can also be done automatically in respect to commands from other systems. In more complex haulage systems for example with more than 10 trains, computers may be needed, which then can take over dispatching and supervising tasks from the operator or assist him with these tasks.

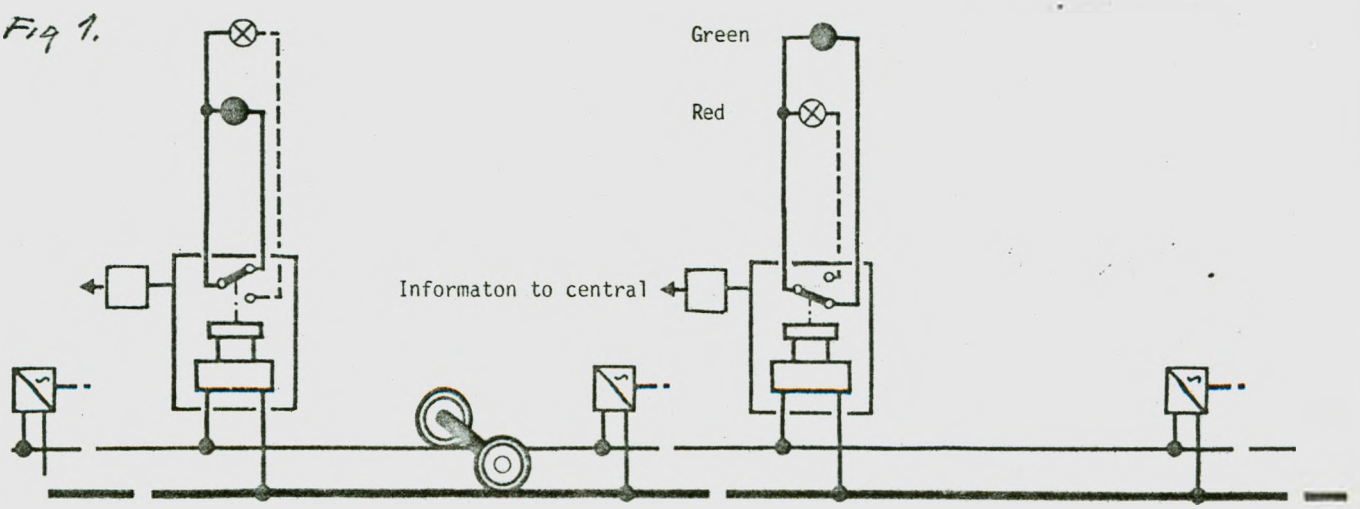
The design of the system is made in modules (building blocks), which makes it possible to increase the degree of automation step by step to a complete automatic driverless train control system.

DETECTION OF TRAINS

The basic system for train haulage is a block safety signalling system providing a fail-safe operation for the trains and supplying data to other systems for implementation of dispatching and control systems. The block safety signalling system has to be based upon detection of the trains.

The complete track is divided into fixed blocks to separate the trains from each other. The common way to do this is to electrically insulate the track into sections. For each block a current source is connected to one end of the block and a pick-up relay to the other end. As long as no train is in the block the relay is activated. When a train enters into the block the relay is short-circuited by the train wheel sets and the relay is de-energized.

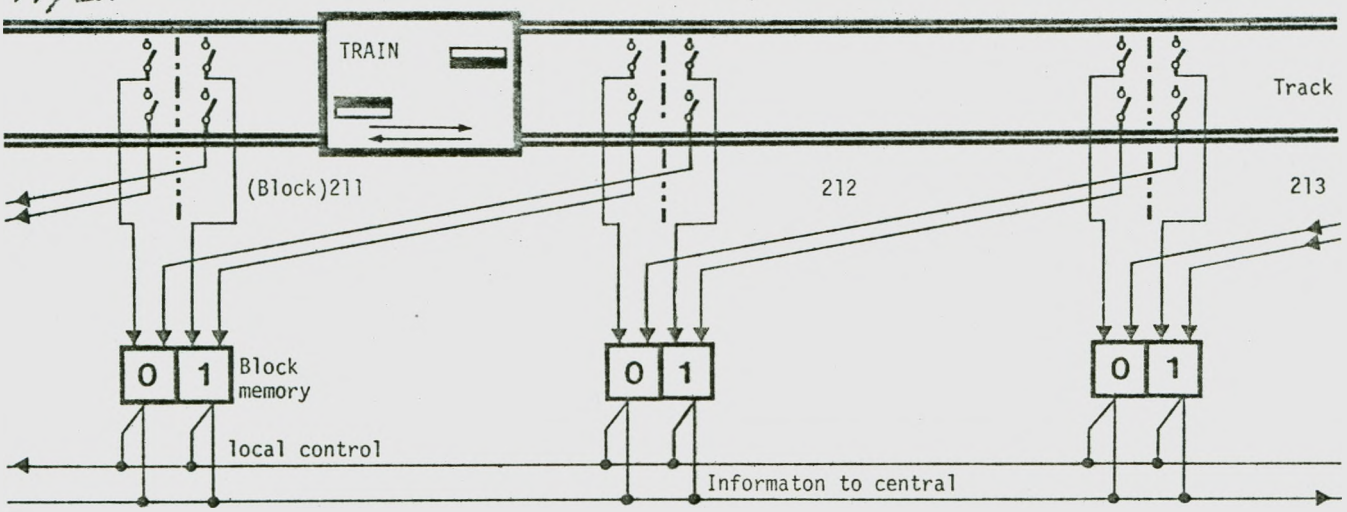
Fig 1.



The function of this system depends on the condition of the track ballast. The system is working in mines with extremely good non-conductive ballast but cannot generally be used in wet mines. The system also requires good conductive connection between the wheels on the axles as well as "clean" rails, i.e. free from rust or other oxides.

For mine train haulage systems a check in - check out system is recommended. The complete track is divided into blocks by sensors at each block limit. The sensors which consist of reed contacts are activated by magnets on the trains, one in each end of a train.

Fig 2.



Together with the track-side block signalling logic with a block memory, this equipment constitutes a safe and reliable train detection system, which is not dependent on the electrical condition of the rail ballast. This system has also the advantage to indicate trains, which enter into an already occupied block. An alarm can then be given to the dispatcher or in complete driverless systems the trains can immediately be stopped. This system can also be easily installed in existing rail systems as no insulated sections have to be implemented to the rails.

The information received from the detection system is used for interlocking of routes and switch points for controlling the block light signals and for giving information of train locations to the dispatcher central. In complete driverless ATC-systems it controls the local train movement command transmitters as well.

DISPATCHING OF TRAINS

The route selection through a rail system means in practice switching of tracks. This is done and supervised by the dispatcher on a central console and is carried out by the switch point machines via the wayside block control system. The dispatcher selects the routes on information from the block occupancy information, which are transmitted from the wayside stations to the central and on information from other systems about the amount of ore in the different chutes.

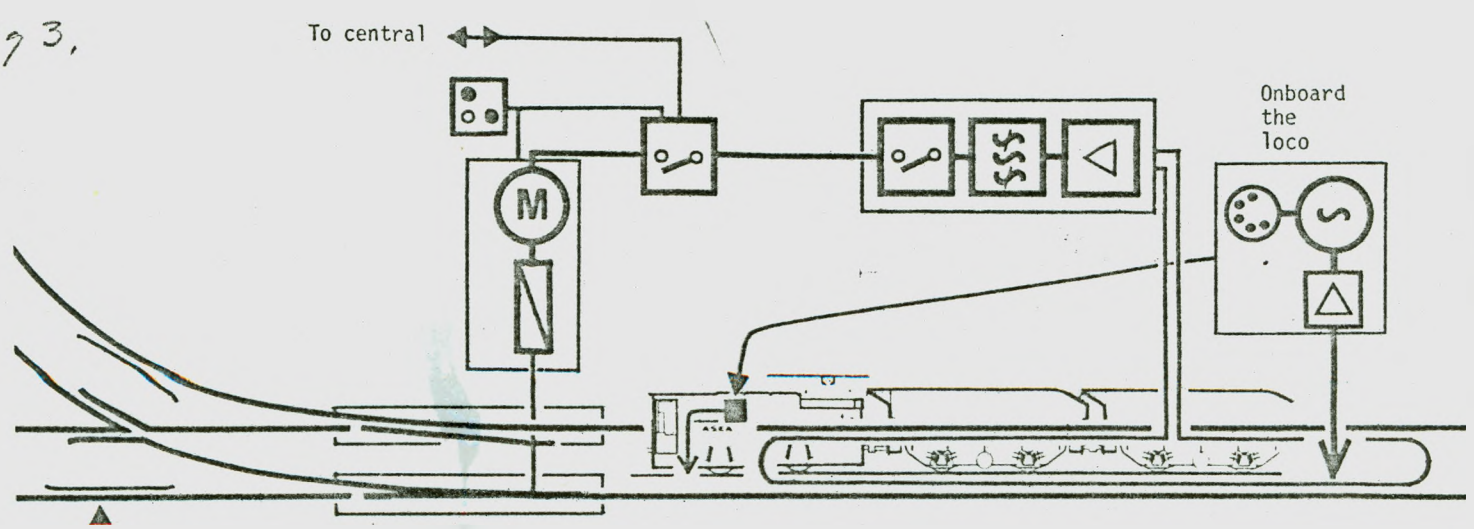
The route selection can also be done automatically on basis of the same information, which then leaves the dispatcher to the supervisory tasks only. The dispatcher can, however, always override the automatic routing, but never the local block control system or operate a switch point in an occupied block.

The interlocking protection is the direct responsibility of the local wayside logic. The switch point positions are checked and the switch points are electrically locked in advance of train movements.

All information and commands between the dispatcher central and the wayside station are sent by a signal transmission system, which has a capacity of 200 signals simultaneously in both directions.

In less complex haulage systems, i.e. with one or two trains and a simple track layout no dispatcher central is needed. The driver on the trains can then make up their routes themselves. The switch point machines can be remotely controlled from the locomotive cab by means of an inductive transmission system. A transmitter in the loco, which is operated from a control unit in the cab, feeds a transmitting antenna placed under the loco. At the switch point a receiver is located, which with the aid of an antenna loop between the rails picks up the signal from the transmitter and gives a throwing over command to the switch point drive unit.

Fig 3.



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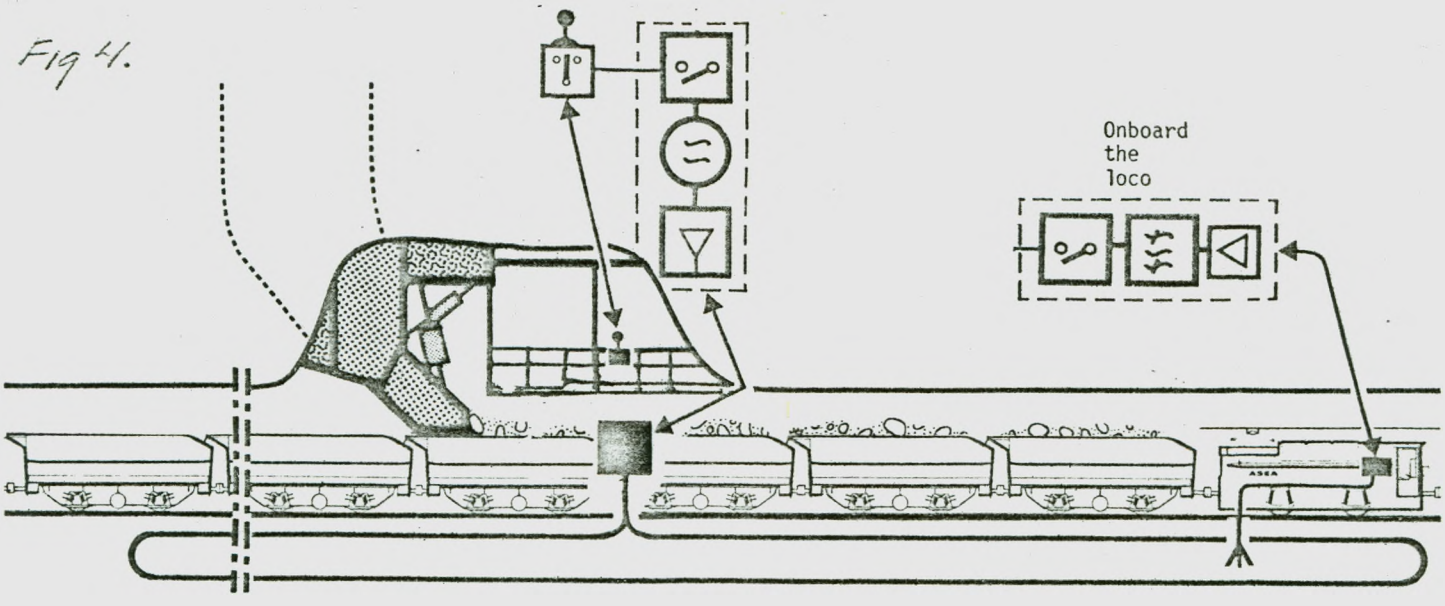
REMOTE CONTROL OF TRAIN MOVEMENTS DURING LOADING

A basic step towards automation in haulage system is remote control of the train movement at the loading stations. By aid of remote control equipment the loco driver performs the loading operation simultaneously with the controlling of the train movements during loading. The remote control equipment consists of a stationary inductive transmitter controlled from a control unit at the chute and feeding an antenna loop located either between the rails at the trackbed or mounted in the tunnel ceiling. Onboard the loco there are the pick-up antenna and the receiver. The output from the receiver is fed to the loco circuitry.

The signals from the transmitter are only received by the loco, which is within the antenna loop. Therefore there is no need of coding the message with the loco identity as is the case with radio control. The propagation of radio signals in underground mines is very limited and sensitive to disturbances.

Fig 4.



The basic requirements on the locomotive are that its brakes must be applied by means of electrical circuits and that the "Forward" and "Reverse" switching have to be electrically controlled as well as the selection of speed. For safe operation the brake system should be of "inverted" type, i.e. the brakes shall be applied at loss of power or loss of transmission from the transmitter. Modern type of thyristor controlled locomotives usually fulfil those requirements.

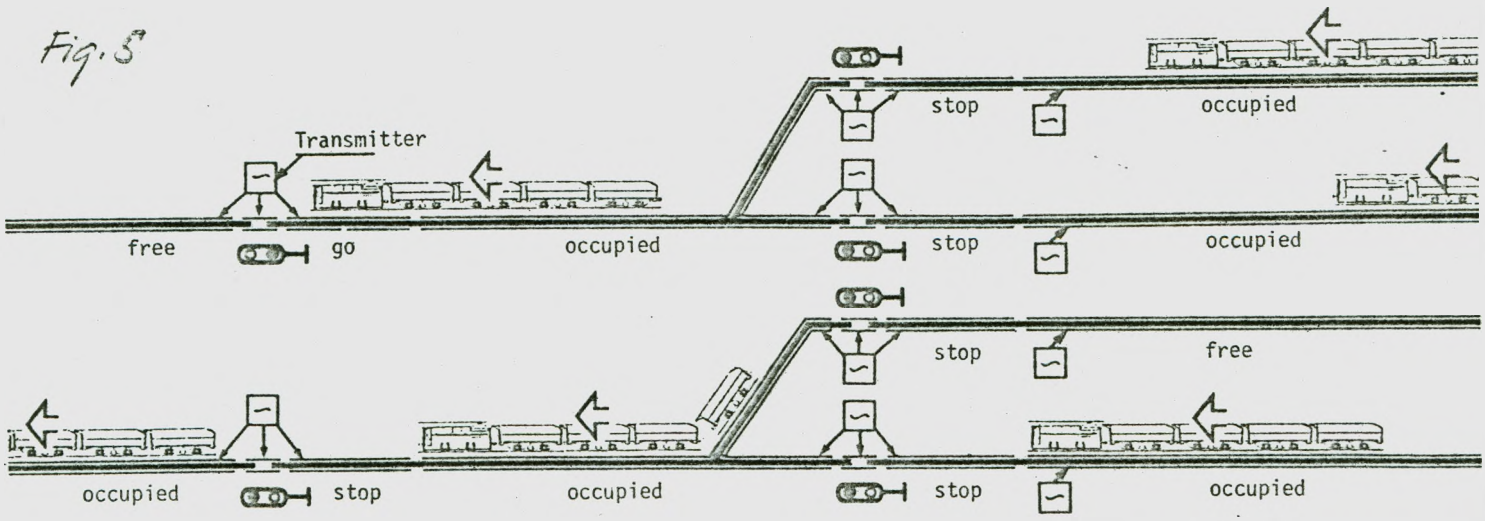
CAB SIGNALLING SYSTEM

To further increase the safety in manually operated haulage systems a cab signalling system is recommended.

The system is based upon the block safety signalling system. Added to this system is a track-to-train transmission system with stationary transmitters and receivers onboard the locos. This transmission system is the same as used for remote control of train movements during loading.

The complete track is covered by an antenna system divided into sections or loops. Each loop can be individually connected to transmitters, which are transferring speed and other information to the locos. The transmitters are located in the same cabinets as the block safety signalling system logics and directly controlled by this system.

Fig. 5



Each block is normally controlling two antenna loops. One loop ahead of the block limit and one after the limit. The former one transmits the state of the following block, the latter one the recommended speed within the block. If this block is occupied the former antenna is sending stop command. If the driver in such a case does not obey the red block approach signal, the emergency brakes on the loco will automatically be applied.

An announciator in the driver's cab tells the driver the state of the block and the speed recommended. The driver has the information about the block state even when he has passed the block approach signal. If a second train for some reason should enter the same block as he is within, he will immediately be informed and stopped. Optionally the cab signalling system can also serve as an overspeed protection system. The actual speed is then compared to the recommended speed transmitted to the loco from the track antenna loop. If the actual speed is less than recommended speed the train operates normally. However, if the actual speed is greater than the recommended speed, the overspeed protection system will bring the train to the proper speed.

AUTOMATIC TRAIN CONTROL SYSTEM, ATC

The basic equipment for an automatic train control system is the same as for the cab signalling system. In the automatic system the speed command signals from the trackside transmitters directly control the locos circuitry and the trains can be unmanned.

As the system demands that a block shall monitor occupancy as a condition for transmitting speed commands within the block, this system assures that all train movements are supervised. Any interruption in transmission implies a direct stop.

The systems described in this paper have through installation throughout the world proven to insure a safe, efficient and economic operation of mine haulage systems.