# Remote Control Interlocking H

Southern Pacific has installed a remote control interlocking which uses a solid state (transistorized) time division multiplex system for handling control and indication codes between the control machine at Fruitvale, Calif., and the field location at Elmhurst, about four miles distant. Fruitvale, about three miles south of Oakland, is on the double-track mainline to San Jose. Elmhurst is the end of the double-track mainline and also a junction with the single-track line to Santa Clara.

At the end of double track, just before the Santa Clara line branches off, a spring-switch crossover as aligned so that southbound trains trail through a spring switch, and northbound trains diverge from the single-track through this same spring switch (lined reverse) and trail through a spring switch at the other end of the crossover. (The northbound main track is a yard track south of the end of the double track.) The Santa Clara line joins the mainline through a power switch. This switch and the controlled signals governing movements over the junction and the end of double track are remotely controlled from a machine in the existing Fruitvale tower. The control machine is the conventional type with a track diagram and indication lamps. There is one switch lever and two signal levers, as well as a maintainer's call toggle switch and a code start button.

A Marc 051A solid state multiplex control system, made by Moore Associates, Inc., was used in this remote control interlocking installation. The master control station at Fruitvale consists of a Marc coder which scans the switch and signal levers, and transmits a serial pulse code over a tone derived channel to Elmhurst. At Elmhurst the pulse code signals are decoded and appropriate commands are executed. Verification of the field condition of switches and signals is transmitted back over a duplicate multiplex system to Fruitvale, where the information is displayed on the control machine track diagram.

The transistorized multiplex system uses electronic circuits mounted on plug-in printed circuit cards. The modular units simplify maintenance, and are only 7 in. high, 13 in. deep, and mounted on standard 19-in. wide relay rack standards. Both the coder and decoder operate from the 12-volt batteries at Fruitvale and Elmhurst and current drain is approximately 500 ma. More information on the multiplex controls (furnished by Moore Associates, Inc.) follows:

The Marc 051A system actually consists of control and indication subsystems which share common power supplies and mounting assemblies, but which are otherwise completely independent. Each subsystem consists of a time-division-multiplex coder, a frequency-shift tone transmitter, a frequency-shift tone receiver and a time-division-multiplex decoder.

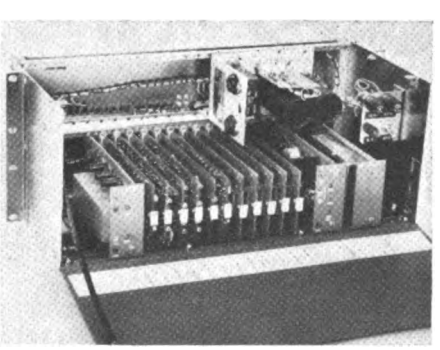
The coder of the control subsystem is at the attended location (Fruitvale tower). The control coder inputs are the contacts of the control panel switches. The output of the coder is a DC pulse code which represents all inputs in each code cycle. The DC pulse code electronically keys a frequency-shift tone transmitter. The tone output of the transmitter carries the control information to the remote terminal via the user's transmission facility (wire line, for example).

In the 051A system the control coder generates a pulse code only after a "start" contact is momentarily closed by the operator. The tone transmitter, however, owing to its frequency-shift design, always produces either a "mark" or a "space" tone and never neither tone.

At the remote terminal (Elmhurst) a frequency-shift tone receiver receives the tones transmitted from the master terminal (Fruitvale tower) and converts these tones back into a DC pulse code with which it drives a time-division-multiplex decoder. The decoder, after evaluating the received code, causes its output relays to correspond to the input contacts of the coder at the master terminal.

When the pulse code ceases to be received at the remote terminal, the decoder allows its output relays to remain as last commanded. These relays are magnetically-latched so that they will remain as commanded even if power fails.

Provision was made in the 051A system for limited local control of the output relays. External cancellation circuits can reset any relay upon the passage of a train, for example. Lock-out straps are also provided for each relay to prevent its operation by remote control.



Solid-state coder-decoder unit has power supply and plug-in circuit cards.

The coder of the indication subsystem is contained within the remote terminal. Its inputs are the dry contacts provided to represent indications. The information flow of the indication subsystem is the same as the control subsystem, except that it is from the field location to the office location. A TDM coder drives an FS tone transmitter whose tone is carried by the transmission facility to an FS tone receiver whose output drives a TDM decoder. Unlike the control coder, the indication coder generates its pulse code continuously, cyclicly representing every indication.

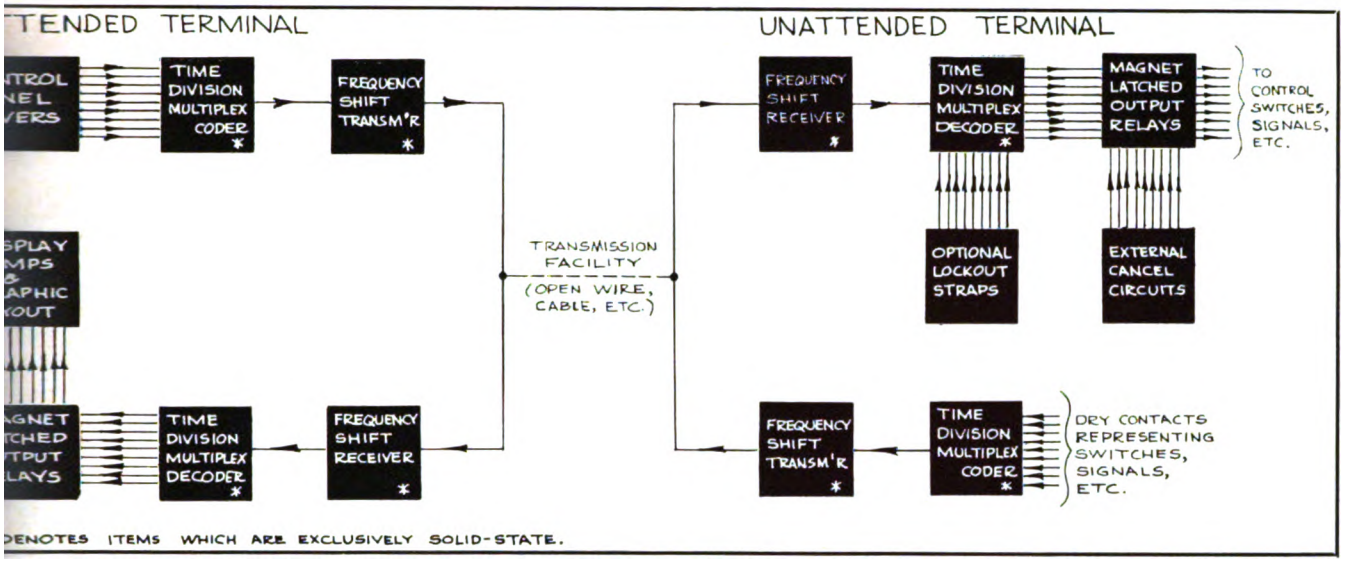
Synchronization of the coder and decoder (see diagram) is obtained by the use of a return-to-zero code in which each pulse begins at one polarity and ends at the opposite polarity. The decoder thus can "count" the number of pulses in order to remain in step with the coder. A normal or "off" pulse is divided into ⅔ negative-⅓ positive, and an "on" pulse is ⅓ negative-⅔ positive. A zero pulse at the end of each frame checks the synchronization of the coder and decoder.

The heart of the coder is a clock, a free-running multivibrator which, with DC applied, changes state automatically and continuously at a predetermined rate, yielding a train of rectangular pulses. The output wave is unsymmetrical, divided ⅔ negative and ⅓ positive.

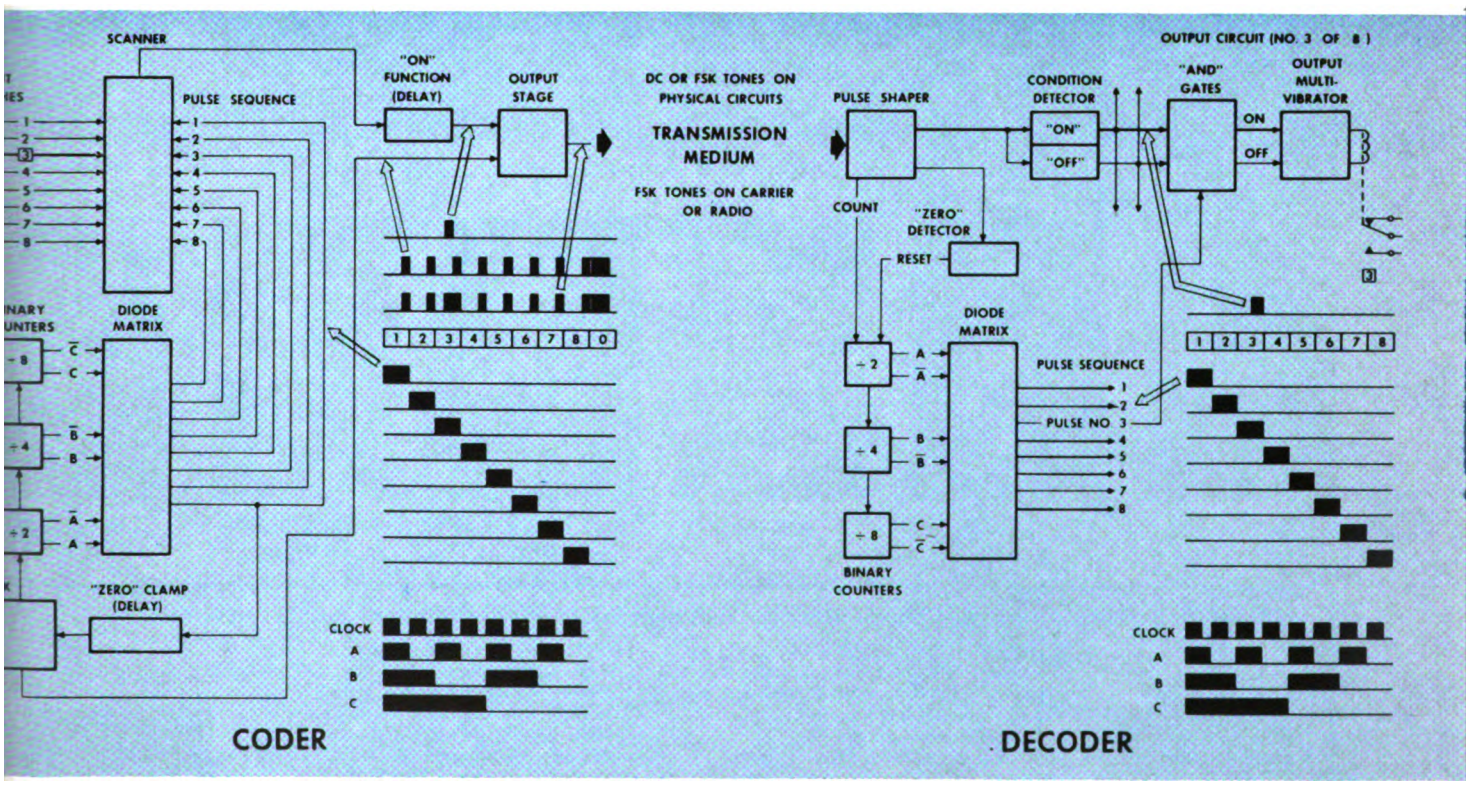
Continuous transmission is practical because, in contrast with electromechanical systems, solid state circuits have no moving parts and are not subject to mechanical wear. And since solid state circuits do not produce arcs in switching, they are not subject to the contact erosion and transfer which causes variable contact resistance and eventual failure. The most outstanding attribute of solid circuitry is that its life is not affected by the number of switching operations performed, the manufacturer states.

Continuous transmission is desirable because it is "fail-safe." In systems which report upon remote change-of-state, the operator must assume that the remote terminal is intact between the occasions when he interrogates the terminal. If the interrogation is routinely performed at the beginning of each shift, an entire shift can trans-

# ne Division Multiplex System




k diagrams are of TDM system (above) and details of coder and decoder units (below) for SP interlocking.




e with an unreported remote alarm d an unreported system failure. If quent interrogation is employed, intenance problems will increase in ctromechanical systems. Moreover, quent interrogation depends on the erator, who may be busy or occasionally forgetful.

Except for control panel levers, audie alarm bell and output relays, the ntire system is exclusively of solidate design. No vacuum tubes, stepping switches, or thermal relays are used. Relays are used only as outputs on a per-indication or per-control basis. Relays are never used in the internal logic, where their failure could affect more than one indication or control.

Coders or decoders do not need adjustment because these items are digital rather than analog devices.

All external connections are located at the rear of the chassis. Screw terminals are provided for all external connections. Multipin connectors or telephone blocks are alternately available.

To facilitate maintenance and future expansion or rearrangement of the proposed system, all logic circuits, tone transmitters, tone receivers, and frequency-determining elements are plug-in. Notches on the circuit cards and keys in the card sockets substantially minimize maintenance-induced damage. RSC