Centralized Control
On the Chesapeake & Ohio

Installation at Alleghany, Va., extends over five miles of double-track territory and replaces three interlockings.

The Chesapeake & Ohio has made an extensive installation of remotely-controlled power switches and signals to facilitate train operations on the five miles of line over the summit of the Allegheny mountains, near Alleghany, Va. This new signaling project combines into one C.T.C. machine the control of facilities formerly included in three interlockings, and in addition, it provides control of signals for directing train movements in this five-mile area. The traffic handled daily over the territory includes 8 passenger trains, 4 manifest freight trains, and from 12 to 16 extra freight trains. In addition, there are return moves of helper engines for some of the tonnage freight trains. Therefore, the total traffic ranges from 30 to 40 movements daily.

Approaching from the east on an ascending grade of 1.3 per cent, the double-track line passes through Kelly's Tunnel, and about 3,000 ft. west of the tunnel, a center passing siding starts and extends for about one mile westward, with a facing-point crossover just west of the west end of the siding. This siding layout, together with an end of double-track for the previous single track westward through the old Lewis Tunnel, was formerly operated by a 24-lever, electro-mechanical interlocking plant known as Jerry's Run. When a second single-track Lewis Tunnel was constructed, the old tunnel was assigned for the westward track and the new tunnel for the eastward track.

At East Alleghany, at the west end of the old single-track Lewis Tunnel, there was previously a 24-lever, electro-mechanical plant, which included the end of double-track switch and the switches for the east end of two
sidings which extend westward to Alleghany. When the new Lewis Tunnel was completed and the double track extended from Jerry's Run to East Alleghany, the track layouts at these two points were revised accordingly.

At Alleghany, 1.25 miles west of East Alleghany, the track layout includes several crossovers and switches to handle the west end of the two passing tracks and connections to the two main tracks extending westward through the two separate single-track Alleghany tunnels, the summit of the grade approaching from each direction being located about 600 ft. east of the east portals of these tunnels. For eastward tonnage trains, the helper engines are attached at Hinton, W. Va., 51 miles west of Alleghany, and are cut off at Alleghany. For westward trains, they are attached at Clifton Forge, 29 miles east, and are cut off at East Alleghany. The track layouts at Alleghany and at East Alleghany are arranged to facilitate cutting the helpers off and for moves to and from the turntable at Alleghany.

Prior to the installation of the C.T.C. machine, a 32-lever mechanical interlocking machine was in service at "A" Cabin, Alleghany, to handle the switches and crossovers at the west end of the passing tracks and for controlling the home interlocking signals, including remote control of the signals at the west end of old Alleghany Tunnel, near Tuckahoe, W. Va. During the construction of the new tunnels, temporary changes were made in the track layout at the three old interlocking plants which required a rearrangement of the interlocking facilities, and after the tunnel work was completed, arrangements were made to extend the westward passing siding at Alleghany so that it would hold long freight trains. The extension of this siding made it necessary to rearrange some of the crossovers and switches at Alleghany.

**New Interlocking and Remote Control**

The track changes in connection with the extension of the westward siding involved major revisions in the interlocking arrangement at Alleghany which would have made it necessary to install a new interlocking machine, and as it was desirable to arrange for train operation in either direction by signal indication on both main tracks through the territory—Tuckahoe to Jerry's Run—it was decided that, as a part of the program, the logical procedure would be to abandon the three old interlockings, install power-operated switches and signals, and control all these facilities from a new C.T.C. type machine in a new tower to be known as "A" Cabin, located just west of Alleghany station. By arranging the signals for either-direction operation on the two main tracks, train movements would be greatly expedited in case of landslides or trouble developing in one of the tunnels. Furthermore, it would permit turning one of the tunnels over to track or other forces for certain hours of the day, thus facilitating their work. Another advantage of either-direction operation is that runaround movements can be made, thus keeping all trains moving rather than putting one of them on a siding.

The switches in the general vicinity of the tower are operated by electro-pneumatic switch and lock movements, while low-voltage electric switch and lock movements are used at Tuckahoe, East Alleghany, and Jerry's Run, with the exception of the switch at the east end of the cen-
The C.T.C. control machine is so arranged that the operator can reach any lever without leaving his chair.

The C.T.C. Control Machine

The C.T.C. type control machine in "A" Cabin is arranged in two panels, the end section at the right being set at an angle with the main section, so that the operator can readily reach any of the levers without leaving his chair. The machine has 15 levers for the control of 7 single switches, 2 derails and 6 crossovers; 23 levers for the control of 44 signals, 2 traffic levers and 4 levers for the control of electric switch locks and as selector levers on hand-operated switches. The levers are of the usual miniature type, each lever being equipped with indication repeater lamps, so that the leverman knows the position of each switch and the aspect of each signal. An illuminated track diagram, mounted just above the levers, indicates the location of all trains on the main tracks in the five-mile controlled territory.

Control of Tunnel Fans

Mounted in a small case to the right of the C.T.C. machine is a one-lever controller used for the control of the ventilating fans for removing locomotive smoke from the westward Lewis Tunnel. Normally, the operation of these motor-driven ventilating fans is controlled automatically by track circuits, as a train approaches the tunnel. However, provision was also made for the fans to be operated manually when desired. This is accomplished by the operator at "A" Cabin throwing the lever to the "down" position to cause the fans to operate independent of the track circuit control. On the other hand, when a passenger train is being operated through the tunnel, for which it is not necessary for the fans to be operated, the operator can offset the track circuit control and prevent the fans from operating by throwing the lever to the "up" position. A yellow lamp on the C.T.C. machine is lighted when the fans are in operation, and a red lamp is lighted when the fans are not in operation. The control of the fan is by direct wire, but the indications, between the fan house at the tunnel and "A" Cabin, are transmitted as a part of the code control system.

Train Order Signal Control

"A" Cabin is a block office for the delivery of train orders when required. Two color-light type signals, one for eastward movements and the other for westward movements, are mounted on the track side of the tower, and are designated as train order signals. These signals are controlled by a small two-lever controller mounted on the operator's desk at the right of the C.T.C. machine. The levers are normally on center and the signals normally dark, indicating no orders. When the lever is thrown down, the signal displays a yellow aspect indicating that a non-restricting "19" order is to be delivered, but when the lever is thrown up, the signal displays red indicating that the
train is to stop for a "31" or restricting "19" order. The aspect displayed by either signal is repeated on the controller so that the operator knows that the signal aspects correspond to the position of the lever, and he also has a check against a burned out lamp bulb. Under normal operating conditions, train movements in the territory from Jerry's Run to Tuckahoe are directed by signal indications without written train orders. The orders, when issued at "A" Cabin, are ordinarily with reference to moves or track conditions beyond the control zone.

Construction at "A" Cabin

The switches and signals throughout the area from the east portal of Alleghany Tunnel eastward to Alleghany station are controlled by direct wire connections. However, the code control system, using only two line wires, is used for the control of the functions at East Alleghany and Jerry's Run. A separate two-wire code circuit extends westward for the control of the switches and signals at Tuckahoe.

The section of the installation in the general vicinity of "A" Cabin, although a part of the complete C.T.C. project, is in reality an electro-pneumatic interlocking, employing the all-relay principle, so far as interlocking of the functions is concerned.

The compressed air for the operation of the 10 electro-pneumatic switch machines is furnished by a 12.5-cu. ft. compressor driven by a 2-hp., 220-volt, 3-phase motor, operating at 1,410 r.p.m. A duplicate motor-driven compressor is provided for stand-by or alternate service. Each motor is controlled by a twin-break starter, controlled automatically by the pressure in the air lines. The compressor on first call cuts in when the air pressure drops to 55 lb. and cuts out at 75 lb. In case the pressure drops below 50 lb., the second compressor also cuts in.

The power equipment, including enclosed type switches, circuit breakers, transformers and rectifiers, is mounted on a large board made of asbestos sheets attached to angle-iron uprights. The wires running to the devices on this board are in metal conduit with outlets at each device, as shown in one of the illustrations.

Each of the two relay racks in this

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... extending from the relay racks up to the machine are enclosed in chases made up of asbestos board.

The 2-in. pipe line for the distribution of the compressed air for the operation of the switches is run along the north side of the tracks, being supported on stakes. Each stake is made of a piece of 2½-in. angle-iron set in concrete, the pipe being supported in a hook made of ½-in. by 2-in. strap iron. When constructing the line, the stakes were set, the pipe was distributed, and connected up, screwclamps were used temporarily to hold the hooks to the stakes, the pipe was then set in place, and the hooks adjusted up or down on the stakes so as to align the pipe properly. The hooks were then welded to the stakes permanently, and the clamps removed.

The local wiring distribution over the plant area in the vicinity of the tower is in steel-taped cable run in cable rings suspended from stranded messenger attached with special brackets to the same stakes used for...
the support of the main air line, the
cables being run at the same level as
the pipe line, about 12 in. to 15 in.
above the level of the ground. The
main cables are run on the communic-
ation pole line.

At certain points, as required, the
main cables enter junction boxes or
instrument cases, from which under-
ground steel-taped cables extend to
the various switches, signals or track
connections. The instrument cases
and of the welded sheet-metal type
with two hinged doors at the front
and, at the rear, two removable panels
provide access to the wiring space be-
hind the terminal board. As a means
of protecting the incoming cables at
the ground line, the cables are
brought up through a vitrified clay
tile, and after the cables are in place,
the void space is filled with sand and
sealed at the top with about one inch
of pothead compound. The No. 14
AWG solid copper, steel-taped cables
for switch and signal wiring are made
up with two wraps of steel tape and
jute covering.

For rail connections, single-con-
ductor No. 9 AWG solid copper,
steel-taped cables are used, the make-
up including two wraps of steel tape
and jute covering. At the rail, this
cable is brought up through a wooden
box riser, the wire end being soldered
to two lengths of No. 9 flexible in-
sulated wire, each of which is run out
through a hole in the top of the riser
and fastened to either side of the rail
by means of a rail terminal which
consists of a %-in. plug threaded on
one end and equipped with an eye-
let, cupped washer and nut. The
connection at the rail and the plug is
treated with a coat of No-Ox-Id, to
prevent corrosion.

Construction at Outlying Points

Beyond the limits of the Alleghany
area, the control of the switches and
signals is accomplished by the time-
coding system in contrast to the
direct-wire control in the Alleghany
area. Furthermore, in the remote
areas, low-voltage d-c. electric switch
machines are used, instead of electro-
pneumatic machines as employed at
Alleghany.

The signal, code and power line
wires in this territory are carried on
a 10-pin crossarm mounted below the
crossarms which carry the communi-
cation line circuits on the pole line.
They are all protected with double-
braid, weatherproof covering, the
signal control wires being No. 10
AWG copper-covered steel, and the
two code wires, as well as those for
the 440-volt a-c. power distribution,
are No. 6 AWG, hard-drawn copper.
Porcelain insulators are used for the
440-volt line, brown type pyrex glass
insulators for the code circuit and
ordinary glass insulators for the
signal control circuits.

The a-c. power for this territory is
distributed at 440 volts, single-phase,
this circuit being marked on the end
of each crossarm with 2-in. aluminum
markers. At each signal location a
440/115 volt line transformer is
mounted on the crossarm and each
transformer layout is protected by
pellet-type arresters and fused cut-
outs. The line taps are made with
solderless clamp-type connectors. The
machine at "A" Cabin is equipped
with indication lamps to show when
power is cut off at each of the four
locations; namely, Tuckahoe, Alle-
ghany, East Alleghany and Jerry's Run.

The signals are normally a-c.
lighted, and the power line also fur-
nishes current for operating the rect-
ifiers which charge the various sets
of storage battery. At each of the
field stations, a set of 13 cells of
112-a.h. capacity lead battery is used
for the operation of the switch ma-
chines, 8 of these cells being used also
for code operating battery. Five
cells of 168-a.h. or 224-a.h. capacity
lead-type battery, as required at the
various locations, are used to feed
local control relays and to act as a
stand-by for the signal lamps. Two
sets, one of 12 and one of 7 cells of
8-a.h. capacity lead-type battery,
located at "A" Cabin, are used to
feed the code lines east and west of
"A" Cabin, respectively. Each track
circuit is operated by one nickel-iron
Cable is run on messenger at the pipe-line level

Sheet-metal cases house the instruments and battery at the home signals

storage cell. Each battery is on floating charge through a dry-plate rectifier.

The field control batteries, relays, rectifiers and equipment, including coding apparatus, are located in four centrally located houses, one at the east end of Jerry's Run, one at the west end of this layout, one at East Alleghany and one at Tuckahoe. Each of these houses is 8 ft. wide and of varying lengths from 9 ft. to 14 ft., of frame construction, using 2-in. by 4-in. studdings, and 1-in. by 8-in. shiplap siding and roof. The outside walls and roof are covered with heavy gage corrugated galvanized sheet iron. The foundation and floor are in one piece, made of concrete poured in place.

In order to allow space for a man to get behind the relay racks in the house, those on the rear and two sides are set out 20 in. from the wall. The racks are built up solid from the floor to the ceiling, of 1-in. boards bolted to ½-in. by 2-in. by 2-in. angle-iron uprights. All incoming cables and wires are brought into this outer compartment, and the wires are run through small holes to bakelite base terminals, which are mounted on the rear wall of the relay rack. The interior wiring is No. 16 flexible with ⅛-in. insulation wall and single braid. Distributing wires from the terminals to the various instruments are run back through the wall, thence on messenger rods in the wire-way to a point where they again pass through holes to the binding posts on the instruments. In this way all the wiring runs are out of sight, and yet there is adequate space behind the racks to install or inspect the wiring. All terminals, arresters, limiting resistances, fuses, etc., are mounted on the rear wall of the terminal rack.

A 5-ohm adjustable resistor is used for each track circuit, and a 3.5-ohm adjustable resistor is used for each signal lamp circuit. The battery connections to the code units are fused with 6-amp. fusetrons. The signal line control circuits are protected by series line clock-coil type arresters, and the track relays are protected by shunt-type arresters with the center tapped grounded. These arresters are connected to grounds used exclusively for this purpose, being separate from the ground for the arresters on the 440-volt circuits.

The lightning protection for the code line is of special interest. At each instrument house the following combination is used: Neon Argon arresters are connected in series and are located in a box on the line pole. Number 60 AP arresters with carbon blocks are connected across the line and are located in each instrument house and in the tower at “A” Cabin. This arrangement of arresters has proved very successful in preventing failures of the code line which might otherwise be caused by lightning. For testing or changing out code apparatus, the code line equipment at any of the outlying field stations can be by-passed by reversing a knife switch which cuts off the line coding unit and inserts a 20-ohm resistance in series with the line.

Relay Assignments

The track relays are of the DN-11 type, using 4-ohm relays for short detector sections and 2-ohm relays for normal length circuits. The line control relays for the three-position automatic signals are the DP-21 retained-neutral polarized type rated at 400 ohms, and DN-11, 500-ohm re-