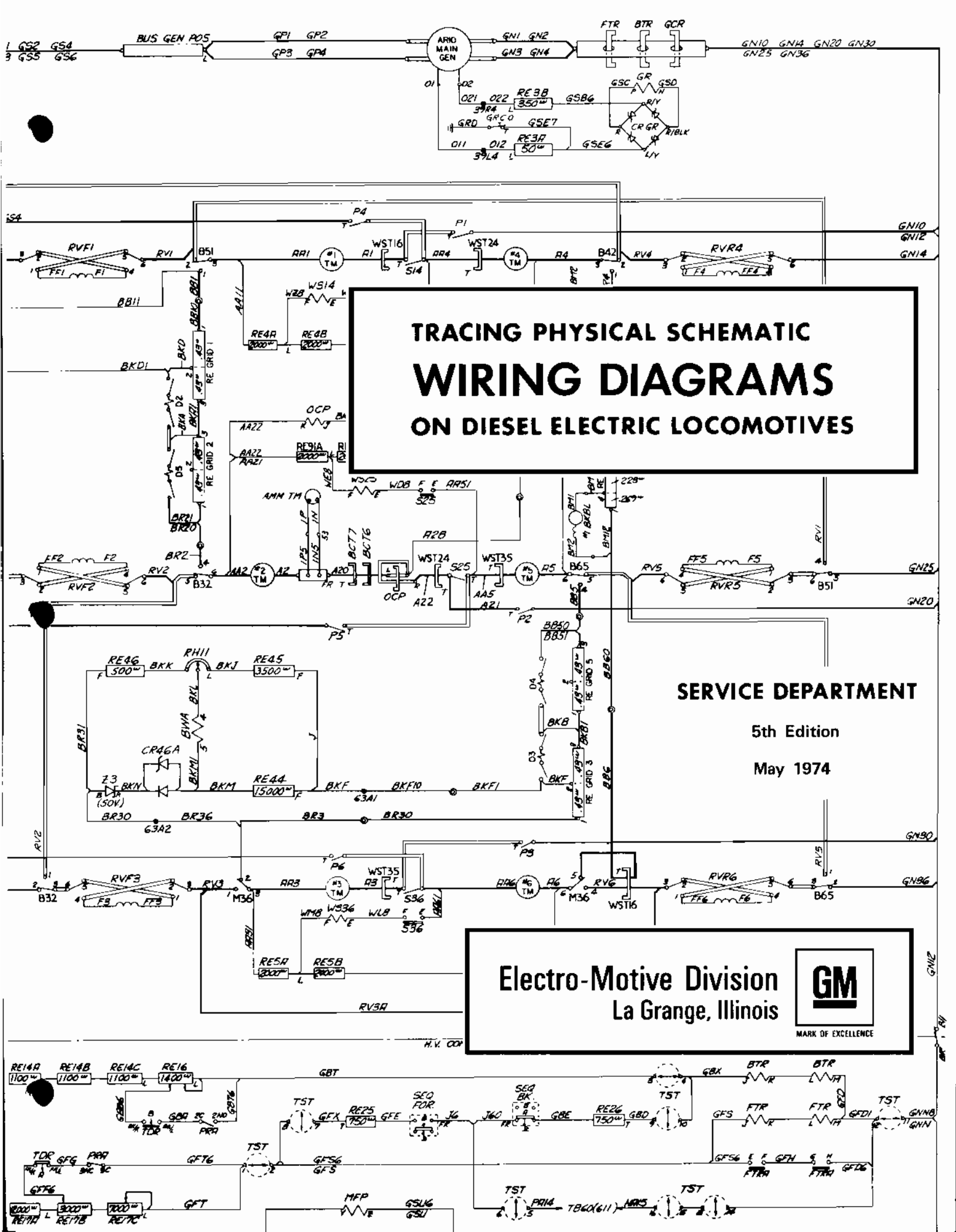
TRACING PHYSICAL SCHEMATIC
WIRING DIAGRAMS
ON DIESEL ELECTRIC LOCOMOTIVES
SERVICE DEPARTMENT
5th Edition
May 1974
Electro-Motive Division
La Grange, Illinois
GM
MARK OF EXCELLENCE

TRACING PHYSICAL SCHEMATIC WIRING DIAGRAMS

INTRODUCTION

The purpose of this manual is to describe the physical schematic wiring diagram along with its associated diagrams and wiring list book, and to provide a guide to aid in the use and understanding of the diagrams and list.

The name "physical schematic" literally describes the diagram. That is, its form is a combination of the physical wiring diagram and the schematic wiring diagram. It provides a direct presentation of electrical circuit paths with complete identification of point to point wiring.

The actual location of electrical equipment on the locomotive and within electrical cabinets can be determined through use of the wiring list and the conduit layout diagram associated with the physical schematic diagram.

ASSOCIATED DIAGRAMS AND WIRING LIST

A legend (see Fig. 1) located at the lower right corner of the physical schematic diagram provides identification numbers for the wiring running list and for diagrams associated with the physical schematic. These generally include the following.

1. Wiring Running List Book (includes device location sketches and component parts list).
2. Cable And Conduit Layout Diagram (sometimes part of the physical schematic).
3. Electrical Devices Wiring Diagram (sometimes supplemented by a diagram covering printed circuit devices).
4. General Charts And Graphs Drawing (sometimes supplemented by individual charts and graphs drawings for specific plug-in circuit modules).
5. Main Generator Schematic Wiring Diagram.

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FOR SCHEMATIC WIRING OF MAIN GEN. SEE DRG. 8391243.
FOR SCHEMATIC WIRING OF ELECTRICAL DEVICES SEE DRG. 8385273.
FOR SCHEMATIC WIRING OF PRINTED CIRCUIT ELECTRICAL DEVICES SEE DRG. 8449686.
FOR SETTING CHARTS & GRAPHS SEE GENERAL DRG. 8398212.
FOR TR10 GRAPH SEE DRG. 8448641.
FOR PF13 GRAPH SEE DRG. 8448642.
FOR LOCOMOTIVE WIRING RUNNING LIST SEE 8438460.
FOR LOCOMOTIVE CONDUIT LAYOUT DIAGRAM SEE DRG. 8438459.

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ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION
LA GRANGE, ILLINOIS, U.S.A.

LOCOMOTIVE WIRING DIAGRAM
PHYSICAL SCHEMATIC
GP40-DE

DATE OF PRINT

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Fig. 1 — Sample Legend Of Associated Diagrams And List

THE PHYSICAL SCHEMATIC WIRING DIAGRAM

All locomotive wiring and all electrical devices are shown on the circuitry portion of the physical schematic diagram. The circuit paths are arranged in groups and are identified as to function. All wires and all terminal points, whether on devices or on terminal boards, are shown and are identified. The wires (with the exception of many jumper wires) bear a letter or number prefix that is common to all wires in the same functional group.

Locator charts are provided to point out the vicinity in which devices and terminal points

appear on the drawing. Locator numbers at the margins of the diagram identify the vicinity.

Fig. 2 illustrates a sample portion of a circuit appearing on the physical schematic wiring diagram. The "A" portion of the illustration shows the circuit as it would appear on a basic schematic presentation. The actual wiring cannot be determined from the basic schematic.

The "B" portion of Fig. 2 shows the physical schematic presentation of the same circuit. This form provides all the information given by the basic schematic, but in addition indicates the actual physical wiring.

The "C" portion shows a pictorial example of the physical schematic. It is presented here only as a guide in interpreting the conventions used on the physical schematic wiring diagram.

Before tracing the sample circuit, examine the basic symbols, a clear understanding of which is necessary to properly use the diagram.

As on the basic schematic, a single wire line represents an electrical current path. This line can represent one or more wires, but the wires are connected as an electrical unit. A junction point on the basic schematic is indicated by a heavy dot where lines cross or meet. On the physical

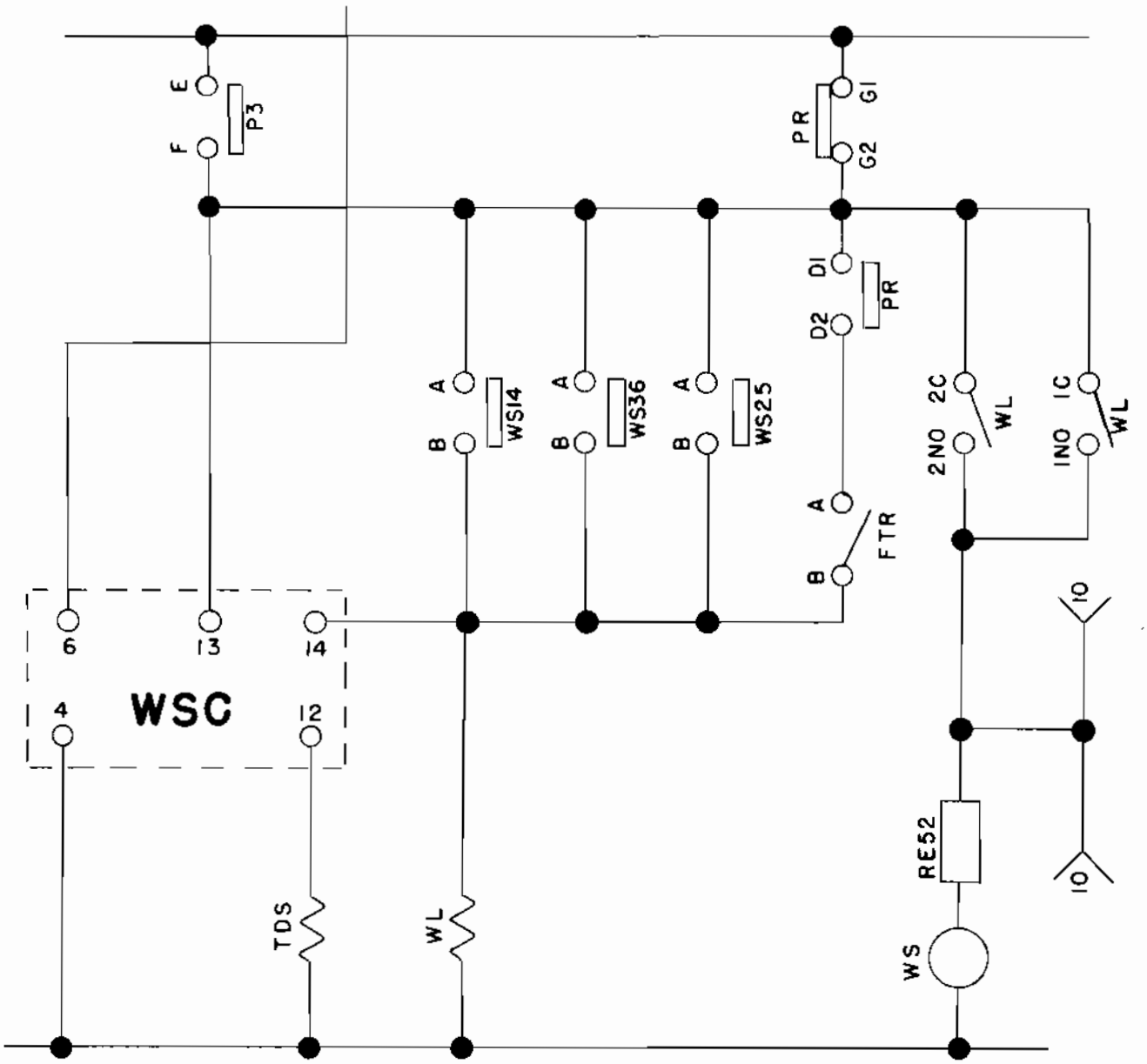
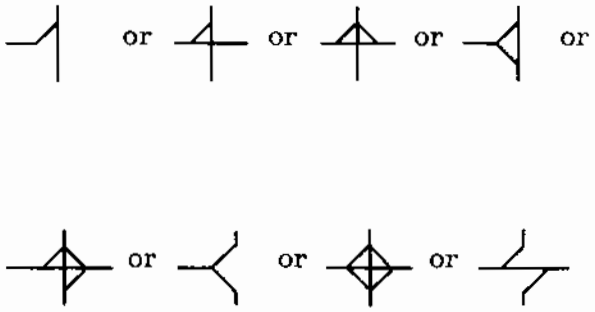


Fig. 2A — Basic Schematic Presentation

schematic diagram the electrical junction is indicated thusly:

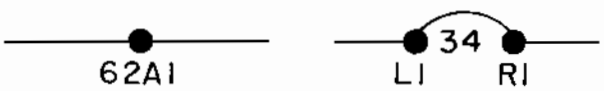


Each of the above symbols is electrically equivalent to the symbols  and  on the basic schematic.

On both the basic schematic and physical schematic, crossed wire lines

that do not bear a connection symbol (either the dot on the basic schematic or the small diagonals on the physical schematic) indicate that no electrical connection is made at the point of intersection.

It will be well to observe at this point that a solid dot symbol is used on the physical schematic wiring diagram. This dot symbol represents a terminal board connection. It will always be identified by a terminal board number and terminal identification.



Observe on Fig. 2B that the crossed lines in the vicinity of 6B8 and 13AC3 do not constitute an electrical connection, but the crossed lines at the 13AC6 abd 13AC8 designations, joined by small diagonals, do constitute an electrical connection. The actual wires are not, however, connected at that point. There is no splice or terminal. This can be noted by observing the same area in Fig. 2C. By tracing on the pictorial example one can find that an electrical path exists just as surely as on the circuit shown on the basic schematic diagram.

Notice on Fig. 2B that while small diagonals at an area of crossed wire lines indicate a common electrical point, they also provide a guide in circuit tracing of actual wires. For example, the junction at 13AC6/13AC8 indicates that the 13AC6 wire leads to the left, and the 13AC8 wire leads to the right, while the jumper "J" runs vertically. The 13AC and "J" designations at 2C of WL eliminate that point as the termination of the 13AC8 wire, therefore the 13AC8 wire must terminate at 1C of WL, even through it is not so identified in the vicinity of WL. Normally, however, the 13AC8 wire would be identified at the vicinity of WL, but for purposes of explanation the wire identification was intentionally omitted. This is to point out that the logic of the wire identification scheme enables identification of wire lines where the number may not appear.

The 13AC6 wire terminates at "F" of P3. This can be determined by following the wire lines, the diagonals, and wire identifications.

The electrical junction symbol also indicates by logical process of elimination that the 13AC wire leads horizontally through the junction symbol located between D1 and G2 of PR and to the adjacent symbol. At that connecting symbol the 13AC wire makes electrical contact with "A" of WS25, but the symbol indicates that the actual 13AC wire must pass through the junction symbol The diagonal at the junction does not indicate a change in the direction of the 13AC wire. To use an analogy in railroad terms, a branch cannot be entered by passing over a switch in a "leaving" direction. The small diagonals at wire line intersections can be construed to symbolize "entering" and "leaving" sides of a switch. At the next junction the diagonal symbol would allow the 13AC wire to lead downward to "A" of WS36, but the wire identifications indicate that this is not the case. Therefore, the 13AC wire must continue horizontally to the next junction where it again may continue on or bend downward. The wire identifications indicate that it does in fact lead down and terminate at "A" of WS14.

Referring again to the pictorial (Fig. 2C) of the physical diagram, observe that all wires labeled 13AC are shown darker than others. This is merely to accentuate the 13AC wire circuit which is being used as an example. Notice that all wires in the 13AC circuit are connected continuously from "F" of P3 to 13 of WSC without passing through a device. In a manner of speaking, this is the AC wire sub-circuit in the 13 group.

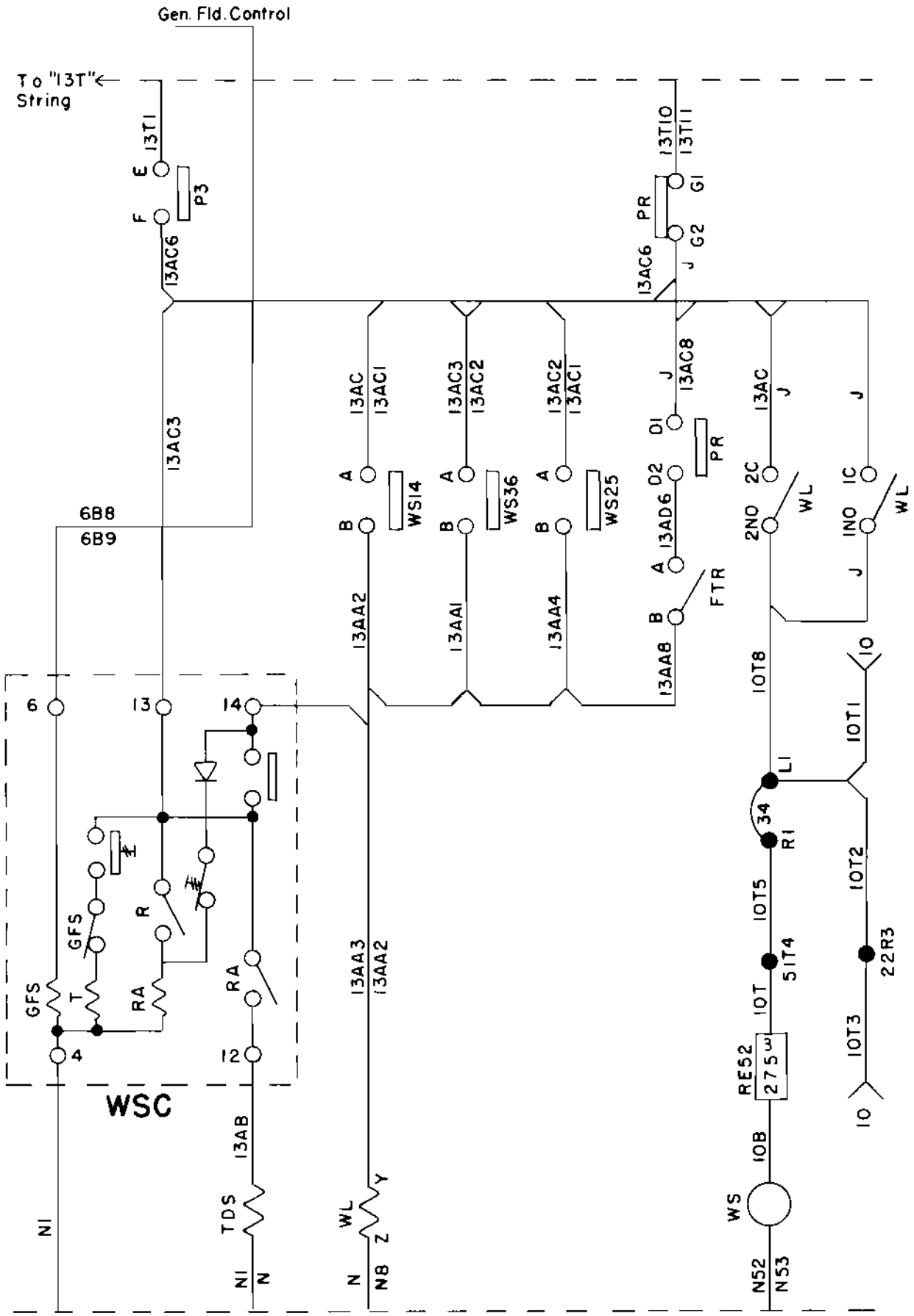


Fig. 2B – Physical Schematic Presentation

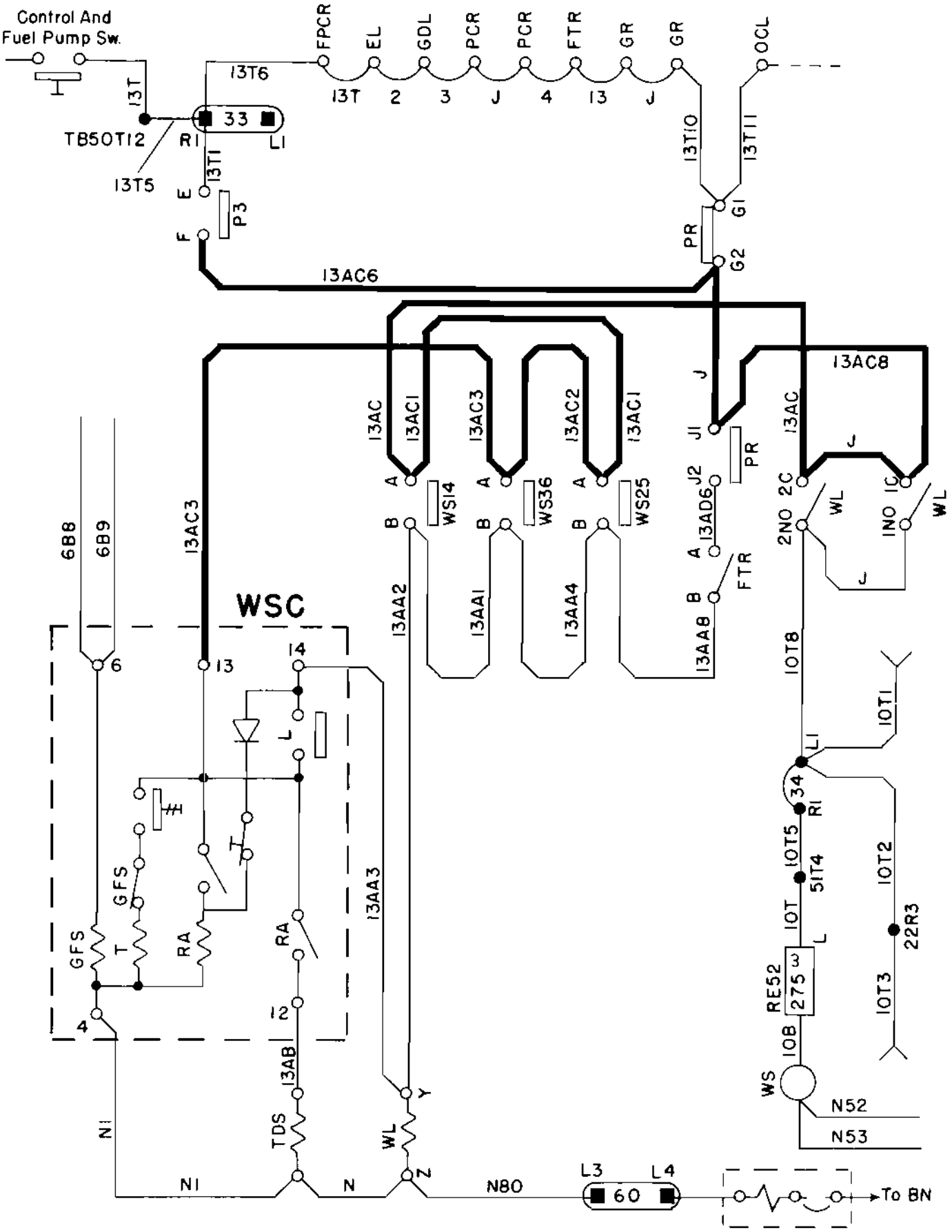


Fig. 2C — Pictorial Example Of Physical Schematic Diagram

INTERLOCK AND EQUIPMENT LOCATOR CHART

An "Interlock And Equipment" locator chart is provided at the right-hand area of the physical schematic diagram. The chart lists contactors, relays, main and auxiliary generators, control system components, capacitors, resistors, rheostats, rectifiers, and diodes. Locator numbers are provided on the chart to show the location of the component itself or for parts of the component, such as operating coils, main contacts, or interlocks. Thus, if the operating coil of a power contactor appears in the vicinity of locator number 860 at the margin of the drawing, its main contacts may appear at 125, while various interlocks are at locations such as 884, 650, and 130.

LOCATOR NUMBERS AT MARGINS OF THE PHYSICAL SCHEMATIC DIAGRAM

Circuits on the physical schematic are located by function at specific areas on the diagram. The margins of the diagram are provided with locator numbers in groups or series that identify the function. The individual numbers in the series assist in locating specific electrical components. The marginal numbering scheme is as follows.

Number Series	Margin Location	Circuits At The Area
100	Left	Power Circuits
200	Btm & Top	Excitation Circuits
300	Btm Or Top	Auxiliary Circuits
400	-	–
500	Btm Or Top	Lighting Circuits
600 & 700	Btm	Local Control Circuits
800 & 900	Top	Trainlined Control Circuits

LOCATOR LEGENDS AT CIRCUIT AREAS

In addition to grouping of circuits by general function, they are also grouped as closely by specific function as practicality permits. Legends adjacent to negative appear in brackets to identify the specific function of a particular area. Examples follow.

6T
GEN. FIELD CONTROL

"M" MOTOR CONNECT CONTROL

INTERLOCK LOCATOR CHART

The Interlock Locator Chart, Fig. 3, provides a listing of relays and contactors and associated interlocks.

The relays and contactors are arranged in alphabetical order in the ITEM column. Location of the operating coil of the item is provided in the COIL column. Location of main contacts, when applicable, is provided in the MAIN column. The ZONE column gives the physical location of the item.

The INTERLOCKS column gives the location and designation of all interlocks of each item. Notice that each item has two rows for interlock information. The top row identifies and locates the normally open interlocks. Identification and location of normally closed interlocks is provided in the bottom row.

Locate PR in the ITEM column of Fig. 3. The coil is located at 647 on the physical schematic wiring diagram and is physically located in zone 36. Interlocks A through F are normally open and G through M are normally closed. Normally open interlock A is located at 648 on the physical schematic wiring diagram. Normally open interlock F and normally closed interlock M are located at 650 on the physical schematic wiring diagram.

NOTE If the locomotive is equipped with motor operated switchgear, the "normal" position relates to the switchgear position as indicated at the symbol for the operating mechanism.

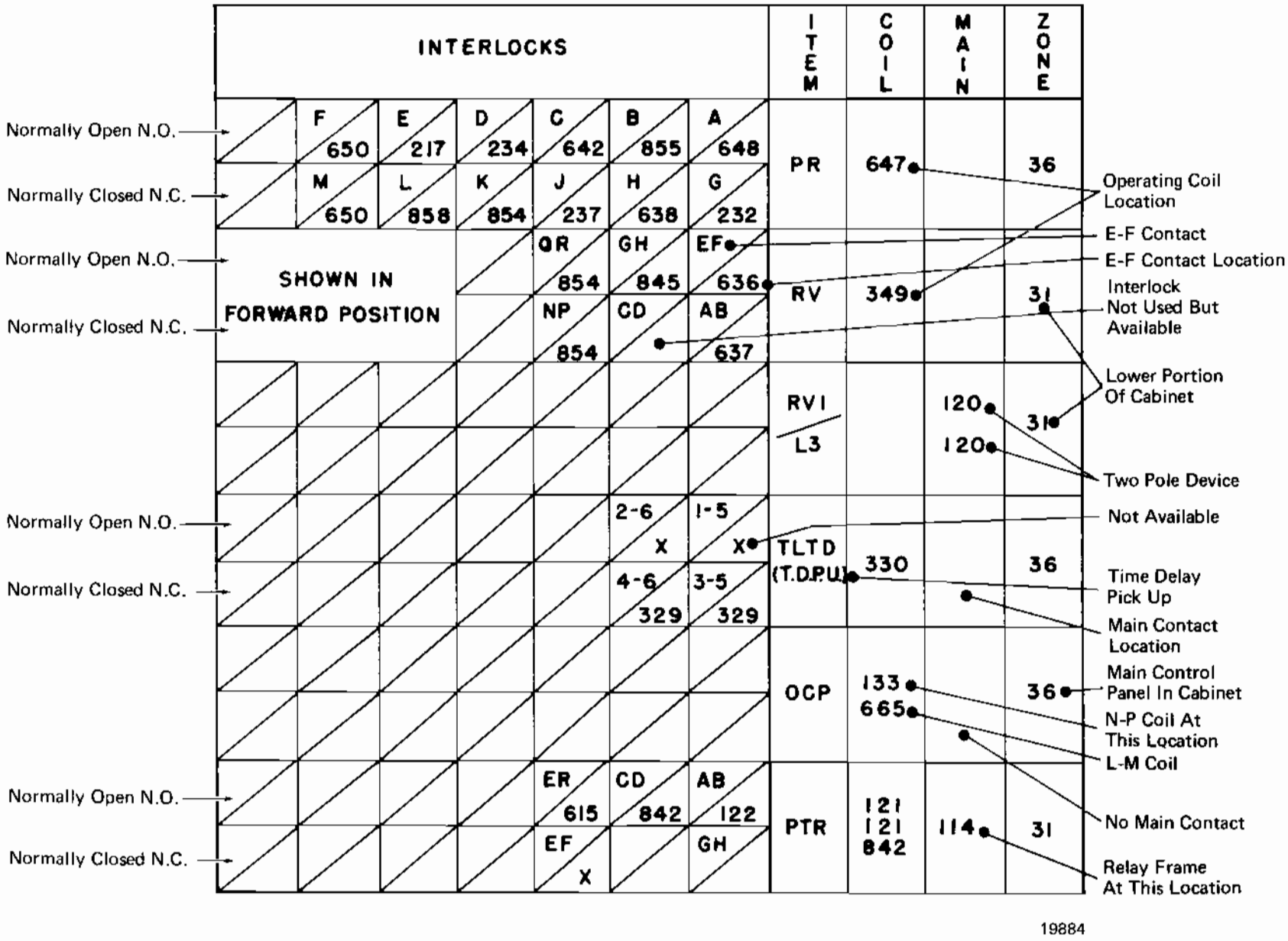


Fig. 3 -- Interpretation Of Sample Locator Chart

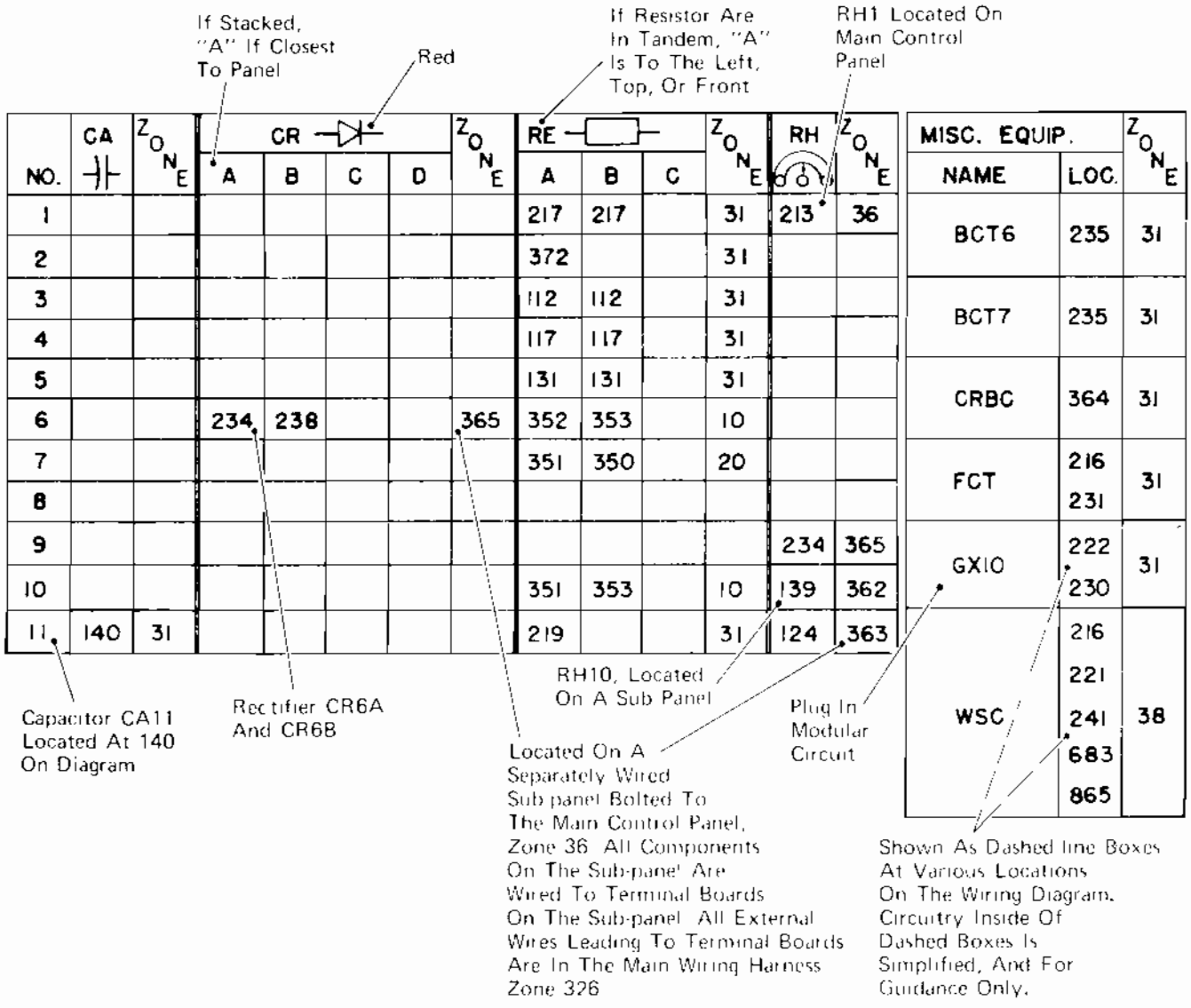
EQUIPMENT LOCATOR CHART

Fig. 4 is a sample of the form used for the equipment locator chart. The main portion of the chart covers common electrical components, capacitors, diodes, resistors, rheostats. These components are arranged in columns by type and in rows by number. When the components are part of an assembly, letters are used to identify each part of the assembly. Thus, the first entry on Fig. 4 is a resistor RE1A, which appears at location 217 of the wiring diagram. The actual physical location of the resistor is at zone 31 in the electrical cabinet.

The last entry on the main portion of the equipment locator chart shown in Fig. 4 is rheostat RH11, which appears at location 124 on the wiring diagram, and is physically located at the main control panel (zone 36) of the electrical cabinet, refer to zone diagram Fig. 8. The zone number given further indicates that this rheostat is located on the sub-panel on the main control panel.

A miscellaneous equipment locator chart is also provided. This covers equipment (other than contactors and relays) and common components that are not identified by a number (e.g. CR-BC and RE-BC).

Notice that two or more location numbers are given for certain pieces of miscellaneous electrical equipment. This is because the devices function in various electrical circuits, consequently must be shown in the vicinity of those circuits. Depending upon the type of device involved, each



NO.	CA	ZONE	CR A	CR B	CR C	CR D	ZONE	RE A	RE B	RE C	ZONE	RH	ZONE
1								217	217		31	213	36
2								372			31		
3								112	112		31		
4								117	117		31		
5								131	131		31		
6			234	238			365	352	353		10		
7								351	350		20		
8													
9												234	365
10								351	353		10	139	362
11	140	31						219			31	124	363

MISC. EQUIP. NAME	LOC.	ZONE
BCT6	235	31
BCT7	235	31
CRBC	364	31
FCT	216 231	31
GX10	222 230	31
WSC	216 221 241 683 865	38

Fig. 4 – Interpretation Of Sample Equipment Locator Chart

portion of the device may be represented by a symbol or it may be represented by a broken-line rectangle with symbols inside of the rectangle. For example, a symbol is used to indicate the magnet frame of FCT at one location on the diagram, while FCT coils are represented by another symbol at another location.

MODULE LEGEND AND LOCATOR CHART

Certain locomotive models are equipped with transistorized control and regulating circuits that are "packaged" in modular form. The modules consist of circuit boards on which the necessary circuit components are mounted. The boards are

MODULE LEGEND AND LOCATOR CHART

NAME	FUNCTION	LOCATION					
DE10	Dynamic Brake Extended Range Control	122	212	235	658		
DG10	Dynamic Brake Grid Protection	232	674	684			
DP10	Dynamic Brake Protection Brake Warning, Motor Fld.	118	123	236	678	888	
DR10	Dynamic Brake Regulator	126	212	237			
EL10	Excitation Limit Control	235	678	672			
GV10	Generator Voltage Regulator	226	231				
GX10	Generator Excitation Regulator	226	234				
PF10	Performance Control	236					
RC10	Rate Control	216					
SA10	Sanding Control	844					
SB10	Sensor Bypass Max. Performance (if applicable)	128	226	230	230		
SE10	Sensor (Excitation Control)	116	226	226	229		
TH10	Throttle Response & Reference Voltage	213	861	867			
TR10	Transition Control (if applicable)	240	237	647	651		
VR10	Voltage Regulator	375					
WO10	Wheel Overspeed (if applicable)	240	230	232	224	680	686
WS10	Wheel Slip Control	128	216 220	223 230	242	676	226

Number suffix is not shown at device locations at schematic diagram circuitry.
All modules are located in Zone 33 of the electrical cabinet

Fig. 5 — Sample Module Legend And Locator Chart

fitted with terminal pins that mate with receptacles mounted on a rack in the electrical cabinet. They are readily installed or removed when slid in guideways provided in the electrical cabinet. A handle and faceplate facilitate installation and removal. The module faceplate contains test points for in-place circuit testing.

Some locomotive models use a few plug-in modules for specific functions. Other locomotive models employ plug-in modules extensively and a full compliment of modules is used. In such cases a separate locator chart and legend, Fig. 5, is provided on the wiring diagram, and all circuit representations of modular components are shown as broken-line rectangles on the diagram.

BROKEN-LINE RECTANGLES

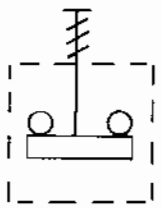
Broken-line rectangles are used to represent various types of equipment.

1. Electrical switches or breakers that are operated by means other than electromagnetic coils. These can include manually, pneumatically, or thermally operated switches, and magnetically or thermally operated circuit breakers.

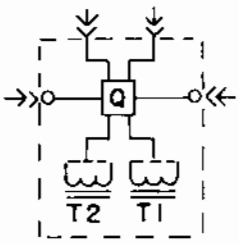
2. Equipment that involves electrical circuitry within an assembly. Such assemblies can generally be unfastened or unplugged, and the entire circuit replaced by application of another assembly. Plug-in modules are examples of such assemblies.

   For example, WSC and GX are shown as broken-line rectangles at a number of locations on the physical schematic wiring diagram, and circuit symbols are shown within the rectangles. The symbols provide a guide to the function of the components at that portion of the diagram. The circuitry within broken-line rectangles is symbolic and is intended only for guidance in tracing through the rectangles. The devices drawing referenced in Fig. 1 provides more complete diagrams showing the circuitry in such devices. Fig. 6 is an example illustrating the intention of the symbols used.

Pneumatically Operated Switch

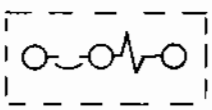


Manually Operated Switch (Spring Loaded)

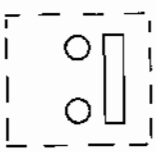


Circuit Assembly

Thermally Operated Switch



Magnetically Operated Circuit Breaker



Cam Or Handle Operated Switch

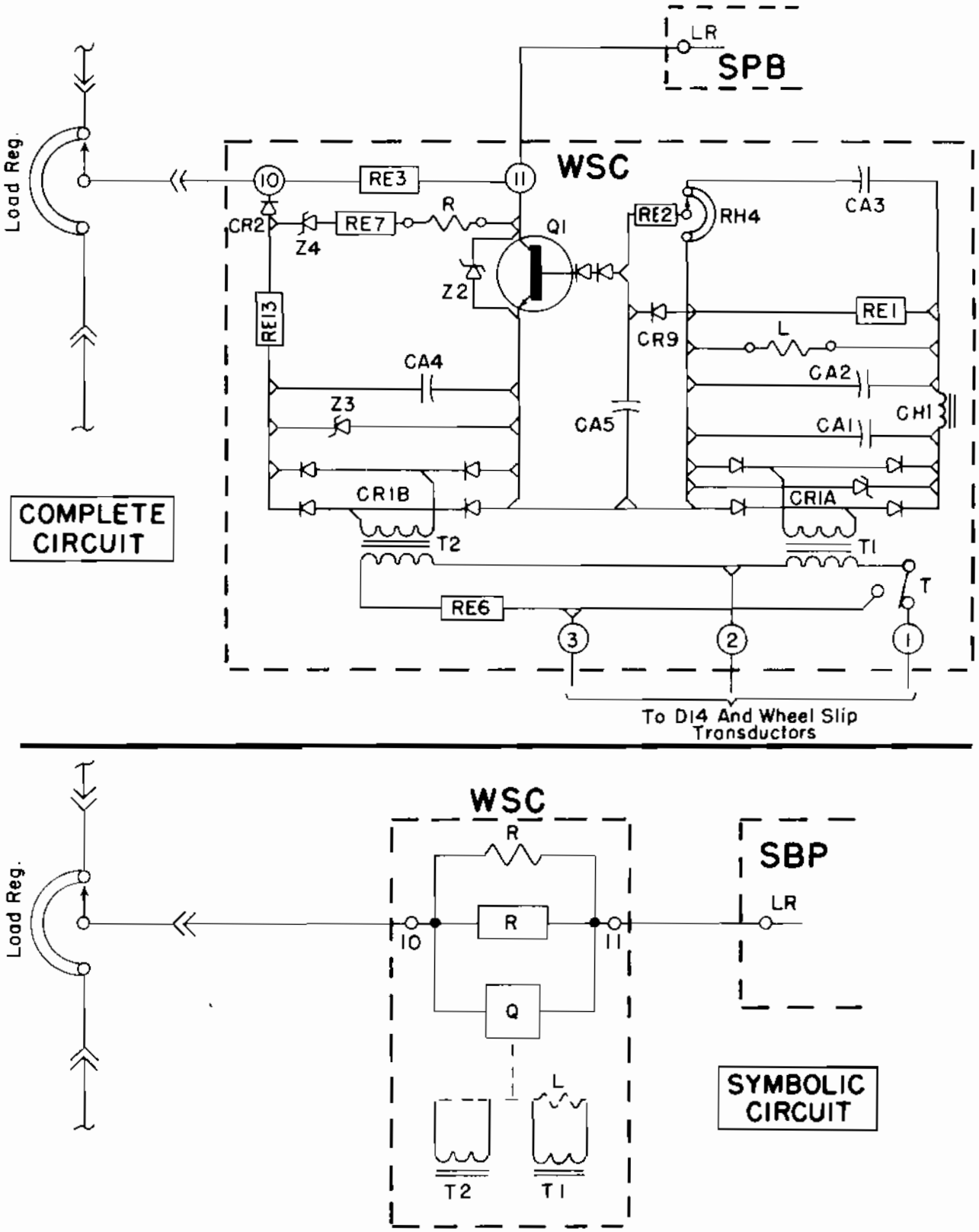
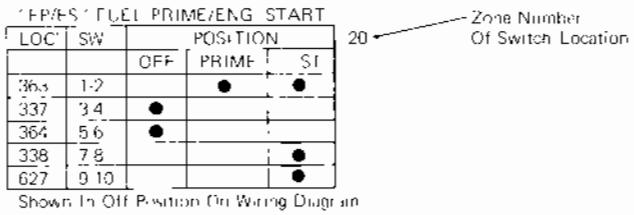


Fig. 6 – Example Of Symbols Within Broken-Line Rectangles

SWITCH LOCATOR AND POSITION CHARTS

Various switches used on a locomotive are of the multiple-pole ganged type. They employ either lever or motor driven cams to operate the individual switches in the gang, or are the rotary snap or spring loaded type.

The individual poles of any given switch perform separate functions, therefore must be located at various places on the schematic wiring diagram. The switch location charts provide marginal locator numbers for each set of switch contacts.

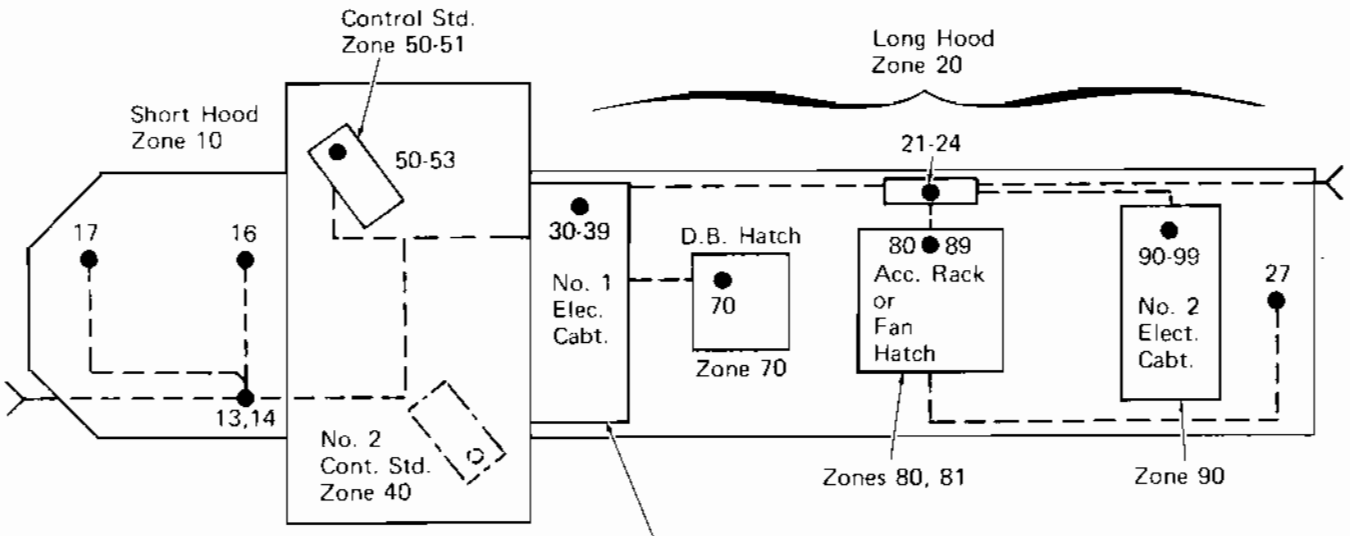


The charts also indicate whether contacts are open or closed at specific positions of the switch operating device.

EQUIPMENT LOCATION ZONES

Zone numbers are assigned to various locomotive areas that contain electrical equipment. Figs. 7, 8, and 9 illustrate the zones. Notice that terminal boards within a zone bear identification numbers related to the zone number. For example, terminal boards in zone 10 are numbered 13, 14, 16, and 17. Terminal boards in zone 80 may be numbered 81 and 82. Terminal boards in the lower portion of the main electrical cabinet may be numbered from 30 through 39. Exceptions to this general guide for numbering of terminal boards may be seen at terminal boards that are located on the main control panel – zone 36. Such terminal boards are identified by numbers 60 through 69, which relates to the second digit of zone 36.

Wiring harnesses are also identified by zone numbers. A wiring harness is completely assembled before the wires are connected to equipment. It is a group of wires formed on a pegged pattern board. Wires of appropriate size and length are layed out on the peg pattern and bundled together with "tie wraps" so that all wires hold



*On Units With Full Compliment Of Circuit Modules

**CB Panel On Units With Zone 33*

Zone 31 Elect. Cabinet
Zone 32 Main Cable Form
*Zone 33 Circuit Module Rack
Zone 36 Main Control Panel
(Zones 361, 2, 3, 5 & 6)
Zone 37 Fuse, Switch, & (Circuit Breaker Panel**)
**Zone 38 Wheel Slip Panel
Zone 39 Engine Control Panel

Fig. 7 – Equipment Location Zones

their relative position. When the harness is correctly arranged at an electrical panel or in the electrical cabinet, all wire ends are positioned in the vicinity of the component to which they are to be connected.

The electrical cabinet main wiring harness is identified as zone 32. It contains all wires that connect between devices in the lower portion of the main electrical cabinet, and it also contains wires that connect from devices at one zone within the cabinet to devices located at another zone within the cabinet. For example, a wire that connects from a device in the lower portion of the electrical cabinet (zone 31) to a device on the main control panel (zone 36) is in the 326 branch of the main wiring harness. Wires that connect from a device on the main control panel to a device on the engine control panel (zone 39) are also part of the main wiring harness – the 329 branch.

Secondary wiring harnesses – zone 36 for example – are used for all connections made between devices located within a zone in the electrical cabinet. Zone 36 identifies a wiring harness that connects between devices located on the main control panel. This harness is applied to the main control panel, and all connections are made before the panel is placed in the electrical cabinet. Once the panel is in place, and the main wiring harness is also in place, tie wraps may be applied to bind the harnesses together, and the zone 36 harness may have the appearance of being part of the 326 branch of the main wiring harness.

Other secondary wiring harnesses may be used for other zones within the electrical cabinet. Since these zones are normally mounted in the vicinity of the main control panel, they carry the same number 36 with a suffix number added in sequence for each additional zone. For example, the dynamic brake regulator panel and its applicable wiring harness are identified by zone number 362. The dynamic brake step control panel and its wiring harness are identified by zone number 366.

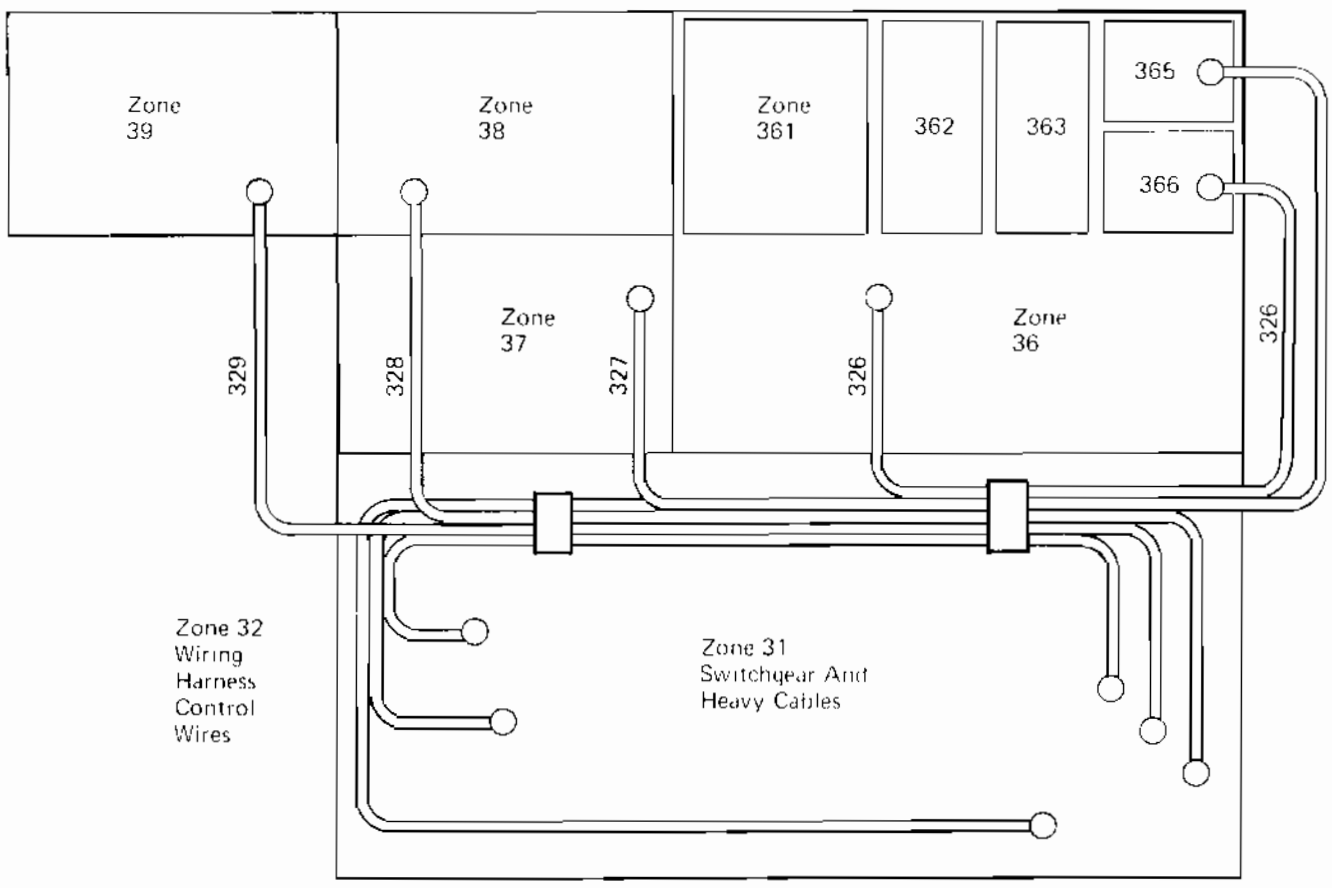


Fig. 8 – Equipment Location Zones, Electrical Cabinet (Unit Without Full Compliment Of Circuit Modules)

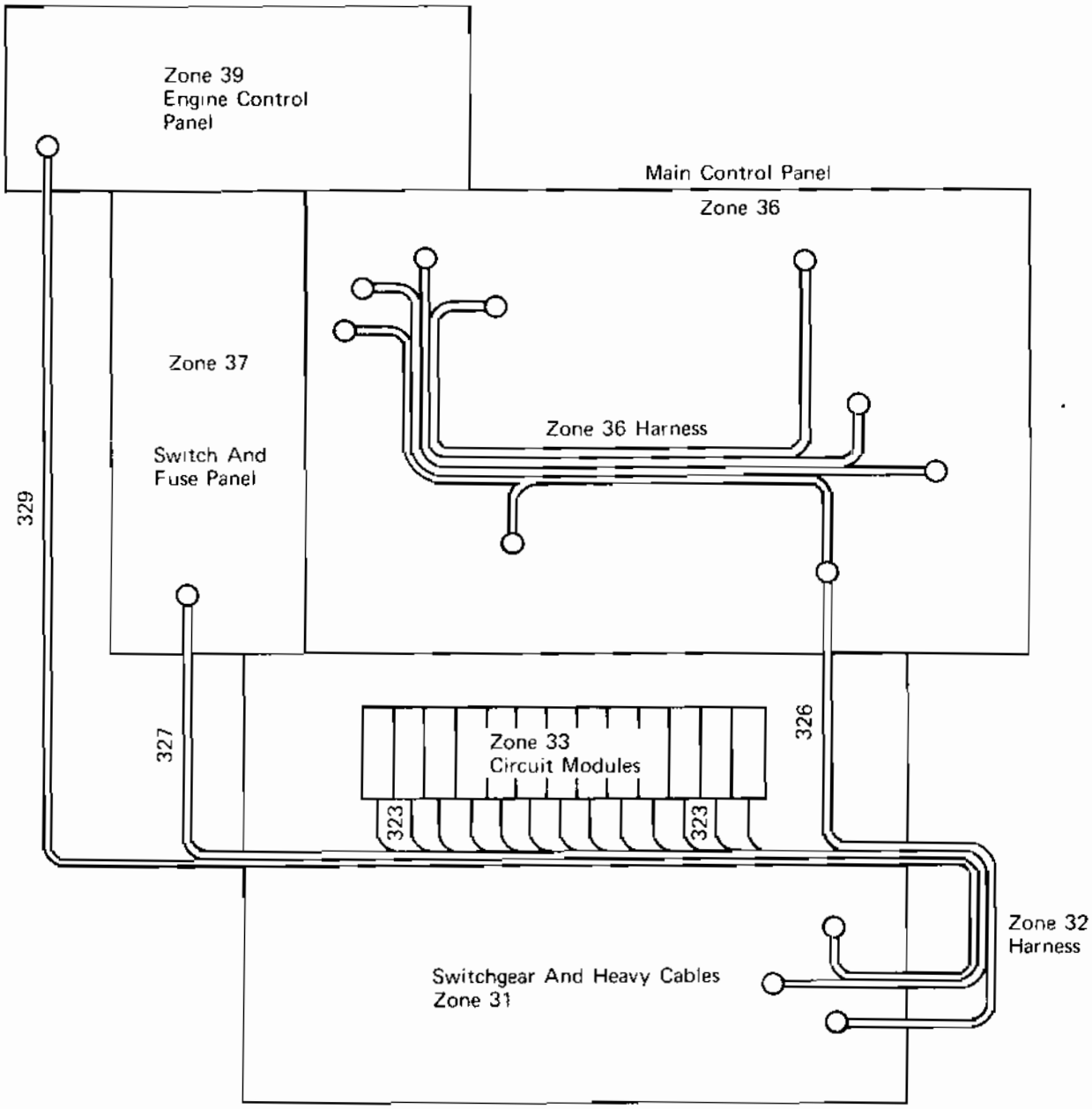


Fig. 9 – Equipment Location Zones, Electrical Cabinet
(Units With Full Compliment Of Plug-In Modules)

WIRE IDENTIFICATION SCHEME

In developing the physical schematic wiring diagram, the draftsman endeavors to follow certain general guidelines when assigning "name" or number identifications to wires. These guidelines will be outlined here. Do not consider them as mandatory or rigid requirements. For reasons of practicality, the draftsman is allowed flexibility of approach to allow for ease and simplicity of presentation and to facilitate design change.

WIRE IDENTIFICATION SCHEME FOR TRAINLINED CONTROL CIRCUITS

Wires in control circuits bear the following identification:

1. Number prefixes.
2. A single or double letter middle element.
3. Usually a number suffix.

NUMBER PREFIXES
(e.g. the "13" in wire 13AB6)

With the exception of the trainlined control negative ("N" wires), number prefixes apply to trainlined control circuits. Since most locomotives are equipped for electrical control of trailing units from the cab of the lead unit (MU operation), the control circuits extend to all locomotive units coupled to form a consist. Such circuits are called trainlined circuits. Electrical connection of trainlined circuits is made by standardized MU (multiple unit) receptacles and jumper cables. The prefix numbers of the trainlined wires and the corresponding receptacle pin numbers are standardized with respect to function as follows.

Wire Or Pin Number	Standard Function
1	Power Reduction Setup
2	Alarm Signal
3	Governor Solenoid DV — Engine Speed
4	Negative "N"
5	Optional — Emergency Sanding
6	Generator Field Control
7	Governor Solenoid CV — Engine Speed
8	Forward
9	Reverse
10	Wheel Slip
11	Spare
12	Governor Solenoid BV — Engine Speed
13	Positive Control/Fuel Pump
14	Optional
15	Governor Solenoid AV — Engine Speed
16	Engine Run
17	Dynamic Brake
18	Spare
19	2nd Negative
20	Brake Warning Light
21	Dynamic Brake
22	Compressor Control
23	Sanding
24	Brake Control/Power Reduction Control
25	Headlight
26	Separator Blowdown/Remote Reset
27	Boiler Shutdown

ALPHABETICAL MIDDLE ELEMENT (e.g. the "T" in wire 13T6 or the AB in 13AB6)

The single letter "T" following the prefix number indicates that the wire is connected to an MU receptacle pin without going through an electrical control device such as a switch or relay. An occasional exception occurs when an "X" is used.

After the circuit passes through an electrical device, the designation changes to a letter or letters such as "A," "B," "AA," "AB." However, the designation may remain a "T" prefixed by a different number if the circuit then connects to another receptacle pin.

NUMBER SUFFIX (e.g. the "6" in 13AB6)

Several guides apply to the use of number suffixes.

1. A "T" wire connected to the MU receptacle at the No. 1 end of the locomotive bears the suffix number 1.

2. A "T" wire connected to the MU receptacle at the No. 2 end of the locomotive bears the suffix number 3 (three). This changes to a No. 2 at a terminal board located within a junction box.

3. Wires leading from the main terminal board panel located at the back of the main electrical cabinet bear the suffix number 5 when they lead to the locomotive control stand in the cab.

4. Electrical equipment is located at numbered zones. Wires leading to a zone or from one zone to another take on a numbered suffix equivalent to the higher numbered zone. These generally are single digit numbers ranging above 5. Suffix numbers of wires leading from device to device within a zone generally follow numbers in sequence 1 through 5.

WIRE IDENTIFICATION SUFFIX NUMBERS IN RELATION TO ZONES

Fig. 10 shows the same circuits shown in Fig. 2B, but with dashed lines and shading used to indicate the zones in which various components are located. The dark wire lines are employed to accentuate the number suffixes of wires leading from one zone to another. On such wires, the number suffix of the wire identification is equivalent to the higher numbered zone. For example, a 13AC_ wire leads from "F" of P3 in zone 31 to G2 of PR in zone 36. The wire takes on the digit "6" of zone 36, and is therefore called the 13AC6 wire.

WIRE IDENTIFICATION SCHEME FOR LOCAL CONTROL, EXCITATION CONTROL, AND HIGH VOLTAGE CIRCUITS

Wires in local control, excitation control, and high voltage circuits bear double or triple letter prefixes, generally followed by a number suffix of one or two digits (e.g. MB41).

Local control circuits take their power from the individual locomotive unit. The circuits are not trainlined. Excitation control circuits are involved with the unit's main generator. High voltage circuits are involved with the unit's main generator, traction motors, and dynamic brakes.

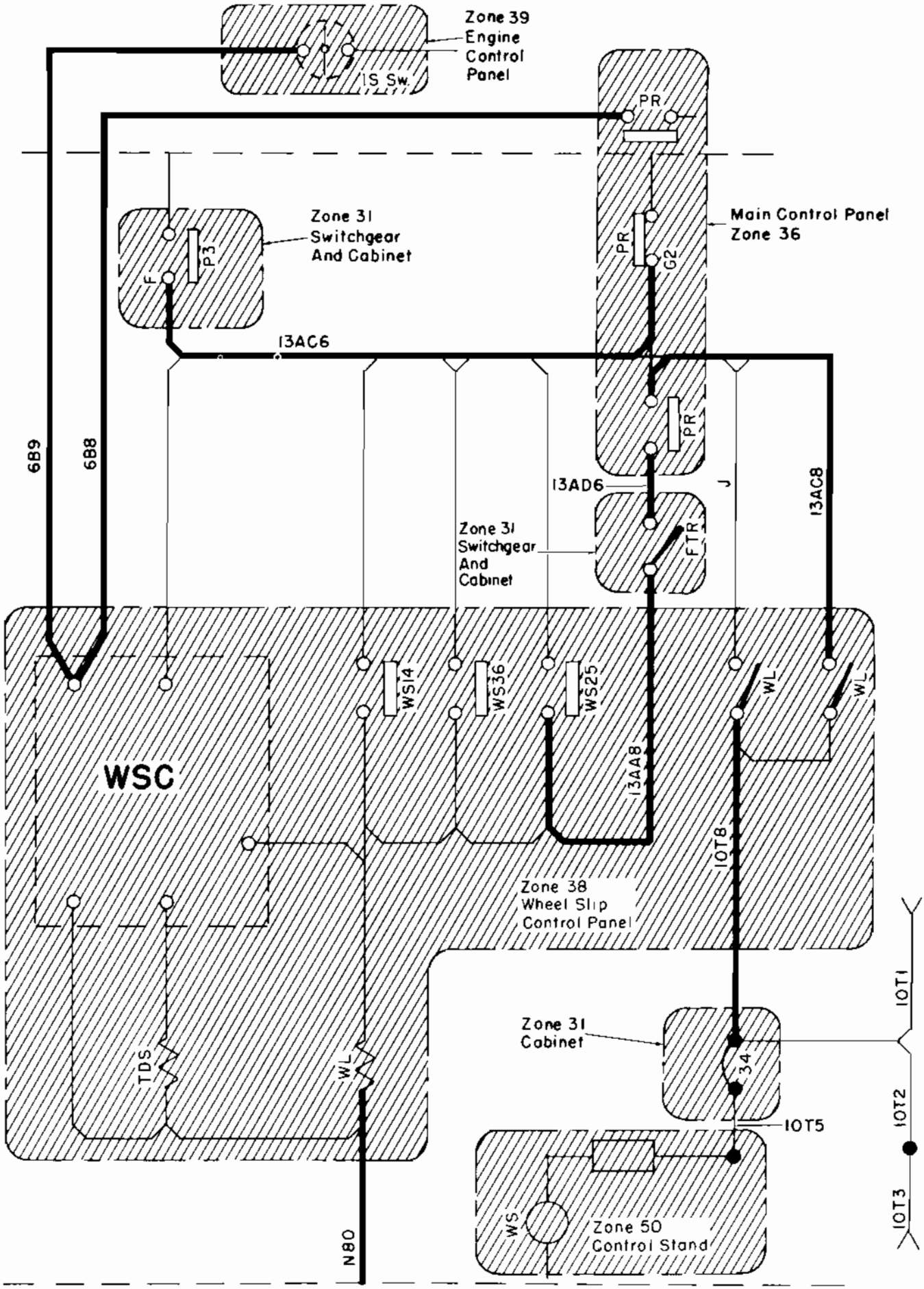


Fig. 10 — Relationship Between Wire Numbers And Zones

LETTER DESIGNATIONS

Local control circuits as well as control circuit positive and negative feeds bear letter identification that relates to the circuit function.

Letters	Function
AG	Auxiliary Generator
AL - A	D14 Alternator
BC	Battery Positive
BP	Battery Positive
BN	Battery Negative
C	Radiator Cooling
D	Direction Control
F	Field Loop Control
FS	Motor Field Shunting Control
H	Headlights
L	Lighting
M	Motor Control
MB	Motor Connect Control - Dynamic Brake
NA	Control Negative
NX	Control Negative
PA	Battery Positive
S	Engine Shutdown And Local Fuel Pump Control
ST	Starting

Excitation control circuits bear the following letter identification.

Letters	Function
AX	D14 AC For Control
AY	D14 AC For Control
E	Main Generator Excitation Control
EZ	Stable Reference Voltage For Control
G	Main Generator Excitation Control

High voltage circuits bear the following letter identifications.

Letters	Function
A - AA	Connections At Traction Motor Armatures
BB	Dynamic Brake Regulation (Positive)
BK	Dynamic Brake Regulation
BM	Dynamic Brake Blower Motor
BR	Dynamic Brake Regulation (Negative)
F - FF	Connections At Traction Motor Fields
FV	Motor Cables
GB - GF	Voltage Sensing For Transition Or Wheel Speed
GN	Generator Negative
GP - GS	Generator Positive
RV	Motor Cables
W	Wheel Slip Connections

ADDITIONAL LETTERS

The primary identification letter or letters of a wire are often followed by an additional letter that either indicates function or is of an alphabetical series. For example:

1. An AL wire may be identified ALP to indicate positive polarity or ALN to indicate negative polarity. An ALF wire may indicate connection to a generator field.

2. Wires in an example circuit may be identified MB, MBA, MBB, MBC, MBD, with the additional letter added and changing as the circuit passes through devices such as contactor interlocks. In addition to such sequential lettering, sequential numbering is also employed as indicated in the following text.

NUMBER SUFFIXES

Local control wires are electrically connected to the local control circuit breaker at the main electrical cabinet. The number suffixes on local control wire designations consist of either a single digit or of two digits.

Single Digit Numbers

1. Single digit numbers may identify wires that are separated from the "PA" or "NA" strings by some electrical device that is located at a numbered zone in the main electrical cabinet. Such wires take on a number suffix equivalent to the higher numbered zone.

2. Wires in the "PA" or "NA" strings that lead from the local control circuit breaker to devices outside of the main electrical cabinet may bear suffixes that follow in number sequence 1 through 5.

TWO DIGIT NUMBERS

Wires in the "PA" or "NA" strings that lead from the local control circuit breaker to devices inside of the main electrical cabinet may bear suffix numbers in the following series of numbers.

1. Series 10 through 50 to devices in zone 31 of the main electrical cabinet.

2. Series 60 through 90 to devices in other zones of the main electrical cabinet.

CONTROL CIRCUIT WIRING STRINGS

Where positive or negative feeds to control, local control, and lighting circuits connect to a common point by means of a "string" of wires and jumper wires, Fig. 11, the circuit presentation at the circuit area on the physical schematic diagram is simplified by use of a dashed line. This dashed line indicates that all wires represented by the line are electrically connected to some common device such as a circuit breaker. A legend at the end of the dashed line identifies the wiring string represented by the line. The actual wiring of such strings is then shown in its entirety, generally to the left and adjacent to the applicable circuits.

The wiring string manner of circuit presentation facilitates accurate and rapid isolation of circuits for test purposes such as troubleshooting. In fact, special locomotive models have been equipped with isolation knife switches called ground check switches that perform the isolation without disconnecting wires.

In the wiring string presentation, the wires that connect between terminals in the various strings are identified by a number, while the wire leading initially to the first terminal in the string bears both a letter and a number designation. To be understood here is the fact that all wires in the string carry the same letter prefix. For example, in Fig. 11 the N30 wire connects between TB60R4 to a terminal on the GF contactor, and a wire identified as 31 connects between GF and ELR. The actual wire identification is understood to be N31. Wires N33 and N34 follow in the same string.

An exception to the general rule is shown directly below the N33 and N34 wires. Dashed unnumbered jumper wires connect TRP-B to TRP-C and TRP-D. The dashes indicate that the jumpers are part of the TRP device and not part of electrical cabinet wiring.

The device terminals are not identified at the wiring string presentation. The actual terminal can readily be located and identified by scanning the dashed-line negative that represents the string. For the most part, in negative strings the wires connect to operating coils of relays or contactors. In positive strings the wires connect to relay contacts or contactor interlocks.

In certain instances, the dashed lines that represent the wiring strings appear at more than one

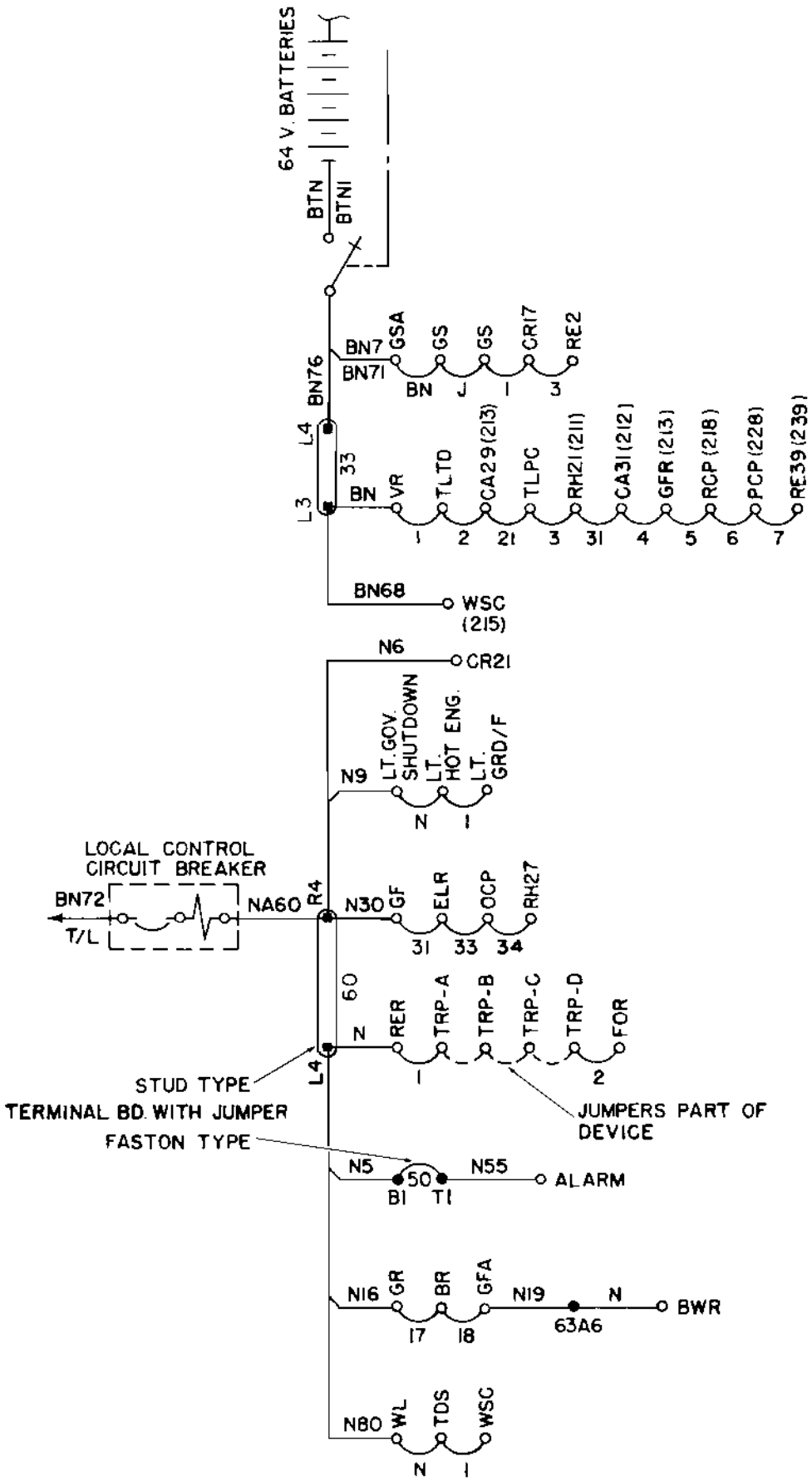
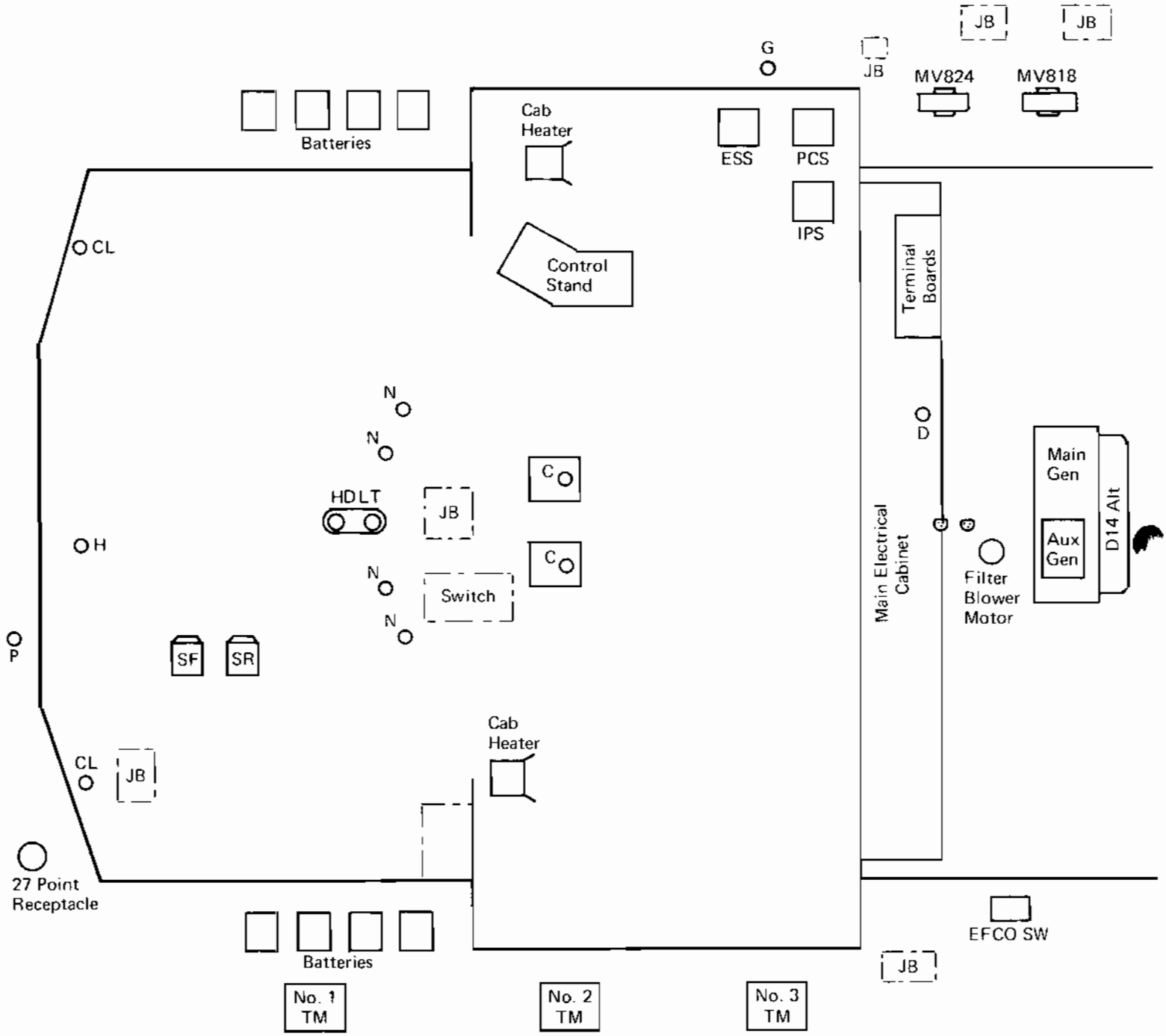


Fig. 11 — Sample Wiring String Presentation


JB
JB
G
JB
MV824
MV818
Batteries
Cab Heater
ESS
PCS
IPS
CL
Control Stand
Terminal Boards
N
N
D
Main Gen
Aux Gen
D14 Alt
C
HDLT
JB
H
C
N
Switch
N
Main Electrical Cabinet
Filter Blower Motor
P
SF
SR
Cab Heater
CL
JB
27 Point Receptacle
EFCO SW
Batteries
JB
No. 1 TM
No. 2 TM
No. 3 TM

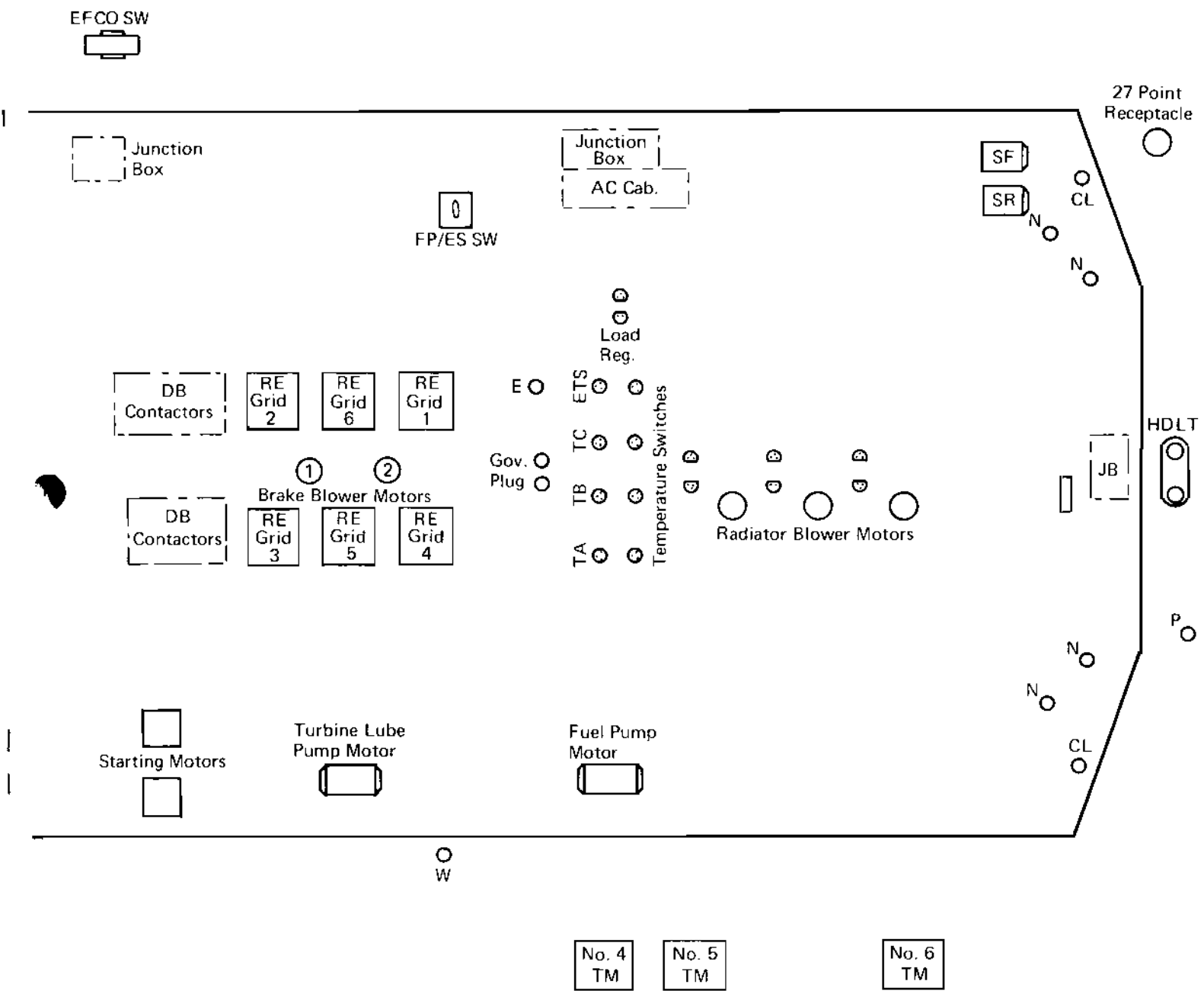


Fig. 12 – Equipment Location Portion Of Conduit Layout Diagram (Conduit And Wires Omitted)

area of the physical schematic diagram. For example, one dashed line BN negative is located at the 200 series of marginal locator numbers, while another is located at the 300 series of marginal locator numbers. If the wiring string presentation is also at the 300 series of numbers, any devices that are located in the 200 area will carry a locator number adjacent to the terminal identification in the wiring string. This enables easy reference to the location of the device on the schematic. See the BN string of Fig. 11 for an example.

CABLE AND CONDUIT LAYOUT DIAGRAM

The cable and conduit layout diagram provides the following information.

1. General location on the locomotive of electrical cabinets and compartments, and location of electrical equipment outside of the electrical cabinets.

2. Layout of conduit and cable duct, and location of splices in wire and cable. (Permanent splices such as those used on traction motor cables are not indicated on the diagram.)

3. Identification and wire size code for cables and wires in conduit, duct, and terminal boxes. Provides the means for tracing wires that are not indicated on the wiring running list.

NOTE: The wiring running list book covers those wires and cables that connect from one device to another within electrical cabinets. It also covers certain cables and wires that connect from devices within electrical cabinets to equipment located outside of the electrical cabinets. Such connections generally involve traction motors, generators, dynamic brakes, and battery.

4. Wiring at terminal boards located at the back of the main electrical cabinet and elsewhere on the locomotive.

5. Table of wire and cable sizes.

EQUIPMENT LOCATION

Fig. 12 shows the locomotive outline sketch as it appears on the cable and conduit layout diagram, but the sketch has been modified to accentuate the location aspect by deletion of the wiring, cabling, conduit, and duct. The actual layout drawing shows wiring and conduit leading to the equipment locations.

CABLE AND CONDUIT

Fig. 13 shows a portion of the layout sketch with some cable duct and conduit added for purposes of explanation. The following points may be observed on the illustration.

1. Fillage charts are provided to identify all wires and cables running within conduit or duct. The charts give the wire "names" and sizes. At areas where the fillage chart would be too large to be shown close to the duct, a reference symbol is used. The chart is then placed at an available area on the drawing.

   Wires and cables that connect from a splice or device located outside of an electrical cabinet to a device also located outside of an electrical cabinet can be traced using the cable and conduit layout drawing and fillage charts. The layout drawing and fillage charts must also be used to trace most wires and cables that connect from a device or splice located outside of an electrical cabinet to a device, terminal board, or bus located within an electrical cabinet.

   A small percentage of wires and cables that connect from a device or splice located outside of an electrical cabinet to a device or bus located within an electrical cabinet are shown in the wiring running list book. These wires are termed "cabinet hangouts"; that is, for reasons of practicality during manufacture, cables and sometimes wires are connected to cabinet components during cabinet assembly. The other end of the cable is allowed to hang out of the cabinet and is connected to locomotive components after the cabinet is in place on the locomotive frame. For the most part, these include traction motor and main generator cables, battery cables, and dynamic braking cables and control wires.

   Refer to the circuit tracing section of this manual for a guide to circuit tracing with the physical schematic wiring diagram and the conduit and cable layout diagram.

2. Conduit size is indicated in inches. For example, 1-1/4, 2-1/2, 3-1/2.

3. Splices are located (except certain permanent cable splices).

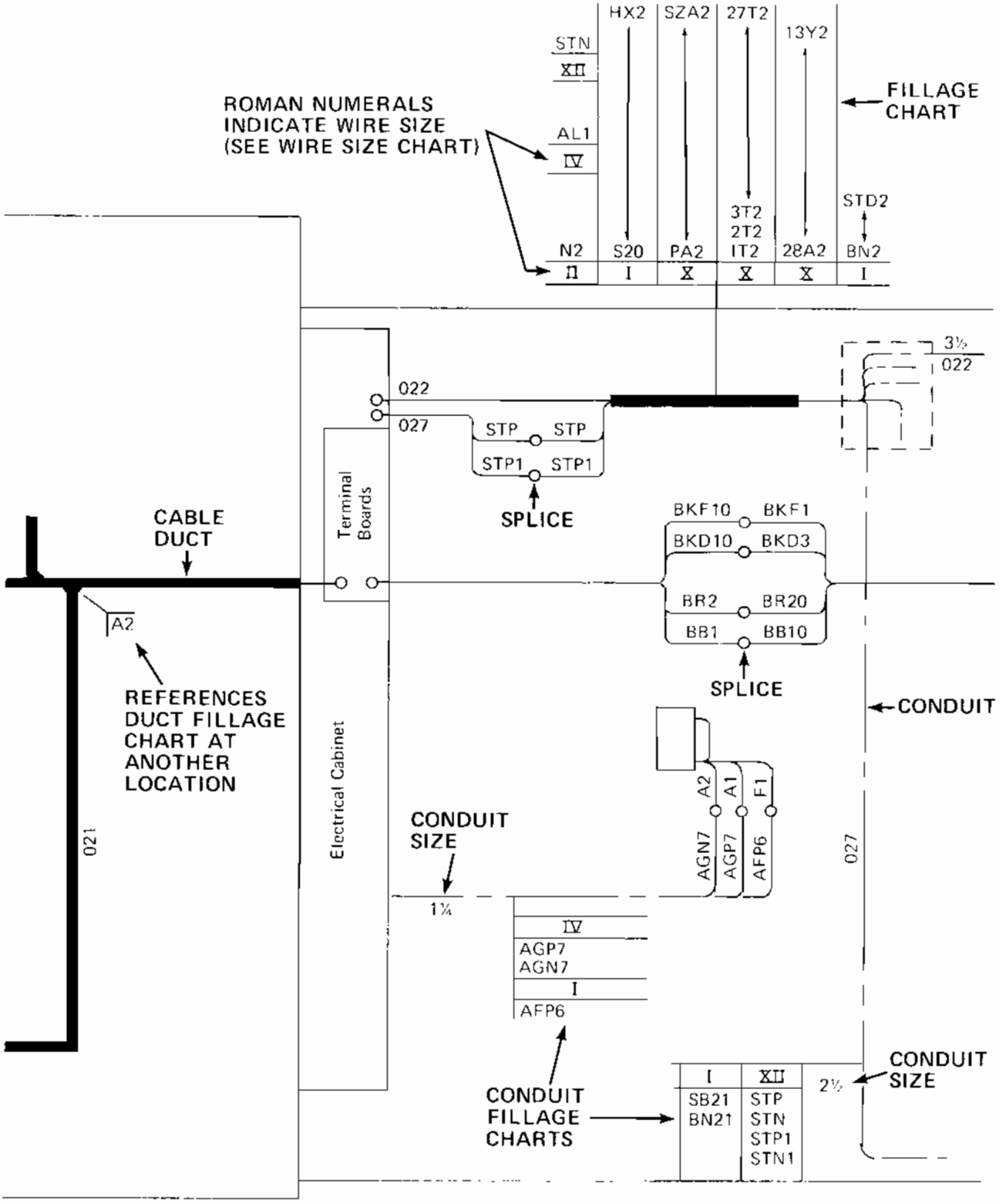
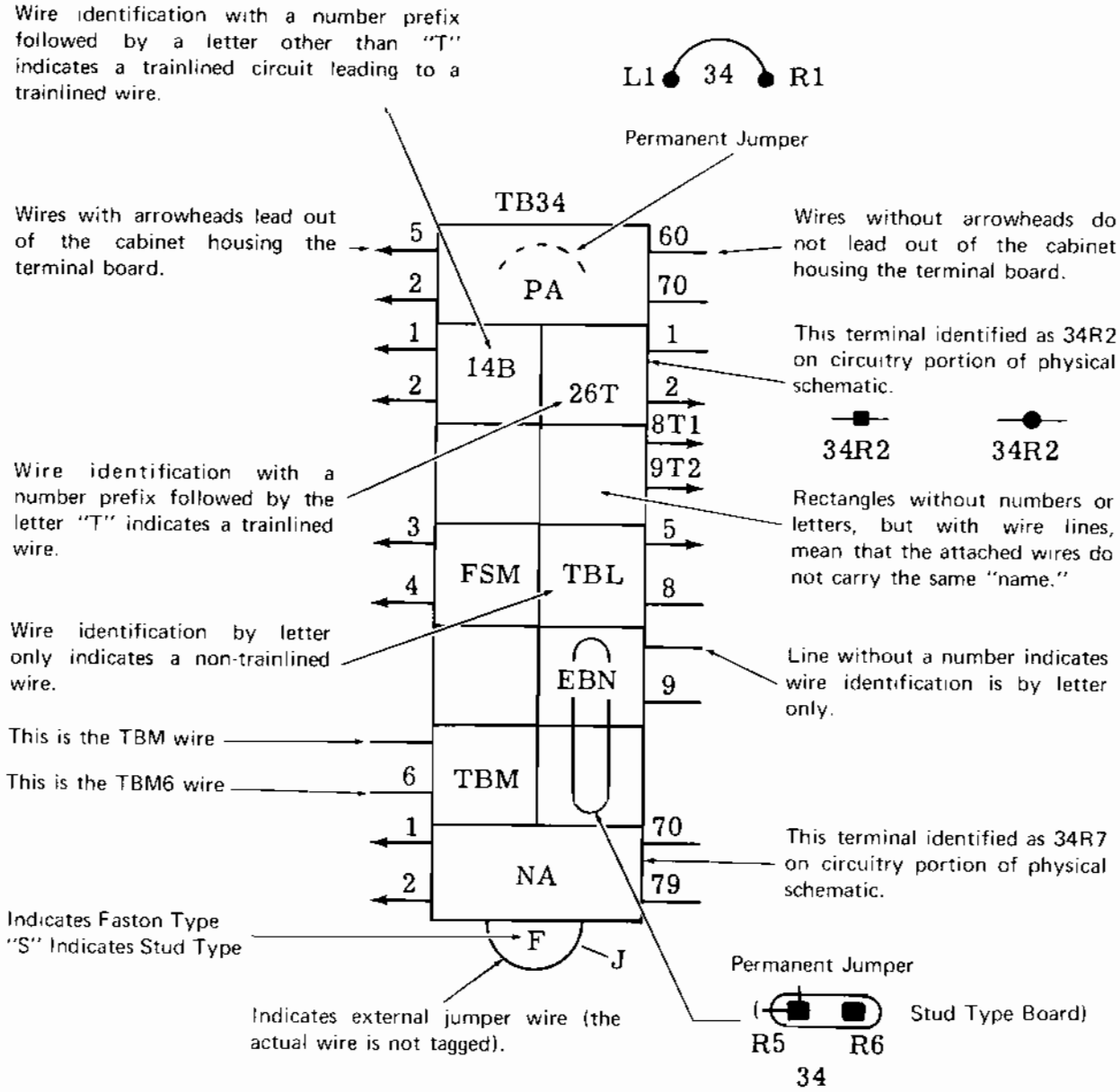


Fig. 13 — Duct And Conduit Identification



NOTE: IP IP5

This symbol located adjacent to a terminal board indicates a connection, such as for calibrated meter leads, that is made outside the terminal board. The hollow dot indicates a splice.

Fig. 14 — Sample Terminal Board Symbol

4. Cable form index numbers (e.g. 021) are provided adjacent to conduit or duct. These are normally used for manufacturing and design purposes. However, they may be useful in cases of wreck or fire damage where reference to an entire cable form can be made without extensive listing of all wires involved.

TERMINAL BOARD WIRING

Terminal board symbols are shown in blocks on the cable and conduit layout diagram. The blocks are identified as to cabinet or compartment, which then can be generally located on the locomotive by use of the layout sketch.

Terminal boards are identified by two-digit NUMBERS, not by letters.

The individual boards, Fig. 14, are shown in rectangular form identified by the terminal board number. The board is divided into smaller rectangles that indicate individual electrically isolated terminals on the board. A dotted arc within a rectangle indicates that terminals on the right and left side of the board are permanently connected by a jumper at the time the board is constructed. On the faston type terminal board, this jumper is visible upon close examination through an arc shaped "window" between faston terminal tabs. On stud type boards, a copper jumper bar is apparent.

Terminals boards are constructed in two sections, identified as left and right if the board is mounted vertically, or top and bottom if the board is mounted horizontally. The terminals in each section are numbered from top to bottom or from left to right starting with the number 1. The system presents no problems regarding terminal identification, therefore the numbers do not actually appear on the board. On the circuitry portion of the physical schematic, a terminal is identified by the terminal board number, by a letter indicating right-hand, left-hand, top, or bottom section, and the number of the terminal counting from the top or the left side. For example; 28R7, 50B5.

Each rectangle on the terminal board symbol contains identifying letters or numbers if that terminal is in use. These letters or numbers provide the general identification of the wires that are connected to the terminal. Specific identification of the wires is indicated by subnumbers adjacent to short lines connected to the rectangle. For example, the fourth terminal on the left-hand section of TB34 may have two wires connected to it. These wires are identified as FSM3 and FSM4. The letters FSM appear within the rectangle that symbolizes the terminal; the numbers 3 and 4 appear adjacent to the lines connected to that rectangle. If a line is not identified by a number, the wire it represents does not carry a suffix. It is identified only by letters within the rectangle.

If a line is terminated with an arrowhead, the wire it represents leaves the cabinet wherein the terminal board is located. For example, the TBL5 wire connected to the No. 4 terminal on the right-hand side of terminal board 34 in the electrical cabinet may reach to the engineer's control stand where it connects to another terminal board. Lines that are not terminated with arrowheads indicate that the wires they represent do not leave the cabinet in which the terminal board is located. In such case the wire will generally lead to a device rather than to another terminal board.

Obviously, the terminal board portion of the physical schematic does not provide indication as to where a wire leads from the terminal board. The circuitry portion of the physical schematic must be consulted for such information. However, starting to trace from a terminal board, the wire identification letters or numbers provide a guide. The wire identification indicates the area on the circuitry portion of the diagram where the terminal is located. Bracketed locator legends at circuit areas help to identify the areas.

LEGEND OF WIRE SIZES AND INSULATION

The duct or conduit fillage charts provided on the cable and conduit layout drawing list wire "names" in columns. A roman numeral or other index number appears at the base of such columns. All wires identified in the column are of the type and size that the number represents. The legend of wire sizes and insulation, Fig. 15, identifies the kind of wire represented by the index numbers.

WIRE & CABLE

SYMBOL	CABLE SIZE		DIAMETER		TYPE OF INSULATION	PART NO.
	AWG/CM	STRAND	OUTSIDE	BARE		
I	#12 AWG	19/25	.240	.092	EPR & HY *	8421203
II	14,950	37/24	.31	.148	EPR & HY	8421204
III	36,760	91/24	.44	.232	EPR & HY	8421205
IV	50,500	125/24	.498	.285	EPR & HY	8421206
VI	211,600	2100/30	.865	.640	EPR & HY	8421416
IX	131,300	325/24	.77	.460	EPR & HY	8421208
X	#14 AWG	19/27	.192	.070	EPR & HY	8421202
XI	444,400	1100/24	1.205	.870	EPR & HY	8421211
XIH	444,400	1100/24	1.140	.916	S.R.G & D *	8333126
XII	222,200	550/24	.91	.610	EPR & HY	8421209
XIV	313,100	775/24	1.070	.740	EPR & HY	8421210
XV	#14 AWG	19/27	.160	.070	EPR & HY	8421200
XVII	#12 AWG	19/25	.180	.092	EPR & HY	8421201
XX	535,300	1325/24	1.36	.970	EPR & HY	8421212
14H	#14 AWG	19/.0142	.150	.076	S.R.G & D	8278231
12H	#12 AWG	19/0179	.191	.095	S.R.G & D	8292312
16T	#16 AWG	19/29	.090	.063	TEF *	8269142
C2	#16-2COND	65/34	.410	.059	NEOPRENE	8077432
W2	#14-2COND	41/30	.530	.078	NEOPRENE	8077433
J3	#14-3COND	41/30	.600	.082	NEOPRENE	8183415
T2	#16-2COND	65/34	.390	.063	SIL. RUBB.	8337786
T3	#16-3COND	65/34	.440	.063	SIL. RUBB.	8337787
3H	#3 AWG	133/.0199	.480	.296	S.R.G & D	8376487
6H	26,200 CM	133/.0140	.400	.216	S.R.G & D	8405158
XXVI	646,400	1600/24	1.47	1.060	EPR & HY	8421213
XXX	777,700	1925/24	1.57	1.12	EPR & HY	8421214
XXII	90,900	225/24	.68	.390	EPR & HY	8421207

*EPR & HY — Ethylene Propylene Diene With Chlorosulfonated Polyethylene Jacket.
*SRG & D — Silicon Rubber, Glass, & Polyester
*TEF — Poly-tetra fluoroethylene

Fig. 15 — Legend Of Wires Sizes And Insulation

LOCOMOTIVE WIRING RUNNING LIST

The wiring running list is composed of data sheets assembled in book form. The data is provided in three parts to supplement the physical schematic wiring diagram. These three parts are as follows.

1. BLOCK DIAGRAMS

The first few pages of the wiring running list book contain block diagrams that show the location of electrical devices within electrical cabinets and the control stand. Fig. 16 shows a sample block diagram. A device may be located on the block diagram by first determining the zone location of the device through use of the electrical parts list or through use of the equipment and interlock locator charts on the physical schematic diagram, then by scanning that zone on the block diagram. Location can also be determined easily by total scanning of the block diagram. Once the device is located on the diagram, it is a simple matter to relate this location to the actual electrical cabinet.

2. PARTS LIST

The second portion of the wiring running list is a list of electrical cabinets, panels, and devices. Fig. 17 shows a sample parts list page. The first entries on the page cover electrical cabinets and panels. These entries are followed by components listed in alphabetical order. The information is presented in seven column format as follows.

Column	Data
1	Name of equipment.
2	Data pertinent to the equipment. a. Number of normally open and closed interlocks. b. Voltage or current rating or wattage. c. Number of poles or throws. d. Number of devices in tandem or in a stack. e. Number of points in a receptacle. f. Number of switch positions.
3	Description or common name of equipment.
4	EMD part number.
5	Zone location.
6	Locomotive code number for manufacturer's use.
7	Revision letter of entry. A breakdown of revised pages and revision dates is shown on the first page of the wiring running list book.

3. WIRING RUNNING LIST

The third portion of the list book is the wiring running list. Fig. 18 shows a sample wiring running list page. The entries on the page are made alphabetically by terminal identification; thus AC1-COIL/L is the first entry on the sample list.

The list shows all wires and heavy cable that have -

a. Both ends of the wire connected to devices within an electrical cabinet. Such wires have duplicate from/to entries in the running list, with the from/to portion transposed for the second entry.

b. One end connected to a device or bus within an electrical cabinet during cabinet assembly by the manufacturer. The wire end outside of the electrical cabinet is allowed to hang free until the cabinet is in place on the locomotive frame. The wire then may terminate at a piece of electrical equipment or it may terminate at a splice. Such wires have a single from/to entry in the wiring running list.

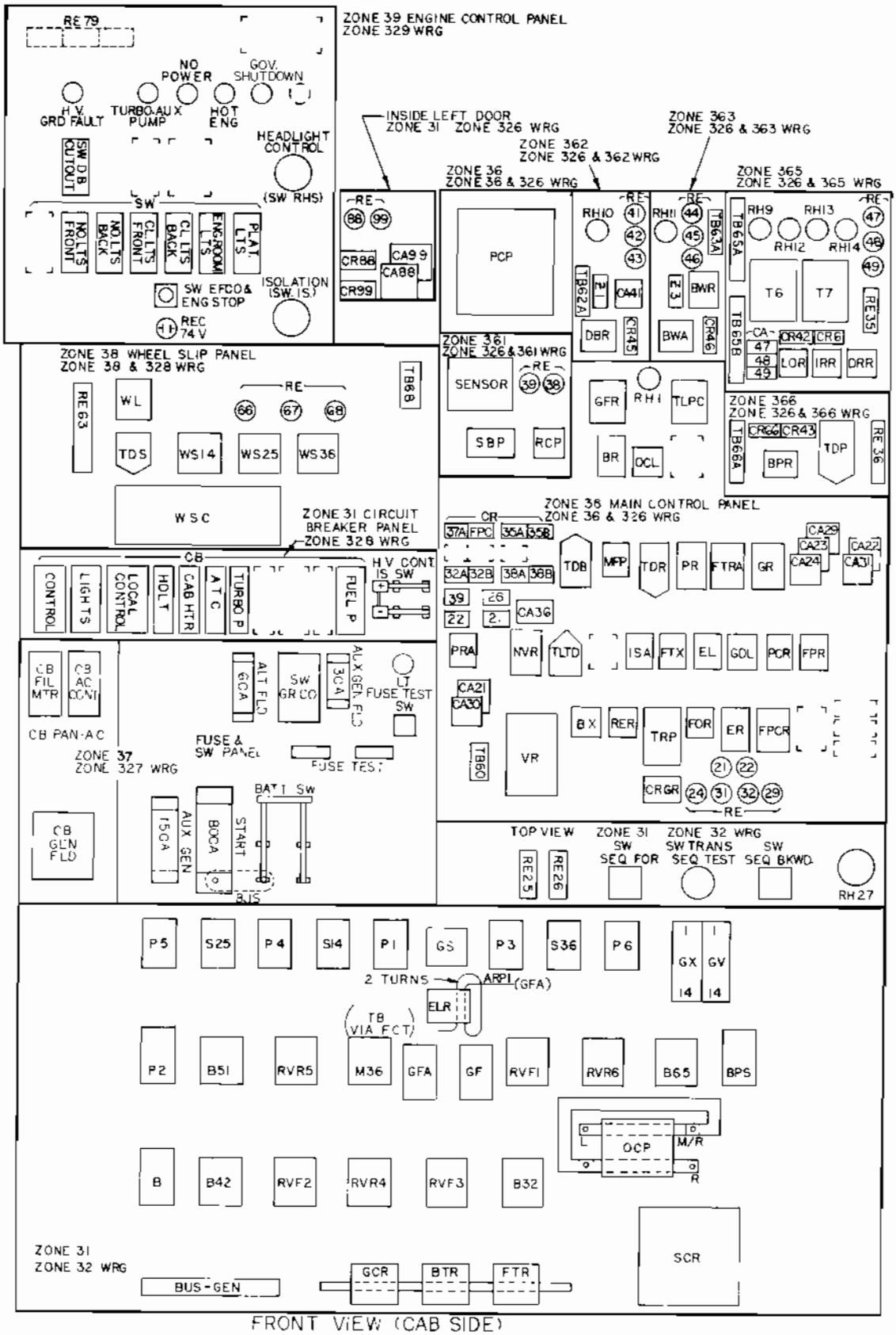
When the wire terminates at a splice outside of an electrical cabinet, the wire "name" may or may not change after the splice.

The following wires and cable do not appear on the wiring running list. Such wires are identified and located by reference to the cable and conduit layout diagram.

a. Wires leading from a splice to electrical equipment outside of an electrical cabinet.

b. Wires leading from a piece of equipment outside of an electrical cabinet to another piece of equipment outside of an electrical cabinet.

c. Most wires leading from a piece of equipment outside of the electrical cabinet to the terminal board area of an electrical cabinet.



FRONT VIEW (CAB SIDE)

Fig. 16 – Sample Component Location Block Diagram

8446018 WIRE RUNNING LIST SD45 BASIC DYNAMIC EXT SHEET 1

SYMBOL OR NAME OF EQUIP	ADD INFO	DESCRIPTION OF EQUIP	PART	ZONE		REV
ZONE 31		ELECTRICAL CABINET	8446892	31	104	
ZONE 31		CB PAN ASSEM	8362105	31	104	
ZONE 31		RESISTOR PAN ASSEM	8446894	31	104	
ZONE 31		TRANS SEQ TEST PANEL	8432392	31	104	
ZONE 32-326-7-8-9		ELECT CABT WIRING		32	104	
ZONE 36		MAIN CONTROL PANEL	8446893	36	104	
ZONE 361		EXCIT CONTROL PANEL	8377915		104	
ZONE 362		D B REGULATOR PANEL	8366057	362	104E	
ZONE 363		D B WARNING PANEL	8364238	363	104E	
ZONE 365		D B CONT PANEL	8366463	365	104E	
ZONE 366		D B STEP CONT PANEL	8366411	366	104E	
ZONE 37		CB PAN ASSEM	8449177	37	104	
ZONE 37		FUSE & SWITCH PANEL	8449176	37	104	
ZONE 38		WHEEL SLIP PANEL	8428652	38	104	
ZONE 39		ENG CONTROL PANEL	8444640	39	104	
ZONE 51		ENGRS CONTROL STAND	8332829	51	104	
ZONE 80		A C CABINET	8344409	80	104	
AC1-		CONTACTOR	8307357	80	104	
AC2-	2NO-2NC	CONTACTOR	8314549	80	104	
AC3-	2NO-2NC	CONTACTOR	8314549	80	104	
AMM TM-		AMMETER	8411333	51	104	
B-	2NO-2NC	CONTACTOR	8399648	31	104E	
BATT 1-		BATTERY		10	104	
BATT 2-		BATTERY		10	104	
BATT 3-		BATTERY		10	104	
BATT 4-		BATTERY		10	104	
BATT 5-		BATTERY		10	104	
BATT 6-		BATTERY		10	104	
BATT 7-		BATTERY		10	104	
BATT 8-		BATTERY		10	104	
BCT6-		TRANSDUCTOR	8250988	31	104E	
BCT7-		TRANSDUCTOR	8250988	31	104E	
BELL ALARM-		BELL ALARM	8430783	51	104	
BELL ALARM- OPTIONAL		BELL ALARM	8430284	51	104	
BPR-		RELAY-DIR	8327263	366	104E	
BPS-		SWITCH-MTR DRIVE	8350813	31	104E	

COLUMN NO. 1	2	3	4	5	6	7

Fig. 17 — Sample Parts List Page

8446018 WIRE RUNNING LIST SD45 BASIC DYNAMIC EXT SHEET 14

FROM	TAG	TO	SIZE	ZONE		REV
AC1-COIL/L	NA3	AC2-COIL/L	14H	80	104	
AC1-COIL/L	NA4	TB81-T 9	14H	80	104	
AC1-COIL/R	CA	TB80-B 8	14H	80	104	
AC2-A	J	AC2-C	14H	80	104	
AC2-A	PA	TB80-T11	14H	80	104	
AC2-B	J	AC3-A	14H	80	104	
AC2-C	J	AC2-A	14H	80	104	
AC2-COIL/L	NA2	AC3-COIL/L	14H	80	104	
AC2-COIL/L	NA3	AC1-COIL/L	14H	80	104	
AC2-COIL/R	CB	TB80-B 9	14H	80	104	
AC2-D	CD1	AC3-C	14H	80	104	
AC3-A	J	AC2-B	14H	80	104	
AC3-B	CE	MV CC/SH-SH COIL/R	14H	80	104	
AC3-C	CD1	AC2-D	14H	80	104	
AC3-COIL/L	NA1	MV CC/SH-SH COIL/L	14H	80	104	
AC3-COIL/L	NA2	AC2-COIL/L	14H	80	104	
AC3-COIL/R	J	AC3-D	14H	80	104	
AC3-COIL/R	CC	TB80-B10	14H	80	104	
AC3-D	J	AC3-COIL/R	14H	80	104	
AMM TM-NEG	IN	TB53 AREA SPL-IN5	XVII	51	104	
AMM TM-POS	IP	TB53 AREA SPL-IP5	XVII	51	104	
B-A	6T	TB32-L 1	XV	32	104E	
B-A	6T9	SW IS-N	XV	32	104E	
B-B	6A6	MFP-1C	XV	32	104E	
B-BOT	RV3A	RVF3- 3	XX	31	104E	
B-C	MBE	P2-D	XV	32	104E	
B-COIL/L	NX18	P2-COIL/L	XV	32	104E	
B-COIL/R	MSY6	BX-Y/COIL	XV	32	104E	
B-D	MBB	P6-C	XV	32	104E	
B-E	21T	TB35-L11	XV	32	104E	
B-F	21B6	CR39-C/BLK	XV	32	104E	
B-G	MK	GS-F	XV	32	104E	
B-G	MK6	BR-B1	XV	32	104E	
B-H	MV	M36-C	XV	32	104E	
B-TOP	RV6A	RVR6- 3	XX	31	104E	
BCT6-F	J	BCT7-F	XV	32	104E	

FROM	TAG	TO	WIRE SIZE	ZONE		REVISION LETTER

Fig. 18 - Sample Wiring List Page

CIRCUIT TRACING

Before beginning an analysis of sample locomotive electrical circuits it will be well to clarify the use of symbols on the schematic wiring diagram. All symbols are to some extent pictorial, that is, they are drawn to look something like the devices they represent or in some manner indicate the function of the device. However, the more closely the symbols represent the actual device, the more complex circuit presentation becomes. For this reason, relay contacts are shown independent of their mechanical actuating devices and magnet coil. Circuits are generally drawn in the shortest practicable direct line from the source of current to the magnet coil of a contactor or relay. This is to say, a contact is not an individual piece of equipment existing by itself, but rather a part of some relay or contactor and it is actuated by that relay or contactor.

The main contacts of power contactors are generally identified by numerals. These contacts may be found in the high voltage section of the schematic diagram.

If the contactor has one set of auxiliary contacts they may be identified as A-B, and are generally located in the low voltage control circuits. If the contactor has several sets of auxiliary contacts these may be identified as C-D, E-F, and so on, omitting the letters I and O. Relay contacts may be identified in a variety of ways.

Remember that all contacts bearing the same relay designation operate simultaneously unless an arrow indicating time delay pickup or dropout of the contact (not necessarily all contacts on the relay) is attached to the contact bar.

You may note that some of the auxiliary contacts are closed when the contactor that controls them is not energized. Others may be open. The former are referred to as normally closed NC contacts, the latter as normally open NO contacts.

Schematic wiring diagrams are always presented with the circuits de-energized, that is, with the locomotive dead. Therefore, all contacts assume their normal position. When motor operated switchgear is used, the "normal" position is indicated at the symbol for the switchgear operating mechanism.

When tracing circuits it should always be remembered that electricity will not flow until a complete path or circuit is established. Electricity will flow from some source, such as a battery or generator, to some device to be operated or to some coil where a magnetic force is created, and then it will return to its source. Sample circuits are presented here with an explanation of circuit operation.

TRACING A SAMPLE FUEL PUMP CIRCUIT

The function of the fuel pump circuit is to provide battery power to operate the fuel pump motor and prime the fuel system before engine start. After engine start, power to operate the fuel pump motor is obtained from the auxiliary generator through relay contacts which provide shutoff control of the fuel pump motor.

Refer to Fig. 19 and assume that all switches and circuit breakers are open and the engine is stopped. The normal engine starting procedure is to close the main battery switch, the control and local control circuit breakers, the fuel pump motor circuit breaker, and the control and fuel pump switch. When the control and fuel pump switch is closed, the fuel pump relay coil is energized.

Contacts of FPR that are not shown on Fig. 19 close to allow completion of a circuit to the coil of generator (engine) starting contactor GS. This is done to prevent engine starting before the control circuit is established

The fuel prime/engine start switch is held in the FUEL PRIME position. The circuit is as follows

Battery positive to top right terminal of the main battery switch as viewed from the back of the switch and fuse panel,

BP7 wire to RE-BC,

BC2 wire to fuel pump circuit breaker,

SRX wire to TB35L9 at the back of the main electrical cabinet,

SRX2 wire to TB22R2 at the junction box under the AC cabinet;

SRX9 wire to TB80B4 in AC cabinet;

SRX wire to 2C of FPC in AC cabinet;

Jumper from 2 NO to 1C of FPC,

SR1 wire to TB81T7 in AC cabinet,

SR to fuel pump motor on rack;

BN to TB80B2 in BN string,

SRX wire to No. 1 of FP/ES at the AC cabinet;

Jumper from 2 to 6 of FP/ES;

SV1 to TB81T3 in AC cabinet;

SV to FPC coil in AC cabinet;

BN3 to TB80T2 in BN string;

BN2 wire to TB33L5 at back of the main electrical cabinet,

BN70 wire to bottom left terminal of the battery switch as viewed from the back of the switch and fuse panel;

BTN wire to battery negative.

When the fuel prime/engine start switch is rotated to the START position, FP/ES contacts 1-2 remain closed, contacts 5-6 open, contacts 9-10 close. The operating coil of fuel pump control relay FPCR is energized and FPCR A1-A2 contacts close to hold FPCR picked up. FPCR B1 B2 contacts also close, but since the 5-6 contacts of FP/ES are open, no circuit is made.

The fuel prime/engine start switch is released when the engine fires. FP/ES contacts 1-2 open, and contacts 5-6 close With the engine running, the auxiliary generator provides power in the following circuits:

The AGP7 wire from A1 of the auxiliary generator to the top of the auxiliary generator fuse;

The BCP wire to BCP1 wire to BCP3 wire, to BCP2 wire, to the fuel pump circuit breaker,

SQ6 wire to 2C of FPR;

SSX wire to B1 of FPCR;

SS6 wire to TB34L8 at the back of the main electrical cabinet;

SS2 wire to TB22L2 in the junction box under the AC cabinet;

SS wire to No. 5 of FP/ES on the rack;

SV1 to TB81T3 in the AC cabinet,

SV wire to FPC coil;

BN3 wire to TB80T2,

BCP7 wire to CR-BC;

BC wire to RE-BC, and circuit to fuel pump motor is repeated as indicated under fuel priming.

BN wire to TB80B2;

BN2, BN70 to battery switch,
AGN7 wire to A2 of the auxiliary generator.

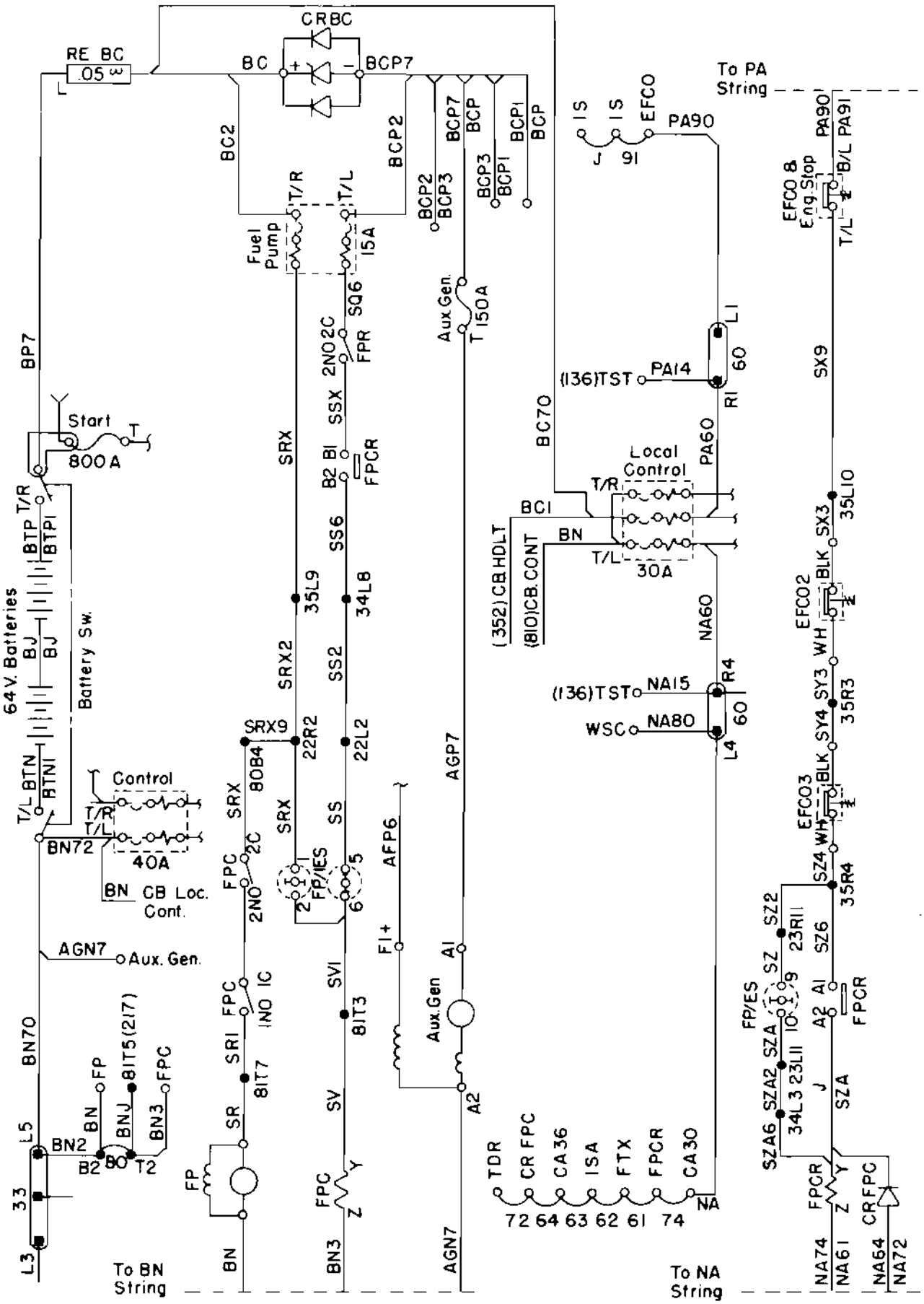


Fig. 19 — Sample Circuit, Physical Schematic Diagram

TRACING THE SAMPLE FUEL PUMP CIRCUIT ON THE CABLE AND CONDUIT LAYOUT DIAGRAM

Fig. 20 shows selected portions of the cable and conduit layout diagram. This diagram, along with Fig. 19, the physical schematic diagram, can be used to trace the sample fuel pump circuit.

Starting from battery positive, BTP and BTP1 wires enter the cable duct. Fillage chart A3 gives the wire size.

BTP and BTP1 wires enter the main electrical cabinet and connect at the battery switch. These particular wires are also covered in the wiring running list book because they are connected to the battery switch during cabinet manufacture and are allowed to hang out, rather than being connected at the cabinet after the cabinet is mounted on the locomotive.

The circuit from the battery switch to TB35L9 is entirely within the electrical cabinet, hence the wires are covered only on the wiring running list and on the physical schematic.

Wire SRX2 leads from TB35L9 at the back of the main electrical cabinet through the 022 conduit to TB22R2 in the junction box at the AC cabinet. This wire is not listed in the wiring running list book. The fillage chart indicates that the SRX2 wire runs in the cable duct to the right of the electrical cabinet and through junction box "F." The 022 conduit continues from junction box "F" to the AC junction box. The fillage chart indicates that the SRX2 wire runs in the 3-1/2 conduit 022.

The physical schematic diagram, Fig. 19, indicates that an SRX wire leads to No. 1 of FP/ES and that an SRX9 wire leads to TB80B4. The conduit drawing shows a conduit between the AC junction box and the AC cabinet. The fillage chart for this conduit calls out the SRX9 wire. Conduit leading to the FP/ES switch calls out the SRX wire, and in addition indicates that it is connected to terminal No. 1 of FP/ES.

A wire identified as SV1 leads from the FP/ES conduit to the AC cabinet. The physical schematic shows the SV1 wire connected to TB81T3. Wiring inside of the AC cabinet is covered in the wiring running list.

An SR wire runs in the 824 conduit from the AC cabinet (TB81T7) to the fuel pump motor, and a BN wire leads back to the AC cabinet (TB80B2). A fillage chart indicates the wire size.

The physical schematic indicates that the BN wire leads to TB80B2 and the BN3 wire leads to TB80T2; both in the AC cabinet. This can be seen at the terminal board block.

The fillage charts show the BN2 wire leading from the AC cabinet to the AC junction box; through the 022 conduit; through the cable duct and to the main electrical cabinet. It connects to TB33L5 as seen on the physical schematic.

A BN70 wire leads from TB33L5 to the main battery switch negative side. This is shown on the physical schematic and in the wire running list.

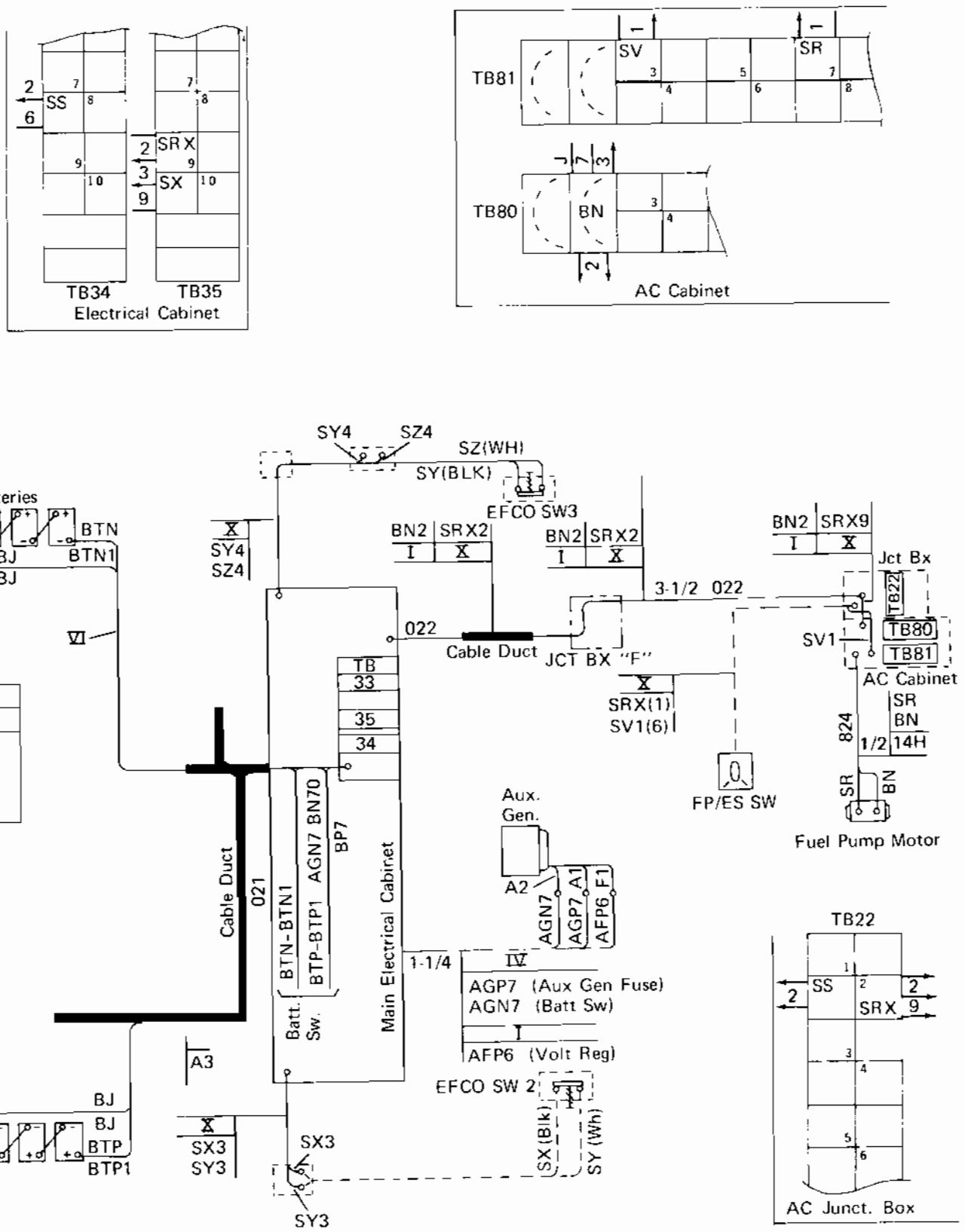


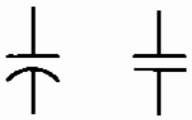
Fig. 20 – Selected Layout – Cable And Conduit Layout Drawing

SYMBOLS USED ON THE PHYSICAL SCHEMATIC DIAGRAM

This glossary attempts to explain symbols and charts likely to appear on a schematic diagram. Space prohibits coverage of all possible symbols, but the most common and important are shown.

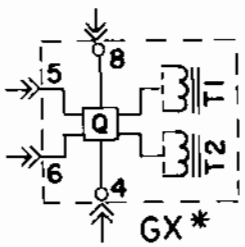
All symbols are to some extent pictorial; that is, they are drawn to look something like the devices they represent, or in some manner indicate the function of the device.

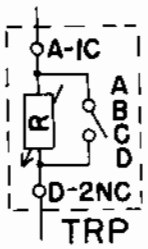
CA – CAPACITOR



A capacitor stores electrical charges on its plates. Its usual purpose on a locomotive is to dampen the affect of voltage peaks or to delay dropout of a relay. When used with the rate control panel it times the rate at which power changes take place.

CIRCUIT ASSEMBLIES



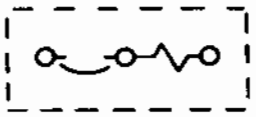


*See Miscellaneous Equipment Locator Chart Or Module Legend And Locator Chart for number suffix applicable to modular components.

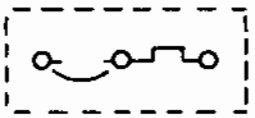
Complete circuits are "packaged" in various forms such as boards mounted on electrical cabinet panels, "black boxes" mounted on cabinet panels, and plug-in modules inserted in compartments equipped with receptacles. These assemblies are shown as broken-line rectangles on the physical schematic diagram, with symbols included only for guidance. The actual circuits in such assemblies are not shown on the physical schematic diagram. Broken-line rectangles representative of a single assembly may appear at several locations on the diagram in order to integrate the various functions of the circuit assembly at proper positions on the diagram.

CIRCUIT BREAKING DEVICES

Fuse.



Magnetically operated circuit breaker.



Thermally operated circuit breaker.

COIL, MAGNET

When current passes through a coil, a magnetic force is created. This force is used to move a piece of iron (armature) which in turn moves electrical contacts (switches).

COIL, POLARIZED RELAY

When a coil has numbered terminals, the relay armature is so arranged that it responds in relation to the direction of current flow through the relay coil. The common relay does not distinguish the direction of current flow; it responds to current or no current.

COIL (OF A POLARIZED OR EI TYPE RELAY CONTAINING MORE THAN 1 COIL)

Some relays contain several coils. The terminals of such coils may be lettered. Current flow in ascending alphabetical order will pick up the relay. Current flow in descending alphabetical order will act to drop the relay.

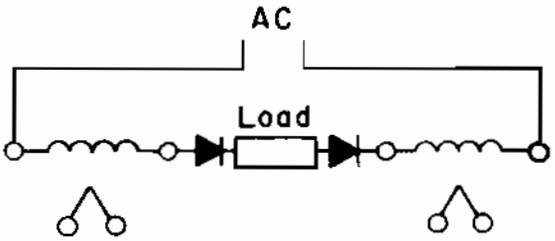
CR, RECTIFIER

This device allows conventional current flow in the direction of the arrow portion of the symbol. It blocks current flow in the opposite direction, but will break down and fail if the applied voltage is too high. The red terminal of the rectifier is at the arrow point. The black terminal is at the broad portion of the arrow symbol.

CR SUPPRESSION RECTIFIER

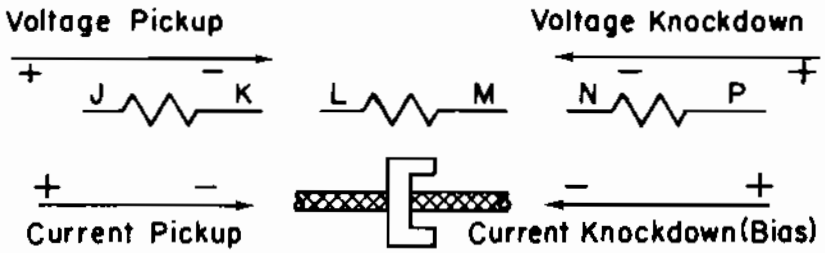
The suppression rectifier passes current in the forward direction and effectively blocks reverse current at normal circuit voltage. However, reverse polarity high voltage spikes result in reverse conduction. The reverse current flow results in suppressing the high voltage spikes which might otherwise destroy other circuit components. The primary purpose of the suppression rectifier is to protect conventional rectifiers from reverse polarity high voltage spikes.

MAGNETIC AMPLIFIER



Load windings are connected to alternating current, but rectifiers that are part of the magnetic amplifier allow current flow in only one direction. The pointed symbols indicate bias and control windings that carry direct current to control output of the magnetic amplifier. The various windings are not necessarily located adjacent to one another on the physical schematic diagram.

EI RELAY



The letter E in the name EI RELAY is the conventional symbol for electrical potential or voltage. The letter I is the symbol for electrical current. The EI relay is so constructed and connected in electrical circuits that its operation is dependent upon voltage at the operating coils and current in cables or a bus passing through the relay frame.

The relay will operate when DC voltage of a specific value is applied to the coils in alphabetical order and no current passes through the relay frame. However, when current passes through the relay frame a higher voltage value is required to actuate the relay.

Since the locomotive main generator is a constant kilowatt machine; that is, its voltage and current output are maintained at a definite ratio at all rotating speeds, the EI relay can sense the ratio and be calibrated to operate at various voltage values. The EI relay is generally calibrated to operate when generator voltage is approaching its upper limit for a given rotating speed.

If the relay frame symbol is shown pointing in the same direction as current, current through the relay frame is considered to be the primary operating factor. When the relay frame is shown pointing opposite to current flow, current through the relay frame biases the relay and voltage at the coils is considered to be the primary operating factor.

The coil and frame symbols are not necessarily adjacent to one another on the physical schematic. Furthermore, all coils in the relay are not necessarily connected in the same circuit. Various arrangements are used to obtain desired characteristics.

MOTOR AND GENERATOR FIELD WINDINGS

Motor field

Motor or generator armature

Generator field windings

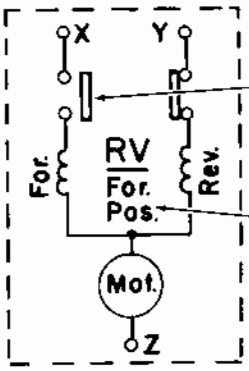
Compensating

Commutating

Differential

Shunt or battery field or single field

MOTOR OPERATED TRANSFER SWITCH

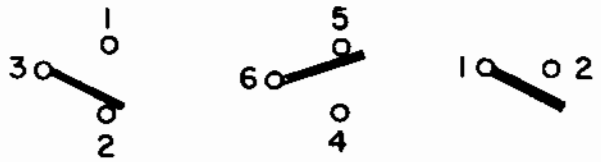


Travel Limiting Interlock

Indicates That All Contacts And Interlocks Are Shown With Switch In FORWARD position.

The main contacts of the switchgear are heavy duty, but are not equipped for arc discharge. Switch position is changed by a rotary motor, gear box, and cam. When the operating circuit is de-energized, the contacts and interlocks remain at the position to which they have been driven. Switchgear contacts and interlocks appear in the conventional manner in various circuits on the schematic diagram, but the normally closed or open positions do not relate to a de-energized switch operating mechanism. Contacts and interlocks for motor operated switches are shown as normally open or normally closed with the operating mechanism driven to the position indicated at the symbol for the operating mechanism.

POWER CONTACTS

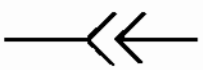


Contacts are always shown in their normal position when the operating coil is not energized. Observe that the attitude of the movable contact on single break power contactors does not necessarily imply a gravity dropout so far as the contact symbol is concerned.

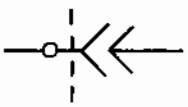
Double break contacts always employ the gravity convention for dropout when they are shown horizontally. The 1-2 contacts are normally open; the 3-4 contacts are normally closed.

When double break contacts are shown in a vertical attitude the contact bar is considered to fall to the right when the contactor is de-energized. The 1-2 contacts are normally open; the 3-4 contacts are normally closed.

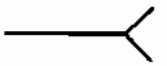
RECEPTACLES AND PLUGS



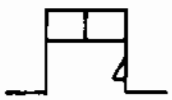
Cable connection, plug and jack



Indicates test point at jack.



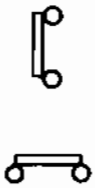
Cable connection, jack only.



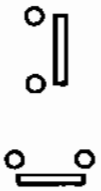
Test jack, circuit opening

Accessory power receptacle.

RELAY CONTACTS OR AUXILIARY CONTACTS



Normally closed when device is not energized, or when motor operated device is in position indicated at operating mechanism symbol.



Normally open when device is not energized, or when motor operated device is in position indicated at operating mechanism symbol.

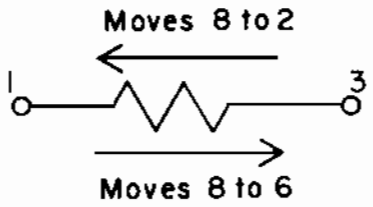
Normally closed after a time delay when device is de-energized.

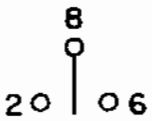
Normally open after a time delay when device is de-energized.

Normally closed, but open after a time delay when device is energized.

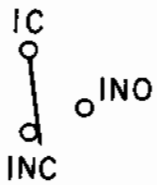
Normally open, but closing delayed when device is energized.

Shaded bars indicate that the normally open contacts close before the normally closed contacts open. The contacts overlap.

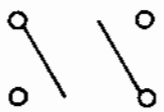




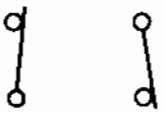
Contacts of a polarized relay. The movable contact makes with neither stationary contact when no current is passing through the relay coil. That is, the potential (electrical pressure) is the same at both relay coil terminals. The relay operates when a differential in electrical potential exists across the coil terminals. Relay action is illustrated above. The arrow points from high toward low potential.



Double throw, single break relay contacts. The contact is shown in its normal (de-energized) position. "C" indicates common; NC — normally closed, NO — normally open.



Normally open single break relay contacts.

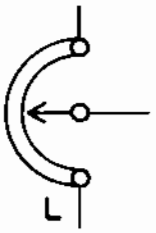


Normally closed single break relay contacts.

RH – RHEOSTAT

The rheostat is essentially a variable resistor when connected as shown.

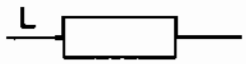
RH – RHEOSTAT (Pontentiometer)



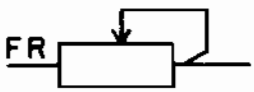
The rheostat is used as a voltage divider when connected as shown.

The letter L will generally appear adjacent to the rheostat and a wire connected to it. This indicates that the wire is connected to the actual left side terminal of the rheostat. The letter T for top and FR for front will be used if applicable.

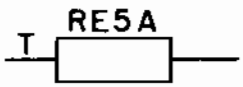
RE – RESISTOR



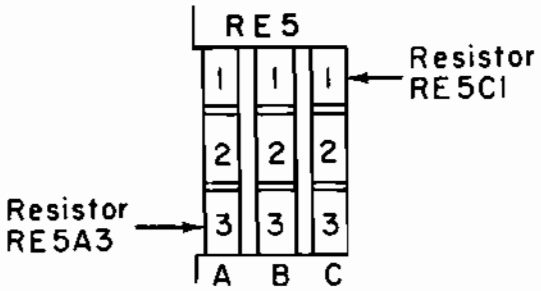
A resistor restricts the flow of electrical current and causes a voltage drop across its terminals. It is used to obtain proper values of current or voltage at a circuit or device.



The adjustable resistor is equipped with a slider to vary the resistance. It is used to calibrate circuits.



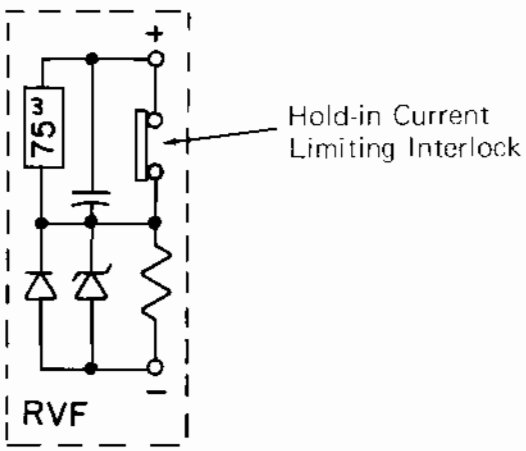
On the physical schematic wiring diagram the letters T, FR, L, or R will appear adjacent to the resistor and a wire connected to it. This indicates that the wire is connected to the actual top, front, left side, or right side of the resistor.



All resistors are identified by the letter prefix RE. This prefix is followed by a number to identify the specific resistor or group of resistors in a stack. When the resistor identification is applicable to a stack of resistors containing more than one tube, the tubes are identified by the letters A, B, C, etc., starting at the feet of the resistor stack and working outward.

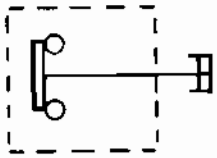
If each resistor stack is further divided, the number 1 resistor is to the left or top, depending upon the orientation of the resistor assembly.

SOLENOID OPERATED TRANSFER SWITCH



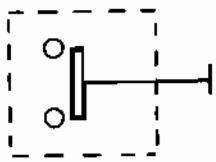
The main contacts of this switchgear are heavy duty, but are not equipped for arc discharge. Contacts and interlocks appear in various circuits on the schematic diagram. They are shown in the position that they take when the switchgear operating coil is de-energized.

SWITCHES

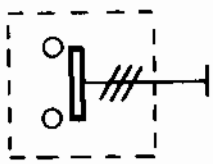


Normally closed pneumatically or hydraulically operated, double break.

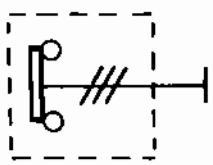
Normally open thermally operated, single break.



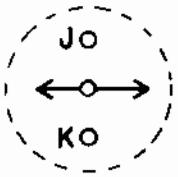
Manually operated double break. Switch remains in the position to which it is set.

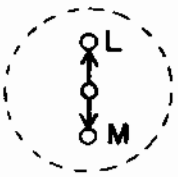


Manually operated double break, spring loaded to the open position.

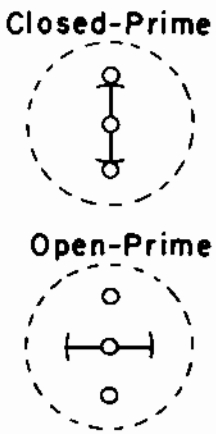


Manually operated double break, spring loaded to the closed position.



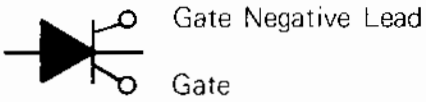


Manually operated rotary snap switch. Switch remains in position to which it is set. Such a switch may have numerous wafers ganged on a single shaft. The individual contacts may be open or closed at a given position of the operating device.



Spring loaded rotary switch. Manually operated, it returns to its normal position when the operating device is released. Such a switch may have several wafers ganged on a single shaft. The individual contacts may be open or closed at a given position of the operating device. Contact positions will be noted adjacent to the switch symbol.

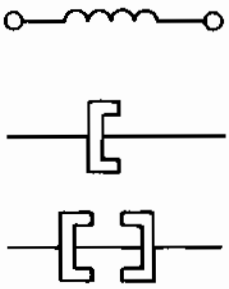
SILICON CONTROLLED RECTIFIER



The controlled rectifier will block a reverse flow of current as does a conventional rectifier, but it will also block in the "forward" direction until a small charge is placed on its gate. Once it is turned on, the controlled rectifier will remain on until current flow drops to a small value (each cycle of AC) and a charge is absent from the gate.

STANDOFF INSULATOR

TRANSDUCTOR – CURRENT SENSITIVE



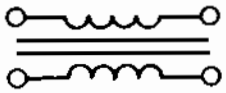
The transductor contains a single winding on a gapless core. DC current carrying cables pass through the core. The winding carries alternating current and is often connected in series with a transformer primary. Current in the cables that pass through the core of the transductor controls the output of the transductor.

The core symbol is not necessarily adjacent to the winding symbol.

TRANSDUCTOR – VOLTAGE SENSITIVE

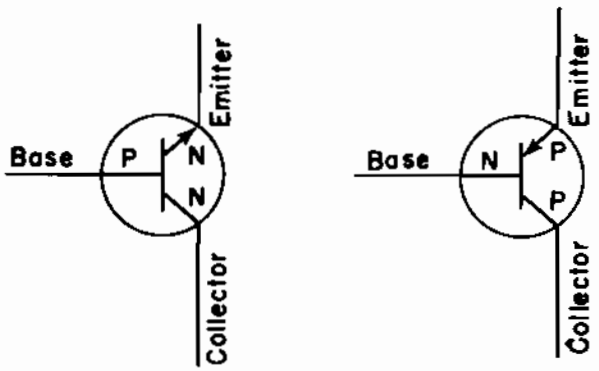
The transductor contains two types of windings on a gapless core. The 4-loop symbol winding carries alternating current and is usually connected in series with a transformer primary. The pointed symbol winding (not necessarily adjacent to the loop symbol) carries direct current that controls the output of the transductor.

TRANSFORMER



The primary and secondary windings of a transformer are not necessarily shown adjacent to one another on the physical schematic diagram; however, both parts are identified with an identical reference designation.

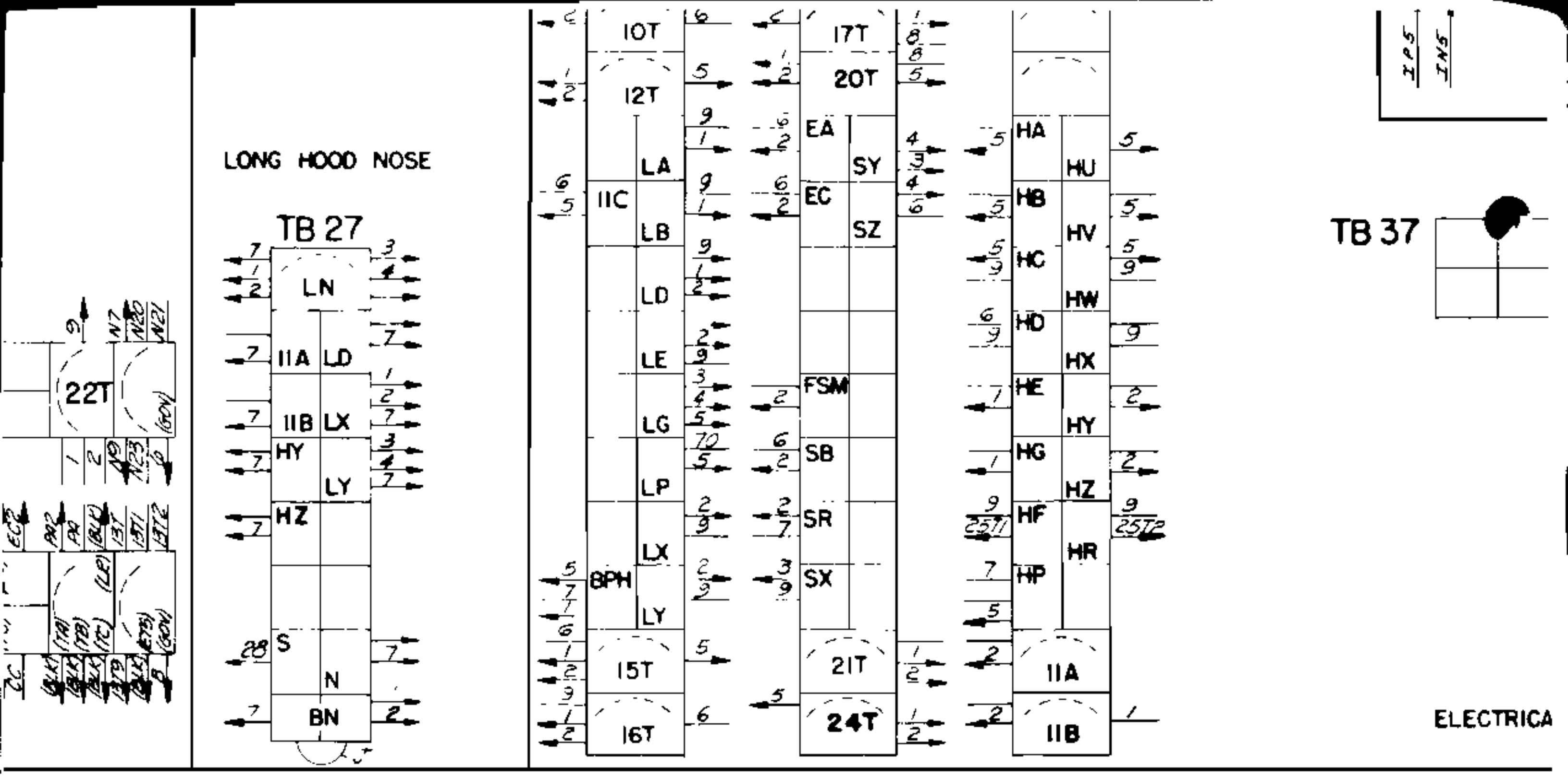
TRANSISTOR

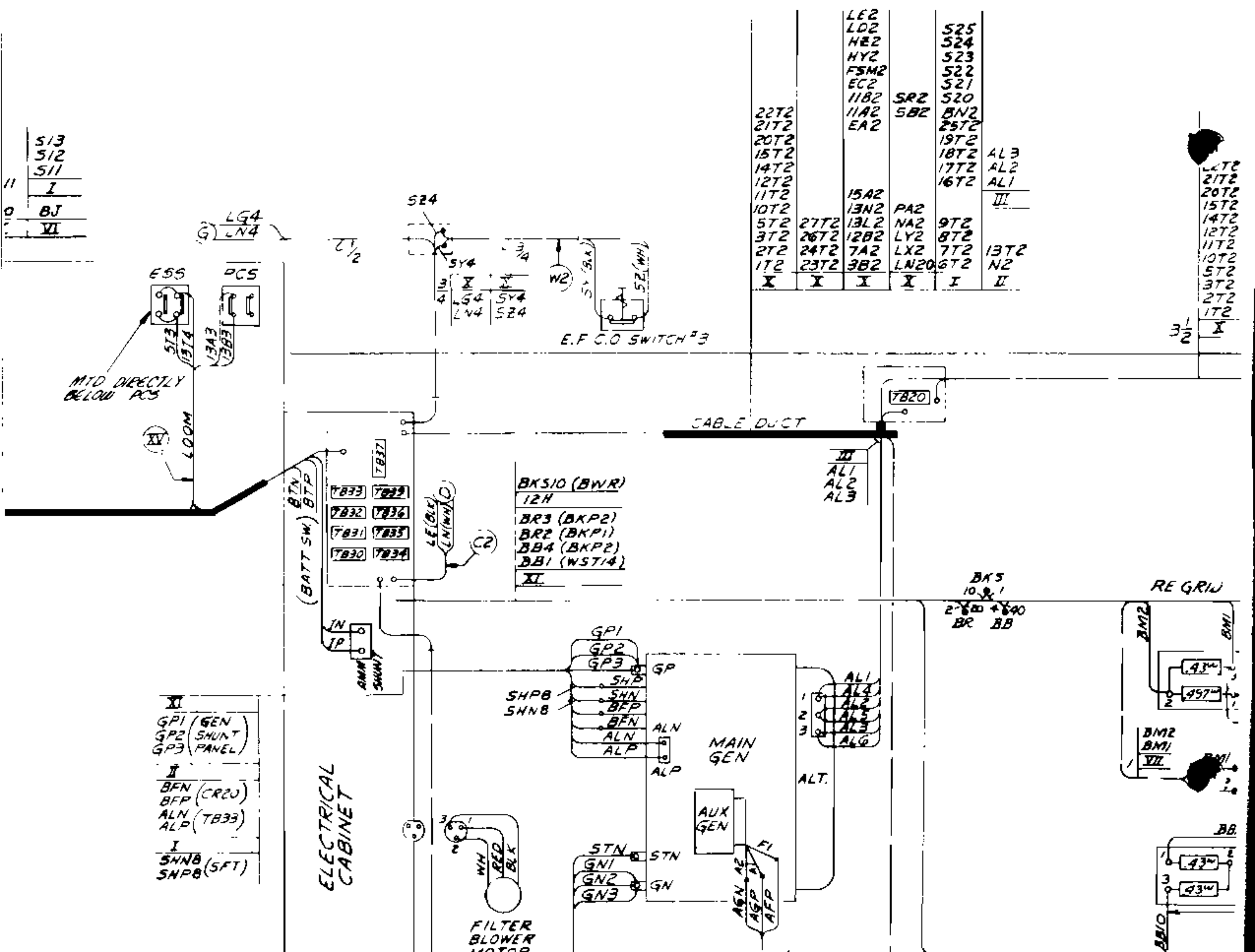


Current flow through a transistor is in proportion to a small current flow at its base. Conventional current into the base turns on the NPN type transistor, while current out of the base turns on the PNP type.

Z – ZENER DIODE

This diode will conduct in the normal blocking direction if sufficient voltage is applied. When the Zener diode conducts in the normal blocking direction it maintains a constant voltage drop across the diode. This characteristic is used to provide voltage reference values in circuitry.


LONG HOOD NOSE
TB 27
TB 37
ELECTRICA


ESS
PCS
MTD DIRECTLY BELOW PCS
LOOM
E.F C.O SWITCH # 3
CABLE DUCT
(BATT SW)
ELECTRICAL CABINET
MAIN GEN
AUX GEN
ALT.
FILTER BLOWER MOTOR
RE GRID