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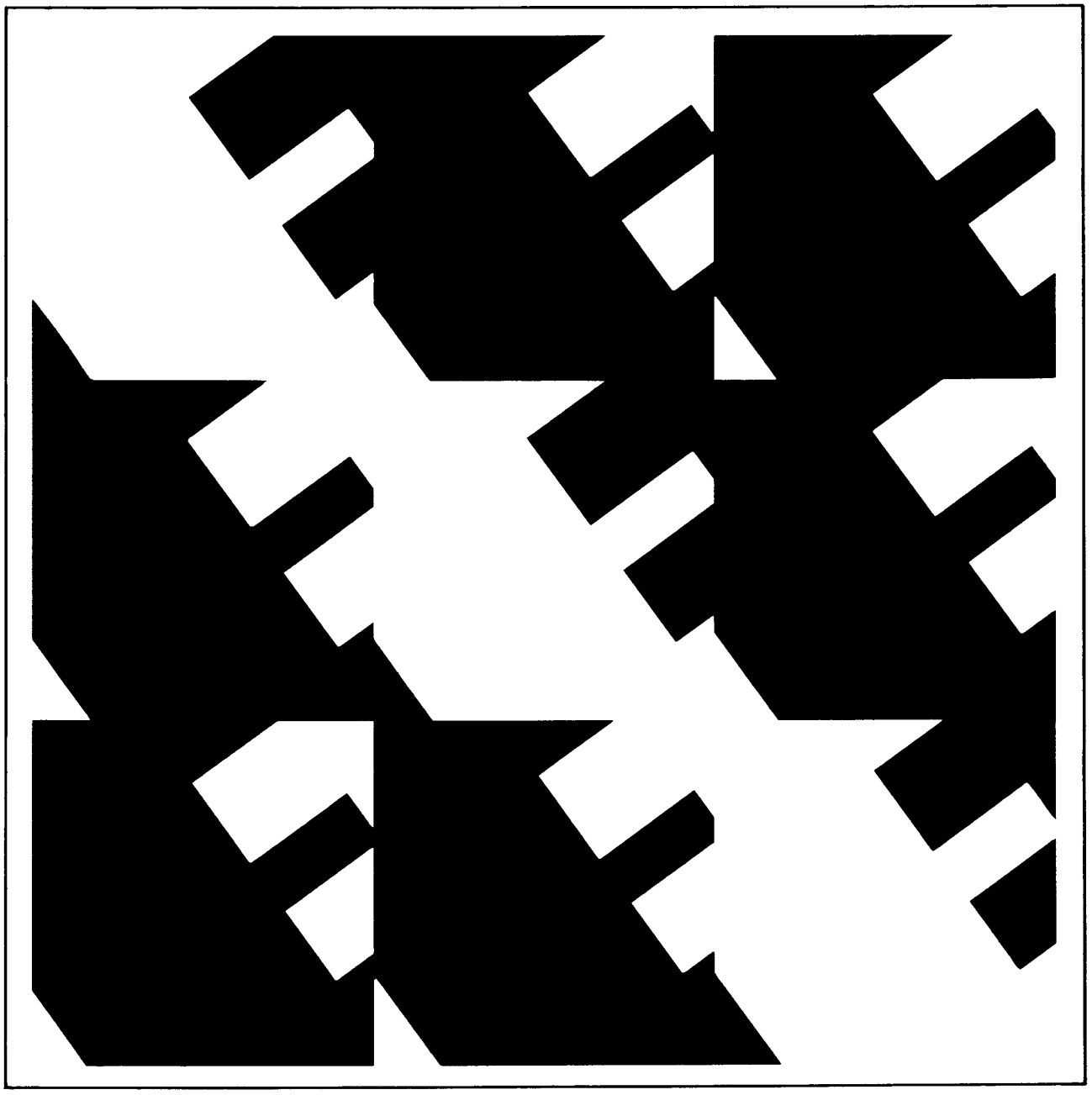
IEEE Standard Electrical Power System Device Function Numbers



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1. Scope and References

1.1 Scope. This standard applies to the definition and application of function numbers for devices used in electrical substations and generating plants and in installations of power utilization and conversion apparatus.

NOTE: Although the wording of this standard is directed specifically to equipment comprising conventional electromechanical devices, it also applies to equipment consisting totally, or in part, of electronic or solid-state devices.

1.2 References. When the American National Standards referred to in this standard are superseded by a revision approved by the American National Standards Institute, the revision shall apply.

[1] ANSI Y1.1-1972 (R1984), Abbreviations for Use on Drawings and in Text.[1]

[2] ANSI/IEEE Std 315-1975, Graphic Symbols for Electrical and Electronics Diagrams.[2]

[3] ANSI/IEEE C37.1-1987, IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control.

[4] ANSI/IEEE C37.20.1-1987, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

[5] ANSI/IEEE C37.20.2-1987, IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear.

[1] ANSI publications are available from the American National Standards Institute, Sales Department, 1430 Broadway, New York, NY 10018.

[2] ANSI/IEEE publications are available from The Institute of Electrical and Electronics Engineers Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ, 08855-1331, or from The American National Standards Institute, Sales Department, 1430 Broadway, New York, NY 10018.

2. Purpose of Device Function Numbers

A device function number, with appropriate prefix and suffix where necessary, is used to identify the function of each device in all types of partial automatic and automatic switchgear and in many types of manual switchgear. These numbers are to be used on drawings, on elementary and connection diagrams, in instruction books, in publications, and in specifications. In addition, for automatic switchgear, the number may be placed on, or adjacent to, each device on the assembled equipment so that the device may be readily identified.

NOTE: These device function designations, which have been developed as a result of usage over many years, may define the actual function the device performs in an equipment, or they may refer to the electrical or other quantity to which the device is responsive. Hence, there may be in some instances a choice of the function number to be used for a given device. The preferable choice to be made in all cases should be the one which is recognized to have the narrowest interpretation so that it most specifically identifies the device in the minds of all individuals concerned with the design and operation of the equipment.

3. Standard Device Function Numbers

3.1 Standard Device Function Numbers.. Each number with its corresponding function name and the general description of each function is listed below.

NOTE: When alternate names and descriptions are included under the function, only the name and description which applies to each specific case should be used. In general, only one name for each device, such as relay, contactor, circuit breaker, switch, monitor, or other device, is included in each function designation. However, when the function is not inherently restricted to any specific type of device and where the type of device itself is thus merely incidental, any one of the above listed alternative names, as applicable, may be substituted. For example, if for device function 6 a contactor is used for the purpose in place of a circuit breaker, the function name should be specified as starting contactor.

For every application of device function numbers, the originator should provide a brief definition for all device function numbers used in that application, including all combinations of prefixes, function numbers and suffixes. Typical definitions are illustrated in Fig 3a. These definitions should be included on the drawing where the device function number is used, or on a separate drawing or list to which the other drawings refer. All instruction books and other documents shall also include the device function number definitions.

Numbers from 95 to 99 should be assigned only for those functions in specific cases where none of the assigned standard device function numbers are applicable. Numbers which are "reserved for future application" should not be used.

1. master element is the initiating device, such as a control switch, etc, which serves either directly or through such permissive devices as protective and time-delay relays to place an equipment in or out of operation.

NOTE: This number is normally used for a hand-operated device, although it may also be used for an electrical or mechanical device for which no other function number is suitable.

2. time-delay starting or closing relay is a device that functions to give a desired amount of time delay before or after any point of operation in a switching sequence or protective relay system, except as specifically provided by device functions 48, 62, and 79.

3. checking or interlocking relay is a relay that operates in response to the position of a number of other devices (or to a number of predetermined conditions) in an equipment, to allow an operating sequence to proceed, or to stop, or to provide a check of the position of these devices or of these conditions for any purpose.

4. master contactor is a device, generally controlled by device function 1 or the equivalent and the required permissive and protective devices, that serves to make and break the necessary control circuits to place an equipment into operation under the desired conditions and to take it out of operation under abnormal conditions.

5. stopping device is a control device used primarily to shut down an equipment and hold it out of operation. (This device may be manually or electrically actuated, but excludes the function of electrical lockout (see device function 86) on abnormal conditions.)

6. starting circuit breaker is a device whose principal function is to connect a machine to its source of starting voltage.

7. Reserved for future application.

8. control power disconnecting device is a disconnecting device, such as a knife switch, circuit breaker, or pull-out fuse block, used for the purpose of respectively connecting and disconnecting the source of control power to and from the control bus or equipment.

NOTE: Control power is considered to include auxiliary power which supplies such apparatus as small motors and heaters.

9. reversing device is a device that is used for the purpose of reversing a machine field or for performing any other reversing functions.

10. unit sequence switch is a switch that is used to change the sequence in which units may be placed in and out of service in multiple-unit equipments.

11. multifunction device is a device that performs three or more comparatively important functions which could only be designated by combining several of these device function numbers. All of the functions performed by device 11 shall be defined in the drawing legend or device function definition list.

NOTE: If only two relatively important functions are performed by the device, it is preferred that both function numbers be used, as described in 3.6.

12. overspeed device is usually a direct-connected speed switch which functions on machine overspeed.

13. synchronous-speed device is a device such as a centrifugal-speed switch, a slip-frequency relay, a voltage relay, an undercurrent relay, or any type of device that operates at approximately the synchronous speed of a machine.

14. underspeed device is a device that functions when the speed of a machine falls below a predetermined value.

15. speed or frequency matching device is a device that functions to match and hold the speed or frequency of a machine or of a system equal to, or approximately equal to, that of another machine, source or system.

16. Reserved for future application.

17. shunting or discharge switch is a switch that serves to open or to close a shunting circuit around any piece of apparatus (except a resistor), such as a machine field, a machine armature, a capacitor, or a reactor.

NOTE: This excludes devices that perform such shunting operations as may be necessary in the process of starting a machine by devices 6 or 42, or their equivalent, and also excludes device function 73 that serves for the switching of resistors.

18. accelerating or decelerating device is a device that is used to close or to cause the closing of circuits which are used to increase or decrease the speed of a machine.

19. starting-to-running transition contactor is a device that operates to initiate or cause the automatic transfer of a machine from the starting to the running power connection.

20. electrically operated valve is an electrically operated, controlled or monitored valve used in a fluid, air, gas, or vacuum line.

NOTE: The function of the valve may be more completely indicated by the use of suffixes as discussed in 3.2.

21. distance relay is a relay that functions when the circuit admittance, impedance, or reactance increases or decreases beyond a predetermined value.

22. equalizer circuit breaker is a breaker that serves to control or to make and break the equalizer or the current-balancing connections for a machine field, or for regulating equipment, in a multiple-unit installation.

23. temperature control device is a device that functions to raise or lower the temperature of a machine or other apparatus, or of any medium, when its temperature falls below, or rises above, a predetermined value.

NOTE: An example is a thermostat that switches on a space heater in a switchgear assembly when the temperature falls to a desired value. This should be distinguished from a device that is used to provide automatic temperature regulation between close limits and would be designated as device function 90T.

24. volts per hertz relay is a relay that functions when the ratio of voltage to frequency exceeds a preset value. The relay may have an instantaneous or a time characteristic.

25. synchronizing or synchronism-check device is a device that operates when two ac circuits are within the desired limits of frequency, phase angle, and voltage, to permit or to cause the paralleling of these two circuits.

26. apparatus thermal device is a device that functions when the temperature of the protected apparatus (other than the load-carrying windings of machines and transformers as covered by device function number 49), or of a liquid or other medium exceeds a predetermined value; or when the temperature of the protected apparatus or of any medium decreases below a predetermined value.

27. undervoltage relay is a relay which operates when its input voltage is less than a predetermined value.

28. flame detector is a device that monitors the presence of the pilot or main flame in such apparatus as a gas turbine or a steam boiler.

29. isolating contactor is a device that is used expressly for disconnecting one circuit from another for the purposes of emergency operation, maintenance, or test.

30. annunciator relay is a nonautomatically reset device that gives a number of separate visual indications upon the functioning of protective devices, and which may also be arranged to perform a lockout function.

31. separate excitation device is a device that connects a circuit, such as the shunt field of a synchronous converter, to a source of separate excitation during the starting sequence.

32. directional power relay is a relay which operates on a predetermined value of power flow in a given direction, or upon reverse power flow such as that resulting from the motoring of a generator upon loss of its prime mover.

33. position switch is a switch that makes or breaks contact when the main device or piece of apparatus which has no device function number reaches a given position.

34. master sequence device is a device such as a motor-operated multicontact switch, or the equivalent, or a programming device, such as a computer, that establishes or determines the operating sequence of the major devices in an equipment during starting and stopping or during other sequential switching operations.

35. brush-operating or slip-ring short-circuiting device is a device for raising, lowering, or shifting the brushes of a machine, or for short-circuiting its slip rings, or for engaging or disengaging the contacts of a mechanical rectifier.

36. polarity or polarizing voltage device is a device that operates, or permits the operation of, another device on a predetermined polarity only, or verifies the presence of a polarizing voltage in an equipment.

37. undercurrent or underpower relay is a relay that functions when the current or power flow decreases below a predetermined value.

38. bearing protective device is a device that functions on excessive bearing temperature, or on other abnormal mechanical conditions associated with the bearing, such as undue wear, which may eventually result in excessive bearing temperature or failure.

39. mechanical condition monitor is a device that functions upon the occurrence of an abnormal mechanical condition (except that associated with bearings as covered under device function 38), such as excessive vibration, eccentricity, expansion, shock, tilting, or seal failure.

40. field relay is a relay that functions on a given or abnormally low value or failure of machine field current, or on an excessive value of the reactive component of armature current in an ac machine indicating abnormally low field excitation.

41. field circuit breaker is a device that functions to apply or remove the field excitation of a machine.

42. running circuit breaker is a device whose principal function is to connect a machine to its source of running or operating voltage. This function may also be used for a device, such as a contactor, that is used in series with a circuit breaker or other fault protecting means, primarily for frequent opening and closing of the circuit.

43. manual transfer or selector device is a manually operated device that transfers the control circuits in order to modify the plan of operation of the switching equipment or of some of the devices.

44. unit sequence starting relay is a relay that functions to start the next available unit in a multiple-unit equipment upon the failure or nonavailability of the normally preceding unit.

45. atmospheric condition monitor is a device that functions upon the occurrence of an abnormal atmospheric condition, such as damaging fumes, explosive mixtures, smoke, or fire.

46. reverse-phase or phase-balance current relay is a relay that functions when the polyphase currents are of reverse-phase sequence, or when the polyphase currents are unbalanced or contain negative phase-sequence components above a given amount.

47. phase-sequence or phase-balance voltage relay is a relay that functions upon a predetermined value of polyphase voltage in the desired phase sequence or when the polyphase voltages are unbalanced or when the negative phase-sequence voltage exceeds a given amount.

48. incomplete sequence relay is a relay that generally returns the equipment to the normal, or off, position and locks it out if the normal starting, operating, or stopping sequence is not properly completed within a predetermined time.

49. machine or transformer thermal relay is a relay that functions when the temperature of a machine armature winding or other load-carrying winding or element of a machine or power transformer exceeds a predetermined value.

50. instantaneous overcurrent or rate-of-rise relay is a relay that functions instantaneously on an excessive value of current or on an excessive rate of current rise.

51. ac time overcurrent relay is a relay that functions when the ac input current exceeds a predetermined value, and in which the input current and operating time are inversely related through a substantial portion of the performance range.

52. ac circuit breaker is a device that is used to close and interrupt an ac power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.

53. exciter or dc generator relay is a relay that forces the dc machine field excitation to build up during starting or which functions when the machine voltage has built up to a given value.

54. turning gear engaging device is an electrically operated, controlled, or monitored device which functions to cause the turning gear to engage (or disengage) the machine shaft.

55. power factor relay is a relay that operates when the power factor in an ac circuit rises above or falls below a predetermined value.

56. field application relay is a relay that automatically controls the application of the field excitation to an ac motor at some predetermined point in the slip cycle.

57. short-circuiting or grounding device is a primary circuit switching device that functions to short circuit or to ground a circuit in response to automatic or manual means.

58. rectification failure relay is a device that functions if a power rectifier fails to conduct or block properly.

59. overvoltage relay is a relay which operates when its input voltage is more than a predetermined value.

60. voltage or current balance relay is a relay that operates on a given difference in voltage, or current input or output, of two circuits.

61. density switch or sensor is a device which operates on a given value, or a given rate of change, of gas density.

62. time-delay stopping or opening relay is a time-delay relay that serves in conjunction with the device that initiates the shutdown, stopping, or opening operation in an automatic sequence or protective relay system.

63. pressure switch is a switch which operates on given values, or on a given rate of change, of pressure.

64. ground detector relay is a relay that operates on failure of machine or other apparatus insulation to ground.

NOTE: This function is not applied to a device connected in the secondary circuit of current transformers in a normally grounded power system, where other device numbers with a suffix G or N should be used, that is, 51N for an ac time overcurrent relay connected in the secondary neutral of the current transformers.

65. governor is the assembly of fluid, electrical, or mechanical control equipment used for regulating the flow of water, steam, or other medium to the prime mover for such purposes as starting, holding speed or load, or stopping.

66. notching or jogging device is a device that functions to allow only a specified number of operations of a given device, or equipment, or a specified number of successive operations within a given time of each other. It is also a device that functions to energize a circuit periodically or for fractions of specified time intervals, or that is used to permit intermittent acceleration or jogging of a machine at low speeds for mechanical positioning.

67. ac directional overcurrent relay is a relay that functions on a desired value of ac overcurrent flowing in a predetermined direction.

68. blocking relay is a relay that initiates a pilot signal for blocking of tripping on external faults in a transmission line or in other apparatus under predetermined conditions, or cooperates with other devices to block tripping or to block reclosing on an out-of-step condition or on power swings.

69. permissive control device is generally a two-position device that in one position permits the closing of a circuit breaker, or the placing of an equipment into operation, and in the other position prevents the circuit breaker or the equipment from being operated.

70. rheostat is a variable resistance device used in an electric circuit, which is electrically operated or has other electrical accessories, such as auxiliary, position, or limit switches.

71. level switch is a switch which operates on given values, or on a given rate of change, of level.

72. dc circuit breaker is a circuit breaker that is used to close and interrupt a dc power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.

73. load-resistor contactor is a contactor that is used to shunt or insert a step of load limiting, shifting, or indicating resistance in a power circuit, or to switch a space heater in circuit, or to switch a light or regenerative load resistor of a power rectifier or other machine in and out of circuit.

74. alarm relay is a relay other than an annunciator, as covered under device function 30, that is used to operate, or to operate in connection with, a visual or audible alarm.

75. position changing mechanism is a mechanism that is used for moving a main device from one position to another in an equipment; as, for example, shifting a removable circuit breaker unit to and from the connected, disconnected, and test positions.

76. dc overcurrent relay is a relay that functions when the current in a dc circuit exceeds a given value.

77. telemetering device is a transmitter used to generate and transmit to a remote location an electrical signal representing a measured quantity, or a receiver used to receive the electrical signal from a remote transmitter and convert the signal to represent the original measured quantity.

78. phase-angle measuring or out-of-step protective relay is a relay that functions at a predetermined phase angle between two voltages or between two currents or between voltage and current.

79. ac reclosing relay is a relay that controls the automatic reclosing and locking out of an ac circuit interrupter.

80. flow switch is a switch which operates on given values, or on a given rate of change, of flow.

81. frequency relay is a relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency exceeds or is less than a predetermined value.

82. dc reclosing relay is a relay that controls the automatic closing and reclosing of a dc circuit interrupter, generally in response to load circuit conditions.

83. automatic selective control or transfer relay is a relay that operates to select automatically between certain sources or conditions in an equipment, or performs a transfer operation automatically.

84. operating mechanism is the complete electrical mechanism or servomechanism, including the operating motor, solenoids, position switches, etc, for a tap changer, induction regulator, or any similar piece of apparatus which otherwise has no device function number.

85. carrier or pilot-wire receiver relay is a relay that is operated or restrained by a signal used in connection with carrier-current or dc pilot-wire fault relaying.

86. lockout relay is a hand or electrically reset auxiliary relay that is operated upon the occurrence of abnormal conditions to maintain associated equipment or devices inoperative until it is reset.

87. differential protective relay is a protective relay that functions on a percentage or phase angle or other quantitative difference of two currents or of some other electrical quantities.

88. auxiliary motor or motor generator is one used for operating auxiliary equipment, such as pumps, blowers, exciters, rotating magnetic amplifiers, etc.

89. line switch is a switch used as a disconnecting, load-interrupter, or isolating switch in an ac or dc power circuit. (This device function number is normally not necessary unless the switch is electrically operated or has electrical accessories, such as an auxiliary switch, magnetic lock, etc.)

90. regulating device is a device that functions to regulate a quantity, or quantities, such as voltage, current, power, speed, frequency, temperature, and load, at a certain value or between certain (generally close) limits for machines, tie lines, or other apparatus.

91. voltage directional relay is a relay that operates when the voltage across an open circuit breaker or contactor exceeds a given value in a given direction.

92. voltage and power directional relay is a relay that permits or causes the connection of two circuits when the voltage difference between them exceeds a given value in a predetermined direction and causes these two circuits to be disconnected from each other when the power flowing between them exceeds a given value in the opposite direction.

93. field-changing contactor is a contactor that functions to increase or decrease, in one step, the value of field excitation on a machine.

94. tripping or trip-free relay is a relay that functions to trip a circuit breaker, contactor, or equipment, or to permit immediate tripping by other devices; or to prevent immediate reclosure of a circuit interrupter if it should open automatically even though its closing circuit is maintained closed.

95-99. Used only for specific applications in individual installations where none of the assigned numbered functions from 1 to 94 are suitable.

3.2 Addition of Prefixes and Suffixes. Letters and numbers may be used as prefixes or suffixes to device function numbers to provide a more specific definition of the function, as discussed below. They permit a manifold multiplication of available function designations for the large number and variety of devices used in the many types of equipment covered by this standard. They may also serve to denote individual or specific parts or auxiliary contacts of these devices or certain distinguishing features, characteristics, or conditions which describe the use of the device or its contacts in the equipment.

Prefixes and suffixes should, however, be used only when they accomplish a useful purpose. For example, when all of the devices in an equipment are associated with only one kind of apparatus, such as a feeder or motor or generator, it is common practice, in order to retain maximum simplicity in device function identification, not to add the respective suffix letter F or M or G to any of the device function numbers.

3.2.1 Defining Letter Suffixes. In order to prevent any possible conflict or confusion, each letter suffix should preferably have only one meaning in an individual equipment. To accomplish this, short distinctive abbreviations, such as contained in ANSI Y1.1-1972 [1][3], or any appropriate combination of letters, may also be used as letter suffixes, where necessary. However, each suffix should not consist of more than three (and preferably not more than two) letters, in order to keep the complete function designation as short and simple as possible.

The meaning of each suffix should be designated on the drawings or in the publications with which they are used, similar to: TC-trip coil, V-voltage, X-auxiliary relay.

In cases where the same suffix (consisting of one letter or a combination of letters) has different meanings in the same equipment, depending upon the device function number with which it is used, then the complete device function number with its suffix letter or letters and its corresponding function definition should be listed in the legend in each case, as follows: 63V-vacuum relay, 70R-raising relay for device 70, 90V-voltage regulator.

3.3 Suggested Prefixes. A similar series of numbers, prefixed by the letters RE (for "remote") may be used for the interposing relays performing functions that are controlled directly from the supervisory system. Typical examples of such functions are RE1, RE5, and RE94.

In multiple-unit installations, it may be desirable to use a prefix number to distinguish between device functions associated with individual units. For example, in pipeline pump stations, the numbers 1 through 99 are applied to device functions that are associated with the overall station operation. A similar series of numbers, starting with 101 instead of 1, are used for those device functions that are associated with unit 1; a similar series starting with 201 for device functions that are associated with unit 2; and so on, for each unit in these installations.

3.4 Suggested Suffix Letters. Sections 3.4.1 through 3.4.6 describe letters which are commonly used and are recommended for use when required and as appropriate.

3.4.1 Auxiliary Devices. These letters denote separate auxiliary devices, such as

C Closing relay or contactor
CL Auxiliary relay, closed (energized when main device is in closed position)
CS Control switch
D "Down" position switch relay
L Lowering relay
O Opening relay or contactor
OP Auxiliary relay, open (energized when main device is in open position)
PB Push button
R Raising relay
U "UP" position switch relay
X Auxiliary relay
Y Auxiliary relay
Z Auxiliary relay

NOTE: In the control of circuit breaker with a so-called X-Y relay control scheme, the X relay is the device whose main contacts are used to energize the closing coil or the device which in some other manner, such as by the release of stored energy, causes the breaker to close. The contacts of the Y relay provide the antipump feature of the circuit breaker.

3.4.2 Actuating Quantities. These letters indicate the condition or electrical quantity to which the device responds, or the medium in which it is located, such as

A Air or amperes or alternating
C Current
D Direct or discharge
E Electrolyte
F Frequency or flow or fault
H Explosive
J Differential
L Level or liquid
P Power or pressure
PF Power factor
O Oil
S Speed or suction or smoke
T Temperature
V Voltage or volts or vacuum
VAR Reactive power
VB Vibration
W Water or watts

3.4.3 Main Device. These letters denote the main device to which the numbered device is applied or is related:

A Alarm or auxiliary power
AN Anode
B Battery or blower or bus
BK Brake
BL Block (valve)
BP Bypass
BT Bus tie
C Capacitor or condenser or compensator or carrier current or case or compressor
CA Cathode

[3]The numbers in square brackets correspond to those of the references listed in 1.2.

CH Check (valve)
D Discharge (valve)
DC Direct current
E Exciter
F Feeder or field or filament or filter or fan
G Generator or ground[5]
H Heater or housing
L Line or logic
M Motor or metering
MOC Mechanism operated contact[4]
N Network or neutral[5]
P Pump or phase comparison
R Reactor or rectifier or room
S Synchronizing or secondary or strainer or sump or suction (valve)
T Transformer or thyratron
TH Transformer (high-voltage side)
TL Transformer (low-voltage side)
TM Telemeter
TT Transformer (tertiary-voltage side)
U Unit

3.4.4 Main Device Parts. These letters denote parts of the main device, except auxiliary contacts, position switches, limit switches and torque limit switches which are covered in Section 4.

BK Brake
C Coil or condenser or capacitor
CC Closing coil
HC Holding coil
M Operating motor
MF Fly-ball motor
ML Load-limit motor
MS Speed adjusting or synchronizing motor
S Solenoid
SI Seal-in
TC Trip coil
V Valve

3.4.5 Other Suffix Letters. The following letters cover all other distinguishing features or characteristics or conditions, not specifically described in 3.4.1 to 3.4.4, which serve to describe the use of the device in the equipment, such as

A Accelerating or automatic
B Blocking or backup
C Close or cold
D Decelerating or detonate or down or disengaged
E Emergency or engaged
F Failure or forward
H Hot or high
HR Hand reset
HS High speed
L Left or local or low or lower or leading
M Manual
O Open
OFF Off
ON On
P Polarizing
R Right or raise or reclosing or receiving or remote or reverse
S Sending or swing
T Test or trip or trailing
TDC Time-delay closing
TDO Time-delay opening
U Up

3.4.6 Use of Suffix Letters. Lower case (small) letters are used in practically all instances on electrical diagrams for the auxiliary, position, and limit switches as shown in 4.1. Capital letters are generally used for all suffix letters in 3.4.

The letters in 3.4.1 to 3.4.3, since they should generally form part of the device function designation, are usually written directly after the device function number, as, for example, 52CS, 71W, or 49D. When it is necessary to use two types of suffix letters in connection with one function number, it is often desirable for clarity to separate them by a slanted line or dash, as, for example, 20D/CS or 20D-CS.

The suffix letters in 3.4.4 which denote parts of the main device, and those in 3.4.5, which cannot or need not form part of the device function designation, are generally written directly below the device function number on the drawings, as for example,

$$\frac{52}{CC} \text{ or } \frac{43}{A} \text{ (see Fig 3)}$$

3.5 Suffix Numbers. If two or more devices with the same function number and suffix letter (if used) are present in the same equipment, they may be distinguished by numbered suffixes, as, for example, 4X-1, 4X-2, and 4X-3, when necessary.

3.6 Devices Performing More Than One Function. If one device performs two relatively im-

[4]MOC denotes a circuit breaker mechanism operated auxiliary switch which is mounted on the stationary housing of a removable circuit breaker.

[5]Suffix N is generally used in preference to G for devices connected in the secondary neutral of current transformers, or in the secondary of a current transformer whose primary winding is located in the neutral of a machine or power transformer, except in the case of transmission line relaying, where the suffix G is more commonly used for those relays that operate on ground faults.

portant functions in an equipment so that it is desirable to identify both of these functions, a double function number and name, such as 50/51 instantaneous and time overcurrent relay, may be used.

4. Device Contacts

4.1 Auxiliary, Position, and Limit Switch Contacts. The letters *a* and *b* shall be used for all auxiliary, position, and limit switch contacts for such devices and equipment as circuit breakers, contactors, valves and rheostats, and contacts of relays:

a—Contact that is open when the main device is in the standard reference position, commonly referred to as the nonoperated or deenergized position, and that closes when the device assumes the opposite position

b—Contact that is closed when the main device is in the standard reference position, commonly referred to as the nonoperated or deenergized position, and that opens when the device assumes the opposite position

The simple designation *a* or *b* is used in all cases where there is no need to adjust the contacts to change position at any particular point in the travel of the main device or where the part of the travel where the contacts change position is of no significance in the control or operating scheme. Hence the *a* and *b* designations usually are sufficient for circuit breaker auxiliary switches.

Standard reference positions of some typical devices are as follows:

Device	Standard Reference Position
Power circuit breaker	Main contacts open
Disconnecting switch	Main contacts open
Load-break switch	Main contacts open
Valve	Closed position
Gate	Closed position
Clutch	Disengaged position
Turning gear	Disengaged position
Power electrodes	Maximum gap position
Rheostat	Maximum resistance position
Adjusting means[6]	Low or down position
Relay[7]	Deenergized position
Contactor[7]	Deenergized position
Relay (latched-in type)	See 4.5.3
Contactor (latched-in type)	Main contacts open
Temperature relay[8]	Lowest temperature
Level detector[8]	Lowest level
Flow detector[8]	Lowest flow
Speed switch[8]	Lowest speed
Vibration detector[8]	Minimum vibration
Pressure switch[8]	Lowest pressure
Vacuum switch[8]	Lowest pressure, that is, highest vacuum

4.1.1 Auxiliary Switches with Defined Operating Position. When it is desired to have the auxiliary, position, or limit switch designation indicate at what point of travel the contacts change position, as is sometimes necessary in the case of valves and for other main devices, then an additional letter (or a percentage figure, if required) is added (as a suffix to the *a* or *b* designation) for the purpose.

For a valve, the method of designating such position switches is shown in the diagram and legend in Fig 1. There are thus two points to consider in visualizing or describing the operation of these position switches. The first is whether the contact is an *a* or *b* as indicated by the first letter. The second is where the contact changes position, either at or near:

(1) The closed position of the valve *c*

(2) The open position of the valve *o*, or

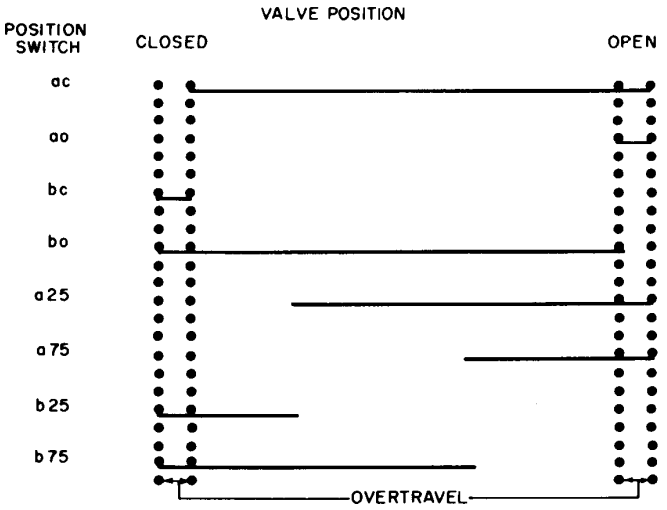
(3) A specified percentage such as 25% of the full open position, as for example *a25*.

When applied to devices other than valves, gates, circuit breakers, and switches for which the letters *o* and *c* are used for *open* and *closed*, respectively, it will be necessary to use other applicable letters. For example, for such devices as a clutch, turning gear, rheostat, electrode, and adjusting device, the letters *d, e, h, l, u, d*, meaning *disengaged, engaged, high, low, up*, and *down*, respectively, are applicable. Also, other appropriate suffix letters may be used for special *a* or *b* position switches, when these are considered

[6]These may be speed, voltage, current, load, or similar adjusting devices comprising rheostats, springs, levers, or other components for the purpose.

[7]These electrically operated devices are of the non-latched-in type, whose contact position is dependent only upon the degree of energization of the operating or restraining or holding coil or coils which may or may not be suitable for continuous energization. The deenergized position of the device is that with all coils deenergized.

[8]The energizing influence for these devices are considered to be, respectively, rising temperature, rising level, increasing flow, rising speed, increasing vibration, and increasing pressure.



Each of the eight valve positions can be described as follows:

ac, *a* contact which changes position at or near the closed position of the valve, that is, open only when valve is fully closed

ao, *a* contact which changes position at or near the open position of the valve, that is, closed only when valve is fully open

bc, *b* contact which changes position at or near the closed position of the valve, that is, closed only when valve is fully closed

bo, *b* contact which changes position at or near the open position of the valve, that is, open only when valve is fully open

a25, *a* contact which changes position when valve is 25 percent open, that is, closed only when valve is open 25 percent or more

a75, *a* contact which changes position when valve is 75 percent open, that is, closed only when valve is open 75 percent or more

b25, *b* contact which changes position when valve is 25 percent open, that is, closed only when valve is open less than 25 percent

b75, *b* contact which changes position when valve is 75 percent open, that is, closed only when valve is open less than 75 percent

Example:

$\frac{\text{20 BL}}{\text{ac}}$ designates an auxiliary switch, on a block valve, which is open only when the valve is fully closed

$\frac{\text{20 D}}{\text{a 10\%}}$ designates an auxiliary switch, on a discharge valve, which is open except when the valve is 10 percent or more open

Fig 1
Valve

more appropriate and if their meaning is clearly indicated. For example, in the case of an early opening auxiliary switch on a power circuit breaker, adjusted to open when the breaker is tripped before the main contacts part, it may be thus described and then designated as an *ae* auxiliary switch.

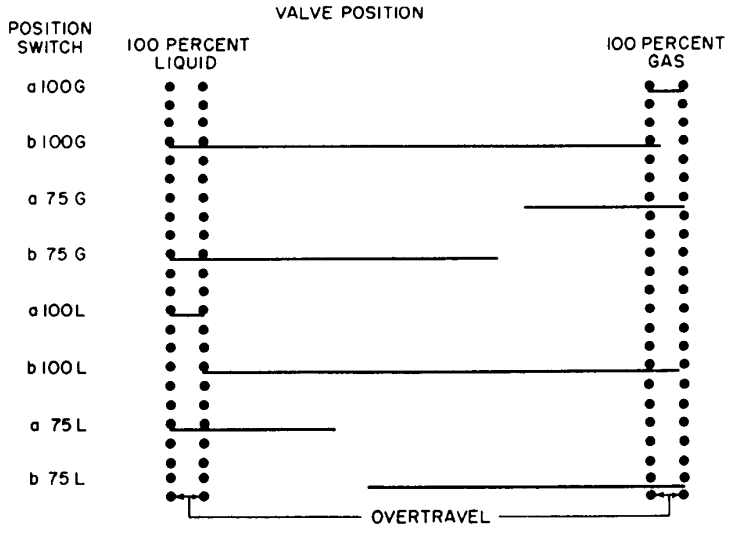
4.1.2 Auxiliary Switches for Devices Without A Standard Reference Position. In designating position switches for such a special device as, for example, a fuel transfer device, which has no standard reference or nonoperated position and may be placed in either extreme or any intermediate position for normal operation, *a* and *b* designations are still applicable. However, a percentage figure of the "full open" or "on" position should always be used, and for the sake of consistency, this percentage should always be in terms of the position which is 50% or more of the full open or on, as shown in Fig 2.

4.1.3 Auxiliary Switches for Circuit Breaker Operating Mechanisms. For the mechanically trip-free mechanism of a circuit breaker:

aa Contact that is open when the operating mechanism of the main device is in the nonoperated position and that closes when the operating mechanism assumes the opposite position

bb Contact that is closed when the operating mechanism of the main device is in the nonoperated position and that opens when the operating mechanism assumes the opposite position

The part of the stroke at which the auxiliary switch changes position should, if necessary, be specified in the description. LC is used to



Each of the eight positions can be described as follows:

a100G, closed only when 100 percent of the fuel being supplied is gas

b100G, closed only when less than 100 percent of the fuel being supplied is gas

a75G, closed only when 75 percent or more of the fuel being supplied is gas

b75G, closed only when less than 75 percent of the fuel being supplied is gas

a100L, closed only when 100 percent of the fuel being supplied is liquid

b100L, closed only when less than 100 percent of the fuel being supplied is liquid

a75L, closed only when 75 percent or more of the fuel being supplied is liquid

b75L, closed only when less than 75 percent of the fuel being supplied is liquid

Fig 2
Fuel Transfer Device

designate the latch-checking switch of such a mechanism, which is closed when the mechanism linkage is relatched after an opening operation of the circuit breaker.

4.2 Limit Switches. LS designates a limit switch. This is a position switch that is actuated by a main device, such as a rheostat or valve, at or near its extreme end of travel. Its usual function is to open the circuit of the operating device, but it may also serve to give an indication that the main device has reached an extreme position of travel. The designations *ac*, *ao*, *bc*, and *bo*, given in Fig 1, are actually more descriptive for valve limit switches than such designations as LSC or LSO. Also, in the case of a fuel transfer device as covered in 4.1.2 designations such as a100G, b100G, a100L, and b100L are more descriptive than LS designations. In both cases they indicate whether the specific contact is an *a* contact or *b* contact.

4.3 Torque Limit Switches. This is a switch that is used to open an operating motor circuit at a desired torque limit at the extreme end of travel of a main device, such as a valve. It should be designated as follows:

tqc Torque limit switch, opened by torque-responsive mechanism, to stop valve closing

tqo Torque limit switch, opened by torque-responsive mechanism, to stop valve opening

4.4 Other Switches. If several similar auxiliary, position, and limit switches are present on the same device, they should be designated with supplementary numerical suffixes as 1, 2, 3, etc, when necessary.

4.5 Representation of Device Contacts on Electrical Diagrams

4.5.1 Contacts with Defined Reference Position. On electrical diagrams the *b* contacts of all devices as described in 4.1 to 4.1.3 including those of relays and those with suffix letters or percentage figures, should be shown as closed contacts, and all *a* contacts should be shown as open

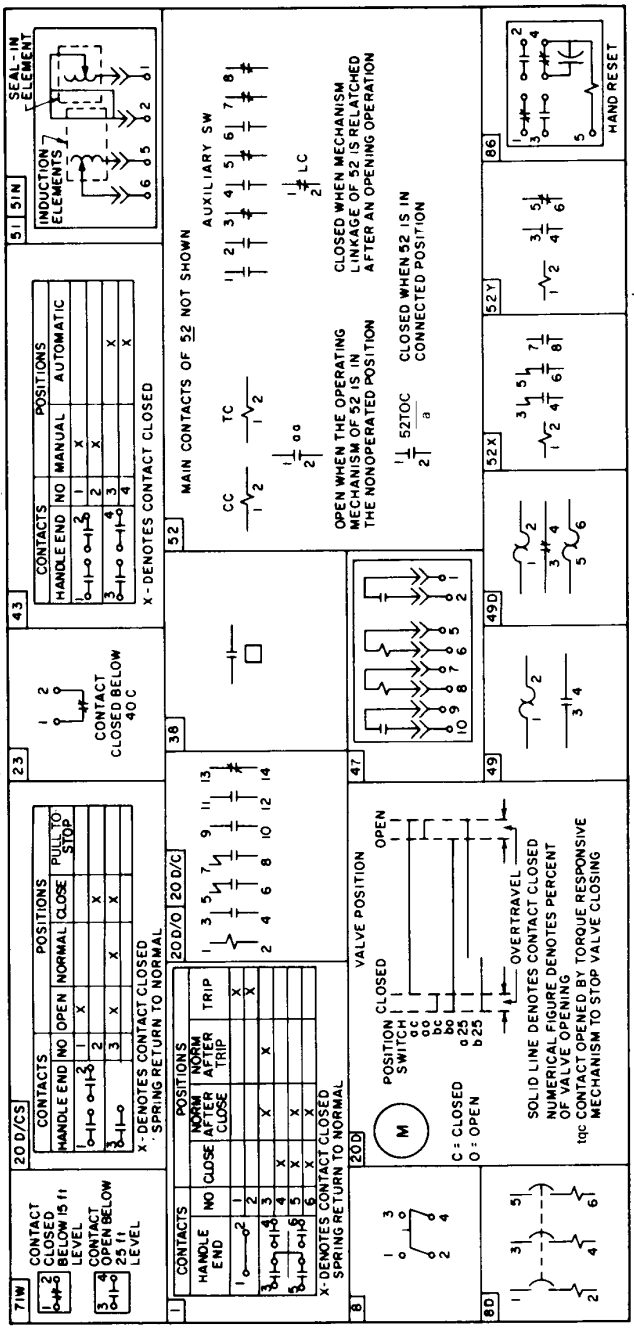


Fig 3a
Typical Elementary Diagram

Device Function Numbers

1	Master element (control switch)
8	Control power switch
8D	Control power circuit breaker for 20D
20D	Discharge valve
20D/CS	Control switch for 20D
20D/C	Closing contactor for 20D
20D/O	Opening contactor for 20D
23	Temperature control device
38	Bearing protective device
43	Manual transfer switch
47	Phase sequence voltage relay
49	Machine thermal relay
49D	Thermal relay for 20D motor
51	AC time overcurrent relay
51N	AC time overcurrent relay (neutral)
52	AC circuit breaker
52TOC	Housing auxiliary position switch
52X	Auxiliary relay for 52 (closing)
52Y	Auxiliary relay for 52 (antipump)
71W	Water level switch
86	Locking-out relay

Abbreviations

A	Automatic
AM	Ammeter
AMP	Ampere
CC	Closing coil
CT	Current transformer
HR	Hand reset
M	Manual
MOT	Motor
SI	Seal in
SW	Switch
TC	Trip coil
V	Volt
VT	Voltage transformer
W	Watt

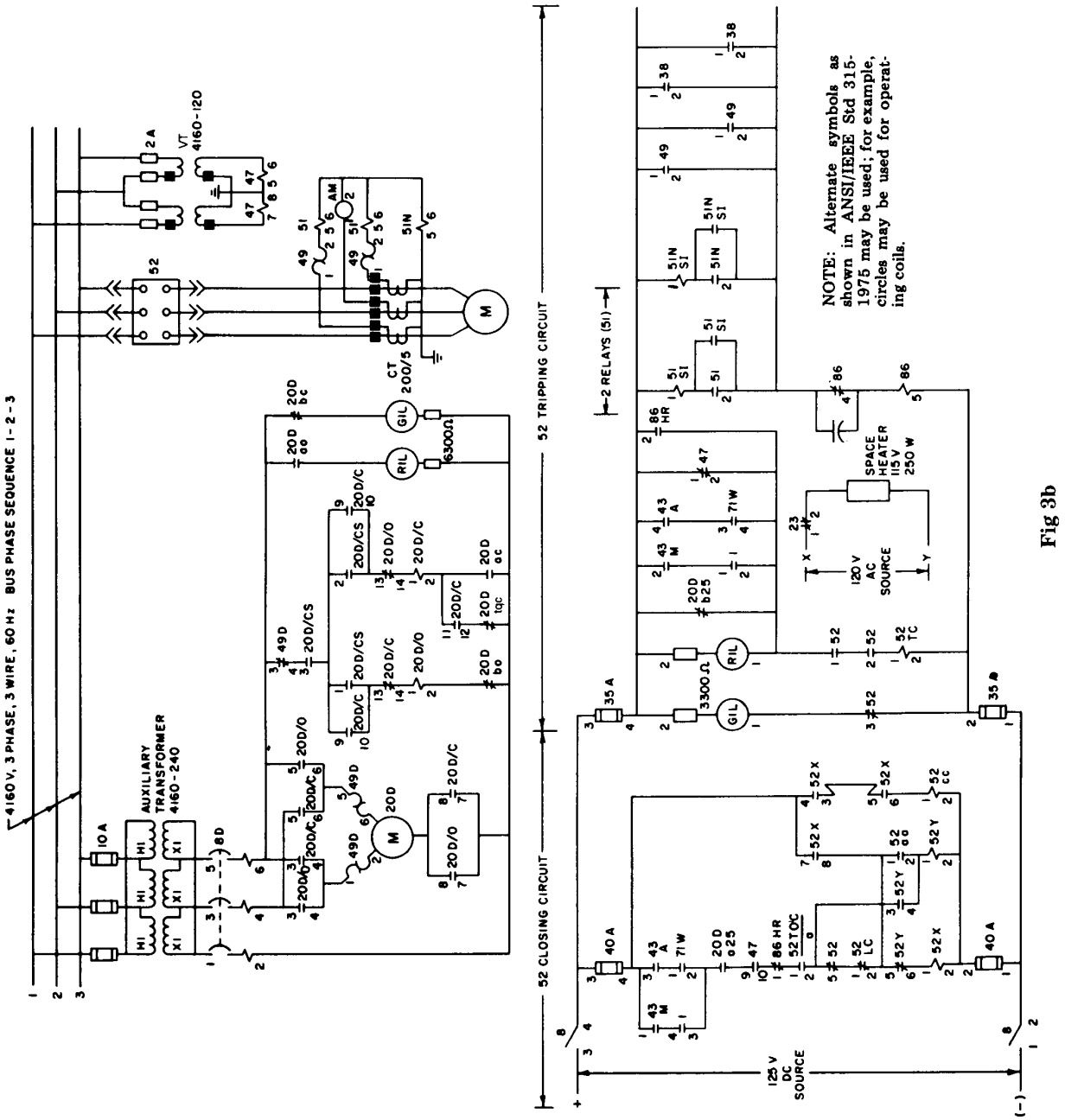


Fig 3b
Typical Elementary Diagram

contacts. The use of the single letters *a* and *b* with the contact representation is generally superfluous on the diagrams. However, these letters are a convenient means of reference in the text of instruction books, articles, and other publications (see Fig 3 and ANSI/IEEE Std 315-1975, [2], for representation of closed and open contacts on electrical diagrams).

4.5.2 Contact Opening and Closing Settings. The opening and closing settings of the contacts, and auxiliary, position, and limit switches, covered in 4.1 to 4.3 should, when necessary for the ready understanding of the operation of the devices in the equipment, be indicated on the elementary diagram for each such contact. In the case of relay contacts, this indication would consist of the numerical settings; and in the case of the switches, would consist of a chart similar to those shown in Figs 1 and 2, respectively.

4.5.3 Devices Without a Standard Reference Position. For those devices that have no deenergized or nonoperated position, such as manually-operated transfer or control switches (including those of the spring-return type) or auxiliary position indicating contacts on the housings or enclosures of a removable circuit breaker unit, the preferred method of representing these contacts is normally-open. Each contact should, however, be identified on the elementary diagram as to when it closes.[9] For example, the contacts of the manual-automatic transfer switch, device 43, which are closed in the automatic position, would be identified with the letter A, and those that are closed in the manual position would be identified with the letter M; and the auxiliary position switches on the housing 52 TOC of a removable circuit breaker unit, which are closed when the unit is in the connected position, may be identified by

$$\frac{52\,\text{TOC}}{\text{a}}$$

and those which are closed when the unit is withdrawn from the housing may be identified by

$$\frac{52\,\text{TOC}}{\text{b}}$$

as shown in ANSI/IEEE C37.20.1-1987, [4] and ANSI/IEEE C37.20.2-1987, [5].

In the case of latched-in or hand-reset relays, which operate from protective devices to perform the shutdown of an equipment and to hold it out of service, the contacts should preferably be shown in the normal nonlockout position. In general, any devices, such as electrically operated latched-in relays, which have no deenergized or nonoperated position, have not been specifically covered in the above paragraphs or under 4.1, should have their contacts shown in the position most suitable for the ready understanding of the operation of the devices in the equipment, and sufficient description should be present, as necessary, on the elementary diagram to indicate the contact operation.[10]

4.5.4 Recommended Representation of Device Functions and Contacts on Drawings. The typical elementary diagram in Fig 3 illustrates the recommended method of representing the contacts of typical devices on an elementary diagram. All other representations and features, except those specifically covered in other American National Standards, are illustrative only and are not necessarily generally accepted practice.

[9]This information should be included on that part of the elementary diagram, either with the device symbol or with the contacts in the circuit diagram itself, where most convenient for the ready understanding of the operation of the devices and equipment.

[10]See footnote 9.