

# TIPOS DE RELÉS

- ELETROMECHANICO
  - ATRAÇÃO(ARMADURA, AXIAL)
  - INDUÇÃO(DISCO, COPO)
  - ELETRODINÂMICO
  - TÉRMICO
  - OUTROS
- ESTÁTICO
  - VÁLVULA
  - TRANSISTORIZADO
  - CI
- MICROPROCESSADO

PEA 2402

15/5/2003

23 cópias

# RELÉS - QUANTIDADE DE GRANDEZAS

- UMA GRANDEZA
  - SOBRECORRENTE
  - SUB E SOBRETENSÃO
  - TEMPERATURA
  - FREQUÊNCIA
- DUAS GRANDEZAS
  - DIRECIONAL
  - DIFERENCIAL
  - DISTÂNCIA

# FUNÇÕES DOS RELÉS

- SOBRECORRENTE-FASE E NEUTRO
  - INSTANTÂNEO(50)
  - TEMPORIZADO(51)
    - INVERSO
    - MUITO-INVERSO
    - EXTREMAMENTE-INVERSO
    - TEMPO-INDEPENDENTE
- SOBRECORRENTE COM RESTRIÇÃO DE TENSÃO(51-V)
- DIFERENCIAL(87)
  - GERADOR
  - MOTOR
  - BARRA
  - TRANSFORMADOR
- DISTÂNCIA(21)
- DIRECIONAL DE SOBRECORRENTE(67)
- TÉRMICO(49)
- SEQUÊNCIA NEGATIVA(46)
- SOBRETENSÃO(57) E SUBTENSÃO(27)
- OUTROS

## Electrical Power System Device Numbers and Functions

The devices in switching equipment are referred to by numbers, with appropriate suffix letters when necessary, according to the functions they perform.

These numbers are based on a system adopted as standard for automatic switchgear by IEEE, and incorporated in American Standard C37.2-1970. This system is used in connection diagrams, in instruction books, and in specifications.

Device Number	Definition and Function
---------------	-------------------------

- |   |  |
|---|--|
| 1 | Master Element is the initiating device, such as a control switch, voltage relay, float 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.   |
| 2 | Time-delay starting, or closing relay is a device which 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 described later.  |
| 3 | Checking or interlocking relay is a device which 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, 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 No. 1 or 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 other or 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.]  |

Device Number	Definition and Function
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- |  |  |
|--|--|
| 6  | Starting circuit breaker is a device whose principal function is to connect a machine to its source of starting voltage.   |
| 7  | Anode circuit breaker is one used in the anode circuits of a power rectifier for the primary purpose of interrupting the rectifier circuit if an arc back should occur.  |
| 8  | Control power disconnecting device is a disconnective device — such as a knife switch, circuit breaker or pullout fuse block, used for the purpose of connecting and disconnecting the source of control power to and from the control bus or equipment. |
| <p>Note: Control power is considered to include auxiliary power which supplies such apparatus as small motors and heaters.</p> |  |
| 9  | Reversing device is used for the purpose of reversing a machine field or for performing any other reversing functions.   |
| 10   | Unit sequence switch is used to change the sequence in which units may be placed in and out of service in multiple-unit equipments.  |
| 11   | Reserved for future application.   |
| 12   | Over-speed device is usually a direct-connected speed switch which functions on machine over-speed.  |
| 13   | Synchronous-speed device, such as a centrifugal-speed switch, a slip-frequency relay, a voltage relay, an undercurrent relay or any type of device, operates at approximately synchronous speed of a machine.  |
| 14   | Under-speed device functions when the speed of a machine falls below a predetermined value.  |
| 15   | Speed or frequency, matching device functions to match and hold the speed or the 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 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.   |

**Device Number**    **Definition and Function**

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**Note:** This excludes devices which 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 73 function which serves for the switching of resistors.

- 18 Accelerating or decelerating device is used to close or to cause the closing of circuits which are used to increase or to decrease the speed of a machine.
- 19 Starting-to-running transition contactor is a device which 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 in a fluid line.  
  
**Note:** The function of the valve may be indicated by the use of the suffixes.
- 21 Distance relay is a device which functions when the circuit admittance, impedance or reactance increases or decreases beyond predetermined limits.
- 22 Equalizer circuit breaker is a breaker which 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 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 which switches on a space heater in a switchgear assembly when the temperature falls to a desired value as distinguished from a device which is used to provide automatic temperature regulation between close limits and would be designated as 90T.
- 24 Reserved for future application.
- 25 Synchronizing or synchronism-check device operates when two ac circuits are within the desired limits of frequency, phase angle or voltage, to permit or to cause the paralleling of these two circuits.

**Device Number**    **Definition and Function**

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- 26 Apparatus thermal device functions when the temperature of the shunt field or the armortisseur winding of a machine, or that of a load limiting or load shifting resistor or of a liquid or other medium exceeds a predetermined value; or if the temperature of the protected apparatus, such as a power rectifier, or of any medium decreases below a predetermined value.
- 27 Undervoltage relay is a device which functions on a given value of undervoltage.
- 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 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 connects a circuit such as the shunt field of a synchronous converter, to a source of separate excitation during the starting sequence; or one which energizes the excitation and ignition circuits of a power rectifier.
- 32 Directional power relay is one which functions on a desired value of power flow in a given direction, or upon reverse power resulting from arc back in the anode or cathode circuits of a power rectifier.
- 33 Position switch 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 multi-contact 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 used 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.

Device Number	Definition and Function
36	Polarity or polarizing voltage device 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 functions when the current or power flow decreases below a predetermined value.
38	Bearing protective device functions on excessive bearing temperature, or on other abnormal mechanical conditions, such as undue wear, which may eventually result in excessive bearing temperature.
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 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 which functions to apply, or to 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 transfers the control circuits so as to modify the plan of operation of the switching equipment or of some of the devices.
44	Unit sequence starting relay is a device which functions to start the next available unit in a multiple-unit equipment on the failure or on the non-availability 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.

Device Number	Definition and Function
46	Reverse-phase, or phase-balance, current relay is a relay which 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 voltage relay functions upon a predetermined value of polyphase voltage in the desired phase sequence.
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. If the device is used for alarm purposes only, it should preferably be designated as 48A (alarm).
49	Machine, or transformer, thermal relay is a relay that functions when the temperature of a machine armature, or other load carrying winding or element of a machine, or the temperature of a power rectifier or power transformer (including a power rectifier 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, thus indicating a fault in the apparatus or circuit being protected.
51	Ac time overcurrent relay is a relay with either a definite or inverse time characteristic that functions when the current in an ac circuit exceeds a predetermined value.
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	Reserved for future application.
55	Power factor relay is a relay that operates when the power factor in an ac circuit rises above or below a predetermined value.
56	Field application relay is a relay that automatically controls the application of the field excitation to

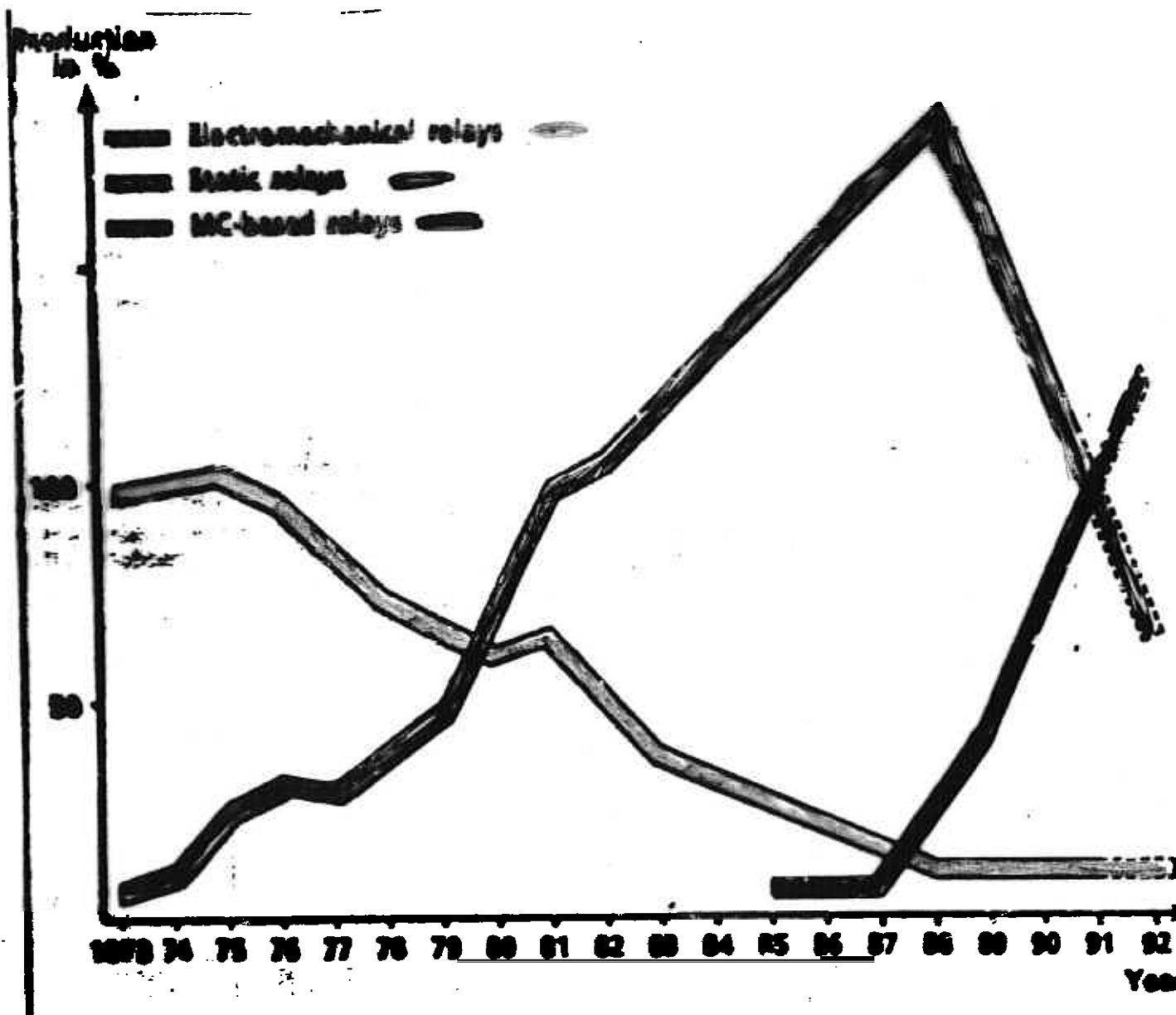
Device Number	Definition and Function	Device Number	Definition and Function
	an ac motor at some predetermined point in the slip cycle.		device, or equipment, or a specified number of successive operations within a given time of each other. It also functions to energize a circuit periodically or for fractions of specified time intervals, or that is used to permit intermittent acceleration or jogging of a machine at low speeds for mechanical positioning.
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.	67	Ac directional overcurrent relay is a relay that functions on a desired value of ac overcurrent flowing in a predetermined direction.
58	Rectification failure relay is a device that functions if one or more anodes of a power rectifier fail to fire, or to detect an arc-back or on failure of a diode to conduct or block properly.	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.
59	Overvoltage relay is a relay that functions on a given value of overvoltage.	69	Permissive control device is generally a two-position, manually operated switch 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.
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.	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.
61	Reserved for future application.	71	Level switch is a switch which operates on given values, or on a given rate of change, of level.
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.	72	Dc circuit breaker is used to close and interrupt a dc power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.
63	Pressure switch is a switch which operates on given values or on a given rate of change of pressure.	73	Load-resistor contactor 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.
64	Ground protective relay is a relay that functions on failure of the insulation of a machine, transformer or of other apparatus to ground, or on flashover of a dc machine to ground.  Note: This function is assigned only to a relay which detects the flow of current from the frame of a machine or enclosing case or structure of a piece of apparatus to ground, or detects a ground on a normally ungrounded winding or circuit. It is not applied to a device connected in the secondary circuit or secondary neutral of a current transformer, or in the secondary neutral of current transformer, connected in the power circuit of a normally grounded system.	74	Alarm relay is a device other than an annunciator, as covered under device No. 30, which is used to operate, or to operate in connection with, a visual or audible alarm.
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.	75	Position changing mechanism is a mechanism that is used for moving a main device from one
66	Notching or jogging device functions to allow only a specified number of operations of a given		

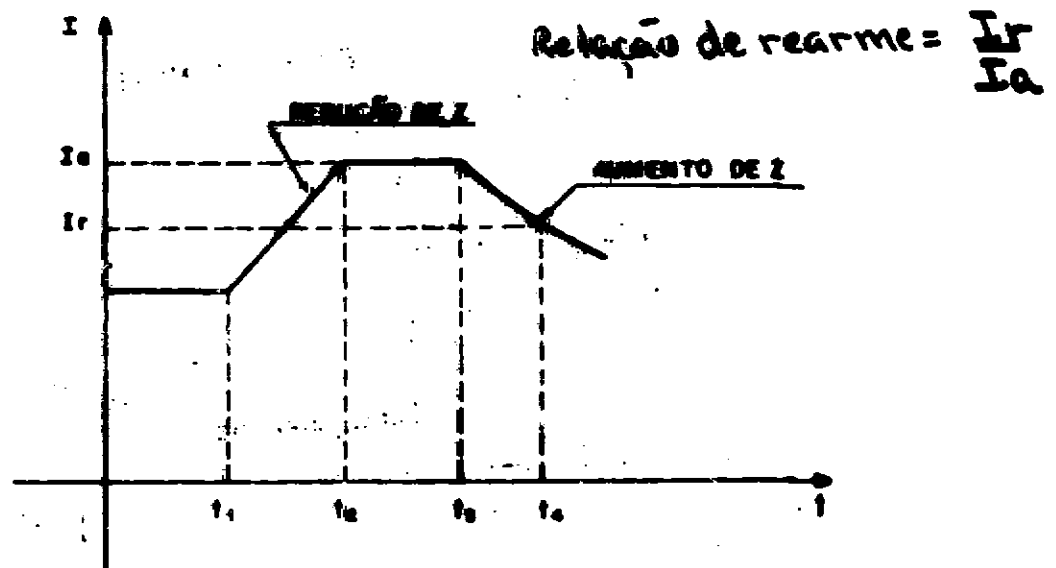
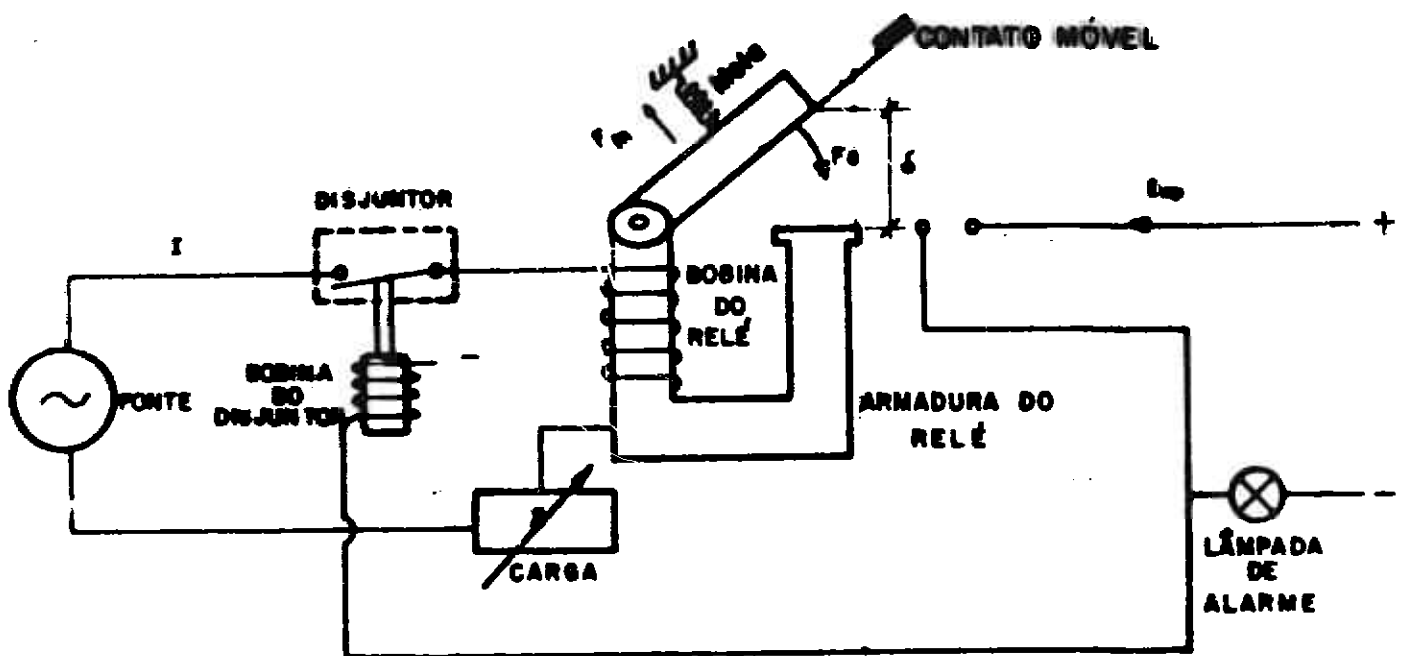
Device Number	Definition and Function
	position to another in an equipment; as for example, shifting a removable circuit breaker unit to and from the connected, disconnected, and test positions.
76	<b>Dc overcurrent relay</b> is a relay that functions when the current in a dc circuit exceeds a given value.
77	<b>Pulse transmitter</b> is used to generate and transmit pulses over a telemetering or pilot-wire circuit to the remote indicating or receiving device.
78	<b>Phase angle measuring, or out-of-step protective relay</b> is a relay that functions at a predetermined phase angle between two voltages or between two currents or between voltage and current.
79	<b>Ac reclosing relay</b> is a relay that controls the automatic reclosing and locking out of an ac circuit interrupter.
80	<b>Flow Switch</b> is a switch which operates on given values, or on a given rate of change, of flow.
81	<b>Frequency relay</b> is a relay that functions on a predetermined value of frequency — either under or over or on normal system frequency — or rate of change of frequency.
82	<b>Dc reclosing relay</b> is a relay that controls the automatic closing and reclosing of a dc circuit interrupter, generally in response to load circuit conditions.
83	<b>Automatic selective control or transfer relay</b> is a relay that operates to select automatically between certain sources or conditions in an equipment, or performs a transfer operation automatically.
84	<b>Operating mechanism</b> is the complete electrical mechanism or servo-mechanism, including the operating motor, solenoids, position switches, etc., for a tap changer, induction regulator or any similar piece of apparatus which has no device function number.
85	<b>Carrier or pilot-wire receiver relay</b> is a relay that is operated or restrained by a signal used in connection with carrier-current or dc pilot-wire fault directional relaying.

Device Number	Definition and Function
86	<b>Locking-out relay</b> is an electrically operated, hand or electrically reset, relay that functions to shut down and hold an equipment out of service on the occurrence of abnormal conditions.
87	<b>Differential protective relay</b> 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	<b>Auxiliary motor or motor generator</b> is one used for operating auxiliary equipment such as pumps, blowers, exciters, rotating magnetic amplifiers, etc.
89	<b>Line switch</b> is used as a disconnecting load-interrupter, or isolating switch in an ac or dc power circuit, when this device is electrically operated or has electrical accessories, such as an auxiliary switch, magnetic lock, etc.
90	<b>Regulating device</b> 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	<b>Voltage directional relay</b> is a relay that operates when the voltage across an open circuit breaker or contactor exceeds a given value in a given direction.
92	<b>Voltage and power directional relay</b> 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	<b>Field changing contactor</b> functions to increase or decrease in one step the value of field excitation on a machine.
94	<b>Tripping or trip-free relay</b> 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, in case it should open automatically even though its closing circuit is maintained closed.
95	Used only for specific applications on individual
96	installations where none of the assigned num-
97	bered functions from 1 to 94 is suitable.

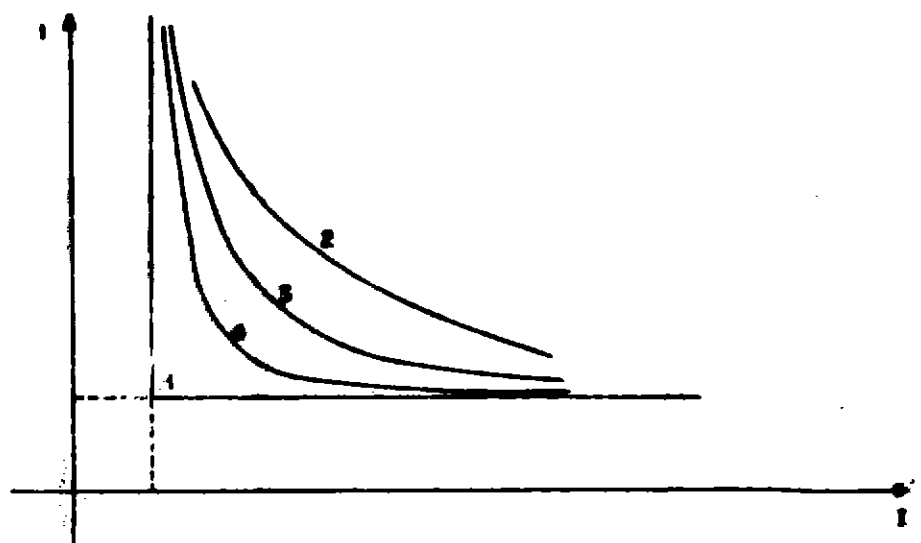


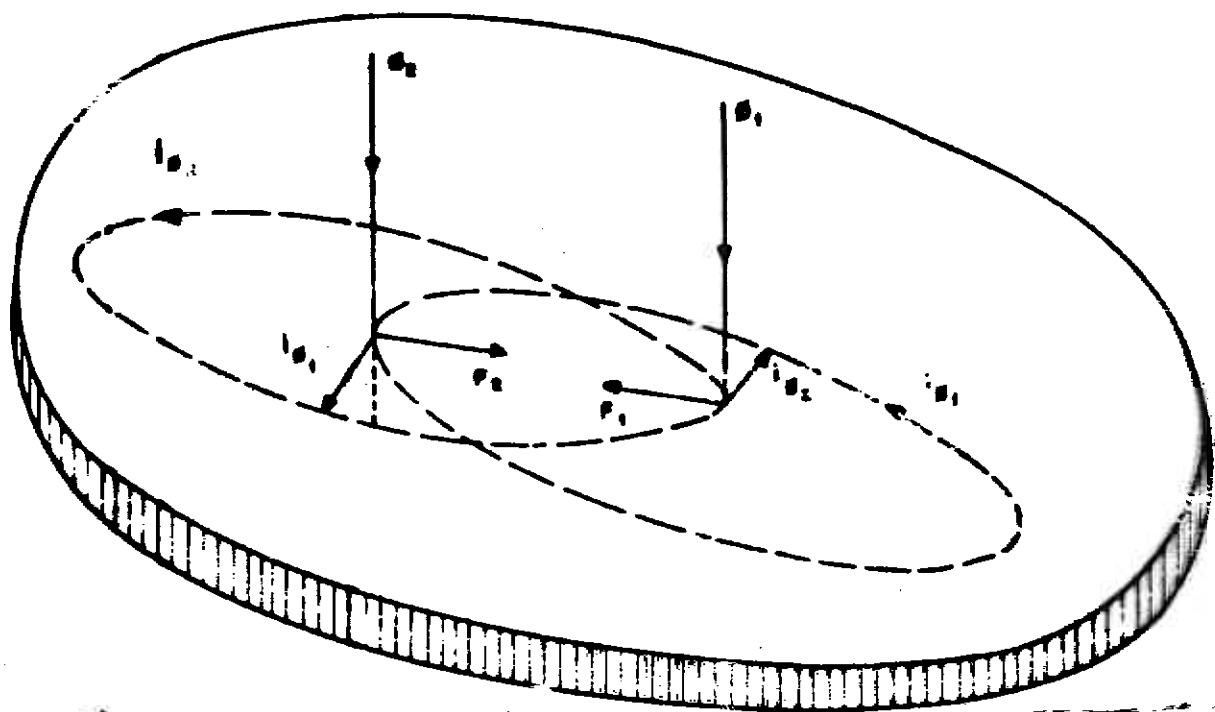
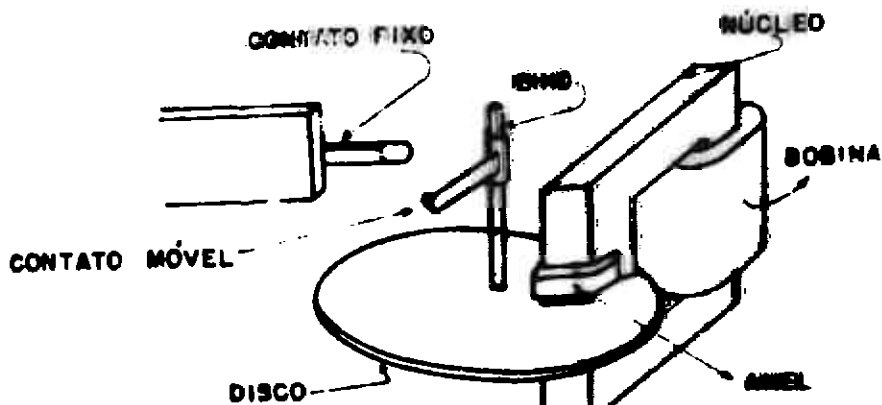
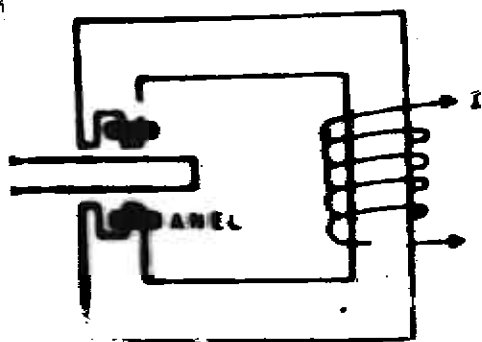
Year	Technology	Measured values	Principle
1885	free	(I)	O/C
1902	attracted armature	(I, t)	O/C
1910	attracted armature	(I <sub>1</sub> , I <sub>2</sub> )	differential
1920	induction disc	(V, I, t)	directional O/C
1928	induction disc	(V, I, t)	distance
1929	foundation of separate Relay Department		
1950	moving coil	(V, I, t, f)	various
1965	electronic	(V, I, t, f, Δφ)	various
1976	process computer	(V, I, t, f, Δφ)	various
1983	microcomputer	(V, I, t, f, Δφ)	various





- tempo independente 1
- tempo inverso 2
- tempo muito inverso 3
- tempo extremamente inverso 4





$$\Phi_1 = \phi_1 \text{ sen } \omega t$$

$$F = \phi_1 \phi_2 \text{ sen } \theta$$

$$\Phi_2 = \phi_2 \text{ sen } (\omega t + \theta)$$

$$\lambda \phi_1 \cong \omega \phi_1 \cos \omega t \quad (d\Phi_1/dt)$$

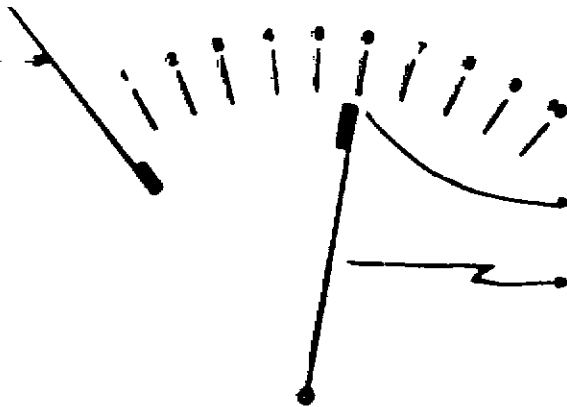
$$\lambda \phi_2 \cong \omega \phi_2 \cos (\omega t + \theta) \quad (d\Phi_2/dt)$$

$$F = F_2 - F_1 \cong \phi_2 \lambda \phi_1 - \phi_1 \lambda \phi_2$$

$$F = \omega \phi_1 \phi_2 (\text{sen } (\omega t + \theta) \cos \omega t - \text{sen } \omega t \cos (\omega t + \theta))$$

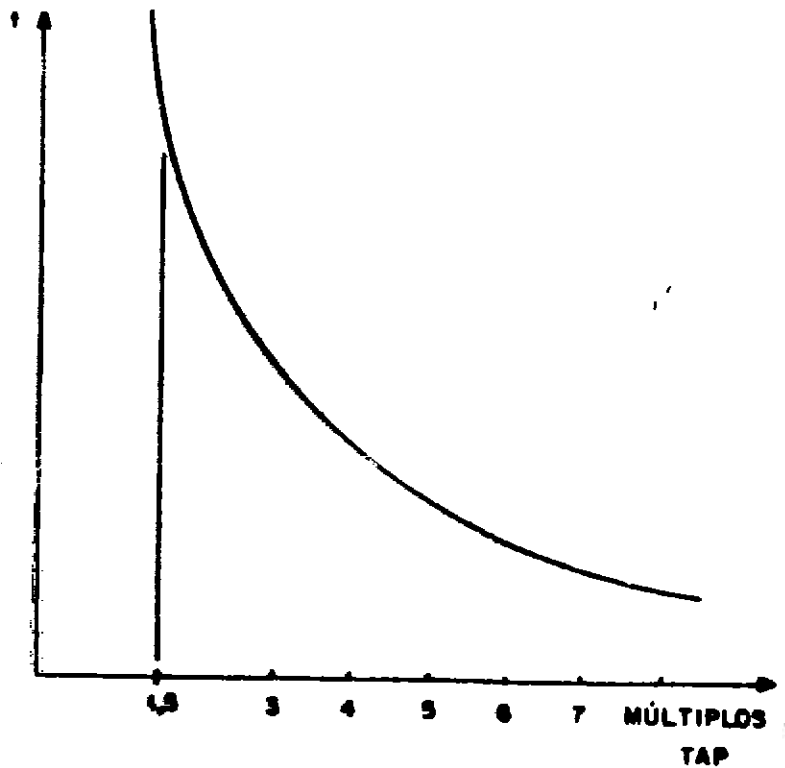
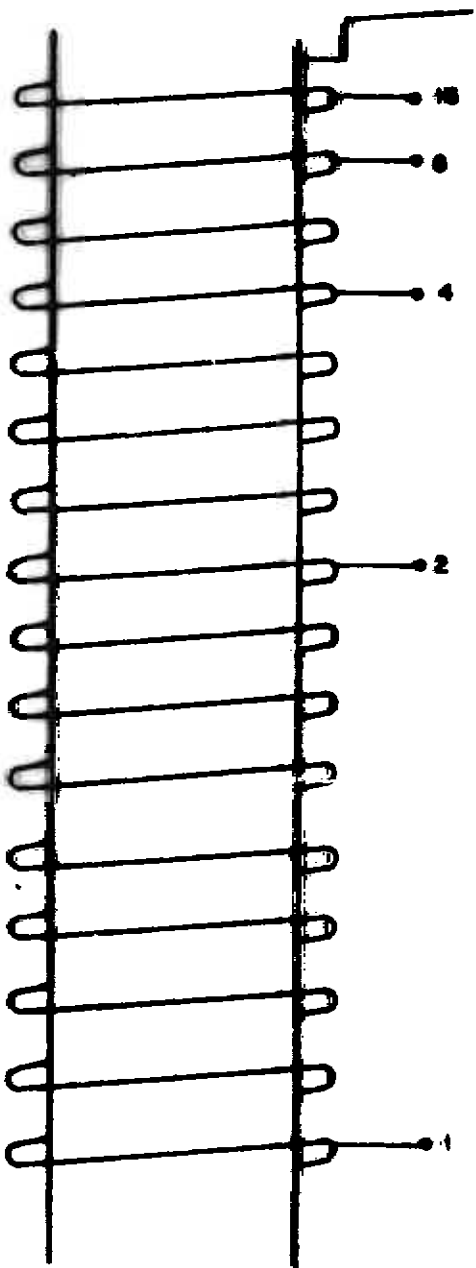
$$F \cong \phi_1 \phi_2 \text{ sen } \theta$$

CONTATO FIXO



CONTATO VARIÁVEL

CONTATO MÓVEL



# TAP

- RTC — I<sub>CARGA MÁX</sub>  
 $I_{CC\ MÁX} \leq 20 \cdot I_{NOM\ TC}$

- $I_{SEC.\ TC} = \frac{I_{PRIMÁRIO\ TC}}{RTC}$

- TAPS - derivações do enrolamento do 'relé'

$$N = \frac{1}{N^{\circ} \text{ espiras}}$$

TAP	N: ESPIRAS
36	1
8	2
4	4
2	8
1	36

$$MA = \frac{I}{RTC \times TAP}$$

múltiplo de atuação

$$F.M.M. = N I$$

EXEMPLOS

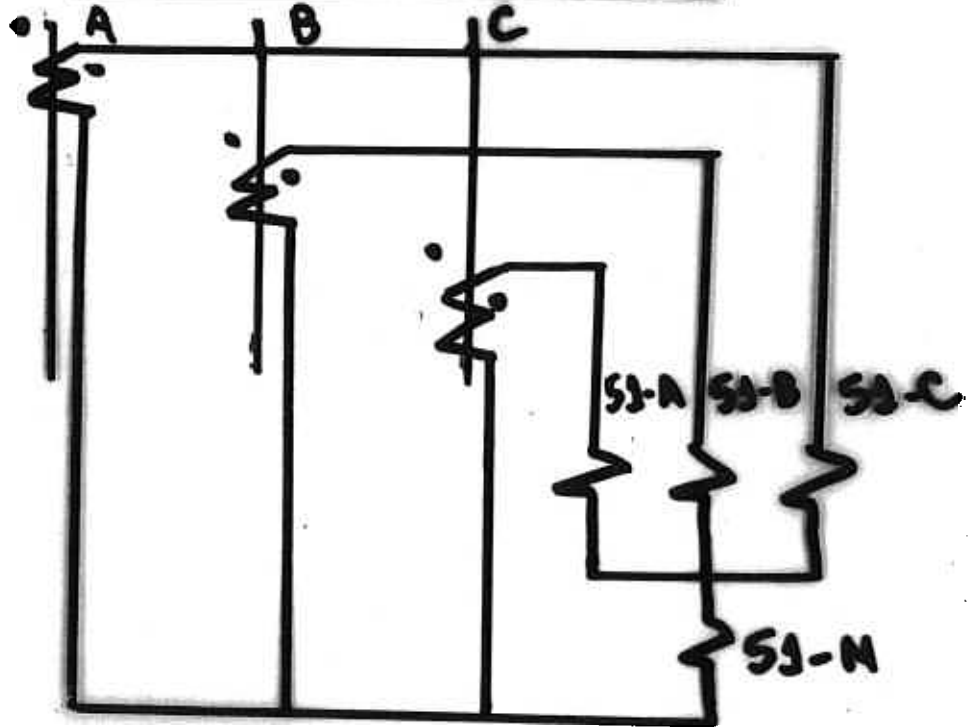
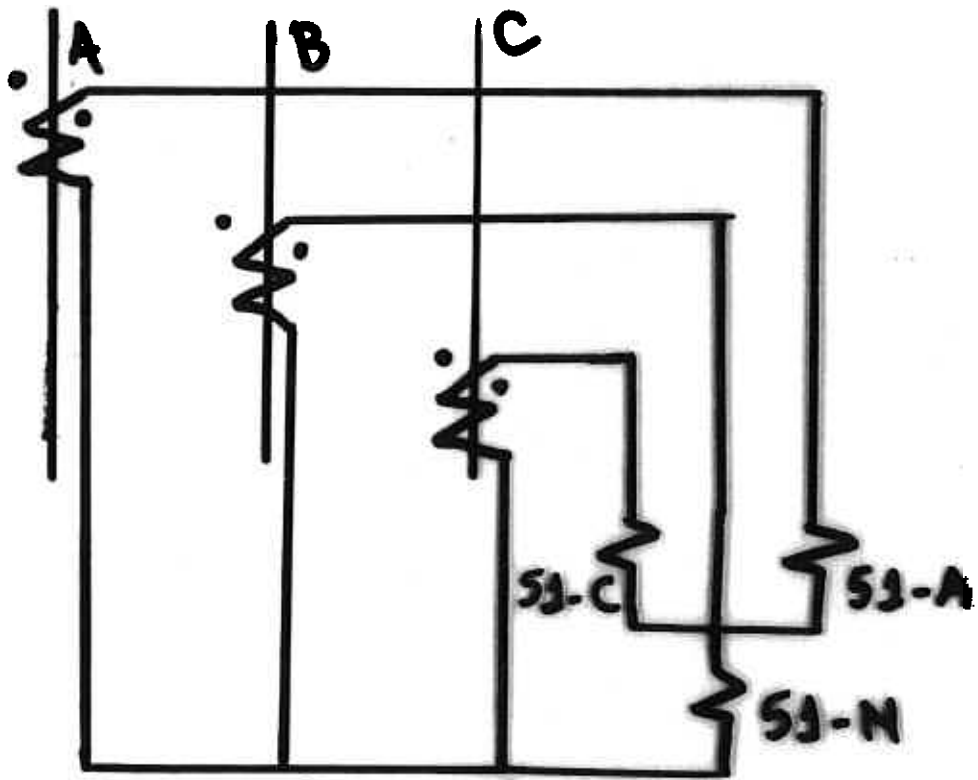
5A, TAP=2  $\left\{ \begin{array}{l} MA = 2.5 \\ FMM = 40A \end{array} \right.$

10A, TAP=4  $\left\{ \begin{array}{l} MA = 2.5 \\ FMM = 40A \end{array} \right.$

# CARACTERÍSTICAS

- C. A. E EM C. C.
- TIPOS: MERGULHADOR  
ARMADURA ARTICULADA
- RELAÇÃO DE DESARME =  $\frac{I_{OP}}{I_A}$   
↓  
0,9 - 0,95
- FORÇA  $\sim I^2$  ( $f = 50$  Hz)
- NÃO SÃO DIRECIONAIS
- INSTANTÂNEOS
- PODE ACIONAR TEMPORIZADO
- APLICAÇÕES:
  - ICC ALTAS
  - $I_{cc} \sim 1$  A  $2 \times I_{nom}$   
(aciona outro relé)
  - SUBTENSÃO
  - SOBRETENSÃO
  
- C. A.
- TIPOS: DISCO / TAMBOR (A1)
- PRINCÍPIO: MOTOR DE INDUÇÃO
- TIPOS: INVERSO, MUITO INVERSO  
EXTREMAMENTE INVERSO
- DIAL: AJUSTA O TEMPO DE OPERAÇÃO

# LIGAÇÕES



## CURTOS

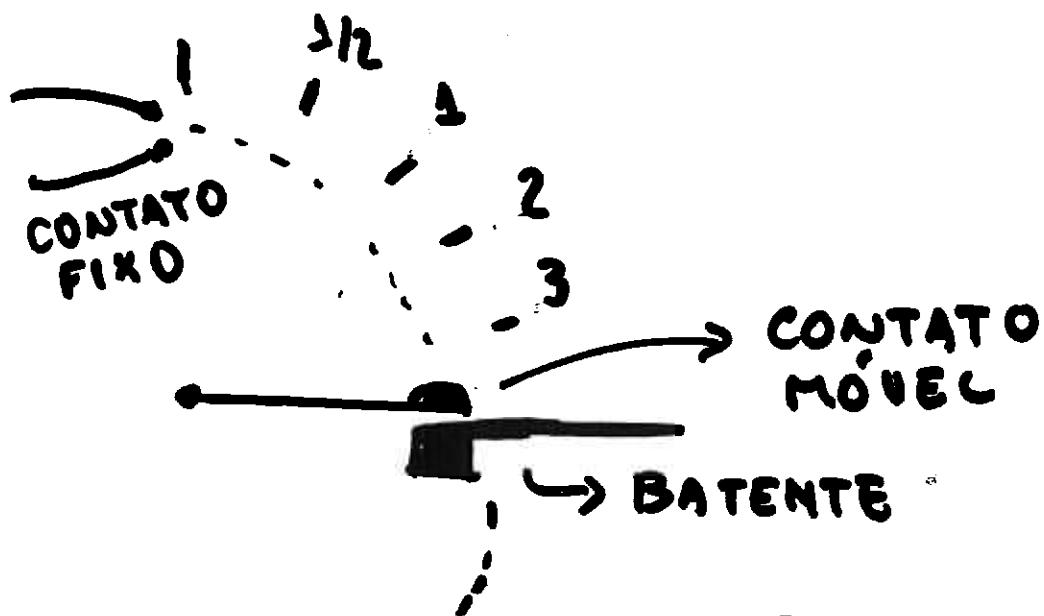
- 3φ
- 2φ
- 2φ-T
- 3φ-T

# DIAL

•  $\frac{1}{2}, 1, 2, 3, 4, \dots, 10$

• CONTINUO

• DIAL  $\downarrow \Rightarrow$  ATUAÇÃO  $\downarrow$



## ESCOLHA DO TAP

•  $TAP_2 > \frac{I_{\text{CARGA MÁXIMA}}}{RTC}$

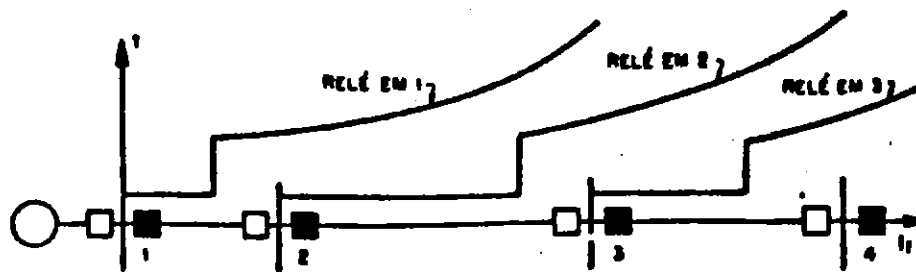
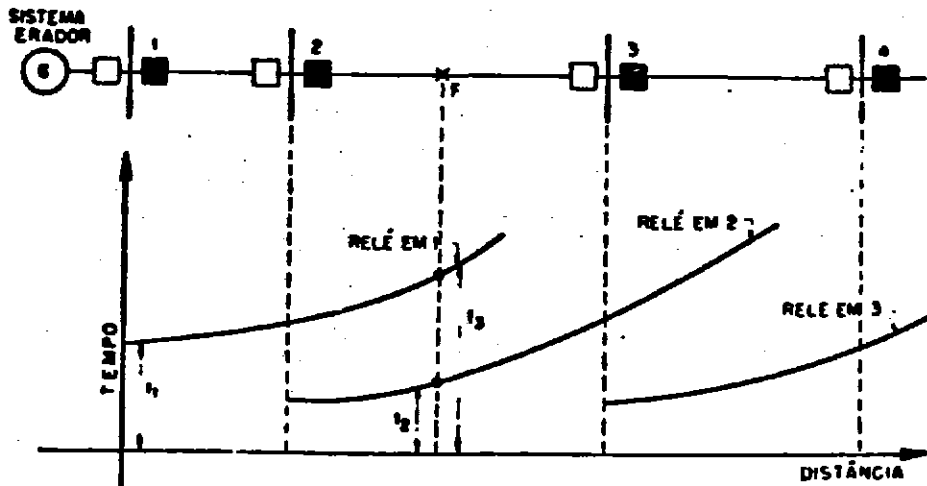
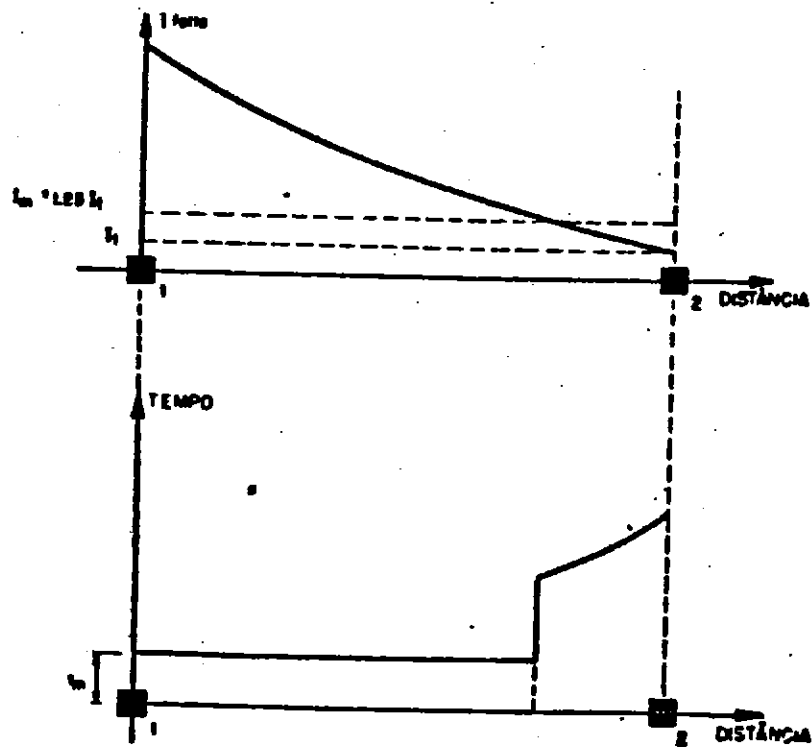
•  $TAP_2 < \frac{I_{\text{mínimo defeito}}}{RTC \approx 1,5}$

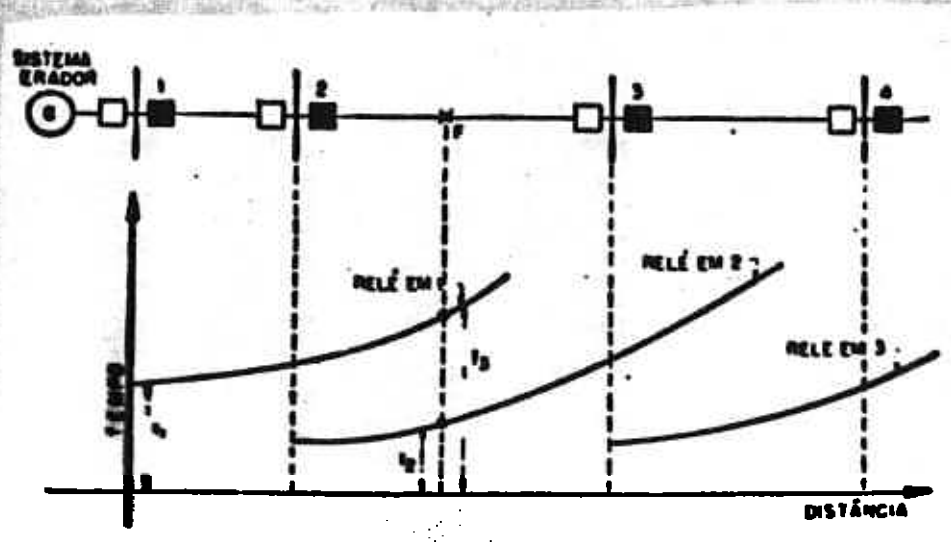
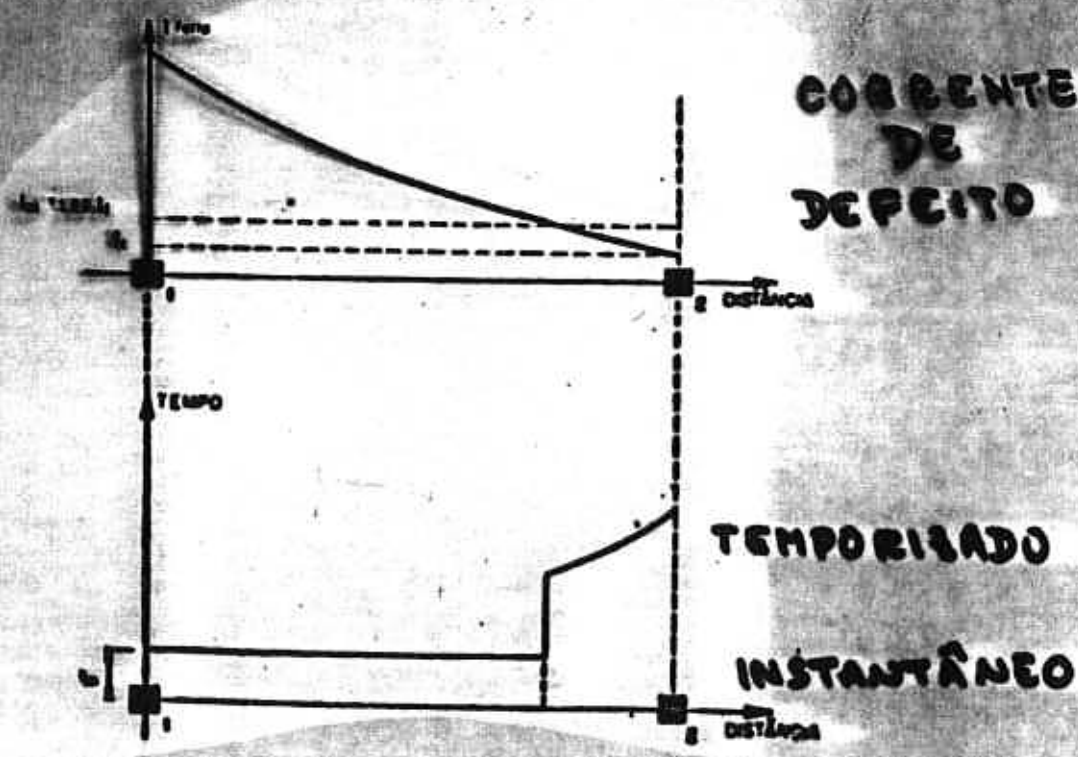
•  $TAP_3 > \frac{I_{\text{máximo defeito}}}{RTC \approx 20}$



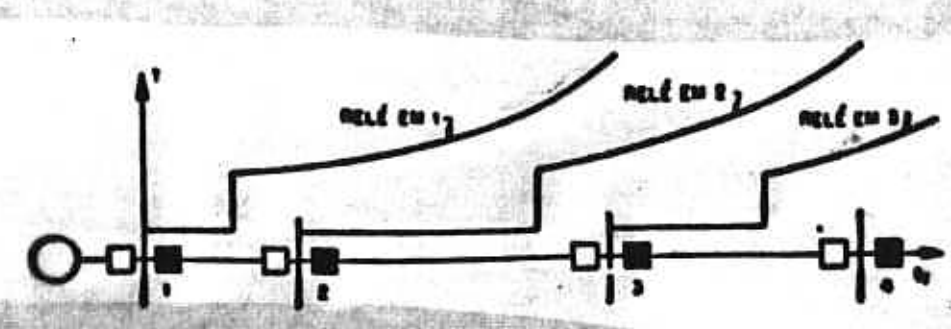
# UNIDADE INSTANTÂNEA

- 50
- TEMPO INDEPENDENTE
- FATOR DE ASSIMETRIA (F.A.)
  - ↳ FUNÇÃO DA RELAÇÃO X/R
- $I_{50} = F.A. \times I_{CC3\phi\text{-simétrico}}$





**LINHA COM TEMPORIZADO**



**LINHA COM INSTANTÂNEO E TEMPORIZADO**

	<u>TIPO</u>	<u>CURVA <math>t \times I</math></u>
WESTINGHOUSE	CO-5	LONGO
	CO-6	MINIMO DEFINIDO
	CO-7	MODERADAMENTE INVERSO
	CO-8	INVERSO
	CO-9	MUITO INVERSO
	CO-11	EXTREMAMENTE INVERSO
	CO-2	TEMPO CURTO
GE	IAC-51, 52	INVERSO
	IAC-53, 54	MUITO INVERSO
	IAC-77, 78	EXTREMAMENTE INVERSO
SIEMENS	7SK 88 (ESTÁTICO)	INVERSO
		MUITO INVERSO
		EXTREMAMENTE INVERSO
	7SJ 50 (DIGITAL)	INVERSO
		MUITO INVERSO
		EXTREMAMENTE INVERSO
7SJ 591 (DIGITAL)	INVERSO	
	MUITO INVERSO	
	EXTREMAMENTE INVERSO	
SCHULUN- BERGER	RSAS 3000	I M E T E T.D.

DIGITALS    SIEMENS     $\left\{ \begin{array}{l} 7SJ50 \\ 7SJ511 \end{array} \right.$

CURVA     $t \times I$

INVERSO     $t = \frac{0.14}{(I/I_p)^{0.02-1}} \times t_p$

MUITO INVERSO     $t = \frac{13.5}{(I/I_p)-1} \times t_p$

EXTREMAMENTE INVERSO     $t = \frac{80}{(I/I_p)^2-1} \times t_p$

$\left\{ \begin{array}{l} I_p - \text{TAP} \\ t_p - \text{DIAL} \end{array} \right.$

INEPAR - ESTÁTICO

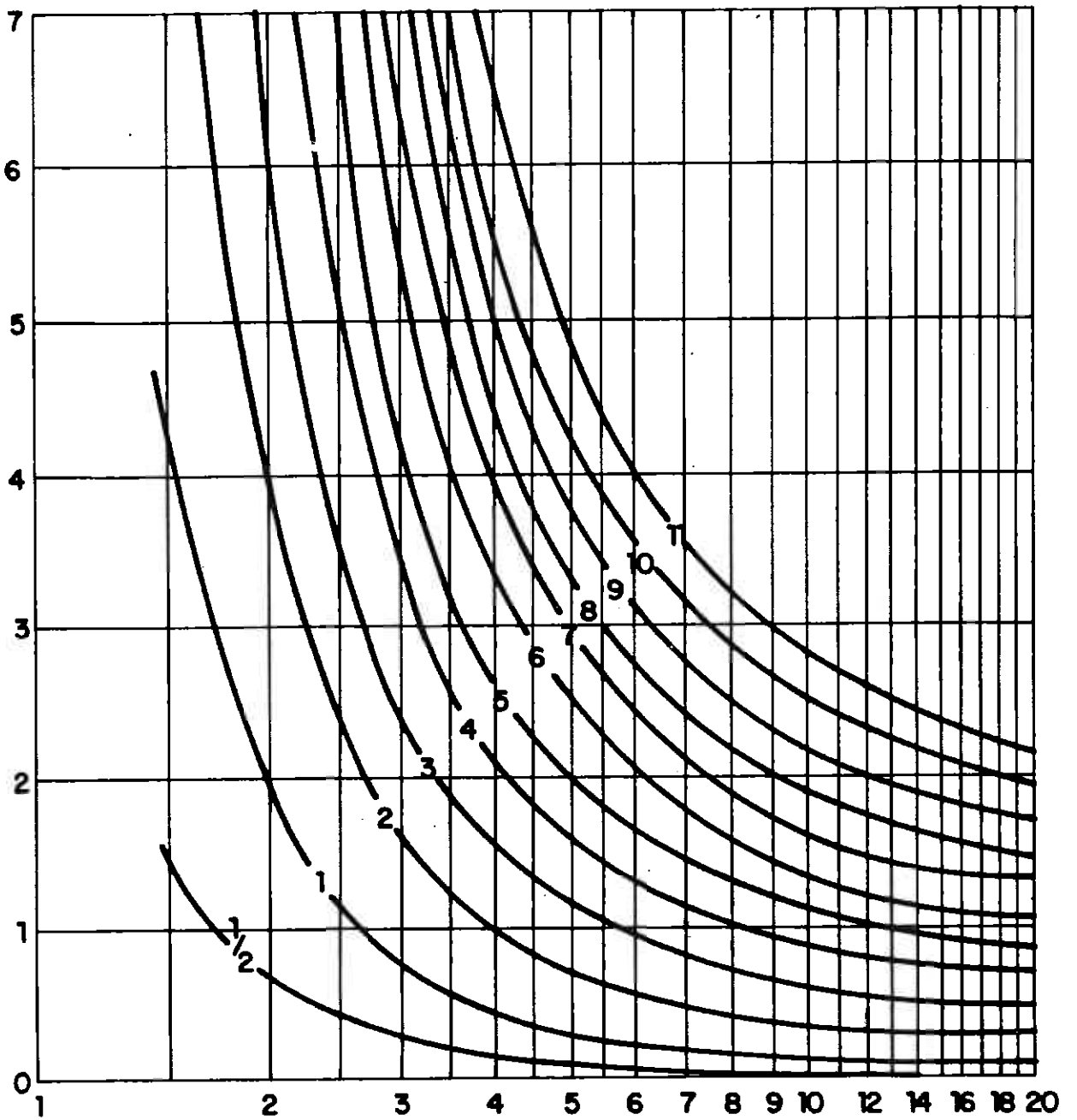
↳ LINHA I

IN - INVERSO

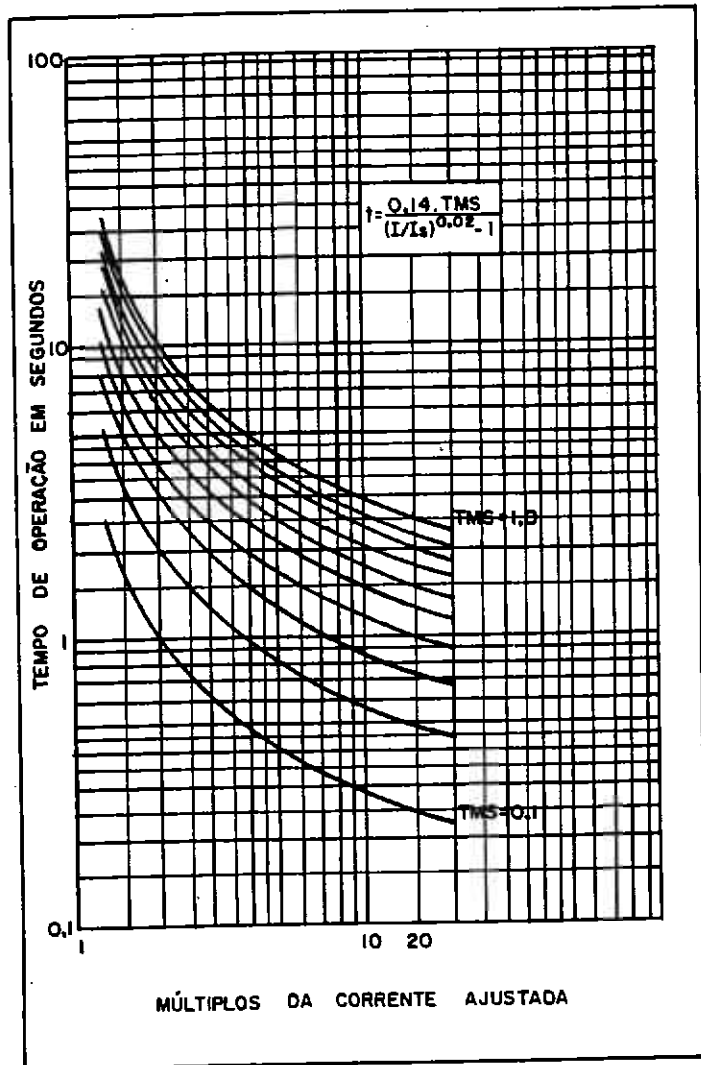
IE - MUITO INVERSO

IM - EXTREMAMENTE INVERSO

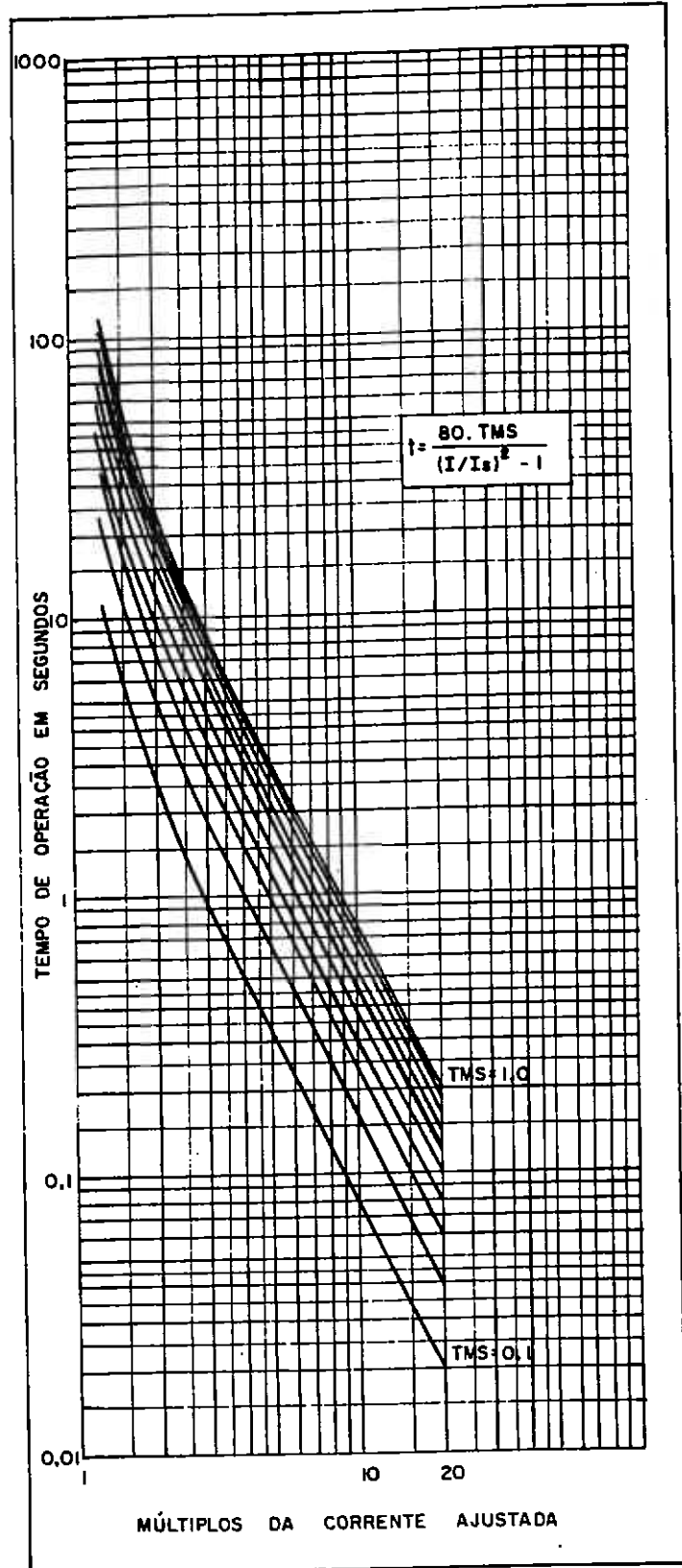
ID - TEMPO DEFINIDO



# CURVAS CARACTERÍSTICAS: TEMPO X CORRENTE



**FIG. 5**  
Características típicas tempo/corrente para relé de tempo normal inverso, tipo IN.



**FIG. 6**  
Características típicas tempo/corrente para relé de tempo extremamente inverso tipo IE.

# CURVAS CARACTERÍSTICAS: TEMPO X CORRENTE

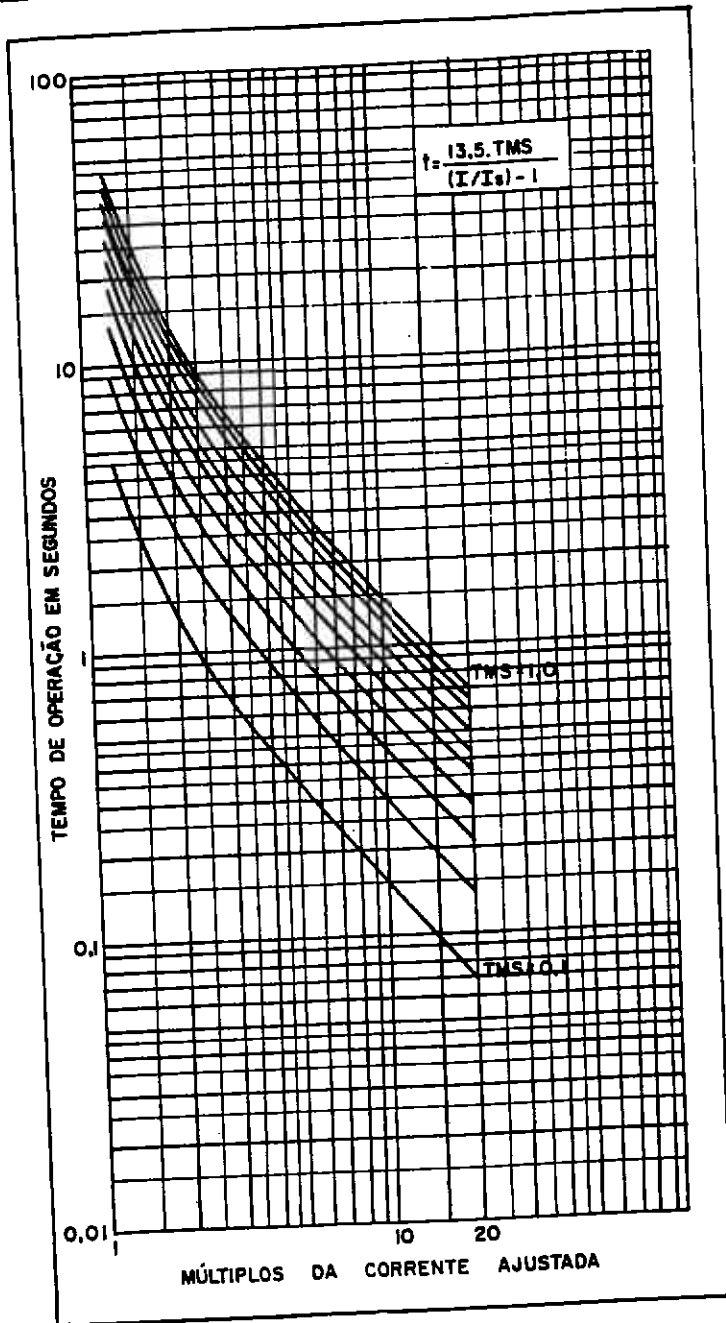


FIG. 7  
Características típicas tempo/corrente para relé de tempo muito inverso, tipo IM.

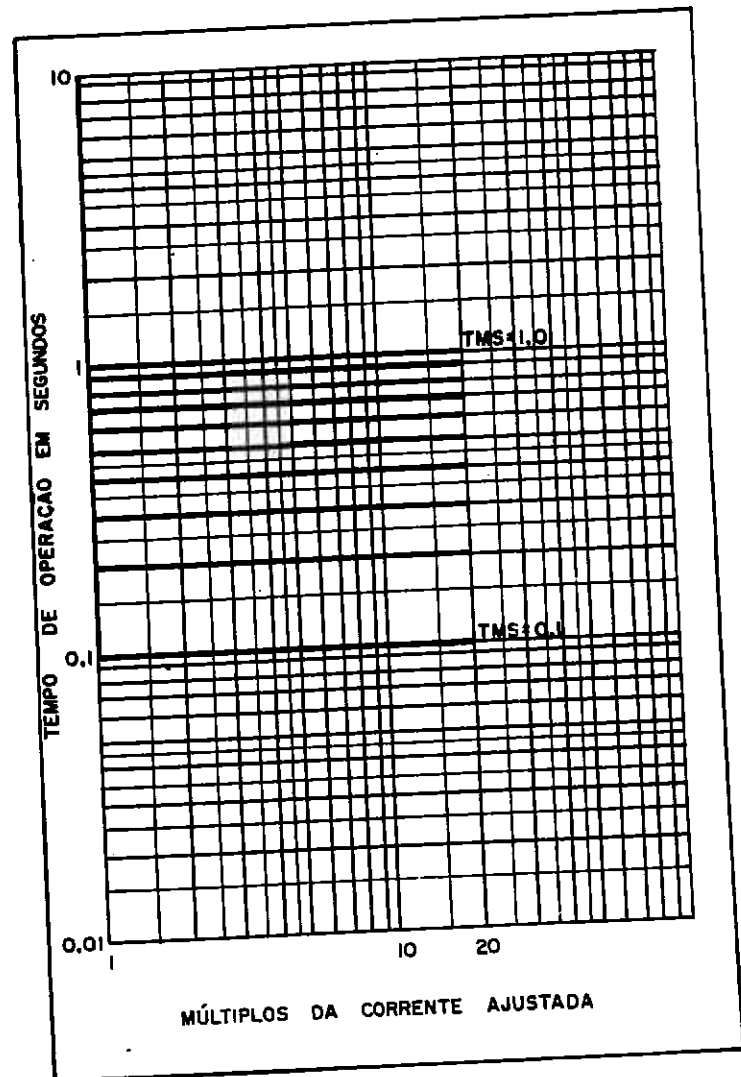
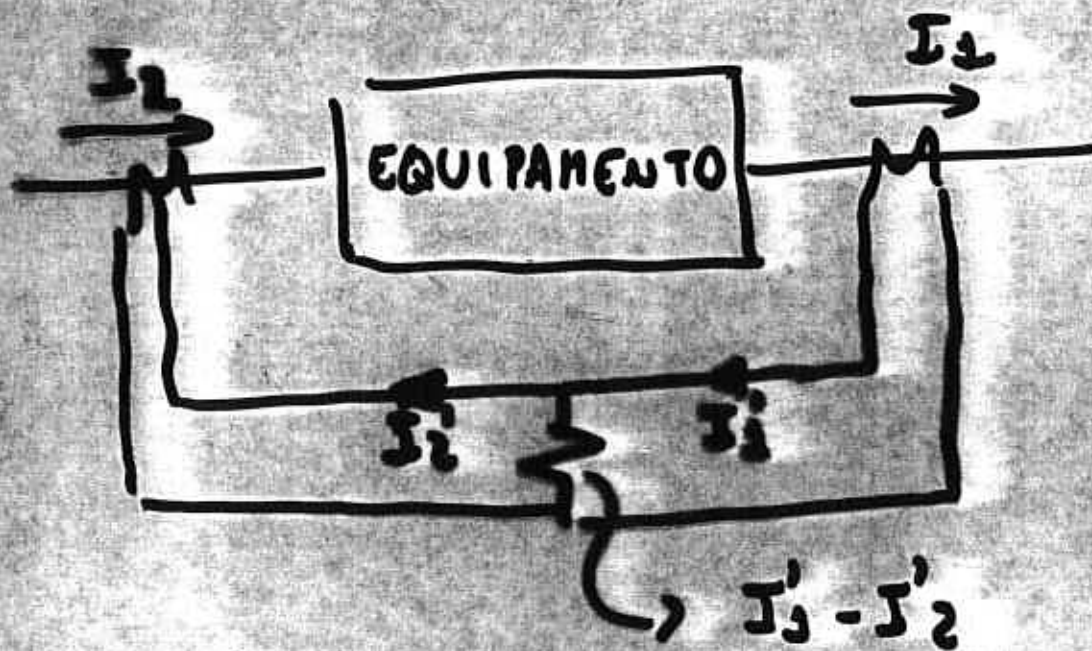


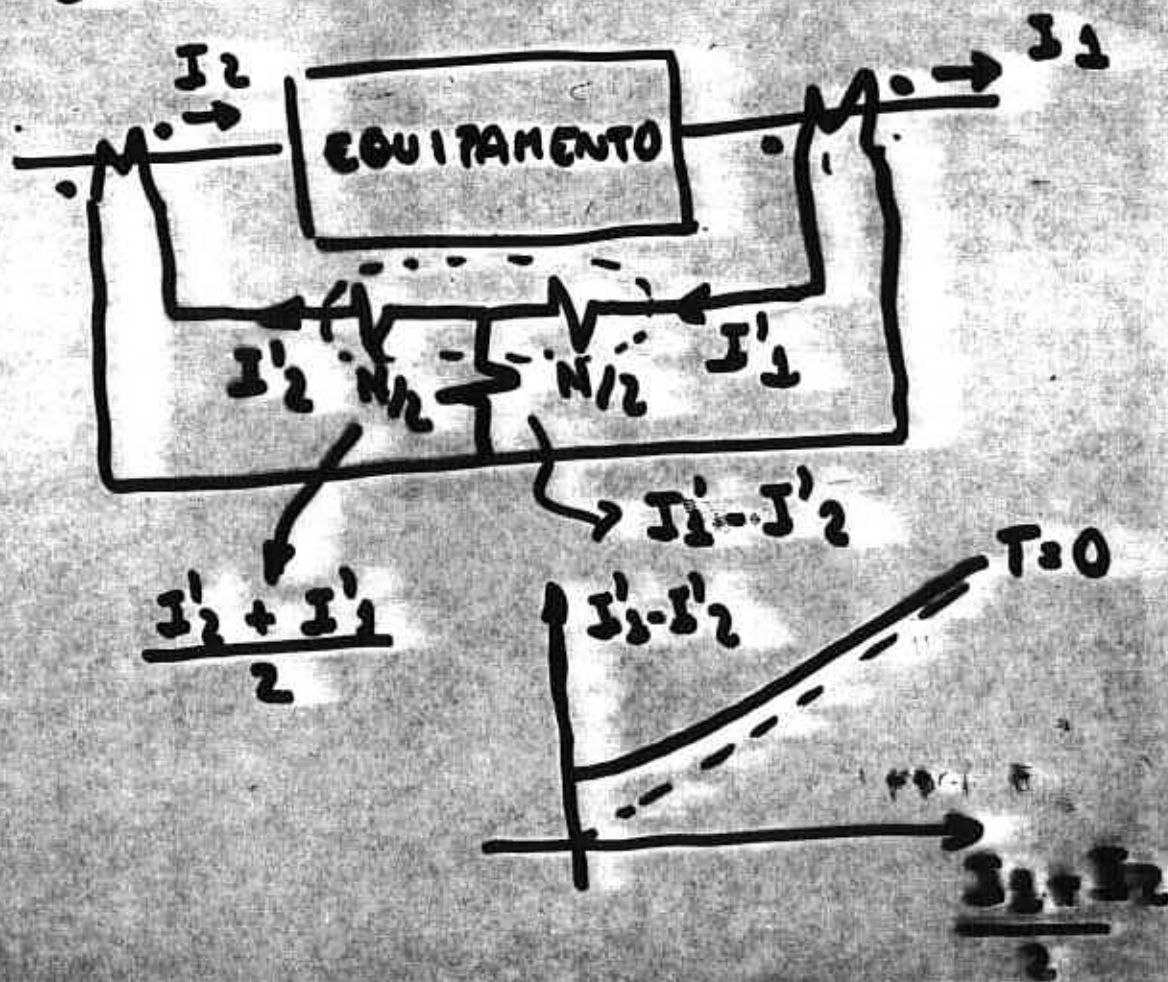
FIG. 8  
Características típicas tempo/corrente para relé de tempo definido tipo ID.

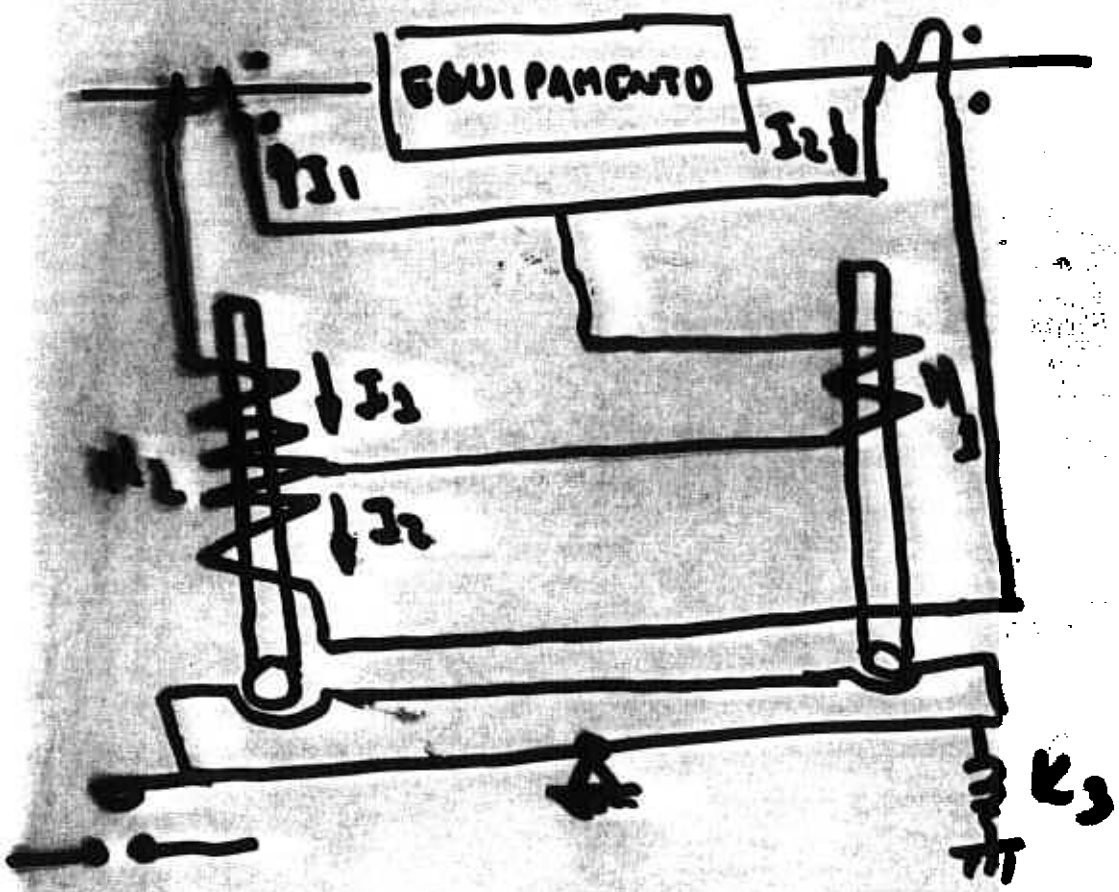


# PROTEÇÃO DIFERENCIAL



## • DIFERENCIAL PERCENTUAL





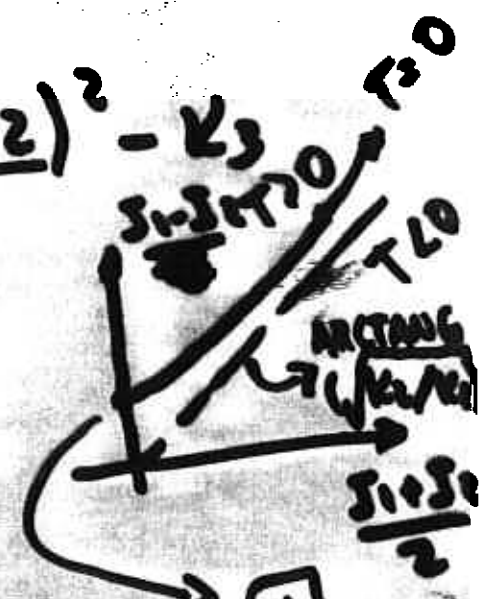
$$T = K_1 (I_1 - I_2)^2 - K_2 \left( \frac{I_1 + I_2}{2} \right)^2 - K_3$$

P/  $K_3 = 0$  e  $T = 0$

$$(I_1 - I_2) = \left( \frac{I_1 + I_2}{2} \right) \sqrt{\frac{K_2}{K_1}}$$

P/  $K_3 \neq 0$  e  $T = 0$

$$(I_1 - I_2)^2 = \frac{K_2}{K_1} \left( \frac{I_1 + I_2}{2} \right)^2 + \frac{K_3}{K_1}$$



RECURSIVO: 30-45%

PICK-UP =  $\sqrt{\frac{K_3}{K_1}}$





DIGITALS

SIEMENS

7SJ50

7SJ511

23

CURVA

$t \propto I$

INVERSO

$$t = \frac{0.14}{(I/I_p)^{0.02}} \cdot t_p$$

MUITO INVERSO

$$t = \frac{33.5}{(I/I_p)^{-1}} \cdot t_p$$

EXTREMAMENTE INVERSO

$$t = \frac{80}{(I/I_p)^{-2}} \cdot t_p$$

$\left\{ \begin{array}{l} I_p - \text{TAP} \\ t_p - \text{DIAL} \end{array} \right.$

INEPAR - ESTÁTICO

↳ LINHA 3

IN - INVERSO

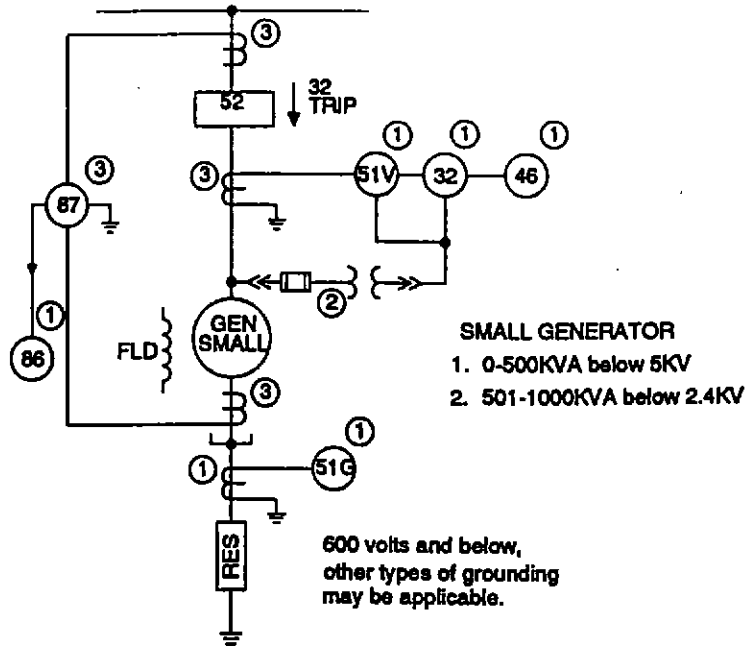
IE - MUITO INVERSO

IM - EXTREMAMENTE INVERSO

ID - TEMPO DEFINIDO

**NOTES:**

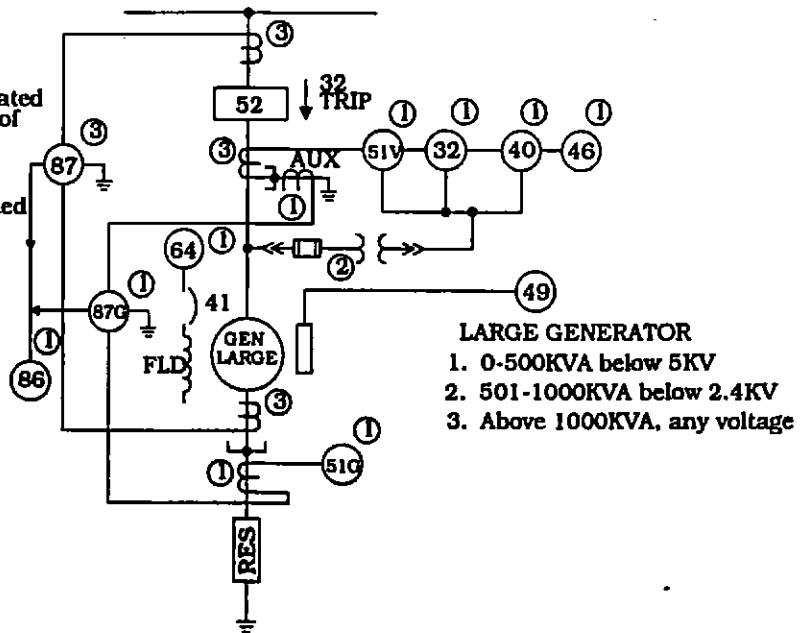
- A) Phase ct's should be rated approximately 150% of full load.
- B) Neutral ct's should be rated approximately one half of the maximum ground fault current.



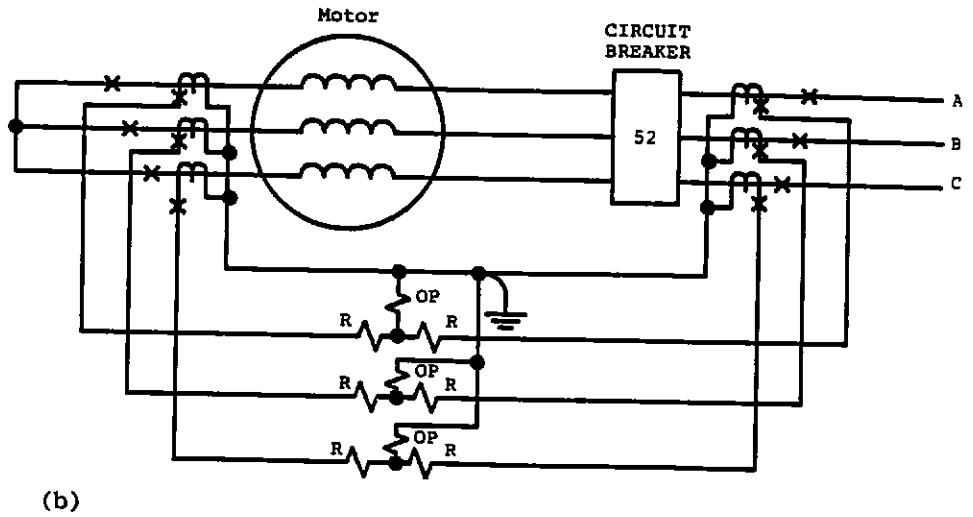
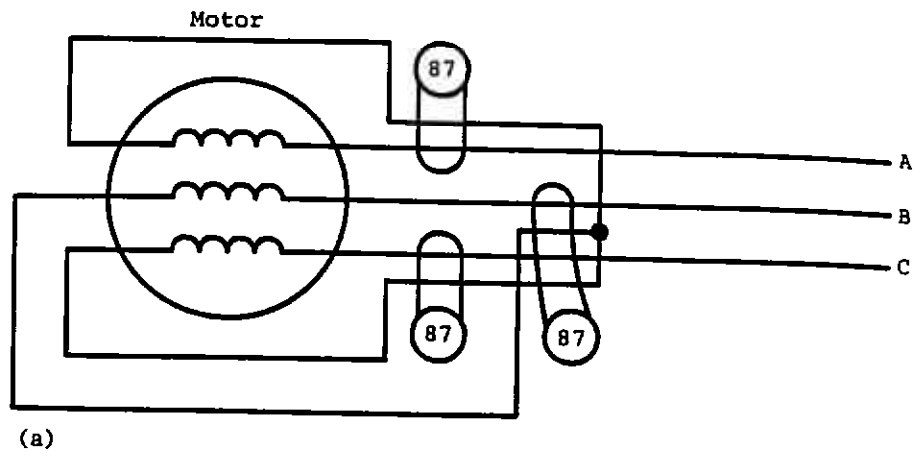
Recommended protection for small generators as used in industrial plants.

**NOTES:**

- A) Neutral ct's should be rated approximately one-half of the maximum ground fault current.
- B) Phase ct's should be rated approximately 150% of full load.

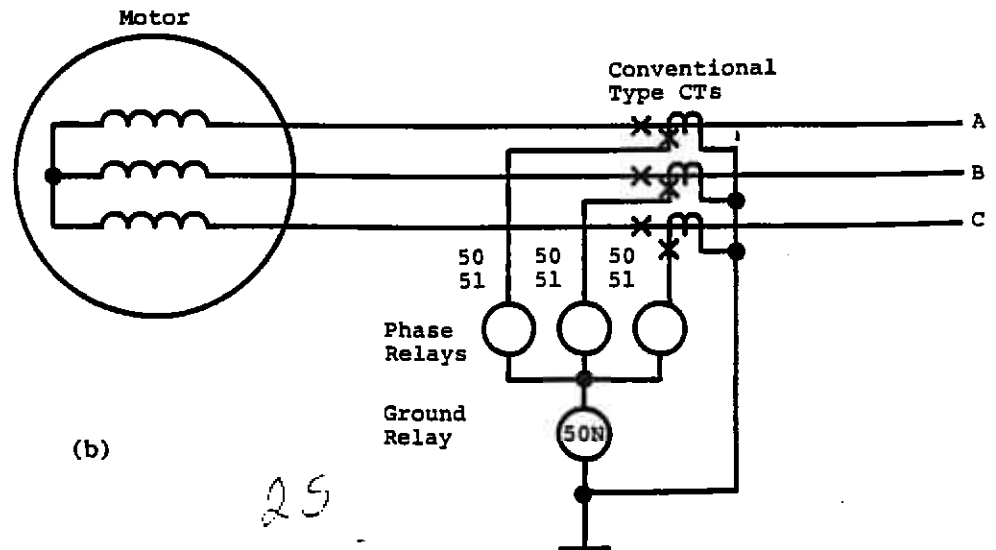
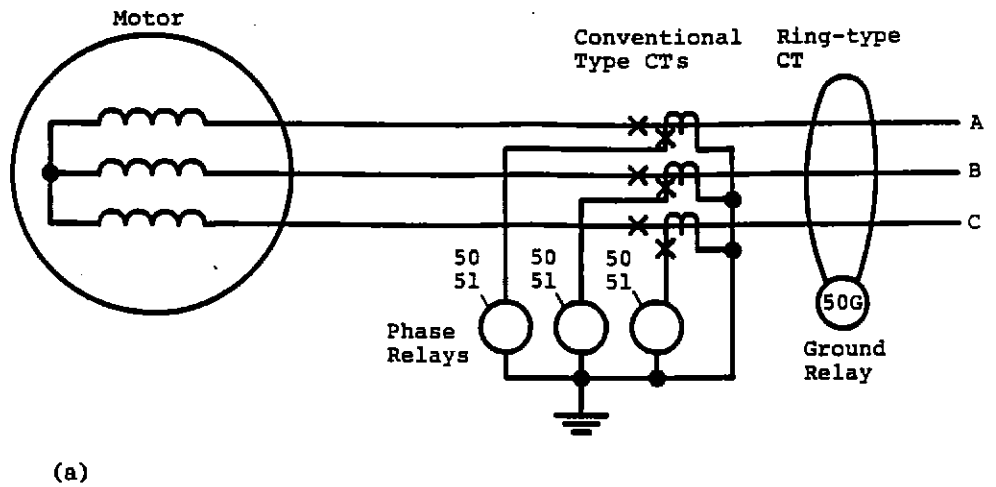


Recommended protection for large generators as used in industrial plants.

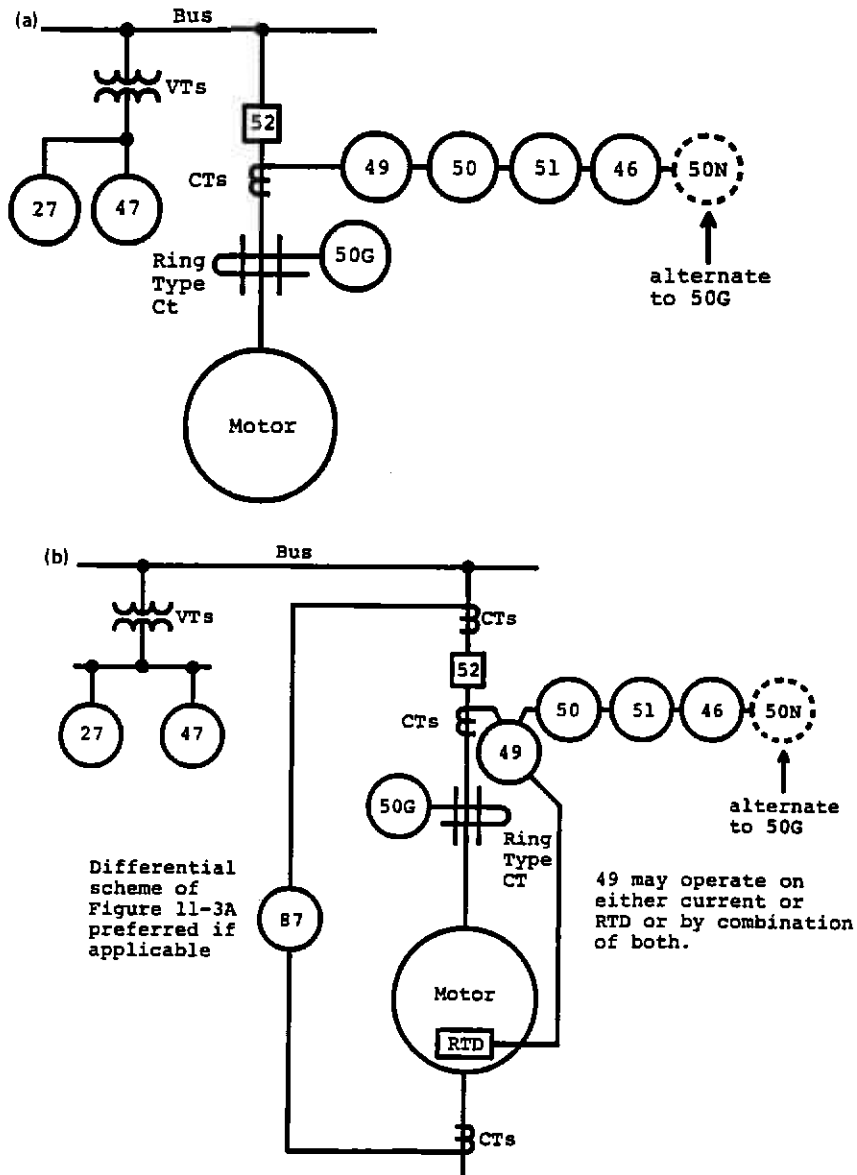


Differential protection for motors where the neutral leads are available: (a) with toroidal (ring) type CTs and instantaneous overcurrent relays (50); (b) with conventional-type CTs and differential relays.

Ground overcurrent protection for motors: (a) with the three conductors passed through a ring-type current transformer; (b) with conventional-type current transformers.

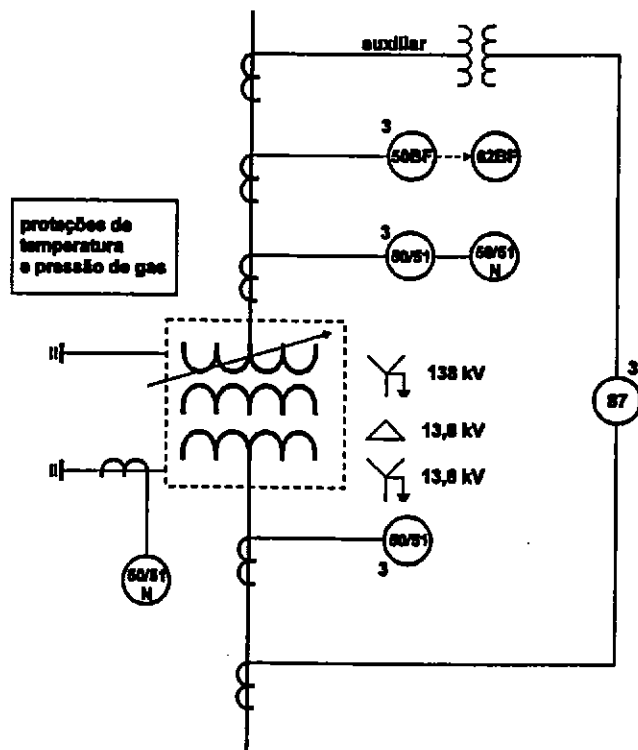


25



- Notes:**
1. The circles indicate functions that may be packaged individually or in various different combinations.
  2. Additional protection for Synchronous motors covered in Section 11.16.
  3. Protection to avoid re-energization after short-time interruptions covered in Section 11.14.

Typical recommendations for motor protection: (a) for motors without neutral leads and RTD's available; (b) for motors with neutral leads and RTD's available.

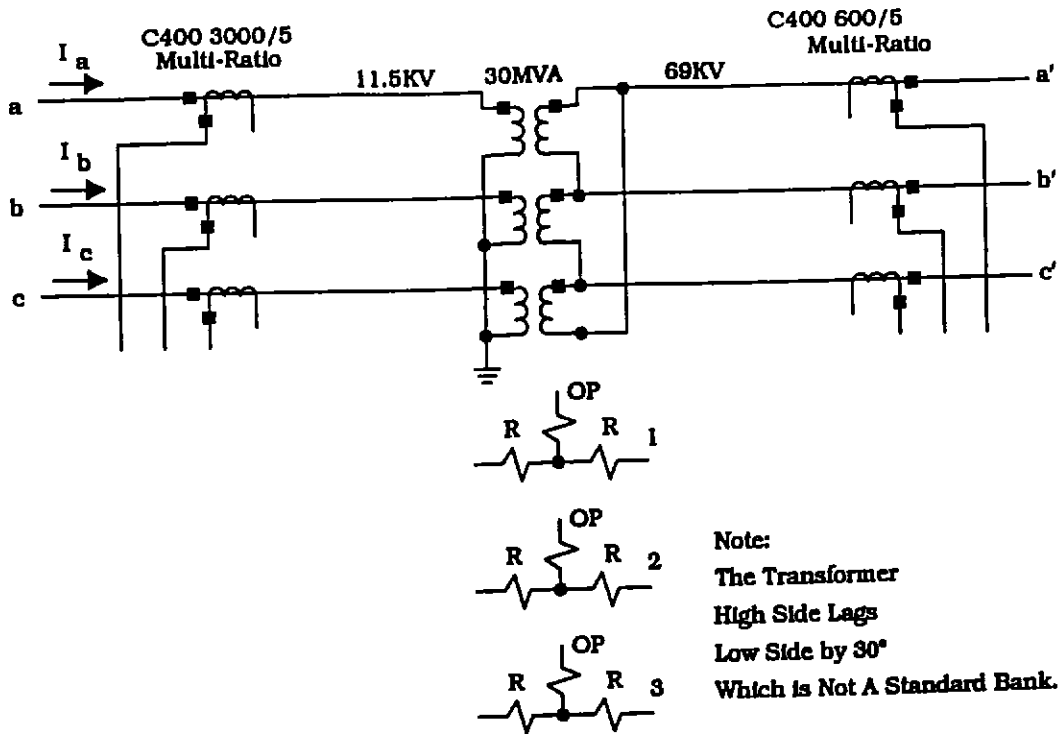


**Proteção de transformador**

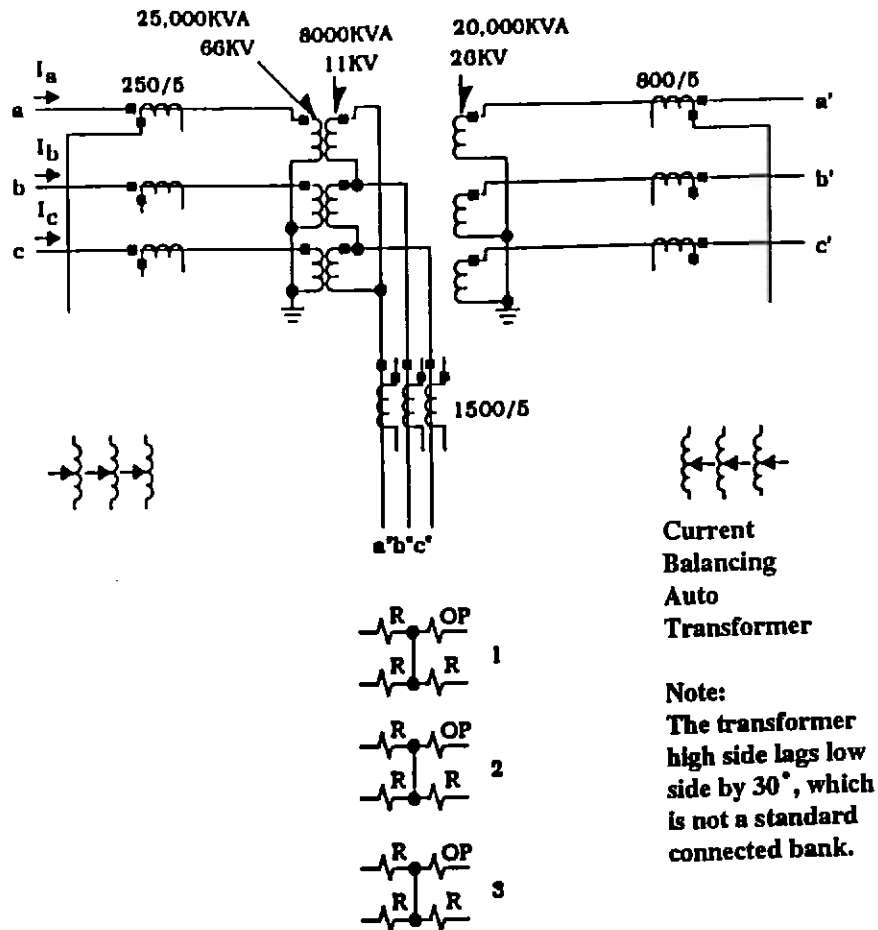
50 BF/62 BF	falha de disjuntor / temporização
50/51	relé de sobrecorrente instantâneo e temporizado
50/51 N	relé para defeito a terra
87	diferencial

outros:	
26.1/26.2	temperatura do óleo
49.1/49.2	temperatura do enrolamento
63.1/63.2 TR	bucholz do transformador
63.1/63.2 C	bucholz do comutador sob carga
71	nível de óleo do transformador
63 VS	válvula de segurança

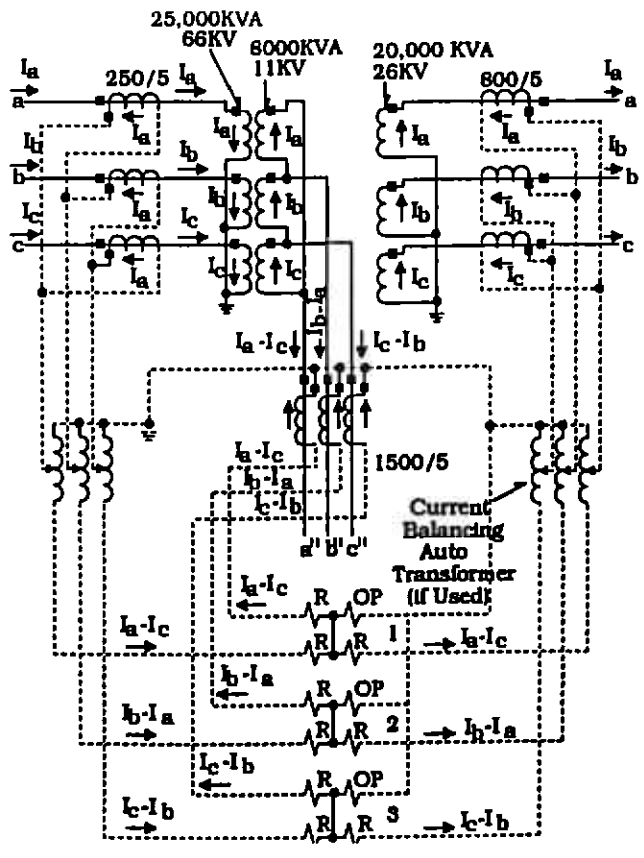
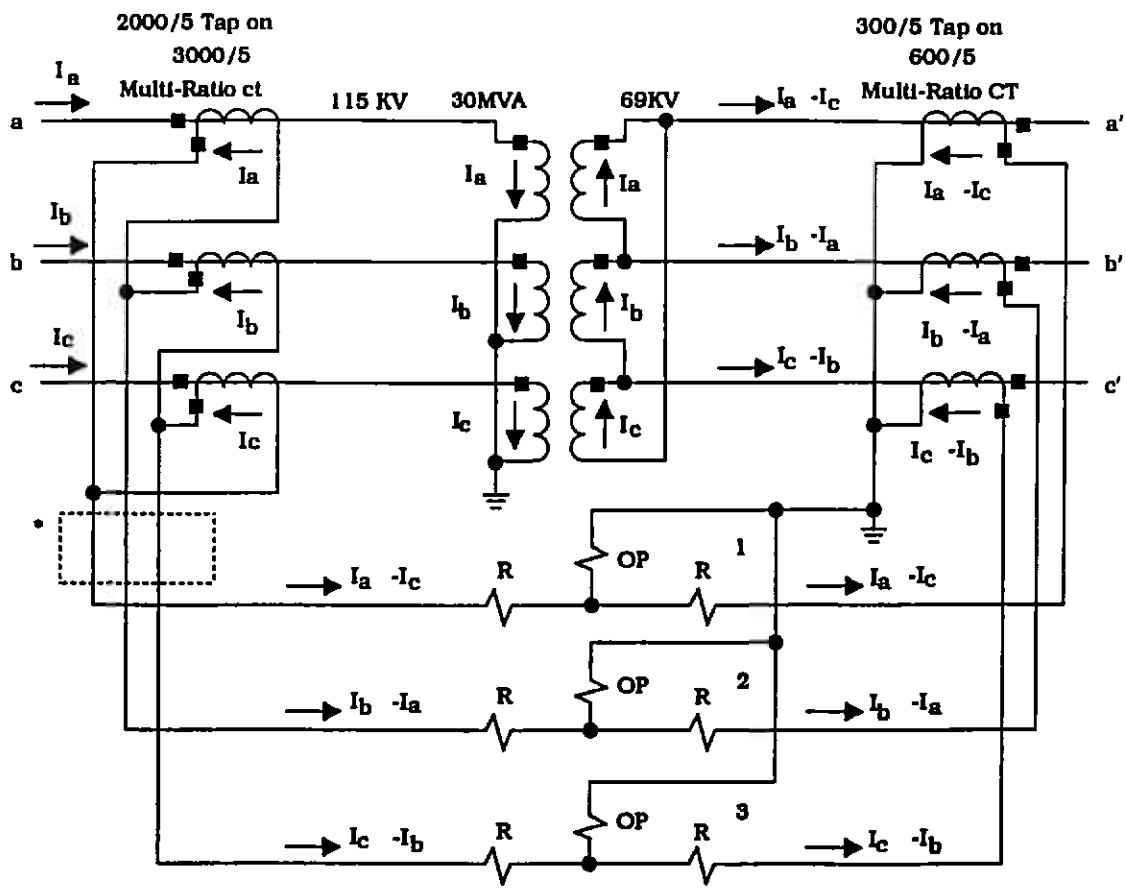




Work sheet for connecting differential relays around a two-winding transformer bank.



Work sheet for connecting differential relays around a three-winding transformer bank.



## PROTEÇÃO DE SOBRECORRENTE EM SISTEMAS RADIAIS

### 1) Determinar os parâmetros da rede em estudo

- níveis de curto-circuito dos pontos de conexão com a concessionária de energia (Thevenin do sistema para as 3 sequências ou o nível de correntes de curto-circuito trifásico e monofásico)

- geração própria - dados de potência dos geradores, tensão, reatâncias

- dados da rede

. cargas (potência, tensão, fator de potência)

. cabos (parâmetros, capacidade)

- cenários da rede - contingências (perda de elementos, geração só pela concessionária, geração própria e ambas, etc)

- equipamentos de proteção (fusíveis, relés térmicos, disjuntores, relés de sobrecorrente (51/50, 51-N/50-N, 51-G/50-G), diferenciais)

### 2) Cálculo dos níveis de curto nas várias barras da rede

- monofásico

- trifásico

- e se necessário : duplafase e duplafase-terra

### 3) Definição das relações dos TC's dos relés de sobrecorrente

- máxima carga em cada TC

- critério de curto-circuito (saturação do TC)

### 4) Definição das proteções de baixa tensão (máxima corrente de carga e níveis de corrente de curto-circuito e de partida, no caso de motores)

- fusíveis + relés térmicos

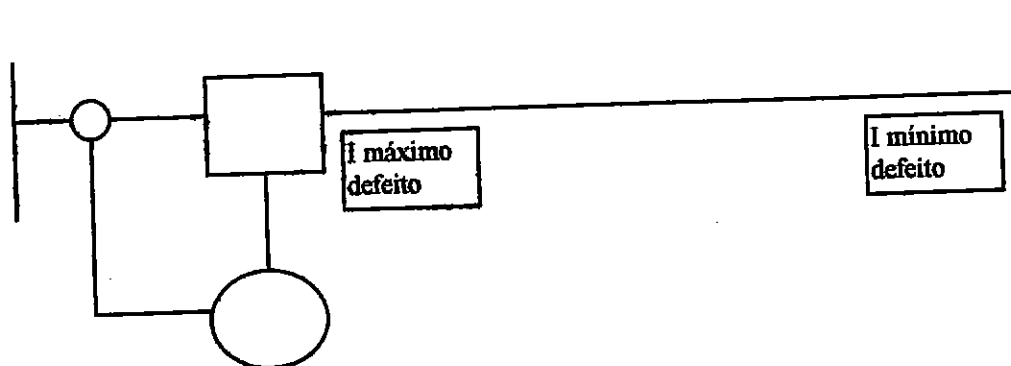
- disjuntores de baixa tensão

### 5) Definição dos TAPES dos relés

- TAPE1 >  $I_{\text{máximo de carga}} / (\text{RTC} \times 1.0)$

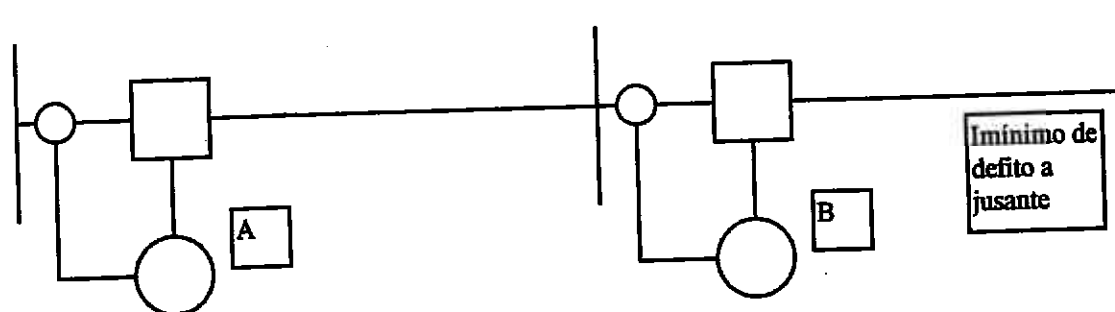
- TAPE2 <  $I_{\text{mínimo de defeito}} / (\text{RTC} \times 1.5)$

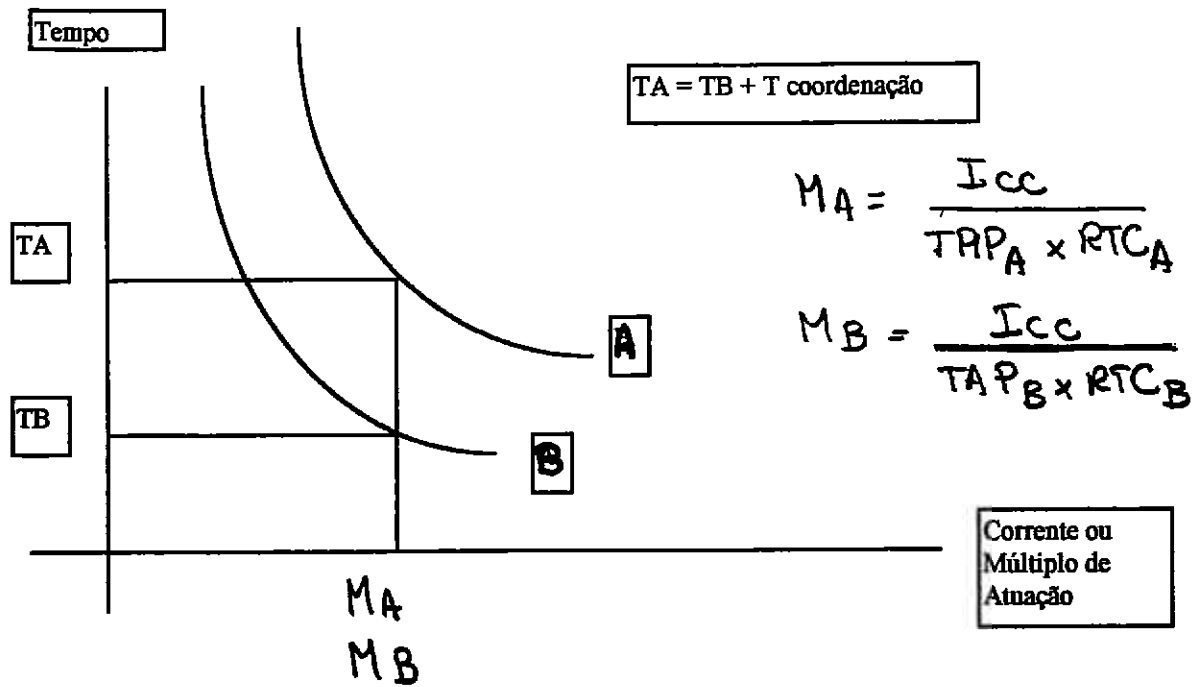
- TAPE3 >  $I_{\text{máximo de defeito}} / (\text{RTC} \times 20)$



6) Definir os dias para que exista coordenação entre elementos adjacentes dos extremos da rede (pontos de carga) até as fontes, garantindo proteção contra situações de curto-circuito e seletividade.

- tempo do relé a montante (B) = tempo de coordenação + tempo de atuação do relé a jusante (A) ( tempo de coordenação = 0.4 s - relés eletromecânicos e 0.3 s - relés estáticos e microprocessados) para a menor corrente de defeito do relé a jusante.





7) Proteções específicas de equipamentos

- diferenciais de transformadores (ponto e curva ANSI e INRUSII), motores e barramentos

- proteções térmicas (curto-circuito) - cabos

$$I_{cc} = \frac{0,34 S}{\sqrt{t}} \sqrt{\log\left(\frac{234 + T_f}{234 + T_i}\right)}$$

$$t = \frac{1250}{I^2}$$

(p/ z = 4%)

T <sub>f</sub>	360°	250°
T <sub>i</sub>	70°	90°
	PVC	XLPE/EPR