Secondary Thermal Relays type ST for a.c. or d.c.

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For overload protection in electrical installations

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Contents

Notes

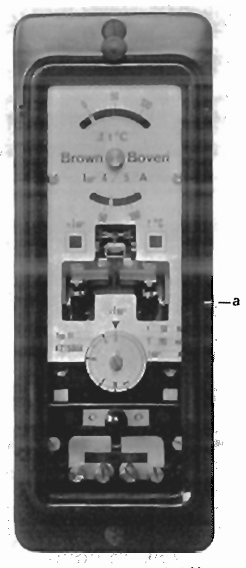
A. Purpose

The secondary thermal relay type ST is used for overload protection of electrical equipment of all kinds, such as machines, transformers, cable, etc. Even when the load is variable, its temperature rise closely follows that of the object or part of the installation being protected. When the set temperature rise is exceeded, the relay actuates its contact and thus closes a warning or tripping circuit. Until this limit is reached, it permits any load and thus allows full advantage to be taken of the thermal capacity of the protected object.

Overcurrent relays are not suited to this task as they do not take into account the thermal properties of the protected object.

The secondary thermal relay type ST is also equipped with an overcurrent relay independent of the thermal part, which picks up immediately a set current is exceeded. This is known as the limit-current trip and may be used for instantaneous short-circuit protection or, in conjunction with a separate time-lag relay, for overcurrent-time protection (see examples of connections on page 28).

The a. c. design of the relay is intended for connection to current transformers having a secondary current of 5 A, while the d. c. version is connected to a shunt, or parallel to the winding of a machine with the voltage drop at full load of at least 1·75 V.



57835 V

Fig. 1

Secondary thermal relay type ST in casing for flush mounting with rear connection
a = Signal reset button

Definition of temperature rise

The temperature rise which concerns the relay is the difference between the temperature of the protected object when loaded and the ambient temperature.

B. Properties of the Secondary Thermal Relay type ST

The relay offers the following features:

It is a good thermal overload protection and renders superfluous such foreign elements as thermocouples, detectors, auxiliary leads, etc., in the protected object.

It indicates the momentary temperature rise and is thus a means of checking the temperature of the protected object at any time without any special instruments.

It indicates the maximum temperature rise by means of a pointer which can be reset after reading.

Simultaneously it affords short-circuit protection by means of an overload element which can be set over a wide range; this is known as the limit-current trip.

It can be adapted to the protected object over a wide range since the thermal time constants are variable between 20 and 110 min.

It has a very low consumption.

It has a visible signal both for the thermal and overload trip.

The **type designation** is ST. Changes in the internal connection and certain special designs are denoted by additional small letters (see page 16, Special designs).

C. Design and Principle

Thermal part

The secondary thermal relay type ST contains a thermal element for overload protection and an overcurrent relay for short-circuit protection.

The thermal element comprises the **measuring system** (consisting of a pile of bimetal strips), a **heat storage element** (metal plates, the number and thickness of which determine the time constant of the relay) and a **heater element** which carries the input current and heats the bimetal element and the storage element. The measuring system, heat storage and heater elements are all enclosed in a jacket r to prevent radiation (see Fig. 3).

At its upper end the **measuring system** transmits its linear expansion, proportional to the temperature, through an insulating bar to the temperature rise pointer a (Fig. 3). In the normal design of relay the measuring system is supported through an insulating rod in a bimetal strip which compensates for any change in the ambient temperature under all conditions likely to be experienced in service. Thus the relay indicates the temperature rise of the protected object, or a proportional value. The lower bearing of the measuring system is fitted with an adjustable screw with which, in the normal design, the temperature rise pointer can be set exactly to zero when the relay is dead and quite cold. This correction must be undertaken with

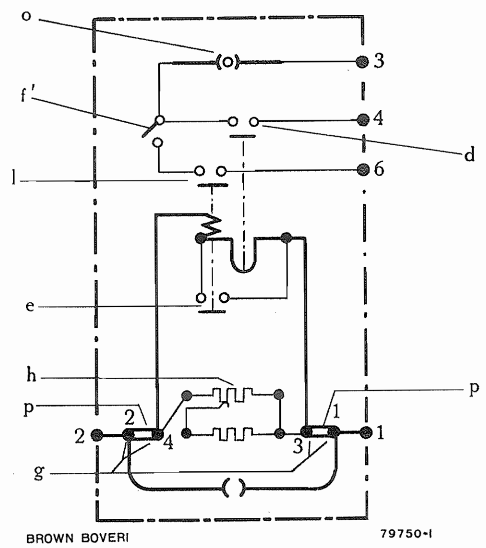


Fig. 2

Internal connection of secondary thermal relay type ST

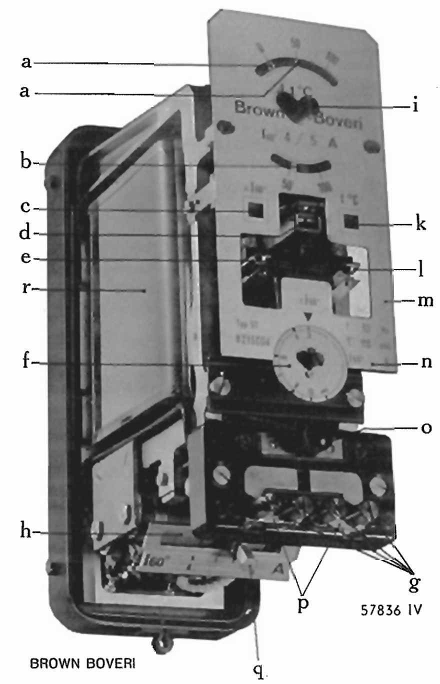


Fig. 3

Secondary thermal relay type ST with casing removed

Legend for Fig. 2 and 3

- a Temperature rise scale
- a' Maximum pointer
- b Pointer for setting pick-up temperature rise
- c Signal of limit-current trip
- d Contact of thermal trip
- e Internal contact
- f Scale for setting limit-current trip
- g Test terminals
- h Setting resistor
- i Reset knob for maximum pointer
- k Signal of thermal trip
- l Contact for limit-current trip
- m Front plate
- n Note of setting
- o Screw plug of test terminals
- q Screw to balance current setting
- r Jacket to prevent radiation

great care and should be checked when the relay is overhauled (see Operating Instructions).

A **red pointer** a′ (Fig. 3), carried forward by the temperature rise pointer, indicates the maximum temperature rise reached by the protected object. It can be reset by means of the button i (Fig. 3).

The **measuring element** actuates the temperature rise pointer a (Fig. 3) and on the trip contact d through a differential gear. On reaching the pick-up temperature rise, the contact operates with a snap action and actuates the signal k for thermal trip. The pick-up temperature rise can be set on the setting spindle when the reset button of the maximum temperature pointer has been pulled off. This adjustment must be performed with a screw-driver and is visible on the scale b on which the pick-up temperature rise is set. When the temperature rise drops to about 20% below its pick-up value the contact reverts to its position of rest.

The secondary thermal relay is designed for a current setting of 4–5 A. The match between these limits and the full-load current of the protected object is made with the sliding resistor H (Fig. 3) in parallel with the measuring system. Re the current match and setting see chapter D (page 14).

Tripping characteristics of the thermal relay

When a homogeneous body with a uniform heat transfer resistance to a cooling medium across its surface, is heated at a constant rate, its temperature rises according to an exponential law:

$$\vartheta - \vartheta_0 = (\vartheta_\infty - \vartheta_0)\left(1 - e^{-\frac{t}{\tau}}\right)$$

With no initial load, and therefore with $\vartheta_0 = 0$, we obtain

$$\vartheta = \vartheta_\infty \left(1 - e^{-\frac{t}{\tau}}\right)$$

where

ϑ = temperature rise

ϑ_0 = initial temperature difference

ϑ_∞ = steady-state temperature difference

t = time

τ = time constant, i.e. the time in min in which the body reaches 63% of the rise to its new steady state ϑ_∞, starting from the sustained initial value ϑ_0. (See Fig. 4.)

The objects protected by thermal relays are never homogeneous objects though; the dissipation of the heat generated by them usually takes place in a number of stages. Thus, in a power transformer immersed in oil, for example, the copper losses resulting from the passage of current are fairly uniformly distributed in the total volume of copper. First it is transferred through the insulation of the winding to the oil. The ratio of the thermal capacity of the winding copper and the heat transfer resistance of the winding insulation is such that this transfer of heat usually has a time constant of several minutes. The heat absorbed by the oil, which duly becomes hotter, is distributed by it throughout the whole of the transformer mass and

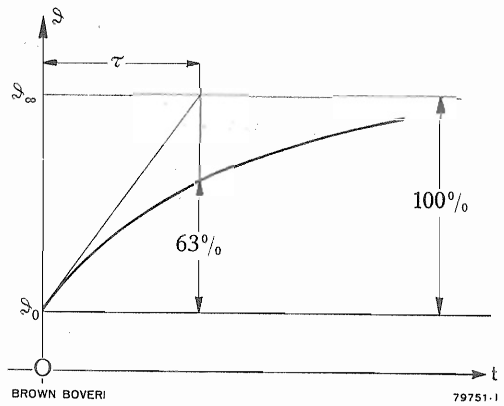


Fig. 4

Defining the time constants

conducted by it to the cooling medium (air and/or water). The time constant of this second transfer of heat is of the order of 1–2 hours. Thus the curve showing the temperature rise of the transformer copper can be treated as the sum of two exponential curves with different steady-state temperature rises, one having a small time constant, the other a large one. If the current, and thereby the losses in the transformer are abruptly increased, the copper rapidly assumes its steady-state temperature relative to the oil; the rise in temperature of the oil, however, is much slower. If a definite upper limit is stipulated for the temperature rise in the copper, the permissible duration of this load is primarily

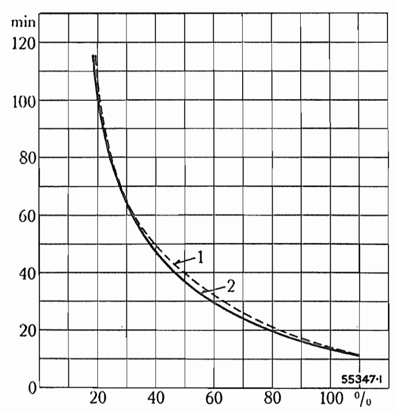


Fig. 5

Tripping time of the secondary thermal relay type ST, compared with the permissible duration of an overload of a 200-kVA transformer

Legend:
1 Relay
2 Transformer

governed by the smaller time constant of the heat transfer between copper and oil, but for a small overload it is governed by the larger time constant of the transfer from oil to coolant. The conditions are similar for cables and rotating machines.

The suitability of the secondary thermal relay type ST for supervising objects whose temperature rise follows the rules outlined above is based on the fact that the temperature rise of its measuring element is largely governed by a series connection of two heat transfers, the first having only a moderate temperature difference and small time constant between the heater element complete with measuring element and heat carrier, the second having a larger temperature difference and large, variable time constant for the transfer between the heat carrier and the atmosphere. Hence the curves for the temperature rise of the thermal relay type ST exhibit a small initial time constant (initial tangent) and a high sustained time constant (until 63% of the steady-state temperature rise is attained); the latter is known as τ the time constant of the relay.

The temperature rise of the relay with respect to time is depicted in the curves Fig. 6 to 11. Since, in accordance with the foregoing remarks, these are the sum of two curves, they only apply to the current at which they were plotted and cannot necessarily be converted to heavy current loads.

$\tau = 20$ min
$\tau = 30$ min

Curves of temperature

of secondary thermal relays type ST

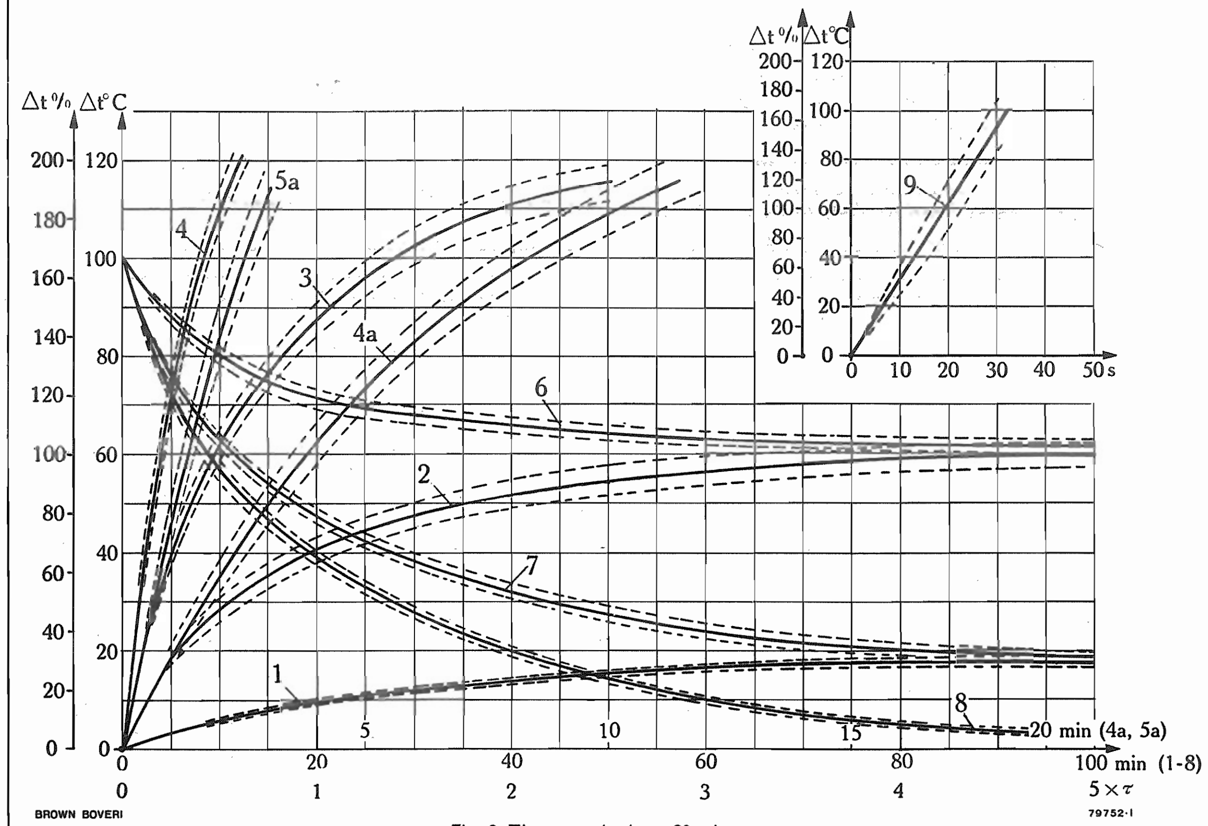


Fig. 6. Time constant $\tau = 20$ min

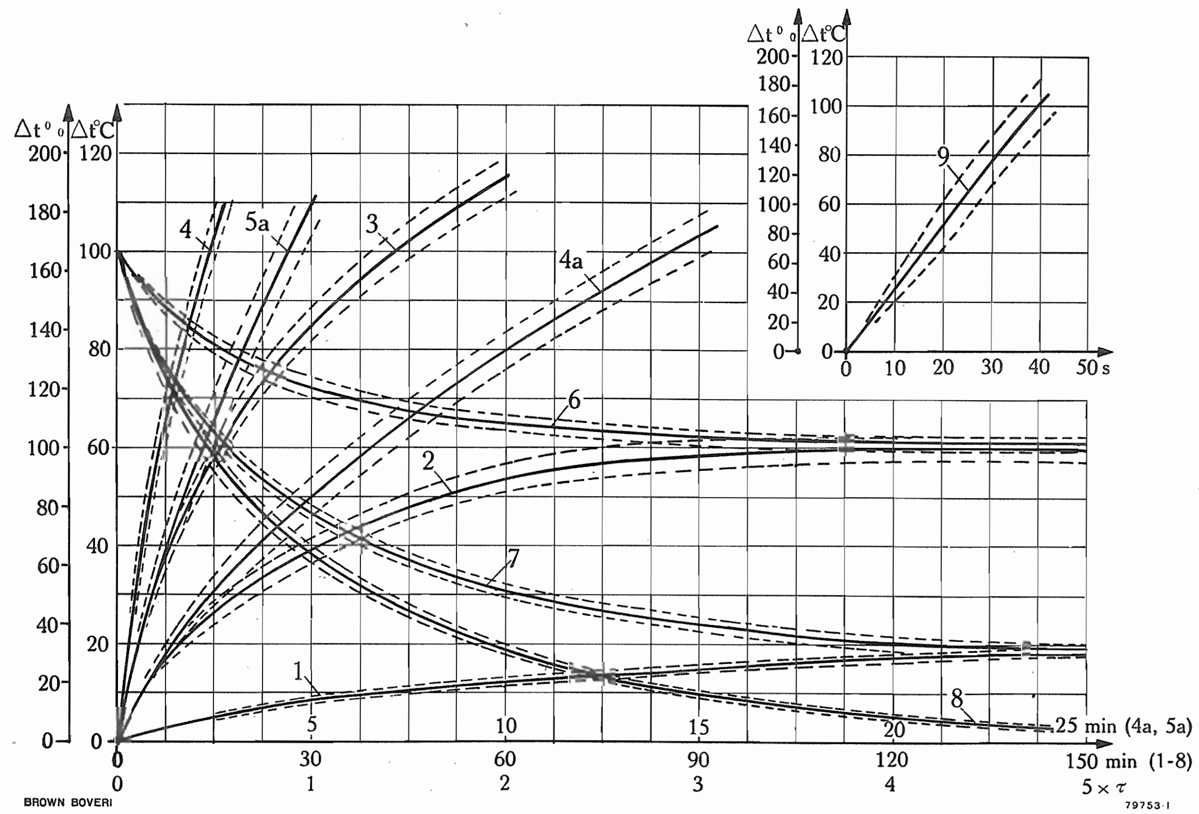


Fig. 7. Time constant $\tau = 30$ min

rise and decrease

$\tau = 40$ min

Steady-state rise for set current = 60° C

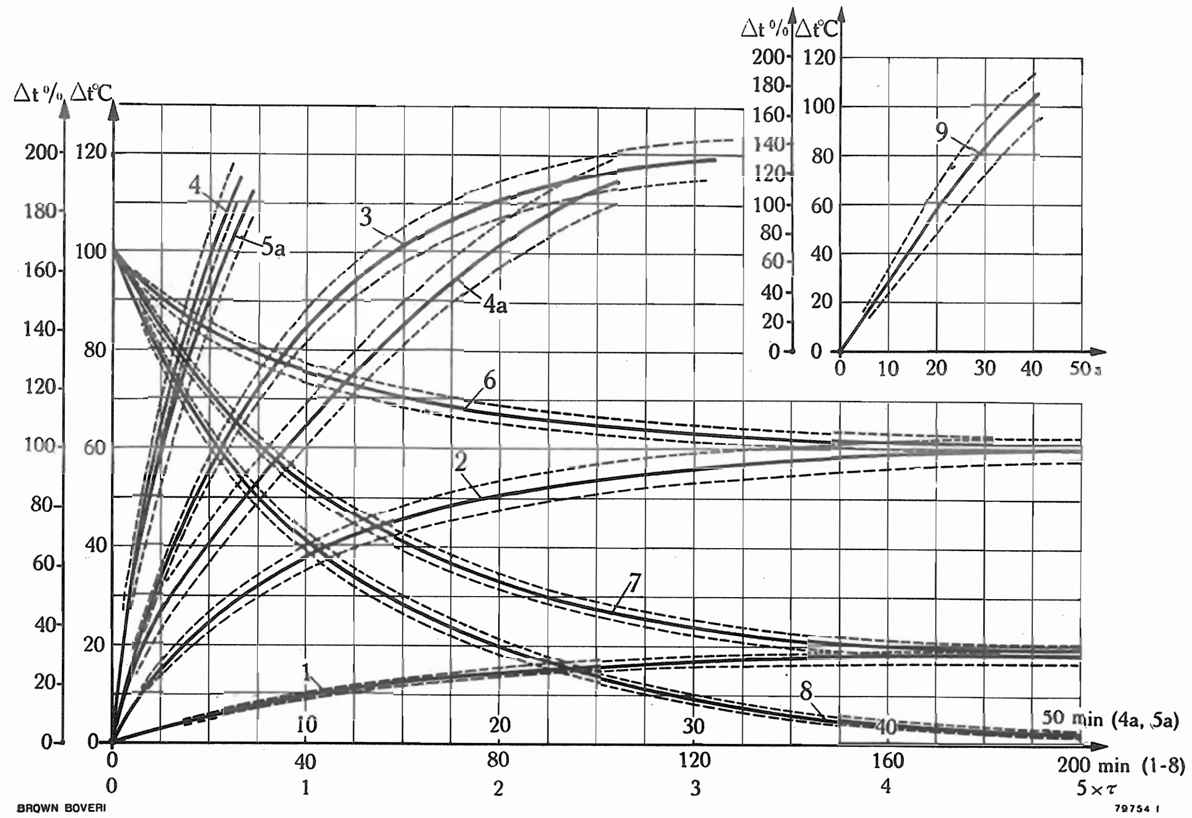


Fig. 8. Time constant $\tau = 40$ min

Legend:

1 Curve of temperature rise for $0{,}5 \times I_E$
2 Curve of temperature rise for $1 \times I_E$
3 Curve of temperature rise for $1{,}5 \times I_E$
4 Curve of temperature rise for $2 \times I_E$
4a Curve of temperature rise for $2 \times I_E$
5a Curve of temperature rise for $3 \times I_E$
6 Cooling curve when fed with $1 \times I_E$
7 Cooling curve when fed with $0{,}5 \times I_E$
8 Cooling curve when relay dead
9 Curve of temperature rise for $6 \times I_E$

The cooling curves are plotted with an initial temperature rise of 100° C (relay with degree scale)

The following are plotted:

Ordinates: Temperature rise $\Delta t\%$ for relays with % scale
Temperature rise $\Delta t°$ C for relays with ° C scale
Abcsissae: Time in min for curves 4a and 5a
Time in min for the other curves
Time as multiple of the time constant τ
——————— Mean value
- - - - - - - - Scatter

$\tau = 60$ min

Curves of temperature

of secondary thermal relays type ST

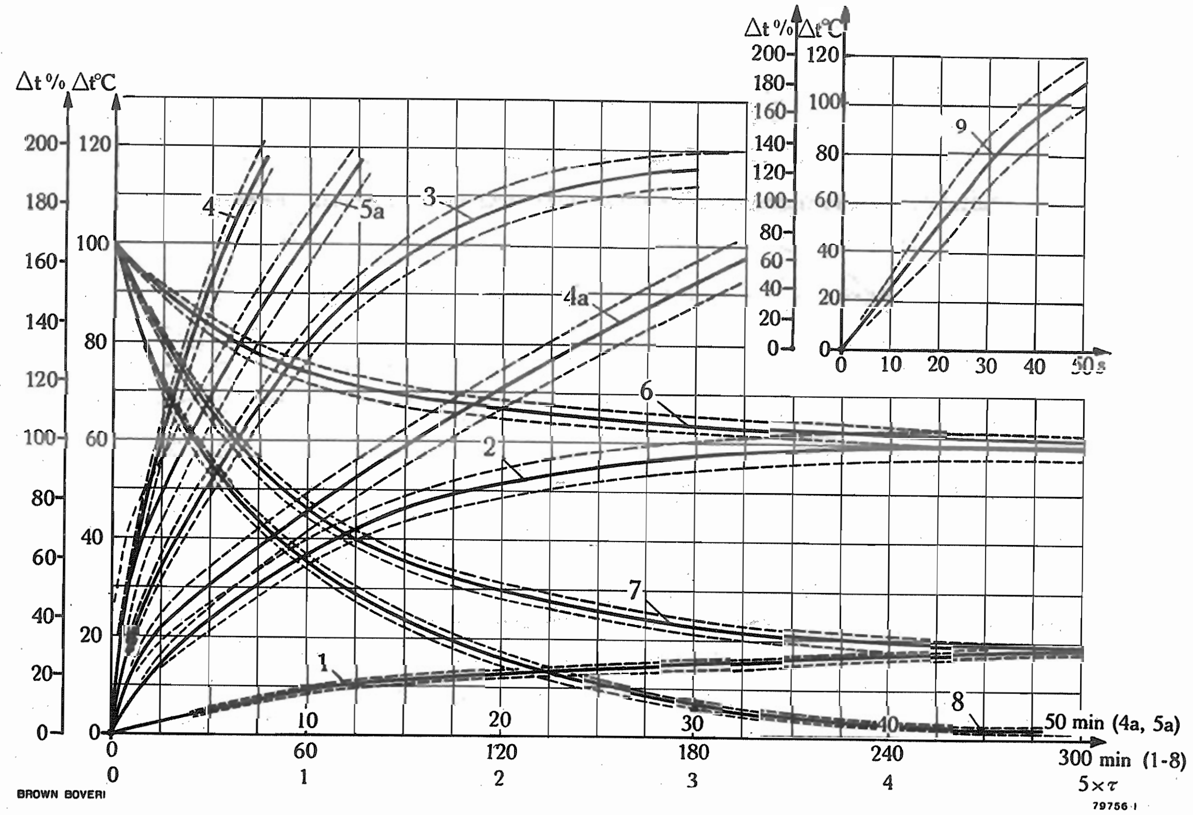


Fig. 9. Time constant $\tau = 60$ min

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rise and decrease

Steady-state rise for set current = 60°C

$\tau = 80$ min

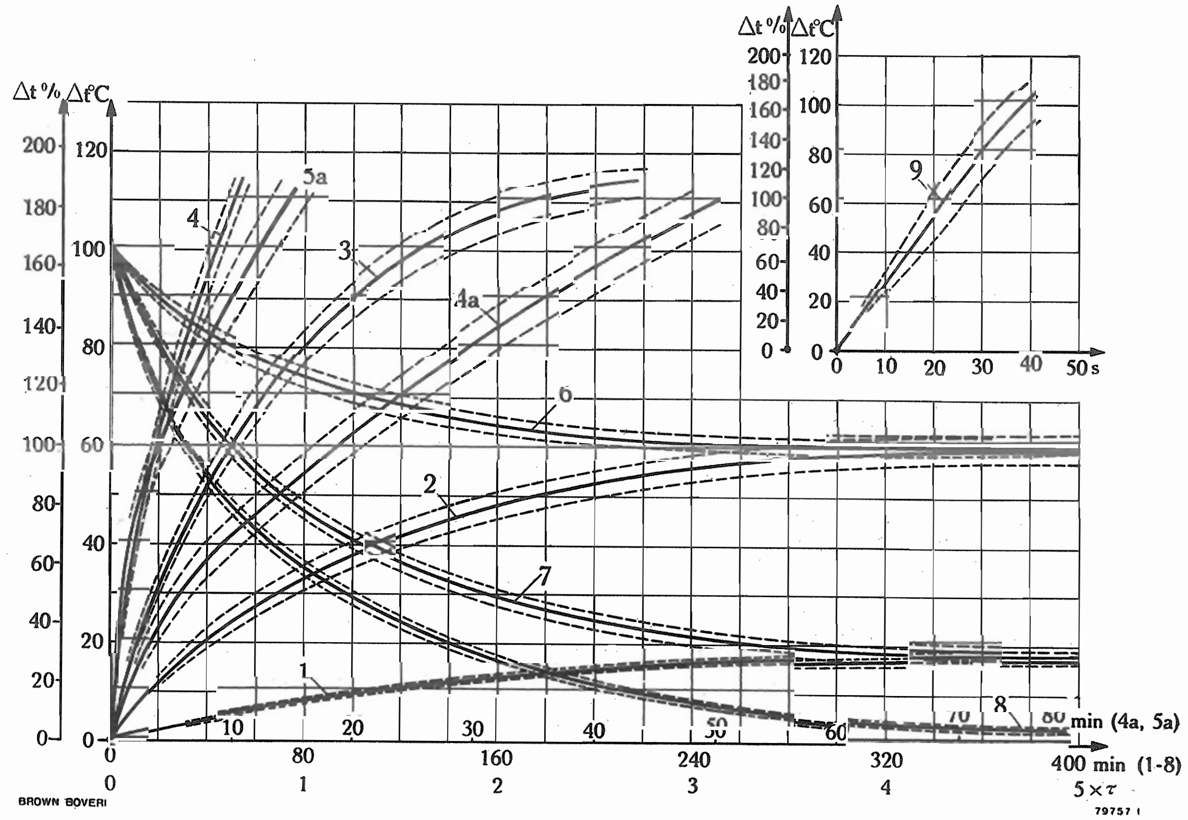

Fig. 10. Time constant $\tau = 80$ min

Legend:

1	Curve of temperature rise for 0,5 × I_E	6	Cooling curve when fed with 1 × I_E
2	Curve of temperature rise for 1 × I_E	7	Cooling curve when fed with 0,5 × I_E
3	Curve of temperature rise for 1,5 × I_E	8	Cooling curve when relay dead
4	Curve of temperature rise for 2 × I_E	9	Curve of temperature rise for 6 × I_E
4a	Curve of temperature rise for 2 × I_E		
5a	Curve of temperature rise for 3 × I_E		

The cooling curves are plotted with an initial temperature rise of 100° C (relay with degree scale)

The following are plotted:

Ordinates: Temperature rise $\Delta t\%$ for relays with % scale
Temperature rise $\Delta t°$ C for relays with ° C scale

Abscissae: Time in min for curves 4a and 5a
Time in min for the other curves
Time as multiple of the time constant τ

———— Mean value

- - - - - - - - Scatter

$\tau = 110$ min

Curves of temperature rise and decrease

of secondary thermal relays type ST
Steady-state rise for set current = 60°C

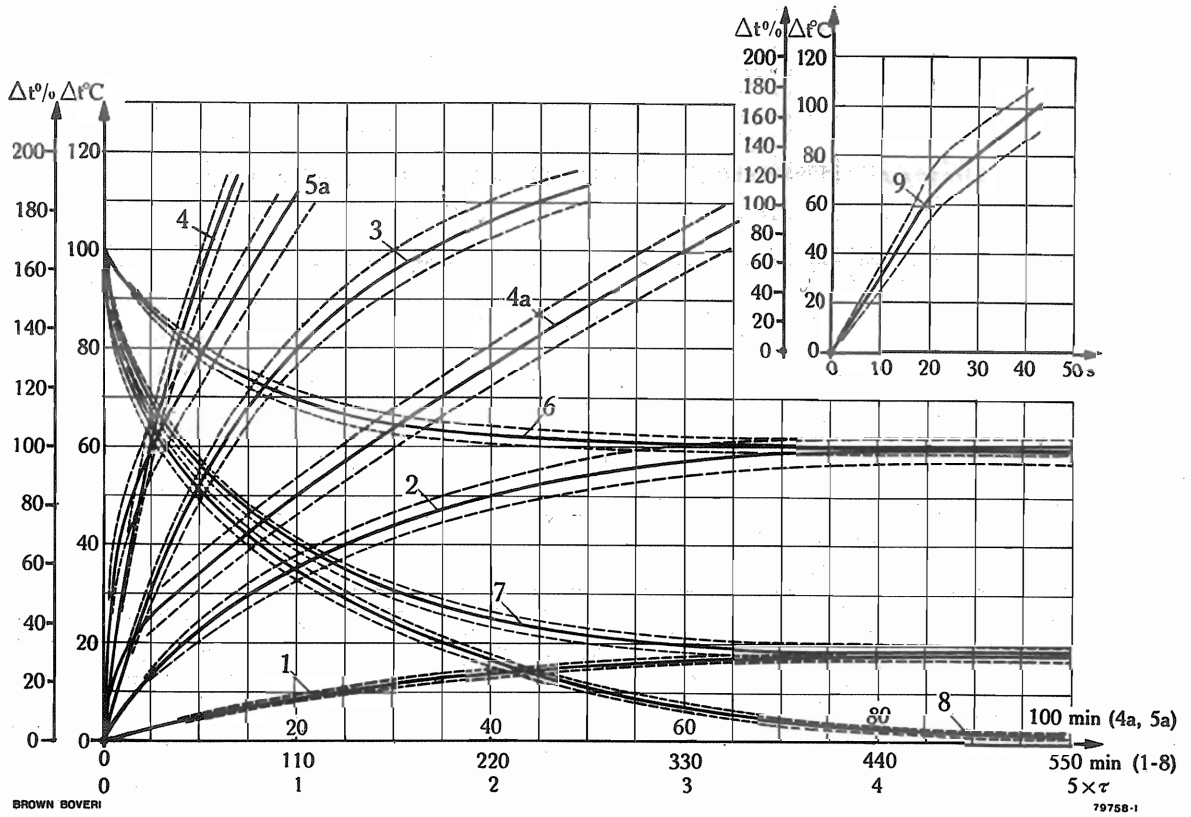

Fig. 11. Time constant $\tau = 110$ min

Legend:

1 Curve of temperature rise for 0,5× I_E
2 Curve of temperature rise for 1 × I_E
3 Curve of temperature rise for 1,5× I_E
4 Curve of temperature rise for 2 × I_E
4a Curve of temperature rise for 2 × I_E
5a Curve of temperature rise for 3 × I_E
6 Cooling curve when fed with 1 × I_E
7 Cooling curve when fed with 0,5× I_E
8 Cooling curve when relay dead
9 Curve of temperature rise for 6× I_E

The cooling curves are plotted with an initial temperature rise of 100° C (relay with degree scale)

The following are plotted:

Ordinates: Temperature rise Δt% for relays with % scale
Temperature rise Δt °C for relays with °C scale
Abscissae: Time in min for curves 4a and 5a
Time in min for the other curves
Time as multiple of the time constant τ
———— Mean value
- - - - - - - - Scatter

If the curve of the temperature rise of the relay is to be predicted for a definite load programme, an approximate value can be obtained by combining the various temperature rise curves (see Fig. 12); the exact value is determined in practice by carrying out a trial.

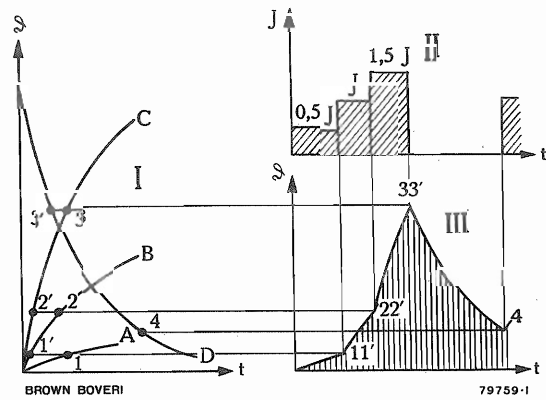

Fig. 12
Determination of the final temperature rise

Legend:

I Curves of rise and fall of temperature
II Load diagram
III Temperature rise diagram
A Temperature rise curve for relay at 0·5× I_E
B Temperature rise curve for relay at 1·0× I_E
C Temperature rise curve for relay at 1·5× I_E
D Cooling Curve of the relay when dead

To approximately determine the time taken by the relay to trip with a certain load programme, the temperature rise curves are plotted for the particular programme, as shown in Fig. 12, and the tripping time is obtained in the abscissa, where the resultant curve intersects the horizontal of the set temperature for tripping. For this the scatter bands indicated in Fig. 6–11 must be observed, as well as exceeding the pick-up temperature rise by a slight amount, as will be explained below.

When the pick-up temperature rise has been reached, the measuring system has to produce the force needed to actuate the contact. Since this is performed by a tip action, the force used is quite small, but it creates a certain thermal stagnation in the very sensitive measuring system, which can amount to a few degrees.

To judge the settings and the resultant tripping times it must be appreciated that the thermal behaviour of the protected object can in most cases only be stated with fairly large tolerances, depends on external influences, also that the danger limit from the thermal aspect cannot be sharply defined.

Fig. 13 shows the tripping curves for the secondary thermal relay type ST with different time constants, calculated from the cold state, i.e. with no initial load. These curves apply for the exact correction of the zero and current setting (see page 15).

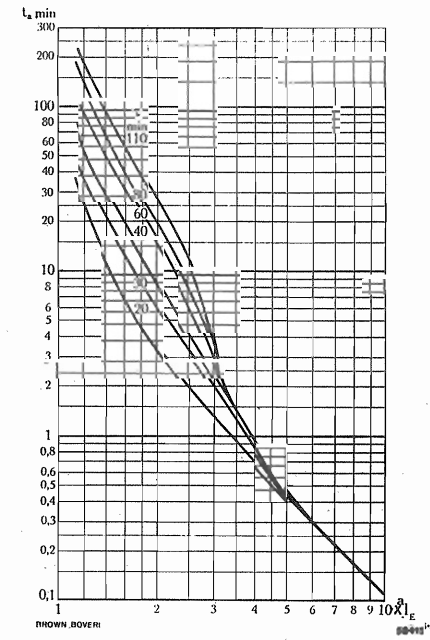

Fig. 13

Tripping times t_a of the secondary thermal relay type ST as a function of multiples of the set current I_E for different time constants of the relay (in min) from cold. Pick-up temperature rise = steady-state rise at I_E

Legend:

t_a Tripping time
a Multiple of the set current I_E

Instantaneous limit-current trip

The limit-current trip functions independently of the thermal part of the relay. It comprises an electromagnet energized by the relay current. Its pick-up current is selected by turning the setting scale (Fig. 3, page 5). For setting ranges see table of technical data and chapter E, Special designs (pages 25 and 16).

When the set maximum current is exceeded, the limit-current trip picks up and actuates the trip contact 1 (Fig. 3); at the same time the heater element is short-circuited to protect it against the overload (contact e in Fig. 2). The instantaneous limit-current trip contact may be a normally-closed or normally-open contact. On the position ∞ an auxiliary contact is actuated, rendering the limit-current contact ineffective. The heater element is nevertheless shorted out at the maximum pick-up value on the setting scale (e.g. 10× set current) and protected against damage, provided the current is not more than 180 A. When the limit-current trip is being used, the feeding current transformer should have an overcurrent rating not less than the pick-up value of the limit-current trip (for short-circuit currents over 180 A see chapter E, page 17).

The normal range for limit-current setting with a normally-open contact is 3–10 × I_E, with a normally-closed contact 4–10 × I_E and ∞.

When the limit-current trip picks up, a red signal button appears.

Front plate

The front plate carries the scales for setting the pick-up temperature rise and indicating the rise of the relay, together with the setting and indicating gear (Fig. 3). On normal relays the setting scale is calibrated in °C and marked 20–120°C Δt; the temperature rise is indicated between 0 and 120°C Δt.

The point 60° Δt, the steady-state rise at the set current, is specially marked. (For other scale markings see under special designs, pages 16 and 18).

For protected objects whose steady-state temperature rise does not amount to 60°C, we recommend the use of the special design type STc (see page 16). The setting scale in this case is calibrated in % and marked 40–200% Δt; the temperature rise is then indicated between 0 and 200% Δt. The point 100% Δt, the steady-state rise at the set current is then specially marked.

Signals

For the normal design the pick-up signal k for thermal trip is marked "Δt°C", the signal c for the limit-current trip being marked "x $I_{60°}$". These signals consist of a red disc which appears behind a window in each case. They can be reset from outside the relay without opening the casing, by pressing the button a (Fig. 1) at the side of the casing. The signal for thermal trip can only be reset when the relay has cooled down sufficiently.

Contacts

The normal design has normally-open contacts for both thermal and limit-current trip. Both are of silver; they are intended to function independently. For designs with normally-closed contacts see chapter E, Special designs (page 16).

Casing and terminals

The relay is supplied with a dust-tight casing enamelled matt black and has a front glass through which the front plate with the pick-up signals and test terminals are easily visible (Fig. 1). The terminals for connecting the leads are at the rear. By displacing the mounting frame the relay can be modified for flush or surface mounting.

If on a surface-mounted relay it is desired to have the terminals at the front, an additional mounting frame with a terminal block has to be used (see dimension drawing, page 35); this is screwed to the relay and contains the connections between the normal terminals at the rear of the relay and those on the front of the frame. The screw for closing the cover can be sealed.

The terminals are suitable for wires up to 3·5 mm diameter. If the relay has to be mounted on a panel more than 6 mm thick, with rear connection, extended terminals can be supplied against an extra charge.

D. Settings on the Thermal Relay type ST

Time constant

The time constant τ of the relay is the time in minutes taken by the relay to reach 63% of the steady-state temperature rise from cold when supplied with the set current (see page 6).

(a) Choice of time constant:

It should be roughly equal to or slightly less than that of the protected object, in order that the temperature rise of the relay may take place at the same rate or slightly more quickly than that of the object. Since the time constant for the rise in temperature of technical equipment can only be determined with a fairly large tolerance, the approximate match by the relay is quite adequate. When there are several successive objects, each with a different time constant, (e.g. cable feeders connected to motors), the relay should be adapted to the smallest time constant.

If there is no information available regarding the time constants of the protected object, the values can be obtained with sufficient accuracy from the tables on pages 26/27.

(b) Setting the time constants:

The desired time constant is set on the relay before it leaves the works and is inscribed on the front plate, bottom right. The time constant of the relay can be varied in steps of 20, 30, 40, 60, 80 and 110 min, by combining different numbers of metal plates of various thicknesses in the heat carrier.

(c) Measuring the time constants and the steady-state temperature rise of the protected object:

If in special cases the time constant is to be determined for a machine or cable carrying full-load current, the curve of the temperature rise of the copper should be plotted against time at full current by a suitable means. The time constant is then the time in which 63% of the steady-state temperature rise is attained (Fig. 4 on page 6).

The steady-state temperature rise of an object with a large time constant can be determined by the following time-saving construction (Fig. 14). Feed the protected object with full-load current and measure the temperature rise $\Delta\vartheta$ at equal intervals t'. As shown in Fig. 14, plot the temperature rise perpendicular to the ordinates. On joining the points A_1, A_2, and so on, a straight line is obtained which intersects the vertical axis at the desired value of the steady-state rise ϑ_∞.

The steady-state figure is usually reached after about four times the time constant.

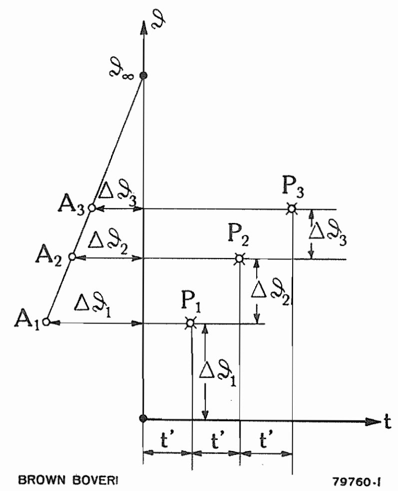

Fig. 14

To determine the steady-state temperature rise

P_1—P_3 Measured points

Set current

The set current I_E raises the ralay to its steady state temperature of 60°C above ambient (or 100% for relays with percentage scale, type STc) or 40°C for relays with a special Centigrade scale (see page 18). It can be adjusted between 4 and 5 A and is marked on the relay with $I_{60°}$ or $I_{100\%}$, etc.

This current setting must correspond to the maximum admissible sustained current for the protected object. If the c.t. secondary current corresponding to this is between 4 and 5 A, the relay may be set accordingly. If it outside this range, an extra auxiliary c.t. must be used (see chapter I, Accessories, p. 21).

If the order lists all the information required for the protected object and current transformers, as shown on page 22, the appropriate current setting is adjusted in the factory and noted on the front plate of the relay, together with the ratio of the c.t.

Examples of how to determine the current setting:

Example 1:

Rated current of generator	87 A
Transformation ratio of c.t.	100/5 A
Steady-state temp. rise of object	70°C
Relay scale chosen (type STc)	0–100–200%
Rated secondary current	87 × 5/100 = 4·35 A
Setting resistor of relay set to	I_E = 4·35 A

Thus, at full-load current of the generator the relay shows a temperature rise reading of 100%

Example 2:

Rated current of motor	70 A
Transformation ratio of c.t.	100/5 A
Steady-state temp. rise of object	60°C
Relay scale chosen	0–60–120°C
Rated secondary current	70 × 5/100 = 3·5 A

In this case an auxiliary c.t. with a ratio of 3·25/4 (see page 21) has to be provided and the setting resistor adjusted to
70 × 5/100 × 4/3·25 = 4·3 A.

Pick-up temperature rise

The pick-up temperature rise is set about 5°C higher, but not more than 10°C higher, than the steady-state rise of the protected object at the set current. Thus with normal calibration at 60°C this means 65–70°C; with percentage setting (relay type STc) with 100% as steady-state figure, it means 110–120%. For this setting pull off the reset knob i and turn the slotted shaft till the pointer b (Fig. 3) is on the desired setting of the pick-up temperature rise.

Instantaneous limit-current trip

The normal setting range of the relay is 3–10 times the set current and ∞ for limit-current trip with a normally-open contact; when set to ∞ the limit-current trip is blocked. The set pick-up value for the limit-current trip must be less than the minimum short-circuit current likely to be experienced at the relay and yet above the highest service current which may occur.

To protect motors with starting current peaks of brief duration exceeding $10 \times I_E$, a special design may be used (see chapter E).

E. Special Designs

Type STa

Other setting ranges for the limit-current trip:

- 2–$6 \times I_E$ and ∞ for normally-open contact
- 3–$6 \times I_E$ and ∞ for normally-closed contact
- 4–$12 \times I_E$, also a point at $15 \times I_E$, and ∞ for both normally-open and normally-closed contacts.

The type with a range up to $15 \times I_E$ is for use with motors whose starting current surge can reach such a high value. (Most motor manufacturers normally quote the locked-rotor current at normal frequency as starting current. But when the motor is switched on, a brief peak due to the build-up of the field must be added to this.) At a current of $12 \times I_E$ the relay is just capable protecting itself against overheating, without the heater element being damaged. A setting of the limit-current trip above this figure is therefore unsafe for the relay, unless only peaks lasting a few half-cycles are involved.

Type STb

Without compensation for ambient temperature:

The relay has a Centigrade scale from 0–120°C. When ordering, do not state the admissible temperature rise above ambient, but the actual temperature in °C and the current which produces this temperature. The pick-up temperature should then be set 5–10°C higher.

With this design the lower bearing of the measuring system is carried by a steel tape instead of a bimetal strip. The relay no longer indicates the temperature rise above ambient but the actual temperature. In order to secure agreement between the temperatures of the relay and the protected object with this design, it is necessary for both to be exposed to the same ambient. When dead, this relay indicates the ambient temperature.

Type STc

With percentage scale:

For protected objects whose steady-state temperature rise is not 60°C it is advisable to choose secondary thermal relays with a percentage scale from 0–100–200% Δt. The steady-state rise for the current marked $I_{100\%}$ is then 100%. In this way it is possible to compare the extent to which advantage can be taken of the thermal properties of protected objects having different steady-state rises in the same installation.

Type STd

For frequencies below 40 c/s:

For frequencies of 16⅔ and 25 c/s the relay can be specially calibrated, but in this case no limit-current trip is incorporated.

Type ST (without suffix, specially calibrated)

For frequencies from 60 to 500 c/s:

The range of the set current and limit-current trip differ slightly from the normal design; the consumption is also a little higher. Depending on the particular frequency, this information is obtainable on application, when required.

Connection of the contacts (Types STe, STf, STh, STi, STm, STn, STp, STq, STr)

If the limit-current and thermal trips are both connected to the same battery, the standard design type ST or STq should be used, depending on whether it is "energize to break" or "de-energize to break". The test plug then interrupts both trip circuits or shorts them out.

If two different batteries are used, the limit-current trip to disconnect the object, the thermal trip only for signalling, use the types STf, STi, STm and STn. In this case the test plug only interrupts or shorts out the limit-current trip.

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Alternative connections in which the test plug only interrupts or shorts out the thermal trip are the types STe, STh, STp and STr.

With these variants it should be remembered that in all types in which the limit-current trip coil actuates one normally-closed and one normally-open contact (i.e. the types with suffixes i, m, h, p, q and k), the limit-current trip has a range corresponding to the type with a normally-closed limit-current trip contact.

Normally-closed contacts are used wherever a circuit-breaker is equipped with no-volt release, or the signals are given by de-energizing the circuit. The normally-closed limit-current contact can also be used to a limited extent for current transformer tripping (see page 20).

Connection of the contacts

Auxiliary supply	Use of relay trip circuit	Thermal trip: de-energize (noc)	Thermal trip: energize (ncc)	Limit-current trip	Limit-current trip	Test plug blocks	Relay type
Common	Limit-current and thermal tripping of breakers	x		x		both relay trip circuits	ST
			x		x		STq
Separate	Limit-current tripping of breaker	x		x		only limit-current trip circuit of relay	STf
			x	x			STn
	thermal trip for signalling	x			x		STi
			x		x		STm
	Thermal trip for breaker	x		x		only thermal trip circuit of relay	STr
			x	x			STe
	limit-current trip for signalling	x			x		STp
			x		x		STh

noc = normally-open contact ncc = normally-closed contact

Type STg

For use on d.c.:

The relay is constructed in the same manner as for a.c., but the limit-current trip can only be supplied for a range of $1{\cdot}5$–$4 \times I_E$ and ∞. In this case the limit-current trip should only be used when, in the event of a short circuit, the relay causes the protected object to be disconnected without the assistance of a time-lag element. The relay is connected to a shunt or in parallel with a winding of the protected object (e.g. an interpole winding). The voltage drop at the relay, referred to the set current, is 1·75–1·85 V; to this must be added the drop in the leads to the relay.

If, when the relay is connected to a machine winding, the current in the latter varies frequently and abruptly, or if the current is supplied by rectifiers, a suitably dimensioned choke must be connected before the relay, thereby making the electric time constants of the machine winding and the relay circuit equal to one another. By this means a rapid change in the current or ripple cannot increase the share of the current in the almost completely non-inductive relay circuit, which might cause a disproportional temperature rise in the latter, even tripping the relay.

When the secondary thermal relay is connected to a d.c. transformer, the relay calibrated for 50 c/s should be used. Type STg should only be used when a rectifier is connected in series.

Type STk

For short-circuit currents higher than 180 A.

Since at such heavy currents the contact of the limit-current trip which short-circuits the heater element tends to weld, an auxiliary current transformer and current limiting resistor have to be used (as shown in the circuit diagrams, pages 33 and 34). This enables the relay to withstand short-circuit currents up to $70 \times I_E$.

The contact e of the limit-current trip (Fig. 3) is normally-closed in this case and switches on the limiting resistor, thus saturating the auxiliary c.t. and limiting any further rise in the current. The auxiliary c.t. can be used at the same time for adapting the secondary current of the main c.t. to the set current of the relay. If this is unnecessary, it is given a 1:1 ratio. For this task only the special model type SB 0·5 (page 21) may be used, otherwise we cannot guarantee proper functioning, particularly by the limit-current trip, nor that the relay will be able to withstand the short-circuit current.

The short circuit in this case must be cleared and the protected object disconnected either by the limit-current contact or by some other quick-acting means of short-circuit protection. The setting range of the instantaneous limit-current trip is the same as for the normally-closed limit-current contact.

Type STs

Design with special scales:

(a) Scale with special Centigrade calibration:
Primarily for use with cables, a special scale calibrated between 0 and 80°C can be provided. The steady-state temperature rise at the set current is 40°C in this case.

(b) Scales allowing for temperature rise due to iron losses:
The thermal relay is only fed by the current carried by the protected object. Since the ambient temperature is compensated in the standard design, it reflects the temperature rise of a conductor relative to its surroundings. The indication for cable, for example, is therefore correct over the entire range of the scale and corresponds to the difference between the temperature of the cable and transformers, however, the iron losses in most cases cause a basic temperature rise, which is usually known, and which superposes itself on that of the winding (Fig. 15). Since the thermal relay is set in the station in such a manner that its temperature rise at full-load current is the same as that of the winding, the reading is correct in the region of full load. Its protective action is based on this property. Below the temperature rise for rated load the reading is somewhat low, above rated load it is too high, as shown in Fig. 15.

Theoretically, a second source of heat, connected to the mains voltage could also be used to simulate the iron losses in the relay and thus eliminate the error in the reading. The same goal can, however, be attained much more easily if the scale on the relay does not start at zero, but at the no-load temperature rise, and is appropriately calibrated (Fig. 16 and 17). Of course, the relay always indicates the no-load rise when the machine is switched off, but this slight blemish is not very disturbing, as protection and indication of the temperature rise are no longer interesting when the machine is switched off.

Three different scales are available:
1. Graduated 20–100°C, reads 20°C when disconnected.
2. Graduated 30–90°C, reads 30°C when disconnected.
3. Graduated 40–80°C, reads 40°C when disconnected.

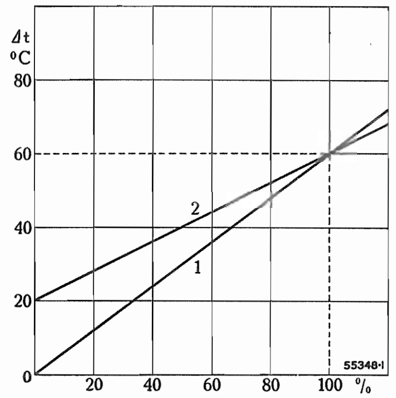

Fig. 15
Temperature rise of conductor in terms of iron losses
1 Without initial rise due to iron losses
2 With initial rise due to iron losses

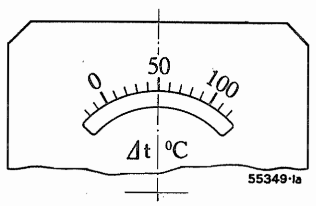

Fig. 16
Temperature scale **without** correction of iron losses

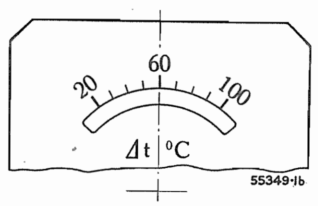

Fig. 17
Temperature scale **with** correction of iron losses
The iron losses are also taken into account by specially calibrating the scale

F. Table of Type Designations

Normal design designated ST
Special designs (see chapter E)

Design	Suffix to type	Specification
Limit-current trip Supply	a, d, g (no suffix)	a = other range for limit-current trip (see also chapter E) d = for frequencies below 40 c/s g = for use on d.c. .. = (no suffix) for frequencies > 60–500 c/s
Temperature indication	b, c, s	b = without compensation of ambient changes c = percent scale s = special Centigrade scale, or allowance for iron losses
Connection of contacts	e, f, h, i, m, n, p, q, r	see Table on page 17
Short-circuit strength	k	k = design for increased short-circuit strength (for short-circuit currents over 180 A)

For possible combinations see page 25 (Weights and Prices)

G. Application

Choice of scale

Generally speaking, the temperature rise in itself is not so interesting as the state of the load on the protected part of the installation. In this case the percentage scale (type STc) may be chosen with advantage. This enables the extent to which the equipment is utilized thermally to be read off direct. It is also most valuable when objects having different maximum permissible steady-state temperature rises are protected, e.g. motors and cables. Apart from the scales being identical, they also show the same reading when the thermal utilization is the same for both elements.

If the Centigrade reading is desired, choose a scale calibrated in °C.

Determining the number of relays per circuit-breaker

The decision regarding the number of thermal relays to be provided for a particular protected object is governed by the symmetry of the load in service.

One thermal relay is adequate if the current is normally reasonably symmetrical. It then acts solely as overload protection. For protection against short circuits, supplementary relays, e.g. overcurrent-time relays or distance relays, are required. In power systems with an insulated neutral, for instance, a thermal relay in one phase is used as overload protection, with overcurrent relays in the other two phases as short-circuit protection.

Two thermal relays per breaker are used in systems with insulated neutral or where the neutral is impedance-earthed, in which case they act as combined overload and short-circuit protection. The limit-current contacts as short-circuit protection actuate the breaker direct or through a time-lag element. The thermal contact may either be used for signalling or tripping in parallel with the limit-current contact.

Three thermal relays should be provided to each breaker when large objects are being protected, where unbalanced loads can be expected in normal service, and in systems with solidly earthed neutral, in which case the relays act as combined overload and short-circuit protection. Before load circuits the limit-current trip is allowed to act briefly on the breaker trip circuit, either direct or through a time-lag relay type MLT (price list AB 372), thereby providing an arrangement corresponding to the normal overcurrent-time protection (see diagram of connections on page 28).

Limit-current trip

The limit-current trip is intended for protection against short circuits. In cases where there is no need for graduation of the tripping times, it can act on the breaker trip coil direct. This applies, for example, to motors which, as power consumers, are the natural ends of the distribution lines.

If time graduation is necessary, the limit-current trip must actuate a time-lag relay type MLT, which in turn actuates the trip coil of the breaker.

Short-circuit strength

Since the ability of the relay to resist short circuits is restricted, it is preferable to install the secondary thermal relay at points in the system where only limited short-circuit currents are likely to be experienced. This is true, for instance, of transformers with unilateral infeed; in this case the thermal relay should be installed on the load side. Similarly, with generators and synchronous capacitors, it is preferable to connect the relay to current transformers at the neutral.

When the short-circuit current is more than 180 A, we recommend the use of the relay type STk (see page 17).

Undervoltage trip

When undervoltage trip is employed (de-energize to trip), the limit-current contact should be normally-closed. This form of trip is used when there is no auxiliary supply to energize the breaker trip coil, i.e. at the instant the normal supply fails.

The thermal contact does not normally need to be operated in this manner, because overload does not represent a fault in which the voltage collapses. If the thermal contact has to actuate the no-volt release of a breaker, it should be normally-closed (type STq).

Current transformer trip

The normally-closed limit-current contact can be used for retarded current transformer trip provided the current does not exceed 75 A. This limitation of the current must be effected on the primary side by the fact that such a heavy current is not likely to occur, or on the secondary side by appropriate design or loading of the current transformers, so that their secondary current cannot exceed this figure.

The normally-closed thermal contact is unsuitable for this kind of tripping. But since there is no likelihood of the supply failing when the thermal trip picks up, the normally-open thermal contact may be used for series trip with a.c.

When these solutions cannot be considered, the supplementary device type J2 or J3 must be used, according to whether the c.t. trip is single- or three-phase. In this case the relays must have normally-open contacts (see page 21).

Protection of machines with special cooling

When protecting machines with variable cooling (e.g. generators in which the hydrogen is switched on in stages, transformers with forced-draught cooling switched on by thermal action), the permissible sustained current of the machine varies according to the change in cooling.

On the relay, these different currents must always correspond to the same relay setting. To ensure that this is so, auxiliary current transformers must be used, the tappings on which are automatically or manually changed over when the cooling changes, care being taken to change without interrupting the circuit.

Protection of machines for short-time loading
(e.g. starting motors of gas turbines)

The correct type of thermal relay and current transformer is determined as follows: The rated current of a starting motor is considered as the permissible sustained current during the short operating period t_a. This time can be the duration of a single start, or the time during which a fixed, limited number of successive starts take place.

In any case, at this rated current the relay must just receive so many times the set current that its temperature rises by 60°C or 100% in the time t_a, depending on the scale. In the curves in Fig. 13 (page 13) these times for the relay are plotted in terms of multiples of the set current. From them a multiple a times the set current should be taken for a time t_a for a particular relay. The ratio of the c.t. must then be $I_N : a\,I_E$, where I_N is the secondary motor current referred to above and aI_E is the necessary multiple of the setting of the relay. Since the set current I_E must be between 4 and 5 A, the c.t. ratio required must lie between I_N : 5a and I_N : 4a, or between 1.25 I_N : 5a and I_N : 5a.

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Example:

We are given:
I_N = 250 A, rated motor current
t_a = 420 s, starting period of the motor
Δt = 80°C, permissible temperature rise of the motor (corresponding to Δt = 100% for relays with 0–200% scale)
τ = 60 min, time constant of the motor

The thermal relay is assumed to have a time constant of 60 min.

For t_a = 420 s we find a = 2·44 from Fig. 13 (page 13).

The primary current setting I_E = 250/2·44 = 103 A.

Therefore the ratio of the c.t. must be between the limits 103 : 5 A and 1·25 × 103, i.e. 129 : 5 A. Supposing 125 : 5 is chosen, the set current of the relay works out to I_E = 103 × 5/125, i.e. I_E = 4·1 A. Thus the relay attains the temperature rise of Δt = 100% at a motor current of I_N during the period t_a when set to 4·1 A. The pick-up temperature is set to 100% or slightly higher.

H. Testing

The relay is equipped with test terminals g (Fig. 3, page 5) by means of which it can be tested in situ with a test set at regular intervals, without the normal service connections having to be undone during the test. The relay is prevented from tripping by turning the screw plug in the appropriate manner, thereby short-circuiting the current transformer. For this purpose a test plug is provided on relays with thermal and limit-current trip normally-open contacts for connection to a common source of auxiliary supply (for connection see Fig. 2, page 5), enabling both tripping circuits to be interrupted simultaneously and the c.t. short-circuited. In the relay type STq with normally-closed thermal and limit-current trip contacts for connection to the same source of supply, there are two test plugs. The one shorts out the two relay contacts, the other the current transformer. Likewise in all alternative connections for use with separate sources of supply, with thermal and/or limit-current trip contacts (normally-closed) and where the screw plug blocks the contact from opening, there are two plugs.

In all circuits for use with separate sources of supply it is only possible to test either the thermal or the limit-current trip circuit, which must be taken into account when selecting the connection of the relay (see Table on page 17).

When the two links p (Fig. 2 and 3) have been disconnected, the relay can be supplied from a test set connected to the two inner terminals. For this the Brown Boveri test set type CB (see price list AB 393) is particularly suitable.

In many cases the test equipment incorporated in the switchboard can be used, but then no manipulations must be carried out on the relay itself.

I. Accessories

Auxiliary current transformer

If the c.t. secondary current is not between 4 and 5 A when the primary current is the thermally permissible sustained current of the object, it is necessary to use a special auxiliary current transformer type SB 0·5 For currents between 3·25 and 4 A, and 5 and 6·25 A a special c.t. is stocked having alternative ratios of 3·23 : 4 or 6·25 : 5 A. It enables the input ranges of 3·23–4 A or 6·25–5 A to be employed, which are the most usual ranges necessitating an auxiliary c.t. For other currents the auxiliary c.t. must be designed to produce a secondary current of 4·5 A.

An auxiliary c.t., possibly with a 1 : 1 ratio, must be used when the relay type STk with increased short-circuit strength is employed. This c.t. must be accurately matched and may not be used without the resistor (see also page 17). This auxiliary current transformer type SB 0·5 for use with the thermal relay type ST is auto-connected (consumption appr. 3 VA).

Resistor

When the relay type STk is used, a resistor type TDv 2/100 with 2 parallel 5-ohm elements is required to limit the current.

Series choke

A series choke is needed when the relay type STg is connected to a winding of a machine in which the current changes rapidly (for further details see page 17). One choke is required for each relay type STg. The calculation of its rating has to be individually performed for every case.

C. T. trip unit

Type J2 and J3 (see chapter G), details on application.

Ordering Instructions

In order to avoid unnecessary correspondence, the order should contain the following information:	Example
A. For the relay	
1. Quantity	6
2. Brown Boveri designation	secondary thermal relay
3. Type (with suffix)	STs
4. Rated frequency	50 c/s
5. Time constant	30 min
6. Circuit diagram (see p. 29–34)	AK 420302
7. Details of casing and terminals	flush, rear connection
8. Special installation details (e.g. for relays for fitting in panels more than 6 mm thick)	–
9. Special designs	calibration 20–100°C to allow for iron losses
B. For the protected object ①	
10. Nature of the object	transformer
11. Rated current	70 A
12. C. T. ratio	100 : 5 A
13. Resistance of shunt, or machine winding used as shunt ②	–
14. Inductance of machine winding ② ③	–
C. For auxiliary current transformers ④	
15. Quantity	6
16. Brown Boveri designation	auxiliary c.t.
17. Type	SB 0·5
18. Ratio	3·25 : 4 A
D. For the current-limiting resistor	
19. Quantity ⑤	–
20. Type	–
E. For the series chokes	
21. Quantity ② ③	–
22. Type	

Remarks:

① If the information under 11 and 12 is stated, the relays will be set in the factory and the scale inscribed with the ratio of the associated c.t. and the current setting.

② Only required for type STg.

③ Only required when the load varies rapidly in service, i.e. with frequent load surges, or currents from rectifiers.

④ Only required when the secondary current of the main c.t. at the maximum admissible service current of the protected object is not between 4 and 5 A, or when relay type STk is used.

⑤ Only required for type STk.

Technical Data

Rated current	5 A
Setting range of current for steady-state temperature $\Delta t = 60°C$ (corresponding to 100%)	4–5 A
Frequency	40–60 c/s
Short-circuit strength for $< 0·3$ s	$40 \times I_E$
Time constant, variable	20, 30, 40, 60, 80, 110 min
Pick-up temperature, variable	0–120°C
Limit-current tripping at	$3–10 \times I_{60°}$ or blocked
Scatter as % of pick-up current	± 10%
Tripping times in terms of current	see Fig. 13 (page 13)
Delay after thermal trip, before reclosure is possible	1–20 min, depending on the thermal time constant of the relay, initial load and magnitude of the overload ①
Consumption (p.f. = 1) at 4 A / at 5 A	7·2 VA / 9 VA

Contact ratings:			Thermal	Limit-current
(a) Normally-open contact				
On closing				
D.C. or A.C.		up to 220 V	10 A	10 A
On opening				
D.C.	inductive	110 V	0·3 A	0·5 A
D.C.	inductive	220 V	0·2 A	0·3 A
A.C.	inductive	220 V	10 A	10 A
A.C.	inductive	380 V	5 A	5 A
(b) Normally-closed contact				
Sustained current			1 A ②	10 A
On closing				
D.C. or A.C.		up to 220 V	2 A ②	10 A
On opening				
D.C.	inductive	110 V	0·3 A	0·5 A
D.C.	inductive	220 V	0·3 A	0·3 A
A.C.	inductive	220 V	1 A ②	10 A
A.C. short-time for c.t. trip			—	75 A

Remarks:

① If necessary, the thermal relay can be made to fall back at once by raising the pick-up temperature rise by about 10°C; on expiry of a suitable period, it must be restored to its original setting.

② Only for no-volt trip with a.c.

Secondary thermal relay type ST

Flush or surface mounting, rear connection, time constant 20 min

Weights and Prices

Type	Short-circuit strength for < 0·3 s	Circuit diagram No.	Fig.	Contacts and screw plugs: Thermal contact	Limit-current contact	PL No.	Weight appr. kg	Price each
Relay contacts for common auxiliary supply								
ST	180 A	544 d	1	4 — 3 — 6 (91530-I)		AB 323 01	3,55	
ST q	180 A	544 d	3	3 — 4 (91531-I)		AB 323 02	3,55	
Relay contacts for separate auxiliary supply, screw plug only blocks limit-current trip								
ST f	180 A	545 d	1	3 — 4 (91532-I)	5 — 6 (91534-I)	AB 323 03	3,55	
ST n	180 A	545 d	2	3 — 4 (91533-I)	5 — 6 (91534-I)	AB 323 04	3,55	
ST i	180 A	545 d	3	3 — 4 (91532-I)	5 — 6 (91535-I)	AB 323 05	3,55	
ST m	180 A	545 d	4	3 — 4 (91533-I)	5 — 6 (91535-I)	AB 323 06	3,55	
Relay contacts for separate auxiliary supply, screw plug only blocks thermal trip								
ST r	180 A	546 d	1	3 — 4 (91536-I)	5 — 6 (91538-I)	AB 323 07	3,55	
ST e	180 A	546 d	2	3 — 4 (91537-I)	5 — 6 (91538-I)	AB 323 08	3,55	
ST p	180 A	546 d	3	3 — 4 (91536-I)	5 — 6 (91539-I)	AB 323 09	3,55	
ST h	180 A	546 d	4	3 — 4 (91537-I)	5 — 6 (91539-I)	AB 323 10	3,55	
Relays for frequencies below 40 c/s (no limit-current trip)								
ST dr	180 A	547 d	1	3 — 4 (91536-I)	–	AB 323 11	3,55	
ST de	180 A	547 d	2	3 — 4 (91537-I)	–	AB 323 12	3,55	
Relay contacts for common auxiliary supply								
ST k	280 A	548 d	1	4 — 3 — 6		AB 323 13	3,55	
Relay contacts for separate auxiliary supply, screw plug only blocks limit-current trip								
ST fk	280 A	549 d	1	3 — 4 (91532-I)	5 — 6 (91534-I)	AB 323 14	3,55	
ST kn	280 A	549 d	2	3 — 4 (91533-I)	5 — 6 (91534-I)	AB 323 15	3,55	
Relay contacts for separate auxiliary supply, screw plug only blocks thermal trip								
ST kr	280 A	549 d	3	3 — 4 (91536-I)	5 — 6 (91538-I)	AB 323 16	3,55	
ST ek	280 A	549 d	4	3 — 4 (91537-I)	5 — 6 (91538-I)	AB 323 17	3,55	

Alternative and Special Designs ①

Designation			Suffix to type	PL No.	Extra Weight appr. kg	Extra Price
For surface mounting, front connection			–	AB 323 21	0,7	
Time constant		30 min	–	AB 323 22	0,05	
		40 min	–	AB 323 23	0,15	
		60 min	–	AB 323 24	0,25	
		80 min	–	AB 323 25	0,45	
		110 min	–	AB 323 26	0,55	
Limit-current trip	2–6 × I_E and ∞ (with normally-open contact)		a	AB 323 27	–	none
	3–6 × I_E and ∞ (with normally-closed contact)		a	AB 323 28	–	none
	4–12 × I_E with point at 15 × I_E and ∞		a	AB 323 29	–	none
Without compensation for ambient			b	AB 323 30	–	none
Special scales	Δt % instead of Δt °C (0–200%)		c	AB 323 31	–	
	0–80°C Δt (for cable)		s	AB 323 32	–	③
	to allow for iron losses	20–100°C Δt	s	AB 323 33	–	
		30– 90°C Δt	s	AB 323 34	–	
		40– 80°C Δt	s	AB 323 35	–	
For use on d.c. (only with limit-current trip 1·5–4 I_E and ∞)			g	AB 323 36	–	none
For frequencies > 60 to 500 c/s (special calibration)			–	AB 323 37	–	none
Elongated terminals for mounting in panels 7–56 mm thick for surface mounting			–	AB 323 38	0,1	④

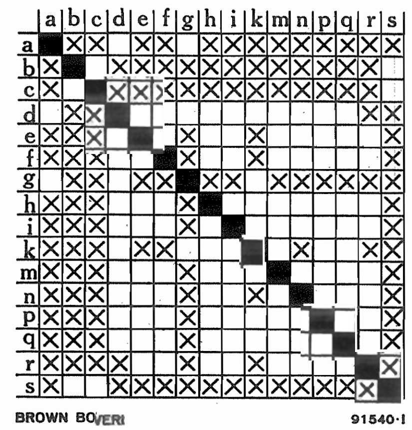
Accessories ②

Designation		Type	Weight and Prices
Auxiliary current transformer to match current		SB 05	Price list A 3–2
Resistor for relay type STk		TDv 2/100	Price list MA 342
Choke for relay type STg		–	on application
C.T. trip unit	two-phase	J 2	on application
	three-phase	J 3	on application

Remarks:

① Notes see page 16

Possible combinations:



x can be combined □ cannot be combined

② Notes see page 21.

③ Reduced extra price when 10 or more relays of the same type ordered at one time:
instead of

④ Reduced extra price when several relays of the same type ordered at the same time:
from 4 instead of
from 8 instead of

Thermal Time Constants of

The following table contains figures giving the approximate

Three-phase motors

Enclosure	Poles	Rating kW	Time constant of relay in min
Drip-proof	2–12	15–400	20
Totally enclosed	2	–70 70–170	30 40
	4	–55 55–400	30 40
	6	–40 40–300	30 60
	8–12	–15 15–250	60 60

Synchronous machines

Type	Time constant of relay min
Salient-pole	20–60
Turbo machines	20–40

Transformers (oil-immersed)

Type of cooling	Rating MVA	Time constant of relay min
Natural	all ratings	80
Forced-draught	15–30	80
	> 30	110
Forced-draught with forced oil circulation	40	110
Water	< 30	80
	> 30	110

Parts of Electrical Installations

magnitude of the thermal time constants of the parts listed

Cable, asphalted and ducted

Cross-section mm²	Thermal time constants											
	Belted cable at service voltage								Hochstaedter cable at service voltage			
	< 1 kV		6 kV		10 kV		20 kV		20 kV		30 kV	
	cable min ①	relay min	cable min ①	relay min	cable min ①	relay min	cable min ①	relay min	cable min ①	relay min	cable min ①	relay min
3× 50	20	20	25	20	34	30	56	40	38	30	42	40
3× 70	20	20	30	30	38	30	61	60	42	40	44	40
3× 95	23	20	36	30	43	40	66	60	47	40	47	40
3×120	27	20	39	30	47	40	70	60	52	40	51	40
3×150	30	30	45	40	49	40	74	60	57	40	53	40
3×185	34	30	49	40	55	40	78	60	64	60	59	40
3×240	40	40	55	40	61	60	83	80	73	60	68	60

Remarks:

① The cable time constants are approximate minimum values.

Circuit diagrams for

Secondary thermal relays type ST

Index:

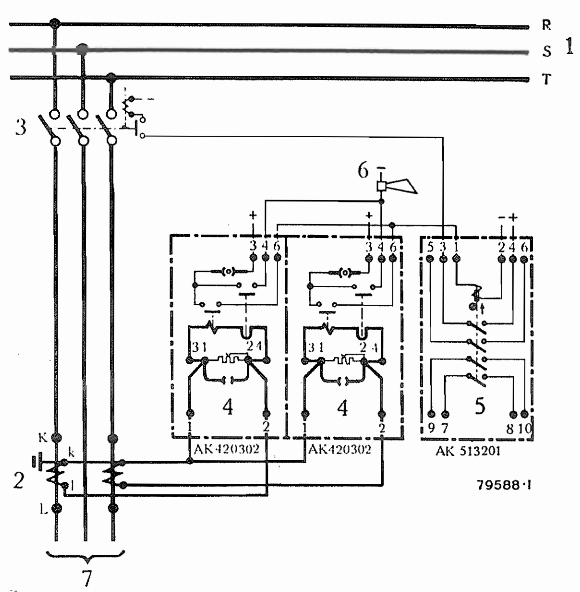


Fig. 19

Example of circuit diagram (AK 420321)
Overload protection with overcurrent time protection
Neutral insulated

Legend:

1 Busbars
2 Current transformer
3 Circuit-breaker
4 Secondary thermal relay type ST
5 Time-lag relay
6 Signalling device
7 To protected object

BROWN, BOVERI & CO., LTD., BADEN, SWITZERLAND

Circuit diagrams for

Secondary thermal relays type ST

Short-circuit current ⩽ 180 A

Common auxiliary supply – Series trip

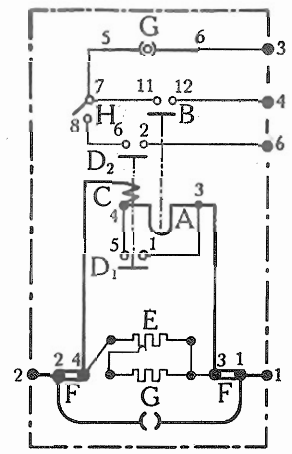


Fig. 1
Type ST (standard design)
AK 420302)

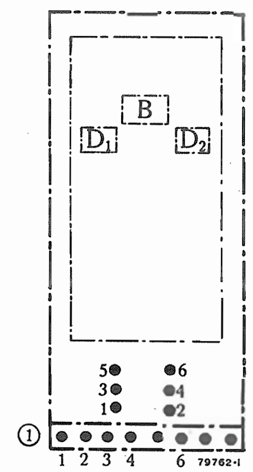


Fig. 2
Front view of Fig. 1

Common auxiliary supply – Undervoltage trip

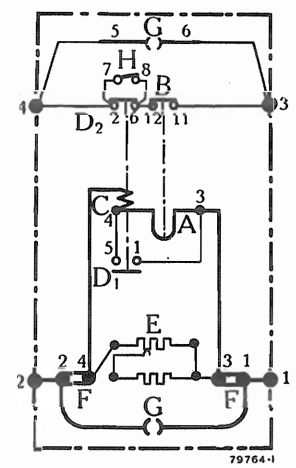


Fig. 3
Type STq
(AK 420588)

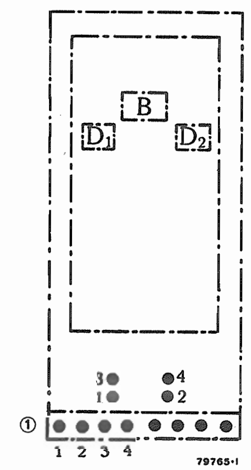


Fig. 4
Front view of Fig. 3

Legend:

A Heater element
B Thermal contact
C Limit-current trip relay
D Instantaneous contact
E Setting resistor
F Test terminals
G Screw plug
H Blocking contact

① Terminals for front connection; only supplied when expressly stipulated. Terminals marked the same are connected to one another.

Circuit diagrams for

Secondary thermal relays type ST

Short-circuit current ⩽ 180 A

Separate auxiliary supplies

Limit-current trip for breaker, thermal trip for signalling

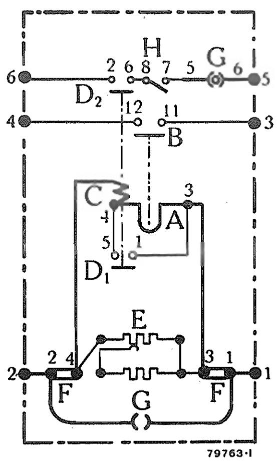


Fig. 1
Type STf
(AK 420303)

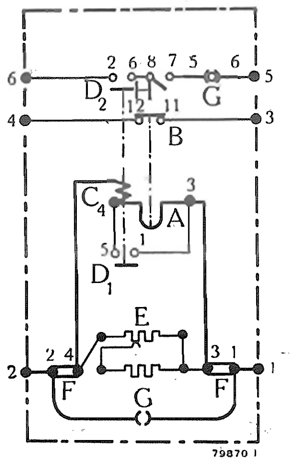


Fig. 2
Type STn
(AK 420589)

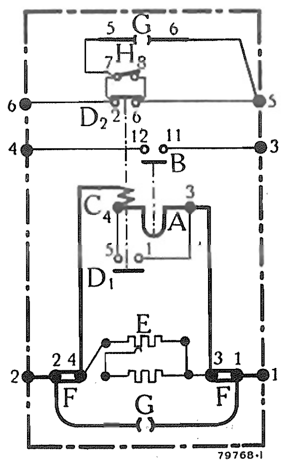


Fig. 3
Type STi
(AK 420304)

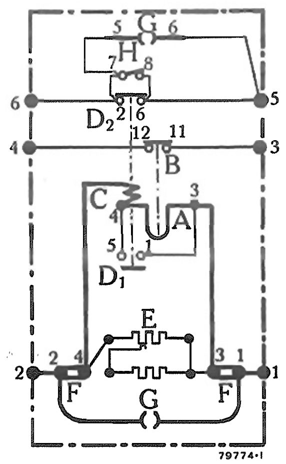


Fig. 4
Type STm
(AK 420305)

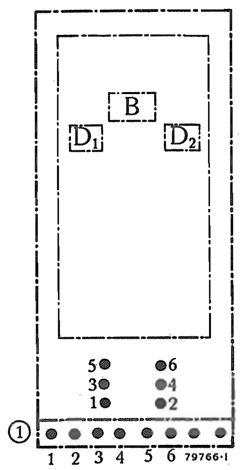


Fig. 4
Front view of Fig. 1–4

Legend:

A	Heater element	E	Setting resistor
B	Thermal contact	F	Test terminals
C	Limit-current trip relay	G	Screw plug
D	Instantaneous contact	H	Blocking contact

① Terminals for front connection; only supplied when expressly stipulated. Terminals marked the same are connected to one another.

Circuit diagrams for

Secondary thermal relays type ST

Short-circuit current ⩽ 180 A

Separate auxiliary supplies

Limit-current trip for signalling, thermal trip for breaker

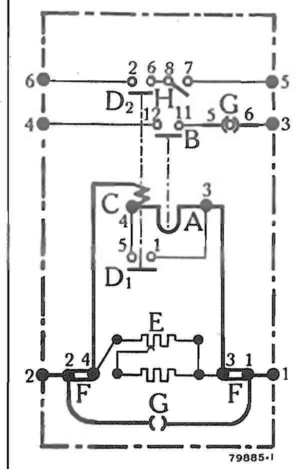


Fig. 1
Type STr
(AK 420591)

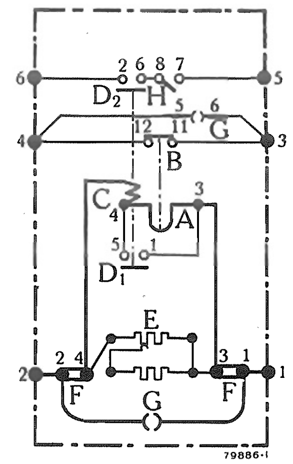


Fig. 2
Type STe
(AK 420422)

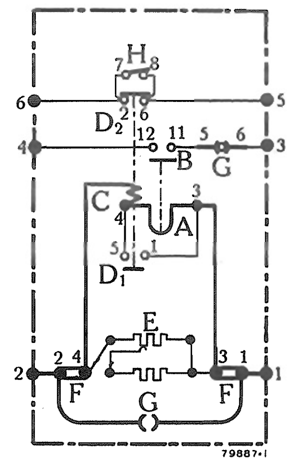


Fig. 3
Type STp
(AK 420593)

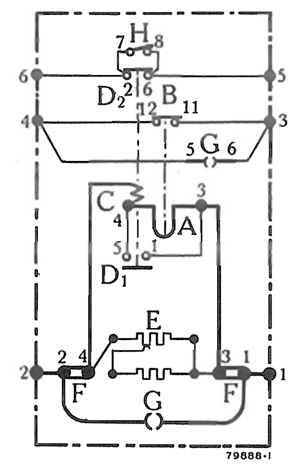


Fig. 4
Type STh
(AK 420594)

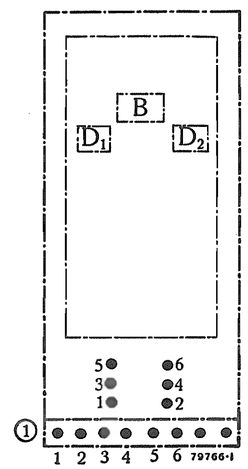


Fig. 5
Front view of Fig. 1–4

Legend:

A	Heater element	E	Setting resistor
B	Thermal contact	F	Test terminals
C	Limit-current trip relay	G	Screw plug
D	Instantaneous contact	H	Blocking contact

① Terminals for front connection; only supplied when expressly stipulated. Terminals marked the same are connected to one another.

Circuit diagrams for

Secondary thermal relays type ST

Short-circuit current ≤ 180 A

For frequencies below 40 c/s ②

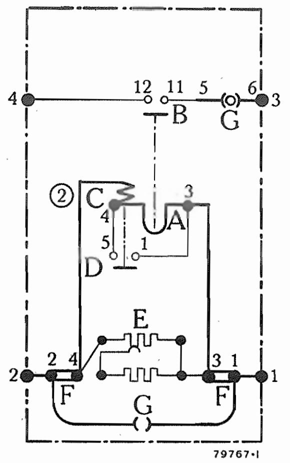


Fig. 1
Type STdr
(AK 420340)

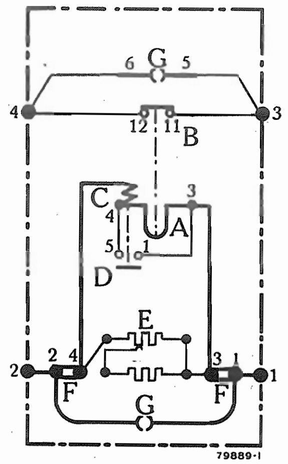


Fig. 2
Type STde
(AK 420341)

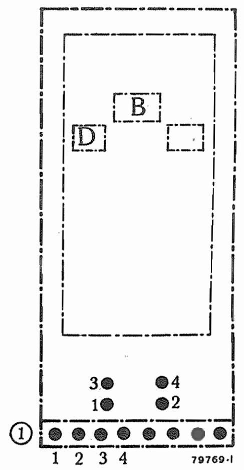


Fig. 3
Front view of Fig. 1 and 2

Legend:

- A Heater element
- B Thermal contact
- C Limit-current trip relay
- D Instantaneous contact
- E Setting resistor
- F Test terminals
- G Screw plug

① Terminals for front connection; only supplied when expressly stipulated. Terminals marked the same are connected to one another.

② Limit-current trip cannot be used.

Circuit diagrams for

Secondary thermal relays type ST

Short-circuit current ≤ 180 A

Common auxiliary supply

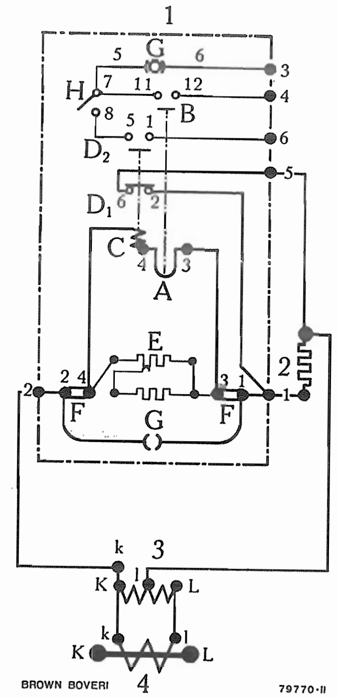


Fig. 1
Type STk
(AK 420306)

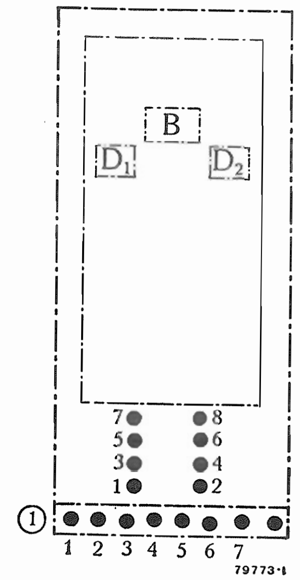


Fig. 2
Front view of Fig. 1

Legend:

- 1 Relay type STK
- A Heater element
- B Thermal contact
- C Limit-current trip relay
- D Instantaneous contact
- E Setting resistor
- F Test terminals
- G Screw plug
- H Blocking contact
- 2 Resistor type TDv 2/100
- 3 Auxiliary current transformer SB 0·5
- 4 Current transformer

① Terminals for front connection; only supplied when expressly stipulated. Terminals marked the same are connected to one another.

Circuit diagrams for

Secondary thermal relays type ST

Short-circuit current ⩽ 180 A

Separate auxiliary supplies

Limit-current trip for breaker, thermal trip for signalling

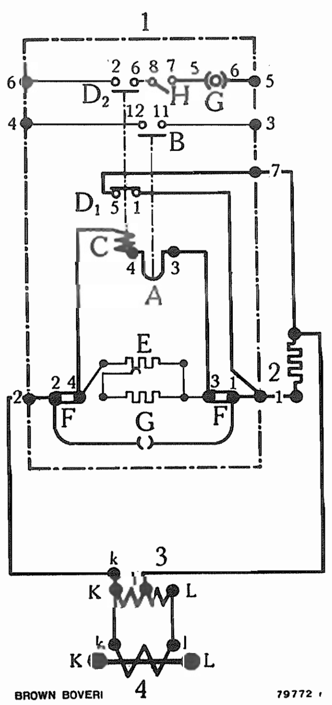


Fig.1. Type STfk (AK 420307)

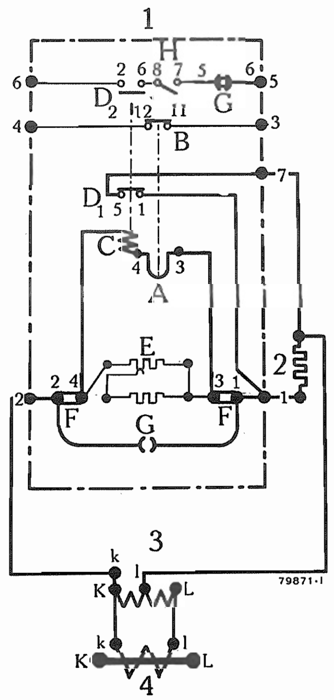


Fig. 2. Type STkn (AK 420590)

All variants

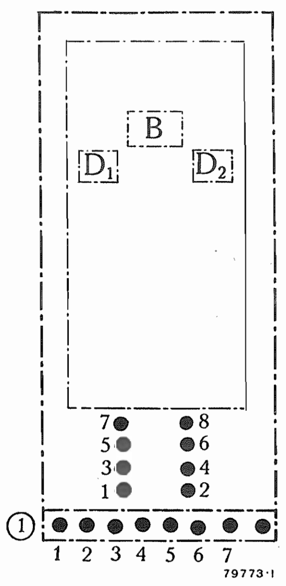


Fig. 5
Front view of Fig. 1–4

Limit-current trip for signalling, thermal trip for breaker

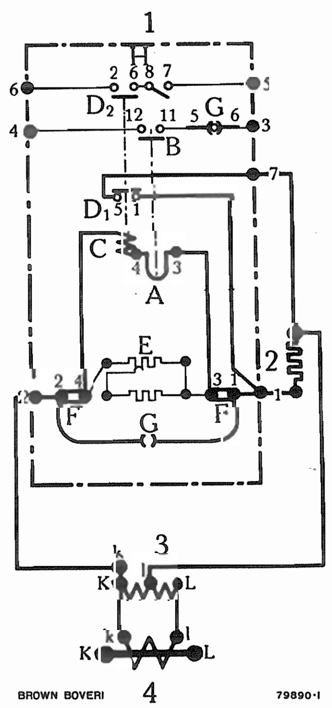


Fig. 3. Type STkr (AK 420592)

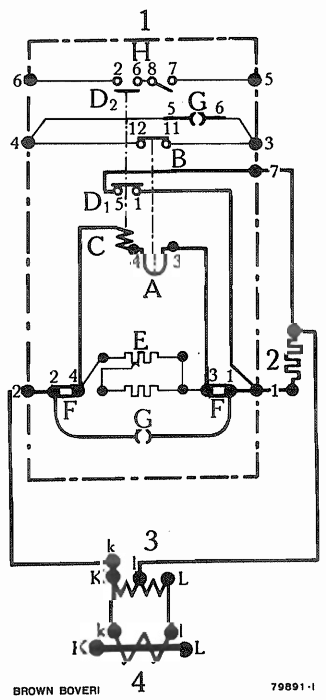


Fig. 4. Type STek (AK 420567)

Legend:

1 Relay type STK
A Heater element
B Thermal contact
C Limit-current trip relay
D Instantaneous contact
E Setting resistor
F Test terminals
G Screw plug
H Blocking contact
2 Resistor type TDv 2/100
3 Auxiliary current transformer SN 0·5
4 Current transformer

① Terminals for front connection; only supplied when expressly stipulated. Terminals marked the same are connected to one another.

Secondary thermal relays type ST

for a. c. or d. c.

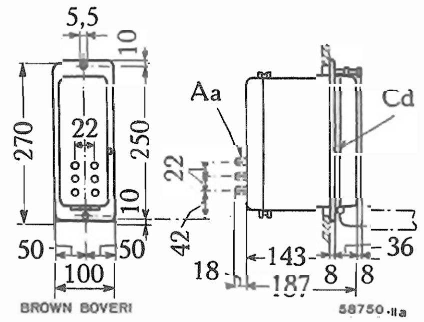


Fig. 1
For flush mounting
rear connection

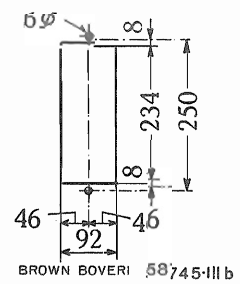


Fig. 2
Hole in panel
for Fig. 1 and 3

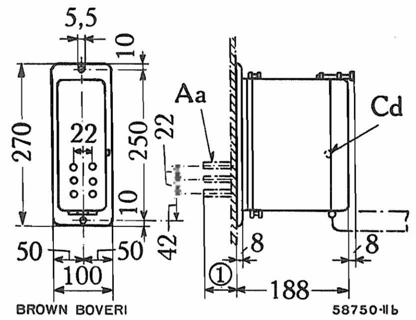


Fig. 3
For surface mounting
rear connection

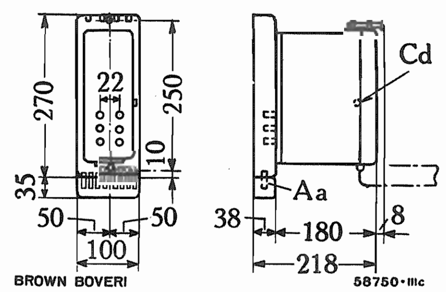


Fig. 4
For surface mounting with extension
frame and front connection

Legend:

Aa Terminals for leads up to 3·5 mm
Cd Reset button for signals

① 18 mm for thicknesses up to 6 mm, 51 mm for 6–40 mm thick.

Dimensions in millimetres (binding)

To convert approximately to inches
multiply millimetres by 0·04

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Division E

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