

LATEST EXPLOSION-PROOF ELECTRIC MACHINERY AND APPARATUS FOR FACTORY USE (II)

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VIII. EXPLOSION-PROOF SWITCHES

1. Flame-proof Low-Tension Air-Insulated Magnetic Switch and Circuit Breaker

- 1) Main features of the flame-proof magnetic switch and circuit breaker manufactured by our Company are as follows.

- (1) Maintenance and inspection can be easily conducted.

Bolt locking of cover of flame-proof main enclosure containing a switch is effected by one bolt, and the opening and closing of the cover is easily carried out by only driving the bolt.

- (2) Property of perfect flame-proof construction is always assured.

By using only one-bolt securing lock, such possibility of reducing the flame-proof property is minimized that in case of using many bolts some bolts of them may become loose by any chance or may be forgotten to be tightened, which caused danger of overstressing on other few bolts by explosion pressure or opening of jointing surface.

Furthermore, in this one-bolt securing lock system, such interlock can be easily provided between cover opening and switch operation that the cover cannot be opened unless the contained switch is in open position and the switch cannot be operated whenever the cover is open or securing lock is not perfectly made. In other words, operation can be secured by only paying attention to the one lock-bolt

- (3) Contained magnetic switch and circuit breaker have superior performance.

High switching capacity or interrupting capacity is guaranteed. Especially on magnetic switches, our RC3931 Series having highest performance: class A, grade 1 and kind 1 specified in JIS-C8325, i. e., durable against high switching duty, capable of long life and adoptable for every fields, is used. Thermal overload relay is provided with a surrounding temperature compensating device to keep correct action and the heat element is capable of carrying current of 10

times as much as rated current.

- (4) Safe operation of machine is secured.

Magnetic switch box is provided with such a control switch that in case of ON operation the contacts and handle of control switch are of self-reset action, and in case of OFF operation they are kept at OFF position with lock. Therefore, after automatic opening of magnetic switch caused by voltage drop etc., the magnetic switch cannot be automatically closed until the control switch is manually operated again even if the voltage has recovered, and safety can be secured by keeping OFF position with lock.

- 2) Details of flame-proof main enclosure and one bolt clamping construction.

Our flame-proof enclosure was completed by introducing the technique of Siemens Schukertwerke A. G., and it is epock-making one as the construction of flame-proof enclosure.

It is classified into three types as follows:

Type dR1490: Magnetic Switch dHRC3931-5-1 etc.

Type dU₁~dU₅: Magnetic Switch dRC3931-5-1, ~4T, No-fuse breaker 30~225A frame etc.

Type dR1457: Magnetic Switch dRC3931-8, ~10, Magnetic contactor K917 III-12 etc.

The dimensions of each enclosure is determined to be suitable for a unit of U-system control board. These flame-proof enclosures are widely used not only for magnetic switch and circuit breaker, but also other electric apparatuses.

- (1) Flame-proof enclosure, type dR1490

As protection system against flame propagation, screw-in system which is available for gas and vapor of explosion class 3 is adopted. In our country, official approving organization regarding the explosion-proof property of electric machinery and apparatus for factory use is not yet established, however, in West Germany this type of flame-proof enclosure has received the official test certificate (No. PTBIII-B/E-2259) from Physikalisch-Technischen Bundesanstalt Bra-

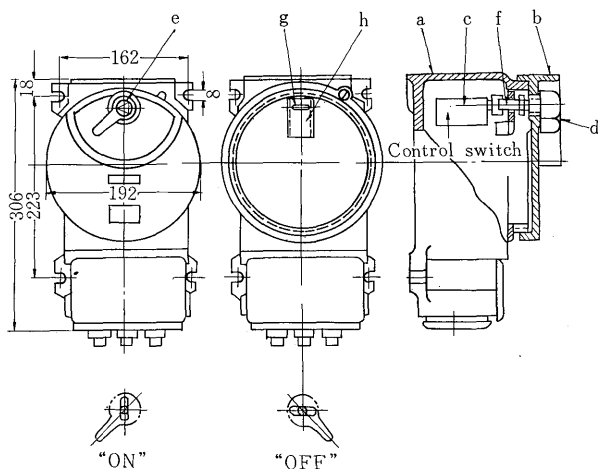


Fig. 32 Outline of flame-proof enclosure, type dR1490

unschweig that it is in conformity with the flame-proof property of Exd 3nG5 specified in VDE standards. Fig. 32 shows the construction of this enclosure. Case "a" and cover "b" are connected by screw-in system by which explosion pressure withstanding as well as flame propagation protection are effected. Control switch "c" is operated by outside handle "d". This handle is provided with a screw "e" having triangle head and by turning the screw, shaft "f" moves forward or back-ward, which makes coupling with the control switch and results in cover stopping (cover cannot be opened). The case is provided with a protection plate "h" in which a narrow hole "g" is made, and the shaft "f" can be inserted into this hole "g". Since the top of the shaft "f" has a shape of T as a hook, unless the control switch is in OFF position the shaft "f" cannot be taken out from the hole "g" because of stopping by the hook even when the screw "e" is loosened. When the control switch is in OFF position, the shaft "f" can be taken out

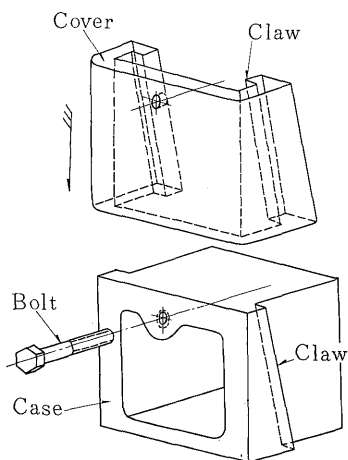


Fig. 33 Illustration of one-bolt clamping mechanism

from the hole "g" by loosening the screw "e" as can be understood in the figure, then the cover "e" can be freely rotated to open. From the above description, it may be understood that the perfect locking is effected by one bolt "e" and the cover cannot be opened unless the inside switch is in no-current condition.

The under part of enclosure is equipped with a terminal box, and the complete enclosure can be fitted to U-system bus enclosure as well as separately installed.

(2) Flame-proof enclosure, type dU₁~dU₅

This enclosure has a explosion-proof property of d₂G₄ and the flame propagation protection is made by the adjoining surface contact between case and cover, and the explosion pressure withstanding is effected by the biting surface of claws provided on both case and cover. The securing lock bolt is not to receive directly the explosion pressure but only to keep the biting of claws, and has the following functions.

(a) Perfect flame-proof construction by one bolt.

Fig. 33 shows the construction principle of this type of enclosure. It is understood from this illustration that this type of enclosure is different from the enclosures so far manufactured in which explosion pressure is directly received by bolts.

The biting between the case and the cover is practically made by the intermittent claws as shown in Fig. 34, which requires only small sliding distance in horizontal direction for biting or releasing action of claws by adopting suitable hinged system.

(b) Cover cannot be opened unless the control switch is in OFF position.

Fig. 34 shows the principle of this interlock. Fig. 34 (a) shows the normal position in which the operating handle of control switch is in middle posi-

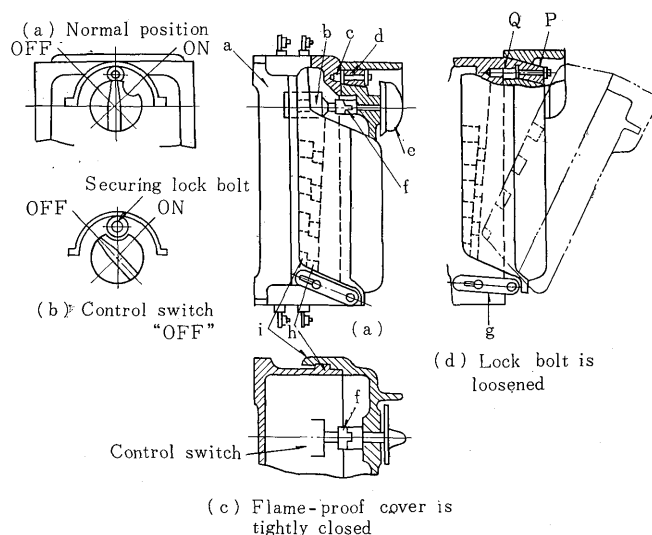


Fig. 34 Illustration of interlock between one-bolt locking mechanism and control switch.

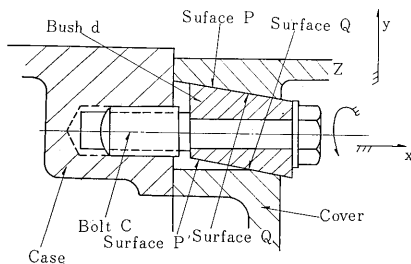


Fig. 35 Cover slide mechanism

tion and even when the handle is turned to ON position, after removing the hand it is automatically reset to the middle position. On the other hand, when the handle is turned to OFF position, it stops at the position shown in Fig. 34 (b) and does not reset even after removing the hand. In the OFF position, a cut of disc provided on the switch handle comes just on the securing lock bolt, which permit fitting a box-spanner to the securing lock bolt to loosen or tighten the bolt and this action can be easily done because the handle keeps stopping at this position. In other position than OFF, the disc of the handle covers on the securing lock-bolt, by which the cover cannot be opened definitely.

(c) Perfect cover mounting and removing can be secured by tripple tapering.

Fig. 34 (c) and (d) show the relation between the case and the cover under the cover mounting and removing procedure, and Fig. 35 is the detail illustration of cover slide mechanism by the securing lock bolt. The bolt is not only to hold the cover as a latch, but also to support the biting of the claw, to keep the tightness of the cover with the case by strong force and also to loosen the cover by strong force when it is opened. When the bolt is turned to the direction of arrow "z" to loosen the cover, it moves to x-direction and inclined surface "P" of bush "d" moves to the right together with the bolt, which pushes up surface "Q" and the cover slides to y-direction. Consequently, the biting of the claws "h" and "i" illustrated in Fig. 34 (c) is gradually released, and it is so constructed that just when the bolt is completely loosened, the biting of the claws is completely released as shown in Fig. 34 (d). In this position, if the cover is pulled up making "g" as a hinge as shown by the dotted line in Fig. 34 (d), the cover can be easily opened. The torque of the bolt is converted into the strong force in x-direction by the tapering of screw threads and farthermore converted into stronger force in y-direction by the action of inclined surfaces "P" and "Q", to slide the cover. Moreover, the claws of the case and the cover have slight taper as shown in Fig. 34 (b), by which the force of y-direction is amplified to further stronger force to tighten the claw connection of the case and the cover when clamping or

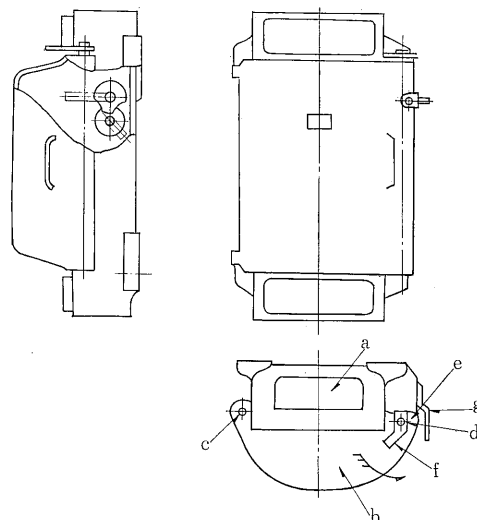


Fig. 36 Outline of flame-proof enclosure, type dR1457

to loosen it with great force when opening the cover. In other words, with the tremendous force amplified by the three tapering, i. e., bolt, bush and claw, the strong cover mounting and removing is effected and this system not only assures the perfect flame-proof property, but also removes such a trouble the cover cannot be opened on account of sticking dust, rust etc.

(3) Flame-proof enclosure, type dR1457

This type of enclosure is of door-opening system and has explosion-proof property of d2G4. The construction of this type is rather different from the constructions described in (1) and (2).

Fig. 36 shows the outside view of this type of enclosure. Case "a" and cover "b" as a door are connected together by hinge "c". On the other side of the case a shaft "d" is provided and so constructed not to open the cover by making a latch as shown in Fig. 37 (a) and to

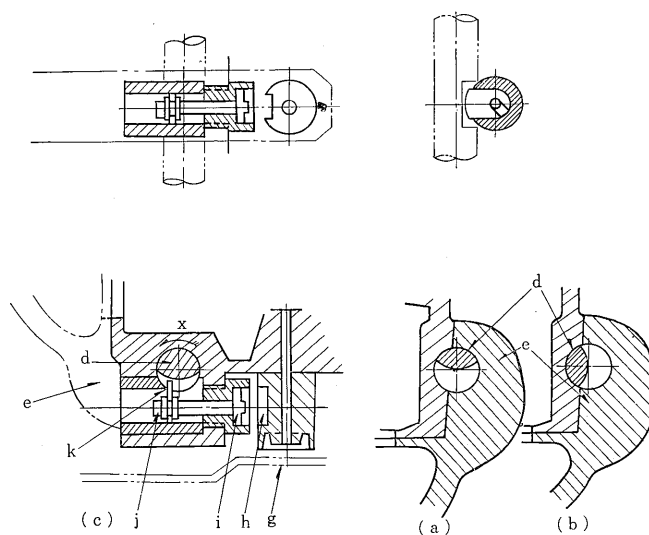
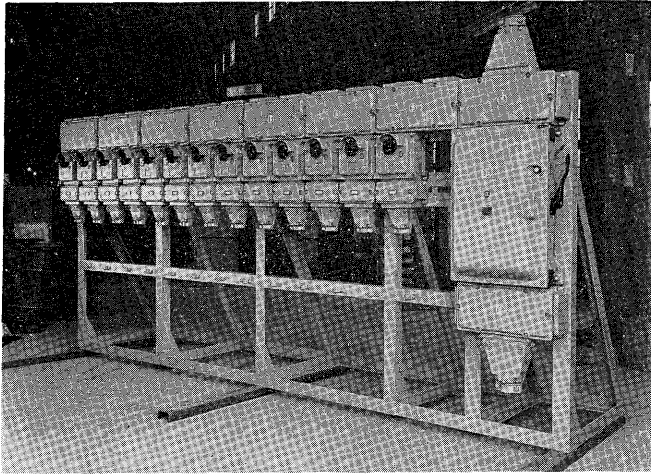
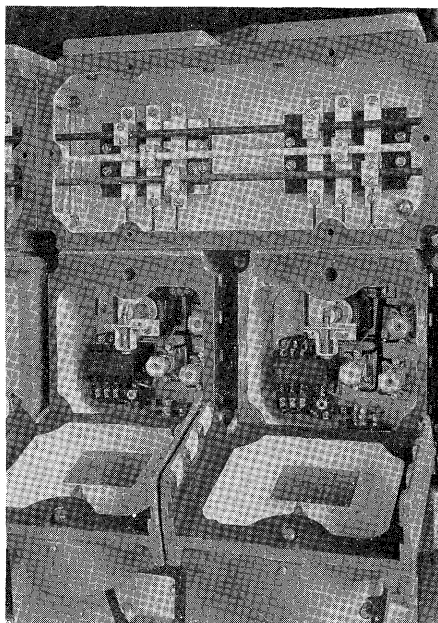


Fig. 37 Cover opening mechanism and one-bolt securing lock mechanism



(a)



(b)

Fig. 38 Flame-proof U-system control board

be able to withstand the explosion pressure. When the cover is to be opened, handle “*f*” in Fig. 36 is turned to arrow direction to rotate the shaft “*d*” and to release latching of shaft “*d*” on protruding part “*e*” of the cover as shown in Fig. 37 (b), by which the cover can be opened. Interlock is provided between the shaft “*d*” and the control switch by suitable method as shown in Fig. 37 (c) and the shaft “*d*” cannot be rotated unless the control switch is in OFF position.

Only when the handle of the control switch shown as “*g*” in Fig. 37 is in OFF position, the dent “*h*” on driving shaft and the tip “*i*” of interlocking bolt “*j*” face each other. On the other hand, the shaft “*d*” is stopped by the interlocking plate “*k*” provided on the interlocking bolt “*j*”, and cannot be rotated to

the arrow direction unless the bolt “*j*” is screwed in to shift the interlocking plate “*k*” to the right side of the center line “*x*” of the shaft “*d*”. Accordingly, the tip “*i*” should be driven into the dent “*h*” to rotate the shaft “*d*”, however, if the operating handle “*g*” is not in OFF position, the tip “*i*” cannot be driven in to the dent “*h*” and the cover cannot be opened. In other words, it also means that unless the cover is closed in perfect securing lock condition, the control switch cannot be operated and consequently the main circuit cannot be in live condition.

3) U-system control board

U-system is the abbreviation of Universal System or Unit System, in which units of flame-proof enclosure or increased safety enclosure standardized in their dimensions are combined together to compose a suitable control board. Fig. 38 (a) shows outside appearance of a U-system control board. It has the following features.

(1) Because it is composed of uniform and well-organized units, it gives beautiful appearance, the unit enclosures can be reasonably arranged and the wiring system can be obviously understood.

(2) Required space is very small.

Since individual explosion-proof switch enclosures are compactly combined together with bus enclosures, only a small space is required to install it.

(3) Because of having high combination ability, extension or addition of units can be easily made.

(4) Installation and wiring work can be easily carried out.

Wiring work will be completed only by leading the power supply cable into the receiving terminal box and by connecting the each output terminal box with lead cable.

(5) Maintenance and inspection is very easy.

Each unit enclosure is mounted on a supporting frame, and is also combined one another with bolts. Both wall-mounted type and self-stand type can be manufactured.

Fig. 39 shows the standard dimensions of the unit enclosure. Unit enclosure is made of high quality cast iron, and water pressure test is applied on each enclosure to secure the explosion-proof construction.

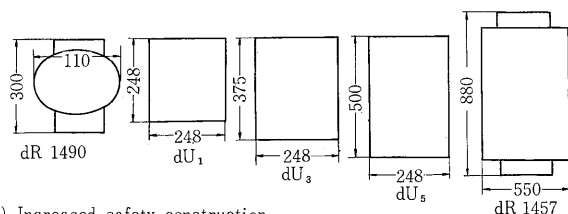
Type dR or dU means flame-proof construction, and type eU shows increased safety construction.

Since the details of main unit enclosure are described before, other constituting units and parts will be illustrated in the following columns.

(a) Bus enclosure

For bus enclosure, increased safety big size unit enclosure is generally used, having various holes as shown in Fig. 40 (a) and (b) through which bus

(a) Flame-proof construction



(b) Increased safety construction

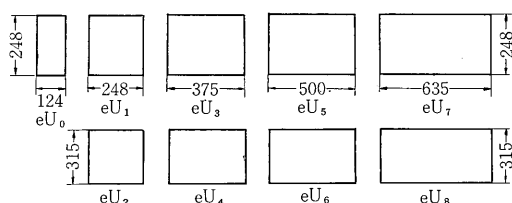


Fig. 39 Standard dimensions of U-system unit enclosures

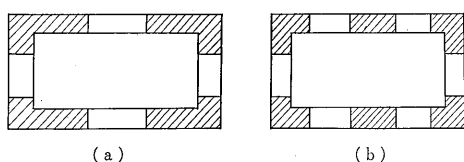


Fig. 40 Hole arrangement of bus enclosure, type eU

bars can be suitably arranged. Inside of the bus enclosure, bus bar clamping base and terminals etc. are provided to arrange wirings in good order.

(b) Penetrating conductor

As a penetrating conductor through the wall of flame-proof enclosure, the stud system using bakelite mould as shown in Fig. 41 is adopted, and it is deemed to be the best system for flame-proof construction and its connection with wires is easily made by clamping.

For control circuit, the multi-conductor stud in which three conductors are built in as shown in Fig. 41 (b) is used and for main circuit, the single conductor stud having proper size of conductor according to rated current as shown in Fig. 41 (a) is used.

(c) Terminal box

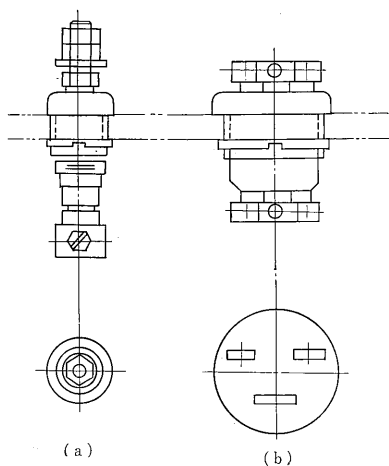


Fig. 41 Connecting stud-conductor

As a terminal box, increased safety unit enclosure, type $eU_0 \sim eU_8$ or flame-proof unit enclosure having the same size of the series eU is used. The applied standard of explosion-proof construction on terminal box is flame-proof construction and as draw-in system of external wirings, screw-in system of thickly made steel conduit pipe is preferable but compound filling system or packing system is also adoptable.

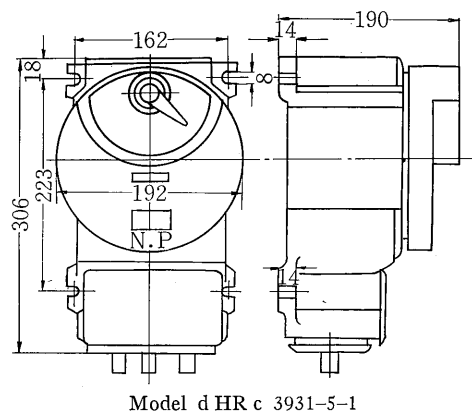
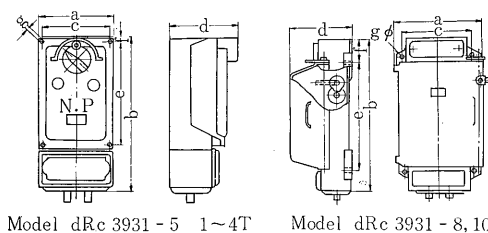
4) Individual flame-proof magnetic switch

By dividing the above-mentioned U-system control board, each unit can be used as an individual flame-proof magnetic switch.

Table 14 shows the standard application of flame-proof magnetic switches. Fig. 42 and Fig. 43 show the outside dimensions and connection diagrams, respectively.

5) Combination starter

This is made by the application of U-system control board.



Model	a	b	c	d	e	f	g
dHRC 3931-5-1	—	—	—	—	—	—	—
dRC 3931-5-1	248	392	223	230	223	12.5	12
dRC 3931-2	248	392	223	230	223	12.5	12
dRC 3931-4	248	519	223	230	350	12.5	12
dRC 3931-4 T	248	644	223	300	475	12.5	12
dRC 3931-8	545	880	445	360	624	128	21φ
dRC 3931-10	545	880	445	360	624	128	21φ

Fig. 42 Dimensions of flame-proof magnetic switches

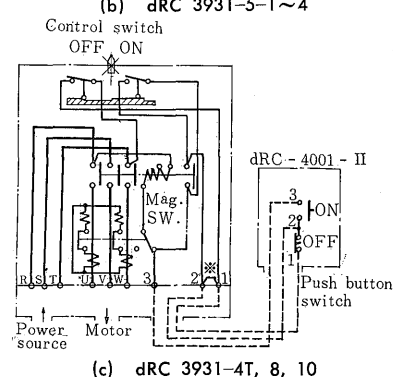
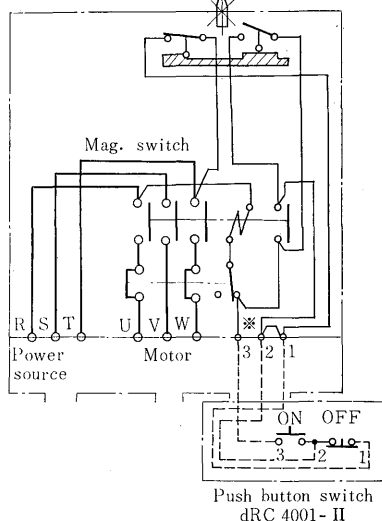
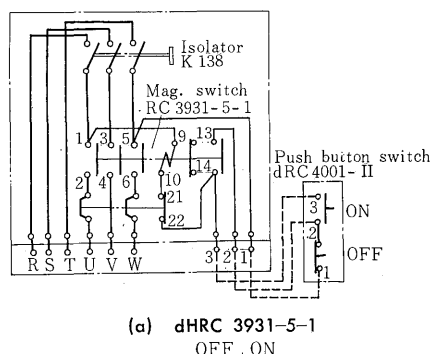


Fig. 43 Connection diagram of flame-proof magnetic switches

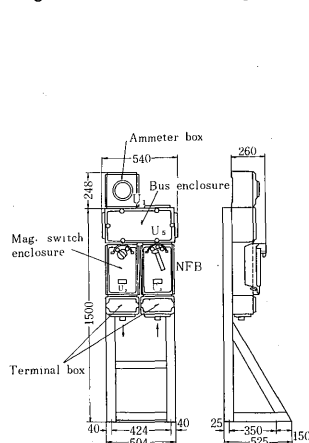


Fig. 44 Outline of flame-proof combination starter

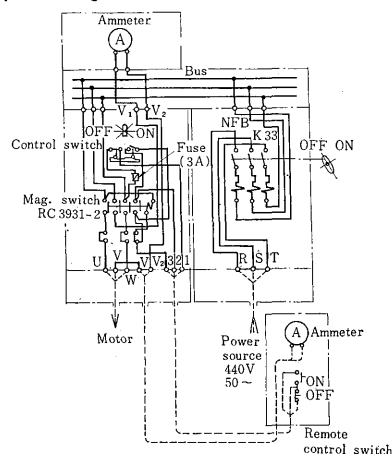


Fig. 45 Connection diagram of flame-proof combination starter

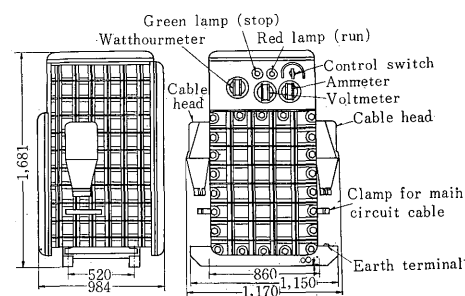


Fig. 46 Outline of flame-proof HT air-insulated switch box

Table 15 is to show the standard application of flame-proof combination starter. Fig. 44 and Fig. 45 show respectively the outside dimensions and the connection diagram of flame-proof combination starter for 7.5 kW 440 V motor based on this standard application.

6) Flame-proof low-tension air circuit breaker

This is used in case where the more interrupting capacity is required for the breaker than that obtained by no-fuse breaker or where the circuit breaker is required to be of remote operated type.

2. Explosion-Proof High-Tension Air-Insulated Switch Box

Model : dB 250

Explosion-proof construction : de 2 G 4

Use : Operation and protection of high-tension induction motor or other high-tension AC circuit.
Up to 400 kW for direct-on-line starting of cage motor
Up to 1,000 kW for wound rotor motor

Rating : 3.6 kV 200 A

Interrupting capacity of 25 MVA at 3.6 kV with high-tension air insulated magnetic switch, KF 926 III-25-3/200

Terminal box : Increased safety construction for cable connection as standard. External wiring draw-in system to the terminal box is either compound filling system or packing system.

Mounting instruments : Voltmeter, ammeter, watt-hour meter, red & green signal lamp, overcurrent relay, shortcircuit relay, potential transformer, current transformer, auxiliary transformer for magnet coil, etc.

Table 14. Standard table of flame-proof type magnetic switch

Model		dHRC 3931-5-1	dRC 3931-5-1	dRC 3931-2	dRC 3931-4	dRC 3931-4T	dRC 3931-8	dRC 3931-10
Appli- cable output	220 V	3.7 kW	3.7 kW	7.5 kW	15 kW	20 kW	33 kW	40 kW
	440 V	3 kW	3 kW	7.5 kW	30 kW	30 kW	65 kW	80 kW
Lated voltage		550 V	550 V	550 V	550 V	550 V	550 V	550 V
Current		16 A	16 A	35 A	60 A	75 A	50 A	200 A
Constituting parts	Magnetic switch	1×RC 3631-5-1	1×RC 3631-5-1	1×RC 3631-2	1×RC 3631-4	1×RC 3631-4 T	1×RC 3631-8	1×RC 3631-10
	Thermal over- load relay	1×RCa 3737-1	1×RCa 3731-1	1×RC3737-4	1×RC 3737-4	1×RC 3737-20	1×RC 3737-20	1×RC 3737-20
	Isolator	1×K 138	—	—	—	—	—	—
	Control switch	—	1×K 138-2 C	1×K 138-2 C	1×K 138-C	1×K 138-2 C	1×K 138-2 C	1×K 138-2 C
	Enclosure	dR 1490	dU ₁ +dU ₀	dU ₁ +dU ₀	dU ₃ +dU ₀	dU ₅ +dU ₀	dR 1457	dR 1457

Table 15. Standard table of flame-proof combination starter

Model			dRC 9331-5-1	dRC 9331-2	dRC 3931-4	dRC 3931-4 T	dRC 3931-8	dRC 3931-10
Permissible max. voltage			550 V	550 V	550 V	550 V	550 V	550 V
Current			16 A	35 A	60 A	75 A	150 A	200 A
Max. applica- ble output of motor	Cage rotor	220 V	3.7 kW	7.5 kW	15 kW	19 kW	33 kW	40 kW
		440 V	3 kW	7.5 kW	30 kW	30 kW	65 kW	80 kW
	Wound rotor	220 V	3.7 kW	7.5 kW	15 kW	20 kW	33 kW	50 kW
		440 V	3 kW	15 kW	30 kW	40 kW	75 kW	100 kW
Constituting parts	Isolating switch	Model	1×K 138x-2 C	1×NFB 50A	1×NFB 100 A	1×NFB 100 A	1×NFB 200 A	1×NFB 200 A
		Rup. capacity AC 250/600 V	3×Main cir- cuit fuse AFSC-30	5/5 kA	15/15 kA	15/15 kA	20/15 kA	20/15 kA
	Aux. circuit fuse		1×AFSC-3	1×AFSC-3	1×AFSC-3	1×AFSC-3	1×AFSC-3	1×AFSC-3
	Mag. contactor		1×RC 3631-5-1	1×RC3631-2	1×RC 3131-4	1×RC 3631-4T	1×RC 3631-8	1×RC 3631-10
	Thermal overload relay		1×RC 2737-1	1×RC3737-4	1×RC 3737-4	1×RC 3737-20	1×RC 3737-20	1×RC 3737-20
	Control switch		2×K 244 x-2	1×K 138-2 C	1×K 138-2 C	1×K 138-2 C	1×K 138-2 C	1×K 138-2 C
	Ammeter		1×YAS 3	1×YAS 3	1×YAS 3	1×YAS 3	1×YAS 4	1×YAS 4
	CT for ammeter		—	—	1×40 VA	1×40 VA	1×40 VA	1×40 VA
Switch enclosure			1×dU ₁	1×dU ₃ 1×dU ₃	1×dU ₃ 1×dU ₅	1×dU ₅ 1×dU ₅	1×dR 1457 1×dU ₅	1×dR 1457 1×dU ₅
Terminal box			1×dU ₀	2×dU ₀	2×dU ₀	2×dU ₀	1×dU ₀	1×dU ₀
Bus enclosure			—	1×eU ₅	1×eU ₅	1×eU ₅	2×eU ₅	2×eU ₅
Ammeter box			1×dU ₁	1×dU ₁	1×dU ₁	1×dU ₁	1×dU ₁	1×dU ₁

Fig. 46 shows the outline of this air insulated switch box. Since the switch box has air-insulated breaking system, wear of contact parts is comparatively small which is suitable for frequent switching operation of motor and there is no fear of ignition to insulation oil. To this switch box, it is not

necessary to supply separately low-tension power source because an auxiliary transformer for control circuit is contained inside the switch box.

It is also possible to simplify the switch box to make small size and low cost by only providing an air-insulated magnetic switch and an ammeter.

3. Oil-Immersed Explosion-Proof High-Tension Switch Box

Model : ORF 18
 Explosion-proof construction : ode 2 G 4
 Use : Operation and protection of high-tension induction motor or other high-tension AC circuit.
 Rating : 3.6 kV 100 A
 Max. switching capacity of 10 MVA at 3.6 kV
 Rated switching capacity : Class A
 Constituting part : As shown in Table 16.
 Terminal box : Increased safety construction as standard.
 External wiring draw-in system to the terminal box is either compound-filling system or packing system.

Fig. 47 and Fig. 48 are outview and connection diagram, respectively.

Operating device of this switch box is of perfect free-trip mechanism and even at any position during closing operation the switch is opened regardless of the operating handle if the low-voltage or overload relay is in action. Contact parts in oil consist of main contact and arcing contact which is protecting the main contact against arc.

Inspection and replacement of oil or arcing contact can be easily carried out only by lowering the oil tank.

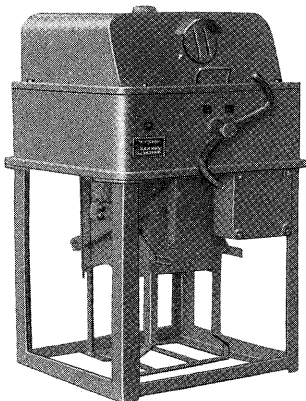


Fig. 47 Outview of oil-immersed explosion-proof HT switch box, ORF 18

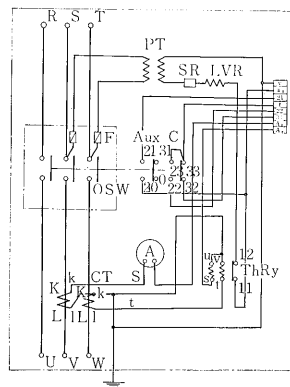


Fig. 48 Connection diagram of oil-immersed explosion-proof HT switch box, ORF 18

4. Flame-Proof Push Button Switch

Model : dRC 4001-II P for 2-points (on, off)
 dRC 4001-III P for 3-points (normal, reverse, off)
 Explosion-proof construction : d 2 G 4
 Rating : AC 550/250 V, 8/15 A
 Terminal box : External wiring draw-in system to the terminal box is thick steel conduit pipe screw-in connection

as standard.

Fig. 49 shows the outline of flame-proof 2-points push button switch.

This push button switch can be locked at OFF position to assure safe operation, if required.

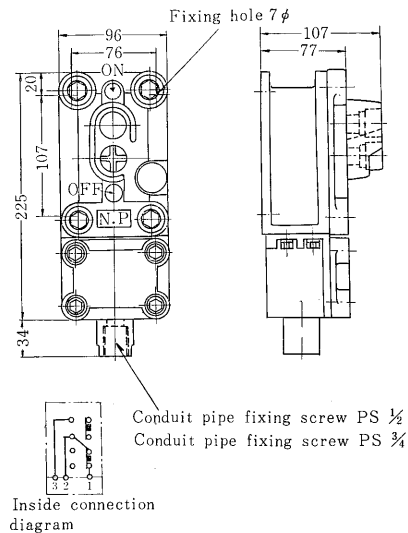


Fig. 49 Outline of flame-proof 2-points push button switch, dRC 4001 -IIP

IX. EXPLOSION-PROOF STARTER

1. Oil-Immersed Explosion-Proof Starter

Model : Knep 3300 VI, oil-immersed drum type manual operated.
 Explosion-proof construction : oeG 4
 Use : Starting of 3-phase wound rotor induction motor.
 Up to 95 kW for full-load starting
 Up to 190 kW for half-load starting
 Rotor max. voltage : 600 V
 Rotor max. current : 300 A
 Resister : Oil-immersed self-cooled grid-iron type
 Terminal box : Increased safety construction.
 External wiring draw-in system to the terminal box is compound filling system.
 Oil quantity : 83 l

Fig. 50 and Fig. 51 are the outline drawing and the connection diagram, respectively.

2. Oil-Immersed Explosion-Proof High-Tension Starting Reactor

Model : RC 3206 I/RC 3206
 Explosion-proof construction : oed 2 G 4
 Use : Starting of high-tension 3-phase cage motor
 Rating : Max. applicable motor : 3,300 V
 190 kW/370 kW
 Constituting parts : As shown in Table 17.
 Terminal box : Increased safety construction.
 External wiring draw-in system to

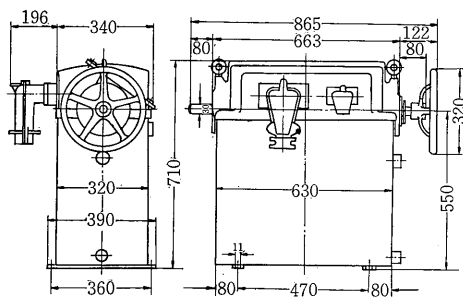


Fig. 50 Outline of oil-immersed explosion-proof starter

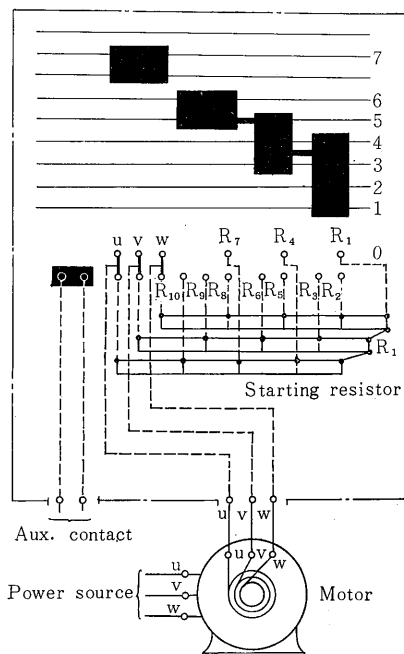


Fig. 51 Connection diagram of oil-immersed explosion-proof starter

the terminal box is compound filling system.

Fig. 52 and Fig. 53 are the outline drawing and the connection diagram, respectively. As can be seen in the figure, the starting reactor is provided inside with all of necessary parts for automatic starting.

3. Oil-Immersed Explosion-Proof Reversible Liquid Controller

Model : RC 5030 II

Explosion-proof construction :
oe G4

Use : Manual reversible operation or speed control of high-tension 3-phase wound rotor type induction motor.

Table 16 Constituting parts of oil immersed explosion proof hightension switch box

Mark	Parts	Type and specifications	Explosion-proof construction
OSW	Oil switch (Oil Q'ty: 15 l)	R18, trip-free 3 P.S.T. hand operated	Oil-immersed explosion-proof
Aux. C.	Aux. contact	2A+2B	Flame-proof
Th. Ry.	Thermal overload relay	RC3737-4 (self-reset)	Flame-proof
PT	Potential transformer	FTW-1 B, 40 VA 3,300/110 V, 50/60c/s	Increased safety
CT	Carrent transformer	FCR-1 CB, 20 VA 150/5A, 50/60c/s	Increased safety
LVR	Low voltage release	110V, 50/60c/s	Increased safety
A	AC ammeter	AK, 0~150 A	Increased safety
F	HT fuse		Oil-immersed explosion-proof

Table 17 Constituting parts of oil immersed explosion proof automatic starting reactor

Parts	Specifications	Explosion construction
Oil-immersed magnetic contactor	3.45 kV, 100 A/200 A 2P. S.T., Oil Q'ty: approx. 52 l	Oil-immersed explosion-proof
Starting reactor	Dry type, insulation class H	Increased safety
Auxiliary transofrmer	Dry type, insulation class H	Increased safety
Time relay	AC coil	Flame-proof
Auxiliary relay	AC coil	Flame-proof

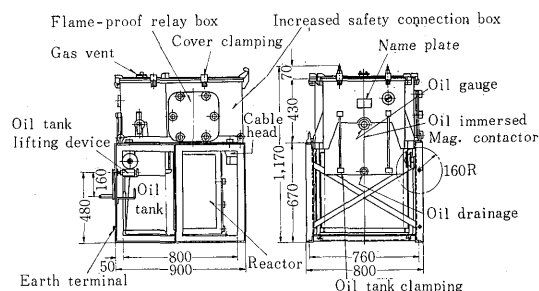


Fig. 52 Outline of oil-immersed explosion-proof HT starting reactor

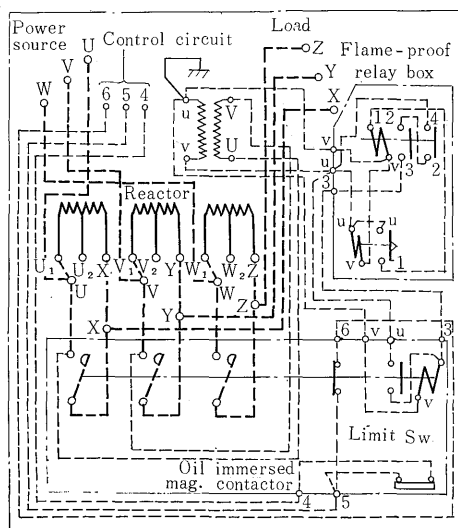


Fig. 53 Connection diagram of oil-immersed explosion-proof HT starting reactor

- Rating : Max. applicable motor : 3,300 V
150 kW
Rotor max. voltage : 600 V
Rotor max. current : 300 A
- Oil quantity : Approx. 73 l (for reversible controller)
- Liquid quantity : Approx. 260 l (for liquid resistor)
- Cooling water quantity (at inlet temperature 15°~20°C) :
10 l/min. up to 75 kW
15 l/min. up to 110 kW
20 l/min. up to 150 kW
- Terminal box : Increased safety construction.
External wiring draw-in system to the terminal box is compound filling system.

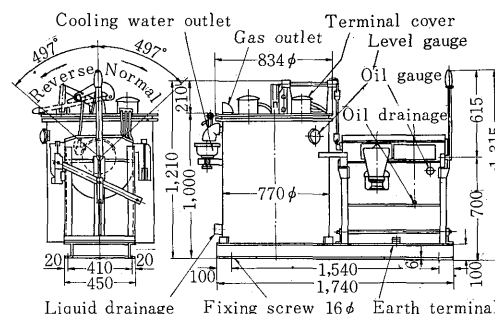


Fig. 54 Outline of oil-immersed explosion-proof reversible liquid controller

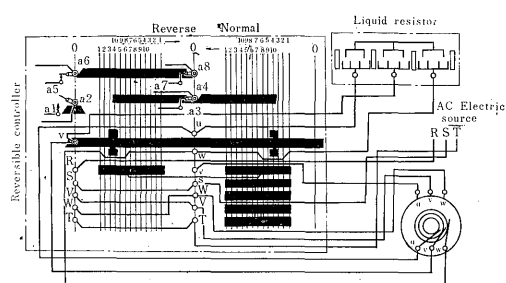


Fig. 55 Connection diagram of oil-immersed explosion-proof reversible liquid controller

Fig. 54 and Fig. 55 show respectively the outline drawing and the connection diagram of this reversible liquid controller.

The controller is of horizontal mounting drum type, and at the notch of "Stop", primary side (3,300 V) can be opened and makes the motor perfectly off from power source without fail.

Movable electrodes of resistor are set below the fixed electrodes and move vertically as the secondary neutral point, so that the electrode is not disconnected with liquid. The resistor liquid is cooled by the ring cooler provided along the internal surface of liquid tank.

X. EXPLOSION-PROOF SWITCHBOARD

1. Explosion-Proof Control Pillar

Control pillar is usually used for the local operation of motors. The control pillar having a small number of mounting instruments may be of flame-proof construction, however, generally it is made of increased safety enclosure in which control switches and signal lamps of flame-proof construction are provided and ammeter and other instruments which can be seen

Table 18 Connection system of explosion-proof construction with external wirings

	Explosion-proof construction	Connection sytem with external wirings	External wiring draw-in system
1st class hazard-ous location	ed2G4	Terminal box (flame-proof) Terminal box (increased safety)	Thick steel conduit pipe screw-in system Dust-proof packing system
2nd class hazard-ous location	ed2G4	Direct draw-in system	Dust-proof packing system

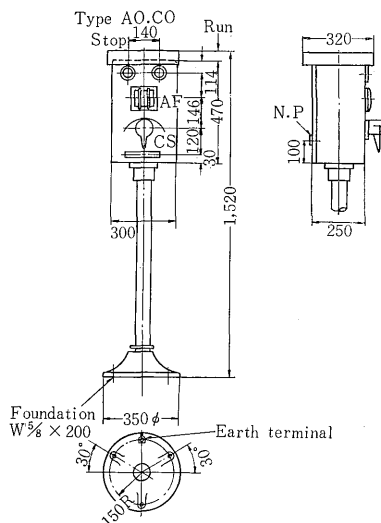


Fig. 56 Outline of outdoor use increased safety control pillar

through window are mounted.

The applied standard of explosion-proof construction and external wiring connection system is shown in Table 18.

The rear side of the enclosure is provided with the cover which is equipped with a locking mechanism, and by removing the cover the connection between the external wiring and terminal block for mounting instruments in the enclosure can be easily carried out.

Fig. 56 shows an example of outdoor use increased safety control pillar (direct draw-in system of external wirings).

2. Pressurized Explosion-Proof High-Tension or Low-Tension Switchboard

The applied standard of explosion-proof construction is $fG 4$.

The purpose of this construction is to contain the apparatus such as circuit breaker, disconnecting switch, PT, CT, etc. and other constituting parts such as relay, contactor, control switch, etc. in a common enclosure inside of which is pressurized to maintain explosion-proof property. In this system, it is necessary to take some measures on mechanical protection and contact prevention of the parts exposing outside (e.g., signal lamp globe) and to provide the cover with a locking mechanism, which is however easier and more economical than the system in which each apparatus contained inside is of explosion-proof construction. As a pressurized explosion-proof construction, sealing system pressurized explosion-proof construction is generally adopted so far as there is no high heat generating apparatus in the enclosure.

As draw-in system of external wirings, direct draw-in system of multi-core cable is considered to be the easiest.

XI. EXPLOSION-PROOF SEMICONDUCTOR RECTIFIER EQUIPMENT

As a semiconductor of explosion-proof construction, only selenium rectifier element was adoptable before, however by the revision of the Recommendations, such semiconductors as silicon, germanium etc. has also come to be adoptable.

1. Explosion-Proof Silicon Rectifier Equipment

The applied standard of explosion-proof construction on silicon rectifier equipment covers flame-proof construction, pressurized explosion-proof construction and increased safety construction. Since silicon rectifier generates only a little heat loss, it can be totally enclosed in case of small capacity, by which flame-proof construction or increased safety construction is easily made.

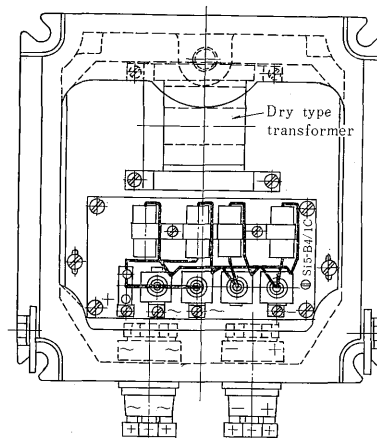


Fig. 57 Flame-proof silicon rectifier equipment

Fig. 57 shows a flame-proof silicon rectifier equipment for instrument power source, DC 8 V 2 A. As an enclosure, unit dU_1 described before is used in which a transformer is also contained.

As a large capacity silicon rectifier equipment, ventilating system pressurized explosion-proof construction is most suitable on the view-point of cooling effect.

2. Oil-Immersed Explosion-Proof Selenium Rectifier Equipment

Applied standard of explosion-proof construction on this equipment is $oeG 4$. In case of small capacity, both selenium rectifier element and transformer are contained together in a common enclosure.

XII. EXPLOSION-PROOF TRANSFORMER

1. Flame-Proof Dry Type Transformer

Applied standard of explosion-proof construction on dry type transformer is $d_2G 4$. Windings of insulation class H are used, and as an external wiring draw-in system to terminal box, packing system or

compound filling system is adopted for high-tension and thick steel conduit pipe screw-in connection system is for low-tension.

2. Oil-Immersed Explosion-Proof Transformer

Applied standard for explosion-proof construction is oEG 4. Outline dimensions of standard transformer up to 50 kVA HT (3.3 kV class) 3-phase are shown in Fig. 58. In this figure, direct draw-in system of external wirings is adopted, while the transformer more than 50 kVA is generally provided with terminal

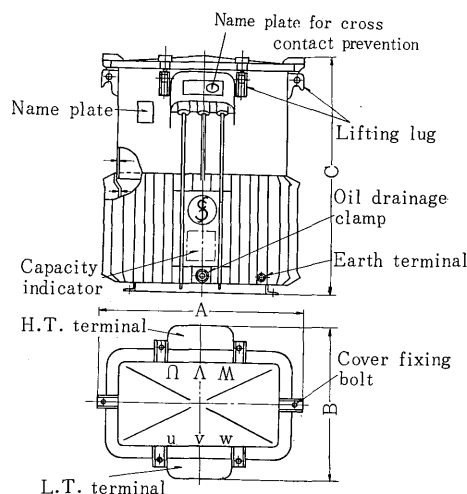
box and compound filling system or packing system is adopted as external wiring draw-in system. The transformers of course meet the requirement for oil-immersed explosion-proof construction such as oil level maintenance, locking of oil draining device, provision of cross contact preventing plate, etc.

XIII. EXPLOSION-PROOF APPARATUS

There are various kinds of explosion-proof apparatus such as end limit switch, pressure switch, etc. The

Table 19 List of explosion-proof apparatus

Apparatus	Model	Contact rating	Contact constitution	Remarks
End limit switch	dRC 4006 R	AC 250 V 15 A	1 A+1 B	Roller-push type
„	RCep 431 R, L	DC 550/250 V 13/25 A AC 550/250 V 25 A	3 B	Lever type
„	dJMF 341 r, 1	DC 250 V 50 W AC 250 V 5 A	Optional combination available with 3 cams Number of terminals: 6 Contact example: 3 B 2 B+1 A 1 B+2 A 3 A	3-poles: Rotary type
„	dJMF 342 r, 1	„		3-poles: Self-reset type
„	dJMF 343 r, 1	„		3-poles: Self-reset type, with insertion mechanism
„	dJMF 344	„		3-poles: Self-reset type, with both shaft ends
„	dJMF 345	„		2-poles: Self-reset type 1-pole: Rotary type with both shaft ends
„	dJMF 346	„	Optional combination available with 5 cams Number of terminals: 6	5-poles: Rotary type, with adjustable cams and both shaft ends
„	dJMF 347	„	3 B, 2 B 1 A, 1 B 2 A or 3 A Number of terminals: 6	3-poles: Change-over type with both shaft ends
Magnetic end limit switch	dB 430	AC 250 V 1 A	1 C	Switch actuated by permanent magnet fixed on movable part
Float switch	Rep 160/25	DC 550/250 V 13/25 A AC 550/250 V 25 A	3 B (in case of DC 2 poles is in series)	
Pressure switch	dURF 170 n 8	AC 250 V 8 A	3 B, 2 B 1 A, 1 B 2 A or 3 A	Detecting object: Oil, air, water Pressure range: Approx. 1~5 kg/cm ²
Speed limit switch	RCep 4022	AC 250 V 1 A	1 A	Speed adjusting range: 400~900 rpm
Centrifugal force switch	dJM 301/O, F	AC 250 V 5 A	3×(1 A+1 B)	Speed adjusting range: 100~1,400 rpm Three different speed can be detected.
Belt-slip relay	dKF 1452	AC 250 V 1 A	1 C	Standard belt speed: 1.3 m/s Standard rpm: 500 rpm Standard pick-up roller: 50 mmφ
Local control switch	dB 410	AC 250 V 15 A	Capable of 8-steps of NS 387, Number of terminals: 8	Self-reset type, with T-handle
Local change-over switch	dB 410 II, III, IV, V	AC 250 V 15 A	„	With T-handle. II, III, IV, V show number of change-over step
Local control switch	dB 411, 412	AC 250 V 15 A	Capable of 8-steps of NS 387. Number of terminals: 6	With control lever handle. Self-reset type



Out-put (kVA)	Voltage (V)		Max. dimensions (mm)						Oil Q'ty (ℓ)		Total weight (kg)	
	1st	2nd	A	B	C	E	F	50c/s	60c/s	50c/s	60c/s	
20	3150	210	700	550	830	3.2	1.6	68	70	290	282	
25	3150	210	790	580	"	3.2	1.6	80	83	350	342	
30	3150	210	810	"	860	3.2	1.6	93	97	400	392	
40	3150	210	820	600	900	3.2	1.6	115	120	450	441	
50	3150	210	840	630	990	3.2	1.6	150	115	560	550	

Fig. 58 Outline dimensions of oil-immersed explosion-proof 3-phase transformer

principal items of explosion-proof apparatuses are listed in Table 19. The body enclosures of all apparatuses listed in this table are of flame-proof construction, of which the applied standard is $d_2G 4$ or $de_2G 4$. External wiring draw-in system to terminal box is thick steel conduit pipe screw-in connection system for flame-proof construction and packing

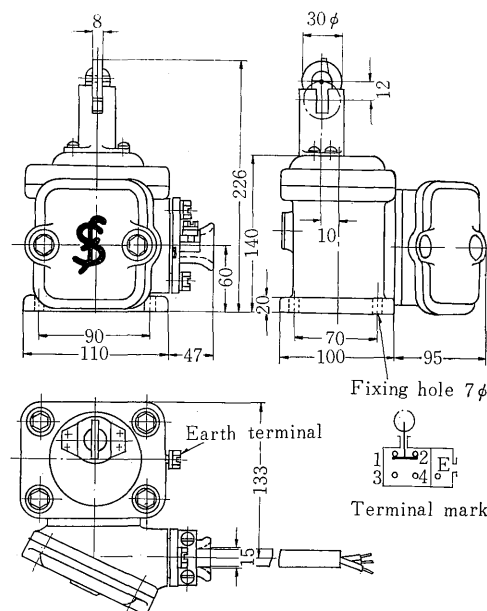


Fig. 59 Outline of flame-proof end limit switch, dRC 4006 R

system for increased safety construction.

Fig. 59 shows outline dimensions of flame-proof roller-push type end limit switch, Model dRC 4006 R.

XIV. CONCLUSION

The outline of recent explosion-proof electric machinery and apparatus for factory use is described above, and we are afraid that there may be lack of explanation on account of limited space.

In the end, we hope this description will help to understanding on our explosion-proof electric machinery and apparatus, and also wish to have kind suggestion and assistance from users.