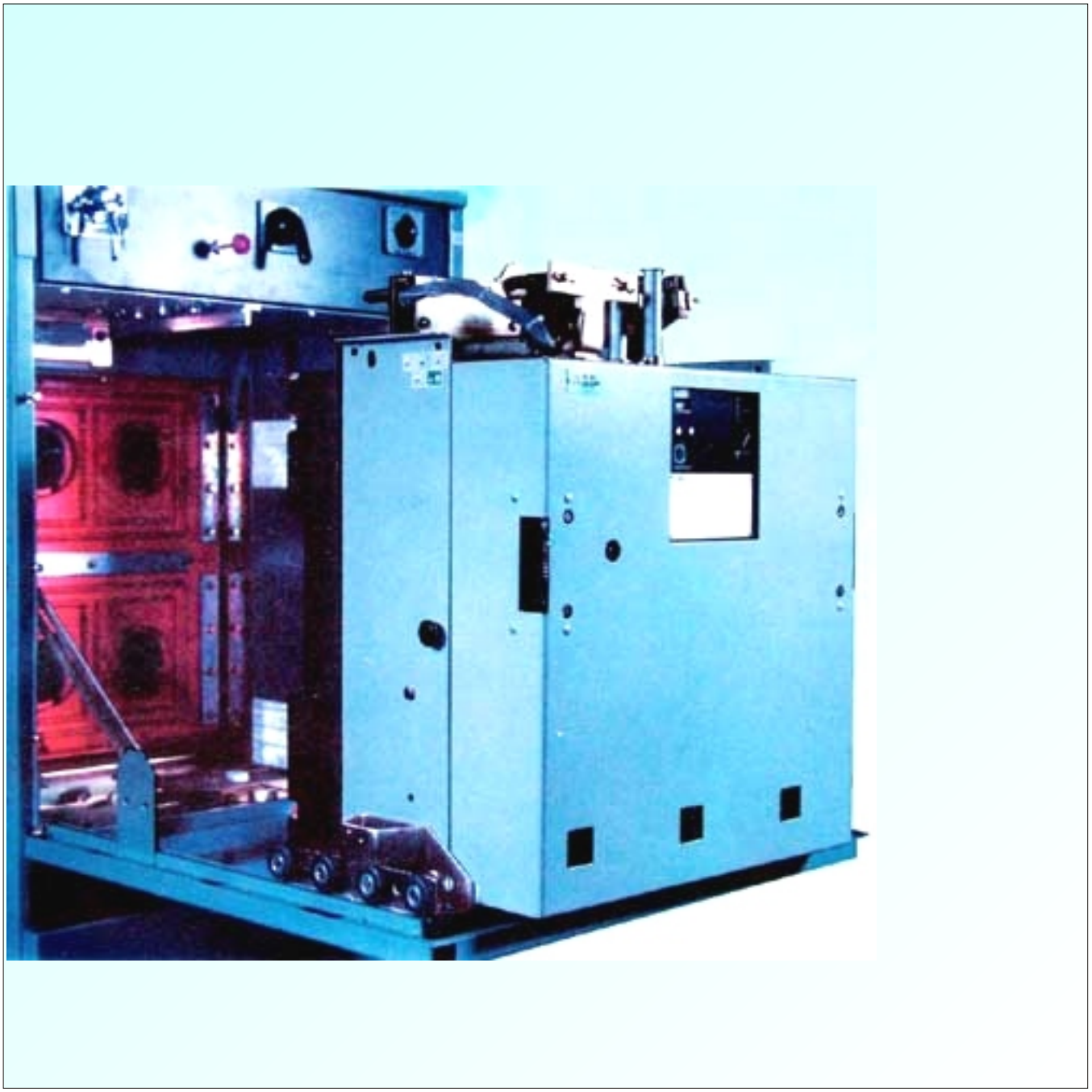
MV SF6 Indoor Circuit Breaker

Model HPA 12kV, 24kV & 36kV

Instruction for Installation, Service and Maintenance

1VDU22001-YN



Notice **1**

Based on our own experience, you will obtain the best possible operational reliability from our equipment by following the recommendations given in these instructions.

The data contained herein purports solely to describe the product and is not a warranty of performance or characteristics. It is with the best interests of our customers in mind that we constantly strive to improve our products and keep them abreast of advances in technology. This may, however, lead to discrepancies between a product and this instruction.

Notice **2**

Within the scope of this instruction, it is impossible to take into account every possible eventuality which may arise with technical equipment in service. Please consult our local agents in the event of any irregularities. Especially if not referred to herein.

Notice **3**

We expressly decline liability for any damage resulting from any incorrect operation or wrong handling of our equipment, even if these instructions contain no specific indication in this respect. We lay particular stress on the fact that only genuine spare parts should be used for replacements.

Notice **4**

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HPA - BREAKER

1.1 Data

* Rated voltage	kV	12	24	36
* Rated current	A	1250, 1600, 2000, 2500, 3000	1250, 2000, 2500	1250, 1600, 2000
* Rated breaking current	kA	40	26.3	26.3
* Rated making current (peak)	kA	100	66	66
Short time rated current, 1/3 sec	kA	40	26.3	26.3
Sf_6 pressure, (over pressure)	bar	2.5	2.5	2.5
Electrical endurance, (number of interruptions at rated breaking current)	No	6	25	10
Mechanical endurance (number of interruptions at rated current)	No	10000	10000	5000

With maintenance as detailed in this manual.

2.2 Construction and function

The circuit breaker type HPA operator on the puffer principle.

2.2.1 Breaker poles

The breaker pole contains Sf_6 gas (sulphur hexafluoride). This gas in many respects is one of the best media for circuit breaker in use for several decades and its excellent performance is demonstrated by experience.

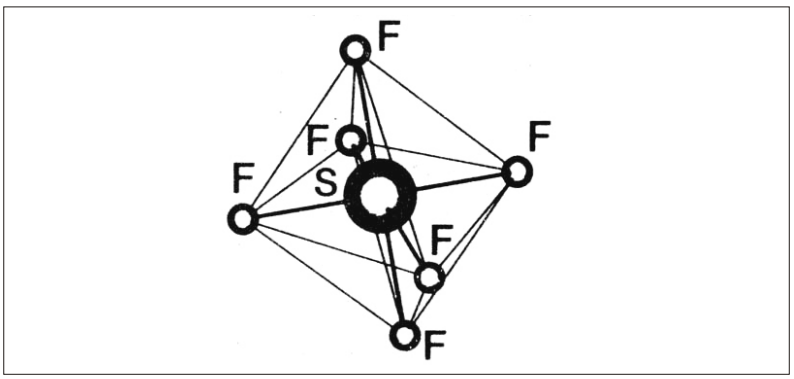


Fig - 1
Structure of SF_6 molecule

The main characteristics of Sf_6 gas are:

The gas is neither combustible nor toxic.

It is chemically stable and will not age with time.

Breaking capacity of Sf6 gas is high even at relatively low pressure, because of its superior dielectric and thermal properties.

The interruption in Sf_6 gas is not forced and thus no over voltages are generated. No damping resistor or surge arrestor is needed, not even when controlling small motors.

The dielectric strength at the relevant pressure is about 3 times higher than air and is roughly at par with oil.

Any leakage is easily detected. To provide an extra margin of safety, the breaker is capable of interrupting its rated current at rated voltage even at atmospheric pressure.

The Sf_6 breaker type HPA operates on what is usually referred to as the puffer principle. This involves compressing the gas between a static piston and a movable cylinder during the interruption action. The compressed gas is then blown through a nozzle in which the arc is taking place. A combination of careful attention to design and the use of proven components has meant that arcing times in the new HPA breaker have been reduced to a minimum. As a result, the new breaker contacts will normally not need replacement during the service life of the breaker. The breaker pole operation is shown in fig. 2.

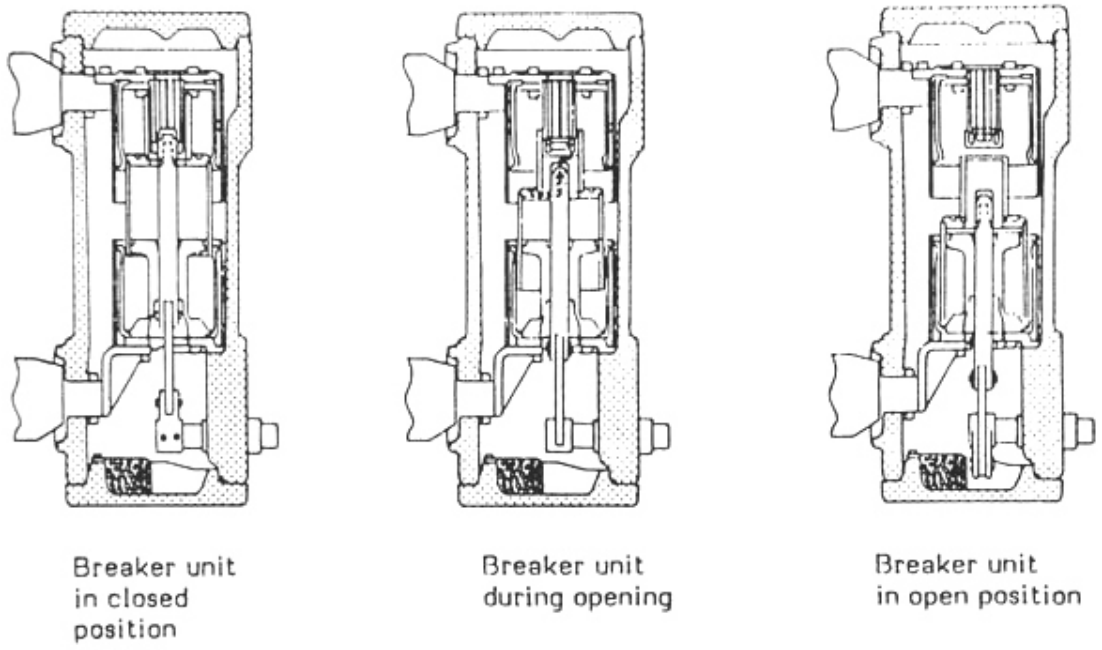


Fig - 2
(The Puffer Principle)

During the manufacture of the breaker pole, it is dried internally through vacuum pumping. The breaker pole is then pressurized and also tested against leaks. Inside the pole there is an absorption medium for the decomposition products of the gas. The breaker poles should only be opened up by trained service personnel at the manufacturing factory. The locking screws are tightened up to a predetermined torque at the factory and must not be opened. If it is assumed that moisture has entered (gas pressure = atmospheric 0) the pole, the same should be returned to the factory for repair.

SF_6 gas which has been exposed to arcs contain components which combined with moisture become corrosive. Filling up of gas should always be carried out according to section 2.3.2 “Checking and Refilling of Sf_6 gas”.

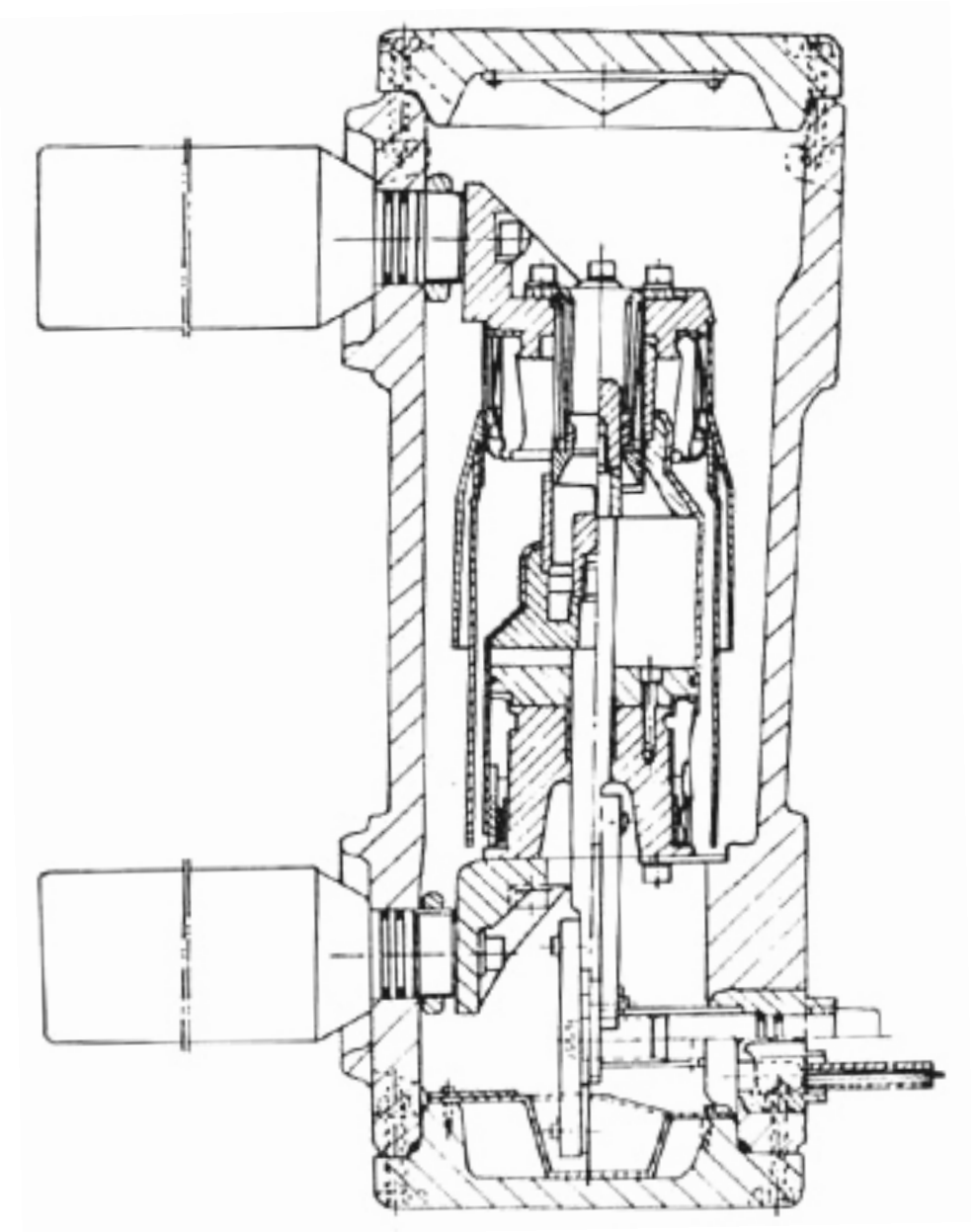


Fig - 3a
(HPA breaker pole for 12 kV / 24 kV)

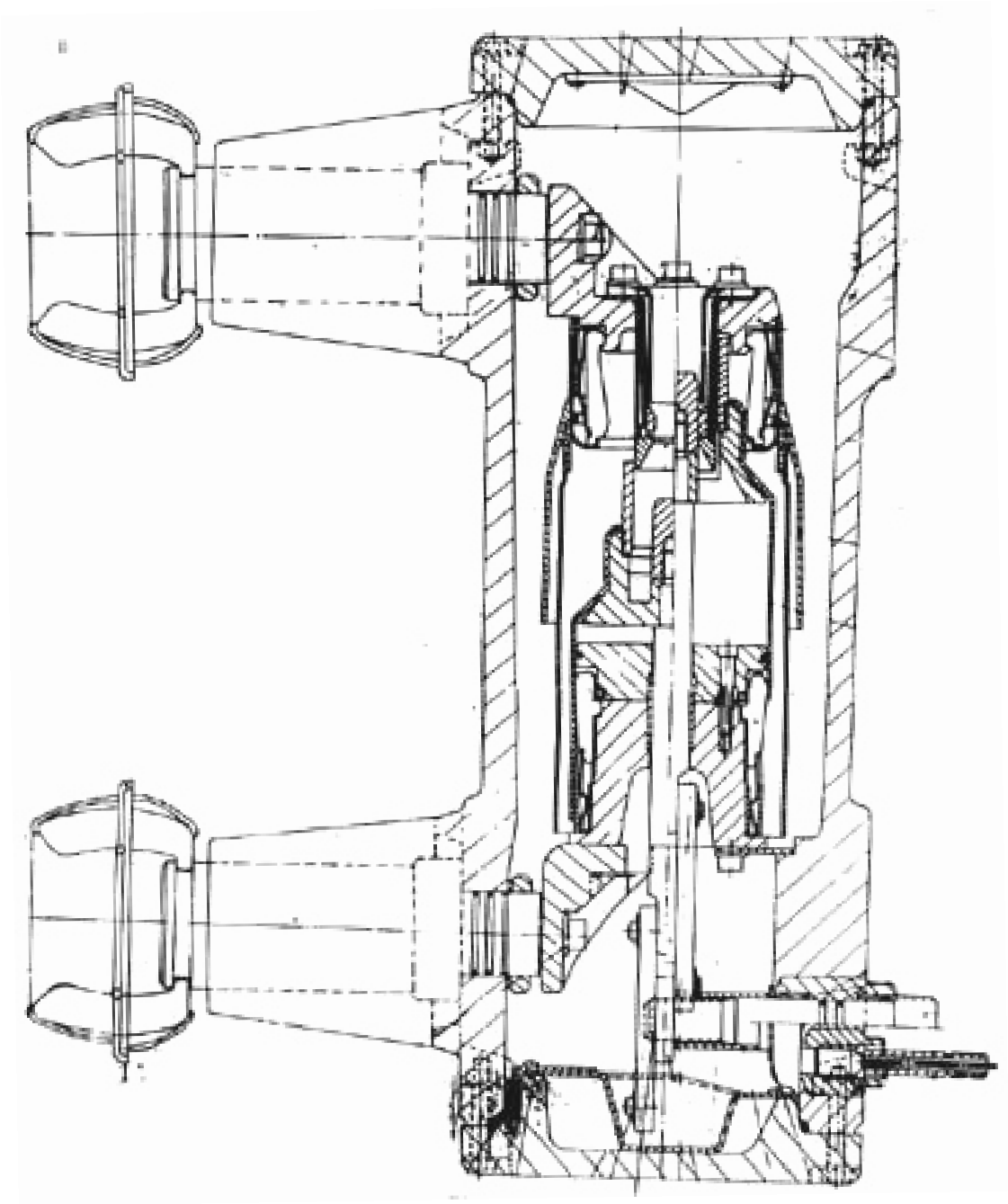


Fig - 3b
(HPA breaker pole for 36 kV)

1.2.2 Operating mechanism

The operating mechanism has a spring charging device which can be operated by motor or by hand. Once a closing command has been given it is always completed by the breaker; this is important in the event of short circuit. Since, the circuit breaker closes completely before it opens, the correct contact speed and full breaking capacity are obtained. The operating device has compression springs for closing and opening. The opening spring is charged automatically when the breaker is closed. A closed breaker with charged closing springs can be operated open - close - open without intermediate motor or manual charging and the breaker can therefore be used for auto re-closing. Charging of the closing spring can be discharged by disconnecting the voltage to the motor and manually operate the breaker close - open.

An indication shows whether the closing spring are charged or not and the number of opening operations are recorded on a counter.

The motor can be supplied via a station battery, a network or via a voltage transformer with a limit load of at least 300 VA. The motor starts after each closing operation and charges the closing springs within 9 seconds. The breaker is fitted with a knob for mechanical openings and with magnetic coils for closing and openings. The same operating mechanism is used for all types of HPA breaker.

The construction of the operating mechanism is shown in fig. 4. The device has two shafts. The lower shaft (6) is connected to the breaker poles via links and is directly actuated by the openings springs (5). The upper shaft (3) is connected directly to the closing spring (11). These two shafts are linked via the driving disc (9) and the link (12), and by the trip free device (14). The upper shaft is also connected to the charging device via the trip-free device (1) and the link (4).

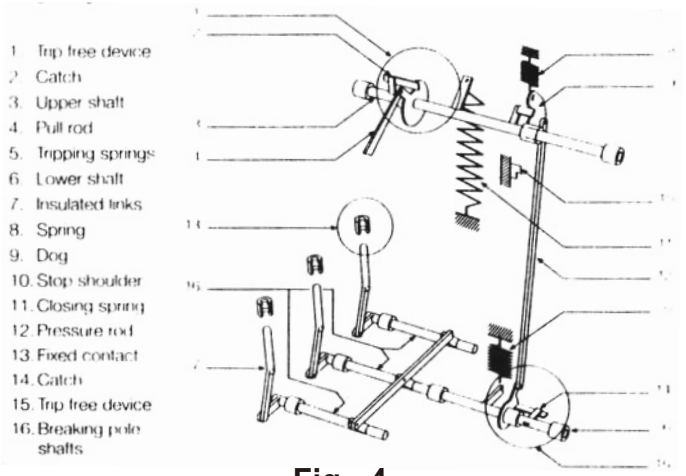


Fig - 4
(Principle diagram of Circuit Breaker)

The latching and trip-free devices (1) and (14) are of the same type that have been used in ABB equipment since 1950 and have proven extremely reliable.

The motor operated unit consists of a toothed transmission gear with an eccentrically driven tooth wheel as a last step. The operating device also contains auxiliary contacts and trip coils.

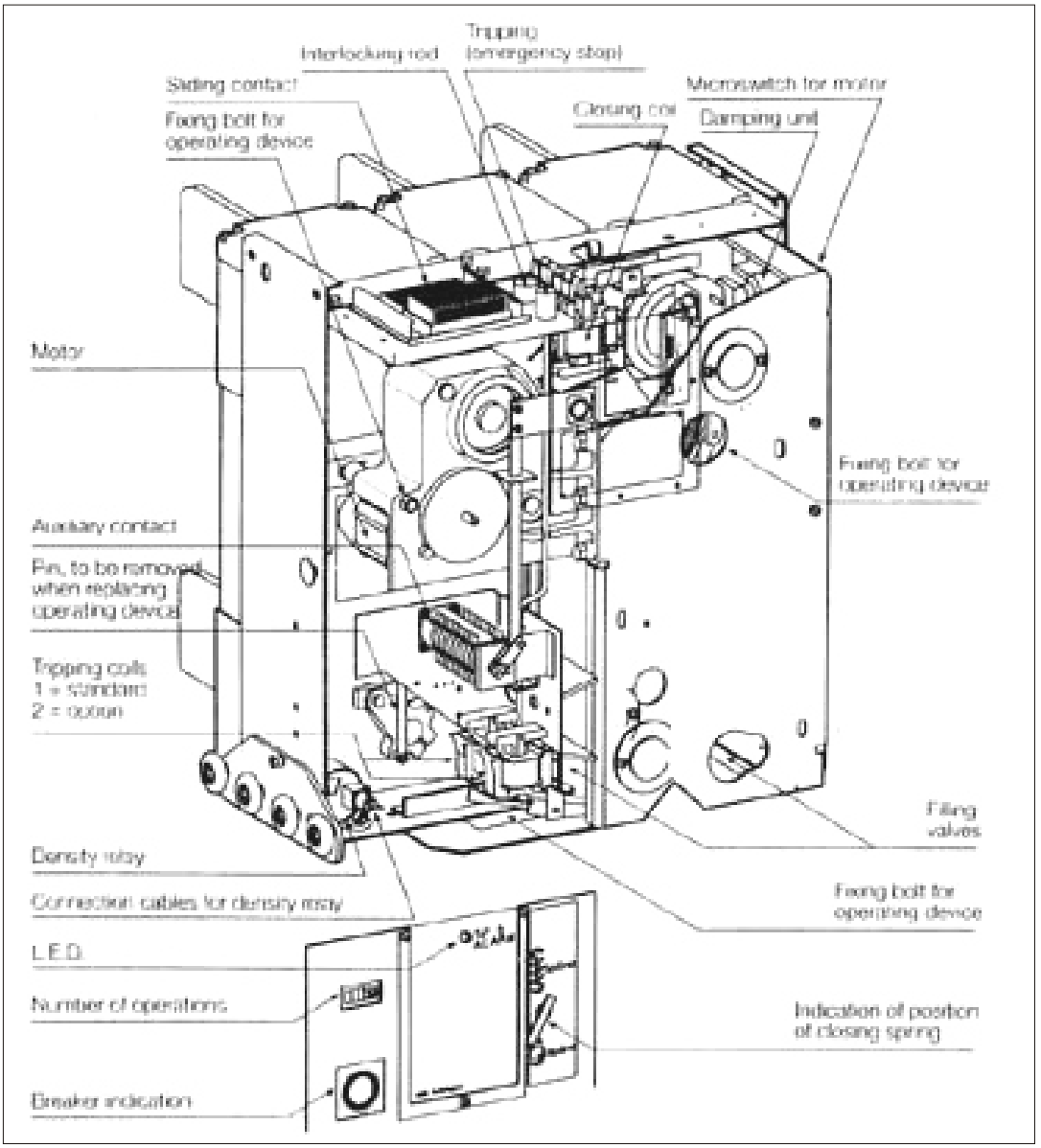


Fig - 5
(Circuit Breaker)

SPRING MECHANISM

SR. NO.	ITEM DESCRIPTION	PART NO.
1 & 2	Trip free device top	IN 5436 0001 - A
3	Upper shaft assembly	IN 5439 0002 - D
4	Link or pull rod	IN 2104 00101 - AK
5	Opening spring	IN 2192 0002 - D
6	Bottom shaft assembly	IN 5439 0002 - B
7	Insulating links	will not be supplied loose
8	Spring	IN 2192 0001 - 21
9	Driver	IN 2184 0002 - 34
10	A) Stopper or M16 X 50 Hex socket head Grub screw	IN 2122 2768 - 50
	B) M16 nut	IN 2126 2768 - 124
	C) M16 spring washer	IN 2154 2022 - 9
11	Closing spring	IN 2192 0002 - B
12	Link	IN 2194 0001 - AE
13	Contact	will not be supplied loose
14 & 15	Trip free device (bottom)	IN 5436 0001 - B

OPERATING MECHANISM

SR. NO.	ITEM DESCRIPTION	PART NO.
1	Closing coil	IN 5274 0001 - A*
2	Closing Damping device	IN 5256 0711 - 4
3	Micro switch	IN 5445 0744 - A
4	Fixing bolts for Operating device tripping coil	IN 5274 0001 - A*
5	Short cover	IN 5428 0002 - 2@
6	'O' ring	IN 2152 2018 - 10@
7	Density switch	IN 5663 0162 - 1
8	Auxiliary contact	IN 5218 0004 - 1
9	Motor	IN 4461 0002 - E*
10	Indicating plate assly.	IN 5428 0001 - M
11	Counter	IN 5692 0501 - 2

***Please specify voltage.**
@ If density Switch is used, short cover will be supplied in place of refilling vent

Operating Mechanism Working Principle:

Fig. 6A shows the operating device with the breaker in the open position. The closing spring (11) is charged if the latch (2) is tripped, the upper shaft is released, its turning is transmitted via link (12) to the breaker pole shafts (6).

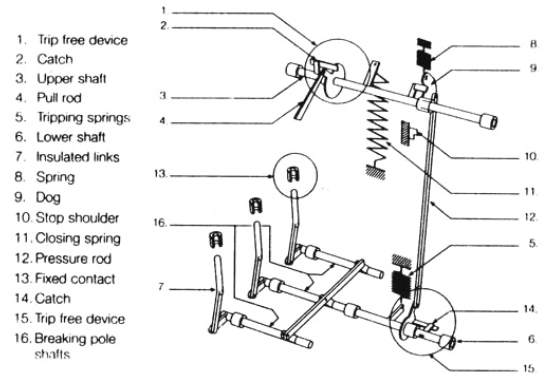


Fig - 6A

In fig. 6B the breaker has closed and at the same time the opening spring (5) has been charged. Driving disc (9) comes to rest against stop (10) which, via link (12) and trip free device (14) also prevents the opening spring turning the breaker pole shaft (6). Now the charging device starts and link (4) moves upwards until latch (2) is engaged. At this point link (4) turns and begins to move downwards, whereupon the upper shaft turns and retentions. The closing spring position is reached according to fig. 6C.

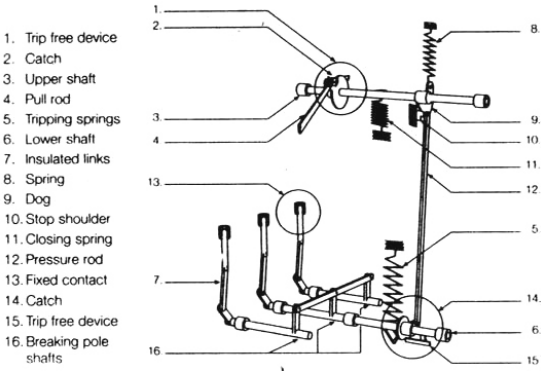


Fig - 6B

During the breaker opening, latch (14) is released, thus releasing the lower shaft which via the insulating links (7), actuates the moving contact of the breaker poles, for interruption. The spring (8) returns the link (12) with the associated driving pin and the operating device to the position in fig. 6A.

For rapid re-closing the associated switchgear cubicles can be fitted with suitable relay equipment. The HPA can be fitted with two opening coils, one closing coils.

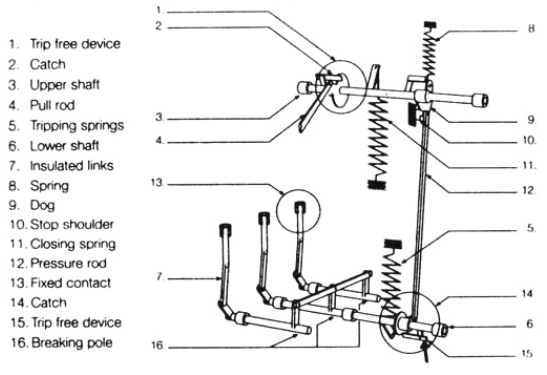


Fig - 6C

2.3 Maintenance

2.3.1 Maintenance schedule (As per Drg. 1VYN400290-005 Pg. 11 & 12)

Sr. No.	Description	Before Start up	Interval of 6 months	Interval of 5 years	Every 1000 operation
01	CHECKING OF OPERATING MECHANISM.				
1.1	Checking of fastener tightness fig. 7A Item B. H. L. & M.	✔	✔	----	✔
1.2	Checking of shock absorbers for Leakage or stuck-up fig. 7A item F & G	✔	✔	----	✔
1.3	Checking of top & bottom trip free mechanism, cap & coupling Fig. 7A, item J & K	✔	✔	----	✔
1.4	Closing & Tripping spring assembly & split pin (N) on them (fig. 7A)	----	----	----	✔
1.5	Bearing item (P) fig. 7A	----	----	----	✔
1.6	Checking of setting *Coupling and knife catch gap (Setting 1, fig. 7B) *Bottom TFM and CAP gap (Setting 2, fig. 7A) both gaps should be between 1 - 2 mm	✔	✔	----	✔
1.7	Spring cut off micro switches.	✔	✔	----	✔
02	OVERHAUL & LUBRICATION OF CHARGING DEVICE AND OPERATING GEAR	----	----	✔	----
03	GAS PRESSURE CHECK	✔	✔	✔	✔

NOTE

1) Complete overhaul of circuit breaker with replacement of poles to be done after 10,000 operations.

2) Ask ABB for details of overhaul procedures.

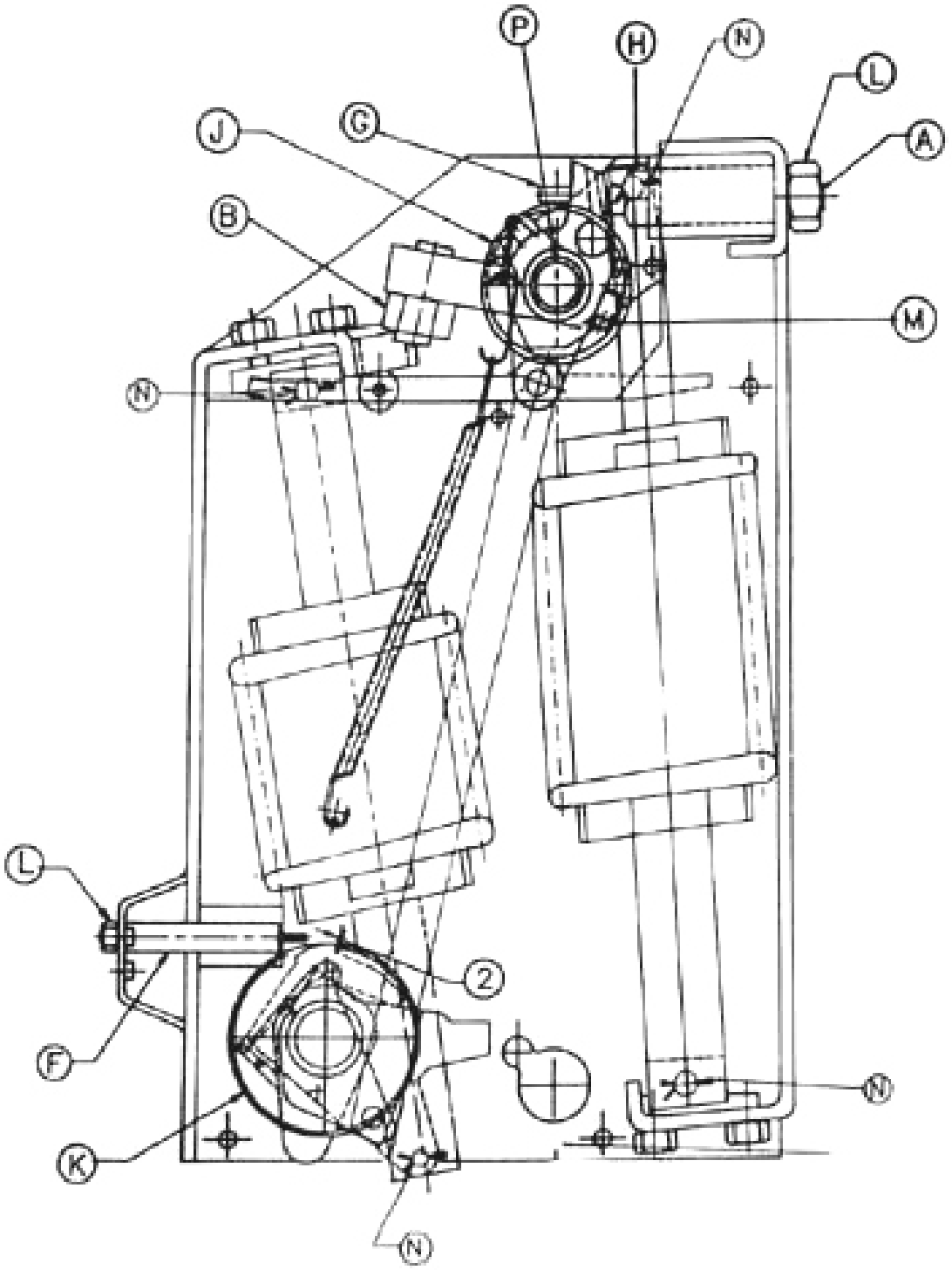


Fig. 7A
Maintenance schedule for frequently operated breaker type HPA (1VYN400290-005)

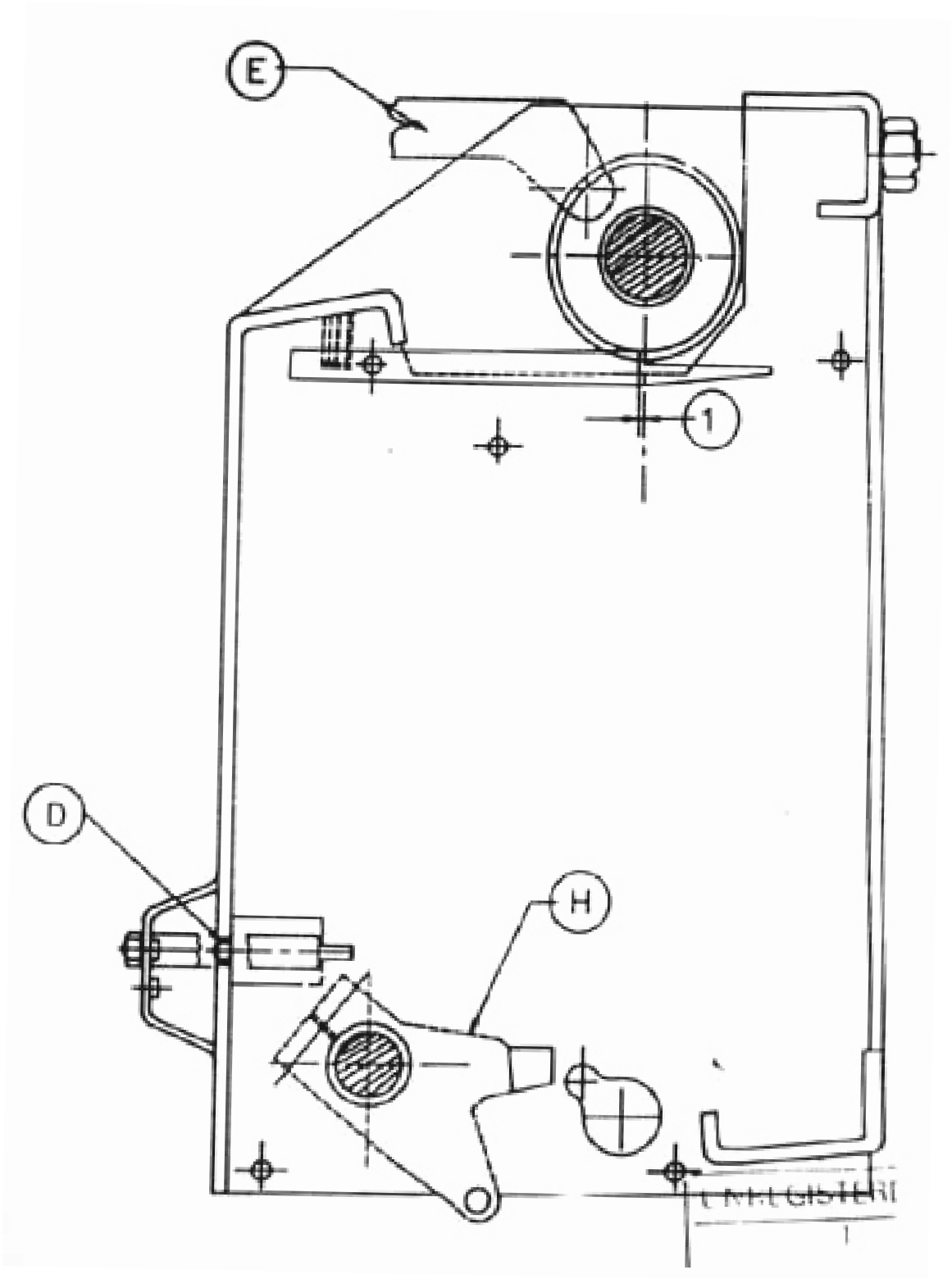
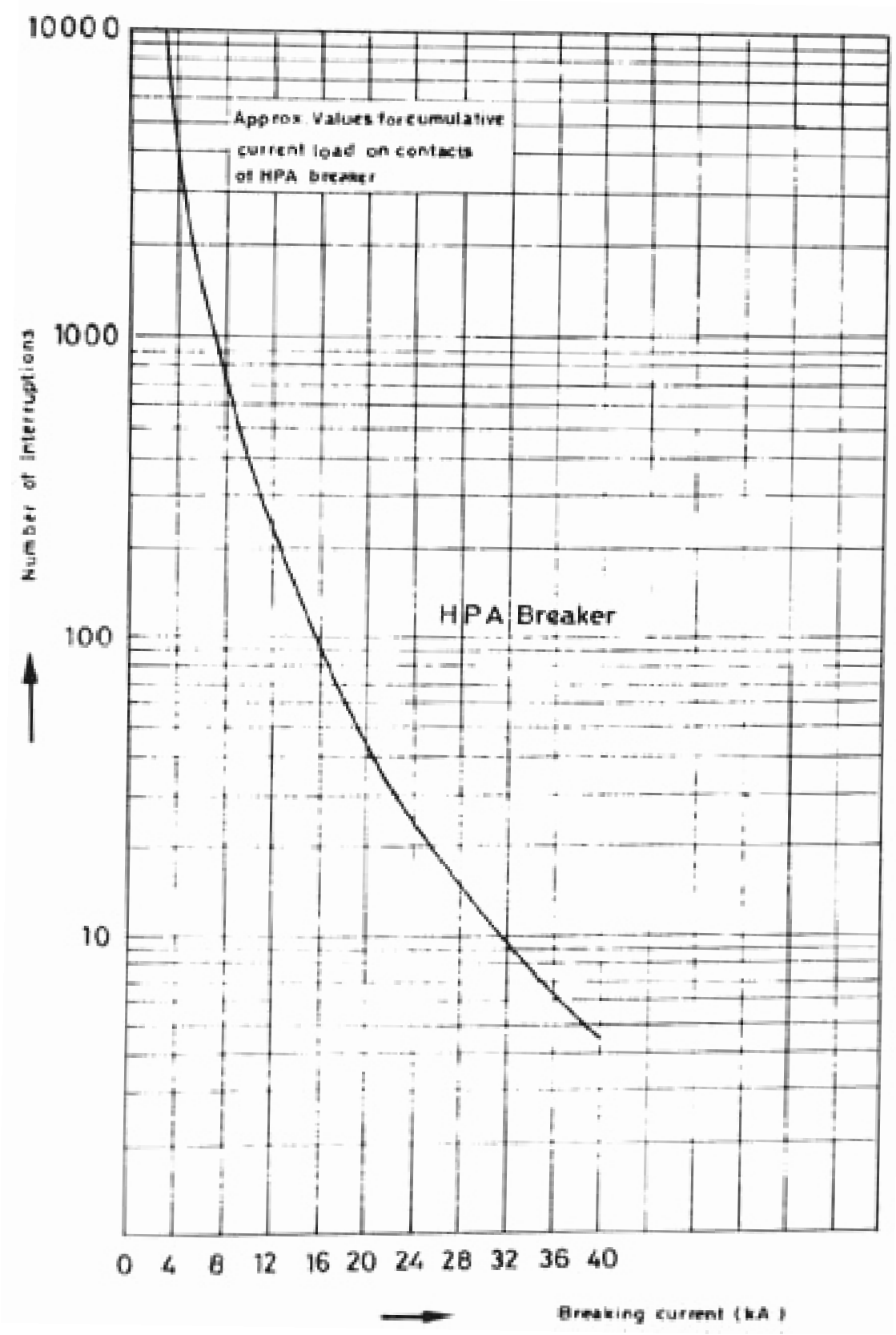


Fig. 7B
Maintenance schedule for frequently operated breaker type HPA (1VYN400290-005)



Electrical endurance (HPA)

1.3.2 Checking and Refilling of SF_6 Gas

Checking and refilling can be done with the front plate fixed. Refilling not be carried out with the breaker in service position. The gas pressure should be between 3 and 3.5 bar absolute, in other words 2 and 2.5 bar over pressure at 20^0C. Lower currents than 25kA can still be in broken at lower pressure. Rated current can be interrupters at atmospheric pressure provided that there is SF_6 gas in the breaker pole, which is certainly valid if there is little over pressure.

At temperature other than 20^0C of the gas the pressure (abs.) must be according to the table below.

Pressure at 20^0C abs.	Corresponding pressure in bars at various temperatures				
Bar	0^0C	10^0C	20^0C	30^0C	40^0C
0.5	0.47	0.48	0.50	0.52	0.54
1.0	0.93	0.97	1.00	1.03	1.06
1.5	1.40	1.45	1.50	1.55	1.60
2.0	1.36	1.93	2.00	2.07	2.14
2.5	2.33	2.41	2.50	2.59	2.68
3.0	2.80	2.90	3.00	3.10	3.20
3.5	3.26	3.42	3.50	3.62	3.74

The HPA breaker can be fitted with a density gauge with an alarm contact and indicator. The green area of the indicator shows the correct pressure, the yellow area indicates enough pressure for breaking, and when the indicator shows red the pole has to be refilled with SF_6 gas. If the breaker is not supplied with density gauge the pressure is measured manually with a special instrument. The measurements should take place at three intervals. The HPA circuit breaker can also be fitted with pressure switches.

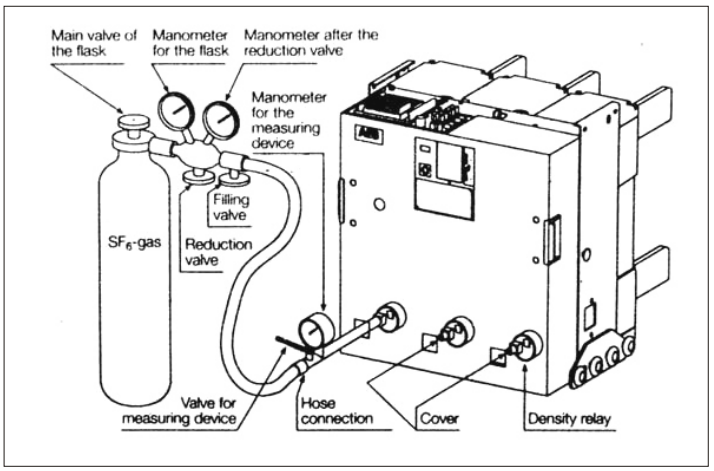


Fig - 8
Connection for filling of Breaker with SF_6 gas

Checking and refilling of SF_6 gas is carried out according to the following instruction. Equipment according to fig. 16 is needed.

SF_6 GAS REFILLING EQUIPMENT

Sr. No.	ITEM DESCRIPTION	PART No.
1	Gas cylinder S 194-5600-103-17	supplied in 10 kg or 25 kg cylinder.
2	Regulator a) cylinder pressure gauge b) outlet pressure gauge c) reducing valve	 IN 6821 0001 - 1
3	Pressure House	IN 2515 0001 - 1
4	Gas filling valve 'OR' Snap connection	IN 2529 0001 - 7
5	Connecting nipple	IN 2529 0001 - 8 IN 2529 0001 - 9 IN 2529 0001 - 5
6	Refilling unit with density switch without density switch *with pressure switch*	IN 5428 0001 - 5 IN 5428 0001 - 6 *1VYN 400 201 - AY*

1.3.3 Control of gas pressure (only for poles without pressure gauge / Pressure switch)

1. Close metering pressure valve

2. Connect metering pressure gauge to pole.

3. Read pressure compensation for temperature as shown on page 14. If reading Is between 2.0 and 2.5 disconnect gauge.

4. Disconnect the operating device by disconnecting the voltage to the motor and operate by hand "close" and "open".

5. Close cylinder reducer valve.

6. Close charging valve.

7. Open cylinder main valve, and note reading on gauge (should show approx. 70 bar for full cylinder).

8. Open the reducer valve until a reading of 2.5 bar pressure is registered. (If the reading is too high, close reducer valve and release gas by opening charging valve with hose disconnected).

9. Open charging valve a little so that the gas leaks a little, thereby emptying Hose of any air.

10. With the use of the snap connection, connect the hose to the metering tube.

11. Open the metering pressure valve.

12. Open the charging valve until a reading of 2.5 bar (20^{0}C) is registered on the metering gauge.

13. Close cylinder main valve.

14. Close both charging and metering valves.

15. Loosen the snap connection.

Note: The hose contains gas at a pressure of 2.5 bar and this will blow out.

16. Loosen the metering unit until gas begins to escape, then disconnect immediately the metering unit so that the back pressure valve in the pole automatically closes.

17. Disconnect metering unit.

18. Check the O-ring of the covers, if they are dry, exchange with new ones which have been greased with ABB grease IN 1171 4014 - 49.

Note: Mineral grease must not be used on EPDMO - rings. Replace the cover on the connection nipple.

1.3.4 Checking of operating speed and time

Checking of operating speed can be made with a capacitive sensor. The sensor is connected to a conventional oscilloscope. The curve shown in fig. 9 shows what valves should be obtained on the oscilloscope.

Closing speed (a/10)	2.0 - 2.5 mtrs. / sec.
Opening speed (b/10)	3.6 - 4.3 mtrs. / sec.
Closing time with nominal voltage max.	75 ms
Opening time with nominal voltage	36 - 45 ms
Contact travel	62 - 66 mm

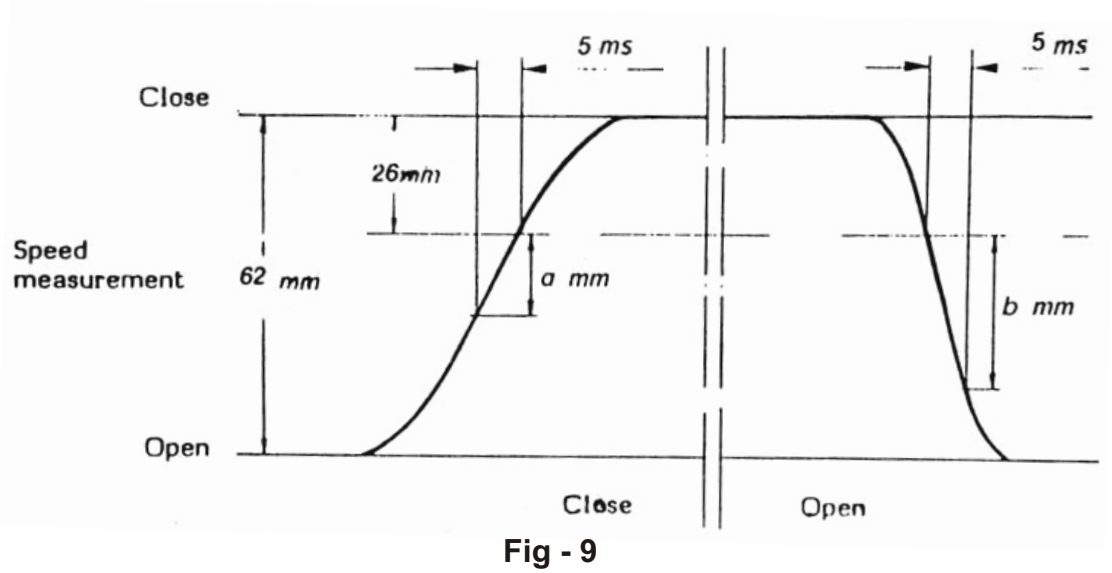


Fig - 9
(Travel diagram)

F*unctional check is carried out as follows*

1. Connect the sensor to the connecting link of the poles, see fig. 10.

2. Check with the aid of vernier callipers that the movement from open to closed positions is 81 - 85 mm.

3. Adjust the oscilloscopes input to 85 mm, see fig. 9.

4. Make an opening operation. The curve on the oscilloscope should be as shown in fig. 9.

5. Make a closing operation.

6. If the speeds are not correct, the spring force is to be adjusted. See section 1.4.9 “Adjustment of operating device”.

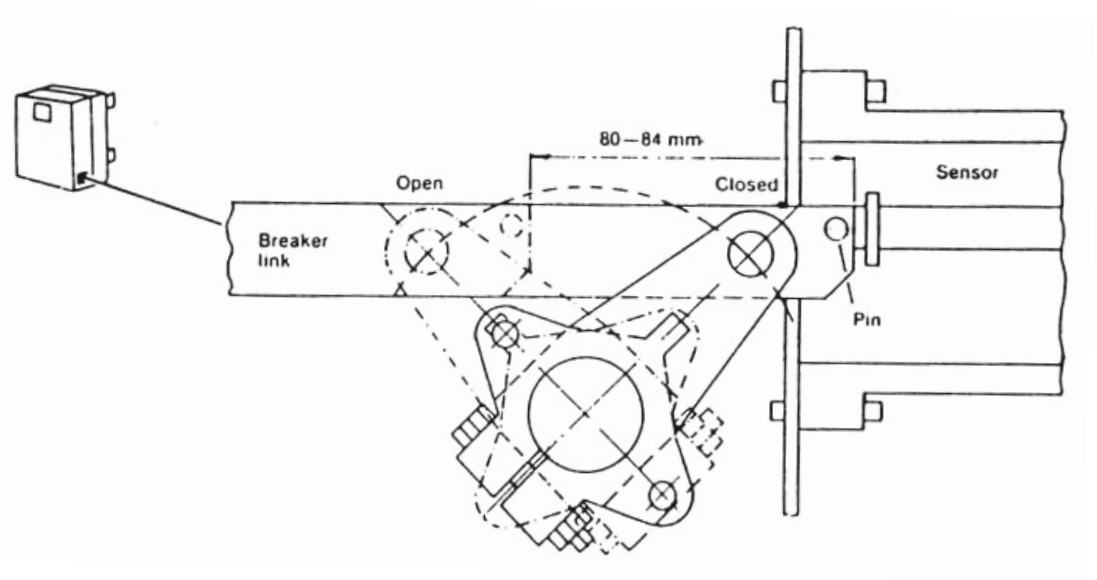


Fig - 10
(Connection of capacitive sensor)

1.4 Service instructions

Safety instructions - For dismantling and servicing of breakers, the following steps should be followed:

1. Disconnect the breaker.
2. Pull out the breaker on the door.
3. Manually release the closing springs.
4. Manually release the opening springs.

1.4.1 Fault finding chart

FAULT	CAUSE	REMEDY
Spring will not charge	Motor has wrong or no operating voltage	Measure voltage on the motor leads.
	Motor shaft broken	Change motor
	Motor gear damage	Change motor
	The latch for tripping device does not function	Check mechanism NOTE: Read safety instruction in paragraph 1.3 before taking action
	Disconnection in the wires	Check by measuring.
Closing of breaker does not take place although there is an indication that the springs are tensioned.	Operating coil does not pull	Measure the voltage, adjust the coils adjust-ment screw. Check breaker springs
Breaker closes then opens again.	The toggle joint of the mechanism are incorrectly adjusted	Adjust the toggle joint
	Main circuit is wrong	Find fault and adjust
	Wrongly adjusted clearance of opening magnets armature	Adjust
Breaker continuously opens and closes	Anti-pumping relay wrong	Change relay
Breaker will not close completely	Micro-switch arm wrongly adjusted	Find fault and adjust
	Under-voltage relay released.	Find fault and adjust

1.4.2 Replacement of operating coils

For positioning of operating coils, see fig. 11A & 11B. The coil is fixed with 4 screws.

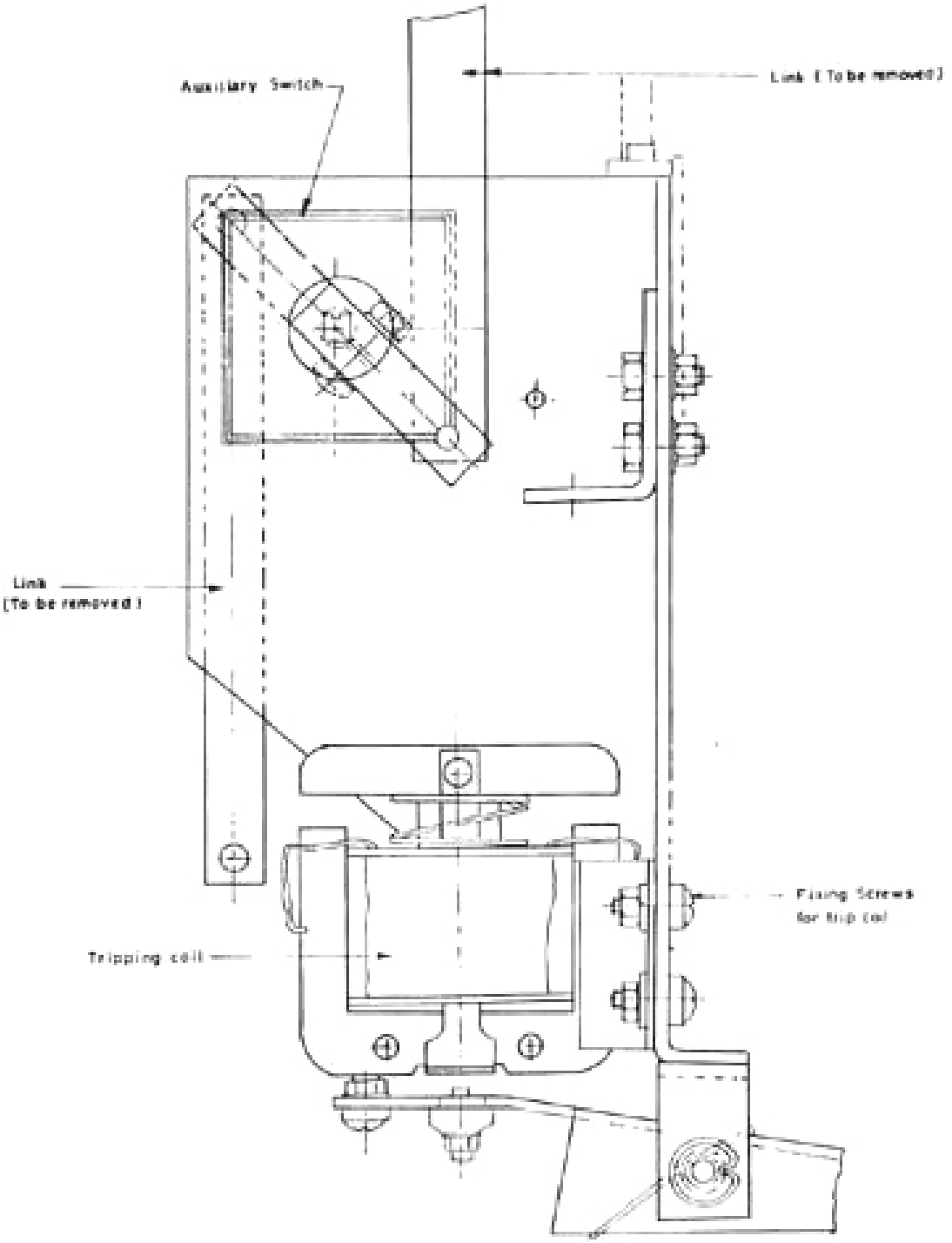


Fig - 11A
(Replacement of Trip coil & auxiliary switch)

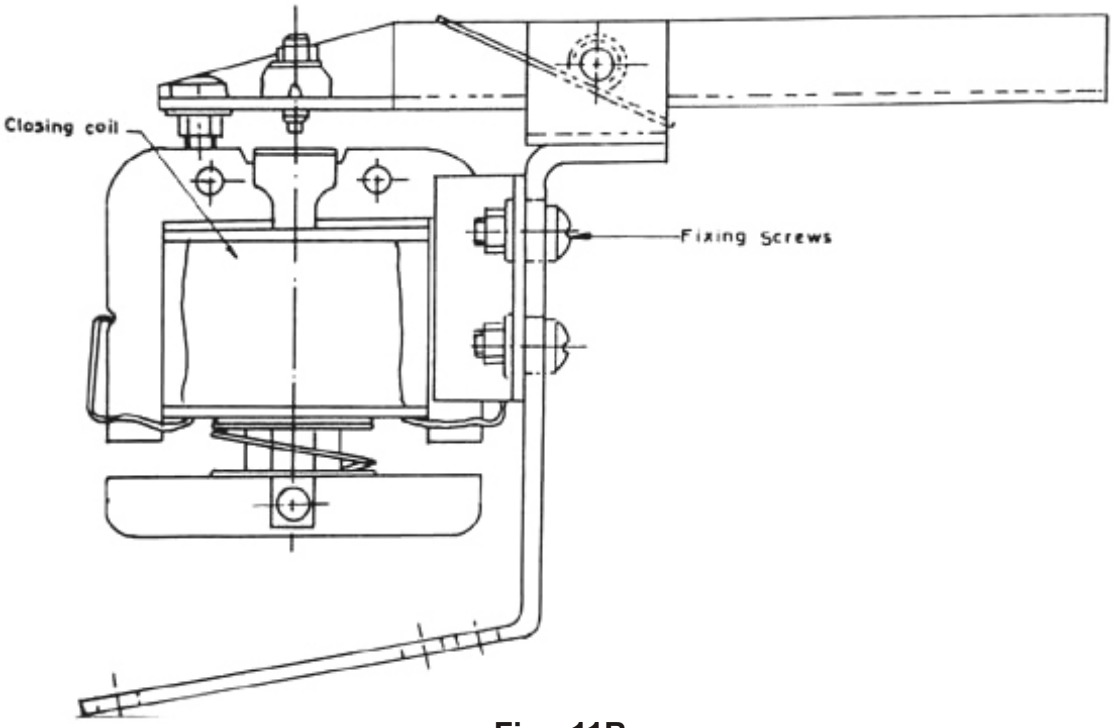


Fig - 11B
(Replacement of closing coil)

1.4.3 Replacement of Micro-Switch

For positioning of micro-switches, see fig. 12. The switches are fixed with 2 screws.

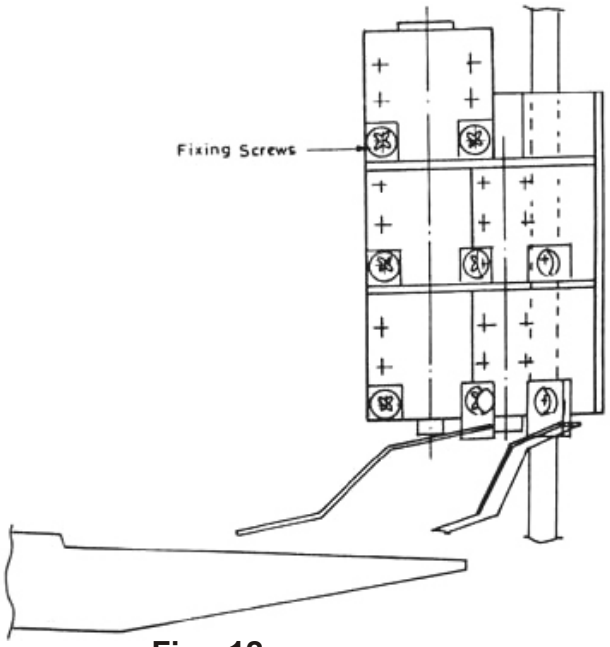


Fig - 12
(Replacement of Micro - switch)

1.4.4 Replacement of auxiliary contacts

Positioning of auxiliary contacts, see fig. 5. The contacts are fixed with 4 screws. Remove the 2 links as shown in the fig. 11A Disconnecting cable (note marking before removing switch and connect in same position).

1.4.5 Replacement of motor

Motor is fixed with 4 screws. There are flat terminals for cables. See fig. 13.

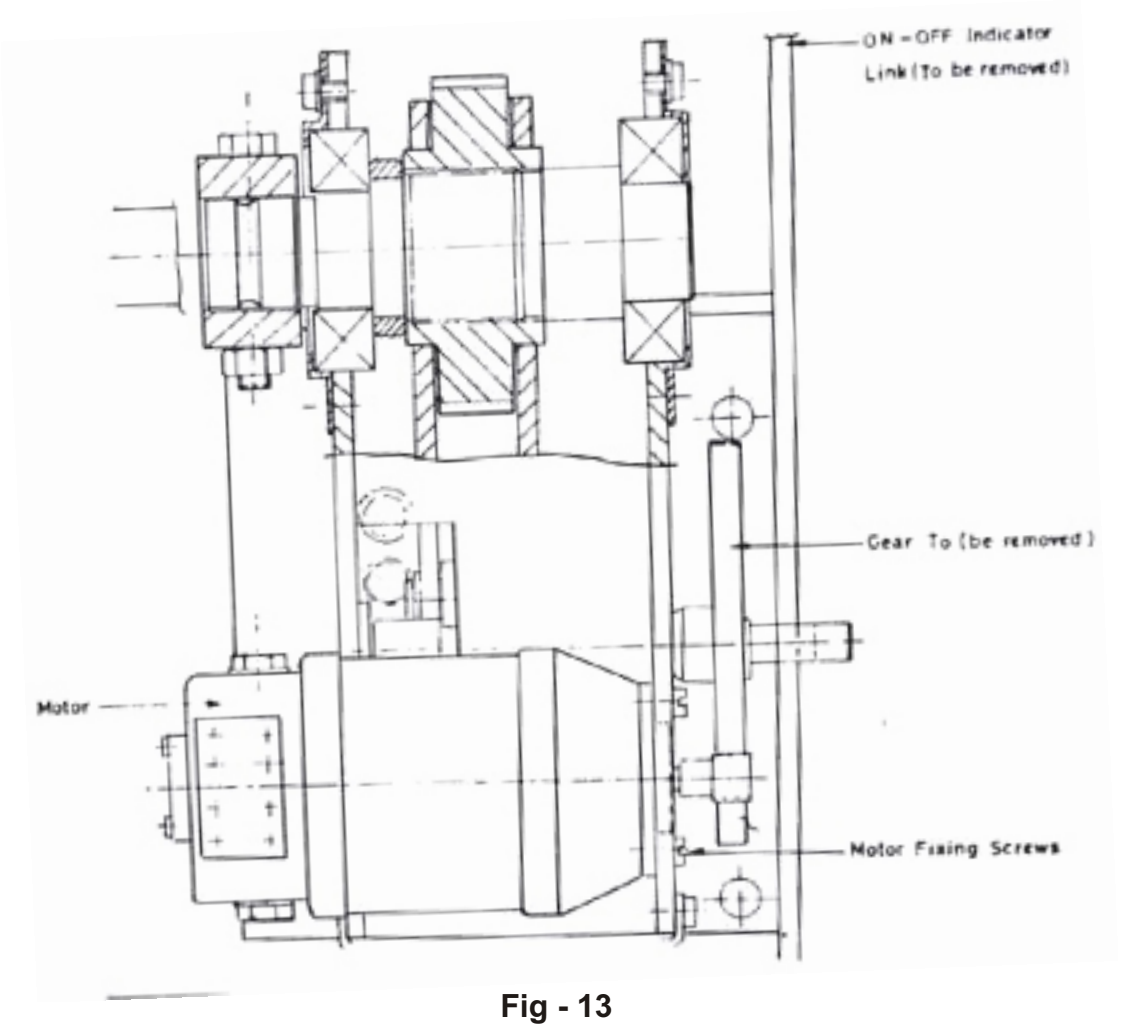


Fig - 13
(Replacement of Motor)

1.4.6 Replacement of Damping device

When replacing the damping device, the closing spring must be charged. For this work the release mechanism for the spring unit must be secured, see fig. 14. Securing the device can be achieved with a G-clamp.

Note: For extra security both the opening and the closing springs must be fastened. On one side of the damping device there is an adjustment screw. The position of this screw should not be altered.

Reasons for changing the damping device can be oil leaks normally the device does not need maintenance. Repair of the device must not be carried out. Never operate the breaker without the damping device as damage to the breaker can occur.

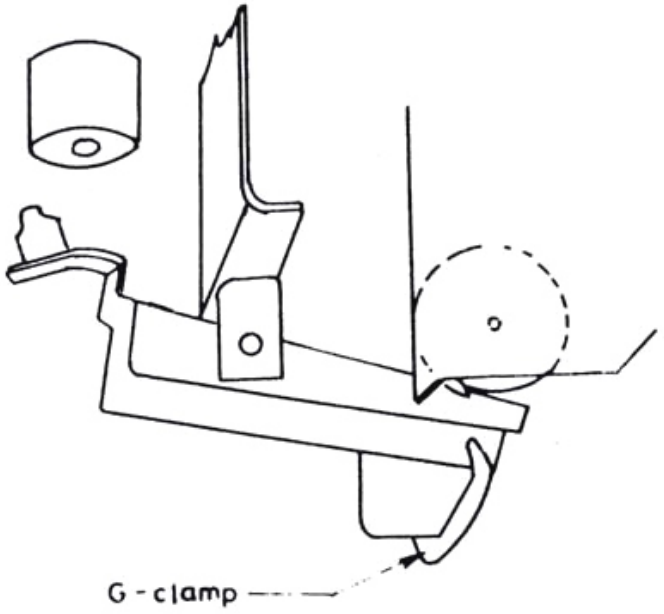


Fig - 14
(Locking of the release mechanism for spring)

Changing of damping device is carried out as follows:

1. Move the breaker out onto the door.
2. Close the breaker if the damping device is to be changed.
3. Lock and secure the release mechanism according to fig. 14. Be extremely careful that hands are kept clear of the mechanism and the springs in case of release.
4. Loosen the devices safety nuts. Withdraw the device from the plate. No other units need to be loosened. If other units are loosened, there is a risk of the springs being released. The lower part of the device is pulled out through a hole in the plate.
5. Insert the new damping device. Adjust it so that at the “ON” position, the step of the shaft of damping device shall be in line with the damping device housing.
6. Tighten the safety nuts.
7. Loosen the locking for release mechanism.

1.4.7 Replacement of operating mechanism

1. Remove the breaker from the cubicle and keep it on a suitable foundation.

2. Loosen the operating devices cover, see fig. 15. Lift off cover.

3. Loosen the sliding contacts screws, pin, connecting cables and the 4 screws, see fig.

4. Completely withdraw the operating device.

CHANGING OF BREAKER POLE

SR. NO.	ITEM DESCRIPTION	PART NO.
1.	Sliding contact screws	IN 2121 2016 - 408
2.	Operating mechanism	IN 5432 0001 - F
3.	Fixing screw and operating arm	IN 2121 2016 - 418
4.	Density gauge	IN 5663 162 - 1
5.	Nut M-45	IN 2126 0001 - 9
6.	Nut M-27	IN 2126 0001 - 10
7.	Screw M-12 X 20	IN 2121 0001 - 523
8.	Breaker pole 11kV Breaker pole 22kV	IN 5452 0002 - L IN 5452 0002 - U
9.	Short cover	IN 5425 0002 - 2

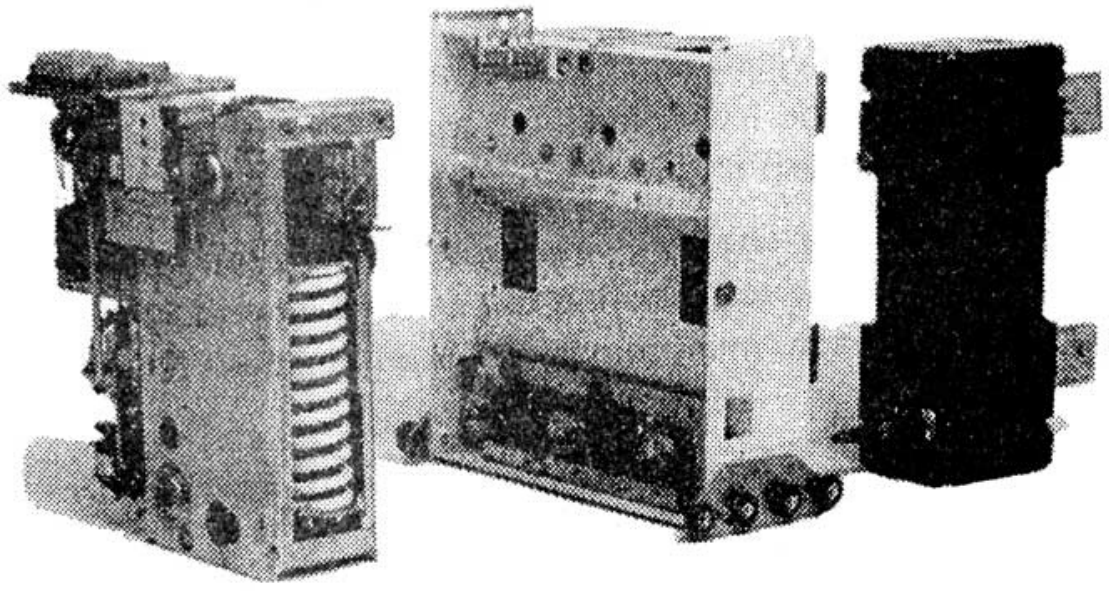


Fig - 15
(HPA Breaker with operating device & breaking pole dis-assembled)

1.4.8 Changing of breaker pole

1. Loosen the operating device according to section 1.4.7
2. Loosen the 2 screws of the operating arms. (The pole in the middle has no screws). Remove the links and arms.
3. Remove the density gauge (special key) or loosen the cover for gas refilling.
4. Put on the long cover which is mounted on the new pole.

Note: Do not put on the short cover, without the density gauge, because the back pressure valve will open allowing gas to escape.

5. Loosen the pole with key 32 and 55. Loosen the M12 screws.

6. Mount the long cover on the new pole.

7. Fit the new pole.

8. Mount the long cover on the old pole and mount the density gauge and short cover. (Check that the O-ring are good). Fasten the nuts with special tool.

9. Replace the short cover.

2.4.9 HPA-Operating gear adjustments (ref. Fig. 5, 7A, 7B)

For a preliminary adjustment, check the operating gear separate and without springs and dash pot.

Locate the dock point screw (B) on top shaft are in minimum position (unlocked). This is to ensure that the trip free mechanism operates safely when the spring is charged and thus preventing “dummy stroke”.

1. Adjustment of knee joint (blue gauge) adjust gap (3) (from centre of upper pin in push rod to a line from centre of upper shaft to the lower pin in push rod) 3.5 - 4.5 with the help of dog-point screw (A). Lock the screw after adjustment.

2. Adjustment of lower shaft - closed position. The arm (H) must hit the stop (C), but not enough to cause blocking of push rod when forced over knee position. Lower trip free mech. must remain in locked position. Secure the lock nut after adjustment.

3. Adjustment of lower shaft.

4. Lower dash pot. Mount the dash pot (F). Check the dash pot piston has an over travel of 0.5 to 2 mm when lower shaft is in final “trip” position. If necessary adjust with washers. Secure the loci nut.

5. Upper dash pot and springs. Mount upper dash pot (G) opening spring, closing spring and return spring. Over travel in dash pot should be 0.5 to 2 mm if necessary adjust with washers.

6. Link (E). Mount charging device on the spring mechanism. Adjust link (E) to allow the trip free device to catch when the closing spring is about to be charged. Ensure that coupling is locked in 2nd step of knife catch.

7. Complete operating gear. Mount the operating gears on frame with breaker poles.

    7.1 Charge the closing spring.
    7.2 Close the breaker.
    7.3 Charge the closing spring again. Check that clearance.

        1. At upper trip free mechanism and knife catch is 0.8 - 1 mm. This should be checked when spring is fully charged, i.e. Before the link (E) is disconnected (immediately before click noise).

    7.4 If clearance is more than 1 mm then shorten the pull link (E), and if it is less than 0.3 mm extend the link.

    7.5 secure the lock nuts in link (E).

8. Lower trip free mechanism. Open the breaker and check the clearance (2). Adjust clearance (2) to 1 mm by using dog point screw (B) on upper arm. Secure the lock nut, when breaker is closed.

9. Micro-switches to be adjusted as per instruction IN 5452 0003 - 15.

10. Final test. Check breaker with operating circuit connected. While charging at minimum operating voltage of motor the charging gear is supposed to rotate until the coupling is locked by knife catch.

11. After 50 electrical operations, knee point setting (3), coupling clearance (1) and cap clearance (2) should be checked and corrected, if necessary.

12. Seal various lock nuts of various setting with red point.

2.5 Accessories, spare parts and additional equipment

We recommend the following parts to be held as spare parts for the breaker unit

1 X Motor	IN 4461 0002*
1 X Coil	IN 5445 0007*
2 X Micro-switches	IN 5445 0744 - A
1 X Breaker pole	

The above quantity we estimate to be suitable for a station size of between 1 - 10 cubicles.

* You must state voltage when ordering
* You must state rated voltage and rated current when ordering.

For details refer SAFESIX spare part list.

Crank	
For cranking on cubicle front.	
Normally supplied with cubicle.	Ordering no. IN 6887 0001 - 1
For HPA	Ordering no. IN 2188 0002 - C
Moving trolley	
For removal and insertion of cassette into cubicle	Ordering no. IN 6189 0001 - A
Loose tools	
Refilling device for SF_6 gas for a breaker without density gauge	Drg. No. IN 5428 0001 - C
Refilling device for SF_6 gas for a breaker with density gauge	Drg. No. IN 5428 0001 - E
Pack of washer for refilling device	IN 2152 2018 - 1070 - 4nm
Pressure refilling equipment with a regulator for connecting to SF_6 gas cylinder.	Drg. No. IN 5428 0001 - K
Handle for protective covers on breaker for refilling of SF_6 gas.	IN 2188 0002 - G

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As the design of switchgear from ABB are subject to constant improvement, the product supplied may differ in some details from the specifications and illustrations given here

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