

NRC Medium Voltage Circuit Breaker Training



CHAPTER 8

INTRODUCTION TO ABB HK CIRCUIT BREAKERS

Learning Objectives



- The basic function of the HK circuit breaker.
- How the HK breakers are classed or grouped.
- How the breaker frame size method further identifies the breaker.
- The component attributes of the HK breaker:
 - Chassis Mounting Arrangement
 - Primary Contacts and Arc Chutes
 - Electrical Devices including wiring
 - Mechanical and Safety Interlocks
 - Operating Mechanism
- Basic understanding of common failure modes of HK Breakers.
- Basic understanding of maintenance scheduling.
- Basic understanding of subcomponent replacement.
- Basic understanding of design upgrades for the HK breakers.
- Proper lubrication type for HK breakers.
- Basic understanding of routine maintenance using the Preventative Maintenance Manual for the HK Circuit Breaker.

WHAT IS AN HK CIRCUIT BREAKER



Horizontal “Draw out” design

“ACB” - Air Circuit breaker

Spring Charged operating mechanism

HOW HK CIRCUIT BREAKERS ARE CLASSSED



5HK 250, 1200 Amp

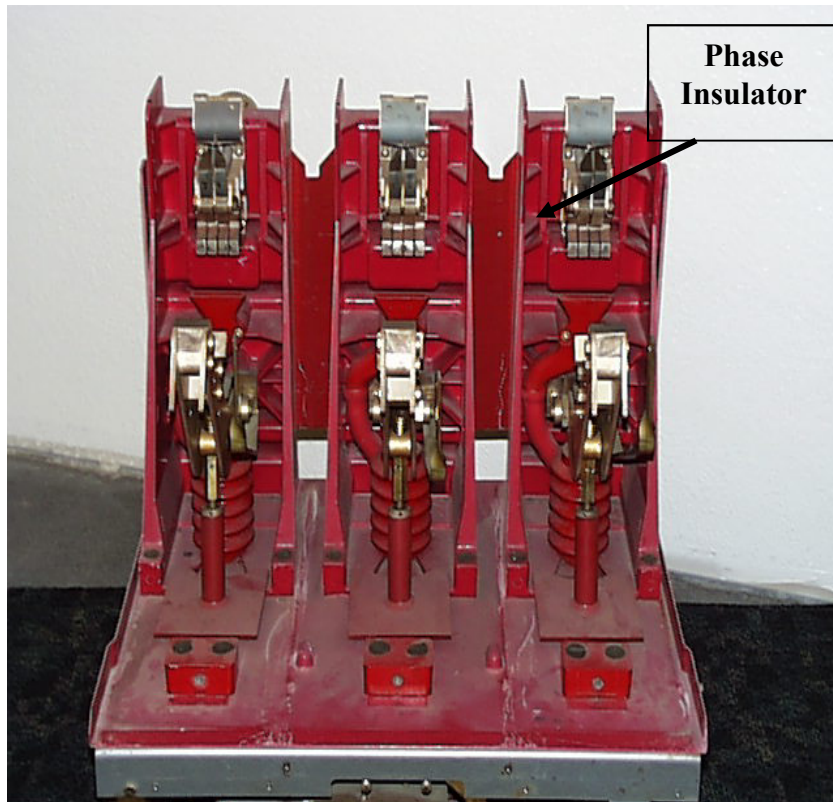
- **5HK-** 5 KV Voltage Class
- **250-**Interrupting Capacity (MVA)
- **1200 Amp-** Maximum continuous amperage

Major Components



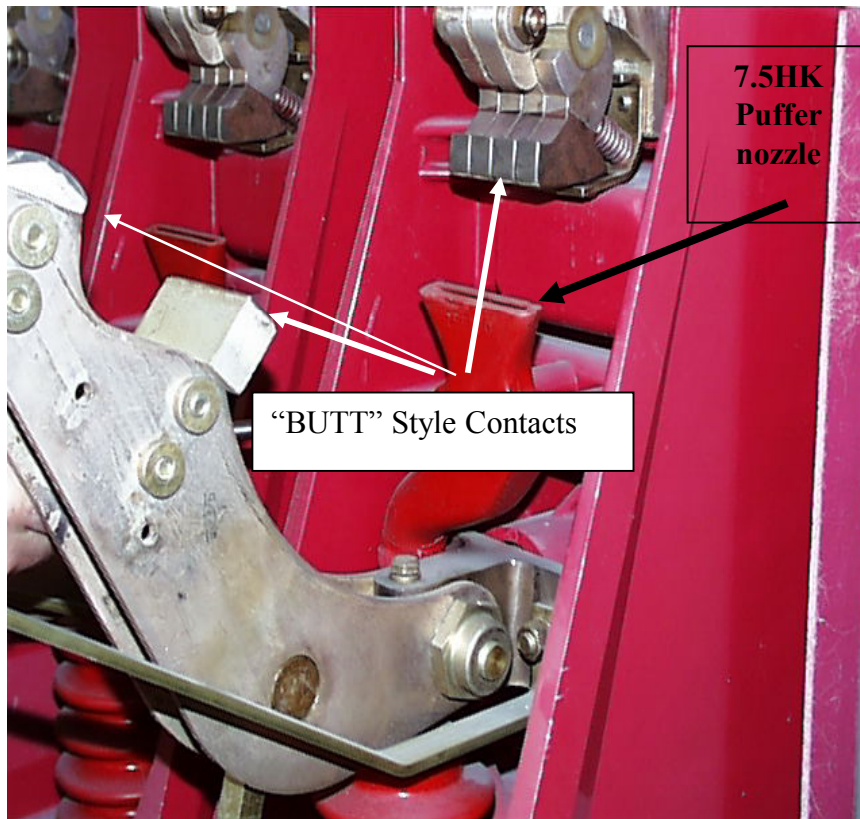
- Front cover, insulator barriers, and arc chutes
- The contact assemblies
- The electrical devices
- The racking device
- Chassis mounted components
- Operating mechanism

contact assemblies



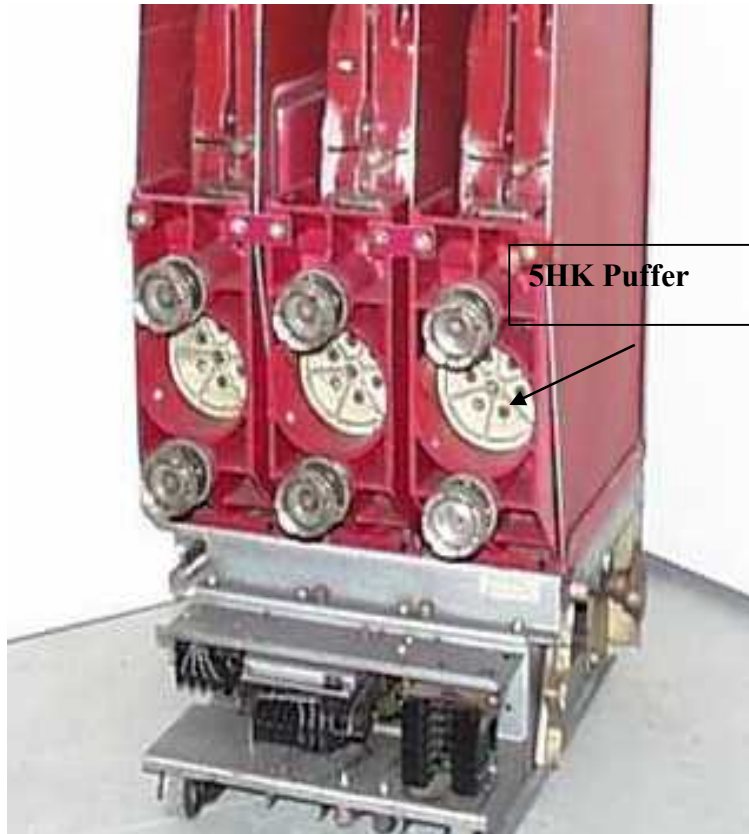
- Contact.
- Phase insulators

Contacts / Puffer



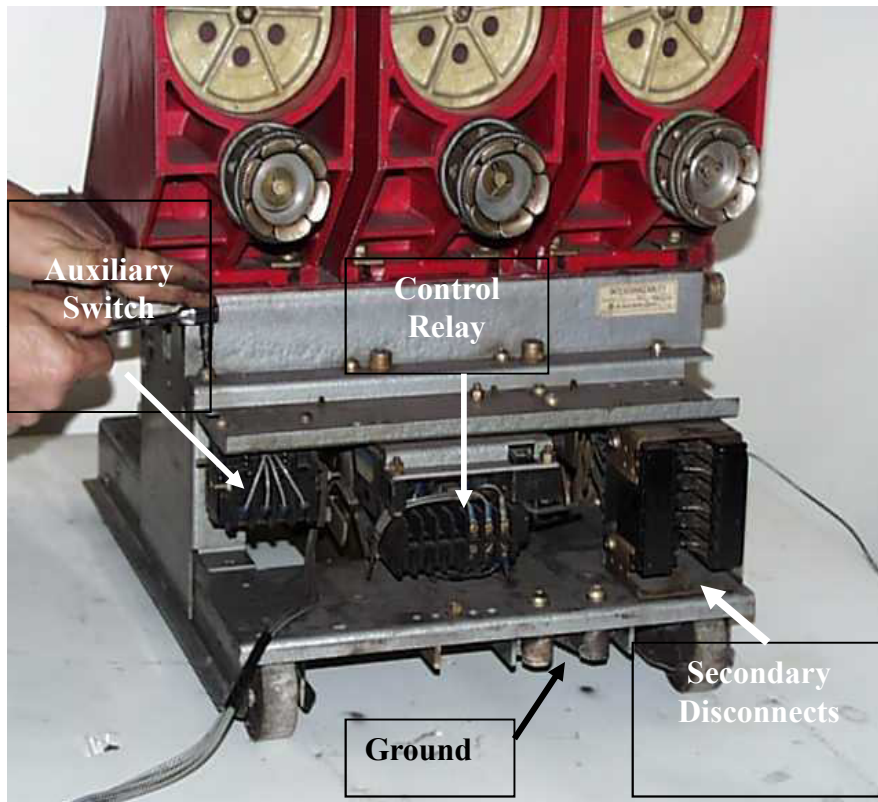
- The HK contacts are a "BUTT" type design in that they "MAKE" flatly against each other
- The 7.5 HK and above has a single puffer assembly

Puffer nozzle



- On a 5HK breaker the puffer is part of the moving contact assembly with an individual puffer for each phase

Electrical Devices



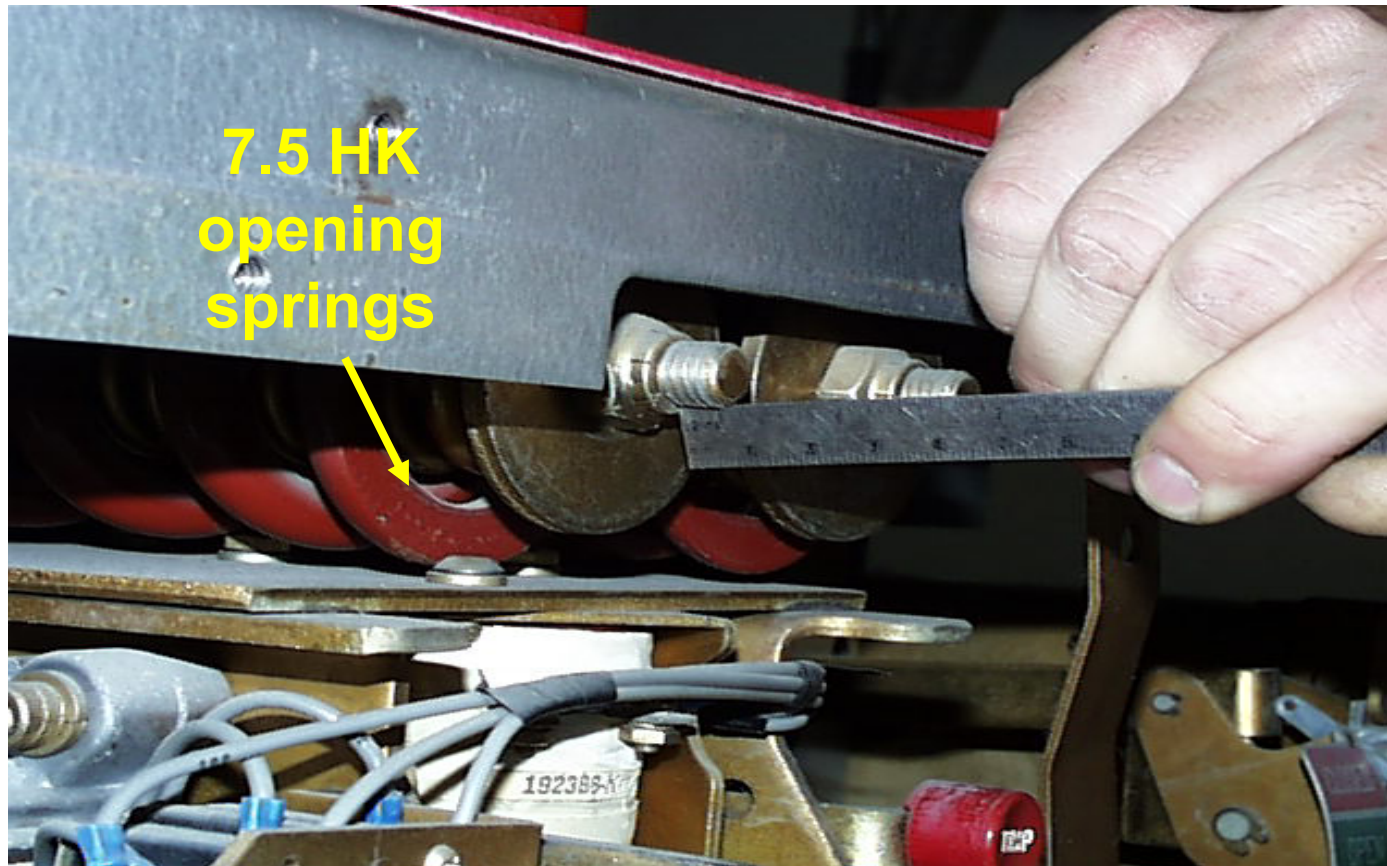
- Auxiliary switch
- Control Relay
 - MCO (Motor Cutoff)
 - Anti-Pump protection for the breaker
- Secondary disconnect

Racking Device

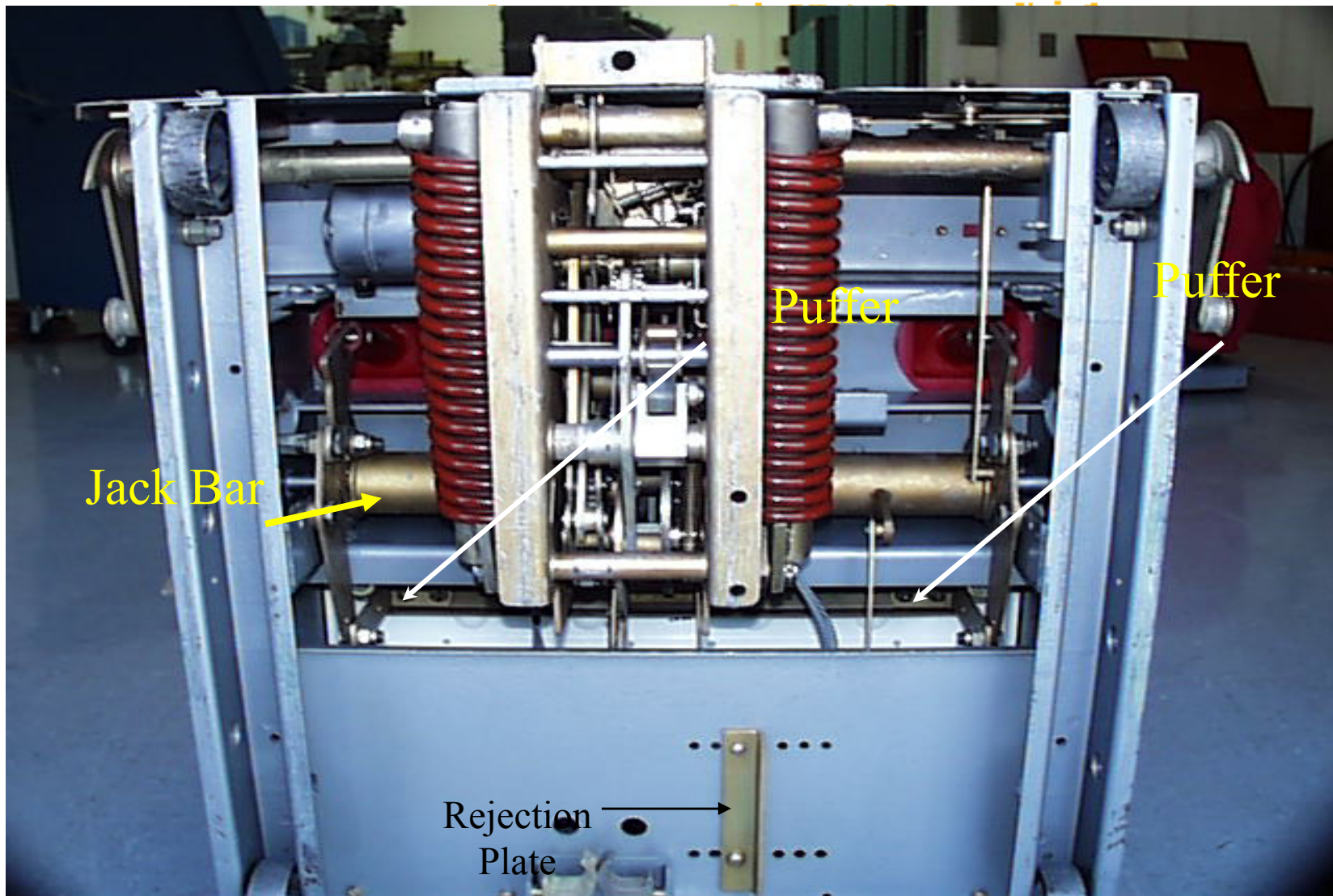
Racking operation and safety Interlocks.



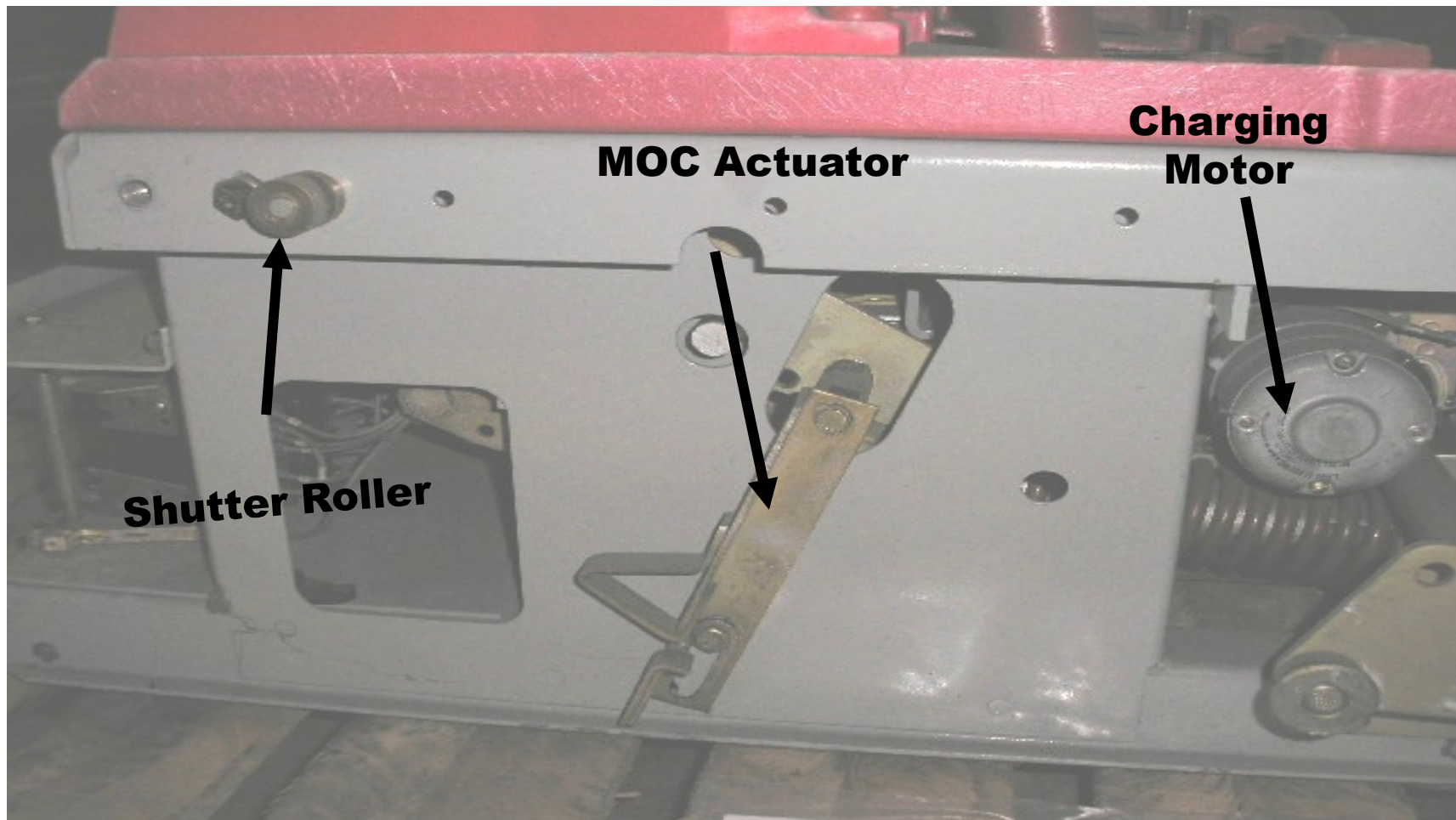
Opening Spring



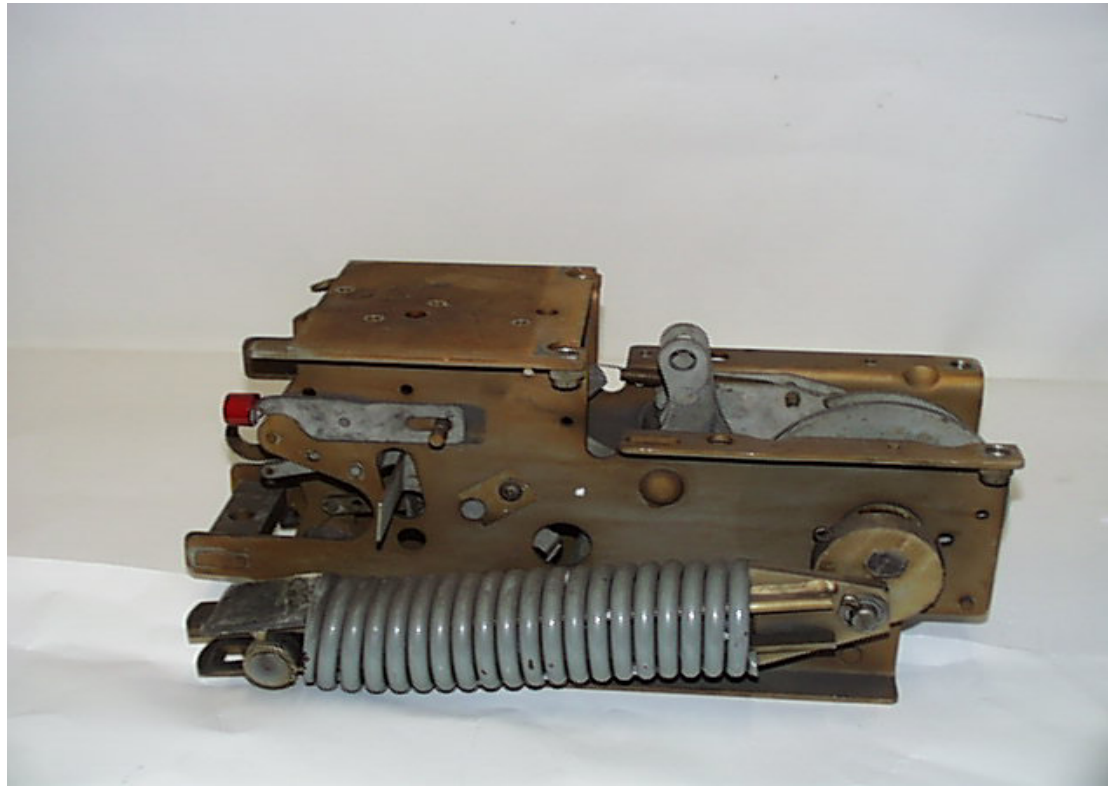
Bottom of breaker



Left Side of chassis



HK operating mechanism



PARTS LIST							
ITEM NO.	PART NO.	QTY	DESCRIPTION	ITEM NO.	PART NO.	QTY	DESCRIPTION
1	195048-K3	1	MECHANISM HOUSING	23	650040-AH	1	PIN (4 25/32" LG.)
2	197478-K1	2	CRANE ARM ASSEMBLY	24	53113-F5	2	COTTER PIN (1/8" X 1 1/4" LG.)
3	53113-H9	2	COTTER PIN (3/16 X2 1/4 LG.)	25	650050-B31	3	STOP PIN (3/8" LG.)
4	650301-B6A	2	BUSHING	26	198241-A	1	PIN (11 1/8" LG.)
5	650353-A2	8	FLAT WASHER (1 1/64" I.D.)	27	650404-A6	2	RETAINER (TRIANG.)
6	18028A-A	2	BEARING	28	191555-K1	1	MANUAL CRANE LEVER
7	191566-A	2	NEEDLE BEARING	29	163377-A	1	RETAINING LINK
8	191517-A	2	BUSHING (SHOULDERED)	30	703250-A	3	RETAINER
9	180098-A	1	SHAFT (HEX)	31	152374-A	1	TENSION SPRING
10	195099-K1	1	MOTOR CONNECTING ROD	32	650301-B51	1	BUSHING
11	650440-E	8	RETAINER (TRIANG.)	33	650213-B	1	SPRING
12	650050-B32	1	PIN (1.16 LG.)	34	650301-B52	1	BUSHING
13	191245-A	1	RATCHET PLATE	35	19156A-A	1	FLANGED BEARING
14	18028A-B	2	BEARING	36	195205-A	2	SPRING
15	195046-A	2	TENSION SPRING	37	193976-K1	1	MANUAL FIRING LEVER
16	650301-B66	1	BUSHING	38	193971-A	1	SPRING
17	54390-B1	1	SCREW, HEX HD. (5/16" X 1/2" LG.)	39	191275-K2	1	BELL CRANE
18	53103-A24	1	LOCKWASHER (.570 O.D.)	40	650216-A40	1	SPRING
19	191992-A	1	RETAINER	41	702312-A	1	RETAINER
20	195030-A	1	PIN (4 17/32" LG.)	42	191274-K1	1	MANUAL TRIP BRACKET
21	193192-A	1	PIN (4 27/32" LG.)	43	54391-C3	1	SCREW, HD. (3/8 X .38 LG.)
22	53113-F6	2	COTTER PIN (1/8" X 1 1/2" LG.)	44	702186-A	1	TRIP BUTTON

SCALE: HALF SIZE

(12)

BBC Brown Boveri Electric, Inc.
Manufacturers of A.C. & D.C. Industrial Power Equipment

L-11584

MANUAL TRIP MECHANISM

DATE: 2-5-62

BY: R. BOYER

CHKD: J. J. J.

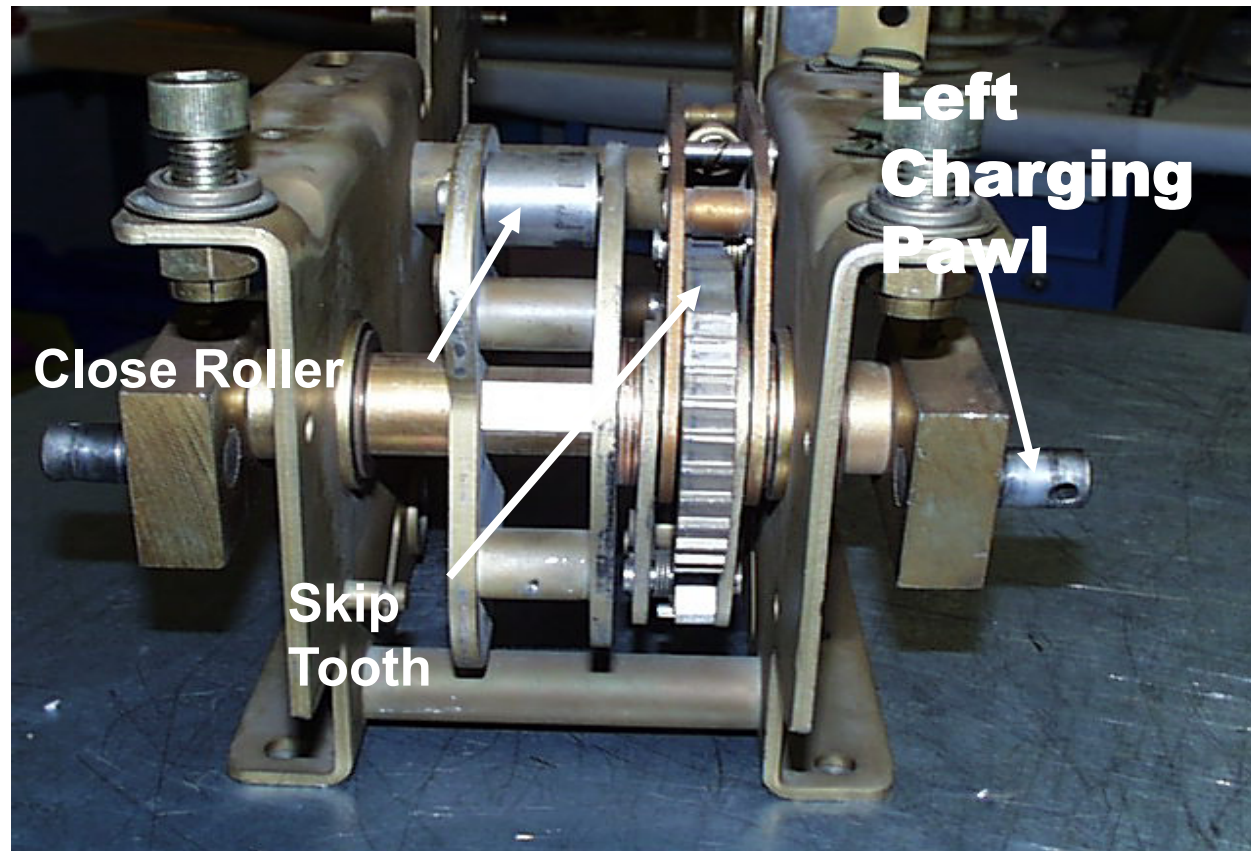
APP'D: J. J. J.

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ITEM NO.	PART NO.	QTY	DESCRIPTION	ITEM NO.	PART NO.	QTY	DESCRIPTION
1	395048-K3	1	MECHANISM HOUSING	23	650040-AN	1	PIN (IN 25/32" LG.)
2	197478-K1	2	CRANK ARM ASSEMBLY	24	53131-F5	2	COTTER PIN (1/8" X 1 1/4" LG.)
5	53131-B9	2	COTTER PIN (5/16 X 1 1/4" LG.)	25	650050-B31	3	STOP PIN (3/64" LG.)
6	650031-B64	2	BUSHING	26	180281-A4	1	PIN (1 1/8" LG.)
5	650352-15	4	FLAT WASHER (1 1/64" LG.)	27	650046-AN	2	RETAINER (TAUAC)
6	180284-A	2	BEARING	28	193155-K1	1	MANUAL CHARGE LEVER
7	191566-A	2	NEEDLE BEARING	29	163377-A4	1	RETAINING LINK
9	191517-A	2	BUSHING (SHOULDERED)	30	703250-A	3	RETAINER
9	160098-A	1	SHAFT (HEX)	31	152374-A	1	TENSION SPRING
11	650091-B2	1	ROTOR CONNECTING ROD	32	650301-B51	1	BUSHING
11	650040-B	6	RETAINER (TAUAC)	33	650213-B	1	SPRING
12	650050-B52	1	PIN (1.16 LG.)	34	650301-B52	1	BUSHING
13	191274-A	1	RATCHET PLATE	35	191564-A	1	FLANGED BEARING
14	180284-B	2	BEARING	36	195205-A	2	SPRING
2	195206-A	2	TENSION SPRING	37	193976-K2	1	MANUAL FIRING LEVER
16	650301-B66	1	BUSHING	38	193971-A	1	SPRING
17	64390-B1	1	SCREW, HEX HD. (5/16" X 1 1/2" LG.)	39	191725-K2	1	BELL CRANK
18	53103-A24	1	LOCKWASHER (.570 O.D.)	40	650216-A40	1	SPRINGS
19	191992-A	1	RETAINER	41	702312-A	1	RETAINER
20	19530-A3	1	PIN (17/32" LG.)	42	191724-K3	1	MANUAL TRIP BRACKET
21	193132-A1	1	PIN (IN 27/32" LG.)	43	543911-CS	1	SCREW, HD. (H8 X .38 LG.)
22	53131-F6	2	COTTER PIN (1/8" X 1 1/2" LG.)	44	702186-A	1	TRIP BUTTON

SCALE: HALF SIZE		THIS DRAWING AND ALL OF ITS DATA ARE THE PROPERTY OF BROWN BOVERI ELECTRIC, INC. IT IS LOANED TO YOU BY THE COMPANY AND IS NOT TO BE REPRODUCED OR COPIED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION OF THE COMPANY.	
BASIC OPERATING MECHANISM			
(172) _____ Sand 15 H		L-11584	
BROWN BOVERI ELECTRIC, INC. MANUFACTURER OF A.E. Electrical Power Equipment			
DWG. NO. 1-11584 REV. 1-11-54	DES. BY H. BOYER	CHECKED BY R. C. C.	APPROVED BY R. C. C.

HK operating mechanism



NRC bulletins and Information Notices



- IN # 83-50 Issued by the NRC to address the issue of Failures to Close on demand on Class 1E Circuit breakers. Although not specifically noted in this Information Notice the HK breaker could display the same failure modes. This notice is a result of a study by the NRC over a 5-year period and over 100 licensee events on 1E Class breakers. The study concluded that the failures were attributed to the failed breakers closing circuitry in the breakers cubicle. Most commonly, blown control fuses, electrical connections or dirty contacts, etc. The failures were common for a certain breaker type, which indicates that the corrective actions did not solve the problem. The results of this study by the NRC were improvements in surveillance of the breakers, maintenance procedures and Operations training.

NRC bulletins and Information Notices



- IN # 84-46- Issued by the NRC to address the “Failure to Close” on demand of a 5HK breaker. In this incident, the failed breaker was RACKED OUT to isolate a pump circuit for testing.
- When the test was complete the breaker was RACKED IN and the Control Room had a confirmed that the breaker was ready to operate due an indicator light on the control board. When the Operator attempted to close the breaker a week later, the breaker failed to close. It was found that the Racking Interlock kept the breaker in a “TRIP FREE” state since it was between TESTS and CONNECT positions. Due to this failure it was determined that 4 conditions must be met to ensure operability of the breaker. First, visual confirmation of breaker status by markings on the breaker and cubicle floor are lined up that show breaker is RACKED IN, that the Racking lever is fully in the CONNECT position, that the racking lever is in the fully CCW position, that the motor disconnect toggle switch is in the ON position, and the control fuses are in place and power is available.

NRC bulletins and Information Notices

- IN # 87-41- Issued due to the general failure of certain HK breakers at separate Nuclear Power plants. At one facility the breaker closed unexpectedly when it was RACKED IN to the CONNECT position. Upon evaluation by the OEM, it was determined that the failed breaker did not have a small Close Latch spring. Depending on which year (prior to 1973 and between June 1975 to June 1977) the breaker was built there may or may not have been a spring on the latch. At another Nuclear plant the same model breaker had a "Failure to Close" when desired. Plant personnel determined that the Charging Motor had loose mounting bolts. At that time the plant Maintenance Procedure did not check the torque of the mounting bolts for the charging motor. After finding several other breakers with the same potential failure mode the procedure was amended.

NRC bulletins and Information Notices



IN # 88-42- Issued to address the same basic failure mode identified in the IN # 87-41. This notice was issued 10 months after the first event was documented. This incident involved 2 Emergency Diesel Generators circuit breakers that were the same model as the previous failure. In this case the Charging Motor fell out of the charging linkage in the Operating Mechanism. As with the first licensee the Maintenance Procedure was changed to ensure reliability. This facility enhanced the procedure to include the addition of Loctite on the mounting bolts and a torque value of 12 foot-pounds.

NRC bulletins and Information Notices



- IN # 89-86- Issued by the NRC to address the same basic potential failure mode identified in the IN # 87-41. This notice was issued 20 months after the first event was documented. This report involved the same model breaker as the previous failure. The problem was discovered during a maintenance period during a refueling outage. The licensee inspected both Safety and Non-safety related Type HK models and found that the Close latch spring was missing on approximately 40 safety related breakers that were manufactured in 1974. This was outside the previously reported gap of the OEM (prior to 1973 and between June 1975 to June 1977).

NRC bulletins and Information Notices



- IN # 95-22- Issued to address the general failure of various circuit breaker types due to Hardened or Contaminated lubricants. The primary breaker type in this notice was the 5HK. The failure modes included both "Failure to Close" and "Failure to Open". As to the 5HK in particular, the affected plants maintenance procedures did not effectively address the issue of hardened or contaminated greases in the Operating Mechanism. This hardened grease did not allow critical linkages and levers to operate as intended. To resolve the issue many plants have a regular overhaul timeline for their circuit breakers, which include complete disassembly of the Operating Mechanism and Main Contacts.

Other breaker material issues



- The control device contacts
- The control device housing
- The motor disconnect switch
- Secondary disconnects
- Hardened grease

MAINTENANCE SCHEDULING FOR THE HK BREAKER



- In most cases the OEM will recommend how often the PM cycle should be, but environment role in determining the PM frequency as does the number of operations.
- What is User groups doing

Adjustments



- The main contact wipe is the only major adjustment required for the HK breaker. There are some minor control component adjustments.

SUBCOMPONENT REPLACEMENT



- Replacement parts for most HK breakers are readily available and are well supported by the OEM.

LUBRICATION



- Non-current carrying:
 - Anderol 757
 - Or Mobil Red 28 if approved for use
- Current carrying:
 - NO-OX-ID - on main current carrying parts