07-771-91

NMP2 VENDOR MANUAL DISCREPANCY SHEET

RESPONSIBLE NMPC LEAD ENGINEER James Bunyan

VMRP NO. 0757

PC NO. N2M17500TRANSF001

INITIALS DW

FILE SEQUENCE NO. N20445

PROBLEMS IDENTIFIED: There is no section #6 of this manual
Drawing #CC-441227 and the last ~~four~~ six pages of this manual
are not listed on table of contents

RESOLUTION:

NOTE: All problems described on this sheet have been identified by SSDC personnel as those which require Engineering Resolution.

Submitted by: Daniel Williams Date 3/17/88

SITE SERVICES DOCUMENT CONTROL

Continued on attachments: ____ Yes X No

Page 1 of 1

9305070147 911031
PDR ADOCK 05000410
S PDR

9305070147

RECORD OF REVISIONS

DOCUMENT TITLE: Instructions for Generator Step-Up Shell Power Transformer

NMPC FILE NUMBER: N2M175COTRANSF001 FILE SEQUENCE NUMBER: N20445

REV. NO.	REVISION SUMMARY/REMARKS	REISSUE	INSERT	SUPERSEDES	ISSUE DATE	INIT.
.00	New Issue			Inst. 01105000A	6-12-87	KS

INFORMATION ONLY

RECEIVED
J. O. NO. 12187

JUL 14 1987

STONE & WEBSTER
ENG. CORP.
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CAUTION: WHEN USING SPARE PARTS LISTS, CHECK WITH VENDOR PRIOR TO ORDERING TO VERIFY PART NUMBERS.

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MANUAL APPLICABILITY CHECKLIST

VMRP 0757 -

N2 VENDOR CODE M17500 COMPONENT CAT. TRANSF

VENDOR NAME McGRAW EDISON

MANUAL TITLE INSTRUCTIONS FOR GENERATOR STEP-UP SHELL POWER TRANSFORMER

MANUAL NUMBER C-06607-5 REVISION N/A

P.O. NUMBER E-011A PARENT MANUAL NUMBER N/A

MODEL NUMBERS

FOA

APPLICABLE COMPIDS .

1 2MTX-XM1A
2 2MTX-XM1A(1)
3 2MTX-XM1A(2)
4 2MTX-XM1A(3)
5 2MTX-XM1B
6 2MTX-XM1B(1)
7 2MTX-XM1B(2)
8 2MTX-XM1C
9 2MTX-XM1C(1)
10 2MTX-XM1C(2)
11 2MTX-XM1D
12 2MTX-XM1D(1)
13 2MTX-XM1D(2)
14 2MTX-XM1D(3)

REFERENCE DRAWINGS (FILE NO/DWG NO/REV/SHEET)

SEE PAGE 2

SECTIONS NOT APPLICABLE S210-05-5 - Page 1,3,4

LEGIBLE: YES (✓) NO ( ) CONTINUATION SHEET: YES (✓) NO ( )

COMMENTS

COMPLETED BY
Responsible Engineer
DATE 3-3-87

REVIEWED BY
Engineering Supervisor
DATE 870618

MANUAL APPLICABILITY CHECKLIST

CONTINUATION SHEET

VMRP 0157 -

N2 VENDOR CODE M17500 COMPONENT CAT. TRANSF

SWEC File Number	Document No
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0001110201003C	3932C602
0001110201004B	NP268223
0001110201005E	3918D878SD
0001110201006E	3918D878SD
0001110201007E	3918D878SD
0001110201008A	3943C481
0001110201009A	3945B587
0001110201010A	3945B357
0001110201018A	3904E717
0001110201019B	3904E717
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011105008C	LTR 850415

C-1

STONE & WEBSTER ENGINEERING CORPORATION

SUPPLIER'S DOCUMENT DATA FORM

NINE MILE POINT NUCLEAR STATION - UNIT 2
NIAGARA MOHAWK POWER CORPORATION
J.O. 12177

RESPONSIBLE ENGINEER (E1) (16): R. DAS

RESP. DISP (E1) (17): E

SUPERSEDES SWEC FILE NO. (E1) (1): TYPE MISC | ID NO 1•110-5001 | REV. A

REVIEW REQUIREMENTS: (R,E1) (18)
REVIEW REQUIRED ☐
REVIEW NOT REQUIRED ☒

REMARKS (E1) (2) (CODES OR SPECIAL REQUIREMENTS): N/A

REVIEWER (E1) (19): NR

DATE TO REVIEW (C) (20): MON | DAY | YR

P.O. NUMBER (C) (3): E011A

DOCUMENT TYPE (E1) (4): ~~MISC~~ INST

RELEASED FOR (R,E2) (21)
RETURN TO SUPPLIER ☐
ENG. & DESIGN ☒
FABRICATION ☐

DIRECTIONS TO SITE (R,E2) (22)
FOR CONSTRUCTION ☒
NOT FOR CONSTRUCTION ☐

MFR'S DOC. NO. (E1) (5) (INCLUDE DOC. REV. OR DATE): C-06607-5

DOCUMENT STATUS (R,E2) (23)

✓	APP — APPROVED/ACCEPTABLE FOR USE
	AAR — APPROVED AS REVISED
	UNA — UNACCEPTABLE
	BLT — AS-BUILT
	FIO — FOR INFORMATION ONLY

MFR'S NAME (C) (6): McGRAW-EDISON

S & W EQUIP. I.D. CODE (E1) (7): 2MTX-XM1A

COMPONENT TYPE (E1)(8): XFMR

MFG EQUIP I.D. (E1) (9): N/A

AREA DESIGNATION CODES (E1) (10): NA

7,8,9 & 10 CONTINUED ON ATTACHMENT(S): YES ☒ NO ☐

MFG. CODE (E1) (11): M17500

REVIEWER'S DATE STAMP (R) (24): NR

DATE REC'D (12): MON 06 | DAY 10 | YR 86

MAX DAYS IN REVIEW (13): 10

RESPONSIBLE ENGINEER'S DATE STAMP (E2) (ISSUE DATE) (25): NOTED JUN 10 1986 R. K. DAS

FUNCTION TITLE (E1) (14): INSTRUCTION BOOK

RESUBMITTAL REQ'D (E2) (26): YES [✓ NO]

RESUB. REQ. DATE (E2) (27): N/A MON | DAY | YR

SWEC FILE NO. (E1) (15): TYPE INST | ID NO. 1•110-5000 | (C) REV. A

TRANSMITTAL DATE (C) (28): 06 17 86

TRANSMITTAL NUMBER (C) (29): T-89,012

(C) DOCUMENT CONTROL (R) REVIEWER (E1) RESPONSIBLE ENG. PRIOR TO REVIEW (E2) RESPONSIBLE ENG. AFTER REVIEW

ADDITIONAL REVIEWERS (E1): (30)

REVIEWER'S COMMENTS (R): (31) MISC DOCUMENT 1-110-5001B IS APPROVED (REF TF-5134 DATED 6-19-84) AND IS CONSOLIDATED INTO THIS DOCUMENT. DOCUMENT HAS BEEN CHANGED FROM MISC TO INST.

STONE & WEBSTER ENGINEERING CORPORATION

NINE MILE POINT NUCLEAR STATION - UNIT 2
NIAGARA MOHAWK POWER CORPORATION
J.O. 12177

ATTACHMENT
SUPPLIER'S DOCUMENT DATA FORM

SWEC FILE NO. (E1) (1)
TYPE MISC 01●110-5000 ID NO REV. A

S & W EQUIP. I.D. CODE (E1) (7)	COMPONENT TYPE (E1) (8)	MFG. EQUIP. IDENTIFIER (E1) (9)	AREA (E1) (10)
	SEE ATTACHED PE5050		

ADDITIONAL SUPERSEDES S&W FILE NO.

TYPE	ID NO	REV.	TYPE	ID NO	REV.
MISC	1●110-5001	B		●-	
	●-			●-	
	●-			●-	
	●-			●-	

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REPORT NO. PES050                          PROJECT EQUIPMENT SYSTEM                        REPORT DATE 05/13/86
                                           AD-HOC PRODUCTION REPORT                        UPDATE DATE 05/12/86
J.O.NO.    1217700               ** INFORMATION ONLY - NOT FOR DESIGN INPUT **             RESET NO.   020
JOB NAME   NINE MILE - UNIT 2             REQUESTED BY - BBICKMORE                         RESET DATE  02/27/86
JOB CLIENT NIAGARA MOHAWK

EQUIPMENT ID   ALT EQUIP ID   DESCRIPTION                  SPEC   PURCHASE ORD   VALVE DESCNO   V.SIZE  Q.A.CAT.
------------   ------------   -----------                  ----   ------------   ------------   ------  --------

2MTX-XM1A                     24/462KV MAIN TRANS 1A       E011A  C062P-5                          .00  2

2MTX-XM1A(1)                  MAIN TRANS A COOLING         E011A  E011A                            .00  2

2MTX-XM1A(2)                  MAIN TRANS A COOLING         E011A  E011A                            .00  2

2MTX-XM1A(3)                  MAIN TRANS A SIGNAL BUS      E011A  E011A                            .00  2

2MTX-XM1B                     24/462KV MAIN TRANS 1B       E011A  C062P-5                          .00  2

2MTX-XM1B(1)                  MAIN TRANS B COOLING         E011A  E011A                            .00  2

2MTX-XM1B(2)                  MAIN TRANS B COOLING         E011A  E011A                            .00  2

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2MTX-XM1D(1)                  MAIN TRANS D COOLING         E011A  E011A                            .00  2

2MTX-XM1D(2)                  MAIN TRANS D COOLING         E011A  E011A                            .00  2

2MTX-XM1D(3)                  MAIN TRANS D SIGNAL BUS      E011A  E011A                            .00  2

2STX-XNS1                     25/13.8KV NSS TRANS.         E011A  E011A                            .00  2
```

McGRAW-EDISON

Power Systems Division
McGraw-Edison Company
Canonsburg, PA 15317

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INFORMATION ONLY

Instructions

456960 KVA - 65°C RISE
FOA - 1 PHASE - 60 HERTZ
GENERATOR STEP-UP SHELL POWER TRANSFORMER
(CONSERVATOR OIL PRESERVATION SYSTEM)
NIAGARA MOHAWK POWER CORPORATION
CUSTOMER ORDER NMP2-E011A
MCGRAW EDISON ORDER C-06607-5
SERIAL NO. 1, 2, 3, 4

Stone & Webster Engineering
J.O. No. 12177
Spec No. E011A

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ENG & DESIGN ☒
FABRICATION ☐

DIRECTIONS TO SITE:
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Date
By

Stone & Webster Engineering
J.O. No. 12177
Spec. No. NMP2-E011A

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☐ BLT - As - Built
☐ FIO - For Information Only

Date 3-27-84
By E. KHALAFALLA

ORDER NO. C-06607-5
SPEC NO. 13354
NIAGARA MOHAWK POWER CORF

TABLE OF CONTENTS

[illegible]
Power Systems [illegible]
Millburn Ave [illegible]
[illegible]

June 15, 1984

Niagara Mohawk Power Corporation
Stone & Webster Engineering Corp., Agents
P.O. Box 63
Lycoming, New York 13093

Attention: Ms. Theresa Ciappa

Reference: Your Verbal Inquiry 6/4/84
McGraw-Edison Quotation NYQ-1962

Dear Theresa,

With reference to Item No. 2 of our subject quotation, we have quoted Catalog #L82 as #281 is obsolete. Catalog #L82 is the current replacement for this item.

Please contact me if you have any questions or require any additional information.

Very truly yours,

O. E. Giangiordano
O. E. Giangiordano
Senior Sales Engineer

OEG:slc

Stone & Webster Engineering
J.O. No. 12177 E4HA
Spec. No.

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DIRECTIONS TO SITE:
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[illegible] only

Date 6/13/84
By J. Knudsen [illegible] per telcon.

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J. O. NO. 12187
JUN 28 1984
STONE & WEBSTER
ENG. CORP.
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NOTED JUN 18 1984 D. A. KUCHEK

McGRAW-EDISON

Power Systems Group

Power Transformers

General
Moving Large Units

S210-05-2
Service Information

INTRODUCTION

The information in this manual is to be considered as a guide to those who are required to move large power transformers and who would like some guidance. The contents do not restrict experienced power company personnel or professional movers who have their own equipment and methods, except that the unique construction of each transformer base must be recognized so that rollers can be properly placed to avoid any damage to the transformer.

These instructions apply to transformers with unit shipping weights up to 1,000,000 lb.

MOVING BY CRANE

Transformers may be moved by a crane if one is available. Use lifting equipment of a reputable manufacturer, within its rated capacity. Spreaders should be employed so that the lifting cables, bars, or chains are vertical. Core-form transformers should be lifted only when the regular tank cover or the shipping cover is securely fastened in place.

Shell-form transformers, which have lift lugs low on the tank, should be lifted only when the regular tank cover or the shipping cover is securely fastened in place, and the slings are securely restrained by sling guides. Shell-form transformers should never be lifted without the use of sling guides. Beyond this, only standard precautions need to be taken.

MOVING BY ROLLING OR SKIDDING

Since cranes are infrequently available, the remainder of these instructions will be concerned with moving transformers along the ground.

First, when moving a transformer, it is necessary to provide a steady platform from which to work. This requires that the railroad car or trailer bed be jacked off its springs and firmly blocked.

Second, it is necessary to consider the shape and base design of the transformer that is to be moved. There are two main types:

1. Tank with a base exterior to the bottom plate of the transformer.
2. Tank with a flat bottom plate which conceals the reinforcing members of the bottom plate.

Each of these types of transformers may be moved by

A. skidding on greased plates, planks, or rails;

or

B. rolling on wood or steel rollers.

CAUTION

There are several general precautions which must be taken with all of the above methods. No large power transformer can be tilted more than 15° from the vertical in any direction.

When moving a transformer, whether the ground is level or sloped, one winch should pull and another on the far side of the transformer should pay out slack. This precaution is necessary where greased plates, planks, or rails are being used, as the pull required to start the transformer moving is greater than that required to keep it moving. This tends to make the first movement of the transformer a rapid springing movement which could be uncontrollable and dangerous without the second winch.

The arrangement with two winches is also a requirement when rollers are being used on the level or on a slope. The better way to use rollers on a slope is to slant them inward in a chevron effect (Figure 1). This causes restraining friction so that, on a small slope, the transformer must be pulled down instead of being let down.

Another precaution which should be followed is to use all of the pulling lugs which are available on the transformer. This means that if two lugs are placed for pulling in one direction, both should be used to avoid dangerous overloading and structural failures, and to provide greater stability.

Care should be taken to keep the surface over which the transformer is moved as level as possible. Any deflection of this surface when sliding a transformer will cause the leading edge of the base to dig in (Figure 2).

Such an occurrence will cause the winch, cables, shackles and pulling lugs to be stressed much higher than necessary. Any deflection in the member over which rollers are moving will overload outside rollers and the transformer (Figure 3).

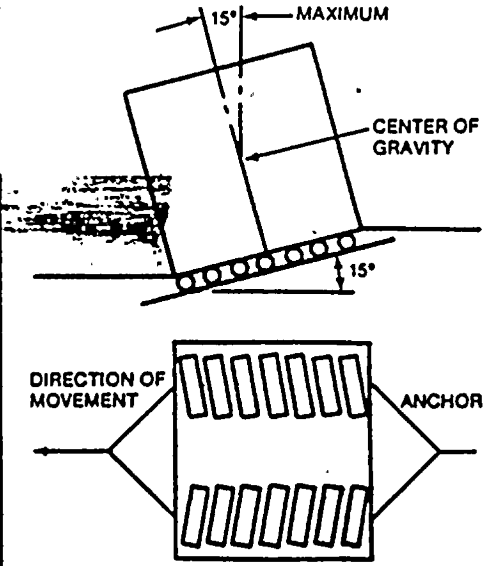

Figure 1.
When moving a transformer on a slope, slant the rollers inward in a chevron effect.

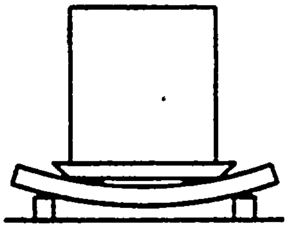

Figure 2.
Leading edge of transformer base will dig into a deflecting surface.

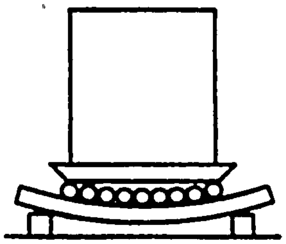

Figure 3.
Deflecting surface overloads outside rollers and transformer.

Tanks with Exterior Bases

To move a transformer which has a base necessary to provide adequate support under main outer members of the base that are parallel to the direction of movement (Figures 4 and 5).

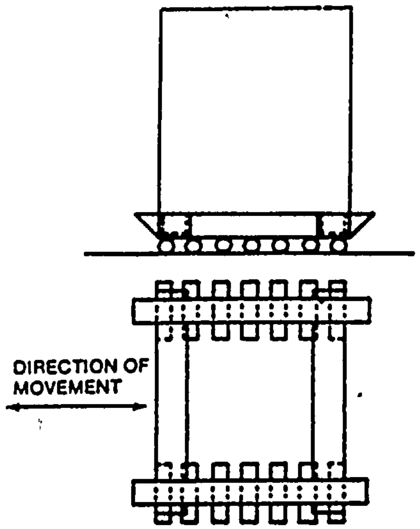

Figure 4.
Base support for tanks with exterior bases.

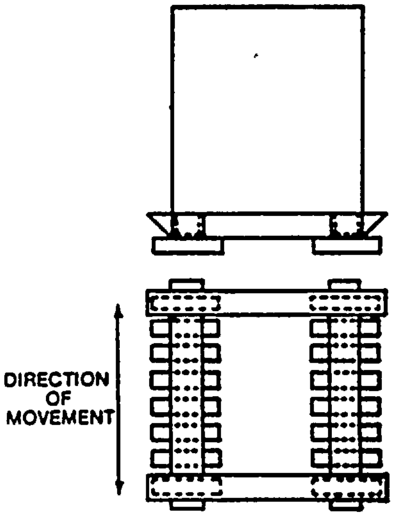

Figure 5.
Base support for tanks with exterior bases.

Rectangular Tanks with Concealed Braces

Rectangular tanks with concealed brace members are McGraw-Edison's standard construction on shell-form and are an alternate construction on core-form transformers. The bottom plate, except under the tank walls, will *not* support rollers. Thus, for all rolling, blocking, or skidding operations, the supporting members must be placed so that they are directly under the tank walls (Figures 6 and 7).

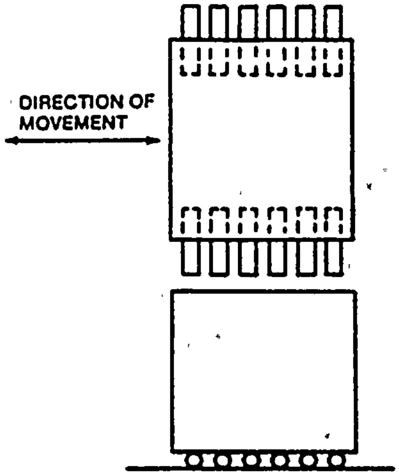

Figure 6.
Base support for tanks with concealed braces.

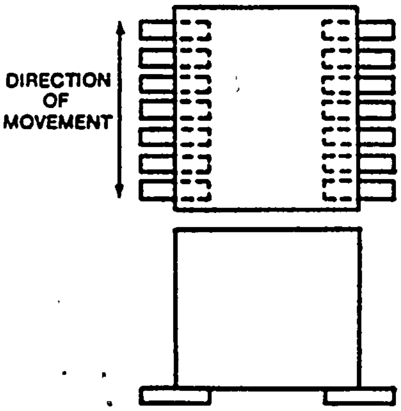

Figure 7.
Base support for tanks with concealed braces.

GENERAL INSTRUCTIONS

A satisfactory method of moving any large transformer might be as follows: Lay down a runway of 12 × 12 timbers, as nearly continually supported as possible, for each set of rollers to be used. Firmly attached to the top of each timber runway should be a ½-in.-thick mild steel plate which is wider than the rollers. With available winch trucks, the larger members can be winched into position.

The rollers may, for example, be 3-in. ips, with a 0.6-in. wall thickness, and may be about four ft long. The ends of the rollers should be tapered. This is to prevent a lip, having a greater diameter than the rest of the roller, from developing when the rollers are pounded into position with a sledge hammer.

Table 1 may be used as a guide for selecting rollers. These figures are for steel rollers and will result in satisfactory bearing areas. Wooden rollers also may be used, but the number and the size of such rollers must depend on the experience of the mover.

TABLE 1
Guide for Selecting Steel Rollers

Shipping Weight (in 1,000 lb)	Nominal Size and Number of Rollers Double-Extra Strong, Standard Pipe					
	1 in.	2 in.	3 in.	4 in.	5 in.	6 in.
100—150	50	26	18	14	—	—
150—200	66	34	22	16	14	10
200—250	84	42	28	20	18	14
250—300	100	50	34	24	20	18
300—350	116	58	38	30	24	20
350—400	132	66	44	34	26	22
400—500	166	84	56	42	34	28
500—600	200	100	66	50	40	34
600—700	—	—	76	58	46	40
700—800	—	—	90	66	54	44
800—900	—	—	—	—	50	50
900—1000	—	—	—	—	68	56

The winches should be attached to the transformer as previously stated; that is, one to pull and one to act as an anchor. When attaching the cables to the pulling lugs, the yoke must not be too short. A minimum is when A equals B (Figure 8). The force F gets larger as A gets smaller. If A is small enough, this sideways force will get large enough to cause a failure in the transformer pulling lugs or yoke cables. Therefore, if A must be smaller than B, a spreader illustrated in Figure 9 is necessary.

Turning a Transformer

A transformer which is being moved must sometimes be turned. The maneuver can most easily be accomplished, whether skids or rollers are being used, by pulling on diagonally opposite lugs. When a transformer on rollers has to be turned, the roller should be kept as nearly perpendicular to the outside arc of the turn as possible. The rollers will then turn more easily and will remain under that section of the transformer for a longer distance.

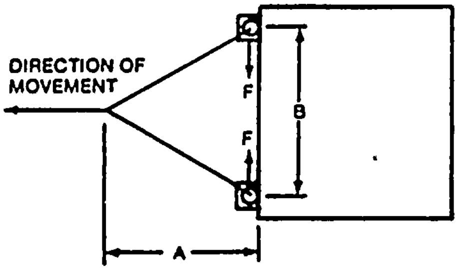

Figure 8.
When attaching cables to pulling lugs, the yoke must not be too short; minimum yoke length is when A = B.

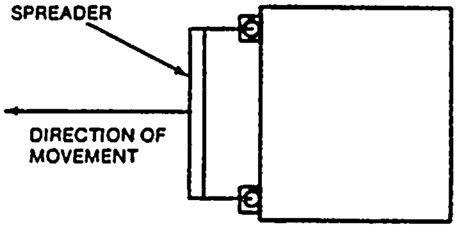

Figure 9.
If distance A must be smaller than B, use a spreader.

McGRAW-EDISON

Power Systems Group
McGraw-Edison Company
Post Office Box 2850
Pittsburgh, PA 15230

Power Transformers

General
Insulating Oil

S210-05-3
Service Information

CONTENTS

GENERAL

Insulating oil used by the McGraw-Edison Power Systems Division is a pure mineral oil meeting all the requirements of ANSI/ASTM D-3487, Standard for Mineral Insulating Oil for Use in Electrical Apparatus. This oil is refined to obtain characteristics especially suited for transformers which include:

1. High dielectric strength or insulating ability.
2. Low power loss.
3. Excellent oxidation stability for longer life.
4. Low viscosity to facilitate rapid heat transfer.
5. Freedom from substances injurious to transformer materials.
6. High flash and fire points for safety.

McGraw-Edison's transformer oil is carefully checked upon receipt to assure compliance with this standard. Also, the condition in which this oil leaves the factory in transformers or in separate containers is carefully controlled.

The approved oil refiners warrant that McGraw-Edison oils contain no PCB.

The importance of careful field handling and treatment of transformer insulating oil cannot be overemphasized. The slightest contamination can destroy essential qualities. This is especially true of moisture and particle contamination, minute quantities of which will lower the dielectric strength below the acceptable level. Precautions must be taken to prevent inadvertent PCB contamination of new oils through storage vessels or mixing with pool oils that may be contaminated with PCB.

These instructions are issued as a guide for the proper handling and treatment of insulating oil to secure the most dependable performance of a transformer. Insulating oil used in McGraw-Edison's transformers should be the grade recommended by McGraw-Edison. A list of acceptable oils will be supplied upon request.

SHIPMENT AND RECEIPT

When possible, transformers are shipped filled to the 25 C level with insulating oil. Very large transformers may be shipped without oil, in which case the oil may be shipped in tank cars, trucks, or drums. Specific instructions describe procedures for receiving, inspecting, accepting, and filling of transformers.

When there are detachable radiators or coolers, the oil for these is shipped separately in drums. Drums should be checked immediately upon receipt, to insure that the gasketed screw-in bungs are tight and that the drums have no leaks. It is possible that rough handling during transit can cause leakage. It is recommended that the seal not be broken until test samples are to be taken, and then only under conditions described under SAMPLING.

Modern tank cars and trucks are usually equipped with breathers to allow for change in volume due to temperature variations.

Prior to acceptance of tank car, truck, or drum oil shipments, the dielectric breakdown voltages should be determined. The procedures and minimum acceptable values are given in the section on TESTING.

STORAGE

Oil received in drums should be stored indoors, if possible. If stored outdoors, the drums should be placed on timbers and protected with tarpaulins. In any event, the drums should be positioned with the bungs down to protect against moisture and to disclose any leakage.

When oil is shipped in tank cars and especially tank trucks, it must be transferred promply to the transformer or other forms of storage to avoid demurrage penalty by the carrier.

Storage containers must be clean and dry so that oil from storage meets the acceptance requirements of new oil from the refinery. It is especially important that storage or transfer containers and hoses be completely free of PCB contamination to prevent the inadvertent contamination of equipment.

FIRE PROTECTION

Although transformer oil will not burn unless it is heated to a relatively high temperature of over 300 F, it is advisable to. be prepared for the possibility when handling the oil. The best basic approach is to smother an oil fire—cut off the source of oxygen. Chemical extinguishers are effective. Water should only be used in the form of a fog spray.

PRECAUTIONS

Temperature and Moisture

It is extremely important that every precaution is taken to insure absolute dryness when handling insulating oil.

The weather should be clear and dry when transformers and oil drums are opened. Moisture can readily be absorbed from humid air. The exposure time of oil to air should be held to a minimum.

Foreign Material Contamination

There should be no blowing dust or dirt when oil is exposed to the atmosphere. All apparatus and vessels must be absolutely clean. Wiping cloths must be clean, dry, and lint-free. Cotton waste is undesirable because of the lint. McGraw-Edison recommends use of a filter during filling of apparatus.

Hoses used for oil transfer must be metal or oil-proof compound. A hose made of natural rubber must not be used as it may easily contaminate the oil with sulphur.

Oil should never be put into any used drums except those previously containing new oil of acceptable quality. If new oil drums must be reused, they should be tightly sealed immediately after emptying to keep out moisture and other contaminants. Also note the precautions against PCB contamination under STORAGE. If PCB contamination is suspected, an analysis is recommended by an analytical laboratory which will also specify detailed sampling procedures. Upon refilling, a new bung washer (available from refineries) of a material other than natural rubber, should be used if the drum is to remain sealed and put in storage.

These instructions do not claim to cover all details or variations in the equipment, procedure, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your McGraw-Edison Power Systems Division sales engineer.

SAMPLING

The quality of insulating oil shipped in tank cars, tank trucks, and drums, or in transformers themselves should be determined by testing a representative sample. The samples are obtained by a carefully controlled standard procedure described in ASTM D 923. A brief summary of this standard follows.

Samples of oil are collected in sampling devices such as those shown in Figures 1-4. These devices were carefully designed to insure an uncontaminated representative oil sample from any type of container. Drums or storage tanks are sampled using a thief, dipper, or pressure-type device. Tank cars and tank trucks, or new apparatus received oil filled are sampled with a variety of devices to suit the sampling provisions. Transformers are generally sampled from an auxiliary sampling valve which is an integral part of the tank drain valve (Figure 4).

Oil samples obtained by ASTM D 923 procedures should be transferred directly into the test device allowing a minimum exposure to air, dust, or other sources of contamination which can adversely effect the test values leading to erroneous conclusions regarding the acceptability of the oil or equipment. Experience shows that oil sampling procedures conforming strictly with this standard will provide the most reliable assessment of the actual conditions of the oil in the containers.

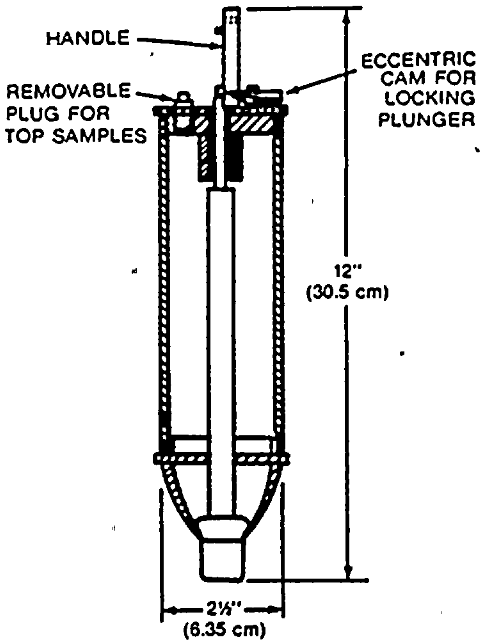

Figure 2.
Tank car-type sampling device.

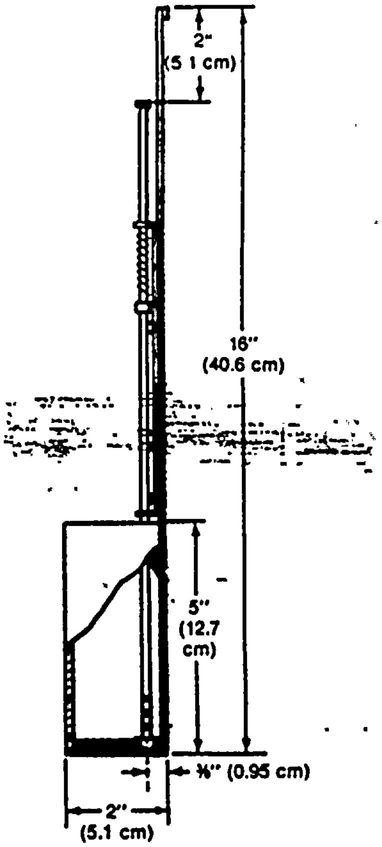

Figure 3.
Cream dipper-type sampling device.

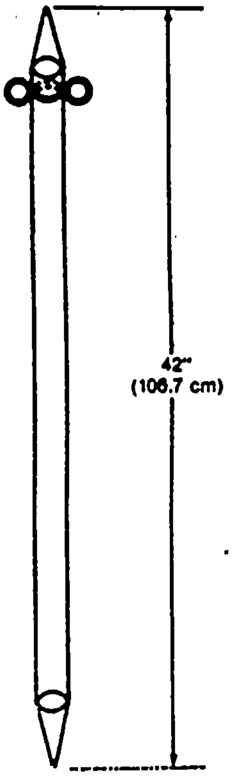

Figure 1.
Dip-type sampling device.

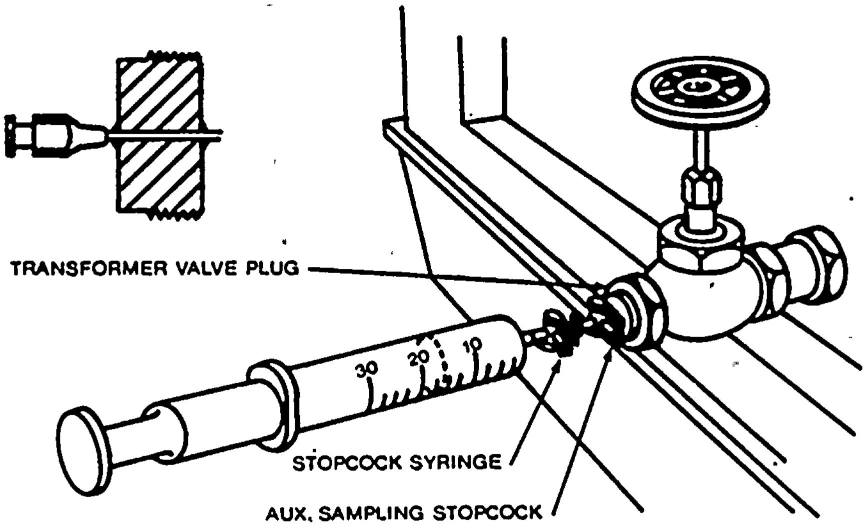

Figure 4.
Syringe-type sampling device (rigid).

Drawings reprinted by permission of the American Society for Testing and Materials 1916 Race Street Philadelphia PA [illegible]

TESTING

New transformer oil received from approved sources in tank cars, tank trucks, and drums is certified by the refiner to meet McGraw-Edison standards; however, a final check prior to filling the apparatus is recommended.

Also during the service life of the apparatus, periodic routine maintenance tests and procedures are recommended. IEEE No. 64, Guide for Acceptance and Maintenance of Insulating Oil in Equipment, contains an appendix listing the results of an industry survey on current oil practices throughout the country, giving typical test data from transformers in service. The Guide also lists test limits beyond which oils in service should be reconditioned or reclaimed.

The significance of oil tests follow:

Dielectric Breakdown Voltage

Changes in the dielectric breakdown voltage are primarily indicators of the presence or absence of particle contaminants and moisture. The standard square edge ASTM D 877 cup test was initially conceived as a field test to detect free water replacing existing crude indicators. Later, adopting the more uniform VDE electrode from European practice, the ASTM developed the modern ASTM D 1816 procedure and established the relative sensitivity of the D 877 and D 1816 methods to particulates and moisture.

Method D 1816, employing a stirring action, is the most sensitive to all impurities especially particulates and dissolved moisture.

Method D 877 is the least sensitive to these impurities, however, it provides a familiar benchmark evaluation on new oils and affords useful comparisons with existing records.

In applying these tests, it should be recognized that new oil is relatively free from most contaminants, whereas oil removed from equipment will contain certain household impurities normally associated with the contruction materials used within the equipment or those resulting from its operation. Interpretation of the tests performed on oils removed from equipment should take this into consideration. Useful information can also be obtained by comparing tests on oils removed directly from the equipment and on the same oils after removing moisture and particulates.

Moisture Content

The quantity of moisture contained in new oil is best determined in a laboratory. Two methods, ASTM D 1513 and ASTM D 1533, are used. D 1533, using automated equipment that reads directly in ppm, is the most popular and can also be utilized for field tests.

Table 1 shows the recommended values for new oils as received in tank cars, tank trucks, or drums, oils sampled from new transformers as received, and oils removed from transformers in service. The values listed for oils removed from equipment in service represent the most recent IEEE consensus beyond which reconditioning or reclamation should be considered.

RECONDITIONING AND RECLAIMING

IEEE No. 64 contains a useful section on reconditioning and reclaiming oil.

McGraw-Edison recommends that both reconditioning and reclaiming should be performed on deenergized equipment only. Not only does this precaution eliminate the possibility of accidental injury, but it also prevents possible failure of the equipment that may result from the accumulation of particulate and other contaminants which are carried by the contaminated oil through the energized insulation system.

TABLE 1

Oil Condition	Dielectric Breakdown Voltage ASTM D 1816		ASTM D 877 0.100 Gap	Moisture Content ppm (wt)
	0.040 Gap	0.080 Gap		
New oil as received	18 kv min * 26 kv avg	42 kv min * 52 kv avg	28 kv min * 36 kv avg	30
New oil** processed	22 kv min * 34 kv avg	44 kv min * 58 kv avg	30 kv min * 36 kv avg	5
New oil taken from new equipment	18 kv min 27 kv avg	36 kv min * 46 kv avg	30 kv min * 36 kv avg	15
	19 kv min * 30 kv avg	40 kv min * 52 kv avg	30 kv min * 36 kv avg	5
Oil from equipment in service: 69 kv and below	18 kv avg	30 kv avg	26 kv avg	25 max
69 kv to 288 kv	22 kv avg	38 kv avg	29 kv avg	18 max
345 kv and up	26 kv avg	45 kv avg	34 kv avg	15 max

*The ASTM procedure provides for the average values only. The minimum values given in the table are expected minimums based on the usual variations.

**Processed oil has been vacuum degassed to a gas content below 0.25% and dehydrated to the moisture content listed in the table.

McGRAW-EDISON

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McGRAW-EDISON
Power Systems Division

Power Transformers
Gaskets
Rubber—Cork—Cork-Rubber

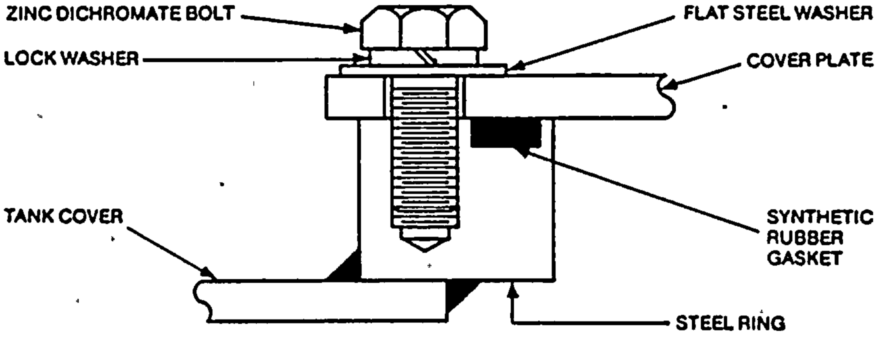
S210-05-4
Service Information

RUBBER GASKETS
General

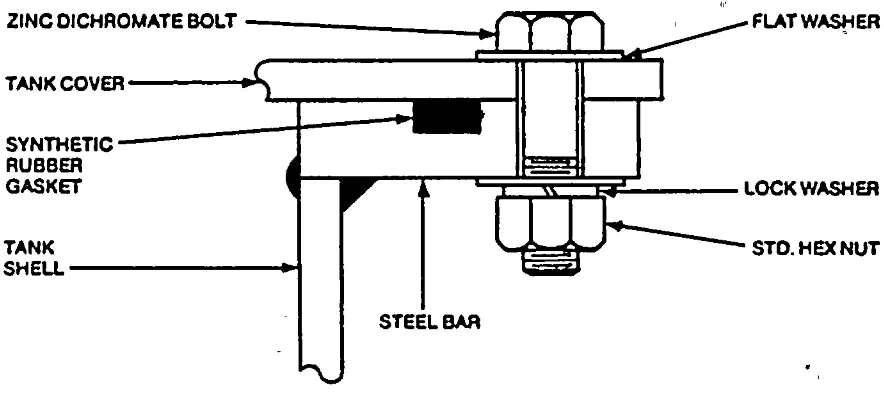
Before a transformer is placed in service, it is essential that all openings in the case be tightly sealed to prevent entrance of water or air, or the leakage of oil or gas. This is necessary whether the transformer is for indoor or outdoor operation. For transformers requiring gasketed seals, McGraw-Edison Power Systems Group employs almost exclusively a nitrile synthetic rubber formula which is highly resistant to solvents and which will not contaminate nor be contaminated by transformer oil.

Most gaskets are designed to be retained in position without the use of a rubber cement. This is accomplished by the use of retaining grooves or retaining rings. These grooves, or rings, also serve to automatically limit the amount of gasket compression to a predetermined value, since proper compression is a significant factor in the useful life of a gasket.

In the event that a gasket should crack, peel or lose its resilience, it will be necessary to replace this gasket with a new one. This is easily done by following these instructions.



TYPICAL MANHOLE COVER SEAL



TYPICAL TANK COVER SEAL

Figure 1.
Gaskets for manholes, and gaskets between tank and tank cover, fit into machined gasket seats.

Preparation of Metal Gasket Surface

It is essential that the surface to receive the gasket be in proper condition. Remove any rust or scale by scraping or wire brushing and apply a suitable solvent such as denatured alcohol or carbon tetrachloride to the metal surface to remove water, grease, or oil. Apply a coat of oilproof primer and finish paint, allowing each to dry. A good coat of either primer or finish paint alone also may be used.

Preparation of Gasket

Gaskets, such as those used for the main tank cover, see Figure 1, which cannot be made from one piece, are made of strip rubber with a scarfed, cemented joint.

CUTTING RUBBER STRIP

The rubber strip ends should be scarfed at an angle the length of which is equal to four times the thickness of the strip, (Figure 2). The ends should then be sandpapered smooth, suitable for cementing. Extreme care must be employed to make the scarfed surfaces flat and the fit neat. The quality of adhesion is dependent upon the texture and cleanliness of the surfaces to be joined.

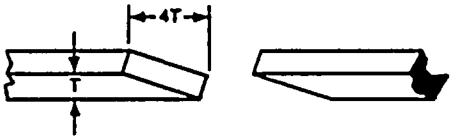


Figure 2.
Method of scarfing rubber ends.

CEMENTING SCARFED ENDS

Apply a thin, even coat of Minnesota Mining Mfg. cement, No. E.C.678. Air dry for 30 to 45 minutes, until the adhesive becomes tacky.

JOINING SCARFED ENDS

Place the cemented surfaces together and firmly apply pressure to displace all air. (See Figure 3.) Make certain that no sliding occurs. Apply a clamp over the joint with only

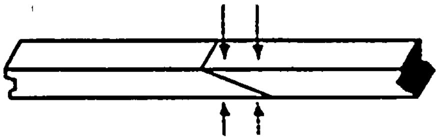


Figure 3.
Joining scarfed ends. Arrows show direction of pressure to be applied.

a moderate pressure, in order that the gasket is not distorted excessively. Approximately 30 minutes should elapse before removing the clamp.

TESTING SCARFED ENDS

A satisfactory bond has been attained if the joint is capable of withstanding sharp bending, twisting, and elongation up to 100%.

O-RING GASKETS

Some gaskets employed by McGraw-Edison Power Systems Group are of the o-ring type. These gaskets, also, are made of a nitrile synthetic rubber formula that is highly resistant to solvents and will not contaminate oil or be contaminated by oil. They are designed for use either in a retaining groove or where the compression is limited to a predetermined degree by a compression stop.

In a few cases, one or both of the planes between which the o-ring gasket is located must be rotated during installation. For this type of installation, the gasket should be lubricated with Vaseline to prevent its being damaged. Typical examples of o-ring gaskets in compression, illustrating both straight compression and compression where one plane was rotated, are shown in Figure 4.

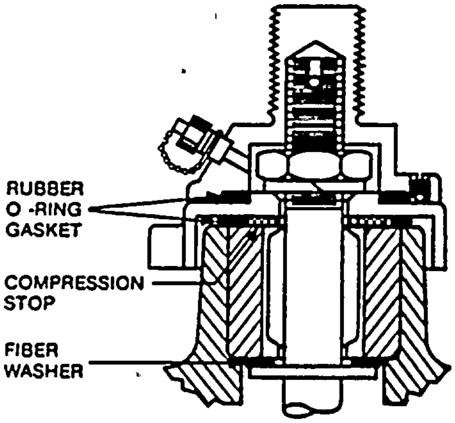


Figure 4.
Bushing terminal with o-ring gaskets.

Final Placing and Bolting Down

Most gasket seats consist of either retaining grooves or joints where compression is limited by compression stops. In most cases, therefore, drawing the flanges together to a metal-to-metal contact produces the necessary tight joint. No subsequent tightening of bolts is required.

Where it is necessary to mount gaskets on a vertical plane or on a bottom surface, the gasket surface should be prepared in accordance with instructions under Preparation of Metal Gasket Surface. Then, spots of Armstrong N-111 Cement, approximately ½-inch wide, should be applied to the gasket seating surface every four or five inches around the circumference. The cement should be allowed to dry until it becomes tacky. (See Figure 5.) The treated face of the gasket should then be placed in its proper position against the prepared surface and held firmly until the gasket adheres. This prevents the gasket from moving during installation.

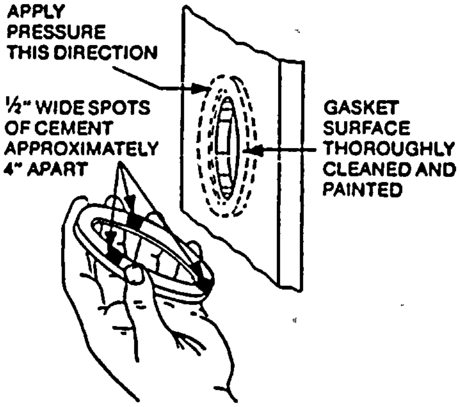


Figure 5.
Spot cementing rubber gaskets to vertical and bottom surfaces.

All bolts should be drawn down uniformly in small increments—going around the bolt circle until the gasket is compressed to a stop or to the specified thickness.

Extra gaskets and cement may be ordered from the factory. No materials should be used except those approved by McGraw-Edison. When stored in a dark, cool, dry area, nitrile synthetic rubber gaskets should have a minimum shelf life of five years, but should be inspected before being used.

CORK GASKETS

General

Cork gaskets are used on such items as air-filled compartments and in some instances on bushings. If any accessory sealed with a cork gasket is removed, a new gasket must be installed as per instructions below.

Preparing Gasket and Metal Surface

Clean the metal gasket surface as described under Preparation of Metal Gasket Surface. Primer and paint may be omitted if the Glyptal treatment, described later in this section, is applied reasonably soon after cleaning the metal surface.

Any gasket requiring a scarfed joint should be cut as shown in Figure 6. The cork strip ends should be scarfed at an angle the length of which is equal to five times the thickness of the strip.

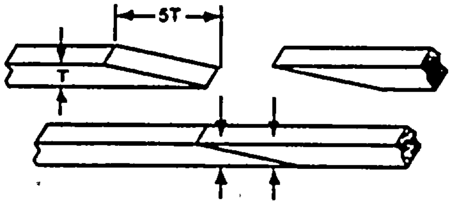


Figure 6.
Method of scarfing cork ends. Arrows show direction of pressure during drying.

Brush the scarfed surfaces of the gasket with Glyptal No. 1201 and allow the compound to become tacky before pressing the ends firmly together.

Because cork will permit oil to seep through it under medium pressure, it is necessary, in most cases, to seal all surfaces and edges by dipping or brushing the complete gasket in Glyptal Compound No. 1201, or equivalent, and allowing it to air dry. Use care to suspend the gaskets by either clips or pins in such a way that nothing touches the inner edge of the gasket. Pins may be inserted into the flat sides of the gasket. Such drying usually requires less than four hours. At the same time, apply a fairly heavy coat of Glyptal to the metal surfaces to be sealed and allow to air dry. This "precoating" procedure is important and should be followed for all cork gaskets.

Installing Gaskets

When a cork gasket is being replaced, brush the bottom surface of the precoated gasket as well as the cleaned and precoated metal gasket surface with Glyptal No. 1201. After this coat of compound has dried sufficiently so it will not adhere to the fingers (about 15 minutes) assemble the gasket on the metal. If there are any scarfed joints in the gasket, they must always be located between bolt holes. Work the gasket back and forth a few times over the coated metal surface. To obtain best possible adhesion to the metal, clamp or weight the gasket at frequent intervals. Allow the compound to set at least 30 minutes so that when the clamps are removed the gasket will not slip.

After the clamps are removed, apply a light coat of gasket compound to all exposed surfaces of the gasket and to the other metal surface to be joined. This includes coating the inside of all bolt holes in the gasket. It is important also that the inside edge of the gasket be given this second coating of Glyptal. When this coat of compound has become tacky (15 minutes) mount the metal part. Progressive tightening of bolts is recommended until the gasket is compressed to one-half of its original thickness or until the gasket stops are reached. Keep oil away from the joint until the tightening is completed.

To replace a bushing gasket, the same procedure should be followed as outlined above. In this case, however, it is not necessary to preclamp the gasket before the final bolting down operation.

Glyptal No. 1201, as supplied in the can, is of the proper consistency. If the Glyptal has been exposed to the air and has thickened, thin it with G.E. No. 1500 thinner. Extra gaskets and compound may be ordered from the McGraw-Edison Power Systems Group at Post Office Box 440, Canonsburg, Pennsylvania 15317.

FOAM RUBBER GASKETS

Air-filled compartments, such as cabinets for automatic pressure-type nitrogen gas equipment, control cabinets, etc., are sealed from the atmosphere by closed-cell foam rubber gaskets.

The following procedure is recommended for installing these gaskets:

Clean the painted, gasket-mounting surface of the door with a suitable solvent, such as denatured alcohol, and allow it to dry. Apply one coat of Johns-Mansville Dutch Brand Neoprene Adhesive No. 281 to the matching surfaces of the gasket and door, and allow the cement to dry. Then, apply a second coat to the gasket and place the gasket on the door, pressing it firmly into place, while the cement is wet. Where possible, to provide the best possible adhesion, the door should not be closed on the gasket for 24 hours.

Proper installation will produce a cemented joint that is stronger than the gasket itself.

CORK RUBBER GASKETS

General

Gaskets made of cork rubber composition are used primarily for cover joints on split-tank shipments and for sealing air-filled throats. Cork rubber gasket materials approved for this application are Chloroprene DC-167 and Nitrile Butadiene NC-710 manufactured by Armstrong Cork Company.

Preparing Gasket and Metal Surface

Clean the metal gasket surface as described under Preparation of Metal Gasket Surface on page 1.

Any gasket requiring a scarfed joint should be cut as shown in Figure 6. The strip ends should be scarfed at an angle the length of which is equal to five times the thickness of the strip. Apply a thin, even coat of Minnesota Mining Mfg. cement, E.C.678, to each scarfed piece to be joined, and allow to dry for 30 to 45 minutes, or until tacky. Join the scarfed ends by pressing the cemented surfaces together and apply firm pressure to displace all air which may be entrapped in the joint. Make certain that no sliding occurs and that the pieces are correctly aligned, then apply a clamp over the joint with moderate pressure for 30 minutes.

Installing Gaskets

Gasket must be compressed approximately 30%. No cementing is required for gaskets mounted on upfacing horizontal or slightly inclined surfaces. Gaskets mounted on vertical or severely inclined surfaces or on the underside of horizontal surfaces may be spot cemented for ½ inch at five-inch intervals to keep them in place until compressed. Spot cementing is done with Armstrong N-111 Cement, applied to one surface of gasket only. Allow cement to dry until tacky, and then hold or clamp in place until it adheres to the surface. Progressive tightening of bolts is recommended until the gasket is compressed to about 70% of its original thickness.

Care in the preparation and installation of this gasket may permit its removal and reuse several times before it must be replaced.

McGRAW-EDISON

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McGRAW-EDISON

Power Systems Division

Power Transformers

Liquid-Immersed Units
Installation and Maintenance Instructions

THIS TRANSFORMER SHIPPED
FILLED WITH DRY AIR.
SEE SPECIAL INSTRUCTIONS
DWG. A-240265.

S210-05-5
Service Information

CONTENTS

Far car: 150,000 kva, Class FOA. HV: 220,000GrdY volts. LV: 69,000Y volts. TV: 13,000 Δvolts.

Near car: 315,000 kva, Class FOA. HV: 230,000GrdY volts. VL: 17,000 Δvolts.

Figure 1.
Transformers ready for shipment with auxiliary parts loaded on other cars.

GENERAL

Service Information S210-05-5 pertains specifically to McGraw-Edison liquid-immersed power transformers (Figure 1).

SHIPPING

Station-type transformers are usually shipped in one of the following ways:

1. Core and coils assembled in a tank with the insulating liquid just over the coils (including transformers shipped in the bottom part of a split tank) or with the tank filled with liquid to the 25 C level.
2. Core and coils assembled in a tank without liquid (including transformers shipped in the bottom part of a split tank).

When transformers are shipped in their tanks without oil, the core and coils are sealed in dry nitrogen or dry air at a positive pressure and the oil is shipped in tank trucks or tank cars.

RECEIPT AND ACCEPTANCE

When a transformer is received, thoroughly inspect the impact recorder tape (if supplied) and the transformer tank for evidence or rough handling in transit.

NOTE: See **IMPACT RECORDER** section for tape interpretations.

If there are indications of rough handling, the transformer should remain on the car and both the carrier and Service Section of McGraw-Edison Power Systems Group should be notified immediately. Note the delivery receipt for the shipment, "possible internal or hidden damages" and request that the carrier be present for an internal inspection of the unit. The applicable portions of these instructions for internal inspections should be followed.

If the transformer is in acceptable condition, put the gas-regulating and sealing equipment into operation as soon as possible.

IMPACT RECORDER

Two basic types of impact recorders are in general use for transformer shipments: one-way and two-way recorders. Both types measure the longitudinal impacts in five zones from zero to 10 Gs. Impacts above the midpoint of zone 2 (approximately 3 Gs) are considered rough handling.

The two-way impact recorders also measure the vertical forces, usually on a scale of ten. Specific instructions for the tape interpretations are enclosed in the recorder case. Vertical impacts above 1 G are considered rough handling.

INTERNAL INSPECTIONS

CAUTION

Before opening a transformer, reduce the internal pressure in the transformer to zero by opening a valve in the gas space.

If the nitrogen has not been completely blown out of a transformer, wear an oxygen mask to enter the transformer.

The gas in the space above the oil must be replaced with fresh air (about 20% oxygen) to sustain life.

Moisture

Moisture may condense on any surface that is cooler than the surrounding air. Moisture in insulating material or liquid lowers its dielectric strength and may cause a transformer to fail. If a transformer or oil drums are placed in a location warmer than the transformer or the drums themselves, allow time for all signs of external condensation to disappear before opening them. See **WHEN TO DISCONTINUE DRYING** on page 6 for moisture-measuring techniques.

Insulating Liquid

Before opening a transformer shipped with its insulating liquid, take samples of the insulating liquid and test the dielectric strength. See **SAMPLING AND TESTING OF INSULATING LIQUID** on page 5.

Core and Coil Assembly

If a transformer has been shipped with oil, lower the insulating liquid to the top of the core and coil assembly, test for unintentional core grounds, and inspect the interior.

To minimize the risk of moisture entering the insulation, it is recommended that the coils be covered with oil when the tank is opened for inspection; however, continuous purging with dry air as described in *Service Information S210-10-1, Power Transformers: Vacuum Filling Oil-Immersed Core-Form, Load Tap Changing, and Shell-Form Units,* is acceptable.

Inspection made through the insulating liquid of transformers using a weighted spot or a pyrex-glass-type flood lamp enclosed in a fine wire mesh will show displaced, broken, or loose parts if damage has occurred enroute. The fine wire mesh prevents scattering the glass if the lamp is accidentally broken. Use a lamp cord with non-oil-soluble synthetic insulation to prevent contaminating the transformer liquid. *Do not use natural-rubber-insulated cords.* To minimize thermal shock, submerge the lamp before turning it on.

Examine the top of the core-and-coil assembly, all horizontal surfaces, and the underside of the cover for signs of moisture. Close the transformer as promptly as possible. If there are signs of moisture inside the tank, determine the extent and the manner in which the moisture entered the transformer. See **TESTING FOR LEAKS**, page 5.

If the transformer appears to have been damaged internally, contains moisture or if it seems advisable to remove the core-and-coil assembly for further inspection, McGraw-Edison Power Systems Group should be notified and special instructions requested. Should a dryout be required, see **DRYING CORE AND COILS** on page 6.

HANDLING

Complete Transformers

A transformer should always be handled in the normal upright position unless advised by McGraw-Edison Power Systems Group that it can be handled otherwise. When a transformer cannot be handled by a crane, it may be skidded or moved into place on rollers provided the transformer base design and the surface over which it is to be moved are compatible. Moving instructions must be strictly followed. Care must be taken to prevent damage or overturning. Most transformers can be tilted 15 degrees. For moving large transformers, see *Service Information S210-05-2, Power Transformers: Moving Large Units.*

Lifting With Slings

Lifting lugs are provided for lifting a complete transformer. When necessary, additional means are provided for lifting the various parts requiring assembly. Lifting lugs are designed for vertical lift only. When lifting a complete transformer or a heavy component, the cables should be attached so as to provide a vertical pull on each lug. Use lifting cables of the same length so that the transformer will be lifted evenly. To prevent the tank walls from buckling, the cover must always be fastened securely in place during a lift. The approximate total weight of the transformer is shown on the nameplate and on the outline drawing.

Raising With Jacks

Ports are provided on most transformers so that the transformer can be raised by jacks. On some transformers, jacks may be placed under the transformer bottom plate at points designated by the outline drawing. Do not attempt to jack, pry under, or tie to drain valves, pipe connections, or other attachments. It is recommended that these appendages not be subjected to a man's weight.

STORING

It is advisable to completely assemble, process, and oil fill a transformer at its permanent location as soon as possible after receipt. It is considered normal for intransit time plus the installation operation to take as long as a month which requires no special storage considerations. However, for shipping time plus installation periods longer than a month, the special precautionary steps outlined below must be taken. Any deviation from these recommendations should be agreed to by McGraw-Edison Power Systems Group, Service Department.

Storing Up To Three Months (Four Months Since Shipped)

MAIN TANK. The tank must be sealed with dry nitrogen or dry air. If so equipped, install and put the inert-gas equipment in operation. If not so equipped, install a pressure gage and maintain a positive pressure of between ½ and 6 psi at all times.

RADIATORS. Ascertain that all cover plates and gaskets are secure. Store radiators in a manner to prevent ground water from entering through the shipping gaskets.

COOLERS. Coolers are normally shipped under pressure. Ascertain that a minimum of ½ psi is maintained during storage. Remove fan motors and store indoors.

BUSHINGS. Bushings may be stored outdoors in a vertical or tilted position. See *Service Information S315-10-1, Types PA Apparatus Bushings* for details.

FANS AND PUMPS. Store indoors.

LTC COMPARTMENTS NORMALLY OIL FILLED. On a unit with an isolated interrupter-type tap changer, the selector switch compartment should be connected to the main tank with common gas. The interrupter compartment should either be oil filled (with the breather installed) or sealed under positive pressure to a maximum of 5 psi. It is recommended that a pressure gage be installed for regular inspection. On a unit with an arcing tap-switch-type tap changer, follow the same recommendation as with the interrupter switch compartment.

AIR-FILLED COMPARTMENT. To prevent condensation, put the cabinet heaters into operation.

TOP SECTION OF TWO-PIECE TANK SHIPMENT. Preferably, install the top section to the main tank before storing. If the top section was shipped sealed under gas pressure, it contains high-voltage parts and it must be stored by maintaining this positive pressure to a maximum of 2½ psi. If the top section was not shipped sealed under pressure, it may contain low-voltage insulating materials (such as current transformers). These must be removed and stored under oil.

Storage For Three To Twelve Months

MAIN TANK. The main tank—with the separated top section installed—must be vacuum processed, oil filled to normal oil level, and the automatic gas-sealing equipment must be put into operation. Use the vacuum-processing procedure in *Service Information S210-10-1* for final filling.

RADIATORS. The radiators must be stored oil filled, preferably installed and open to the main tank. Because of oil expansion and contraction during temperature changes, do not fill and seal the radiators unless they are provided with an additional expansion reservoir.

COOLERS. Same as radiators. Remove and store fan motors indoors.

BUSHINGS. Install to main tank or store indoors.

FANS. Store indoors or install on radiators and run at least three hours every six months.

PUMPS. Install and open to main tank or store indoors.

LTC COMPARTMENTS NORMALLY OIL FILLED. Fill with oil using the normal final filling and gas-sealing equipment.

AIR-FILLED COMPARTMENTS. To prevent condensation, put the cabinet heaters into operation.

TOP SECTION OF TWO-PIECE TANK SHIPMENT. Install to main tank.

STORAGE LONGER THAN ONE YEAR, CONTACT McGRAW-EDISON POWER SYSTEMS GROUP, SERVICE DEPARTMENT.

Processing Units Stored in Gas or Oil

Prior to final filling and after an extended storage period, extra precautions should be taken to make sure the transformer remained sealed and dry.

If the unit was stored in gas, test the dew point prior to releasing the pressure and report any abnormalities to McGraw-Edison Power Systems Group, Service Department since more than normal field processing may be required. If all is well, process and oil fill the unit in accordance with *Service Information S210-10.1.* However, because additional time may be required for the oil to repenetrate the drained insulation, double the specified holding time prior to energizing.

If the unit was stored in oil, follow the appropriate general procedure that follows, depending on the manner in which the unit was prepared for storage.

1. **On units that were fully assembled and fully processed before storing,** test the dew point of the gas for dryness and the oil from the bottom of the tank in accordance with *Service Information S210-10-1* to make sure that all is normal. If all is not normal, contact McGraw-Edison Power Systems Group, Service Department. If all is normal, run the pumps (if supplied) for 12 hours before energizing.
2. **On units that were not fully assembled and/or fully processed before storing** test the dew point of the gas and oil from the bottom of the tank to make sure that all is normal. If all is not normal, contact McGraw-Edison Power Systems Group, Service Department. If all is normal, complete the assembly operation and follow the normal vacuum-filling procedure, assuming the storage oil fill was partial fill. Run pumps (if supplied) for 12 hours.

LOCATION OF INSTALLATION

Accessibility, ventilation, and ease of inspection should be given careful consideration in the location of transformers.

~~Self-Cooled Transformer (Class OA)~~

~~A self-cooled (OA) transformer depends entirely upon the surrounding air for carrying away its heat. For this reason, care must be taken to provide adequate ventilation by not crowding transformers together nor too close to walls.~~

~~For indoor or vault-type installations, the room in which a transformer is placed must be well ventilated so that heated air can escape readily and can be replaced by cooler air. The inlet opening(s) should be near floor level and distributed so as to be most effective. The outlet opening(s) should be as high above the apparatus as the construction of the building will permit. The number and size of air openings required will depend on the distance of outlets above the transformer and on the efficiency and load cycle of the apparatus. A conservative general rule is to provide one square foot net for each inlet and outlet area per kilowatt of transformer loss. If forced ventilation is used, a conservative figure is 200 cubic feet of air per minute per kilowatt of loss.~~

~~An indoor self-cooled transformer must be so located that rain cannot blow on it nor can water fall on the tank.~~

~~Self-Cooled/Forced-Air-and-Oil-Cooled Transformer (Classes OA/FA, OA/FA/FA, OA/FA/FOA and OA/FOA/FOA)~~

~~A transformer with self- and forced-cooled ratings depends on circulation of large quantities of air of the proper temperature for cooling. Transformers must be positioned at least six feet from walls and all multiple-transformer installations spaced far enough apart that heated air from one unit cannot affect the cooling of another (Figure 2). On a vault-type installation, inlet and exhaust ports must be provided to limit air velocities to less than 1100 feet per minute.~~

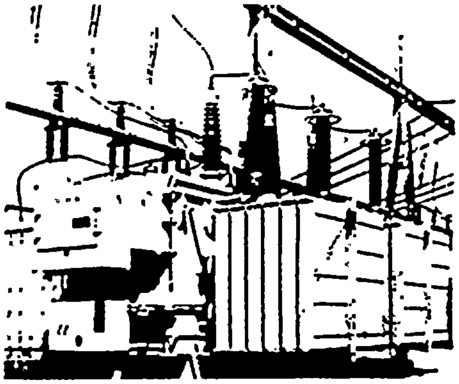


Figure 2.
Core-form transformer with fans mounted on the cooling radiators to provide 150/200/250/280-Mva, Class OA/FOA/FOA, rating.

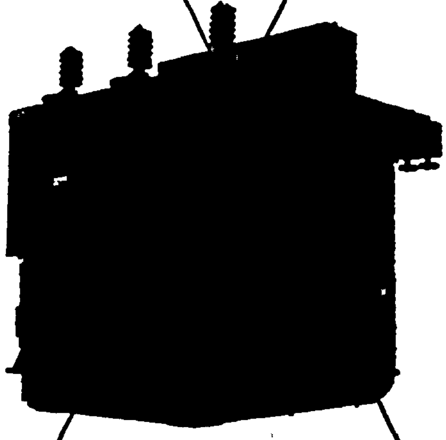
Forced-Oil-Cooled Transformers With Forced-Air Coolers (Class FOA)

Cooling an FOA transformer depends on the amount and temperature of the air passed through the heat exchangers which are selected to meet specific requirements. An FOA transformer must be positioned at least six feet from walls and all multiple-transformer installations must be spaced far enough apart that heated air from one unit cannot affect the cooling of another (Figure 3). On vault-type installations, inlet and exhaust ports must be provided to limit air velocities to less than 1100 feet per minute.

Figure 3.
Shell-form transformer rated 590/660 Mva with Class FOA cooling system.

~~Water-Cooled Transformers Forced-Water Coolers (Class FOW) and Self-Cooled (Class OW)~~

~~FOW and OW transformers depend almost entirely upon the flow of water through the oil-to-water heat exchangers for carrying away the heat so that the temperature of the surrounding air has practically no effect upon the temperature of the transformers. Water-cooled transformers may be located in any convenient place without regard to ventilation (Figure 4).~~



~~**Figure 4.**
Furnace transformer rated 6000/6720 kva, Class OW, with motor-operated tap changer.~~

PREPARING FOR SERVICE

Make an internal inspection of all transformers whether or not there has been evidence of damage or rough handling in shipment and even though it is not otherwise necessary to open the transformer for assembly. Instructions for INTERNAL INSPECTION on page 2 should be observed.

Assembly practices below are essentially a continuation of preparation for service, following or concurrent with the internal inspection. Before a transformer is opened for assembly, a check should be made to see that all accessory parts not shipped on the transformer are available and in good condition.

CAUTION

As indicated in INTERNAL INSPECTION on page 2, every precaution should be taken, when a transformer is opened, to prevent the entrance of moisture, dust, or other foreign material. A transformer should be opened only in good weather with low humidity.

Particular care must be taken in handling tools and other loose articles so that nothing is dropped into the windings, thus creating a potential cause of failure.

As previously cautioned, a transformer cannot be safely entered until the nitrogen is replaced with air.

Additional Internal Checks

Checks for the general condition of internal parts are outlined under INTERNAL INSPECTION. In addition to checking for damage and for loose hardware and connections, a check should be made of the tap changer to make sure it operates properly from the external control.

Terminal boards should be checked to see that connections are as desired. If specific connections have not been specified, the following practices apply:

1. Single- or three-phase transformers are usually shipped with both high- and low-voltage windings connected for their highest rated voltage ("rated voltage" is defined in ANSI Standards) even when there are taps above rated voltage.
2. Single-phase transformers designed for both series-multiple and three-wire operation are usually shipped connected in series with the mid-point brought out for three-wire operation.
3. Single- or three-phase transformers designed for series-multiple connection only are usually shipped connected in series.
4. Three-phase transformers designed for both delta and wye operation are usually shipped connected for wye operation.

Common Assembly Practices

The time during which a transformer is open for assembly and the oil or core-and-coil unit is exposed to the atmosphere should be held to a minimum. Advance planning to shorten the assembly period is well justified.

The quality of seals at all points is very important. Practices under SEALS on page 5 should be followed. Upon completion of the assembly, sealing of the unit, and filling with liquid, pressure tests should be made, as described in TESTING FOR LEAKS on page 5.

Before pressure testing for leaks, the gas space of all but open-breathing transformers should be purged with dry nitrogen to reduce the oxygen content to less than 3%. Fittings are provided on the transformer to permit the introduction of nitrogen at one point in the gas space and the exhaust of gas at another to accomplish the purging.

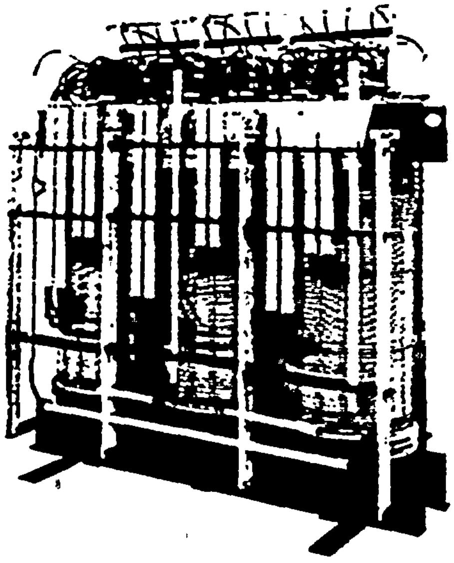


Figure 5.
18,000/24,000/30,000 kva, Class OA/FA/FA, 110-24 x 48-kv core-and-coil assembly with series-parallel terminal board and rotary tap changer.

Transformers Shipped With Insulating Liquid

Inspection and preparation for service of a transformer shipped filled with insulating liquid usually requires that the liquid level be lowered. Radiators and heat exchangers shipped separately may, when added, provide sufficient additional space to lower the liquid without drainage. Should this capacity not be sufficient, their lower valves should be closed to trap the oil in the radiators or coolers before liquid is drained from the main tank.

When refilling to the 25 C level, the insulating liquid should be introduced from the top under a vacuum in accordance with separate instructions on vacuum filling.

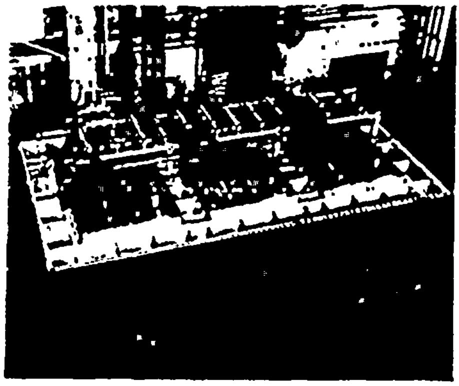


Figure 6.
Transformer rated 325/364 Mva, 55/65-C rise, 230 kv, as viewed with bus and tap changer, *before top section of tank is installed.*

Transformers Shipped Without Insulating Liquid

When a transformer is shipped without liquid (usually because of weight restrictions), the tank is normally filled with dry nitrogen under 2 to 3 psi positive pressure. Additional instructions and precautions for dry air shipments are described at the end of this section. Such a transformer is first thoroughly dried at the factory and vacuum filled with oil for tests. Then the oil is replaced with dry nitrogen for shipment. The oxygen content of the gas filling is below 3%.

A transformer should arrive at its destination with a positive pressure as indicated by the pressure-vacuum gage on the transformer. Temporary shipping gages are not intended for continuous service and are to be removed before the transformer is put in service. The oxygen content of the gas should test below 3%. Under these conditions, it is reasonable to assume that no leaks have developed and no moisture has entered the unit. Filling with oil can proceed.

If leakage is suspected, the unit should first be pressure tested (see TESTING FOR LEAKS on this page) to locate any leak. Even though there has been leakage (which must be corrected before the transformer goes into service), if the oxygen content measures below 3%, filling can proceed. If the oxygen content is higher, moisture can be suspected and drying out may be required. See DRYING CORE AND COILS on page 6.

A transformer should be filled with oil under as high a vacuum as the tank design will permit. The permissible value is shown on the nameplate. Detailed procedures on vacuum filling, including the vacuum rating of standard accessories, are outlined in *Service Information S210-10-1.*

Seals

Careful attention should be paid during installation of radiators, coolers, bushings, covers, and other parts with gasket seals to see that gaskets are properly seated. Joints should be tightened up gradually all around. In most cases, gaskets are fully confined and are provided with compression-controlling stops. Cements are not required for synthetic rubber gaskets except if needed to hold the gasket in position for assembly. Detailed instructions on gaskets are contained in *Service Information S210-05-4, Power Transformers: Rubber, Cork; Chloroprene Gaskets.*

All threaded pipe fittings depend on sealing compound to keep them from leaking. When a threaded pipe fitting (like a pipe plug or screw-type valve) leaks or if the seal is broken by turning or removing the fitting, it becomes necessary to thoroughly clean the threaded surfaces before resealing. All the oil, grease, old sealer, and dirt must be removed from the threads. Rethread and retap the threads, if necessary, taking care to prevent cuttings from entering the equipment. When replacing threaded fittings, coat both male and female threads with sealing compound. Do not overtighten. Once the seal is set, do not turn the fitting because this will break the seal and cause it to leak.

Energizing the Transformer

When voltage is first applied to the transformer, a gradual increase to full value is desirable so that any wrong connection or other trouble may be discovered before damage results. After full voltage has been applied successfully, the transformer should preferably remain energized for a short period without load. It should be kept under observation during this time and also during the first few hours that it delivers load. After four or five days of service, it is advisable to again test the oil for moisture.

Transformers Shipped In Dry Air

When so specified, a transformer may be shipped in dry air rather than dry nitrogen. This allows inspection of the core and coil unit after arrival. However, the oxygen content of the dry air must be checked before entering to assure it is sufficient to support life.

There must be no welding or burning on a tank that is air-filled.

SAMPLING AND TESTING OF INSULATED LIQUID

Sampling

The sample containers should be large-mouth glass bottles with cork stoppers. They should be thoroughly cleaned, rinsed with non-leaded gasoline, and dried before being used. The sample taken for dielectric tests should be at least one-half gallon and the container should be filled completely.

The insulating liquid in a transformer or a drum should stand undisturbed for at least an eight-hour period before samples are taken. Humidity should be low and the container should be above ambient temperature when samples are taken to guard against condensation.

Oil samples are taken from the bottom of the tank or drum. When taking samples from a transformer, discard sufficient liquid so that the sample does not include liquid that was in the valve and piping assembly.

Testing

For testing insulated liquid see TESTING in *Service Information S210-05-3, Power Transformers: Insulating Oil,* and IEEE Guide No. 64 for *Acceptance and Maintenance of Insulating Oil in Equipment.*

TESTING FOR LEAKS

Main Tank

Although completed transformers are subjected to pressure tests for leaks before leaving the factory, it is advisable to again pressure test them when completely assembled—before they are placed in service—to check new seals and to recheck seals broken during inspection and assembly. One of two methods is suggested:

1. Completely fill the tank with oil and hold the oil under 5 psi pressure for several hours. It will be necessary to watch the pressure closely as a change in ambient temperature can easily cause a drastic change in pressure. The pressure must not be allowed to exceed the safe value to be found on the nameplate. Powdered blue chalk dusted on the joints will turn dark when wet with oil and will aid in detecting leaks.
2. Maintain a nitrogen pressure of approximately 1 psi less than the safe pressure indicated on the nameplate. A soap-bubble solution (such as glycerine and liquid soap) painted onto welded and gasketed joints will disclose leaks. Or, the unit may be sealed under the gas test pressure for a period of hours while checks are made for loss of pressure.

DRYING CORE AND COILS

There are a number of approved methods for drying a transformer core-and-coil assembly, any one of which will be satisfactory if carefully performed. However, too much stress cannot be laid upon the fact that, if carelessly or improperly performed, great damage may result to the transformer insulation through overheating.

The methods in use may be broadly divided into two classes:

1. Drying the core and coil in the tank with vacuum.
2. Drying the core and coil in the tank with hot oil only.

Method No. 1—Drying With Vacuum

The most practical and efficient method to dry a core-and-coil assembly in the field when the transformer tank is designed for full vacuum is with heat and vacuum. A cold trap in the vacuum line is desirable to improve the effectiveness of the vacuum pump and to help measure the results.

PREHEATING THE CORE-AND-COIL UNIT

Because the rate of transformer vacuum drying is determined by the difference between the vapor pressure of the water in the insulation and the absolute pressure (vacuum) in the tank, it is practical to make and maintain this difference as great as possible. This is best accomplished by preheating the core and coil unit, up to 90 C either before or during the vacuum.

There are three basic acceptable methods of preheating the core-and-coil units in the transformer tank: preheating with hot oil and vacuum; preheating with external oil heaters; preheating under oil with short-circuit current.

1. Preheating with hot oil and vacuum. This method of treatment usually employs a commercial-type-vacuum-oil-heating system that circulates, heats, filters, and vacuums a full or less-than-full transformer tank of oil which, in turn, heats, and begins to dry the core-and-coil unit. This is a preferred method of heating, especially when a less-than-full tank of oil is used, because the vacuum and/or dry oil begins the drying process at the start of the operation. When using all transformer oil heaters, care must be taken to control the surface temperature of the heating elements to prevent heat damage to the oil.

2. Preheating with external oil heaters. With this method of heating, the transformer is filled with oil to operating level (or to 6 inches of the cover on a conservator sealed tank) and the tank is vented to the atmosphere. The oil is then circulated through an external heat source that will not damage the oil and the unit is brought up to temperature. Experience has shown that approximately 12 hours are required for the core and coil temperatures to level off at maximum temperature following the oil in the tank.

3. Preheating with short-circuit current. This is the least desirable method of heating the core-and-coil unit because of the risk of creating damaging hot spots in the windings. With this method, the transformer tank is filled with oil to the operating level and the tank or conservator is vented to the atmosphere. With one winding short-circuited, a reduced voltage is applied to the other winding to circulate a partial rated current through both windings. McGraw-Edison Power Systems Division, Service Department should be contacted for advice on the voltages and temperatures to be used.

After using any one of the hot oil-preheating methods described above, the oil should be removed from the tank as quickly as possible and the vacuum started.

VACUUM

After heating the core-and-coil unit, the vacuum operation should be started as soon as possible to minimize heat loss. If a cold trap is available, it should be connected into the vacuum line to increase the efficiency of the pump and, by keeping a log of the moisture removed from the trap, it will aid in determining the end point of the drying operation. The specific length of time the unit must remain under vacuum depends on many variables and is discussed in a following paragraph.

Method No. 2—Drying With Hot Oil Only

The drying-with-hot-oil-only method is also accomplished with the core-and-coil unit in its tank. It is a slow process that cannot reach as low a moisture end point as the vacuum method can; however, it may be the only choice available if the tank is not designed for full vacuum.

In this method, the moisture is driven off by heat developed from current circulated for a limited time through the windings while they are immersed in oil with the top of the tank open to the air or with some other arrangement made for adequate ventilation. The necessary current, voltages, and maximum safe temperatures for the particular transformer may be secured from McGraw-Edison Power Systems Group, Service Department. These values should be strictly adhered to in order to obtain the desired results without damaging the transformer.

With one winding short-circuited, a voltage is applied to another winding to circulate a partial rated current through both windings. The required high oil temperature is obtained by blanketing the tank (or by reducing the flow of water for water-cooled transformers).

During the drying run, ventilation should be maintained by slightly raising the manhole cover and protecting the opening from the weather. With good ventilation, the moisture as it is driven off in the form of vapor will escape to the outside atmosphere and no condensation of moisture will take place on the underside of the cover or elsewhere, provided these parts are lagged with heat insulating material to prevent condensation of moisture within.

When To Discontinue Drying

Because of the many variables involved in drying a transformer such as the amount of moisture that was picked up, the size of insulation package, and the temperature and vacuum used for drying, it is not possible to make a general prediction on how long a drying operation might take. However, for a particular transformer, McGraw-Edison Power Systems Group, Service Department may be contacted to give some insight. There are a number of measuring techniques used to determine the amount of moisture remaining in the transformer insulation, thus indicating an end point to the drying operation, all of which are not exact, but each one, or a combination of them, can give a fairly accurate indication. If a cold trap is used in the vacuum drying process, the amount of water condensate removed over equal periods of time can give a good indication of the remaining moisture in the insulation. The technique normally used is to measure and record the amount of water condensate removed from the trap over regular intervals of time and plot the results on a curve with water in ounces on the ordinate and time in hours on the abscissa. The water extraction rate is greatly dependent on the insulation temperature but, when the curve levels off and is in the general range of 12 ounces or less of water removed per 10,000 pounds of insulation over a 24-hour period, the unit is probably dry. The insulation weight may be estimated at approximately 12% of the untanking weight.

A dew point measurement of the gas in the transformer tank is another moisture measuring technique that is reliable. Normally with this method the vacuum in the transformer tank is relieved with dry nitrogen or dry air to approximately 2 psi and then allowed to stand for about 24 hours so the vapor pressure in the insulation and the gas approach equilibrium. The dew point of the gas in the tank is then measured along with the temperature of the transformer insulation and, with these two measurements, the moisture remaining in the insulation may be estimated using available curves.[*] It should be understood that this measuring technique is, in fact, measuring the moisture content of the gas which is as-

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[*] Referring to the curves in Figures 7 and 8, McGraw-Edison Power Systems Group considers the area above Curve B as acceptable. Example: Measured dew point = -20F, tank pressure = 2½ psi, and insulation temperature = 20C. Enter toward Curve A from left and find approximately 260 microns. Enter toward Curve B from 20C at left to 280 microns. Intersection is in acceptable range.

sumed in equilibrium with the surface of the insulation. It does not give an exact measurement of the average moisture content of the insulation.

Another method of determining insulation dryness is with dissipation factor measurements. This method is not generally considered as reliable as those previously discussed, but it may be considered worthwhile. Using this method, the tank must first be filled with processed oil before the readings are made. The readings are then adjusted to the same temperature as those made at the factory when the unit was tested.

Probably the least reliable, but a commonly used, method of determining the dryness of the transformer insulation is by using the measured amount of water in the oil to estimate the moisture in the insulation. To get meaningful results with this method, the oil and insulation must be at—or near—equilibrium and at a constant temperature. The constant temperature is difficult to maintain outdoors. Another disadvantage to this method is that there are often large variations in the results of the measuring process which make the equating step meaningless.

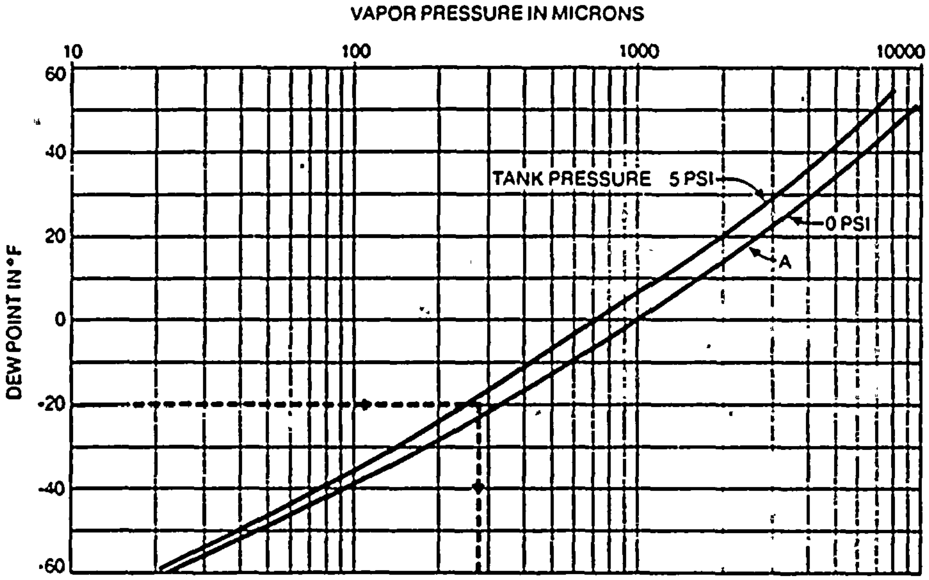

Figure 7.
Curve A. Step 1: Enter toward Curve A with dew point in ° F to determine vapor pressure in microns.

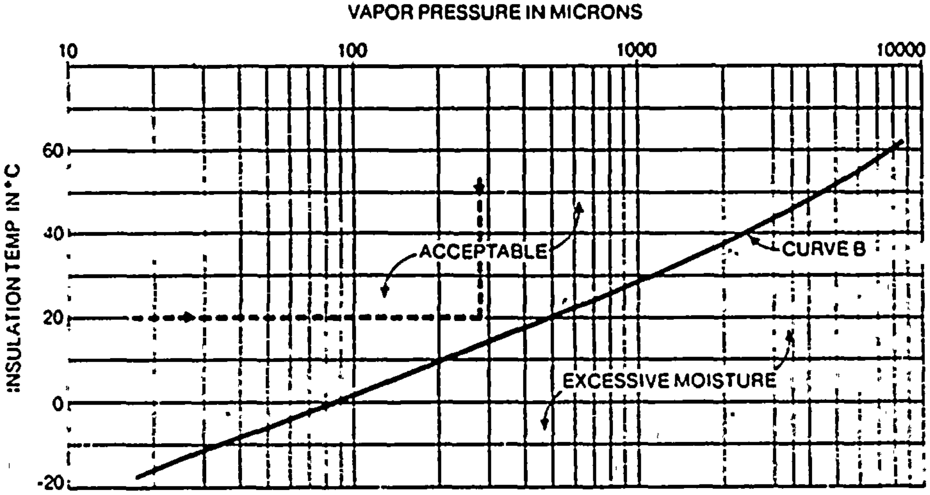

Figure 8.
Curve B. Step 2: Determine insulation temperature in ° C. Enter with the vapor pressure from Step 1 toward Curve B. Area above curve is acceptable.

MAINTENANCE

To assure continued dependable service from a transformer, a program of periodic inspection and maintenance should be set up. Certain routine operating procedures should be included. The size of the unit, the complexity of its controls, and its importance in the system all have a bearing on the scope of the program.

Specific instructions are supplied by McGraw-Edison Power Systems Group which apply to such individual components of the transformer as the oil preservation, cooling and load tap changing equipment. *Following are some of the more general* points common to all transformers.

Figure 9.
Top section of 240/300/400-Mva transformer being lowered into place. Auxiliary windings for LTC are located in the compartment at the right.

Cooling Equipment

The temperature should be watched. ANSI Standards provide a guide for safe operation. A rapid or extreme change from normal temperatures may indicate that cooling equipment requires maintenance such as cleaning of clogged oil-to-air heat exchangers or water-cooling coils. The actual cause must be corrected.

Insulating Liquid

The level and condition of the insulating liquid should be regularly checked. Its condition should be maintained by periodic dielectric tests and filtering as required to maintain the required dielectric strength (see SAMPLING AND TESTING OF INSULATING LIQUID on page 5). Frequent sampling and testing of the insulating liquid during the early period of operation will help determine a routine schedule. Appreciable moisture in a transformer and low dielectric test may indicate gas leaks (except with open-breathing transformers) and the need for a pressure test as outlined under TESTING FOR LEAKS.

Fault-Gas Detection

As a part of a preventive maintenance program, the scheduled use of a McGraw-Edison portable Fault-Gas Detector or a semiportable continuous Fault-Gas Monitor is recommended. These instruments disclose incipient faults in a transformer and can thus prevent serious damage and unanticipated loss of service.

External Inspection

A transformer needs periodic external inspection and maintenance. Bushings should be kept reasonably clean, especially where the atmosphere is contaminated: for example: smoke-, salt-, cement-, or acid-laden. The tank should be protected from corrosion by an adequate painting program.

REPLACEMENT PARTS

When ordering replacement parts, supply complete identification of the transformer and parts required (including drawing numbers of the parts if available). Address the nearest McGraw-Edison Power Systems Group office or representative or address the Service Section, McGraw-Edison Power Systems Group, P.O. Box 440, Canonsburg, Pennsylvania 15317.

McGRAW-EDISON

Power Systems Division
Post Office Box 2850
Pittsburgh, PA 15230

McGRAW-EDISON

Power Systems Group

Power Transformers

Shell-Form Transformers Core-Clamping System with Elastic Follow-Thru

Supplement 1
S210-05-5
Service Information

These instructions describe the general construction of the elastic follow-thru core-clamping system (Figure 1) used on McGraw-Edison shell-form transformers to assure development of strength in the core to withstand short-circuit forces and the procedures to be followed to retighten the pressure disks around the core perimeter when the transformer is installed and during periodic maintenance.

GENERAL CONSTRUCTION

Short-circuit forces act against the end yoke steel, the center tank top side frame member, and the bottom tank short-circuit manifold (Figure 1). Tank members directly resisting the short-circuit forces are totally boxed in for mechanical strength. The short-circuit forces acting on the end yoke steel are contained by core friction between overlapping laminations. This friction force is developed and maintained by compressing large helical-coil springs over each critical overlapped core joint.

The procedure used at the factory to compress the springs is shown in Figure 2. All springs are installed in the center tank section side-frame members. The center tank, with the spring assemblies installed, is lifted and lowered over the stacked core steel to rest on the top core insulation. At this point, there is a nominal 2-3/16-in. gap between the lower center tank flange and the bottom tank flange. Hydraulic cylinders are then attached to the lugs at each of the four tank corners and the entire center tank section is uniformly pulled down to compress all the helical-coil springs simultaneously.

When the two tank flanges are in contact, measurements are taken of the actual compression of each spring to assure factory-specified spring compression. After measurements have confirmed that each spring is adequately compressed, the tank flanges are welded together around the entire perimeter. The hydraulic equipment is then removed.

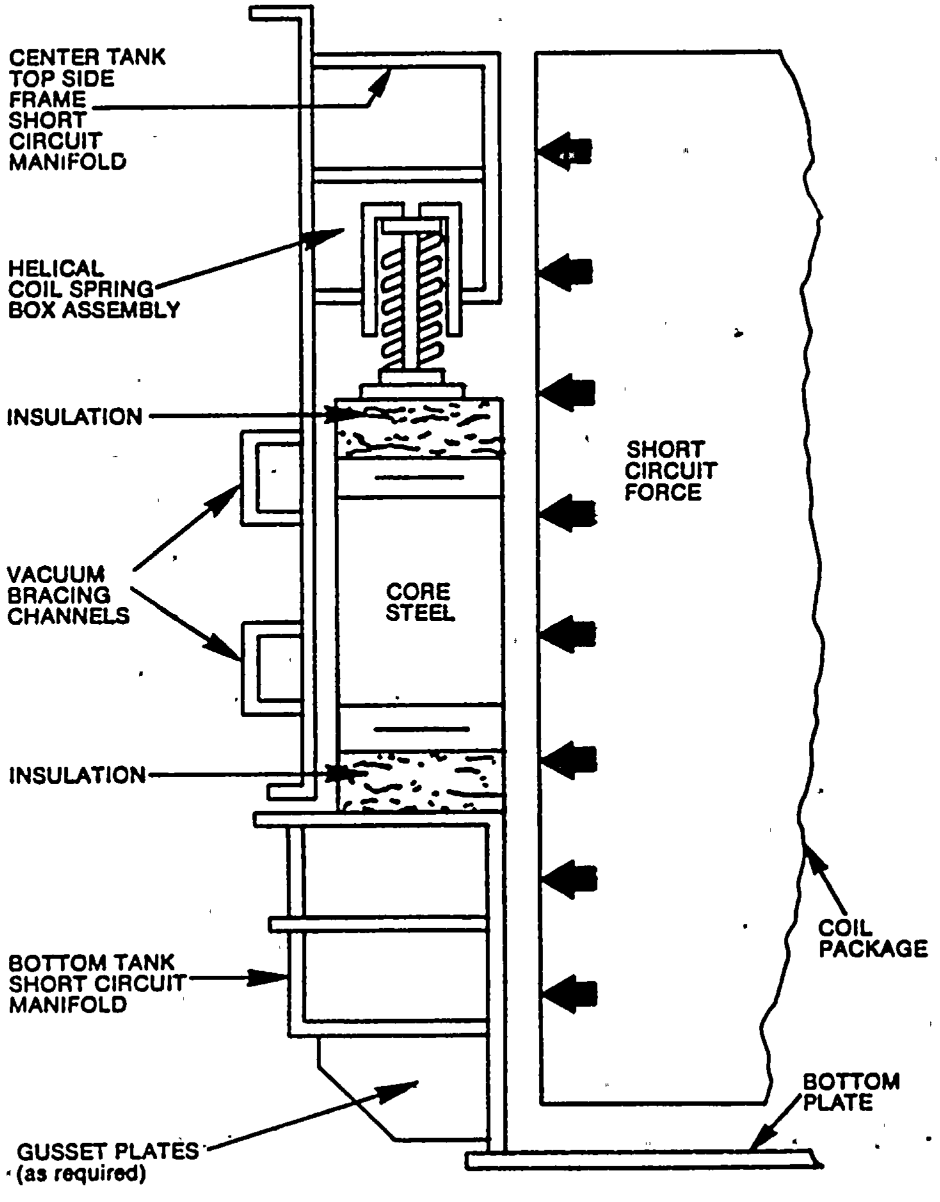

Figure 1.
Cross-sectional view of the tank and core clamping.

WARNING
The center tank section of the transformer is springloaded and must be removed only by using hydraulic equipment and special instructions which must be obtained from The Service Department, McGraw-Edison Company, Power Systems Group, Canonsburg, PA 15317. Before any springloaded central tank section is burned loose from the bottom tank flange and released, it is imperative that the coil leads be unbrazed and/or unbolted from the lead support superstructure. DO NOT ATTEMPT TO SEPARATE THE CENTER TANK FROM THE BOTTOM TANK SECTION BY BURNING PRIOR TO OBTAINING THE HYDRAULIC EQUIPMENT FROM McGRAW-EDISON.

February 1982 • New Issue

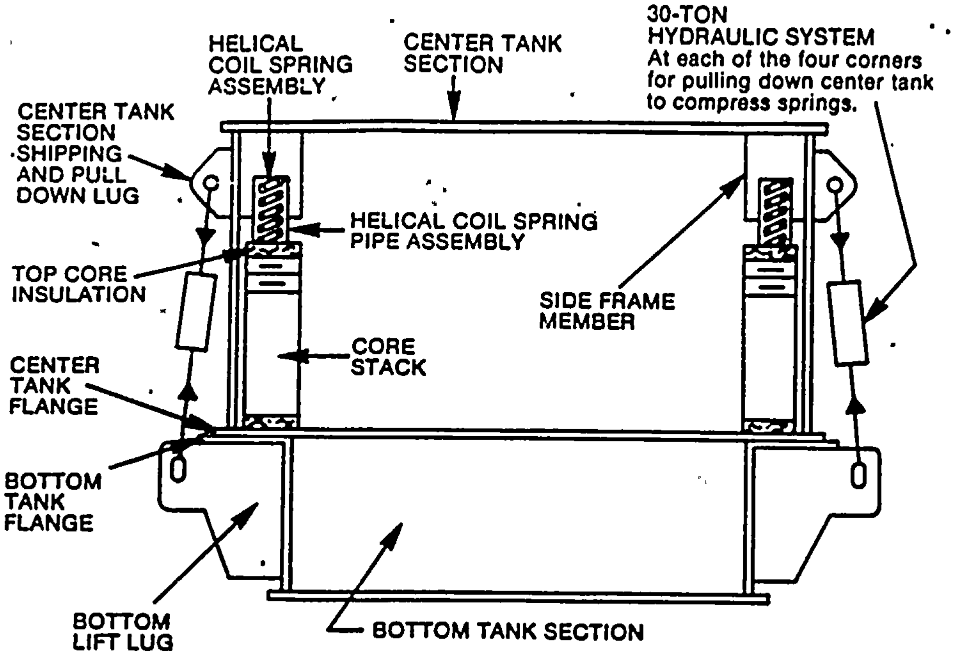

Figure 2.
External pulldown arrangement to compress helical springs.

PRESSURE DISKS

Threaded pressure disks around the core perimeter (between the spring assemblies) at the top of the core insulation clamp the core steel laminations for short-circuit strength. These pressure disks also hold the core laminations in position during upright or laydown shipment of the transformer.

CAUTION
All pressure disks are pretorqued to 250—450 ft-lb at the factory prior to shipment, but require retightening to a minimum of 250 ft-lb at installation. It is also recommended that the pressure disks be retorqued during periodic transformer maintenance.

All pressure disks are accessible from inside the transformer tank. To retighten each pressure disk, refer to Figure 3 and

1. Loosen the top locking nut.
2. Tighten the disk to 250 ft-lb.
3. Retighten the top locking nut.

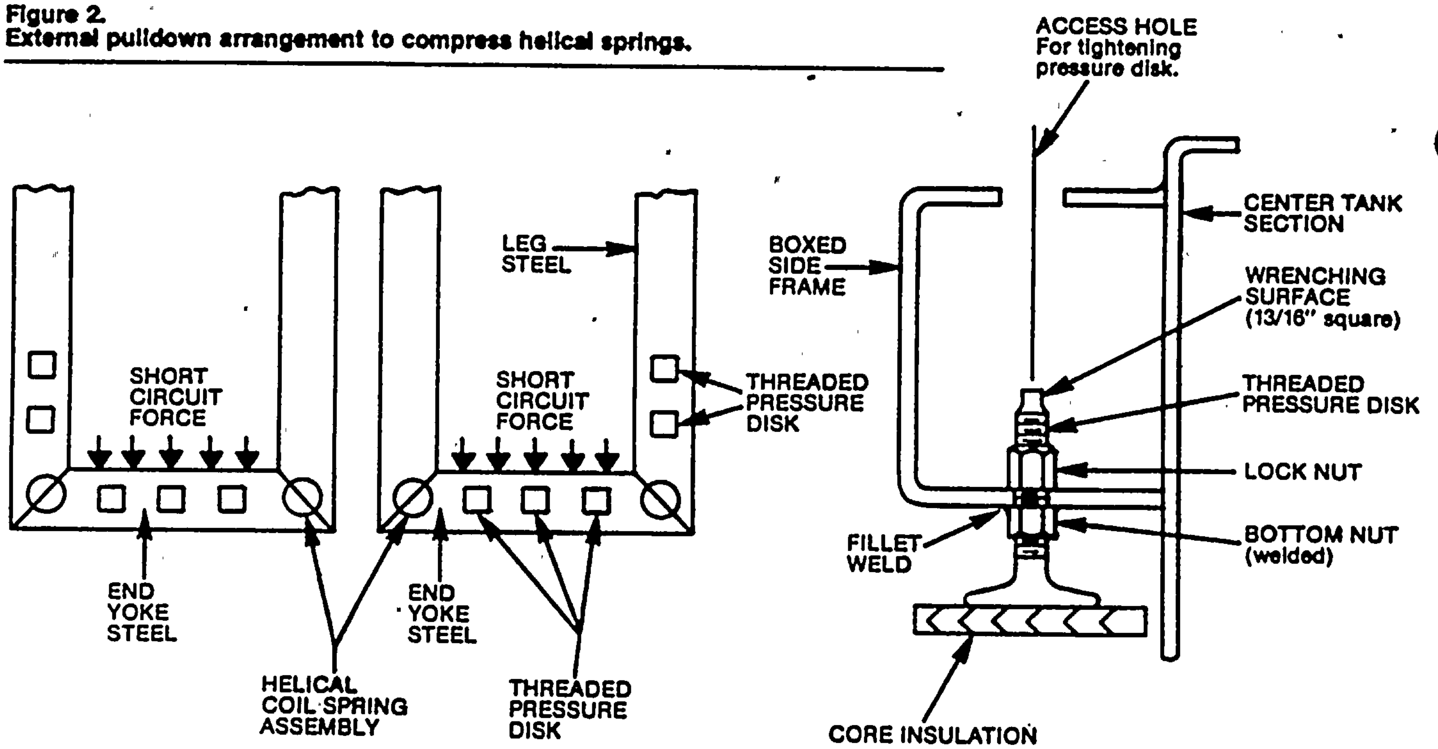

Figure 3.
Pressure disk assembly and locations.

McGRAW-EDISON

Power Transformers
Vacuum Filling Oil-Immersed Core-Form, Load Tap Changing, and Shell-Form Units

S210-10-1
Service Information

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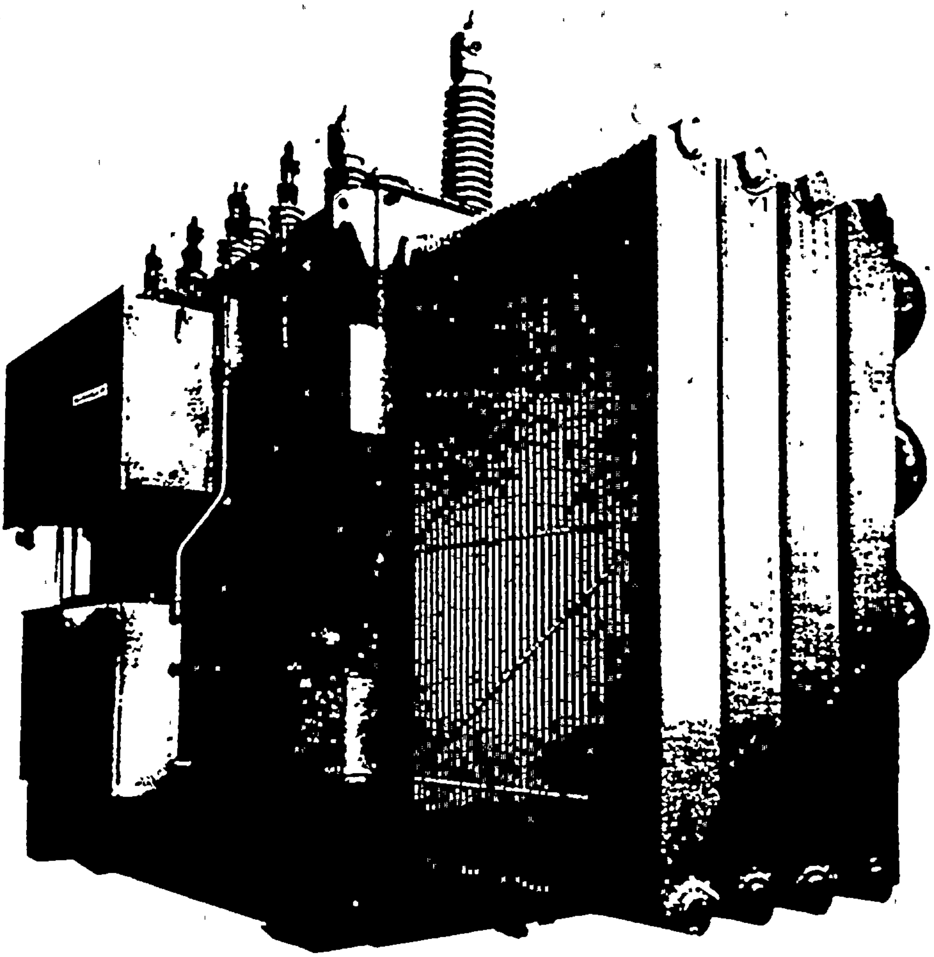

Figure 1.
Typical McGraw-Edison core-form, load tap changing power transformer (with arcing tap-switch-type mechanism) designed for vacuum filling.

GENERAL

Service Information S210-10-1 pertains specifically to vacuum filling McGraw-Edison oil-immersed core-form power transformers, load tap changing power transformers and shell-form power transformers. These instructions apply only to vacuum filling units that were received and installed in a normal manner and where no special field drying is required.

Because high-vacuum filling (near-full vacuum) is the most effective method of removing entrapped air and surface moisture that reduce insulation strength, high-vacuum filling is recommended for all transformers where it is permitted by the tank design. High-vacuum—rather than low-vacuum—filling is required for all transformers rated above 69 kv and/or 10 Mva.

To reduce the risk of moisture entering the insulation, it is recommended that the coils be covered with oil when the tank is opened. Although this preferred procedure is described in these instructions, an alternative method—using dry air—is permissible and is described on page 5.

PRESSURE-VACUUM DESIGN LIMITATIONS

Pressure-vacuum ratings of main tanks are divided into two classes:

High-vacuum: tanks capable of withstanding 15 psi vacuum.

Low-vacuum: tanks capable of withstanding approximately five to eight psi vacuum as shown on the outline drawing and the connection diagram nameplate.

NOTE: The low-vacuum rating shown on the outline drawing and the connection diagram nameplate must not be exceeded.

These instructions do not claim to cover all details or variations in the equipment, procedure, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your McGraw-Edison Power Systems Group sales engineer

PRELIMINARY PREPARATIONS PRIOR TO FILLING

Before filling the transformer tank with oil:

1. Fit and properly seal all accessories that can be connected during filling: valves, detachable radiators, heat exchangers, gages, bracing bands providing auxiliary gas expansion space, and piping.
2. The copper-tube common gas connection between the selector switch compartment and the main transformer tank must be in place and the valve must be open.
3. Disconnect all rigid connections between the top of the bushings and other members.
   NOTE: This is essential because the tank and the cover will deflect when high vacuum is applied.
4. Open the valves to detachable radiators and heat exchangers.
5. Disconnect (or protect by closing the valves) those accessories that cannot withstand the vacuum levels to be used.
6. Open all shut-off valves used to isolate the auxiliary gas expansion space in the bracing bands.
   NOTE: These shut-off valves must remain open during vacuum filling as well as during normal operation to maintain equal gas pressure in the bracing bands and the main tank.

   Where bracing bands provide auxiliary gas expansion space in the sealed-tank oil-preservation system, the lowest of these auxiliary gas space bands has a gasketed nipple and cap. The cap can be removed for purging the transformer tank. If oil appears when the cap is removed, it is probably residual oil from the factory testing process.
7. The type of oil-protective system and cooling system determines the accessories furnished and the steps required to prepare for filling. Instructions for such preparation are contained in the following paragraphs in which items are grouped according to their pressure-vacuum design limitations.

High-Vacuum Parts

The high-vacuum-rated items listed below are capable of withstanding 15 psi (or 30 inches of mercury). Auxiliary items so rated need not be disconnected or protected during filling.

1. Main tanks and bracing bands used for expansion space. Refer to the transformer nameplate for confirmation of the vacuum rating.
   NOTE Transformer tanks designed for full vacuum are pretested at the factory
2. Radiators.
3. Heat exchangers
4. Pressure-type protective relays such as sudden-pressure relays
5. Thermometers.
6. Oil-level gages.
7. Pressure-vacuum gages.
8. Tubing connections for gas.
9. Bushings.
10. Mechanical pressure-relief devices.
11. Gasket pipe connection one inch ips.

Low-Vacuum Parts

The low-vacuum-rated items listed below must be disconnected and the openings plugged or capped or the valves in the lines connecting them to the main tank must be closed during high-vacuum filling. These auxiliaries need not be disconnected or shut off during low-vacuum filling.

1. Main tanks. Refer to the transformer nameplate for confirmation of the vacuum rating.
2. Auxiliary oil- or gas-expansion tanks (except bracing bands used for expansion space).
   A. For high-vacuum filling, gas connections must be disconnected at the tank and the outlets must be sealed.
   B. Oil-conservator connections are usually provided with valves that can be tightly closed.

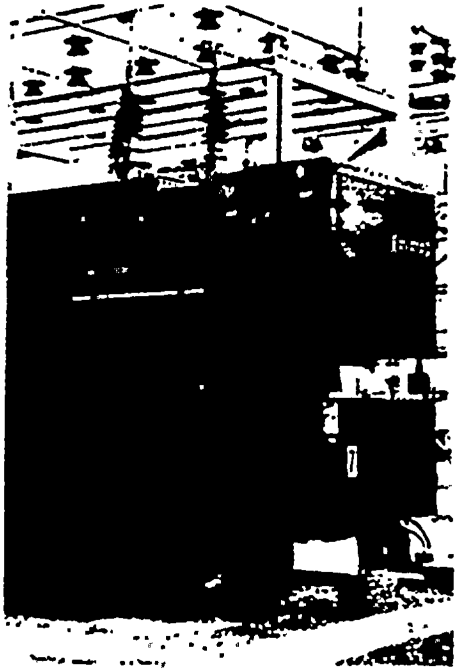

Figure 2.
Typical McGraw-Edison load tap changing power transformer (with isolated interrupter-type mechanism) designed for vacuum filling.

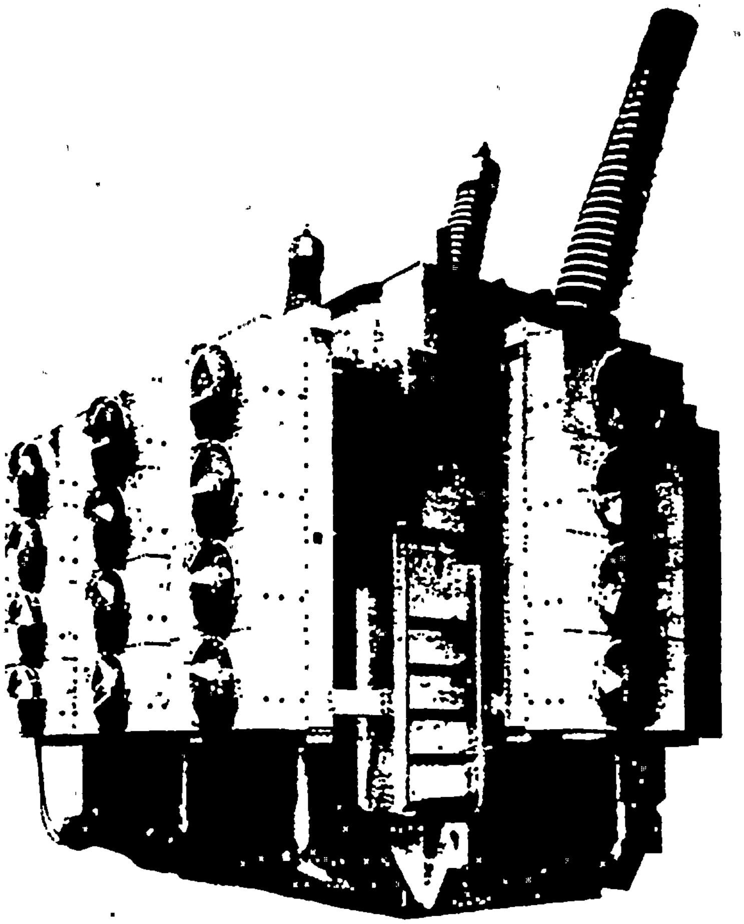

Figure 3.
Typical McGraw-Edison contour design shell-form power transformer designed for vacuum filling (590 Mva with FOA cooling).

Unsealed Devices

The accessories listed below have normal breathing or relief characteristics. For *any* vacuum-filling operation, these devices must be valved off or removed and the openings sealed.

1. Breathers of either the open or the dehydrating type.
   NOTE: They must be removed and the openings sealed.
2. Pressure-vacuum bleeder devices for main tanks.
   NOTE: These devices must be removed and replaced by caps.
3. Nitrogen-pressure equipment.
   NOTE: The pressure-relief devices and gas regulators of such equipment must be isolated by closing the valve in the gas-feed tubing lines connected to the transformer main tank.

Isolated Interrupter-Type Load Tap Changers

Isolated interrupter-type load tap changing equipment can be recognized by the double compartments at the top of the tank. These compartments contain the separated selector and interrupter switches (Figure 5).

Interrupter Switch Compartment

The outside compartment (containing the interrupter switches) is effectively sealed from the other compartment and has its own oil-preservation and handling facilities. The interrupter switch compartment has a crossflow, open-breathing system to exhaust the arcing gases. A mechanical pressure-relief device relieves any sudden, excessive pressure such as might be developed by excessive arcing under the insulating liquid. The exterior walls of the interrupter switch compartment cannot withstand high vacuum. The interrupter compartment of these load tap changers should be filled separately with dry oil to the proper oil-gage level. Since vacuum filling is not required for this outside compartment, the walls are designed for a maximum of five psi pressure or vacuum (equivalent to ten inches of mercury).

Selector Switch Compartment

The compartment next to the main tank contains the selector switch. This compartment is separated from the main tank by a Pennsylite panel on which the selector switch is mounted and through which the tap leads pass.

The selector switch design, with the selector switch mounted on the Pennsylite panel, requires that equal pressure be maintained on both sides of the panel at all times. Equal pressure is attained by connecting the top of the compartment to the top of the main tank with copper tubing.

A valve in the connecting copper tubing allows inspection and maintenance of the selector switch without losing the nitrogen in the main tank. The slight pressure on the Pennsylite panel caused by sealing the main tank and opening the selector switch compartment can be tolerated. However, it is most important that this valve be kept open during normal operation and during vacuum filling. Do not pump down or release vacuum on the main tank through the selector switch.

The compartment and tube connection are designed for full vacuum and, therefore, are not to be disturbed during filling or normal operation. Important special instructions applying to drainage procedures are furnished as part of the specific instructions book for each transformer.

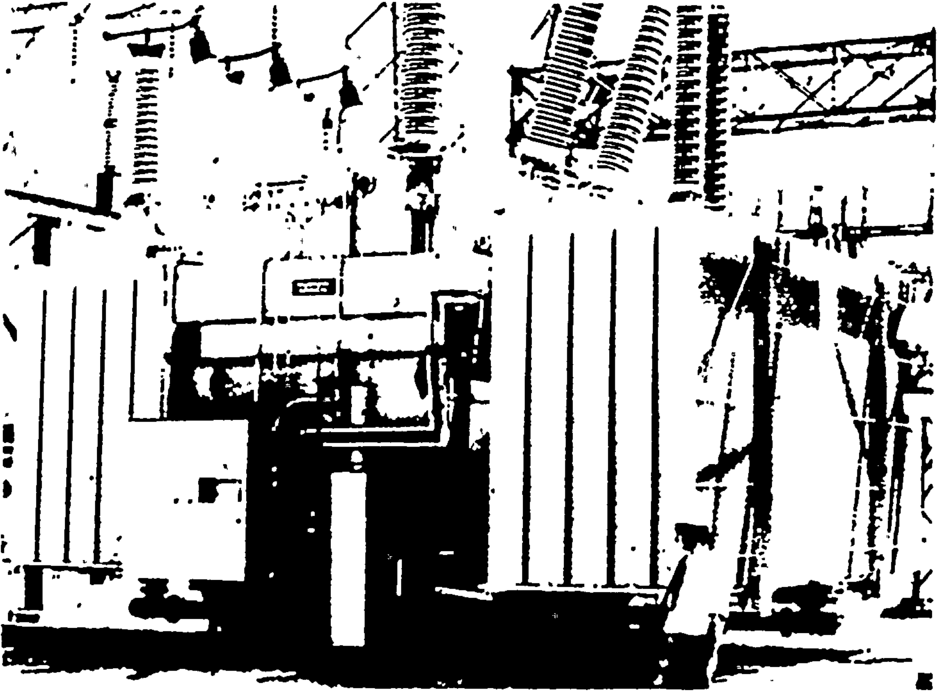

Figure 4.
Typical McGraw-Edison contour design shell-form power transformer designed for vacuum filling (161 Mva with forced-air/forced-oil cooling equipment to increase capacity to 214 and 268 Mva).

Arcing Tap-Switch-Type Load Tap Changers

Arcing tap-switch-type load tap changers (Figure 1) have a top-mounted pressure-relief device and a crossflow open-breathing system to exhaust the arcing gases. The arcing tap-switch compartment is isolated from the main tank by a Pennsylite panel that is capable of withstanding full vacuum or pressure and requires no protective precautions during the filling of the main tank. The exterior walls of the load tap changer arcing tap-switch compartment, however, cannot withstand high vacuum or pressure. Since vacuum treatment is not required for the switch compartment, these walls are designed for a maximum of five psi pressure or vacuum and should be filled accordingly.

See Figure 6 for a typical vacuum oil-filling hookup; see Table 1 for sequence and values.

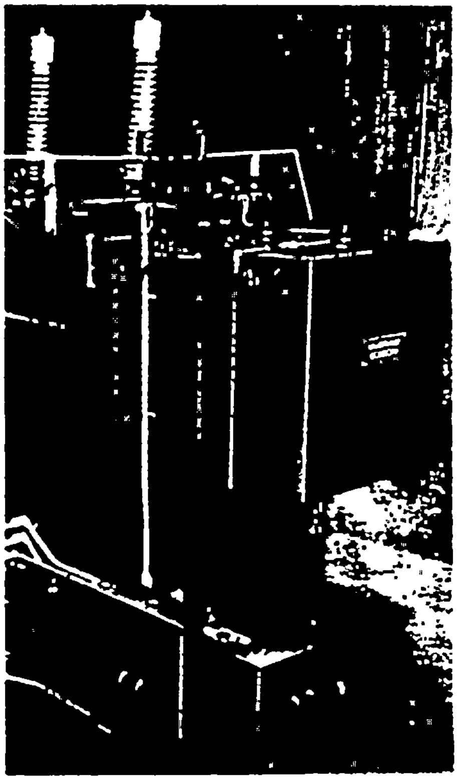

Figure 5.
Typical McGraw-Edison double compartment containing isolated interrupter-type load tap changing equipment.

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PREINSTALLATION VACUUM

Purpose

To evacuate any gas pockets prior to the initial oil filling and to remove any surface moisture introduced while the core-and-coil unit was exposed to the atmosphere.

NOTE: To make this vacuum effective in removing moisture, the temperature of the core-and-coil unit must be above zero C.

Procedure

1. Ground all internal line leads that have not been brought out of the tank through the bushings.
2. Open all valves to those accessories requiring vacuum. (See PRELIMINARY PREPARATIONS PRIOR TO FILLING and Figure 6.)
3. Blank off all accessories that are not capable of withstanding high vacuum. (See PRELIMINARY PREPARATIONS PRIOR TO FILLING and Figure 6.)
4. Connect a vacuum gage to the cover.
5. Connect the vacuum hose to the cover outlet.
6. Pump down to the maximum pressure, holding this pressure with the pump running for the minimum hours shown in Table 1.

WARNING

During the first two hours that a transformer is under high vacuum, all personnel must stay clear of the tank to assure the soundness of field welding and other field assembly operations.

Do not operate load tap changing mechanism during high vacuum.

Table 1
High-Vacuum-Filling Sequence and Values

Operation	High-Voltage Operating Class (kv)				
	69 or less	115-230	345	500	765
Preinstallation vacuum					
Pressure, max	50 torr	25 torr	4 torr	2 torr	1 torr
Hold hours	2+E hr	2+E hr	4+E hr	8+E hr	12−E hr
Partial oil fill for inspection and installation					
Pressure during filling, max	60 torr	30 torr	6 torr	4 torr	2 torr
Drain oil	not required	not required	yes	yes	yes
Final vacuum					
Pressure, max	50 torr	25 torr	4 torr	2 torr	1 torr
Hold hours	2+E hr	2+E hr	4+E hr	8+E hr	12+E hr
Final oil fill					
Pressure during filling, max	60 torr	30 torr	6 torr	4 torr	2 torr
Degassed oil	not required	not required	recommended	recommended	yes
Pressurize* and run pumps					
Pressure (lb)	2-3	2-3	2-3	2-3	2-3
Total hold/run pumps (hr)	6/6	12/6	12/12	24/12	48/12

*See special procedure on page 5 for a conservator or similar system.

1 torr = 1 mm hg = 1000 microns

E = hours the core-and-coil was exposed during inspection and/or installation. Use E/2 if the coils were covered with oil.

Oil dielectric strength: See Service Information S210-05-3, Insulating Oil.

PARTIAL FILL FOR INSPECTION AND INSTALLATION

NOTE: To minimize the exposure of the core-and-coil unit to the moist atmosphere, the coils should be covered with oil when the tank is open for an extended period of time such as when installing a top tank section or bushings.

1. Make sure that all transformer line leads not brought out through the bushings are grounded to the tank.
2. Ground the tank, the bushings, and the oil-processing equipment to prevent a static charge buildup from the oil entering the tank.
   A. Each container of oil must meet the minimum dielectric strength specified in Table 1.
   B. Each container of oil must pass through a filter press as it is entered into the transformer tank.
   C. The temperature of the oil which is admitted at this time and not removed before final filling (see Table 1) must be between 10 C and 90 C.
3. Enter the oil into the tank.
   A. Control the rate of flow so that the pressure does not exceed that shown in Table 1.
   B. Bring the oil level up to cover the coils or to within two or three inches of the tank split if a top tank section is to be installed.
4. Release the vacuum with dry nitrogen or dry air.

WARNING

Do not enter the tank unless the oxygen content is at least 18 percent.

Do not open the transformer unless the temperature of the transformer and the oil is at least 10 C above the dew point of the outside air.

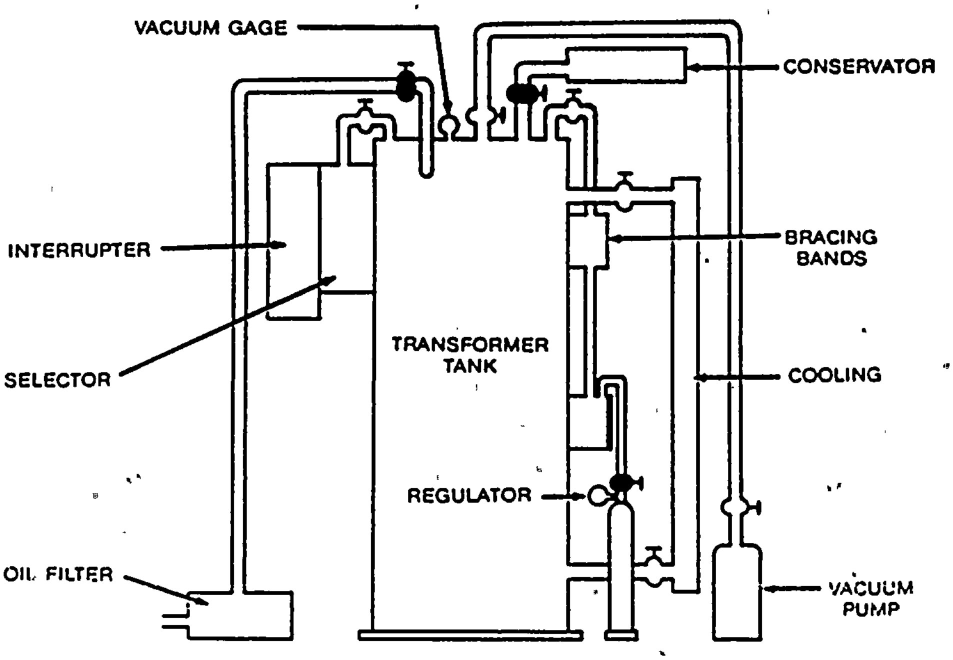

Figure 6.
Typical vacuum oil-filling hookup.

5. After the internal assembly of the transformer has been completed, seal the tank, and drain the oil from the tank while admitting dry nitrogen or dry air (Table 1).

   NOTE: Oil is drained from the tank to reduce the possibility of a gas pocket being entrapped in the insulation structure. This can occur if the gas that has been absorbed by the oil leaves solution greatly expanded from the subsequent vacuum cycle and becomes entrapped in the insulation.

FINAL VACUUM

Purpose

To flash off any surface moisture introduced while the tank was open and to remove all gas pockets prior to the final oil-filling operation.

NOTE: To make this vacuum effective in removing moisture, the temperature of the core-and-coil unit must be above zero C.

Procedure

1. Open all valves to accessories requiring vacuum. (See PRELIMINARY PREPARATIONS PRIOR TO FILLING and Figure 6.)
2. Blank off all accessories that are not capable of withstanding high vacuum. (See PRELIMINARY PREPARATIONS PRIOR TO FILLING and Figure 6.)
3. Connect to the cover a vacuum gage capable of accurate readings.
4. It is recommended for all transformers—and *it is essential for conservator transformers*—that a clear-plastic sight hose be connected between the top and the bottom of the tank to determine the rate of oil flow and the oil level reached.
5. Connect the vacuum hose to the cover outlet.
6. Pump down to the maximum pressure, holding this pressure with the pump running for the minimum hours shown in Table 1.

WARNING

During the first two hours that a transformer is under high vacuum, all personnel must stay clear of the tank to assure the soundness of field welding and other field assembly operations.

Do not operate load tap changing mechanism during high vacuum.

FINAL OIL FILL

Purpose

To fill the unit with oil to its final level prior to energizing.

Procedure

1. Ground the tank, the bushings, and the oil-processing equipment to prevent a static charge buildup from the oil entering the tank.
   A. Each container of oil must meet the minimum dielectric strength specified in Table 1 of Service Information S210-05-3, Insulating Oil.
   B. Each container of oil must pass through a filter press as it is entered into the transformer tank.
   C. The temperature of the oil must be between 10 C and 90 C.

      NOTE: On higher voltage transformers (Table 1), it is recommended that the oil be pretreated in a vacuum-degassing-and-dehydrating unit. This unit should be capable of upgrading the oil entered into the transformer to the dielectric strength, water content, and gas content specified in Table 1 of Service Information S210-05-3, Insulating Oil.
2. Enter the oil into the tank.
   A. Control the rate of flow so that the pressure does not exceed that shown in Table 1.

      Sealed tank: Fill to the 25 C level.

      Tank with a conservator-type system: Fill to within two or three inches of the cover.

PRESSURIZE AND RUN PUMPS

Purpose

To help assure that any entrapped gas has had sufficient time to be absorbed by the oil.

Procedure for Sealed-Tank Construction

1. Release the vacuum by introducing dry nitrogen into the gas space above the oil level to a slight positive pressure.
2. Reduce the pressure to zero and adjust the oil level in accordance with the transformer nameplate.
3. Purge the gas space with dry nitrogen, reseal, and increase the pressure to two or three psi.

   NOTE: This pressure will gradually drop due to absorption of the nitrogen into the oil.
4. Place the tank sealing equipment in operation.
5. Allow the transformer to stand with the sealing equipment in operation and the pumps (if supplied) operating at any time during the period for the minimum times shown in Table 1.

Procedure for Conservator-Type Construction

1. Release the vacuum to atmo pressure by introducing dry ni or dry air into the gas space above oil level.
2. Open all vents above the oil level on the bushing casings, gas detector (if supplied), pressure-vacuum bleeder, mechanical pressure-relief device, etc. and on the cover of the conservator tank.
3. Open the shut-off valve on the thermo trap line.
4. Continue to fill with oil while closing each vent as oil is discharged.
5. Allow the transformer to stand with the pumps (if supplied) operating for the minimum times shown in Table 1.

LOW-VACUUM FILLING

If a tank is not designed for high vacuum or if high-vacuum facilities are not available, it is permissible to use a low vacuum for filling a transformer with oil if the unit is rated 69 kv or below and/or 10 mva self-cooled or below.

When low-vacuum-type filling is used, the maximum pressure must not exceed minus five psi and all "hold hours" specified in Table 1 for 69 kv or less m doubled.

ALTERNATIVE METHOD OF INSPECTING AND INSTALLING A TRANSFORMER WITHOUT OIL COVERING THE COILS

If it is necessary to inspect or install a transformer without bringing the oil up to cover the coils:

1. Remove the shipping nitrogen with a vacuum or by purging with dry air.
2. Using canvas or a similar material, cover all openings that are not necessary for evacuating the air.

WARNING

Do not enter the tank unless the oxygen content is at least 18 percent.

Do not open the transformer unless the temperature of the transformer and the oil is at least 10 C above the dew point of the outside air.

3. While the tank is open, continuously blow in dry air at the bottom of the tank while venting at the top.
4. Final vacuum and fill the tank in accordance with Table 1.

McGRAW-EDISON

Power Systems Group

Power Transformers

Tap Changing Equipment
Large Geneva-Gear-Drive Tap Changer

S210-40-1
Service Information

DIRECT OPERATING MECHANISM

General

A geneva-gear-drive tap changer has an external operating mechanism with a geneva-gear position index. One complete revolution of the operating handle makes one tap position change.

The external operating mechanism, Figure 1, has a shaft that passes into the transformer tank through a self-adjusting packing in an oil-tight and gas-tight stuffing box. The shaft is connected to the internal tap changer by a slotted steel coupling, shaft, and universal joint. This arrangement permits slight shaft misalignments without hindrance to operation.

Installation

The operating mechanism and the tap changer are usually shipped completely assembled. During the inspection of the transformer and before the transformer is energized, the operating mechanism and tap changer should be operated over the complete range to check for alignment and possible damage in transit. The operating mechanism should then be set on the desired tap position before energizing the unit.

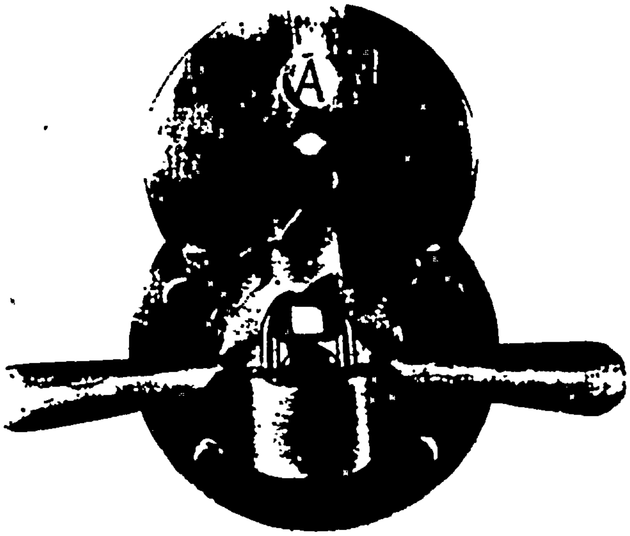

Figure 1.
Operating mechanism for geneva-gear-drive tap changer.

Description

The tap-changer operating mechanism, Figure 2, consists of an operating handle with a lock-pin assembly to hold the handle in tap position, a geneva-gear index to indicate the respective tap position, and an oil-tight and gas-tight stuffing box with self-adjusting packing that allows the operating shaft to go through the side of the transformer tank. The manual operating handle of the operating mechanism is rigidly fastened to one end of a noncorrosive shaft. The other end of this shaft within the tank has a rigidly fastened irreversible cross pin. In operation, the pin transmits the operating torque applied at the handle to the slotted steel coupling fixed to the drive shaft which operates the geneva-gear-driven tap changers. Means are provided for padlocking the operating handle in each tap position. Placed nearby is a plate with instructions for preparing the shaft for untanking the transformer.

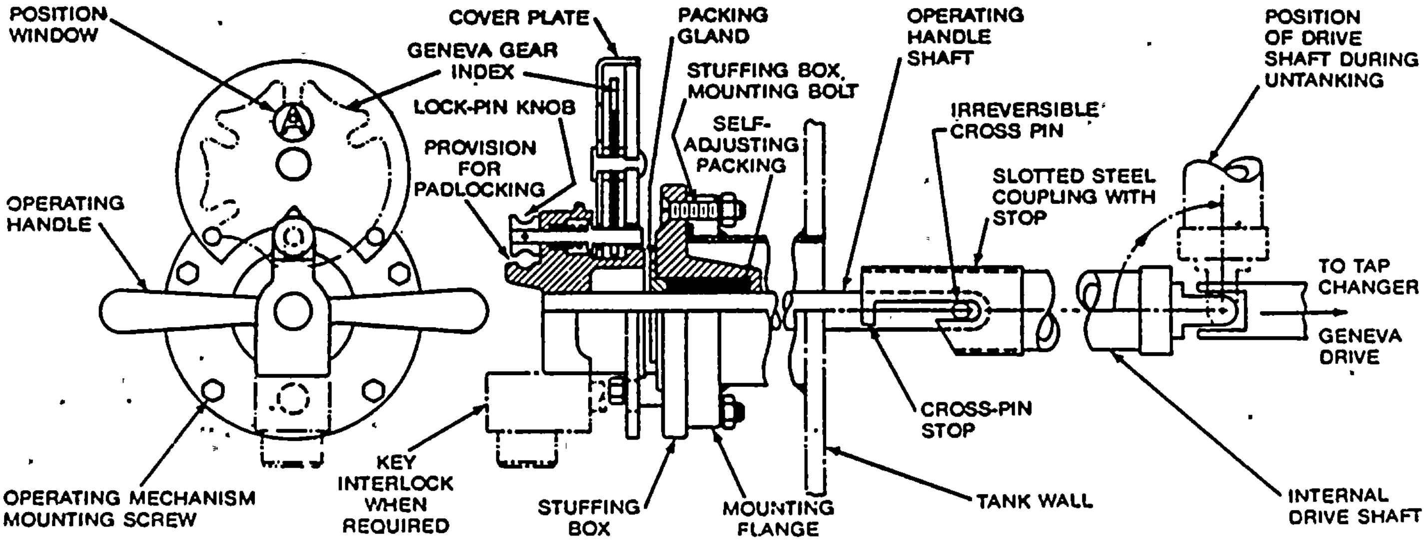

Figure 2.
Cross section of operating mechanism for geneva-gear-drive tap changer.

Voltage and current ratings at various positions of the tap changer, and a diagrammatic sketch of the transformer windings and connections are indicated on a stainless-steel connection-diagram nameplate mounted on the main tank.

A mechanical, electrical, or key interlock system can be provided to prevent operation of the operating mechanism while the transformer is energized. When an interlock is provided, the interlock requirements are in addition to those of the regular lock pin described.

Operation

CAUTION
The tap changer should be operated only when the transformer is disconnected from the lines and completely deenergized. The transformer must never be energized unless the tap changer is in an operating position. Failure to observe these safety precautions may result in damage to the transformer or injury to the operator.

PROCEDURE FOR CHANGING TAPS

Completely deenergize the transformer. Remove the padlock (if provided) and pull out the lock-pin knob to release the operating handle. (The pin is springloaded and cannot be entirely removed.) Turn the operating handle until the desired tap position is indicated and the lock pin drops into the retaining hole. Each complete revolution of the operating handle makes one tap change. The cam design of the geneva-gear indexing plate prevents overtravel of the limit positions. After the tap change has been made and the lock pin is in the retaining hole, replace the padlock.

PROCEDURE FOR UNTANKING TRANSFORMER

Refer to the instruction plate mounted adjacent to the tap-changer operating handle. With the operating handle padlocked in any tap position, record the actual position of the tap-changer contacts corresponding to this position, remove the operating-mechanism mounting screws, and pull out the operating mechanism until it comes to a stop. At this point, the irreversible cross pin will be against the coupling stop lugs.

Now lift the internal tap changer drive shaft to disengage the steel coupling, being careful not to turn the shaft from its recorded position. Withdraw the operating mechanism until it comes to a positive stop. The cross pin will then be against the internal side of the stuffing box which prevents the shaft from being completely withdrawn from the tank and provides the proper clearance for untanking.

If the tap changer shaft must be turned from its recorded contact position for any reason, it must be returned to the recorded contact position before retanking the transformer.

When the core-and-coil unit is to be placed back into the tank, reverse the procedure just described being very cautious not to alter the contact position corresponding to the operating handle position. To assure proper coordination, ratio tests must be made on the rated voltage connection and on all tap connections after the transformer is retanked.

Maintenance

The springloaded, self-adjusting packing in the stuffing box requires no adjustment. No other maintenance is required.

GROUND-LEVEL OPERATING MECHANISM

General

A ground-level operating mechanism is available as optional equipment on tall transformers. The construction of this mechanism is shown in Figure 3. The operating handle provides the torque for moving the vertical shaft which extends up to a pair of miter gears. The gears are connected by a horizontal shaft to the slotted steel coupling on the internal tap changer drive shaft. This shaft passes through self-adjusting packing in an oil-tight and gas-tight stuffing box.

Installation

The operating mechanism and the tap changer are usually shipped completely assembled. During the inspection of the transformer and before the transformer is energized, the operating mechanism and tap changer should be operated over the complete range to check for alignment and possible damage in transit. The operating mechanism should then be set on the desired tap position before energizing the unit.

Description

The manual operating handle rigidly fastened to an interconnecting vertical shaft transmits the operating torque through miter gears to a horizontal shaft which has an irreversible steel pin on the end. This pin transmits the torque applied at the external operating handle to the drive shaft of the internal tap changing mechanism.

The manual operating handle is provided with a geneva-gear index to indicate the respective tap position and a lock-pin assembly to hold the handle in tap position. Means are also provided for padlocking the operating handle in each tap position. Placed nearby is a plate with instructions for preparing the tap changer shaft for untanking the unit

Voltage and current ratings at various positions of the tap changer, and a diagrammatic sketch of the transformer windings and connections are indicated on a stainless-steel connection-diagram nameplate mounted on the tank.

A mechanical, electrical, or key interlock system can be provided to prevent operation of the operating mechanism while the transformer is energized. When an interlock is provided, the interlock requirements are in addition to those of the regular lock-pin described.

Operation

CAUTION
The tap changer should be operated only when the transformer is disconnected from the lines and completely deenergized. The transformer must never be energized unless the tap changer is in an operating position. Failure to observe these safety precautions may result in damage to the transformer or injury to the operator.

PROCEDURE FOR CHANGING TAPS

Completely deenergize the transformer. Remove the padlock (if provided) and pull the lock-pin knob upward to release the operating handle. (The pin is springloaded and cannot be entirely removed.) Turn the operating handle until the desired tap position is indicated and the lock pin drops into the retaining hole. Each complete revolution of the operating handle makes one tap change. The cam design of the geneva-gear indexing plate prevents overtravel of the limit positions. After the tap change has been made and the lock pin is in the retaining hole, replace the padlock.

PROCEDURE FOR UNTANKING TRANSFORMER

Refer to the instruction plate mounted below the operating-mechanism gear housing. With the operating handle padlocked in any tap position, record the actual position of the tap-changer contacts corresponding to this position. Remove pins from coupling on vertical shaft and slide the couping down past the shaft joint. Remove the gear-box mounting bolts and pull out the gear and shaft assembly until it comes to a stop. At this point, the irreversible cross pin will be against the coupling stop lugs.

Now lift the internal tap changer drive shaft to disengage the steel coupling; being careful not to turn the shaft from its recorded position. Withdraw the gear and shaft assembly until it comes to a positive stop. The cross pin will then be against the internal side of the stuffing box, which prevents the shaft from being completely withdrawn from the tank and provides the proper clearance for untanking.

If the tap changer shaft must be turned from its recorded contact position for any reason, it must be returned to the recorded contact position before retanking the transformer.

When the core-and-coil unit is to be placed back into the tank, reverse the procedure just described, being very cautious not to alter the contact position corresponding to the operating handle position. To assure proper coordination, ratio tests must be made on the rated voltage connection and on all tap connections after the transformer is retanked.

Maintenance

The springloaded, self-adjusting packing in the stuffing box requires no adjustment. Before shipping the transformer, the miter gears in the gear housing are coated with silicone grease, but it is advisable during scheduled inspections to check the gears and add silicone grease, if necessary.

REPLACEMENT PARTS

When ordering replacement parts, refer to Figures 2 or 3 for identifying parts and include all pertinent information contained on the nameplate attached to the transformer. Address all correspondence to the nearest McGraw-Edison Power Systems Division Office, or write directly to McGraw-Edison Power Systems Division, Canonsburg, Pa. 15317.

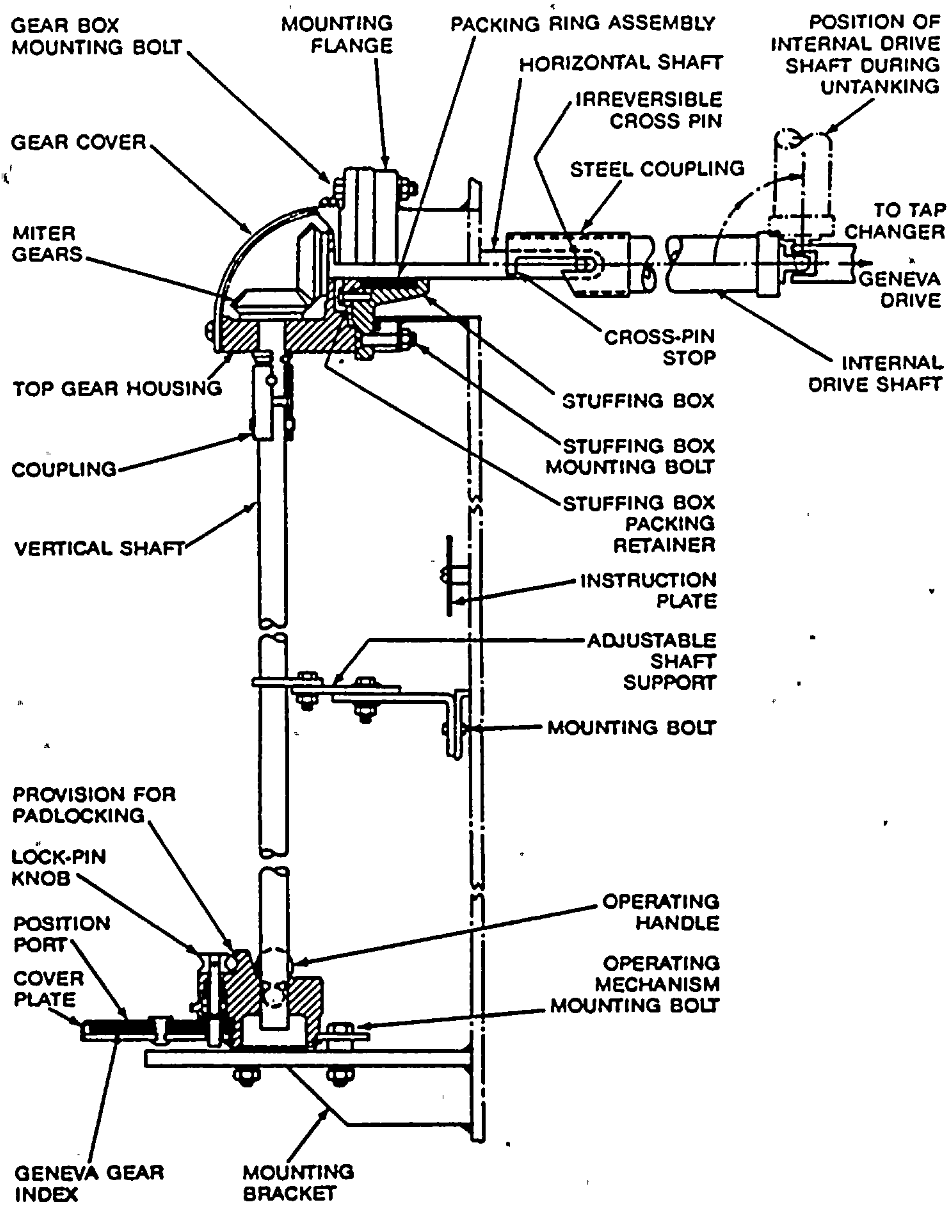

Figure 3.
Mechanism for ground-level operation of geneva-gear-drive tap changer.

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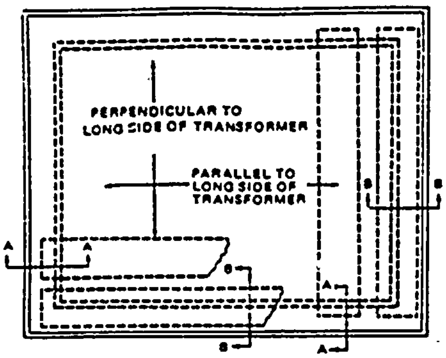
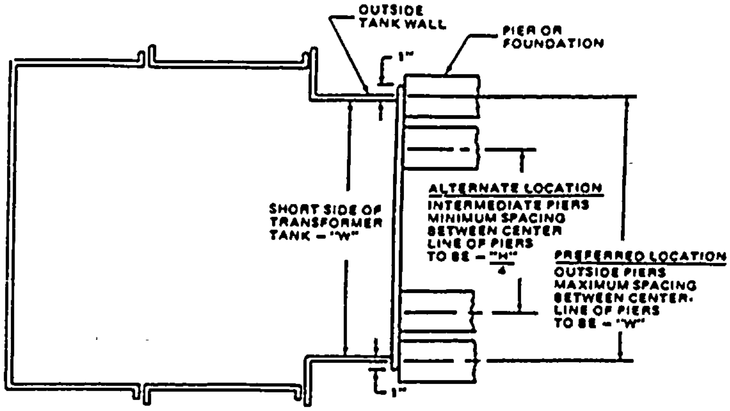
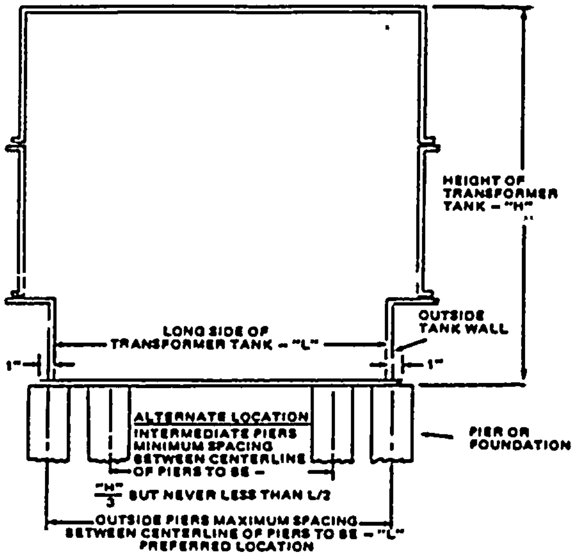
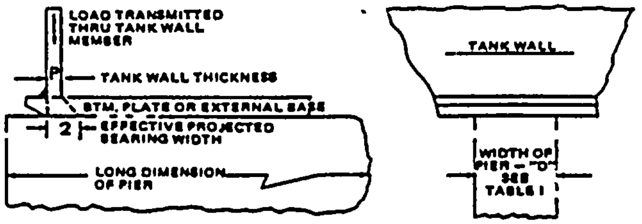


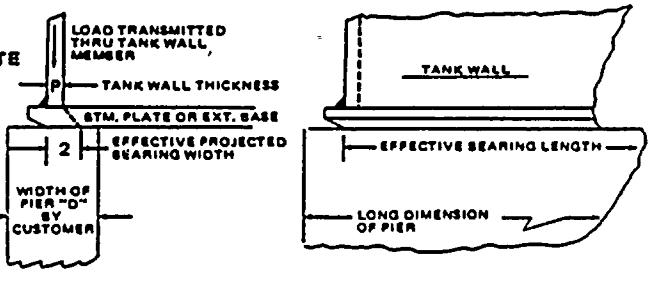




SECTION A-A – WHEN PIERS ARE LOCATED INTERMEDIATE BETWEEN OUTSIDE TANK WALL MEMBERS, THE TRANSFORMER LOAD IS CONCENTRATED ON THE PIER OVER AN EFFECTIVE BEARING AREA OF 2" TIMES THE WIDTH OF THE PIER. SEE TABLE I FOR MINIMUM REQUIRED PIER WIDTH "D" TO PREVENT DAMAGE TO THE TRANSFORMER TANK WALL.



SECTION B-B – WHEN PIERS ARE LOCATED DIRECTLY UNDER THE TANK WALL MEMBERS, THE LOAD IS UNIFORMLY DISTRIBUTED ON THE PIER OVER AN EFFECTIVE BEARING AREA OF 2" TIMES THE EFFECTIVE BEARING LENGTH OF THE PIER.



NOTES:

1. SHELL-FORM TRANSFORMERS MAY BE SUPPORTED BY TWO OR MORE PIERS. THE PIERS MAY BE EITHER PERPENDICULAR OR PARALLEL TO THE LONG AXIS OF THE TRANSFORMER. PERPENDICULAR PIERS MAY BE LOCATED WITH MAXIMUM CENTERS EQUAL TO THE TRANSFORMER BOTTOM TANK LENGTH – "L", OR WITH MINIMUM CENTERS EQUAL TO 1/3 OF THE TANK HEIGHT – "H", BUT NEVER LESS THAN $\frac{L}{2}$. PARALLEL PIERS MAY BE LOCATED WITH MAXIMUM CENTERS EQUAL TO THE TRANSFORMER TANK WIDTH – "W", OR WITH MINIMUM CENTERS EQUAL TO 1/4 OF THE TANK HEIGHT – "H".
2. WHEN INTERMEDIATE PIERS ARE USED, THE PIER WIDTH MUST NOT BE LESS THAN THAT SHOWN IN TABLE I IN ORDER TO PREVENT DAMAGE TO THE TRANSFORMER TANK WALL.
3. THE TOTAL TRANSFORMER WEIGHT IS TRANSMITTED TO THE PIERS OR FOUNDATION THROUGH THE OUTSIDE VERTICAL TANK WALLMEMBERS AS SHOWN IN SECTIONS A-A AND B-B. THE PIER MUST BE DESIGNED TO ACCOMMODATE THIS WEIGHT DISTRIBUTION.
4. WHEN ROLLING TRANSFORMER, ROLLS MUST BE PLACED DIRECTLY UNDER THE TANK WALLMEMBERS – SEE MEPS SERVICE INFORMATION S210-05-2 FOR SPECIFIC INSTRUCTIONS.
5. WHEN TRANSFORMER IS MOUNTED ON A FLAT PAD, THE LOAD IS DISTRIBUTED UNIFORMLY OVER THE ENTIRE BOTTOM PERIMETER OF THE TANK (2W + 2L) ON A 2" EFFECTIVE BEARING WIDTH.
6. THIS DRAWING IS INTENDED TO EXPLAIN THE LIMITATIONS THAT THE TRANSFORMER IMPOSES ON THE PIER OR FOUNDATION CONSTRUCTION. IT DOES NOT INTEND TO INSTRUCT IN THE DESIGN OF THE PIERS THEMSELVES, NOR DOES IT CLAIM TO COVER ALL DETAILS AND VARIATIONS. WHEN ADDITIONAL INFORMATION IS DESIRED, THE MATTER SHOULD BE REFERRED TO THE McGRAW-EDISON COMPANY POWER SYSTEMS DIVISION.
7. PROVISION FOR JACK SUPPORT IN JACKPAD AREA IS BY CUSTOMER WHEN REQUIRED.
8. SEE TRANSFORMER OUTLINE DRAWING FOR L, W, AND H.

TABLE I – (FOR INTERMEDIATE PIERS ONLY)

MINIMUM WIDTH OF PIER TO PREVENT DAMAGE TO TRANSFORMER TANK WALL WHEN USING INTERMEDIATE PIERS – INCHES – "D"	8	10	12	14	16	18
MAXIMUM TRANSFORMER WEIGHT IN THOUSANDS OF POUNDS	400	500	600	700	800	900

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CANONSBURG, PA. 15317 • U.S.A.

PIER & FOUNDATION GUIDE FOR
SHELL-FORM TRANSFORMERS

Addendum to Instructions S210-05-5 for transformers shipped filled with dry air. Replaced items in S210-05-5 referring to shipping in dry nitrogen.

SPECIAL INSTRUCTIONS FOR TRANSFORMERS SHIPPED FILLED WITH DRY AIR

This transformer is shipped filled with dry air in accordance with purchaser's specifications.

The tank and all sealed auxiliary compartments are filled with dry air under 2 to 3 psi positive pressure, and having an oxygen content of approximately 18 percent.

The transformer should arrive at the destination with a positive pressure (as determined with a pressure gauge usually available on the transformer). Pressure will vary approximately with temperature in accordance with table.

TEMPERATURE	GAS PRESSURE
40° C	3-1/2 psi
30° C	3-1/4 psi
25° C	2-1/2 psi
20° C	2-1/4 psi
15° C	2 psi
10° C	1-3/4 psi
5° C	1-1/2 psi
0° C	1 psi
-5° C	3/4 psi
-10° C	1/2 psi

The oxygen content of the gas should test approximately 18 percent upon arrival at destination.

If a decrease in the pressure has occurred without a proportionate decrease in temperature, leakage may be indicated. The transformer should be pressure tested and any leaks corrected before the transformer goes into service.

CAUTION: Do not weld or burn on any transformer filled with dry air. If necessary to burn or weld, purge with dry nitrogen to reduce oxygen content to less than 3 percent.

Refer to S210-05-5 for General Installation and Maintenance Instructions

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BY ____________________

APPROVED ______________

MCGRAW EDISON POWER SYSTEMS DIVISION

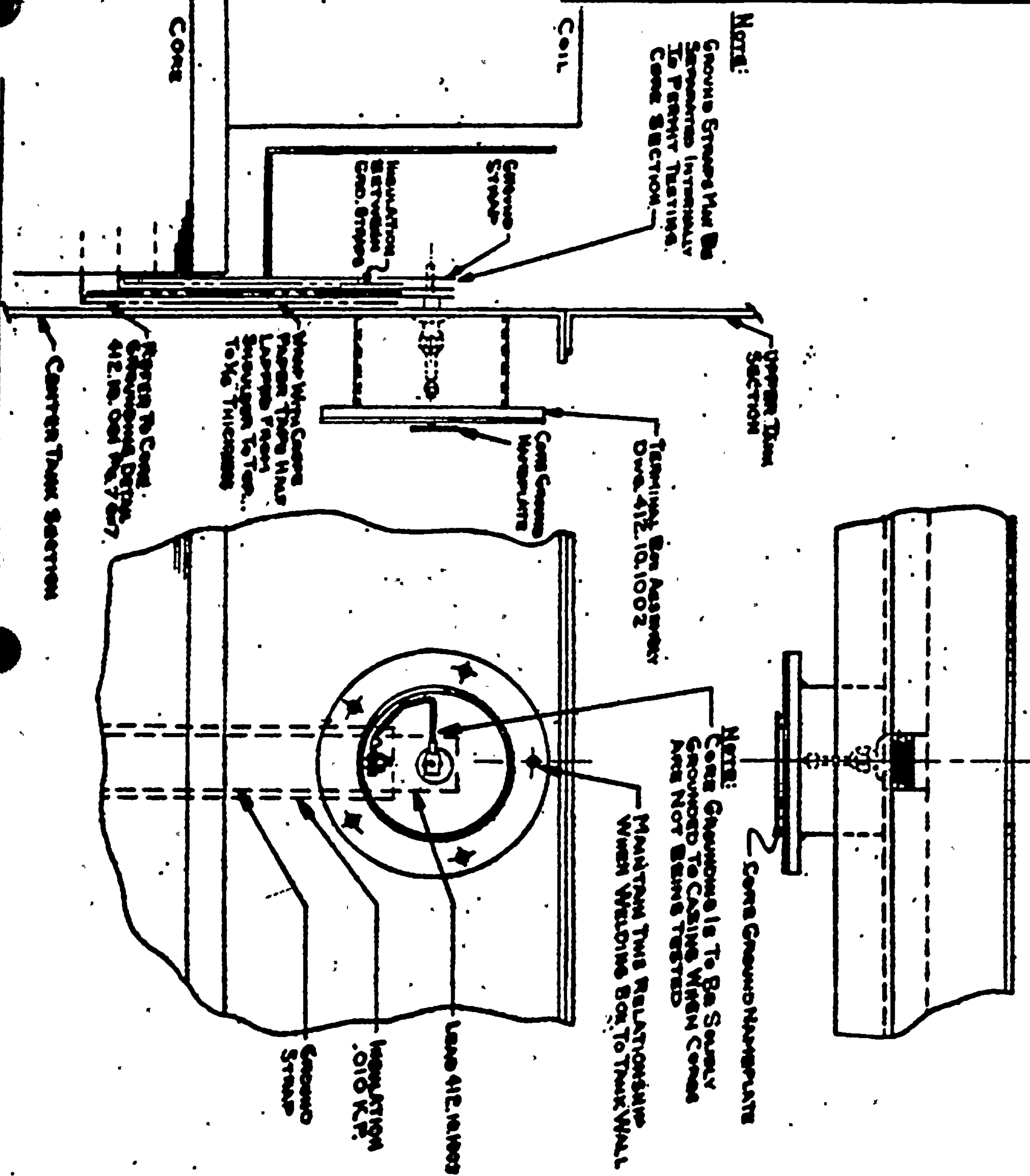
CANONSBURG, PENNSYLVANIA

DATE 30 JAN1967
REVISED 28 March 196
REVISED 1 Nov. 1973
REVISED 21 MAY 1981

DRAWING A-240265

Form No. 459-A

REVISIONS	SYM.	DATE	SIGNATURE	DESCRIPTION



PRINTS TO	
ASSEMBLY	
CARPENTER	
CORE BLDG.	
INSULATION	
MACHINE	
STOREROOM	
TRAFFIC	
TANK SHOP	
ELEC. FIN.	
COM. APPARATUS	
MASTER	
INSPECTION	
OFFICE	
COIL TREAT	
INDUS. ENG.	
CU. FAB.	
ACCOUNTING	
SERVICE	
RAD SHOP	
MECH DESIGN BY	

ITEM	REQ.	NAME	DRAWING NUMBER OR DESCRIPTION

NO. UNITS ORDERED

DRAWN AZ DATE 8-12-81

CHECKED

APPROVED Ales

DESIGN REFERENCE

CONFIDENTIAL
MUST NOT BE USED IN

MCGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNSYLVANIA 15317

DESCRIPTION EXTERNALLY ACCESSIBLE CORE GROUND-FOR SHELL TRANS.

CUSTOMER

CUSTOMER'S ORDER

SPEC.

ORDER

TYPE SHELL

DEPT. MPC

Power Transformers

Cooling Systems
Class FOA Cooling Equipment

Service Information
S210-50-3

GENERAL

Each Class FOA cooling unit consists of an oil-circulating pump, an oil-to-air heat exchanger or cooler, connecting piping, valves that isolate the cooling unit from the tank, oil-flow indicator and control panel. A typical FOA cooling system for a shell-form transformer is shown schematically in Figure 1. Assembly for core-form transformers is similar.

Also refer to the drawings accompanying instructions on the specific equipment.

EQUIPMENT DESCRIPTION

PUMPS

The pump is shown in Figure 2. The pumping element is mounted on the shaft of a squirrel cage induction motor that is completely immersed in the oil being pumped, eliminating the need for rotary seals or stuffing boxes. A small portion of the oil being pumped is forced through the motor, where it cools the windings and lubricates the bearings. See the specific wiring diagram for information on electrical connections.

HEAT EXCHANGERS

Heat-transfer surfaces of the oil-to-air cooler consist of round seamless tubes with fins. Tubes of adjacent rows are staggered to provide efficient heat transfer and equal air distribution. Turbulators (spiral metal strips locked in place inside the tubes), provided over the entire length of the tubes, create turbulence and additional heat transfer. A metal enclosure, open at the front and rear, is bolted to mounting brackets on the tank wall.

The front of the enclosure is a chamber that houses the fans and serves to equalize the flow of air over all tubes and fins. The fans draw the air over the tubes and blow it away from the transformer. Each cooler may have one, two, or three fans with totally enclosed motors connected as shown on the specific diagram. Motors are normally furnished with automatic-reset thermal overload protectors.

CONTROLS

The control panels are located in the central control cabinet. The specific diagram shows the details of wiring and control equipment furnished. An oil-flow indicator, Figure 3, for each pump indicates proper pump operation and is designed to operate in a vertical or horizontal pipe.

INSTALLATION

COOLER ASSEMBLIES

The cooling units may or may not be mounted on the tank for shipment. If shipped detached from the transformer, refer to the assembly drawing furnished with the transformer when mounting the cooling units on the tank. Flange joints are sealed with nitrile gaskets confined in pressure-limiting grooves. Be sure that no strain is placed on the inlet or outlet flanges when mounting the pump.

After all components are mounted on the tank and all flanges are tightened metal-to-metal, the cooling unit may

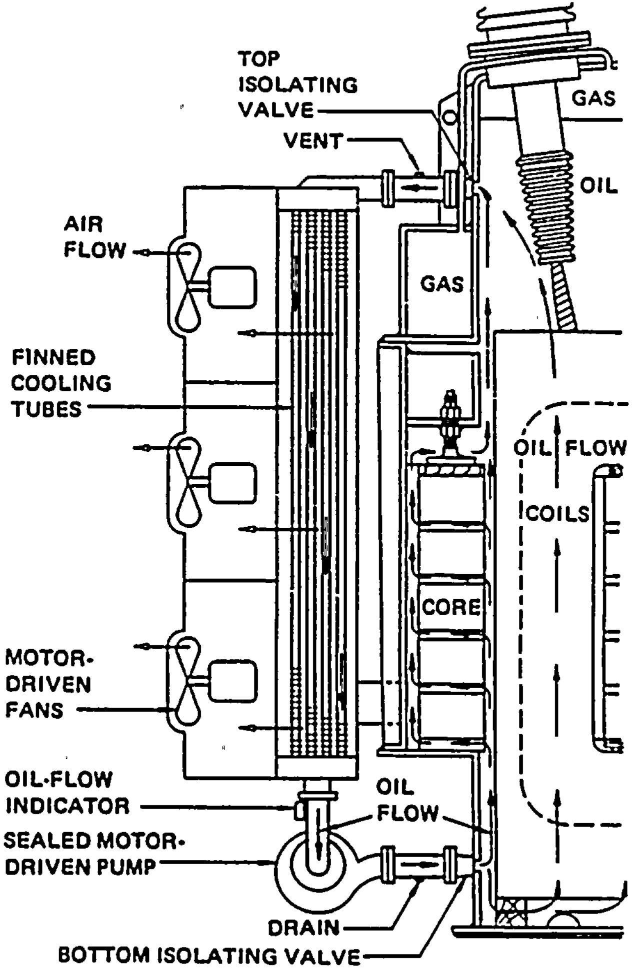


Figure 1
Schematic of typical Class FOA cooling system.

McGRAW-EDISON COMPANY
Power Systems Division
Canonsburg, Pennsylvania 15317

April 1974
Supersedes [illegible]

be filled with oil. The recommended filling procedure is to open the vents on the piping and pump and then open the bottom isolating valve. As the cooling unit fills from the transformer, close each vent as oil appears. Open the top isolating valve after oil appears at the highest vent. Inspect all joints for leakage. Add oil to the transformer to replace the oil used in filling the cooling units.

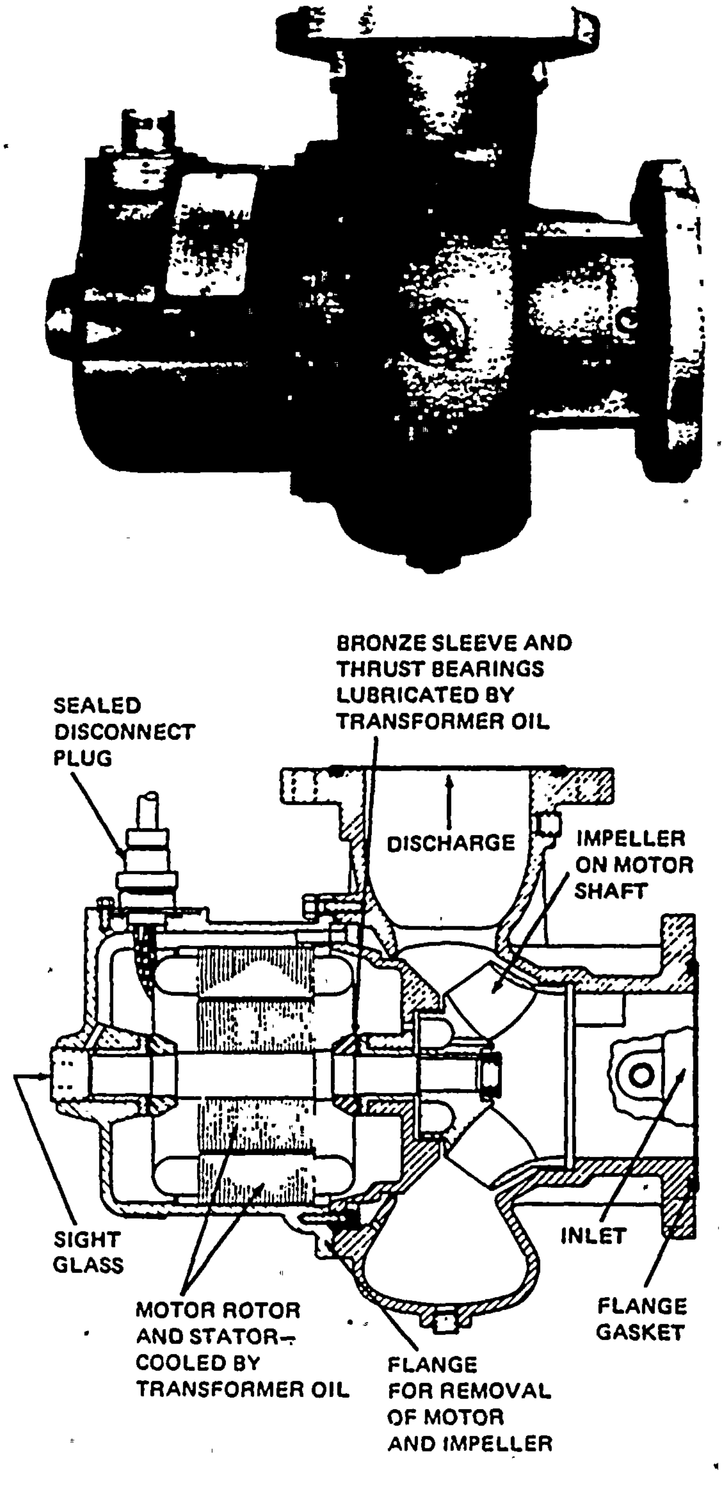


Figure 2
Typical oil pump.

> **CAUTION**
>
> During assembly, keep all foreign material and moisture out of the oil piping, pumps, and coolers.

ELECTRICAL EQUIPMENT – PUMP AND FAN MOTORS

All wiring should be done in accordance with the wiring diagram that is furnished with the transformer. Couple the plug-in receptacles provided for connecting fan motors, pump motors, and the oil-flow indicators.

The pump may be checked for proper rotation before or after installation. Before installation, looking at the inlet flange, the proper rotation is counterclockwise. After installation the rotation may be viewed through the sight glass (Figure 2). The correct rotation viewed from this end is clockwise. Incorrect rotation produces a churning noise. Rotation may be reversed by interchanging any two leads, if the supply is 3-phase.

When looking at the fan guard, toward the fan, the correct fan rotation is clockwise, and the direction of air flow is away from the transformer. The proper rotation and direction is indicated by arrow plates on each cooler.

Each fan motor has a front and rear drain plug to drain any condensation. The rear plug is removed before shipment. However, the front plug is shipped in place to prevent the entrance of any water in transit. It should be removed after installation to allow free breathing within the motor.

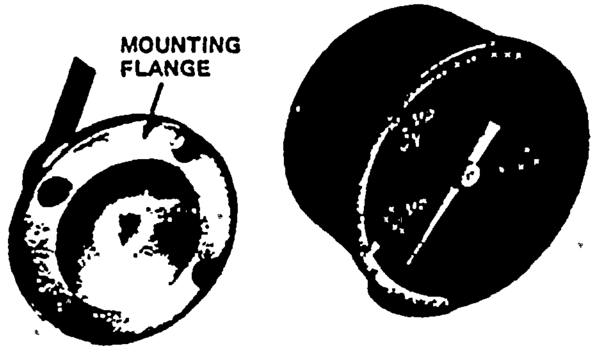


Figure 3
Oil-flow indicator.

OIL-FLOW INDICATOR

The oil-flow indicator must be installed with arrow on the indicator mounting flange (Figure 3) pointing in the direction of oil flow.

For remote indication, contacts within the gage actuate in response to adequate oil flow.

OPERATION

Most transformers are furnished with two separately controlled banks of cooling equipment. One bank is designed to provide 70% of the rated transformer capacity. The second bank of coolers is started automatically by a winding temperature relay. Transfer switches permit the selection of either cooling bank to operate continuously. For specific operating instructions, refer to the wiring diagram.

MAINTENANCE

PUMPS

The pumps should require no maintenance. The bronze sleeves and thrust bearings in the motor are continuously lubricated by the oil which it pumps. The motor and impeller can be removed at the flange indicated in Figure 2 without disconnecting any piping.

HEAT EXCHANGERS

The tubes and fins on the coolers must be kept clean to maintain the original high efficiency. Dust and other foreign material should be blown out periodically with air pressure.

> **CAUTION**
>
> When the cooling unit is to be isolated for a period of time, drain approximately five gallons of oil to provide expansion space.

If the cooling system is completely filled with oil and the isolating valves are closed, high pressure will develop with increased ambient temperature, because of the oil expanding within a confined volume.

The cooling unit must be properly vented when being refilled with oil.

FANS

The fan motors are equipped with double-shielded ball bearings. The shield permits the grease to enter the bearing but restricts the entrance of dirt. A grease retainer labyrinth is designed to prevent grease from reaching the motor windings on the inner side of the bearings. Alemite fittings are provided for adding grease. When grease is added and the housing becomes filled, some grease will be forced into the bearings and any surplus grease will be squeezed out along the close clearance between the shaft and the outer cap, or through the grease relief which is adjacent to the Alemite fitting.

Bearings should be lubricated approximately every six months. They are lubricated at the factory with silicone grease, Dow Corning #DC-33M or equivalent, and it is recommended that this grease be used for maintenance.

REPLACEMENTS

When ordering replacement parts, include the serial number of the transformer with a complete discription of the part, and send to the nearest McGraw-Edison Power Systems Division office, or the Service Section, McGraw-Edison Company Power Systems Division, P.O. Box 440, Canonsburg, Pennsylvania 15317.

McGRAW-EDISON COMPANY
Power Systems Division
Canonsburg, Pennsylvania 15317

McGRAW-EDISON

Power Systems Group

Power Transformers

Temperature Indicating Equipment

S210-70-3

Service Information

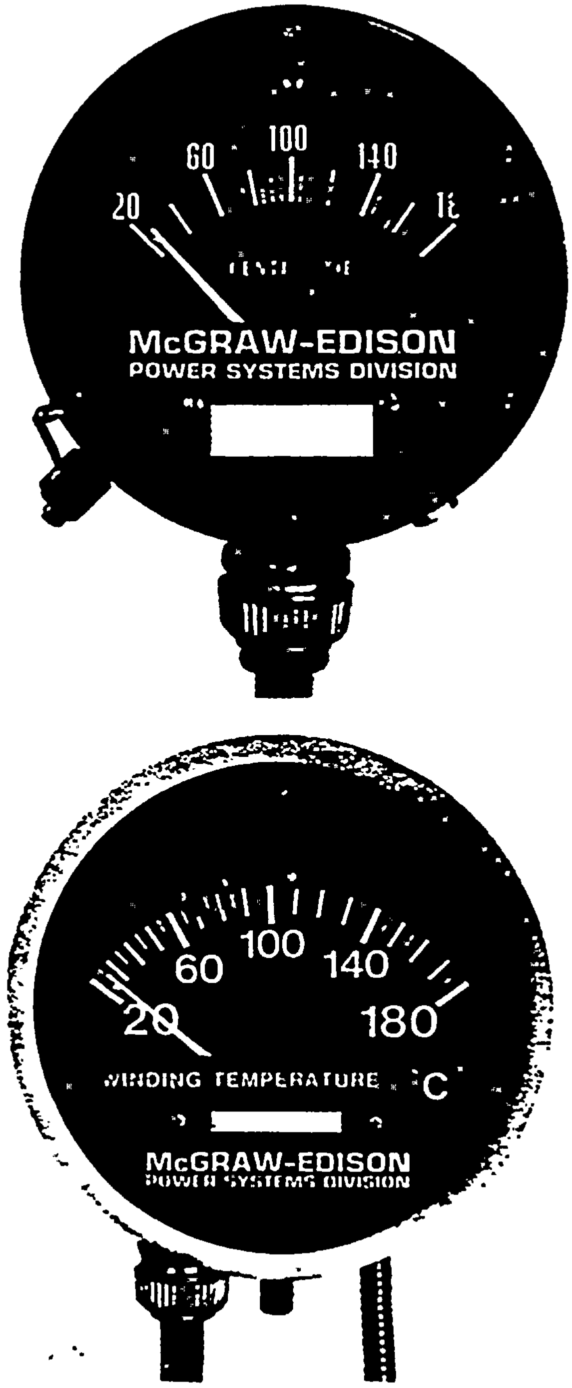


Figure 1.
Dial thermometer temperature indicating equipment.

CONTENTS

GENERAL

The standard temperature indicating equipment supplied on power transformers manufactured by McGraw-Edison Company is categorized as the liquid-filled, thermal-expansion, mechanical-indicating type. The liquid-filled, temperature-sensitive bulb is connected either directly, or remotely, through a capillary system, to a bourdon-tube-type mechanical indicating device and the bulb is inserted into an ANSI Standard transformer thermometer well. All thermometers and resistance transducers used by McGraw-Edison Company (or the Pennsylvania Transformer Company) since 1950 will either fit or can be easily adapted to fit the present ANSI well. All of these thermometers are ambient compensated and are furnished with from zero to four electrical snap-type switches to operate control or alarm devices. Thermometers containing one or two switches are usually mounted at the top oil level. Thermometers containing three or four switches have their indicating mechanisms mounted at eye level. All thermometers are equipped with resettable orange/red maximum indicating drag hand. This pointer will indicate the maximum temperature that the thermometer has reached since the last resetting. Resetting is accomplished by removing a cover screw and pulling down on the reset stem. See Figures 2 and 4 for cover screw locations.

Thermometer Switch Contact
Minimum Ratings

0.02 amps d-c inductive
0.2 amps d-c non-inductive
2.5 amps a-c inductive or non-inductive
250 volts maximum in all cases

APPLICATION

Quantity, function, and calibration of thermometers on McGraw-Edison power transformers vary with transformer design and user requirements. The general guidelines in the TOP OIL and WINDING TEMPERATURE sections of these instructions apply unless user specifications dictate otherwise.

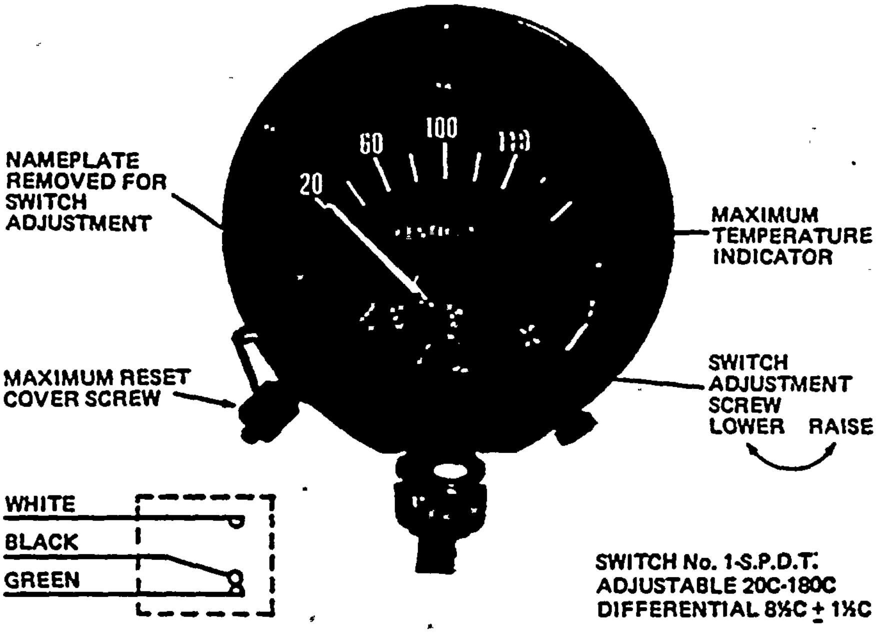
Thermometer application and identification are shown on the thermometer nameplate. Switch temperature settings vary with application and user specifications. Consult individual transformer accessory schematic diagram for specific information.

TOP OIL TEMPERATURE THERMOMETER

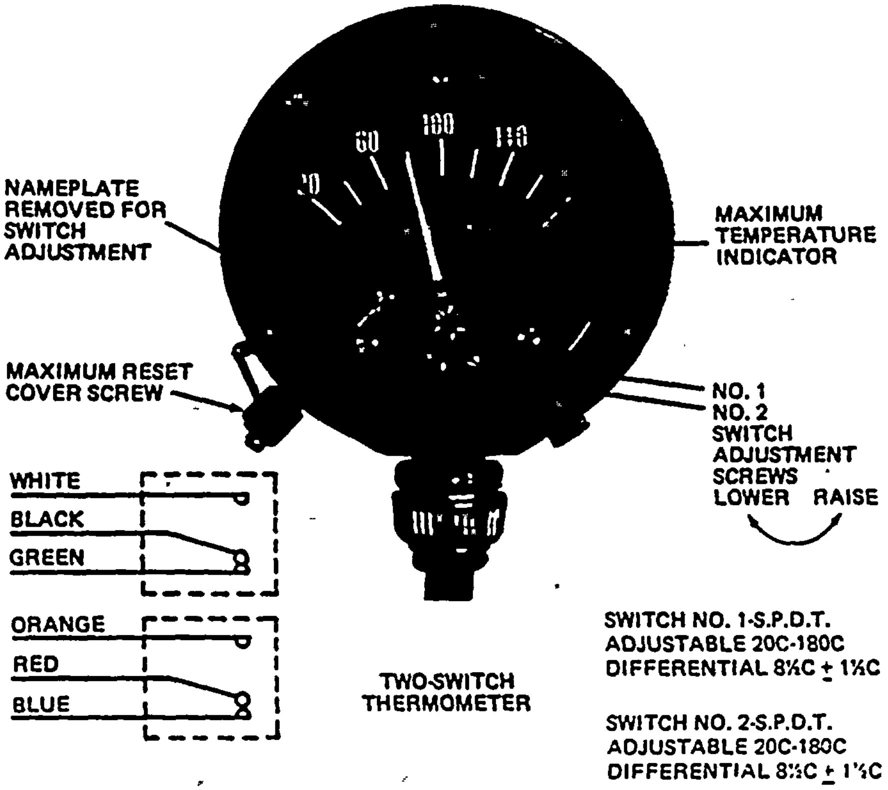
All power transformers are furnished with a thermometer to indicate the top oil temperature. Transformers having a thermometer level of less than eight feet above the base line are mounted with the face perpendicular to the ground. Thermometers that are mounted at a level higher than eight feet above the base line are equipped with a face inclined 30 degrees for easy reading at ground level. Oil temperature thermometers will be mounted at ground level when required. If, because of the number of switches involved, it is necessary to mount it or another thermometer at ground level, all thermometers will be mounted at ground level.

Ten ohm, copper, resistance-type transducers for remote indication are available as optional equipment.

OA/FA transformers having an OA rating of less than 100 mva, unless otherwise specified, are equipped with a top oil thermometer having a switch contact to control the forced air cooling equipment. Additional switches for control or alarm settings are available when specified.



ONE-SWITCH THERMOMETER



TWO-SWITCH THERMOMETER

Figure 2.

WINDING TEMPERATURE THERMOMETER

Transformer winding hottest spot temperature is duplicated in a small electrical heating coil having thermal characteristics corresponding to those of the windings. To accomplish this, the heating coil is mounted in the path of the hottest oil and is connected to a current transformer located in the appropriate winding. The current in the heating coil will be proportional to the winding current and the temperature of the coil will correspond to that of the hottest spot in the winding. In order to make use of standard heating coil and current transformer designs, it is often necessary to install a shunt resistor in parallel with the heating coil. When used, the resistor is installed between terminals S and U and the ohmic value of the resistor appears on the certified test sheets. Do not remove or change the value of this resistor without consulting the factory. To record the hottest spot temperature, a thermometer or ten ohm, copper, temperature transducer is mounted within a well directly in the heating coil (Figure 3). The method for locating and mounting winding temperature thermometers is identical to the one used for top oil thermometers.

OA/FA transformers having an OA rating of 100 mva or above and all OA transformers having two additional forced cooled ratings, unless otherwise required, are equipped with a winding temperature thermometer having a sufficient number of electrical switches to control the forced cooling stages individually. Additional switches for control or alarm settings are available as optional equipment (Figure 4). Multiple, winding temperature thermometers duplicating individual winding hottest spots can be furnished as optional equipment.

All forced cooled transformers which do not have a self-cooled rating (unless otherwise required) are furnished with a winding temperature thermometer containing an electrical switch to control the second stage of forced cooling.

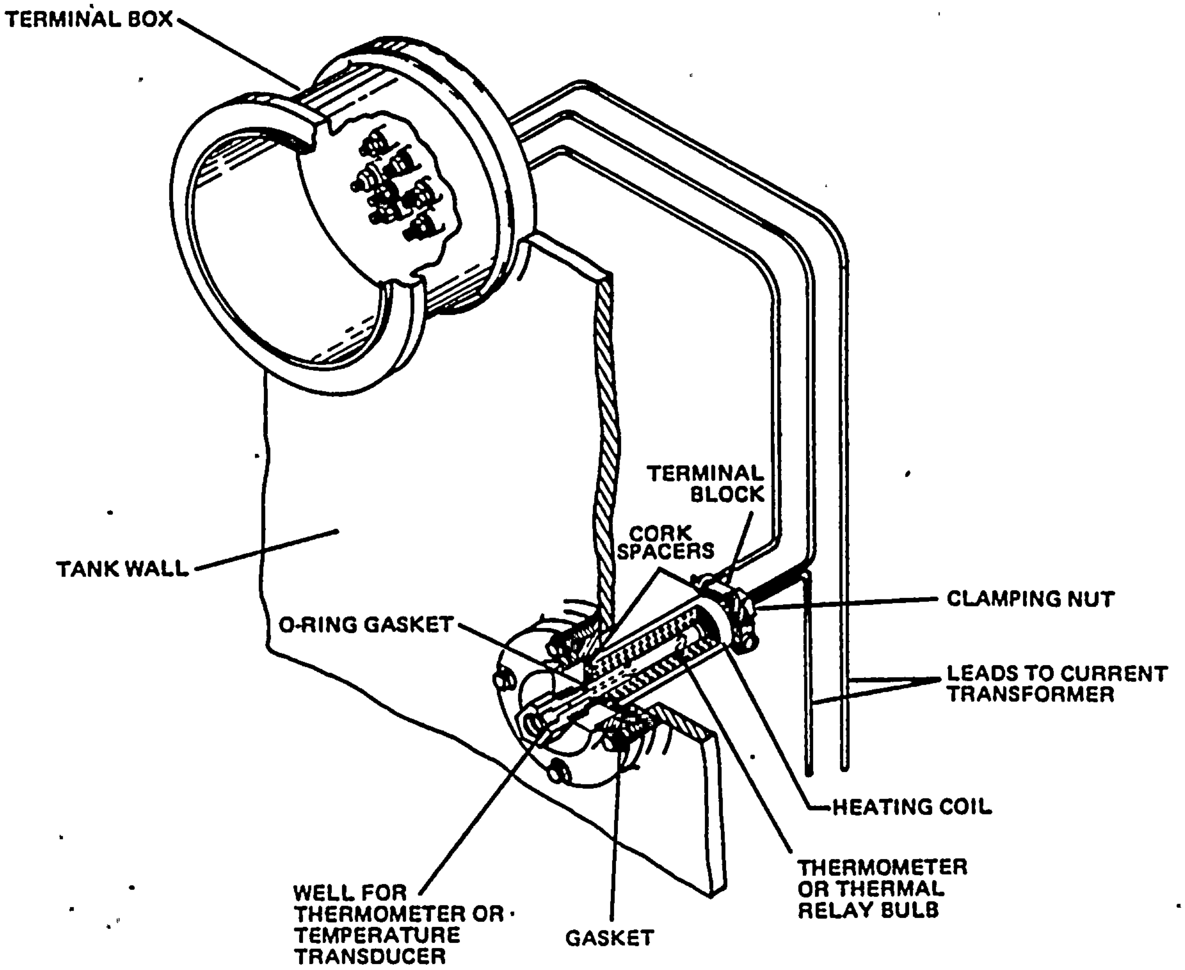
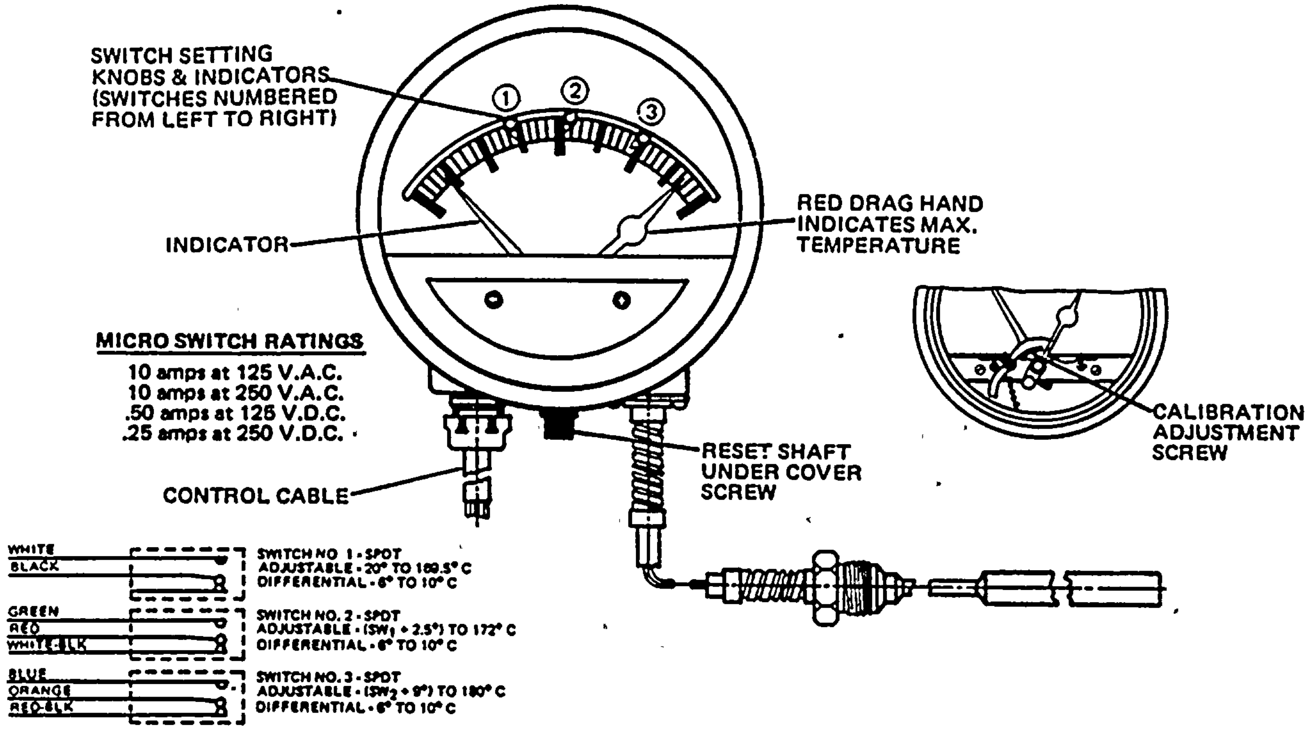
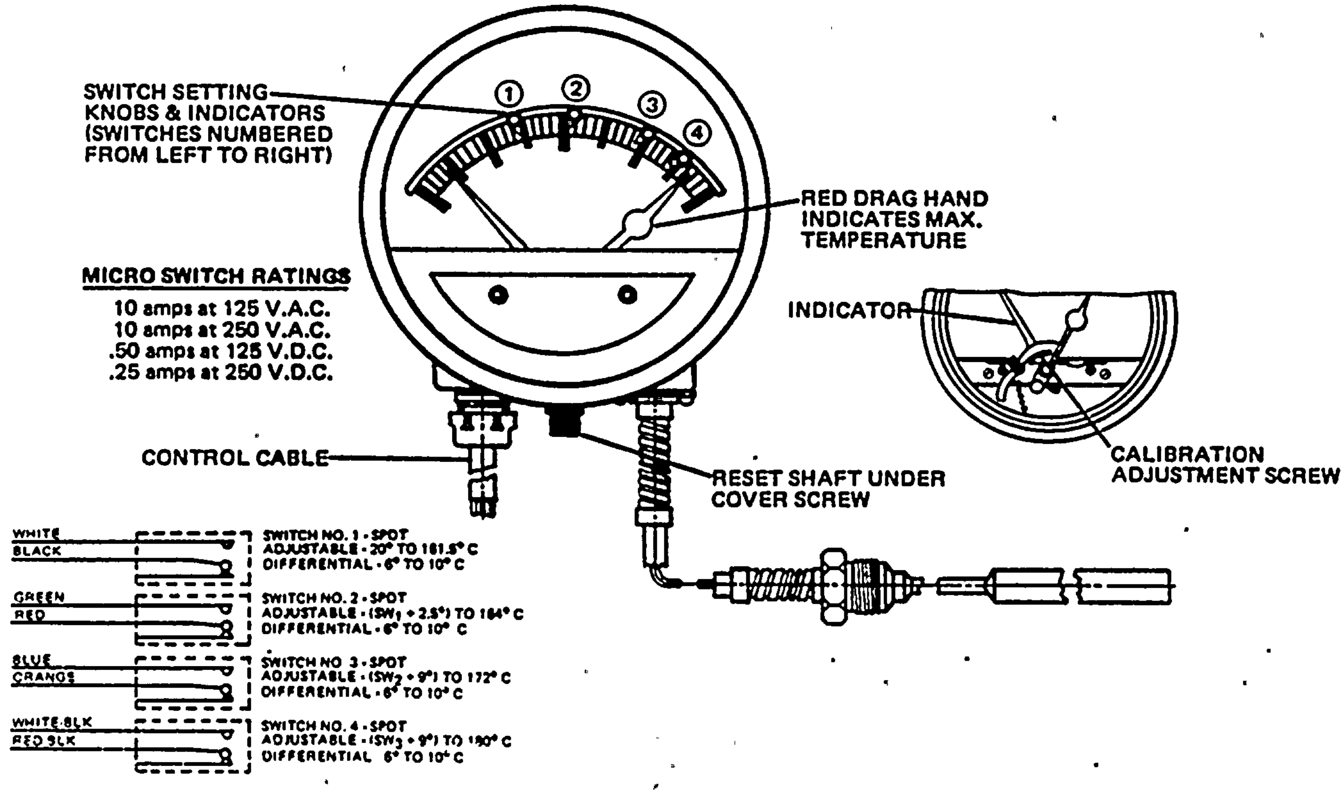


Figure 3.
Typical mounting arrangement for winding temperature equipment.



THREE-SWITCH, DIAL-TYPE THERMOMETER



FOUR-SWITCH DIAL-TYPE THERMOMETER

Figure 4.

TEN OHM, COPPER, RESISTANCE-TYPE TRANSDUCER

The ten ohm, copper, resistance-type transducer (Figure 5) uses a copper resistance coil calibrated to ten ohms at 25 C and is inserted into a well mounted at the top oil level, and when specified, can be used for either or both top oil and hottest spot remote indication. This transducer is usually connected to a switchboard-type temperature indicator supplied by the user. The switchboard indicator ordinarily has a selector switch which permits several transducers to be connected to the same equipment and a test position for checking the instrument at the 70 C point of the scale. Resistance for any given temperature or temperature for any given resistance can be calculated from the following formulas:

$$Rt = T\text{-}25\ (0.038536) + 10$$

$$T = 25.95\ (Rt) - 234.5$$

Rt = Resistance for any given temperature, ohms

T = Temperature for any given resistance, °C

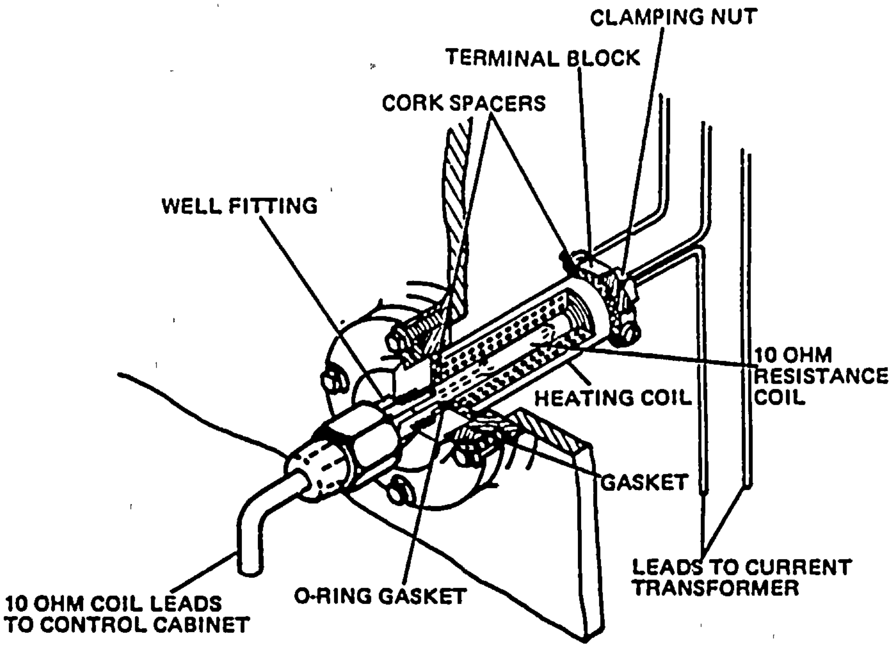


Figure 5.
The ten ohm, resistance-type of winding temperature indicating equipment, mounted in the tank wall.

WINDING TEMPERATURE ASSOCIATED EQUIPMENT LOCATION

The current transformer to which the heating coil is connected is mounted either on the support structure immediately above the core and coils inside the tank or on the underside of the cover usually around the shank of one of the bushings. Figure 3 shows a typical arrangement. The weatherproof terminal box that receives the leads for the current transformer and heating coils is mounted on the transformer case.

INSTALLATION

The temperature indicating equipment is completely installed at the factory. It is only necessary to make the required electrical connections for alarm leads or remote indication when required.

WARNING

Check current transformer terminals in the terminal box and control cabinet. Make sure that any shorts which were installed for shipment are removed.

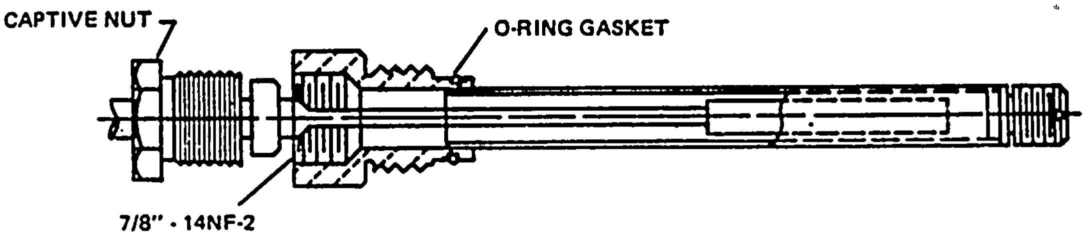


Figure 6.
Thermometer well.

SETTING SWITCH CONTACTS

A. Instructions for re-setting switches on one- and two-switch thermometers.

1. Remove thermometer from well by loosening the captive nut which secures it to the well. The well must be held securely with a second wrench during this operation (Figure 6).
2. Remove bezel.
3. Remove nameplate covering mechanism in lower section.
4. Connect an indicating device (test light, ohmmeter, etc.) to the appropriate switch leads. (If switch leads are terminated in a control cabinet, they should be temporarily removed from the terminal board on the thermometer side of the circuitry).
5. Making use of an external heating supply, bring the indicator to the point on the scale corresponding to the desired switch setting.
6. Loosen the appropriate adjustment screw and move in the desired direction until the switch just closes (Figure 2).
7. Tighten the adjustment screw and check the switch action by varying the bulb temperature (Step 5).
8. Reassemble in reverse order.

B. Instructions for resetting switches on three- and four-switch thermometers.

1. Remove bezel (1/4 turn counterclockwise).
2. Loosen appropriate switch setting knob and move the switch indicator to the desired setting. Resecure knob and replace the bezel (Figure 4).

SWITCH SETTINGS CHECK

1. Connect an indicating device (test light, ohmmeter, etc.) to the appropriate switch leads.
   (If switch leads are terminated in a control cabinet, they should be temporarily removed from the terminal board on the thermometer side of the circuitry).
2. Remove thermometer bulb from the well by loosening the captive nut which secures it to the well. The well must be held securely with a second wrench during removal (Step 4). See Figure 6.
3. Remove the bezel.
4. Immerse the bulb in a constant temperature bath (Step 2 can be eliminated and the normal position in the well used if oil temperature is constant).
5. Allow indicator to stabilize. Record temperature reading.
6. Remove nameplate covering in the lower section.
7. Loosen calibration adjustment screw. Using a Phillips-head screwdriver to hold the screw stationary, move the pointer across the scale to check the switch settings and differentials. (Hold calibration adjustment screw firmly to prevent distorting the bourdon tube).
8. Loosen appropriate switch setting knob and move the switch indicator to desired setting if switch adjustment is necessary. (Switch indicator accuracy is approximately ± two degrees. Maximum switch setting accuracy is obtained by correlating switch operation with thermometer pointer position).
9. Return pointer to temperature recorded in Step 5. Secure calibration adjustment screw.

CAUTION

Do not try to improve thermometer accuracy by securing the indicator at a point closer to the actual temperature. The thermometer indicating errors are not linear and the indicator position has been factory selected to give maximum accuracy throughout the entire scale range.

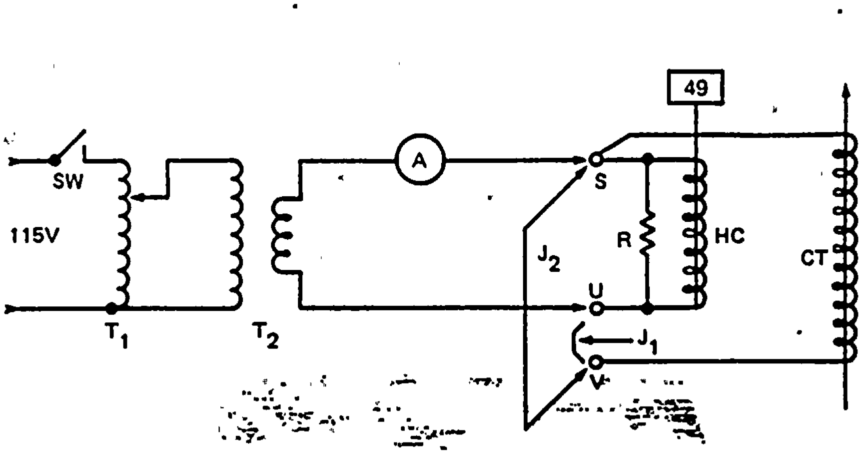
10. Reassemble in reverse order.

TESTING WINDING TEMPERATURE EQUIPMENT

The winding temperature equipment circuitry has been designed to permit field testing of the heating coil, thermometer, and other associated components.

The recommended test circuit is shown in Figure 7.

1. Connect powerstat (T_1) V. A. rating dependent on ratio to T_2 (150 V. A. with recommended Triad T_2) to T_2 and to a stable 115 volt, 60 hertz power source.
2. If the transformer containing the winding temperature equipment is energized, connect jumper J_2 between terminals S and V.
3. Open jumper J_1.
4. Check the heating coil circuitry for the presence of a shunt resistor (R) connected between terminals S and U. (See reference to this resistor in WINDING TEMPERATURE THERMOMETER section and on certified test sheets.) If provided, this resistor must be connected during test.
5. Connect the low-voltage winding of transformer T_2, through ammeter (A) to terminals S and U in winding temperature circuit.



T_1 - Variable ratio transformer (powerstat, variac, etc).

T_2 - Stepdown transformer 115/6 to 25 volts, 15 amps (Triad F22A or similar).

A - Ammeter (2.5 - 25 amp points on scale must be both legible and accurate).

R - Shunt resistor (if provided).

HC - Heating coil.

49 - Winding temperature thermometer.

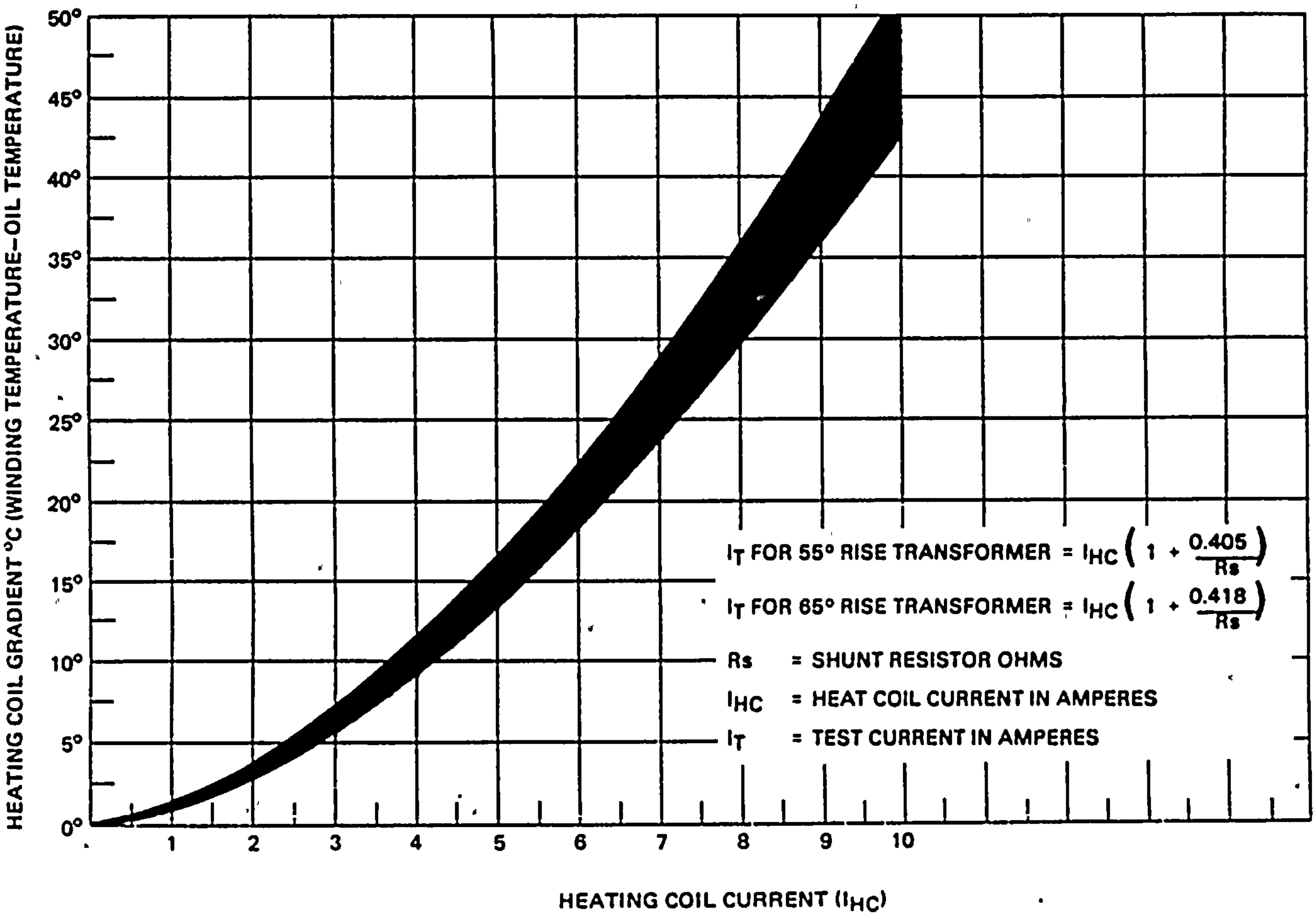
CT - Internal winding temperature current transformer.

J_1 - U - V jumper (provided).

J_2 - S - V jumper (not provided).

SW - S.P.S.T. switch.

Figure 7.
Test circuit for winding temperature equipment.



I_T FOR 55° RISE TRANSFORMER $= I_{HC}\left(1 + \frac{0.405}{Rs}\right)$

I_T FOR 65° RISE TRANSFORMER $= I_{HC}\left(1 + \frac{0.418}{Rs}\right)$

Rs = SHUNT RESISTOR OHMS

I_{HC} = HEAT COIL CURRENT IN AMPERES

I_T = TEST CURRENT IN AMPERES

Figure 8.

6. Figure 8 shows the heating coil gradient curve and formulas used to determine the test currents required to obtain the corresponding heating coil currents. Consult the certified test sheets to determine the value of shunt resistor (R).

   NOTE: If test sheets are not available, disconnect resistor temporarily and measure its resistance with a Wheatstone bridge. The resistor (when provided) must be in place during test.

7. Using the appropriate formula from Figure 8, select at least two test currents and circulate the calculated test currents in the heating coil circuit until the heating coil temperature is constant (45 to 60 minutes). The heating coil gradient can be determined by subtracting the oil temperature reading from the hot spot reading. (Thermometer reading differential should be recorded before starting test). (Suggested heating coil test currents I_{HC} are 5 and 7.5 amps).

8. When evaluating the test results, keep in mind that thermometer accuracies ± three degrees can influence the outcome especially at low currents where gradients are of the same magnitude as the reading accuracy. Thermometer switch settings should also be considered. (The indicator may temporarily lag the actual temperature by one or two degrees just before a switch is actuated. Resistance transducers placed in the thermometer wells instead of the thermometers will give better accuracy if a test result is in doubt.

MAINTENANCE

Both types of temperature indicating equipment are tested and calibrated at the factory and should require little or no maintenance. If the dial-type thermometer becomes inoperative, replace it. When a new thermometer is used, silicone grease (Dow Corning DC44 or equivalent) saturated with graphite, should be applied to the thermometer bulb before insertion into the well. (This reduces response time between the winding temperature and the thermometer indication).

CAUTION

The terminals of any open or inoperative auxiliary winding must be short circuited. Wiring diagrams supplied with the transformer indicate the proper terminals for this operation.

McGRAW-EDISON

Power Systems Group
McGraw-Edison Company
Post Office Box 2850
Pittsburgh, PA 15230

McGRAW-EDISON

Power Systems Group

Power Transformers

Mechanical Pressure-Relief Device

S210-70-5

Service Information

GENERAL

The mechanical pressure-relief device relieves sudden or accumulated internal pressure at a predetermined value. The device uses combinations of one or two springs for different pressure settings. It may be used for oil-filled transformers and compartments with the application of suitable gasket materials.

Although unusual, it is always possible that an internal fault may result in a primary explosion. The abnormal pressure resulting from a fault is often great enough to rupture tank or compartment walls, if no effective relief device is provided.

OPERATION

The pressure-relief setting of the device and the type of insulating liquid with which it is to be used is marked on a rating nameplate on the cover. When this pressure is exceeded, the spring force acting on the diaphragm is overcome and the pressure, initially confined to the small "primary" area of the relief diaphragm escapes to the larger "secondary" area and lifts the diaphragm, from its outer sealing gasket to relieve the excess pressure. This moves the indicator rod to the exposed, tripped position.

Upon completing its operation, the device will reseal at a fraction of the relief pressure and will require no manual resetting or replacement of parts for subsequent pressure-relief operations, except that the indicator rod must be returned to its original position.

The space between the inside gasket and the outside gasket is vented to the atmosphere by a slot around the outside gasket. This allows the diaphragm to seal positively on the inside gasket without gas entrapment between the gaskets.

When an alarm switch is also provided, the indicator rod and alarm switch reset lever must be reset individually.

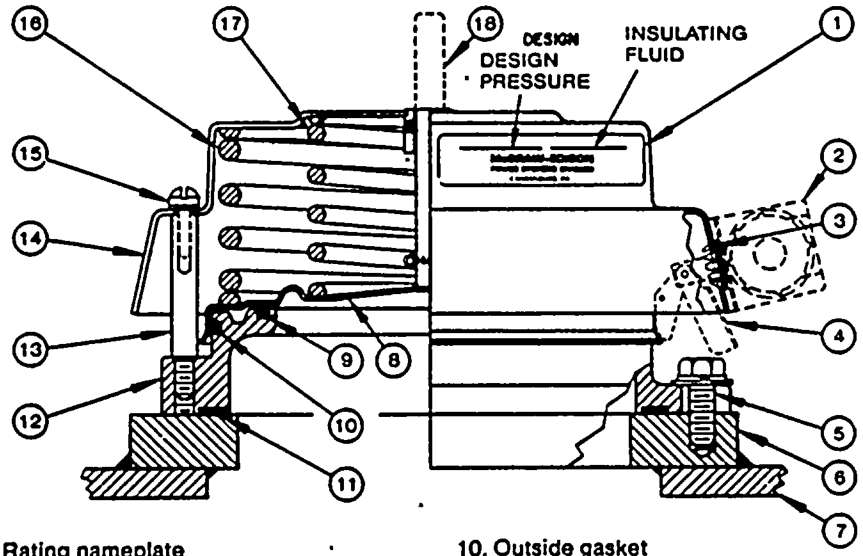
PRESSURE-RELIEF ALARM

The pressure-relief device has a colored indicator rod. It may also be supplied with an alarm switch, if requested. In the cocked position, the indicator rod is depressed inside the cover and the alarm switch operating lever rests against the edge of the diaphragm. During operation of the relief device, the upward movement of the diaphragm forces the indicator rod to an exposed position where it is visible from ground level and simultaneously activates the alarm switch. Both the indicator rod and alarm switch may be reset using a hot stick.

The alarm switch is SPDT with the N.C. contacts held open in the normal position of the pressure-relief device. These contacts close when the pressure-relief device operates and remain closed until the switch is manually reset to the normal position. Switch ratings are shown in Table 1.

Table 1.
Switch Ratings

Voltage		Current	
(Vac)	(Vdc)	(amps)	Type of Load
125, 250		10	Non-inductive
125, 250		10	Inductive
	125	0.5	Non-inductive
	250	0 25	Non-inductive



1. Rating nameplate
2. Alarm switch (optional)
3. Plug for switch mounting
4. Switch reset lever
5. Mounting bolt
6. Mounting flange
7. Tank cover
8. Diaphragm
9. Inside gasket
10. Outside gasket
11. Mounting gasket
12. Base
13. Cover support stud
14. Cover
15. Cover bolt
16. Large spring
17. Small spring
18. Indicator—tripped position

Figure 1.
Cross section of mechanical pressure-relief device.

These instructions do not claim to cover all details or variations in the equipment, procedure or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your McGraw-Edison Power Systems Group sales engineer.

HL

November 1981 • Supersedes July 1970

INITIAL INSPECTION

The mechanical pressure-relief device and alarm switch are usually shipped completely installed and ready for operation. Should the transformer have experienced rough handling in transit, it is possible that the indicator rod or the alarm switch may have been forced to the tripped position. Reset by pushing the indicator rod in the cover back to its original retracted position and pushing the switch reset lever inward.

When the device is shipped detached, a temporary blanking plate is placed on the mounting flange. In order to install the device, remove the blanking plate and bolt the assembly to the flange, using the same gasket that sealed the blanking plate.

It is not necessary to remove the mechanical relief device from the transformer or oil-filled compartment during vacuum treatment, as the device will withstand full vacuum.

When a deflector shield is used, it is mounted on one side of the mechanical pressure-relief device to direct the flow of any liquid or gas that may be ejected when the device operates. This shield is held in place by tapped-in bolts in the side of the mounting flange.

CAUTION

The pressure-relief devices supplied must be used for the intended application only. Some transformers will have one pressure-relief device setting for the main transformer and another for an auxiliary compartment. However, pressure-relief devices with the same rating and for the same insulating liquid are interchangeable.

MAINTENANCE

The only maintenance normally required is resetting the indicator rod and alarm switch after operation of the device.

SERVICE

This device is designed for minimum maintenance and is completely tested for leaks before it leaves the factory. If the operator suspects a leak, the Service Department of McGraw-Edison Company, Power Systems Group at Canonsburg, Pennsylvania, should be consulted. Instructions will be promptly given.

REPLACEMENT PARTS

The component parts of the pressure-relief device are designed to provide long life service and will not normally require replacement. However, should renewal parts be required, identify the parts on Figure 1 and include all pertinent information contained on the nameplate attached to the transformer. Address all correspondence to the nearest McGraw-Edison Company, Power Systems Group district office or write directly to the factory.

McGRAW-EDISON

Power Systems Group
Post Office Box 2850
Pittsburgh, PA 15230

Power Transformers
Accessories
Pressure Bleeder Device

1152-0373

Service Information
S210-70-6

Replaces PTI 197-1 dated 8/60
No change in text

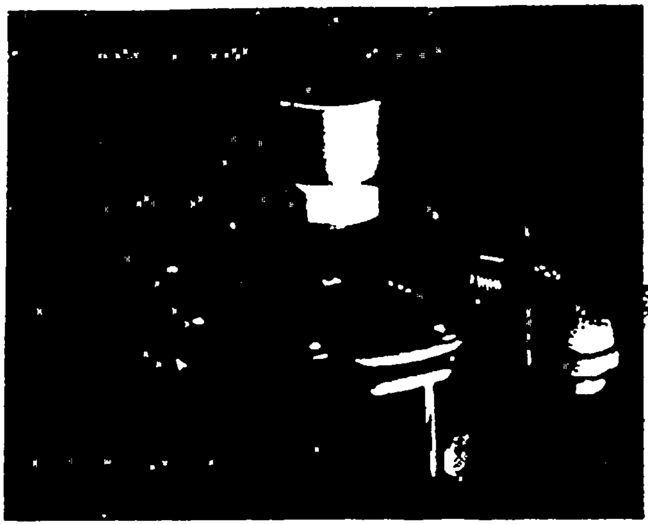


FIGURE 1
Pressure bleeder device mounted horizontally on side of compartment.

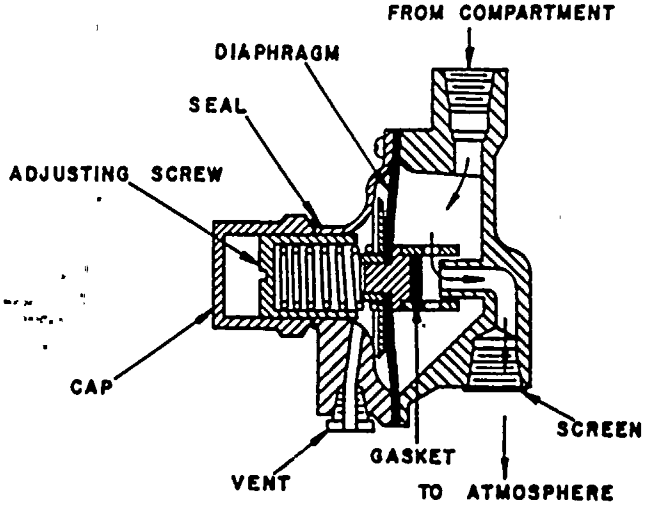


FIGURE 2
Schematic drawing of vertically mounted bleeder device showing position of diaphragm during relief of pressure.

The Pressure Bleeder Device is a simple operating device which will limit the internal pressure within the tank or compartment to a safe operating value. This unidirectional pressure bleeder, as shown in Figure 1, vents the gas to the atmosphere whenever the relief pressure is exceeded. As soon as the pressure has been relieved, the diaphragm closes by spring pressure, so that the bleeder seals at ½ psi below the predetermined pressure. This self-resealing under positive pressure prevents oxygen and moisture from entering the compartment. The exact relief setting is stamped on the cap of the device.

The bleeder is located on the external side of the compartment, thus making it possible to remove the device and to cap the connection to the compartment whenever it is necessary.

A screen is provided for both the bleeder outlet and vent outlet to keep foreign material from entering. These outlets should be open at all times.

CAUTION: Protect or remove bleeder before painting equipment, to prevent clogging the vents with paint.

Periodic Inspection

The bleeder is a device that requires no maintenance or adjustment. This relief device is set at the factory and the cap on the adjusting screw is sealed with a drop of solder. Although no maintenance is required for this device, the operation of the bleeder may be checked periodically. The procedure should be the following:

1. Remove bleeder from compartment, replacing it with a cap or another bleeder device.
2. Apply pressure to the bleeder opening which connects the bleeder to the compartment.
3. Increase pressure slowly until it reaches set pressure.
4. The device should then expel gas through the outlet. The accuracy of the bleeding pressure is ± ½ psi.

CAUTION: It is dangerous to exceed the upper pressure limit that is stamped on the bleeder device. If testing indicates that the pressure bleeder is not functioning within upper pressure limits, the device should be replaced immediately.

McGRAW-EDISON COMPANY
Power Systems Division
Canonsburg, Pennsylvania 15317

October 1970

452-0373

McGRAW-EDISON
Power Systems Division

Power Transformers
Magnetic Liquid-Level Indicator Installation Instructions

S210-70-8
Service Information

DESCRIPTION

McGraw-Edison transformers are equipped with magnetic liquid level indicators, Figure 1, which provide visible indications, from reasonable reading distances, of the fluid level inside the transformer tanks. The OPERATING RANGE, TOO HIGH and TOO LOW level indications appear on a calibrated scale on the dial face. The gage assembly consists of a float mechanism inside the tank whose movement operates a horseshoe magnet which induces motion through a nonmagnetic partition to the fluid level indicating pointer on the dial. The entire assembly is simple in operation and rugged in construction. No stuffing glands, multiplying apparatus or gears are required.

A tight seal is maintained between the gage and the mounting flange on the tank wall with a controlled-compression gasketed joint. A gasket is also provided between the dial and the dial housing. A solid metal partition behind the dial prevents the entrance of any fluid that may affect dial readings or cause leakage.

The gage may be equipped with alarm switch, Figure 2, which will operate when the oil level reaches the low point as indicated by the pointer on the dial.

INSTALLATION

The gage is usually installed at the factory and is ready for operation. The indicating pointer should be approximately at the 25 C mark on the dial with the float rod in a horizontal position inside the tank. In the event the transformer has been jarred during shipment, the float rod may stick in a vertical position. This would be indicated by the pointer resting at the TOO HIGH position on the dial. The gage may be rendered operative by merely returning the float rod to the 25 C horizontal position.

To aid in checking the accuracy of the liquid level gage, the transformer nameplate indicates the normal distance between the highest point of the manhole flange and the liquid level at 25 C. In addition, the change in liquid level per 10 C is listed on the nameplate; all changes are in direct proportion to the figure specified.

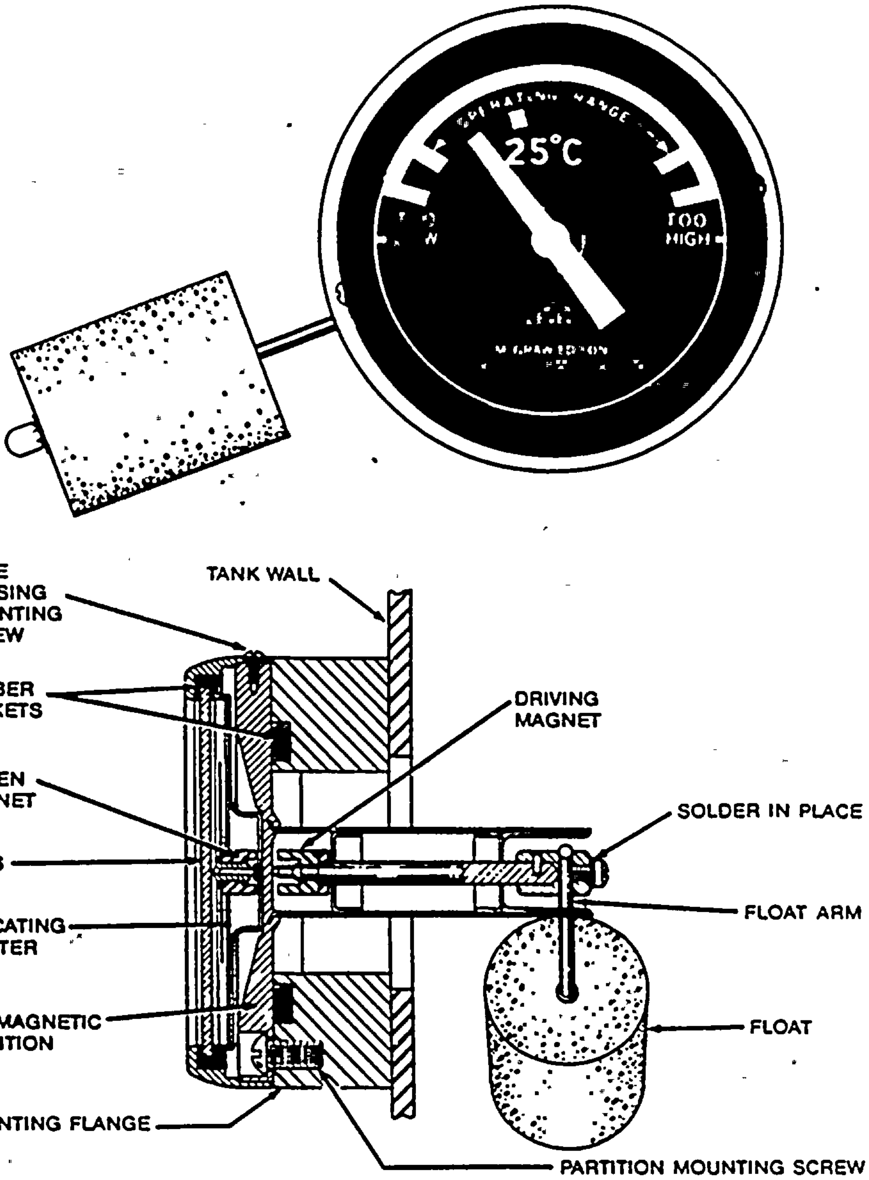


Figure 1.
Magnetic liquid-level indicator.

As a further aid in checking the accuracy of the gage on transformers with the gas-oil-seal type of oil preservation, a guide plate showing the 25 C oil level is mounted on the outside of auxiliary tanks.

If the complete gage assembly is shipped separately, or if a replacement is made, the oil level within the tank must be lowered below the gage mounting flange on the tank wall. The nonmagnetic partition of the assembly should be bolted rigidly to the mounting flange on the transformer tank to insure an oil-and air-tight gasketed seal. Secure the gage housing to the nonmagnetic partition. Check the operation of the float by moving it over its entire range. The movement of the indicating pointer on the dial should correspond to the movement of the float.

When the gage has alarm contacts, they should be checked for operation at the TOO LOW level point. The micro switch contacts are rated at 5 amps at 250 volts ac, or 0.02 amps at 250 volts dc, with an inductive load.

MAINTENANCE

The gage assembly will generally require no maintenance. If for some reason the gage assembly becomes inoperative, examine it to determine whether the complete gage assembly or only the gage needs to be replaced.

Ordinarily, lens breakage will not affect the operation of the gage. However, in the event of such breakage the gage can be removed and replaced without lowering the oil level within the tank. To remove the gage, loosen the screws on the black enameled gage housing and remove the housing and the attached gage. It is not necessary to break the gasketed joint between the mounting flange on the tank and the nonmagnetic partition.

REPLACEMENT PARTS

When ordering replacement parts, the serial number found on the nameplate of the transformer should be given. Address all correspondence to the nearest McGraw-Edison Power Systems Division office, or the Service Section, McGraw-Edison Power Systems Division, P.O. Box 440, Canonsburg, Pennsylvania 15317.

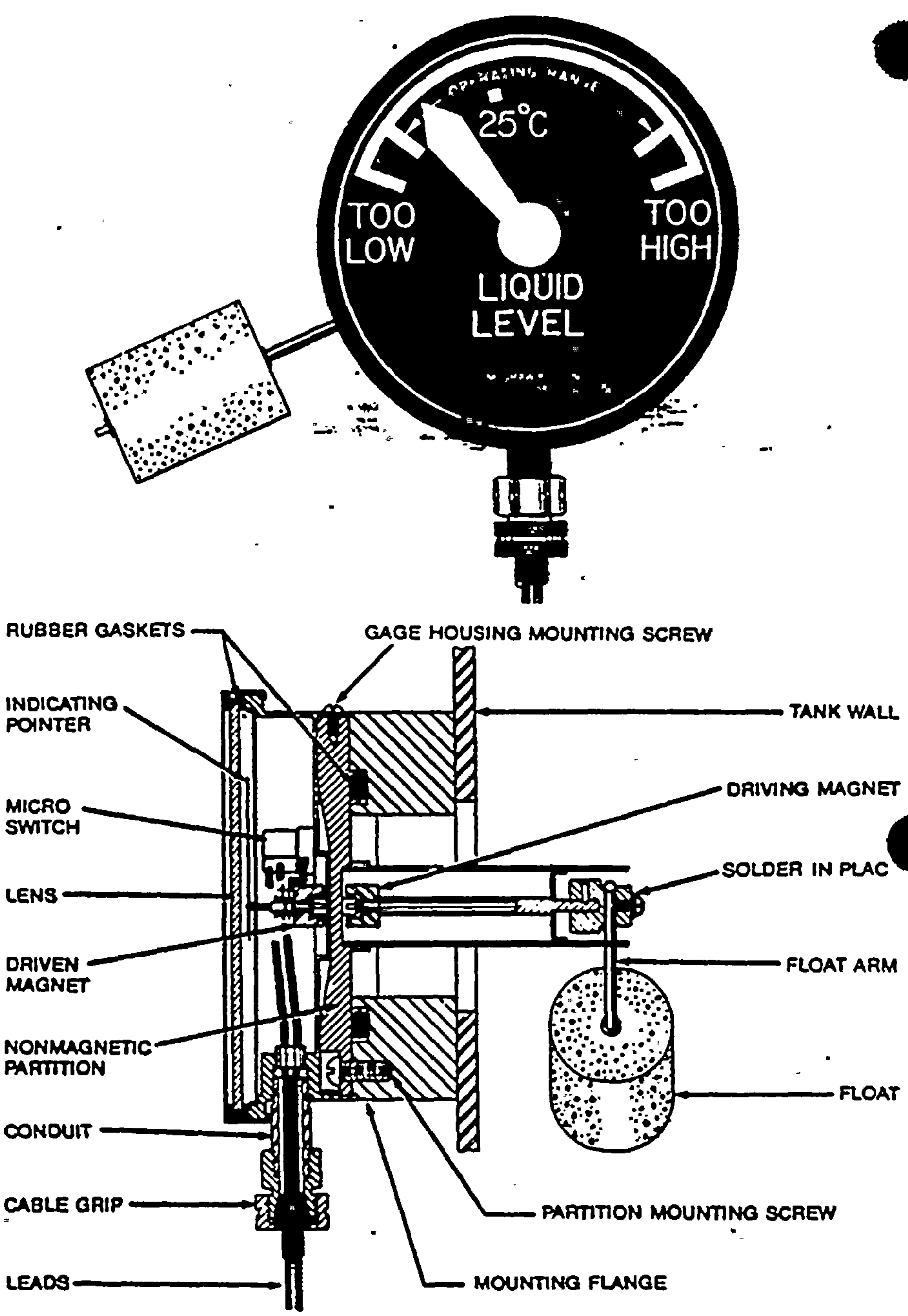
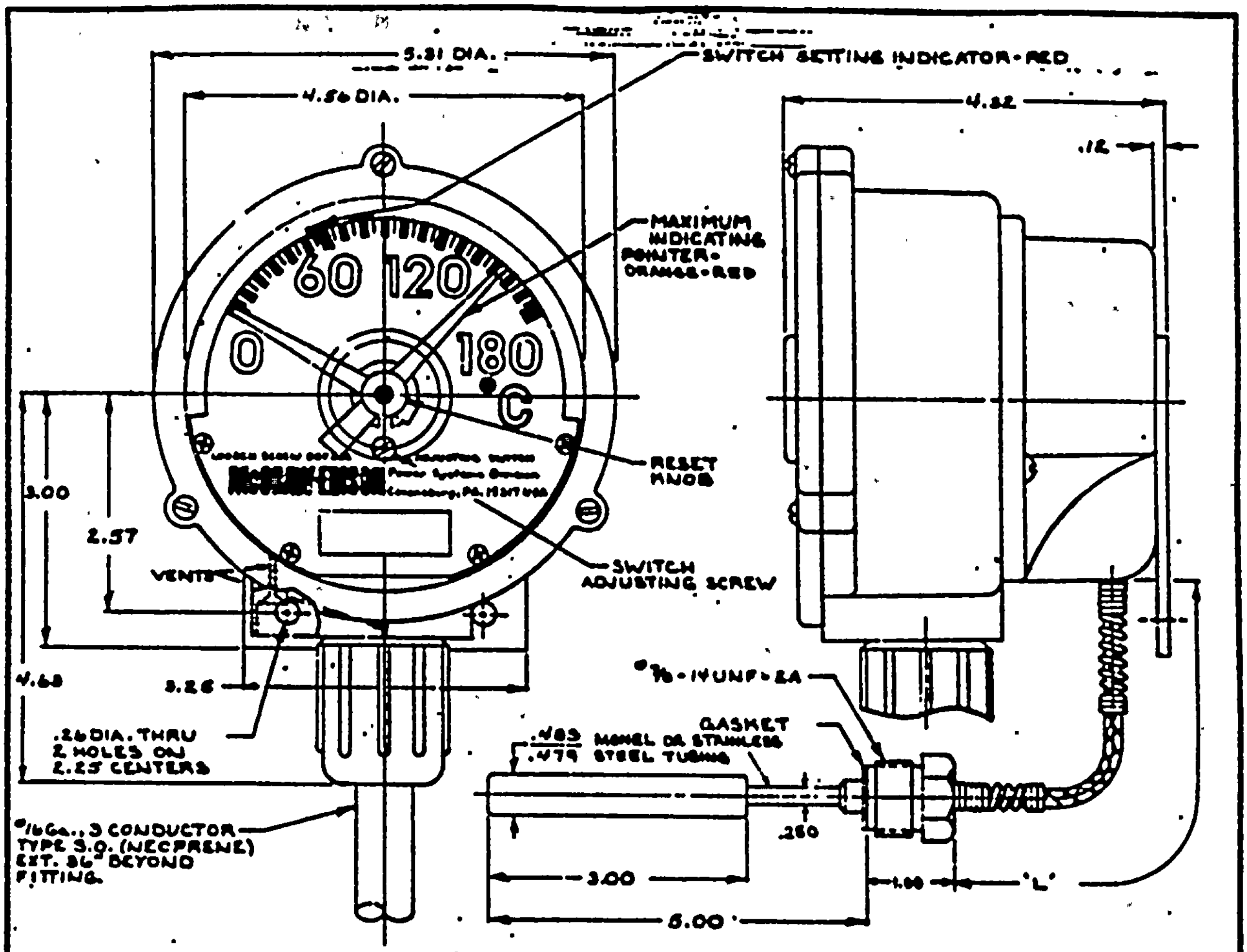


Figure 2.
Magnetic liquid-level indicator with alarm switch.

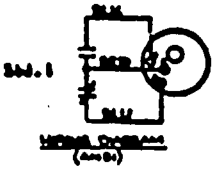
McGRAW-EDISON

Power Systems Division
Post Office Box 2850
Pittsburgh, PA 15230



NOTES:

1- ALL DIMENSIONS ARE FOR REFERENCE ONLY.
2- COLORS: CASE: ... "TO LIGHT GRAY
DIAL: CHAR'S. WHITE ; BKGRND. BLACK
POINTER: WHITE
3- INSTRUMENT TO BE SHOCK RESISTANT & FREE BREATHING.
4- INSULATION MUST WITHSTAND 1500V TO GROUND FOR 60SEC.
SWITCH RATING:
1 A @ 125, 250 V.A.
.. A @ 125 V.D.C.
.. A @ 250 V.D.C. RESISTIVE
1.5 A @ 48 V.D.C.
5- TO ADJUST SWITCH, REMOVE LENS ASSY., LOOSEN SWITCH ADJUSTING SCREW, MOVE INDICATOR TO DESIRED TEMP. AND TIGHTEN SCREW.
6- USE WELL DWG. NO. A122034.
7- A MIXTURE OF SILICONE GREASE WITH GRAPHITE MUST BE APPLIED TO THE THERMOMETER ELEMENT BEFORE INSERTING IN WELL. SEE INSTRUCTION BOOK 3210-70-3.
8- SEE DWG. NO. A-353111 FOR IDENTIFICATION DECAL INSTRUCTIONS.
9- AMBIENT TEMPERATURE RANGE: -40° TO 160° F.
10- SWITCH SETTINGS INDICATED ARE AS RECEIVED FROM MANUFACTURER. SWITCH TO BE SET AT OPERATING TEMPERATURE INDICATED ON ACCESSORY SCHEMATIC DIAGRAM.



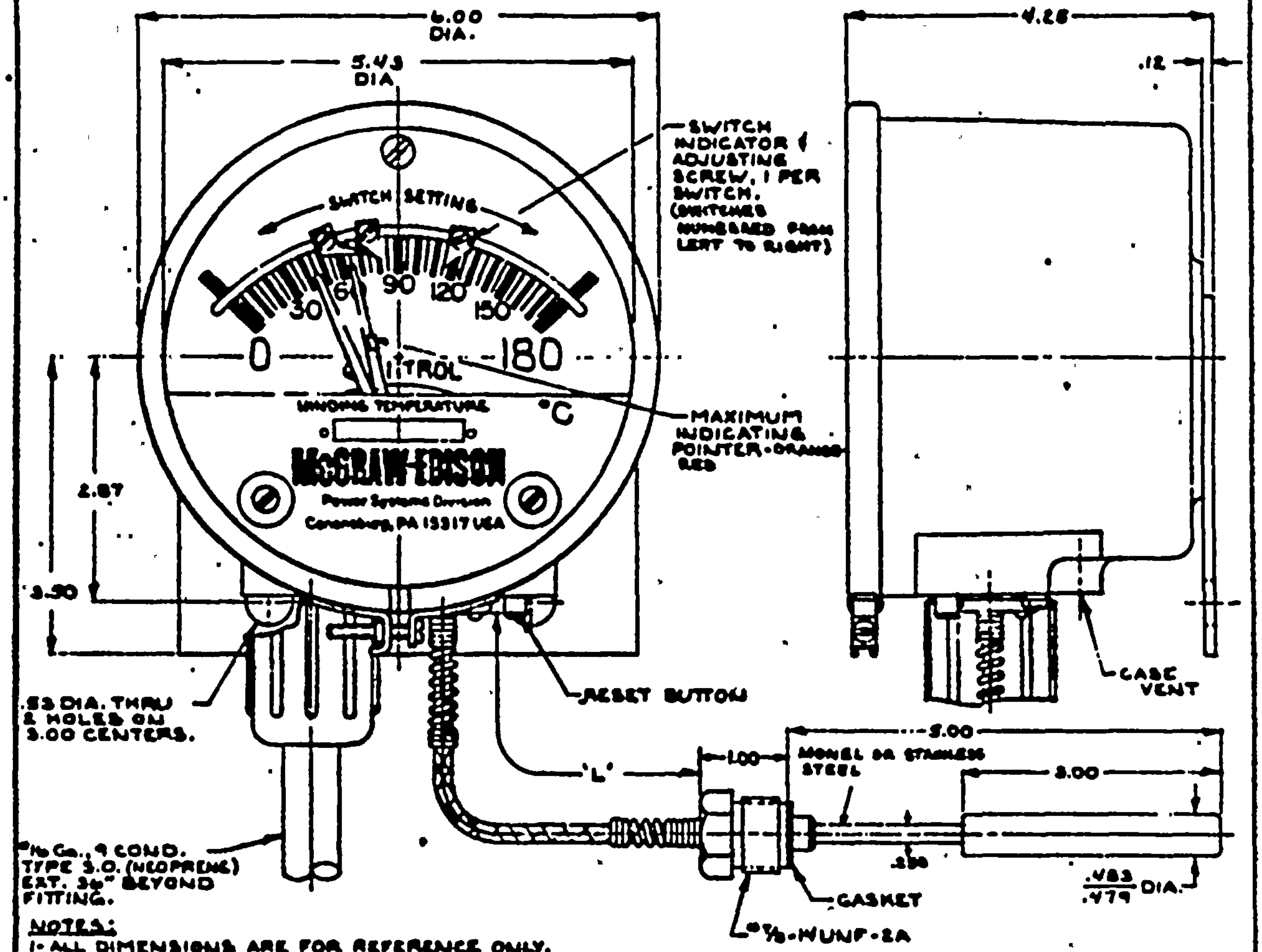
M-E'S PART	QUALITROL MODEL NO.	CPLRY. 'L'
00A	105-217-01	120
00B	-02	180
00C	-03	240
00D	-04	300
00E	105-217-05	360

1	SPDT	90° C	42-51°C	0-180°C
SWITCH	POLARITY	MAKE	BREAK	ADJUSTMENT

McGRAW-EDISON

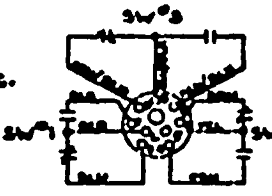
THERMOMETER & SWITCH
WITH CAPILLARY TUBING

CZ0440251



NOTES:

1- ALL DIMENSIONS ARE FOR REFERENCE ONLY.
2- COLORS: CASE: ANSI 70 LT. GRAY
DIAL: CHAR'S. WHITE ; BKGRND. BLACK
POINTER: WHITE
3- INSTRUMENT TO BE SHOCK RESISTANT & FREE BREATHING.
4- INSULATION MUST WITHSTAND 1500v TO GRND. FOR 60 SEC.
SWITCH RATING: 10A@125,250 V.A.C. .5A@ 125 V.D.C. / .25A@ 250 V.D.C. / 1.3A@ 48 V.D.C. RESISTIVE
5- TO ADJUST SWITCHES, REMOVE LENS ASSY., LOOSEN SWITCH ADJUSTING SCREW, MOVE INDICATOR TO DESIRED TEMP. AND TIGHTEN SCREW.
6- USE WELL DWG. NO. A-122094
7- A MIXTURE OF SILICONE GREASE AND GRAPHITE MUST BE APPLIED TO THE THERMOMETER ELEMENT BEFORE INSERTING IN WELL. SEE INSTRUCTION BOOK 3210-70-3.
8- SEE DWG. NO. A-38314 FOR IDENTIFICATION DECAL INSTRUCTION.
9- SWITCH SETTINGS INDICATED ARE AS RECEIVED FROM MANUFACTURER. SWITCH TO BE SET AT OPERATING TEMPERATURE INDICATED ON ACCESSORY SCHEMATIC DIAGRAM.
10- AMBIENT TEMPERATURE RANGE: -40° TO 160°F.



WIRING DIAGRAM (ANSI)

00E	104-149-05	360°
00D	-.04	300°
00C	-.03	240°
00B	-.02	180°
00A	104-149-01	120°
MEPS PART	QUALITROL MODEL NO.	CPLRY. 'L'

3	SPDT	115°C	105-110	20-170°C
2	SPDT	80°C	70-75	20-170°C
1	SPDT	75°C	65-70	20-170°C
SWITCH	POLARITY	MAKE	BREAK	ADJUSTMENT

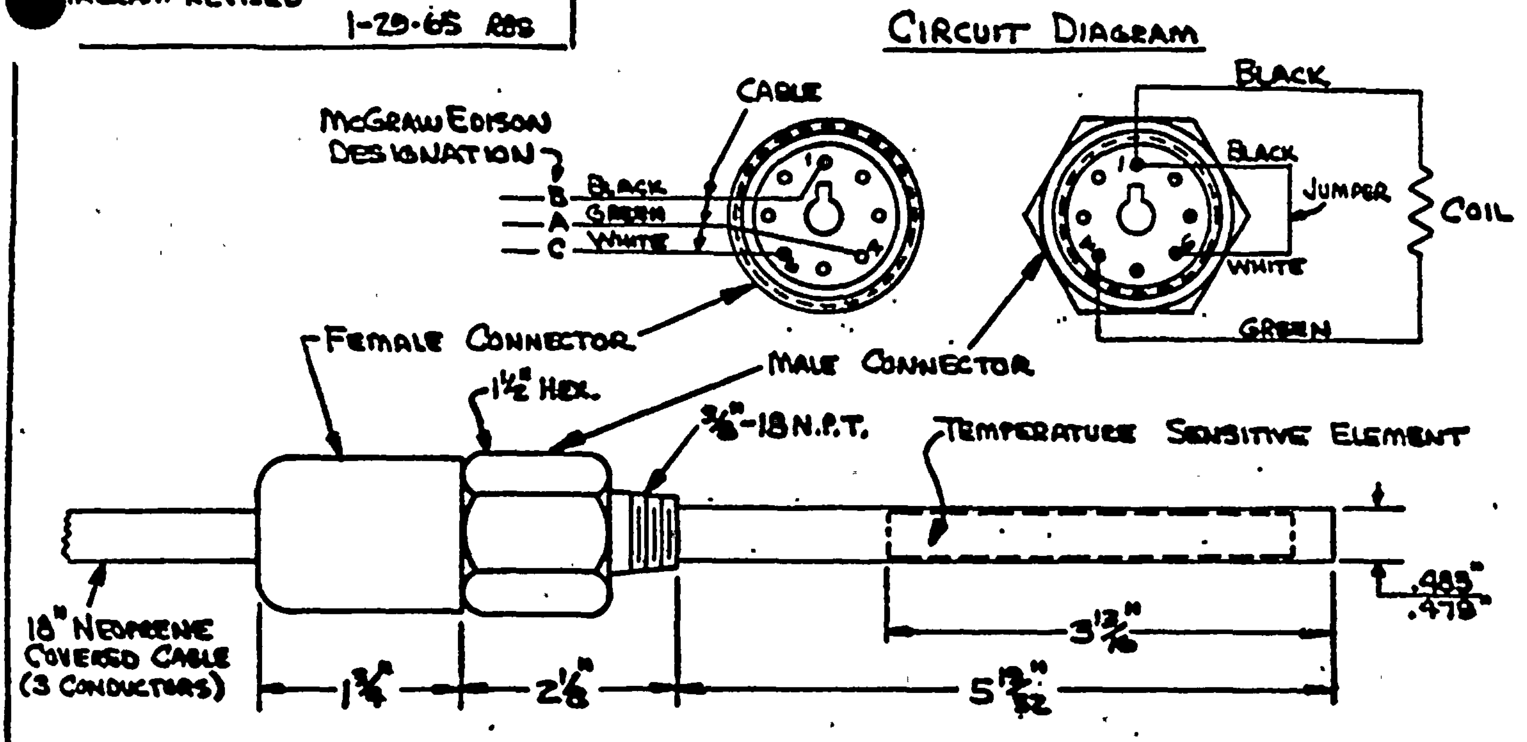
McGRAW-EDISON

THERMOMETER 3 SWITCH
WITH CAPILLARY TUBING

CZ0440253

Form No. 459-A

		REVISIONS	SYM.	DATE	SIGNATURE	DESCRIPTION
A	WELL NOTE ADDED 2-13-56 AP					
B	WELL REVISED AND CIRCUIT DIAGRAM REVISED 1-29-65 RBS					



RESISTANCE BULB - SHOWN WITH DETACHABLE CABLE GRIP CONNECTOR INSTALLED

USE WELL DWG. A-122097

SPECIFICATIONS:

RESISTANCE AT 25°C. - 10.00 OHMS ± .02 OHMS.

RESISTANCE AT 80°C. - 12.12 OHMS - BASED ON COEFFICIENT FOR COPPER.

INSTRUMENT TO BE SHOCKPROOF AND SUBMERSIBLE.

INSULATION TEST - 1500 V. FOR 60 SECONDS.

INSULATION TO BE SUITABLE FOR TEMPERATURE UP TO 150°C.

NOTE: THIS RESISTANCE BULB IS SUITABLE FOR CLASS "A" TRANSFORMERS.

PRINTS TO	
ASSEMBLY	
CARPENTER	
CORE BLDG.	
INSULATION	
MACHINE	
STOREROOM	
TRAFFIC	
TANK SHOP	
ELEC. FIN.	
COIL APPARATUS	
MASTER	
INSPECTION	
OFFICE	
COIL TREAT	
PROC. ENG.	
CU. FAB.	
ACCOUNTING	
SERVICE	
RAD SHOP	
MECH. DESIGN BY	

ITEM	REQ.	NAME	DRAWING NUMBER OR DESCRIPTION

NO. UNITS ORDERED

RE DRAWN GHC DATE 4-16-82

CKED GJT 4-18-82

VED GJT 4-18-82

DESIGN REFERENCE

McGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNSYLVANIA 15317

DESCRIPTION RESISTANCE BULB FOR LIQUID OR WINDING TEMPERATURE (THREE LEAD)

SPEC.

ORDER

TYPE

S.S. No. 487-H

CUST.

CUSTOMER

CUSTOMER'S ORDER

CONFIDENTIAL
MUST NOT BE USED IN
ANY WAY DETRIMENTAL TO

B-94210-B

INSTRUCTIONS

GEI-28074D
Supersedes GEI-28074C

GAS DETECTOR RELAY

FOR ATMOSEAL* TYPE TRANSFORMERS

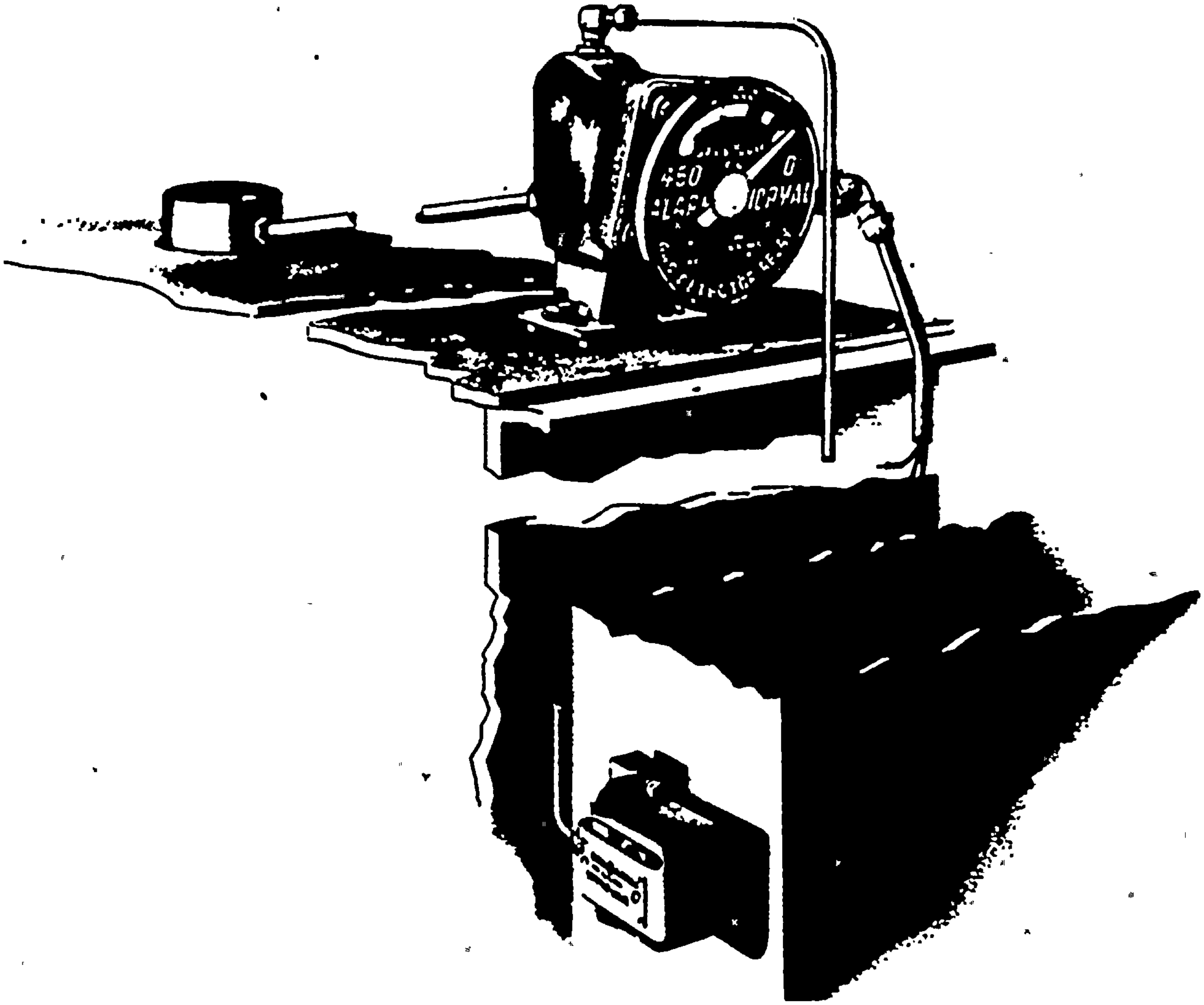


Fig. 1 Gas-detector relay system. Alarm cable shown cut off is normally terminated in the control housing

GENERAL ELECTRIC

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*Registered trademark of the General Electric Company

CONTENTS

GAS DETECTOR RELAY FOR ATMOSEAL TYPE TRANSFORMERS

INTRODUCTION

The gas-detector relay warns of the approach of transformer faults which are preceded by a period of gradual deterioration and gas evolution. The relay can only be used on transformers that are completely filled with oil (such as those equipped with Atmoseal or conservator oil preservation systems).

The relay, Fig. 1, is mounted near the edge of the transformer cover so that the dial can be observed from the ground.

The gas-detector relay is usually shipped in place on the transformer cover. Occasionally the relay is removed in order to meet shipping clearances.

DESCRIPTION

Gas generated by an incipient fault will rise to the center of the domed transformer cover and pass through tubing to the gas-detector relay.

The accumulated gas forces the oil down in the normally full relay chamber. A liquid level gage (graduated in cubic centimeters) indicates the gas volume (or volume of displaced oil).

An alarm switch, with normally open and normally closed contacts, operates when 200 cc of gas have accumulated in the chamber. The normally open contacts can be used to close an alarm circuit at the 200 cc point. The switch leads are connected to a

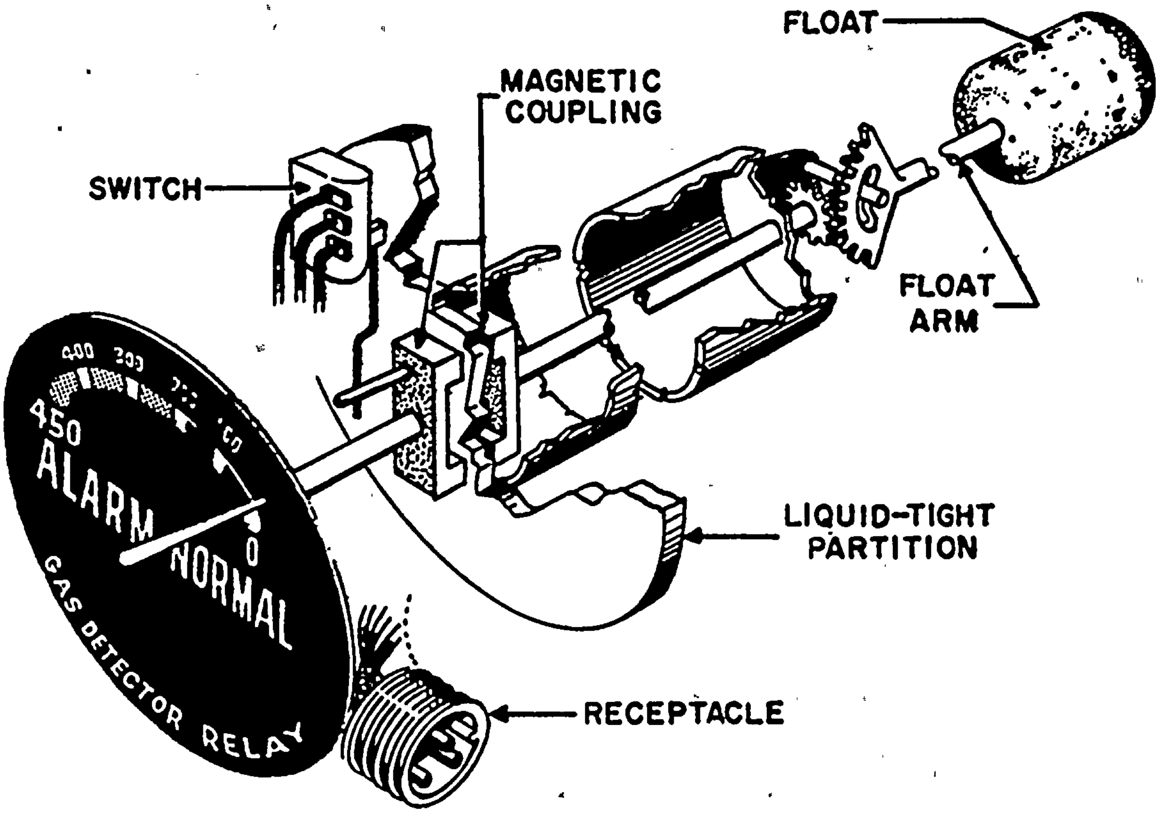


Fig. 2 Schematic view of relay mechanism

pin-type receptacle. See Figs. 2 and 3. The switch is rated as follows:

Type of Circuit	Type of Load	Circuit Volts	Amperes	
AC	Inductive and	115	10	
	Non-Inductive	230	5	
DC	Inductive	125	0.05	
		250	0.03	
	Non-Inductive	125	[illegible]	
		250	[illegible]	
AC or DC	Inductive		Restrict starting inrush currents to values below	
		125 and 250	Already Closed Contacts	Closing Contacts
			30	15

A test valve and petcock are located on the side of the transformer control housing. See Fig. 4. The valve is connected to the relay float chamber, thus providing a convenient means of obtaining a gas sample. The collected gas can be tested in order to determine whether or not a fault is developing within the transformer. The procedure for obtaining and testing a gas sample is described later.

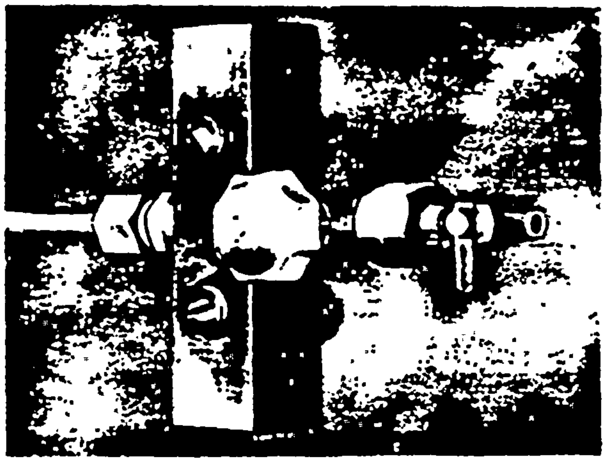


Fig. 4 Sampling valve and petcock with cover removed

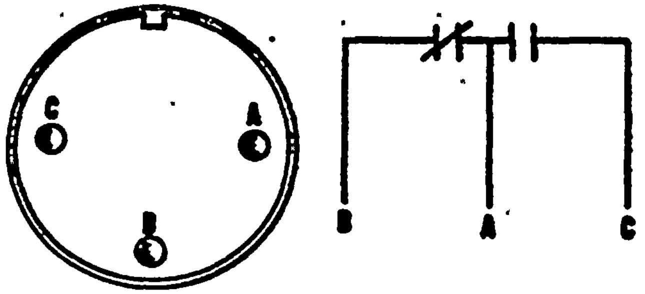


Fig. 3 Relay receptacle pin location and alarm switch connections

INSTALLATION

The gas-detector relay when shipped separately must be assembled and located as shown on the transformer Outline drawing. A pipe plug closes the opening in the flange on the transformer cover. When installing, proceed as follows:

1. Locate the gas-detector relay as shown on the transformer Outline drawing.
2. Mount the relay and relay support (when furnished) with the hardware provided. Place the short side of the support towards the center of the transformer cover. The relay will tip back slightly when installed. Leave the mounting nuts loose until the tubing shown in Fig. 5 is fastened in place.
3. Install the length of tubing between the transformer cover flange and the relay chamber. Refer to the Gas Detector Relay Installation drawing. Be sure the tubing is straight. Use a coupling to assemble the straight tubing to the flange on the transformer cover. See Fig. 5. Make a minimum bend at the flange coupling so that a constant pitch is maintained to the relay coupling. It may be necessary to make a slight bend at the relay coupling. After connecting the tubing, and tightening the mounting bolts, assemble the pipe (or tube) supports as shown on the installation drawing.
4. Connect the tubing between the relay and the sampling valve on the side of the control housing if tubing or housing was removed for shipment. Make sure tubing is not kinked or pinched closed at any point.
5. Remove the protective cap from the receptacle on the relay.
6. Install the cable assembly provided. The cable end is fitted with a pin-type connector. Do not make sharp bends in the cable (radius should be greater than three inches).
7. Make wiring connections. The common supply line to the alarm should be grounded.

After installing the gas-detector relay, refer to installation instructions in the leaflet entitled "At-

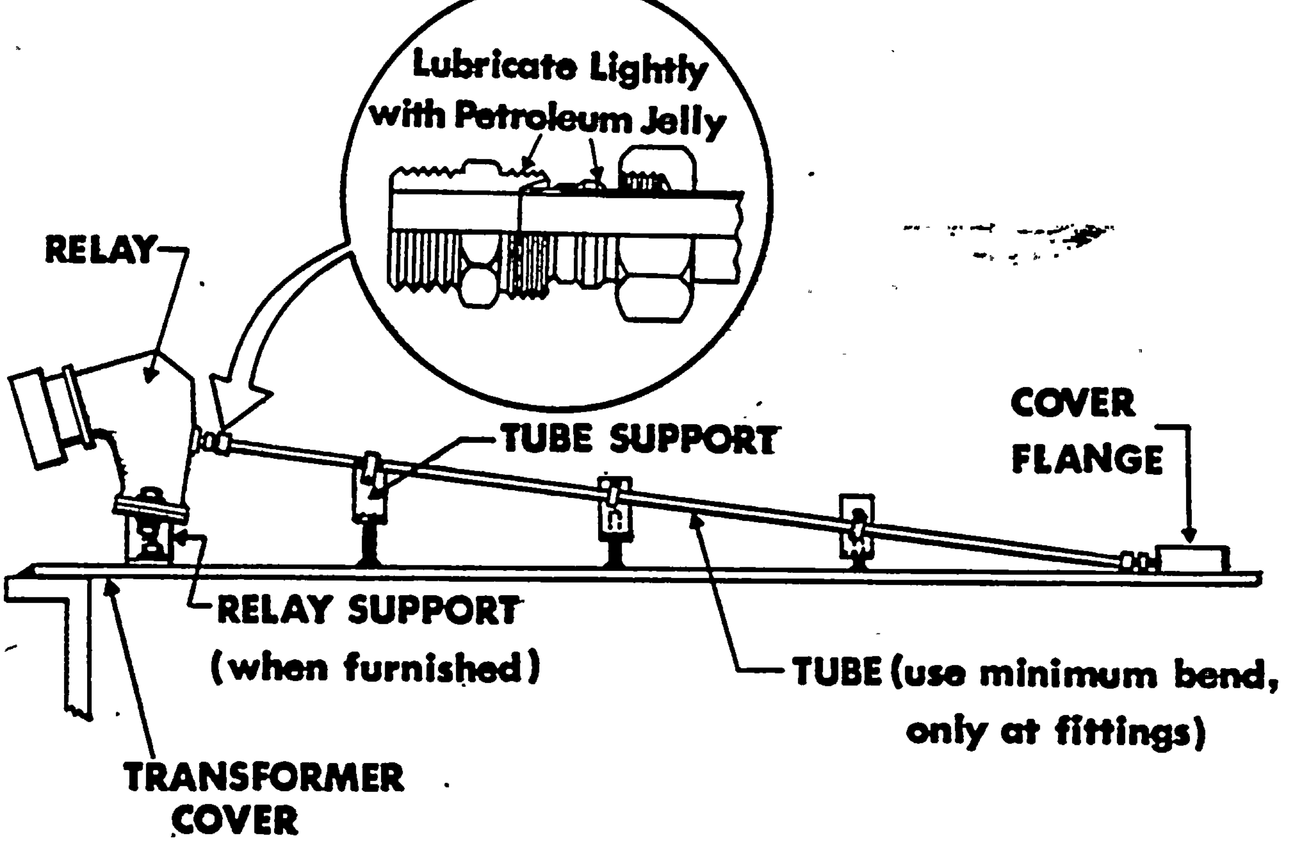


Fig. 5 Outline of typical relay installation on transformer cover

mosecal Oil-Preservation System" which refers to the gas detector relay in its installation procedure. The oil chamber of the gas-detector relay must be allowed to fill during the initial oil filling of the Atmoseal expansion tank before the aircell in the tank has been deflated.

The system can be primed using the syringe as a suction pump. See Figs. 6 and 7.

1. Insert syringe petcock "C" into petcock "B", opening the petcocks and valve "A".
2. Using the syringe as a suction pump; withdraw air from the line (and relay chamber) until oil appears in the syringe. Close petcock "B" to maintain the system each time the syringe is removed to eject air.

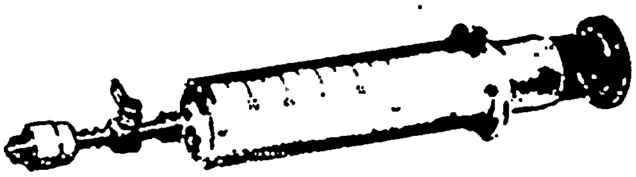


Fig. 6 Syringe with flame check device attached

3. Close valve "A" and petcock "B" and remove the syringe.
4. System is now primed (full of oil). Indicator should read zero cc.
5. Replace syringe (after cleaning; refer to "Maintenance") in its container and fasten the sampling valve cover in place.

SAMPLING

The rate of gas accumulation in the gas-detector relay is an indication of the magnitude of the fault. Should sufficient gas accumulate to give an alarm, a sample is removed and analyzed as described in the following paragraphs. The remaining gas is exhausted from the relay and the length of time noted to obtain a second alarm. Repetition of this procedure will show the magnitude of development of a fault. Depending upon the results, orderly arrangements can be made to remove the transformer from service before a failure occurs. In this manner damage can be minimized and the most convenient time for inspection and repair selected. Note that if installation or servicing has occurred within the

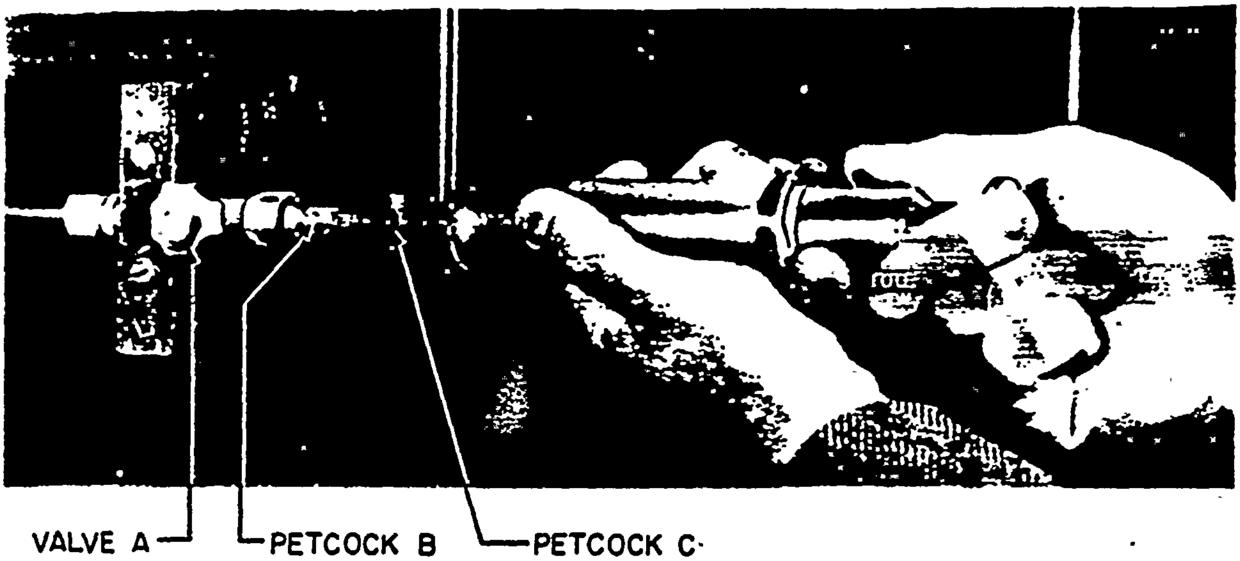


Fig. 7 Taking gas sample

preceding two week period, air may have been entrapped.

OBTAINING GAS SAMPLE

The gas sampling device consists of a graduated syringe of 50 cc capacity and a separable petcock, see Fig. 6. The syringe petcock has an externally tapered end, designed to be inserted into the matching petcock on the sampling valve assembly, assuring a leakproof joint between petcocks that can easily be made and broken. Make sure both petcocks are closed anytime that the syringe is removed from the sampling valve.

Refer to Fig. 7 and proceed as follows:

1. Insert the closed syringe into petcock "B".
2. Open valve "A", petcock "B" and petcock "C".
3. Fill the syringe.
4. Close both petcocks and remove the syringe.

Repeat the above 4-step procedure until approximately 10cc of gas appears in the syringe. Then expel the contents of the syringe and withdraw a 50 cc gas sample for testing.

As many 50 cc gas samples can be withdrawn as required for making the tests, however, the system should be restored to its "primed" condition in order to observe any further accumulation of gas on the indicator.

Prime the system as described previously under "Installation".

TESTING GAS SAMPLE

Combustibility Test

Test the gas for combustibility by obtaining a gas sample as described under "Sampling".

After obtaining the gas sample and before perform-

Fig. 8 Method of testing gas for combustibility

ing the test for combustibility, it is necessary to have a flame check on the syringe to prevent possible flash back. A flame check device will be found stored along with the sampling syringe. Attach the flame check device to the tapered syringe petcock and test the gas sample as follows:

Hold a naked flame ½-inch beyond the flame check device and expel 2 to 5 cc of gas into the flame. See Fig. 8. If the flame brightens, the gas is combustible and indicates the presence of an electrical fault. *CAUTION: PROPER SAFETY PRECAUTIONS MUST BE OBSERVED WHEN USING AN OPEN FLAME IN A POTENTIALLY HAZARDOUS ATMOSPHERE.* If the gas is not combustible, it is air.

To prevent swelling of the rubber in the syringe, clean thoroughly as described in the "Syringe" paragraphs under "Maintenance." Replace the syringe in the container and fasten the sampling valve cover in place.

Fig. 9 Chemical test of gas sample

Chemical Test

Prepare a solution of palladium chloride by adding approximately 0.1 gram of palladium chloride to 100 cubic centimeters of water. Filter the solution through coarse laboratory filter paper to remove any residue.

Before conducting the chemical test which consists of bubbling gas through the solution, it is recommended that some means be used to reduce the size of the gas bubbles expelled from the syringe petcock. For instance, a medicine dropper squeeze-bulb with its closed end pierced by a pin can be placed over the end of the petcock.

Submerge the end of the syringe in the palladium chloride solution and expel the gas slowly until the syringe is empty. See Fig. 9. The solution reacts with any of the main constituents of arc-formed gases (hydrogen, carbon monoxide and acetylene) to form a finely divided black precipitate within three to four minutes. When only very small concentrations of these gases are present (approximately ten percent of the total volume), a darkening of the solution constitutes a positive test.

If any doubt exists about whether or not the test is positive, withdraw another gas sample and bubble it through the same solution.

To prevent swelling of the rubber in the syringe, clean thoroughly as described in the "Syringe" paragraphs under "Maintenance." Replace the syringe in the container and fasten the sampling valve cover in place.

MAINTENANCE

Little maintenance will normally be required. It is desirable to make an occasional inspection to check external connections. Also inspect the relay after it has operated.

TESTING ALARM CONTACTS

To test the operation of the alarm contacts, proceed as follows:

1. Open valve "A" and insert gas-sampling device, with the syringe full of air, into petcock "B"
2. Open petcocks "B" and "C" and pump air through the test valve and up into the gas chamber.
3. Close petcock "B", remove device and recharge with air.
4. Repeat operations 1, 2, and 3 until the float

chamber is filled with air and the alarm switch has operated.

5. Restore the system to its oil filled condition by withdrawing the air and priming the system as previously described.

SYRINGE

After each use, clean the syringe thoroughly and replace carefully in the box on the inside of the control housing door.

Clean the syringe with non-leaded gasoline or with naptha. Remove the rubber and clean it thoroughly inside and outside in order to prevent swelling due to the transformer oil. Allow the parts to dry. Coat the rubber with silicone oil before reassembling.

CAUTION - Observe proper safety precautions when using the solvent, due to possible toxic or explosive characteristics.

The syringe and petcock can be obtained from most medical supply firms, if it becomes necessary to replace them. The syringe is Cat. No. 850-S made by Becton, Dickinson and Company.

POWER TRANSFORMER DEPARTMENT
GENERAL ELECTRIC
PITTSFIELD, MASS.

6-68(1M)

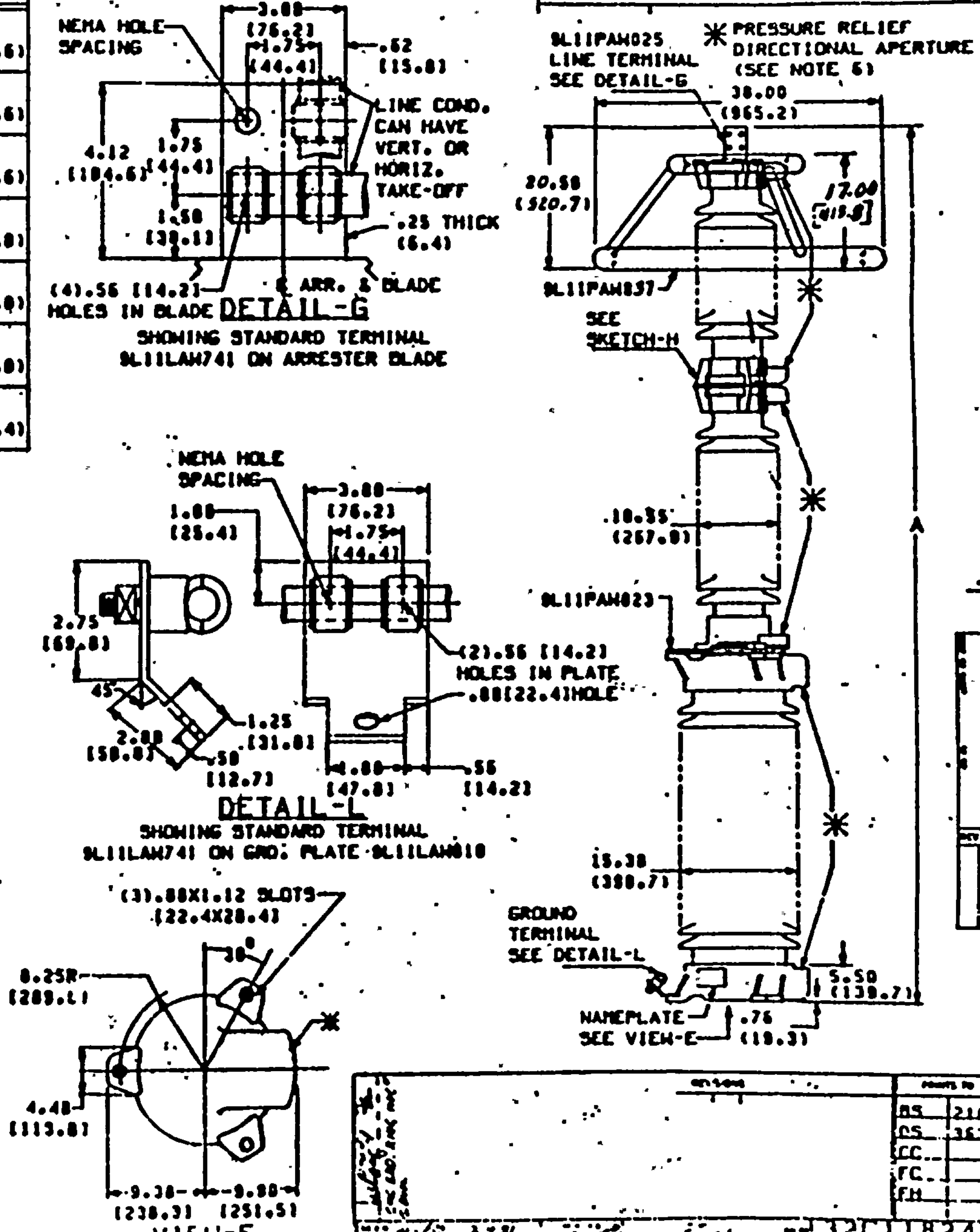
Printed in U.S.A.

GENERAL ELECTRIC 32C118243

OUTLINE

9L11T STATION ARR

ARRESTER MODEL NO. SEE NOTE 7	STACKING ORDER TOP TO BASE	KV RATING	OVERALL HEIGHT A ± 1%	NET WEIGHT LBS.	NET WEIGHT KG.	MINIMUM CLEARANCE SEE NOTE 3	LEAKAGE DISTANCE
9L11THA258	9L11TGH203 GH601 HH103	258	134.70 (3421.4)	925	420	72.50 (1841.5)	284 (7213.6)
9L11THA264	9L11TGH203 GH601 HH104	264	134.70 (3421.4)	930	422	74.50 (1892.3)	284 (7213.6)
9L11THA276	9L11TGH203 GH604 HH104	276	138.30 (3512.8)	955	433	78.50 (1993.9)	294 (7467.6)
9L11THA288	9L11TGH203 GH601 HH105	288	144.00 (3657.6)	1015	460	82.40 (2093.0)	315 (8001.0)
9L11THA294	9L11TGH203 GH603 HH105	294	147.60 (3749.0)	1040	472	84.30 (2140.0)	325 (8255.0)
9L11THA300	9L11TGH203 GH604 HH106	300	147.60 (3749.0)	1040	472	86.00 (2184.4)	325 (8255.0)
9L11THA312	9L11TGH203 GH605 HH106	312	151.20 (3840.5)	1060	481	90.00 (2286.0)	336 (8534.4)



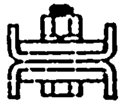
DETAIL-G

SHOWING STANDARD TERMINAL 9L11LAH741 ON ARRESTER BLADE

DETAIL-L

SHOWING STANDARD TERMINAL 9L11LAH741 ON GRD. PLATE 9L11LAH010

VIEW-E



SKETCH-H

NOTES

1. THESE ARRESTERS ARE FOR 0 TO 10.000 FT. (0 TO 3.000M.) ALT. FOR SPECIAL ARRESTERS INVOLVING HIGH ALTITUDES.OTHER COMBINATION OF HARDWARE.ETC..REFER TO THE NEAREST G.E. APPARATUS SALES OFFICE.
2. STOCK ARRESTERS INCLUDE LINE TERMINAL.GROUND PLATE. BOLTS.ETC..AND FOUR CLAMP TYPE TERMINALS. THESE STEEL TERMINALS ARE GALVANIZED. HAVE .75(19.1) DIA. OPENINGS. AND WILL ACCOMODATE #2 TO 350MCM COPPER OR AL. CABLE
3. RECOMMENDED MIN. CLEARANCES APPLY LINE-TO-LINE AND LINE-TO-GROUND AND ARE FOR 3300FT.(1.000M)ALTITUDE; ADD 3% TO CLEARANCES FOR EACH 1000FT.(300M).
4. CANTILEVER STRENGTH IS IN EXCESS OF 200.000 INCH POUNDS (22597N•M).
5. VALUES IN ( ) ARE METRIC AND ARE INCHES TO MILLIMETERES UNLESS OTHERWISE SPECIFIED.
6. WHEN INSTALLED.PRESSURE RELIEF DIRECTIONAL APERTURES SHOULD BE LOCATED AWAY FROM ADJACENT APPARATUS TO PREVENT ARC TRANSFER OR DAMAGE IN THE REMOTE CASE OF ARRESTER FAILURE.
7. ALL PORCELAIN CONTAINERS ARE GRAY COLOR.
8. TO ATTAIN DESIGN CANTILEVER STRENGTH AND RIGIDITY. USE STIFFENING WASHERS AS SHOWN IN SKETCH H.

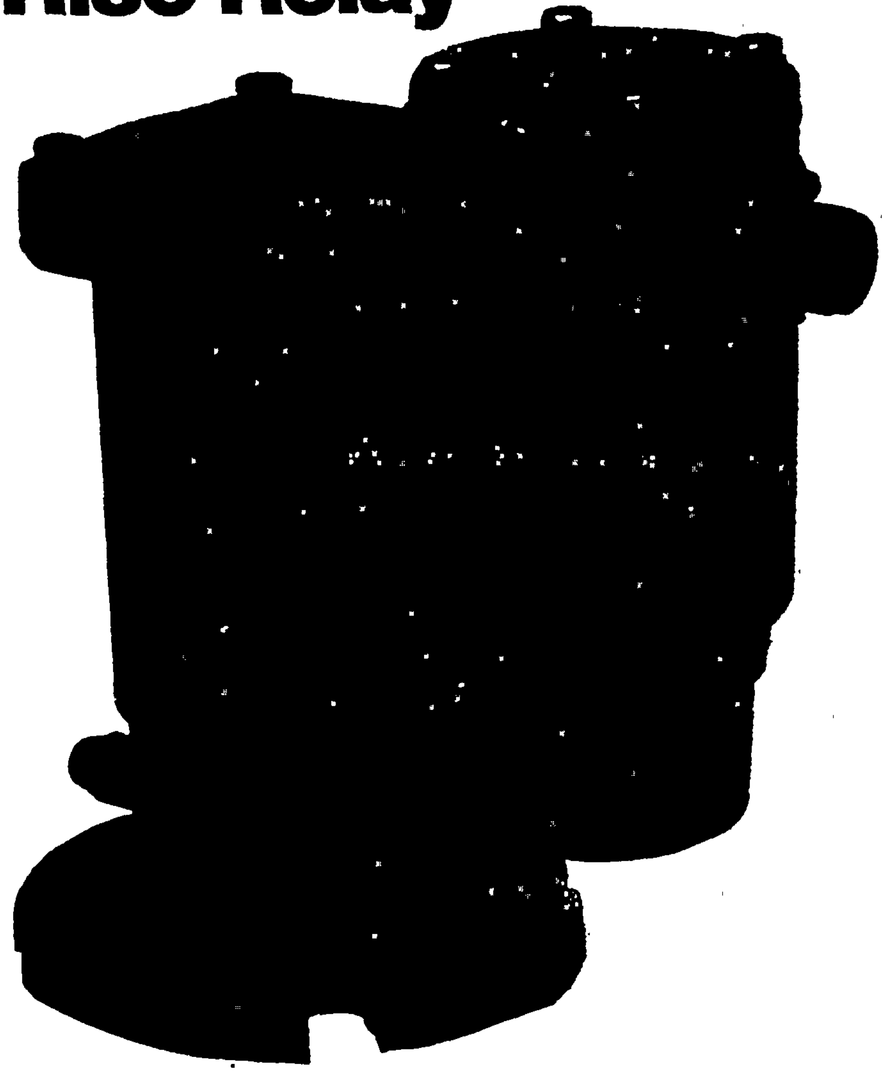
BS	210P
DS	363D
CC	
FC	
FM	

PITTSFIELD

32C118243

900,910 Series

Rapid Pressure Rise Relay



FEATURES

- High sensitivity and repeatability in response to fault pressures.
- Temperature compensation for consistent performance over wide temperature variations. (Standard Relay operates from −40° to 180°F. Special low temperature models available.)
- Balanced system inherently resistant to shock and vibration.
- Small size and low silhouette.
- Easy installation via flange or thread mounting.

QualiTROL CORPORATION

APPLICATION

Internal arcing in oil filled power transformer tanks generates excessive gas pressures that can severely damage equipment and present extreme hazards to operating personnel. The QualiTROL Rapid Pressure Rise Relay, when mounted on the transformer, minimizes the possibility of such occurrences by detecting rates of pressure increase in excess of the safe limits established by the transformer manufacturer. When such conditions are experienced, it will initiate an electrical signal for circuit breaker operation to de-energize the transformer and institute an alarm if desired.

The 900 Series Relay is calibrated for use under oil and the 910 Series for use in the gas space. The design of both Relays is such that they will not be actuated by normal pressure variations caused by temperature change, vibration, mechanical shock, or pump surges. The Relay, as mounted on the transformer, can be subjected to full vacuum or 20 psi positive pressure without damage.

OPERATION

Please refer to Figure 1.

Changes in transformer internal pressure deflect the sensing bellows and responding control bellows that are part of a sealed system filled with silicon oil. A small orifice in the line of one of the control bellows, whose effective area is varied with temperature by a bimetal strip, causes differential deflection of the two control bellows. The resultant cocking of the actuator linkage trips the electrical switch at unsafe rates of pressure rise. When the two control bellows again reach equilibrium, the electrical switch automatically resets itself.

INSTALLATION

The 900 Series Rapid Pressure Rise Relay (mounted under oil) is supplied with a bleed valve located on top of the housing. After the Relay is securely mounted and exposed to oil, the bleed valve should be opened long enough to allow one-half pint of oil to flow out. This will insure that all air has been purged from the lower cavity and the sensing bellows is exposed to only insulating fluid.

This procedure is not necessary for the 910 Series (mounted in the gas space).

All units used in the horizontal position must be installed with the electrical connector pointed straight down.

FIGURE 1

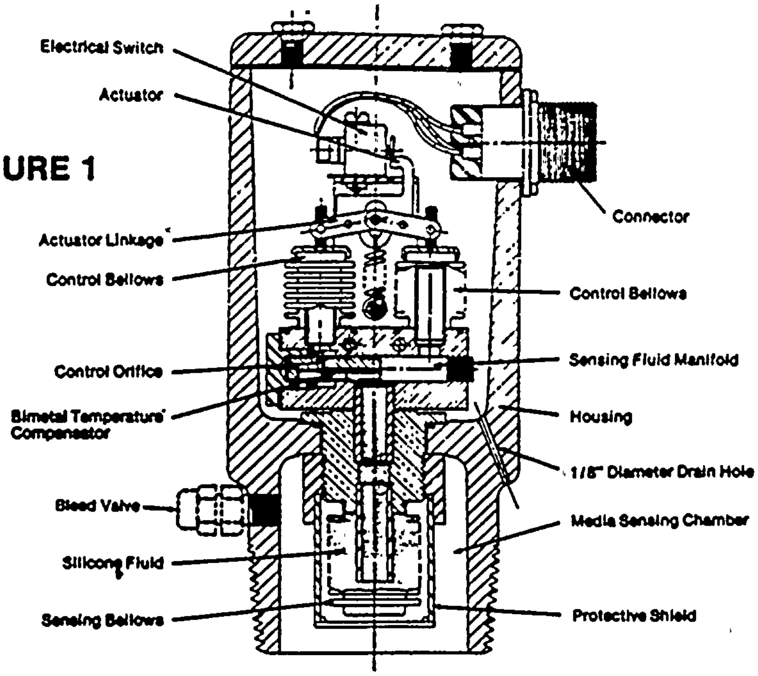
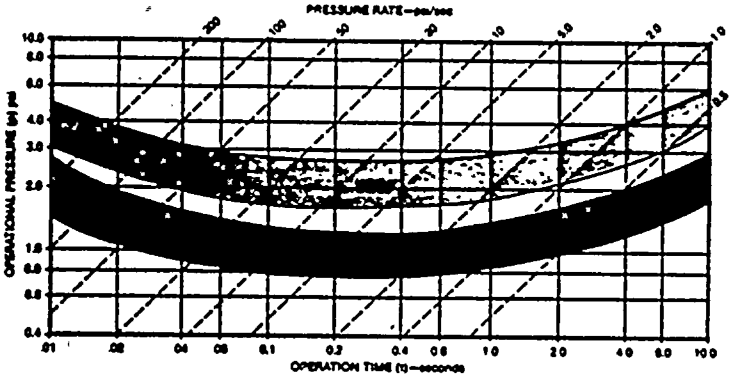


FIGURE 2



RESPONSE CURVE FOR 900, 910 SERIES RAPID PRESSURE RISE RELAY

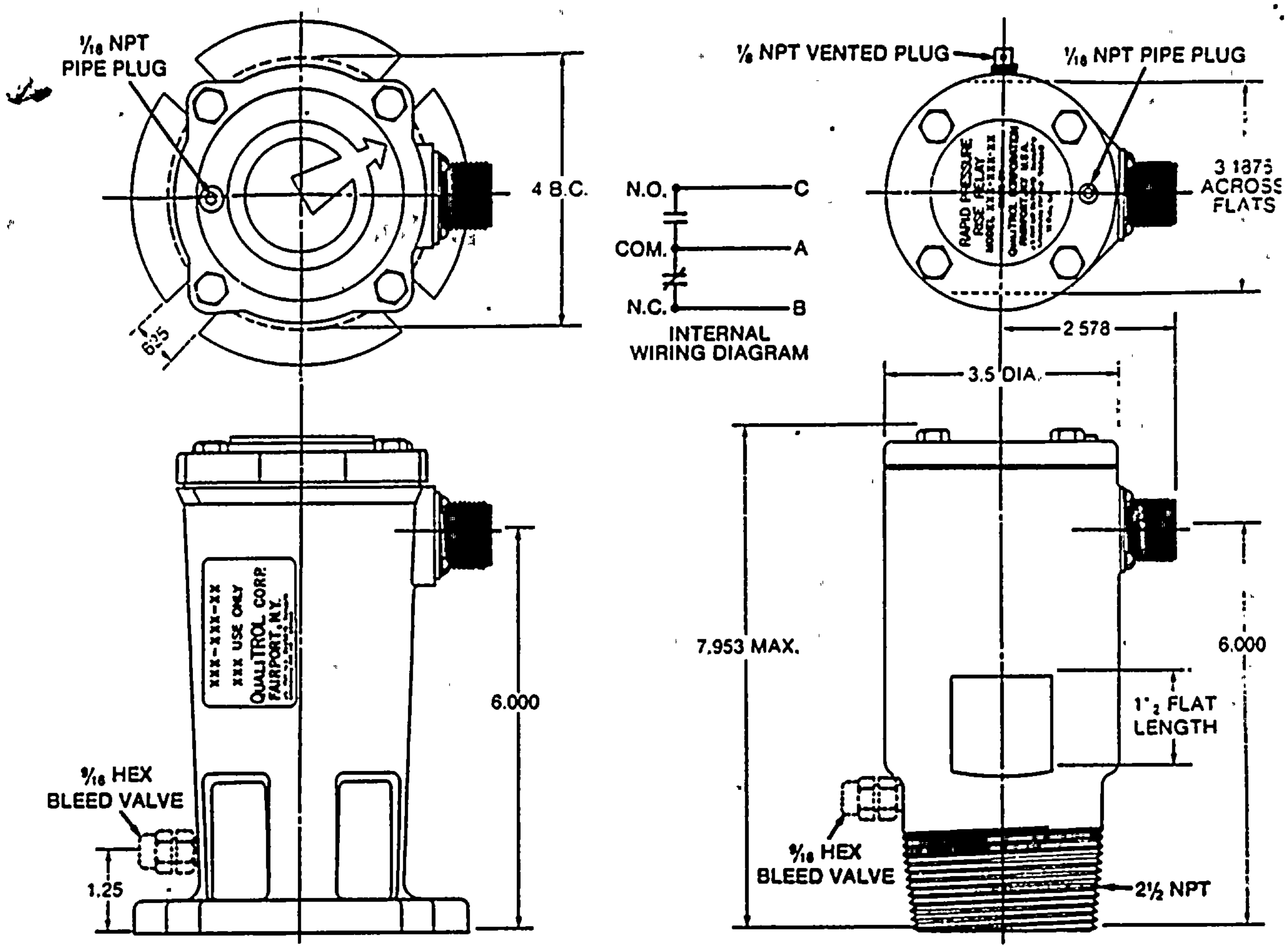
TESTING

SET UP

1. De-energize the Rapid Pressure Rise Relay control circuit and remove the cable plug from the unit.
2. Connect the test light to pins "A" and "C" in the electrical connector.
3. Remove the $\frac{1}{16}$" pipe plug from the cover of the Relay and install a cross connector in the tapped hole.
4. Connect a 0 - 5 psi pressure gage to the top of the cross and a squeeze bulb to the other side, using rubber tubing if necessary.
5. If there is a $\frac{1}{8}$" NPT breather plug in the Relay housing, remove it and replace it with a solid pipe plug of the same size.
6. If there is a drain hole situated near the base of the housing, plug this hole with a small tapered rubber plug.
7. The objective of this set up is to prevent any air from escaping the housing while the test is being conducted. To insure this, be positive that the system is airtight when the set up is complete.

OPERATING PROCEDURE

1. Place finger over the open port of the cross connector and operate the squeeze bulb to attain test pressure (3.00-3.25 psi for 900 Series) (2.50-2.75 psi for 910 Series) on the gage and hold this pressure for 30 seconds minimum by squeezing the bulb as necessary.
2. After 30 seconds, remove finger quickly from the open port, allowing the air to escape rapidly from the Relay housing. *If the test light glows, the Rapid Pressure Rise Relay is within specification for this portion of the test.* If the test light does not glow, several more attempts shoud be made to verify operating procedure. If the light bulb still fails to light, the Relay is not within specification.
3. Wait one minute for Relay mechanism to stabilize.
4. Next, place finger over open port again and operate the squeeze bulb to attain test pressure (1.25-1.50 psi for 900 Series) (.75-1.00 psi for 910 Series) on the gage and hold for 30 seconds minimum by squeezing the bulb as necessary.
5. After 30 seconds, remove finger quickly, allowing air to escape rapidly from the Relay housing. *If the test light does not glow, the Rapid Pressure Rise Relay is within specification for this portion of the test.* If the test light does glow several more attempts should be made to verify operating procedure. If the light bulb still continues to light, the Relay is not within specification



INTERNAL WIRING DIAGRAM

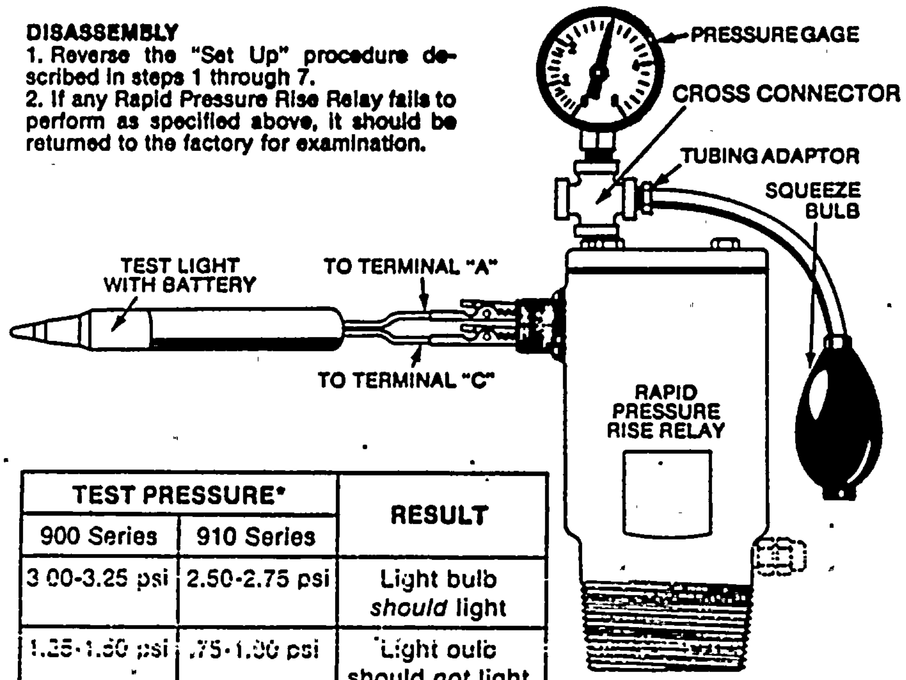
FLANGE MOUNT

THREAD MOUNT

MODEL	900-003-01	900-004-01	910-005-01	910-006-01
MOUNTING	Flange	Thread	Thread	Flange
APPLICATION	Oil Space	Oil Space	Gas Space	Gas Space

DISASSEMBLY

1. Reverse the "Set Up" procedure described in steps 1 through 7.
2. If any Rapid Pressure Rise Relay fails to perform as specified above, it should be returned to the factory for examination.



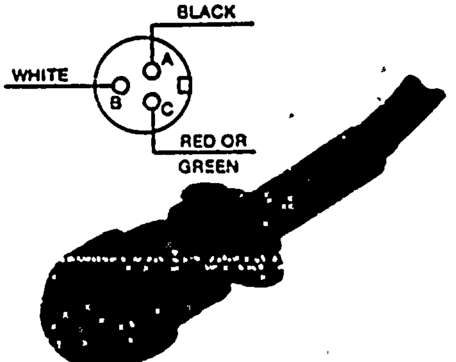
TEST PRESSURE*		RESULT
900 Series	910 Series	
3.00-3.25 psi	2.50-2.75 psi	Light bulb *should* light
1.25-1.50 psi	.75-1.00 psi	Light bulb should *not* light

*Not to exceed 4.0 psi

CON-630 SERIES

A mating connector and cable assembly is available from QualiTROL.

Part Number	Cable Length
CON-630-1	2 feet
CON-630-2	3 feet
CON-630-3	8 feet
CON-630-4	5 feet
CON-630-5	4 feet
CON-630-6	6 feet
CON-630-7	7 feet
CON-630-8	15 feet



SEAL-IN RELAY

QualiTROL Series 909 Seal-in Relays are designed for use with QualiTROL 900 or 910 Series Rapid Pressure Rise Relays to provide an electrically maintained contact after operation of the protective device. The Seal-in Relay provides one SPDT contact and one SPST, normally open, contact which switch upon Relay operation and are maintained electrically until the Seal-in Relay is released by pushing the reset button.

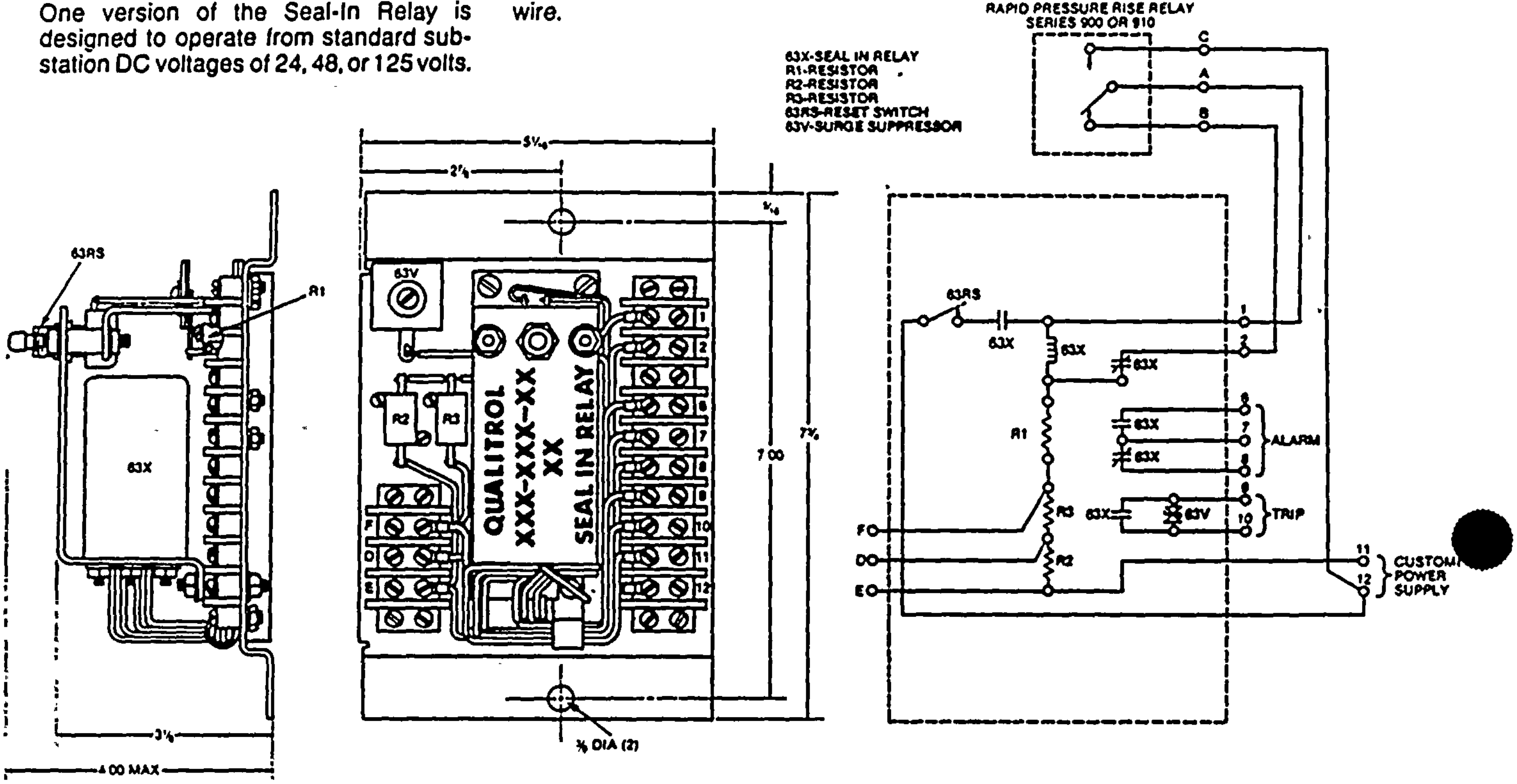
One version of the Seal-In Relay is designed to operate from standard substation DC voltages of 24, 48, or 125 volts.

A second design can be connected to operate from 115, 220 or 230 VAC, 50 HZ or 60 HZ. This flexibility allows the user to stock only one or two models to satisfy requirements for a variety of applications.

Each QualiTROL Seal-In Relay utilizes components selected to reduce environmental problems and provide required product life. All external connections and internal reconnections are made on screw type terminal blocks capable of accepting up to #14 AWG wire.

MODEL	SERVICE
909-007-01	24, 48, or 125 VDC
909-008-01	115, 220, or 230 VAC
909-004-01*	24, 48, or 125 VDC
909-005-01*	115, 220, or 230 VAC

* Special Hermetically Sealed Relay



A WORD ABOUT QUALITROL

The QualiTROL Corporation, over the last 30 years, has become a leader in supplying pressure, liquid level and temperature controls primarily to utilities and electrical equipment manufacturers. We have established a reputation for quality and reliability within this group of customers and are gradually establishing the same reputation within other industries. A team of engineers is ready to service your immediate or future control needs. Call us.

TO ORDER, OR FOR QUOTATIONS, SPECIFY

I. Model numbers
II. If model numbers cannot be determined:
  A. Rapid Pressure Rise Relay
    1. Application
      a. Gas Space
      b. Under Oil
    2. Mounting
      a. Thread
      b. Flange
  B. Connector and Cable Assembly
    1. Cable length (even foot lengths only)
  C. Seal-In Relay
    1. Power source
      a. Alternating current (AC)
      b. Direct current (DC)
  D. Any special environmental or operating conditions.

QualiTROL CORPORATION

1385 FAIRPORT ROAD • FAIRPORT, NEW YORK 14450 • (716) 586-1515 • TWX 510-254-1611

OF 910 '83

Printed in U.S.A

McGRAW-EDISON
Power Systems Division

Bushings
Type PA
Installation and Maintenance Instructions

S315-10-1
Service Information

CONTENTS

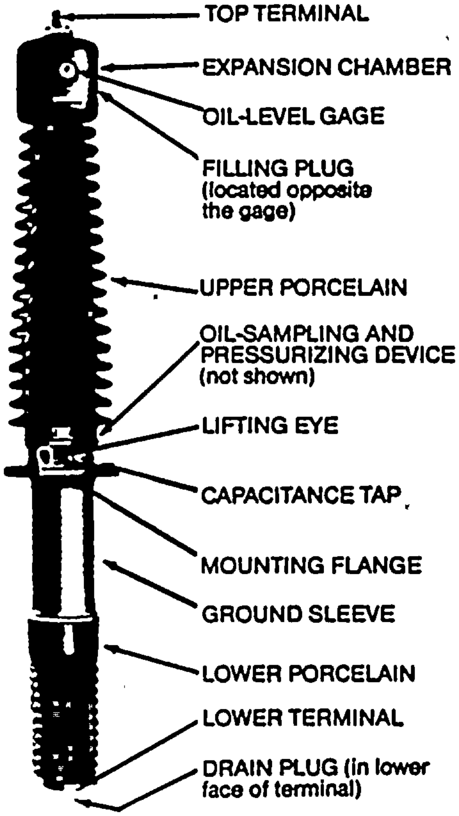


Figure 1.
Typical McGraw-Edison Type PA bushing.

GENERAL

The McGraw-Edison Type PA apparatus bushing (Figure 1) is a condenser bushing insulated with oil-impregnated kraft paper. Aluminum foil layers in the insulation distribute electrical stresses and provide voltage gradients. The shell porcelain and the center flange section of the bushing are clamped together under the pressure of multiple springs in the expansion chamber. These springs maintain proper pressure on the gaskets to assure a permanent seal under varying operating conditions.

Oil level in the Type PA bushing is adjusted at the factory and set at the normal position (see Figure 2) on the oil-level gage at an ambient temperature of approximately 25 C (77 F). The oil level should remain virtually unchanged for this temperature throughout the life of the bushing unless the bushing is damaged sufficiently to cause oil leakage. The top of the expansion chamber is filled with nitrogen applied at 5 to 10 psi to keep the bushings continuously pressurized while the oil level fluctuates due to changes in ambient and operating temperatures.

Figure 2.
Magnetic oil-level gage showing normal oil level.

Each Type PA bushing rated 115 kV or higher is equipped with a capacitance tap (a tap to one of the foil layers in the insulation) for connecting a potential device.

SHIPPING

Each Type PA bushing is packed in the horizontal position—braced and blocked at the center flange to prevent movement during shipping—in an individual crate.

INITIAL INSPECTION

Immediately upon receipt of a bushing—preferably before unloading—thoroughly inspect the bushing for chipped or cracked porcelain and oil leakage.

Should there be damage, evidence of rough handling in transit, and/or shortage, notify—and file a claim with—the carrier at once. Also notify McGraw-Edison Power Systems Division, Canonsburg, Pa. 15317.

IDENTIFICATION RECORDS

Retain complete identification records for each bushing:

- Serial number.
- Type, description, and rating.
- All pertinent instructions and drawings.

Accurate and complete identification—including serial number, catalog number and rating—should accompany any reference or inquiry about a bushing to McGraw-Edison Power Systems Division.

HANDLING UPON RECEIPT

Ordinarily, handling relates to a bushing immediately upon its receipt. However, if the bushing is moved or is out of service for an extended period of time, applicable portions of these instructions must be observed.

1. Uncrating
   A. Pry open the top of the crate. Be extremely careful to avoid damaging the porcelain and other bushing parts.
2. Lifting

CAUTION
Since the Type PA bushing is top-heavy, the balance force required in lifting the bushing may be as much as one-third its total weight.

A. Use the following table as a guide for the capacity of the lifting rig required to lift a bushing:

Bushing Rating (kV)	Net Bushing Weight (lb*)
115	855
138	875
161	925
196	1525

*Add 20 to 40% for crating.

NOTE: For applications above 196 kV refer to the bushing outline drawing accompanying the equipment.

B. Attach rigging similar to that shown in Figure 3 to the bushing:
   (1) Attach the main harness to the lifting eyes on the bushing flange.
   (2) Attach an auxiliary tackle to a sling around the top of the bushing.

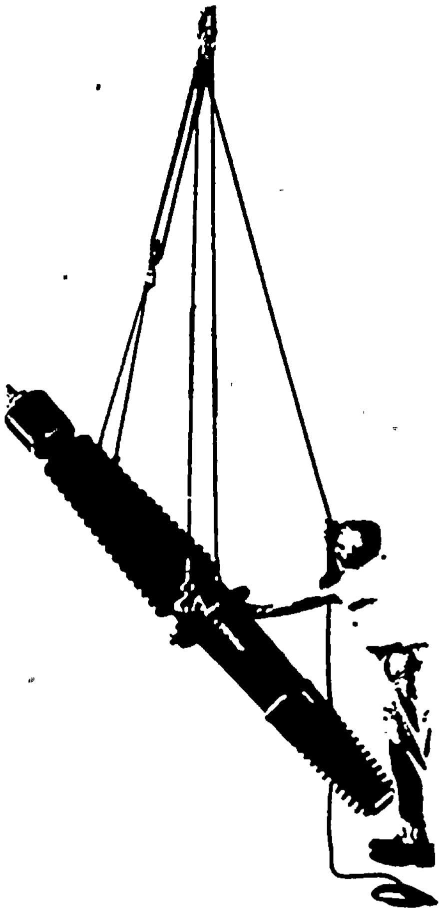


Figure 3.
Typical handling rigging with main harness attached to lifting eyes on flange and auxiliary tackle attached to sling around top of bushing.

> **CAUTION**
> If a Type PA bushing is set down on its lower end at any time, be extremely careful to set it down in such a manner that the spherical contact surface and the bottom terminal corona shield are not damaged.

PREPARING A BUSHING FOR STORAGE

Type PA bushings may be stored outdoors. The bottom and top terminals of a bushing to be stored outdoors for an appreciable period should be given a heavy coat of grease.

1. Store the bushing in the upright (vertical) position, supported in this position at the center flange.
2. If a bushing cannot be stored in the vertical position:
   A. Tilt the bushing from the horizontal position so that the expansion chamber is at least 8 to 10 in. above the lower terminal.
   B. In the tilted position, the bushing should be supported at the center flange and upper porcelain or expansion chamber.

INSTALLATION

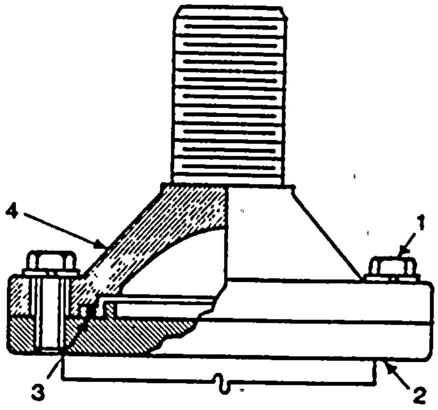
1. Attach the main sling of the lifting rig to the lifting eyes in the bushing flange (Figure 3).
2. Attach the auxiliary sling of the rig at the top of the bushing for positioning (Figure 3).
3. Lift the bushing to the vertical position.
4. Wipe the entire bushing. Be sure to clean off all dirt, oil, and moisture that may have adhered to the surface during shipping and/or storage.
5. If the bushing has been shipped or stored in the horizontal position, keep the bushing in the upright (vertical) position for 48 hours before energizing it.
   - Before installing the bushing, rock it back and forth—while suspended—to release all trapped gas.
6. A bushing installed at an angle with the vertical should be mounted with the oil-level gage facing either up or down in the plane of tilting to properly indicate the oil level.
7. When attaching the bushing to the apparatus, the mounting bolts should be tightened a fraction of a turn at a time—moving progressively in one direction—until the bolts are uniformly tight.
   - Approximate torque to which bushing bolts should be tightened:
     ⅝-in. bolt, NC thread: 60 ft-lb;
     ¾-in. bolt, NC thread: 85 ft-lb.

ELECTRICAL CONNECTIONS

Connections between a bushing and the apparatus on which it is to be mounted may be either fixed-conductor or draw-lead.

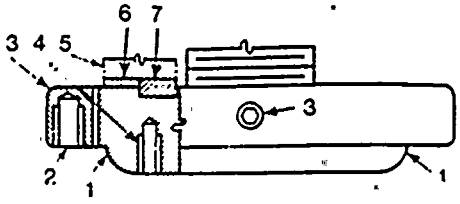
Fixed-Conductor Connections

1. For a fixed-conductor bushing, the tube or rod of the bushing is used as the conductor and a connection is made directly to a terminal at the bottom of the bushing. The upper and lower terminal constructions are shown in Figures 4 and 5.
   A. The top terminal of a bushing which uses the central tube or rod as the conductor need not be removed.
   B. To install a fixed-conductor bushing, bolt the flange to the apparatus cover.

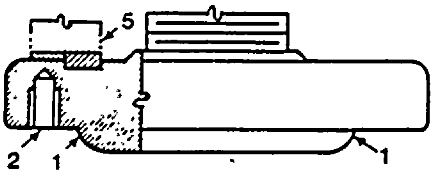


1. Six ⅝—16 capscrews for ratings 115 kV through 196 kV.
2. Terminal flange of bushing.
3. Nitrile o-ring gasket.
4. Tinplated copper terminal.

Figure 4.
Top terminals of fixed-conductor bushings.



115-kV, 138-kV, 161-kV RATINGS



196-kV RATING

1. Curved, tinplated contact surface of lower terminal.
2. Eight ½—13 tapped holes on 6¾-in. bolt circle for terminal fitting or corona shield.
3. Screwed-on adapter ring (used for corona shield and terminal fitting) locked in position with setscrew.
4. Four ⅜—16 tapped holes on 3¾-in. bolt circle for corona shield of draw-lead bushings.
5. Porcelain shell of bushing sealed to terminal.
6. Stop gasket.
7. Sealing gasket.

Figure 5.
Lower terminals and bolting flanges for fixed-conductor bushings rated 1200, 1600, and 2000 amps.

Draw-Lead Connections

1. For a draw-lead bushing, a draw-lead cable is passed through the central tube of the bushing and a connection is made between the top-end terminal and the apparatus. The upper terminal and the lower-end shield constructions are shown in Figures 6 and 7. The terminal and lead are normally made up by the transformer manufacturer. A draw-lead bushing is equipped with a corona shield (Figure 7) on the lower terminal.

A. To install a draw-lead bushing:

(1) Unscrew terminal cap 7 (Figure 6).

(2) Remove anchor pin 2 and terminal stud 6 (Figure 6).

NOTE: Terminal adapter 3 is not removed unless the bushing is being converted for fixed-terminal use.

(3) Determine the exact required length of the draw lead.

(4) Crimp, braze, or sweat the lower end of terminal 6 to the draw lead.

(5) Pass a wire or cord down through the bushing and attach the wire or cord to the top of the terminal using lead pulling eye 1 (Figure 6).

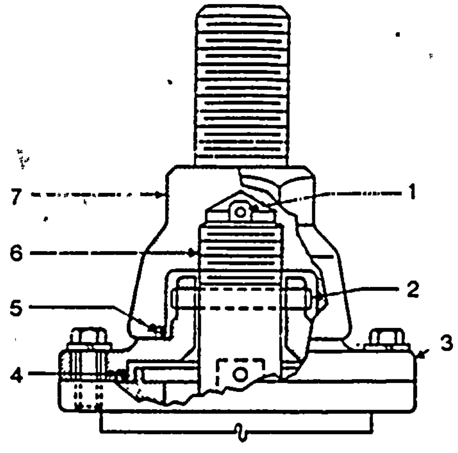
(6) As the bushing is lowered into place on the apparatus, pull the lead through the bushing.

(7) Lock the lead into position by replacing anchor pin 2 through the holes in the terminal stud and the adapter fitting.

(8) Replace terminal cap 7 (Figure 6) with its o-ring sealing gasket 5.

NOTE: The gasket should be lubricated with a thin coat of oil or silicone grease.

(9) Tighten terminal cap 7 with a torque of approximately 50 ft-lb.

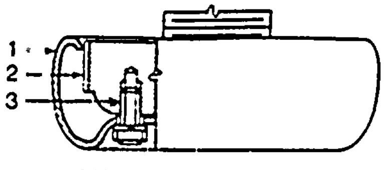


1. Lead pulling eye.
2. Terminal anchor pin.
3. Adapter flange held with six ⅜—16 capscrews.
4. Nitrile o-ring gasket for adapter.
5. Nitrile o-ring gasket for terminal.
6. Copper draw-lead terminal with hole for crimp connection.
7. Tin plated copper terminal.

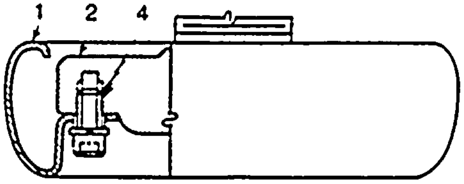
Figure 6.
Top terminal for draw-lead bushing rated up to 800 amps.

EXTERNAL LINE CONNECTIONS

When connecting the bushing to the line or external circuit, make sure the line and bushing terminal connections are clean and tight. The line span should be short with sufficient flexibility to avoid mechanical strain due to expansion or contraction of the line or from wind loads.



115-kV, 138-kV, 161-kV RATINGS



196-kV RATING

1. Corona shield.
2. Lower terminal.
3. Four ⅜—16 capscrews.
4. Four ½—13 capscrews.

Figure 7.
Corona shields for lower terminals of draw-lead bushings.

CAPACITANCE TAP

A capacitance tap is provided on each McGraw-Edison Type PA bushing rated 115 kV or higher. The tap is accessible in a small chamber just above the mounting flange (Figure 8). This chamber is closed by screwed-on sealing cap 8 (Figure 8) with an internal grounding contact. If the bushing is to be operated with a potential device, the ground must be provided in the device.

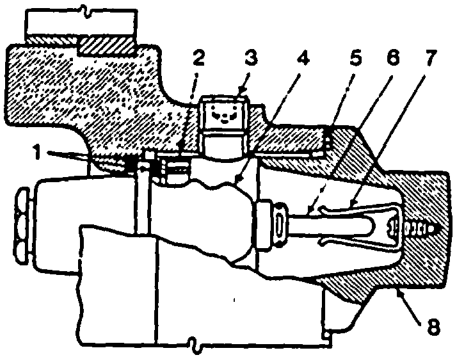
NOTE: The capacitance tap is also used for checking the bushing power factor.

The capacitance tap outlet dimensions and voltages of McGraw-Edison Type PA entrance bushings permit the use of GE Type KA-108 potential devices with high-voltage cables having 2.250—12 threaded-end connections. To use Westinghouse PBA-2 potential devices, Westinghouse adapter 302306-GO1 must be used.

WARNING
The Type PA bushing must not be energized or operated unless the grounding cap is in place or a potential device with a grounded impedance network is properly connected. Special procedures apply to power factor tests.

To connect the bushing to a potential device:

1. Unscrew sealing cap 8 (Figure 8). (Approximately ¼ pint of oil will drain from the housing).
2. Connect the potential device cable tightly in place.
3. Remove filling-hole plug 3 (Figure 8).
4. Fill the housing with cable compound (GE A13A1B2 cable compound or transformer oil), leaving an air space of about ¼ in. over the liquid.



1. Insulator sealing gaskets.
2. Threaded sealing ring.
3. Filling plug.
4. Porcelain insulator.
5. Cap o-ring gasket.
6. Tap contact finger.
7. Grounding contact clip.
8. Screwed-on sealing cap.

Figure 8.
Capacitor-tap outlet assembly.

CAUTION
Do not remove tap contact finger 6 (Figure 8) of the capacitance tap. Removal of this contact finger will cause oil leakage from the bushing.

POWER-FACTOR TESTING

The power factor of a McGraw-Edison Type PA bushing when it is shipped from the factory is not in excess of 0.60%.

If power-factor readings are to be made in the field as periodic checks, it is recommended that a reading be taken immediately after the bushing is first installed. This reading—which may differ from the factory value—will provide a reference for future comparative data.

MAINTENANCE

Under normal operating conditions, a McGraw-Edison Type PA bushing requires only a minimum amount of maintenance:

1. An occasional cleaning of the porcelain.
2. A check of the oil level.
3. A scheduled power-factor test.

In exceptionally contaminated (dust- or salt-ladened) atmospheres, all exposed bushing surfaces should be cleaned at regular intervals to prevent an accumulation sufficient to cause corona or flashover.

Do not attempt to disassemble a bushing in the field. Special bushing jigs and fittings—available only at the factory or in an especially well-equipped shop—are required.

Powerful springs in the oil-expansion chamber, capable of maintaining gasket-sealing pressure under varying operating conditions, are preset and locked at the factory. They need no further adjustment.

The oil-drain plug under the bottom terminal, the oil-filling plug in the expansion chamber, and the sampling and pressurizing fitting on the flange should not be disturbed.

Any oil leakage from the bushing (evidenced by the oil-level gage) indicates the need for a major inspection—and possible disassembly of the bushing. This is a shop job.

Should the bushing be subjected to damage of any kind, details of the type and extent of damage should be reported to McGraw-Edison Power Systems Division, Canonsburg, Pa. 15317. Do not attempt to repair a damaged Type PA bushing without consulting McGraw-Edison for a recommendation.

McGRAW-EDISON

Power Systems Division
Post Office Box 2850
Pittsburgh, PA 15230

McGRAW-EDISON

Power Systems Division

Type PA Apparatus Bushings
With Prismatic Oil-Level Gages

Supplement 1

S315-10-1

Service Information

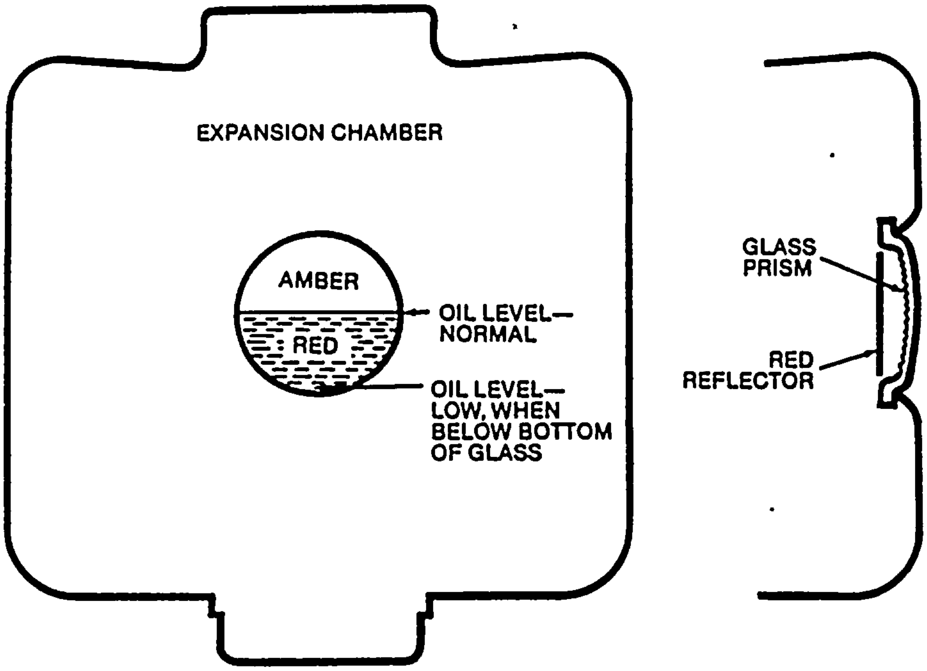


Figure 1.
Prismatic oil-level gage.

McGraw-Edison Type PA bushings with prismatic oil-level gages are adjusted at the factory to the normal oil level at 25 C (77 F). The oil level should remain unchanged for this temperature during the life of the bushing unless the bushing experiences mechanical damage.

Slight variations in the oil level will occur due to temperature changes. Therefore, the top of the expansion chamber is filled with nitrogen gas at 5 to 10 psi to accommodate the resultant oil volume changes and eliminate voids.

Actual oil level can be observed on the prismatic oil-level gage as indicated in Figure 1. The oil level is at a satisfactory height as long as the oil level can be seen in red on the face of the glass prism. Low oil level is indicated when the red color has disappeared. The glass prism will appear amber in color over its entire surface area when oil level is low.

NOTE: When the oil level is low, the bushing should be examined for a possible oil leak since continued loss of oil could result in an electrical failure.

March 1979 Supersedes 3/74

Power Systems Division
P.O. Box 2850
Pittsburgh, Pa 15230

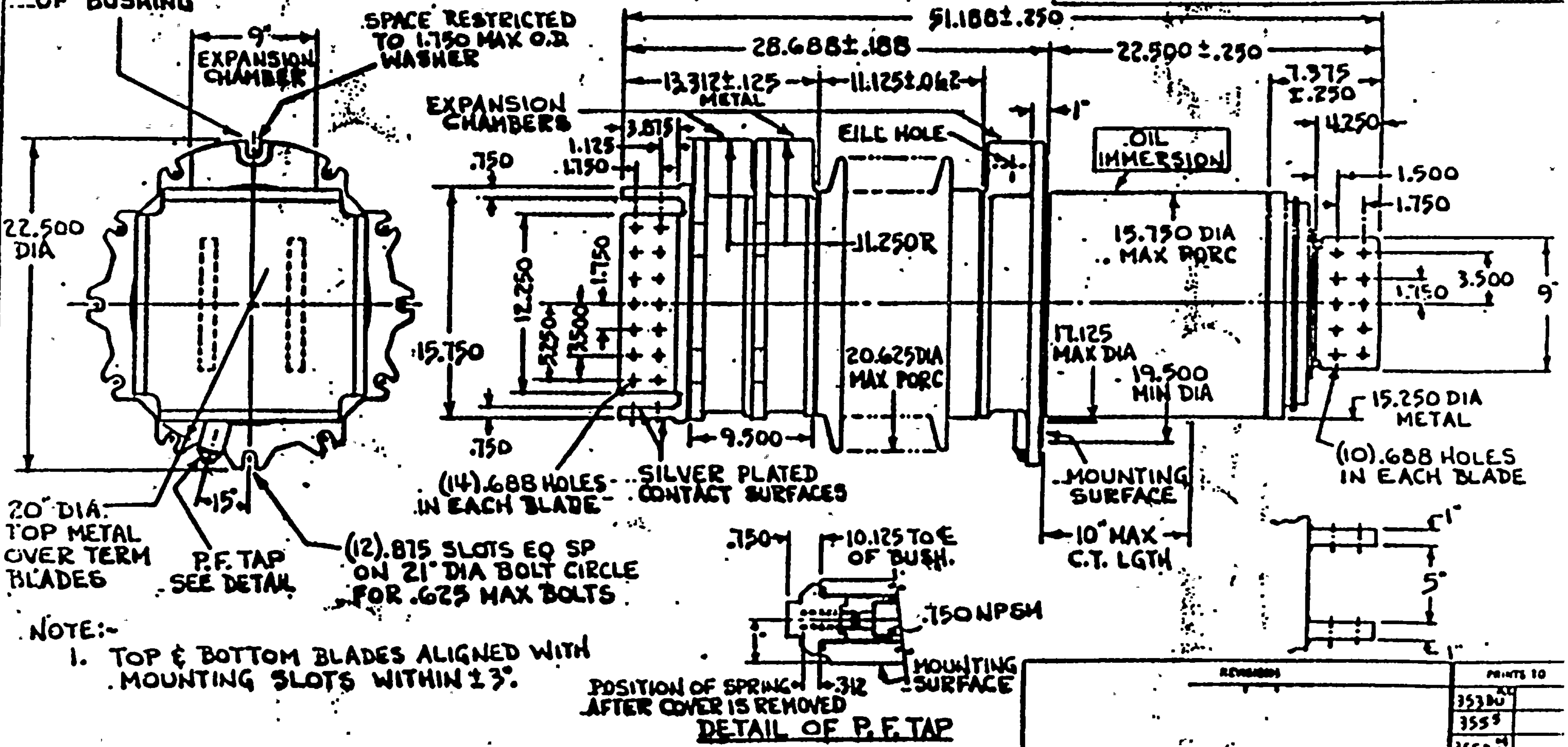
GENERAL ELECTRIC 3967B84

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING

SURFACES ✓

OUTLINE BUSHING

TYPE "T" FOR TRANS



NOTE:-

1. TOP & BOTTOM BLADES ALIGNED WITH MOUNTING SLOTS WITHIN ±3°.

REVISIONS

PRINTS TO
353BU
355S
355BU
BUS

AHTLY25	21500	15B619BB 15B619	GRAY CHOC	HORIZ	12 O.D. TUBE	125°C CLASS INSULATION	16	150 KV	4.6 GAL	885 LB
CLASS	AMP	CAT NO	PORC GLAZE	MTG	COND	SPECIAL FEATURE	MAX KV TO GRD	IMP OR BIL	APPROX AMT OF FILLER	APPROX NET WT FILLED

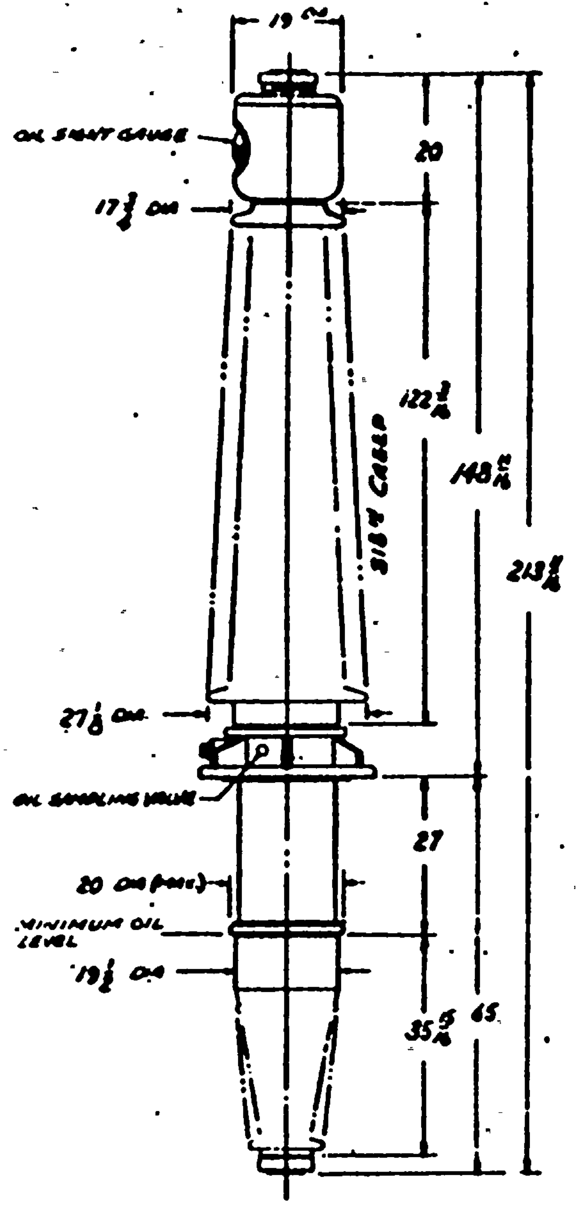
Jan 18, 1983
1-24-83

PITTSFIELD 3967B847

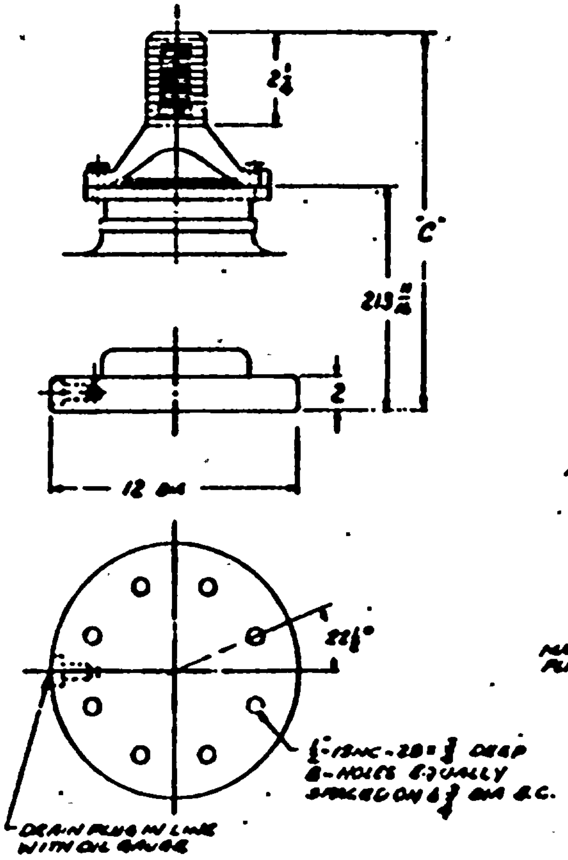
L6960 T6423ACB

SB801147 A

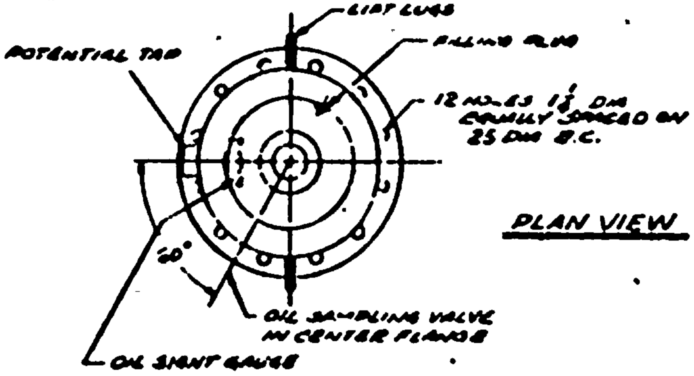
CATALOG NO.	COLOR	AMP RATING	APPLICATION	DIM "C"	TOP TERMINAL DESCRIPTION
535-A-726	BROWN	2500	BOTTOM CONN	219 3/16	3-12UN × 2 1/4 USABLE THREAD
535-AA-726	GRAY	2500	BOTTOM CONN.	219 3/16	3-12UN × 2 1/4 USABLE THREAD



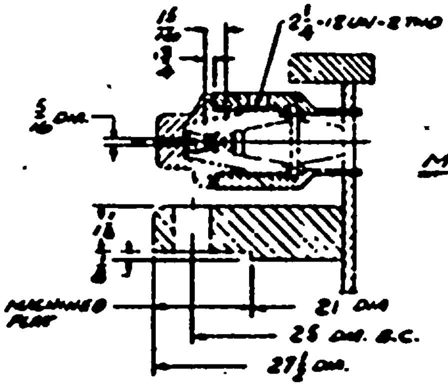
BUSH. B.I.L 1300 KV



BOTTOM TERMINAL



PLAN VIEW



MOUNTING FLANGE SECTION

McGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNA.
15317

CONFIDENTIAL
MUST NOT BE USED IN
ANY WAY DETRIMENTAL TO
McGRAW-EDISON CO

DWN JHA | DATE 5-11-83 | APPD | DATE 5/10/83

SB801110A

TRANSFORMER BUSHING
1300 KV BIL 2500 AMP

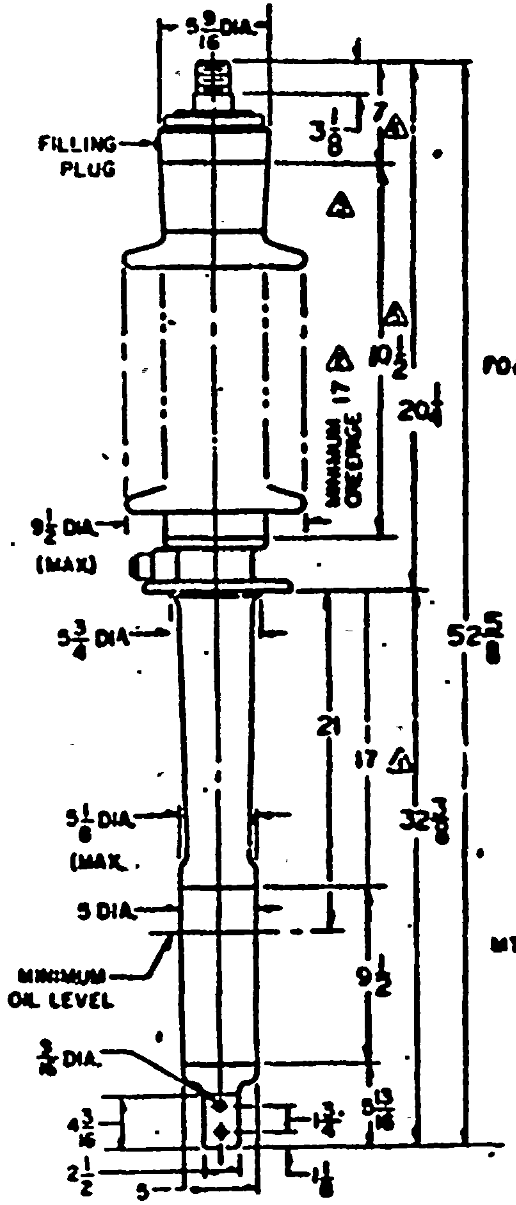
BUSHING OUTLINE

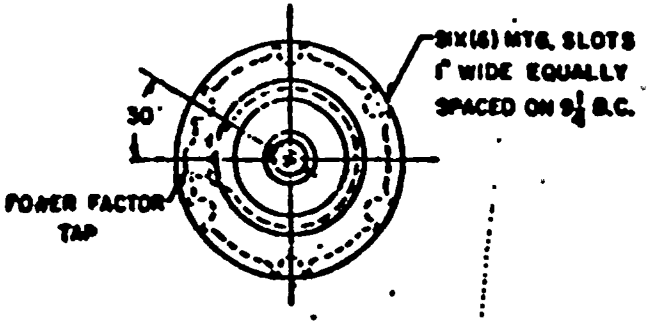
SCALE NONE | SB801147A

SBE 01066A

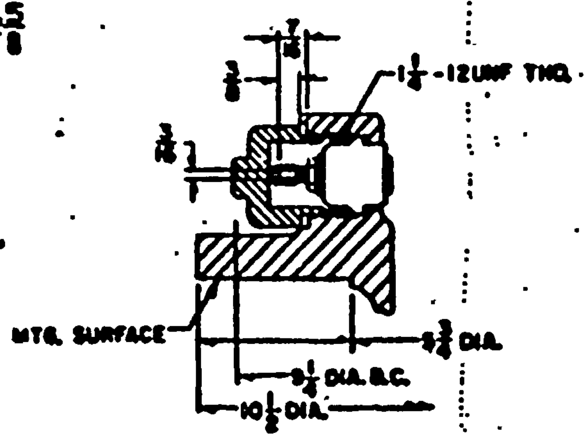
CATALOG NO.	COLOR	TERMINAL DESCRIPTION
509-D-722	BROWN	H2-2ATHD 3 ½ USABLE THD
509-DD-722	GRAY	H2 2ATHD 3 ½ USABLE THD

BUSHING BIL 150KV





PLAN VIEW



MOUNTING FLANGE SECTION

NOTES:

1. BUSHING NOT DESIGNED FOR DRAW LEAD APPLICATION.
2. ALL TERMINALS ARE SILVER PLATED.

C	11-24-80	DLC	△ WAS 23 KV
B	3-13-73	JB	[illegible] LINE RELOCATED [illegible] WAS [illegible] WAS
A	[illegible]	GP	△ ADDED DIM △ ADDED NOTE

WT. LBS

McGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNA.
15317

CONFIDENTIAL
[illegible] McGRAW-EDISON CO.

RK

TRANSFORMER BUSHING
25 KV 3000 AMP

BUSHING OUTLINE

SBB01066A C

SBB01066A

McGRAW-EDISON

Power Systems Division

Power Transformers

Removing and Replacing Welded-on Tank Covers and Sections

S210-05-1

Service Information

These instructions cover in-the-field removal and replacement of welded-on tank covers and sections of core-form and shell-form transformers.

TANK COVERS AND SECTION JOINTS

Core-form transformers usually have flat covers welded to flanges on the tank. The joints vary in design depending on the size and type of transformer (Figures 1 and 2).

Large core-form and shell-form transformers have tanks that may be split for shipment, but the joint is essentially the same, occurring at—or near—the top of the tank, usually above the oil-level line.

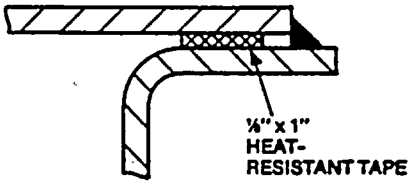


Figure 1.
Typical cover joint of smaller core-form transformers.

Tanks of McGraw-Edison contour-design, shell-form transformers are made in three sections with joints as illustrated in Figure 3. The core and coils are assembled in the bottom section, the core resting on the shelf of this section. Access to the core and coils requires the removal of the top or both top and center sections, depending on the required exposure of the core and coils. By removing the top section alone, complete access is gained to the tap changer and bus connections. Both section joints of a shell-form transformer are below oil level.

Heat-resistant gaskets in all cover and section joints facilitate safe welding or burning out the joints. The gaskets act as arc or flame barriers and provide a partial seal for inert gas during the welding or cutting operation.

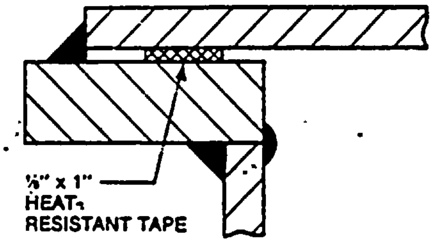


Figure 2
Typical cover joint of larger core-form transformers.

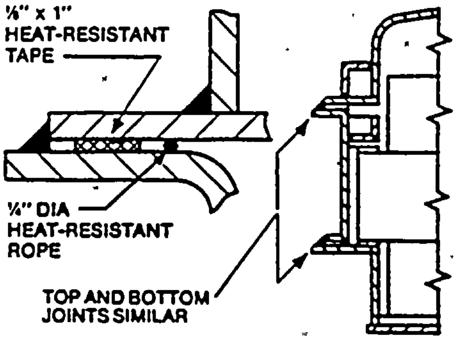


Figure 3
Typical section joints of shell-form transformers.

PREPARING A TRANSFORMER FOR DISASSEMBLY

Suitable oil handling equipment is required to lower the oil level in the transformer to a point where the transformer can be entered and all connections with the cover can be disconnected.

All shell-form and some split-tank, core-form transformers must be completely drained so that all cooling and other connections that bridge section joints can be removed.

If the joints of oil-filled transformers are to be flame cut—which requires purging—the oil should be lowered in stages:

1. Lower the oil sufficiently to enter the tank and disconnect the internal connections.
2. Reseal the tank and purge with nitrogen.
3. Continue supplying nitrogen as the oil is drained, thus maintaining the purged condition with the efficient use of nitrogen.
4. As the cooling connections are removed, temporarily seal the openings in the transformer.

WARNING
Before entering a transformer to make disconnections, nitrogen—which will cause suffocation—must be flushed out with air until the oxygen content of the transformer approaches pure air (20.99%).

REMOVING A WELD BY CHIPPING

Removing the joining weld of a cover or tank section by chipping does not require purging the tank, but the process is relatively slow.

Equipment

1. A heavy pneumatic hammer.
2. A 3/8-inch diamond-point chisel.
3. A 1/8-inch diamond-point chisel.
4. A flat chisel with a slight (1/64- x 1/8-inch) bevel, ground back from the cutting edge on the flat side.
5. Protective gloves and safety glasses.

Procedure

1. Cover all tank openings to prevent entrance of chips.
2. Apply a lubricant (oil or grease) to the joint.
3. Directing the long point of the 3/8-inch chisel to the root of the joint as shown in Figure 4, cut along the fusion zones of the fillet (flush with the horizontal, but slightly back—up to 1/8 inch—of the vertical face of the fillet).
4. Using the 1/8-inch chisel, clean out the weld at the root where the weld may have penetrated behind the fusion line.
5. Before breaking the seal, chip the joint with the flat chisel, making the joint ready for rewelding.
6. Wipe away all loose chip particles so that none can fall into the transformer when it is opened.
7. Match-mark or key the position of the adjoining parts so that they can be returned to the same relative position when rewelding.

   NOTE: Matching the position of the adjoining parts is especially important in contour-design tanks because there are usually rigid pipe connections bridging these joints and these connections require very close alignment.

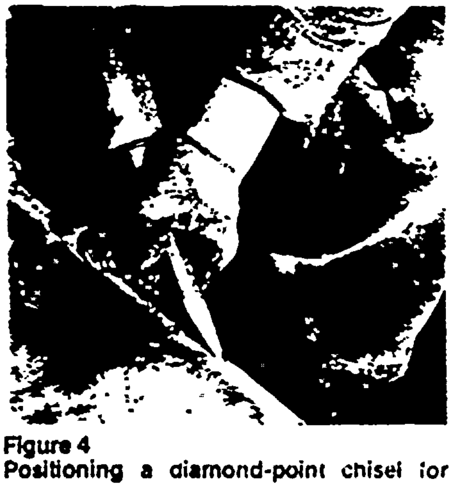


Figure 4
Positioning a diamond-point chisel for chipping a weld.

8. Drive the flat chisel directly into the joint to crack the seal.
   NOTE: A lift on the cover or tank section will help to break open the joint.
9. Lift off the cover or tank section very carefully to avoid damaging the internal assembly.

CAUTION
It is especially important that the center section of shell-form tanks be lifted evenly—straight up—because clearances to the core assembly are very small and damage could be caused by poor lift.

REMOVING A WELD BY BURNING

Opening a welded joint by gas cutting (burning) is safe and fast if proper precautions and procedures are followed. Gas cutting is especially suitable for larger transformers where the welds are heavier.

WARNING
When burning out a weld joint or rewelding a joint, all tank openings must be sealed and the gas space purged with nitrogen. The oxygen content must be reduced to a value not exceeding 3%. The tank must be kept under positive pressure—up to one psi—so that there will be an outward flow of gas at leakage points in the weld joint. The transformer must be under continuous inert-gas pressure when weld joints are cut open. Gas pressure should be held on the tank for two or three minutes after the weld cutting has been completed.

During cutting and welding operations, fire-extinguishing equipment (CO_2 is suggested)—and the manpower to handle it—must be on hand.

Another recommended safety precaution is a wet heat-resistant blanket for extinguishing spot fires that can start because of residue oil in the joint seeping out and becoming ignited.

In the burning-out operation, as a section is burned out, pack the joint with a paste made of high-temperature Quik Cote cement or equivalent, and water to control spots of burning oil and to help seal gas leaks.

As more and more weld is cut out in the burning operation, it becomes increasingly difficult to maintain a positive gas pressure; however, a **safe, positive pressure must be maintained at all times.** A positive pressure can be recognized by the smoke from cutting being blown out to the side rather than drifting upward.

Equipment

1. A heavy-duty, gas-cutting torch, preferably an oxy-acetylene torch.
2. Heavy-duty, flame-cutting tips or gouging tips equivalent to Airco Style 183, size no. 6 or no. 8.
   NOTE: Very heavy welds can be more efficiently cut with no. 10 or no. 12 tips.
3. Sufficient c-clamps to permit about 15-inch spacing along the weld joint.
4. A heavy machinist's hammer or pneumatic hammer.
5. A flat chisel.
6. Purging equipment (including adequate nitrogen).
7. Oxygen-content measuring equipment.
8. Fire-extinguishing equipment.
   A. CO_2 is suggested.
   B. A wet heat-resistant blanket is recommended.
   C. High-temperature Quik Cote cement or equivalent.
9. Welding gloves and welding goggles.

Procedure

1. Starting at a corner, use a neutral flame to heat the weld joint to a white heat before introducing the cutting oxygen to the joint.
   NOTE: Move the torch forward slowly an inch or two, then move it back quickly about half an inch to blow out the cut as shown in Figure 5.

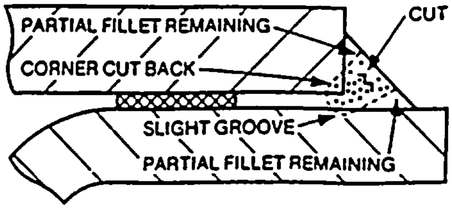


Figure 6.
Typical section through gas-cut fillet weld.

2. Open the weld joint by cutting diagonally down through the center of the fillet, cutting slightly beyond the fusion line to include weld penetration as shown in Figure 6.
   NOTE: This may leave the edges of the fillet in place, a condition which is acceptable because this is good material and saves rod when rewelding.
3. As cutting progresses, apply a c-clamp in the center of each 15-inch (approximate) section to keep the joint sealed as well as possible, thus conserving gas and reducing fire hazard.
   NOTE: No chance should be taken of driving the cutting flame past the heat resistant gasket stop by allowing the joint to separate.
4. As each 15-inch section is cut loose, apply high-temperature Quik Cote cement or equivalent to the joint to conserve nitrogen gas.

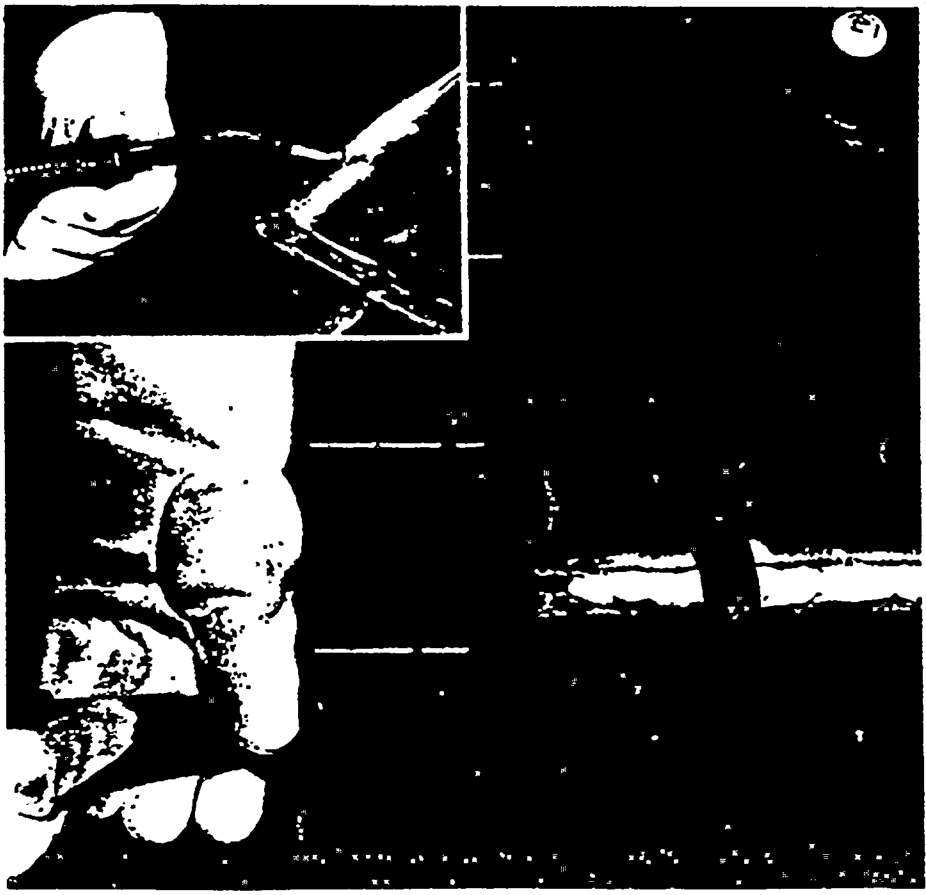


Figure 5.
Positioning the torch and flame-cutting a weld.

5. Before removing the c-clamps, all slag and spatter must be carefully cleaned off the tank.

   NOTE: If necessary, use the air hammer and flat chisel to remove irregularities and particles that are not good metal.

6. Before unclamping, match-mark or key, the position of adjoining parts so they can be returned to the same relative postions.
7. After the clamps have been removed, use the air hammer and flat chisel to break the joint open.

   NOTE: A lift on the cover or tank section will help in this operation.

8. Lift off the cover or tank section very carefully to avoid damaging the internal assembly.

   NOTE: This is especially important for the midsection of contour-design tanks because clearances to the core assembly are very close.

REWELDING A TANK JOINT

Preparing The Tank For Rewelding

1. Thoroughly clean the meeting faces of the cover and the tank sections before reassembling.

   NOTE: Very little chipping should be necessary if the material is good metal.

2. Remove the old heat-resistant gasket and clean the flange surface.
3. Exercise great care to prevent any foreign material from getting into the transformer in the clean-up operation.

   NOTE: This may require some form of barrier with a sealing lip that can be moved along the tank flange as the surface is cleaned.

4. Install a new 1/8-inch x 1-inch heat-resisant tape gasket as shown in Figures 1, 2, or 3. This gasket must be installed around the entire tank perimeter to be welded. Tight butt joints, without gaps, are required at the corner splice points. Cement the gasket to the flange using G.E. compound no. 1201 (Glyptal) or equivalent.
5. Carefully position the tank parts using the match-marks or keys made before breaking the joint open.
6. Clamp the tank parts at close intervals, reducing the gasket thickness by about one-half to make the best possible seal and alignment.
7. Purge the tank with inert gas to less than 3% oxygen content and hold the tank under pressure during the entire rewelding operation.

Rewelding The Joints

1. On all joints, use 5/32-, 3/16-, or 1/4-inch-diameter American Welding Society Type E-6010, E-6012, E-7018 low-hydrogen, or E-7024 welding rods.

   NOTE: E-7018 low-hydrogen rods must be dry—*moisture content must be less than 0.6%*—to prevent hydrogen embrittlement which can result in porosity and weld cracking.

2. If the edges of the cover of core-form transformers can be pulled down tight with clamps, a satisfactory seal can usually be effected by laying a fillet weld at least as large as the original weld with a single pass.
3. If the edges cannot be closed tightly, one pass may not adequately fill (or burning gasket cement may cause gases to blow out), preventing a good single-pass weld.
4. For welding joints between sections of contour-design tanks, three weld passes—resulting in a 1/2-inch fillet weld—are recommended for structural as well as sealing reasons.
   A. Lay the first fillet in the root of the joint.

      NOTE: This is a plugging weld which does not provide a perfect seal, but it does provide strength and a base for the final two fillet welds.

   B. Figure 7 shows the general areas occupied by the three fillet welds.
   C. Slag must be chipped away after each weld pass.

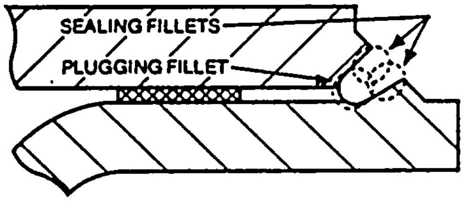


Figure 7.
Typical bead deposit of a three-pass fillet reweld.

TESTING FOR LEAKS

After all welding has been completed, test the weld joint for leaks. An acceptable leak-testing method is:

1. With relief devices mounted, place the tank under a nitrogen pressure equal to one psi less than the maximum positive pressure shown on the transformer nameplate.
2. Paint the weld joint with a soap-bubble solution such as glycerin and liquid soap.

FINISHING

After all weld joints have passed the leak test:

1. Using a wire brush and an evaporating solvent, thoroughly clean the weld joints, removing all dirt, slag, and oil.
2. Paint the weld joints, applying a primer coat and two finish coats with adequate drying time between coats.

McGRAW-EDISON

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Pittsburgh, PA 15230

In Canada:
3595 St. Clair Avenue, East
Scarborough, Ontario M1K 1M1

STATION AND INTERMEDIATE HIGH-VOLTAGE ARRESTERS **S-200, S-210, S-225, D-235**
INDOOR OR OUTDOOR SERVICE **S-230, S-300, S-990**

TRANQUELL® Station Arresters

2.7-612 kV Rms

PRICES

Power Transformer Products-P(A85000)

Arrester Rating† kV-rms	Continuous Capability† (L-N) kV-rms	Normally Used on System Voltage Class (L-L)		Single-pole Arrester††			
				High-current Shunt Gaps		Gapless	
		Delta or Impedance Grounded Neutral System kV-rms	Solidly Grounded Neutral System kV-rms	Model Number (Grey Porcelain) ★	List Price, GO-76D ★	Model Number (Grey Porcelain) ★	List Price GO-76D ★
STANDARD OUTDOOR CONSTRUCTION—METAL TOP							
2.7	2.20	2.4	—	—	—	9L11RGA002	$ 250
3	2.54	2.4	4.16	—	—	9L11RGA003	250
4.5	3.70	4.16*	—	—	—	9L11RGA004	289
5.1	4.20	4.16 & 4.8*	—	—	—	9L11RGA005	289
6	5.08	4.8	—	—	—	9L11RGA006	289
7.5	6.10	6.9*	—	—	—	9L11RGA007	361
8.5	6.90	6.9	—	—	—	9L11RGA008	361
9	7.62	7.2	12.47	—	—	9L11RGA009	361
10	8.47	7.62	13.2	—	—	9L11RGA010	421
12	10.16	7.97	13.8	—	—	9L11RGA012	421
15	12.70	13.8*	20.78	—	—	9L11RGA015	599
18	15.24	13.8	24.94	—	—	9L11RGA018	630
21	17.1	—	24.94	—	—	9L11RGA021	665
24	19.5	23*	—	—	—	9L11RGA024	746
27	21.9	23	34.5	—	—	9L11RGA027	947
30	24.4	—	34.5	—	—	9L11RGA030	947
36	29.3	34.5*	—	—	—	9L11RGA036	1117
39	31.7	34.5	—	—	—	9L11RGA039	1262
45	36.5	41.6	—	—	—	9L11RGA045	1412
48	38.9	46*	—	—	—	9L11RGA048	1485
54	43.7	—	69	9L11THA054	1702	9L11TNA054	1582
60	48.6	—	69	9L11THA060	1816	9L11TNA060	1688
66	53.5	69	—	9L11THA066	2100	9L11TNA066	1953
72	58.3	69	—	9L11THA072	2198	9L11TNA072	2044
90	72.9	—	115	9L11THA090	2848	9L11TNA090	2647
96	77.8	—	115	9L11THA096	2983	9L11TNA096	2774
108	87.5	115	138	9L11THA108	3482	9L11TNA108	3238
120	97.2	115	138/161	9L11THA120	3790	9L11TNA120	3524
132	105	138	161	9L11THA132	4205	9L11TNA132	3910
144	110	138/161	161	9L11THA144	4625	9L11TNA144	4301
168	119	161	—	9L11THA168	5487	9L11TNA168	5102
172	139	—	230	9L11THA172	5896	9L11TNA172	5483
180	146	—	230	9L11THA180	6104	9L11TNA180	5676
192	152	—	230	9L11THA192	6373	9L11TNA192	5926
228	164	230	—	9L11THA228	7751	9L11TNA228	7208
240	171	230	—	9L11THA240	8227	9L11TNA240	7651
258	209	For Nominal 345 kV Systems		9L11THA258	8944	9L11TNA258	8586
264	214			9L11THA264	9189	9L11TNA264	8821
276	224			9L11THA276	9681	9L11TNA276	9293
288	228			9L11THA288	10182	9L11TNA288	9774
294	232			9L11THA294	10433	9L11TNA294	10015
300	234			9L11THA300	10683	9L11TNA300	10255
312	236			9L11THA312	11197	9L11TNA312	10749
300(S)	243	For Nominal 400 kV Systems		9L11THS300	10683	—	—
312(S)	253			9L11THS312	11197	—	—
336	265			9L11THA336	12465	9L11TNA336	11966
360	275			9L11THA360	13554	9L11TNA360	13011
396	321	For Nominal 500 kV Systems		9L16EHA396	16431	—	—
420	340			9L16EHA420	17289	—	—
444	350			9L16EHA444	18002	—	—
588	476	For Nominal 765 kV systems		9L16EHA588	35504	—	—
612	496			9L16EHA612	37628	—	—
PORCELAIN-TOP ARRESTERS FOR CUBICLE OR OUTDOOR MOUNTING							
2.7	2.20	2.4	—	—	—	9L11RGB002	$ 250
3	2.54	2.4	4.16	—	—	9L11RGB003	250
4.5	3.70	4.16*	—	—	—	9L11RGB004	289
5.1	4.20	4.16 & 4.8*	—	—	—	9L11RGB005	289
6	5.08	4.8	—	—	—	9L11RGB006	289
7.5	6.10	6.9*	—	—	—	9L11RGB007	361
8.5	6.90	6.9	—	—	—	9L11RGB008	361
9	7.62	.7.2	12.47	—	—	9L11RGB009	361
10	8.47	7.62	13.2	—	—	9L11RGB010	421
12	10.16	7.97	13.8	—	—	9L11RGB012	421
15	12.70	13.8*	20.78	—	—	9L11RGB015	599
18	15.24	13.8	24.94	—	—	9L11RGB018	630
21	17.1	—	24.94	—	—	9L11RGB021	665
24	19.5	23*	—	—	—	9L11RGB024	746
27	21.9	23	34.5	—	—	9L11RGB027	947

† See note, page 101.

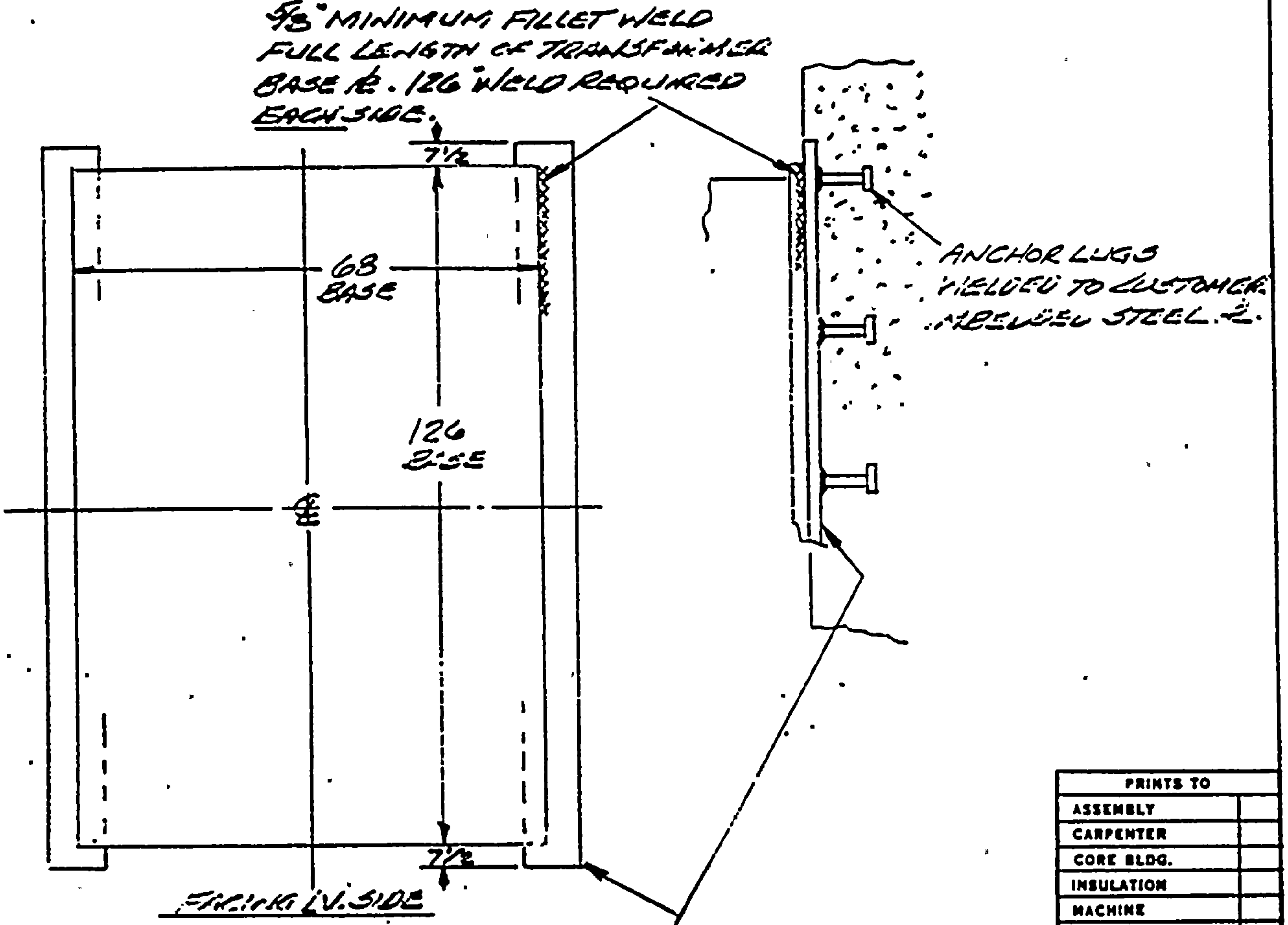
* Application of specified rating is permissible for ungrounded or resistance grounded systems where a single phase ground may be tolerated for a substantial period of time not to exceed the TRANQUELL arrester's overvoltage capability as described in GET-6460.

†† Arresters are available with different protective characteristics. Optimum arrester characteristics are provided with the high current shunt gaps designs. Refer to page 101 for data. Slightly high protective characteristics are provided with the gapless design. Refer to page 102 for data.

★ *Major revision since Feb. 8, 1982 issue.*

Form No. 459-A

REVISIONS	SYM.	DATE	SIGNATURE	DESCRIPTION
A		5-23-83	CLH	STL. PLATE WAS 6" WIDE × 132 LG. ADDED 7½" DIM.



3/4" THICK × 12" WIDE - 141" LG. EMBEDDED STEEL PLATE FLUSH WITH TOP SURFACE OF CONCRETE. PLATE MUST BE PERMANENTLY ANCHORED BY ANCHOR LUGS

MUST BE CAPABLE OF WITHSTANDING AN OVERTURNING MOMENT OF 73,950 KIP-INCHES. STEEL PLATES NOT FURNISHED BY MEPS

PRINTS TO	
ASSEMBLY	
CARPENTER	
CORE BLDG.	
INSULATION	
MACHINE	
STOREROOM	
TRAFFIC	
TANK SHOP	
ELEC. FIN.	
CON. APPARATUS	
MASTER	
INSPECTION	
OFFICE	
COIL TREAT	
INDUS. ENG.	
CU. FAB.	
ACCOUNTING	
SERVICE	
RAD SHOP	
MECH. DESIGN BY	

NINE MILE POINT NUCLEAR STATION - UNIT 2
NIAGARA MOHAWK POWER CORPORATION
S.O. NO. 12177, P.O. NO. NMP2-E011A

ITEM	REQ.	NAME	DRAWING NUMBER OR DESCRIPTION

NO. UNITS ORDERED 4
DRAWN CK DATE 1-24-83
CHECKED ED 2-3-83
APPROVED
DESIGN REFERENCE

McGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNSYLVANIA 15317

DESCRIPTION T.E.-DOWN ARRANGEMENT

CUSTOMER NIAGARA MOHAWK POWER CORP.

CUSTOMER'S ORDER

SPEC. 13354
ORDER C-06607-5
TYPE
DEPT.

A-441E72

REV. A

CONFIDENTIAL
MUST NOT BE USED IN ANY WAY DETRIMENTAL TO McGRAW-EDISON

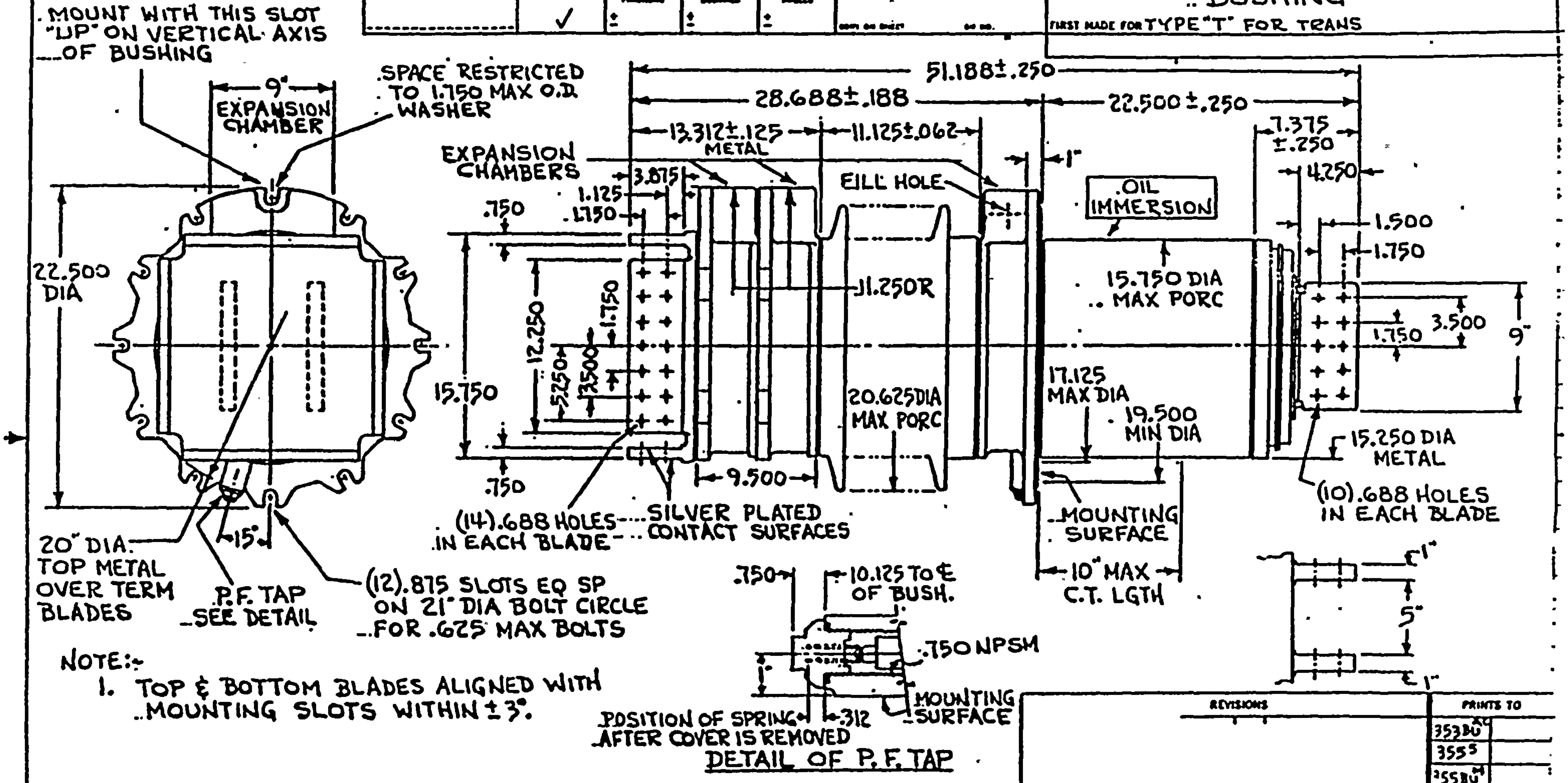
GENERAL ELECTRIC 3967B847

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:-

APPLIED PRACTICES	SURFACES			
	✓	±	±	±

TITLE OUTLINE BUSHING

FIRST MADE FOR TYPE "T" FOR TRANS



NOTE:-

1. TOP & BOTTOM BLADES ALIGNED WITH MOUNTING SLOTS WITHIN ±3°.

ANTLY25	21500	15B619BB 15B619	GRAY CHOC	HORIZ	12" O.D. TUBE	125°C CLASS INSULATION	16	150 KV	4.6 GAL	885 LB
CLASS	AMP.	CAT NO	PORC GLAZE	MTG	COND	SPECIAL FEATURE	MAX KV TO GRD	IMP OR BIL	APPROX AMT OF FILLER	APPROX NET WT FILLED

REVISIONS

PRINTS TO
353BU
355
355BU
BUS

J. Wezzacka Jan 18, 1983
J. Wezzacka 1-24-83

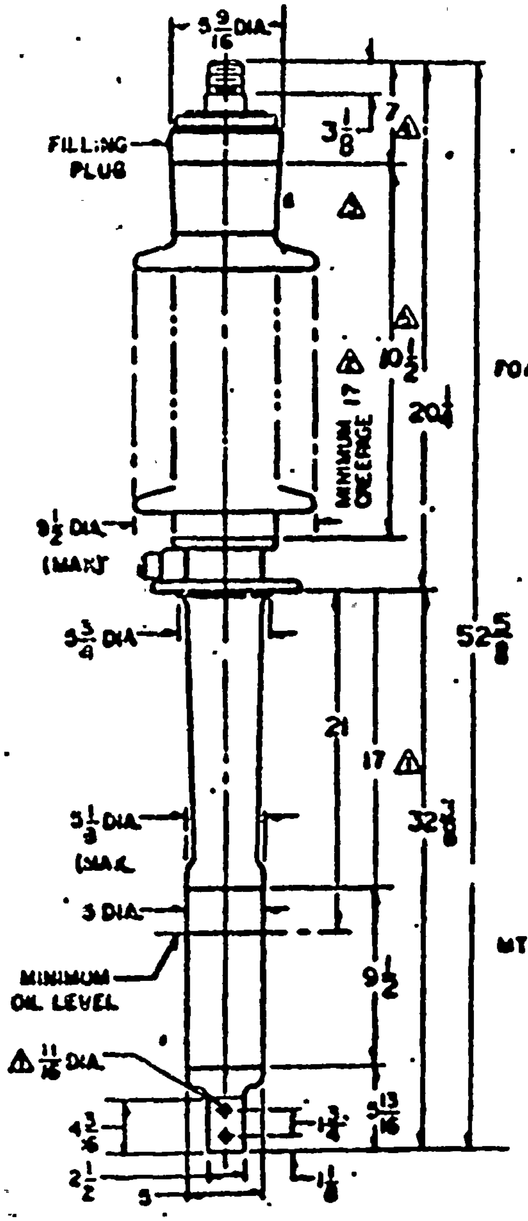
PITTSFIELD 3967B847

6960 | T6423A&B

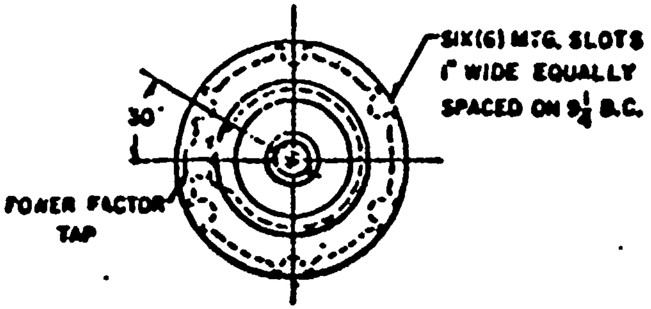
ACB

SBB01066A

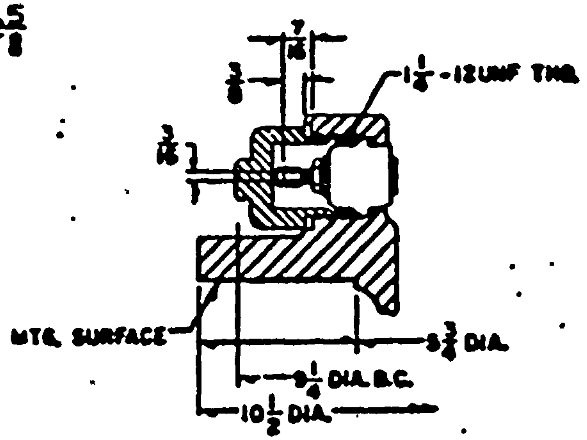
CATALOG NO.	COLOR	TERMINAL DESCRIPTION
509-D-722	BROWN	3-12-2A THD 3 1/2 USABLE THD
509-DD-722	GRAY	3-12 2A THD 3 1/2 USABLE THD



BUSHING BIL 150 KV



PLAN VIEW



MOUNTING FLANGE SECTION

WT. 115 LBS

NOTES:

1. BUSHING NOT DESIGNED FOR DRAW LEAD APPLICATION.
2. ALL TERMINALS ARE SILVER PLATED.

C	[illegible]	JHA	WAS 9/16 ADDED 115
C	11-24-80	DLC	WAS 23 KV
B	3-13-73	JB	[illegible]
A	[illegible]	CP	ADDED DIM ADDED NOTE

McGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNA.
15317

CONFIDENTIAL

RK

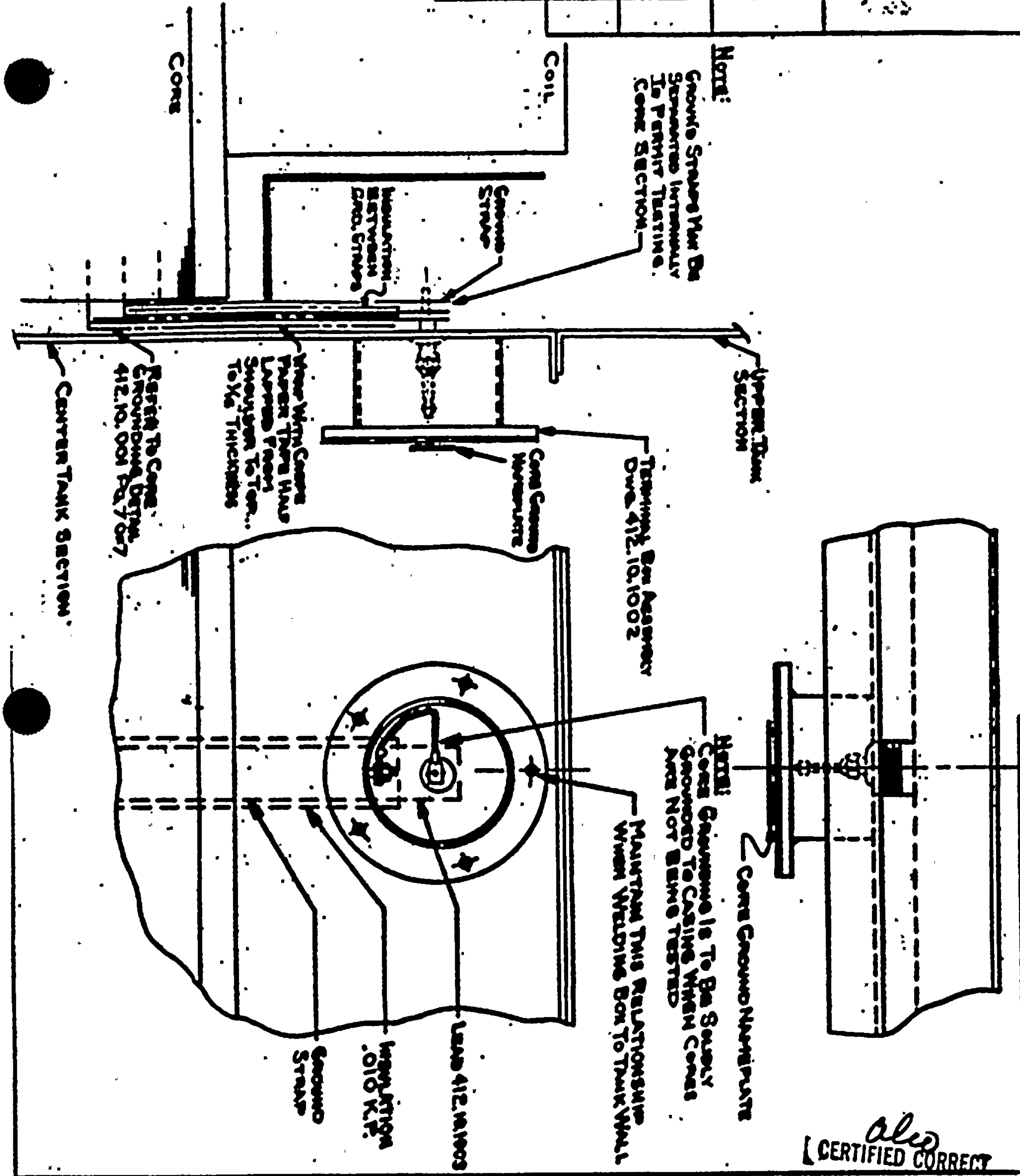
TRANSFORMER BUSHING
25 KV 3000 AMP

BUSHING OUTLINE

SBB01066A D

Form No. 459-A

REVISIONS	SYM.	DATE	SIGNATURE	DESCRIPTION



PRINTS TO	
ASSEMBLY	
CARPENTER	
CORE BLDG.	
INSULATION	
MACHINE	
STOREROOM	
TRAFFIC	
TANK SHOP	
ELEC. FIN.	
COIL APPARATUS	
MASTER	
INSPECTION	
OFFICE	
COIL TREAT	
INDUS. ENG.	
CH. FAB.	
ACCOUNTING	
SERVICE	
RAD SHOP	
MECH. DESIGN BY	

Alex
CERTIFIED CORRECT

ITEM	REQ.	NAME	DRAWING NUMBER OR DESCRIPTION

NO. UNITS ORDERED

DRAWN AZ DATE 8-12-81

CHECKED

APPR. Alex

AS REFERENCE

McGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNSYLVANIA 15317

DESCRIPTION EXTERNALLY ACCESSIBLE CORE GROUND-FOR SHELL TRANS.

CUSTOMER

CUSTOMER'S ORDER

SPEC.

ORDER

TYPE SHELL

DEPT. M P D

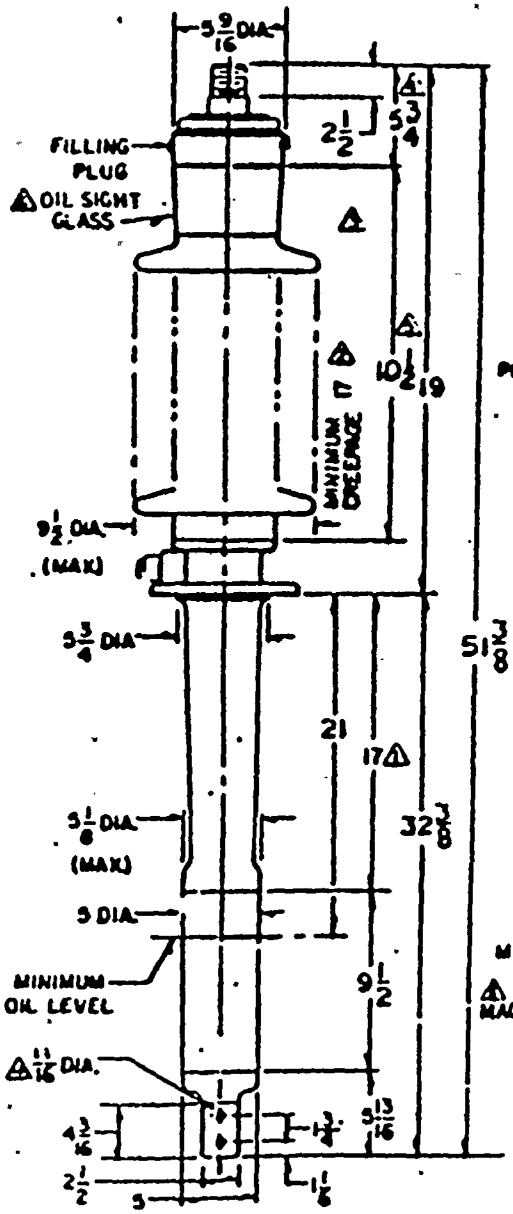
A-416574

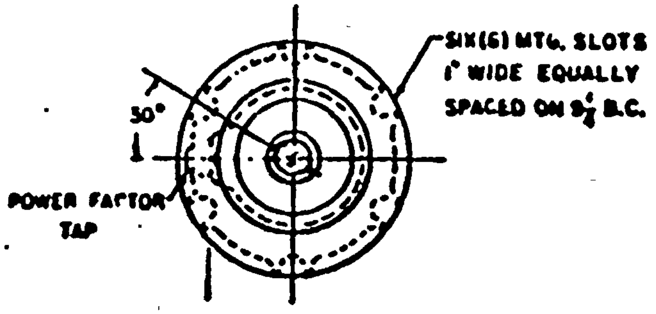
CONFIDENTIAL
MUST NOT BE USED IN ANY WAY DETRIMENTAL TO McGRAW-EDISON

SBBO1047A

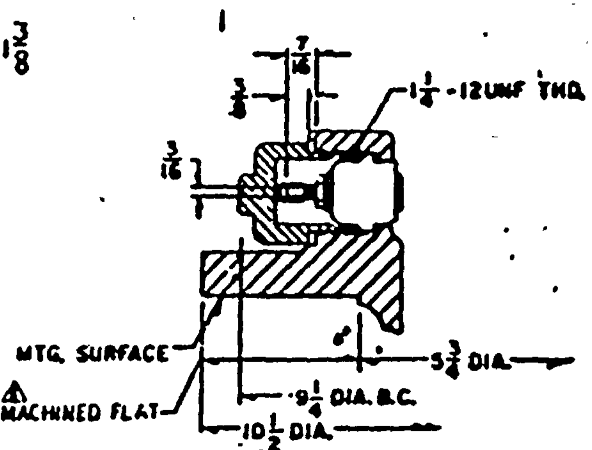
CATALOG NO	COLOR	TERMINAL DESCRIPTION
509-A-000	BROWN	212 2ATHD2 USABLE THD
509AA000	GRAY	212-2ATHD2 USABLE THD

BUSHING BIL 150KV





PLAN VIEW



MOUNTING FLANGE SECTION

NOTES:

1. BUSHING NOT DESIGNED FOR DRAW LEAD APPLICATION.
2. ALL TERMINALS ARE SILVER PLATED.

McGRAW-EDISON
POWER SYSTEMS DIVISION
CANONSBURG, PENNA.
15317

CONFIDENTIAL
[illegible]
McGRAW-EDISON CO.

G	10 11 81	JMA	△ WAS 9/16
[illegible]			
E	1-17-77	A.D.	△ △ ADDED
D	3-12-73	JB	△ WAS 9¾ △ WAS 7 [illegible]
C	10-7-71	GP	△ ADDED DIM △ ADDED NOTE
B	5-24-7.	RE	REVISED/REDRAWN

TRANSFORMER BUSHING
KV 2000 AMP

BUSHING OUTLINE

SBBO1047A G

WT. 110 LBS

SBBO1047A