ATTACHMENT NO. 4

Limitorque

Limitorque Corporation

5114 Woodall Road P.O. Box 11318 Lynchburg, VA 24506-1318
Telephone—804-528-4400 • Telex—82-9448 • FAX—804-845-9736

November 3, 1988

U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Limitorque Corporation
Part 21 Notification

Attention: Director, Nuclear Reactor Regulation

Gentlemen:

Pursuant to the requirements of Title 10 of the Code of Federal Regulations Part 21 herein provided is notification of defect in Limitorque Corporation supplied safety related SMB valve actuators, as detailed in the attached letter. In order to expedite the notification of the facilities affected, Limitorque has made simultaneous written notice to both the commission and the attached list of nuclear utility customers.

Signed:

J. E. Wilkinson
Vice President of Engineering
Limitorque Corporation

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Limitorque

Limitorque Corporation

Automated Valve Actuators and Jacks for Industry

5114 Woodall Road P.O. Box 11318 Lynchburg VA 24506-1318
Telephone—804-528-4400 • Telex—82-9448 • FAX—804-845-9736

November 3, 1988

Subject: 10 CFR Part 21 Notification

Gentlemen:

Be advised that Limitorque has concluded it's evaluation of the elevated ambient temperature effects on RH insulated DC motors. The results of our evaluation indicate that in some cases, RH insulated motors may not develop full rated starting torque at elevated ambient temperatures. It should also be noted that Limitorque has had no reported failures as a result of this phenomenon.

Therefore, pursuant to the requirements of 10 CFR Part 21 herein provided is notification of a potential safety issue.

IDENTIFICATION OF BASIC COMPONENT

Limitorque supplied SMB valve actuators with RH insulated DC motors installed in safety related application

NATURE OF THE DEFECT

As a result of our continuing evaluation of temperature effects on cable sizing and actuator performance, Limitorque's investigation has concluded that elevated temperatures also affect motor performance. At elevated ambient temperatures, the DC motor resistance increases and consequently, the available output torque decreases.

Limitorque's qualification report B-0009 includes environmental testing of an RH insulated DC motor operator at temperatures up to 340 F. As a result of our concerns, we have reevaluated the temperature affects on our qualified DC motors. Our investigation used the assumption that the valve actuator motor would be required to produce its full rated starting torque in order to meet the valve load requirements at elevated temperatures. This is a conservative assumption, because in many cases the full motor starting torque is not required. Based on our evaluation, we have determined that the below listed DC motors cannot produce the full rated starting torque at 340 F.

AFFECTED EQUIPMENT

The following represents a complete listing of the RH insulated DC motors installed in Limitorque SMB valve actuators and the corresponding maximum ambient temperature at which full rated torque can be developed:

Motor Starting Torque	Rated Voltage	*Max. Ambient Temp.
40 foot-pounds	250 VDC	250 F
60 foot-pounds	250 VDC	200 F
80 foot-pounds	250 VDC	200 F
100 foot-pounds	250 VDC	150 F
40 foot-pounds	125 VDC	300 F
60 foot-pounds	125 VDC	250 F
80 foot-pounds	125 VDC	300 F
100 foot-pounds	125 VDC	120 F

* The maximum ambient temperate at which the motor will produce its' rated starting torque.

DC motor sizes not listed above have enough safety margin to provide their rated starting torque at ambients up to 340 F.

LICENSEE CORRECTIVE ACTION

Limitorque recommends that the licensee review your DC motor operated valves to determine if any of the above size RH insulated DC motors are required to operate at ambient temperature above those specified. For those applications exceeding the allowable temperature limits, please advise Limitorque of the order number and serial number from the actuator nameplate, the maximum ambient temperature, and the valve load requirements. Limitorque will review the application to determine if the motor size is suitable for the temperature conditions.

LIMITORQUE CORRECTIVE ACTION

We are revising our motor selection procedures for environmentally qualified actuators to account for elevated temperature affects.

Any questions or clarification regarding the above notification may be directed to:

Dan Warsing - Technical Manager
Pat McQuillan - Special and Nuclear Project Manager

Very truly yours,

I. E. Wilkinson
Vice President of Engineering
Limitorque Corporation

cc: T. Mignogna
10 CFR 21 - 7 file

ATTACHMENT NO. 3

Limitorque Corporation

Automated Valve Actuators and Jacks for Industry

5114 Woodall Road P.O. Box 11318 Lynchburg, VA 24506-1318
Telephone—804-528-4400 • Telex—82-9448 • FAX—804-845-9736

Limitorque

Attention:

Gentlemen:

Subject: Limitorque Maintenance Update

Enclosed is a copy of a Limitorque Maintenance Update letter which addresses a number of motor operated valve concerns which have recently developed. We plan to publish a maintenance update periodically for the purpose of keeping the industry informed of the latest valve actuator issues. We welcome your comments on this material and your suggestions of items which you would like to see addressed in future issues.

Should you have any questions concerning the material in this letter, please contact our Lynchburg Corporate Headquarters and ask to speak to the Power Group, Service Department, or the Technical Manager. We trust the information provided will assist you in properly maintaining your Limitorque valve actuators.

Sincerely,

LIMITORQUE CORPORATION

Daniel S. Warsing
Technical Manager

DSW/lc

Attachment

Limitorque®

Limitorque Corporation

Automated Valve Actuators and Jacks for Industry
5114 Woodall Road P.O. Box 11318 Lynchburg, VA 24506-1318
Telephone -804-528-4400 • Telex—82-9448 • FAX—804-845-9736

NOTES FROM THE FIELD

A LIMITORQUE MAINTENANCE UPDATE

NUCLEAR QUALIFIED LIMIT AND TORQUE SWITCHES

Reported Problem:

The DC Cook Plant recently reported finding torque switches installed in e of their safety related SMB-00 actuators which have not been qualification .ested. The incident developed during an environmental qualification training program in which plant personnel were instructed that there are three colors (red, white, and brown) of qualified torque switch insulating materials. The plant maintenance personnel recalled having seen a fourth material described as a brown laminated phenolic in the SMB-00 actuators.

Limitorque Engineering Evaluation:

A sample of one of the switches in question was returned to Limitorque for evaluation. We inspected the torque switch and identified the switch as an SMA type torque switch which was used in the SMB-00 actuators built in the mid and late 1960's. This torque switch design was originally utilized in Limitorque's SMA electric actuators which were the generation of actuators manufactured prior to the development of the SMB product. The use of the SMA type torque switch was discontinued prior to Limitorque's first nuclear qualification test program.

In a similar manner, the SMB-000 actuators manufactured in the late 1960's also used a different design torque switch and four-train limit switch assembly than those that were later qualified.

In each of these cases, the switch design is visibly different making it possible to distinguish between the qualified and unqualified switch designs.

Figures 1, 2, and 3 show the torque switch and limit switch designs that were used prior to qualification testing. All of our qualification tests have used the limit and torque switch designs shown in our maintenance manual (Figures 4, 5, and 6.)

Conclusions and Recommendations:

The SMB-00 torque switch identified by the D. C. Cook Plant was not originally furnished as qualified equipment. SMB-000 and -00 actuators furnished prior to Limitorque's qualification program could contain these unqualified switch designs. Actuators in this category will have serial numbers less than 108000. Limitorque recommends that plant personnel be trained to recognize qualified and unqualified switch designs. SMB-000 and -00 actuators with serial numbers less than 108000 should be inspected to insure that safety related units contain only the qualified switch designs. We also recommend that the spare parts inventory be reviewed and any unqualified switch designs be appropriately tagged.

TORQUE SPRING ASSEMBLY RELAXATION

Reported Problem:

In the past two years we have received a few reports of spring pack relaxation. The term "spring pack relaxation" refers to spring packs found in the field which have free play or no pre-load.

Limitorque Engineering Evaluation:

In response, we have analyzed a number of returned spring packs and found that the height of the individual springs was less than shown on our detail drawings which is consistent with the reported relaxation. In evaluating the relaxed spring pack, we found that although the spring height had changed, the overall spring rate of the assembly still conformed to specifications.

Each spring pack assembly includes a limiter sleeve for the purpose of limiting the overall compression of the Belleville springs preventing an overstress condition. At this time, we do not have an explanation for the cause

of the relaxation. One theory that explains this phenomenon is that these valves were placed in the closed position (where the spring pack is compressed) and allowed to remain in that state for a long period of time. Possibly having the spring in the compressed position for an extended period could result in a creeping affect causing the relaxation.

Conclusions and Recommendations:

Limitorque is continuing the root cause analysis and Part 21 evaluation of the spring pack relaxation phenomenon. Currently, we are conducting tests to determine the affects of long term continuous compression of our Belleville spring pack designs. We recommend that spring packs with relaxation identified through diagnostic testing or disassembly and inspection be replaced at the first available opportunity. As an interim corrective action, it is acceptable to re-establish the design preload and continue to use the spring pack (Note: spring cartridge cap locknut must also be adjusted). We have had reports of spring pack relaxation on different size SMB actuators, however, the SMB-0 spring pack, Part No. 60-600-0017-1, has had the greatest number of relaxation reports. We recommend you be aware of this phenomenon in the performance of plant maintenance activities and evaluation of valve/actuator performance, particularly on valves left in the full closed position or backseated.

IMPROPER USE OF THE DECLUTCH MECHANISM

Reported Problem:

There have been a number of reported incidents of failures of the pin that holds the arm to the torque switch shaft (Pc. No. 23 of Figure 4). In the most recent case reported to Limitorque, the failed pin was subjected to a metallurgical evaluation which indicated the failure was caused by a single overload condition.

Limitorque Engineering Evaluation:

We proceeded to conduct a series of tests on the SMB-00 torque switch and the actuator. Tests revealed that one foot-pound of torque on the torque switch shaft is required to open the switch contacts. In testing to failure, we found

that 18 to 25 foot-pounds of torque is required for the pin to fail. Because of the excessive overload condition required to cause this failure, we investigated various situations which might produce enough impact load to cause a failure. The worst condition for impact loading on the torque switch arm and pin is the presence of gap in the spring pack (caused by lack of preload on the spring pack or incorrect positioning of the spring cartridge cap locknut). The following tests were conducted with a gap in the spring pack.

1. Multiple cycles running in the closed direction until the torque switch cut off the motor and using the limit switch as the control switch in the opening direction. Test cycles were run with loads up to three times the SMB-00's rating.
2. Repeatedly run the unit to locked rotor condition.
3. Cycling in the closed direction until the torque switch trips and shuts off the motor then declutch the unit into manual operation.

In all the above tests, the pin did not fail. The only tests which duplicated the torque switch arm pin failure was when the actuator was declutched while the motor was running. This condition created enough impact load to duplicate the reported field problem. In addition, the failure was a single overload failure similar to the field incident.

Conclusions and Recommendation:

It is Limitorque's conclusion that the cause of the pin failure was due to the actuator being declutched while the motor was running , which is abnormal use and not recommended. The Limitorque actuator declutch mechanism for all size SMB actuators was not designed with the intention that the declutch mechanism be operated while the motor is running. In addition to the reported failure of the torque switch arm pin on the SMB-00, we have also seen cases of motor pinion, worm shaft gear, and worm shaft clutch failures of the SMB-0 through SMB-5 resulting from the unit being declutched while the motor is in operation. We recommend that training programs conducted for plant personnel include instruction on the proper use of the declutch mechanism.

DC MOTORS

Reported Problem:

We have had reports of repeated DC motor failures on a couple of specific valves at a nuclear power plant.

Limitorque Engineering Evaluation:

As a result of the most recent incident of a DC motor failure on one of the problem valves, we were invited by the utility to participate in the evaluation. In assisting plant personnel with this evaluation, we found a number of different problems which contributed to the motor failures. This particular installation continuously energized the shunt winding of a compound wound DC motor to act as a heater to prevent condensation damage. The shunt winding of the compound wound motor is not designed for continuous energization and consequently over a long period of time the shunt winding temperature will exceed the insulations rating. The excessive temperature on the insulation syetem leads to premature motor failures.

Our investigation included evaluation of the MAC (Limitorque's Motor Actuator Characterizer) diagnostic test data taken after the last maintenance activity on the failed actuator. The diagnostic test data showed some unusual characteristics. Based on information provided by the utility, we learned that these particular actuators had starting resistors in the control circuit which limited the motor current to 200 percent of the motor nameplate full load amperage for the first two and one-half seconds of the stroke. The MAC traces indicated that when the motor tried to unseat the valve, the starting resistors limited the motor's output torque (due to the amperage limit) such that the motor slowed down to a stop until a relay dropped the starting resistor out and allowed the motor to draw enough amperage to unseat the valve.

In evaluating the operability of the valve/actuator assembly for the design conditions, we recalculated the motor size based on the starting resistor being in the circuit. This required use of a lower actuator efficiency resulting from the starting resistor causing the motor to stop during the unseating of the

valve. Static efficiency of the actuator is less than the published pullout efficiency which accounts for the hammerblow mechanism allowing the actuator to accelerate under no load. The result was that a larger motor would be required based on the starting resistor being left in the circuit.

As part of the evaluation, the motor circuit was analyzed for the minimum voltage condition. In evaluating the power circuit, we considered the minimum design voltage at the motor control center, the motor resistance, and the cable resistance to determine the maximum current flow that would take place. This evaluation included accounting for the actual cable resistance based on the ambient temperature at the plant accident condition. These calculations indicated that the cable size was not adequate to allow enough motor current to flow to meet the valve unseating requirements (without the starting resistors) at the minimum voltage condition.

Conclusions and Recommendations:

Based on the information gathered in this incident, it appears that the motor control center with starting resistors and cabling were sized using techniques normally applied to continuous duty motors designed to operate at full load current. The Limitorque motors are designed to use the starting torque rating of the motor to seat or unseat the valve, consequently, the motor power circuit must be able to provide at least five times the nameplate full load amperage at the minimum voltage to insure that the actuator will perform as designed.

The actuators in this application were sized to meet the valve load requirements based on an 85 percent reduced voltage specification. In selecting the motor size for the application, we intentionally oversized the motor to insure that we will provide the required torque with 85 percent voltage at the motor. If the 85 percent voltage condition exists at the MCC, we cannot account for the losses in the power circuit at the time that the actuator is selected because sufficient data is not provided in the specification or purchase order.

As a result of this recent incident, Limitorque recommends the following:

1. The shunt winding of the compound wound DC motor should not be continuously energized, if you are currently using this practice we recommend that you modify your circuitry.
2. Limitorque's motor designs do not require the use of starting resistors to protect the motor. However, 150 foot-pound and larger DC motors can have high locked rotor currents and it may be beneficial to use starting resistors to protect the reversing contactor or some other component. When using starting resistors, they must allow for a current draw of at least five times the full load current or the time delay relay be set to drop the starting resistor out before the lost motion of the hammerblow device in the actuator completes its travel.
3. The cable size used for the DC motors should be sized to allow for five times full load current flow at the minimum voltage condition. Accident ambient temperature conditions should be taken into account in determining cable resistance. Attachment 1 is an example of the typical calculations which should be performed.
4. In conjunction with the use of DC motors, Limitorque also recommends the use of a discharge resistor or varistor to absorb the energy when the shunt field circuit is opened quickly (typical wiring diagram - Attachment 2).

GASKET MATERIAL

Limitorque's standard gasket material has been Anchorite 425. Our Engineering Department has evaluated and approved the use of Klinger K-61 gasket material which is manufactured to this same ASTM and MIL standards. This material is approved for use in our nuclear safety related applications. Installation of gaskets made of the K-61 material will not affect the qualification status of the Limitorque valve actuators.

We recommend that you notify the appropriate departments within your organization so that they will be aware of the alternate qualified gasket material.

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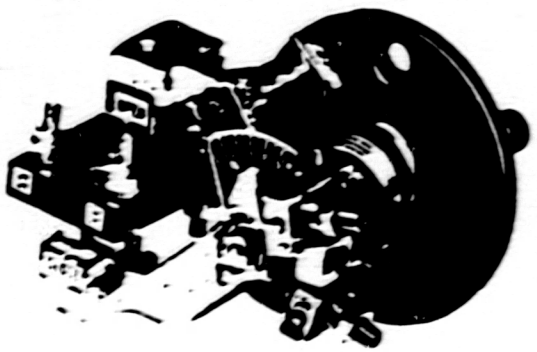
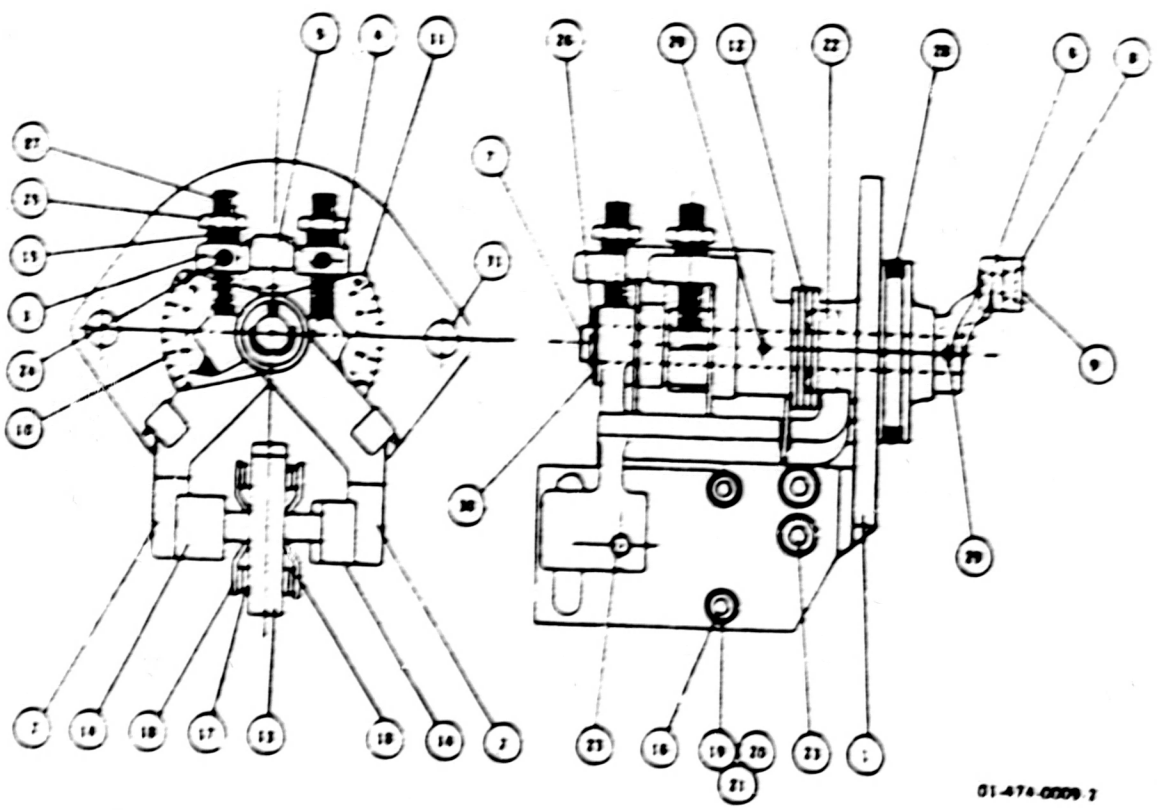
FIGURE 1

PROCEDURE FOR SETTING TORQUE SWITCH FOR SMB-00



1. Make sure all electric power is off.
2. Loosen jam nut, pc. #25.
3. For the open direction torque switch or close direction torque switch move socket head set screw, pc. #27, in or out to decrease or increase amount of torque output desired.
4. Tighten pc. #25.
5. Operate valve electrically to seat valve, insuring tight shut-off.

DOUBLE TORQUE SWITCH SMB-00



PC. NO.	NO. REQD.	DESCRIPTION	PC. NO.	NO. REQD.	DESCRIPTION	PC. NO.	NO. REQD.	DESCRIPTION
1	1	BRACKET	11	1	DIAL L.S.	22	1	"O" RING #6227-8
2	2	ACTUATING ARM R.S. & L.S.	12	1	SPRING	23	4	SOCK HD CAP SCREW
3	1	DIAL HOLDER R.S.	13	1	STA. TERMINAL BLOCK	24	2	HEADLESS SET SCREW
4	1	DIAL HOLDER L.S.	14	2	MOVABLE TERMINAL BLK.	25	2	JAM NUT ¼-20
5	1	ACTUATING LINK	15	2	THREADED BUSHING	26	1	COTTER PIN & WASHER
6	1	TRIPPER ARM	16	6	TERMINAL STUDS	27	2	SET SCREW #¼-20 x 1¼ LG.
7	1	ACTUATING ARM SHAFT	18	2	CONTACTOR	28	1	"O" RING #6227-27
8	1	ROLLER	19	8	HEX NUTS #10-32	29	2	GROOVE PIN ⅛ DIA. x ¾ LG.
9	1	ROLLER PIN	20	8	WASHERS #10	30	1	WASHER—FLAT ⅝
10	1	DIAL R.S.	2.	4	LOCKWASHERS #10	31	2	#⅝-18 x ⅝ FILL HD M.S.

TORQUE SWITCHES

FIGURE 2

The LimiTorque valve control torque switches control the amount of torque which the unit may develop before its contacts open and cut out the motor control circuit to stop the electric motor. All torque switches are factory preset for the given condition. However, they may be set at a higher torque cutout position, or a lower torque cutout position, and it is a simple matter to make adjustments.

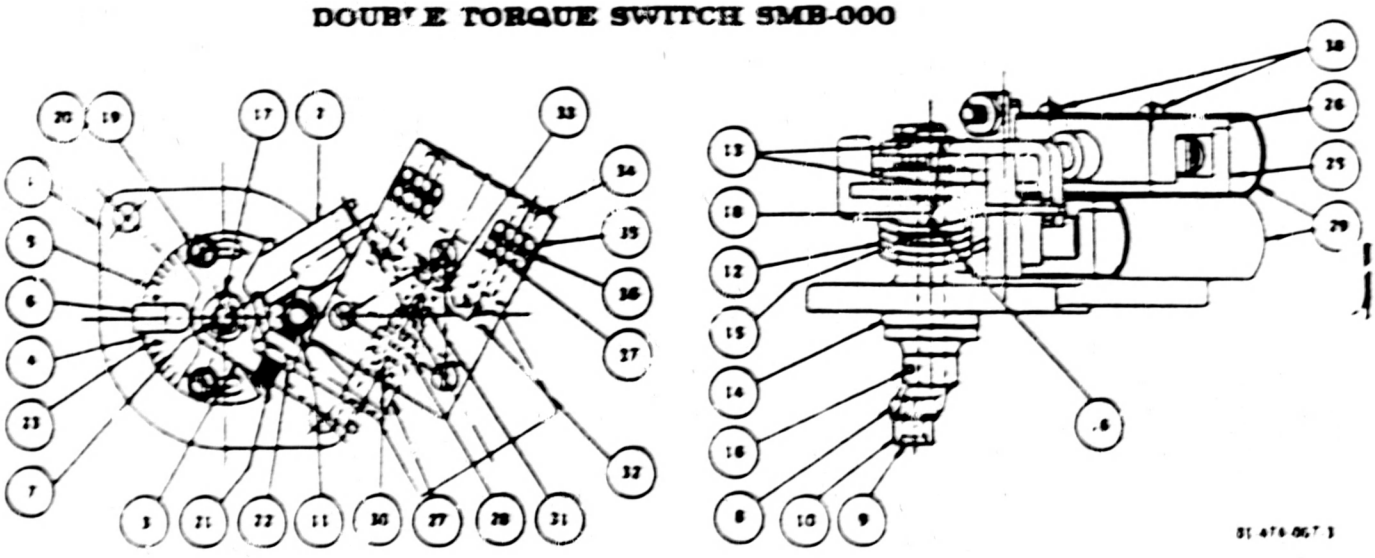
The torque switch is used to stop the motor operator upon closing the valve in the case of wedging type gate valves. For valves which do not wedge into the seat, the geared limit switches are used to stop the LimiTorque operator when the valve reaches the full open or full closed position. The torque switch, in this case, is used as a protective device to stop the motor operator in the event of a mechanical overload during the closing or opening cycle.

Examples of torque seated valves are: wedge type gate valves, globe valves and wedge plug valves. Examples of position seated valves are: butterfly valves, plug valves, ball valves, sluice gates and thru conduit pipeline gates.

PROCEDURE FOR SETTING TORQUE SWITCH FOR SMB-000

1. Make sure the electric power is off.
2. Loosen machine screw, pc. # 19, for either the open direction torque switch or the closed direction torque switch.
3. Re-set the torque switch by moving pc. #2 or 3 to a higher setting or lower setting as desired.
4. Secure pc. # 19 and operate the valve electrically to insure the proper setting required to give tight shut-off.

DOUBLE TORQUE SWITCH SMB-000



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PC. NO.	NO. REQD.	DESCRIPTION	PC. NO.	NO. REQD.	DESCRIPTION	PC. NO.	NO. REQD.	DESCRIPTION
1	1	BRACKET	14	1	"O" RING #6227 13	28	2	PLUNGER SPRING
2	1	ACTUATING ARM R.S.	15	1	"O" RING #6227 5	29	2	INSULATOR
3	1	ACTUATING ARM L.S.	16	2	GROOVE PIN 3/16 DIA x 1/4 LG	30	2	SELF TAPPING SCW #6-40 x 1/4 LG.
4	1	DIAL CAM R.S.	17	1	COTTER PIN 1/16 DIA x 1/4 LG	31	2	CONTACT SPRING [5]
5	1	DIAL CAM L.S.	18	1	WASHER 1/4 I.D. x 3/8 O.D. x .016	32	2	CONTACT FINGER [5]
6	1	ACTUATING LINK	19	2	PAN HD. MACH SCW #6-32 x 3/8 LG.	33	2	CONTACT SUPPORT [5]
7	1	ACTUATING SHAFT	20	2	WASHER #6	34	2	TERMINAL STUD
8	1	TRIPPER ARM	21	2	SET SCREW #10-32 x 1/4 LG	35	8	HEX NUT #10-32
9	1	ROLLER PIN	22	2	HEX NUT #10-32	36	8	FLAT WASHER #10
10	1	ROLLER	23	2	ROLL PIN 3/16 DIA x 3/4 LG	37	4	LOCKWASHER #10 SPRING
11	1	SPRING PIN 1/8 DIA x 1 1/4 LG	25	2	TERMINAL HOUSING BASE	38	3	MACH SCW #6-32 x 1 1/4 LG
12	1	SPRING	26	2	PLUNGER HOUSING			
13	2	BUSHING	27	2	PLUNGER			

FIGURE 3

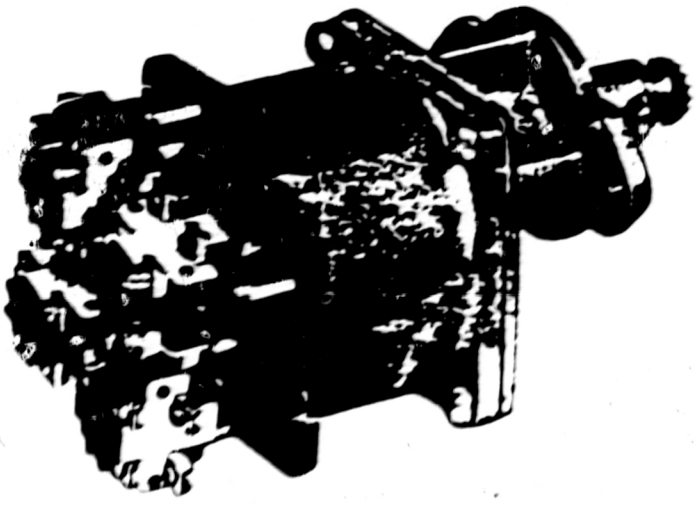
PROCEDURE FOR SETTING SMB-000 FOUR TRAIN GEARED LIMIT SWITCH

The four train geared limit switch, for the SMB-000 only, is shown on the opposite page. Size SMB-000 is the only one which employs this cam operated switch, when a four train geared limit switch is required.

The operation of the four train geared limit switch for the SMB-000 is such that the upper terminals of the individual limit switch will be in the open position when the switch plunger is sitting in the low section of the cam, and will be in the closed position when the switch plunger is sitting on the high section of the cam. The lower terminals of the switch will be in the closed position when the plunger is in the lower section of the cam, and will be in the open position when the plunger is sitting in the high section of the cam.

In order to set this geared limit switch to trip at any desired position, the following procedure should be observed.

1. All electric power must be turned off.
2. Use the handwheel to manually open the valve and note direction of rotation of gear shaft "A". This gear shaft "A" controls the setting of switch No. 1; Gear shaft "B" for switch No. 2; Gear shaft "C" for switch No. 3; and "D" for switch No. 4.
3. Back the valve down slightly to allow for coast of moving parts.
4. With a screwdriver, turn clockwise on setting rod "E" until it reaches the stop position. Do not force. This mechanically disconnects the gear train of the geared limit switch with the gearing inside the LimiTorque operator. It allows you to set the individual electric limit switches by turning on gear shaft "A", "B", "C" or "D" depending on which limit switch is to be set.
5. Determine which limit switch is to be set, and if the terminals of that switch are closed and should be open—turn the gear shaft in the same direction as previously noted until the cam turns 90°. If the terminals of the individual switch to be set are already open and should be open, or are already closed and should be closed, turn the gear shaft ("A", "B", "C" or "D") in the opposite direction as previously noted until the cam turns 90°. Then turn the gear shaft back slightly until the cam turns back 90° to the correct position desired.
6. Back off on setting rod "E" until it reaches the stop position. Do not force.
7. With a screwdriver, check to insure that gear shaft "A", "B", "C", and "D" will not rotate. In this position, the gear train is locked together again and ready for operation.
8. Turn the valve to the next desired position with the handwheel where another switch is to be set. Follow the same procedure as described above.



SMB-000 four train geared limit switch

FIGURE 4

SMB-00 THRU SMB-5 DOUBLE TORQUE SWITCH*

Procedure for Setting:

1 Torque settings must be made with switch mounted in Limitorque

2 Make sure all electric power is off

3 For the open direction torque switch or close direction torque switch loosen screw, pc. #35 and set pointer, pc. #7, at desired torque setting The higher the number the higher the torque output of the unit

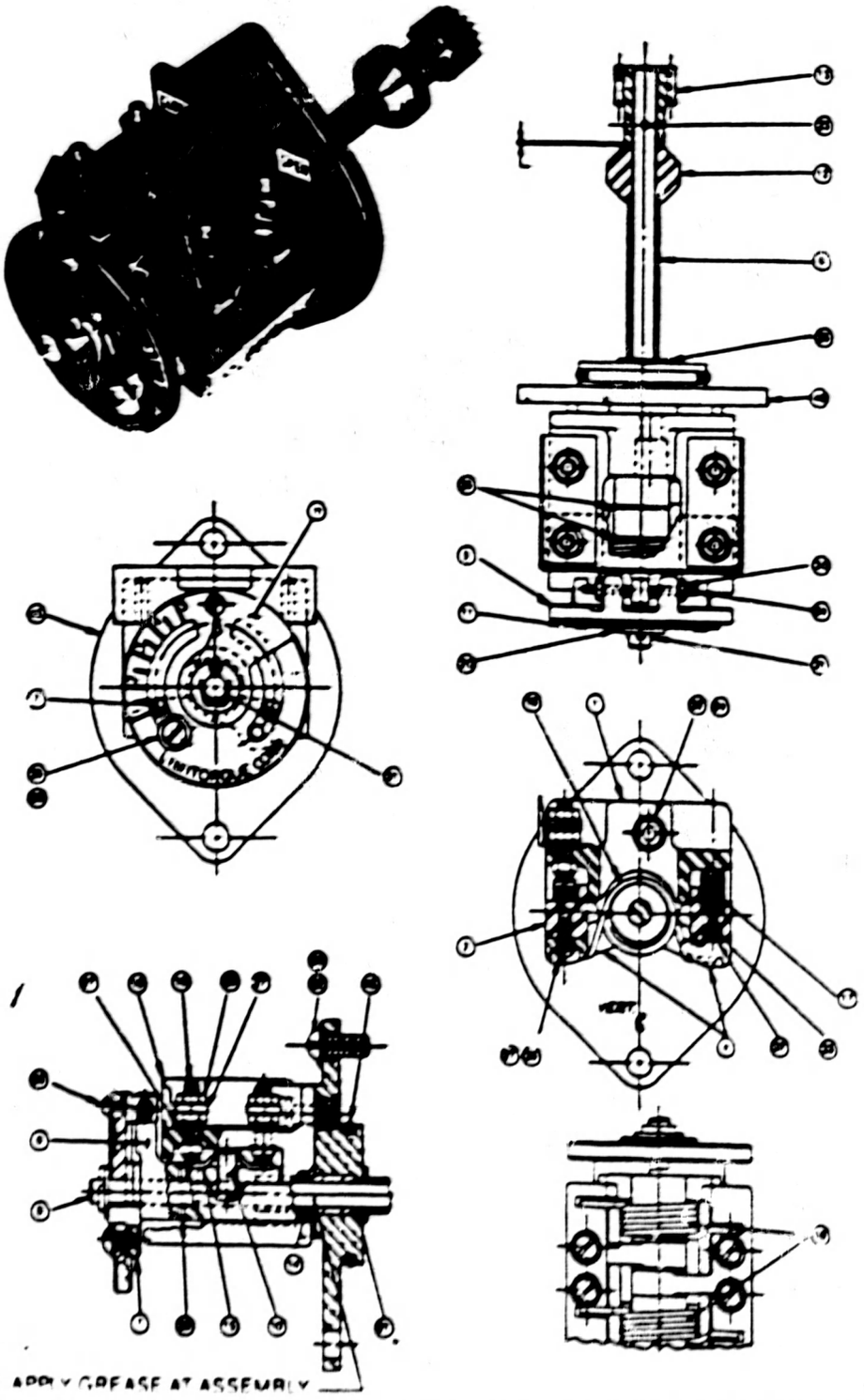
4 Tighten pc. #35

5 Operate valve electrically to seat valve insuring tight shut-off

6 A maximum stop setting plate is furnished on all units Do not exceed this setting without consulting factory.

*Available in assembled form only

PC NO.	NO REQ.	DESCRIPTION
1	1	TERMINAL BLOCK
2	2	CONTACT BLOCK
4	2	ARM
5	1	DIAL
6	1	ACTUATING LINK
7	2	POINTER
8	1	SHAFT
9	1	SPACER
10	2	CONTACT SUPPORT
11	1	TORQUE LIMITER
12	1	BUSHING
13	1	TSW PINION
14	1	BEARING
15	2	CONTACT FINGER
16	4	TERMINAL STUD
17	2	COMPR SPRING
18	2	TORSION SPRING
19	7	INSULATOR
20	1	FLAT WASHER
21	1	O-RING
22	2	SCREW-ROUND HD. SLOTTED ¼-18 x ⅝ LG
23	1	ROLL-PIN 3/32 DIA x .500 LG
24	1	LOCKWASHER-¼
25	18	THRUST-WASHER
26	2	#10 LOCKWASHER
27	12	LOCKWASHER #10
28	1	ROLL PIN 3/32 DIA x 3/4 LG
29	18	HEX NUT #10-32
30	2	HEX NUT #6-32
31	13	COTTER PIN 5/32 DIA x ⅝ LG
32	1	SCREW-SOC HD CAP ¼-20 x ⅝ LG
33	12	SCREW-PAN HD. SELF-[illegible] #4-40 x ⅛ LG
34	2	SCREW-HEX SOC SET #6-32 x 1/4 LG
35	18	SCREW-MACH RD HD #10-32 x 3/8 LG
36	1	SCREW-MACH RD HD #5-80 x 3/16 LG
37	61	WAX AS REQUIRED
39	2	LOCKWASHER
45	11	O-RING
46	1	MOUNTING BRACKET



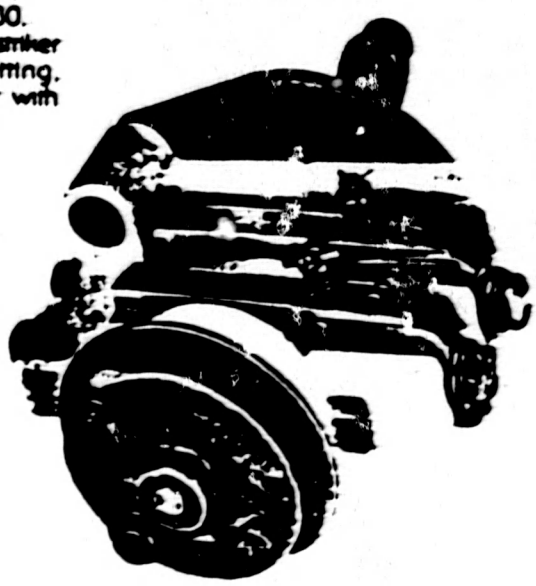
NOTE APPLY GREASE AT ASSEMBLY

FIGURE 5

SMB-000 DOUBLE TORQUE SWITCH*

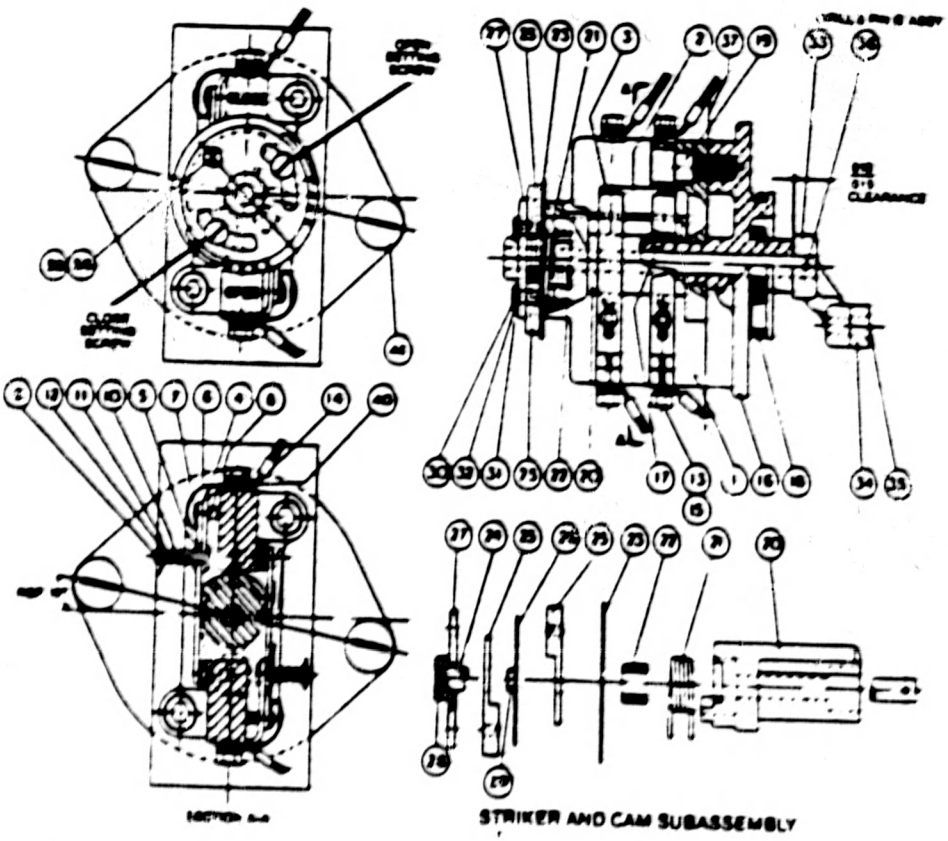
Procedure for Setting:

1. Torque setting must be made with switch mounted in Limitorque.
2. Make sure all electric power is off.
3. Loosen pan head screws, pc. #30.
4. For open or close operation set striker pc. #25 to required torque setting, matching the edge of the striker with desired number. Output torque increases with higher numbers.
5. Tighten pc. #30.
6. Operate valve electrically to seat valve, insuring tight shut-off.



*Available in assembled form only

NO. REQD.	DESCRIPTION
1	TERMINAL BLOCK
2	CONTACT BRIDGE
4	CONTACT SCREW
6	FINGER HOLDER
4	FINGER
42	SPLINE
4	SHUNT WASHER ⅛ O.D. 1/16 I.D. 1/32 THK.
4	RIVET
4	FINGER SPRING STUD
4	COMPRESSION SPRING
8	SPRING CUP WASHER
4	COTTER PIN (1/32 x ½)
4	HEX. HD. MACH. SCR. #10-32 x ⅝
4	RING TORQUE CONNECTOR 18" #18 AWG TYPE TU PIGTAIL
4	LOCKWASHER SHAKEPROOF
1	TORQUE SW. MTG. BRACKET
1	"O" RING
1	"O" RING
2	SOC. HD. CAP SCR. ¼-20 x ½ LG.
1	CAM
1	TORSION SPRING
1	SPRING MANDREL
1	DIAL
1	SHAFT
2	STRIKER
1	TORQUE LIMITING PLATE
1	STRIKER HUB
1	ROLL PIN 1/16 Ø x ½
1	#4 SWAGE NUT
2	PAN HD. SCREW #8-32 x 9/16 LG. SLOTTED
2	LOCKWASHER SHAKEPROOF
2	FLATWASHER 9/64 I.D. x 9/16 O.D. x .032 THK
1	ARM
1	ROLLER
1	ROLLER PIN
1	GROOVE PIN 1/16 DIA. x ½
1	ARC BARRIER
1	PAN HD. SCR. #4-40 x ¼
1	LOCKWASHER EXTERNAL TOOTH
4	WASHER 7/16 O.D. x 1/4 I.D. x 1/16 THK.
2	RD. HD. MACH. SCR. 1/4-28 x ½



STRIKER AND CAM SUBASSEMBLY

FIGURE 6

FOUR TRAIN GEARED LIMIT SWITCH-ROTOR TYPE*

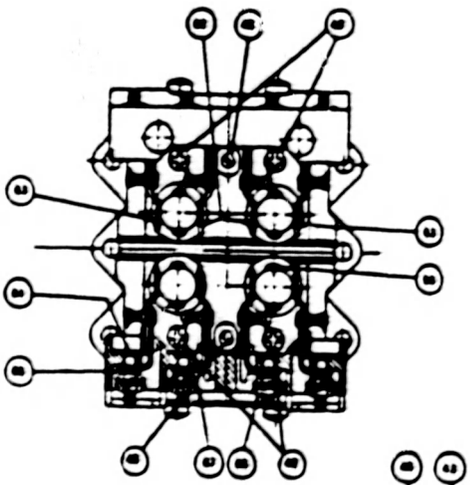
Procedure for Setting:

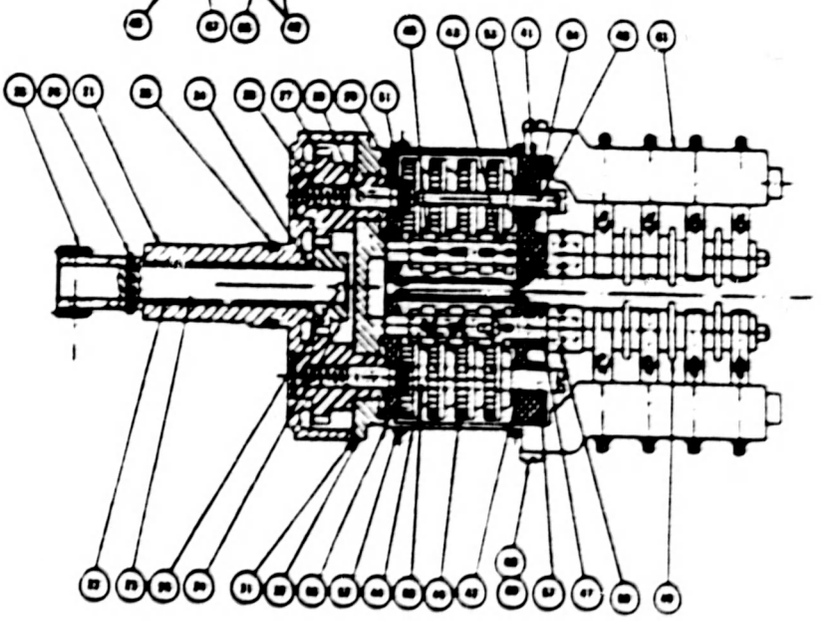
The four train geared limit switch (Rotor type) employs four rotary drum switches, each having four contacts. When the rotor is properly set to trip at the desired position, two of these contacts open and two close electric circuits. Generally, one rotor is set to trip at full open position of the valve, and one rotor is set to trip at full close position of the valve. The other two rotors are set at some intermediate position, depending on the requirements of the project.

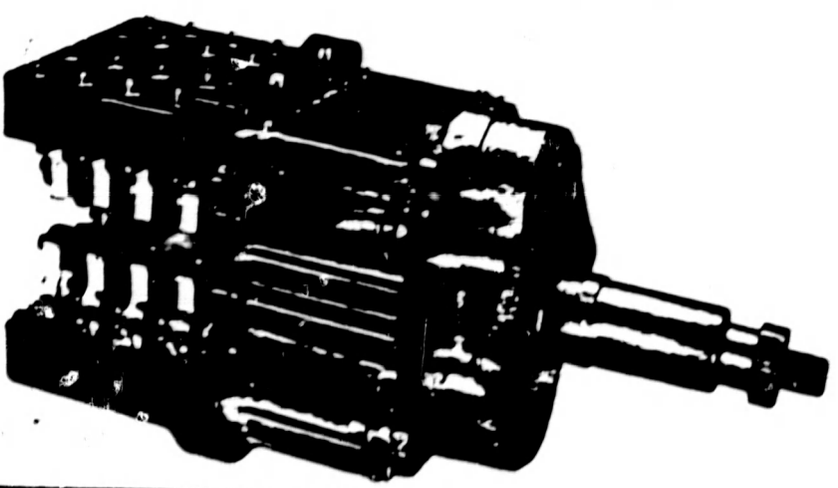
To set the switches of a four train rotor type switch, follow the same procedure as described for the two train rotor type switch. The upper setting rod, pc. #48 allows adjustment of the two adjacent upper rotors, and lower setting rod, pc. #48, allows adjustment of the two adjacent lower rotors.

* Individual items not sold separately. Consult factory for the sub-assembly required

PC NO.	NO REQD	DESCRIPTION
21	1	CARTRIDGE
22	2	OILITE BUSHING
23	1	DRIVE SHAFT
24	1	DRIVE PINION (INTERNAL
25	1	HELICAL PINION
26	2	GROOVE PIN 1/8 Ø x 1" LG.
27	2	DRIVE SLEEVE & GEAR
28	2	DECLUTCH SPRING
29	2	DRIVE PINION SPUR
30	2	PIN 1/8 Ø x 11/16 LG.
31	1	CARTRIDGE GASKET
32	1	CARTRIDGE MTG. PLATE
33	4	8-32 x 3/8 LG. SOC. HD. CAP
34	1	"O"-RING 2-227-11
35	1	"O" RING 2-227-21
36	4	3/8-16 x 3/4" FILL HD. SOCKET SCREW & LW
41	2	GEAR FRAME
42	44	INTER. GEAR/SHAFT
43	4	INTER. PINION SHAFT
44	4	G.L. FRAME COVER
45	16	INTERMITTENT GEAR
46	12	INTERMITTENT PINION
47	4	STEM SPUR PINION
48	12	SET ROD
49	4	ROTOR
50	4	GROOVE PIN 3/32 Ø x 3/8
51	4	COVER GASKET
52	96	4-32 x 1/4" LG. FILLISTER
53	2	"O"-RING 2-220-3
54	2	SETTING ROD BUSHING
55	2	GASKET GEAR FRAME
56	96	INSERT (ROTOR)
57	2	"O"-RING 2-220-5
58	2	GROOVE PIN 1/8 Ø x 1"
61	2	FINGER BASE
62	96	R.H. FINGER ASSY
63	16	L.H. FINGER ASSY
64	32	#10-32 x 1" LG. HEX
65	32	#10 LOCKWASHER
66	64	#10-32 HEX NUT
67	64	#10 SWBD WASHER
68	4	8-32 x 3/8 FILL HD. C.
69	4	#8 INT. TOOTH LOCKWASHER







ATTACHMENT #1

LIMITORQUE DC MOTOR
CABLE SIZING

The motor's ability to generate design torque is dependent on the amount of current the circuit can conduct.

$$\text{Max. Current Draw} = \frac{\text{Min. Bus Voltage}}{\text{Motor Resistance} + \text{Total Cable Resistance}}$$

$$\text{Motor Resistance (Rm)} = \frac{\text{Rated Motor Voltage}}{\text{Locked Rotor Amperage}}$$

Total Cable Resistance = Four times resistance of a single cable at accident ambient condition.

Resistance of single cable at 25°C (R_1) = Resistance per foot times number of feet.

$$\text{Resistance at Elevated Temperature } (R_2) = R_1 \times \frac{234.5 + T}{259.5}$$

(Calculation method taken from IEEE 118)

Where "T" is the elevated temperature in °C.

Temperature effect on motor resistance is covered by the Limitorque Motor Selection Procedure. This subject will be covered in greater detail in a separate letter.

Example:

60'#, 250 VDC motor, Full Load Amps (FLA) = 17.

Minimum Bus Voltage 210V.

Locked Rotor Current is 105 Amps (from motor curve).

$$\text{Motor Resistance} = \frac{250}{105} = 2.381 \text{ ohms.}$$

Cable is #10 AWG and length is 300 feet.

$$R_1 = 300 \times .00108 = .324 \text{ ohms.}$$

Elevated temperature is 200°F or 93.33°C.

$$R_2 = .324 \times \frac{234.5 + 93.33}{259.5} = .4093 \text{ ohms.}$$

Total Cable Resistance = 4 x .4093 = 1.6372 ohms.

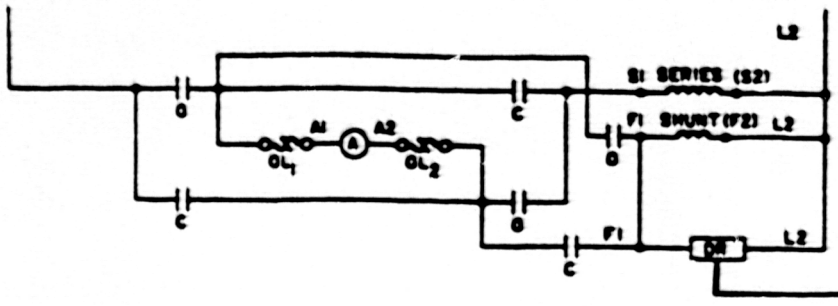
Max. Current Draw = $\frac{210}{2.381 + 1.6372}$ = 52.26 amps. $\frac{210}{2.381}$ = 88 amps

Recommended Minimum Available Current Draw is 5 x FLA = 5 x 17 amps = 85 amps.

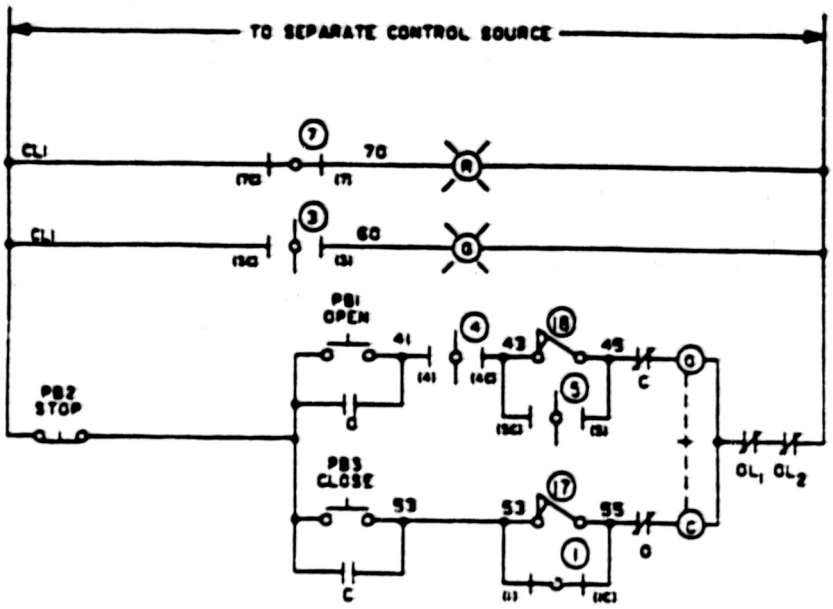
Available current draw is considerably less than required. The motor performance curve indicates that 52.26 amps will produce approximately 40 foot-pounds from a motor rated for 60 foot-pounds of starting torque.

If the above example is for an existing installation, you may want to determine the motor torque required to operate the valve under design conditions or at the existing torque switch setting. This application would be acceptable if the motor required torque is less than 40 foot-pounds. In a case where the required motor torque is greater than 40 foot-pounds, you would then want to evaluate the options for modifications to the actuator or a change in cable size. The actuator change in this situation would be to increase the gear ratio and thus reduce the torque required from the motor. An increased gear ratio will also result in a proportionally longer stroke time.

ATTACHMENT #2



Discharge Resistor or Varistor



VALVE SHOWN IN FULL OPEN POSITION

MOTOR	CONTACT	LIMIT SWITCH CONTACT DEVELOPMENT VALVE POSITION FULL OPEN	A	B	FULL CLOSE	FUNCTION
1	1					BYPASS CIR.
	2					SPARE
	3					IND LIGHT
	4					OPEN LIMIT
2	5					BY-PASS CIR.
	6					SPARE
	7					IND LIGHT
	8					SPARE
3	9					SPARE
	10					SPARE
	11					SPARE
	12					SPARE
4	13					SPARE
	14					SPARE
	15					SPARE
	16					SPARE

(7) CLOSING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING CLOSING CYCLE OR FULLY CLOSED VALVE

(8) OPENING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING OPENING CYCLE

NOTES

1. ---OPEN CONTACT
2. ═══ CLOSE CONTACT
3. ROTORS 3 & 4 CAN BE SET AT VALVE POSITION FULL OPEN, FULL CLOSED OR ANY POSITION IN BETWEEN AS INDICATED BY POINTS A & B
4. WIRES CL1, 43, 45, 53 & 55 BETWEEN LIMIT SWITCHES & TORQUE SWITCHES BY LIMITORQUE CORP. ALL OTHER WIRING BY OTHERS
5. TERMINAL BLOCK FOR CUSTOMERS CONNECTION 600 VOLT, 30 AMP LUG TYPE BLOCK W/#10 STUD

LEGEND

O-OPEN CONTACT
C-CLOSE CONTACT
(O)-OPENING COIL
(C)-CLOSING COIL
OL-OVERLOAD RELAY (1 & 2)
•-MECHANICAL INTERLOCK
(R)-RED INDICATING LIGHT
(G)-GREEN INDICATING LIGHT
PB1-OPEN PUSHBUTTON
PB2-STOP PUSHBUTTON
PB3-CLOSE PUSHBUTTON
DR-DISCHARGE RESISTOR

} FOR SUGGESTED OPERATION ONL NOT SUPPLIED BY LIMITORQUE C

A-ARMATURE
HTR-SPACE HEATER (L.S. COMPT.) PROVIDED FOR ALL EXPLOSION PROOF UNITS OR WHEN SPECIFIED BY CUSTOMER
HTR2-MOTOR HEATER