Instruction Manual

Types 546, 546S and 546ST Electro-Pneumatic Transducers

Form 1783, February 1977

INTRODUCTION

Scope of Manual

This instruction manual pertains only to the installation, operation, and maintenance of the Types 546, 546S, 546ST and Type 82 relay. Refer to the Type 87FR Instruction manual for regulator maintenance information.

Purpose

Fisher Type 546, 546S, and 546ST transducers receive a milliampere direct current input and transmit a proportional pneumatic output pressure. A typical application configuration includes electronic controllers, a control valve, pneumatic cylinder, and a feedback mechanism. The input signal, output pressure range, and electrical characteristics of each transducer are indicated on the nameplate attached to the cover.

The Types 546S and 546ST are mode safe and are approved as being intrinsically safe when used with certain systems. The approved systems are listed in Table 2.

PRINCIPLE OF OPERATION

Refer to the schematic drawing in Figure 2. Assume that the transducer is direct acting. An increase in the milliampere signal increases the magnetic field around the coil. This field increases the magnetic strength in the armature and the magnet attracts on across the air gap between the armature and the pole pieces.

The pole pieces are radially polarized by the permanent magnet. The armature polarity is shown in the schematic. The magnet attracts on with the armature moving downward at the nozzle end and upward at the feedback end, resulting in a torque that rotates the armature about the fixed torsion rod to cover the nozzle. The resulting restriction produces an increased pressure in the nozzle, in the upper chamber of the relay, and in the feedback chamber. The relay responds to the increased nozzle pressure to increase the output pressure to the control valve, the normal output load. The increased pressure in the feedback chamber creates a force which acts on the armature to move the nozzle back to an equilibrium position. In this way, the new nozzle pressure is compared to the input current by the force balance principle.
Table 1 Specifications

| INPUT SIGNALS* | Type 546: 1 to 5 mA dc, 4 to 20 mA dc, 10 to 50 mA dc, 1 to 9 Vdc, or | 5000 ± 12U ohms (standard) or 12,000 ± 50 ohms (temperature compensated at rated) |
| INTERNAL RESISTANCE | 4 to 20 mA dc Input Signal: 176 ± 10 ohms |
| OF TORQUE MOTOR | 4 to 20 mA dc Output Signal: 90 ± 10 ohms |
| 1 to 9 Vdc Input Signal: 1300 ± 50 ohms (temperature compensated at rated) |
| OUTPUT SIGNALS* | Ranges: 3 to 15 psig, 6 to 30 psig, or 3 to 27 psig |
| | Action: Type 546 sends direct or reverse (Types 546S and 546ST add an additional output signal) |

| SUPPLY PRESSURE* | Recommended: 5 psig higher than upper range of output signal |
| | Maximum: 50 psig |

| MAXIMUM STEADY-STATE AIR CONSUMPTION* | 20 psig Supply: 0.35 scfm |
| | 35 psig Supply: 0.50 scfm |

| MAXIMUM SUPPLY AIR DEMAND | 20 psig Supply: 8.0 scfm |
| | 35 psig Supply: 11.5 scfm |

| PERFORMANCE† | Reference Accuracy: ± 0.75% of output signal span |
| | Independent Linearity: ± 0.50% of output signal span |
| | Open Loop Gain: 26 |
| | Frequency Response: Gain is attenuated 3 dB at 20 Hz when Type 546 output signal is led to a typical 100-inch tub ng |

| OPERATIVE AMBIENT TEMPERATURE | 40 to +150°F |

| ELECTRICAL CLASSIFICATION | See Table 2 |

| APPROXIMATE WEIGHT | 9 pounds (transducer on y) |

The relay operates in this manner: The nozzle pressure acts on the larger daphragm to force the center spacer assembly (mounted between the two daphragms) downward against the inner valve, causing the exhaust port and open the supply port. Supply air then flows through the open port to the output. The output pressure continues to increase until the relay daphragm assembly is pushed back by the force of the pressure acting on the smaller daphragm, causing the inner valve to close again.

When a decrease in the nozzle signal is received, the magnet attracts the armature to uncover the nozzle and decreases the pressure in the nozzle, resulting in feedback. The relay daphragm assembly moves upward and the exhaust port opens to the atmosphere. The output decreases until the daphragm assembly is forced back to its original position and the exhaust port is closed again. The reduced pressure in the feedback line decreases the force to return the armature to the equilibrium position.

Reverse acting transducers operate in a similar manner except that when the d input signal increases, the output pressure from the relay decreases. Conversely, a decrease in input signal increases the output pressure.
<table>
<thead>
<tr>
<th>Type Number</th>
<th>Electrical Classification</th>
<th>D vs. on Hazardous Locations</th>
<th>Approved Systems (if applicable)</th>
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<td>CSA L tested as Exp on Proof</td>
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<td>Fisher Type AC301 ntr ns c Safety Barr or w th or w thou Type 43M or 44M meters</td>
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<td>Cass Groups C and D</td>
<td>Tay or zener barr es rated 30 V or ess 120 ohms or more, w th or w thou Type 43M meter Dwg 23A3861</td>
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<td></td>
<td></td>
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<td>Cass Group D</td>
<td>Leeds and Northup* System Dwg D 883 1 and D 883 2)</td>
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<td>Cass Groups C and D</td>
<td>Fisher and Porter* ESL System 24</td>
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<td>Cass Groups B C and D</td>
<td>Tay or ntr ns c y safe barr or 124S1134 124S1144 F sher Dwg 22A3640, Tay or Dwg SL 92900 30 nstruct ons 17607 and 176209</td>
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<td>Br sto * Metronet c 2000 contro oop configurat ons contro oops t through 6 nstruct ons SS 8299</td>
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<td>546S</td>
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<td>Leeds and Northup* connect on to be made through a non hazardous area part number 316569 or 316747 direct on book 177849</td>
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<td>Cass Groups C and D</td>
<td>BASEEEFA Cert fed EX a C 28 vo t 300 ohm shunt zener d ode barr er of ke p or ty or BASEEEFA Cert fed EX a C Dua 28 vo t 300 ohm shunt zener dode barr er each f k e p or ty safe area apparatus unspec fed except that t must not be supplied from nor conta a source of potent al w th respect to earth in excess of 250 vo ts RMS or 250 vo ts DC under both norma and abnorma work ng cond ons perma ns b e interconnect ng cab e F sher Dwg 13A981 or 13A9888</td>
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<td>ANY BASEEEFA EX a C 28 vo t 300 ohm shunt zener dode barr er safe area apparatus unspec fed except that t must not be supp ed from nor conta a source of potent al w th respect to earth in excess of 250 vo ts RMS or 250 vo ts DC under both norma and abnorma work ng cond ons perma ns b e interconnect ng cab e</td>
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<td>Be ey Meter* Type 766600 AAA1 nstruct ons 4576K16 00A2</td>
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<tr>
<td>546ST</td>
<td></td>
<td>Cass Groups C and D</td>
<td>Be ckman* nstruct ons 01S 082291</td>
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<tr>
<td></td>
<td></td>
<td>Cass Groups B C and D</td>
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<td>Cass Groups C and D</td>
<td>Un ts Manufactured n Woodstock Ontario Canada</td>
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<td>Cass Groups C and D</td>
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<td></td>
<td>Cass Groups B C and D</td>
<td>Tay or ntr ns c y safe barr er 124S932, 124S932, 124S1254 or 124S1264 Tay or nstruct ons SL 92900 30 or F sher Dwg 22A3640</td>
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<tr>
<td></td>
<td></td>
<td>Cass Groups A B C and D</td>
<td>Fisher Type AC303 ntr ns c Safety Barr or</td>
</tr>
</tbody>
</table>

Certification received by named company

* Please add the add one cond on for BASEEEFA certi ca on
1 The Cert on must con rm to the approved drawing number and en BASEEEFA nta e on
2 The certificate and nture ance of ract a e since L R ratio of the cab e connected to the terminals e is not excced

<table>
<thead>
<tr>
<th>Group</th>
<th>Capacitance ( \mu \text{F} )</th>
<th>Inductance ( \text{mH} )</th>
<th>or L/R ratio ( \text{mH}/\Omega )</th>
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</thead>
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<tr>
<td>C</td>
<td>0.13</td>
<td>4.2</td>
<td>58</td>
</tr>
<tr>
<td>B</td>
<td>0.6</td>
<td>2.0</td>
<td>60</td>
</tr>
<tr>
<td>A</td>
<td>0</td>
<td>35.9</td>
<td>470</td>
</tr>
</tbody>
</table>
Types 546, 546S & 546ST

INSTALLATION

WARNING

The Type 546 transducer, ke most other devices of th s type, b eads to atmosphere f a combust b e, tox c, or otherwise hazardous gases used as the supply source. ocate the transducer n a we vented area. Accumulated gas may create an exposure hazard or ocasion ventitious cond t on with the poss b e of persona injury or eqipment damage.

Mounting

When a contro valve s ordered and t s specified that a Type 546 be mounted on the actuator, the factory mounted transducer will be connected to the actuator with the necessary tubing and adjusted for the conditions specified on the order.

If the transducer is purchased separate for mounting on a control valve and serves a ready n service, a the necessary mounting parts will be furnished. Th s nc udes the output tubing and the appropriate bracket for both the un t to an actuator boss with tapped holes or for fastening t to the daphh gem cas ng.

If preferred, mounting parts can be supplied for mounting the transducer on a 2 inch d a meter p e stand, a flat surface or a bulkhead. No output tubing will be supplied for these remote mounting methods unless a specific length and size is specified. The recommended tubing size is a 3/8 inch outside diameter. Th ng length between the transducer output and the transducer case is a parameter to be considered to minimize e turbulence effect on the control system.

Pneumatic Connections

The Type 546 transducer is normally furnished with a Type 67FR 1 inch regulator mounted on the transducer case. A pressure gauge on the regulator shows the supply pressure to the transducer.

Note

The supply source must be clean, dry, non corrosive air or gas at an unfla ng pressure at least 5 ps hger than the upper limit of the transducer output pressure range. Th s means that for an output pressure range of 3 to 15 ps the supply pressure should be at least 20 ps, for a 6 to 30 ps range, the supply pressure should be at least 35 ps. The supply to the Type 67FR regulator should not be more than 250 ps at a maximum temperature of 150°F.

1. Connect the nearest supply source to the 1/4 inch NPT. Connect on the 1/4 inch NPT SUPPLY connect on to the transducer case.
2. Run 3/8 inch O.D. tubing from the 1/4 inch NPT OUTPUT opening to the transducer case to the input connection on the pneumatic actuator or valve positioner. Th s connection will be made at the factory if the unit is shipped mounted on an actuator as shown in figure 1.

Electrical Connections

The electrical connections are made on the transducer case. A 1/2 inch NPT conduit connect on is provided through the bottom of the case. Use a suitable conduit seat for hazardious ocations. Th wres that carry the m ampere s gn from the control are connected to the terminal strip (key 53, figure 6). The terminal strips marked + and to the positive and negative terminals. For a direct acting unit (e.g., increases current produces an increase in output pressure), connect the positive wire from the control to the positive terminal of the transducer and the negative wire to the negative terminal. For a reverse acting unit (e.g., increases current produces a decrease in output pressure), connect the positive wire from the control to the negative terminal and the negative wire to the positive terminal. Typical circuit diagrams are shown in figure 3.

Note

An antiseptic compound should be used on the case cover threads (marked AS in figure 5) to prevent the threads from galling.

ADJUSTMENTS

Assuming the 1 inch regulator has been adjusted to provide the proper supply pressure to the transducer, there are two adjustments incorporated into the Type 546. They are the zero adjustment and the span adjustment (figure 4). The zero adjustment is used to set the output pressure so that it corresponds to the proper value of the input signal. For example, if the output range is 3 to 15 ps and the input range is 0 to 5 mA dc and the unit is direct acting, the zero adjustment would be used to set the output pressure at 3 ps when the input signal is 0 mA. The span adjustment is used to set the span of the output pressure so that full output pressure change results from a full change in the
Types 546, 546S & 546ST

Figure 3 Typical Circuit Drawings

Figure 4 Zero and Span Adjustments (Cover Removed)

NPUT DC SIGNAL TO 5 MA
2500 OHMS

INPUT DC SIGNAL 4 TO 20 MA
176 OHMS

NPUT DC SIGNAL 0 TO 50 MA
90 OHMS

450 OHMS
TH3RM STOR
500 OHMS

NPUT DC SIGNAL TO 5 VOLTS
ADJUST RESISTANCE ACROSS
NPUT TERMINALS TO 300 OHMS

TYPE 546

76 OHMS

NTRANS CALLY SAFE
DC SIGNAL 4 TO 20 MA
TYPES 546S AND 546ST

magnet to shunt away or add to the magnet flux n the
armature a r gap Thus, the amount of torque produced n
the armature w vary accord ng y Turn ng the adjusting
screw c okwse w pu the magnet c mate a away from
the magnet and increase the span A abe nd cate the
drect on n wch an adjustment must be made to increase
the span.

The span adjustment s on y a vernor type and s not
designed to create a very rage change n output pressure
over ts fu range of adjustment Norma y, however, the
adjustment range w be suff cent to set the transducer
property.

If s not cffent, refer to the Span Adjustment
A gnment sect on under Troubleshoot ng.

PRECAUTIONS

There are severa precaut ons to be observed when work ng
on the Type 546 transducer f t s known that e ther the
torque motor or re ay needs to be rep aced for any reason,
p ase rep ace the ent re transducer.

1. The torque motor assembly which cons ts of perma-
nent magnets, po e pces, top and bottom po e pces,
pates, etc., shou d never be d sasembled because the eve
of ay et s that the magnets w decrease, and w not
return upon reassembly Consequent y, you w be unable to
obta n proper span. So, f t s known that the torque motor
(and/or re ay) are fau ty, rep ace the ent re transducer w th
a new one and return the fau ty un t to the factory for
repar F gure 6 shows the torque motor and associated
parts Those key numbers that are shaded nd cate the parts
that should not be d sassembled from the torque motor.
### OPERATIONAL CHANGES

#### To Change Output Pressure Range

It is necessary to change the output pressure range from 3 to 15 psi to 6 to 30 psi or vice versa, as the feedback be ows (key 57, figure 6) must be changed. To do this, proceed as follows:

1. Loosen the ocknut (key 31)
2. Remove the be ows screw (key 56)
3. Pu be ows assembly out. The armature sotted to ows be ows on the be ows
4. Inspect O ring (key 36). Replace, if necessary
5. Choose proper be ows as out ned n tab e 3 new be ows assembly. Make sure that the O ring is n place
6. Nsta be ows screw and tghten. Be sure be ows s not skewed n any d rect on Tghten ocknut
7. Reset the span and zero adjustments

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#### To Reverse the Action

No specia parts are required to reverse the action of the Type 546 transducer. The d rect on of armature rotaton w th a change n nput current s dependent upon the d rect on of the current f ow. Therefore, by s m p y revers ng the nput ends to the transducer, the oppos act on can be obta ned. Whenever the act on is changed, t s necessary to re zero the transducer as out ned n the sect on Adjustments

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**Note**

The Type 546S or 546ST cannot be reversed n the f ed because the protect ve d odes across the co s w effect ev y short the reverse nput current s gna. Do not attempt to reverse a Type 546S or 546ST. There s no danger, but the unit w not operate.

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#### Split Range Operation

Type 546 transducers are su tab e for two way sp t range operaton where n the m ampere output s gna of a s ng e contro e s sp t between two transducers eect ca y connected n ser es. Each transducer rece ves ha f of the s gna and transms a fu oput pressure range of 3 to 15 ps or 6 to 30 ps to the contro va ve. Since the Type 546 operates on on ye ha f of the norma nput span, t s necessary to change the feedback be ows to compensate for the shorter span. Refer to the sect on To Change Output Pressure Range, and change the be ows as desc bed there. The tab uat on of ava be ows nd cates what be ows w be ored for your cond t ons. Please note that s m p y interchang ng be ows n the Type 546 cannot provide a d way sp t range. Reset the span and zero adjustments to the sp t range va ues

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#### TROUBLESHOOTING

The f st step n a troubleshoot ng s to so ate the source of the d ff cu ty mproper supply pressure and mecha ca defects n ar n eect ca y connect ons shou d be apparent upon y su a exam nat on. The f ow ng po nts may serve as a gu d e n so at ng any troub e that mght occur

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**Electrical**

1. Check the contro er output. Make sure that t s reach ng the transducer
2. Check the eect ca y s gna t shou d be the same as the range stamped on the name pate
Types 546, 546S & 546ST

Coils

The coil assembly (key 42, figure 6) consists of a pastc bobbin wound with wire. The coils do not attach to the armature itself and therefore, they must not touch the armature or armature movement be restricted. If there is problem existing, send the transducer back to the factory for repair.

MAINTENANCE

Maintenance of the Type 546 transducer consists of mated relay assembly and recalibration of the feedback be low. Do not attempt any repairs of the torque motor assembly.

Relay

As noted in the precautions section, removal of the nner va ve and restrct on pug assembly. A new relay (figure 7) should be ordered if repair would require separating the relay body (key 60), casing spacer (key 61), and relay casing (key 62).

1. The relay can be removed without disrupting the transducer mounting. Refer to figure 7, loosen the two mounting screws (key 68) and remove the relay from the transducer. Be careful that the four O rings are not lost.

2. Remove two screws (key 77) that hold the nner va ve spring seat (key 64), and nner va ve (key 63) in place. Take these parts out.

3. Unscrew the restrict on pug or face assembly (key 67).

4. Inspect the O rings (keys 73, 72, 74, and 75), the nner va ve, and other parts for wear or damage. Note that the nner va ve seat is an insert in the body if there is part. bad, replace the relay and torque motor.

5. After checking and cleaning the fixed restrict on (0.017 inch diameter) n the restrict on assembly and n the relay body, make sure that the O ring (key 75) is good and in place. Then replace the restrict on assembly into the relay.

6. Replace the nner va ve and nner va ve spring. Secure them in place with the spring seat and two screws.

7. Make sure all O rings (keys 73, 72, 74) are good and in place then fasten the relay to the transducer case.

Feedback Bellows

Instructions for replacing the feedback bellows are found in the To Change Output Pressure Range section, page 6.
SERIAL NUMBER

A number is assigned to each transducer and is stamped on the nameplate attached to the cover. Always refer to the serial number when communicating with your supplier about the equipment and when ordering spare parts. Please note the complete equipment character part numbers from the following parts list when ordering spare parts.

![Figure 5: Type 546 Transducer](image)

- **Type 546, 546S & 546ST Transducers (Figure 5)**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transducer Case Assembly</td>
<td>1P4210 000A2</td>
</tr>
<tr>
<td>2</td>
<td>Case Cover a um num</td>
<td>3P4213 000A2</td>
</tr>
<tr>
<td>3</td>
<td>Pipe Fug cast iron</td>
<td>1A3619 19012</td>
</tr>
<tr>
<td>4</td>
<td>Tagging plate opt on SST</td>
<td>1R4851 38992</td>
</tr>
<tr>
<td>5</td>
<td>Nameplate a um num</td>
<td>1P4263 11032</td>
</tr>
<tr>
<td>6</td>
<td>O Ring Mtr e</td>
<td>1D4448 06992</td>
</tr>
<tr>
<td>7</td>
<td>Drive Screw stee p 2 req d</td>
<td>1A3062 28982</td>
</tr>
<tr>
<td>8</td>
<td>Gauge use w th f ter regulator on y</td>
<td>1P4263 11032</td>
</tr>
<tr>
<td>9</td>
<td>Mach ne Screw brass Cdp</td>
<td>1C2111 99012</td>
</tr>
<tr>
<td>10</td>
<td>Screw stee p 2 req d</td>
<td>1C3066 99012</td>
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- **Torque Motor (Figure 6)**

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<td>14</td>
<td>Adjust ng Screw</td>
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<tr>
<td>15</td>
<td>Spr ng Seat</td>
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<td>16</td>
<td>Spr ng Zero Adjustment</td>
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<td>18</td>
<td>Nozzle</td>
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<tr>
<td>26</td>
<td>Cap Screw</td>
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<tr>
<td>27</td>
<td>Cap Screw</td>
<td>1P4263 11032</td>
</tr>
<tr>
<td>28</td>
<td>Mach ne Screw</td>
<td>1P4263 11032</td>
</tr>
<tr>
<td>29</td>
<td>Hex Nut stee p</td>
<td>1P4263 11032</td>
</tr>
</tbody>
</table>

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Recommended tool parts:
1. For use manufactured by Vee Ap
2. Sae 27/32 OD
3. Sae 1 1/2 OD
4. Sae 3/8 OD
5. Brass copper
3 Check the resistance of the transducer core to see that it is not less than 50 ohms. If it is not, check the connections and the wiring.

4 Check the terms as for proper connections of the reverse action and the input picks. Re-zero the transducer (except on Type 546S or 546ST).

### Pneumatic

1. Check adjustments for proper settings.

2. Check supply pressure. Make sure that it is at least 60 psi higher than the upper limit of the output pressure range.

3. Check the Type 67FR filter regulator for an accumulation of moisture in the drum. Drain off through petcock, clean filter element, if necessary.

4. Make sure that there are no sharp bends in the copper capillary feedback tubing because they will restrict the open pressure feedback to the balance arm. Slow the transducer w cycle.

5. The nozzle size is 0.070 inch diameter. Do not attempt to remove the nozzle for cleaning because this cannot be done without disassembling the torque motor. However, if the nozzle clogged, remove the entire torque motor assembly from the case by removing four screws (key 9, figure 5). Then run a wire through the nozzle from the underside of the assembly.

6. Check the flame arresters (figure 5) to see if they need cleaning. To do this, the entire torque motor assembly as shown in figure 6 has to be removed from the case. The flame arresters are dry, clean by blowing them out with air pressure.

7. Check the torque motor assembly for metal chips in the armature and the pole pieces. Check for wear in the armature travel and reduce the flux across the armature to reduce the span and cause error of operation. Blow out any chipping with air pressure.

8. Perform a manual check on the operation of the transducer as follows. Hook up a suitably pressure gauge to measure the output pressure.

9. Force the baffle (key 18, figure 6) against the nozzle. The output pressure should drop off to less than 0.5 psi if it does not, the flame arresters and nozzle path probably needs cleaning. See item 6 above.

### Input—Output Linearity

For proper operation and satisfactory nearness between the input signal and output pressure, the armature (key 40, figure 6) must be centered between the faces of the pole pieces (key 49, figure 6). The armature is centered and aligned at the factory, but rough handling or unauthorized tampering with the transducer may move the armature off center.

For a check on the nearness of the transducer, hook up an accurate test pressure gauge to measure the output pressure, and an accurate test meter to measure the input signal. Vary the input signal over the full range and observe and note the output pressure. Pot a cap on the curve of input versus output and determine the nearness of the baffle beyond acceptable limits. Align the armature as described above.

The baffle screw (key 18, figure 6) can be adjusted to position the armature. Loosen the locknut and then turn the baffle screw in the direction of the armature to move the armature away from the nozzle. Sight the armature alignment by eye to see that it is centered between pole piece faces. Be careful when oosening or tightening the baffle screw locknut so that the collar of the zero adjustment spring (key 17, figure 6) are not stretched by the wrench.

### CAUTION

Never oosen a four cap screws (key 26, figure 6) at the same time. Reactment once the test is done with most key require factory equipment and such tests may be possible to oosen two screws on one side on y and move the entire support assembly (key 41, figure 6) to improve a gnment, but this is not recommended.

### Span Adjustment Alignment

If it is possible to set the required span, add 0.1 span adjustment can be obtained by shifting the entire span.
Types 546, 546S & 546ST

Figure 6 Torque Motor Assembly

Key | Description | Part Number
--- | --- | ---
Type B2 relay (figure 7) | | 
60 | Re ay Body a um num/brass | AP4203 X00B2
61 | Cas ng Spacer a um num | 
62 | Re ay Cas ng a um num | 
63 | inner Valve brass | 1P4195 14012
64 | Spr ng Seat brass | 1P4196 15102
65 | Lower D aphr gm Assy | 
66 | Upper D aphr gm n t r e | 
67 | Restr ct on Assy | 1U8180 000A2
68 | Re ay Mtg Screw stee Cdp 2 req d | 1P4203 24102
69 | Screen Mone t | 0L0783 43062
70 | Spr ng SST | 1P4204 37022
71 | Spr ng Re ay stee Cdp | 
72 | O R ng, n t r e | 
73 | O R ng n t r e 2 req d | 1P4207 06992
74 | O R ng n t r e | 1D6875 06992
75 | O R ng n t r e | 
76 | Mach ne Screw stee p 6 req d | 
77 | Mach ne Screw stee p 2 req d | 1A5120 28982
78 | Lockwasher stee p (2 req d) | 1H2671 28982

Figure 7 Type B2 Relay

Recommended spare parts:
1. Thimbles of various sizes, Fisher Co.