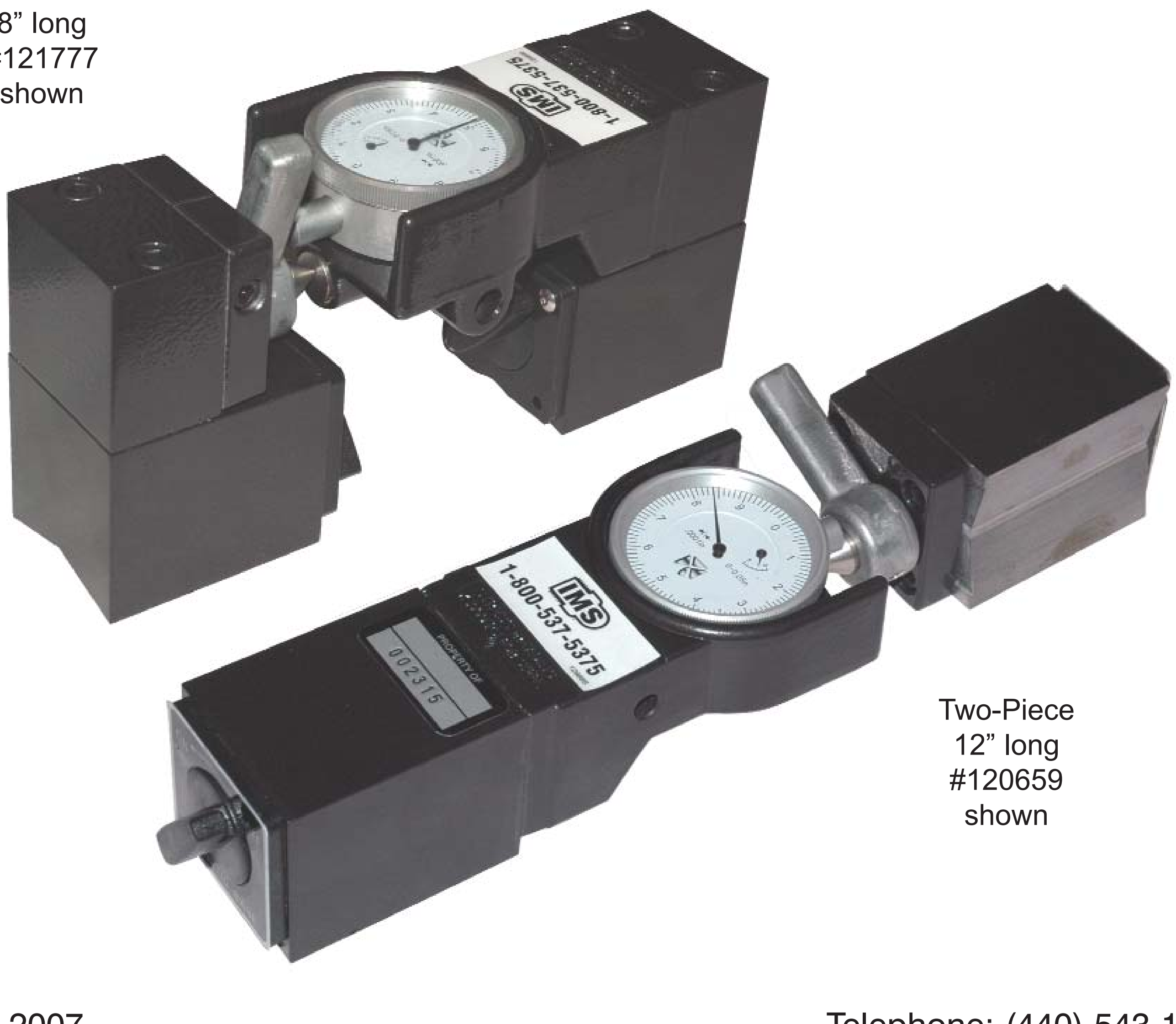
Tie Bar Strain Gauges

IMS # 121777, 120659

INSTRUCTION MANUAL

Two-Piece
8” long
#121777
shown



Two-Piece
12” long
#120659
shown

April, 2007

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SAFETY INSTRUCTIONS

This manual uses the following words to show different levels of danger:

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or property damage.

The following is a general warning that applies when using the Tie Bar Strain Gauge:

WARNING

MACHINERY can cause **DEATH** or **INJURY**

Using this tie bar strain gauge may involve being very close to a die casting machine clamp while the machine is moving. Die casting machine clamps are capable of very fast, extremely powerful movements that could kill you or severely injure you.

Follow machine's safety procedures when using gauge.

Test machine's safety devices before using gauge.

Do not defeat or bypass machine's guards or interlocks when using gauges.

Only qualified technicians are to use this gauge.

Use gauge only if it can be used safely on your machine.

IMS TIE BAR STRAIN GAUGE

The IMS Tie Bar Strain Gauge directly monitors the amount of stretch in a tie bar under strain. An amplifying arm proportions the stretch onto a dial indicator, yielding a strain reading. By relating the strain reading to the diameter of the tie bar, you can determine the actual strain level on that tie bar.

NOTE:
This gauge has been designed for machines in which there is 10,000 psi of pressure on each tie bar at full locking tonnage. Most injection presses fall into this category.

Because the gauge starts with a measurement of tie bar stretch, abnormally sized tie bars or abnormal machine designs could produce different readings.

Before using the readings from this gauge in a calculation of tonnage, determine the tie bar pressure for which your machine was designed. The equation for that determination is on page 9.

The measurement of strain on the four tie bars can be used two ways:

- To determine if there is equal locking pressure on all four tie bars
- To determine the actual tonnage the press is generating at lockup

The information acquired by using the Tie Bar Strain Gauge will help you obtain maximum, uniform press clamping pressure without overloading toggles or tie bars. Using this unique instrument will help to eliminate costly and unnecessary breakage while verifying the actual tonnage your press is delivering. The IMS Tie Bar Strain Gauge also comes in a special two-gauge package that allows you to check both sides of your press at the same time. For information concerning the special two-gauge package or for questions about the Tie Bar Strain Gauge, contact a IMS Customer Service Representative at 800-537-5375.

NOTE: INSTRUCTIONS ARE EASIEST TO UNDERSTAND IF YOU REFER TO THE PARTS IDENTIFICATION FIGURE ON PAGE 17 and 18.

TAKING MEASUREMENTS

1. Prepare Tie Bars

   a. Select a gauging position on each tie bar.
   Use the following criteria to select a location:

      (1) 14" run of tie bar needed for a 12" gauge, or 9" run needed for an 8" gauge.

   NOTE: The 12" gauge is easier to align than the 8" gauge, and is slightly more accurate. Use the 12" gauge if possible. In addition to the difference in length, there is a different bevel angle on the magnetic bases. The bevels on the larger gauge may not fit the radius of bars less than 2" in diameter. The smaller gauge may not fit bars larger than 6" in diameter.

      (2) Gauge should not be in way of any moving machine parts.

      (3) If possible, locate behind moving platen, but not on tie bar threads.

      If it is necessary to take readings in front of moving platen, take a reading on both the inward and outward sides of tie bar. Average the two readings. This averaging will compensate for possible tie bar bending caused by the stationary platen bowing during lockup.

      (4) If possible, use the top side of the bottom tie bars and the bottom side of the top tie bars. See figure 1 on page 3.

   b. Clean area on tie bar. Remove any dirt. Dirt could prevent the housings from being centered on the bar, therefore preventing accurate measurements. Leave a thin film of oil or grease.

NOTE:

If using this gauge on chrome plated tie bars, you will need to use a special set of clamps (available from IMS) to attach gauge to tie bar. Need additional information? Please call 1-800-537-5375.

FIGURE 1

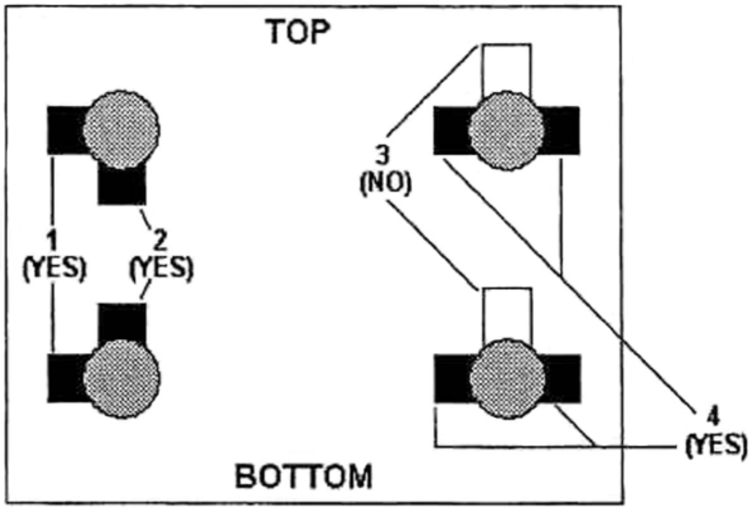


Figure 1 – Proper Combinations of Gauge Positions

2. Attach Gauge on Bar (**ONE-PIECE** STRAIN GAUGE)
The item numbers in Parentheses in the following procedure refer to Figure 2 on page 17.

a. Turn the actuator rod lock (figure 2, item 6) clockwise to tighten it. This will keep the magnetic bases aligned while the gauge is being installed on the bar.

b. While the clamp is open and hydraulic power is locked out to the clamp, hold the gauge on the bar.

Turn the magnet control lever (figure 2, item 1) on the indicator housing base (B) to the ON position.

c. Wiggle the indicator housing base until it is holding very firmly and is parallel with the tie bar.

d. Loosen the actuator rod lock (figure 2, item 6).

Hold the bases far enough apart that the dial indicator reaches the end of its travel. It should stop at about 2 - 1/2 turns.

Turn the zero-setting lever (3) to the 10 o'clock position (as viewed across the dial). Press the magnetic bases as close together as possible. Tighten the actuator rod lock. The dial indicator should read 9 + 3 divisions. If it does not, adjust the actuator rod according to the instructions on page 16.

e. Turn the magnet control lever on the actuator rod base (A) to the ON position.

f. Loosen the actuator rod lock. Move the zero-setting lever clockwise (as viewed across the dial) making sure the dial indicator goes past the 0 mark by the time the zero-setting lever reaches the one o'clock position. Make sure you can reach 2 on the indicator. If not, adjust the length of the actuator rod according to instructions on page 16.

g. Tap squarely on the far side of the actuator rod base while moving the zero setting lever, until there is little drag on the zero setting lever. There should be some resistance (to prevent backlash), but the movement should not be tight.

This will indicate that the bases are aligned (with the actuator rod sliding through the bore in the indicator housing without resistance).

Try to wiggle the base. The base and needle should not move.

Install Gauge on Bar (**TWO-PIECE** STRAIN GAUGE)

The item numbers in parentheses in the following procedure refer to Figure 2 on page 18.

a. Place the magnet base containing the indicator (B) on the bar with the indicator on the left side. Turn the magnet handle (1) on the and insure the base is seated on the tie bar and locked down by trying to move it.

b. Place the magnet base (A), with the zeroing lever (3) in the 10 o'clock position, against the actuator rod (5) of the first magnet. Push toward indicator until indicator long hand reads between 7 & 9, short hand on 0. Turn the magnet handle (1) on and insure that base is seated on the tie bar and locked down by trying to move it.

c. Move the zeroing lever (3) away from you. It should start to move by the time you reach the far corner of the magnet.

d. Place the long hand on "0". Gently try to move each magnet. You should not get a movement of the indicator.

3. Zero the Gauge

a. Move the zero-setting lever (3) back and forth. Check for light resistance. Redo steps (d) through (g) in the One-Piece Instructions if there is more than light resistance.

> **NOTE:**
> **The first time you use gauge on any particular machine, take readings from various places on the bar. Find locations that give the most repeatable values.**

b. Turn the zero-setting lever until the indicator needle is pointing to the zero.

4. Take Measurements

a. Close safety gates. Enable machine.

b. Run machine 2 or 3 cycles. The vibration of the machine while it is cycling will help to seat the gauge.

c. Use machine's manual mode and a slow clamp speed to inch clamp into fully locked position.

d. Disable machine. Open safety gates.

e. Read Dial indicator. Record results.

f. Close safety gates. Enable machine. Open clamp just enough to part the dies.

g. Disable machine. Open safety gates.

h. Read Gauge, It should read 0 ± 3 divisions. If it does not return to 0 ± 3 divisions, magnets are slipping on tie bar. Make sure tie bar and magnets are clean and free of burrs.

i. Repeat steps a through h. You should obtain the same result.

j. (One –Piece Only) Lock the actuator rod lock. Unlock magnetic bases and remove gauge.

5. Repeat gaging procedure for all four-tie bars.

6. Remove and store gauge.

   Take gauge off tie bars, turn magnetic locking levers OFF and store gauge in the wooden box in which it was shipped. Keep boxed gauge in a dry area, protected from extreme temperatures.

CAUTION :
Constant shock and vibration can knock gauge out of calibration.
Do not leave gauge on tie bar when you are not using it..

CAUTION :
Leaving locking levers in ON position will wear out magnets.
Do not leave locking levers in ON position.

DETERMINING TIE BAR PRESSURE FOR WHICH YOUR MACHINE WAS DESIGNED

$P=F_T/area_T$

where:
P = pressure expected on tie rod at full lockup {psi}

F_T = total rated force {lbs} {= total rated tonnage x 2000lbs}

$area_T = 4 \times 3.14 \times (D/2)^2$ {sq in} {D= diameter of one tie bar}

If P does not equal 10,000 psi, divide P by 10,000.

When any equation in the manual calls for an actual reading (R), multiply the reading by P/10,000 first. Do not multiply R_T by P/10,000, however.

EXAMPLE:

100-ton press with 2.5" diameter tie bars.
$P = 100 \times 2000 / 4 \times 3.14 \times (2.5/2)^2$
= 200,000 / 19.625
= 10,191
10,191 / 10,000 = 1.019

USING READINGS TO DETERMINE TONNAGE

1. The first step in using readings is to determine tie bar pressure for which your machine was designed. Use the equation on page 9. For machines not set up for 10,000 psi at full lock-up, all tonnage figures must be adjusted.

2. Use readings and equations in one or more of the following ways:

    a. **To find tonnage of one tie bar** (see below)

    b. **To approximate machine tonnage** (without using math, see page 11 for graph method and table method)

    c. **To compute machine tonnage** (see page 12)

FINDING TONNAGE OF ONE TIE BAR

The formula for finding the tonnage of one tie bar is:

T = strain x area
T = R/2 x pi x $(D/2)^2$

where:

T =tonnage
R =dial reading at lockup
D =diameter of tie rod (in inches)

Take pi to 2 places; use 3.14
The formula becomes:

T = R/2 X 3.14 X $(D/2)^2$

EXAMPLE:

Gauge reads 10
5" diameter tie bar
T =10/2 x 3.14 x $(5/2)^2$
=5 x 3.14 x 6.25
=98.125 tons

Refer to tie bar adjustment notes on page 14 for adjustment information.

APPROXIMATING TOTAL MACHINE TONNAGE

There are two ways to approximate total tonnage of your machine once you know what strain is on each tie bar.

1. Using Graph (page 19)

   When your average tie bar readings are between 8 and 12, you can use figure 3 on page 19 to find approximate tonnage of your machine.

   a. Average readings from four tie bars.

   b. Find diagonal line in figure 3 that corresponds to average dial reading.

   c. Find horizontal line corresponding to diameter of your tie bars (1" thru 14").

   d. Locate point where horizontal line (tie bar) meets diagonal line (average reading).

   The vertical line that goes through that point represents the tonnage of your machine.

   For example, if average reading from a machine with 5" tie bars were "9", the total locking tonnage would be 350.

2. Using Table 1 (page 20)

   Table 1 is based on a reading of 10 on machines with tie bars that are designed for 10,000 psi pressure at full lockup. It can be used for readings other than 10, but cannot be used for machines rated other than at 10,000 psi. To use this table:

   a. If you have a reading of 10 for a single tie bar or an average of 10 for 4 tie bars:

      1. Find horizontal row in Table 1 that corresponds to your tie bar diameter.

      2. Look under either single tie bar or total tonnage column for tonnage.

b. If you have a reading or average other than 10:

1. Divide actual reading by 10.
2. Find horizontal row in Table 1 that corresponds to your tie bar diameter.
3. Multiply tonnage listed in that row of table by the number obtained by dividing actual reading or average by 10.

COMPUTING TOTAL MACHINE TONNAGE

To find total tonnage of the machine:

T =total strain x area of one tie bar

$= R_T / 2 \times pi \times (D/2)^2$

where:

T =tonnage

R_T =total of dial readings

D =diameter of one tie bar (in inches)

Take pi to 2 places; use 3.14

Add dial readings from individual tie bars (R_1 =reading from tie bar 1, etc.) to get total.

$R_T = R_1 + R_2 + R_3 + R_4$

The formula becomes:

$T = R_T / 2 \times 3.14 \times (D/2)^2$

EXAMPLE:

Tie bar diameter = 5 inches

Readings are 9.8, 10, 10.2, 10

R_T = (9.8 + 10 + 10.2 + 10)

= 40

T = 40/2 x 3.14 x $(5/2)^2$

= 20 x 3.14 x 6.25

= 392.5 tons

This tells you the actual tonnage of your machine. If the value is above machine's rated tonnage, adjust tie bar nuts as needed. Adjust tie bars to be equal.
Recheck all tie bars after adjustment. See the tie bar adjustment notes on page 14 for more adjustment information.

CALCULATING TARGET DIAL READING

Use this formula to obtain dial reading you should receive when machine is creating its maximum rated tonnage. Avoid exceeding that number on any tie bar.
This formula is valid only on machines designed for 10,000 psi on tie bars.

$Rp = 2 \times T_r / area_T$

where:

Rp = predicted reading

T_r = rated machine tonnage

$area_T$ = total area of four tie bars

The formula for total area is:

area = pi x D^2

where D =diameter of one tie bar

Take pi out 2 places; use 3.14

The formula then becomes:

$Rp = 2 \times T_r / 3.14 \times D^2$

EXAMPLE:

Rated tonnage of 400 tons

Tie bar diameter of 5"

$Rp = 2 \times 400/\{3.14 \times (5)^2\}$

$= 800/78.5$

= 10.191 reading on dial

ADDITIONAL GAUGE USE NOTES

1. Tie Bar Adjustment Notes

   a. Use tie bar nuts to set all tie bars to same tonnage. Contact your machine manufacturer for allowable variance from tie bar to tie bar. Do not vary tonnage among tie bars without approval of machine manufacturer. For any one tie bar, do not exceed 1/4 of total rated tonnage of machine.

   b. Recheck all tie bars after adjusting one; changing load on one tie bar will change load on all of them.

   c. If adjusting tie bars when mold is cold, adjust for a slightly lower tonnage. Tonnage will increase as mold gets warmer and expands.

   d. It is possible to compensate for wearing toggle components and a weakening hydraulic cylinder by adjusting tie bars to equal tension.

2. Extra Heavy Molds
   With a particularly heavy mold on a press with worn slides, weight of mold may bend tie bars. The gauge can be used to detect this sort of bending.

   a. Stop clamp at various positions in its stroke and check gauge reading.

   b. Any strain registering on gauge when clamp is not locked would be due to weight of platen and mold on tie bars.

   c. When measuring tonnage on a press that has tie bars bending due to heavy mold, take a reading on both inward and outward sides of tie bars. Average two readings. This method will eliminate the effects of sag from the strain calculation.

3. Press Wear
   Falling tonnage readings could indicate worn clamp, cylinder or pump.

4. Machines with Solid Cast Frames
   Test machine with solid cast frames, (ex: old Lesters), using basically the same procedure as for tie bars. Choose clean, paint-free, smooth sections of the cast frames. Compute area of frame using the equation:

   area = length x width

TROUBLESHOOTING

1. Zero-setting knob does not move freely
    - Bases out of alignment

2. Gauge won't zero
    - Move bases closer together until gauge drops below zero. Then zero with zero-setting knob.

3. Readings much different than predicted
    - Take new readings from locations on bar that are separated by 90 degrees from locations where old readings were taken.
    - Recalculate predicted readings.
    - Make sure bases are aligned on tie bar.
    - Make sure tie bars are clean and lubricated.
    - Clean and inspect gauge according to instructions in Adjusting and cleaning (pg. 16).
    - There should be a little anti-backlash tension on zero-setting lever. Check this when bases are not together. Adjust backlash screw if necessary.
    - Zero-setting lever should be at about 5 or 6 o'clock (as viewed across dial) when end of actuator rod is flush with back face of front of housing (viewed through slot in housing).
      To adjust: Loosen set screw on zero-setting lever, slide lever in or out on actuator rod as necessary. Tighten set screw. Check adjustment again. Readjust if necessary.
    - Was your machine designed for less than 10,000 psi pressure on tie bars? To find out, use the following formula:

$P = F_T / area_T$

where:

P = pressure {psi}
F_T = total rated force (lbs) = (total rated tonnage x 2000 lbs)
$area_T = 4 \times 3.14 \times (D/2)^2$ {sq in}   (D = dia of one tie bar)
If P does not equal 10,000 psi, divide P by 10,000.

When any equation in the manual calls for an actual reading (R), multiply reading by P/10,000 first. Exception: Do not multiply R_T by P/10,000.

ADJUSTING AND CLEANING

Other than keeping gauge clean and dry, there is no maintenance necessary as long as gauge is maintaining relative accuracy.

If the gauge is losing accuracy or is not returning to zero after starting the cycle at zero, try the following procedures to locate and correct the problem. If these procedures do not solve the problem, contact IMS Tech Support at 1-866-467-9001.

1. Check Dial Indicator Position (**ONE-PIECE** gauges)

Dial indicator may have shifted in housing. To return it to its proper position:

a. Loosen dial indicator clamping screw (Figure 2, item 4). Separate the bases.

b. Press indicator all the way into indicator housing.

c. **GENTLY** tighten dial indicator clamping screw.
DO NOT screw too tightly. If it is too tight, it will interfere with indicator movement.

d. Reassemble the bases. Press the bases together to make sure indicator needle moves freely.

e. Move bases all the way together, then all the way apart. There should be approximately 2 - 1/2 revolutions of dial. If there are too many or not enough revolutions, adjust actuator rod length as follows.

2. Actuator Rod Length Adjustment (**ONE-PIECE** gauges)

a. Loosen the actuator lock. Separate the bases.

b. Loosen socket head set screw in side of actuator rod.

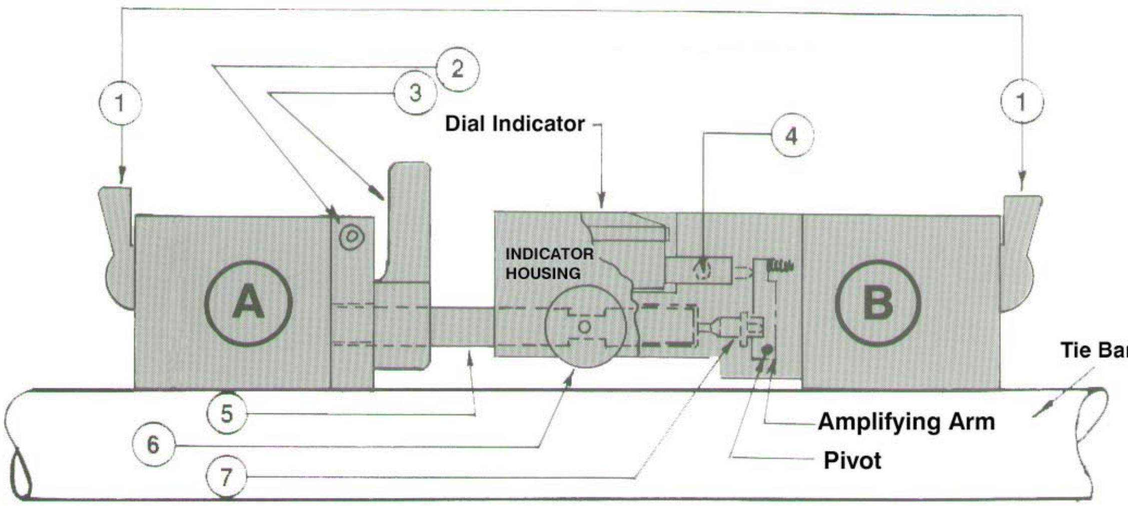
c. Use soft-jaw pliers to turn headless screw in end of shaft. Turn screw only a slight amount; a length change of .001" will mean 1/3 revolution of dial. Turn screw clockwise if dial indicator does not reach 0 in step f located on page

7. Turn screw counterclockwise if dial indicator does not drop to 9±3 when bases are pressed together during setup (step d on page 6).

d. Tighten set screw lightly.

e. Reassemble the bases. Check again for 2 - 1/2 revolutions. Readjust as necessary.
It may take several attempts to get adjustment right.

FIGURE 2
PARTS IDENTIFICATION (ONE-PIECE STRAIN GAUGE)



(A) ACTUATOR ROD BASE

Holds actuator rod in line with tie bar axis and in alignment with indicator housing bore.

1. Magnet Control Levers - Control magnetic attachment force between magnetic bases and tie bar.
2. Backlash Adjustment Screw - Controls looseness in threaded connection between actuator rod and its housing. Screw should be adjusted to produce a little stiffness in the movement of the Zero-Setting Lever.
3. Zero-Setting Lever.
4. Dial Indicator Clamping Screw - Holds dial indicator in proper position. Do not screw too tightly; this will lock up indicator movement. Extreme tightening will permanently damage indicator.

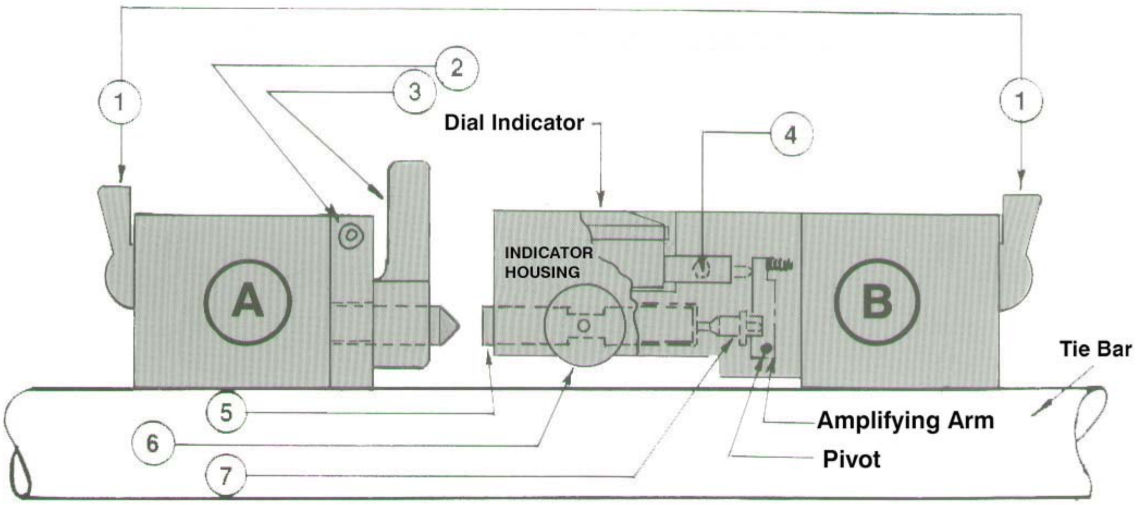
(B) INDICATOR HOUSING BASE

Holds indicator housing in line with tie bar axis and with actuator rod. Contains indicator and related mechanism.

5. Actuator Rod - Spaces the two magnetic bases the proper distance apart and transmits tie bar stretch to Amplifying Arm Mechanism.
6. Actuator Lock - Holds the two magnetic base units together so the instrument can be moved easily between tests. Loosen knob during test. Retighten knob before turning magnets off, and before removing instrument from tie bar. Always make certain actuator lock screw engauges undercut in rod (as indicated in sketch) when reassembling.
7. Amplifying Arm Mechanism - Transmits rod movement to, and amplifies the tie bar.

FIGURE 2
PARTS IDENTIFICATION (<u>TWO-PIECE</u> STRAIN GAUGE)

FIGURE 2
PARTS IDENTIFICATION (TWO-PIECE STRAIN GAUGE)



(A) ACTUATOR ROD BASE

Holds actuator rod in line with tie bar axis and in alignment with indicator housing bore.

1. Magnet Control Levers - Control magnetic attachment force between magnetic bases and tie bar.
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Holds indicator housing in line with tie bar axis and with actuator rod. Contains indicator and related mechanism.

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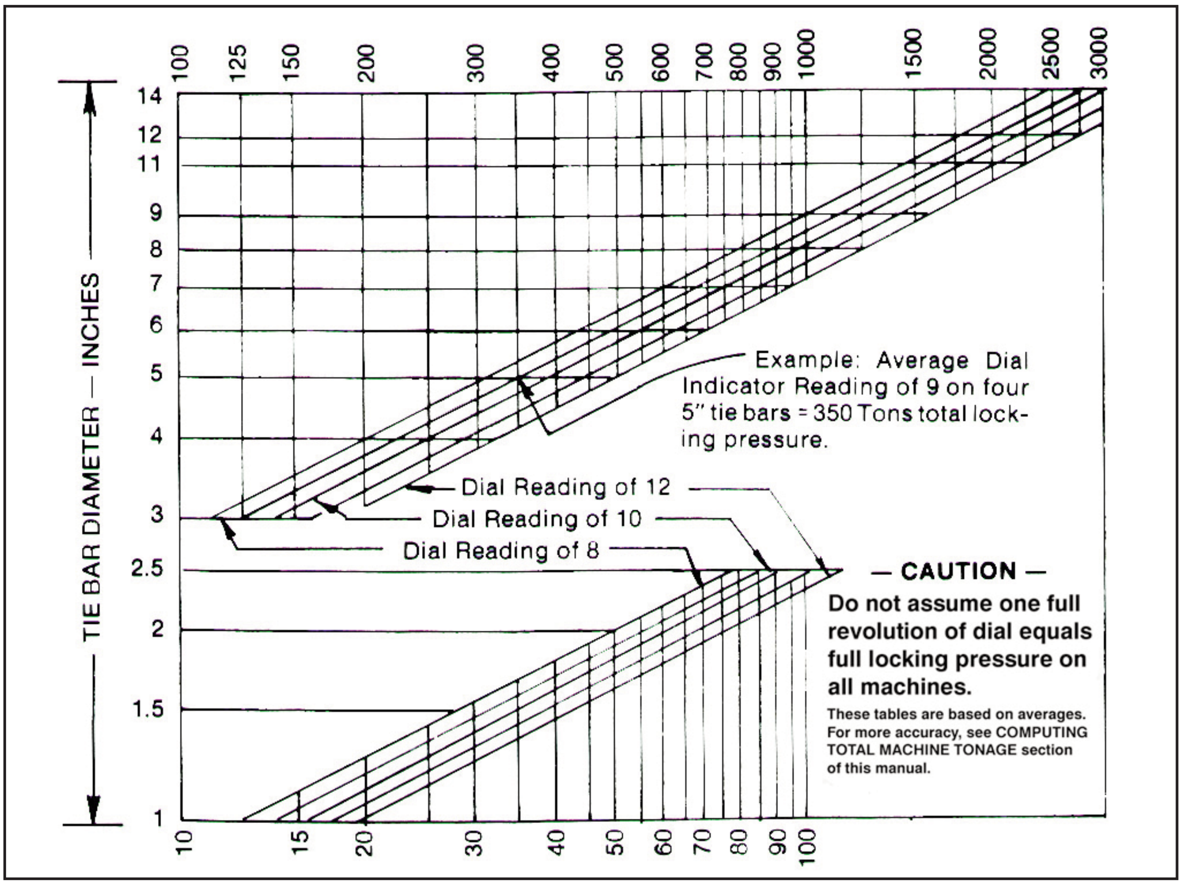
7. Amplifying Arm Mechanism - Transmits rod movement to indicator, and amplifies the tie bar stretch.

FIGURE 3

APPROXIMATE TONNAGE

NOTE:
This graph applies only to machines designed for 10,000 psi on tie bars at lockup. See COMPUTING TIE BAR PRESSURE section of this manual.



TOTAL LOCKING PRESSURE IN TONS, ON FOUR TIE BARS
at average dial indicator readings from 8 to 12.

The Diagonals on the above chart represent averaged dial readings of 8, 9, 10, 11, and 12 units on Strain Gauge dial where 10 equals one complete revolution on indicator. Do not use this graph for readings under 8 or over 12; use formula in COMPUTING TOTAL MACHINE TONNAGE section of this manual.

TABLE 1
APPROXIMATE TONNAGE

Tie Bar Diameter (inches)	Tonnage Per Tie Bar (at reading of "10")	Total Tonnage (average reading of “10")
2	16	64
3	35	140
4	63	252
5	98	392
6	141	564
7	193	772
8	251	1004
9	318	1272
10	393	1572
12	565	2260
14	770	3080

Based on reading of "10" on machines designed for 10,000 psi pressure on tie bars.

For readings other than "10", divide the actual or average readings by 10. Multiply the listed tonnage by the result.

WARRANTY

Seller fully warrants that equipment, service, repair or parts supplied shall conform to the description in the quotation and agrees to repair or replace F.O.B. shipping point, any parts (excepting expendable items such as ladle cups, ladle attachment brackets, ladle attachment arms, hydraulic seals, fuses, etc), services, or repairs that fail due to defects in material or workmanship within (1) one year of start-up of equipment or eighteen (18) months after shipment, whichever occurs first, or in the case of service, repairs, or part within one (1) year of supplying such service, repair, or part. If the equipment, service, repair, part includes software, Seller warrants, for a period of one (1) year of start-up or eighteen (18) months after shipment, whichever occurs first, that the software supplied or serviced will meet its published functional specifications. Should software fail to meet the specifications, or be otherwise defective, Seller shall promptly correct errors or non-conformities. If correction is not possible, Seller shall replace defective software, or, at Seller's option, refund the purchase price paid for such software. Other than those expressly state herein, THERE ARE NO OTHER WARRANTIES OF ANY KIND, EXPRESSED OR IMPLIED, AND SPECIFICALLY EXCLUDED, BUT NOT BY WAY OF LIMITATION, ARE THE IMPLIED WARRANTIES OF FITNESS FOR PARTICULAR PURPOSE AND MERCHANTABILITY.

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NOTES