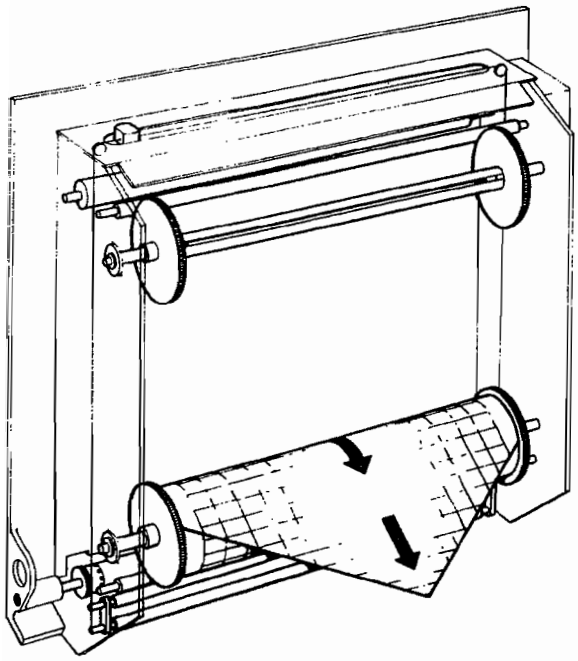
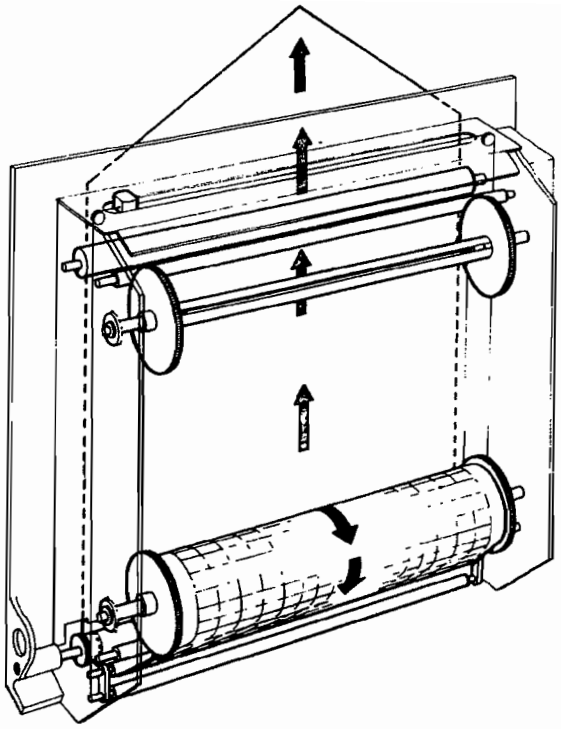
EXHIBIT C

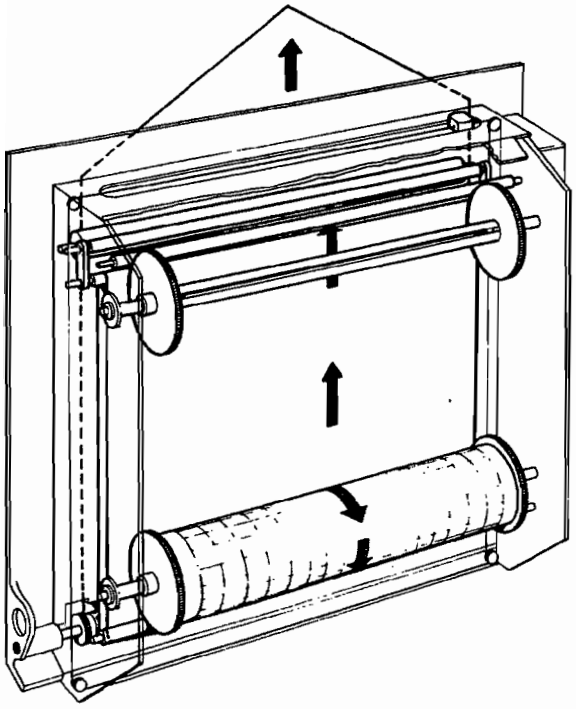
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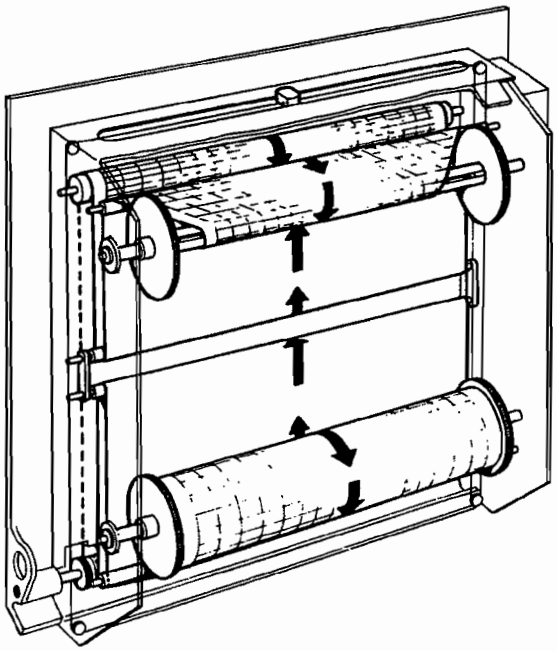
a. Install chart roll on supply roller flanges



b. Feed through reciprocating roller, and over drive roller and platen



c. Allow surplus paper to feed back while moving reciprocating roller up under take-up roller



d. Feed through reciprocating roller, over guide roller, and wind on take-up roller

Figure 5-3. Loading Recorder with Chart Paper

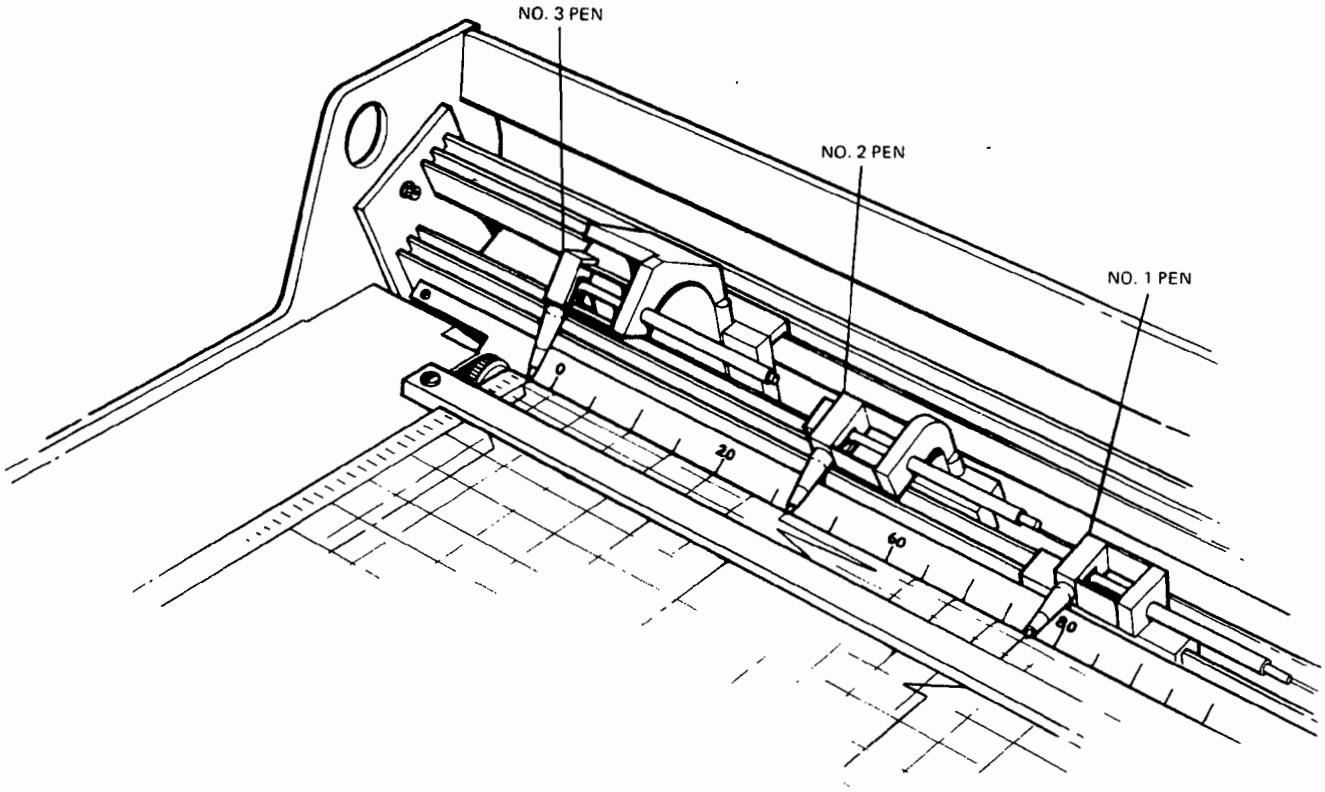


Figure 5-4. Recorder Pen Identification for an Optional 3-Pen Mount

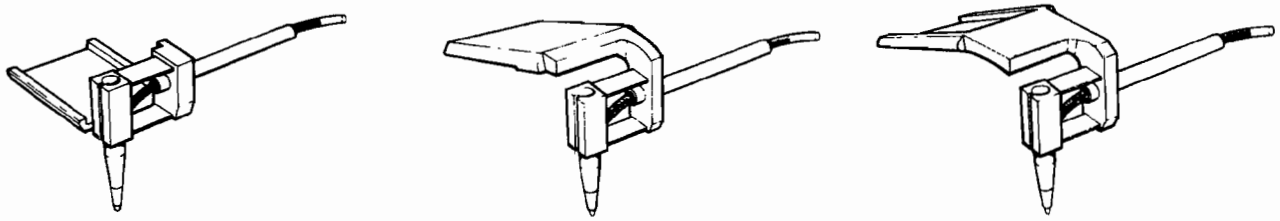
Three types of pen holders are used as shown in figure 5-5.

To change a recorder pen, proceed as follows:

a. Release pen hood by inserting a finger of each hand into hole on both sides of pen housing and pushing up on hood. Withdraw hood while tilting it slightly forward for clearance.

b. Remove pen holder by grasping it as shown in figure 5-6 and sliding unit up and out of carriage.

c. Withdraw pen mount and used pen from holder as shown in figure 5-7. Remove used pen from mount.



Pen Holder No. 1 Pen Holder No. 2 Pen Holder No. 3

Figure 5-5. Recorder Pen Holder Types

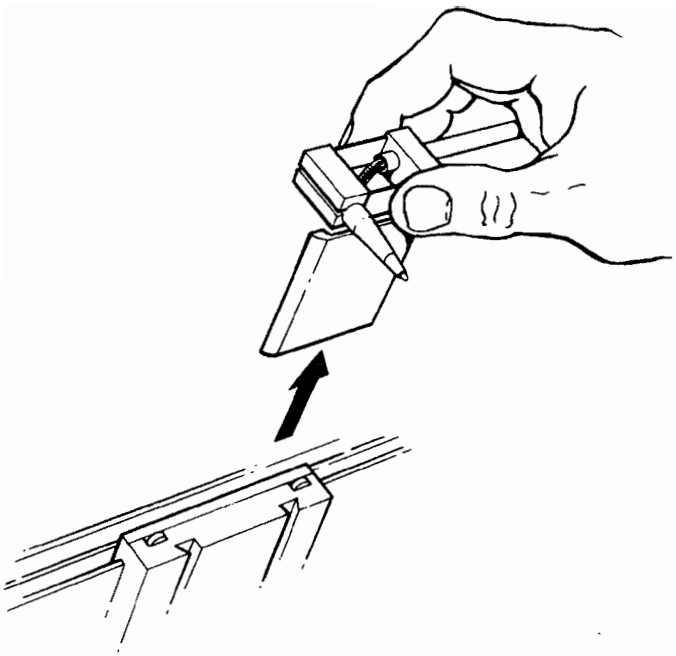


Figure 5-6. Removing Pen Holder from Carriage

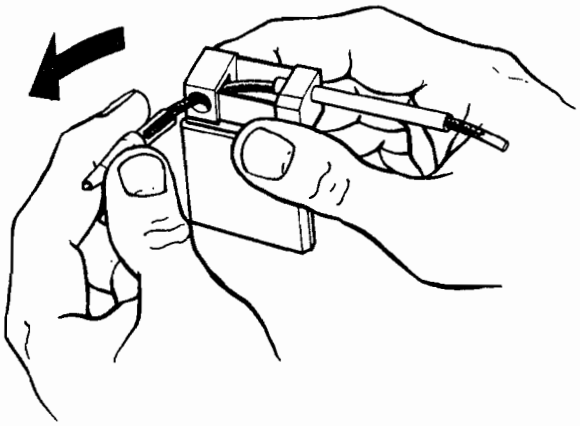


Figure 5-7. Removing Pen from Holder

d. Insert a new ball point pen cartridge into mount (figure 5-8). Color of ink should match color of mount.

e. Carefully insert pen reservoir into holder and form it, without kinking to fit into hole containing protective tubing. Remove tubing temporarily for ease of insertion. Press pen mount firmly into holder. Cut pen reservoir slightly shorter than protective tubing and install tubing.

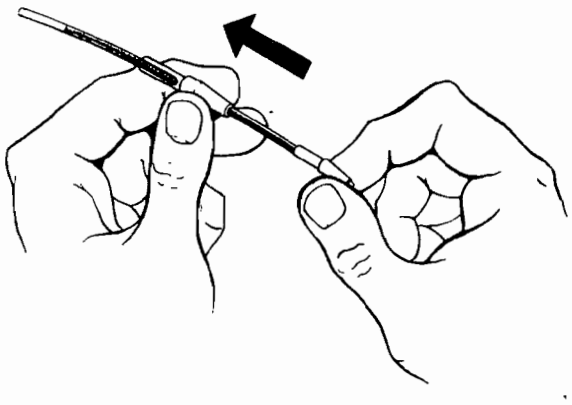


Figure 5-8. Inserting Pen in Mount

f. Slide pen holder assembly fully into carriage. Install hood, ensuring that clips engage pins at bottom.

NOTE: Recorder pen writing pressure is fixed and need not be adjusted. Run pen several times over chart paper until ink flows.

5.2.3 Pen Drive Mechanism Access

To open the recorder for access to pen drive assembly, proceed as follows:

a. With recorder in operating position, press lock buttons on both slides. Carefully pull unit out until "tip-out" panel, mounted above recorder, drops to a vertical position and lock buttons on slides just clear outer brackets.

CAUTION

Do not extend recorder beyond this point, as unit will drop out of slide retaining brackets.

b. Insert a finger into a lifting hole, on either side of pen carriage housing, and pull recorder assembly up to a vertical position.

c. To restore recorder to operating position: lower unit onto brackets, press slide lock buttons, lift "tip-out" panel and push unit in until slide buttons click into lock position.

5.3 SELECTING A LOAD CELL

A load cell of adequate capacity should be selected in accordance with the characteristics of the material to be tested and the following general guidelines:

a. The load cell capacity should be greater than the maximum testing loads anticipated.

b. If a choice is possible between two different cells because of their overlapping ranges:

(1) Select a higher-capacity load cell and use it on its lower load ranges whenever a minimum of deflection is desired.

(2) Select a lower-capacity load cell and use it on the higher load ranges whenever a maximum of long term balance or stability is desired.

Each load cell is supplied with the fixtures required for a standard application of the cell. Various optional devices for special cases are available from Instron.

NOTE: A compression overload carriage accessory is recommended for use with compression load cells of 1000 pounds (500 kg) capacity or less.

The load cell chart in paragraph 4.5 lists the cells, usable with the 1125 instrument, by application. Figure 5-9 is a listing of these cells, specifying for each cell: the usable full scale load ranges; the method of calibrating (mechanical or electrical); and the load cell amplifier FULL SCALE RANGE switch setting for calibrating purposes.

5.4 INSTALLING A TENSION LOAD CELL

Testing a specimen in tension may be done above or below the moving crosshead by mounting the load cell in the fixed or moving crosshead. Tension cells are supplied with a self-aligning coupling for connecting grips or other fixtures. A grip adapter, for base or crosshead, is supplied with the instrument on the baseplate between the columns.

Install a tension load cell as follows:

a. Lower load cell into hole position in center of fixed or moving crosshead (figure 5-10). Fit dowel holes in cell flange over dowels in crosshead.

b. Fasten load cell in place with bolts provided.

NOTE: The load cell can be left unbolted if the sample material does not recoil or release elastic energy when it ruptures. Leaving the cell loose also provides protection against accidental reverse-loading if the grips are forced together.

c. Attach self-aligning coupling to load cell spindle (figure 5-11). If testing is to be done above moving crosshead, remove grip adapter from baseplate and install in position on top of moving crosshead.

d. Insert load cell cable plug into connector. Ensure that load cell cable is secured out of testing area. Allow slack in cable if load cell is mounted in moving crosshead.

DN00009170

ENGLISH LOAD CELLS

Full Scale Range Switch Setting	0.1	0.2	0.5	1	2	5	10	20	50	100	200
Load Cell	Full Scale Ranges										
2511-103	0-0.1 lb	0-0.2 lb	0-0.5 lb	0-1 lb C	0-2 lb	0-5 lb	0-10 lb	0-20 lb	0-50 lb		
2511-105			0-0.5 lb	0-1 lb	0-2 lb	0-5 lb C	0-10 lb	0-20 lb	0-50 lb	0-100 lb	0-200 lb
2511-202	0-0.1 lb	0-0.2 lb	0-0.5 lb	0-1 lb C	0-2 lb	0-5 lb	0-10 lb	0-20 lb	0-50 lb		
2511-204			0-0.5 lb	0-1 lb	0-2 lb	0-5 lb C	0-10 lb	0-20 lb	0-50 lb	0-100 lb	0-200 lb
2511-301		0-2 lb	0-5 lb	0-10 lb	0-20 lb	0-50 lb	0-100 lb	0-200 lb	0-500 lb C	0-1000 lb	
2511-325	0-10 lb	0-20 lb	0-50 lb	0-100 lb	0-200 lb	0-500 lb	0-1000 lb	0-2000 lb C	0-5000 lb		
2511-303		0-20 lb	0-50 lb	0-100 lb	0-200 lb	0-500 lb	0-1000 lb	0-2000 lb	0-5000 lb C	0-10,000 lb	
2511-305			0-50 lb	0-100 lb	0-200 lb	0-500 lb	0-1000 lb	0-2000 lb	0-5000 lb	0-10,000 lb C	0-20,000 lb

METRIC LOAD CELLS

Full Scale Range Switch Setting	0.1	0.2	0.5	1	2	5	10	20	50	100	250
Load Cell	Full Scale Ranges										
2511-101	0-1 g	0-2 g	0-5 g	0-10 g C	0-20 g	0-50 g	0-100 g	0-200 g	0-500 g		
2511-102	0-10 g	0-20 g	0-50 g	0-100 g C	0-200 g	0-500 g	0-1 kg	0-2 kg			
2511-104	0-100 g	0-200 g	0-500 g	0-1 kg C	0-2 kg	0-5 kg	0-10 kg	0-20 kg	0-50 kg		
2511-106		0-200 g	0-500 g	0-1 kg	0-2 kg C	0-5 kg	0-10 kg	0-20 kg	0-50 kg	0-100 kg	
2511-201	0-10 g	0-20 g	0-50 g	0-100 g C	0-200 g	0-500 g	0-1 kg	0-2 kg			
2511-203	0-100 g	0-200 g	0-500 g	0-1 kg C	0-2 kg	0-5 kg	0-10 kg	0-20 kg	0-50 kg		
2511-205		0-200 g	0-500 g	0-1 kg	0-2 kg C	0-5 kg	0-10 kg	0-20 kg	0-50 kg	0-100 kg	
2511-302	0-1 kg	0-2 kg	0-5 kg	0-10 kg	0-20 kg	0-50 kg	0-100 kg	0-200 kg C	0-500 kg		
2511-326			0-5 kg	0-10 kg	0-20 kg	0-50 kg	0-100 kg	0-200 kg	0-500 kg	0-1000 kg C	0-2500 kg
2511-304	0-10 kg	0-20 kg	0-50 kg	0-100 kg	0-200 kg	0-500 kg	0-1000 kg	0-2000 kg C	0-5000 kg		
2511-306		0-20 kg	0-50 kg	0-100 kg	0-200 kg	0-500 kg	0-1000 kg	0-2000 kg	0-5000 kg C	0-10,000 kg	

Figure 5-9. Technical Data for Load Cells Usable with Model 1125 Instrument (See Notes) – Sheet 1 of 2

SI LOAD CELLS

Full Scale Range Switch Setting	0.1	0.2	0.5	1	2	5	10	20	50	100	250
Load Cell	Full Scale Ranges										
2511-109	0-0.01 N	0-0.02 N	0-0.05 N	0-0.1 N C	0-0.2 N	0-0.5 N	0-1 N	0-2 N	0-5 N		
2511-110	0-0.1 N	0-0.2 N	0-0.5 N	0-1 N C	0-2 N	0-5 N	0-10 N	0-20 N			
2511-111	0-1 N	0-2 N	0-5 N	0-10 N C	0-20 N	0-50 N	0-100 N	0-200 N	0-500 N		
2511-112		0-2 N	0-5 N	0-10 N	0-20 N C	0-50 N	0-100 N	0-200 N	0-500 N	0-1 kN	
2511-208	0-0.1 N	0-0.2 N	0-0.5 N	0-1 N C	0-2 N	0-5 N	0-10 N	0-20 N			
2511-209	0-1 N	0-2 N	0-5 N	0-10 N C	0-20 N	0-50 N	0-100 N	0-200 N	0-500 N		
2511-210		0-2 N	0-5 N	0-10 N	0-20 N C	0-50 N	0-100 N	0-200 N	0-500 N	0-1 kN	
2511-317	0-10 N	0-20 N	0-50 N	0-100 N	0-200 N	0-500 N	0-1 kN	0-2 kN C	0-5 kN		
2511-327			0-50 N	0-100 N	0-200 N	0-500 N	0-1 kN	0-2 kN	0-5 kN	0-10 kN C	0-25 kN
2511-318	0-100 N	0-200 N	0-500 N	0-1 kN	0-2 kN	0-5 kN	0-10 kN	0-20 kN C	0-50 kN		
2511-319		0-200 N	0-500 N	0-1 kN	0-2 kN	0-5 kN	0-10 kN	0-20 kN	0-50 kN C	0-100 kN	

NOTES:

1. Numbers shown in each row indicate load range available at each setting of FULL SCALE LOAD switch on load cell amplifier panel. For load cell in use, position outer dial of FULL SCALE LOAD switch so settings above unshaded section ▭ in figure appear in white background of dial. Settings shaded ▨ (orange) are most sensitive ranges of load cell. Settings shaded ■ (grey/black) are not usable.

2. Only the 2511-300 series load cells are electrically calibrated; all others must be calibrated using precision weights.

3. A 'C' in one section of each row indicates FULL SCALE LOAD switch setting for calibrating that load cell.

Figure 5-9. Technical Data for Load Cells Usable with Model 1125 Instrument (See Notes) – Sheet 2 of 2

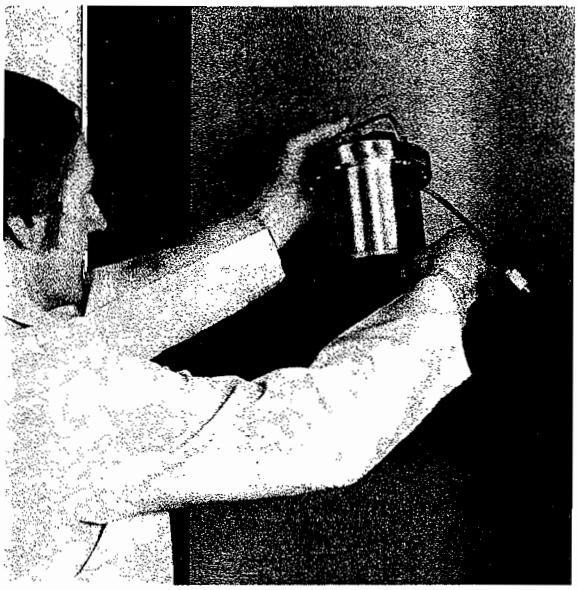


Figure 5-10. Installing a Tension Cell in the Moving Crosshead

5.5 INSTALLING A COMPRESSION LOAD CELL

Testing a specimen in compression is done below the moving crosshead, but the load cell may be mounted in two positions: in the moving crosshead (figure 12a); or on the base-

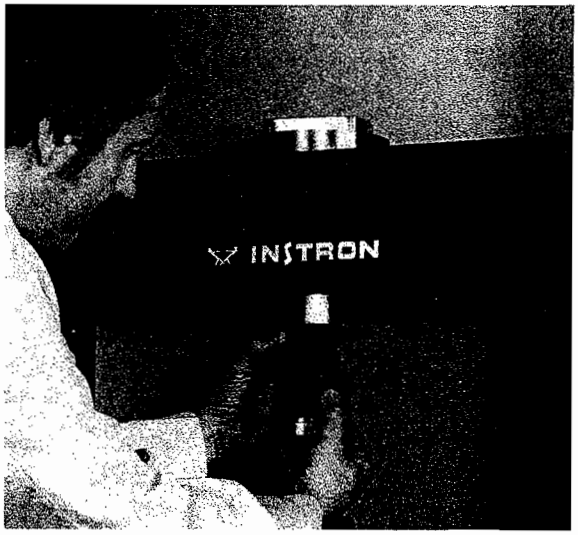


Figure 5-11. Attaching a Self-Aligning Coupling to a Tension Load Cell

plate between the loading frame columns (figure 5-12b).

Each compression cell is supplied with a table that attaches to the cell for supporting a test specimen; however, additional fixtures, available from Instron, are required to support the load cell and specimen depending on the testing method used.

Load cells of 1000 pounds (500 kg) or less require protection against accidental overload, and should be used with the compression overload carriage (figure 5-12c).

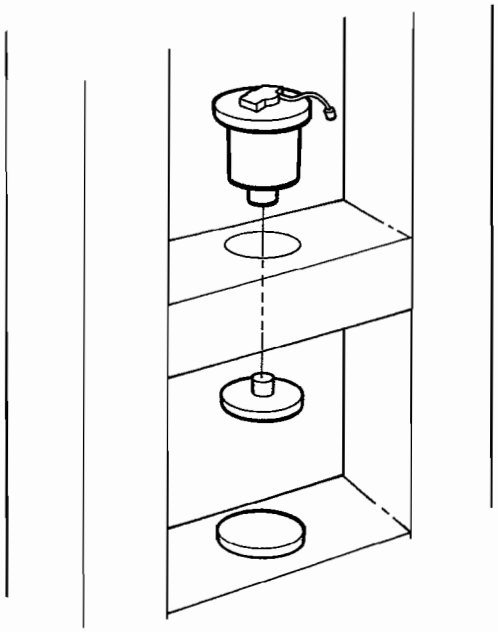


Figure 5-12a. Compression Load Cell Installation in Moving Crosshead

5.5.1 Compression Load Cell Installation in Moving Crosshead

NOTES: 1. When a compression load cell is mounted in the moving crosshead, specimen compression is limited by a minimum separation attainable (4 inches, approximately) between the moving crosshead and baseplate due to the leadscrew covers.

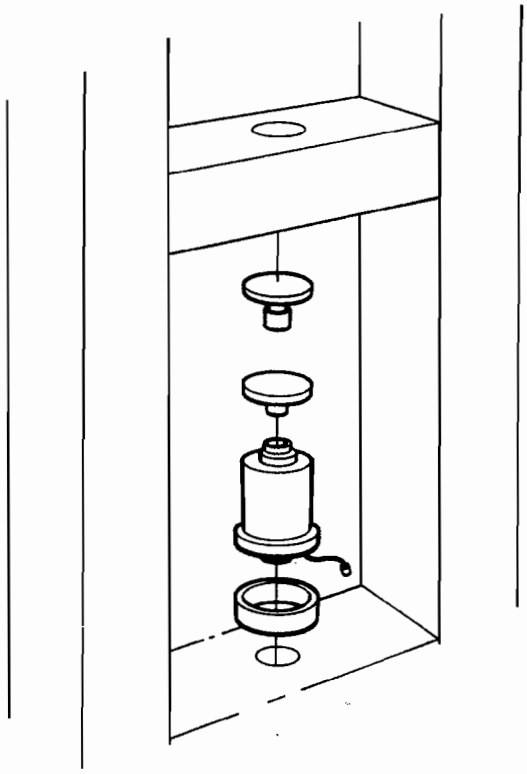


Figure 5-12b. Compression Load Cell Installation on Base of Loading Frame

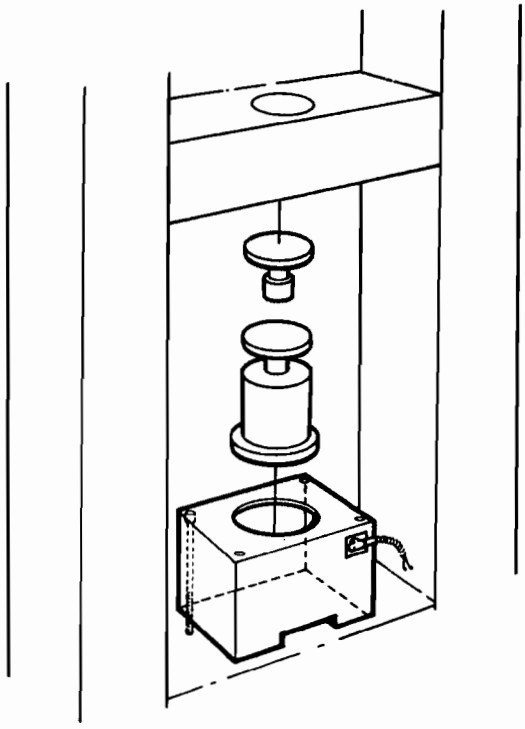


Figure 5-12c. Compression Load Cell Installation in Overload Carriage

2. The mechanical calibration of a compression load cell must be done prior to installation in the moving crosshead.

Install a compression load cell in the moving crosshead as follows:

a. Position load cell on its base and perform calibration procedure of paragraph 6.5.3.

b. Remove compression table and lower load cell into hole position in center of moving crosshead (reference figure 5-10). Fit dowel holes in cell flange over dowels in crosshead. Securely fasten cell in place with bolts provided.

c. Attach compression table to load cell spindle with spanner wrench provided.

d. Install compression cover plate (T379-57) supplied with testing instrument, in position on baseplate beneath load cell.

e. Insert load cell plug into load cell cable connector. Ensure that load cell cable is secured out of testing area.

5.5.2 Compression Load Cell Installation on Base of Loading Frame

Compression testing with the load cell mounted on the loading frame base (figure 5-13) requires several fixtures available as options, including: A support ring to mount on the baseplate for positioning and retaining the cell; and an anvil and anvil adapter to mount on underside of moving crosshead.

Install a compression load cell on base and mount fixtures as follows:

a. Fasten load cell support ring in position

on base plate of loading frame with bolts provided.

b. Mount load cell on spacer with dowel holes in cell flange fitted over dowels in spacer. Securely fasten cell with bolts provided.

c. Bolt anvil adapter to center position on underside of moving crosshead. Thread anvil firmly into adapter.

d. Insert load cell plug into load cell connector. Ensure that load cell cable is secured out of testing area.

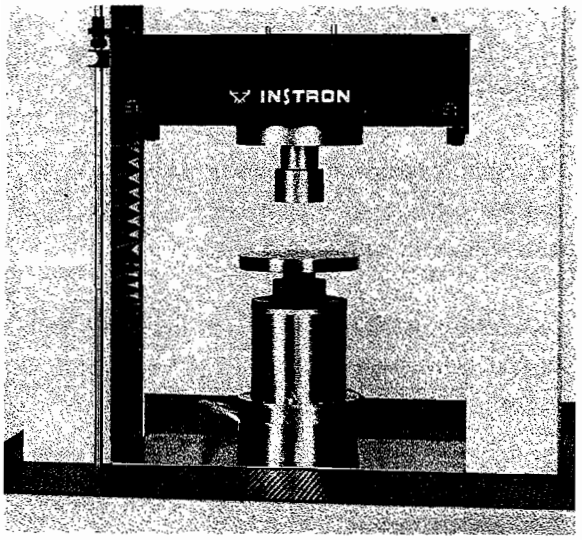


Figure 5-13. Compression Cell Installation on Base of Loading Frame

5.5.3 Compression Overload Carriage Installation

Load cells of 1000 pounds (500 kg) capacity or less require protection against accidental overload and should be used with the compression overload carriage (figure 5-14). This is a rigid box structure incorporating a spring-loaded cell carrier and automatic shut-off switch. The switch is set to actuate and stop the crosshead motion if the load should exceed approximately 1200 pounds.

The overload carriage may also be used with cells of more than 1000 pounds capacity. In this case, two bolts are screwed down to prevent actuation of the overload protective switches. These bolts, large socket-head cap screws, are located beneath the two circular plates on either side of the load cell position on the carriage.

NOTE: Ensure that the two bolts preventing actuation of the overload protection switches are removed from the carriage when testing with cells requiring overload protection.

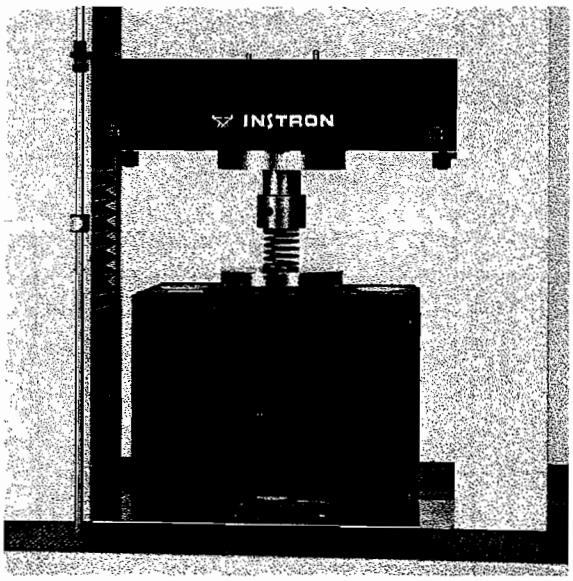


Figure 5-14. Compression Overload Carriage Installation (Typical)

Install overload carriage and compression load cell as follows:

a. Mount overload carriage on loading frame base with four ½-13 x 10-3/8-inch bolts provided.

b. Insert load cell into carriage and ensure

that dowel pins seat in dowel holes. Bolt load cell securely in place.

c. Install and firmly hand-tighten compression table onto load cell.

d. Bolt anvil adapter to center position on underside of moving crosshead. Thread anvil firmly into adapter.

e. If overload carriage is to be used as a safety device, proceed as follows:

1. Remove two bolts from beneath circular plate on top of carriage.

2. Plug carriage control cable into socket provided on column of loading frame.

5.5.4 Installing a Reversible Tension-Compression Load Cell

The reversible load cells, when used for tension or compression testing, are installed in the same manner as the single mode cells, except calibration is performed electrically (reference paragraph 6.5.1). Couplings, compression tables, and adapters are included with these cells for either mode of testing – tension or compression. If the cell is to be mounted on the loading frame base, optional accessories – support ring, anvil, and anvil adapter – are required (reference paragraph 5.5.2).

NOTE: When mounting the 10,000-pound (5,000 kg, 50 kN) or 20,000-pound (10,000 kg, 100 kN) capacity load cells for tension or reverse stress testing, use the six 3/8-24 x 1-1/4 inch socket head cap screws. Tighten these high-strength screws to 120 in-lb of torque.

The load cell may be mounted above or below the moving crosshead for reverse stress testing. The adapters and fittings necessary generally are dependent upon the specimen/grip requirements, hence are not supplied with the cell. Consult an Instron Regional Office for assistance in meeting specific requirements.

6.0 OPERATION

6.1 TURN INSTRUMENT ON: WARM-UP PERIOD

NOTE: Prior to turning on the instrument for a warm-up period, turn off all accessories to avoid difficulty in setting up the basic system.

To power the 1125 instrument, set the main power circuit breaker on the front of the console to on. All units receive power when this switch is actuated, if interconnections were made in accordance with section 5 of this manual. (Ensure that the MOTOR circuit breaker, on the console outlet panel, is on.)

A warm-up period of 15 minutes minimum is recommended to assure load cell stability. This warm-up period is also necessary whenever a load cell is changed even though the instrument may have been operating for some time.

NOTE: Keep the recorder PEN pushbutton switch off when not calibrating or testing. If no load cell is installed or the instrument is not adjusted properly, the recorder pen will be driven off scale.

Perform the procedures for zeroing, balancing, and calibrating the load weighing system (paragraphs 6.2 through 6.5) after the warm-up period.

6.2 REFERENCE ZERO SETTING OF RECORDER PEN

Prior to recording, the pen should be set to a zero reference line. For most tension testing applications, the zero is usually the first line on the left side of the chart. Compression applications are usually referenced from the right side of the chart. The POLARITY switch, on the load cell amplifier panel, will reverse a full left or full right zero by changing the polarity of the load cell excitation voltage. A reference zero in the center of the chart is used when reverse stress testing.

Note that the recorder chart scale, located beneath the pen carriageway, is conveniently numbered for both 0-100 and 100-0 referencing. Also, the scale marks coincide with the English or metric units of the chart paper in use.

Depending on the load cell in use, set the reference zero in accordance with paragraph 6.2.1, 6.2.2, or 6.2.3.

6.2.1 Reference Zero Setting for a Single Mode Load Cell

For single mode tension or compression cells, set POLARITY switch to 1 for pen zero on left side of chart, and to 2 for zero on right side. Then perform the zeroing, balancing and calibrating procedures of paragraphs 6.3, 6.4, and 6.5.

6.2.2 Reference Zero Setting for a Tension-Compression Load Cell

The POLARITY switch allows left-to-right or right-to-left recording of load. This feature enables test charts to be plotted in standard engineering format.

a. Set POLARITY switch to 1 and set pen zero on left side of chart (paragraph 6.3). Balance and calibrate in accordance with paragraphs 6.4 and 6.5 respectively.

b. Refer to the following chart and set the

POLARITY switch as indicated to obtain the required reference zero position.

Test Type	Desired Recorder Pen Motion	Polarity Switch Position
Tension	L to R	1
Tension	R to L	2
Compression	L to R	2
Compression	R to L	1

c. Readjust zero and balance controls (paragraphs 6.3 and 6.4) whenever the POLARITY switch position is changed.

6.2.3 Reference Zero Setting for Reverse Stress Testing

When reverse stress testing, the recorder pen is usually zeroed at the middle of the chart. Two methods are given below for setting a center reference zero. For both methods, increasing tension is a pen deflection to the right and increasing compression is a pen deflection to the left.

a. This method allows the load range setting (inner knob) of the FULL SCALE LOAD switch to be changed to increase or decrease the pen sensitivity (lb/in, gm/cm, N/cm). Proceed as follows:

NOTE: Only 1/2 of any full scale range setting is available due to the centered pen position.

1. Set POLARITY switch to 1, and set pen zero on left side of chart (paragraph 6.3). Balance and calibrate in accordance with paragraphs 6.4 and 6.5, respectively.

2. Reset pen zero (paragraph 6.3) at middle graduation of chart.

b. This method allows a full left and right pen deflection, from a centered reference zero, using the maximum range of the load cell at a fixed sensitivity. For example, if a 20,000-pound range reversible load cell is used, a ± 20,000-pound equivalent (tension-compression) load signal is possible. Proceed as follows:

CAUTION

To avoid damaging the load cell, do not use the CENTER ZERO position of the FULL SCALE LOAD switch unless the recorder pen is to be zeroed at the center of the chart. In this switch position, the load cell amplifier gain is halved, requiring double the safe maximum output of the load cell for full scale pen deflection. An operator should be aware of the recorder pen sensitivity.

1. Set POLARITY switch to 1, and set pen zero on left side of chart (paragraph 6.3). Balance and calibrate in accordance with paragraphs 6.4 and 6.5, respectively.

2. Set FULL SCALE LOAD selector switch inner knob to CENTER ZERO position (fully clockwise).

3. Reset pen zero (paragraph 6.3) at middle graduation of chart.

6.3 ZEROING PROCEDURE

To adjust the ZERO control on the load cell amplifier panel, proceed as follows:

a. Depress and latch No. 1 PEN switch on recorder panel.

b. Unlock ZERO control by turning locking ring counterclockwise about 1/4-turn. Depress and hold ZERO pushbutton (figure

6-l). Adjust ZERO control to set No. 1 PEN at reference zero on chart.

c. Lock ZERO control and release ZERO pushbutton. Pen will move off zero if balancing procedure (paragraph 6.4) is required.

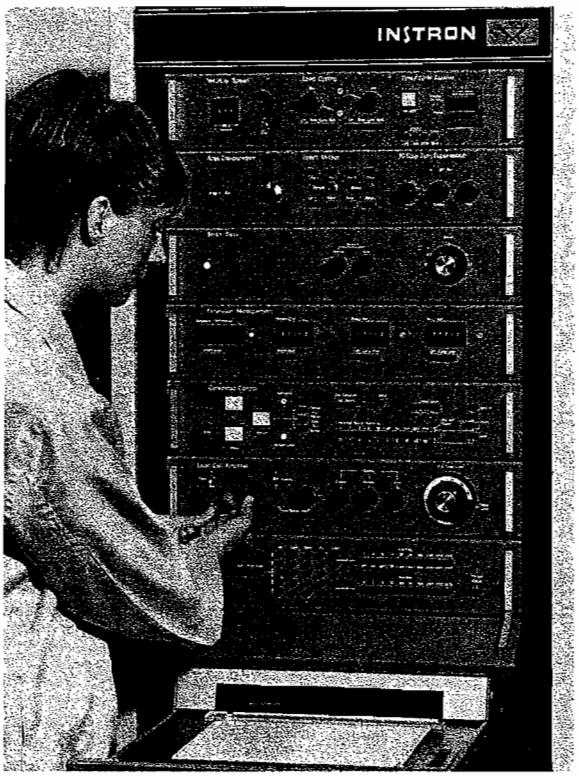


Figure 6-1. Zeroing the Load Weighing System

6.4 BALANCING PROCEDURE

6.4.1 Balancing Load Weighing System

This procedure electrically compensates for weights of fixtures attached to the load cell. The sensitivity of the BALANCE controls will vary with the setting of the FULL SCALE LOAD switch; hence, this switch should always be set to the lowest range (see procedure below) during the adjustment. There will be no shift in the balance when the selector is turned to higher full scale load ranges.

NOTE: If the FULL SCALE LOAD switch is subsequently set to the ultra-high sensitive ranges requiring the FILTER switch to be ON, a rebalancing will be necessary. Also if fixtures are added or removed, readjust the BALANCE controls.

To balance the load weighing system (figure 6-2), proceed as follows:

a. Set outer dial of FULL SCALE LOAD switch, in accordance with figure 5-9, for load cell in use. Turn inner knob to select lowest range in white sector of switch background.

b. If recorder pen is extremely unbalanced – fully left or right of chart scale – bring it onto chart scale by adjusting COARSE BALANCE control.

c. Unlock MEDIUM and FINE controls, and adjust to bring pen to reference zero. Lock BALANCE controls. Unlock and readjust FINE control if pen shifts away from zero setting.

NOTE: If the load cell cable has been altered or replaced, perform the quadrature adjustment procedure of paragraph 6.4.2.

6.4.2 Adjusting Quadrature Compensation

This procedure should be performed periodically to ensure that any quadrature component on the load signal is minimized to obtain optimum linear performance of the load weighing system (reference paragraph 4.6.7).

The quadrature compensating device is variable resistor, R3, mounted internally on the right-hand side of the load cell amplifier's

motherboard. To check and adjust quadrature, proceed as follows:

a. Install load cell with coupling and load cell cable that will be used during regular testing procedures.

b. Zero and balance load weighing system (paragraphs 6.3 and 6.4.1).

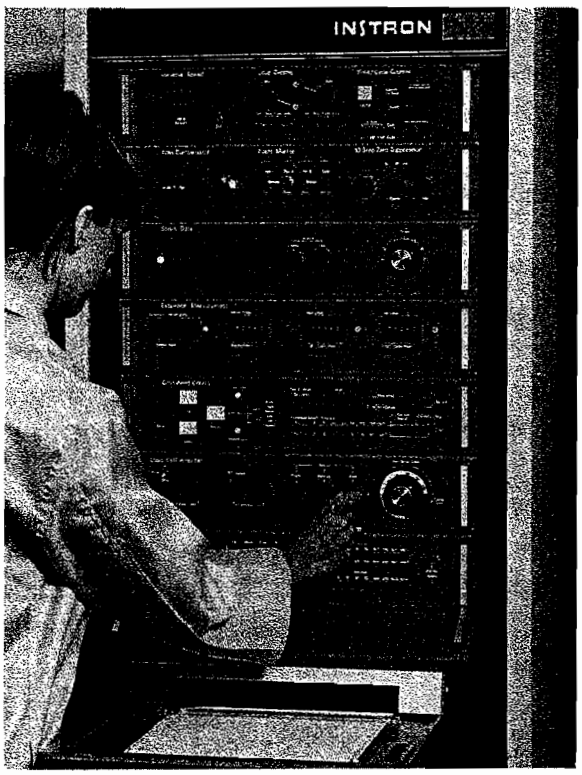


Figure 6-2. Balancing the Load Weighing System

c. Set FULL SCALE LOAD switch to most sensitive range not requiring filtering, as in step a. of paragraph 6.4.1.

d. Set POLARITY switch, on load cell amplifier panel, to position used during regular testing procedures.

e. Slide load cell amplifier unit forward from console for internal access. Attach an oscilloscope to test points TP4 (high) and TP1 (low).

f. Observe an a.c. signal on oscilloscope. A nonsymmetrical waveform indicates presence of a quadrature component. Adjust R3 and FINE BALANCE control alternately until signal waveform is minimized and symmetrical.

6.5 CALIBRATION

The calibration procedure accurately calibrates the load weighing system against a precise load signal, and sets the system calibration for all ranges of the load cell in use. It is recommended that the calibration be checked on a regular basis – at least once a day or whenever a load cell is changed.

A calibration procedure, performed after an instrument warm-up period, must be preceded by zero and balance procedures as described in paragraphs 6.3 and 6.4. Subsequent adjustments of the zero and balance controls do not affect the calibration of the instrument.

6.5.1 Calibration Procedure for Electrically Calibrated Load Cells

The calibration circuit of the electrically calibrated load cells (reference figure 5-9, note 2) is activated by depressing the CALIBRATION pushbutton on the load cell amplifier panel. This provides a load signal that simulates the installation of precision weights on the cell. In the case of tension - compression load cells, the calibration signal is always in the tension load direction. Therefore, the POLARITY switch must be set to 1 when calibrating.

To calibrate the load weighing system with an electrically calibrated load cell installed, proceed as follows:

a. Zero and balance load weighing system as described in paragraph 6.3 and 6.4.

b. Set FULL SCALE LOAD switch, on load cell amplifier panel, to calibration setting indicated in figure 5-9 for load cell in use.

c. Unlock CALIBRATION control. Depress and hold CALIBRATION pushbutton (figure 6-3). Adjust CALIBRATION control until recorder pen is set to full scale on chart. Lock CALIBRATION control. Release CALIBRATION pushbutton and note that pen returns to reference zero. Load weighing system is now calibrated for all ranges of load cell in use.

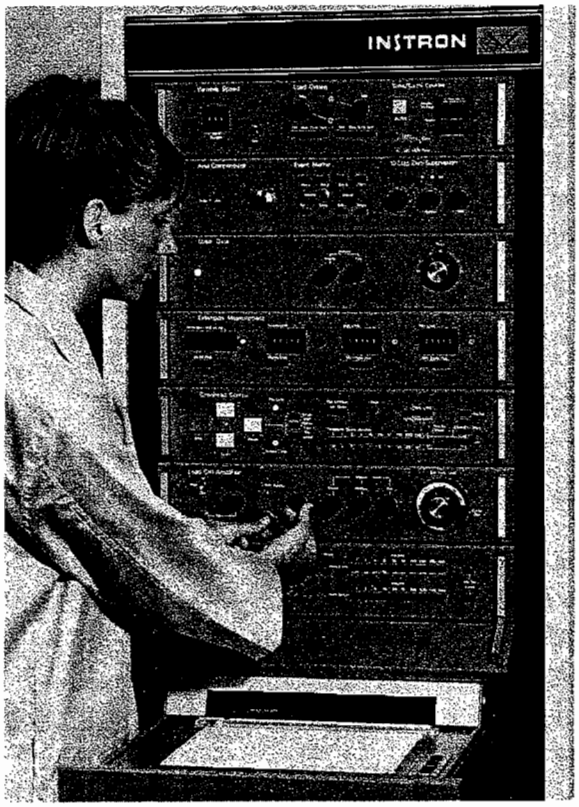


Figure 6-3. Calibrating the Load Weighing System

NOTE: The ZERO and BALANCE controls may be readjusted without affecting the system calibration. Rebalance the system if fixtures mounted on load cell are changed. Recalibrate the system if the load cell is changed.

6.5.2 Calibration Procedure for Mechanically Calibrating Load Cells in Tension

When using a non-electrically calibrated tension load cell, precision weights (figure 6-4) are attached to the cell to provide a reference load signal. A hangar strap is supplied with a weight set for calibrating tension cells.

To calibrate in tension using precision weights, proceed as follows:

a. Zero and balance load weighing system as described in paragraphs 6.3 and 6.4.

b. If using a 500-gram capacity load cell, calibration weight will hang directly from extension wire on cell. If using a 2000-gram cell, insert calibration weight hangar strap in upper grip, or weight will hook directly in grip. With all other mechanically calibrated cells, remove grip from load cell coupling; calibration weight will hang in its place.

c. Readjust BALANCE controls, as required, to return pen to reference zero and compensate for change due to added weight hangar or removed grips.

d. Refer to figure 5-9 and determine FULL SCALE LOAD switch setting for calibrating load cell in use. Calibration weight required is full scale load at this setting.

e. Set FULL SCALE LOAD switch, on load cell amplifier panel, to proper position.

Attach required calibration weight to load cell.

f. Unlock CALIBRATION control. Do not depress CALIBRATION pushbutton. Adjust CALIBRATION control for full scale pen deflection on recorder chart. Lock the CALIBRATION control. Load weighing system is now calibrated for all ranges of load cell in use.

g. Remove calibration weights and weight hangar strap from load cell. Reinstall any fixtures necessary for mounting test specimen.

h. Readjust BALANCE controls, as required, to return pen to original reference zero.

NOTE: The ZERO and BALANCE controls may be readjusted without affecting the system calibration. Rebalance the system if fixtures mounted on load cell are changed. Recalibrate the system if load cell is changed.

6.5.3 Calibration Procedure for Mechanically Calibrating Load Cells in Compression

When using a non-electrically calibrated compression load cell, precision weights (figure 6-4) are mounted on the cell to provide a reference load signal.

To calibrate in compression using precision weights, proceed as follows:

a. Zero and balance load weighing system as described in paragraphs 6.3 and 6.4. Ensure that compression table to be used is mounted on load cell prior to balancing.

b. Refer to figure 5-9 and determine FULL SCALE LOAD switch setting for calibrating load cell in use. Calibration weight is full scale load at this setting.

c. Set FULL SCALE LOAD switch, on load cell amplifier panel, to proper position. Mount required calibration weight on compression table of load cell.

d. Unlock CALIBRATION control. Do not depress CALIBRATION pushbutton. Adjust CALIBRATION control for full scale pen deflection on recorder chart. Lock the CALIBRATION control and remove calibration weights. Load weighing system is now calibrated for all ranges of load cell in use.

NOTE: The ZERO and BALANCE controls may be readjusted without affecting the system calibration. Rebalance the system if fixtures mounted on load cell are changed. Recalibrate the system if load cell is changed.

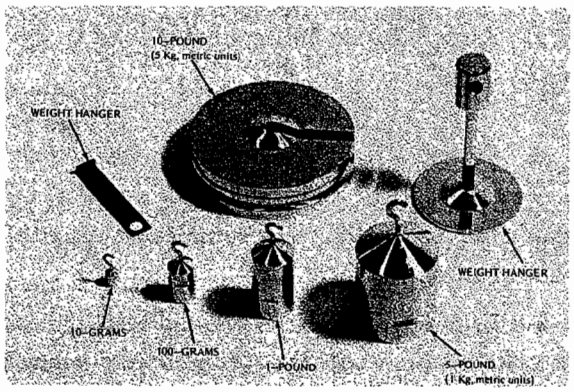


Figure 6-4. Calibration Weights

6.6 PRETEST SETUP PROCEDURES

6.6.1 Adjusting Crosshead Preload Nuts

Preload nuts are mounted on the moving crosshead at both leadscrews. These nuts are tightened, prior to certain types of tests,

while applying a tension preload between the moving crosshead and the loading frame base.

Tighten preload nuts when tension testing above the moving crosshead, compression testing below the moving crosshead, or reverse stress testing above or below the moving crosshead. Proceed as follows (reference paragraph 6.7.1 for setup procedure):

NOTE: Preload nuts must be loosened, when testing in modes other than those specified above, to avoid excessive wearing of the leadscrews. To loosen nuts, reapply the same tension preload to the moving crosshead as applied when nuts were tightened.

a. Mount a tension cell, with a load range equivalent to maximum expected tension/compression loading, in moving crosshead.

b. Assemble grips to load cell and base adapter that will accept a rigid specimen.

c. Zero, balance and calibrate load weighing system.

d. Mount a rigid specimen in grips. Apply a tension load to specimen that exceeds, by approximately 10%, any expected tension/compression loading.

e. Firmly hand-tighten preload nuts against crosshead, then use the 4½-inch bar wrench supplied with the model 1125 to fully tighten each nut.

f. Relieve tension loading, remove rigid specimen, and proceed with planned testing.

6.6.2 Establishing Gage Length

The gage length is the spacing between specimen contact faces of the upper and lower grips or fixtures at the start of a test, and establishes the initial length of a specimen. To ensure a uniformity in specimen length, this spacing must be the same for all similar tests. This requires that the moving crosshead return and stop at a preset limit, or gage length, at the conclusion of each test.

The choice of a suitable gage length depends upon the particular material under test. Factors to be considered are the available length of specimen material, and, in tension testing, the need to minimize strain error due to grip penetration.

6.6.3 Setting Limit Switches

To set the limits for gage length, proceed as follows:

a. Tighten crosshead preload nuts in accordance with paragraph 6.6.1, if required.

b. Loosen knurled screw that clamps each limit stop to limit switch rod. Slide stops beyond where approximate final set position will be.

c. On crosshead control unit, select and depress a crosshead speed pushbutton and a clutch pushbutton. Also depress a TEST DIRECTION pushbutton, either UP or DOWN. Move crosshead by pressing UP, DOWN and STOP control switches, as required, until desired gage length is obtained. Measure spacing between grip or fixture faces with a ruler or vernier caliper.

d. Make final adjustment of crosshead position with manual positioning knob, located beneath cover on right-hand column of loading frame. Clockwise rotation of knob causes upward movement of crosshead.

e. Gage length limit stop is upper stop, if tension testing above moving crosshead or

compression testing below moving crosshead; or lower stop, if tension testing below moving crosshead. Set this gage length limit stop against limit actuating bracket on moving crosshead. Finger-tighten knurled clamping screw.

f. Make fine adjustment for setting gage length by turning large knurled nut on limit stop assembly, until limit switch is just actuated. This is indicated by related limit light on crosshead control panel being lit.

g. Set opposite limit stop at a point slightly beyond expected extension or compression of specimen.

6.6.4 Selecting Chart and Crosshead Speeds

NOTE: When operating the chart in the proportional mode, the chart speed/crosshead speed ratio is the same as that indicated beneath each A CHART SPEED switch only when the crosshead high speed clutch is energized (reference paragraph 4.10.2).

The testing (crosshead) speed is governed by the characteristics of the material to be tested and the desired test conditions. Usually, the testing rate is specified (1) as specimen strain in inches per inch per minute; (2) as % specimen extension or compression/minute; or (3) in terms of crosshead speed in inches/minute. When selecting a crosshead speed, the following should be considered:

1. Test material characteristics.

2. Total elongation or compression of specimen.

3. Maximum speed of recorder response.

The chart speed determines the length of the chart record for the test. A chart record of 5 to 15 inches is sufficient for most tests, but the chart record can be as long as desired. The test results appear on the recorder chart as a load-displacement curve (figure 6-5).

The chart time-drive axis indicates the displacement of the crosshead in a magnified (or reduced) form. The magnification ratio (M) is the ratio of the chart speed to the crosshead speed as follows:

$$\text{Magnification ratio} = \frac{\text{Chart Speed}}{\text{Crosshead Speed}}$$

The following example illustrates the selection of chart and crosshead speeds.

Given Data:

Material	Nylon Yarn
% extension/minute	100%
Expected ultimate extension	50%
Gage length	10 inches

Crosshead speed = (gage length) (% extension/minute)
= (10 inches) (100%/minute)
= 10 inches/minute

A 10-inch chart record is desired for the expected test duration of 1/2-minute (time expected to reach ultimate extension). Therefore, the chart should travel 20-inches in 1-minute, and a chart speed of 20 inches/minute is required. Then,

$$M = \frac{20 \text{ inches/minute}}{10 \text{ inches/minute}} = 2$$

$$\text{Magnification Ratio} = \frac{\text{Chart Speed}}{\text{Crosshead Speed}}$$

$$\text{FOR 1" OF CHART: } \frac{1}{\text{Magnification Ratio}} = \text{Crosshead Displacement}$$

For Example, Using 10 inch per min. Chart Speed and 5 inch per min. Crosshead Speed:

$$\text{Magnification Ratio} = \frac{\dot{C}}{\dot{X}} = \frac{10}{5} = \frac{2}{1} = 2$$

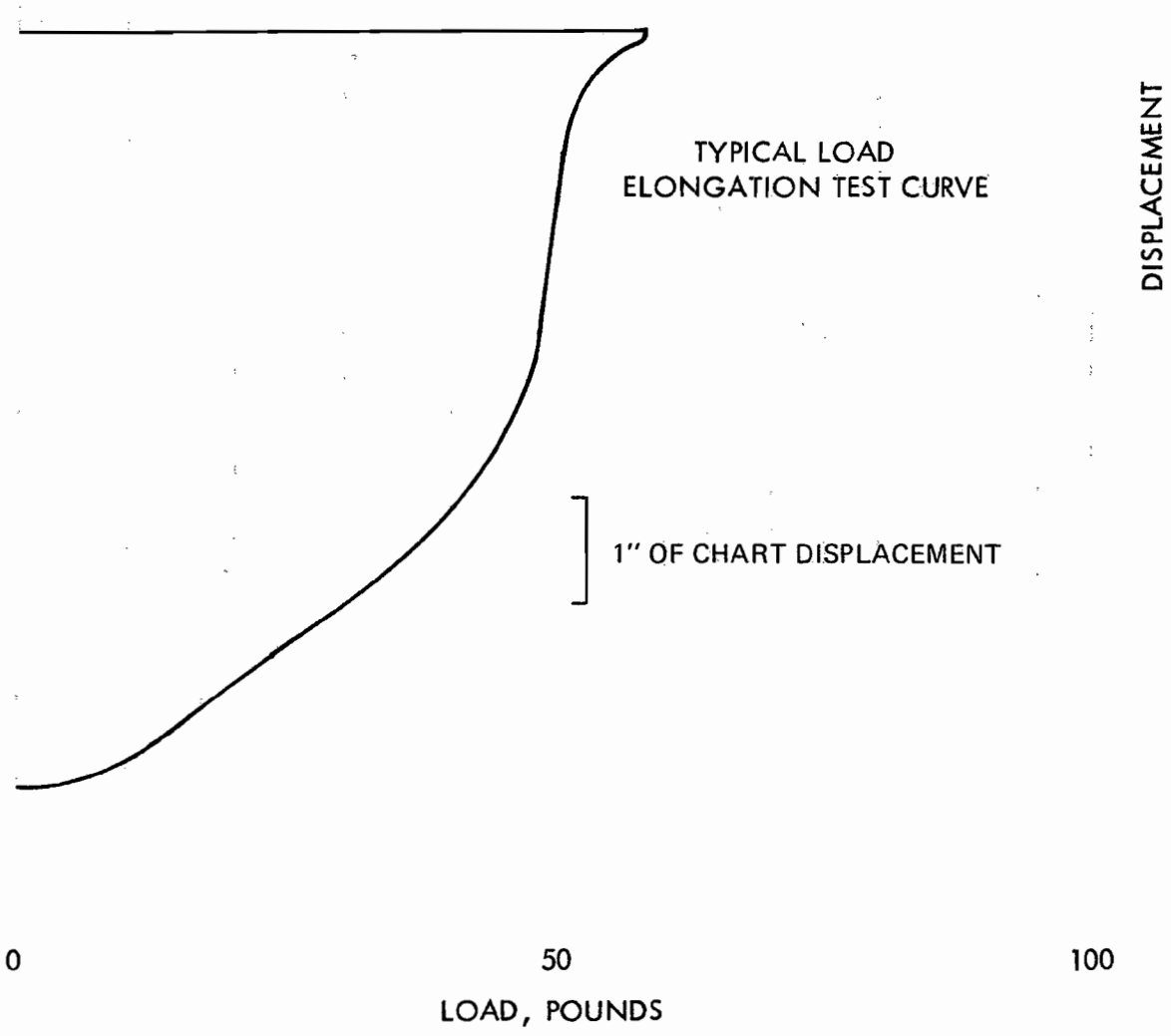


Figure 6-5. Typical Load-Displacement Chart Showing Magnification Ratio

Each inch of chart, along the time-drive axis, will indicate:

$\frac{1}{M} = \frac{1}{2}$ = Crosshead displacement (inches)

To determine the percentage of total strain directly from the chart:

$$\text{Percentage strain} = \frac{\text{Chart displacement} \times 100}{M \times \text{Gage length}}$$

Using this method of indirectly measuring specimen strain is useful for many types of materials. However, it is not applicable when testing rigid materials at high loads without compensating for the machine deflection characteristics.

NOTE: The crosshead displacement approximately equals specimen strain, if the gage length equals the initial separation between the grips.

The following chart illustrates other examples of chart and crosshead speed selection:

Gage Length (Inches)	% extension per minute (Strain rate)	Crosshead speed (in/min)	Chart speed (in/min)	Crosshead displacement per inch of chart	Magnification Ratio
4	50%	2	5	0.4-inch	2.5
5	100%	5	5	1-inch	1
5	400%	20	10	2-inches	0.5

6.6.5 Extension Recording

A direct correspondence between the crosshead and recorder chart is possible when their motions are synchronized. For most testing applications, the time-drive motion of the chart provides an extension axis that gives an accurate measure of specimen extension as related to crosshead displacement. This close relationship is maintained by the low inherent deflection of the load cells and by the almost total elimination of backlash in the crosshead drive mechanism.

However, the chart need not be operated at the same speed as the crosshead. Also, the chart need not be stopped whenever the crosshead is stationary. The extension axis of the chart may be magnified or reduced, and may act as a time axis for the purpose of specimen relaxation and specimen recovery measurements.

For many applications, this method of extension recording affords the necessary accuracy, along with many other conveniences in operating technique. However, when testing rigid materials exhibiting low extension at high loads, such as metals, it is not recommended. The inherent deflections of the load cells and the machine and the slippage of the specimen from the grips may be sufficient to affect the accuracy of this method. Some errors can be compensated for by direct calibration of the machine deflection by running a "no-stretch" curve.

When testing these types of materials, it

may be desirable to use extensometers, compressometers, or deflectometers attached directly to the specimen to measure strain.

6.7 TESTING PROCEDURES

The tensile properties of any material cannot be evaluated by a single test. However, by utilizing the various test techniques possible with the model 1125 instrument, on which the time base is strictly controlled, it is possible to isolate each mechanical property for detailed analysis.

The standard load-elongation test, conducted to specimen failure, can produce curves detailing features such as the elastic and flow regions, the extensibility of the material, and the ultimate tensile strength and rupture characteristics. By means of crosshead control and automatic cycling capability, the material behavior, such as relaxation, recovery, stress-conditioning, and hysteresis properties of many materials may be measured.

A number of typical load-elongation curves are presented in diagrammatic form in section 6.8 of this manual as examples. These demonstrate the instrument's performance and its application in testing a variety of different materials.

6.7.1 Load-Elongation Test

The following summary of steps required to perform a simple load-elongation test assumes that the testing instrument contains only the basic units. Also, that the operator is familiar with the preceding material in this manual.

To prepare the instrument for testing, perform the following steps:

a. Determine the crosshead and chart speeds required for the test conditions and specimen characteristics.

b. Install the required load cell and attach the load cell cable.

c. Switch on the instrument's main power and allow it to warm-up for a minimum of 15 minutes.

d. Zero, balance, and calibrate the load weighing system.

e. Place the FULL SCALE LOAD switch in the required position.

f. Install the required grips. Readjust the BALANCE controls as necessary to reset the pen to 0.

g. Adjust the gage length stop and opposite limit stop to the desired positions (reference paragraph 6.6.3).

To perform a simple load-elongation test to specimen rupture, proceed as follows:

a. Assuming testing is below the moving crosshead (figure 6-6) and the crosshead preload nuts are properly set, position the crosshead at gage length and insert the specimen in the grips. Tighten the upper grip first. If this process applies a preload on the specimen, do not change the balance adjustment to compensate for it.

b. Depress the required crosshead speed, clutch and chart speed pushbuttons on their respective panels (figure 6-7).

c. On the crosshead control panel, depress the TEST DIRECTION UP pushbutton. Also, depress either the MAX LIMIT-STOP (sug-

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gested for rigid specimens) or MAX LIMIT-RETURN pushbutton.

CAUTION

Prior to starting any test, always depress either the CYCLE pushbutton or one of the MAX LIMIT pushbuttons (STOP or RETURN) on the crosshead control unit. Otherwise, when a first-level limit stop is reached the crosshead will stop but will restart in the same direction, automatically, if the limit stop is moved away from the actuator.

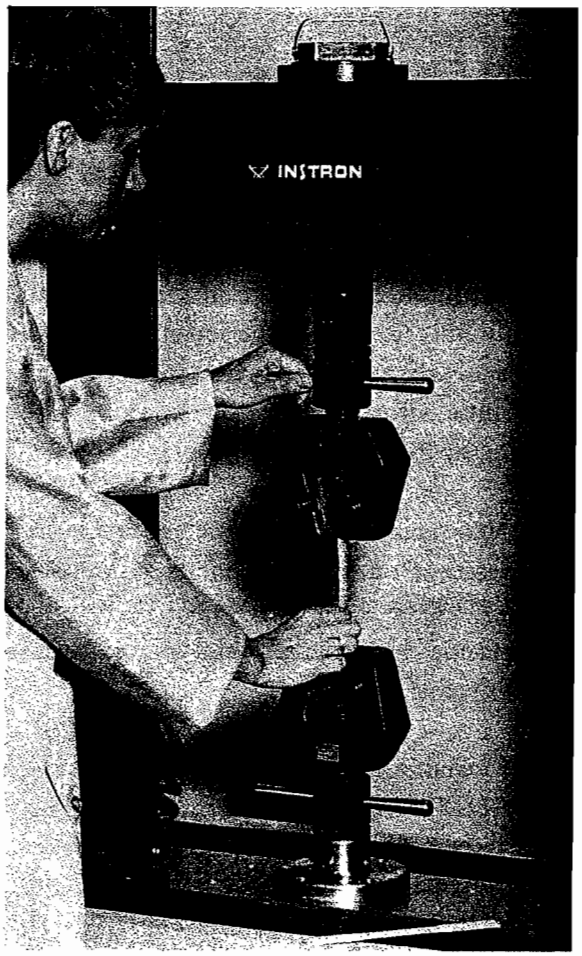


Figure 6-6. Installing a Specimen in Tester

d. Depress the recorder PEN and the CHART TIME pushbuttons.

e. To start a forward recorder chart motion, depress the pushbutton next to the "down" arrow legend on the chart drive control unit.

f. Push the UP button on the crosshead control unit to start the test (figure 6-8). The crosshead will move up until it reaches the upper limit stop. The specimen will presumably rupture. Depending upon the MAX LIMIT crosshead function switch depressed, the crosshead will either stop or return to gage length position.

g. To stop the pen and chart motions, release the PEN and CHART pushbuttons.

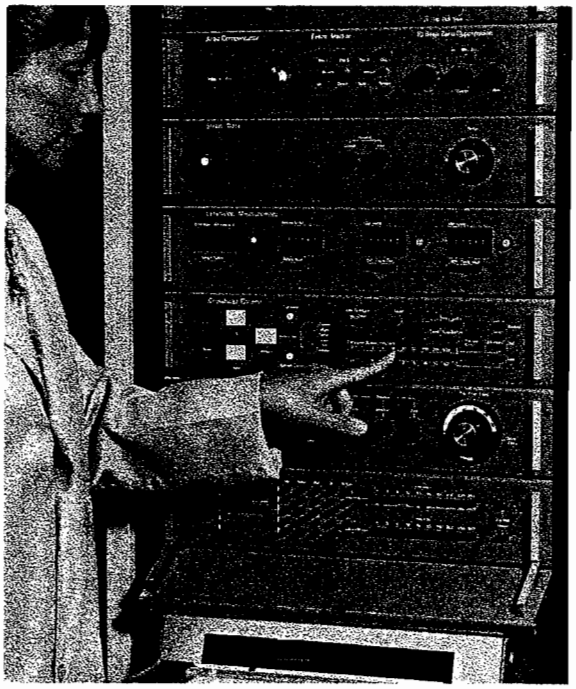


Figure 6-7. Selecting a Crosshead Speed

h. The crosshead may be stopped or reversed at the normal testing speed, by pres-

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sing the STOP button or the DOWN button, thus allowing manual control for any form of relaxation or cyclic test. Alternatively, the crosshead may be returned to gage length at a predetermined speed (reference paragraph 4.7.1) by pressing the RETURN button.

i. At the completion of the test, remove the specimen from the grips. With the crosshead in the gage length position, insert a new specimen.

6.7.2 Automatic Cycling Tests

To change from straight-forward tensile testing to automatic cycling tests involves programming crosshead motion between a minimum and a maximum extension limit.

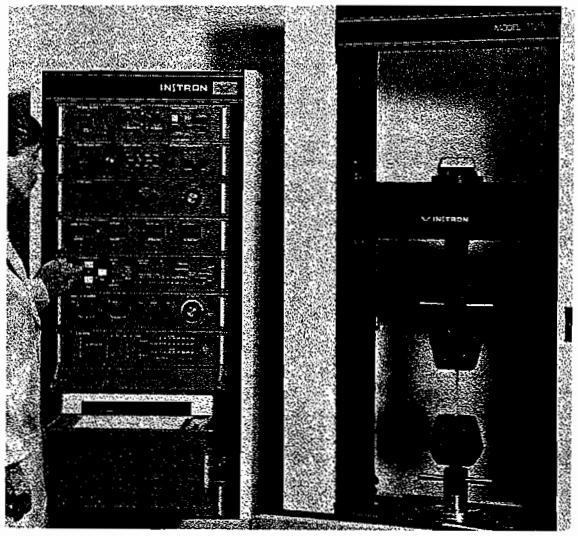


Figure 6-8. Starting a Load-Elongation Test

To perform extension cycling tests, proceed as follows:

a. Prepare the instrument for testing as in paragraph 6.7.1.

b. Assuming testing is below the moving crosshead, the gage length will be the lower cycling limit. Set the upper limit stop at the desired extension limit.

c. With the crosshead at the gage length limit, install the test specimen.

d. Depress the required crosshead speed, clutch and chart speed pushbuttons.

e. On the crosshead control panel, depress the TEST DIRECTION UP pushbutton. Also, depress the CYCLE crosshead function pushbutton.

f. Depress the recorder PEN and the CHART TIME pushbutton.

g. To start a forward recorder chart motion, depress the pushbutton next to the "down" arrow on the chart drive control unit.

h. Push the UP button on the crosshead control unit to start the cycling test. The crosshead will cycle between the preset extension limits. It may be stopped at any time by pressing the STOP button.

i. To facilitate relaxation and recovery measurements during a cyclic test, the MAX LIMIT-STOP or MAX LIMIT-RETURN pushbuttons may be depressed while the crosshead is still cycling.

For relaxation measurement, depress the MAX LIMIT-STOP pushbutton as the crosshead is moving up. The testing speed will not change, but the crosshead will stop at the upper limit position. This corresponds to maximum specimen load, and the decrease in

load as the specimen relaxes may be recorded.

If, as the crosshead is moving down, the MAX LIMIT-STOP or MAX LIMIT-RETURN pushbutton is depressed, the crosshead will continue to move to the lower limit at normal testing speed and then stop. This corresponds, for this test, to minimum extension and load position and enables specimen recovery to be recorded.

6.8 SPECIAL TEST TECHNIQUES

Users of the Instron model 1125 instrument will probably develop individual test techniques connected with their particular application. However, some of the instrument's features are described below and demonstrate other operating techniques that are possible.

6.8.1 Measurement of Relaxation and Recovery

If a specimen is stretched a certain amount and the crosshead is stopped, usually the load will decay with time as the specimen relaxes. If the load on the specimen is reduced and the crosshead is stopped, the load will increase with time, indicating the specimen recovers from the previous stress condition.

This procedure can form the basis for a variety of analytical methods, ranging from simple measurement of the amount of load change with time to mathematical representation of the shape of the relaxation or recovery function.

6.8.2 Changing Load Ranges During a Test

The load range can be changed during a test. This technique can be used to expand the initial portion of a load-displacement

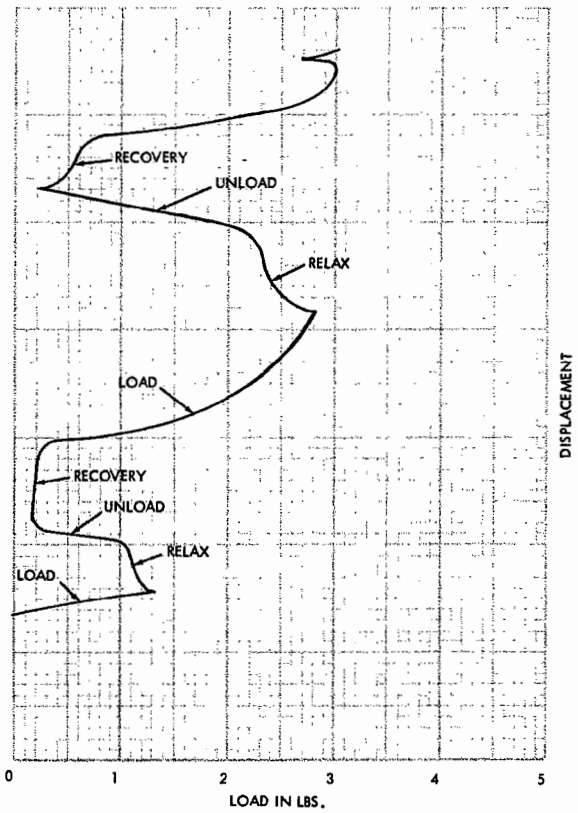


Figure 6-9a. Stress Relaxation - Recovery Composite Behavior Curve of a Rubber Specimen

chart for more detailed study. For example, a test can be started on the 1000-pound range of a 2511-303 cell and then subsequently changed to the 2000, 5000, or 10,000-pound range without recalibrating the system.

6.8.3 Zero Suppression

This operating technique enables an operator to expand selected increments of a test curve to full scale on the recorder chart. This magnifies variations in the loading curve for detailed study. The capability of the instrument to do this is limited by the range of the balance controls.

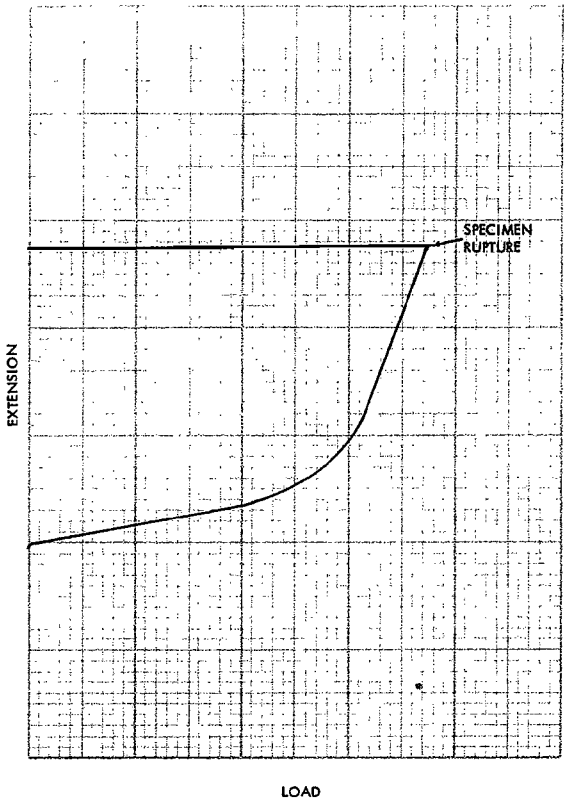


Figure 6-9b. Load-Extension curve of a non-Reinforced Plastic

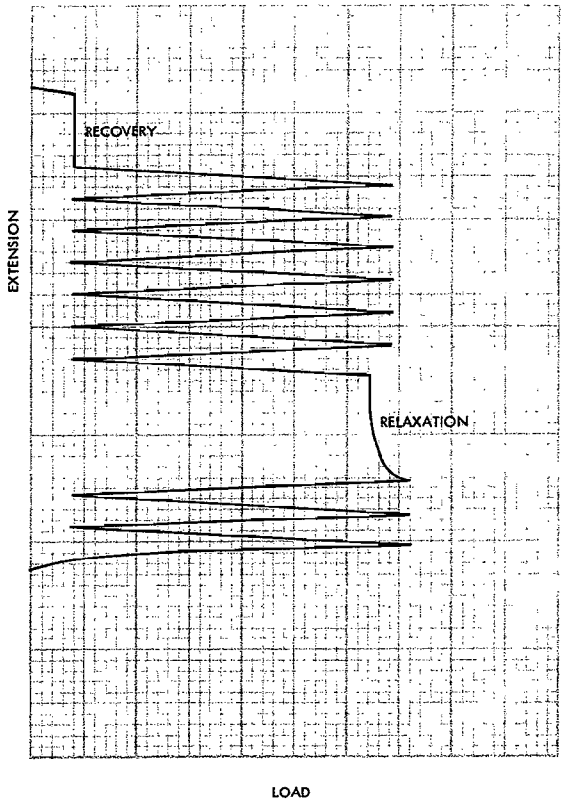


Figure 6-9c. Cyclic Response of a Rubber Specimen

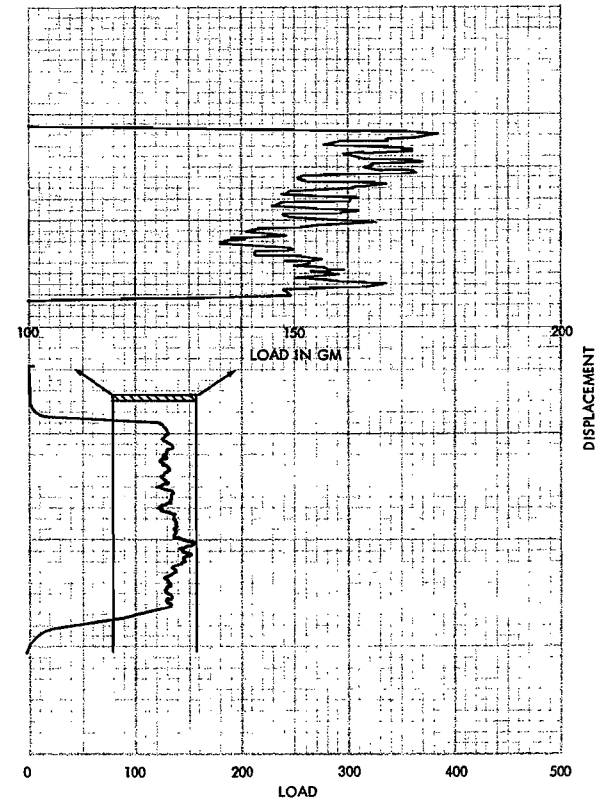


Figure 6-9d. Load-Displacement Curve, Using Zero Suppression to Expand Critical Portion

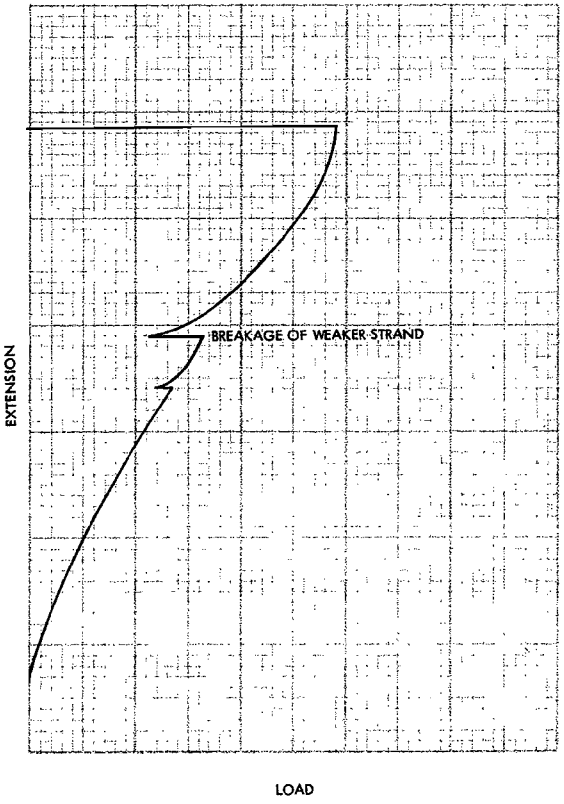


Figure 6-9e. Load-Extension Curve of Yarn Specimen, Indicating Failure of Individual Strands

The zero suppression technique operates by suppressing a portion of the loading curve from 0 to a selected load value. For example, it is possible to suppress the 0 to 300-pound portion of a loading curve, using the procedure outline below. Then, by selecting the 100-pound load range, the chart will indicate the 300 to 400-pound portion (i.e., a 100-pound increment) of the loading curve. The suppressed portion of the loading curve (zero to 300 pounds) will not be recorded.

To use the zero suppression technique, proceed as follows:

a. Install a load cell whose upper range will be greater than the maximum load expected. Zero, balance, and calibrate the load weighing system.

b. Set the FULL SCALE LOAD switch on a range which equals or exceeds the value of load to be suppressed.

c. Adjust the ZERO control to set the recorder pen to the load value that is to be suppressed.

d. Adjust the BALANCE controls to set the recorder pen back to 0. This introduces a negative unbalance which is equal to the load to be suppressed.

e. Adjust the ZERO control to set the recorder pen back to 0.

f. Set the FULL SCALE LOAD switch to the desired position. The recorder pen will be driven down-scale (beyond 0) until the test load reaches the load value which was suppressed. The recorder chart will indicate an increment of the loading curve which is equal to the load range selected.

6.8.4 Calibrating for non-Standard Load Ranges

For some tests it may be desirable to calibrate the load weighing system for a non-standard load range. The capability of the instrument to do this is limited by the range of the calibration control. For example, if a specimen material ruptures at 550 pounds a load scale of approximately 600 to 650 pounds would be desirable.

The following is an example of determining the calibration setting for a non-standard load range:

1. A full scale (f.s.) load range of 625 pounds is required. A 1000-pound capacity load cell is in use, and it has an electrical calibration signal of 500 pounds.

2. To determine where on the recorder chart to set the pen when calibrating the system:

$$\frac{\text{625 pounds f.s.}}{\text{10 major chart divisions}} = \text{62.5 pounds per division}$$

$$\frac{\text{500 pounds}}{\text{62.5 pounds per div.}} = \text{8 divisions}$$

3. Zero and balance the load weighing system. Place the FULL SCALE LOAD switch on 50.

4. Hold the load cell calibration pushbutton depressed, and adjust the CALIBRATION control to set the recorder pen to 8 major chart divisions. The load weighing system is now calibrated for 625 pounds full scale.

CAUTION

Do not overload the load cell.

5. When switching from the initially-calibrated load range, the new load range will be a proportion of the initially-calibrated range. For example, if the "50" FULL SCALE LOAD switch position was calibrated for 625 pounds, the load range for the "20" position can be determined as follows:

$$\frac{20}{50} = \frac{\text{X-Load}}{625}$$

X-Load = 250 pounds full scale, on the "20" position.

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7.0 ACCESSORIES

7.1 EVENT MARKER UNIT

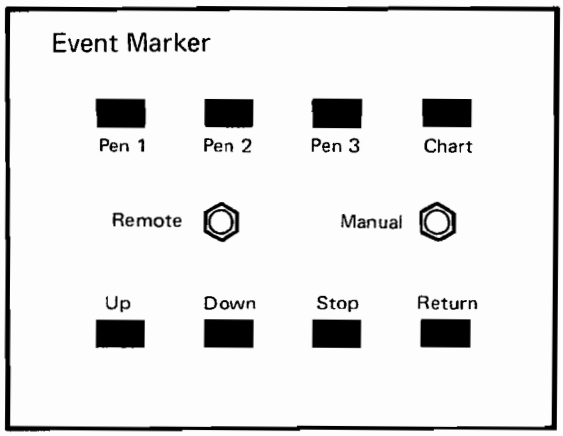


Figure 7-1. Event Marker Operating Controls

7.1.1 Description

The Event Marker control produces a small rapid deflection or "pip" of the recorder pen(s) or in the motion of the chart, either by depressing the MANUAL pushbutton or automatically. The resulting indicator mark on the chart serves as a convenient reference mark for several purposes. For example, the MANUAL pushbutton can be depressed to indicate various points of interest on the load-elongation curve. This unit can also be set to operate automatically when the crosshead starts up or down, stops, or reaches the preset "Return" position. The pip height is normally factory preset at 2% to 3% (figures 7-2 and 7-3), but may be adjusted (VR3 on servo amplifier circuit board).

7.1.2 Operation

a. Depress either PEN 1, 2, or 3, and/or CHART pushbutton(s), as desired. This determines which indicator will mark the desired point on the curve. To release a depressed pushbutton, simply push it in. It should snap out. Note that the chart marker functions only when an optional chart servo drive accessory has been installed on the recorder.

b. For automatic operation, depress UP, DOWN, STOP, and/or RETURN buttons, as desired. When the crosshead is operated in the UP, DOWN, STOP, or RETURN mode, a mark will be made on the chart.

c. For manual operation, depress MANUAL pushbutton when a mark is desired on the chart. Note that a pushbutton with an extension cord that plugs into the front panel is available for remote operation.

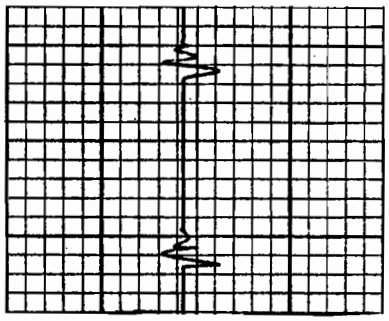


Figure 7-2. Pen Mark at 100 in/min Chart Speed

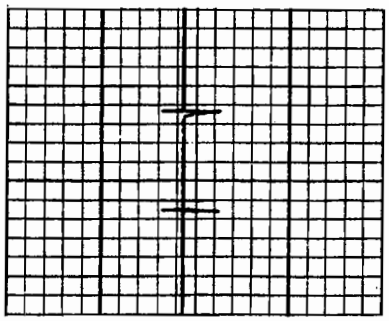


Figure 7-3. Pen Mark at 5 in/min Chart Speed

DN00009194

7.2 SINGLE ZERO SUPPRESSION AND 10-STEP ZERO SUPPRESSION

7.2.1 Description

The zero suppression accessories enable the load-displacement graph on the chart recorder to be greatly magnified over a selected load portion, thus enabling detailed study of that portion.

Assume that a test specimen ruptures at a load of 450 pounds. The zero suppression control would first be preset to suppress a portion of the test curve, for example, 0-400 pounds. Using this accessory, the test can be started on the 0 to 500 pound load range and as the loading approaches 400 pounds, switch in the zero suppression control. This will suppress the initial 0-to-400 pound portion of the loading curve and magnify the narrow load range covering 400 (0%) to 500 pounds (100%). That is, the chart will indicate a load span of 100 pounds over 0 to 100%, greatly magnifying any minor fluctuations in the test curve for detailed study.

The ten-step zero suppression accessory expands this capability further by allowing the progressive suppression of the load curve in ten equal-sized steps. For example, the test can be started on the 0-500 pound range, and as the test load approaches 100 pounds, turn to the first step position to record the 100 pounds (0%) to 200 pounds (100%) segment on the chart. As the load approaches 200 pounds, turn to the second step position to record 200 pound (0%) to 300 (100%) pounds on the chart. In this manner the test can be continued up to sample rupture.

NOTE: Use caution whenever the zero suppression accessories are in use to prevent exceeding the maximum load capacity of the load cell.

The stepped zero suppression unit may be used in conjunction with the single zero suppression unit to provide a single zero suppression of a predetermined amount followed by up to 10 further equal steps of suppression to the full capacity of the load range. Each unit occupies one-third of a standard rack module and figure 7-4 shows the front panel layouts of the controls.

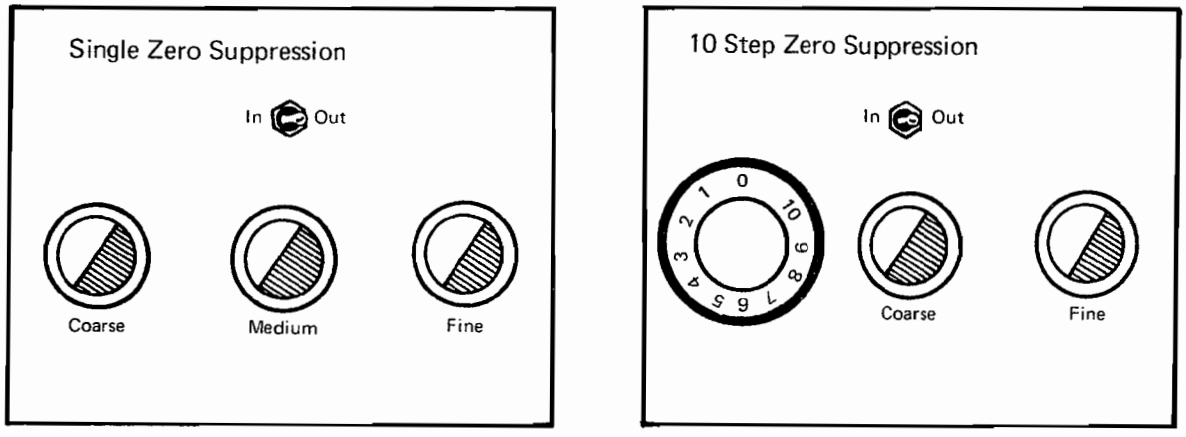


Figure 7-4. Single and 10-Step Zero Suppression Units Operational Controls

7.2.2 Operation

A. Single Zero Suppression

1. Place the zero suppression switch in the OUT position and zero, balance, and calibrate the load weighing system (as described in the operation section).

2. Set the FULL SCALE LOAD switch to the load range required for the test.

3. Adjust the load cell amplifier BALANCE controls to set the recorder pen at the position on the chart corresponding to the amount of zero suppression required. As an example using the full load range of a 2511-301 load cell (0-1000 lbs.), with the FULL SCALE LOAD selector positioned for a range scale of 2-100 and FULL SCALE LOAD switch on position 100: If the 600 to 700-pound portion of the curve is to be magnified, the pen should be moved to the 600-pound point (60% on the 0-100% scale of the recorder).

4. Move the toggle switch on the single zero suppression unit to the IN position. Use the COARSE, MEDIUM and FINE knobs of the zero suppression unit to return the pen to zero on the scale.

5. Move the toggle switch to the OUT position again and return the pen to the zero point on the scale using the load cell amplifier BALANCE controls.

6. Start the test. When the recorder pen reaches the load value to be suppressed, move the toggle switch to the IN position. The recorder pen will now indicate actual load minus the load value being suppressed. Move the FULL SCALE LOAD switch to a lower range position to magnify small load range variation on the chart (in the example quoted the FULL SCALE LOAD switch would be changed to the 10 position).

7. To complete the test using a non-expanded load scale, move the zero suppression unit toggle switch to the OUT position when the full scale load value is reached. Set the FULL SCALE LOAD switch to the original range set in step 2. The pen will move to the chart division corresponding to the actual load on the sample. The test may then be completed normally.

B. 10-Step Zero Suppression

1. Place the 10-step zero suppression switch to the 0 position (fully counterclockwise). Move the IN/OUT switch to the OUT position. Zero, balance, and calibrate the load weighing system, as described in the operation section.

2. Select the full scale load range which corresponds with the amount of load suppression for each step. For instance, with a 2511-301 cell select the 100 pound range (10 position on load range switch) for 100 pounds or less load suppression on each step.

3. Adjust the load cell amplifier balance controls until the recorder pen is at the chart division that corresponds to the desired value of load to be suppressed.

4. Move IN/OUT switch to IN and 10-step suppression switch to position 1.

5. Adjust the COARSE and FINE controls of the 10-step zero suppression unit until the pen returns to zero.

6. Return the 10-step switch to the 0 position. Before commencing tests, reset the pen

to zero on the chart by readjusting the load cell amplifier balance controls.

7. Start the test. Turn the 10-step zero suppression switch through positions 0, 1, 2, 3, etc. during the test to suppress steps of load as desired and expand the load variations.

CAUTION

Use extreme care to ensure that the load cell's maximum capacity is not exceeded.

7.3 LOAD AND STRAIN CYCLING UNITS

7.3.1 Description

These accessory units enable the user to cycle the crosshead between maximum and minimum limits which are set as a function of recorder pen position. It uses the output signal from the load cell or extensometer. Both cycling units occupy one-third of a standard rack unit. Figure 7-5 shows the front panel controls.

Each unit has two sets of controls associated with each of the maximum and minimum positions of the recorder pen. The minimum or maximum position is set by means of a 10-turn potentiometer and an indicator light to show when the associated limit is reached.

There is a set of four pushbutton switches which are interlocked so that the selection of any one will release another previously depressed. These are marked OFF, STOP, CYCLE and HOLD. Depressing the OFF button will make that half of the unit (min or max) inoperative so it will have no effect on the crosshead drive unit. Depressing the STOP button will cause the crosshead to be stopped when the limit is reached. Depressing the CYCLE button will cause the crosshead to be reversed when the limit is reached, and the reversed drive crosshead speed will remain the same as the forward speed. Depressing the HOLD button will cause the crosshead to stop when the limit is reached, but the specimen will remain under a constant load or strain value.

NOTE: When HOLD is selected, specimen relaxation (if the hold is on the maximum limit) or specimen recovery (if the hold is on the minimum limit) will only drift up to 1% of the load or extension value away from the hold position, before the crosshead will be repositioned to that hold position.

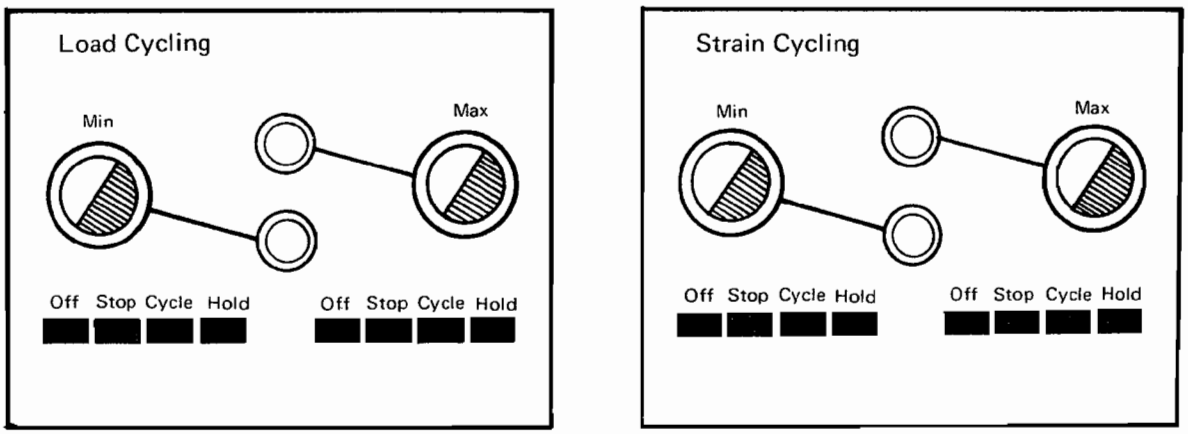


Figure 7-5. Load and Strain Cycling Units Operational Controls

7.3.2 Operation

1. Prepare the load (and strain) cycling accessory for operation with zero load on the sample and, if used, the extensometer set at gage length. Pull out the accessory unit and set the ZERO LEFT/ZERO RIGHT switch to the proper position for the test. That is, zero load (or strain) on the left edge of the chart or zero load (or strain) on the right edge of the chart.

CAUTION

Do not change load (or strain) range switch position during a cycling test. Otherwise, the sample could be inadvertently loaded (or strained) beyond its ultimate strength, since the cycling accessories work on the percentage of recorder scale indicated, not actual load (or strain).

2. After the load cell amplifier or the strain data unit has been zeroed, balanced and calibrated, press both STOP buttons on the respective cycling unit.

3. Use the BALANCE control on the load cell amplifier or the strain data unit to move the recorder pen (or chart paper) to the required minimum position.

4. If the associated indicator is not lit, turn the MIN control clockwise until it lights. Slowly turn the MIN control counterclockwise until the indicator just extinguishes. Lock the control knob by turning the locking ring clockwise.

5. Use the BALANCE controls on the load cell amplifier or on the strain data unit to move the recorder pen (or chart paper) to the required maximum position.

6. If the associated indicator is not lit, turn the MAX control counterclockwise until it lights. Slowly turn the MAX control clockwise until the indicator just extinguishes. Lock the control knob by turning the locking ring clockwise.

7. Depress both OFF switches on the cycling unit and readjust the load cell amplifier (or the strain data unit) BALANCE controls to set the recorder pen (or chart) to zero.

8. Commence testing.

9. During a test, if it is desired to stop the crosshead when it reaches the maximum or minimum position, select the STOP switch for the respective position. However, if it is desired to stop the crosshead at the maximum or minimum position while maintaining the load or strain on it constantly, depress the HOLD switch for the appropriate limit. Note that the load or strain can change up to 1% due to specimen relaxation or recovery before the unit will reposition the crosshead at the limit point.

NOTE: The following additional procedure should be performed in order to assure proper operation when a load or strain cycling accessory is used in the HOLD mode.

10. To turn off the load or strain cycling accessory when using the HOLD mode, and reset the circuitry, proceed as follows:

1. Depress OFF button on the load or strain cycling module.

2. On the crosshead control chassis, depress the UP, DOWN, and STOP crosshead pushbuttons in that sequence. This clears and resets the logic circuits so that normal testing operations can be resumed.

CAUTION

If the UP, DOWN, and STOP buttons are not depressed after turning off the cycling accessory, the crosshead may automatically begin moving whenever the load (or strain) pen reaches the previously set "hold" value.

7.4 EXTENSION MEASUREMENT UNIT

7.4.1 Description

The Extension Measurement Unit (EMU) provides a convenient digital display of the crosshead position in inches (or millimeters) with respect to the gage length. This readout capability is further extended by three, 4-digit, thumbwheel switches which can cause the crosshead to stop or reverse direction when the displayed value matches the value manually set on the switches. Figure 7-6 shows the front panel layout of the EMU.

The EMU EXTENSION display flashes on and off, at a 1 Hz rate, when main power is initially applied or whenever power is interrupted for longer than 10 μseconds. This flashing, which indicates a loss of original gage length, will continue until a gage length point has been established and the RESET pushbutton depressed.

The EXTENSION display shows the crosshead position within a reading accuracy of 0.01 inches (0.1 mm). The red lamp lights when the display shows 00.00 inches (000.0 mm), indicating that the crosshead is at gage length (starting point of the test). This point is selected by depressing the RESET pushbutton under the display when the crosshead is at the desired position. If it is necessary to drive the crosshead through a preset zero point, that is, in a direction opposite to the selected test direction, depress the INHIBIT pushbutton under the display (red lamp will extinguish) before depressing the RETURN pushbutton on the crosshead control unit. When the crosshead starts moving, the display will indicate 99.99 inches (999.9 mm) and count down. The crosshead will continue moving in the same direction, at the return speed, because the EMU is no longer in control. When operating in this manner, the crosshead control unit STOP pushbutton must be depressed when the desired crosshead position is reached (observe CAUTION below).

CAUTION

To prevent accidental damage to load cell, grips, and fixtures, always preset the crosshead mechanical limits on the loading frame.

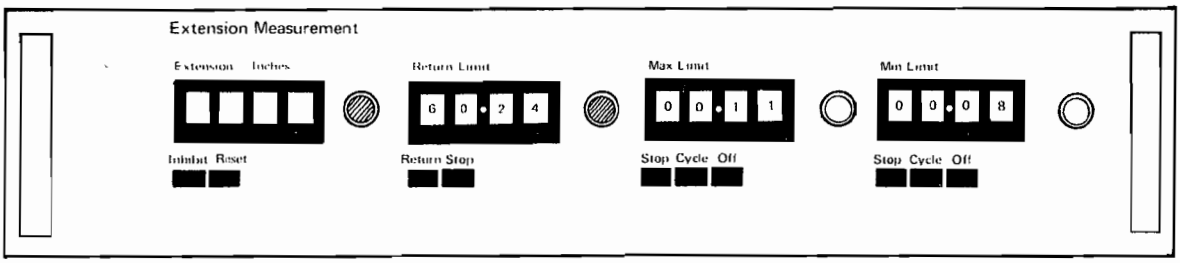


Figure 7-6. Extension Measurement Unit Operational Controls

The three sets of thumbwheel switches on the EMU panel, marked RETURN LIMIT, MAX LIMIT, and MIN LIMIT, are manually set to the required crosshead position limits within an accuracy of 0.01 inches (0.1 mm). The limits set on these switches relate to the EXTENSION display and must be within the crosshead mechanical limit switch settings on the loading frame. When a set limit point is reached, as indicated on the EXTENSION display, the lamp adjacent to the respective limit will light, and the crosshead will stop or reverse direction.

The return limit has two pushbuttons marked RETURN and STOP. Depressing the RETURN button will cause the crosshead to gage length position at return speed when the preset return limit point is reached. Depressing the STOP button will cause the crosshead to stop when the preset return limit point is reached.

The maximum and minimum limit each have three pushbuttons marked STOP, CYCLE, and OFF. Depressing the STOP button will cause the crosshead to stop when the preset limit is reached. Depressing the CYCLE button will cause the crosshead motion to be reversed when the preset limit is reached. Depressing the OFF button will isolate that limit control function and the preset limit point will be passed with no effect on the crosshead motion.

NOTE: To ensure proper operation of the EMU, always depress the TEST DIRECTION switch (UP or DOWN) on the crosshead control unit, whichever represents the initial test direction from specimen gage length.

7.4.2 Operation

Tension Testing

NOTE: If the main power has been interrupted, the EXTENSION display will flash until gage length is set and the RESET pushbutton depressed.

1. Perform the following procedure to set the crosshead gage length position using the extension measuring unit:

a. Carefully move the crosshead, using a low speed, to bring the grips together. Depress the INHIBIT switch if the crosshead is to be driven through the previous gage length point.

b. When the grips are just touching (without placing any reverse load on the load cell and coupling) press the display RESET button. Set the RETURN LIMIT thumbwheels to the desired gage length distance and depress the related STOP pushbutton.

c. Drive the crosshead upward and when it stops, depress the display RESET pushbutton again. This sets the desired specimen gage length (initial grip separation).

2. If the test program requires extension of the specimen to rupture, set the RETURN LIMIT thumbwheel switches to a figure beyond the desired maximum extension. If the specimen is rigid, depress the RETURN LIMIT STOP pushbutton so that the two pieces of the specimen will not be forced together at the return speed, which could reverse-load or damage the load cell. If the specimen is flexible and several tests are to follow, select RETURN. After the specimen ruptures and when the RETURN LIMIT is reached, the crosshead will return to the

gage length point at the return speed. Depress the OFF pushbutton under the MAX LIMIT and MIN LIMIT thumbwheel switches.

3. If a specimen is not to be broken, but only to be extended between certain dimensions, set the RETURN LIMIT thumbwheel switches to a figure beyond the maximum desired extension. Set the MAX LIMIT thumbwheel switches to the desired maximum extension and the MIN LIMIT thumbwheel switches to the desired minimum extension. If the CYCLE pushbuttons are depressed on the MAX LIMIT and MIN LIMIT control functions, the crosshead drive will be reversed when a limit point is reached. Depress the proper STOP pushbutton to stop the crosshead at a limit, if desired. The respective white indicator lamp will light when a limit is reached.

Compression Testing

NOTE: If the main power has been interrupted, the EXTENSION display will flash until gage length is set and the RESET pushbutton depressed.

1. Perform the following procedure to set the RETURN LIMIT using the extension measurement unit:

a. Move the crosshead, using a low speed, to place the anvil at the lower limit position. Depress the INHIBIT switch if the crosshead is to be driven through the previous gage length point.

b. Zero the digital display by depressing the display RESET pushbutton. Move the crosshead away from the compression table and stop it when the required gage length is reached. Set the RETURN LIMIT thumbwheel switches to the figures shown on the digital display and depress the display RESET pushbutton. Depress the RETURN or STOP pushbutton on the RETURN LIMIT, as desired. The gage length and return limits have now been set. Depress the OFF pushbutton under the MAX and MIN LIMIT thumbwheel switches.

2. If the specimen is to be compressed between certain dimensions, set the MAX LIMIT thumbwheel switches to the dimension of the deepest compression and MIN LIMIT thumbwheel switches to the dimension of the shallowest. If the CYCLE pushbuttons are depressed on the MAX and MIN LIMIT control functions, the crosshead drive will be reversed when a limit point is reached. Depress the proper STOP pushbutton to stop the crosshead at a limit point, if desired. The respective white indicator lamp will light when a limit is reached.

7.4.3 Important Operating Note

When using low testing speeds (typically, below 1 in/min or 10 mm/min), the displayed extension reading will reach the preset limit value before the crosshead will stop or reverse direction. At higher crosshead speeds, the display changes so quickly this is not noticeable. At slow speeds, however, it is quite apparent.

For example, when using a crosshead speed of 0.002 in/min and assuming the maximum extension limit is set at 00.001 inches, the display will indicate "00.01" after 2-1/2 minutes but the crosshead will continue to move until it has traveled the full 00.01 inches which will take 5 minutes. On metric

units, when using a crosshead speed of 0.05 mm/min, it will take 2 minutes for the crosshead to travel 000.1 mm which is the smallest settable value on the EMU. In this case, the display would indicate "000.1" after 1 minute but the crosshead will not stop until it has traveled for the full 2 minutes.

The reason for this is that the EMU uses 5-digit electronic counters but displays only the four most significant digits. The least significant digit is used for control and timing purposes and is not displayed. This least significant digit is set to an initial value of "5" which causes the last digit on the display to change ahead of the actual extension value. However, this has no affect on the accuracy of the EMU as the crosshead is controlled by the preset limit switches.

7.5 STRAIN DATA UNIT

7.5.1 Description

The strain data unit is designed for applications where a strain gage extensometer is required to accurately measure specimen elongation (strain), or other types of deformation, with the extensometer attached directly to the specimen.

The strain data unit can be connected to drive either a recorder pen or the recorder chart servo drive system. Thus, specimen strain can be recorded, in magnified form, as chart motion or a pen trace. When driving the second pen of a two pen recorder with the strain data unit, the chart is maintained in a synchronous drive mode, enabling load and strain to be plotted against time.

When the strain data unit functions with the chart servo drive, the recorder pen plots load while chart motion corresponds to strain. This arrangement produces a load versus strain curve directly.

A variety of 120-ohm strain gage transducers may be used with the strain data unit. These include Instron series 2630 strain gage extensometers, series 2640 transverse strain sensors, series 2670 crack opening displacement gages, series 2650 averaging extensometers, or 120-ohm resistance strain gages bonded directly to the specimen. Detailed instructions for Instron strain transducers and calibrators are contained in the following manuals:

Model	Manual No.
Strain gage extensometer	10-69-1
Averaging extensometer	10-324-1
Transverse strain sensor	10-327-1
Crack opening displacement	10-384-1
High magnification calibrator	10-18-2
Low magnification calibrator	10-18-1

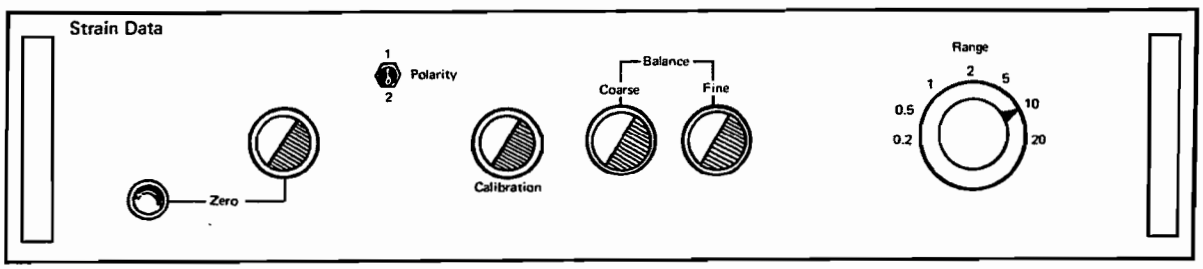


Figure 7-7. Strain Data Unit Operational Controls

Since the chart time drive mode is desirable for many tests, the recorder is designed to be easily switched to or from the chart servo drive mode by depressing (or releasing) the CLUTCH and SERVO pushbutton switches on the recorder. The recorder may be switched to the time drive mode by depressing the TIME pushbutton, or operated independently by depressing the forward (▼) or reverse (▲) pushbuttons.

The strain data unit can be used in conjunction with the strain cycling control in order to perform strain cycling tests. The strain data unit front panel is shown in figure 7-7.

NOTE: Paragraph 7.5.2 describes the operation of the strain data unit when driving the recorder chart. Paragraph 7.5.3 is the operating procedure when driving the second pen of a 2-pen recorder system.

7.5.2 Operating Procedure — Strain Data Unit and Recorder Chart

NOTE: Prior to using the strain data unit in an operating mode, a zero, balance and calibrate procedure must be performed as described below. Refer to the pertinent manuals for details concerning calibrator positioning and strain transducer mounting requirements.

A. Preliminary Setup and Adjustments

a. Mount spindles on calibrator that fit strain transducer clamps, and set unit in its operating position.

b. Adjust calibrator for minimum displacement (gage length); minimize backlash in mechanism by going through zero point and then return.

c. Mount strain transducer on calibrator and plug its cable connector into receptacle (strain gage) at rear of loading frame. Before completing procedure, allow at least 20 minutes for extensometer to stabilize after excitation has been applied.

d. Move POLARITY switch to the 1 position. This will allow the recorder chart to advance with an increasing strain signal.

B. Adjusting Zero Control

a. Turn RANGE switch to 20 (least sensitive position).

b. Depress and engage CLUTCH and SERVO pushbuttons on recorder control panel.

c. Depress and hold ZERO pushbutton while turning ZERO control (10-turn potentiometer) fully counterclockwise; the chart should retract. Then adjust ZERO control clockwise until chart advances 2 minor divisions.

d. Release CLUTCH pushbutton and then manually move chart until a major division is aligned with the edge of the clear plastic scale. Mark this division as a zero point on the chart.

C. Adjusting Balance Controls

a. While ZERO button is depressed, depress and engage CLUTCH pushbutton on recorder panel.

b. Release ZERO pushbutton; the chart will probably offset from its zero position.

c. Adjust COARSE and FINE BALANCE controls to return zero mark on chart back to edge of plastic scale.

d. Turn RANGE switch to the 10 position and readjust BALANCE controls to position chart exactly at zero. Repeat this adjustment at each of the remaining positions through the most sensitive (0.2) range.

e. As a check, turn calibrator adjustment below its zero setting and then back to

eliminate any backlash. Readjust FINE BALANCE control, as required, to set chart position at its marked zero.

NOTE: Setting the POLARITY switch to 2 allows a reversal of the chart movement, with increasing strain, from that of the 1 polarity. If this feature is not required, proceed to paragraph E to perform the calibration.

D. Adjusting Polarity Zero at Position 2

a. Perform zero and balance procedure with POLARITY switch at position 1 (paragraphs B and C above).

b. Depress and hold ZERO pushbutton while adjusting ZERO control in a clockwise direction to move chart a minimum of 20 inches (50 cm.) Mark a major chart division as a zero point for polarity usage at position

c. Move POLARITY switch to position 2. If chart offsets, adjust BALANCE controls to reset chart to the zero for position 2 polarity.

E. Adjusting Calibration Control

NOTE: A quadrature adjustment is provided within the strain data unit to compensate for stray capacitance in the strain transducer being used with the system. This adjustment should be checked periodically, and must be checked whenever the strain transducer is changed, to maintain the linearity and hysteresis of the system within specification. The adjustment is made after the zero and balance procedure and prior to calibrating (refer to paragraph G).

a. Determine strain range and magnification to be used for testing by referring to specification chart in manual for strain transducer in use; also, refer to operating notes in paragraph F of this procedure. Turn RANGE switch to required position.

b. Carefully turn calibrator to a value which corresponds to full scale displacement of transducer on range in use (reference specifications). Do not turn calibrator past full scale point and then have to reverse it, as calibrator backlash will cause an error in calibration.

c. Carefully adjust CALIBRATION control on strain data unit to obtain 20 inches (50 cm) of chart motion, representing maximum strain on range in use.

NOTE: The calibration control should always be adjusted for the particular strain range being used for testing.

d. Turn calibrator back to original zero point; go slightly beyond zero and then return to eliminate backlash. Check that recorder chart has followed and returned to zero; readjust BALANCE control, with RANGE switch on 0.2, until zero and balance positions are at the same point on chart.

e. Repeat calibration procedure for accuracy.

F. Operating Notes

1. When using the strain data unit to drive the chart, the CLUTCH and SERVO pushbuttons on the recorder must be depressed. However, the TIME pushbutton disengages the chart servo drive and the chart will be in the time drive mode. Also, if the chart forward (▼) or (▲) reverse pushbuttons are depressed, the chart servo drive will be disengaged.

2. Each calibrator and servo system has a small, inherent amount of backlash. Therefore, when adjusting the system to a zero point or at full scale displacement use caution to prevent adjustment errors due to backlash. Do not turn the calibrator beyond the full scale displacement point and then reverse it

when setting the calibration. Carefully adjust it up to full scale point and then stop. When setting zero, turn the calibrator beyond the zero point and then turn it back to the zero point.

3. When using high magnification ranges, carefully balance the servo system on the 20 range (low sensitivity). It can then be rebalanced as the range selector switch is turned to the more sensitive ranges.

4. The application of this strain data unit is for recording specimen strain over 20 inches (50 cm) of chart motion. Hence, the magnification ratio - the ratio between chart motion and actual strain transducer deflection - must be doubled over that listed in any strain transducer specification based on 10 inches (25 cm) of chart motion.

5. The least sensitive range of 20 on the strain data unit is not normally used. This range position is intended to be used when operating over ± 10 inches (±25 cm) of chart deflection with extensometers capable of both tension and compression measurements.

6. The maximum hysteresis and nonlinearity percentages, as indicated in the specifications for the strain transducers listed in paragraph 7.5.1, are not applicable if the more sensitive ranges of 0.5 and 0.2 are used.

7. When used in conjunction with the Break Detector accessory, the chart servo clutch is disengaged at sample break and reengaged when the Break Detector unit is reset.

G. Adjusting Quadrature Balance

A Quadrature Balance adjustment (R3) is mounted internally on the right-hand side of the strain data amplifier's motherboard chassis. It is included to compensate for any capacitive unbalance in the strain transducer or cables, which may affect system linearity. Perform the following procedure periodically, or in case the strain transducer is changed, to check and adjust quadrature.

a. Adjust zero and balance controls per paragraphs B and C of this procedure.

b. On recorder control panel, release the SERVO and CLUTCH pushbuttons.

c. On strain data unit panel, set RANGE switch to the 0.2 position and set POLARITY switch to the position to be used during regular testing procedures.

d. Slide strain data unit forward from console for internal access. Connect an oscilloscope to test points TP4 (high) and TP1 (low).

e. Observe an a.c. signal on oscilloscope. A nonsymmetrical waveform indicates presence of a quadrature component. Adjust Quadrature Balance control (R3) and FINE BALANCE control alternately until signal waveform is minimized and symmetrical.

f. Depress SERVO and CLUTCH pushbuttons, on recorder control panel, and readjust FINE BALANCE control to set chart position at its marked zero. Perform calibration procedure (paragraph E of this procedure).

7.5.3 Operating Procedure - Strain Data Unit and Recorder Pen

When driving the second pen of a two pen recorder with the strain data unit, the chart is maintained in a synchronous drive mode, enabling load and strain to be plotted against time.

NOTE: Prior to using the strain data unit in an operating mode, a zero, balance and calibrate procedure must be performed as described below. Refer to the pertinent manuals for details concerning calibrator positioning and strain transducer mounting requirements.

A. Preliminary Setup and Adjustments

a. Mount spindles on calibrator that fit strain transducer clamps, and set unit in its operating position.

b. Adjust calibrator for minimum displacement (gage length); minimize backlash in mechanism by going through zero point and then return.

c. Mount strain transducer on calibrator and plug its cable connector into receptacle (strain gage) at rear of loading frame.

d. Move POLARITY switch to the 1 position. This will allow the strain pen to move left to right.

B. Adjusting Zero Control

a. Turn RANGE switch to 20 (least sensitive position).

b. Depress and engage strain pen pushbutton on recorder control panel.

c. Depress and hold ZERO pushbutton while turning ZERO control (10-turn potentiometer) fully counterclockwise; the pen should move to the left-hand side of the chart. Adjust this control to position pen on first graduation of chart. Mark this line as a zero point.

C. Adjusting Balance Controls

a. Release ZERO pushbutton; the pen will probably offset from its ZERO position.

b. Adjust COARSE and FINE BALANCE controls to return pen to zero.

c. Turn RANGE switch to the 10 position and readjust BALANCE controls to position pen exactly at zero. Repeat this adjustment at each of the remaining positions, through the most sensitive (0.2) range.

d. As a check, turn calibrator adjustment below its zero setting and then back to eliminate any backlash. Readjust FINE BALANCE control, as required, to set pen position at its marked zero.

NOTE: Setting the POLARITY switch to 2 allows a reversal of the pen movement, with increasing strain, from that of the 1 polarity. If this feature is not required, proceed to paragraph E to perform the calibration.

D. Adjusting Polarity Zero at Postion 2

a. Perform zero and balance procedures with POLARITY switch at position 1 (paragraphs B and C above).

b. Depress and hold ZERO pushbutton while adjusting ZERO control in a clockwise direction to move pen full scale (10 inches or 250 mm) on the chart. This is a zero point for polarity usage at position 2.

c. Move POLARITY switch to position 2. If pen is displaced, adjust BALANCE controls to reset it to zero for position 2 polarity.

E. Adjusting Calibration Control

NOTE: A quadrature adjustment is provided within the strain data unit to compensate for stray capacitance in the strain transducer being used with the system. This adjustment should be checked periodically, and must be checked whenever the strain transducer is changed, to maintain the linearity and hysteresis of the system within specification. The adjustment is made after the zero and balance procedure and prior to calibrating (refer to paragraph G).

a. Determine strain range and magnification chart in manual for strain transducer

in use; also, refer to the operating notes in paragraph F below. Turn RANGE switch to required position.

b. Carefully turn calibrator to a value which corresponds to full scale displacement of transducer on range in use (reference specification). Do not turn calibrator past full scale point and then have to reverse it, as calibrator backlash will cause an error in calibration.

c. Carefully adjust CALIBRATION control on strain data unit to obtain 10 inches (250 mm) of pen motion, representing maximum strain on range in use.

NOTE: The calibration control should always be adjusted for the particular strain range being used for testing.

d. Turn calibrator back to original zero point; go slightly beyond zero and then return to eliminate backlash. Check that pen has followed and returned to zero; readjust BALANCE control, with RANGE switch on 0.2, until zero and balance positions are at the same point.

e. Repeat calibration procedure for accuracy.

F. Operating Notes

1. Each calibrator and servo system has a small, inherent amount of backlash. Therefore, when adjusting the system to a zero point or at full scale displacement use caution to prevent adjustment errors due to backlash. Do not turn the calibrator beyond the full scale displacement point and then reverse it when setting the calibration. Carefully adjust it up to full scale point and then stop. When setting zero, turn the calibrator beyond the zero point and then turn it back to the zero point.

2. When using high magnification ranges, carefully balance the servo system on the 20 range (low sensitivity). It can then be rebalanced as the range selector switch is turned to the more sensitive ranges.

3. The least sensitive range of 20 on the strain data unit is not normally used. This range position is intended to be used when operating with a pen zero at center of chart for extensometers capable of both tension and compression capability, or with strain gages bonded directly to the specimen.

4. The maximum hysteresis and nonlinearity percentages, as indicated in the specifications for the strain transducers listed in paragraph 7.5.1, are not applicable if the more sensitive ranges of 0.5 and 0.2 are used.

G. Adjusting Quadrature Balance

A Quadrature Balance adjustment (R3) is mounted internally on the right-hand side of the strain data unit's motherboard chassis. It is included to compensate for any capacitive unbalance in the strain transducer or cables, which may affect system linearity. Perform the following procedure periodically, or in case the strain transducer is changed, to check and adjust quadrature.

a. Adjust zero and balance controls per paragraphs B and C of this procedure.

b. Disable strain pen by releasing its pushbutton on recorder control panel.

c. On strain data unit panel, set RANGE switch to the 0.2 position and set POLARITY switch to position to be used during regular testing procedures.

d. Slide strain data unit forward from console for internal access. Connect an oscilloscope to test points TP4 (high) and TP1 (low).

e. Observe an a.c. signal on oscilloscope. A nonsymmetrical waveform indicates presence of a quadrature component. Adjust

Quadrature Balance control (R3) and FINE BALANCE control alternately until signal waveform is minimized and symmetrical.

f. Depress strain pen pushbutton, on recorder control panel, and readjust FINE BALANCE control to set pen position at its marked zero. Perform calibration procedure (paragraph E of this procedure).

7.6 AREA COMPENSATOR

7.6.1 Description

The area compensator is an accessory which enables the recorder load scale to be calibrated in terms of stress, or similar units, relating force and specimen size. An accurately calibrated potentiometer on the front panel of the unit (figure 7-8) is adjusted by the operator to correspond to the measured cross-sectional area (or similar unit of size) of each specimen being tested. Adjustment of this potentiometer changes the load sensitivity to compensate for various sizes of specimens so that the recorder scale can remain accurately calibrated in terms of stress (force per unit area).

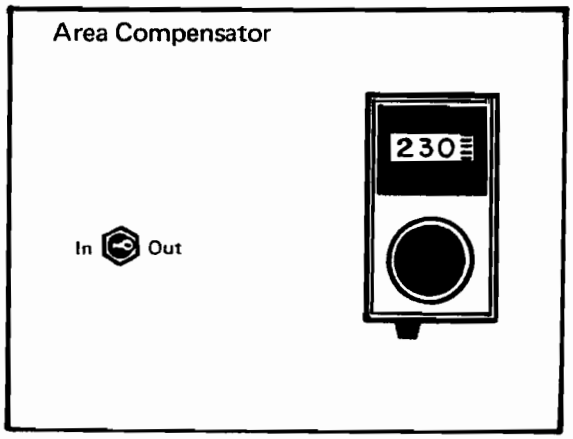


Figure 7-8. Area Compensator Operational Controls

The potentiometer has a 10-turn dial which can be set between 0.9 and 10.9. Increasing the setting of the dial proportionally decreases the sensitivity of the load cell amplifier for any stress range. For example, increasing the dial setting from 1.0 to 2.0 decreases the load cell amplifier sensitivity by 1/2, so that twice as much load will be required for full scale stress response.

If the specimen cross-sectional area was then doubled, the stress sensitivity would remain the same for the two specimens of differing cross-sectional areas. The load-stress relationship is expressed by the formula:

$$L = S \times A \text{ or } S = \frac{L}{A}$$

where: L = Load in pounds
S = Stress in psi
A = Cross-sectional Area in square inches

With the area compensator switched in, the load cell amplifier FULL SCALE LOAD selector switch determines the full scale stress range (instead of a load range) for the recorder, but in the same step multiples.

7.6.2 Determining Stress Ranges

The stress range indicated by 100% (full scale) on the recorder scale may be determined from the following equation:

$$\text{Full Scale Stress} = \frac{\text{D.S.}}{\text{A}} \times \text{L. R.}$$

where:

D.S. = Area Dial Setting - usually set to the same number as the specimen cross-sectional area (ignoring the decimal point).

A = Cross-sectional Area of the specimen under test - in square inches (mm^2 or cm^2, metric units).

L.R. = Load Range – in pounds (grams or kilograms, metric units). Load range is determined by the load cell in use and the load range selector setting.

Example 1: Assume a specimen has an A = 0.675 square inches. Assume also a 2511-103 load cell is in use with the FULL SCALE LOAD range selector switch set at 1. Determine the full scale stress reading as follows:

Set the area dial to 6.75. A type 2511-103 (50-pound) load cell with the range selector switch set at 1 has a full scale load range of 1-pound.

Substituting these values in the equation

Full Scale Stress =

$$\frac{D.S.}{A} \times L.R. = \frac{6.75}{0.675\ in^2} \times 1\ lb = 10\ psi$$

If the load range switch were changed to 5 (L.R. = 5 pounds) the full scale stress would be:

$$\frac{6.75}{0.675\ in^2} \times 5\ lb = 50\ psi$$

7.6.3 Limitations Due to Load Cell Capacity

Use caution to avoid overloading the cell. A full scale reading on the recorder can be above the maximum capacity of the load cell, when using certain settings of the load range selector and area dial.

It is good practice to use a full scale stress range that is less than the maximum allowable stress; where:

Maximum Allowable Stress

$$= \frac{\text{Maximum Capacity of Load Cell}}{\text{Specimen Cross-sectional Area}}$$

In some cases it may not be possible, and only a portion of the recorder scale can be used without overloading the cell. Under these circumstances, the better procedure is to use a higher capacity load cell to increase the safety margin.

For example, assume that a type 2511-301 (1000-pound) cell is being used for testing a specimen having an Area = 0.4 square inches.

$$\text{Full Scale Stress} = \frac{D.S.}{A} \times L.R.$$

$$= \frac{4.0}{0.4\ in^2} \times 1000\ lb$$

The load (in pounds) that would exist at a stress of 10,000 psi is expressed by:

$$L = S \times A$$
$$= 10{,}000\ psi \times 0.4\ in^2$$
$$= 4000\ lb$$

This is 3000 pounds over the range of the cell. The maximum allowable stress is 1000/0.4 = 2500 psi. Note that 2000 psi (200 pounds load) would be indicated with the load range selector on position 20.

7.6.4 Testing Procedure

a. Place the area compensator IN-OUT switch in the OUT position.

b. Zero, balance, and calibrate the load weighing system.

NOTE: The load weighing system may be calibrated with the area compensator switched in or out. If the area compensator is switched IN, the potentiometer dial must be set to exactly 1.0.

c. Move the IN-OUT switch to the IN position. Set the potentiometer dial to 1.0. The recorder pen should remain at the zero position on the chart.

d. Determine the full scale stress range(s) to be used, as described in paragraph 7.6.2. Set the FULL SCALE LOAD range switch to obtain desired full scale stress range.

$$\frac{\text{Max. cell capacity}}{\text{Specimen area}} = \text{Maximum allowable stress}$$

CAUTION

Do not exceed the maximum capacity of the load cell.

e. Set the potentiometer dial to the cross-sectional area of the specimen under test. Set IN-OUT switch to IN position. Install specimen and perform testing required.

7.7 BREAK DETECTOR UNIT

7.7.1 Description

The break detector unit is an accessory which uses a rapid decrease in load signal during a test to detect when the sample breaks. The unit can be set to perform several control functions when this occurs, including automatically stopping the crosshead so that sample extension can be measured, or rapidly returning the crosshead to the gage length position.

A sample break is defined as the load signal falling sharply by an amount greater than the sensitivity control setting. For example, assume the sensitivity is set at 30% of full scale load. This means that a sample being tested can have a rupture strength load value from 30% to 100%; but for the break detector to trigger, the load must fall sharply from the rupture value by greater than 30%.

NOTE: When a chart servo is installed, the break detector will cause the servo clutch to be disengaged at sample break; resetting the break detector unit restores the servo clutch.

The break detector can be used to apply an external trigger for another accessory when the specimen breaks. When used in conjunction with the automatic integrator (Series 2360), it will stop the integration process at the exact moment of sample break, thus providing a more accurate energy figure.

The unit is one-third of a standard rack module in size, and the front panel operational controls are shown in (figure 7-9). Two additional switches – ZERO-LEFT/RIGHT and RESET–MANUAL/AUTO – are located behind the front panel.

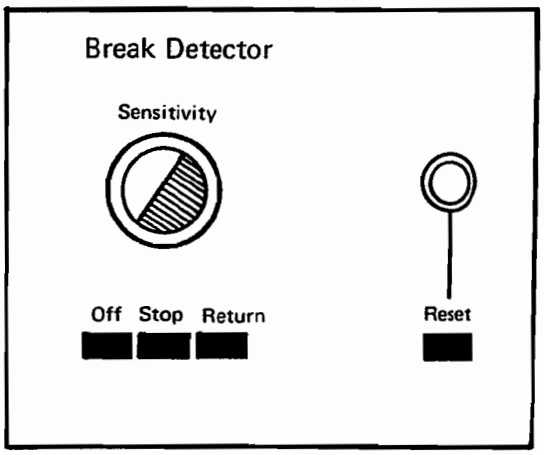


Figure 7-9. Break Detector Unit Operational Controls

When a sample break is detected, the red lamp on the break detector front panel will flash. In the manual-reset mode, this flashing will continue until the unit's RESET pushbutton is depressed; in the automatic reset mode, the flashing will stop when the crosshead motion stops.

7.7.2 Functioning of Controls

The SENSITIVITY control allows the break detection sensitivity to be set between 8% and 30% of the full scale load range. The OFF, STOP, and RETURN pushbutton switches are interlocked and function as follows.

OFF - shuts off break detector unit.

STOP - causes crosshead to stop when a sample break is detected.

RETURN - causes crosshead to return to gage length position when a sample break is detected.

The toggle switches located behind the front panel function as follows:

ZERO-LEFT/RIGHT – allows the break dedector unit to function whether the recorder pen is positioned zero-left or zero-right for an increasing load, as set by the POLARITY switch on the load cell amplifier panel.

RESET-MANUAL/AUTO – when set to MANUAL, the RESET pushbutton must be depressed after a sample break to reset the break detector unit and engage the chart servo clutch (if used); when set to AUTO, the unit (and servo clutch) are reset automatically when the crosshead motion stops.

7.7.3 Operation

Initially zero, balance, and calibrate the load weighing system with the break detector unit off. To set up and use the unit, proceed as follows:

a. Set ZERO-LEFT/RIGHT switch behind break detector front panel to correspond to recorder pen zero position. (The RESET-MANUAL/AUTO switch may be set to AUTO for convenience during set up.)

b. Unlock SENSITIVITY control and turn knob fully counterclockwise (least sensitive setting).

c. Use load cell amplifier BALANCE controls to position load pen at approximate percentage of full scale load desired for sample break sensitivity. This may be between 8% and 30%.

NOTE: Typically, the sensitivity is set at a percentage so that the unit ignores small load fluctuations but triggers when the sample breaks.

d. Depress STOP button on break detector.

e. Start crosshead upwards at test speed. Depress load cell amplifier ZERO switch. If crosshead does not stop, turn SENSITIVITY knob clockwise by about 5° or 10°. Depress ZERO switch again with crosshead moving upwards. Repeat this procedure until the crosshead stops when ZERO switch is depressed. Allow about 5 seconds between successive trials for circuit elements to recover.

f. Rebalance load weighing system.

g. Depress STOP or RETURN button on break detector unit, as required.

h. Set RESET-MANUAL/AUTO switch to desired position.

i. Proceed with test program. When a sample break occurs, the red light will begin flashing until the break detector unit is reset.

NOTE: Avoid adjusting SENSITIVITY control during a test. If it is necessary to do so, depress break detector OFF button, change sensitivity setting, and then depress STOP or RETURN button as required.

7.8 VARIABLE SPEED UNIT

7.8.1 Description

The variable speed unit enables an operator to conveniently set any crosshead speed, that is within the normal range of the testing instrument, in 0.1% increments. This accessory was developed for speed control applications requiring non-standard test speeds. For example, using a "base" speed of 20 inches per minute and setting the percent thumbwheel switches to 60.0 percent would result in a crosshead testing speed of 12 inches per minute. An in-out switch on the unit allows the operator to conveniently switch the variable speed unit into the crosshead control

circuits or out of it as desired. It is important to note that the variable speed unit does not extend the crosshead speed range capability of the instrument beyond the instrument's specifications. The operational controls are shown in figure 7-10.

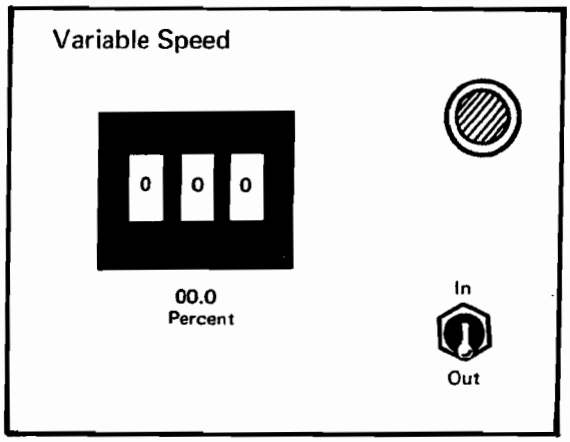


Figure 7-10. Variable Speed Unit Operational Controls

NOTE: When the variable speed unit is IN, the crosshead return speed is also affected.

7.8.2 Operation

a. Depress the desired crosshead speed pushbutton (and the high or low speed pushbutton as appropriate) on the crosshead control panel. This establishes the "base" crosshead speed.

b. Set the PERCENT (%) thumbwheel switches to the appropriate setting for the desired crosshead speed. These thumbwheel switches may be set from 00.0 percent to 99.9 percent.

c. Move the IN/OUT switch to the IN position to activate the variable speed unit. This also lights the panel lamp.

To determine the PERCENT switch setting for a desired crosshead speed, use the following equation:

$$\frac{\text{desired crosshead speed}}{\text{"base" (standard) crosshead speed}} \times 100 = \text{PERCENT switch setting}$$

Note that the base crosshead speed should be greater than the desired speed. For example, if a testing speed of 6 in/min is desired, a "base" speed of either 20 in/min or 10 in/min can be used.

$$\frac{6 \text{ in/min}}{20 \text{ in/min}} \times 100 = 30.0 \text{ percent}$$

or, as an alternative,

$$\frac{6 \text{ in/min}}{10 \text{ in/min}} \times 100 = 60.0 \text{ percent.}$$

7.9 TIME/CYCLE COUNTER

7.9.1 Description

This accessory is designed to count the total number of tests, or up-down crosshead cycles; where a test is defined as the crosshead moving away from the gage length position, reversing direction and returning. The six-digit counter registers a half-count each time the crosshead starts moving in a particular direction.

An additional function is provided in the unit enabling the counter to indicate elapsed time in seconds. Thus, the time/cycle counter unit can be used to indicate the total number of tests, down-and-up cycles of the crosshead, or elapsed time in seconds. In addition, the unit can be programmed to stop crosshead motion when a preset number of counts has been reached.

Three multiplier pushbuttons (X1, X10, X100) enable the unit to register a count on each crosshead cycle, each ten-cycles, and each one-hundred cycles. This feature increases the total counting capability for long term cyclic testing.

The unit is one-third of a standard rack module in size, and all operational controls are on the front panel (figure 7-11).

7.9.2 Operation

a. Select operating mode by depressing

the TIME pushbutton when one-second time counts are desired, or by depressing the X1, X10, or X100 pushbutton when crosshead up-down counts are desired.

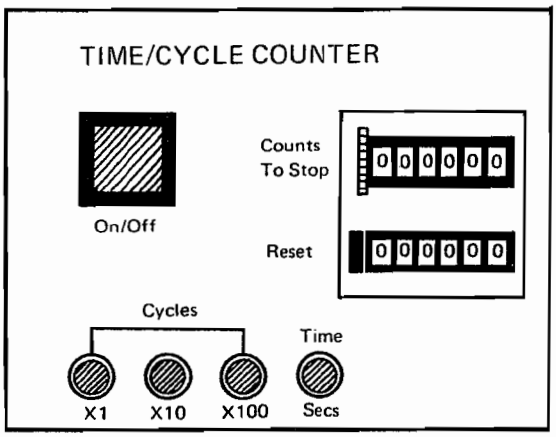


Figure 7-11. Time/Cycle Counter Operational Controls

b. Depress the ON/OFF pushbutton switch to activate the TIME/CYCLE counter. The switch indicator lamp should light.

c. Depress and hold RESET button on mechanical counter. Lift red plastic cover to expose top row of counter wheels.

NOTE: With the red cover left open, the unit can be used to count cycles only. It will not stop the crosshead when the preset number of counts is reached.

d. If desired, set the upper counter to the number of cycles required. Close the red cover so the crosshead will be stopped when this number of counts is reached.

e. Depress the crosshead UP or DOWN pushbutton to start the test. The total number of cycles will be indicated on the lower counter. The crosshead will stop automatically when the preset number of cycles is reached, and the ON/OFF switch lamp will extinguish automatically (see step f).

f. Depress RESET button on counter to reset indicator to zero before starting a new test series; this will activate counter and relight ON/OFF switch lamp.

CAUTION

Always turn off the time/cycle counter by depressing the ON/OFF pushbutton after completing a test run. If inadvertently left on, and not reset to zero, the crosshead will not move when the crosshead UP or DOWN pushbutton is depressed.

7.10 PRE-TENSION UNIT

7.10.1 Description

The Pre-Tension Unit provides precise control of specimen loading conditions prior to a tensile test. For many types of specimens, it is necessary to apply an initial load to the specimen to remove crimp, straighten the specimen and remove any free movement before the test load is applied. This unit enables pre-load to be applied accurately within close limits without the need for attaching weights.

When used in conjunction with pneumatic grips, the pre-tension unit facilitates rapid specimen reloading for repetitive testing due to its automatic start, release and return control features.

The unit is one-third of a standard rack module in size, and all operational controls are on the front panel (figure 7-12).

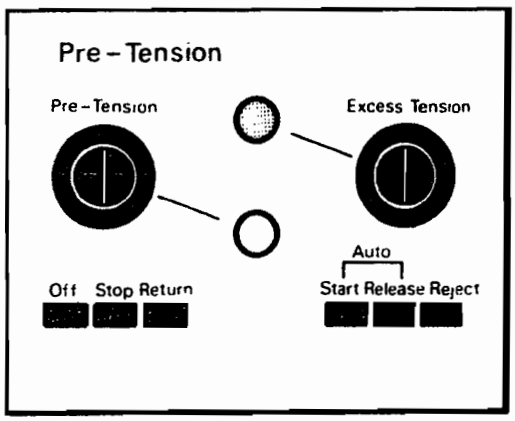


Figure 7-12. Pre-Tension Unit Operational Controls

The PRE-TENSION control sets the lower limit of the applied pre-tension load and is associated with the white indicator lamp. The EXCESS TENSION control sets the upper limit of the applied pre-tension load and is associated with the red indicator lamp. The PRE-TENSION and EXCESS TENSION controls have ranges that allow the setting of these limits up to 10% of full scale on the recorder. The white indicator lamp is lit when there is inadequate applied pre-tension; the red lamp lights if the applied pre-tension is increased beyond the excess tension limit setting; and neither lamp is lit when the applied pre-tension is between limits.

There are two sets of three switches, one set below the PRE-TENSION control and the other below the EXCESS TENSION control. The left-hand set is interlocked and selection of one switch releases the other. The OFF switch is selected when the unit is not required. The STOP or RETURN is selected when it is desired to have the crosshead either stop or return to gage length after specimen break.

In the right-hand set, AUTO-START and AUTO-RELEASE are push-on, push-off type switches and REJECT is a pushbutton switch. AUTO-START starts the crosshead a short period after the required pre-tension load is reached and the lower jaw is closed. AUTO-RELEASE opens the jaws when a test is completed. REJECT, when depressed, causes the current test to be abandoned and both jaws to open.

The upper jaw closes when a switch mounted on the grip is actuated after inserting a specimen. The lower jaw closes after the specimen is in place and a pre-tension, which exceeds the lower limit, is manually applied.

7.10.2 Operation

NOTE: It is assumed that the air kit, including pneumatic grips, has been properly installed in accordance with Instron drawing D379-178 (or D379-183). The grip with the switch actuated jaw must be attached to the load cell in the upper position.

Initially zero, balance and calibrate the load weighing system with the pre-tension unit off. To set up and use the unit, proceed as follows:

a. On the load cell amplifier: set the load range desired on the FULL SCALE LOAD switch; with the BALANCE controls, adjust the recorder pen to the amount of pre-tension required (a percentage of full scale).

b. To turn the pre-tension unit on, depress its STOP pushbutton. If the pre-tension lamp (white) is not lit, turn the PRE-TENSION control counterclockwise until it lights, and then slowly clockwise until it just extinguishes. If the pre-tension lamp lights when the unit is initially turned on, adjust the PRE-TENSION control slowly clockwise until it just extinguishes.

c. With the BALANCE controls on the load cell amplifier, adjust the pen to the maximum acceptable pre-tension load.

d. If the excess tension lamp (red) is not lit, turn the EXCESS TENSION control clockwise until it lights, and then slowly counterclockwise until it just extinguishes. If the excess tension lamp lights during the adjustment in step c, turn the EXCESS TENSION control slowly counterclockwise until it just extinguishes.

e. Rebalance the load cell amplifier to set the recorder pen at zero reference; the white pre-tension lamp should light.

f. On the pre-tension unit: select the desired crosshead function at specimen break by depressing either the STOP or RETURN pushbutton; depress AUTO-START to enable the test to start when the specimen is loaded; depress AUTO-RELEASE to have both jaws open at specimen break.

g. Load the specimen for a tensile test as follows:

WARNING

Pneumatic grips are closed by high air pressure. Do not insert fingers between jaw faces at any time as serious injury could result.

1. Pass the specimen through the upper jaw, and while holding the loose end in one hand pass the other end through the lower jaw and pull the specimen just taut enough to remove any slack.

2. Actuate the upper jaw by pushing back with the loose end of the specimen in order to contact the switch lever.

3. At the lower jaw, pull the specimen tight until the white pre-tension lamp extinguishes and the lower jaw closes; the lower pre-tension limit is now set. If the AUTO-START pushbutton has been depressed, the test will commence in 1 - 3 seconds.

7.10.3 Operating Notes

1. To enable the RETURN feature of the pre-tension unit to function properly, select the appropriate TEST DIRECTION, UP-DOWN pushbutton on the crosshead control unit.

2. If the automatic-start feature of the pre-tension unit is not desired, a test may be started manually from the crosshead control unit.

3. When loading a specimen, if the upper pre-tension limit is accidentally exceeded (red excess tension lamp lights) the test will not start and, if the AUTO-RELEASE pushbutton has been selected, the jaw will open for reloading of the specimen; if AUTO-RELEASE has not been selected, the jaws will not release. To recover from the latter condition, depress the REJECT pushbutton.

4. Depressing the REJECT pushbutton at anytime after exceeding the pre-tension value will cause both jaws to open and the crosshead to either return to gage length (RETURN depressed) or stop (STOP depressed).

5. The pre-tension unit will cause the no. 1 pen to pip when the crosshead starts in the test direction; this is a normal operating function.

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