OPERATION AND MAINTENANCE MANUAL
VERTICAL LONG-PERIOD SEISMOMETER, MODEL SL-210

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OPERATION AND MAINTENANCE MANUAL
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1. GENERAL DESCRIPTION

1.1 PURPOSE OF THE EQUIPMENT

The Long-Period Vertical Seismometer, Model SL-210 (figure 1), is an extremely sensitive electro-mechanical transducer that converts very low frequency vertical motion into an electrical output. Small size and rugged construction make it useful for remote field installation as well as laboratory use. The instrument's electrical characteristics are designed to be compatible with solid-state type amplifiers.

1.2 DESCRIPTION OF EQUIPMENT

The Seismometer, Model SL-210, is a moving-coil transducer with a 2-kilogram inertial mass. The natural period of the instrument is adjustable from 10 to 30 seconds. A calibration coil winding is an integral part of the coil structure.

The coil-magnet design of the seismometer is such that amplifiers with input impedances of a few thousand ohms and input noise levels of approximately one microvolt can be used with this instrument. Solid-state amplifiers with these characteristics are available.

The unit is light weight and compact. The suspension system is mounted on a rigid cast base and enclosed by a cast aluminum cover. The unit is sealed by an "O" ring against water and barometric pressure changes.

1.3 SPECIFICATIONS

Operating Characteristics

Natural Period	Adjustable from 10 to 30 seconds nominal period 20 seconds
Transducer	
Type	Single moving coil (velocity)
Effective generator constant	90 volt/meter/second
Damping	Electromagnetic
Signal Coil	
Terminal resistance	1200 ohms nominal at 20°C (68°F)

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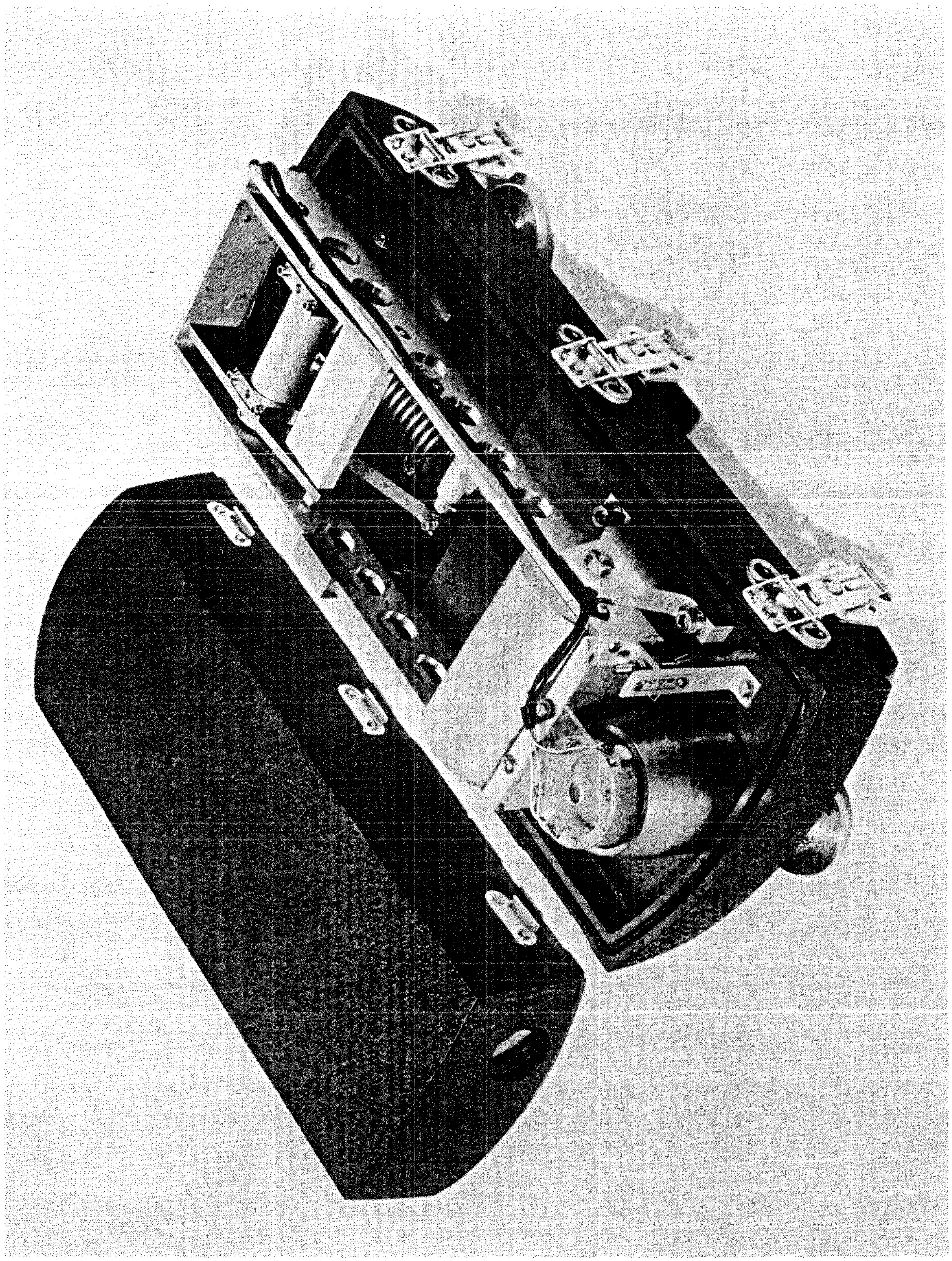


Figure 1. Vertical Long-Period Seismometer, Model SL-210

Calibration Coil	
Terminal resistance	1.7 ohms nominal at 20°C (68°F)
Motor constant	.025 newtons/amp min
Average flux density	0.160 webers/meter^2 (1600 gauss)
Weight of inertial mass	2 kilograms
Critical damping resistance	6440 ohms at 20 sec ±6%
Physical Characteristics	
Height	135 mm (5.31 in.)
Width	194 mm (7.64 in.)
Length	412 mm (16.22 in.)
Net weight	10.5 kg (23.2 lbs)
Shipping weight	15.5 kg (34.16 lbs)
Shipping volume	5.66 x $10^{-2}M^3$ (2 ft^3)

Environmental

Suitable for portable sheltered equipment operation.

Temperature	
Operating	±5°C about some temperature between 0°C and 60°C at which it is adjusted
Storage	-50° to 60°C (-60° to 140°F)
Mass position drift	2.7 mm/°C
Relative humidity	10 to 95%
Shock and vibration	When properly packed will withstand shock and vibration normally encountered in shipment by commercial carrier including air.
Altitude	
Operating	Sea level to 4,572 m (15,000 ft)
Transit	Sea level to 15,240 m (50,000 ft)
Connectors	
Signal output	Bendix PT02A-14-18S mating to PT06E-14-18P (SR)

1.4 EQUIPMENT FURNISHED

1 Vertical Long-Period Seismometer, Model SL-210
1 Operation and Maintenance Manual
1 Mating connector, Bendix PT06E-14-18P (SR)
1 Spring Relief Tool, P/N 90-32215-01-01
1 Customer Data Sheet, P/N 90-28280-96-01
1 weight, 200 mg class C
1 Flexure Alignment Tool, 5/32", P/N 32202-01-01

1 spool thread, #60, cotton/dacron
1 Flexure Alignment Tool, 1/2", P/N 32203-01-01

2. INSTALLATION

2.1 UNPACKING

a. Carefully open the shipping container and remove the packing material from around the inner cardboard box.

b. Remove the inner box from the shipping container, open and remove the loose packing material.

c. Carefully remove the seismometer from the inner box. Do not destroy this box when removing the instrument for the box must be used for reshipment.

d. Replace the inner box and packing material in the shipping container and store for use in reshipment.

2.1.1 Inspection

After the equipment has been removed from its container, inspect it for shortages and damage. Paragraph 1.4 of this manual provides a list of equipment supplied. If shortages are discovered, notify Teledyne Geotech 3401 Shiloh Road, Garland, Texas, giving the missing parts; the model and serial numbers of the instruments; the date received; and the carrier involved. When damage in shipment is evident, file a claim with the carrier immediately.

2.2. LOCATION OF INSTRUMENT

2.2.1 Specific procedures and techniques for locating and protecting the instrument will vary with each installation to such an extent that complete details cannot be given in this manual. General consideration in the use and placement of the instrument are given and additional information about individual installations will be supplied on request.

2.2.2 If possible, the seismometer should be placed on bedrock or a pier anchored to bedrock or in a vault anchored to bedrock. The location should be in a quiet area away from cultural noise. The seismometer should be in a thermally stable atmosphere, protected from wind, moisture, and direct sunlight.

2.2.3 A typical field installation would be a hole dug down to bedrock, lined with plywood and insulation and covered with 2 feet of dirt. The location should be such that run-off water and ground seepage would not enter the hole.

2.3 SET UP PROCEDURES

a. Clean the instrument by wiping and brushing off all debris and dust.

b. Set the seismometer in the prepared location.

c. Screw out the two rear leveling feet six turns each.

d. Cross level the instrument by placing the bubble level on the boom directly over the main pivots and adjusting the rear leveling feet.

e. Make sure the mass limit nuts are tightened to prevent mass movement, then remove the two nuts holding the mass to the shipping brackets.

f. Remove the four bolts holding the shipping brackets to the base and remove the brackets.

g. Adjust the mass limit stop nuts until the mass can travel 10 mm above and below zero as indicated by the pointer and scale. Move the mass by hand (gently) to determine this motion.

h. Loosen the set screw holding the trim weight to the side rail of the boom. Position the trim weight until the mass is within ±2 mm of center.

i. Set the mass in motion at an amplitude of 2 to 3 mm and time one complete cycle with a stop watch or any watch with a sweep second hand.

j. Adjust the period to that desired by screwing out (lengthening) the front leg to increase the period and in (shortening) to decrease the period. Position the mass within 2 mm of center before checking the period.

k. Replace the cover but do not latch. Allow to temperature stabilize for several hours.

l. Make electrical connection to the seismometer using the mating connector supplied and the information in figure 2.

m. Reposition the mass to the center and make adjustments to the period to the desired accuracy.

n. Replace the lid and close the latches.

3. TESTS

3.1 DETERMINING THE NATURAL PERIOD

a. connect the test equipment to the seismometer as shown in figure 3.

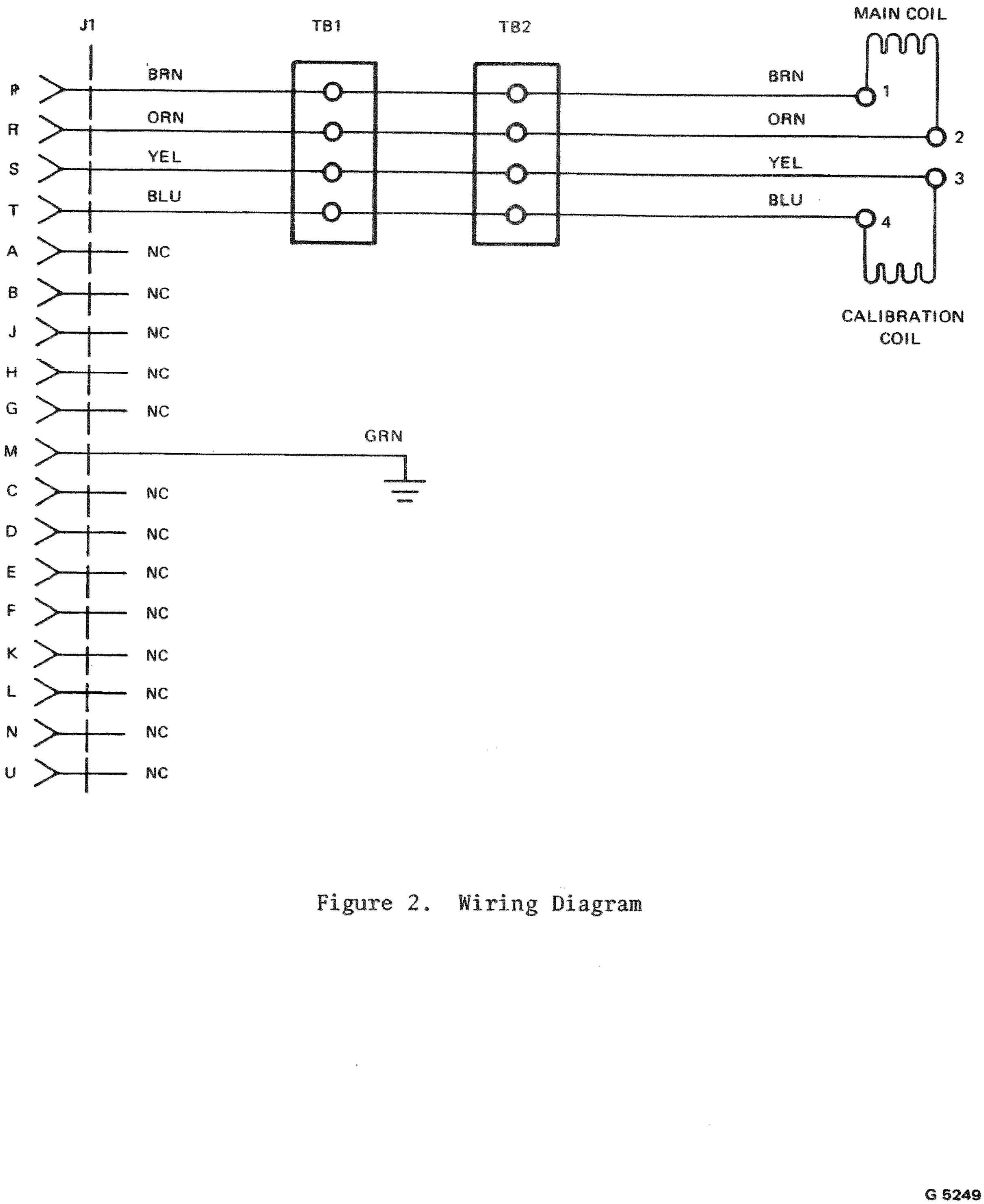
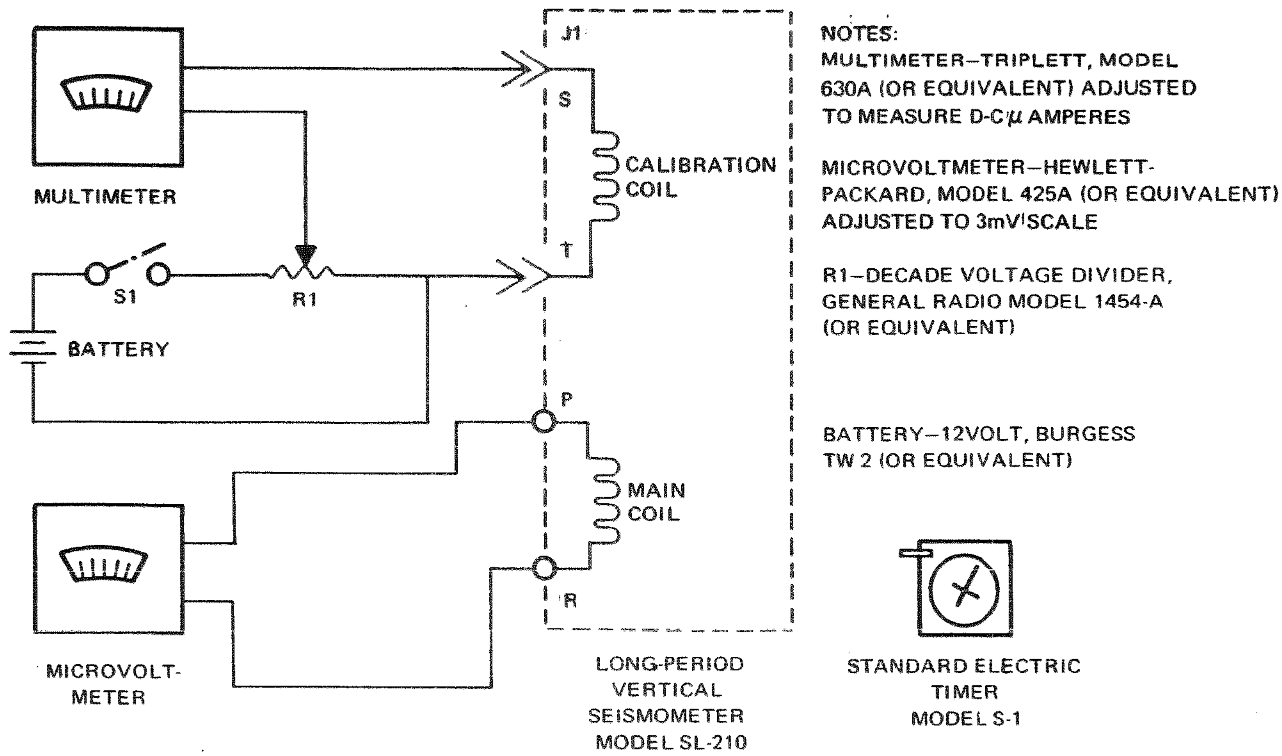


Figure 2. Wiring Diagram

A. PREFERRED METHOD



B. ALTERNATE METHOD

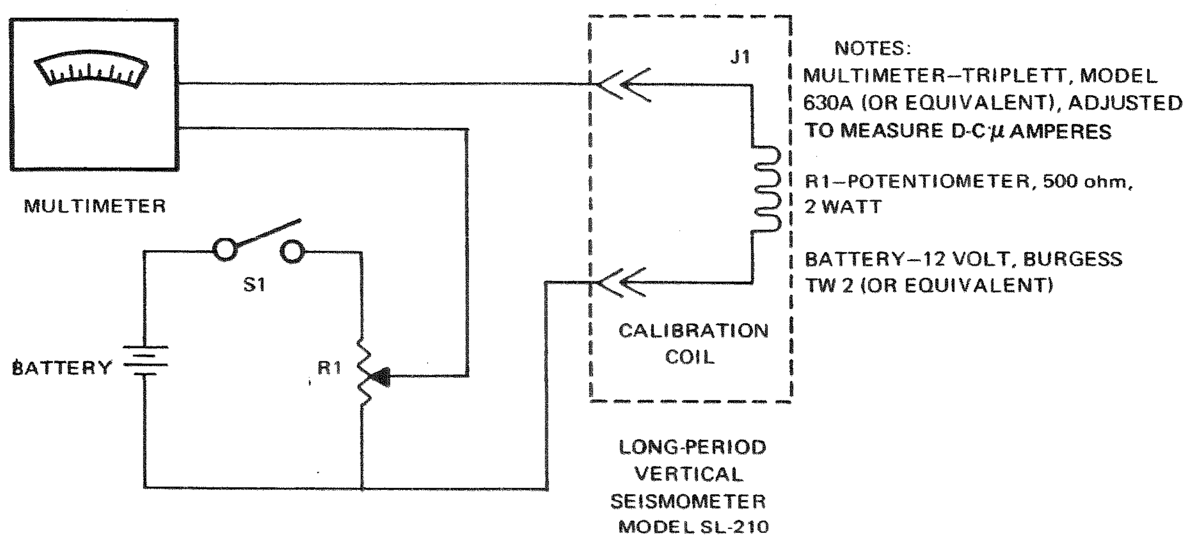


Figure 3. Test set up for natural period and damping

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CAUTION

The maximum current through the calibration coil should be limited to 50 mA and then for only a few seconds.

b. Pulse the calibration coil with just enough current to obtain about 20 mV peak out of the main coil, then turn off the current through the calibration coil.

c. As the meter crosses zero, start timing one complete cycle. This is the natural period in seconds.

d. Perform step c several times and average the results.

e. If the natural period is not the desired value, the period may be adjusted by screwing out (lengthening) the front leg to increase the period or screwing in (shortening) the front leg to decrease the period.

3.2 MECHANICAL DAMPING

a. Perform steps a and b of section 3.1

b. Measure the peak-to-peak amplitude of two consecutive cycles, such as the fourth and fifth.

c. The ratio of their amplitudes should not exceed 1.35; i.e., the amplitude of the fourth cycle divided by the amplitude of the fifth cycle should be about 1.2.

d. If the ratio is greater than 1.35, then the seismometer has too much mechanical damping probably caused by a dragging coil, shorted turn, etc.

3.3 DETERMINING THE CRITICAL DAMPING RESISTANCE (CDR)

a. Set the instrument on the desired natural period.

b. Use the test setup as shown in figure 3 with the addition of a variable resistance connected across the microvoltmeter. Set the value of the resistance to approximately 11,500 ohms. This is essentially the external damping resistance (R_X).

c. Adjust the current through the calibration coil until, when the switch is closed, the initial peak output of the main coil is about 20 mV.

d. Observe the voltmeter until it indicates the seismometer has ceased deflecting. Close the switch to the calibration coil and record the peak output voltage of the main coil in both the positive (initial) and negative (secondary) deflections. Adjust the external damping resistance until the ratio between the initial and secondary deflections is between 10 to 1 and 4 to 1. Repeat the test several times to insure accuracy.

e. Calculate the percent overshoot by dividing the secondary deflection by the initial deflection and multiplying by 100. Enter table 1 with this percent to find λ, the ratio of actual damping to critical damping.

f. Determine the total resistance in the circuit, R_t, i.e., the resistance of the coil plus the external damping resistance. Then:

$$CDR = R_t \times \lambda$$

NOTE

Within ±10%, the CDR in ohms should be 322 times the natural period in seconds. If the CDR is not within the tolerance, check the magnet charge to be 1600 gauss and verify the coil resistance to be the value inscribed at the terminals.

Table 1. Ratio (λ) of actual damping to critical damping

% OVERSHOOT	λ	% OVERSHOOT	λ	% OVERSHOOT	λ
0.1	.911	5.0	.690	10.8	.577
0.2	.893	5.2	.685	11.0	.575
0.3	.888	5.4	.681	11.5	.567
0.4	.879	5.6	.676	12.0	.560
0.5	.861	5.8	.670	12.5	.551
0.6	.853	6.0	.666	13.0	.544
0.7	.845	6.2	.662	13.5	.537
0.8	.838	6.4	.658	14.0	.530
0.9	.831	6.6	.654	14.5	.524
1.0	.825	6.8	.650	15.0	.518
1.2	.815	7.0	.646	15.5	.511
1.4	.805	7.2	.642	16.0	.504
1.6	.796	7.4	.638	16.5	.497
1.8	.788	7.6	.634	17.0	.491
2.0	.780	7.8	.630	17.5	.485
2.2	.772	8.0	.626	18.0	.479
2.4	.765	8.2	.622	18.5	.473
2.6	.759	8.4	.619	19.0	.467
2.8	.752	8.6	.615	19.5	.461
3.0	.745	8.8	.612	20.0	.455
3.2	.739	9.0	.607	20.5	.499
3.4	.733	9.2	.605	21.0	.444
3.6	.727	9.4	.601	21.5	.439
3.8	.722	9.6	.597	22.0	.434
4.0	.716	9.8	.593	22.5	.429
4.2	.710	10.0	.591	23.0	.429
4.4	.705	10.2	.587	24.0	.414
4.6	.700	10.4	.584	25.0	.404
4.8	.694	10.6	.581		

3.4 DETERMINING THE MAIN COIL GENERATOR CONSTANT

The main coil generator constant is determined by using the following equation:

$$G_{\text{main coil}} = \sqrt{\frac{(25.13)\ (\text{CDR})}{T_o}}$$

where: G = generator constant in $\frac{\text{volt-sec}}{\text{meter}}$

CDR = critical damping resistance at T_o in ohms

T_o = natural period in seconds

3.5 DETERMINING THE CALIBRATION COIL MOTOR CONSTANT

a. Determine the external critical damping resistance (CDRX) by subtracting the resistance of the coil (R_{coil}) from the CDR (CDRX = CDR-R_{coil}).

b. Modify the test setup shown in figure 3 by adding a resistance equal to the CDRX across the microvoltmeter.

c. Remove the cover and place on the boom a 200 mg weight, which has been attached to a piece of light thread, exactly 4 cm toward the mass from the center line of the main pivots. (Located at green dot on left side rail.)

d. Connect the modified test setup to the seismometer. Make several weight lifts and record the amplitude of the initial deflections of the microvoltmeter.

NOTE

The tests should be accomplished with the mass position at zero ±2 mm and a period of 18 to 20 seconds.

e. Close the switch to the calibration coil circuit. When the mass has stopped swinging, open the switch and observe the amplitude of the initial deflection on the microvoltmeter. Repeat, adjusting the current in the calibration coil until the deflection is within at least 10% of the deflection observed by lifting the 200 mg weight. Record the current required to produce this deflection.

NOTE

Use only dc pulse deflections in the same direction as the weight lift deflections. Reverse leads to the calibration coil, if necessary.

f. Calculate the motor constant (G) of the calibration coil using the average of three or more weight lifts.

$$G \text{ cal coil} = \frac{0.392 \dfrac{X_i}{X_w}}{i} \quad \text{(for 200 mg weight)}$$

where: G = motor constant of the cal coil in newtons/ampere

X_w = initial deflection of the seismometer caused by weight lift as determined by observation of microvoltmeter

X_i = initial deflection of the seismometer caused by current in the calibration coil being turned off as determined by observation of microvoltmeter

i = current in calibration coil in milliamperes used to obtain deflection X_i above

The motor constant should be 0.025 newtons/ampere, minimum
If the test results do not fall within these limits, check the magnet charge. Look for worn spots on the coil and check clearance of coil in the magnet. Inspect the calibration coil winding. It should be centrally located and on a plane perpendicular to the coil axis. Replace coil if necessary.

3.6 DETERMINING EQUIVALENT EARTH MOTION OF CALIBRATION COIL DRIVE

When the motor constant of the calibration coil has been determined, the equivalent sinusoidal earth motion produced by a sinusoidal signal in the calibration coil can be determined by the following relation:

$$y = \frac{Gi \times 10^6}{4\pi^2 f_1^2 M}$$

where: y = equivalent earth motion in microns, peak-to-peak
G = calibration coil motor constant, newtons/ampere
i = current through the calibration coil, amperes, peak-to-peak
f_1 = frequency of calibration signal in Hz
M = weight of mass in kilograms

3.7 DETERMINING THE SEISMOMETER SYSTEM MAGNIFICATION

The seismometer system, or seismograph, includes the seismometer, amplifier, and recorder. The record made by this system is called a seismogram. The seismometer system magnification (m) is the ratio of the recorded signal divided by the earth motion amplitude.

$$m = \frac{\text{A (peak-to-peak recorded amplitude) meters}}{\text{y (peak-to-peak equivalent earth motion) meters}}$$

for convenience

$$m = \frac{\text{A (millimeters)} \times 10^3}{\text{y in micron}}$$

3.7.1 The magnification of the system at any frequency may be determined by driving the calibration coil with a sinusoidal signal of known frequency and amplitude. The equivalent earth motion of the driving signal is calculated by the formula given in section 3.6.

3.7.2 A more useful form of the magnification formula is as follows:

$$m = \frac{4\pi^2 \times Amf_1^{\,2} \times 10^3}{G\ i \times 10^6}$$

Since for this seismometer the inertial mass (m) is always 2 kilogram, then:

$$m = \frac{4\pi^2 \times 2 \times 10^3\ A\ f_1^{\,2}}{G\ i \times 10^6}$$

$$m = \frac{.079\ A\ f_1^{\,2}}{G\ i} \quad \text{or} \quad \frac{.079\ A}{G\ T_1^{\,2} i}$$

where:

m = System magnification
A = peak-to-peak recorded amplitude in millimeters
f_1 = frequency of calibration signal in Hz
G = calibration coil motor constant, newtons/ampere
i = current through the calibration coil, amperes, peak-to-peak
T_1 = period of calibration signal in seconds

Example:

A 50.8 millimeters
G 0.030 newtons/ampere
T_1 25 seconds
i 20×10^{-6} amperes

$$m = \frac{.079 \times 50.8}{0.030 \times 25^2 \times 20 \times 10^{-6}}$$

$$m = 10700$$

3.8 PERIOD VERSUS MASS POSITION

a. Perform section 3.1, setting the natural period at the center to 20 seconds. Time the natural period at nine points along the scale. Plot period versus mass position on Form 281 (figure 4). One test point should fall under each bracket at top of the graph.

b. Compute the average period. No test point should vary more than ± 10% from the average. At no point should the seismometer be unstable. The ideal curve is symmetrical about scale zero. The maximum period must be within ± 4 mm of zero.

c. If the curve does not meet the above requirements, then the spring length needs to be adjusted according to the following scheme until a "flat" curve is obtained.

d. If the periods are longer for mass positions above center than the period at center, then adjust the spring calibrators to increase the spring rate. Setscrews on calibrators must be loosened before calibrators can be rotated. This is done by turning CW one of the spring calibrators about 1/16-inch and checking the period at positions 0, +8, -8, and ±2 mm.

e. Continue running the abbreviated curve and adjusting the calibrators, first one then the other, until a relatively flat curve is obtained.

NOTE

The tension adjustment nut may be backed out to drop the mass from the top stop since an increase in spring rate will lift the mass.

f. The center period may begin to exceed 20 seconds. Screw in the front leg to maintain the center period near 20 seconds.

g. In cases where the longer periods are at mass positions below center, the calibrators must be turned CCW to decrease the spring rate.

h. As the curve becomes more linear, smaller adjustments should be made to the spring calibrators.

i. The position of the sliding trim weight affects, to some extent, the shape of the curve. If desired, the curve may be further shaped by positioning the sliding trim weight and compensating by adjustimg the spring tension nuts.

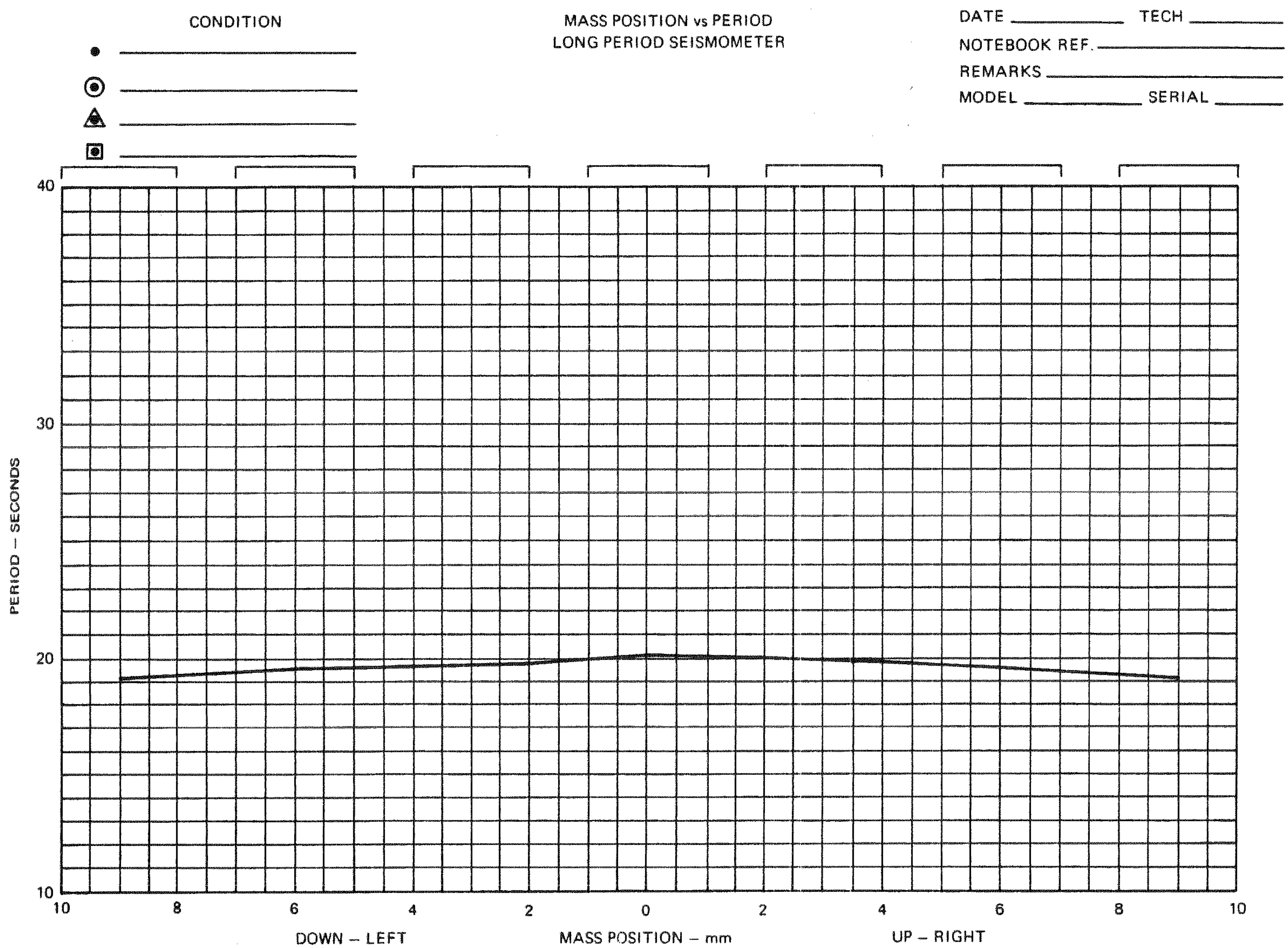

Figure 4. Typical period vs. mass position SL-210

4. MAINTENANCE

4.1 REMOVAL AND INSTALLATION OF MAIN FLEXURES

4.1.1 Install the shipping brackets on the mass retainer pins and allow the mass to settle on the brackets. Secure the mass to the brackets. Secure the brackets to the base.

4.1.2 Disconnect the flexible leads from the rear of the boom.

4.1.3 Mark the location of the spring calibrators, then back off each of the spring-tension adjustment nuts until the end of each spring stem is about one-half way in its nut.

4.1.4 Insert the spring relief tool from the rear of the spring and position on the front spring calibrator. (See figure 5.)

4.1.5 Push with the tool to relieve the tension on the front spring-tension adjustment nut. Remove the nut. Slowly and carefully allow the spring to relax by backing out the tool.

CAUTION

> Do not allow the spring to collapse suddenly or the small flexures may be ruined.

4.1.6 Loosen the four 6-32 set screws clamping the two main flexures.

4.1.7 Remove the flexures through the holes in the side rails flush with the outer surface of the pivot carrier.

4.1.8 Insert the new flexures. The orientation of the flexures is shown in figures 6 and 7. Tighten the 6-32 set screws to clamp the flexures.

4.1.9 Insert the spring relief tool from the rear of the spring and position on the front spring calibrator.

4.1.10 Push with the tool to stretch the spring and insert the spring stem through the front flexure block. Secure with the tension adjustment nut.

4.1.11 Adjust the tension adjustment nuts equally until about 3/16-inch of the spring stem extends through the nuts.

4.1.12 Unscrew the mass from the shipping bracket, then unscrew the shipping brackets from the base and remove the brackets.

4.1.13 Adjust the tension adjustment nuts equally until the mass floats in the center.

4.1.14 Perform the Mass Position Versus Period test per section 3.8.

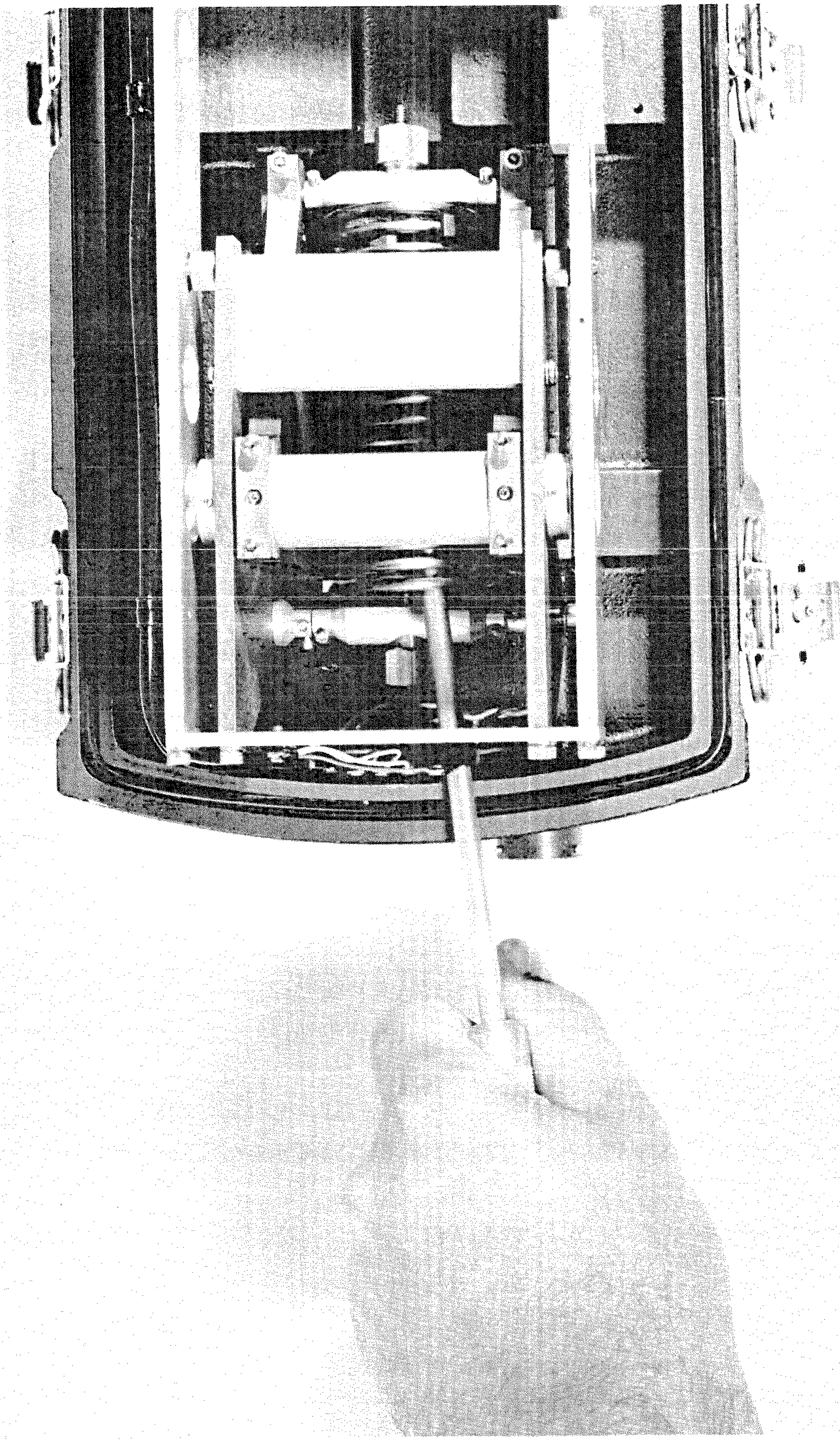

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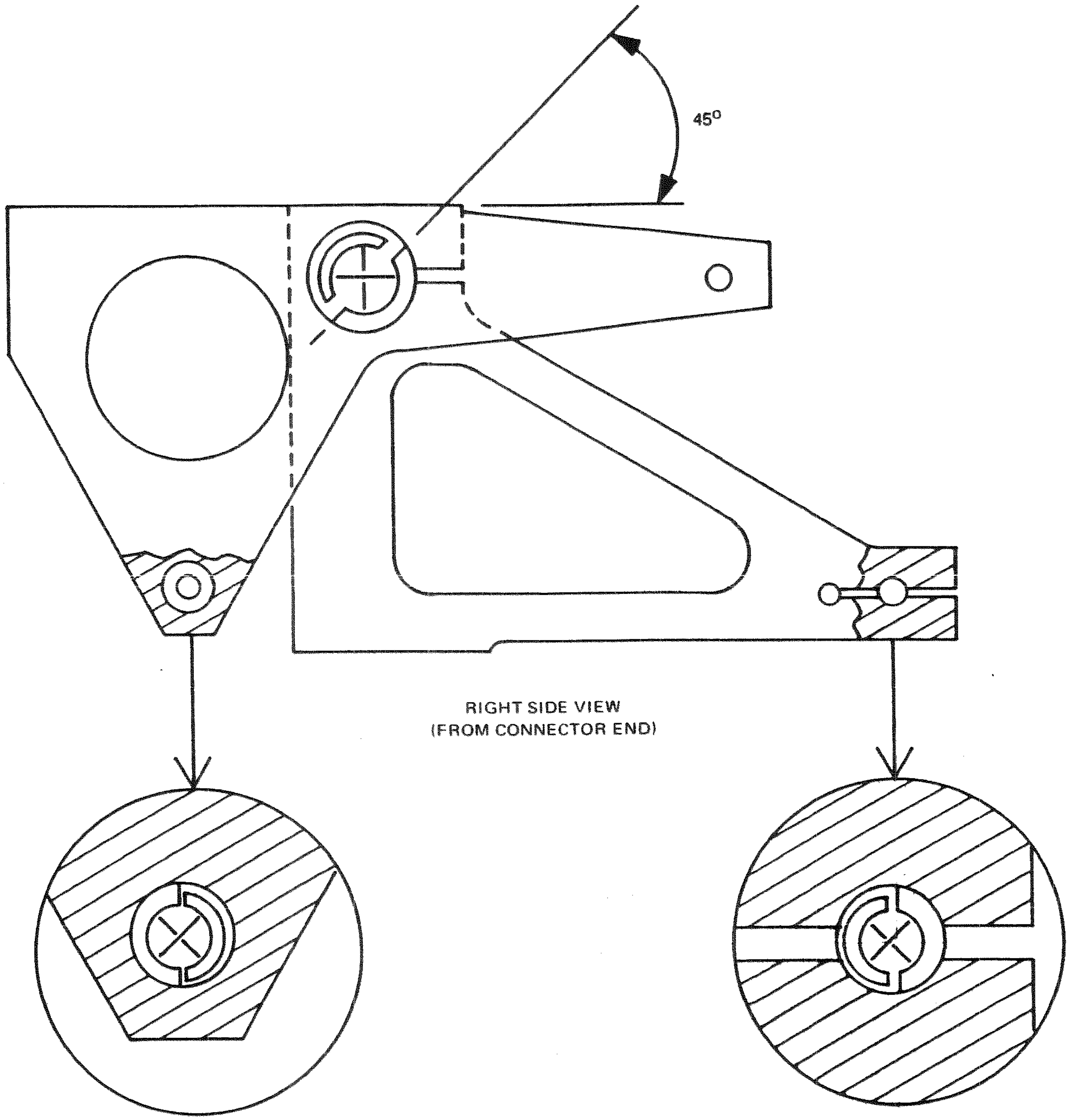
Figure 5. Relieving Spring Tension



NOTE:
1. CHECK ORIENTATION OF FLEXURES TO INSURE THAT FORCES APPLIED TO UNSUPPORTED ENDS WILL LOAD THE FLEXURES IN TENSION

Figure 6. Flexure Alignment, right side view

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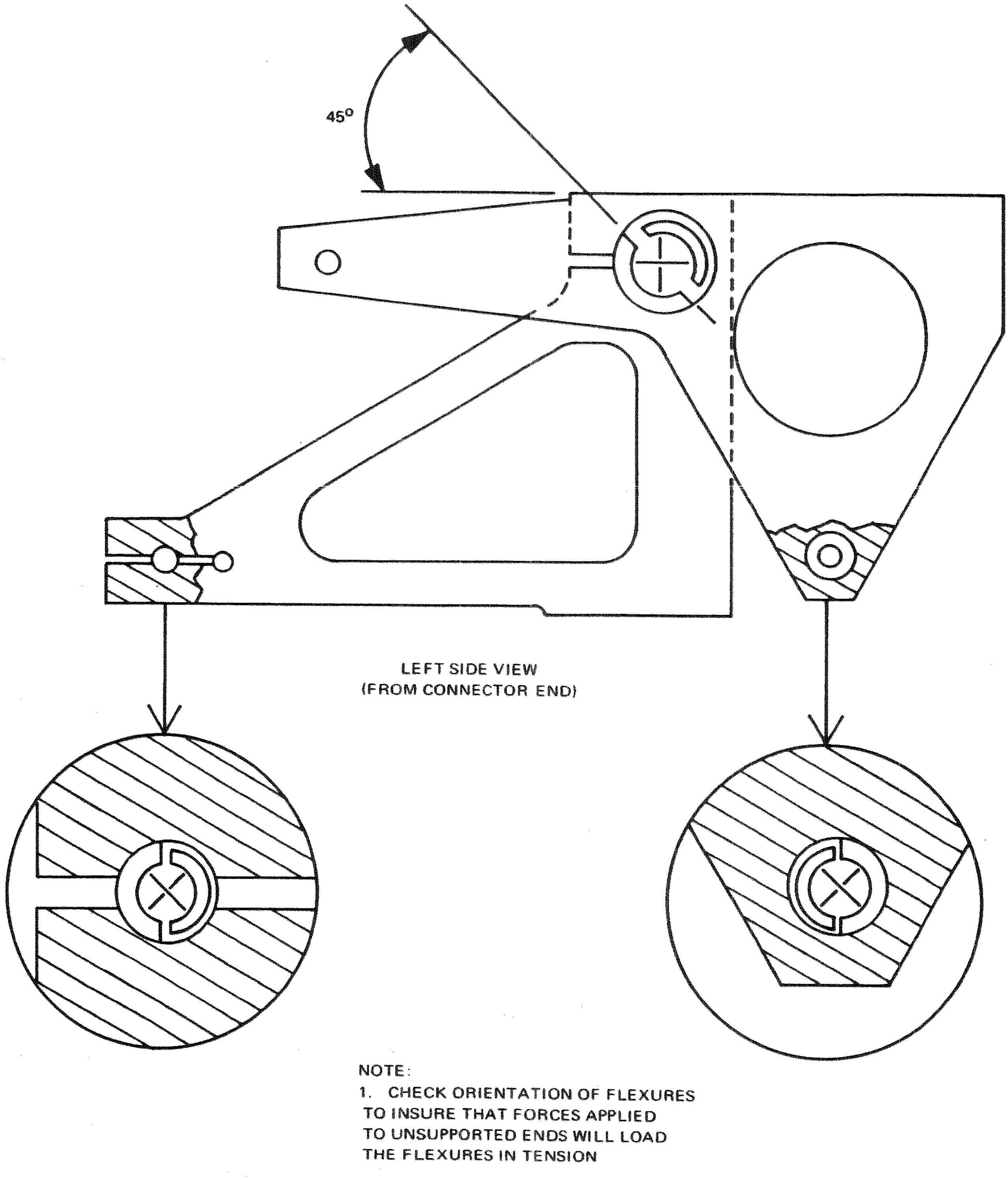

Figure 7. Flexure alignment, left side view

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Table 2. Parts list

Item	Part No.	Mfr. Code No.	Description	Quantity
1	30526-01-01	99019	Instrument base	1
2	30762-01-01	99019	Instrument cover	1
3	31503-01-01	99019	Observation port	1
4	32862-01-02	99019	Side PL assembly	1
5	30931-01-01	99019	Magnet assembly	1
6	33905-01-01	99019	Coil assembly	1
8	29576-01-01	99019	Stationary pivot support	2
9	29582-01-01	99019	Pivot carrier	1
10	29727-01-01	99019	Pivot block	2
11	29641-01-01	99019	Spring end pivot carrier	2
12	32864-01-01	99019	Suspension spring assembly	1
13			DELETED	
14	32863-01-01	99019	Pivot support cap	2
15	29734-01-01	99019	Spring tension adjustment nut	2
16	32862-01-01	99019	Side plate assembly	1
17	32859-01-01	99019	Frame spacer	1
18	29642-01-01	99019	Retainer pin	2
19	32202-01-01	99019	5/32 flexure alignment tool	1
20	29675-01-01	99019	Side rail	2
21	29676-01-01	99019	End plate	1
22	29583-01-01	99019	Vertical 2-kilogram mass	1
23	30992-01-01	99019	Shipping block	2
24	30946-01-01	99019	Coil support bracket	1
25	31502-01-01	99019	Trim weight	2

Table 2. Parts list (cont)

Item	Part No.	Mfr. Code No.	Description	Quantity
26	32203-01-01	99019	1/2-flexure alignment tool	1
27	32215-01-01	99019	Spring relief tool	1
28	30993-01-01	99019	Mass retainer pin	2
29	29854-01-01	99019	Limit stop post	1
30	31495-01-01	99019	Stop block	1
31	30994-01-01	99019	Scale bracket	1
32			DELETED	
33	30927-01-01	99019	Level adjust assembly	3
34		Any	Wire enameled #44 gauge solid copper	4
35	29731-01-01	99019	Bushing	3
36	32189-01-01	99019	Lead wire assembly	1
37	32174-01-01	99019	Harness	1
38			DELETED	
39	04950-01-02	99019	Name plate	1
40		26233	Cup point set screw, soc HD, 4/40 x 3/16 SST	4
41	30684-01-01	99019	Pointer	1
42	2-279-N219-7	02697	Gasket, o-ring	
43		Any	Washer-flat, #4 brass	2
44		Any	Screw - pan hd., 2-56 x 3/8	3
45		Any	Screw - pan hd., 2-56 x 1/8	2
46		Any	Screw - pan hd., 4-40 x 3/16	25
47		Any	Screw - pan hd., 4-40 x 1/4	10
48		Any	Screw - pan hd., 4-40 x 5/16	
49		Any	Screw - pan hd., 4-40 x 5/16 brass	

Table 2. Parts list (cont)

Item	Part No.	Mfr. Code No.	Description	Quantity
50		Any	Washer - flat, #4, SST	1
51	4315	77820	Screw - shoulder	2
52		Any	Screw - soc. hd. cap.	8
53		Any	Washer - lock, #8 SST	2
54		Any	Hexnut, #8-32 SST	2
55		Any	Screw-hex hd. mach., 8-32 x 1, SST	2
56		Any	Lock washer, split, #6, SST	4
57		Any	Screw, hex hd. mach., 10-32 x 1-1/4 SST	2
58		Any	Soc. hd. cap. screw, #2-56 x 1/8 SST	12
59		Any	Hex nut, 1/4-20 SST	2
60		Any	Cap. screw - soc. hd., 6-32 x 1/2 SST	2
61		Any	Screw-soc. hd. cap., 1/4-20 x 7/8 SST	4
62			DELETED	
63		Any	Washer-split lock, 1/4, SST	6
64		Any	Washer, flat, #8, SST	2
65	7500-8	02697	Thred seal	2
66	7500-10	02697	Thred seal	2
67		Any	Pipe plug, 1/8 NPTF brass	1
69		Any	Soc. hd. cap screw, #4-40 x 3/4 SST	4
70		Any	Screw-soc. hd. set	2
71		Any	Lock washer split, #4	4

Table 2. Parts list (cont)

Item	Part No.	Mfr. Code No.	Description	Quantity
73	10-101949-14	77820	Gasket	1
74	5016-800	77820	Flexure pivot	2
75	5016-600	77820	Flexure pivot	4
76		Any	Screw, pan hd., #6-32 x 3/8 SST	2
77	35485-01-01	99019	Scale	1
78		Any	Washer, flat, #10, SST	2
79		Any	Screw, pan hd., 2-56 x 7/16 brass	1
80		Any	Washer, #2 flat brass	1
81	3/16-2	95987	Cable clamp, nylon (NY-Grip) Type 2	5
82		82240	Spring-loaded link lock #3	6
83	CS-11	77820	Soc. hd. set screw, nylon-tip 8-32 x 15/64 long	3
84		Any	Washer, lock #4, Internal Star	24
P1	PT06E-14-18P(SR)	77820	Connector	1
TB1 TB2	4-171	71785	Terminal strip	2
90	10-101960-14	77820	Receptacle prot. cap.	1

MANUFACTURERS' CODE LIST

Mfr. Code	Name and Address
02697	Parker Seal Co. Lexington, KY 40509
26233	USM Corp. Nylok Fastener Div. Torrance, CA 90510
71785	TRW Electronic Components Elk Grove Village, IL 60007
77820	Bendix Corp. Sidney, NY 13838
82240	Simmons Fastener Corp. Albany, NY 12204
95987	Weckesser Co., Inc. Chicago, IL 60641
99019	Teledyne Geotech Garland, TX 75041

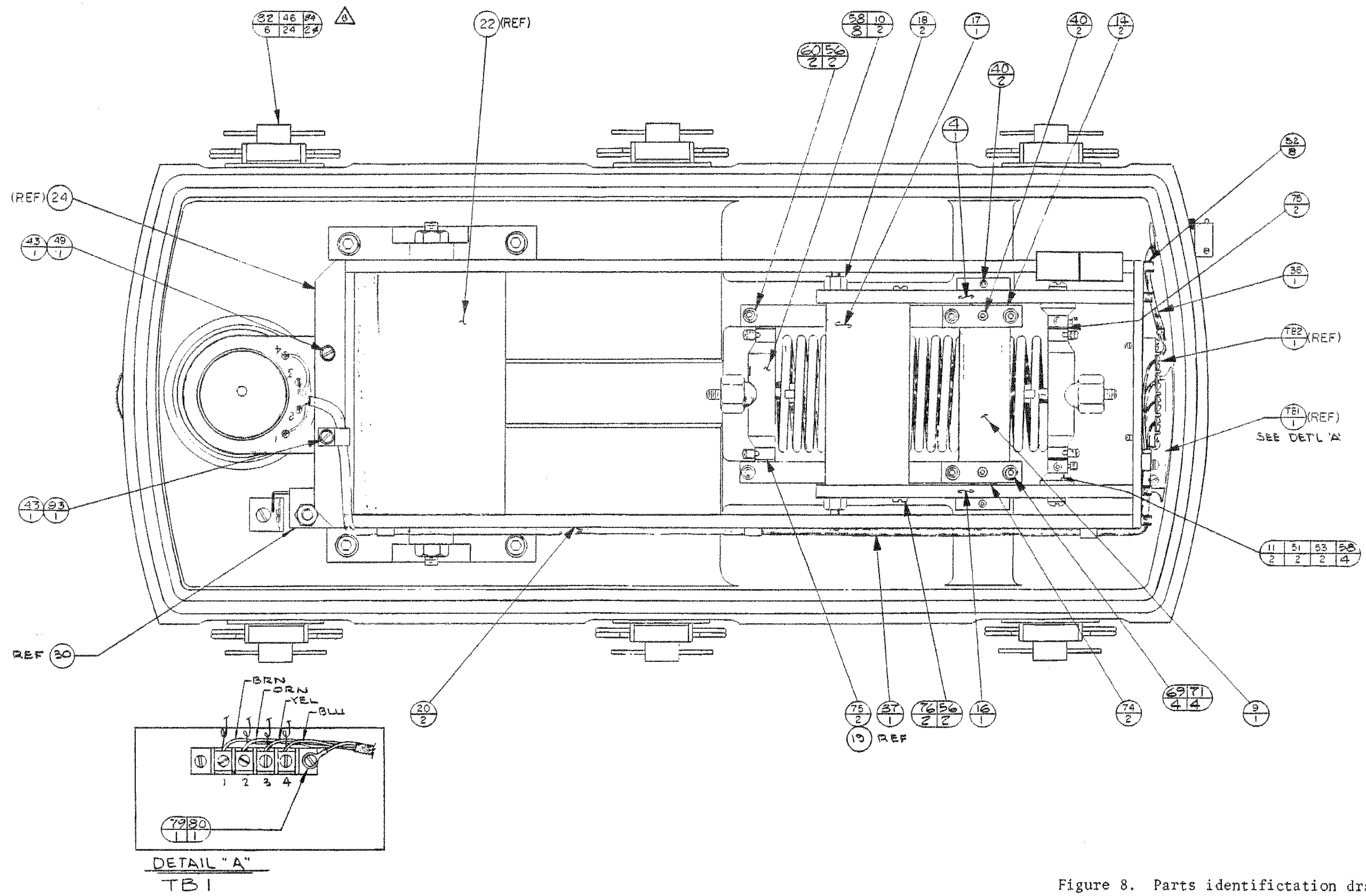

Figure 8. Parts identifictation drawing, Model SL-210 seismometer, top view

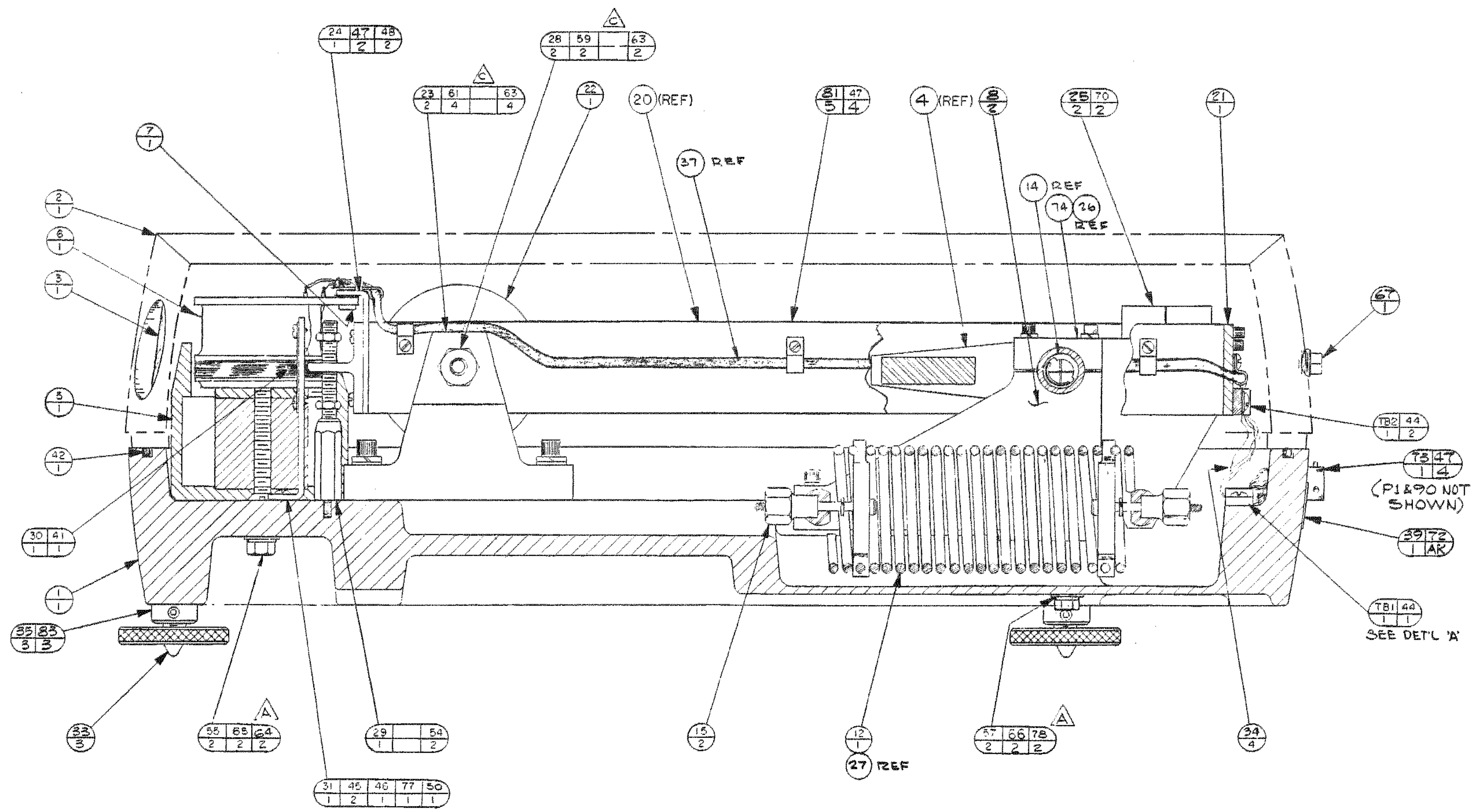

Figure 9. Parts identification drawing, Model SL-210 seismometer, side view