Installation of an Invar Wire Creepmeter
Elkhorn Valley, California
August 1977

by

S. Schulz and R. O. Burford

U. S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

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INTRODUCTION

During the week of August 22-27, 1977, an invar wire creepmeter of the type developed by Duffield and Burford (1973) was installed in Elkhorn Valley near the Carrizo Plain, northwest of Taft, California.

This report briefly describes the design and operation of the creepmeter, but primarily is devoted to describing installation techniques. The section entitled Installation of Instrument describes these techniques in a general way, and is followed by a list of exact specifications.

Appendix A details procedures for assembling and calibrating the instrument. A separate laboratory manual for maintaining USGS wire creepmeters is being prepared.

Description of Instrument

The design of the creepmeter installed is used in sixteen other locations in California, and is described more fully in an article by Duffield and Burford (1973), and an Open-file Report by Yamashita and Burford (1973).

Briefly, the instrument consists of an invar wire suspended between two piers placed on either side of a fault trace. The wire is anchored at one pier and allowed to move at the other. Thus, differential displacement between the piers can be measured manually with a micrometer, and sensed electronically by a DCDT (direct current displacement transducer) as described in the next section. The entire assembly is located underground; piers are enclosed in sets of fiberglass enclosures and the wire hangs inside PVC pipe of 20 cm diameter buried approximately 1.4 m deep.

Figure 1 on the following page shows an illustration of the instrument. At the anchor pier, one end of the wire is secured after passing through a reset screw, which can be turned in or out to reposition the anchor point. The screw is mounted in a moveable stainless steel sleeve which can be unclamped to allow resets of up to 25 mm.

At the instrument pier the wire passes over a rocker arm and is clamped into a splicer block, in close proximity to a micrometer. To make a manual measurement, the micrometer is extended until it just grazes a small point on the top right edge of the splicer block. This measurement is facilitated by observing electrical continuity between the micrometer mounting, which is insulated, and the instrument frame, with an ohmmeter.

A rod connects the bottom of the splicer block to the top of the core of a Hewlett-Packard model 7-DCDT-500 displacement transducer. Another rod connects a free-hanging 2.04 kg weight to the bottom of the transducer core.

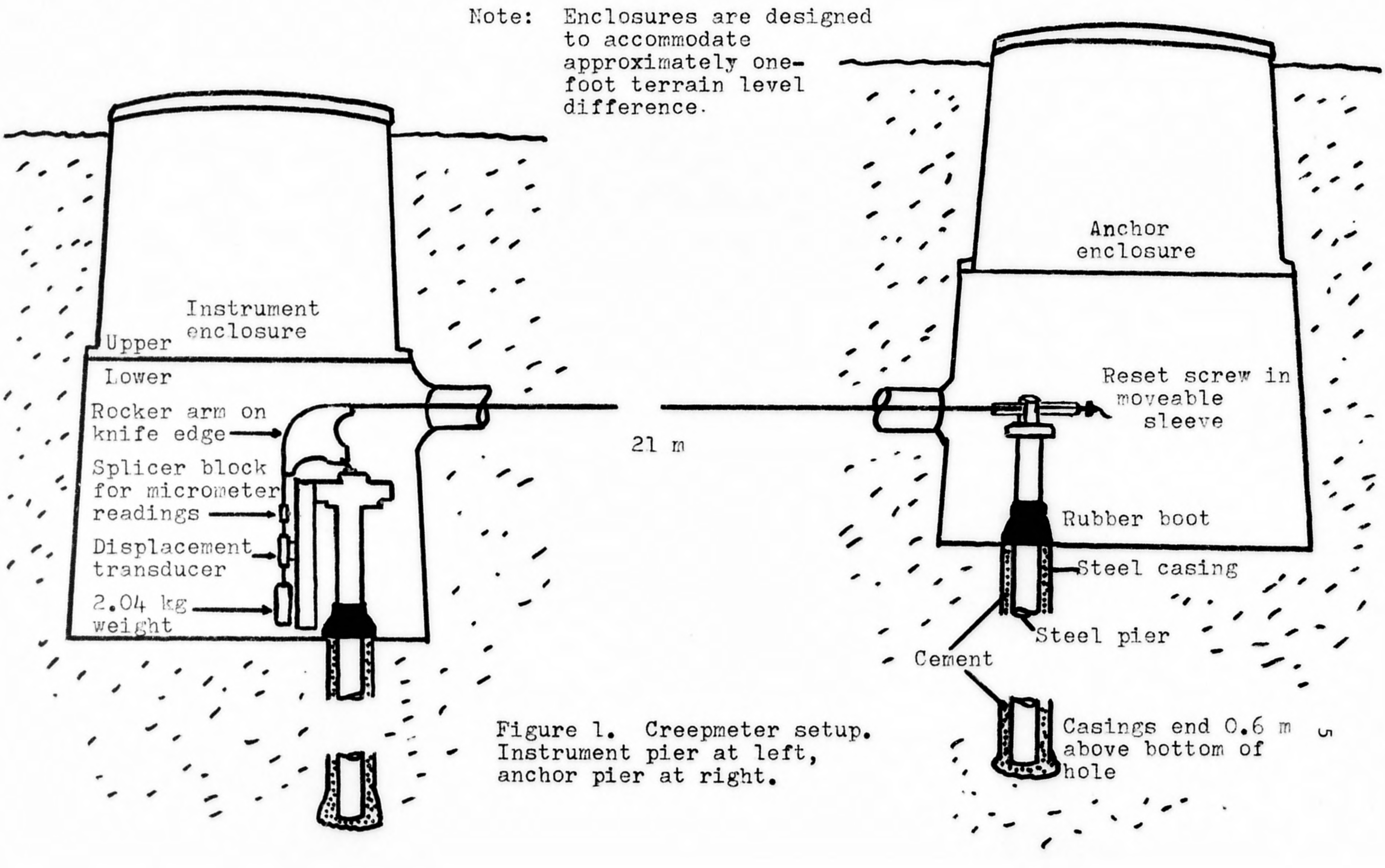
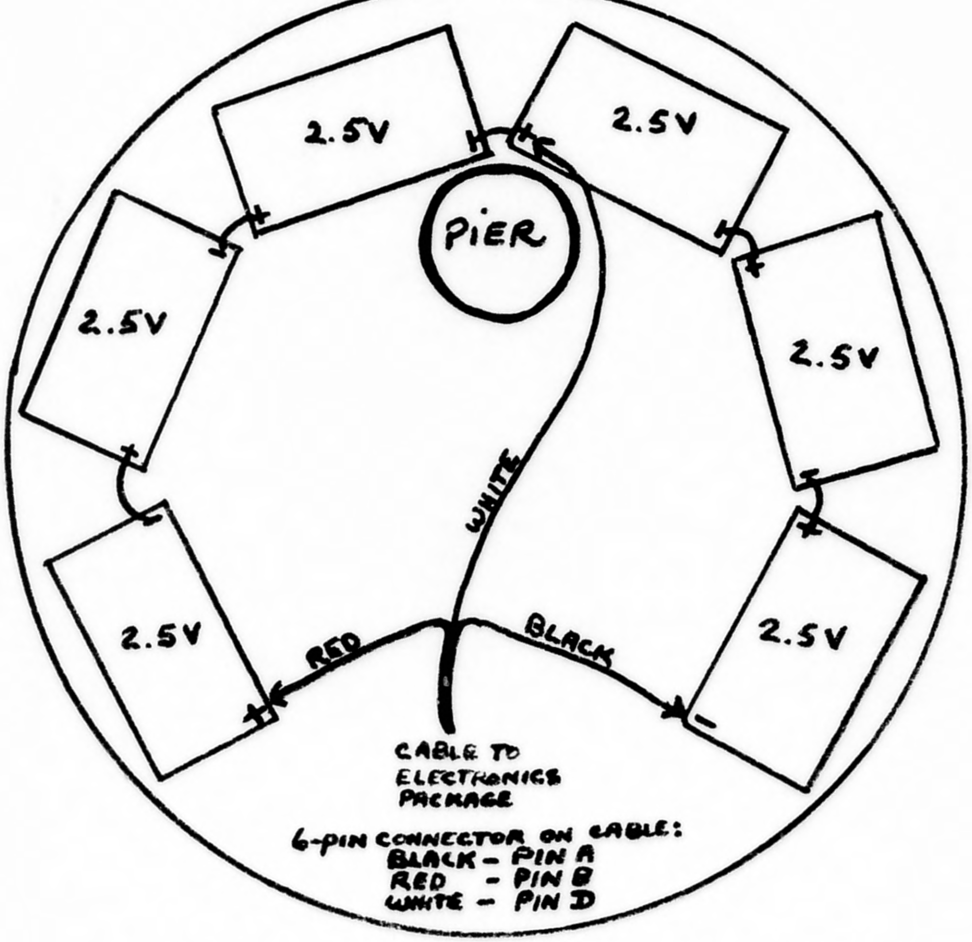


Figure 1. Creepmeter setup. Instrument pier at left, anchor pier at right.

The transducer is wired to an electronics package that provides a ± 5.00 volt regulated reference voltage to the transducer and a bias stepper card. This bias stepper card utilizes a series of LM4250 integrated circuits as voltage comparators to divide the incoming transducer signal into five steps on a Rustrak recorder, each step representing 5 mm of actual ground movement. Five steps allow for a total movement of 25 mm before manual reset of the wire is required.

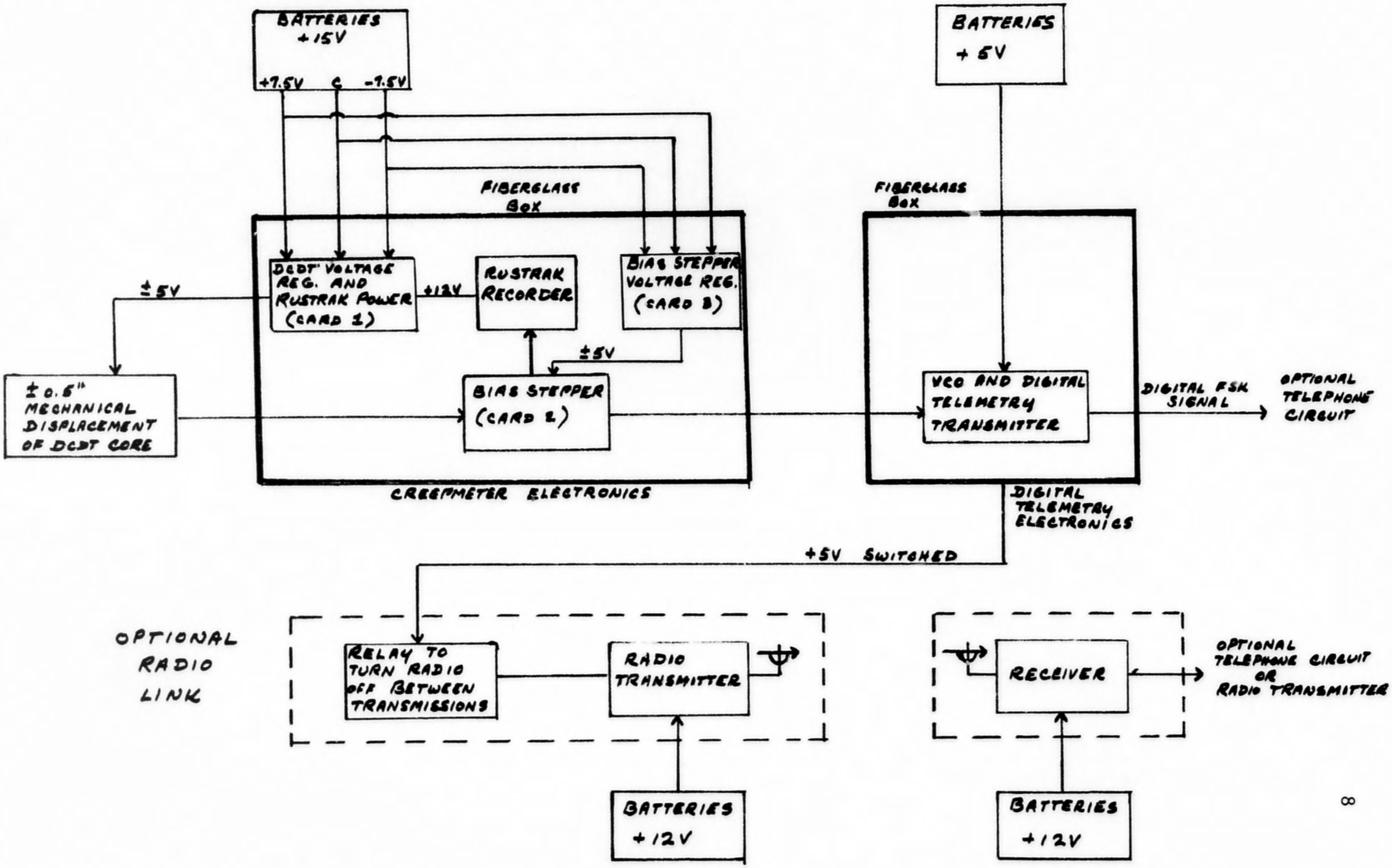
The package is powered by six McGraw-Edison 2.5 volt air cell batteries wired to provide ± 7.5 volts power, with a connection in the electronics package to provide 12 volts to power the Gulton Rustrak model 288/F2146 recorder, producing a permanent record on chart paper.

The signal from the transducer is fed to a digital telemetry transmitter, powered by two separate McGraw-Edison air cell batteries. The digital telemetry system is described in an open-file report by Roger, et al., 1977. Transmission of data from remote stations to a data-collection center is generally accomplished by radio, commercial telephone lines, or a combination of these two. (See page 8 for block diagram of creepmeter electronics.)



CREEPMETER BATTERY HOOKUP
IN INSTRUMENT VAULT

BLOCK DIAGRAM OF CREEPMETER OPERATION



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<u>Description of Site</u>

The site is centered on the San Andreas fault, on a trace of the 1857 surface break, at latitude 35° 08' 56" N, longitude 119° 41' 28" W, Panorama Hills (7.5') Quadrangle. It is reached by traveling approximately 21 miles over dirt roads, after taking the Elkhorn Valley turnoff from Highway 33 south of Taft and Maricopa. Site area is a desert, the only vegetation being small shrubs. There is no sign of ground water 2 m below ground level.

Low hills surround the area, and approximately 30 meters northwest of the instrument location is an elongated crescent-shaped ridge with a fault scarp on its northwest side and a narrow bench along the 1857 break (Fig. 2). From the instrument site the Carrizo Plain is visible to the west over low hills.

Figure 2. Creepmeter site before installation, with stakes indicating center and ends of instrument location. Black cones have been placed over stakes for easier visibility in the photo.

Installation of Instrument

R. O. Burford selected the site and A. Vaughn obtained the necessary permission from the landowners. Stakes were set at the center and either end of the instrument. The azimuth of the instrument was rotated 30^{o} anticlockwise from the strike of the fault (for the right-lateral, strike-slip case) to permit observation of creep for the longest possible period before the trench distorts beyond a useable limit.

A Brunton compass and measuring rod were used to compile a level-line terrain profile along the instrument axis; in turn, this profile was used to calculate depths of the trench at measured intervals along its length to insure a level trench and to allow for the catenary of the wire. As the wire was to be 20+ meters, the catenary was calculated to be 20 cm.

Installation began August 23, 1977, with a backhoe operator hired out of Taft to do the excavation. A pit approximately 2 m square and 2 m deep was opened up at the stake denoting the instrument end; the outline of the pit had been delineated previously by placement of additional stakes. After the first pit was opened, a trench approximately 21 meters long was excavated from it to the location of the second pit. Trench depths at 1-meter intervals were determined by the level-line terrain profile prepared earlier, and a specially-marked measuring stick was used to help the backhoe operator reach the correct depth. Average trench depth was 1.24 m (Fig. 3).

Figure 3. Backhoe operator opening up second pit at end of trench. First pit in foreground.

A second pit was excavated, again approximately 2 m square and 2 m deep. As no ground water was encountered, it was thought unnecessary to excavate a drain trench leading away from the pits to a sump, as has been done in other installations.[1]

After excavation was finished, the pier center was located in the floor of the instrument pit and a stake driven in. Two vertical posts were set up diagonally from each other on either side of the stake, so a line across their tops passed directly over the stake. Thus, by placing a piece of angle iron across the posts and using a plumb bob, it was possible to relocate the pier-center location after removing the stake (Fig. 4).

Figure 4. Posts set so pier location is readily located after stake is removed.

The center of the pit was located (approximately 30 cm behind the pier stake) and reference stakes were driven here to the level of the pit floor. These stakes were used to relocate floor level after subsequent operations.

A drilling platform was set up in the pit and a hand-held power auger with a 20 cm (8 in) bit used to drill a hole where the pier-center stake had been located (Fig. 5).

Figure 5. Drilling the pier hole.

After the pier hole was drilled to about 1 m depth, the auger bit was pulled up, and a 1.5 m length of 20-cm diameter steel pipe pounded down into the hole as a casing for the pier. Drilling was resumed with the auger bit inside the steel pipe, until a depth of 2.1 m was reached. The auger was pulled up and the steel pipe pounded in until its top was level with the pit-floor reference stakes.[2]

A specially-made rubber boot was slipped up over the pier, small end first, and tied securely just below the pier flange. This boot was later to be clamped at its top around the pier and at its bottom around the enclosure flange, sealing off the enclosure from the dirt floor of the excavation (see Fig. 1). A cement grout was mixed and poured into the instrument pier hole casing to a level about 45 cm below the top. The pier was lowered into the grout-filled pipe.

Care was taken in positioning the pier to line up the screw holes in the flange so one pair lay parallel to the trench and the other pair perpendicular to it, thus insuring the instrument could be properly mounted. A carpenter's level was used to insure the pier was vertical and centered in its casing. Additional grout was added up to the top of the casing pipe. The pier was secured in place with wires wrapped around angle iron resting on the posts, and the cement was allowed to set for 24 hours (Fig. 6).

Figure 6. Instrument pier in place in grout-filled casing pipe. Rubber boot is for sealing off interior of vault from environment after enclosure is in place over pier.

The above procedure was duplicated for the anchor end pier. After the cement for both piers had set, the posts were removed and pit floors cleaned out down to the floor-level reference stakes. Using the bottom perimeter of the fiberglass lower enclosure as a guide, stakes were driven down to floor level in a circle at 45-cm intervals to act as support for the enclosures. In spots where the stakes could be driven in easily, longer stakes were driven in to provide additional stability. All stakes had been soaked in creosote for preservation.[3]

Using a block and tackle and a tripod, the instrument lower enclosure was placed in position around the instrument pier.

Figure 7. Block and tackle and tripod setup.

The instrument and the reset screw were assembled on their respective piers, and a test wire strung between them. Measuring from the instrument enclosure coupling, the location of the first PVC pipe coupling was determined. Forty-five centimeters on both sides of this location, stakes were placed on either side of the pipe's path. There were now four stakes around the coupling, two 45 cm before it and two 45 cm beyond it. A 5.1 cm x 10.2 cm (2" x 4") base support was nailed on top of each pair of stakes, crosswise across the trench, to support the pipe. The support was then lowered in the trench until it was the correct distance below the wire: half the diameter of the PVC pipe plus the pipe wall thickness. This procedure was repeated for all the other couplings. In this way, necessary "sag" to match the wire catenary was introduced into the pipe's length (Fig. 8).

Figure 8. Beginning construction of pipe supports either side of each coupling.

In addition, special supports were constructed at the ends of the trench to support the pipe close to where it would enter the fiberglass enclosures.

The instrument was disassembled, the test wire removed to allow placement of the pipe, and the anchor end enclosure was lowered into place.

The 6.1 m sections of PVC pipe had been cut in half to facilitate transport. They were now rejoined using standard couplings and PVC cement. A section of pipe was inserted into the coupling of the anchor-enclosure and slipped several centimeters into the enclosure to allow for insertion of the final section of pipe. The other 6.1 m sections of pipe were coupled together in the trench using gaskets and lubricant supplied by the manufacturer, and the far end of the pipe line inserted into the instrument-enclosure coupling. A piece of pipe was cut and fitted into the remaining gap near the center of the trench, and the excess length in the anchor enclosure slipped back to close the gap. After the pipe was in place, 30 mil wire was wrapped around the pipe and each support, securing them together (Fig. 9).

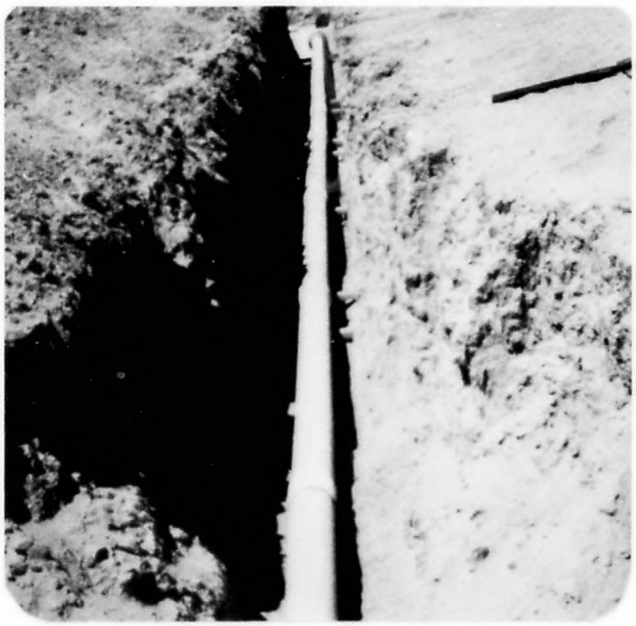


Figure 9. Pipe in trench, secured to its supports.

Using a metal snake (of the type used for threading wire through electrical conduits), the invar wire was drawn under tension through the pipe, secured at the anchor end, pulled approximately 30 cm beyond taut to temper it, and attached to the reassembled instrument. A visual check with a flashlight showed the wire to be hanging properly through the pipe (Fig. 10 and 11).

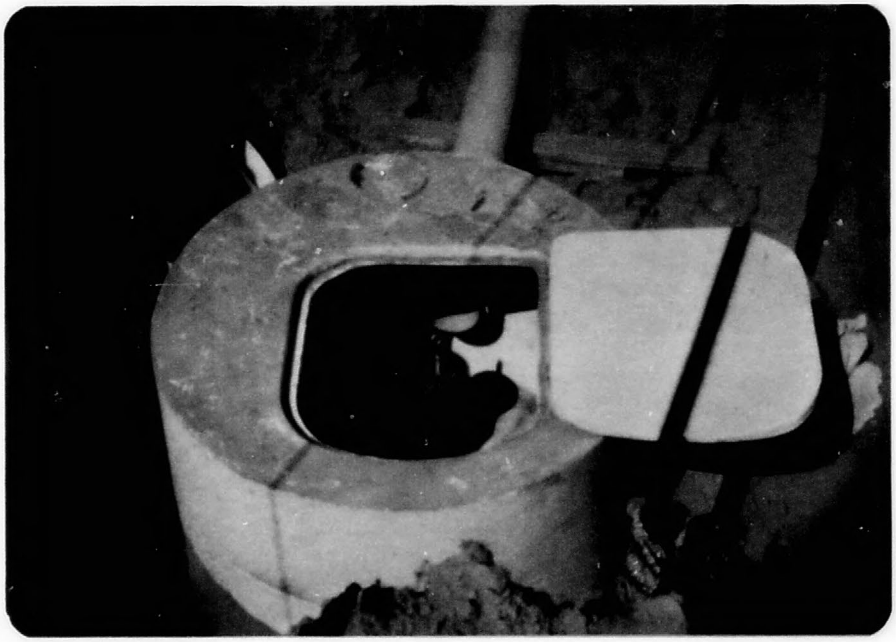


Figure 10. Anchor end lower enclosure, pipe in place.

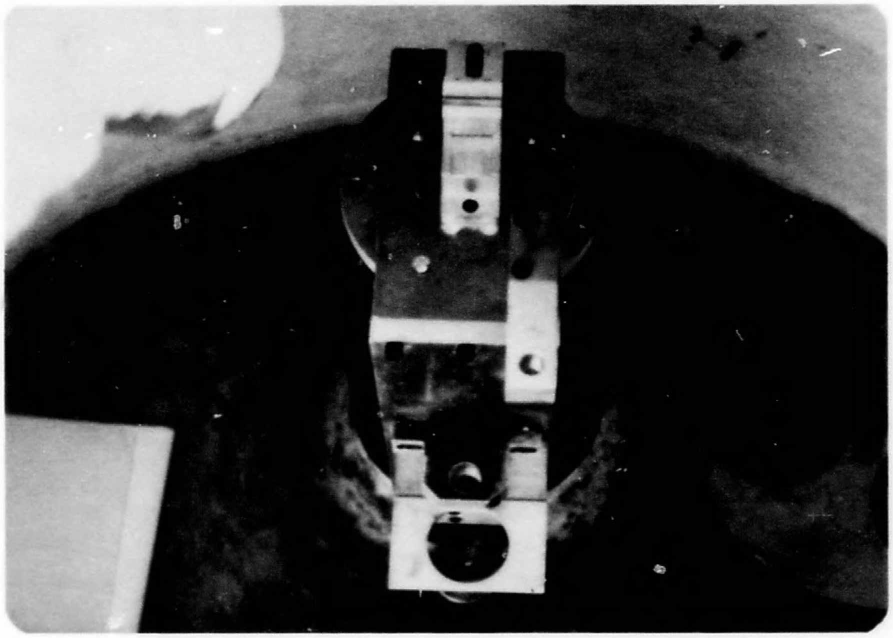


Figure 11. Instrument partially assembled inside its enclosure.

To aid in proper compaction, dirt was shoveled into the trench and tamped down under and around the pipe. Also, dirt was tamped about half-way up the sides of the enclosures for support.

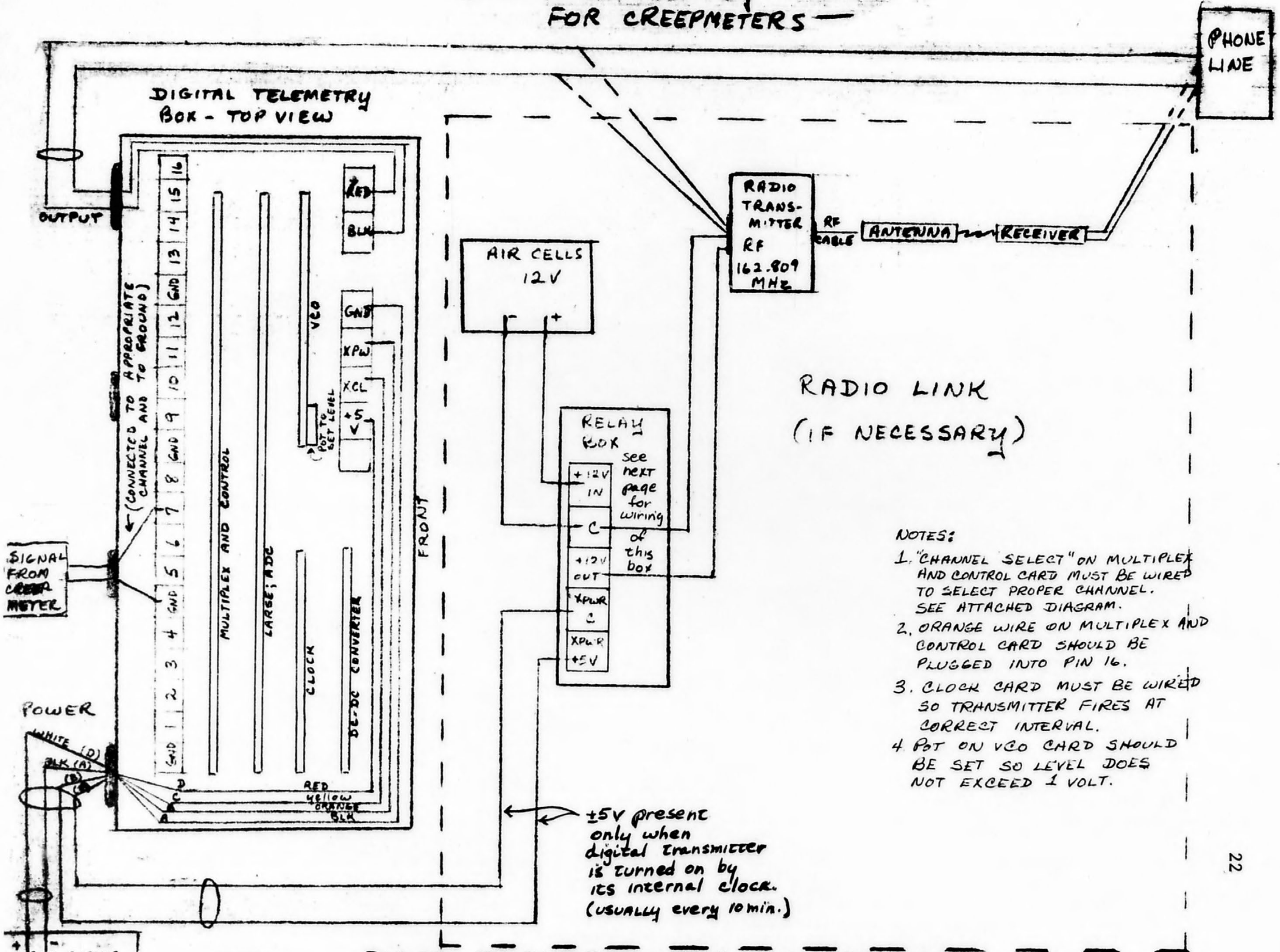
The top of the instrument enclosure was swept off, the top cone set on in the proper orientation, and holes drilled. The top cone was lifted up, a bead of caulking laid down around the flange, the cone lowered, and enclosure and cone drawn together with sheet metal screws. The cone lid was put on, and some modification to the hasp areas with a file was necessary before padlocks could be attached. The same procedures were repeated for the anchor enclosure (Fig 12).

Figure 12. Top cones in place with pipe and lower enclosure already covered with dirt.

On Saturday, August 27, the backhoe operator returned, filled in and compacted trench and pits, and left a mound of extra soil along the trench axis to allow for settling (Fig. 13). After filling was completed, the instrument was set up for proper operation and calibrated. The signal from the transducer was attached to Spiral-4 cable, which was trenched in to a vault on an adjacent hill with line-of-sight view to a radio receiver at Simmler. On the hill, the cable wires were attached to the digital telemetry transmitter, which transmits data via on-site radio every ten minutes. A special relay in the system turns the radio off between transmissions. The next three pages illustrates the wiring of the data transmission system.

Figure 13. Site after installation completed.

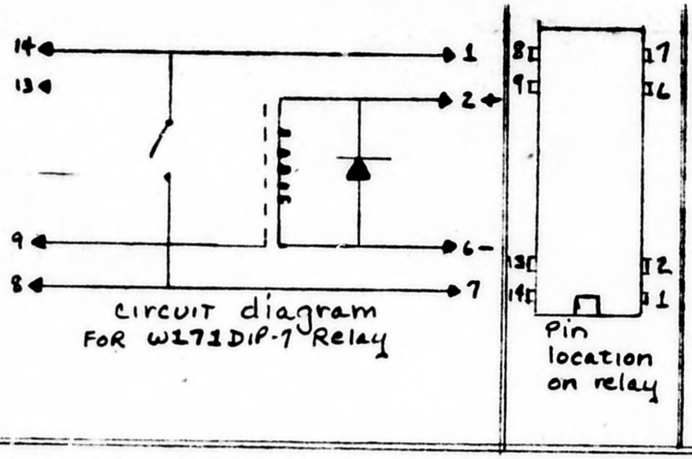
DIGITAL TELEMETRY HOOK-UP FOR CREEPMETERS



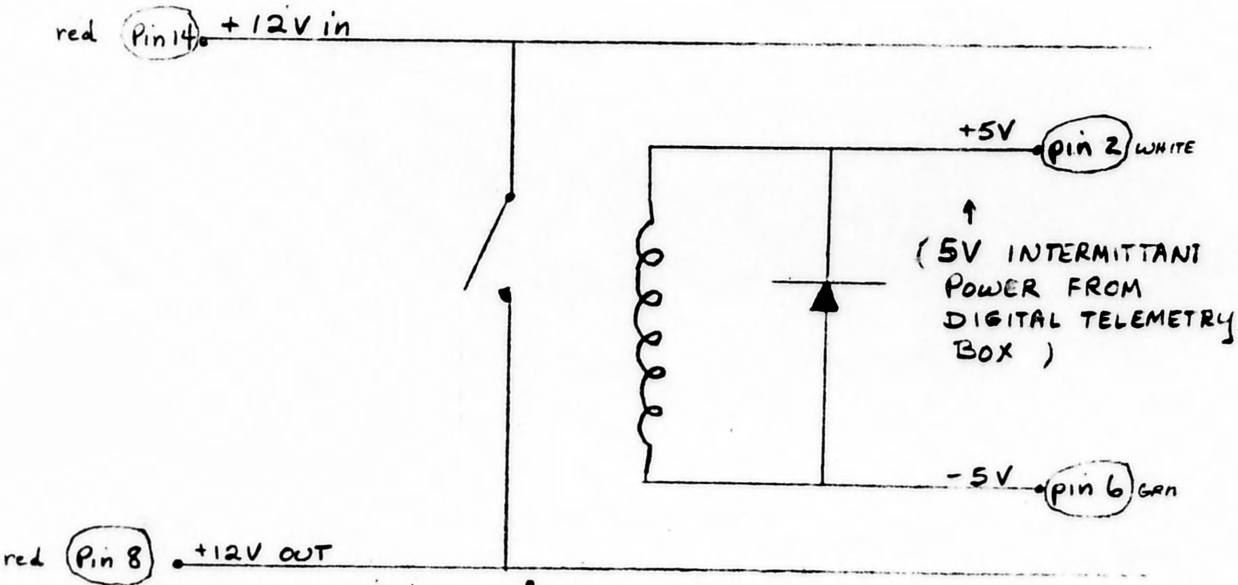
DIGITAL TELEMETRY HOOKUP FOR CREEPMETERS

MAGNECRAFT W171DIP-7 reed relay

WIRING DIAGRAM FOR RELAY BOX



MAGNECRAFT W171DIP-7 REED RELAY

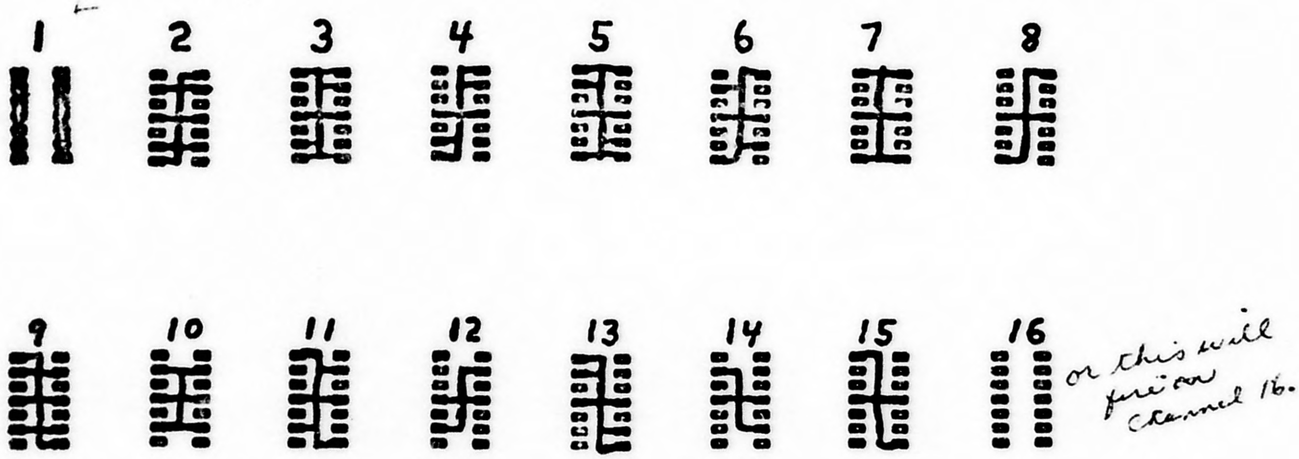


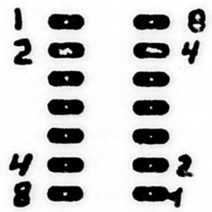
wiring of relay

Note:

Don't use pins 1 and 7 for +12V in and out, respectively — they won't work.

+12V in	TIE POINT FOR 12V C BETWEEN BATTS AND RADIO	+12V OUT	XPWR C	XPWR +5V	





START PROGRAM

HEADER VALUE

TO DECIPHER ADD OPEN PINS AND ADD 1

16

1+2+4+8+(1)

WIRING OF CHANNEL SELECT CIRCUIT

Footnotes

1. If ground water had been high enough to fill the trench, the site would not have been used. However, ground water in the pits could be pumped out and a drain trench dug away to a lower level or to a rock-filled sump. 3.81 cm (1 1/2") plastic pipe would have been laid in the drain trench with one end secured just under the lower enclosure bottom.

2. In operation, the auger is run down until its blade is full, then pulled up and dirt allowed to spin off outside the hole. Drilling was accomplished at this site with little difficulty, owing to the loose nature of the soil. At sites with heavy clay content, however, the auger is not run down more than half its blade length before being pulled up and scraped clean with a shovel. If the entire blade is sunk into the soil, a clay plug will form above it, locking it into the hole. If this happens, parts of the plug are removed by jamming the open end of a 3.8 cm steel pipe into it and cleaning the pipe out with a sharp object. When a sufficient number of clay pieces have been removed, the block and tackle on the tripod is used to pull up on the auger while a pipe wrench is used to turn the auger stem and free the blade.

   At sites where the presence of rocks makes use of the auger infeasible, a hole 1.3 m deep and as narrow as possible is dug with a shovel for each pier. The piers and steel pipes are then torch cut to proper length and care is used to compact the soil around the outside of the steel pipes.

3. At sites with very hard ground, shorter stakes are used.

SPECIFICATIONS FOR PANORAMA HILLS CREEPMETER

Type of wire:	Invar, .762 mm diameter
Length of wire:	Approximately 21 m
Average burial depth of wire:	Approximately 1.4 m
Height of instrument pier above pit floor:	49.5 cm (19 1/2 in)
Height of anchor pier above pit floor:	41.9 cm (16 1/2 in)

(If piers and casings must be torch cut, minimum length of instrument pier is 1.7 m (67 1/2 in), anchor pier 1.6 m (64 1/2 in), and casings 1.2 m (48 in). This insures a mimimum depth of piers in ground of 1.2 m (4 ft).)

Height of wire above pit floor, instrument end:	73 cm (28 3/4 in)
Height of wire above pit floor, anchor end:	47 cm (18 1/2 in)

MATERIALS:

Type of conduit:	15.2 cm (6 in.) PVC water pipe, 11.25 Kg/cm^2 (160 p.s.i.), with Bell x Bell couplings, 6.1 m sections cut in 3 m lengths for easier transport. Care must be used in transporting the pipes; excessive weight placed on them will cause distortion.
Casing:	Steel pipe, 20-cm diameter (8 in.), 3.2 mm wall thickness, 1.5 m long, top 30 cm reinforced with a steel collar welded on, to withstand sledge hammer blows.
Grout used in casing:	Kaiser Chem-Comp, approximately one 42.6 kg (94-lb) bag per pier, mixed 1:3 with sand.

Specifications - continued

Posts used in pits:	10.2 cm x 10.2 cm, 1.83 m long, (4" x 4", 6 ft. long), set approximately 1 m into ground.
Auger:	"Ground Hog", 20 cm power auger, 2.44 m stem.
Survey stakes: Floor-reference stakes:	5.1 cm x 5.1 cm x 30.5 cm (2" x 2" x 12"), cedar.
Enclosure-support stakes: Pipe-support stakes:	5.1 cm x 5.1 cm x 38.1 cm, (2" x 2" x 15"), cedar, creosote-treated.
Pipe supports:	5.1 cm x 10.2 cm x 61 cm (2" x 4", 2 ft.), pine.

Lower enclosure is secured to upper enclosure with 3/8" pan-head sheet metal screws.

MECHANICAL COMPONENTS

The mechanical components have all been custom made to USGS specifications and blueprints.

Anchor End:

Anchor swivel plate:	1.3 cm aluminum plate, 15.2 cm in diameter, attached to pier plate with 1/4-28 x 1/2 socket head screws.
Housing for moveable sleeve:	5.1 cm x 5.1 cm x 5.1 cm, aluminum, attached to swivel plate with 1/4-28 x 2-1/2 screws.
Moveable sleeve:	1.6 cm o. d. stainless steel tubing, 4.8 mm wall thickness, 15.2 cm long, inside threads 3/8-24, clamped into housing.
Brass reset screw:	Overall length 7.1 cm; Shaft: 1.6 cm diameter rod, 5.8 cm long, 3/8-24 threads. Knob: 3.8 cm diameter, 1.3 cm thick, screwed into moveable sleeve.
Brass ferrule: (wire anchor)	1.6 cm diameter brass rod, 2.5 cm long, clamped to wire with 10/32 set screws.

Specifications - continued

Instrument End

Pier plates: (used at both instrument and reset ends)	1.3 cm aluminum plate, 15.25 cm diameter, attached to pier with 1/4-28 x 1 socket head screws.
Instrument swivel plate:	17.8 cm x 10.2 cm x 1.3 cm aluminum plate, attached to pier plate with 1/4-28 x 1/2 socket head screws.
Front panel plate:	33 cm x 10.2 cm x 1.3 cm aluminum plate, attached to swivel plate with 1/4-28 x 1/2 socket head screws.
Knife edge alignment block:	11.4 cm x 3.2 cm x. 3.2 cm aluminum, attached to swivel plate with 10/32 socket head screws.
Swivel pin:	2.3 cm x 1.27 cm brass rod, inserted in center hole of pier plate and bottom hole of swivel plate.
Knife edge sliding block:	5.6 cm x 3.2 cm x 3.2 cm aluminum, attached to knife edge alignment block with 10/32 socket head screws.
Knife edge:	3.2 cm x 1.9 cm x 4.8 cm 440-C stainless steel, held in knife seat by 10/32 screws.
Knife seat:	4.1 cm x 3.2 cm x 3.6 mm 440-C stainless steel, held in groove at bottom of rocker arm by 10/32 screws.
Rocker-arm wire clamp:	1.3 cm x 9.6 mm x 6.3 mm aluminum, holds wire between two 6/32 socket head screws.
Rocker arm:	1.3 cm thick, rounded edge 120^{o} on 15.2 cm radius, aluminum plate.
Micrometer mount:	10.2 cm x 2.5 cm x 4.4 cm at thickest point, aluminum, secured to swivel plate with 10/32 screws.
Micrometer mount insulation:	4.3 cm x 2.5 cm x 0.8 mm, circuit board stock (fiberglass).

Specifications - continued

Weight retainer:	10.2 cm x [illegible].3 cm x 6.3 cm, aluminum, secured to front plate with 10/32 flat head screws.
DCDT clamp block:	8.9 cm x 4.6 cm (at thickest point) x 1.9 cm, aluminum, secured to front plate with 10/32 socket head screws.

ELECTRICAL COMPONENTS

Transducer:	Hewlett-Packard displacement transducer, Model 7-DCDT-500, DC input, DC output, Sensitivity: 3.3 Vdc Linearity: 0.5% of full scale with load impedance of 10K ohms Voltage used: ± 5 Vdc Power consumption: approx. 120 milliwatts Output impedance: 5.3 K ohms Displacement range, full scale (inches): ± 0.500.
Recorder:	Gulton Rustrak, Model 288/F2146, single channel, synchronous motor, with event marker. Power: ± 50 microamps Voltage: 12 Vdc Input impedance: 1 K ohm Geared to run 1/4 in. per hour. Uses WN chart paper.
Batteries:	McGraw-Edison 2.5 volt air cell batteries, Type ST-22, rated for 1000 amp-hrs. Six batteries wired in series with a center ground tap, for creepmeter electronics. Two batteries wired in series for digital telemetry transmitter. Five batteries wired in series for radio transmitter.

Acknowledgements

Swift and accurate completion of the job would not have been possible without the highly efficient crew of E. Y. Iwatsubo, T. L. Murray, and G. Myren. They endured 100^{o} + weather, a continual coating of fine grit, and long work days that started at 6:30 a.m., all cheerfully. Their skill at organization consistently kept the working site, tools, and materials in good order. Most importantly, the three of them were able to improvise a solution to every problem that arose. Their efforts are greatly appreciated.

The authors also wish to thank Carl Mortensen for the generous loan of his crew for the week.

A special word of gratitude is due Herb Mills, who courageously allowed me to handle the installation in my own manner.

Sandra Schulz

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Roger, J., Johnston, M. J. S., Mortensen, C., Myren, G. (1977). A multi-channel digital telemetry system for low frequency geophysical data, U. S. Geological Survey Open-file Report 77-490.

Appendix A: Assembly and Calibration of Instrument

Assembly of Instrument

Figure 14 shows a laboratory setup of the creepmeter.

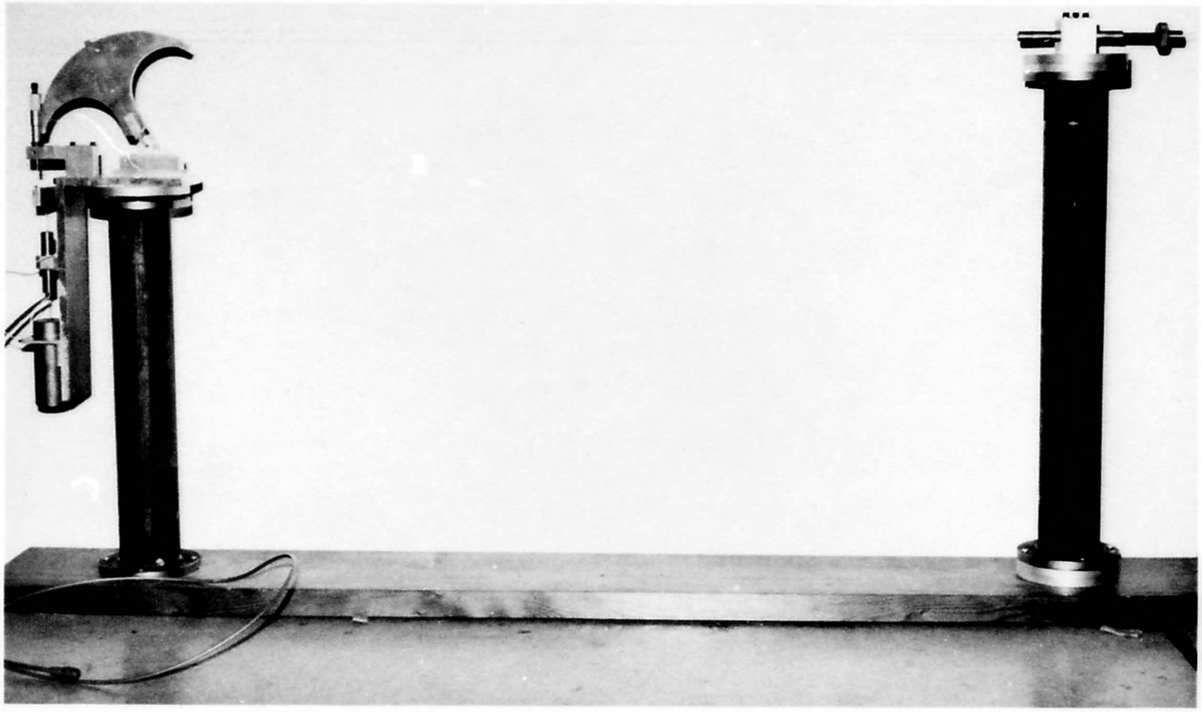

Figure 14. Complete mechanical setup of creepmeter in lab. At right is the reset screw assembly. The wire is secured with set screws in the brass ferrule at far right, then passes through a brass screw and a moveable sleeve and on to the instrument end. Instrument end appears at left, with the wire passing over the rocker arm and into a splicer block. Mounted above the splicer block is a micrometer. Its use in making manual readings is described in the section on Calibrating the Instrument. Representing the continuation of the wire below the splicer block is the transducer assembly: a transducer core attached by threaded rods to the splicer block above and a weight below and hanging free inside the fixed transducer. A change in pier separation will move the core up or down inside the transducer, producing a change in electronic signal.

<u>Reset Screw Assembly</u>

See Figure 15 for details of unassembled reset end, and refer to Figure 16 of the partially-assembled unit.

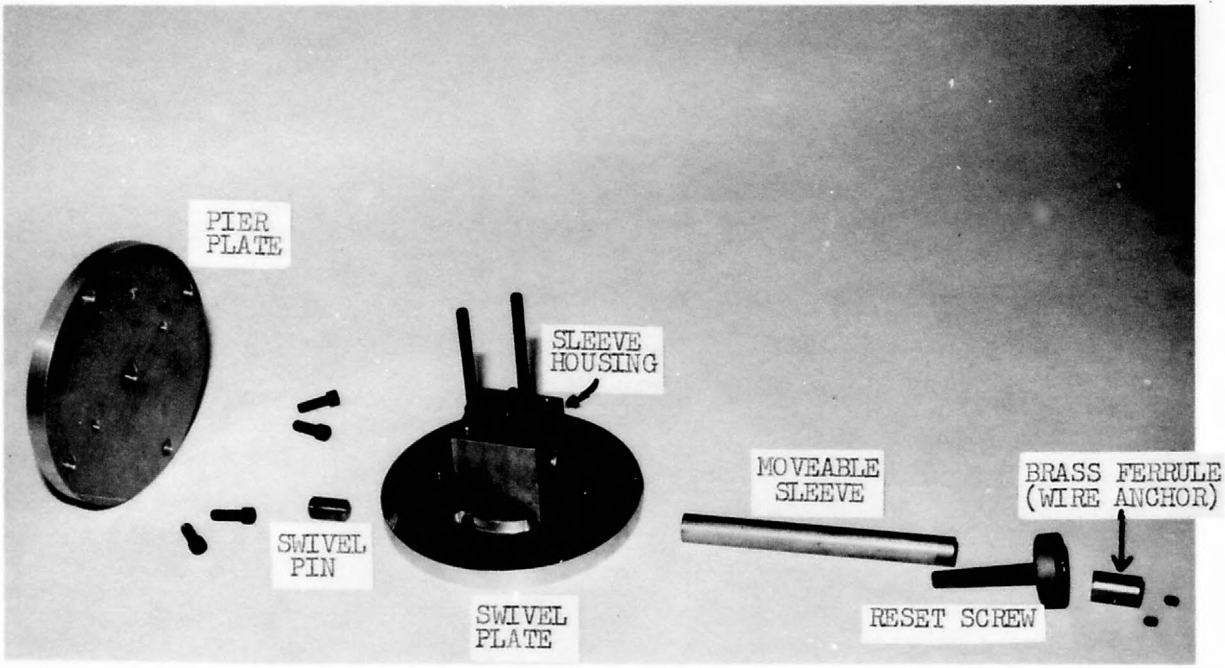

Figure 15 Reset end, unassembled.

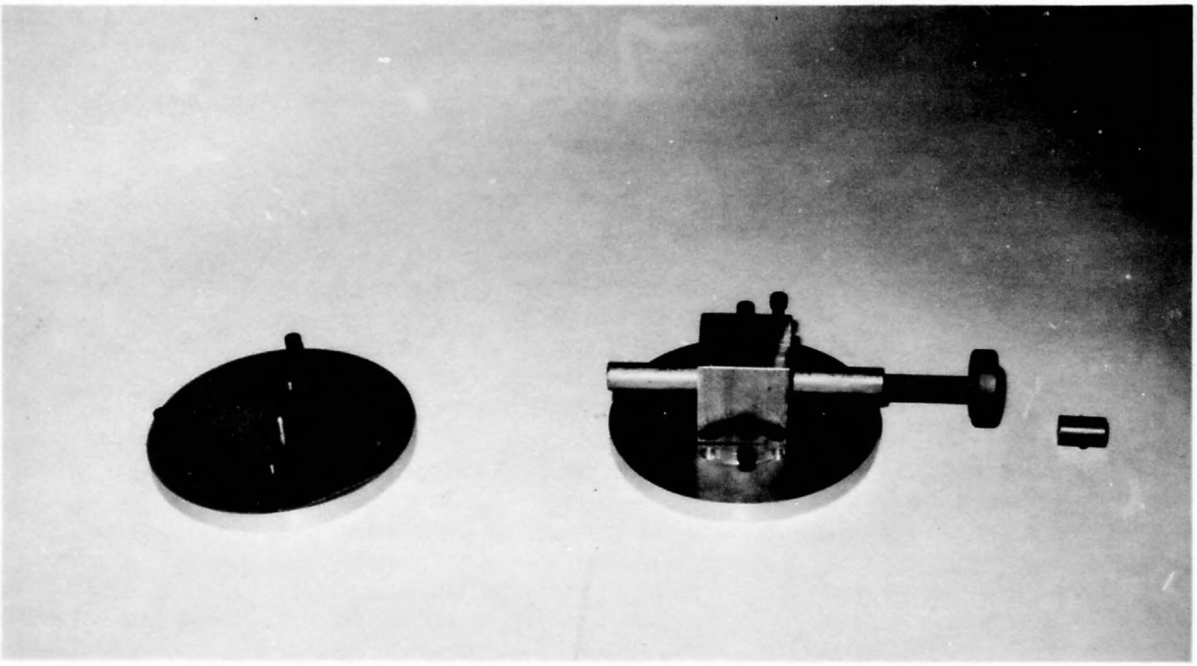

Figure 16 Reset end, partially assembled.

As seen in Figure 15, the pier plate on the left is mounted on the anchor end pier with 1/4-28 x 1/2 socket head cap screws and the swivel plate on the right is mounted on the pier plate with 1/4-28 x 1/4 socket head cap screws. The wire is fed through a brass ferrule, brass screw, moveable sleeve, and on through the pipe conduit to the instrument end. After the wire is fed through the conduit, it is stretched firmly from both ends, about 0.3 m beyond taut. It is not slackened any more than necessary during instrument assembly, to avoid kinking and distorting. Vise grip pliers are used to hold the wire at the anchor end while assembling the instrument at the other end.

Instrument End - Initial Assembly

Refer to Figure 17, which shows the unassembled instrument laid out roughly in the order in which it is assembled. Starting at left center of the Figure and moving clockwise, a large pier screw is tightened into the center hole of the pier. Over the top of the screw is laid a small square of stainless steel. These two components raise the pier plate enough to allow leveling the instrument.

Next, the pier plate is set on top of the steel square and four 1/4-28 x 1 socket head cap screws are inserted into counterbored screw holes in the plate. With a level resting on the plate, the screws are tightened until snug. Care must be used in leveling the pier plate, as over-tightening of one or two of the screws can bend the pier plate.

The swivel plate is fitted over a brass plug in the center of the pier plate, and 1/4-28 x 1/2 in. socket head screws are used to secure it. The knife edge block and the micrometer mount and micrometer are secured to the swivel plate. The rocker arm is attached in a later step.

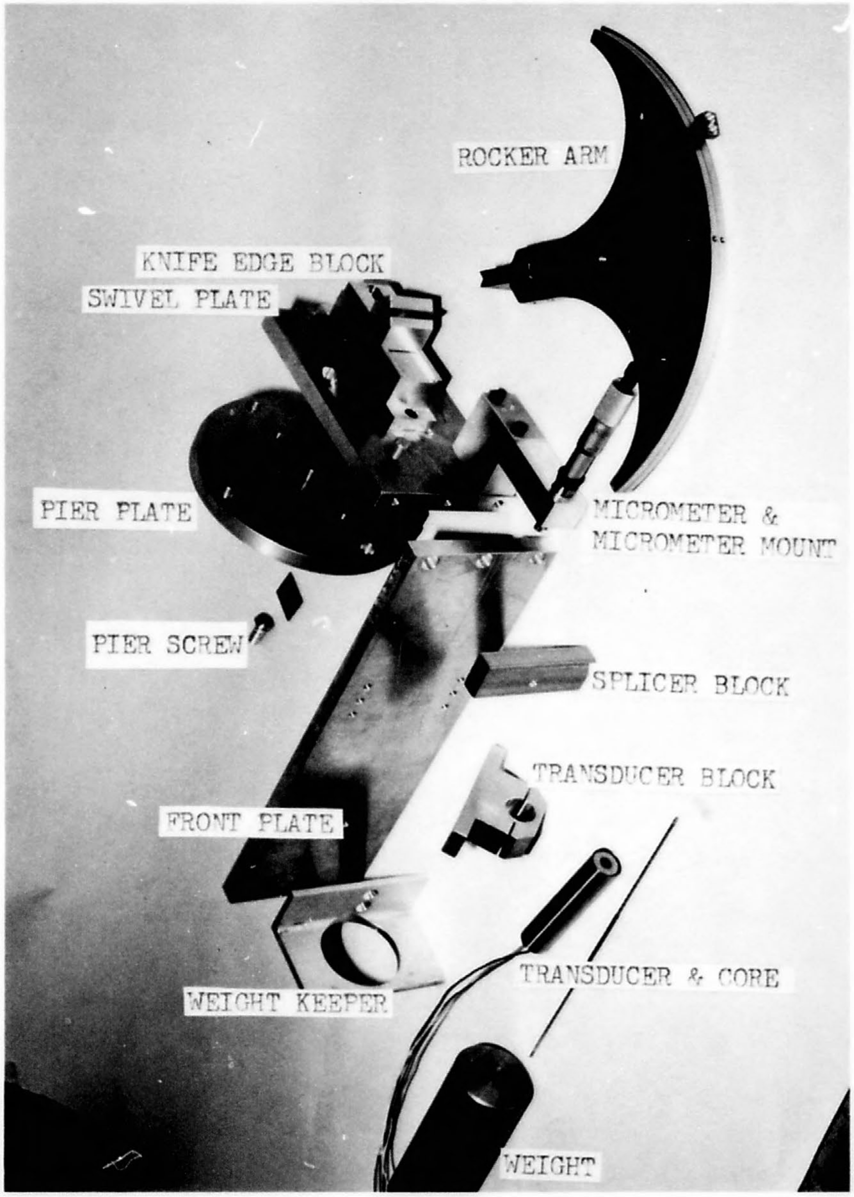

Figure 17. Unassembled instrument.

The front plate is attached to the edge of the swivel plate with 1/4 - 28 x 1/2 in. screws in the counterbored holes. The front plate should be checked with the level to be sure it is hanging perpendicular. If not, adjustment can be made to the pier plate. The keeper for the hanging weight is attached with 10/32 socket head screws. The splicer block, transducer block, transducer and core, and weight are attached in a later step.

After the wire has been fed through the reset end pipe and stretched, the rocker arm is set up in a preliminary position on the knife edge. The wire is pulled over the rocker arm and made to lie flat in the rocker arm groove, and is clamped with the small block on top of the rocker arm. The reset screw is now threaded about 2/3 of the way out of the move-able sleeve, and the sleeve itself slid all the way back in its housing in the direction of the reset screw, leaving just enough to be clamped in the housing.

The micrometer is threaded up to 25 mm and the splicer block held up by hand under the micrometer and touching its bottom point to determine where the wire should be cut. The wire is cut at a point about 10 mm below the top of the splicer block, providing enough wire to clamp in the block but not so much wire that it interferes with the threaded rod at the bottom of the block. A small ink mark on the wire will make cut-ting easier. The cut end is left hanging for the moment. The set screws in the brass ferrule at the anchor end are now tightened gently, just enough to hold the wire. Too much pressure can weaken and cut the wire.

Figure 18 shows the splicer block, transducer, and weight as they are positioned on the front plate. The easiest way to attach them is to assemble the unit separately (excluding the front plate), and attach it to the wire as a unit. The core is attached to its threaded rods and one of the rods is threaded into the top of the weight. The other rod is threaded into the bottom of the splicer block. It is important at this time to check and see that neither of the threaded rods has been bent (as in the Figure).

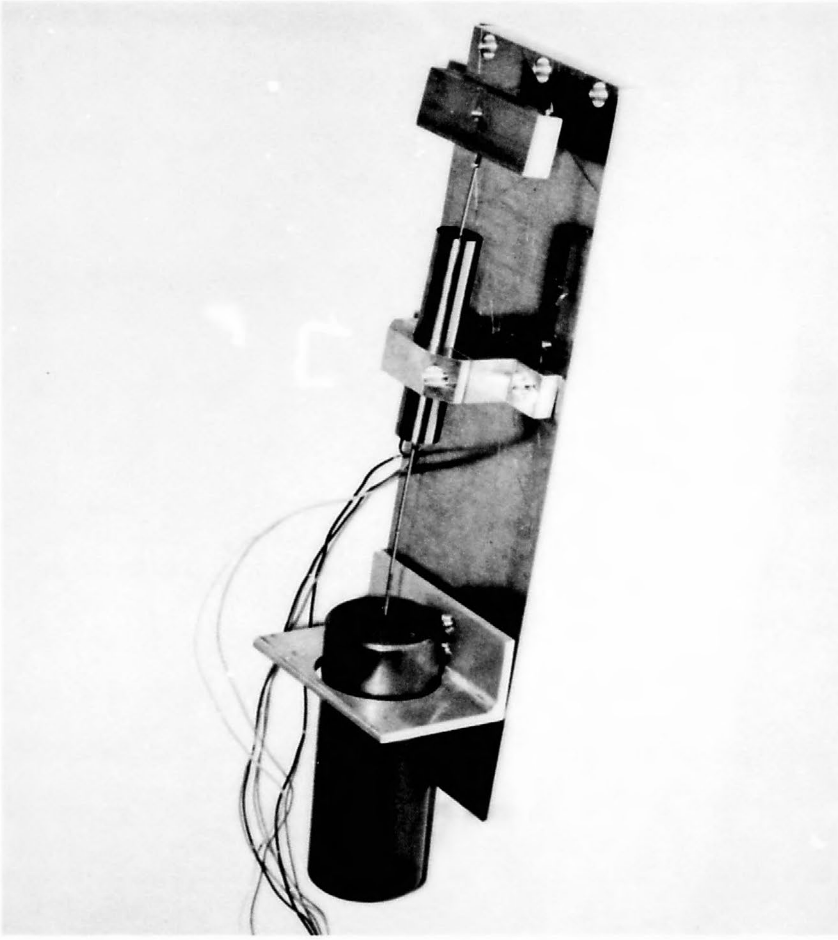

Figure 18. Transducer, core and weight.

The transducer is slipped over the core and allowed to rest on the weight, with the wires emerging from the bottom of the transducer. The transducer holding block is slipped over the transducer and left loose.

The assembled unit is placed in position under the cut end of the wire, the weight in its keeper. Then, using great care not to bend the threaded rods or the wire, the reset screw at the anchor end is threaded in until the wire enters the top of the splicer block far enough to be clamped gently but firmly with the set screws. The transducer block is slipped up and attached to the front panel, and the transducer is slipped up over the core and temporarily secured in its block.

Fine Adjustments

Now, the reset screw is threaded in until the point on the top of the splicer block (see Figure 18) just grazes the micrometer when the micrometer is set at 12.500 mm; at this point, the instrument is midway through its travel. (Note: In the following steps, it is important to thread the micrometer up out of the way whenever the splicer block is to be raised. If the splicer block moves up against the micrometer, a bend will be introduced into the wire and connecting rod.)

The rocker arm can now be positioned in its proper position. The clamp holding the wire on top of the rocker arm is loosened, the weight is raised slightly and held with one hand, and rocker arm positioned so it is positioned evenly and centered on the knife edge. The clamp then is tightened on the wire and the weight allowed to hang free. One end of a short length of hookup wire is attached by a screw to the left side of the rocker arm, and the other end of the wire is screwed down to the swivel plate to provide continuity between splicer block and micrometer anvil.

The core should be hanging free in the transducer and the weight approximately centered in its keeper. If not, the following adjustments can be made and repeated, if necessary, in whatever order they work best:

1. The screw at the back of the knife edge block can be loosened and the block moved forward or backward to center the core.

2. The transducer holding block can be loosened and moved right or left.

After the core is made to hang free inside the transducer and the weight is centered in its keeper, the electronics can be installed.

Installing the Electronics

Six McGraw-Edison 2.5 volt air cells are activated by filling with water and are arranged in the enclosure so they may be hooked together, yet not obstruct the entire enclosure floor. They are wired in series. The power cable to the electronics package is then connected: red wire to the positive terminal at one end of the series, black wire to negative terminal at the other end of the series, and white wire to a terminal halfway through the series. The power cable connector is then attached to the six-pin plug on the electronics package. The transducer cable connector is attached to the four-pin plug on the electronics package. The extra white wire on the transducer cable is attached to the front pier plate with a screw.

Calibrating the Equipment

The core is now to be precisely centered in the transducer. Probes of a voltmeter are inserted into the electronics package panel plug as follows: negative lead to pin C, positive lead to pin 2, Meter sensitivity set to 2 volts. The transducer block is loosened and the transducer moved up or down until the meter reads .000 volts; the block is then tightened carefully, making sure the reading remains .000 volts.

An ohmmeter is now used as follows: one lead is plugged in the hole in the right side of the micrometer mount block, the other lead is plugged in the hole in the right edge of the swivel plate, and the meter set to 10 x. As there is fiberglass insulator between the micrometer mount and the swivel plate, no continuity is normally present between them. However, as soon as the micrometer is threaded down to touch the point on the splicer block, continuity is established and resistance falls to 0. This precise method for making a manual reading is used in the following steps.

The reset screw is threaded out until a reading of 25.000 mm on the micrometer is reached. A scribe or scratch awl is used to make a line on top of the reset screw and in a corresponding position on the moveable sleeve.

With the instrument at 25.000 mm, readings are taken as follows:

1. Negative lead of a voltmeter in socket C of electronics package panel (ground), positive lead in socket 2, meter sensitivity 2v. This reading is put on line 1 of the "DCDT volts" column of the special calibration sheet.
2. Negative lead of voltmeter remains in socket C, positive lead is switched to socket 3, same meter sensitivity. This reading is put on line 1 of the "Stepper Volts" column of calibration sheet.
3. The Rustrak chart paper is advanced and the exact spot on the Rustrak chart where the needle was striking is circled and labeled "1".
4. The exact micrometer reading is determined with an ohmmeter and entered on line 1 of the "Micrometer reading" column of the calibration sheet.

The reset screw is now given one full turn clockwise at a time, lining up the scratch on the screw with the line on the moveable sleeve each time. After each turn, readings are made as in steps 1, 2, 3, and 4 above, and entered on subsequent lines of the calibration sheet. The spot where the Rustrak needle is striking is labeled with the number of the calibration sheet line currently being used. This procedure is repeated until 25 lines on the sheet have been filled with readings.

After calibration is complete, the reset screw is turned until the reading on the micrometer is between 1.500 and 2.000 mm. The micrometer is now turned up to its full UP position, so there will be no interference with the splicer block in the event of pier movement. A special protective plastic cap is placed over the micrometer.

The Rustrak chart is rolled up to a fresh spot, the station code, date, time (GMT), and field crew member's initials are entered on the chart. The Rustrak is replaced in the electronic package, the lid is secured, and the package is set to one side of the vault. The station is now ready for operation.

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