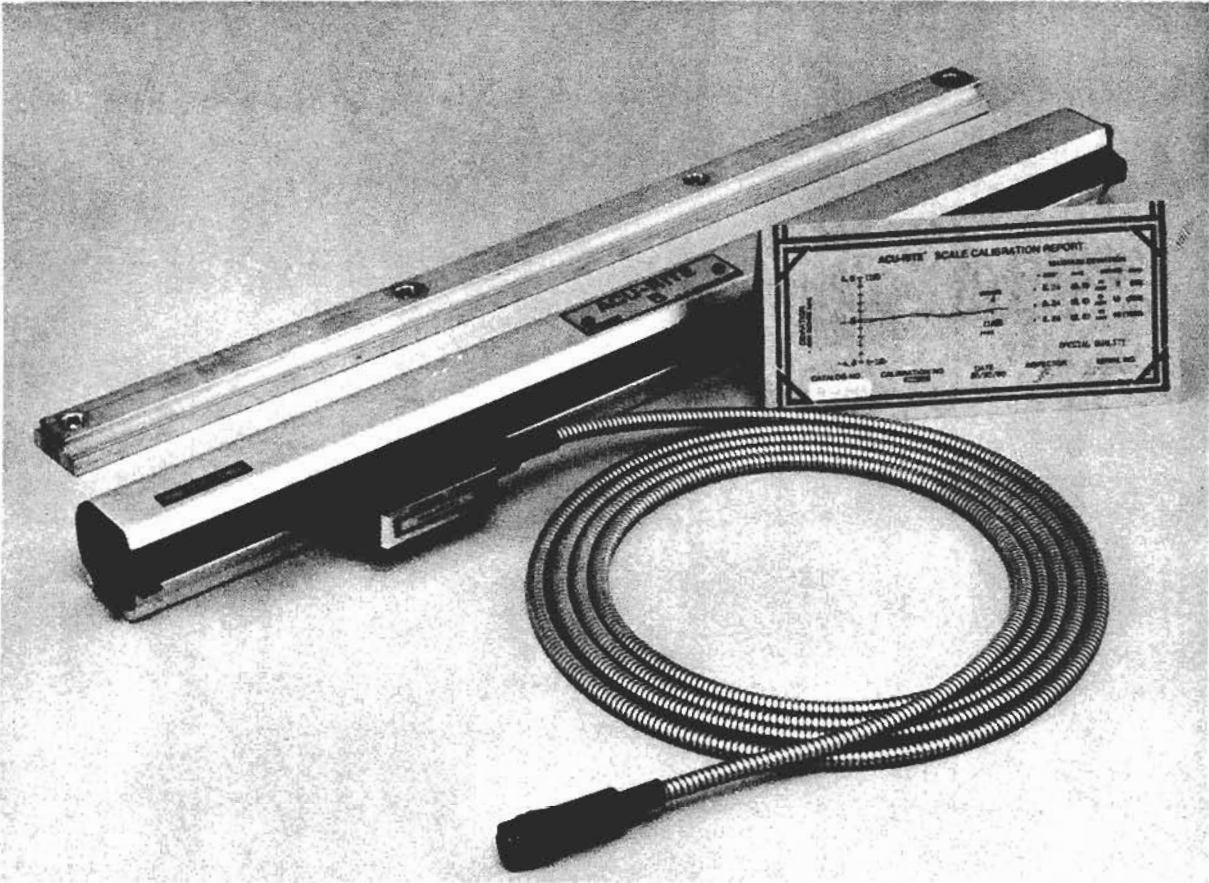


**ACU-RITE®**

# AR-5 SCALE

## LINEAR ENCODER SYSTEM

FOR DIGITAL AND VISION READOUT SYSTEMS



**SALES & SERVICE:**

**A Tech Authority, Inc.**  
13745 Stockton Ave.  
Chino CA 91710  
909-614-4522  
sales@atechauthority.com

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# INSTALLATION MANUAL

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## GENERAL INFORMATION

Your new AR-5 Scale Assembly is manufactured and warranted by the company that has been serving metal working industries for over half a century ACU-RITE INCORPORATED.

The AR-5 Scale has been designed and tested to exacting specifications to provide years of trouble-free service. If you experience any problems with your scale assembly, notify the authorized ACU-RITE distributor from whom it was purchased. Please unpack your scale carefully, and check the items received against those listed on the packing slip. Be sure the items are what you ordered. For your future warranty service or ordering reference, please record the following information in the spaces provided below:

### Serial No.

Can be seen by removing 4 screws on top plate of reading head

\_\_\_\_\_

Date of Purchase \_\_\_\_\_

Acu-Rite Distributor \_\_\_\_\_

Distributor Address \_\_\_\_\_

Distributor Telephone \_\_\_\_\_

## WARRANTY TO THE CONSUMER

1. ACU-RITE® AR-5 scale assembly parts are warranted against defects in material and workmanship to the consumer for a period of one year from date of purchase.
2. This warranty covers all parts, except lamps and other consumable items. It applies only to instruments and accessories which have been installed and operated in accordance with instructions in our reference manuals, have not been tampered with in any way, misused, suffered damage through accident, neglect or conditions beyond our control, and have been serviced only by our authorized distributors or service personnel.
3. Labor to service a defective instrument or accessory is free-of-charge for a period of one year from date of purchase.
4. ACU-RITE INCORPORATED is not responsible for loss in operating performance due to environmental conditions, such as humidity, dust, corrosive chemicals, deposition of oil or other foreign matter, spillage, or other conditions beyond our control.

There are no other warranties expressed or implied, and ACU-RITE INCORPORATED shall not be liable under any circumstances for consequential damages.

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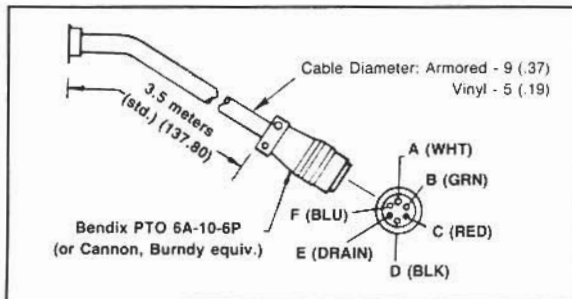
# STANDARD SPECIFICATIONS - AR-5 Assembly

<b>REPEATABILITY</b>	Within one resolution count
<b>OPERATING CONDITIONS</b>	0°C to 50°C (32°F to 122°F) 25% to 95% relative humidity (non-condensing)
<b>STORAGE CONDITIONS</b>	-40°C to 65°C (-40°F to 149°F) 20% to 95% relative humidity (non-condensing)

## ELECTRICAL CHARACTERISTICS

- TTL compatible open collector transistor output with internal pull-up resistor.
- Logic "1" level:  
pull-up to Vcc ( $5.1 \pm .1$  Vdc through a resistor.  
pull-up resistor =  $450 \pm 10\%$  ohms)
- Logic "0" level:  
0.5 Vdc maximum  
-7ma maximum (current sinking limit)
- Required Input Connector:  
Bendix PTO 6A-10-6P or equivalent

## STANDARD CABLE CONNECTOR



### PIN A

Channel A  
(Typical)



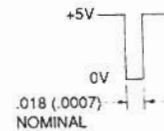
### PIN B

Channel B  
(Typical)



### PIN F

Fiducial  
Trigger  
Output  
(Typical)



### PIN

### INPUT/OUTPUT

A	Channel "A" square wave signal
B	Channel "B" square wave signal in quadrature (90° nominal phase relationship) with channel "A" signal
C	Vcc, $+5.1 \pm .1$ Vdc, current, 200mA max
D	Common (power supply and signal return)
E	Shield, reading head case ground
F	Fiducial trigger output signal (when provided)

## INSTALLATION OF A-R/5 10 $\mu$ m(.0005") RESOLUTION SCALE ASSEMBLY

Read these instructions carefully before proceeding with the actual mounting. It is important that the basic steps in these instructions be followed systematically. Modifications may have to be made to fit each particular machine tool or fixture, even when using universal mountings.

The scale assembly comes preassembled, ready to be mounted to your machine or fixture.

Two temporary alignment brackets hold the reading head casting to the scale case in its correctly aligned position. Until the mounting is completed, the reading head casting should remain fastened. The assembly must be mounted parallel to the machine table and/or spindle travel within .005" (.13mm) total indicated reading (TIR).

### NOTE

The scale case should be mounted with the rubber seals facing down, or away from the machine cutters and coolant sprays. This will afford the system the greatest protection against contaminants.

### Longitudinal-Travel Mounting

Position the longitudinal table at the center of travel and lock it. Hold the scale assembly against the front edge of the table to determine where to mount it. Refer to Figures 1 to 3. In most cases, the scale case is to be mounted to the table or slide and the reading head casting to the knee or stationary part of the machine. The scale assembly may have to be shifted to the left or right of center of the table saddle to provide a

relatively flat surface for mounting the reading head and required spacers.

Be sure that the scale assembly does not overhang or exceed the available table edge mounting space. The male dovetail should make contact over its entire length in order to hold the scale case in its proper alignment position.

The top of the scale case must be below the top surface of the table to avoid interference with table-top fixtures or the clamping positions of overhanging workpieces.

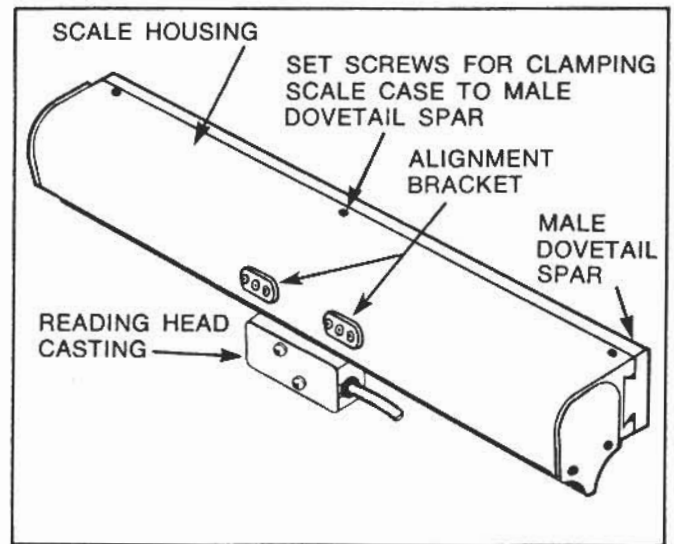


Figure 2. A-R/5 Scale Assembly Mounting Features

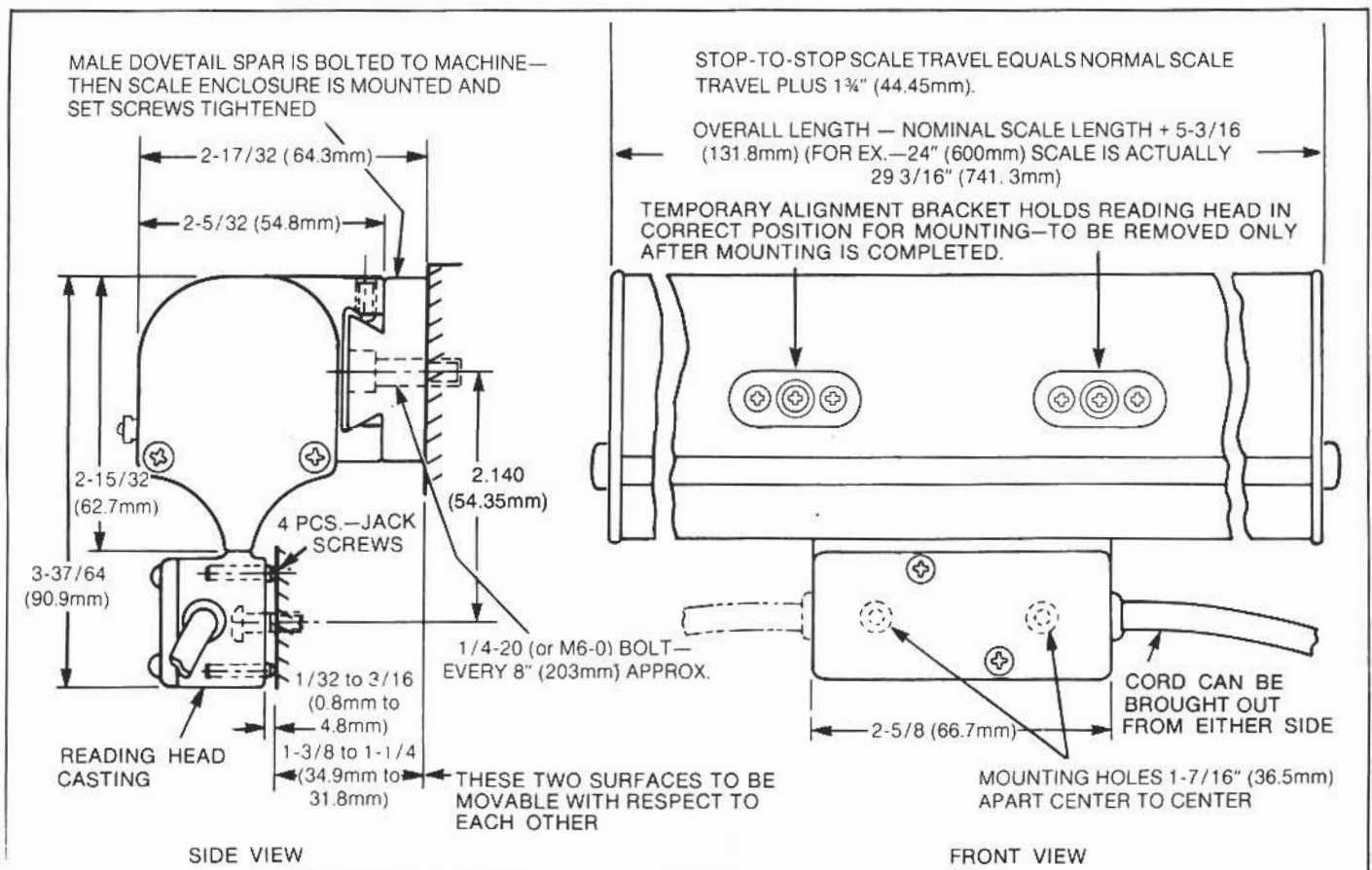


Figure 1. A-R/5 Scale Assembly Dimensions and Mounting Data

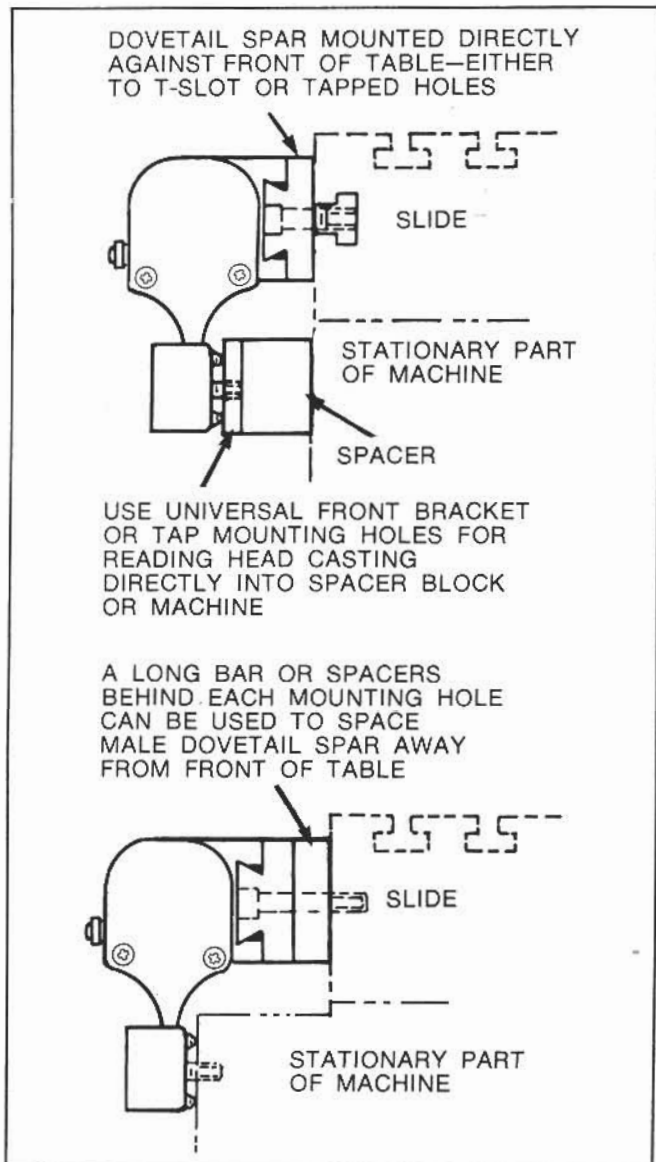
Check the position of all table locking handles, hand wheels, and table stop devices to be sure there will be no interference with the scale case or end caps.

If the scale is to remain stationary (and the reading head movable across the scale length), make sure the reading head and required brackets clear all handles, stop devices, or other projections.

**USE OF SPACER BLOCKS OR STANDOFF BRACKETS**

The ideal mounting condition of the dovetail spar (mounted against the machined side surface of the table or slide) cannot always be met. In these cases (when machine projections, operating controls or accessories prevent the male dovetail spar from making proper contact with the machined surface) use spacer blocks or standoff brackets.

Spacer blocks are generally made of aluminum and are used to support the male dovetail spar at each of its pre-drilled mounting holes (see Figure 3). Take care when machining spacer blocks to allow sufficient bearing surface ( $1\frac{1}{2}'' \times 1''/38.1 \times 25.4\text{mm}$ ) between the spacer block face and the back of the dovetail spar.

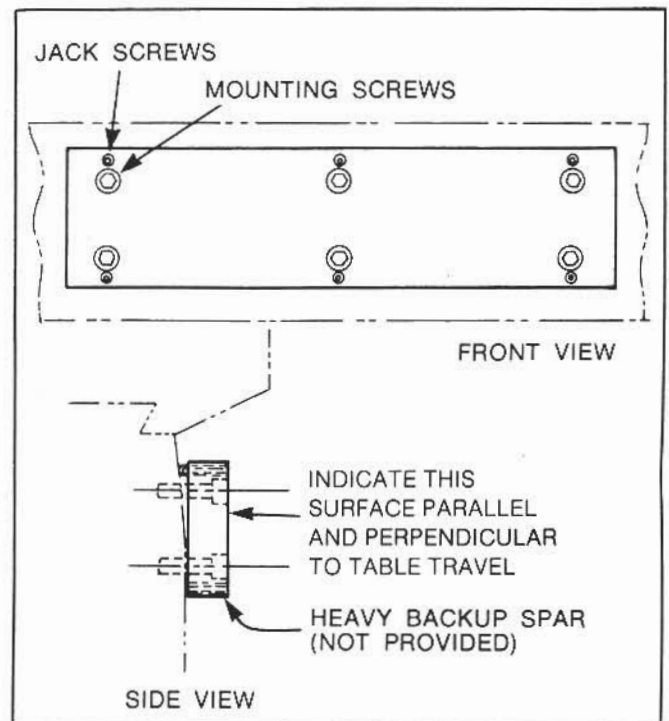


**Figure 3. Two Methods of Longitudinal-Travel Mounting**

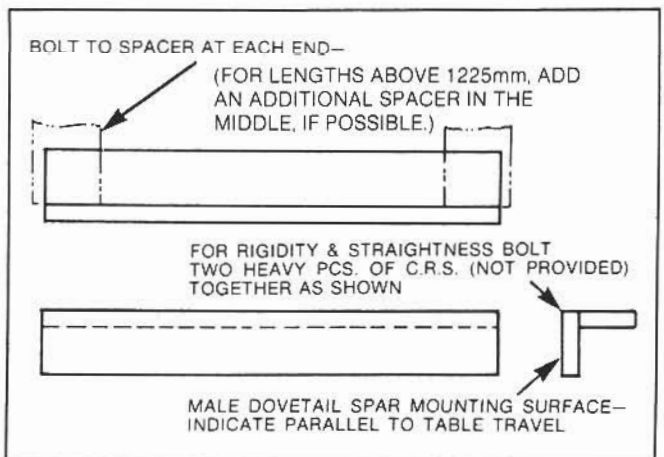
Standoff brackets are used when mounting of the scale assembly to the machine tool requires both horizontal and vertical clearances. These brackets are generally fabricated of cold rolled steel (welding of bracket components is recommended to ensure sufficient rigidity). Be sure that a standoff bracket is provided for each mounting hole in the male dovetail spar, with a minimum bearing surface of  $1\frac{1}{2}'' \times 1''$  ( $38.1 \times 25.4\text{mm}$ ) between the bracket face and the dovetail spar.

**USE OF BACK-UP SPAR**

In cases where spacer blocks or standoff brackets cannot be positioned to support the male dovetail at each predrilled mounting hole, a back-up spar must be used (see Figures 4 and 5).



**Figure 4. Suggested Method of Providing Flat and True Mounting Surface for Male Dovetail Spar Where No Machined Surface is Provided on Machine**



**Figure 5. Alternate Method of Providing Flat and True Mounting Surface for Male Dovetail Spar Where No Machined Surface is Provided on Machine**



A combination of spacer blocks, standoffs and back-up spars should be fabricated in accordance with good machining practice to provide rigid support, parallel planes and flat mounting surfaces to attach the scale assembly.

Once the appropriate mounting technique has been determined, a final check should be made to be certain that the cable from the reading head to the console is of sufficient length.

Determine whether the cable should exit from the right or left side of the reading head casting to provide the best cable route to the console. Be sure that slack loops are provided to permit full travel of the reading head as well as cross travel of the saddle. Determine where the reading head support or spacer will be mounted.

#### ALIGNMENT OF DOVETAIL SPAR

Mount spacer blocks, standoffs and/or back-up spars to their designated locations.

Attach the dovetail spar with the 1/4-20 (or M6-20) socket head cap screws provided. Unlock the table clamp and, using a micrometer or a dial indicator, indicate the front surface of the male dovetail spar to make sure this surface is parallel to the table travel within .005" (.13mm) T.I.R. Deviations may be corrected by the use of shim stock at the appropriate mounting points of the male dovetail spar, or by adjusting jackscrews in the back-up spar or male dovetail spar (see Figure 6).

Using a depth micrometer or a dial indicator, start at one end of the male dovetail spar, indicate and line up each mounting point until the spar is parallel to the top of the table within .005" (.13mm) T.I.R. (see Figure 6). Reposition the table to the center of its travel and lock the table clamp.

#### MOUNTING THE SCALE ASSEMBLY TO THE MALE DOVETAIL SPAR

With set screws on top of scale assembly somewhat loose, place the scale assembly over the male dovetail spar (the assembly fits over the spar without sliding), and tighten set screws located on top of scale case. In some cases, it may be necessary to redrill and tap set screw holes in the bottom dovetail flange of the scale case assembly. Make sure all bottom flange holes are redrilled on the same locations as the factory top flange holes.

#### MOUNTING OF THE READING HEAD

Check to make certain a space of 1/32" to 3/16" (.8 to 4.8mm) remains between the reading head casting and its mounting surface. This spacing is required for proper adjustment of the reading head jackscrews (see Figure 1).

There are two mounting holes in the reading head casting (see Figures 1 and 2). Transfer these holes onto mounting surface and drill and tap two holes for #8-32 x 1/2" (or M4 x 12mm) button head cap screws. Cable should be removed to avoid damage to wiring while drilling and tapping. Cable must also be supported during installation to avoid damage to insulated connections.

Insert four jackscrews (M3 x 8mm long hex socket set screws) into the four tapped holes in the reading head

casting. These should be set to the mounting surface as follows: Place a .002" (.05mm) to .005" (.13mm) thick shim or feeler gage behind each jackscrew and tighten until a slight drag can be felt on the shim or feeler gage. Do not over-tighten, this will force the reading head casting out of its alignment position.

Remove feeler gage or shim. Mount reading head casting with two #8-32 x 1/2" (or M4 x 12mm) button head cap screws. Take care not to pinch or cut wires while installing screws. Do not move table before next step.

Remove alignment brackets (brackets and screws should be retained for future use and system realignment). Be sure to tuck all wire into casting before adding nameplate. Mount nameplate to reading head, using two #6-32 x 1/4" long Phillips-head screws.

Remove backing from scale cover gasket and assemble gasket to cover plate. Mount cover plate assembly to scale alignment bracket holes using two M3 x 6mm long screws.

Crank longitudinal table as far as it can go in both directions, while watching the reading head, making sure that it will not hit the end cover plates at either extreme of travel. If the total table travel of your machine is longer than the travel permitted by the scale case, positive table stops will have to be installed to limit your table travel.

Plug the cord from the scale assembly into the input receptacle on the back of the counter. Turn the male connector so the large spline is on top and give the rotatable sleeve a 1/4 turn to lock.

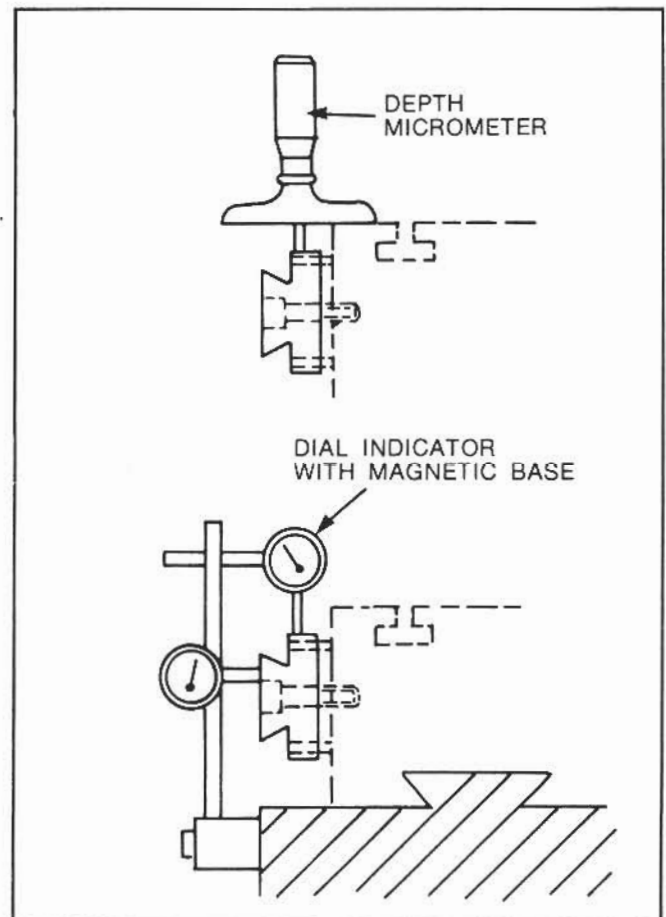


Figure 6. Methods of Lining Up Male Dovetail Spar

## INSTALLING THE READING-HEAD-TO-CONSOLE CABLE

Check cable route and be certain that slack loops are sufficient to allow movement of the reading head, table and saddle to the full extent of travel in all directions. The cable

should be tied to the machine base in an orderly fashion to prevent excess slack from lying on the shop floor where it may become damaged. The cable must not be allowed to lie

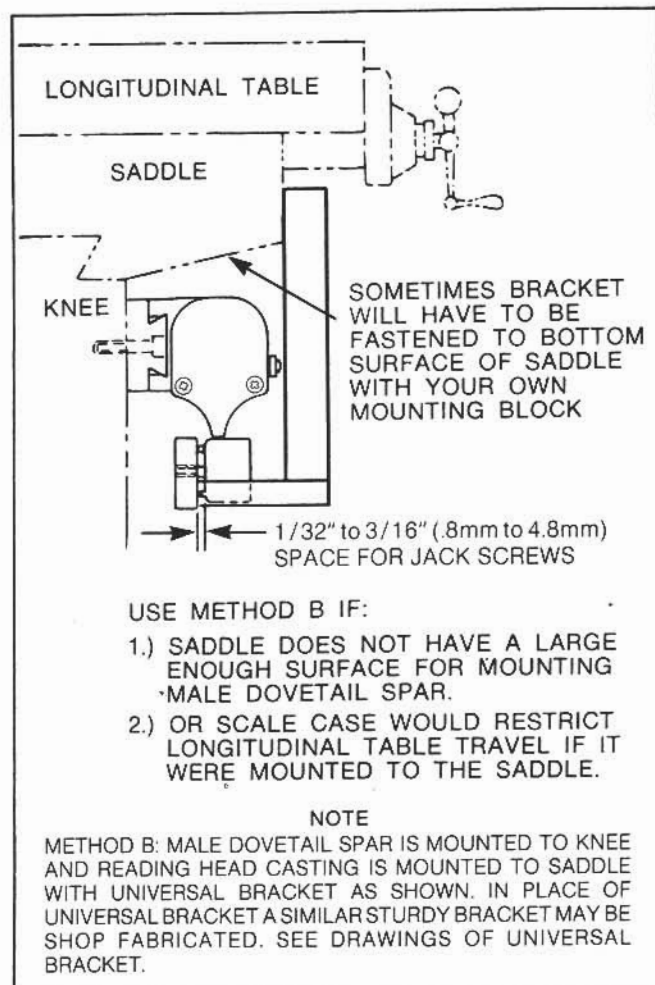
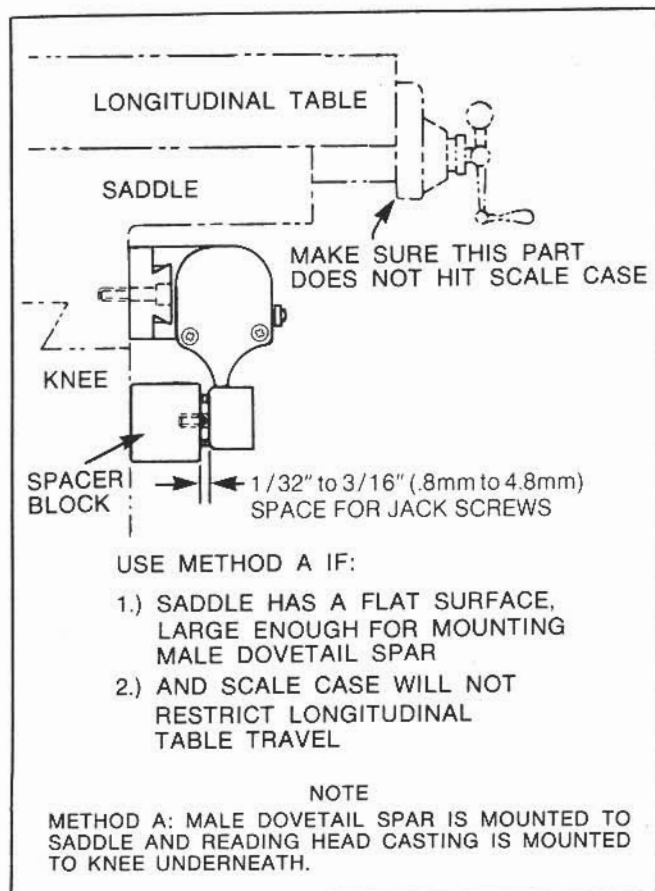


Figure 7. Two Methods of Cross-Travel Mounting

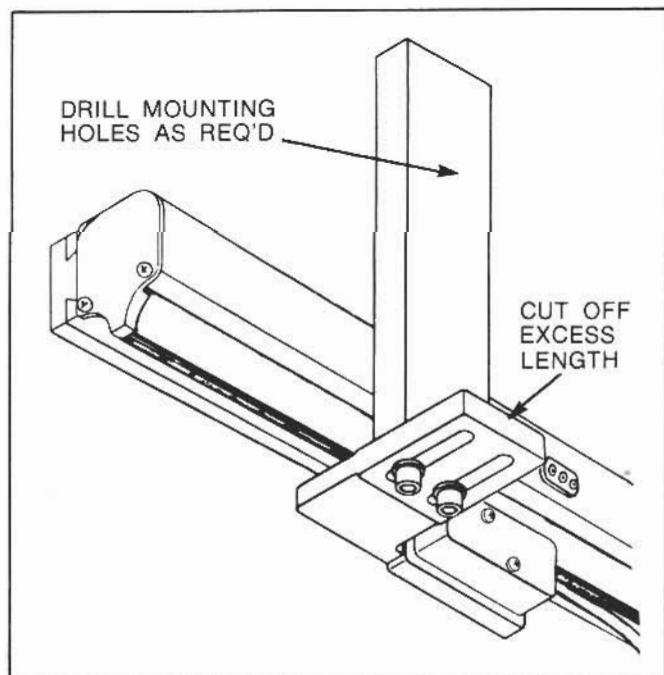


Figure 8. Universal Brackets with Upper Part to the Left of Reading Head.

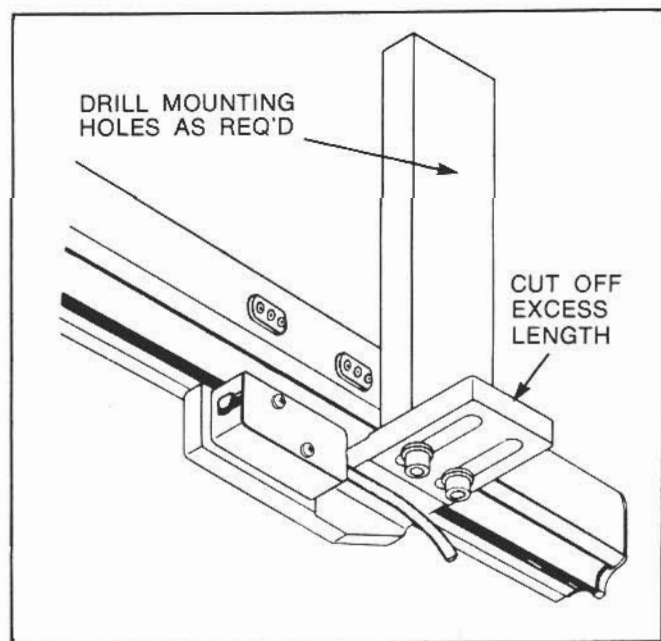


Figure 9. Universal Brackets with Upper Part to the Right of Reading Head.

on ways or lead screws where it is in danger of being pinched or cut. Damaged cables cannot be repaired and must be replaced.

### Cross-Travel Mounting

- a. Determine the mounting position.
- b. Position the cross-travel saddle or slide at the center of its travel and lock it in this position. The cross-travel scale assembly can be mounted on either side of the machine. Study the basic mounting methods in Figures 7 through 9 and hold the scale assembly against the machine to determine the best mounting position.
- c. After determining the mounting position, perform the cross-travel mounting using Longitudinal-Travel Mounting procedures.

### Vertical-Travel Mounting

- a. Position your vertical slide at the center of its travel and lock it in this position. Hold the scale assembly against the machine to determine the best mounting position. The reading head casting should be mounted to the vertical slide and the male dovetail spar should be mounted to the machine base. A back-up spar (not provided) may have to be mounted to the machine base to provide a flat and true mounting surface for the male dovetail spar (see Figures 10 and 11). For greatest accuracy, mount the spar and scale case assembly as close to the spindle travel as

possible. The rubber seals should not face directly into the path of coolant sprays from the cutter. If necessary, mount a sheet metal or rubber splash guard between the cutter and scale assembly for protection.

- b. After determining the mounting position, perform the vertical-travel mounting using Longitudinal-Travel Mounting procedures.

### System Checkout

- a. After location of the console has been established and scale assemblies and reading heads have been mounted and secured properly, a final check should be made to ensure that the reading-head-to-console cables are properly routed and slack loops provided for full reading head, table, and saddle travels.
- b. Be certain reading head cable connectors are properly plugged and locked into the mating connectors on the console.
- c. Make sure the power cord to the console is plugged into a proper A.C. receptacle and the console-to-machine-base ground strap is installed. See grounding instructions in the operator's manual provided with your console.
- d. Check the existing hand wheel dials on the machine tool and determine if they are graduated in English or metric units.

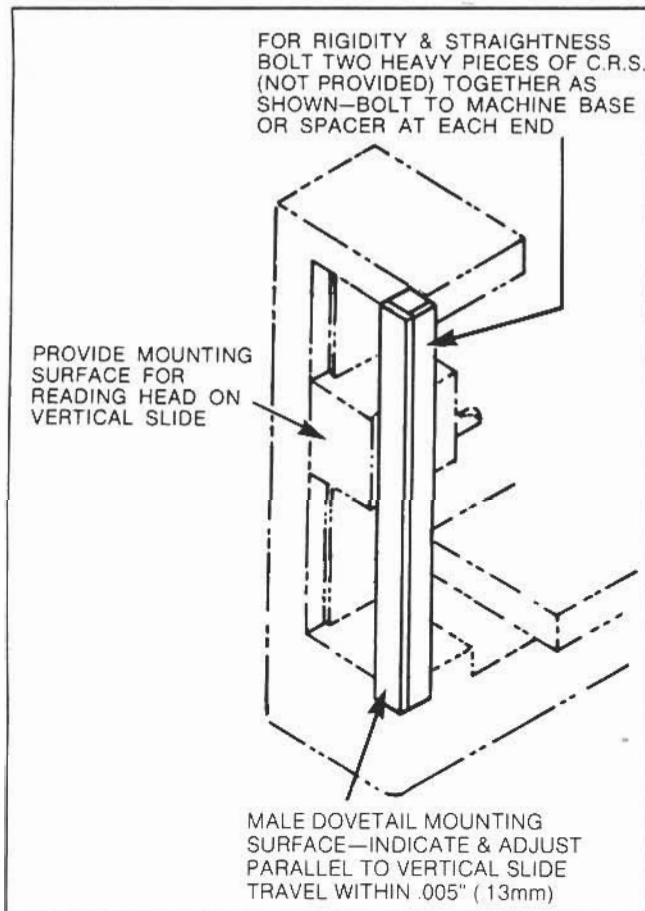


Figure 10. Suggested Method of Providing Back-Up Spar for Male Dovetail Spar on Z-Axis

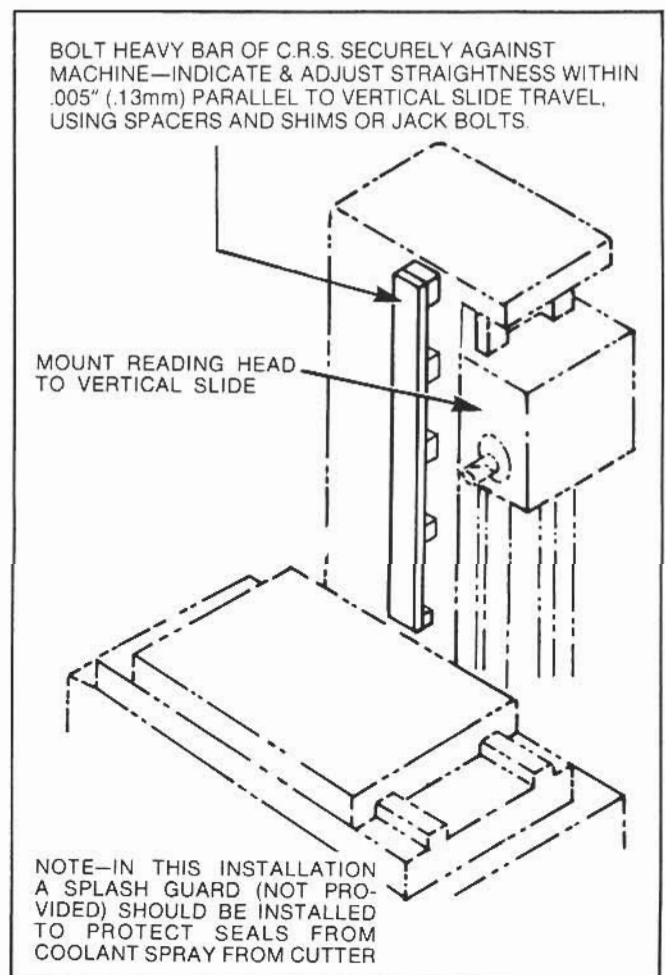


Figure 11. Alternate Method of Providing Back-Up Spar for Mounting Male Dovetail Spar on Z-Axis



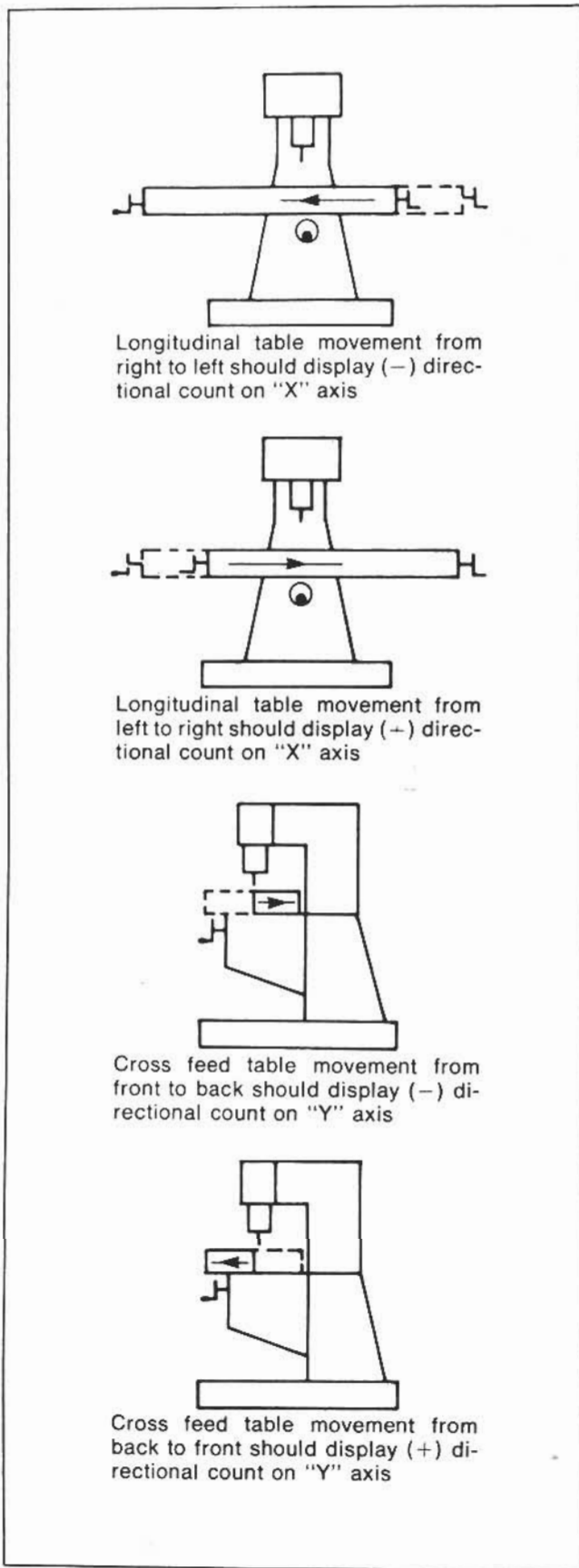


Figure 12. Proper +/- Directional Counts for Longitudinal and Cross-Travel Table Movements

- e. The position of the INCH-mm switch on the console front panel should correspond with the hand wheel dial increments on the machine tool. INCH DIALS — INCH position on console switch; metric dials — mm position on console switch.
- f. Set the POWER switch on the console front panel to the ON position.
- g. Push the ZERO RESET button for each axis (displays for each axis should now display all 0's).
- h. Move the table or slide to insure proper axis display change and +/- directional count (see Figure 12).
- i. To change the axis +/- directional count, first disconnect the line cord, then remove the console top cover and unplug and rotate the reading head output-to-axis board plug 180°. Be sure pins are aligned and firm contact is made when the plug is replaced on the board connector (see Figure 13).

### Repeatability Test

This test should be run periodically to assure proper performance (see Figure 14).

- a. Move the table to one extreme end of travel.
- b. Mount a dial indicator onto a stationary machine part with tip contacting table.
- c. Set dial indicator and digital display console to zero.
- d. Move the table all the way to the other extreme and come back again until the dial indicator reads zero. Digital display console should now also be back to zero, within  $\pm .0005"$  ( $\pm .01\text{mm}$ ).

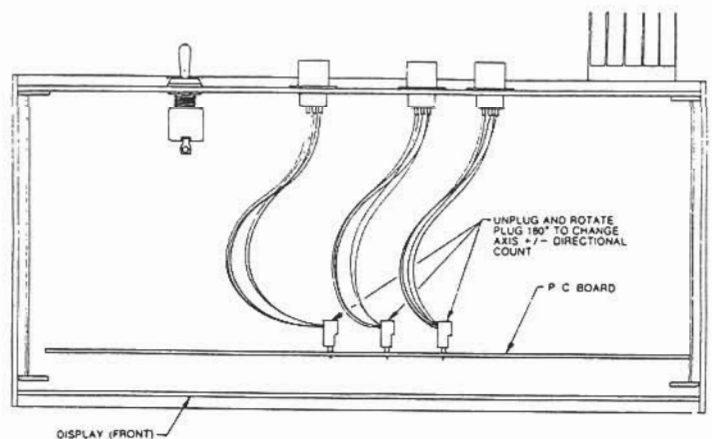
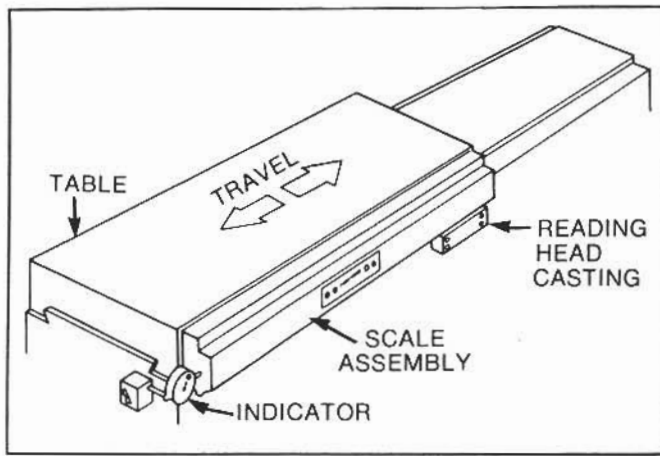


Figure 13. Top Inside View of Console



**Figure 14. Repeatability Test**

### Scale Assembly Maintenance

To insure trouble free operation of your scale assembly, the following minor maintenance procedures should be performed on a **Semi-Annual** basis.

- a) Gently clean the scale with a cotton swab and Isopropyl (Rubbing) alcohol to remove foreign matter. Keep swab saturated while cleaning.
- b) For highly repetitious machining applications lubricate the scale lip seals with Dow Corning Compound III Silicone Grease (or equivalent), by applying a light coat on the inside surface of the lip seals where the reading head casting rides.

### SCALE ASSEMBLY TROUBLESHOOTING A-R/5

When there is a malfunction in the reading head and scale assemblies, check first for correct mounting of the scale and its associated hardware on the machine tool. Sometimes a purely mechanical failure will occur and cause problems in reading head carriage tracking or possibly a calibration error.

#### NOTE

The following are some possible conditions to check in the A-R/5 scale assembly (see Figure 15 for parts identification):

- a. Wires on LED board (11) rubbing against the inside of the scale housing (2). Physically check for this condition by removing one end cap and, with a flashlight, looking inside the scale housing. If wires are rubbing, move the head to the end of the housing and use a convenient tool to reposition the wires. If this is not convenient, remove the head and reposition the wires. Refer to Reading Head Removal and Replacement.
- b. Alignment bracket (5) was bent in shipment or mounting brackets are loose or bent out of place.
- c. Reading head was bumped in shipment and, even though alignment bracket (5) was not bent, the alignment bracket screws have shifted slightly off center. This causes the head carriage (9) to be out of parallel with the bottom of the scale (1).

d. Reading head misalignment can be caused by a few other conditions, including the following:

1. If the reading head is not mounted in its correct position, the ball spring (10) will not be parallel to scale edge (1). Any additional lateral movement between the head and scale will cause a cosine error.
  2. If the carriage (9) rides up and down on a damaged scale edge, the index grating will not track on a true course. Physically check for this condition by separating the lip seals and, with a flashlight, looking at the scale to see if it is chipped or cracked.
  3. If the set screws (15a) that secure the scale housing (2) to the spar (15) are not tightened uniformly, or some are overtightened or are not tightened at all, the scale housing may distort, causing misalignment between the reading head (4,9) and the glass scale (1).
- e. A calibration error can be caused by non-linear tracking of the machine tool carriage on which the scale is mounted. Refer to Error Compensation in appropriate DRO operators manual.
- f. Ball on cantilever spring (10) has come out of its socket on the printed-circuit board (14).
- g. Wires on the inside of the reading head casting (4) have been pinched between the casting and the cover plate (8). If wires are severely damaged, head will have to be replaced or repaired. Contact your ACU-RITE distributor.

### READING HEAD REMOVAL AND REPLACEMENT

1. Disconnect the reading head cable from rear of the counter. To remove the reading head from the A-R/5 scale assembly, remove the end cap from the scale housing by applying a slight pressure to the bottom. (A rubber hammer may be used to tap it loose.) To remount the end cap, use silicone rubber cement and tape in place until cement sets.

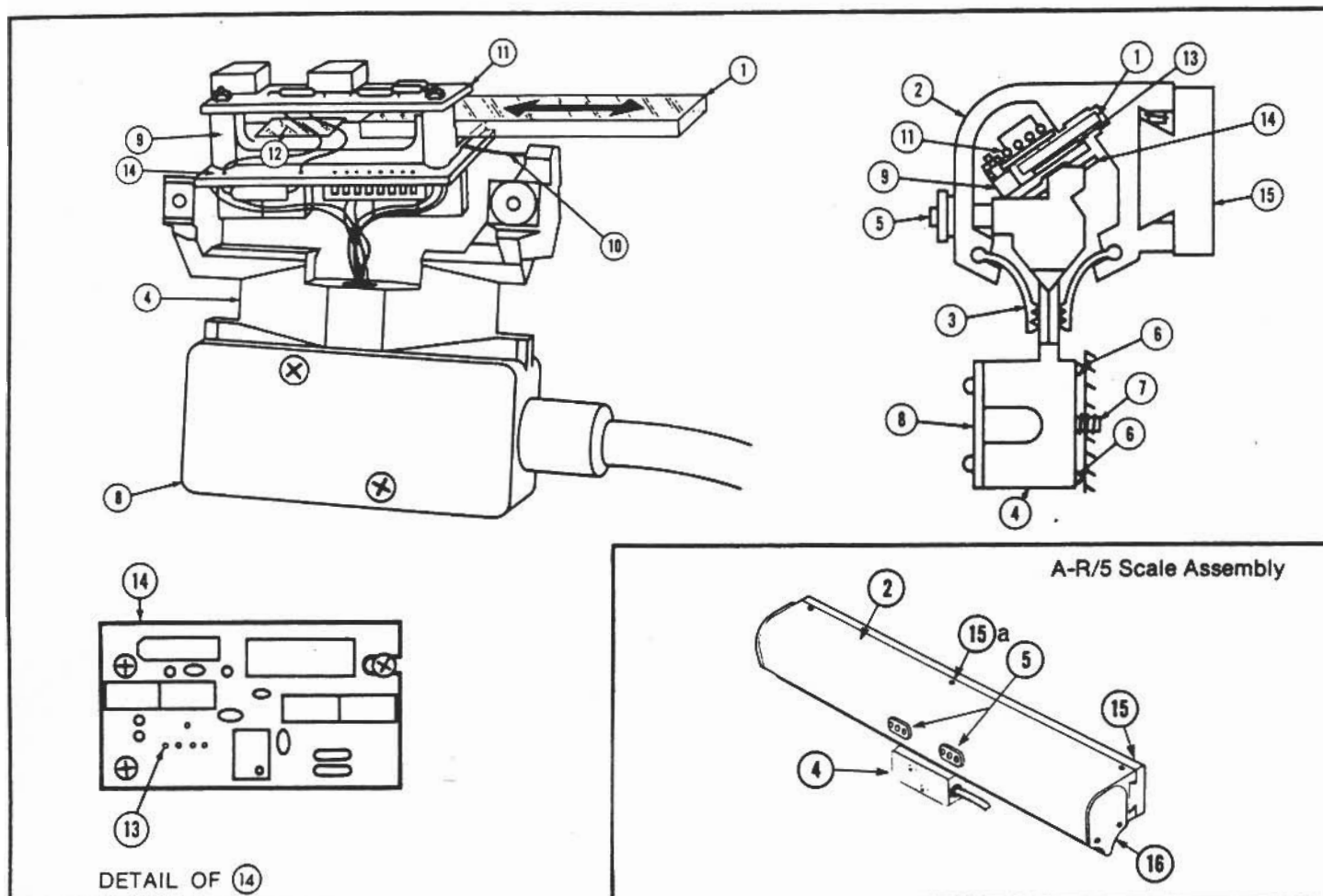
For A-R/5 scales with screwed-on end caps, remove the two mounting screws. No cement is required for re-assembly.

- a. Unpack and assemble the new reading head according to enclosed instructions.

#### NOTE

Before installing new head, clean glass scale with isopropyl alcohol and a lint-free cloth or swab.

- b. Slide the reading head into the scale housing (2) making sure the circuit boards (11, 14) and carriage (9) are properly placed and aligned on the glass scale (1).
- c. Install the temporary alignment bracket (5) on the scale housing (2) and reading head casting (4).
- d. Align the reading head casting (4) with the original mounting surface and secure with associated hardware.
- e. Reroute the reading head cable to the console and plug the connector to the appropriate axis on the back of the console.
- f. Run the repeatability test as detailed earlier.



1. Glass scale — 1/4" with vacuum deposited chrome Ronchi rulings.
2. Scale case or housing — 3/16" thick anodized aluminum.
3. Elastomer lip seals — provide protection from shop environment, coolant sprays, etc.
4. Reading head casting.
5. Temporary alignment brackets — hold reading head in correct position for mounting — to be removed after mounting is completed.
6. Jack screws (4 pcs.) — allow for quick and easy mounting of reading head to different surfaces.
7. Reading head mounting bolts (2 pcs.)
8. Reading head cover plate.
9. Carriage body — low friction, high wear-resistant material slides directly on ground and polished edge of glass scale.
10. Cantilever spring with ball and socket joint — holds carriage body against scale and allows for slight misalignments between scale and reading head.
11. LED board.
12. Index grating — with Ronchi rulings similar to scale, produces moire fringes as the carriage traverses the scale.
13. Photocells (4 pcs.) — convert light and dark patterns of moire fringes into two-channel sine/cosine output.
14. Printed circuit board with integrated circuit — converts sine/cosine waves from photocells into a quadrature square wave (7400 TTL compatible) for console.
15. Male dovetail spar — bolted to machine at approximately 8" intervals. Scale is slid over it and set screws (15a) are tightened.
16. End caps (2 pcs.) — cemented or bolted to each end of the scale housing; allows reading head to be removed or serviced.

Figure 15. A-R/5 Scale Assembly Parts Identification

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