

# INSTRUCTION MANUAL

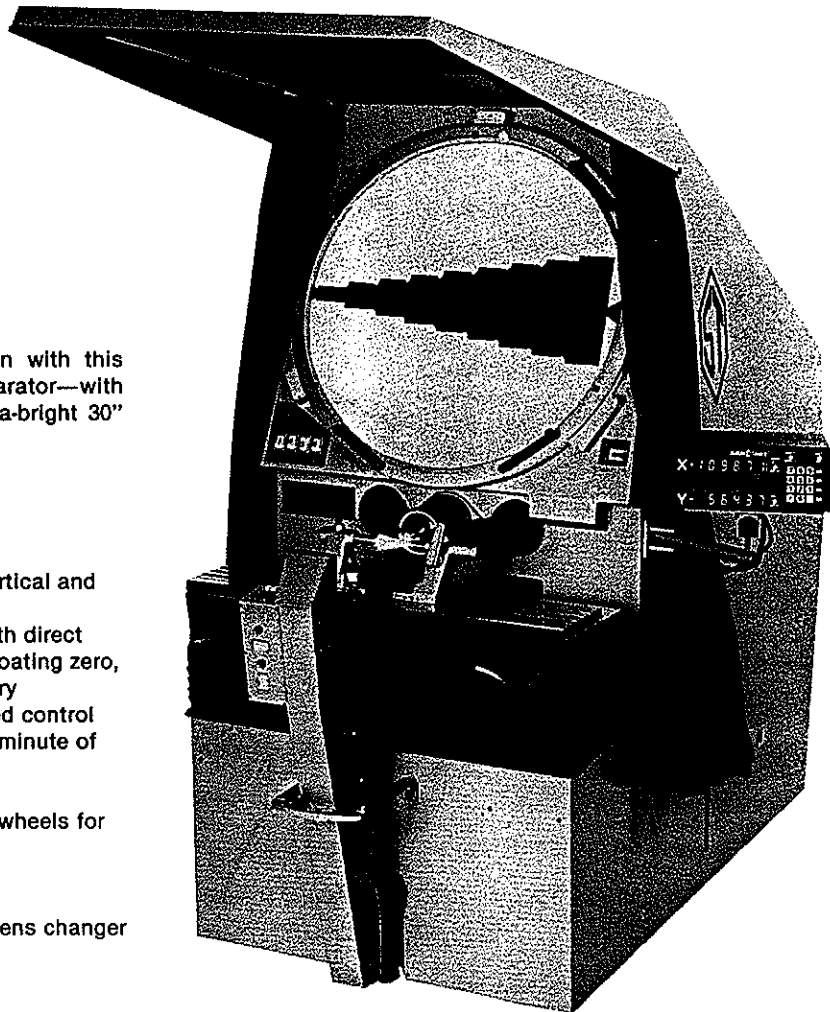
## 22-2500 SERIES 30" OPTICAL COMPARATOR

Quality control adds a new dimension with this universal Rank Precision 30" Comparator—with sharp 5x to 100x magnification on ultra-bright 30" projection screen.

### 22-2500-00 Standard Features

- 8" x 35" table with 500 lb. capacity
- 9" x 12" stage travel
- Power drive with speed controls on vertical and horizontal travel
- Electronic digital readout to .0001" with direct conversion to .002mm, with presets, floating zero, datum step memory and keyboard entry
- Power driven protractor ring with speed control and direct optical/digital readout to 1 minute of arc over 360°
- Curtain canopy
- Mounted on three 7" diameter rubber wheels for portability
- Floor leveling screws

NOTE: Available with 6 position power lens changer



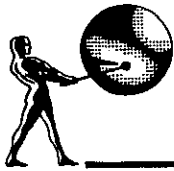
Made in U.S.A.



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**22-2500 SERIES  
RANK PRECISION**

**30" OPTICAL COMPARATOR**

**INSTRUCTION MANUAL**

**INTRODUCTION**

This manual contains the instructions for the installation, operation and maintenance of the Rank Precision 22-2500 series horizontal beam bench comparator.

Due to the Rank Precision policy of continued improvement of products, the right to change without notice is reserved. The information contained in this manual may vary somewhat from the machine with which it is to be used.

Numerous safety features have been designed and built into this machine. These safety devices should never be altered or removed without first consulting Rank Precision.

To fully utilize the capabilities of this machine, a comprehensive study of this manual is essential.

The 22-2500 series comparator has been designed to provide many years of reliable service. Factory-trained service and sales representatives are available for installation, operator training and any service problems that may arise.

A wide range of optional, standard staging fixtures are available as described in this manual. Special staging fixtures are available upon request.

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**ELECTRICAL**

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# 22-2500-00 Series Nomenclature

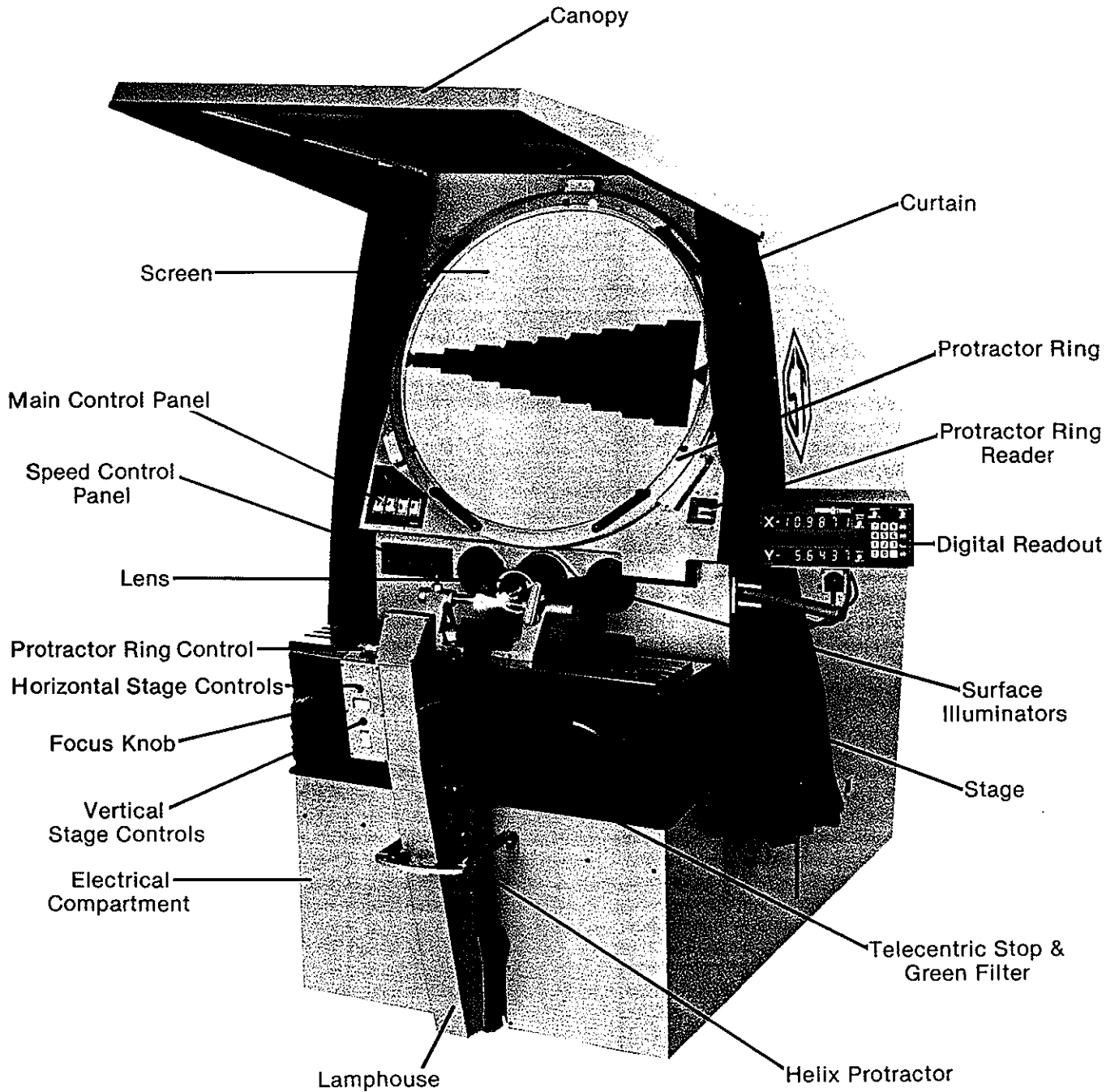


Figure 1

# SPECIFICATIONS

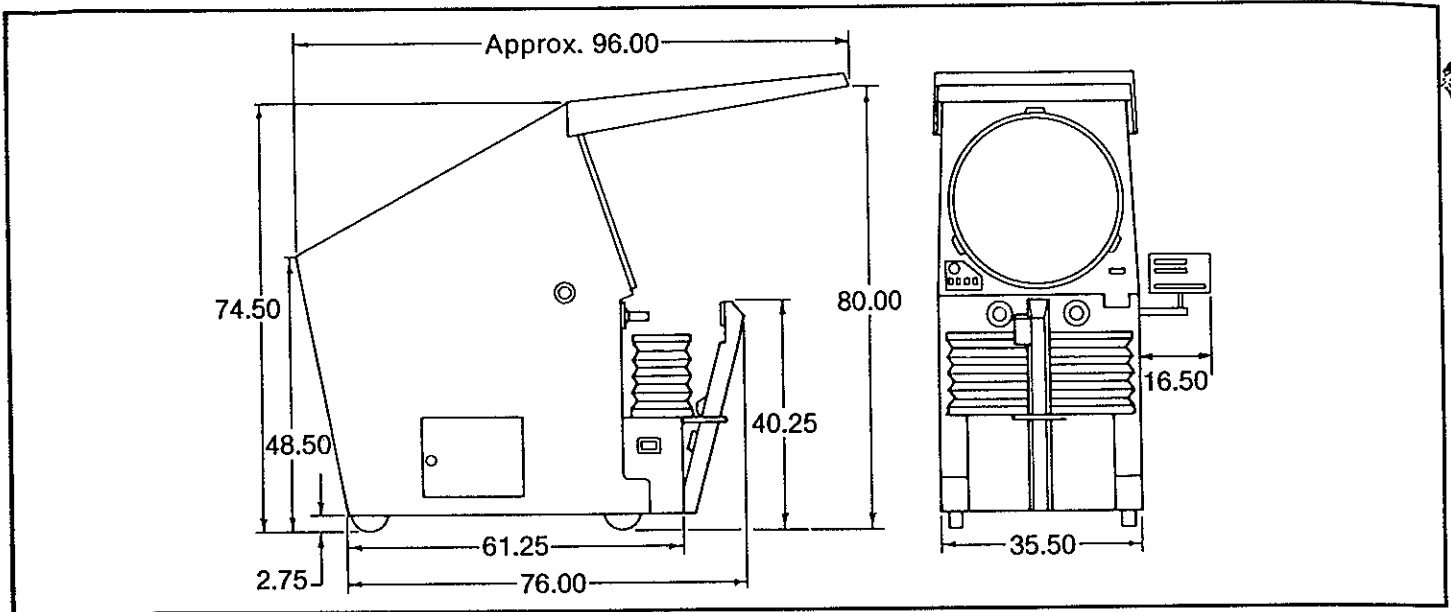


Figure 2 Outline Dimension Drawings of Comparator

## Machine Dimensions

Screen Diameter	30.00"	(762 mm)
Comparator Length	96.00"	(2439 mm)
Comparator Width	52.00"	(1321 mm)
Comparator Height	80.00"	(2032 mm)
Footprint Length	61.00"	(1550 mm)
Footprint Width	36.00"	(914 mm)
Height from Floor to Screen Center	57.00"	(1448 mm)

## Work Table

Length	35.00"	(889 mm)
Width	8.00"	(203 mm)
Standard Clamping Slots	3	
Allowable Workload on Stage	500 lbs.	(227 Kg.)

## Measuring Capacity

Vertical	9.00"	(229 mm)
Horizontal	12.00"	(305 mm)
Focus	3.00"	(76 mm)
Helix (5 min. vernier)	± 10°	
Angular (1 min. vernier)	360°	

## Magnification Lenses

5x, 10x, 20x, 25x, 31¼x, 50x, 62½x, 100x

	MAGNIFICATION					
	5X	10X	20X	25X	50X	100X
Field (circular)	6"	3"	1.5"	1.2"	6"	3"
Max. Work Diameter Using Half Field A	10.1"	14.25"	15.2"	11.00"	8.4"	4.45"
Max. Work Diameter Using Full Field B	9.9"	10.1"	10.3"	7.85"	6.7"	3.65"
Object Distance	4.75"	4.75"	3.98"	3.15"	2.5"	1.37"

Figure 3-A Lens Specifications

## Electrical

Voltage	115 volts, 50 or 60 cycle
Phase	Single
Current	8 amperes
Profile Bulb	200 watts, 24 volts
Surface Illuminator Bulbs	150 watts, 22 volts
Motor	115 volt DC
Fuse (Motor Circuit)	5 Amperes

## Weight

Comparator	1800 lbs.	(817 Kg.)
Crated Comparator	2000 lbs.	(907 Kg.)

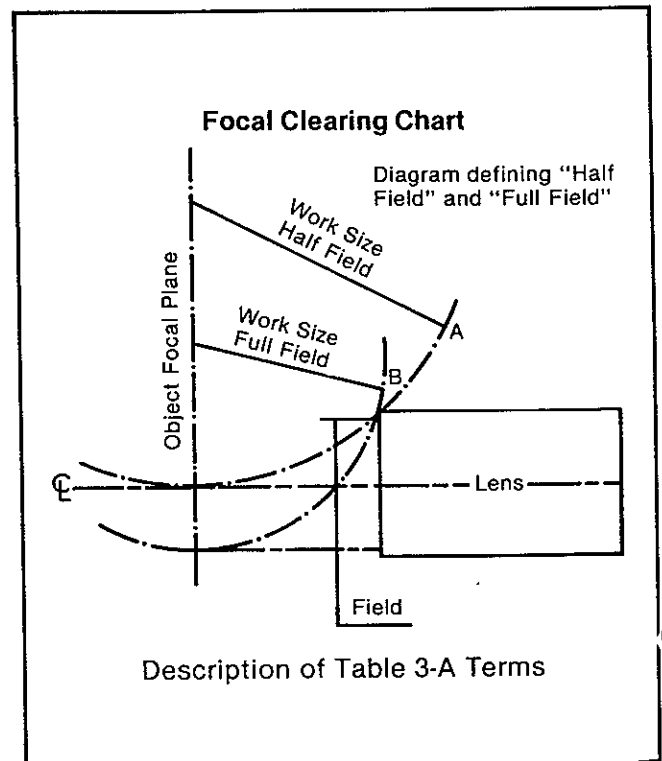


Figure 13-B

## INSTALLATION

### Introduction

The 22-2500 Series Instruction Manual should be kept at the comparator at all times for reference by operators. Exploded views of various machine components are shown, simplifying parts ordering and maintenance.

All inquiries regarding this machine should include model and serial numbers. This information can be obtained from the main control panel switch plate located on the front, right side of the machine.

Any damage, either to the shipping carton or crate or to the contents, should be documented immediately upon receipt of the machine. An inventory of the contents of the carton or crate should be checked against the packing list and any irregularities noted.

### Unpacking, Initial Setup and Alignment Procedure

The unpacking, initial setup and alignment of a new 22-2500 series comparator will be supervised by a representative of Rank Precision. This area will not be covered by detailed instructions.

After a period of extended usage, lens systems may require calibration, the profile lamphouse may require collimating or a screen may need to be replaced. The techniques of collimating, collimating and alignment are covered in detail in the following instructions.

### Screen and Chart Calibration

The following procedure is required to insure the exact centering of the screen or chart in the protractor ring. The use of a 10X or 20X lens is preferable in this procedure.

1. Set a pointed object (such as a scribe or edge-finder) on the stage in a holding fixture with the point up.
2. Set the stage helix to zero.
3. Set the protractor ring to 0° and lock in place.
4. Loosen the screen retaining clips.
5. Rotate the screen until the trademark is at the bottom and the horizontal line is nearly horizontal as judged by the eye.
6. Turn on the profile illumination.
7. Focus the point on the screen.
8. Move the point until it touches the horizontal line at one place.
9. Move the point back and forth with the horizontal stage motion and rotate the screen until the point just touches the line all the way across the screen.
10. Lightly tighten the screen clips.
11. Remove the pointer from its holder.
12. Place a square cornered object (such as a 6" rule or machinists' square) in a holding fixture on the stage.
13. Adjust the stage and square until its horizontal edge aligns to the screen horizontal line, and the vertical edge aligns to the screen vertical line.
14. Unlock the protractor ring.
15. Rotate the protractor ring 180°.
16. If the screen vertical line does not align to the square's vertical, use the pusher screws in the protractor ring edge at the 40° and 130° positions to move the line half of the alignment error. (These screws are accessible from the sides when the 40° and 130° marks are opposite the front casting notches at the horizontal position.)
17. If the screen horizontal line does not align to the square's horizontal, use the pusher screws in the protractor ring edge at the 220°-310° positions to move the line half of the alignment error. (These screws are accessible from the

- sides when the 220°-310° marks are opposite the front casting notches at the horizontal position.)
18. Reset the square to fit the quadrant with the protractor at 180°.
19. Turn the protractor ring back to the 0° position.
20. Note the vertical and horizontal error and use the pusher screws to align half the error in this quadrant.
21. Repeat steps (13) through (20) until the square fits both quadrants; then tighten the screen clips.

#### CAUTION:

Be careful NOT to overtighten the screen pusher screws or the screen may be damaged.

### Lens and Mirror Calibration

Lens and mirror adjustments should be attempted only by qualified, competent service personnel. The following procedure is primarily for reference.

### Use of the Magnification Checker

After the projector has been set up and the mechanical movements operate satisfactorily, the screen image magnification should be checked. In set-up of new projectors this is done to check that the mirror in the projection system has not been shifted due to shipping shock. This check should also be made if the projector has been moved to another location in the same plant. After the projector has been in use awhile, this check should be made periodically to make sure that the projection lens magnification has not been changed by dropping the lens or the lens being bumped by the stage or work object. If a new lens is purchased for the projector at a later time, then it is well to check its magnification to make sure it matches the projector perfectly.

If the projector has an adjustable telecentric stop, it is set according to the manufacturer's manual for the lens magnification to be checked. The block with the master balls is then placed on the stage and a ball size selected which will give an image diameter on the screen of approximately 70 percent of the screen diameter. This would be approximately a 9" to 10" image for the 14" screen projectors and a 19" to 20" image for the 30" screen projectors. For a few odd magnifications and screen sizes, a jo-block must be used for an object. For instance the 5X on the 30" projector requires a 4" jo-block. Other sizes are marked on the glass checking scales. If a jo-block is used it must be squared to the optical axis of the light beam or a false image size will result. The ball selected is first focused sharply in the center of the screen. On projectors with an adjustable telecentric stop, the ball may first be focused with the stop wide open and then the stop closed to the normal position. Measure the ball top to bottom and side to side. The glass scale arc-line traceable calibration is measured from the center of arc-line to center of arc-line. Therefore the scale should be used by first placing the center of one arc-line on the O.D. of the image. This first arc-line would show .002" high cogging effect due to the broken arc-line. The other side of the image should then fall within the .004" line width of the other arc-line. The image would then supposedly be within  $\pm .002$ " for screen magnification. Sometimes a low power hand magnifying glass can be used to help see the lines.

On the 22-2500 projectors the mirror mount is adjusted by three external slotted end screws at the back of the projector. The screws are covered with short jam set screws which have to be removed first. One screw is at the center of the mirror.

Another screw is at one side of the mirror, and the third screw is at the bottom of the mirror. One should make sure the projection lenses are properly seated etc., before tipping the mirrors around, because if the basic projector size as set by the master lenses at the factory is lost, then any lenses ordered later by the customer will be off in magnification.

After the projector screen image has been brought to size for the 70 percent screen diameter image and the side to side and top and bottom image size is okay, it is well to check the image size at the edge of the screen at 45 degree chordal orientations also; i.e., as of along the sides of an octagon. Be sure the glass scale is always the same distance from the edge of the screen; otherwise if the lens has appreciable distortion, different readings will result, depending on the distance of the scale from the edge of the screen. If a jo-block is used for an object and is turned from vertical to horizontal, etc., and refocused each time, the focusing must be done very carefully; otherwise apparent image size changes will be introduced, depending on the change in distance of the jo-block from the projection lens. This is also true if the ball checker is slid by hand. Also, if one side of the jo-block is closer to the projection lens than the other side, then an apparent keystoneing of the image could be introduced. It is best to check the mirror setting using the ball checker and stage motions, and use a jo-block only to check lens magnification on those lenses where a ball size is not available on the ball checker.

After the 70 percent screen diameter image size checks are completed the distortion of the image may be checked. In general the maximum measurable distortion error will occur between the 50 percent image size and the 100 percent image size in a radial direction. Therefore choose a ball size which will give an image of approximately 25 percent of the screen diameter. This would be 7½" on the 22-2500. The 5" and 10" diameters on the glass scale could be used. Otherwise jo-blocks and a precision thin machinist scale with hand magnifying glass can be used. Then place the glass scale centerline in a radial direction along the centerline of the screen as if on a spoke of a wheel. First measure the ball image from say ¼" in from the edge of the screen toward the center of the screen. Do this for the left and right side and top and bottom of the screen. Then place the ball image so as to touch the center of the screen and measure radially outward. Do this for the left and right and top and bottom directions. Also place the 25 percent ball image on the center of the screen and measure it. It can also be placed half way from the center to the edge of the screen and measured in a radial direction.

The distortion error should be less than 0.1 percent under profile conditions; i.e., .010 on the 10" small ball image (30" screen). Under surface illumination conditions the distortion error may rise to 0.15 percent.

### Profile Lamphouse Collimation and Alignment

Usually if lamphouse parts are replaced or the lamphouse is removed from the projector for repair, special alignment and collimation mirror fixtures are required. These are a parallel mirror and spacer ring for the 22-1500 and P-1600 projectors and a right angle mirror fixture for the 22-2500 and the 22-1400 projectors, i.e., one for vertical beam projectors and one for horizontal beam projectors.

On the 22-2500 projector, the basic collimation of the lamphouse main condenser lens and of the condenser relay lenses cannot be changed. However, if the bulb socket or either of the upper or lower mirrors are replaced, the general lamphouse alignment should be checked. Also, if the lamphouse has come loose or been damaged in shipping, its alignment should be checked. If the bulb socket or lower mirror is replaced, then remove the upper mirror and lay a piece of writing paper on the

Iris diaphragm. Have the Iris diaphragm lever on full open and check if the light beam is fairly well centered on the hole. If necessary, rotate the bulb socket until the light is centered. Be sure to try about 3 bulbs so that a best average is attained. Then remove the paper and put back the upper mirror. If the upper mirror has been replaced with a new one or the lamphouse lower pivots have been loosened or changed for some reason, then the general alignment of the lamphouse to the stage and projection lens should be checked. This is done by first mounting the right angle mirror fixture on the stage and against the locating edge of a stage slot. Bring the stage up so that the full lamphouse light beam hits the mirror and is reflected back to the Iris diaphragm. Remove the upper rearward cover button head screws except for the bottom two flat head screws and wedge the cover open a little so that one can see the Iris diaphragm and the return image. Set the iris diaphragm opening at about 1/8" diameter and the return image will be a little bigger. The entire lamphouse would then be tipped from front to rear and swung from side to side (helixed) until the return image of the hole is centered on the hole. The mirror fixture may then be slid out of the way and the centering of the light beam on the projection lens hole checked. This should be done with the telecentric stop set on "Normal." If necessary the lamphouse would be raised or lowered or tipped from side to side until the light beam is fairly well centered on the projection lens hole. Then recheck with the mirror fixture to see that the beam is still square vertically and horizontally to the stage. The lamphouse should then be at the original factory alignment and with the helix plate at zero. Details of the lower lamphouse mounting parts are illustrated in the operation and parts manual. The lower uniball bushing is pressed onto its shaft and vertical lamphouse movement can only be attained by loosening its O.D. clamp. The upper uniball bushing is also pressed on its shaft and the vertical movement is attained by moving the upper shaft up and down with the end bolt and jam nut.

## OPERATION

### Electrical Controls

The comparator control panels are conveniently located in three areas.

1. The main control panel on the left front of the machine;
2. The slow-speed motor controls directly below the main controls;
3. The motor drive switches on the left side of the profile lamphouse.

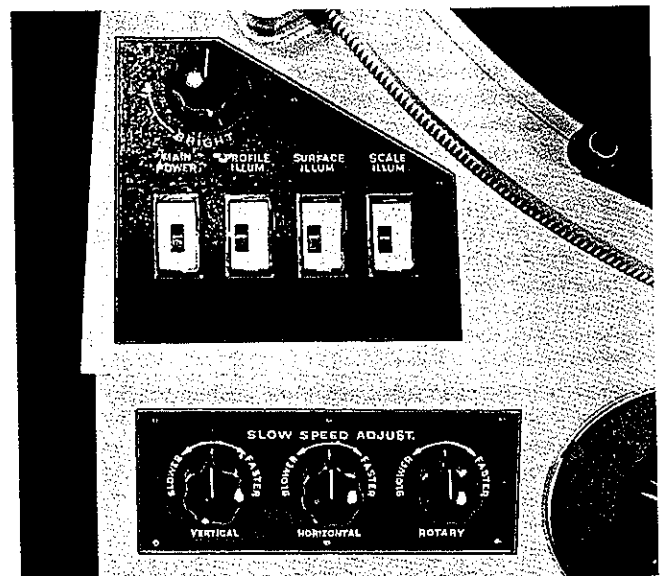


Figure 4

## Main Power Panel Controls

The main power panel consists of five controls, four switches and one control knob (see Figure 4). Reading from left to right the switches are:

1. **MAIN POWER**—power control for all circuits
2. **PROFILE ILLUMINATION**—controls power to the profile illumination lamp
3. **SURFACE ILLUMINATION**—controls power to the surface illumination lamps
4. **SCALE ILLUMINATION**—controls power to the digital reader. The control knob located above the switches controls the brightness of the profile illumination.

## Main Power Switch

The main power switch on the main power panel is the ON-OFF control for the comparator. This switch must be ON before other controls on the comparator can function. Depressing the top edge of this switch will apply power to all circuits. The switch is equipped with a status light to indicate that power is available and being distributed.

## Profile Illumination Switch and Brightness Control

The switch on the main power panel labeled "Profile Illumination" energizes the profile lamp in the lamphouse when the top edge of the switch is depressed. The brightness of the profile lamp is controlled by turning the brightness knob, located above the switches. The profile lamp should be turned up only as bright as necessary to illuminate the part being measured. Using only the required brightness will prolong the lamp life.

The curtain is designed to reduce the illumination required. It can be closed over the screen by pulling the two halves together. The curtain will cut down on backlighting and allow operation at reduced lamp brightness.

## Surface Illumination Switch

The switch on the main power panel labeled "Surface Illuminator" energizes the surface illuminator lamps (on machines so equipped) when the top edge of the switch is depressed. The brightness of the surface illuminators can be set at either of two levels by a slide switch located on the end of the electrical tray. (The electrical tray is in the electrical compartment accessed through the door on the lower left side of the comparator.) Placing the slide switch in the up position sets the illuminators on low and placed in a down position the illuminators are set on bright. The primary reason for two levels of illumination is to extend the lamp life. The low light level is sufficient for most applications when the 10X and 20X lenses are being used. But, the bright level is required for 31.25X and higher magnification lenses.

## Scale Illumination Switch

The switch on the main power panel labeled "Scale Illuminator" energizes the protractor ring reader lamp when the top edge of the switch is depressed. When the reader is not in use, the scale illuminator switch should always be in the OFF position. This will substantially lengthen the life of the optical reader lamp.

The scale illuminator switch will also apply power to the electronic digital readers on machines so equipped.

## Motor Controls

The motor controls operate three motors that drive the stage and protractor ring. The three motors are:

1. Protractor (or rotary) ring motor
2. Horizontal stage motor
3. Vertical stage motor

The motor controls for each motor consists of a speed adjust, a rapid travel switch and a slow travel switch.

1. The speed adjusts are all located on a panel marked "Slow Speed Adjust" directly below the main power panel (Figure 4). The adjusts show on this panel as three control knobs labeled "Vertical", "Horizontal", and "Rotary".
2. The protractor rapid and slow travel switches are located on top of the lamphouse. (The toggle lever switch is the slow travel control). (Figure 5.)

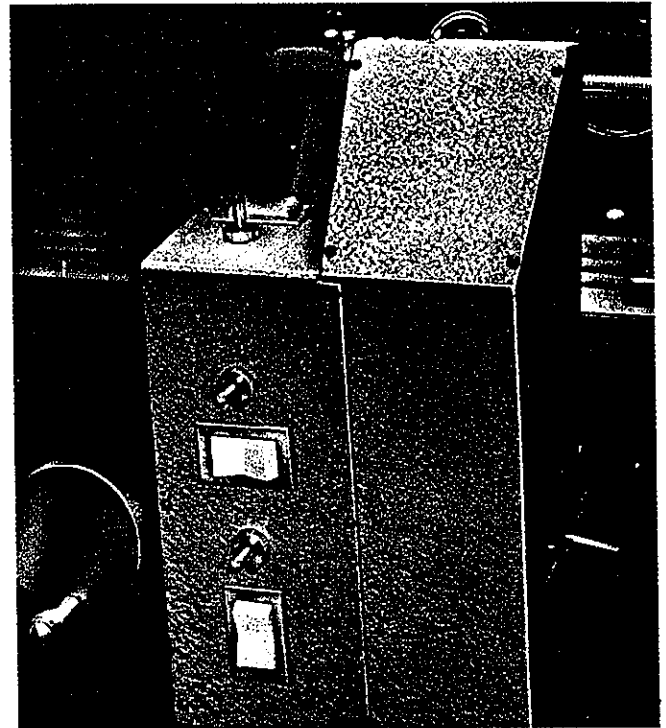


Figure 5

3. The horizontal rapid and slow travel switches are paired together on the front (operator), top side of the lamphouse. (The toggle lever switch is the slow travel control.) (Figure 5.)
4. The pair of switches below the two horizontal switches controls the vertical travel of the stage. (The toggle lever switch is the slow travel control.) (Figure 5.)

The stage or protractor ring are advanced by depressing one end of the flat rapid travel switch (depress the opposite end for the opposite direction of travel) until the stage or ring is near the required placement. Then release the rapid travel switch. The remainder of the distance can be covered by using the lever toggle slow travel switch and the speed adjust control for that particular motion. The lever of the switch is pushed to the same side as the rapid travel switch was depressed. The speed of the slow travel is governed by rotating the associated speed adjust, counterclockwise for slow, clockwise for fast. As the required position is approached, it may be desirable to move extremely slow.

The extreme slow motion is obtained by jogging. This is accomplished by quickly pushing the slow switch to the side and quickly releasing, causing the stage or ring to move in small increments.

## Lens Identification and Mounting

The standard lens systems available for the 22-2500 Series Comparator are listed in the Specifications section under "Lens Specifications."

The magnification of a lens system is engraved on the outer surface of the lens assembly. A system that is engraved "10X" would indicate that the image projected on the screen would be enlarged 10 times.

Mounting a lens system is achieved by loosening the two lens holding screws located in the lens mounting boss, inserting the lens and rotating 90° and securing the two lens holding screws.

Mounting the 5X lens system requires two additional steps.

1. The surface illuminator tubes must be extended and separated sufficiently to allow insertion of the 5X lens system.
2. The condenser lens assembly, which is a part of the 5X lens system, must be mounted on the profile lamphouse. This is accomplished by mounting the condenser onto the profile lamphouse and securing two thumb screws. Illumination of the entire screen cannot be achieved without the condenser assembly.

A 5X lens system can only be mounted on comparators which are equipped with a 5X lamphouse extension.

### CAUTION:

Care must be exercised to insure that parts mounted on the stage DO NOT strike the lens.

## Profile Illumination

The profile illumination is used to project a shadow of the outline of a part. The profile illumination is a collimated light source emanating from the profile lamphouse. This light is controlled electrically for brightness as explained in the section titled "Profile Illumination Switch and Brightness Control". In addition the light is manipulated mechanically by a telecentric stop.

## Profile Illumination Filter

The profile illumination filter is controlled by a knob located above the telecentric stop control on the lamphouse placard. The filter control is marked "Filter" and the extremes of travel are marked "IN" and "OUT". Rotating the knob to the "IN" position will cause the profile illumination to be changed to a green light. The screen will be illuminated by white light when the filter knob is set to the "OUT" position.

## Telecentric Stop

The telecentric stop is mounted in the profile lamphouse to further control the performance of the 22-2500 series comparator. The telecentric stop control lever extends through the right side of the profile lamphouse. An escutcheon plate indicates the mode: open, normal or closed. When a sharply defined edge on a part is to be projected on the screen, the telecentric stop lever should be in the "normal" position for 5X through 20X lens systems and in the "open" position for 31¼X through 250X lens systems.

Cylindrically shaped parts and parts with uneven or chamfered edges to be projected on the screen can be focused more sharply by using the following procedure.

1. Open the telecentric stop lever to the "open" position.
2. Adjust the part for the best focus of the image on the screen.
3. Slowly move the telecentric stop lever toward the "closed" position until the image projected on the screen achieves the best definition.

## Surface Illumination

As the name implies, surface illumination is required when an opaque surface is to be examined.

Surface illumination is accomplished by using the twin telescoping illuminator tubes mounted in either side of the lens mounting boss. The area lighted by the illuminators can be varied by moving the tubes in and out or swinging them from side to side. Generally, the best illumination will be achieved with the tubes fully retracted when using the 10X lens system and fully extended when using the 100X lens system. The amount of retraction or extension for the other lens systems will fall between these extremes.

## Stage Helix or Protractor Measurements

Helix or angular face measurements can be accomplished by the use of the lamphouse protractor. The helix or protractor is located on the front of the profile lamphouse.

Helix measurements can be taken using the following procedure:

1. Secure the part in the center of the stage. (The stage center lies in the middle of the center dovetail slot.)
2. Loosen the protractor by turning the screw handle counterclockwise.
3. Rotate the lamphouse until the protractor and its vernier indicate the required angle, OR until the focused screen image shows as required and then read the protractor.

## Measuring Screw Threads

One of the most frequent uses of the helix is to measure screw threads. It is because of its common occurrence this special section is included. To project a screw thread the following procedure is used.

Use the middle table slot for the centers and place the screw between the centers. The spring loaded center may be shoved somewhat "into" the work to create an initial spring compression. The spring compression may be increased for heavy work by screwing down the knurled knob at the end of the spring.

Then adjust the table height until the profile of the threads is about at the center of the screen. Focus the thread on the screen. Throw the thread image out of focus by moving the table slightly toward the projection lens by means of the focus hand wheel. A bright "out-of-focus" image will appear on the screen, but this will not be symmetrical with the right and left flanks of the thread. Release the stage helix and swing the stage until the "out-of-focus" image is an equal distance in from the right and left flanks of the thread. A thread near the center of the screen should be used. Now refocus the image and the correct normal-to-helix image is obtained.



## Protractor Ring Settings for Angular Measurements

The comparator can be used to measure the angles of screen images with a rotary screen protractor ring. This ring surrounds the screen and is digitally read.

The image angles, or rotary measurements, are made by using the projected image in relation to a screen reference line. The angular measurement is made by either a differential or an absolute method.

The differential measurement is made using two edges of the images. The procedure is as follows:

1. Secure the part to the stage.
2. Focus the image.
3. Position the image as required.
4. Align the screen reference line to the first edge on the image by rotating the ring and position of the stage. Read the angle of the ring.
5. Move the screen reference line to the second edge using the necessary stage and ring motions. Read this second ring angle.
6. The difference between these two angles is the angle between the surfaces.

The absolute method assumes that a standard angle chart such as a 30°-60°-90° has been installed and aligned (see "Chart Setting" in the Setup section of this manual). In this case the angle is being matched with one of the known chart angles.

1. Secure the part to the stage.
2. Focus the image.
3. Set the part with respect to the chart angle lines by adjusting the part in its fixture.

(NOTE: Prealigned stage fixtures will allow deletion of Step 3.)

4. Rotate the rotary ring to the edge to be measured.
5. Read the angle.
6. The difference between the angle read and the chart angle is the error.

(NOTE: If the 0° [horizontal] line is used the angle can be read directly.)

## Measuring Techniques

The optical comparator is capable of making measurements by two methods: by direct optical comparison and by measured optical comparison.

For greater accuracy when using either direct or measured optical comparison the part being examined should be secured to the stage top. A wide range of standard fixtures is available for use on the 22-2500 series comparator. For the special job, specialty fixtures can be supplied by Rank Precision, upon request.

## Direct Optical Comparison

Irregular contours, especially those including angles, radii, tapers, etc., and high quantity measurements are best checked by comparison against a master chart. There are four different ways of preparing such charts:

1. The most common practice is to make an enlarged drawing, whose scale should always correspond to the power (magnification) of the lens used. For instance, for the 20X lens, the drawing should be scaled 20:1. The use of a drawing is the only possible method if only blueprints of the part to be made, but no master part itself, is available. Such drawings should be made with the greatest care and accuracy.

2. Should a master part be available, it is both possible and practical to make a chart by tracing the outline of the image on the screen with a finely pointed hard pencil. This tracing method will again depend on the practice and skill of the draftsman, but under favorable conditions an accuracy of .01" can be approached. This method has the advantage that any errors in the optics or their rated magnifications are cancelled out.
3. Still better results from a master part are obtainable by photographing the image on a photographic plate and using the developed plate as a master chart. This method will eliminate errors inherent to the tracing method.
4. When sufficient quantities of the same part are to be checked Rank Precision can supply from your print or sample part, special comparator charts. These are constructed from over-size master layouts which result in a chart of your part which is, for all practical purposes, without error.

Except for method 2 the contribution from the optical accuracy will not be accounted for. However, the optical system is of highest quality and the inaccuracy caused by the optics will be but a fraction of one percent of the dimension checked.

Overlay drawings or charts may be held in place by the four spring paper clips provided around the periphery of the protractor ring. A number of standard charts are available from Rank Precision. A catalog of these charts is available from your Rank Precision representative.

## Measured Optical Comparison

Bench Comparators equipped with measuring stages can be used to make dimensional checks. The standard measuring stage has the facility to make three measurements, vertical, horizontal and helix angle. The capacities of the three motions is 0 to 9 inches vertical, 0 to 12 inches horizontal and  $\pm 10$  degrees helix angle. Vertical and horizontal measurements are read via a digital readout system as described in the following paragraphs.

## Digital Readout System, 22-2500 Series Comparator

The 22-2500 series digital readout system is a highly accurate, two axis system with 0.0001" (0.002mm) resolution and standard travels of 9" (229mm) vertical and 12" (305mm) horizontal.

The system consists of a transducer for each axis and a readout with digital display for each axis.

Each transducer assembly contains a precision glass scale, a lifetime solid state light source and solid state solar cell sensors. These are contained in a rugged sealed housing which is tolerant of machine variations and machine wear. A dual barrier foam seal effectively protects against dust, liquid splatter and oil mist.

The digital readout display is mounted on a display arm on the right side of the machine. The display housing is totally enclosed, making it impervious to the oil and dirt environment of a machine shop. The unit features the latest solid state devices for the utmost of reliability. Each axis has four control switches, zero set (for a full-floating zero point), preset, step/datum memory and zero reset with keyboard entry.

## Operating Instructions, Digital Readout System

To take full advantage of all the features of the digital readout system, it is essential that you have a good understanding of how it works, what it does, and its limitations.

To activate unit, turn on power switch on back of unit. Only  $\pm$  sign and decimal point will light. Depress the X axis zero button and the entire display will light. The X axis zero button must be depressed each time power interruption has occurred in order to light the display. This operational characteristic is also a signal to the operator that a momentary power interruption has occurred so as to remind him of the need to recalibrate the table position under this circumstance.

Zero set buttons on the right of the display will set the displays to all zeros.

Preset switches are set by turning the individual knobs and observing the number in the window just above each knob. When the desired number is entered into the preset switches, press the corresponding preset switch, and the preset number will be entered into the display.

$\pm$  Sign is preset at the left switch position. This enables selecting the polarity of the preset number.

On most applications, the operation is very simple. Set the machine table position for the start of the machining operation. Next, press the zero button on the display for the axis being used. Then simply read the axis movement on the display.

### Understanding the Plus and Minus

The system is arranged to read a positive increasing number to correspond to a horizontal table movement. The same applies to the Y axis; a plus (+) increasing number corresponding to an increasing stage height. A minus (-) increasing number is the reverse direction starting from zero. If a difference in polarity is required, refer to the Maintenance section of this manual. If you move the table in a positive (+) increasing direction, and then reverse the direction of travel, you will first have a decreasing positive number until you have reached the starting point of zero. As you continue through zero, the sign will change to minus and become an increasing number in the minus direction. Note that the sign (+) always relates to where you are in relation to the starting position, not to the direction of travel.

It is not necessary to consider backlash. Moving the table in either direction results in a proper reading. Remember that the transducer measures actual table movement.

### Reading the Numbers

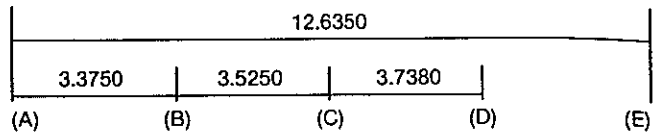
As you move the table and watch the display, notice that the last digit reads 0, 1, 2, 3, etc. in English or 0, 2, 4, 6, etc. in Metric. This digit reads  $\frac{1}{10}$ th of a thousand in the English system and  $\frac{1}{1000}$  of a millimeter in the metric system. This last digit, therefore, divides the one-thousandth increments in  $\frac{1}{10}$ ths in the English system and counts in  $\frac{1}{1000}$ th increments in the Metric system. For example, as you move the table, it will read:

English Systems	Metric Systems
00.0000	000.000
00.0001	000.002
00.0002	000.004
00.0003	000.006
00.0004	000.008
00.0005, etc.	000.010, etc.

### Using the Step/Datum Memory

If your drawings are dimensioned both incrementally (point to point) and to a datum or reference edge, the STEP/DATUM MEMORY option allows you to move to those measurements directly from the drawing without off-table calculation.

For example, if the print was dimensioned as follows and the reference or datum point was (A):



You pick up the location of the first point (A), and with the memory switch on "DATUM", zero the display. Then put the memory switch on "STEP", and again zero the display. Now, leaving the memory switch on "STEP", move to position (B). At position (B) you will again zero the display with the switch still in the "STEP" position. You will now move to position (C), repeat the procedure and move to position (D). At this point, the display will show 3.7380. You must now move to position (E) which is dimensioned from the datum point. By putting the memory switch in the "DATUM" position while still at position (D), the display will show 10.6380 (the sum of 3.3750 + 3.5250 + 3.7380). Leaving the memory switch in the "DATUM" position, you can now move directly to the dimension 12.6350 at which time you will be at position (E).

Remember, presetting a number or resetting zero with the memory switch in the "DATUM" position establishes a new datum point from which subsequent measurements shall be referenced.

### Using the Switchable Inch-Millimeter

The inch/millimeter system is accomplished by the display. The transducers used with the display are the same as the "Inch only" system.

The push button switch to select the millimeter mode on both axes is on the front panel, upper right. This switch will select between IN (Inch) and MM (Millimeter).

The principle of operation is to count the increments of table travel and to display it directly in inches or, when so selected, to calculate the equivalent increment and display it in millimeters.

Note that when metric measurements are desired, the selection switch must first be set to metric and then all measurements will then be in the metric mode.

The inch mode is direct reading, as the precision transducer scales are made to read increments of 0.0001 inches.

To provide the greatest accuracy possible, the internal counter will calculate all 8 digits to avoid accumulated error and the display will round the last displayed digit to the nearest whole number.

As we move an axis, the display will count up as follows:

Inch Reading	Millimeter Reading Accumulated Internally Only	Displayed Reading Rounded to the Nearest Whole Number
00.0001	000.002 54	000.003
00.0002	000.005 08	000.005
00.0003	000.007 62	000.008
00.0004	000.010 16	000.010
00.0005	000.012 70	000.013
00.0006	000.015 24	000.015
00.0007	000.017 78	000.018
00.0008	000.020 32	000.020
00.0009	000.022 86	000.023
00.0010	000.025 40	000.025

The rounding off feature reduces the maximum potential conversion error to 0.0005 mm (approximately 0.00002").

## Accuracy

The 22-2500 Series Digital Readout System is designed for  $\frac{1}{10}$  thousandth of an inch resolution (or 0.002 mm). The greatest accuracy will be obtained by setting the first position to where the last digit just changes; then move to your new dimension until the correct number just changes.

You may observe that a reading change occurs as the machine is jarred, vibrates, or the table is rocked. Remember, you are reading everything that happens to the table position and, therefore, it will allow you to consider all possible errors.

Since the transducer assemblies are mounted on the side of the stage, the reading will correspond closest to what happens to your work when the work is mounted as close as practical to the side where the transducer is.

## Optional Lens Change System

The 22-2500-01 30" optical comparator features a six position power lens changer. Up to six lenses (excluding 5X) may be installed, stored and selected using the following procedure:

1. Turn the main power switch to the "ON" position to activate the lens changer circuits.
2. Rotate the lens selector switch, located adjacent to the main control panel, to the 10X position. Insert the 10X lens into the turret and secure. Follow this procedure for installing each lens.
3. After completion of the initial lens installation, selection of the desired lens is accomplished by positioning the lens selector switch to the appropriate setting.
4. The stage will automatically lower, to gain maximum clearance, each time a lens is selected and positioned. This safety feature may not always be adequate, depending on the combination of large lenses, larger fixtures mounted on the stage and large piece parts. It is imperative that extreme care be exercised to ensure the light path is sufficiently clear to accept the selected lens. Positioning the stage to the right, left or away from the lens opening may provide the required clearance. As a safety precaution, the stage will not raise automatically after completion of the lens change cycle. This operation must be performed by the comparator operator.

### NOTE:

The size and weight of the 5X lens prohibits mounting in the lens changer turret. Manual mounting is required as described under the "Lens Identification and Mounting" section. The lens selector switch must be set on 5X whenever the 5X lens is installed. Do not change lens selector switch setting until the 5X lens has been removed.

## MAINTENANCE

### Lubrication

Stage "V" ways and balls should be lubricated occasionally with a few drops of light oil, as a corrosion preventative.

The top plate of the stage should be cleaned and a coating of light oil applied to prevent rusting and corrosion.

Environmental conditions will determine the frequency of corrosion preventative, lubrication applications.

The stage horizontal and vertical adjusting screws may occasionally require a few drops of light oil.

## Care and Cleaning of the Optical System

### Lens

Lens systems should always be stored when not in use. Dropping or a severe jolting of the lens may not crack the glass but may cause the lens to shift in its mount, resulting in a change of the image size. If a lens is suspected of being out of size, image a ball of known size on the screen and using a precision scale, check the exact size of the image. Precision glass or plastic scales are available from Rank Precision.

### CAUTION:

DO NOT disassemble optical lens system to adjust or clean interior glass surfaces. The assembly and calibration of these systems require special aligning equipment and procedures.

Notify your Rank Precision service representative if a lens problem becomes obvious.

Cleaning of the external surfaces of the lens system should be done in two steps.

1. To avoid abrasive action, remove all dust from the exposed glass surfaces with a soft brush or clean cotton. Brush or wipe gently.
2. After all dust is removed, use a pure grade of anhydrous alcohol and clean absorbent cotton to clean the lens surfaces. Rub gently.

### CAUTION:

Never immerse a lens system in any cleaning solution. Apply alcohol to cotton to moisten only.

Removing dust from the mirror, with a brush, is generally adequate. If additional cleaning is necessary, use clean cotton and alcohol. Wipe in straight lines across the mirror, turning the cotton each time. Mirror cleaning should be done as infrequently as practical due to the delicate nature of the mirror coating.

The projection screen can be cleaned with a nonabrasive, nondetergent soap and water, and soft cloth. DO NOT use paper towels.

## Lamp Replacement, Surface Illuminator and Profile

Should a lamp fail while the comparator is in operation, the cooling fans should be allowed to run for approximately five minutes.

1. Turn all switches to the "Off" position and disconnect main power line.
2. Remove access panel, located on the rear of the profile lamphouse, for access to the profile lamp. (Figure 6.) Remove surface illuminators for access to the surface illuminator lamps. (Figure 7).
3. Grasp the lamp with gloves or cloth, for protection in case of breakage, and remove.
4. Install new lamp in a similar manner, making sure it is clean and free of fingerprints.
5. Replace covers and reconnect main power line.
6. The illuminator bulb for the protractor ring digital readout is replaced by removing the screen and prying the spring fingered socket out of its mounting hole over the readout.

For Figures 6 and 7, see page 12.

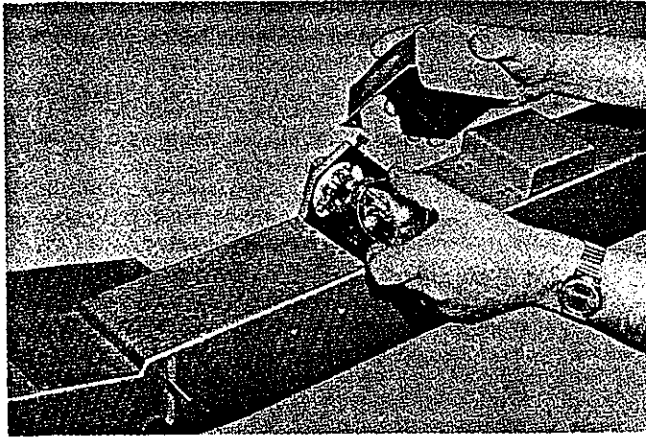


Figure 6

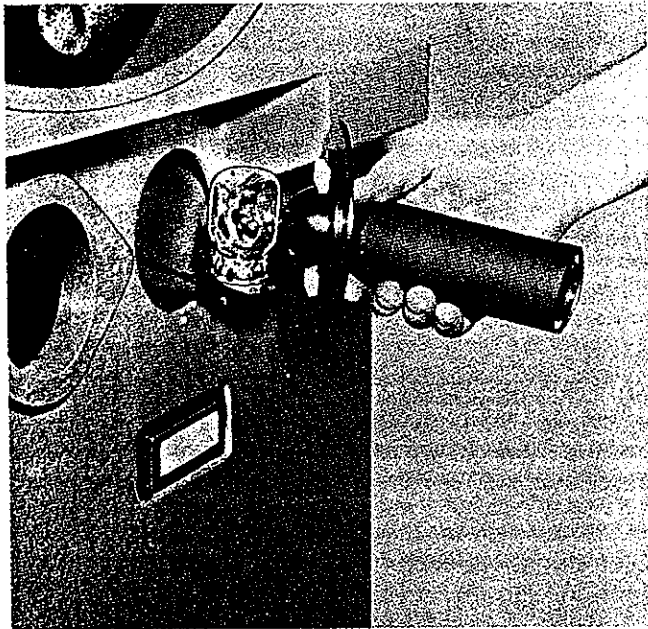


Figure 7

### Cleaning of Cooling Fans

Cooling fans and filters should be checked periodically for excessive dirt and grease accumulations. Routine maintenance will help to avoid premature failure of lamps and fan motors.

### Fuse Protection

A 10 amp. fuse protects all electrical circuits in the 22-2500 series comparators. The illuminated fuse post is located on the panel of the electronic pull out tray. Access to the fuse is gained by unscrewing the fuse cap and replacing the fuse and cap. The fuse cap is illuminated only when the fuse has failed.

**NOTE:**

Before replacing a fuse, correct the condition which caused the fuse to burn out.

### Digital Readout System, 22-2500 Series

#### General

The Digital Readout System has been designed to give long hours of trouble-free operation with a minimum amount of maintenance.

The system uses solid-state electronics throughout, including light-emitting diodes (LED's) solid state numerals.

Servicing of the Digital Readout System should be undertaken only by qualified service personnel. The service procedures outlined in the following paragraphs are for the benefit of qualified service personnel.

#### Transducers

The design of the transducer is very tolerant to wear and misalignment problems, with certain limitations.

The transducer assembly should be mounted flat and parallel to the surfaces of the stage within a tolerance of .005. If there is any indication of a bind, check that all mounting dimensions are correct and that the transducer is parallel to the direction of travel. Refer to Figure (8).

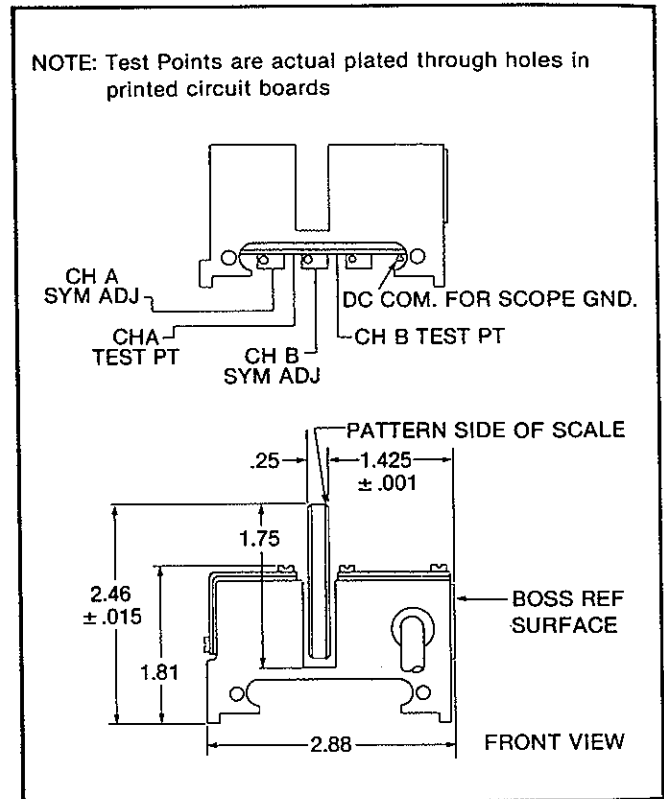


Figure 8 Transducer

The transducer is double-sealed against oil and dirt; however, it is advisable to avoid blasting air directly against the underseal.

#### Display

The display is equipped with a fuse in the back of the cabinet. If the fuse blows upon replacement, a service call is indicated. The displays and the power supply are separate modules. Each module can be replaced individually should service be required.

Cleaning the display window should be accomplished using a cloth moistened with soap and water. Since the window is plastic, avoid the use of solvents that will attack plastic materials.

The display is gasket sealed against oil and chips, but it is unwise to use a high-pressure air blast directly on the front panel. Wiping the panel with a cloth is more appropriate.

## Description and Alignment of Glass Scales, Digital Readout System

### General Description

The RST linear measuring system consists of highly accurate, rugged, dependable, and reliable digital components. The major components are a glass precision scale and an electro-optical sensing head. The basis of measurement is a precision glass scale. The scale patterns are generated from masters which are periodically tested on a laser interferometer controlled linear ruling machine with accuracy traceable to the National Bureau of Standards.

The patterns are vacuum deposited Metri Film which provides a high quality scale with exceptional durability.

The sensing head consists of a rugged cast aluminum housing enclosing the optics system and electronics.

The output of the head is a two channel square wave, TTL compatible, which is fed to the digital readout.

### Theory of Operation, Electrical

#### Sensing Head

The optical system, in conjunction with two pairs of differentially connected cells, produces two sine wave signals, one displaced 90 electrical degrees from the other. Each of these sine waves is adjusted to be symmetrical. The individual signals are amplified, converted to square waves, and fed out through line drivers. See Figure (9).

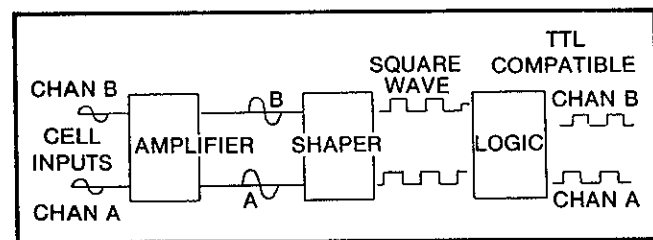


Figure 9 Encoder Schematic Diagram

#### Scale Mounting and Adjusting

The accuracy of the measuring system requires that the scale be accurately mounted to the machine. The scale must be aligned to the axis of travel to within  $\pm .001$ . The scale must be perpendicular to the head mounting surface with  $\pm .001$ . The scale pattern must also be set to the correct height from the head mounting surface to be sure that the optics is centered on the scale pattern. See Figure (8).

Note that the inner (ruled) surface of the scale be no less than  $1.425 \pm .015$  from the nearest surface. This is to allow for movement of the head in the adjusting process. See Figure (8).

If the scale is to be mounted to a spar or a machined surface, first check that this surface is parallel to the axis of travel to  $\pm .001$ . Wipe all surfaces clean. Unwrap the precision scale, inspect it for damage and clean with acetone or soap and water. Next mount the scale and clamp it in place. Adjust the scale pattern height to the dimensions shown in Figure (8) for the encoder head being installed. Now verify that the scale is parallel to the axis of travel to within  $\pm .001$  with an indicator. Also check perpendicularity to the head mounting surface.

If the scale is not sufficiently parallel to axis of travel, use thin plastic shims under the appropriate scale clamping area to straighten the scale to the axis of travel.

### Theory of Operation, Optical

The optical diagram of the Linear Encoder is shown in Figure (10).

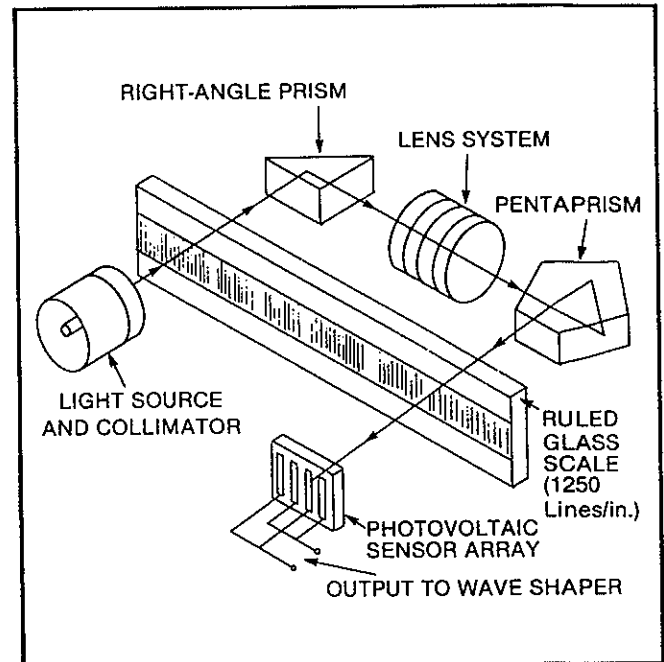


Figure 10 Encoder Optical Diagram

The light source illuminates the ruled glass at A and through proper adjustment of the prisms and lens, an image of the rulings at A is focused at B thereby optically superimposing one set of rulings over another.

When the ruled glass is moved to the left, the image of the rulings appearing at B moves to the right thereby providing optical doubling of the line count at B. (The effect is the same as using two sets of rulings on separate pieces of glass, one moving to the left and the other to the right. The rulings act as light gates allowing light to pass through when they are aligned.) Thus, as the ruled scale is moved, a light sensitive sensor cell positioned as shown in the diagram will provide a varying output as the light gate is opened and closed; this output approximates a sinusoid.

If the lens is adjusted so that the image of the line at A produced at point B is magnified very slightly, there will be a pattern of alternating light and dark areas. This is because the two rulings are aligned in some areas (the light portion) and not aligned in others (the dark portion).

By properly positioning two sets of sensing cells in these areas, two signal channels, a sine wave, and a cosine wave are produced. Two channels are needed to sense direction. If the sine wave leads the cosine wave, it is travelling in one direction. If the sine wave lags the cosine, it is going in the reverse direction.

### Electrical Alignment and Adjustment of Scales and Transducers

1. Before energizing head, be sure that the power supply is properly adjusted to  $5 \pm .25$  volts D.C.
2. Set up an oscilloscope to display a lissajous pattern with the scope voltage sensitivity set at 20 MV (AC) per centimeter and set dot at center screen. Attach probes to test points (See Figure 8); channel A test point to the vertical deflection plate and channel B test point to the horizontal plate.

3. Energize the readhead and move it slowly back and forth. If all mechanical settings are perfect, you will see a circle displayed on scope between 70 MV P/P and 110 MV P/P. Since it is very difficult to achieve perfect mechanical alignment you will probably see less than 70 MVP-P and the phasing will be something less than 90° (a circle). To achieve the minimum output of 70 MVP-P, loosen head and move it toward or away from the scale to achieve maximum signal amplitude. If the pattern then has a sloping ellipse, this indicates a phasing error which can be corrected by rotating the head about its vertical axis. Care must be taken while making these adjustments because a movement of .001 will greatly affect signal amplitude and phasing.

After the head is electrically aligned take notice of the apparent four break ups that occur around the circumference of the circle. These are the shaper turn ons and offs fed back on the amplified analog signal. These break ups should be equally spaced around the circumference; this is accomplished by adjusting the trim pots shown in Figure (8).

## Troubleshooting the Digital Readout System

### Only One Axis Counts

1. Check seating of connectors in back of display.
2. Exchange transducer input connector of the axis in question on back of the display to the opposite axis. If this works, then the fault is in the display unit (which can be interchanged). If this does not work, the problem is then either in the cable or in the transducer.

## Disassembling the Display

### Chassis Removal

One thumbnut on each side and midway up the cabinet back will release the chassis for removal. After the nuts are removed, grasp the front switch knobs and draw the panel forward until you expose a nylon power connector plug on the back left of the chassis. Disconnect this plug and remove the chassis.

### Reassembling Chassis into Cabinet

Rest the back edge of the chassis on the cabinet front bottom. Connect the power plug to the 3 pins on the left rear of the top chassis.

Push chassis into cabinet, being sure to engage the lower right chassis bracket lip to the rail in the cabinet. This prevents the chassis from falling forward when partially withdrawn.

Push the chassis fully back so the fastening bolts on the back penetrate the back panel holes. Assemble two knurled nuts.

Be sure the nuts are drawn up tight so the front panel seal is well compressed.

### Circuit Card Replacement

Before any component removal is undertaken, be sure power plug is disconnected.

The top circuit card is removed by removing the 4 knurled nuts and then unplugging the card from the rear connector card.

The bottom circuit card is removed by first removing the top card, then remove the 2 fastening screws, and then unplug the circuit card from the front panel.

### Power Panel Removal

The back panel of the cabinet carries the power supply. Removing the screws around the edge of the rear panel of the cabinet will remove the power panel.

## LED Digit Replacement

Each LED Digit is individually mounted in a plug-in receptacle accessible from the front panel.

To replace a digit, first remove the faceplate by unfastening the 2 knurled nuts on each side of the front panel. This will expose the LED's.

To remove the LED, use an I.C. pulling tool, if available.

An alternate method is to take a strip of masking tape or Scotch tape about 5" long. Stick one end of the tape to one side of the digit to be removed. Then stick the other end to the other side of the digit. Rub the tape onto the digit side with a pencil to assure adhesion. Then grasp the tape loop as a handle to work the digit out.

It is also possible to grasp the digit with a pair of slip-joint pliers.

To assemble the replacement digit, first be sure the leads of the digit are very straight and that the decimal is toward bottom. Then by holding the LED in your fingers, carefully engage the pins in the socket, press in and seat firmly. Turn power on and check. Reassemble the faceplate, being sure to press it firmly against the counter panel.

Note the LED displays vary in brilliance and are color coded. The color sequence is Red, Orange, Yellow, Green, Black, in increasing brilliance. When possible, keep similarly coded units together for uniformity of brilliance.

If you have determined that the malfunction is in the display unit, the following procedures may assist you in identifying which integrated circuit or circuit card is faulty. Use IC Location Diagram—Figure (11).

### X Axis

\*One segment of all digits does not light.

(Insert all 8's from preset switches to test this.)

In order of most likely:

1	Replace 75492	Location 4J Bottom Board
2	Replace 75492	Location 4H Bottom Board
3	Replace 7448	Location 5J Bottom Board
4	Replace 7495	Location 6H Bottom Board
overflow ±1	Replace 75492	Location 5F Bottom Board

### Y Axis

\*One segment of all digits does not light.

(Insert all 8's from preset switches to test this.)

In order of most likely:

1	Replace 75492	Location 4H Bottom Board
2	Replace 7548	Location 5H Bottom Board
3	Replace 7495	Location 6F Bottom Board
overflow ±1	Replace 75492	Location 5F Bottom Board

\*Same whole digit of both axes doesn't light.

Replace 74145 Location 6J Bottom Board

A single bar of one digit fails to light.

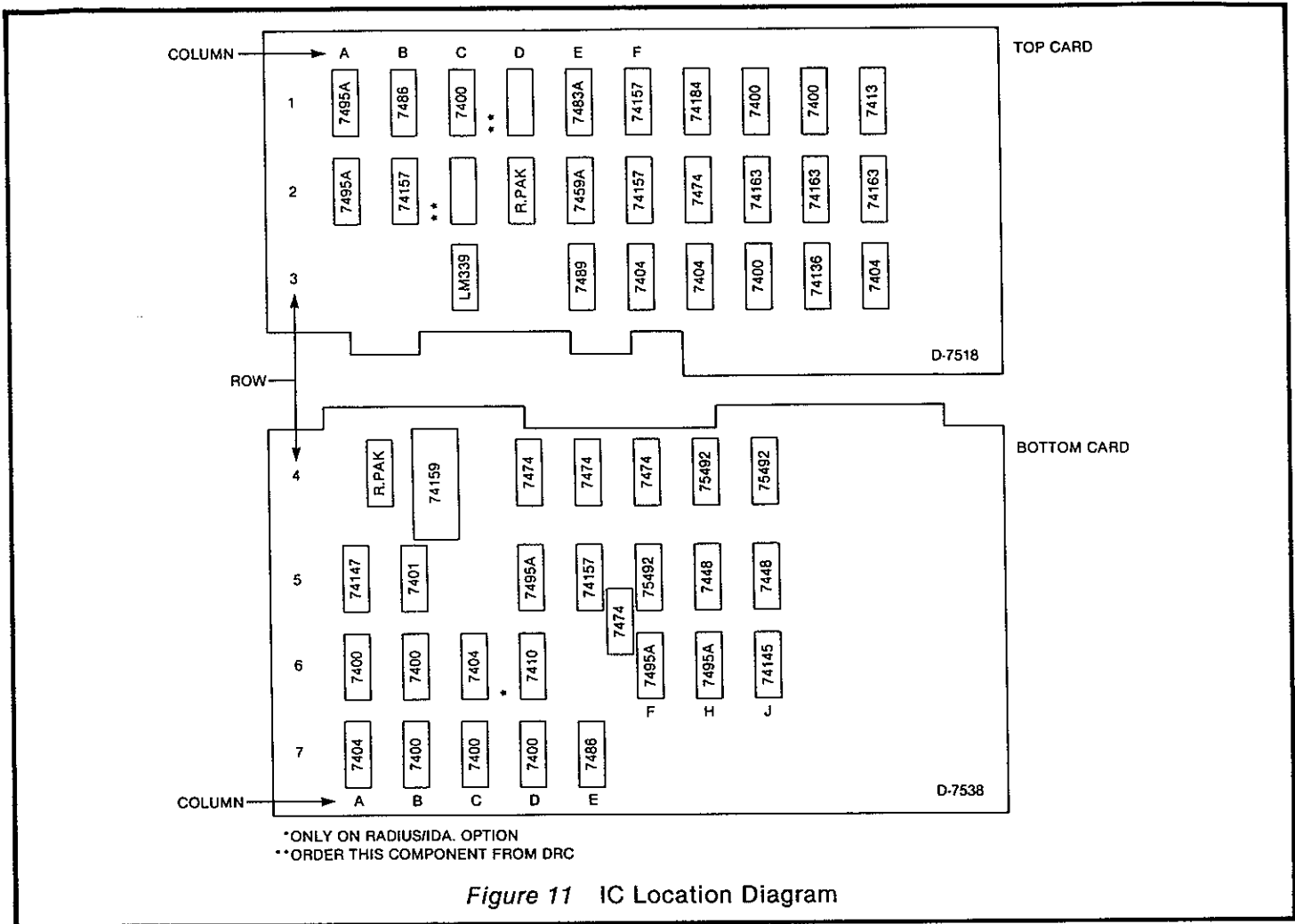
Replace digit (see replacement instruction.)

All other failure analysis is best accomplished by substituting chassis boards.

These are all easily removed for exchange.

### To Reverse Polarity or Direction of Count

To reverse the polarity so that a positive count will go negative, interchange the black and white leads on the transducer head connector (Pins A & B). A small tip soldering iron should be used and care taken to avoid shorting of leads.



### Grounding Suggestions

Here are some suggestions on some typical problems resulting from inadequate electrical grounding:

#### Problem I—Numbers Change When Machine Motor is Turned On

This most frequently occurs when the machine is not grounded. There should be a grounding wire in the switch or connection box, with a heavy wire going from the power cable ground to a lug bolted to the machine.

#### Problem II—Numbers Change by Themselves

This usually is a result of poor grounding of the Readout System. The DRC 500 plugs into a 110V outlet. Outlets for 110V often do not have a 3-pin socket to accommodate the ground pin. Use of an adapter plug leaves the ground floating. Extension cables often do not carry the third wire for ground. It is necessary that a good electrical ground be provided for the system.

If the 110V electrical system does not carry a ground line, you may solve the problem by tying the ground wire of an adapter plug to a good electrical ground point, such as fastening to the electrical outlet box or electrical conduit.

A good practice on any installation is to verify that both the machine ground and the Readout System power cable ground have good, positive grounding points.

#### Problem III—Digital Display Not Operating Properly

The digital display often is exposed to severe shipping shock and vibration, causing the integrated circuits to partially raise out of their sockets.

If you have determined that the display is malfunctioning, it may be remedied by removing the chassis and pressing down on each I.C. (integrated circuit) to be sure it rests solidly in its socket pins. Do not lift them out of their socket, as they are sometimes difficult to put back in.

When replacing the chassis in the case, be sure it is pressed in so the panel is tight against its seal and the thumb nuts are tightened.

### Checklist

1. As soon as power switch at rear of display is turned on, only the  $\pm$  signs will appear. Pressing the X axis reset button activates the display.
2. Pressing the zero set button will display all zeros.
3. Pressing the number insertion switch will display the number present on the rotary switches.
4. Presetting all eights and inserting the number will check that all number segments are working properly.
5. Cranking the X axis from the right side in a clockwise direction will cause the reading to increase with a plus sign.
6. Cranking the Y axis in a clockwise direction will cause the reading to increase with a plus sign.
7. Set the crank dial reading to zero with all backlash taken out. Press the zero button. Then, make a full revolution and carefully come up to zero. The display reading will be 00.2000.
8. To check for possible noise interference, set the crank dial to zero and with backlash eliminated, press the zero set button on the display. Have someone activate any and all motor starters and DC brush motors (portable drill) while you are slowly cranking the lead screw three turns and

carefully stop at zero. Your display should read zero 00.600  $\pm$  0.0005. If not, repeat several times. If you get erratic readings, you are getting electrical noise interference (Item 10 below).

9. If you have power drive on either axis, run it slowly and watch the display for any erratic counting.
10. If step 8 or 9 produces erratic counting, it indicates the presence of severe electrical noise in the power lines greater than the display can handle. First, plug the display into a different power line and recheck counting. If erratic counting continues, power-line noise suppression may be required.
11. Check Motor Connector Box to be sure ground lead is well grounded (see Paragraph on Grounding Suggestions).

### Moving the Comparator

The comparator is equipped with wheels to move the unit short distances. If it is required to transport the machine, the handling can be done by forklift if the following precautions are observed:

1. Unplug from the wall receptacle.
2. Whenever possible, forklift from the front end. See Figure (12).
3. Lift only as high as necessary.
4. Move at a slow speed.
5. Set down very gently.
6. Do not bump the lamphouse.
7. The calibration should be checked for transporting.
8. **ALWAYS** have the tines level and flat on the floor when approaching the machine.

**NOTE:**  
The lamphouse should never be used as a towing handle.

### WARRANTY

Within one year from the date of purchase, any repairs necessary due to defects in material or workmanship will be made without charge by Rank Precision Industries, Inc. Normal wear and tear is not covered by this warranty. This warranty applies to the original purchaser and is not transferable. No other warranty, either expressed or implied, shall be applicable to this equipment.

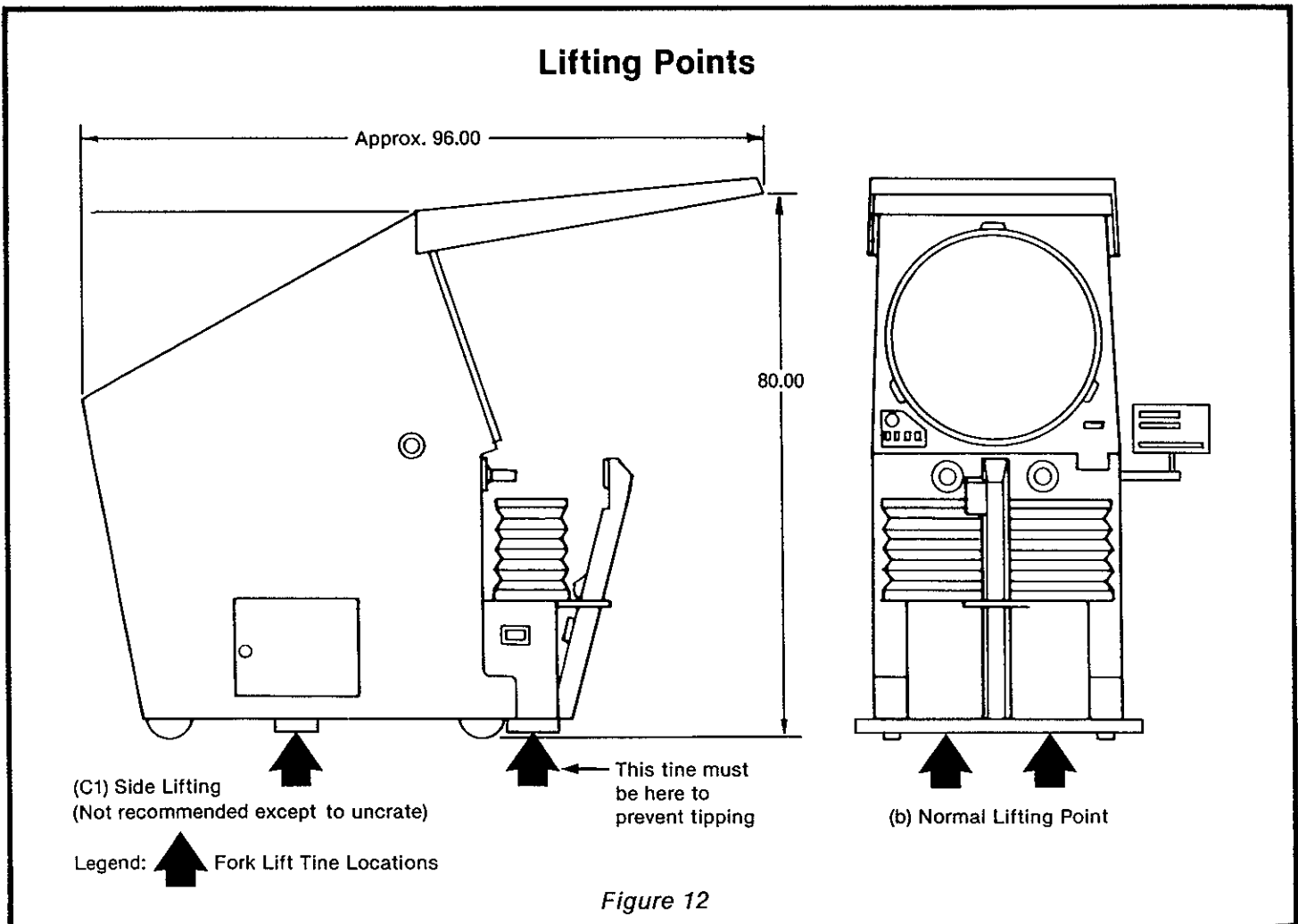
### PARTS ORDERING INFORMATION

1. State the machine model and serial number.
2. State part number, description and quantity of each part required.
3. State shipping instructions.

### PART IDENTIFICATION

The remainder of this manual is devoted to exploded-view drawings illustrating the relative location of the various machine components.

Key numbers relate the exploded-view drawings to the parts list, which includes part number, description and quantity required.





## Electrical Tray Panel Control and Fuse Identification

(For Comparators Serial No. 288 & Up)

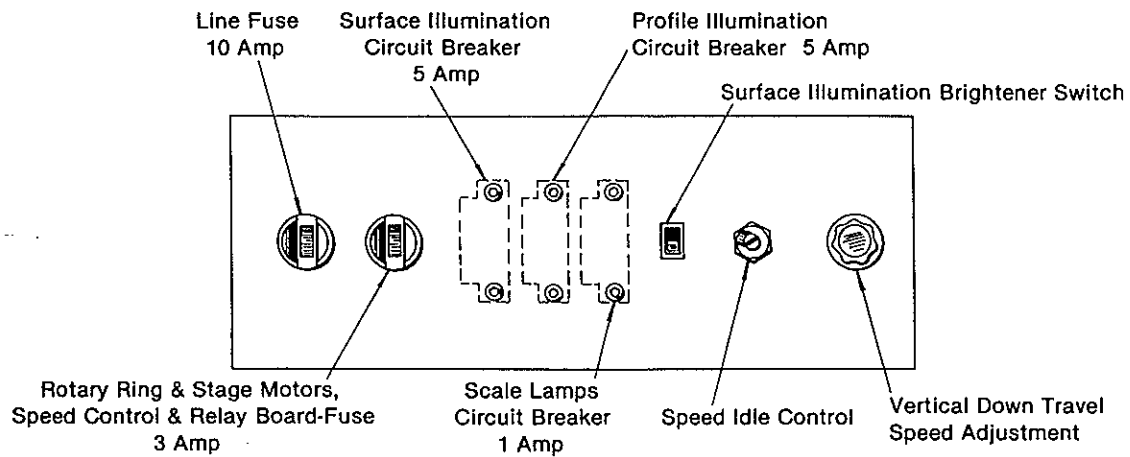


Figure 13A

## Electrical Tray Panel Control and Fuse Identification

(For Comparators Serial No. 192 through 287)

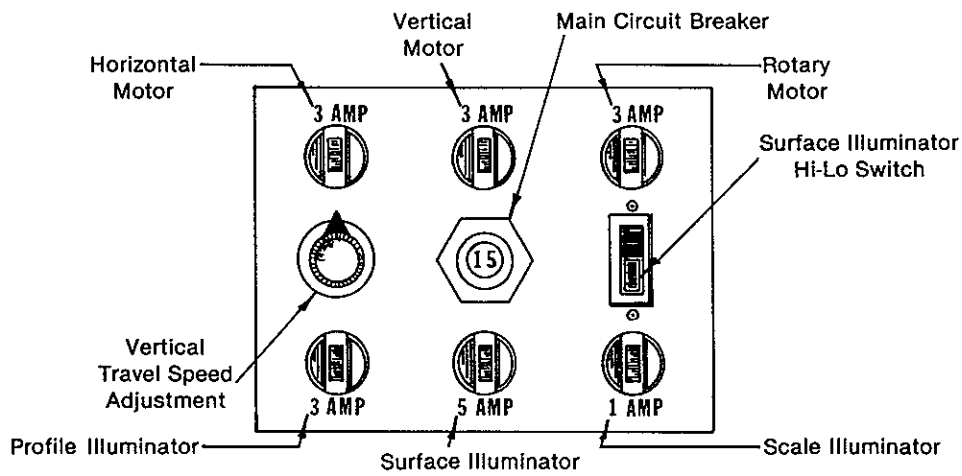


Figure 13B

## Electrical Tray Panel Control and Fuse Identification

(For Comparators Serial Nos. 1 through 191)

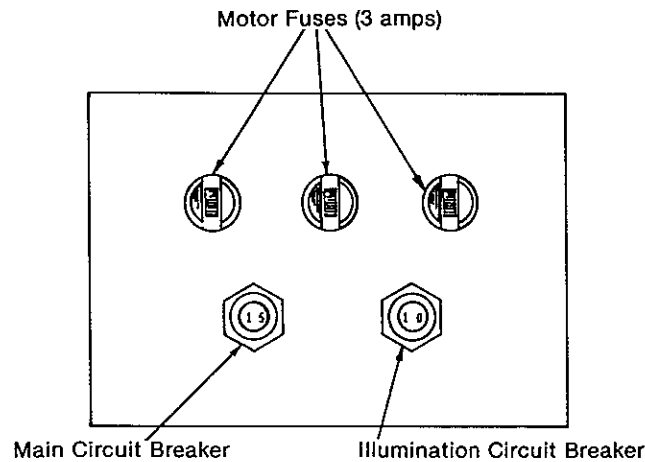
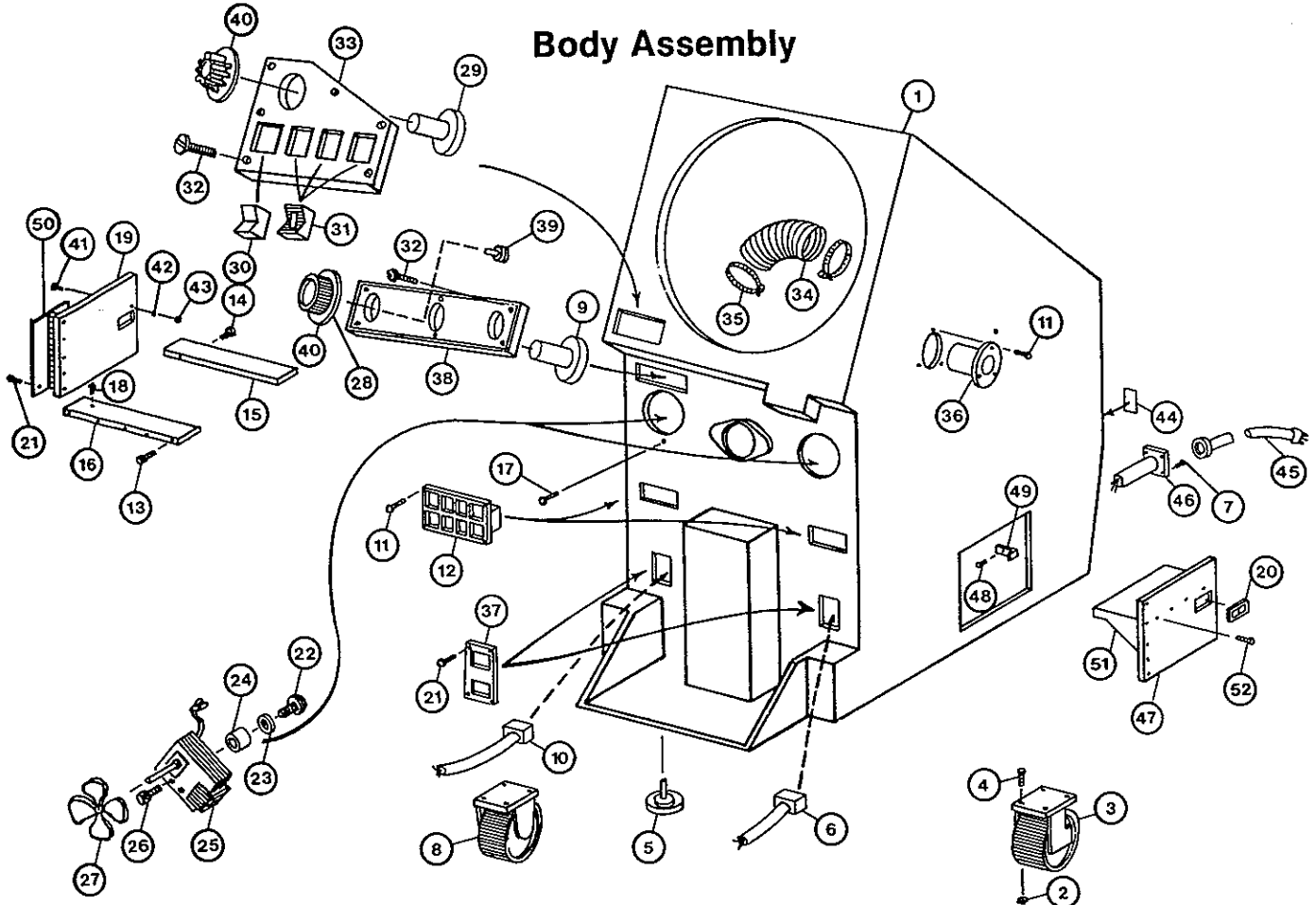


Figure 13C

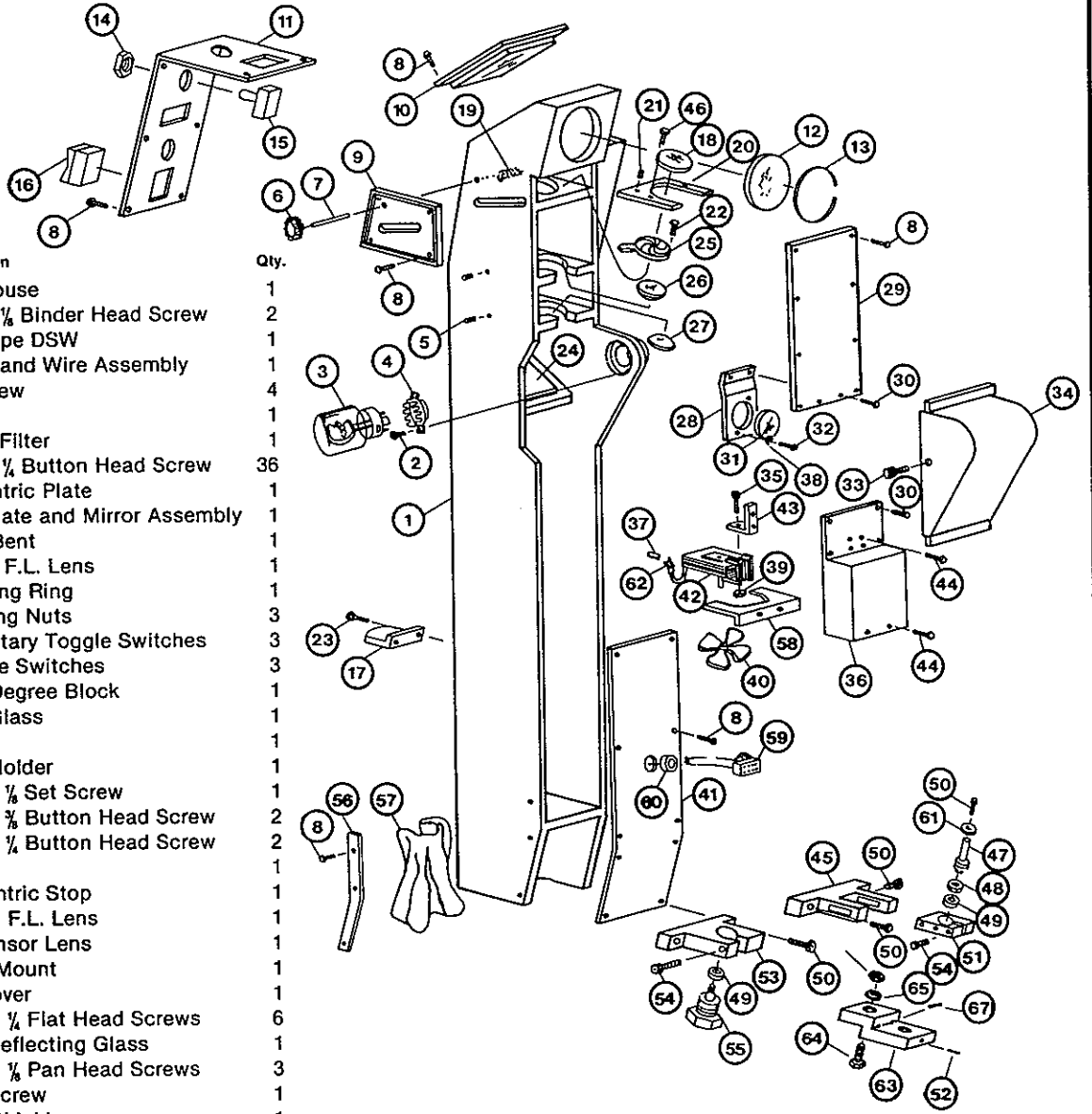
# Body Assembly



Ref.	Part No.	Description	Qty.	Ref.	Part No.	Description	Qty.
1	22 0540	Body	1	31	48 5888	Tippette Switch	3
2	48 6934	Nut	12	32	48 5339	Button Hd. Soc. Cap Sc. 4-40 x 1/4	12
3	48 5929	Swivel Caster	1	33	22 0518	Switch Plate	1
4	48 6011	Button Head Screw 3/8-16 x 1 1/4	12	34	22 0675	Hose	2
5	48 5980	Leveling Pads	4	35	48 5993	Hose Clamp	4
6	22 1099	Red Plug Assembly	1	36	22 0673	Hose Flange	2
7	48 5339	4-40 x 1/4 Button Head Soc. Cap	4	37	22 1107	Mounting Plate	2
8	48 5930	Rigid Caster	2	38	22 1066	Switch Plate for Speed Control	1
9	48 6481	Speed Pot	2	39	22 1571	Dual Potentiometer	1
10	22 1095	White Plug & Receptacle Assembly	1	40	48 5446	Knob	4
11	48 5137	6-32 x 1/4 Button Hd. Soc. Cap	14	41	48 6295	4-40 x 1/2 Button Head Screw	8
12	22 0693	Filter Frame and Filter Assembly	2	42	48 6088	Washer	8
13	48 5051	1/4-20 x 1" Soc. Hd. Cap Screw	5	43	48 5624	4-40 Hex Nut	8
14	48 5057	1/4-20 x 3/4 Soc. Hd. Cap Screw	4	44	22 0749	30" Comparator Name Tag	1
15	22 0674	Left Side Rail	1	45	22 0726	Power Cord	1
16	22 0631	Right Side Rail	1	46	22 0727	Socket for Power Cord	1
17	48 5958	10-32 x 3/8 Flat Head Screw	6	47	22 0534	Door	1
18	48 5358	10-32 x 3/8 Button Hd. Soc. Cap Screw	1	48	48 5331	10-24 x 3/8 Soc. Hd. Cap Screw	2
19	22 0538	Door	1	49	22 1210	Fastener Mount	2
20	48 6220	Door Latch	2	50	22 0531	Hinge	2
21	48 5111	8-32 x 1/4 Button Soc. Screw	18	51	22 0535	Lens Holder	1
22	48 6038	6-32 x 3/8 Button Head Soc. Screw	4	52	48 5981	8-15 Flat Hd. Wood Screw	7
23	48 6721	Washer	4		22 1102	Wiring Harness and Assembly for Switches consists of above reference number items in an assembled unit: 29, 30, 31, 33 & 40.	1
24	48 6727	Spacer for Fan Motor	4		22 1098	Switch Plate Assembly (Speed Control) consists of above reference items in an assembled unit: 9, 38, 39, 40, 53.	1
25	48 5304	2 Pole, Shaded Pole, Dayton Motor	2				
26	48 6039	6-32 x 3/8 Soc. Hd. Cap Screw	4				
27	48 5305	3" Dia. Clockwise Metal Fan	2				
28	48 6080	Hex Nut	3				
29	48 5445	Rheostat (50 watt)	1				
30	48 6041	Tippette Switch	1				

Figure 14

# Profile Lamphouse Assembly



Ref.	Part No.	Description	Qty.
1	22 0449	Lamphouse	1
2	48 5031	5-40 x 1/8 Binder Head Screw	2
3	48 5766	Bulb Type DSW	1
4	22 0950	Socket and Wire Assembly	1
5	22 0244	Set Screw	4
6	48 6017	Knob	1
7	22 0668	Pin for Filter	1
8	48 5339	4-40 x 1/8 Button Head Screw	36
9	22 0682	Telecentric Plate	1
10	22 0499	Coverplate and Mirror Assembly	1
11	22 0508	Cover Bent	1
12	22 1647	203mm F.L. Lens	1
13	22 0515	Retaining Ring	1
14	48 5887	Cap Ring Nuts	3
15	48 5886	Momentary Toggle Switches	3
16	48 5711	Tippette Switches	3
17	22 0722	Grad. Degree Block	1
18	22 0409	Filter Glass	1
19	22 0669	Spring	1
20	22 0664	Filter Holder	1
21	48 5813	4-40 x 1/8 Set Screw	1
22	48 5438	8-32 x 3/8 Button Head Screw	2
23	48 5137	6-32 x 1/4 Button Head Screw	2
24	22 1651	Mirror	1
25	22 0738	Telecentric Stop	1
26	22 1648	120mm F.L. Lens	1
27	22 1649	Condensor Lens	1
28	22 0502	Glass Mount	1
29	22 0493	Top Cover	1
30	48 6001	4-40 x 1/4 Flat Head Screws	6
31	22 0183	Heat Reflecting Glass	1
32	48 6171	4-40 x 1/8 Pan Head Screws	3
33	22 0087	Lock Screw	1
34	22 0507	Light Shield	1
35	48 5296	6-32 x 1" Soc. Cap Screw	2
36	22 0496	Motor Cover	1
37	48 6234	Receptacle	2
38	48 5356	Washer	3
39	48 6121	6-32 Elastic Nuts	2
40	48 5305	Fan	1
41	22 0459	Bottom Cover for Lamphouse	1
42	48 5304	Motor	1
43	22 0494	Motor Mounts	2
44	48 5137	6-32 x 1/4 Button Head Screws	6
45	22 0526	Upper Mount	1
46	48 5082	4-40 x 1/8 Binder Hd. Screw	2
47	22 0522	Pivot Pin	1
48	48 5298	3/8-18 Hex Nut	1
49	48 5972	Bearing	2
50	48 5057	1/4-20 x 3/4 Soc. Cap Screws	9
51	22 0524	Adj. Block	1
52	48 5055	1/4-20 x 3/8 Set Screw	1
53	22 0521	Bottom Mount	1
54	48 5156	8-32 Soc. Cap Screw	2
55	22 0519	Adj. Screw	1

Ref.	Part No.	Description	Qty.
56	22 1644	Bottom Lamphouse Boot	1
57	22 0739	Lamphouse Bag Strip	2
58	22 1085	Air Baffle Plate	1
59	22 1186	White & Blue Plug Assembly	1
60	48 5995	Snap Bushing	1
61	48 5709	Washer	1
62	48 6189	Terminal	2
63	22 1782	Lamphouse Extension Block	1
64	48 6507	3/8-16 x 2" Hex Head Bolt	1
65	48 6174	Lock Washer	1
66	48 6173	3/8-16 Hex Nut	1
67	48 5619	1/4-20 x 3/4 Soc. Set Screw	2
	22 0514	Lamphouse Assembly consists of the above reference number items in an assembled unit: 1 thru 38, 41, 45 thru 57, 59 thru 61, 63 thru 68.	1
	22 0512	Fan Assembly consists of the following reference number items in an assembled unit: 30, 35, 36, 37, 39, 40, 42, 43, 44, 58, 62.	1

Figure 15

## Surface Illuminator Assembly

Ref.	Part No.	Description	Qty.
1	22 0098	Retaining Ring	1
2	22 0446	Adjustable Lens Tube	1
3	48 5137	6-32 x 1/4" Button Head Screw	4
4	22 0447	Lens Tube	1
5	48 5158	2-56 x 1/8" Rd. Head Machine Screw	4
6	48 5958	10-32 x 3/8" Flat Hd. Cap Sc.	3
7	48 5442	Tru-Flector, 150 Watt, Dichoric Bulb	1
8	48 5438	8-32 x 1/8" Type DLS Button Head Screw	1
9	48 6103	Cable Clamp	1
10	22 0950	Socket & Wire Assembly	1
11	22 0442	Adjusting Block	2
12	22 0730	Mounting Strap	2
13	48 5499	Dowel Pin	2
14	22 0444	Swivel End	1
15	22 0443	Mounting Plate	1
16	48 6038	6-32 x 1/8" Button Hd. Screw	4
17	22 1646	Condensor Lens, Heat Abs.	1
18	48 6028	"O" Ring	1
19	22 1645	Condensor Lens	1
20	22 0445	Socket Mount	1
21	48 5906	Green Wire	1
22	48 5581	Spade Terminal	1
23	48 5082	4-40 x 1/4" Binder Hd. Screw	3
	22 0448	Surface Illuminator Assembly consists of above reference number items in an assembled unit 1 thru 22	2

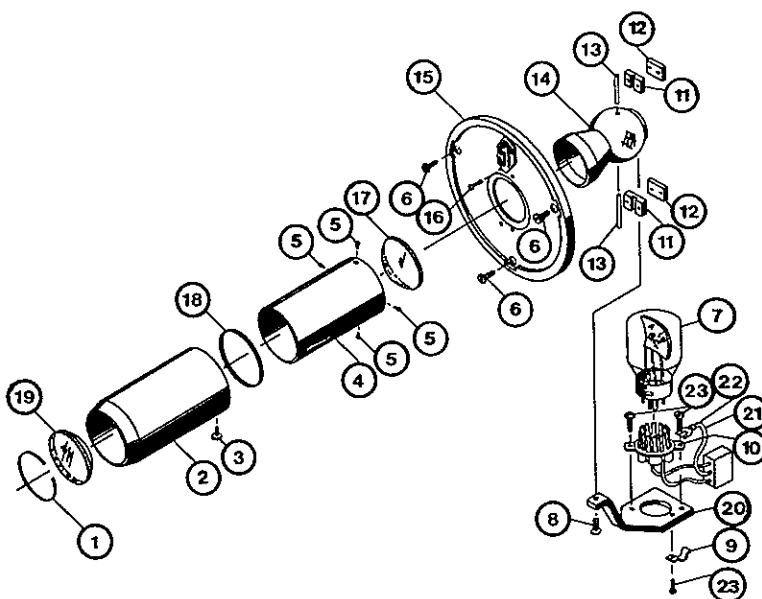


Figure 16

## Canopy Top Assembly (Plain and Vented)

Ref.	Part No.	Description	Qty.
1	22 0571	Curtain	2
2	48 5969	Carriers	50
3	48 5605	Hex Nut 6-32	12
4	48 5137	Button Head Screws 6-32 x 1/4"	12
5	48 5641	Flat Head Rivets	12
6	22 0562	Canopy Top	1
	22 1796	Vented Canopy Top	
7	48 6023	1/8"-18 x 1 1/2" Button Head Socket Cap Screw	2
8	48 5968	End Caps	2
9	48 5967	Hooks	50
10	22 0453	Left Hand Track	1
11	22 0452	Right Hand Track	1
12	48 5695	Rubber Molding	1
13	22 0569	Hinge	1
14	48 6003	10-24 x 3/8" Button Head Screw	12
15	48 6003	10-24 x 3/8" Button Head Screw	12
16	22 1939	Fan Assembly	1
17	48 6399	Fan Guard	1
18	48 5185	Button Head Screw 8-32 x 1/4"	2
19	48 6045	Hex Nut 8-32	2
20	22 1359	Cord Grommet & Plug Assembly	1
21	48 6265	Circuit Breaker	1
22	48 5138	Button Head Screw 6-32 x 1/2"	2
23	22 1358	Fan Switch & Wire Assembly	1
24	48 6240	Tap Connector	2
	22 0570	Canopy Top Assembly consists of above reference number items in an assembled unit: 3 thru 8, 10 thru 15	1
	22 0572	Curtain & Hook Assembly consists of above reference number items in an assembled unit: 1, 2, & 29.	1
	22 1361	Optional Canopy Fan Hook-Up Assembly consists of above reference number items in an assembled unit: 16-24.	1

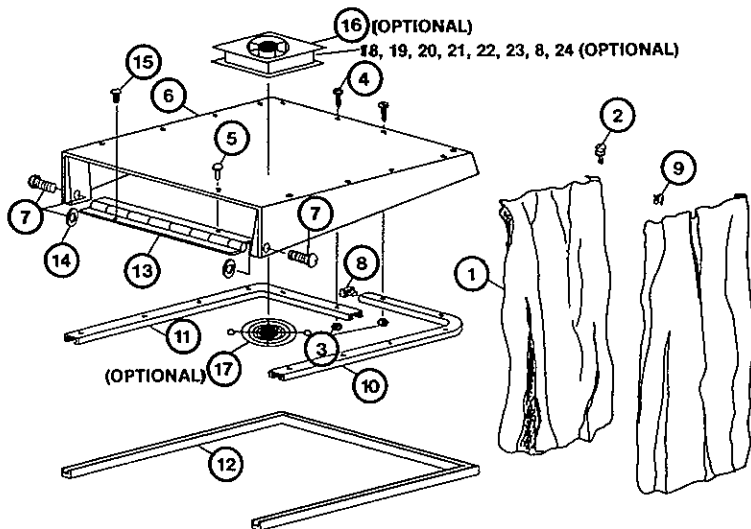
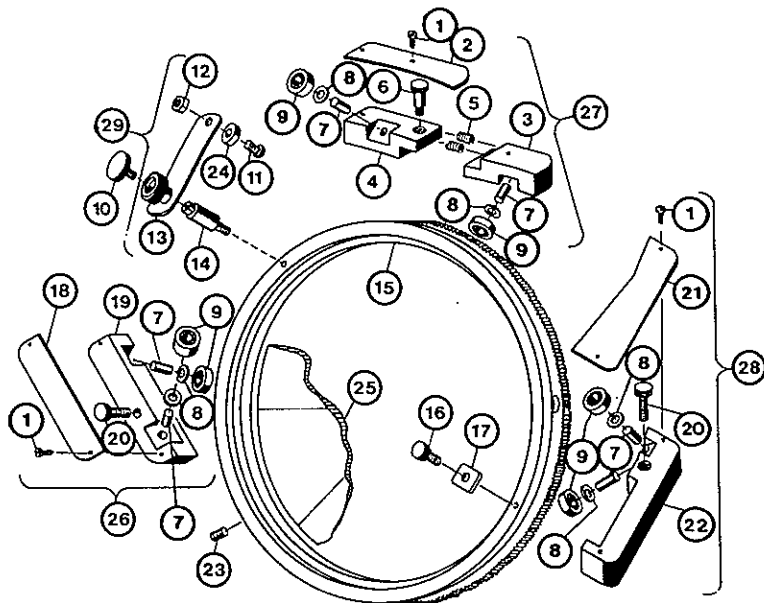


Figure 17

## Protractor Ring Assembly

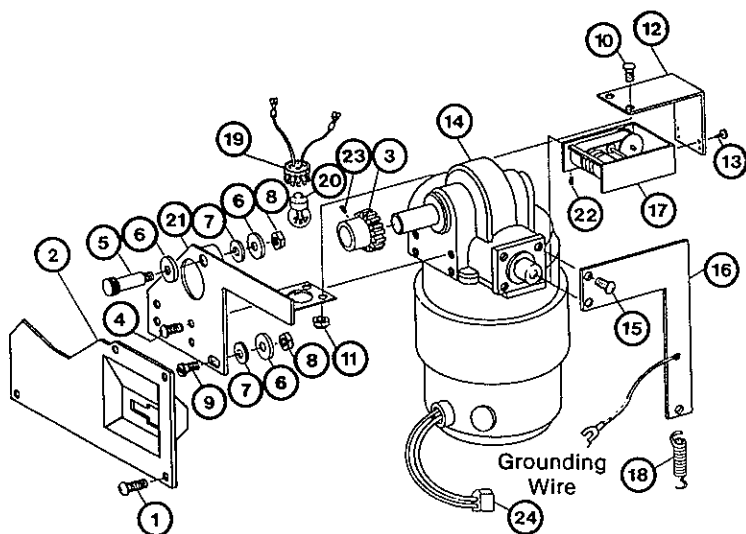
Ref.	Part No.	Description	Qty.
1	48 6171	Pan Hd. Machine Screw 4-40 x 1/8 Long	6
2	22 0487	Roller Housing Cover	1
3	22 0259	Bottom Roller Housing	1
4	22 0258	Top Roller Housing	1
5	22 0141	Lever Spring	2
6	22 0260	Shoulder Screw	1
7	48 5291	Spring Pin	6
8	22 0263	Spacer Washer	6
9	48 5927	Ball Bearing	6
10	16 0134	Locking Screw	4
11	48 6184	4-40 x 3/8" Button Head Screw	4
12	48 6670	Plastic Cap Nut	4
13	22 0954	Clip Bushing Assembly	4
14	22 0952	Pivot Screw	4
15	22 2325	Protractor Ring	1
16	22 0087	Lock Screw	3
17	22 0127	Glass Retainer Clip	3
18	22 0264	Roller Housing Cover	1
19	22 0224	Roller Housing	1
20	48 5492	Cap Screw 1/8" x 1 1/2"	2
21	22 0261	Roller Housing Cover	1
22	22 0223	Roller Housing & Pinion Cover	1
23	48 6063	Soc. Set Screw 6-32 x 3/16	4
24	48 6157	Rubber Pad	4
25	74 0008	Centerline Glass Screen (30" Dia.)	1
26	22 0265	Roller Housing Assembly consists of above reference number items in an assembled unit: 18, 19, 7, 8, 9, 20, & 1.	1
27	22 0266	Roller Housing Assembly consists of above reference number items in an assembled unit: 3, 4, 5, 6, 7, 8, 9, 2, 1.	1



Ref.	Part No.	Description	Qty.
28	22 0267	Roller Housing Assembly consists of above reference number items in an assembled unit: 22, 20, 21, 9, 8, 7, 1.	1
29	22 0955	Clip Assembly consists of above reference number items in an assembled unit: 13, 14, 12, 24, 11.	4

Figure 18

## Protractor Motor Assembly



Ref.	Part No.	Description	Qty.
1	48 5339	4-40 x 1/8" Long Button Hd. Soc. Cap Screw	4
2	22 0681	Filter & Reader Cover Plate	1
3	22 0262	Spur Gear	1
4	48 5106	Button Hd. Screw 10-32 x 1/4"	4
5	48 5131	Shoulder Screw 1/4" Dia. x 1" Long	1
6	48 6069	Steel Washer	3
7	48 6151	Teflon Washer	2
8	48 6152	Elastic Stop Nut	2
9	48 5431	Flat Hd. Screw 10-24 x 3/8" Long	1
10	48 5438	Button Hd. Screw 8-32 x 3/8"	2
11	48 6045	Elastic Hex Nut 8-32	2
12	22 0654	Adj. Counter Bracket	1
13	48 5365	Binder Hd. Machine Screws 2-56 x 1/8	4
14	22 0308	Rotary Ring Motor	1
15	48 5430	Button Head Screw 1/4-20 x 3/8	2
16	22 0695	Spring Bar	1
17	22 1242	Degree Counter	1
18	48 6029	Spring	1
19	48 6494	Bulb Socket	1
20	48 6563	Bulb	1
21	22 0657	Motor Plate & Bracket Assembly	1
22	48 5011	Soc. Set Screw 8-32 x 1/8" Long	1
23	48 5499	1/8" Dia. x 1/4" Long Spring Pin	1
24	48 6233	Connector	1
	22 0663	Protractor Motor & Plate Assembly consists of above reference number items in an assembled unit: 3 thru 25	1

Figure 19

# Lower Stage Assembly

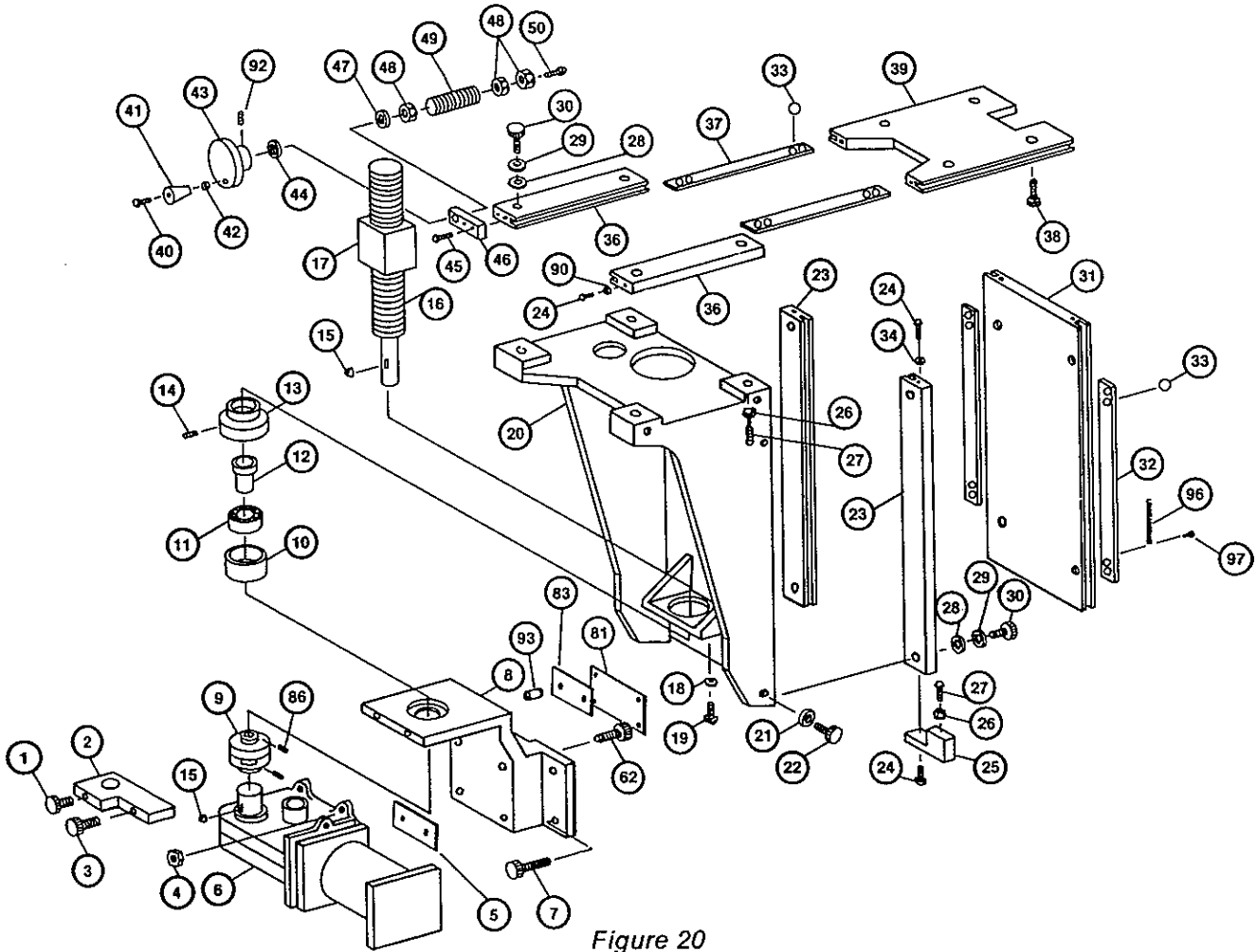


Figure 20

# Upper Stage Assembly

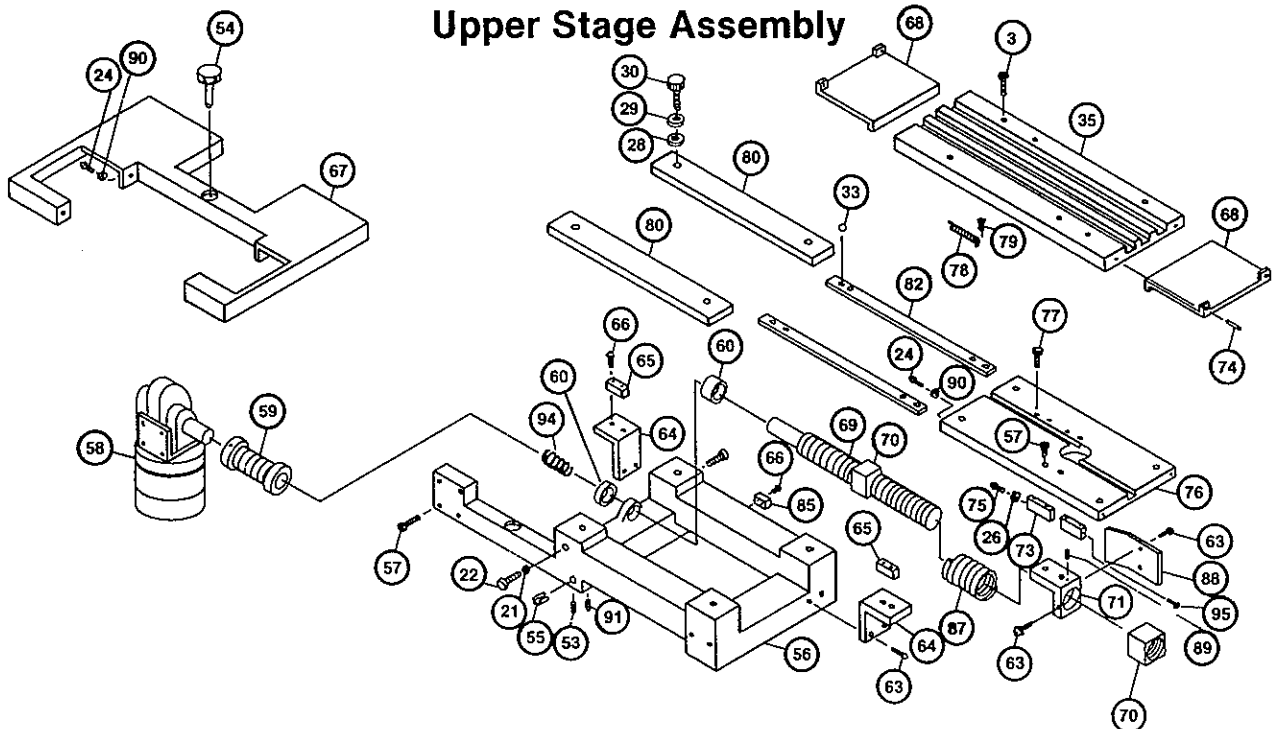
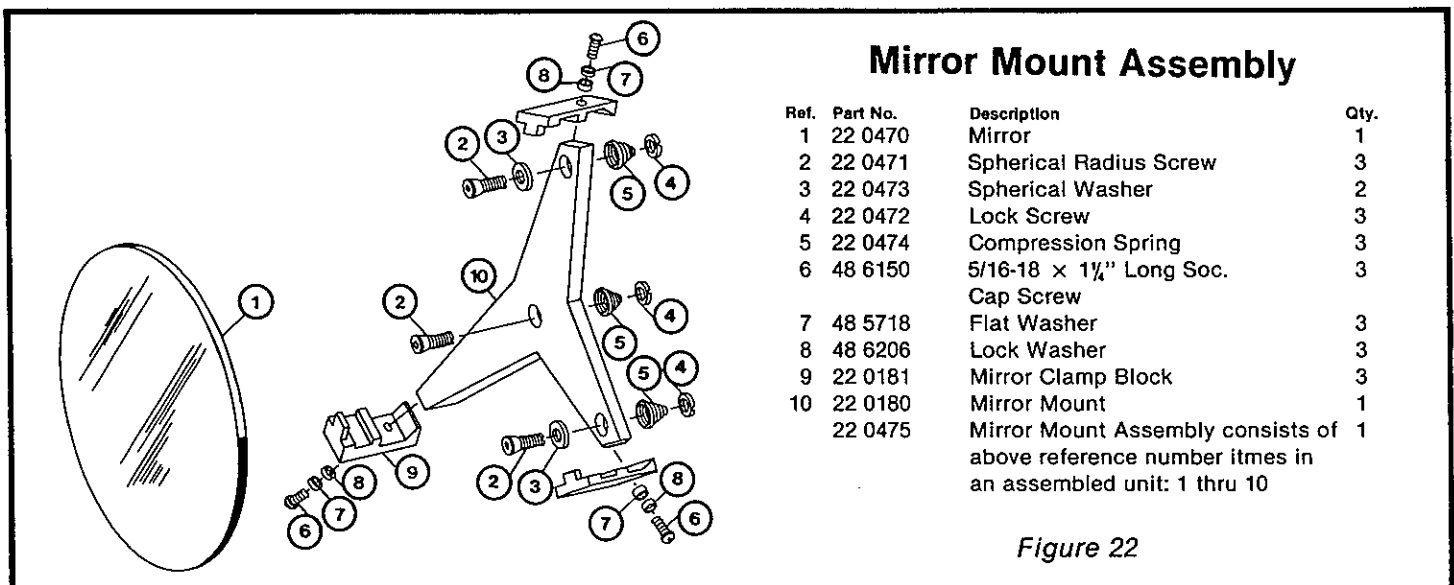


Figure 21

## Lower and Upper Stage Assembly

Ref.	Part No.	Description	Qty.	Ref.	Part No.	Description	Qty.
1	48 6150	Soc. Cap Screw $\frac{5}{16}$ -18 x $1\frac{1}{4}$ " Long	1	54	22 0765	Pin & Cap Assembly	1
2	22 0517	Top Motor Mount Plate	1	55	22 0551	Split Bushing	1
3	48 5984	Soc. Cap Screw $\frac{5}{16}$ x 18 x $\frac{7}{8}$ "	9	56	22 0168	Focus Slide Plate Mount	1
4	48 6152	Hex Nut 10-24	4	57	48 5057	Soc. Cap Screw $\frac{1}{4}$ -20 x $\frac{3}{4}$ " Long	6
5	22 1591	Motor Pad	2	58	22 0307	Horizontal Motor	1
6	22 0306	Vertical Motor	1	59	48 5987	Flexible Coupling	1
7	48 5956	Soc. Cap Screw $\frac{1}{2}$ -20 x $1\frac{1}{4}$ " Long	4	60	48 5478	Thrust Bearing	2
8	22 0178	Motor Mount	1	62	48 6298	10-24 x $1\frac{1}{4}$ " Soc. Cap Screw	4
9	22 1076	Coupling	1	63	48 5111	8-32 x $\frac{3}{4}$ " Button Head Socket Cap	7
10	22 0759	Bushing	1	64	22 0679	Mount for Micro Switch	2
11	48 6049	Thrust Bearing	1	65	48 5594	Micro Switch	2
12	22 0760	Flanged Bushing	1	66	48 6760	5-40 x $\frac{3}{4}$ " Socket Cap Screw	6
13	22 0546	Collar	1	67	22 0704	Top Bag Frame	1
14	48 5052	Soc. Set. Screw $\frac{1}{4}$ -20 x $\frac{3}{4}$ " Long	1	68	22 1902	Stage Slide Dust Cover	2
15	22 0548	Key	2	69	22 0455	Horizontal Drive Screw	1
16	22 0460	Vertical Drive Screw	1	70	48 5760	Ball Nut	2
17	48 6015	Ball Nut	1	71	22 0476	Lead Screw Mount	1
18	48 6033	Washer	2	73	22 0579	Stage Stop Mount	2
19	48 6425	Button Hd. Screw $\frac{1}{4}$ -20 x $\frac{1}{2}$ " Long	2	74	48 5080	Spring Pin	4
20	22 1880	Stage Upright	1	75	48 6491	1/4-20 x 1" Hex Hd. Bolt	1
21	48 6084	Washer	12	76	22 0201	Transverse Slide Plate	1
22	48 5377	Button Hd. Screw $\frac{3}{8}$ -24 x $\frac{1}{2}$ "	12	77	48 6244	Soc. Cap Screw 10-32 x 1"	4
23	22 0200	Vertical Gib Adj.	2	78	22 0243	Spring	2
24	48 5106	Button Head Screw 10-32 x $\frac{3}{4}$ " Long	24	79	48 5339	4-40 x $\frac{1}{4}$ " Button Head Screw	2
25	22 0720	Stage Stop	1	80	22 1749	Transverse Gib, Paired	1
26	48 5286	Jam Nut $\frac{1}{4}$ -20	3	81	22 1592	Back Plate	1
27	48 6491	$\frac{1}{4}$ -20 Hex Hd. Bolt 1" Long	2	82	22 0477	Ball Guide for Transverse	2
28	22 0481	Special Washer	16	83	22 1593	Rubber Pad	2
29	22 0482	Cap Washer	16	85	48 6238	Micro Switch	1
30	22 0480	Special Screw	16	86	48 6179	Set Screw $\frac{1}{4}$ -20 x $\frac{3}{8}$ "	4
31	22 0185	Vertical Slide Plate	1	87	48 6175	Die Spring	1
32	22 0478	Ball Guide for Vertical	2	88	22 1075	Holding Arm	1
33	48 5990	Precision Balls	24	89	48 5055	Set Screw $\frac{1}{4}$ -20 x $\frac{3}{8}$ " Long	1
34	48 6083	Washer	22	90	22 1258	Washer	5
35	22 0202	Top Plate for Stage	1	91	48 5054	Set Screw $\frac{1}{4}$ -20 x $\frac{1}{4}$ "	1
36	22 0188	Focusing Gib	2	92	48 5340	Set Screw 10-24 x $\frac{3}{8}$ "	1
37	22 0479	Ball Guide for Focus	2	93	22 1594	Bushing	4
38	48 5047	$\frac{3}{8}$ -16 x $1\frac{1}{4}$ " Long Soc. Cap Screw	4	94	48 6261	Spring	1
39	22 0184	Focus Slide Plate	1	95	48 6492	$\frac{1}{4}$ -20 x $1\frac{1}{4}$ " Machine Screw	1
40	48 5131	$\frac{1}{4}$ " Dia. x 1" Long Shoulder Screw	1	96	22 0840	Spring	2
41	22 1007	Handle	1	97	48 5158	2-56 x $\frac{1}{8}$ " Button Head Screw	2
42	48 6135	Teflon Washer	1	22 0468	Vertical Drive Screw Assembly consists of the above reference number items in an assembled unit: 10, 11, 12, 13, 14, 16, 17.	1	
43	22 0762	Focus Wheel	1	22 0469	Horizontal Drive Screw Assembly consists of the above reference number items in an assembled unit: 69, 70, 71, 72, 87, 88, 89, 63.	1	
44	48 6854	Washer, Nylon	1	22 0554	Focus Knob Assembly consists of the above reference number items in an assembled unit: 40, 41, 42, 43, 92.	1	
45	48 6132	Button Head Screw 10-24 x 1" Long	2				
46	22 0549	Focus Wheel Mount	1				
47	48 6855	Washer, Nylon	1				
48	48 5991	Jam Nut $\frac{1}{2}$ -13	3				
49	22 0553	Focus Screw	1				
50	22 0757	Focus Screw Stop	1				
53	48 5486	Spring Pin	1				



### Mirror Mount Assembly

Ref.	Part No.	Description	Qty.
1	22 0470	Mirror	1
2	22 0471	Spherical Radius Screw	3
3	22 0473	Spherical Washer	2
4	22 0472	Lock Screw	3
5	22 0474	Compression Spring	3
6	48 6150	5/16-18 x $1\frac{1}{4}$ " Long Soc. Cap Screw	3
7	48 5718	Flat Washer	3
8	48 6206	Lock Washer	3
9	22 0181	Mirror Clamp Block	3
10	22 0180	Mirror Mount	1
	22 0475	Mirror Mount Assembly consists of 1 above reference number itmes in an assembled unit: 1 thru 10	

Figure 22

## Digital Reader Assembly

(Serial No.'s 764 & Up)

Ref.	Part No.	Description	Qty.
1	22 2155-0700	Digital Display without Memory	1
	22 2155-09	Digital Display with Memory	1
2	22 1778	Digital Display Arm Assembly	1
3	22 2215	Vertical Mounting Plate	1
4	48 6818	$\frac{7}{8}$ "-24 x 1" Lg. Button Hd. Screw	7
5	22 2217	Vertical Reader Mount	1
6	48 6425	$\frac{1}{4}$ "-20 x $\frac{1}{2}$ " Lg. Button Hd. Screw	4
7	48 6782	Vertical Scale & Reader	1
8	48 6619	$\frac{7}{8}$ "-24 x $\frac{7}{8}$ " Lg. Socket Set Screw	4
9	22 2226	Spacer Bar	1
10	22 2214	Mounting Bracket	1
11	48 6684	10-24 x $\frac{7}{8}$ " Lg. Button Hd. Sc.	3
12	48 6781	Horizontal Scale & Reader	1
13	48 6819	$\frac{7}{8}$ "-24 x $\frac{7}{8}$ " Lg. Button Hd. Screw	2
14	48 5292	$\frac{7}{8}$ "-18 x $\frac{1}{2}$ " Lg. Button Hd. Scr.	1
15	22 2216	Horizontal Reader Mount	1
16	48 6033	Washer	2
17	48 5051	$\frac{1}{4}$ "-20 x 1" Lg. Socket Cap Scr.	2

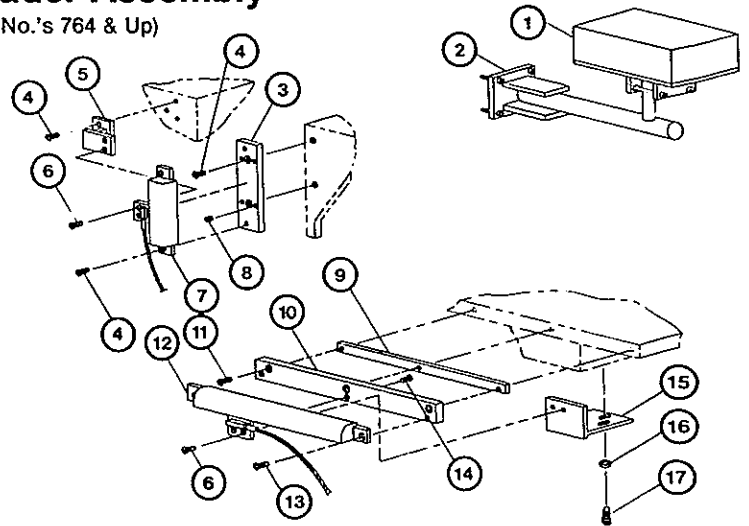


Figure 23-A

## Digital Reader Assembly

(Serial No.'s up to 764)

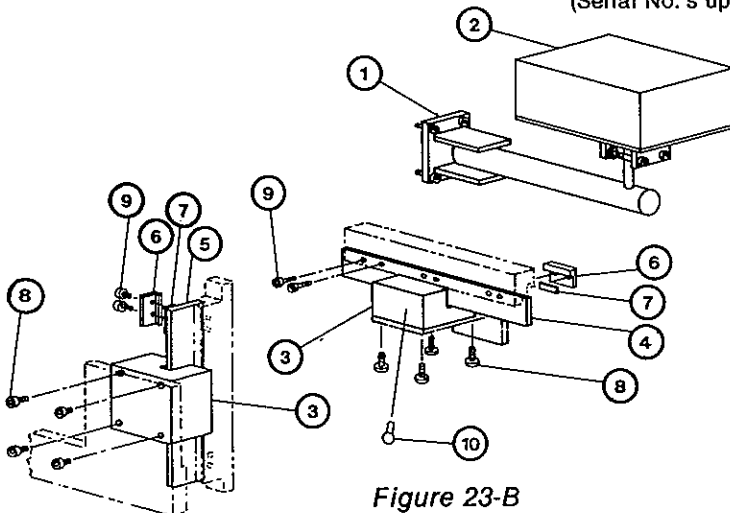


Figure 23-B

Ref.	Part No.	Description	Qty.
1	22 1778	Digital Display Arm Assembly	1
2	48 6596	Digital Display Without Memory	1
	48 6599	Digital Display With Memory	1
3	48 6593	L-3D Encoder Heads	2
4	48 6595	Horizontal Scale	1
5	48 6594	Vertical Scale	1
6	22 1754	Scale Mount Clamp	6
7	22 1755	Scale Mount Pad	6
8	48 5438	8-32 x $\frac{7}{8}$ Button Head Cap Screw	8
9	48 5061	8-32 x $\frac{1}{2}$ Socket Head Cap Screw	12
10	48 6597	Bulb for Replacement	2

## Lens Hold Down Assembly

Ref.	Part No.	Description	Qty.
1	01 0158	Compression Spring	2
2	48 5297	10-32 x $\frac{1}{2}$ " Lg. Socket Hd. Scr.	2
3	48 5004	8-32 x $\frac{7}{8}$ " Lg. Socket Set Scr.	2
4	22 0485	Spacer Ring	2
5	48 5097	$\frac{1}{16}$ " Dia. x $\frac{1}{2}$ " Lg. Spring Pin	2
6	48 6185	Set Screw 10-32 x $1\frac{1}{4}$	2
7	22 1927	Spring Clip	2
8	22 0483	Lock Nut	2
9	22 0486	Lens Hold Down Assembly consists of the above reference number items in an assembled unit: 1 thru 8	2

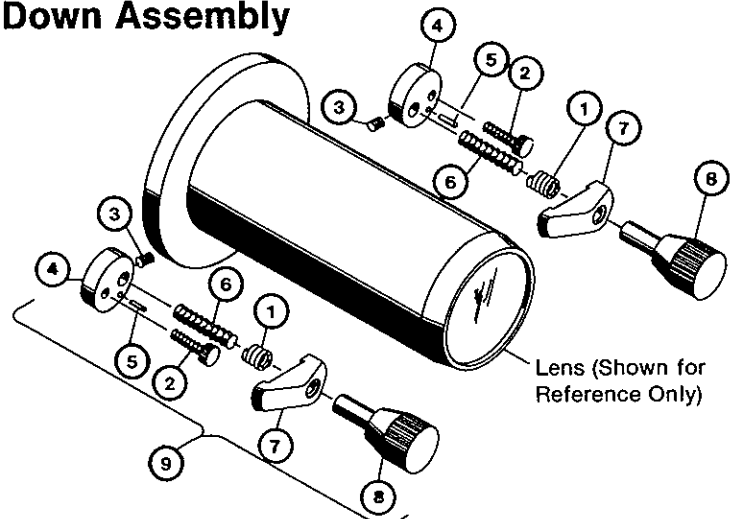


Figure 24



## Bag Assembly (Models with Digital Display)

Ref.	Part No.	Description	Qty.
1	22 1911	Vernier Mount	1
2	48 6736	Spindle Clamp Thrust Washer	1
3	22 0529	Thumb Screw	1
4	22 0723	Vernier Plate	1
5	48 5719	2-56 × 7/16 Button Hd. Soc. Cap. Sc.	2
6	22 1905	Frame Right Side	1
7	22 1922	Frame Left Side	1
8	22 1909	Support, Frame & Vernier	1
9	22 1908	Bracket, Vernier Mount	2
10	48 5137	6-32 × 1/4" Button Hd. Screw	26
11	48 6684	10-24 × 7/8" Button Head Socket Cap Screw	2
12	48 5036	10-32 Hex Nut	4
13	48 6083	Washer	4
14	48 6244	10-32 × 1" Long Socket Cap Screw	4
15	22 1891	Bellows	1
16	22 0740	Front Bag Strip	1
17	48 5111	8-32 × 1/4" Button Hd. Screw	4
18	22 1913	Mounting Strip for Bag (Left & Right Side)	2
19	22 1914	Mounting Strip for Bag (Back Left & Right Side)	2
20	22 1912	Mounting Strip for Bag (Front Left Side)	1
21	22 1915	Mounting Strip for Bag (Back Left & Right Center Sides)	2
22	22 1916	Mounting Strip for Bag (Back Center)	1
23	22 1923	Back Bag Support	1
24	48 5358	10-32 × 7/8" Button Head Screw	16
25	22 1917	Outside Bag Support	1
26	22 0814	Focus Wheel Mount Bag Support	1
27	48 5695	Black Quickedge Plastic Trim	

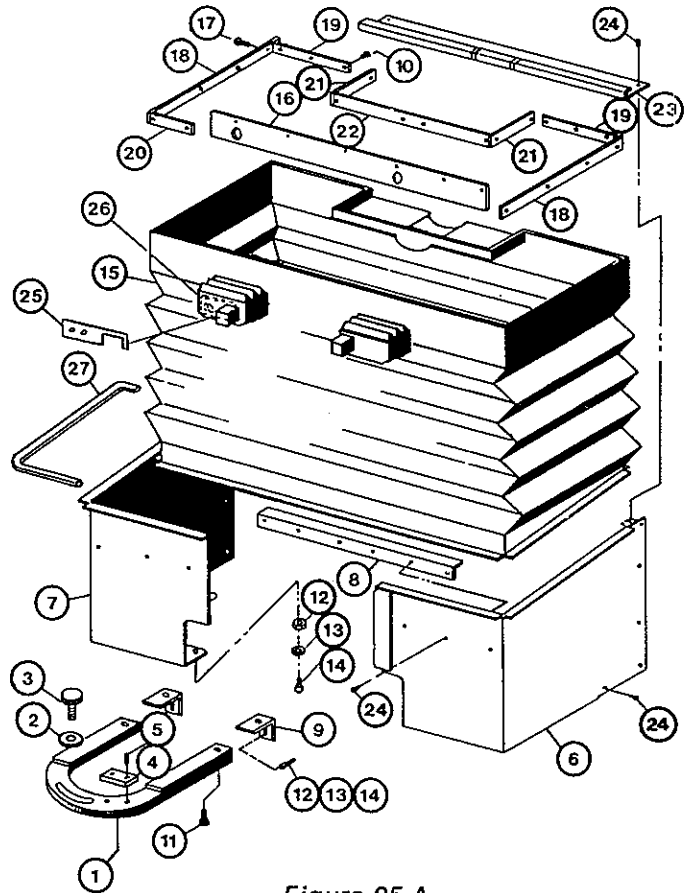


Figure 25-A

## Bag Assembly (Models without Digital Display)

Ref.	Part No.	Description	Qty.
1	22 1784	Vernier Mount	1
2	22 0975	Outside Bag Support	1
3	22 0529	Thumb Screw	1
4	22 0723	Vernier Plate	1
5	48 5719	2-56 × 7/16 Button Head Socket Cap Screw	2
6	22 0715	Left Side Assembly for Bag	1
7	22 0693	Filter Frame and Filter	2
8	48 5137	6-32 × 1/4" Button Head Scr.	41
9	22 1032	Bottom Bag Strip (End)	2
10	22 0740	Front Bag Strip	1
11	48 5111	8-32 × 1/4" Button Head Scr.	28
12	22 0741	Mount Strip for Bag	1
13	22 0699	Mounting Strip for Bag	1
14	22 0742	Mounting Strip for Bag	1
15	48 5156	8-32 × 1" Soc. Hd. Cap Scr.	2
16	22 1080	Back Mounting Strip for Bag	1
17	22 0712	Top Back for Bag	1
18	22 0725-88	Bag	1
19	22 0714	Right Side Assembly for Bag	1
20	48 5007	10-32 × 7/8" Soc. Head Cap Screw	4
21	22 0747	Bag Strip	2
22	22 1033	Bottom Bag Strip (Center)	1
23	22 0798	Outside Bag Support	1
24	22 1081	Back Mounting Strip for Bag	2
25	22 0814	Focus Wheel Mount (Bag Support)	1
26	48 6736	Washer	1

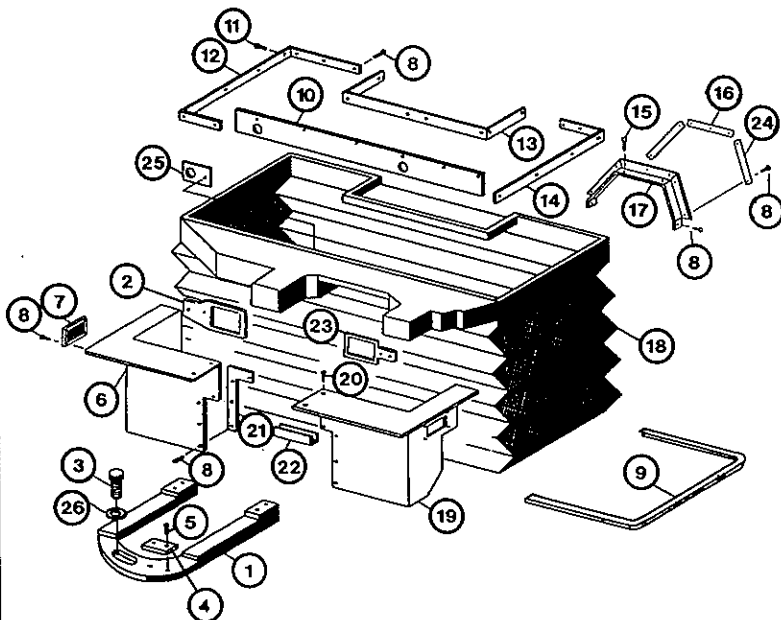
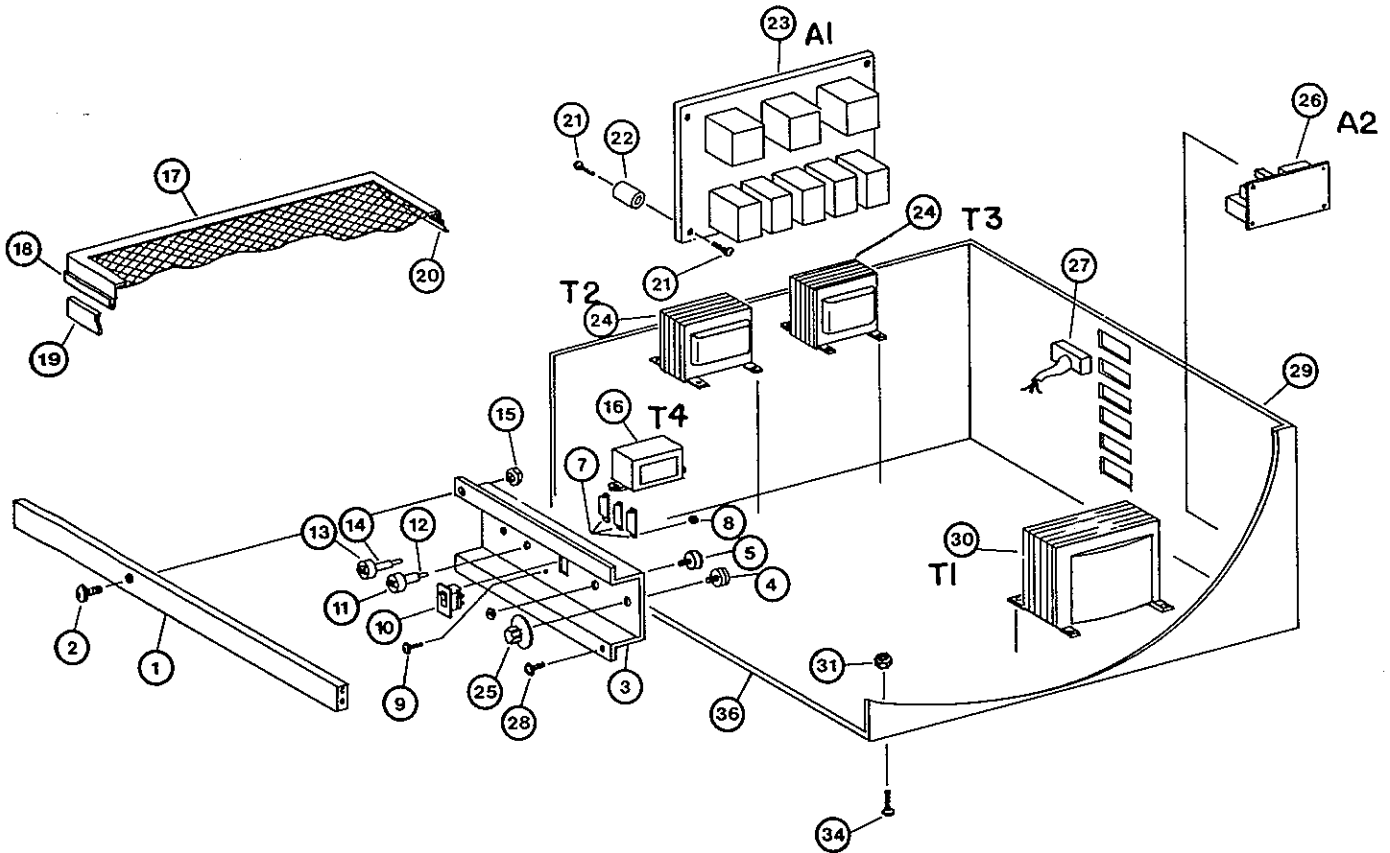


Figure 25-B

# Electrical Tray Assembly

(For Comparators with Serial No. 288 & Up)

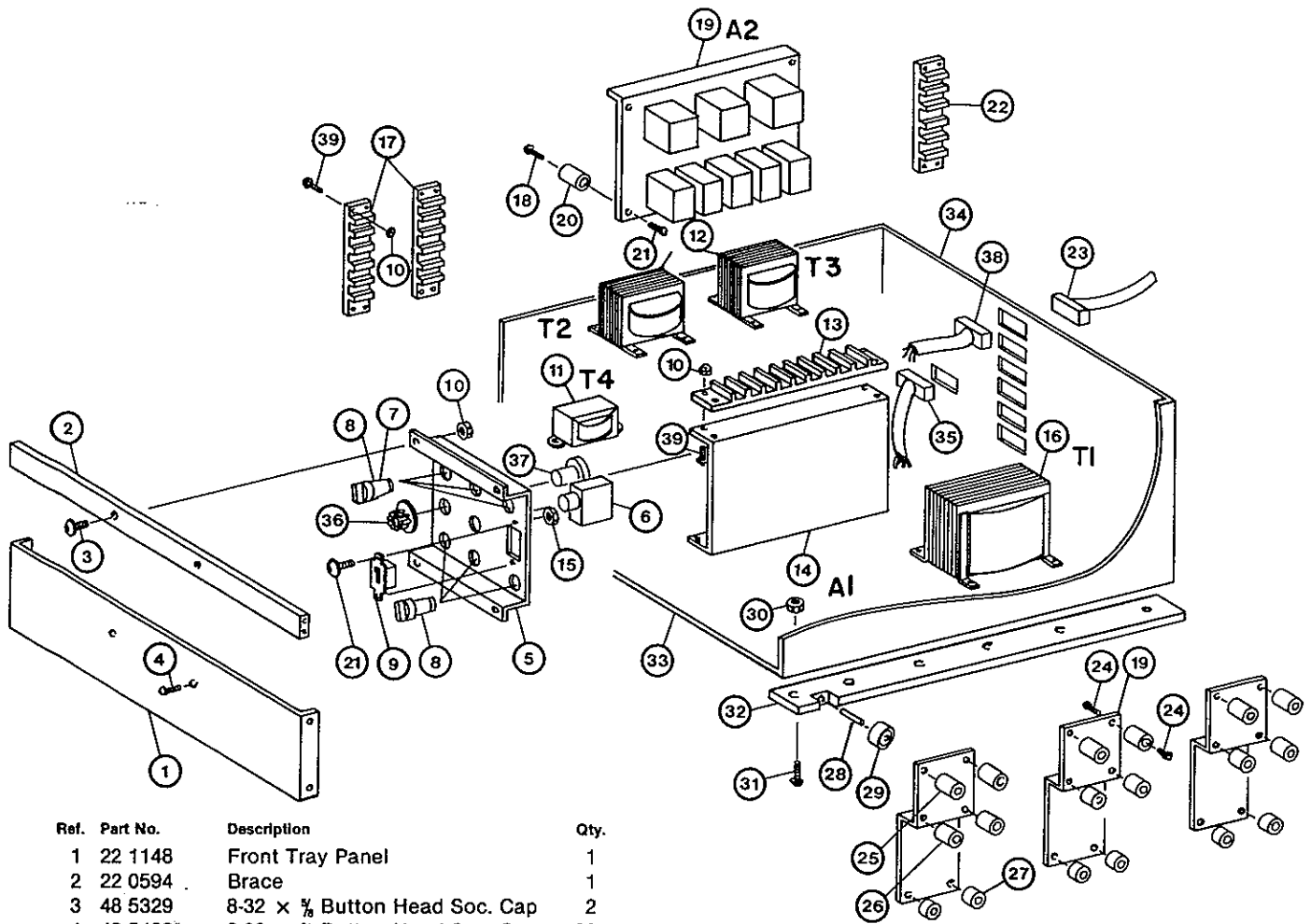


Ref.	Part No.	Description	Qty.	Ref.	Part No.	Description	Qty.
1	22 0594	Brace	1	20	22 1548	Hinge	1
2	48 5329	8-32 x 5/8" Button Head Screw	2	21	48 5137	6-32 x 1/4 Button Head Screw	26
3	22 1984	Tray Front	1	22	48 6457	Stand-Off	12
4	48 6219	500 Ohms Speed Pot.	1	23	22 1574	Relay Board Assembly	1
5	48 6475	2500 Ohm Potentiometer	1	24	22 1430	Transformer Assembly	2
7	48 6268	5 Amp Circuit Breaker	3	25	48 6458	Knob	1
8	48 5624	4-40 Hex Nut	6	26	22 1889	Circuit Board Assembly for Speed Control	1
9	48 5623	4-40 x 1/2" Button Head Screw	6	27	22 1559	Wiring Harness	1
10	22 1010	Switch	1	28	48 5438	8-32 x 5/8" Button Head Screw	20
11	22 1576	Fuse Post	1	29	22 1903	Tray Panel	1
12	48 5885	3 Amp Fuse	1	30	22 1552-01	24 Volt Transformer Assembly	1
13	22 1572	Fuse Post	1	31	48 6044	1/4-20 Elastic Stop Nut	12
14	48 5832	10 Amp Fuse	1	34	48 6424	1/4-20 x 1/2" Button Head Screw	12
15	48 6045	8-32 Elastic Stop Nut	22	36	22 1149	Bottom of Tray	1
16	22 1554	6.3 Volt Transformer Assembly	1	22 0634	Electrical Tray Assembly consists of above reference number items in an assembled unit: 1 thru 36	1	
17	22 1556	Tray Cover	1				
18	48 5695	Plastic Trim	1				
19	22 1547	Front Strap	1				

Figure 26-A

# Electrical Tray Assembly

(For Comparators with Serial No's. 192 thru 287)



Ref.	Part No.	Description	Qty.
1	22 1148	Front Tray Panel	1
2	22 0594	Brace	1
3	48 5329	8-32 x 1/8 Button Head Soc. Cap	2
4	48 5438*	8-32 x 1/8 Button Head Soc. Cap	22
5	22 0630	Mount Bracket	1
6	48 5884	15 Amp Circuit Breaker	1
7	48 5831	Type 3 AG Fuse Post	6
8	48 5885	3 Amp Slo-Blo Fuse	4
	48 6218	1 Amp Slo-Blo Fuse	1
	48 6215	5 Amp Slo-Blo Fuse	1
9	22 1010	Switch	1
10	48 6045	8-32 Elastic Stop Nuts	40
11	48 5917	6-3 Volt Transformer	1
12	22 5175	Transformer	2
13	22 1110	Terminal Block Assembly	1
14	22 1136	Terminal Block Mount	1
15	48 6121	6-32 Elastic Stop Nut	2
16	48 5916	24 Volt Transformer	1
17	22 1109	Terminal Block Assembly	2
18	48 5358	10-32 x 1/4 Button Head Socket Cap Screw	4
19	22 1070	Speed Control System	1
20	22 0348	Standoff	4
21	48 5137	6-32 x 1/4 Button Head Socket Cap Screw	6
22	22 1108	Terminal Block Assembly	1
23	22 1097	Blue Plug Assembly	1
	22 1096	White Plug Assembly	1
	22 1094	Red Plug Assembly	1
	22 1100	Black Plug Assembly	1

Ref.	Part No.	Description	Qty.
	22 1098	Yellow Plug Assembly	1
	22 1102	Green Plug Assembly	1
24	48 5111	8-32 x 1/4 Button Head Socket Cap Screw	30
25	22 1134	Stand-Off	6
26	22 1116	Stand-Off	6
27	22 1133	Stand-Off	6
28	48 5132	Spring Pin	2
29	48 5183	Ball Bearing	2
30	48 6044	1/4-20 Elastic Stop Nuts	12
31	48 6046	1/4-20 x 1/4 Button Hd. Soc. Cap	12
32	22 0586	Slide Bar	2
33	22 1149	Bottom of Tray	1
34	22 1150	Tray Panel	1
35	22 1243	Power Cord Socket Assembly	1
36	48 5683	Knob	1
37	48 6219	Aux. Speed Pot	1
38	22 1089	Blue Receptacle Assembly	1
	22 1090	White Receptacle Assembly	1
	22 1091	Red Receptacle Assembly	1
	22 1088	Black Receptacle Assembly	1
	22 1093	Yellow Receptacle Assembly	1
	22 1092	Green Receptacle Assembly	1
39	48 6125	8-32 x 1/4 Button Hd. Socket Cap Screw	16

Figure 26-B

## Top Tray Assembly

(For Comparators with Serial Numbers 1 thru 191)

Ref.	Part No.	Description	Qty.
1	48 5438	8-32 Button Head Socket Cap Screw $\frac{3}{8}$ " Long	28
2	22 0625	Cover	2
3	48 6045	8-32 Elastic Nut	34
4	22 0626	Channel	2
5	48 5882	1000 Ohm 100 Watt Power Resistor	3
6	48 5881	1000 Ohm 225 Watt Dividohm Resist.	1
7	48 5880	500 Ohm 100 Watt Dividohm Resist.	3
8	48 5875	Single Phase Pull Wave Rectifier	1
9	22 0594	Brace	1
10	22 0630	Mount Bracket (Purchased)	1
11	48 5831	Type 3 AG Indicator Fuse Post	3
12	48 5877	S-246 Polarized Klipvolt/Suppressor	1
13	48 5884	15 Amp Circuit Breaker	1
14	48 5876	S-490 Klipvolt/Suppressor	1
15	22 0585	Top Tray (Purchased)	1
16	48 5329	8-32 Button Head Socket Cap Screw $\frac{3}{8}$ " Long	2
17	48 5185	8-32 Button Head Socket Cap Screw $\frac{3}{8}$ " Long	8
18	22 0595	Rectifier Mount	1
19	48 5885	3 Amp Type 3 AG Slo Blo Fuses	3
20	48 5918	Terminal Block	2
21	48 5878	S-256 Non Polarized Klipvolt/Suppressor	1
22	48 5883	10 Amp Circuit Breaker	1
23	22 1010	Switch	1

Screws used for holding top & bottom trays together:

- 48 6045 Hex Nuts 19 Required
- 48 5438 Screws 19 Required

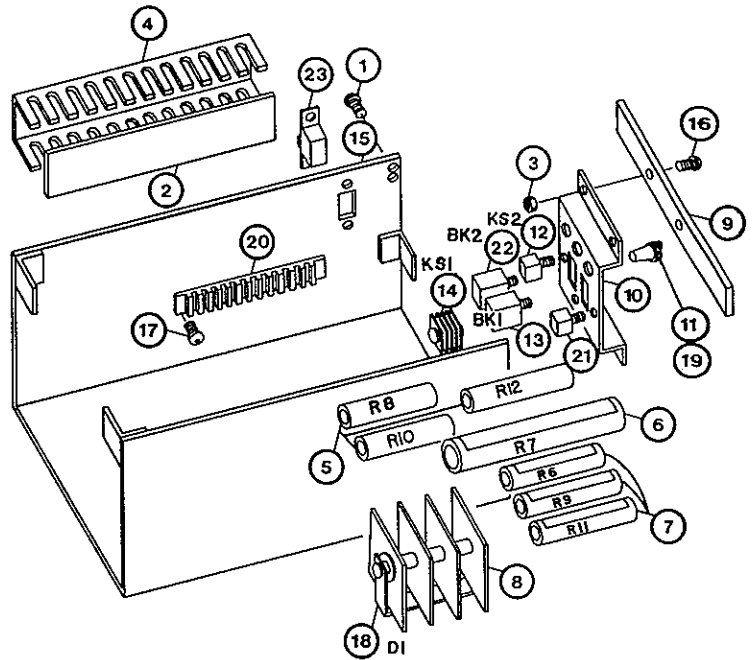


Figure 26-C

## Bottom Tray Assembly

(For Comparators with Serial Numbers 1 thru 191)

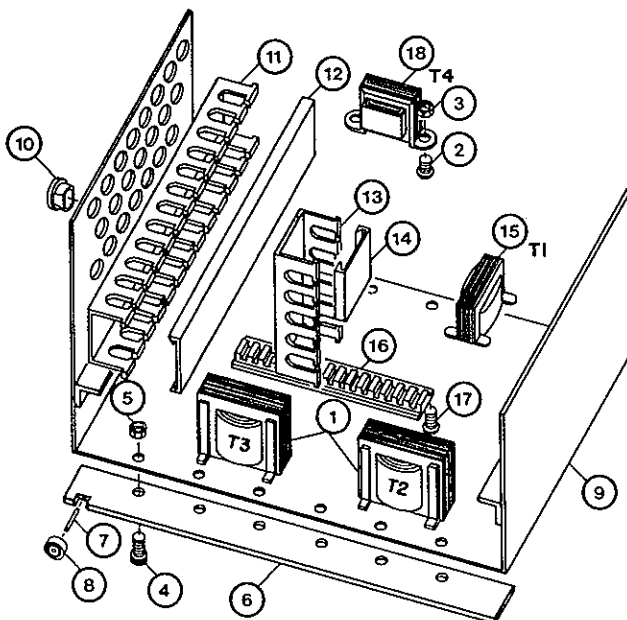
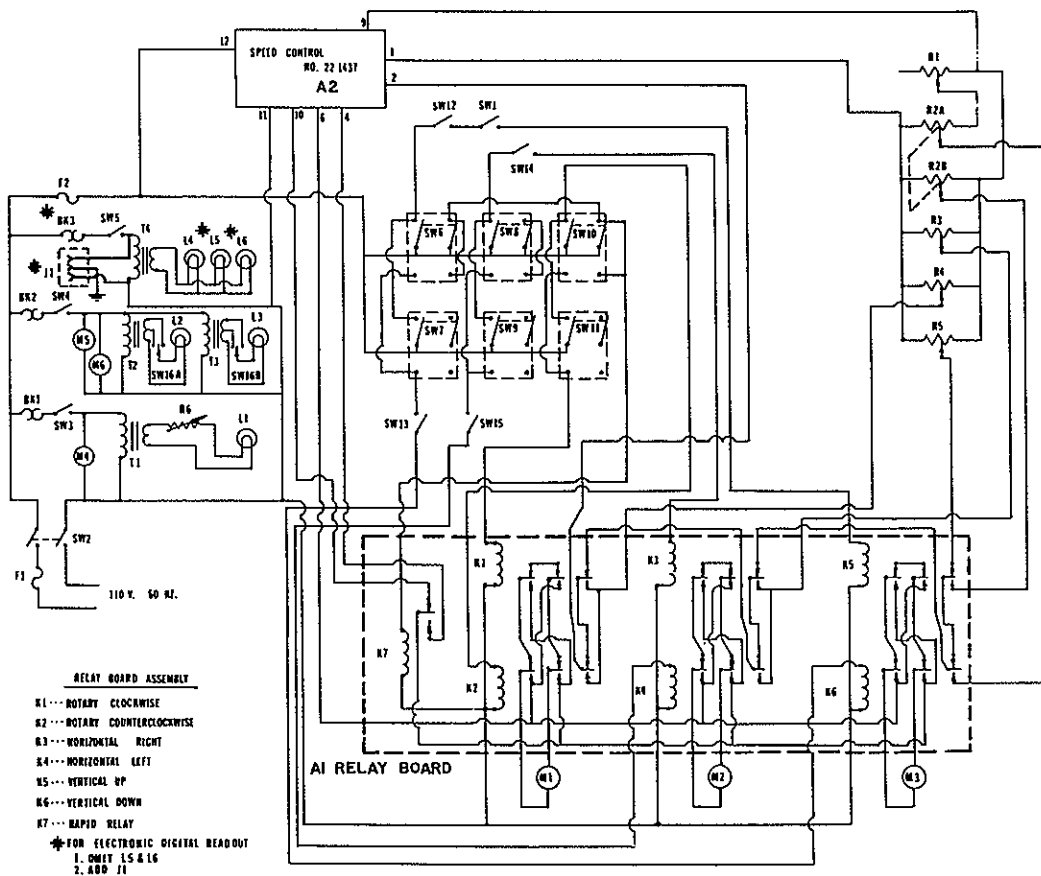


Figure 26-D

Ref.	Part No.	Description	Qty.
1	22 5175	Transformer	2
2	48 5438	8-32 Button Head Socket Cap Screw $\frac{3}{8}$ " Long	22
3	48 6045	8-32 Elastic Nut	26
4	48 6046	$\frac{1}{4}$ -20 Button Head Socket Cap Screw $\frac{1}{2}$ " Long	12
5	48 6044	$\frac{1}{4}$ -20 Elastic Nut	12
6	22 0586	Slide	2
7	48 5132	Spring Pin	2
8	48 5183	Ball Bearing	2
9	22 0584	Bottom Tray (Purchased)	1
10	48 6022	Terminal Bushing	22
11	22 0591	Channel	2
12	22 0624	Cover	1
13	22 0590	Channel	1
14	22 0592	Cover	1
15	48 5916	24 Volt Transformer	1
16	48 5918	Terminal Block	1
17	48 5185	8-32 Button Head Socket Cap Screw $\frac{3}{8}$ " Long	4
18	48 5917	6.3 Volt Transformer	1

# Electrical Assembly

(For Serial Numbers 288 & Up)

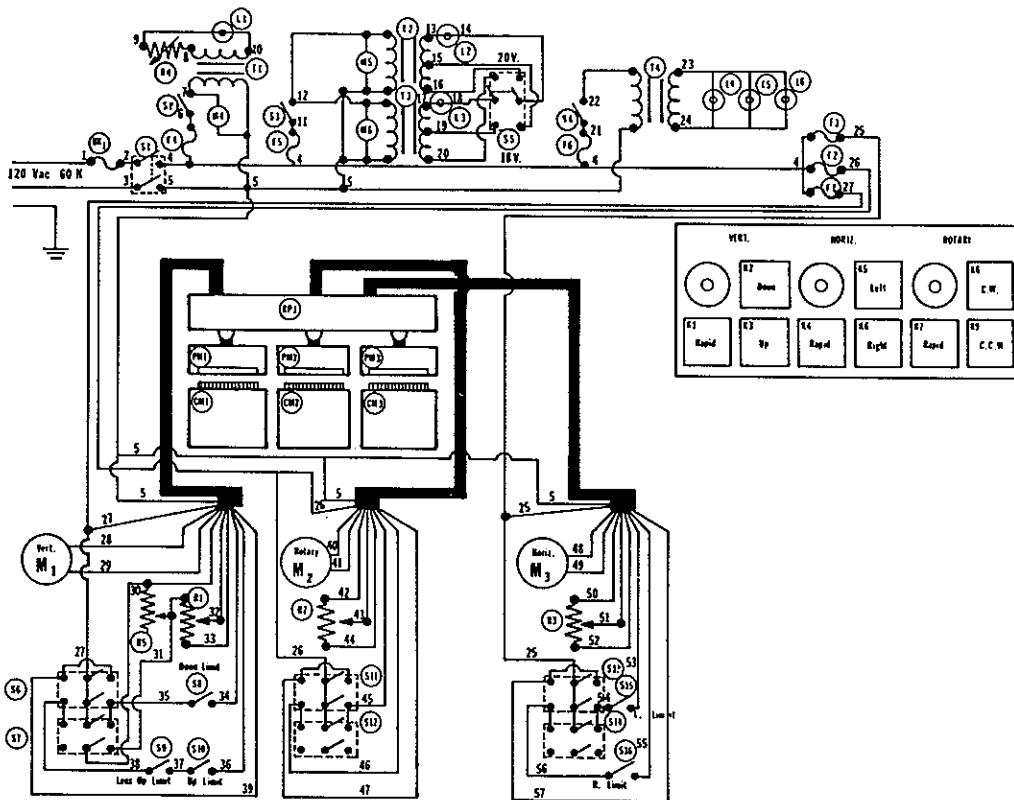


Ref.	Part No.	Description	Ref.	Part No.	Description
SW1	48 5594	Lens Limit Switch	R3	48 6481	2500 Ohms Pot.—Horz. Slow Speed
SW2	48 6041	Main Power Switch	R4	48 6481	2500 Ohms Pot.—Rotary Slow Speed
SW3	48 5888	Profile Power Switch	R5	48 6475	2500 Ohms Pot.—Idle Speed
SW4	48 5888	Surf. Illum. Power Switch	R6	48 5445	½ Ohms Rheostat—Profile
SW5	48 5888	Scale Power Switch	L1	48 5766	Profile Bulb
SW6	48 5711	Vert. Rapid Motion Switch	L2	48 5442	Surf. Illum. Bulb
SW7	48 5886	Vert. Slow Motion Switch	L3	48 5442	Surf. Illum. Bulb
SW8	48 5711	Horz. Rapid Motion Switch	L4	48 6097	Scale Lamp—Vert.
SW9	48 5886	Horz. Slow Motion Switch	L5	48 6097	Scale Lamp—Horz.
SW10	48 5711	Rotary Rapid Motion Switch	L6	48 5675	Scale Lamp—Rotary
SW11	48 5886	Rotary Slow Motion Switch	M1	22 0308	Rotary Motor
SW12	48 5594	Vert. Up Motion Limit Switch	M2	22 0307	Horz. Motor
SW13	48 5594	Vert. Down Motion Limit Switch	M3	22 0306	Vert. Motor
SW14	48 5594	Horz. Left Motion Limit Switch	M4	48 5304	Profile Fan Motor
SW15	48 5594	Horz. Right Motion Limit Switch	M5	48 5304	Surf. Illum. Fan Motor
SW16	22 1010	Surf. Illum. Hi-Low Switch	M6	48 5304	Surf. Illum. Fan Motor
F1	48 5832	10 Amp—3 AG Fuse	K1	48 6205	Relay Rotary Motion
F2	48 5885	3 Amp—3 AG Slow Blow Fuse	K2	48 6205	Relay Rotary Motion
BK1	48 6268	5 Amp Circuit Breaker	K3	48 6205	Relay Horz. Motion
BK2	48 6268	5 Amp Circuit Breaker	K4	48 6205	Relay Horz. Motion
BK3	48 6265	1 Amp Circuit Breaker	K5	48 6205	Relay Vert. Motion
T1	22 1430	Profile Transformer	K6	48 6205	Relay Vert. Motion
T2	22 1430	Surf. Illum. Transformer	K7	48 6205	Relay Rapid All Motions
T3	22 1430	Surf. Illum. Transformer	A1	22 1574	Relay Board
T4	22 1430	Scale Transformer	A2	22 1437	Speed Control Board
R1	48 6219	500 Ohms Pot.—Vert. Up-Down Speed Comparator			
R2	22 1571	Dual 2500 Ohms Pot.—Vert. Slow Speed			

Figure 27-A

# Electrical Assembly

(For Serial Numbers 192 thru 287)

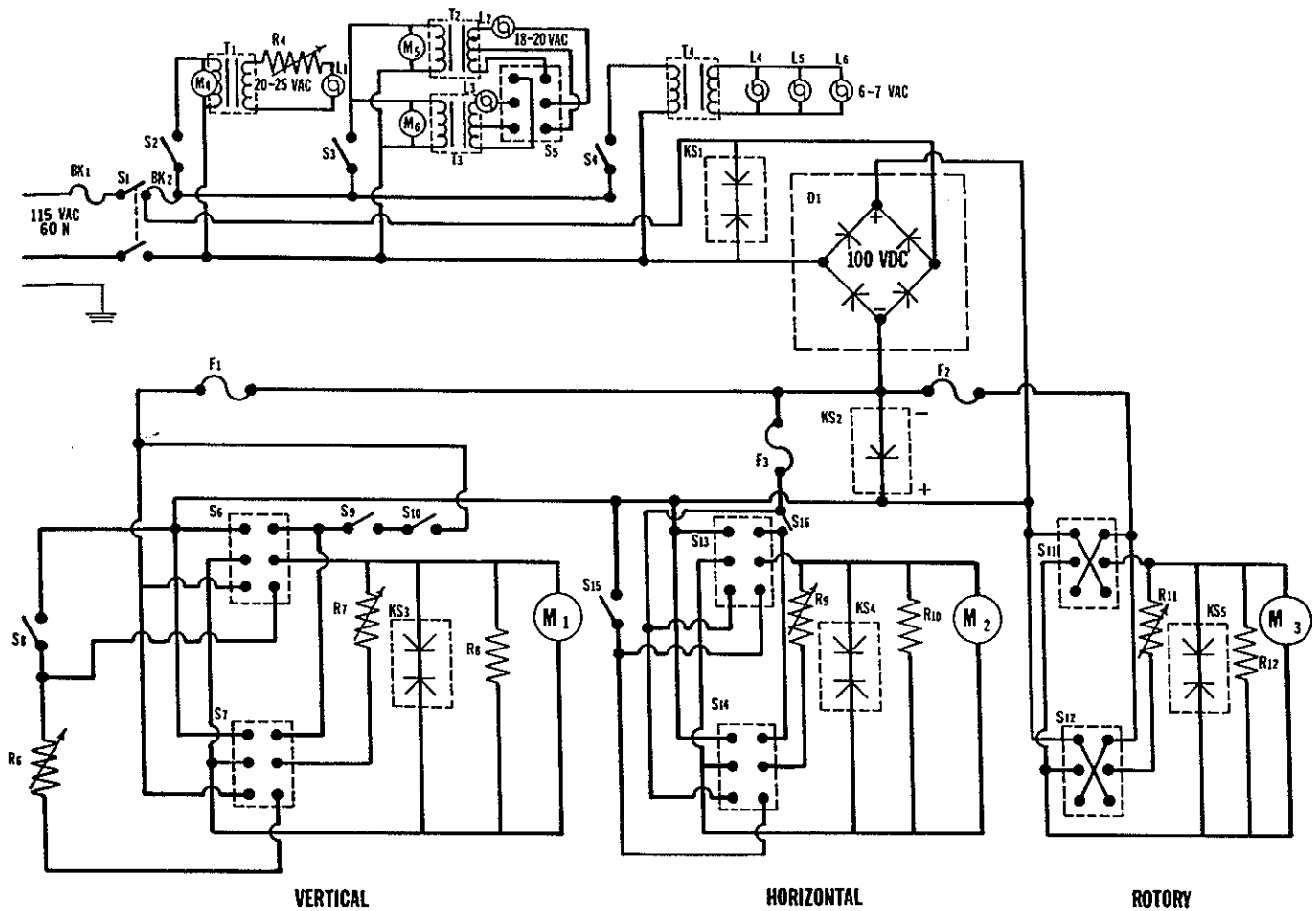


Ref.	Part No.	Description	Ref.	Part No.	Description
S1	48 6041	Switch DPST	L1	48 5766	Profile Lamp
S2	48 5888	Switch SPST	L2	48 5442	Left Surf. Illum. Lamp
S3	48 5888	Switch SPST	L3	48 5442	Right Surf. Illum. Lamp
S4	48 5888	Switch SPST	L4	48 5675	Rotary Scale Lamp
S5	22 1010	Switch DPDT	L5	48 6097	Heid. Reader Lamp
S6	48 5711	Switch DPDT	L6	48 6097	Heid. Reader Lamp
S7	48 5886	Switch DPDT	F1	48 5885	Vertical Fuse 3A
S8	48 5594	Micro Switch SPDT-NC	F2	48 5885	Rotary Fuse 3A
S9	48 5594	Micro Switch SPDT-NC	F3	48 5885	Horz. Fuse 3A
S10	48 5594	Micro Switch SPDT-NC	F4	48 5885	Profile Fuse 3A
S11	48 5711	Switch DPDT	F5	48 6215	Surf. Illum. Fuse 5A
S12	48 5886	Switch DPDT	F6	48 6218	Scale Fuse 1A
S13	48 5711	Switch DPDT	K1	48 6205	Vertical Rapid Relay
S14	48 5886	Switch DPDT	K2	48 6205	Vertical Down Relay
S15	48 5594	Micro Switch SPDT-NC	K3	48 6205	Vertical Up Relay
S16	48 5594	Micro Switch SPDT-NC	K4	48 6205	Horz. Rapid Relay
M1	22 0306	Vertical Motor	K5	48 6205	Horz. Left Relay
M2	22 0308	Rotary Motor	K6	48 6205	Horz. Right Relay
M3	22 0307	Horz. Motor	K7	48 6205	Rotary Rapid Relay
M4	48 5304	Profile Fan Motor	K8	48 6205	Rotary CW Relay
M5	48 5304	Lt. Surf. Illum. Fan Motor	K9	48 6205	Rotary CCW Relay
M6	48 5304	Rt. Surf. Illum. Fan Motor	RP1	22 1188	Relay Pack
R1	22 1193	Vertical Speed Pot.	PM1	22 1189	Vertical Power Module
R2	22 1193	Rotary Speed Pot.	PM2	22 1191	Rotary Power Module
R3	22 1193	Horz. Speed Pot.	PM3	22 1191	Horz. Power Module
R4	48 5445	Profile Brightness Pot.	CM1	22 1190	Vertical Control Module
R5	48 6219	Vertical Down Speed Pot.	CM2	22 1192	Rotary Control Module
T1	48 5916	Profile Transformer	CM3	22 1192	Horz. Control Module
T2	22 5175	Left surf. Illum. Transformer	BK1	48 5884	Main Circuit Breaker
T3	22 5175	Right Surf. Illum. Transformer	A1	22 1136	Terminal Block Mount
T4	48 5917	Scale Transformer	A2	22 1070	Speed Control System

Figure 27-B

# Electrical Assembly

(For Serial Numbers through 191)



VERTICAL

HORIZONTAL

ROTARY

Ref.	Part No. <sup>2</sup>	Description
S1	48 6041	Switch DPST
S2	48 5888	Switch SPST
S3	48 5888	Switch SPST
S4	48 5888	Switch SPST
S5	22 1010	Switch DPDT
S6	48 5711	Switch DPDT
S7	48 5886	Switch DPDT
S8	48 5594	Micro Switch SPDT-NC
S9	48 5594	Micro Switch SPDT-NC
S10	48 5594	Micro Switch SPDT-NC
S11	48 5711	Switch DPDT
S12	48 5886	Switch DPDT
S13	48 5711	Switch DPDT
S14	48 5886	Switch DPDT
S15	48 5594	Micro Switch SPDT-NC
S16	48 5594	Micro Switch SPDT-NC
M1	22 0306	Vertical Motor
M2	22 0308	Rotary Motor
M3	22 0307	Horizontal Motor
M4	48 5304	Profile Fan Motor
M5	48 5304	Left Surface Illuminator Fan Motor
M6	48 5304	Right Surface Illuminator Fan Motor
T1	48 5916	Profile Transformer
T2	22 5175	Left Surface Illuminator Transformer
T3	22 5175	Right Surface Illuminator Transformer
T4	48 5917	Scale Transformer

Ref.	Part No.	Description
L1	48 5766	Profile Lamp
L2	48 5442	Left Surface Illuminator Lamp
L3	48 5442	Right Surface Illuminator Lamp
L4	48 5675	Rotary Scale Lamp
L5	48 6097	Heidenhain Reader Lamp
L6	58 6097	Heidenhain Reader Lamp
F1	48 5885	Vertical Fuse 3A
F2	48 5885	Rotary Fuse 3A
F3	48 5885	Horizontal Fuse 3A
BK1	48 5884	15 A Circuit Breaker
BK2	48 5883	10 A Circuit Breaker
R4	48 5445	Profile Brightness Pot.
R6	48 5880	Vertical Down Speed Resistor
R7	48 5881	Vertical Jog Resistor
R8	48 5882	Vertical Breaking Resistor
R9	48 5880	Horizontal Job Resistor
R10	48 5882	Horizontal Breaking Resistor
R11	48 5880	Rotary Job Resistor
R12	48 5882	Rotary Breaking Resistor
KS1	48 5876	Suppressor
KS2	48 5877	Suppressor
KS3	48 5878	Suppressor
KS4	48 5879	Suppressor
KS5	48 5879	Suppressor
D1	48 5875	Rectifier

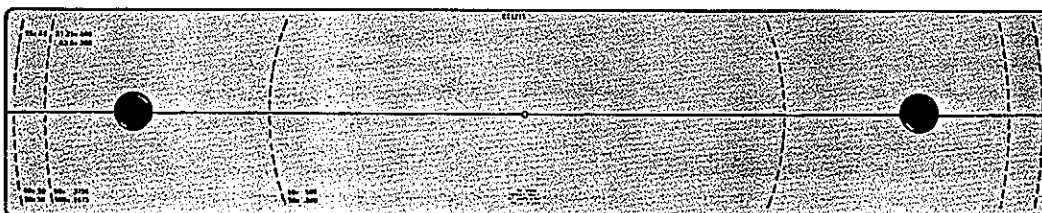
Figure 27-C

## STAGING FIXTURES

for Model Nos. 22-1400-00 and 22-2500-00

 <p><b>Cat. No. 22-1005-00</b> Universal staging kit</p>	 <p><b>Cat. No. 22-1005-24</b> Fixture base with large rotary vise (<math>\frac{5}{8}</math>" <math>\times</math> <math>1\frac{1}{4}</math>" <math>\times</math> 3")</p>	 <p><b>Cat. No. 22-1005-19</b> Fixture base with V block</p>	 <p><b>Cat. No. 22-1005-21</b> Fixture base with small rotary vise (<math>\frac{3}{4}</math>" <math>\times</math> <math>\frac{3}{4}</math>" <math>\times</math> <math>1\frac{3}{4}</math>")</p>
 <p><b>Cat. No. 22-1005-22</b> Fixture base with horizontal fixture plate (<math>\frac{5}{8}</math>" <math>\times</math> <math>\frac{7}{8}</math>" <math>\times</math> <math>2\frac{1}{2}</math>")</p>	 <p><b>Cat. No. 22-1005-23</b> Fixture base with horizontal fixture plate (<math>\frac{5}{8}</math>" <math>\times</math> <math>1\frac{1}{4}</math>" <math>\times</math> 5")</p>	 <p><b>Cat. No. 22-1005-15</b> Fixture base machined with slot and set screws</p>	 <p><b>Cat. No. 22-1005-25</b> Fixture base with V and adjustable end stop. Can be made with parts in Universal Staging Kit. Cat. No. 22-1005-00</p>
 <p><b>Cat. No. 22-1005-26</b> Fixture base with transparent plate (<math>2\frac{1}{2}</math>" <math>\times</math> <math>2\frac{1}{2}</math>" <math>\times</math> <math>\frac{1}{4}</math>")</p>	 <p><b>Cat. No. 22-1005-27</b> Fixture base with transparent plate (5" <math>\times</math> <math>2\frac{1}{2}</math>" <math>\times</math> <math>\frac{1}{4}</math>")</p>	 <p><b>Cat. No. 22-1005-28</b> Fixture base with magnetic top shelf and adjustable end stop</p>	 <p><b>Cat. No. 22-1005-29</b> Fixture base with adjustable vertical centers</p>
 <p><b>Cat. No. 22-1005-30</b> Fixture base with adjustable horizontal V (2"-7") and adjustable center (0"-5") attachment</p>	 <p><b>Cat. No. 22-1005-31</b> Universal shift plate base</p>	 <p><b>Cat. No. 22-1005-32</b> Universal shift plate base with fixture base and adjustable end stop. <b>Specifications</b>—11" <math>\times</math> <math>3\frac{1}{4}</math>" <math>\times</math> <math>1\frac{1}{4}</math>". Order Accessory Bases or use with Kit No. 22-1005-00</p>	 <p><b>Cat. No. 74-0413-00</b> Master magnification ball checker in wood case, certified to NBS. For use on all sizes of comparators</p>

## Magnification/Calibration Kits (for Optical Comparators)

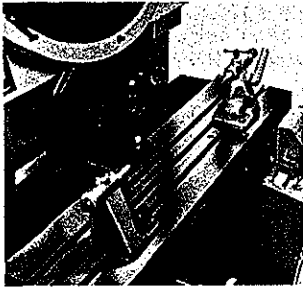


**Cat. No. 74-0321-00**  
10" glass magnification checker with knobs, wood case, certified to NBS for use with 14" comparators.

**Cat. No. 74-0330-00**  
20" glass magnification checker with knobs, wood case, certified to NBS for use with 30" comparators.

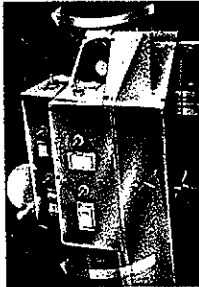


## ACCESSORIES



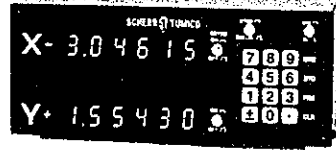
### Heavy-Duty 8" x 35" Stage

As standard equipment, the 8" x 35" stage is motorized over the 12" horizontal and 9" vertical travel, with 3" manual focus travel. The table top has three standard dovetail slots for mounting fixtures with a 500 lb. load capacity.



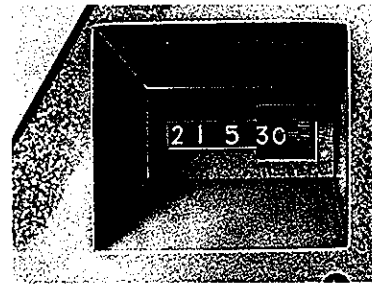
### Adjustable Positioning Lamphouse

As a standard feature the adjustable position lamphouse swings plus or minus 10° for helix angle clarity of thread image, providing a sharp and distortion-free image of the entire thread. The lamphouse also contains the telecentric condenser lens system, a built-in green filter which can be switched from white to green light and the fingertip controls for the power drive systems of the stage and protractor ring.



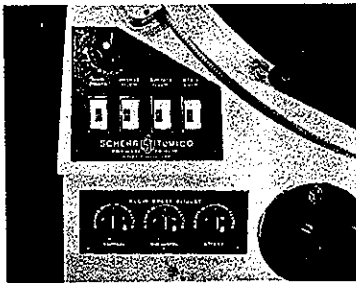
### Electronic Digital Readout System

As standard equipment, the 30" comparator includes electronic digital readout. Readings are to .0001" English, with direct conversion to .002mm. The readings are taken via glass scales on both axis. Both axis have zero resets and numbers can be preset or entered into the datum step memory system via the keyboard.  
Note: BCD or RS232 outputs are available on request.



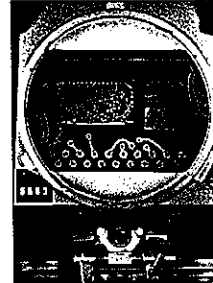
### Optical Protractor Reader

As a standard feature motorized rotary protractor ring reads direct to 1 minute of arc by digital readout. Rapid traverse moves protractor ring at 1 RPM. Fine adjustment power feed lines up crossline on screen and is activated by a jog switch. Reading in the illustration shows digital protractor readout is 215 degrees and 30 minutes of arc. Additional clips are positioned on the rotary protractor ring to hold seated image overlay charts.



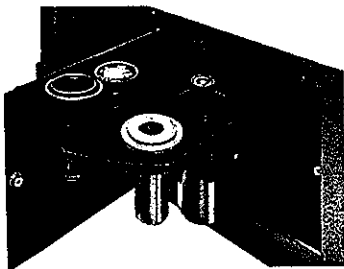
### Power and Speed Control Panel

As a standard feature the 30" Comparator utilizes electronic power control panels with separate individual switches for main power, profile illumination, surface illumination, and digital scale illumination. Each switch has a signal light showing which switch has been left on or what units are in operation. A rheostat to vary light intensity on the screen is standard equipment. Power speed control is also standard equipment.



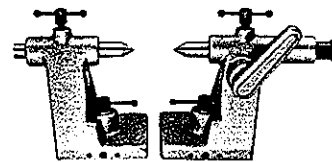
### Duplex Surface Illumination CAT. NO. 22-2518-00

As optional equipment, the 30" Optical Comparator has available a dual surface illumination which incorporates a separate illumination system on both sides of the projection lens. Each illuminator may be directed to the left or right, or telescoped in and out to spotlight or floodlight a part and can be used on all magnifications.



### Lens Storage Compartment

As a standard feature, this lens storage compartment is located on the right side of the comparator. The lens holder swings out of the side door and holds lenses with magnifications of 10x thru 100x. The lenses available for the 30" comparator are of 5x, 10x, 20x, 25x, 31 1/2x, 50x, 62 1/2x, and 100x magnifications.



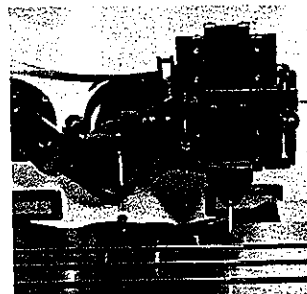
### Staging Centers CAT. NO. 22-2533-00

As optional equipment, the 30" Optical Comparator has available a matched pair of rugged stage centers with the capacity of 8" diameter by 28" length. One stage center is spring loaded for production inspection.



### Central Electronics Control

As a standard feature the comparator has solid state variable speed controls with positive dynamic braking. All of the electronic connections for the 22-2500-00 Comparator are in a centralized area which is easily accessible through a door on the left hand side of the contour projector. A slide-out drawer contains all fuses and central electrical control devices. Defective or blown-out fuses are indicated by automatic light indicators.



### Tracer Attachment CAT. NO. 22-2535-00

As optional equipment, the 30" Optical Comparator has available a tracing attachment with a 3" x 3" motion. A set of .125" diameter ball styli contact a part. Their movement over the part's contour is magnified, appearing on the comparator screen for comparison.

### 30" Optical Comparator

**Cat. No. 22-2500-00** — 30" optical comparator, 8" x 35" stage with 9" x 12" travel, electronic digital readout to .0001"/.002mm, motorized protractor ring with optical/digital readout to 1 minute of arc and other standard features shown on pages 1 and 2.

**Cat. No. 22-2500-01** — 30" optical comparator with same features as 22-2500-00 above, except includes six position power lens changer for use on all lenses except 5x. Electrically operated, just dial lens magnification desired, and lens is automatically selected and placed in position.

### Accessories

**Cat. No. 22-2515-00** — 11" x 14" Camera attachment

**Cat. No. 22-2518-00\*\*** — Duplex surface illumination with adjustable spot of floodlight focusing. No separate lens or reflectors required.

**Cat. No. 22-2537-00\*** — Mercury arc profile lamphouse.

**Cat. No. 22-2536-00\*\*** — Ventilating fan, mount in top of canopy.

### Lenses

**Cat. No. 22-2508-00** — 5x magnification projection lens covering an area of 6.000" diameter, with matching condenser lens, and case.

**Cat. No. 22-2501-00** — 10x magnification projection lens covering an area of 3.000" diameter.

**Cat. No. 22-2502-00** — 20x magnification projection lens covering an area of 1.500" diameter.

**Cat. No. 22-2503-00** — 25x magnification projection lens covering an area of 1.200" diameter.

**Cat. No. 22-2505-00** — 31¼x magnification projection lens covering an area of .960" diameter.

**Cat. No. 22-2504-00** — 50x magnification projection lens covering an area of .600" diameter.

**Cat. No. 22-2506-00** — 62½x magnification projection lens covering an area of .480" diameter.

**Cat. No. 22-2507-00** — 100x magnification projection lens covering an area of .300" diameter.

### Optional Readout Systems

**Cat. No. 22-2509-00** — Preset storage module, dual axis, 96 position memory for each axis with battery back-up to maintain dimension for up to 10 days.

**Cat. No. 22-2510-00\*\*** — Alpha-numeric printer, dual axis, English/Metric.

#### NOTE:

30" Optical comparator can be specially wired for single phase operation other than 115 volt.

### Staging Fixtures

**Cat. No. 22-2533-00** — Stage centers with capacity of 8" diameter by 28" length. Spring loaded for production inspection.

**Cat. No. 22-2535-00\*\*** — Tracer attachment with 3" x 3" motion, with standard set of .125" diameter ball contact styli.

**Cat. No. 22-1005-00** — Universal staging kit.

**Cat. No. 22-1005-15** — Fixture base machined with slot and set screws.

**Cat. No. 22-1005-19** — Fixture base with V block.

**Cat. No. 22-1005-20** — V block adapter to be used with 22-1005-19. (Not shown)

**Cat. No. 22-1005-21** — Fixture base with small rotary vise.

**Cat. No. 22-1005-22** — Fixture base with horizontal fixture plate.

**Cat. No. 22-1005-23** — Fixture base with horizontal fixture plate.

**Cat. No. 22-1005-24** — Fixture base with large rotary vise.

**Cat. No. 22-1005-25** — Fixture base with V and adjustable end stop.

**Cat. No. 22-1005-26** — Fixture base with transparent plate.

**Cat. No. 22-1005-27** — Fixture base with transparent plate.

**Cat. No. 22-1005-28** — Fixture base with magnetic top shelf and adjustable end stop.

**Cat. No. 22-1005-29** — Fixture base with adjustable vertical centers.

**Cat. No. 22-1005-30** — Fixture base with adjustable horizontal V (2"-7") and adjustable center (0"-5") attachment.

**Cat. No. 22-1005-31** — Universal shift plate base.

**Cat. No. 22-1005-32** — Universal shift plate base with fixture base and adjustable end stop.

**Cat. No. 22-0389-02** — Right angle backing plate.

### Screens

**Cat. No. 74-0008-13** — Standard cross line glass replacement screen with 30° cross lines — sealed image. 30¼" dia. x ¼" thick.

**Cat. No. 74-0222-00** — ¼" thick glass screen blank, frosted.

**Cat. No. 74-0221-00** — .03" thick plastic chart blanks, frosted.

### Replacement Bulbs

**Cat. No. 48-5766-00** — Projection bulb, high intensity with built-in reflector, 24 volts, 200 watts, type DSW.

**Cat. No. 48-5948-00** — Bulbs for readers, 6 volts, 10 watts, type BA-15d, for machines with serial No. 116 and under.

**Cat. No. 48-6097-00** — Bulbs for readers, 6 volts, 10 watts, type 27.A, for machines with serial No. 117 and up.

**Cat. No. 48-5442-00** — Surface illuminator bulbs for high intensity light, type DLS, with built-in reflector.

\*These items are available only as original factory installation.

\*\*We recommend that these items be purchased on the basic unit. If installed in the field, there is an installation and service charge. There is a charge of \$750.00 for the shipping pallet and shipping brackets. These items can be returned for full credit; however, they must be returned freight prepaid.

# Notes



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