SUSS MJB 3

MASK ALIGNER

Operator's Reference Manual

Model No. _____ Serial No. _____

Date of Manufacture_____ _____

This Operator's Reference Manual is subject to review and/or revision.

MJB 3 TABLE OF CONTENTS

1 GENERAL DESCRIPTION AND PRINCIPLES OF OPERATION

2 OPERATING PROCEDURES

3 WARNINGS AND SAFETY HAZARDS

4 QUALITY CONTROL

5 MAINTENANCE

LIST OF ILLUSTRATIONS

1 GENERAL DESCRIPTION AND PRINCIPLES OF OPERATION

The SUSS MJB 3 Mask Aligner is designed for high resolution photolithography in a laboratory or pilot production environment. The MJB 3 product line offers unsurpassed flexibility in the handling of irregularly shaped substrates of differing thicknesses, as well as standard size wafers up to 3″ diameter. All operating controls are laid out in a simple, ergonomic design, making the operation of the aligner easy to learn and providing the versatility needed in specialized processes.

Due to its modular construction and robust precision mechanics, the SUSS MJB 3 is particularly easy to service. All functional groups are easily accessible and complete assemblies are quickly modified or replaced.

The MJB 3 is offered in five models, which are outlined in Section 1 of this chapter. In Section 2 you will follow a wafer through one cycle of a typical operating procedure. Section 3 outlines the different exposure modes which may be utilized with the MJB 3. In Section 4 you will learn how to identify the various subassemblies of the MJB 3. Section 5 describes the function of the special features of the MJB 3.

1.1 The MJB 3 Model Series

1.1.1 MJB 3 Standard

The SUSS MJB 3 Standard (Figure 1-1) is equipped with a 200W lamphouse containing a relatively simple and yet comparatively high resolution optical system. A 200W mercury short-arc lamp is used. Primary exposure wavelengths are 350-500nm. The aligner performs exposures in hard contact mode (nitrogen pressure under the substrate) and soft contact mode (vacuum under the substrate). As an option, the MJB 3 Standard can also be equipped to perform proximity exposures. Line/space resolution of 1.5 microns and alignment accuracies of 0.2 microns can be obtained with the MJB 3 Standard under optimum conditions.

1.1.2 MJB 3 HP

The SUSS MJB 3 HP (Figure 1-2) is equipped with the same optical system as the MJB 3 Standard. It can perform exposures in vacuum contact, hard contact, soft contact, or in

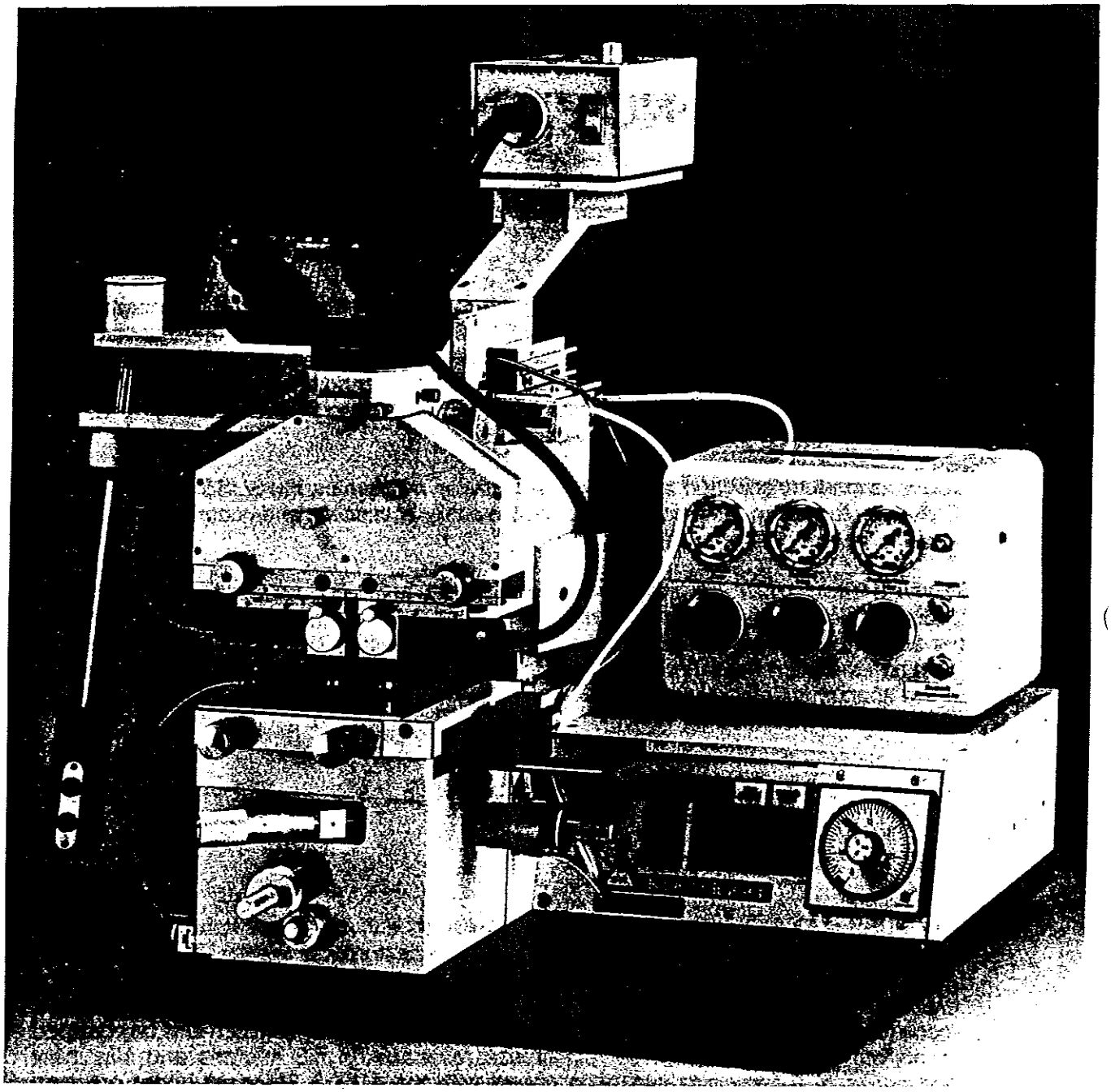


Figure 1-1 SUSS MJB 3 Standard With Splitfield Microscope

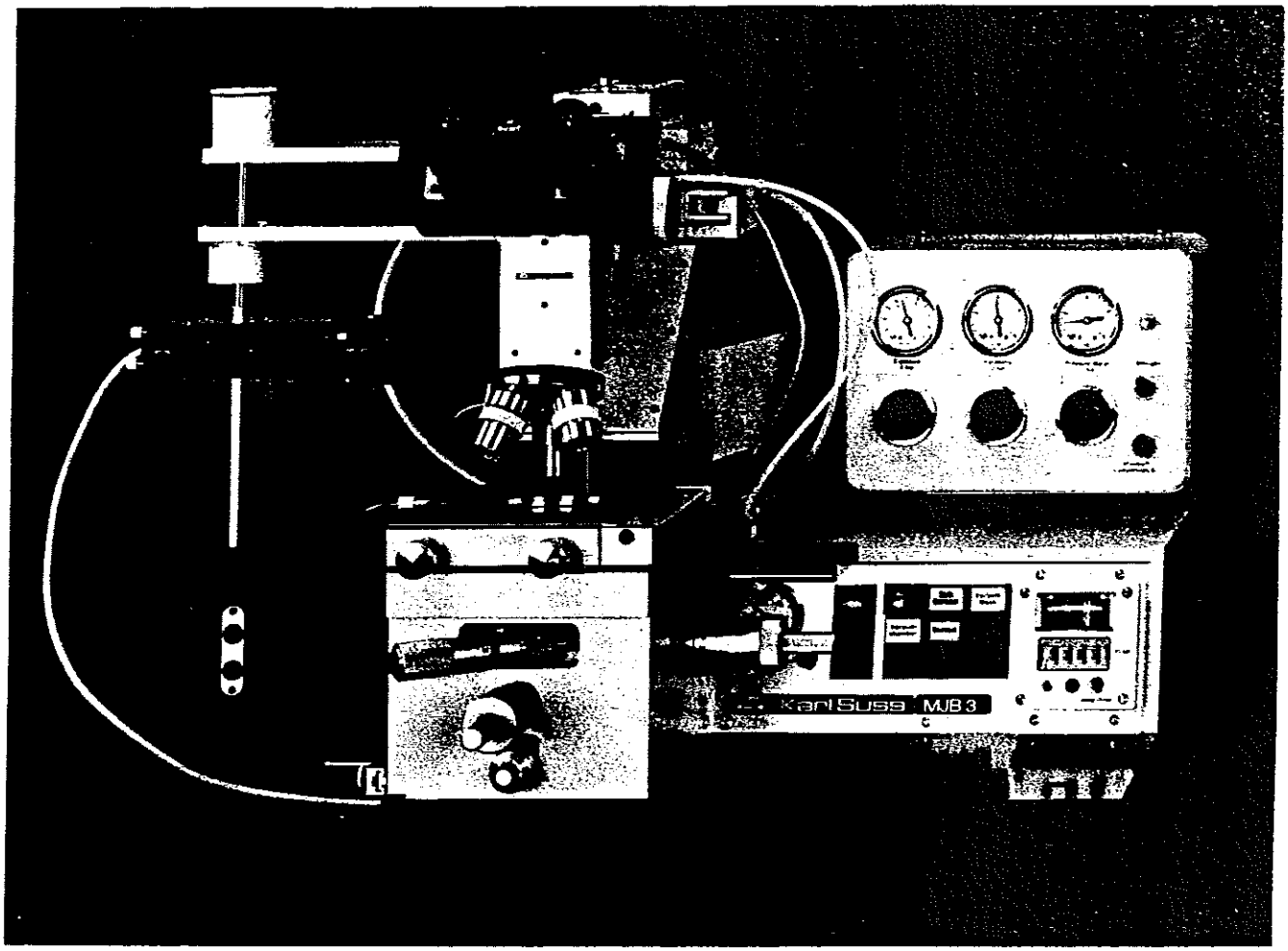


Figure 1-2 SUSS MJB 3 HP with Normalfield Microscope

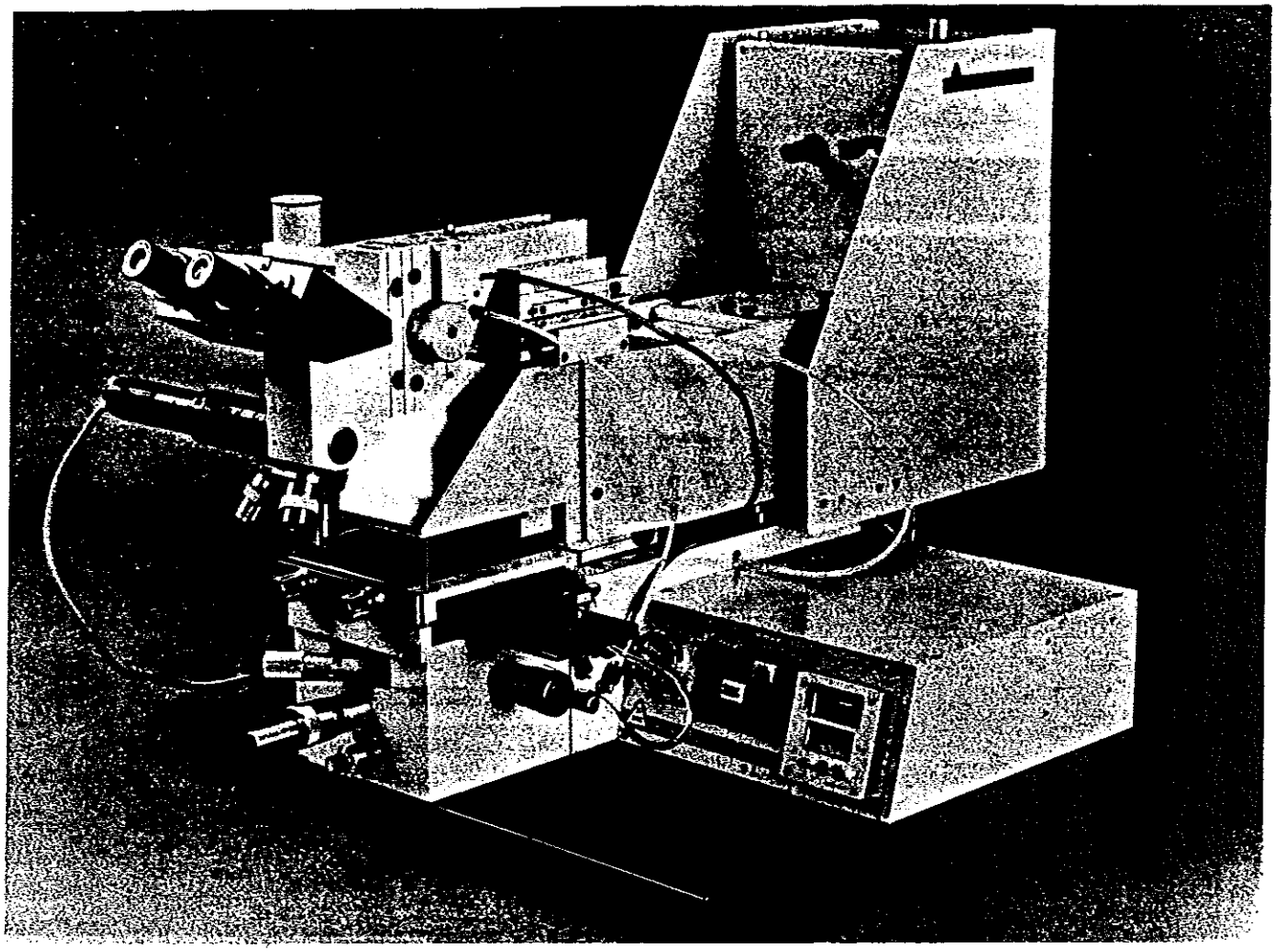


Figure 1-3 SUSS MJB 3 UV400/300

proximity mode (optional). It is equipped with a high precision alignment stage allowing alignment accuracies to 0.1 microns. Resolution of the MJB 3 HP is 0.8 microns under optimum conditions.

1.1.3 MJB 3 UV400

The SUSS MJB 3 UV400 (Figure 1-3) is equipped with a 350W lamphouse and SUSS diffraction reducing exposure optics. A 350W mercury short-arc lamp is used, providing primary exposure wavelengths of 350-450 nm. The machine is equipped with the same high precision alignment stage as the MJB 3 HP, allowing alignment accuracies to 0.1 microns. Like the MJB 3 HP it can perform exposures in vacuum contact, hard contact, soft contact, or in an optional proximity mode. Resolution of the MJB 3 UV400 is 0.6 microns under optimum conditions.

1.1.4 MJB 3 UV300

The SUSS MJB 3 UV300 (Figure 1-3) differs from the MJB 3 UV400 only in its range of exposure wavelengths. The same lamp is used. Different optical filtering and diffraction-reducing elements are used to produce exposure wavelengths of 280-350 nm. Resolution is 0.4 microns under optimum conditions.

1.1.5 MJB 3 UV250

Like other aligners in the MJB 3 series, the SUSS MJB 3 UV250 incorporates the SUSS high precision alignment stage allowing alignment accuracies to 0.1 microns, and performs exposures in vacuum contact, hard contact, soft contact, or in an optional proximity mode. The MJB 3 UV250 uses a diffraction reducing optical system similar to the MJB 3 UV400 and UV300 but is optimized for exposure wavelengths between 230-260 nm. A mercury-xenon lamp is used. When used to expose PMMA resists, which are not sensitive above 260 nm, the effective exposure wavelengths are 230-260 nm. Resolution of the MJB 3 UV250 is 0.3 microns under optimum conditions.

1.1.6 MJB 3 UV200

The SUSS MJB 3 UV200 differs from the MJB 3 UV250 only in its range of exposure wavelengths and the exposure lamp. The MJB 3 UV200 uses a 350 watt cadmium-xenon lamp, and the diffraction reducing filtering optics are optimized for the 210-230 nm range. The MJB 3 UV200 system is ideal for use with PMMA resists, and under optimum conditions, the achievable resolution is 0.2 microns.

1.2 A Brief Orientation

The operation of the SUSS MJB 3 is straightforward and easy to learn. First, you load a mask into the machine. Then you place the substrate on the chuck and insert the chuck into the alignment stage.

At this point, you bring the substrate into contact with the mask by turning the contact lever counterclockwise. The CONTACT light on the front panel illuminates. This operation also accomplishes wedge error (parallelity) compensation.

By pulling the separation lever towards the front of the machine, you will obtain sufficient separation for alignment, and the CONTACT light will go out as the SEPARATION light illuminates. You may now align the substrate to the mask using the X, Y, and Theta micrometers. By using the precision microscope manipulator, you can easily scan the microscope over the substrate in either the X or Y direction, or both simultaneously.

When satisfactory alignment has been obtained, move the substrate back into contact with the mask by pushing the separation lever all the way to its rearmost position until the SEPARATION light goes out and the CONTACT light re-illuminates. The substrate is now ready for exposure.

To initiate exposure, set the exposure time on the timer and press the EXPOSURE button. In most models, the microscope will then elevate a sufficient distance to allow the objective to clear the maskholder (this lifting is not necessary in all cases). The mirrorhouse now moves forward over the mask. When the mirrorhouse reaches its foremost position, the shutter opens and exposure takes place for the specified amount of time. After exposure is complete, the shutter closes, the mirrorhouse retracts, and the microscope moves back down to its original position.

You may now unload the substrate. Rotate the contact lever fully towards the front of the machine, releasing the substrate from the mask. Pull the transport slide carefully to the right and remove the substrate from the chuck.

1.3 Exposure Modes

With the exception of the MJB 3 Standard, which offers only hard contact and soft contact, all MJB 3 models offer three exposure modes which you may select using the HP/ST and SOFT CONTACT buttons on the front panel of the machine. These buttons control what takes place at the interface of the substrate and the mask when the EXPOSURE button is pressed. As an option, some machines are equipped with a PROXIMITY button which allows proximity exposures to be made. A brief description of the exposure modes follows. For complete, detailed descriptions please refer to Section 2.4.

1.3.1 Vacuum Contact (HP) Mode

In the HP mode, a vacuum is pulled between the mask and the substrate immediately prior to exposure. The highest possible resolution is obtained in this mode, since the gap between substrate and mask due to flatness variations, dust particles, etc., is as small as possible. Chucks equipped with vacuum gaskets must be used in this mode in order to obtain a vacuum between the substrate and the mask.

Vacuum contact mode is not an option on the MJB 3 Standard model.

At this point, you bring the substrate into contact with the mask by turning the contact lever counterclockwise. The CONTACT light on the front panel illuminates. This operation also accomplishes wedge error (parallelity) compensation.

By pulling the separation lever towards the front of the machine, you will obtain sufficient separation for alignment, and the CONTACT light will go out as the SEPARATION light illuminates. You may now align the substrate to the mask using the X, Y, and Theta micrometers. By using the precision microscope manipulator, you can easily scan the microscope over the substrate in either the X or Y direction, or both simultaneously.

When satisfactory alignment has been obtained, move the substrate back into contact with the mask by pushing the separation lever all the way to its rearmost position until the SEPARATION light goes out and the CONTACT light re-illuminates. The substrate is now ready for exposure.

To initiate exposure, set the exposure time on the timer and press the EXPOSURE button. In most models, the microscope will then elevate a sufficient distance to allow the objective to clear the maskholder (this lifting is not necessary in all cases). The mirrorhouse now moves forward over the mask. When the mirrorhouse reaches its foremost position, the shutter opens and exposure takes place for the specified amount of time. After exposure is complete, the shutter closes, the mirrorhouse retracts, and the microscope moves back down to its original position.

You may now unload the substrate. Rotate the contact lever fully towards the front of the machine, releasing the substrate from the mask. Pull the transport slide carefully to the right and remove the substrate from the chuck.

1.3 Exposure Modes

With the exception of the MJB 3 Standard, which offers only hard contact and soft contact, all MJB 3 models offer three exposure modes which you may select using the HP/ST and SOFT CONTACT buttons on the front panel of the machine. These buttons control what takes place at the interface of the substrate and the mask when the EXPOSURE button is pressed. As an option, some machines are equipped with a PROXIMITY button which allows proximity exposures to be made. A brief description of the exposure modes follows. For complete, detailed descriptions please refer to Section 2.4.

1.3.1 Vacuum Contact (HP) Mode

In the HP mode, a vacuum is pulled between the mask and the substrate immediately prior to exposure. The highest possible resolution is obtained in this mode, since the gap between substrate and mask due to flatness variations, dust particles, etc., is as small as possible. Chucks equipped with vacuum gaskets must be used in this mode in order to obtain a vacuum between the substrate and the mask.

Vacuum contact mode is not an option on the MJB 3 Standard model.

1.3.2 Standard (ST) Mode

In the ST Mode, nitrogen is used to press the substrate against the mask during exposure (hard contact), or the substrate is pressed against the mask only by mechanical pressure while vacuum under the substrate is retained (soft contact). Chucks with or without vacuum gaskets may be used in this mode.

1.3.3 Proximity Mode (Optional)

If the aligner is equipped with a button marked PROXIMITY on the front panel, exposures may be made with a small gap between the mask and the substrate. This proximity gap is determined by the position of the separation lever.

1.4 The Subassemblies of the MJB 3

The MJB 3 is made up of discrete subassemblies (Figure 1-5). They are as follows.

1.4.1 Alignment Stage

The alignment stage is the heart of the MJB 3, and consists of the pneumatics and mechanics for mask/substrate parallelity compensation and mask and substrate vacuum, maskholder (and maskholder clamping mechanism), Z-axis movement, alignment separation mechanism, X, Y and Theta alignment micrometers, and variable thickness adjustment.

1.4.2 Machine Base

The base contains the relays, pneumatics, valves, and throttles which control the various machine functions.

1.4.3 Front Control Panel

The front control panel (Figure 2-1) contains the indicators and operating controls, including the CONTACT and SEPARATION indicator lights, HP/ST exposure mode selection button (except MJB 3 Standard), SOFT CONTACT exposure mode button, MASK VACUUM button, PROXIMITY button (optional), EXPOSURE button, VACUUM CHAMBER button (except MJB 3 Standard), and the exposure timer. On all models except the MJB 3 Standard, which has no vacuum chamber, a vacuum gauge and throttle for adjusting the vacuum chamber vacuum are located at the left end of the front panel.

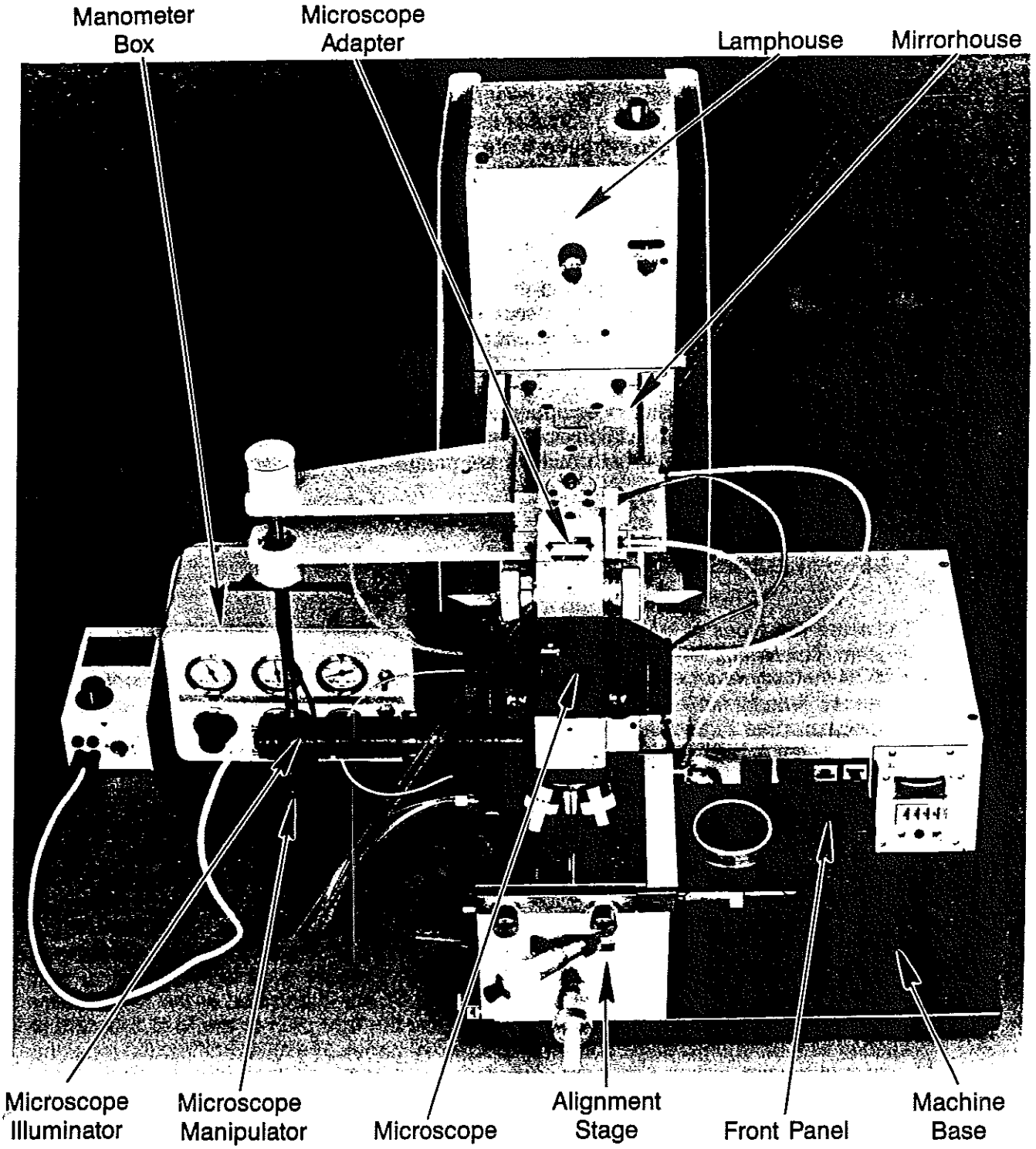


Figure 1-5 Machine Subassemblies

1.4.4 Manometer Box

The manometer box (Figure 2-6) contains the gauges, regulators and throttles for adjustment of compressed air and nitrogen to the machine.

1.4.5 Microscope

The microscope assembly consists of the microscope adapter, microscope manipulator, and the microscope itself. Many microscope options are available, including normalfield, splitfield, and objective revolvers, as well as brightfield, darkfield, and interference contrast illumination.

The microscope manipulator is equipped with pneumatic brakes which are unlocked by pressing the buttons on the manipulator handle. By pressing only one button, you can select an X-only or Y-only scan. If both buttons are pressed, you may scan the microscope in any direction.

1.4.6 Lamphouse and Mirrorhouse

There are two types of lamphouse/mirrorhouse assemblies supplied with SUSS MJB 3 aligners. The MJB 3 Standard and MJB 3 HP are equipped with a lamphouse containing a 200W mercury vapor exposure lamp, a spherical collecting mirror and a condenser lens assembly. Adjustment knobs for each of the components are located on the back of the lamphouse. (See Figure 5-2.) After passing through the condenser lens assembly, the exposure light is reflected off a 45° surface mirror at the front of the mirrorhouse onto the mask and substrate.

The MJB 3 UV400, UV300, and UV200 models are equipped with a lamphouse containing a 350W mercury vapor exposure lamp (cadmium-xenon in the case of the MJB 3 UV200), an ellipsoidal collecting mirror, and a 45° cold light mirror. The cold light mirror reflects the desired short-wavelength ultraviolet light through a fly's eye lens and transmits the longer wavelengths to a heat sink located in the bottom of the lamphouse. Adjustment knobs for moving the lamp in X, Y and Z are located on the upper section of the lamphouse (see Figure 5-6). The mirrorhouse contains two condenser lenses, a diffraction reducing lens plate, a 45° surface mirror and a collimation lens. A slot is provided in the mirrorhouse tube for a filter, where required. In addition, the entire light path of the MJB 3 UV200 is flushed with nitrogen to eliminate the production of ozone. The SUSS diffraction reducing exposure system provides extraordinarily high resolution over the entire exposure area, resulting in steep resist edges and small diffraction effects.

1.5 Special Features

Several special features are incorporated into the SUSS MJB 3 in order to enhance flexibility and simplicity of operation.

1.5.1 VACUUM CHAMBER Button

All MJB 3 models are equipped with a VACUUM CHAMBER button, except for the MJB 3 Standard (which has no vacuum chamber). With this feature it is possible to check the alignment prior to exposure with the mask and substrate in vacuum contact. This feature is particularly useful when using high magnification objectives with restricted depth of focus.

1.5.2 Vacuum Chamber Adjustment

The vacuum chamber is adjustable in all SUSS MJB 3 models except the MJB 3 Standard (which has no vacuum chamber). Under certain circumstances, you may wish to expose substrates in vacuum contact mode with less than full vacuum in the vacuum chamber. For this purpose a vacuum gauge and adjustment throttle are provided which are located at the left end of the front control panel. This adjustment does not affect the amount of vacuum under the substrate during alignment. Instructions for setting the vacuum level can be found in Section 2.5.1.

The vacuum gauge can also be used to detect vacuum leaks in the vacuum chamber due to damaged chucks, vacuum gaskets, etc.

1.5.3 Airing

When using a chuck equipped with a vacuum gasket, a partial vacuum may be unintentionally pulled between the substrate and mask during alignment due to an imperfect seal between the substrate and the chuck. This can occur if the back side of the substrate is unusually rough or scratched, or if scratches are present in the chuck surface. This partial vacuum can cause the substrate and mask to stick together and make alignment difficult or impossible. To overcome this problem, a small flow of nitrogen is introduced into the vacuum chamber whenever the substrate is separated from the mask. Instructions for adjusting the nitrogen flow can be found in Section 2.5.2.

1.5.4 Variable Thickness Adjustment

The MJB 3 is equipped with a device to maintain constant contact pressure when processing substrates of various thicknesses. Alternatively, this device may be used to vary the contact pressure for a given wafer thickness. When the equipment is installed, a reference mask and wafer are used to set the contact pressure between the mask and wafer. This setting may be varied using the thickness adjustment knob located on the front of the stage towards the bottom of the machine (Figure 2-2). For a detailed description of how to set the contact pressure please refer to Section 2.5.3.

1.5.5 Infrared Viewing System for Backside Alignment (Optional)

Any model in the MJB 3 product line may be equipped with a video camera, monitor, and special tooling, enabling printing of features on one side of wafers aligned to features on

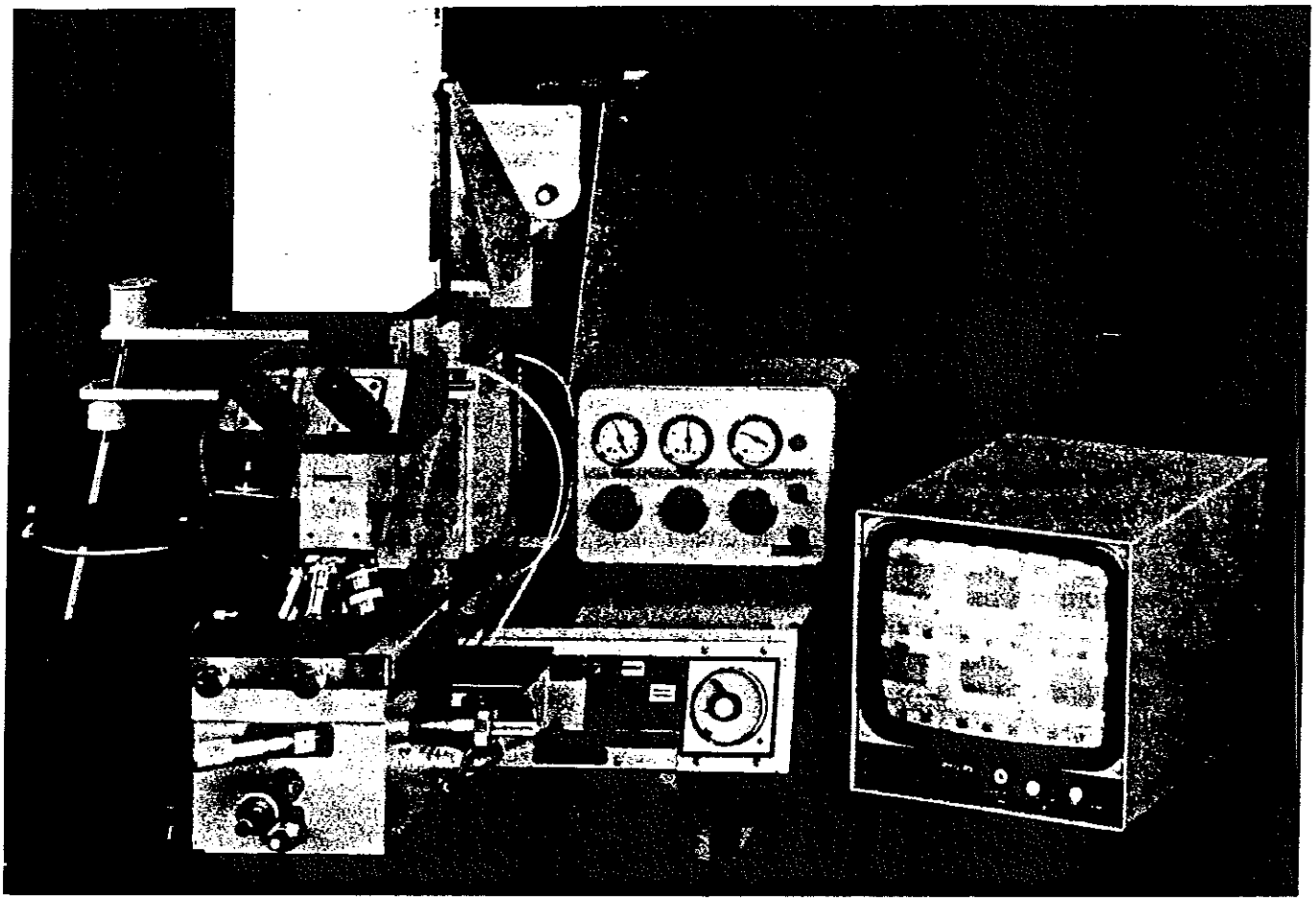


Figure 1-6 SUSS MJB 3 UV200 Equipped with Infrared System

the other (see Figure 1-6). For this application, special chucks are provided with one or more light bulbs mounted below a quartz plate to which the substrate is held by vacuum. The video camera is mounted on the alignment microscope using a trinocular microscope head. The type of image tube employed depends on the transmission characteristics of the substrate material. For materials transparent to short IR (GaAs, Si), a high quality silicon vidicon tube having good response both in the short IR region and the visible part of the spectrum is used. With this equipment, the mask may be illuminated using the direct microscope illumination, to aid in the alignment. For materials which are only transparent at longer IR wavelengths ($>$1.1 microns), a lead sulfide infrared image tube is supplied. This tube has good response at the longer wavelengths but somewhat less resolution and more "lag" (persistence of a previous image and delay in displaying a new image on the monitor) than a silicon vidicon tube. For this reason a true infrared tube is used only where absolutely necessary.

An aligner equipped with the infrared viewing system may also be used for conventional alignment by changing the transport slide and chuck. This can be accomplished very simply in about five minutes.

A detailed description of the operation of the infrared viewing system is included in the Appendix.

2 OPERATING PROCEDURES

2.1 Machine Controls

All of the machine controls are described below.

2.1.1 Front Control Panel (Please refer to Figure 2-1).

a. POWER Button—Pressing the POWER button switches on the mask aligner. When the machine is powered, the POWER button is illuminated.

b. CONTACT Indicator—The CONTACT indicator is illuminated whenever both the contact lever and the separation lever are in the contact position. The substrate is then in contact with the mask. It is not possible to perform alignment when the contact indicator is lit.

c. SEPARATION Indicator—This indicator is illuminated when the contact lever is in the contact position and the separation lever is in the separation position. The substrate is then separated from the mask by a small distance to allow alignment to be performed. Exposure is not possible in this condition unless the aligner is equipped with a PROXIMITY button. (See Section 2.4.3.)

d. EXPOSURE Button—Pressing the EXPOSURE button initiates exposure and illuminates the button until exposure has been completed. The exposure time is determined by the setting on the exposure timer.

e. VACUUM MASK Button—Pressing the VACUUM MASK button switches on the mask vacuum at the maskholder and illuminates the button. In order to avoid damage to masks which may inadvertently be left in the machine, the mask vacuum is always on whenever the machine power is OFF.

f. VACUUM CHAMBER Button—All MJB 3 models are equipped with a VACUUM CHAMBER button, except for the MJB 3 Standard which has no vacuum chamber. In the vacuum contact (HP) mode, the vacuum between mask and substrate is automatically pulled immediately prior to exposure. (Please refer to Section 2.4.1 for a description of the HP mode.) However, it is possible to check the alignment with the mask and substrate in vacuum contact prior to making an exposure. This feature is particularly useful when using high magnification

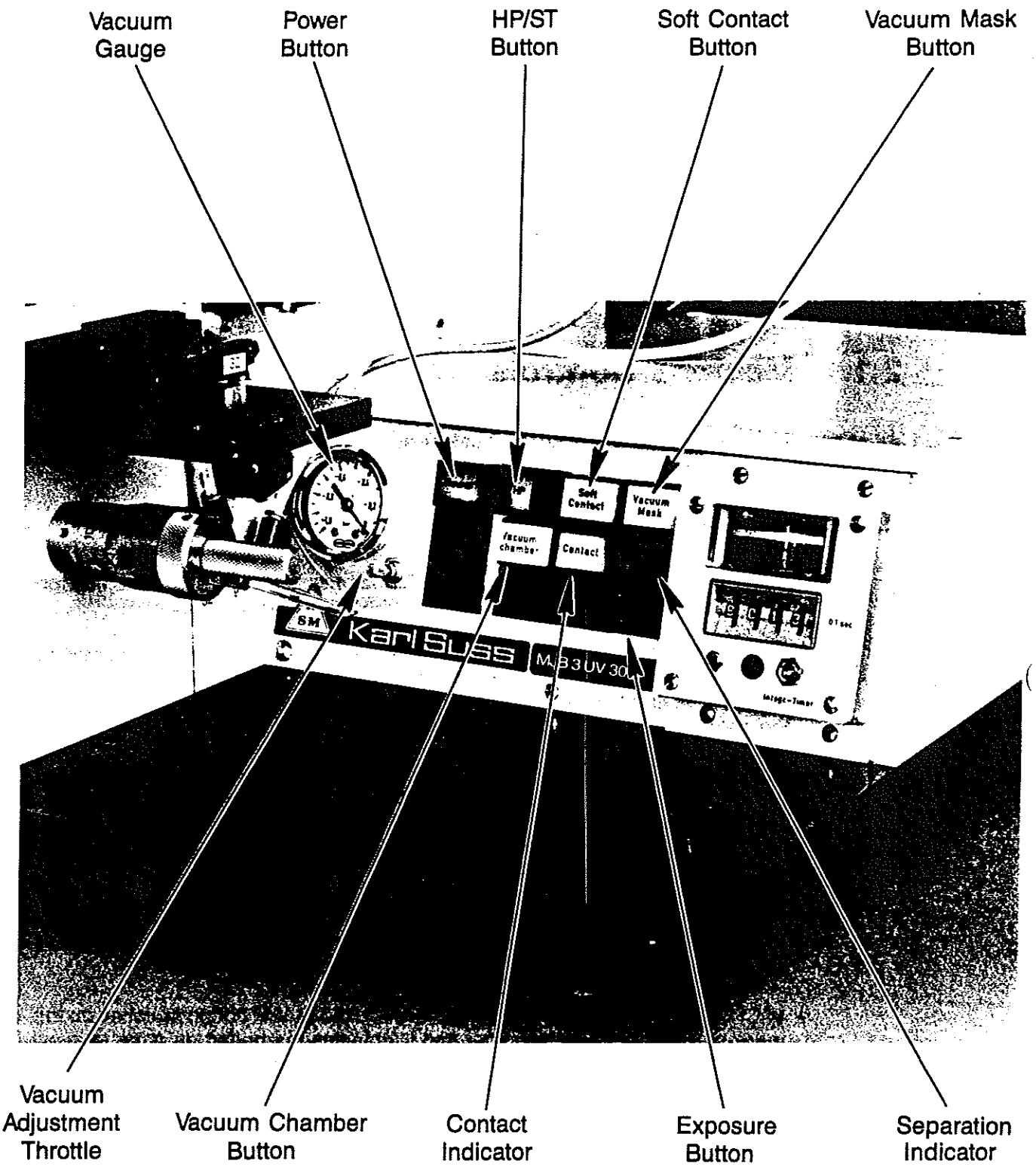


Figure 2-1 Front Control Panel

objectives with restricted depth of focus. Simply press the VACUUM CHAMBER button after moving the substrate to the contact position using the separation lever (CONTACT indicator illuminated), and the vacuum will be pulled. You may release the vacuum by moving the separation lever to the separation position. If you press the EXPOSURE button while the VACUUM CHAMBER button is illuminated, the VACUUM CHAMBER button will go out but the vacuum between mask and substrate will be preserved and exposure will take place in normal fashion.

g. HP/ST Button—All MJB 3 models except the MJB 3 Standard are equipped with a button marked HP/ST which is used to select either vacuum chamber exposure mode (HP) or standard exposure mode (ST). The MJB 3 Standard does not have vacuum chamber exposure capabilities. Please refer to Sections 2.4.1 and 2.4.2 for descriptions of the HP and ST exposure modes. The appropriate indicator light is illuminated to indicate the exposure mode selected.

h. SOFT CONTACT Button—The SOFT CONTACT button is used to select soft contact exposure mode. In this mode, the substrate is pressed against the mask only by mechanical pressure during exposure. The vacuum under the substrate remains on. To select soft contact exposure mode, the HP/ST button must be in the ST position.

i. PROXIMITY Button (Optional)—If the aligner is equipped with a button marked PROXIMITY on the front panel, exposures may be made with a small gap between the mask and the substrate. This proximity gap is determined by the position of the separation lever, and may be adjusted to a maximum distance of 150 microns, depending on the setting of the separation lever range. When the PROXIMITY button is pressed it illuminates, and defeats the interlock which normally prevents exposure unless the separation lever is in contact position.

> **NOTE:** Even when using the proximity exposure mode, it is still necessary to perform two contacts between mask and substrate. Prior to alignment, in order to perform mask to substrate parallelity compensation, and after exposure, when the parallelity compensation head brakes are released.

j. Exposure Timer—The exposure timer is located on the right side of the front panel. In order to set the timer, two controls are used: an inner knob marked "s", "10s", "m", "10m", "h", and "10h" which is used to set the multiplier, and an outer ring which is used to move the timer pointer. The scale for the timer pointer is graduated from 0 to 3. The exposure time is determined by multiplying the pointer setting by the multiplier set on the inner knob.

Example 1 To obtain an exposure time of 2 seconds, set the timer pointer at 2 and the multiplier to "s".

Example 2 To obtain an exposure time of 8 minutes set the timer pointer to 0.8 and the multiplier to "10m".

The timer therefore has a range of 0.1 seconds to 30 hours. When the EXPOSURE button is pressed, the timer pointer rotates counterclockwise to 0 during exposure.

k. Vacuum Gauge and Vacuum Adjustment Throttle—The vacuum gauge and the vacuum chamber adjustment throttles are located on the left end of the front panel for all MJB models except the MJB 3 Standard, where they are unnecessary. They are used to adjust the vacuum level in the vacuum chamber during exposure. This setting has no effect on the vacuum under the substrate during alignment. For instructions on setting the vacuum level, please refer to Section 2.5.1.

2.1.2 Alignment Stage (Please refer to Figure 2-2).

a. Transport Slide (Figures 2-3 and 2-4)—The transport slide is located near the top of the stage at the right hand side and is used to transport the chuck and substrate from the loading position into the stage.

b. Alignment Micrometers (X, Y, and Theta)—The Y and Theta alignment micrometers are located on the front of the alignment stage while the X micrometer is mounted on the right side. They are used during alignment to move the substrate in relation to the mask. The X and Y micrometers have both coarse and fine adjustment. The range of adjustment in X and Y is 6.0 mm and the pitch of the micrometer lead screws is 1.0 mm (coarse adjustment) and 0.05 mm (fine adjustment). The Theta (rotation) micrometer has a range of 30° with a pitch of 0.5 mm for the MJB 3 Standard model and 0.25 mm for the other MJB 3 models.

c. Contact Lever—The contact lever, which controls the Z-axis movement of the chuck, is located at the lower left side of the stage. After inserting a chuck and substrate into the stage using the transport slide, the contact lever is used to bring the substrate into contact with the mask for parallelity compensation.

d. Separation Lever—The separation lever is also located at the lower left side of the stage. This lever is used to move the substrate in and out of contact with the mask in order to perform alignment, once the contact lever has been engaged. Exposure can only be initiated when the separation lever is in the contact position (unless the optional PROXIMITY button is illuminated.)

e. Maskholder—The maskholder is securely clamped in the mask holder frame on the top of the stage using two knurled knobs. It is removed and reinserted into the maskholder frame from the left side of the stage.

f. Variable Thickness Adjustment—The variable thickness adjustment is located on the front of the stage immediately below the Y-micrometer. At the time of installation, the Z-travel of the stage is adjusted using a reference substrate and mask. If substrates or masks of different thicknesses are to be used, this thickness difference must be compensated for, using the variable thickness adjustment. This adjustment procedure is described in Section 2.5.3.

g. Nitrogen Purge (Figure 2-9)—For work with negative resist, the stage is equipped with a purge which flushes the wafer and mask area with nitrogen to reduce the "oxygen effect". The nitrogen is introduced through a number of small holes in the back of the maskholder frame. The purge volume is adjusted using the throttle located on the manometer box.

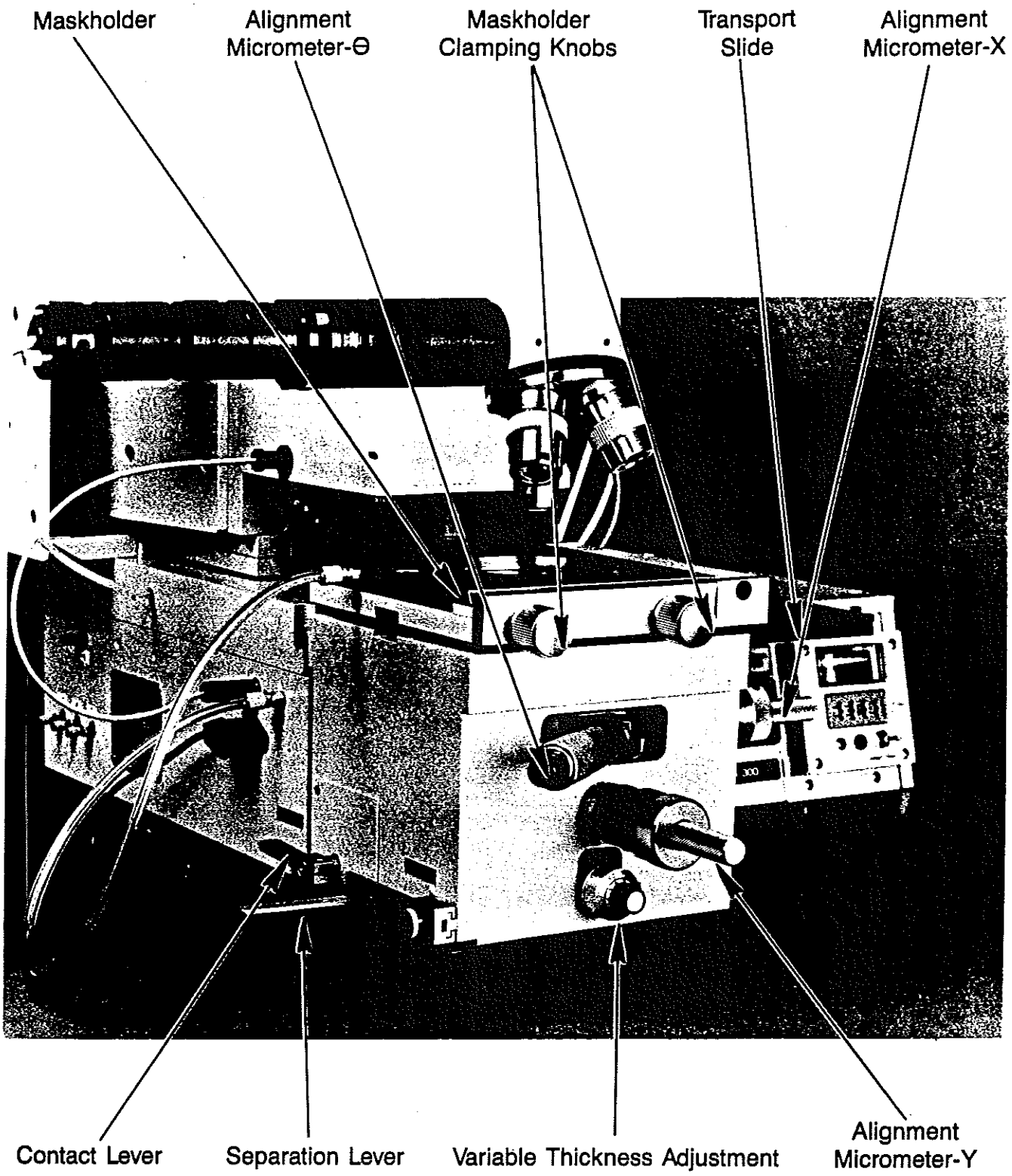


Figure 2-2 Alignment Stage

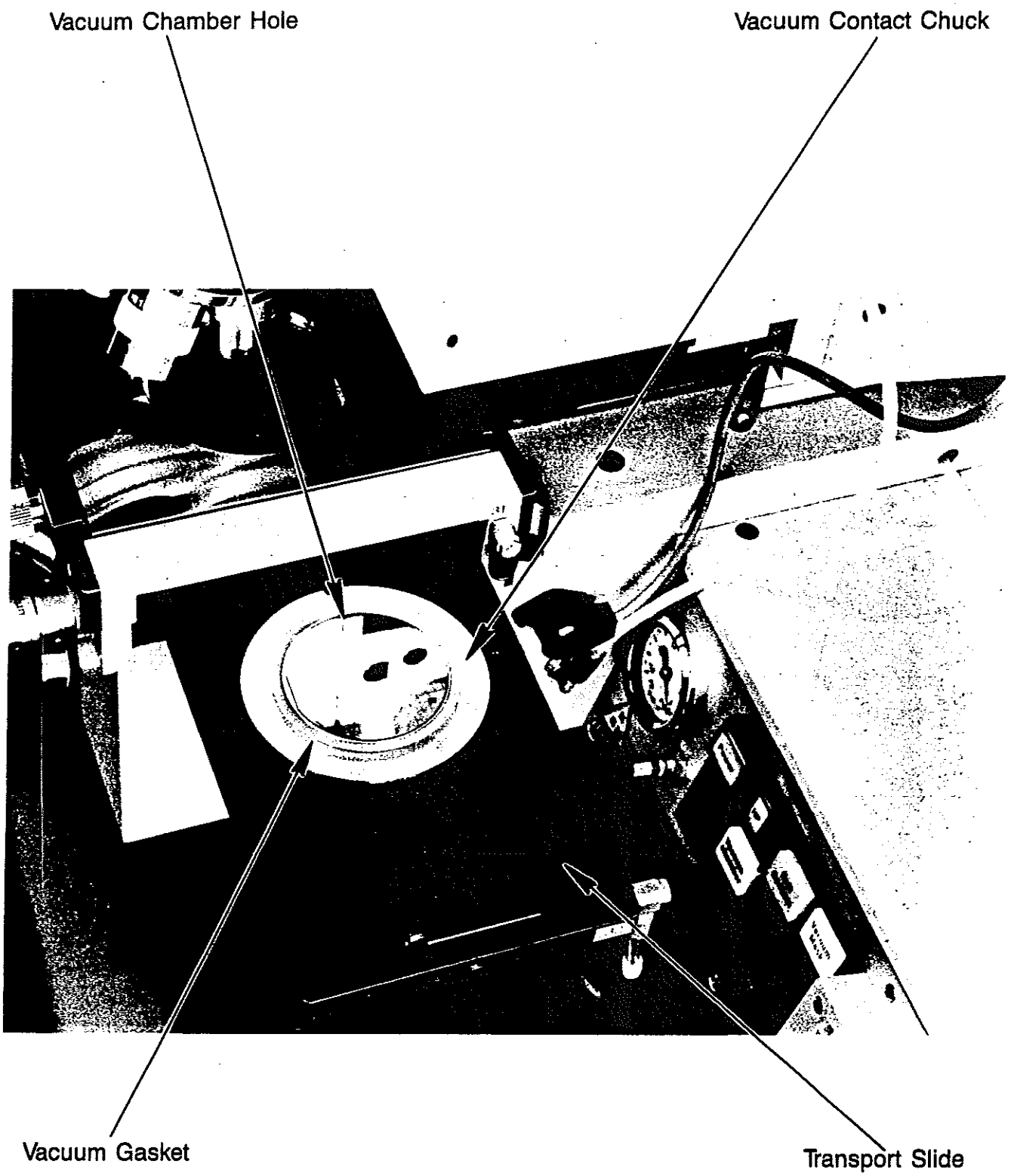


Figure 2-3 Transport Slide with Vacuum Chuck

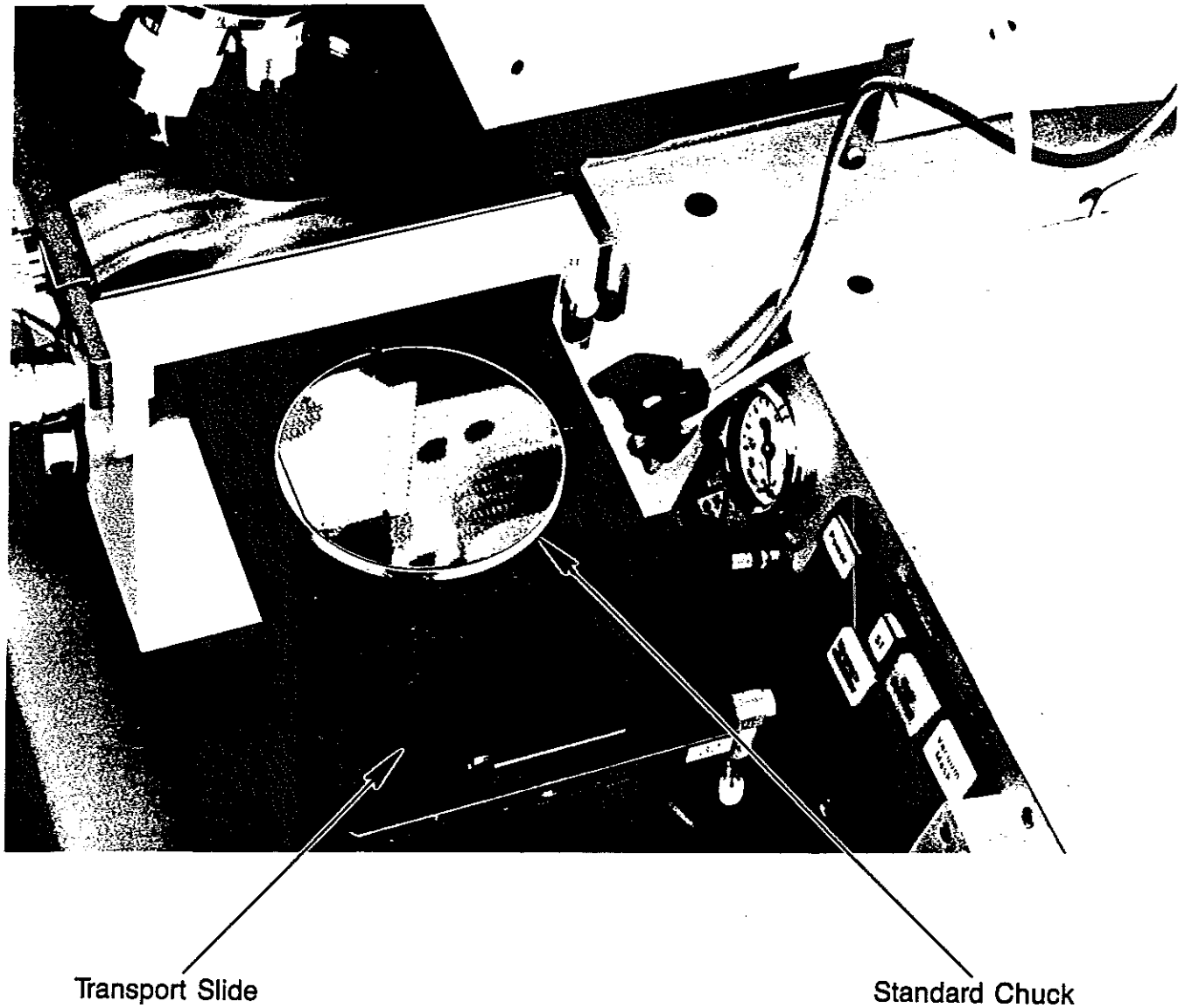


Figure 2-4 Transport Slide with Standard Chuck

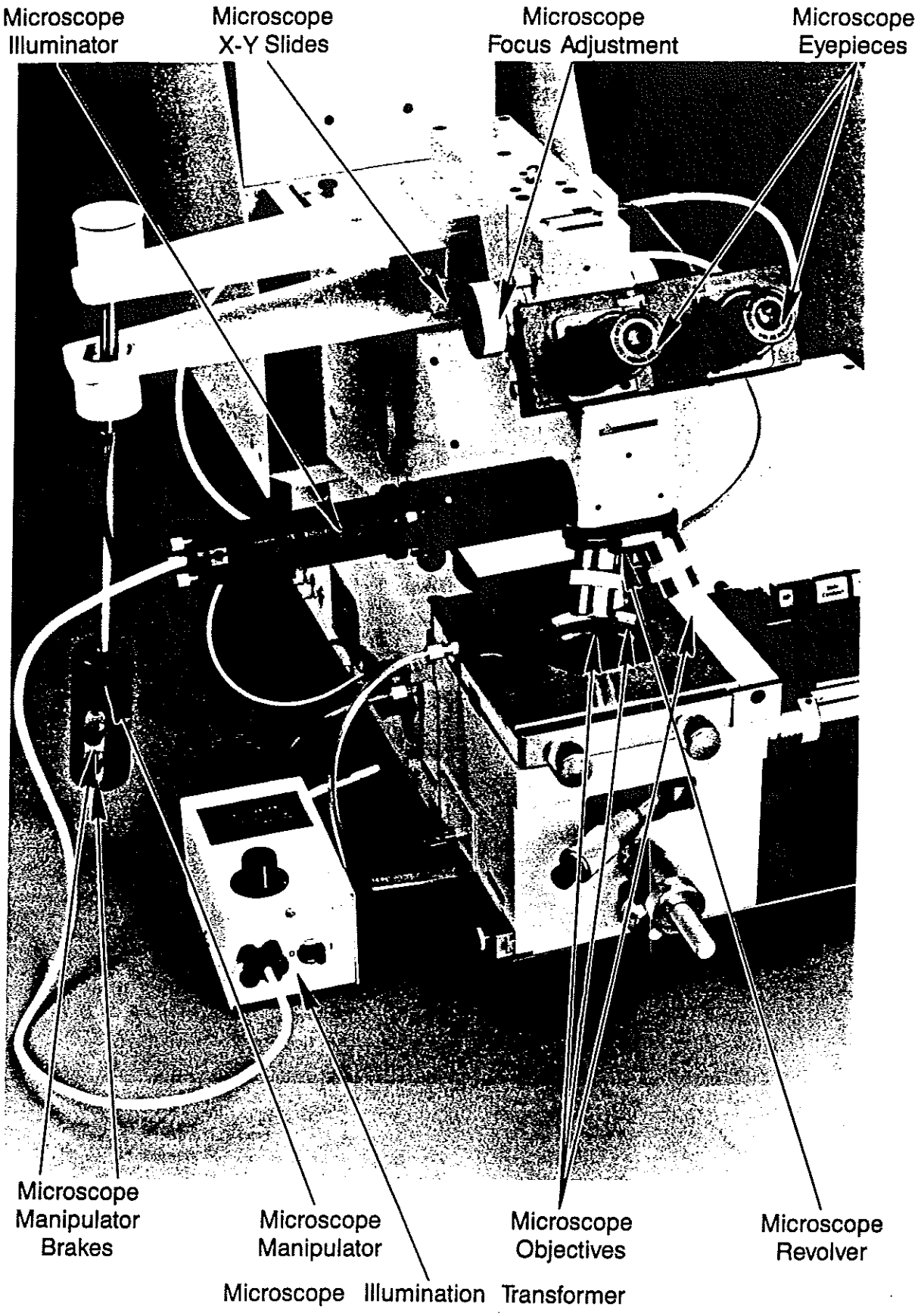


Figure 2-5 Microscope with Focus Knobs and Manipulator

2.1.3 Microscope (Please refer to Figure 2-5)

The microscope manipulator, which controls the movement of the microscope over the alignment stage, is located on the left side of the machine. The microscope itself rides on X-Y slides which are equipped with pneumatic brakes and mounted to the top of the mirrorhouse assembly. Two buttons located on the manipulator handle are used to unlock either or both brakes, thereby enabling the microscope to be scanned in either the X or Y directions exclusively, or in both directions simultaneously. The microscope focus control incorporates a combined coarse-fine adjustment. This allows rapid and convenient focusing of the microscope image. If the focus adjustment is turned in one direction only, the coarse focusing motion will be effective. The fine adjustment is automatically engaged as soon as the slightest turn is made in the opposite direction. The adjustment will again switch to coarse focusing motion when the noticeable limits of the fine adjustment are reached.

A number of microscope options are offered with the SUSS MJB 3 product line, in both normalfield and splitfield types. The three basic configurations are described below. A detailed description of the microscope supplied with your aligner may be found in the Appendix.

a. Normalfield Microscope (SUSS M400) (Figure 8-1)—The SUSS M400 microscope consists of the microscope head (either binocular or trinocular), eyepieces, microscope body, illuminator, objective turret, and objectives. The microscope may be equipped with either a 3 objective or 4 objective revolver depending on the range of magnification desired. The SUSS M400 is offered in two versions: brightfield only, and a brightfield/darkfield/interference contrast combination. Interference contrast illumination is obtained, using an interference contrast objective, by inserting the analyzer and the polarizer into the illumination path. Darkfield illumination is obtained, using a darkfield objective, by inserting the darkfield stop into the light path.

b. Splitfield Microscope (SUSS M200) (Figure 8-3)—The SUSS M200 microscope consists of the microscope head (either binocular or trinocular), eyepiece, microscope body, illuminator, and objectives. The choice of eyepieces and objectives depends on the magnification desired. The objective separation distance is adjusted using the two combination objective separation knobs which also adjust the fine focus. Two small knobs on the body of the microscope are used to select either singlefield or splitfield operation.

c. Splitfield Revolver Microscope (SUSS M230) (Figure 8-4)—The SUSS M230 microscope is similar to the M200 Splitfield microscope except that it is supplied with three pairs of objectives. The objectives supplied are 3.5x, 10x and 20x and are mounted on two 3x revolvers. Locking screws are supplied in the revolver mount dovetail to allow the revolver to be rotated without changing the objective separation distance.

2.1.4 Manometer Box

The manometer box (Figure 2-6) contains the gauges and regulators used to control the machine pneumatics. There are three gauges labelled EXPOSURE, PARALLELITY, and PRESSURE/WAFER. These should be set at 4 bar (60 psi), 2 bar (30 psi) and 1 bar (15 psi) respectively, using the regulators located under each gauge. With the exception of parallelity compensation, the EXPOSURE regulator controls the pressure used for all machine functions controlled by air pressure (mirrorhouse movement, microscope lift and manipulator brakes, lamphouse heat sink cooling, etc.).

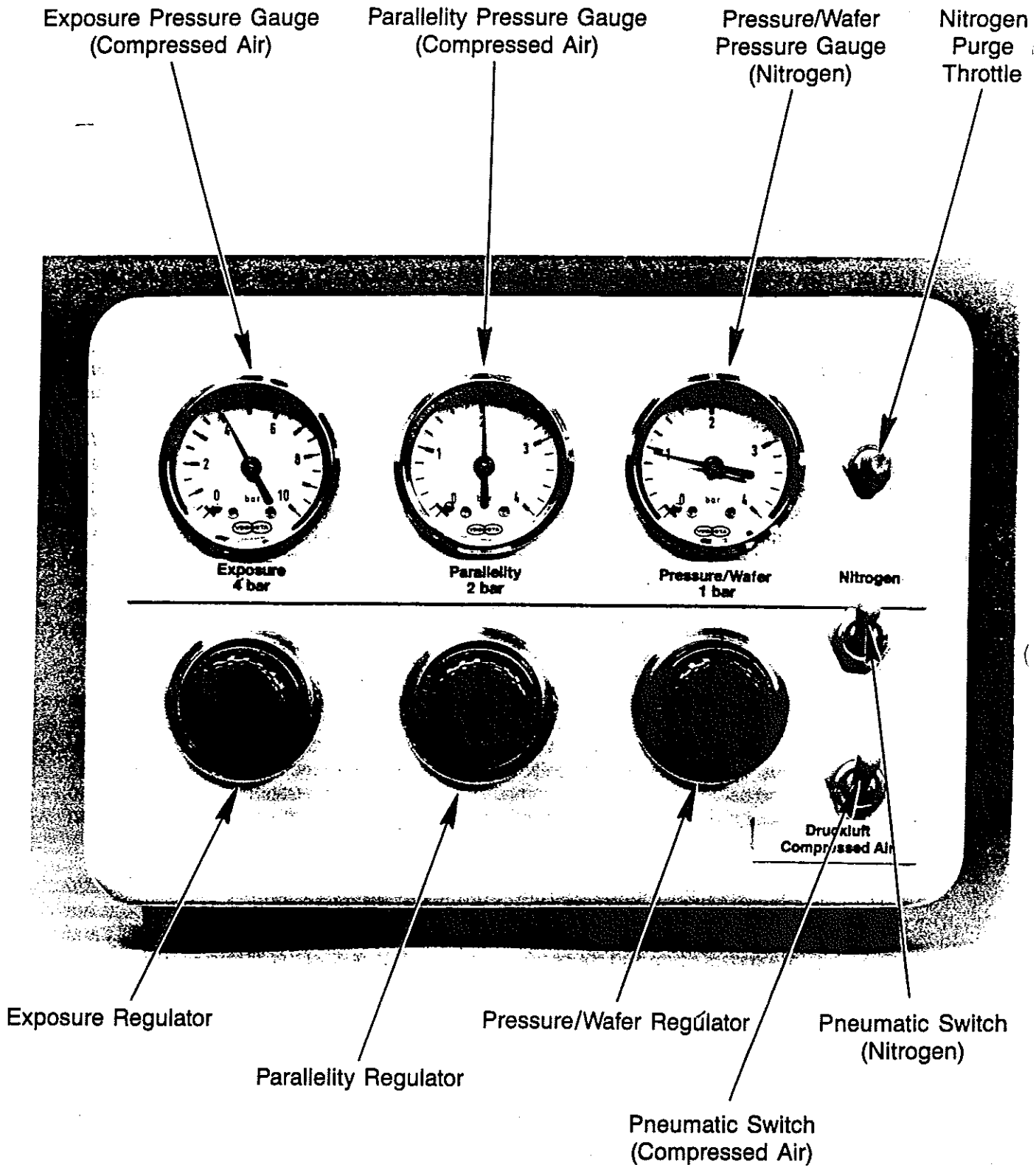


Figure 2-6 Manometer Box

The PARALLELITY regulator controls the pressure in the bladder ring located under the parallelity (wedge error) compensation plate.

The PRESSURE/WAFER regulator controls the nitrogen pressure to the machine. Nitrogen is used for lamp base cooling in the MJB 3 UV400, UV300 and UV200, pressure under the wafer in standard exposure mode, the airing function, the nitrogen purge function, and for releasing the vacuum in the vacuum chamber in vacuum chamber exposure mode. Two pneumatic switches which control the compressed air and nitrogen supplies are located to the right of the gauges and regulators, along with a throttle which is used to control the nitrogen purge to the wafer stage for work with negative resist.

2.2 Start Up Procedure

2.2.1 Pre-Operation Check List

Before starting the MJB 3 it is important to:

a. Switch ON the nitrogen and compressed air (manometer box) and adjust the regulators to the proper settings.

b. Switch on the vacuum to the machine.

2.2.2 Exposure Lamp Ignition

The exposure lamp must be ignited before switching on the main power to the machine. The lamp ignition sequence is as follows:

a. Check that the machine is turned OFF.

b. Switch on the POWER to the power supply.

c. Press the lamp START button and release. If the lamp does not ignite press the lamp START button again.

2.2.3 Power Up

Switch the machine on by pressing the POWER button. The POWER button will illuminate.

2.3 Operation

2.3.1 Loading the Mask (Please refer to Figures 2-7 and 2-8)

To load a mask into the machine, first loosen the two knurled knobs which clamp the maskholder onto the stage and withdraw the maskholder. Carefully place the maskholder on a flat surface, with the vacuum groove up.

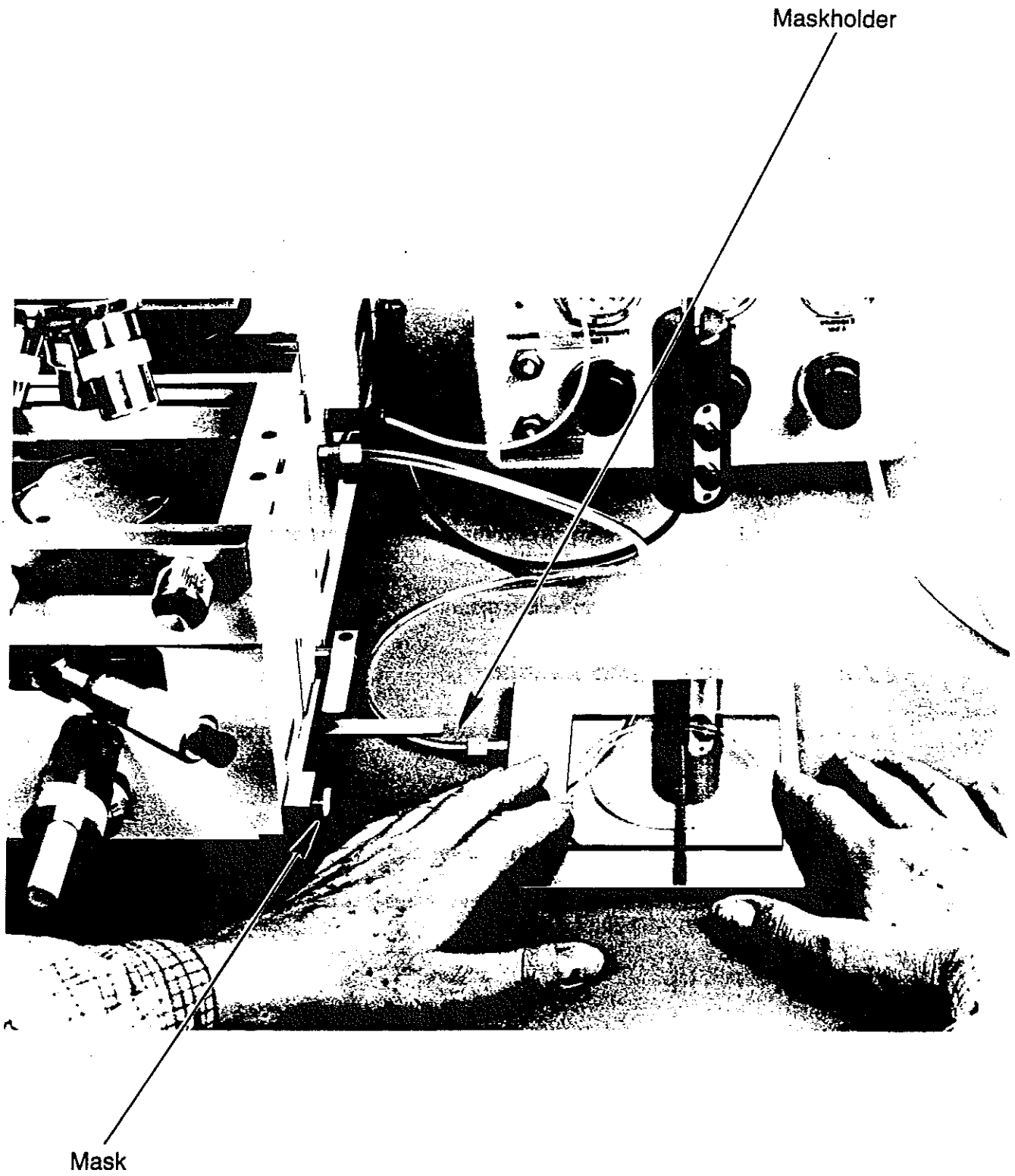


Figure 2-7 Loading Mask on Maskholder

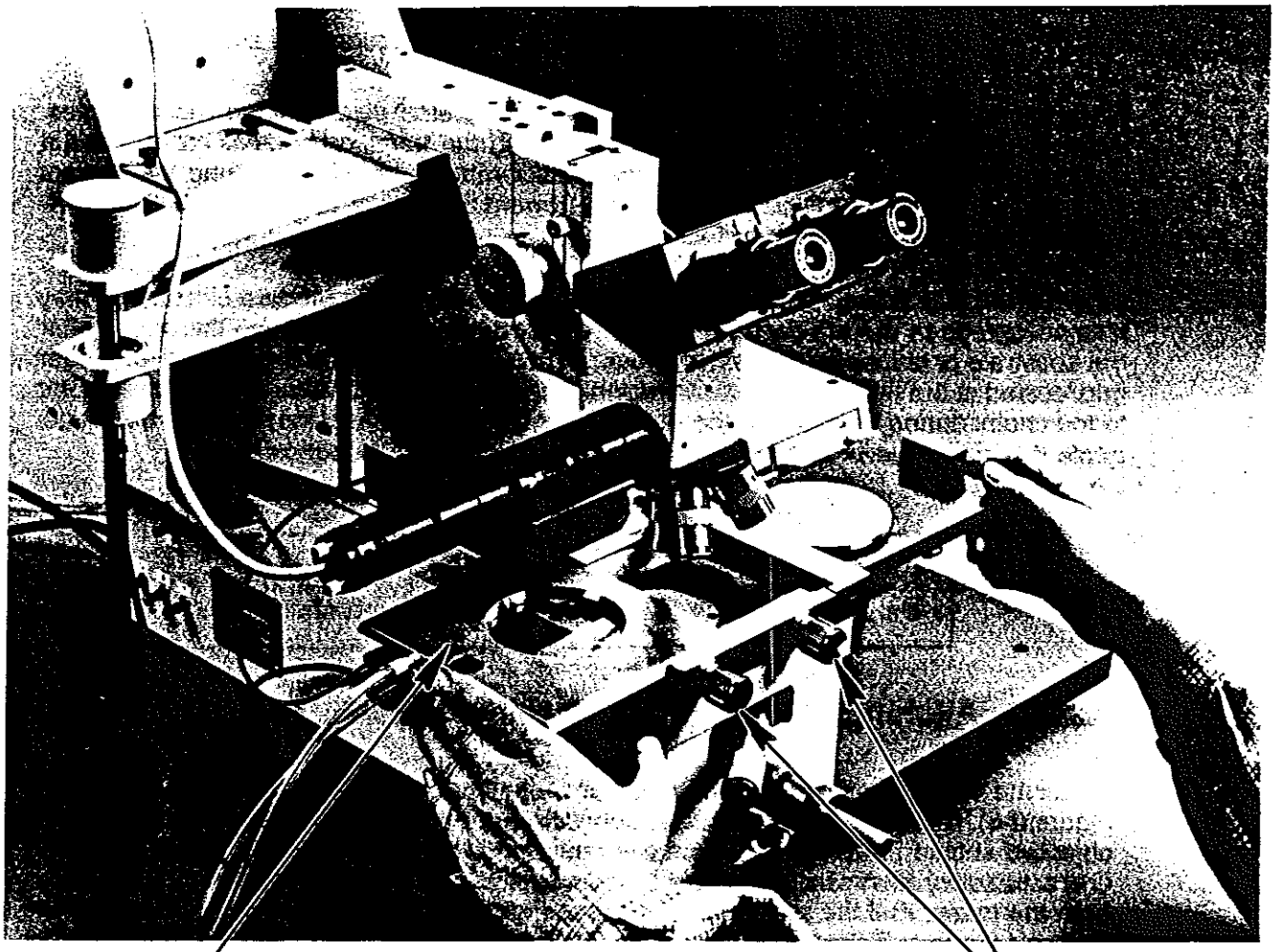


Figure 2-8 Loading Maskholder into Stage

NOTE: It is extremely important at all times to avoid scratching of chucks and maskholders.

Check that the MASK VACUUM button on the front panel is in the OFF position (see Figure 2-1). Place the mask on the maskholder with the patterned side up and then press the MASK VACUUM button. This will fix the mask to the maskholder by vacuum. Now invert the maskholder and reinsert it into the stage. Clamp the maskholder securely in place using the two knurled knobs.

2.3.2 Loading the Substrate (Please refer to Figures 2-3 and 2-4)

Place the substrate on the chuck ensuring that it completely covers all the vacuum holes. Insert the chuck into the stage by carefully pushing the transport slide to the left until it reaches the stop. Bring the substrate into contact with the mask by rotating the contact lever (see Figure 2-2) 180° counterclockwise (toward the rear of the machine). The CONTACT light on the front panel will illuminate.

Where an MJB 3 is used in the standard exposure mode with a standard chuck, you may take advantage of the pre-vacuum feature when inserting the chuck into the stage. After the substrate is placed on the wafer chuck, squeeze the button on the front of the finger grip located at the right edge of the transport slide. This causes a vacuum to hold the wafer to the chuck during transport to the stage. Once the chuck is fully inserted into the stage, rotate the contact lever as above and release the pre-vacuum button.

NOTE: The pre-vacuum feature will only function in the standard exposure (ST) mode with a standard chuck.

2.3.3 Aligning the Substrate to the Mask

Focus the microscope on the mask and substrate using the focus adjustment knobs (see Figure 2-5). If the microscope is equipped with an objective revolver, a low magnification objective should be used for coarse alignment and the magnification steadily increased until satisfactory alignment is obtained. In order to align the substrate it must first be separated from the mask. Pull the separation lever (see Figure 2-2) toward the front of the machine until you obtain sufficient separation. The CONTACT light will go out and the SEPARATION light will illuminate. (The range of the separation stroke is adjustable up to 150 microns and is set at the time of installation.) Now align the substrate to the mask using the X, Y, and Theta micrometers. The X and Y micrometers are equipped with both a coarse and fine adjustment (see Figure 2-2).

If the aligner is equipped with a normalfield microscope, alignment is performed by scanning the microscope back and forth in either the X or the Y direction. The microscope manipulator is equipped with pneumatic brakes which you unlock by pressing the buttons on the manipulator handle. By pressing one button you may select either an X-only or Y-only scan. If you press both buttons, you may scan the microscope in any direction (see Figure 2-5).

If the aligner is equipped with a splitfield microscope, the two objectives are aligned to two alignment features on opposite sides of the substrate using the microscope manipulator and the objective separation controls. In this case it is not necessary to scan the microscope across the mask during substrate alignment.

When you have obtained a satisfactory alignment, move the substrate back into contact with the mask by pushing the separation lever all the way to its rearmost position. The SEPARATION light will go out and the CONTACT light will illuminate.

When using high magnification, you may only be able to see the alignment position clearly in the contact position, due to depth of focus restrictions. If the alignment is unsatisfactory in contact position, repeat the alignment sequence until correct alignment is obtained.

You may wish to refer to the application note on alignment which is contained in the Appendix (Chapter 8).

2.3.4 Exposure

The substrate is now ready for exposure. (Exposure mode should be selected before alignment.) Set the exposure time on the timer located at the right end of the front panel. Section 2.1.1.j contains complete instructions on setting the timer.

Press the EXPOSURE button. On some microscopes, the working distance of the high magnification objectives is so small that the objective extends into the maskholder opening when focused on the mask. In such cases, the microscope adapter, on which the microscope is mounted, is equipped with a lift mechanism. When the EXPOSURE button is pressed, the microscope will then first elevate an amount sufficient to allow the objective to clear the maskholder. The mirrorhouse now moves forward into position over the mask (see Figure 2-9). When the mirrorhouse reaches the frontmost position, the exposure shutter opens and exposure takes place for the amount of time set on the exposure timer. After exposure, the shutter closes and the mirrorhouse automatically retracts. The microscope lift is released and the microscope moves back down to its original position.

2.3.5 Unloading the Substrate

With exposure complete, the substrate may now be unloaded. Rotate the contact lever 180° clockwise (toward the front of the machine), releasing the substrate from the mask. Pull the transport slide carefully to the right and remove the substrate from the chuck.

2.4 Exposure Mode Options

2.4.1 Vacuum Contact (HP) Mode

In the HP Mode, a vacuum is pulled between the mask and the substrate immediately prior to exposure. The highest possible resolution is obtained in this mode, since the gap bet-

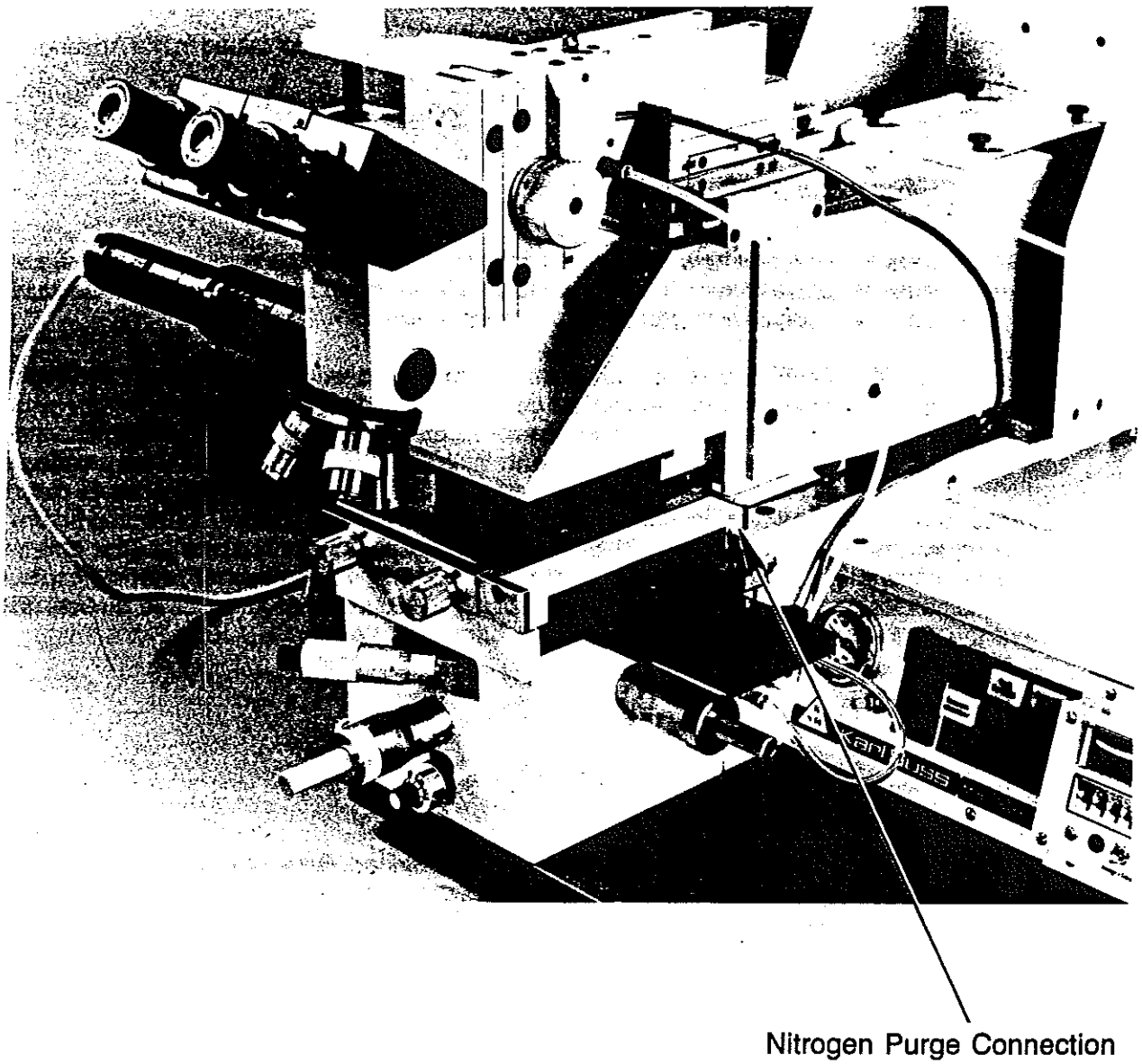


Figure 2-9 Mirrorhouse in Exposure Position

ween substrate and mask due to flatness variations, dust particles, etc., is as small as possible. Chucks fitted with vacuum gaskets (see Figure 2-3) must be used in this mode in order to obtain a vacuum between the substrate and the mask. Vacuum contact mode is not an option on the MJB 3 Standard model.

When printing in the vacuum contact mode, the sequence of events after the EXPOSURE button is pressed is as follows:

1. The vacuum under the substrate is switched off.
2. The vacuum between the substrate and the mask is switched on through the vacuum chamber hole located at the outer edge of the chuck (see Figure 2-3).
3. The shutter opens, exposure takes place for the length of time set on the exposure timer, and the shutter closes, completing the exposure.
4. The vacuum between the substrate and the mask is switched off.
5. The vacuum under the substrate is switched on.
6. A nitrogen burst is introduced through the vacuum chamber hole breaking the vacuum between the substrate and the mask.

2.4.2 Standard (ST) Mode

In the ST Mode, nitrogen pressure is used to press the substrate against the mask during exposure. Chucks with or without vacuum gaskets may be used in this mode (see Figure 2-4).

When printing in the standard (ST) mode, the sequence of events after the EXPOSURE button is pushed is as follows:

1. The vacuum under the substrate is switched off.
2. The nitrogen pressure under the substrate is switched on.
3. The shutter opens, exposure takes place for the length of time set on the exposure timer, and the shutter closes, completing the exposure.
4. The nitrogen pressure under the substrate is switched off.
5. The vacuum under the substrate is switched on.

If soft contact mode has been selected, only step 3 is performed.

2.4.3 Proximity Mode (Optional)

If the aligner is equipped with a button marked PROXIMITY on the front panel, exposures may be made with a small gap between the mask and the substrate. This proximity gap is determined by the position of the separation lever and may be adjusted to a maximum separation distance of 150 microns, depending on the setting of the separation lever range.

When the PROXIMITY button is pressed, it defeats the interlock which normally prevents exposure unless the separation lever is in the contact position. The vacuum under the substrate remains on during exposure, which takes place in normal fashion.

> **NOTE:** Even when using the proximity exposure mode, it is still necessary to perform two contacts between mask and substrate. Prior to alignment, in order to perform mask to substrate parallelity compensation, and after exposure, when the parallelity compensation head brakes are released.

2.5 Adjustment Procedures

Certain features of the SUSS MJB 3 are user adjustable as follows.

2.5.1 Vacuum Chamber Adjustment Procedure

The vacuum chamber is adjustable in all SUSS MJB 3 models except the MJB 3 Standard, which has no vacuum chamber. Under certain circumstances, you may wish to expose substrates in vacuum contact mode with less than full vacuum in the vacuum chamber. For this purpose a vacuum gauge and adjustment throttle are provided which are located at the left end of the front control panel (see Figure 2-1).

To set the vacuum level, first bring a substrate to the contact position in vacuum chamber mode as outlined in Section 2.3.2, and press the VACUUM CHAMBER button. Using the throttle and vacuum gauge reading, adjust the vacuum as desired. Opening the throttle introduces a small amount of nitrogen into the vacuum chamber which offsets the vacuum from the vacuum source. Turn the throttle counterclockwise to decrease the vacuum, or clockwise to increase the vacuum.

> **NOTE:** This adjustment does not affect the amount of vacuum under the substrate during alignment.

The vacuum gauge can also be used to detect vacuum leaks in the vacuum chamber due to damaged chucks, vacuum gaskets, etc.

2.5.2 Airing Feature Adjustment Procedure

When using a chuck equipped with a vacuum gasket, a partial vacuum may be unintentionally pulled during alignment between substrate and mask due to an imperfect seal between the substrate and the chuck. This can occur if the back side of the substrate is unusually rough or scratched, or if scratches are present in the chuck surface. This partial vacuum can cause the substrate and mask to stick together and make alignment difficult or impossible. To overcome this problem, a small flow of nitrogen is introduced into the vacuum chamber whenever the substrate is separated from the mask. This nitrogen flow is controlled by throttle #12 located towards the back of the left panel of the machine (see Figure 2-10).

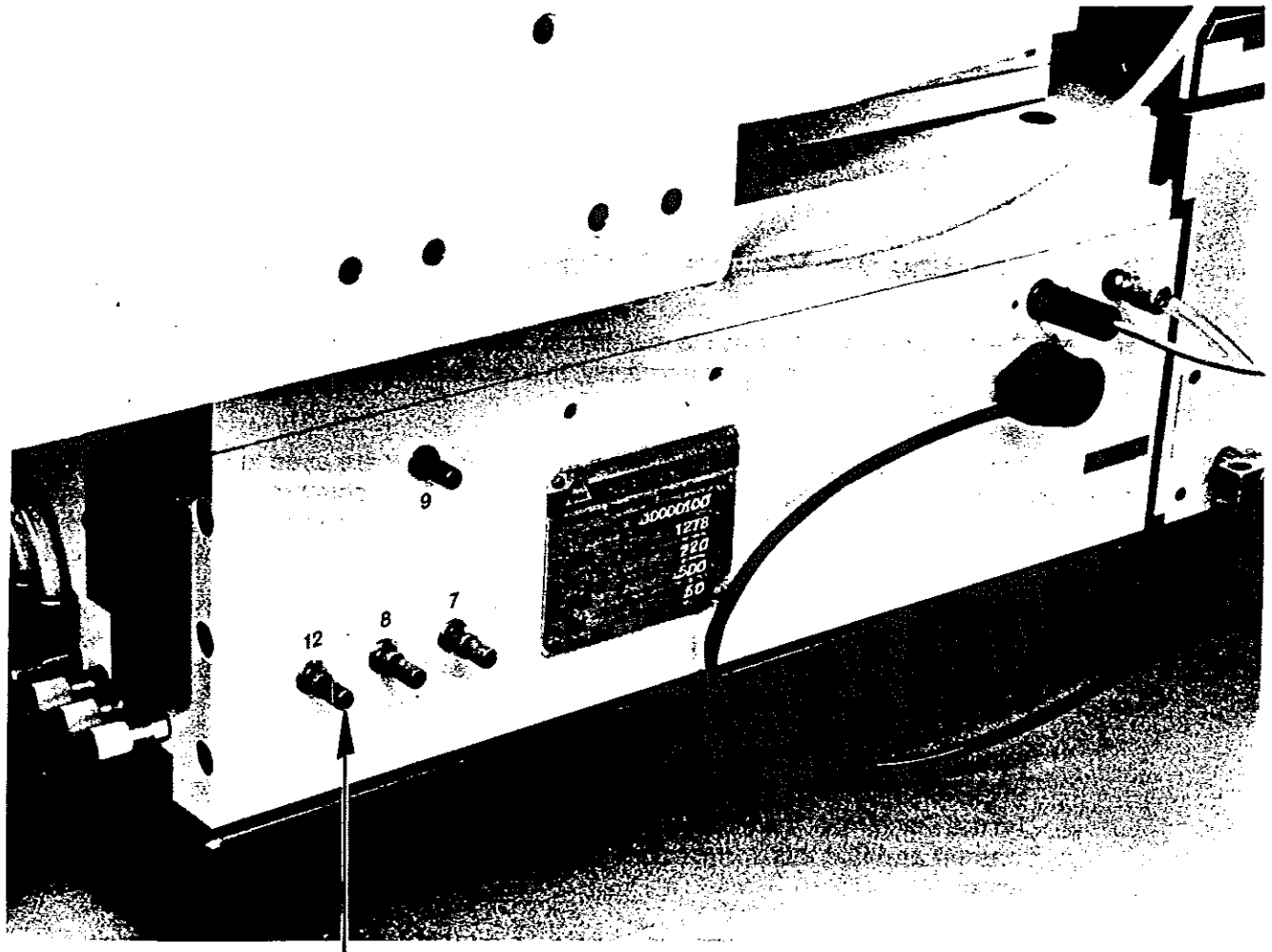


Figure 2-10 Left Side of Machine

To adjust this throttle proceed as follows:

Step 1 Bring a substrate to the separation (alignment) position as outlined in Sections 2.3.1 through 2.3.3.

Step 2 Turn throttle #12 counterclockwise until the substrate and mask do not stick together in separation position and the substrate moves freely in relation to the mask when the alignment micrometers are adjusted.

Step 3 Using the separation lever, move the substrate into contact with the mask and back into separation again. Observe the substrate and mask through the microscope throughout this operation.

Step 4 If the substrate shifts in relation to the mask during this operation, turn throttle #12 clockwise until the shifting is eliminated.

2.5.3 Setting the Variable Thickness Adjustment

The MJB 3 is equipped with a device to maintain constant contact pressure when processing substrates of various thicknesses. Alternatively, this device may be used to vary the contact pressure for a given wafer thickness.

When the equipment is installed, a reference mask and wafer are used to set the contact pressure between the mask and wafer (see Section 2.5.4). This setting may be varied using the thickness adjustment knob located on the front of the stage towards the bottom of the machine (Figure 2-2).

One revolution of the thickness adjustment knob corresponds to a 150 μm variation of substrate thickness or contact pressure. Rotate the knob counterclockwise to increase the contact pressure or substrate wafer thickness, or clockwise to decrease contact pressure or add wafer thickness.

EXAMPLES: Suppose in each case a reference mask of 60 mil (1500 μm) thickness and a reference wafer of 20 mil (500 μm) thickness were used to set up the machine at installation. Further suppose that a contact pressure of 500 μm was set and that this corresponds to a setting of 5.0 on the thickness adjustment knob.

Example 1 It is desired to process 14 mil (350 μm) thick wafers. Procedure: Rotate the thickness adjustment knob counterclockwise to a setting of 6.0 (500 μm-350 μm = 150 μm = 1 revolution).

Example 2 It is desired to decrease the contact pressure from 500 μm to 350 μm. Procedure: Rotate the thickness adjustment knob clockwise to a setting of 4.0 (150 μm = 1 revolution).

Example 3 It is desired to use a mask of 63 mil thickness. Procedure: Rotate the thickness adjustment knob clockwise to a setting of 4.5 (63 mil—60 mil = 3 mil = 75 μm = 0.5 revolution).

2.5.4 Setting Contact Pressure and Separation Stroke Using the Dial Indicator Kit.

To set the contact pressure and separation stroke, please refer to Figure 2-11 and proceed as follows:

1. Move the machine out over the front of the bench to provide access to the separation stroke adjustment located under the stage.

2. Remove the microscope.

3. Place a wafer of known thickness on the chuck. If using a vacuum contact chuck, first remove the vacuum gasket.

4. Place a mask of known thickness on top of the wafer.

5. Assemble the dial indicator to the arms supplied and attach it using the fork behind the small plate located at the right front of the stage (see Figure 2-11).

6. Place the steel bar supplied over the center of the chuck on the maskholder rails.

7. Position the dial indicator over the center of the bar and adjust it downwards until the dial indicator arm contacts the bar and scale deflection is obtained. Rotate the outer ring of the dial indicator to obtain a reference needle reading of zero.

8. Rotate the contact lever 180° counterclockwise. The wafer and mask will contact the bar and move it upwards.

9. The upward movement of the bar (measured from the zero reference) is the contact pressure. The amount of contact pressure is adjusted by rotating the variable thickness adjustment knob counterclockwise to increase it and clockwise to decrease it. One revolution of the knob corresponds to a 150 um variation in contact pressure.

10. When the desired contact pressure has been set, record the wafer thickness, mask thickness, and the reading of the variable thickness adjustment knob. These values are used as the reference when varying substrate thickness or contact pressure without the use of the dial gauge (see Section 2.5.3).

11. Move the separation lever to its rearmost position and observe the deflection on the dial indicator. This is the separation stroke. To adjust it, refer to Figure 2-12. Loosen the locking screw and slide the arm in to increase the separation stroke, or out to decrease it. Re-tighten the locking screw.

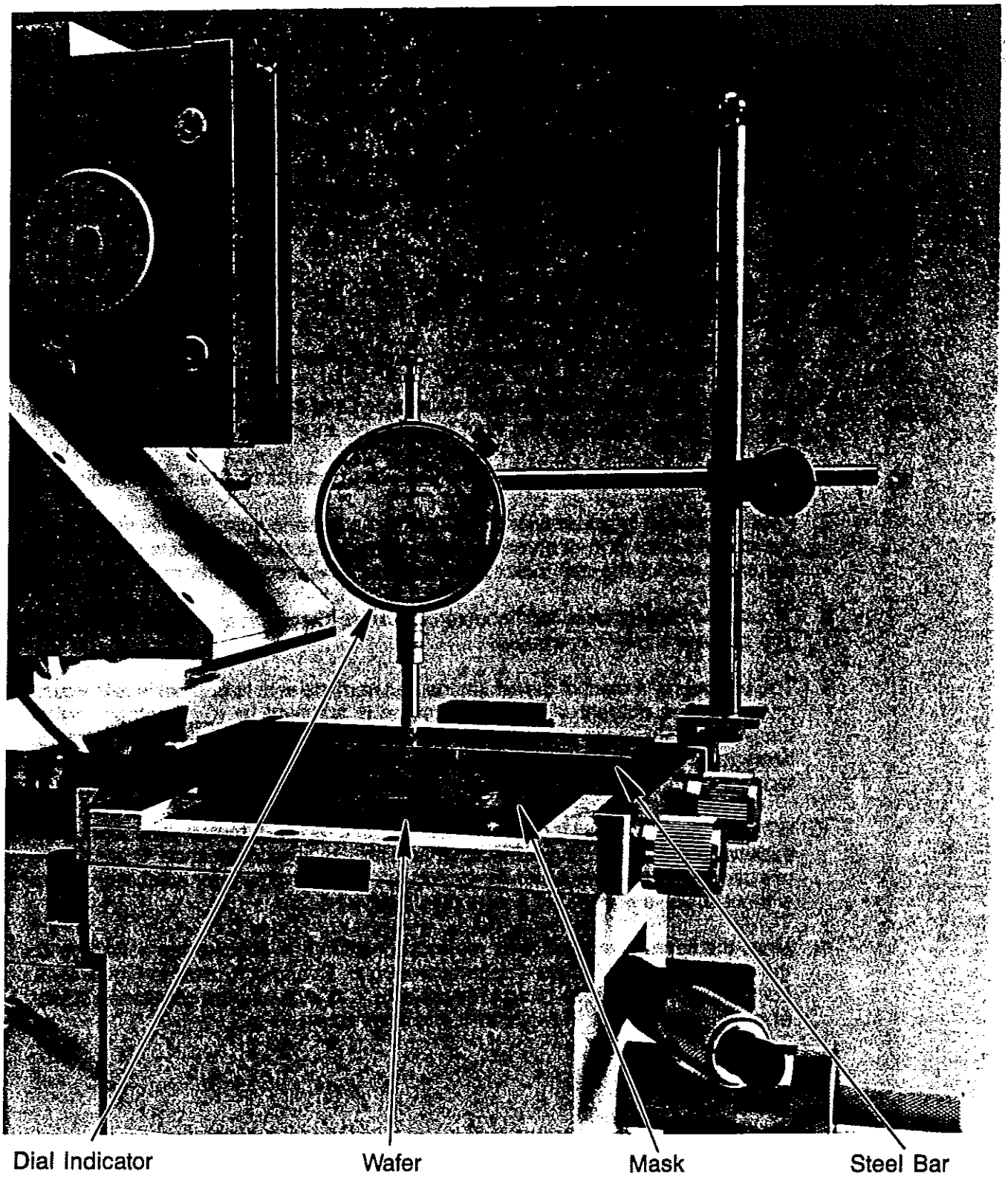


Figure 2-11 Dial Indicator Assembled on Machine

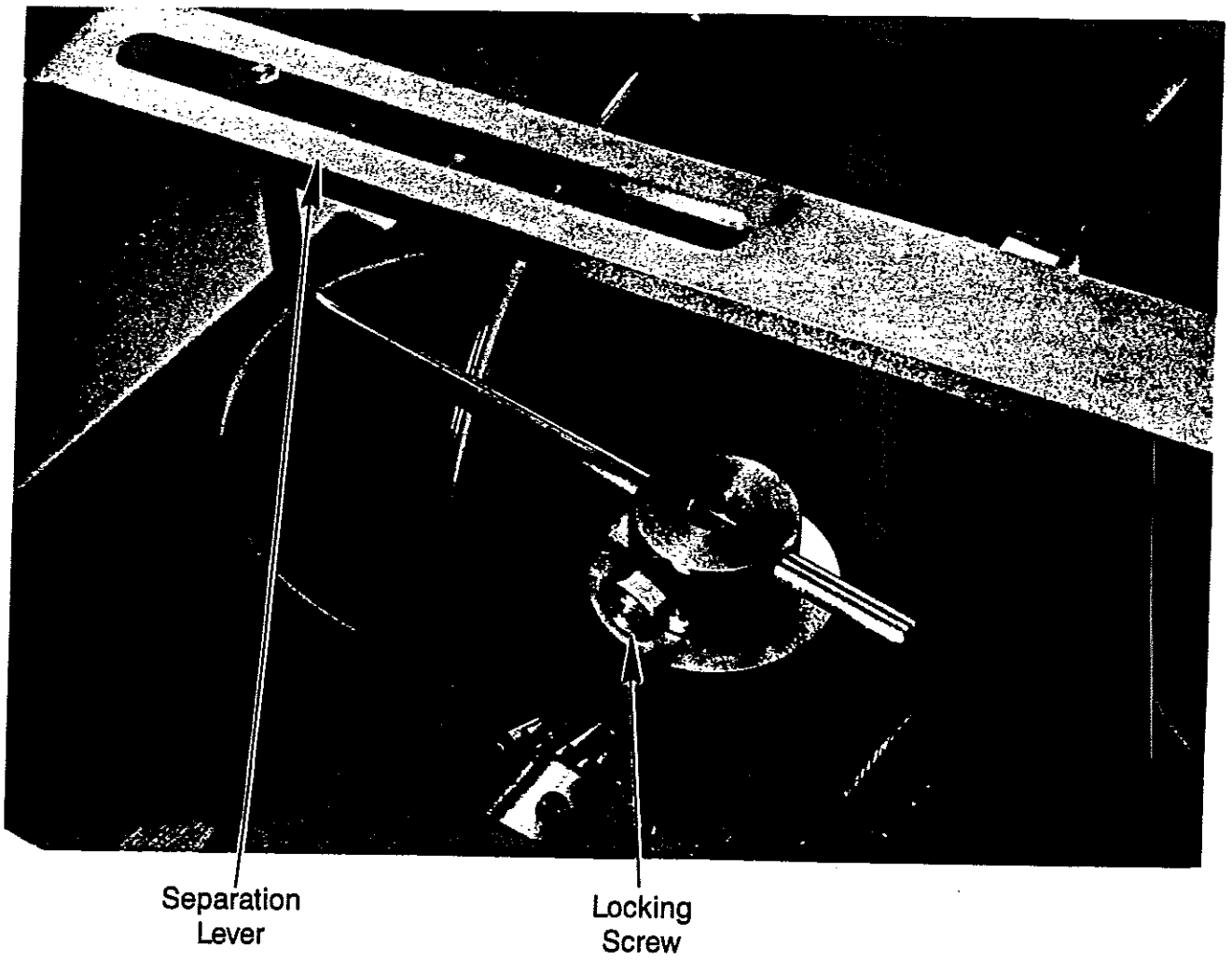


Figure 2-12 Separation Stroke Adjustments

3 WARNINGS AND SAFETY HAZARDS

IMPORTANT: This section contains information that the operator must know and understand to minimize the risk of injuries. This information is consistent with local and federal safety regulations.

KARL SUSS equipment is designed to protect the user against all possible hazards. After review by qualified safety personnel, the user should generate a specific safety procedure with regard to the particular application of the equipment and local codes.

3.1 Electrical Precautions

When the covers are removed from the mask aligner, hazardous voltages may be exposed. When all of the covers are in place, there is no danger from these voltages.

Service of the electrical systems should be performed only by qualified personnel. Therefore, it should never be necessary for the operator to open the cover of the electrical portion of the mask aligner. If any problems occur with the power supply, switch off the machine and notify maintenance personnel immediately.

CAUTION: Never open the housing while the power line is connected.

3.2 High Pressure Lamps

The light source for the concentrated ultraviolet illumination required to expose the wafer is a high pressure lamp. Special precautions must be taken when working with such lamps.

3.2.1 Electrical Hazards

The voltage and current required to run a high pressure lamp constitute a lethal combination. Starting ignition voltages are 30 KV and open circuit potentials range up to 180 VDC at currents between 5 and 50 amps.

When performing any maintenance on the exposure lamp power supply, lamp housing, or the lamp itself, insure that the power line to the power supply is disconnected.

3.2.2 Lamp Explosion

These exposure lamps operate at extremely high pressure (50-70 atm.). Explosion is therefore a possibility if they are handled or operated improperly. They may fail due to improper cooling, improper setting of the power supply, usage outside the manufacturer's guidelines, etc. Additionally, some high pressure lamps, even when cold, are still above atmospheric pressure and should be handled with protective face shields and gloves.

> **NOTE:** Careful handling of the lamp and proper operation of the equipment will substantially reduce the possibility of lamp explosions.

The lamphouse is designed to minimize damage of the interior of the equipment and avoid any possible injury to the operator should a lamp explosion occur. All assemblies and protective covers must be in place during operation of the machine.

Some of these lamps contain hazardous elements, like mercury. If a lamp should break, take precautions to avoid touching the fragments and/or breathing the vapor.

3.2.3 Exhaust Requirements

High pressure lamps produce small amounts of ozone due to the interaction of the radiation emitted below a wavelength of 250 nm with air. Ozone attacks the mucous membranes of the respiratory system, producing symptoms similar to pneumonia. The effects are cumulative. The smaller wattage lamps, cadmium-xenon to 200 watts and mercury to 500 watts, should only be operated in a well ventilated area. Larger wattage lamps should be vented out of the room.

3.2.4 Eye and Skin Safety

The ultraviolet light produced by these lamps can cause erythema of the skin (similar to sunburn) and conjunctivitis. In addition, the large infrared output can cause retinal burns resulting in blindness.

Every SUSS mask aligner is equipped with light guards, and the high pressure lamp and exposure path are enclosed. The mask aligner should not be operated unless all of these protective covers and devices are in place.

3.3 Broken Wafers

Since fragments of broken wafers and substrates can be very sharp, there is a risk of injury to the operator or maintenance personnel when trying to remove them from the machine. Extra care should be taken and proper tools, i.e. tweezers, should be used to minimize this risk.

3.4 Moving Parts

The operator should take extra care to keep loose clothing, long hair, etc. from getting caught in the machine.

See-through covers are provided in certain cases to allow the operator to observe the operation of the machine. These covers should not be removed, as they prevent the operator from reaching into the moving equipment.

4 QUALITY CONTROL

This chapter describes some of the aspects of a quality control program which will help to insure that you obtain the best possible results from your SUSS mask aligner. A mask aligner is a precision instrument that cannot be expected to function properly unless the machine is properly adjusted and maintained, and precautions are taken to insure a clean environment.

The suggestions which follow should form the basis of any quality control program. They are only intended to provide a starting point for the comprehensive program which you must develop to suit your particular application.

4.1 Environment

A mask aligner is intended for use in a well managed, professionally supervised clean room.

Mask dimensions are usually on the order of several microns, and frequently fall into the submicron range. At this level of precision, almost everything in a normal production environment would be judged too "dirty" to make semiconductor devices.

The cleanliness requirement is particularly stringent in the photomasking area. Not only are all of the critical dimensions produced here, but the frequent chemical operations present many opportunities for accidental contamination. Any type of contamination will affect fabrication yield and circuit reliability.

The exposure quality obtained from a mask aligner is a function of many variables in addition to clean room conditions. The quality of the mask used, wafer flatness, specifications and quality of the photoresist, and the condition of the resist spinner all play important roles.

To insure the best possible results, the user must take appropriate steps to insure a clean environment and institute a quality control program for all other aspects of the photomasking process.

4.2 Machine Checks and Adjustments

A mask aligner should be checked on a regular basis to insure that the machine is still adjusted to optimum performance conditions.

Figure 4-1 Measuring Light Intensity

4.2.1 Light Intensity

The light intensity measured at the wafer plane compared with the power input to the lamp gives an indication of any existing or pending failure of the exposure lamp. Towards the end of the lamp's life, the bulb begins to blacken. This is an indication of an increased possibility of a lamp explosion.

You should record the power input to the exposure lamp on a daily basis. Do not exceed the limit specified by the manufacturer of the exposure lamp.

Figure 4-1 shows a setup which can be used to measure light intensity and uniformity.

4.2.2 Light Uniformity

As part of your quality control program, you should measure the light intensity at different points of the wafer plane, for example at the 12, 3, 6, and 9 o'clock positions, and at the center.

By comparing these measurements you can calculate and monitor the light uniformity.

Please refer to Sections 5.2.2 and 5.3.3 for details on intensity and uniformity adjustments.

4.2.3 Chucks and Maskholders

Chucks and maskholders are manufactured to very fine tolerances. Your quality control program should include inspection of chucks and maskholders for cleanliness, mechanical integrity, and evidence of residues of any kind, including photoresist. The use of chucks or maskholders that have scratches or show signs of abuse will result in poor equipment performance.

A visual inspection is usually all that is required.

5 MAINTENANCE

Your SUSS MJB 3 Mask Aligner was carefully designed and solidly built to exacting standards in order to provide many years of reliable performance. There are, in fact, KARL SUSS mask aligners still in daily use in the field after fifteen years of service. To insure the highest quality performance and longest life from your MJB 3, proper maintenance and care is an absolute must.

This chapter will acquaint you with the general maintenance requirements. It also covers the procedures for periodic maintenance such as lamp replacement, intensity and uniformity checks, and power supply calibration.

5.1 General Maintenance

The few minutes spent performing the following checks and tests will greatly improve the overall performance of the MJB 3. In addition to these procedures, you should be alert to any unusual machine noises or behavior. These may indicate a condition that could lead to damage to the mask aligner if left uncorrected.

5.1.1 Visual Checks

A thorough visual check is the main requirement of the daily maintenance program for the MJB 3. Key areas include chucks, maskholders, and the microscope. These parts should be free of dust and residues, especially photoresist. Also inspect for scratches and other signs of wear. The use of scratched or damaged chucks and maskholders will result in poor equipment performance.

5.2 Replacement and Adjustment of Exposure Lamp: Standard and HP Models Only

The procedure for the replacement and adjustment of the exposure lamp for the MJB 3 Standard and the MJB 3 HP models is described below. Please refer to Section 5.3 for instructions regarding the MJB 3 UV400, UV300, and UV200 models.

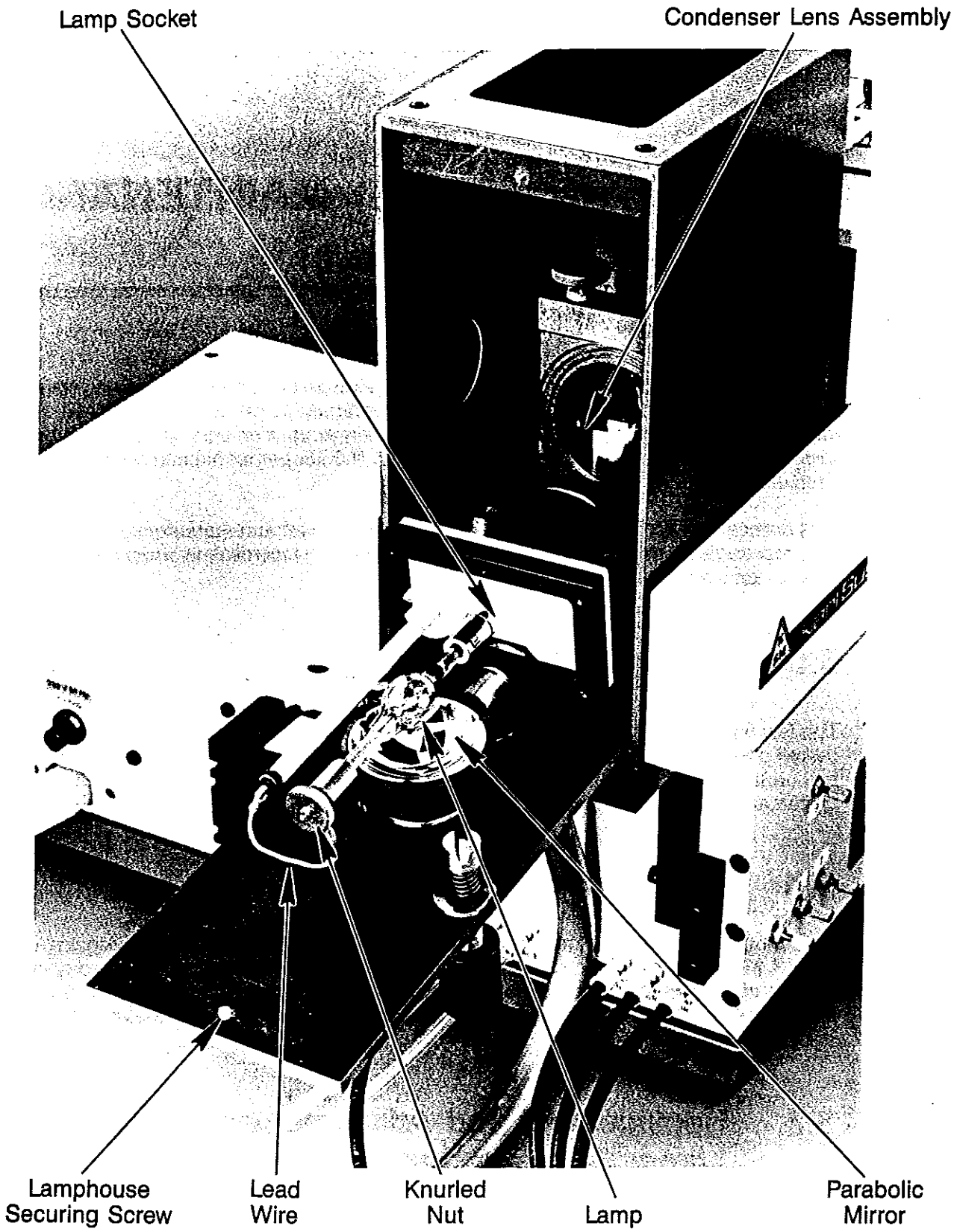


Figure 5-1 Lamphouse Standard/HP

CAUTION: Under no circumstances should you touch the quartz bulb of the exposure lamp with your fingers. Clean inadvertently touched spots immediately with alcohol and a soft lintfree cloth.

The operator should have no trouble replacing and adjusting the lamp. If there are any questions please feel free to contact your KARL SUSS service representative.

5.2.1 Lamp Replacement: Standard and HP Models Only

- Switch off the mask aligner.
- Switch off the exposure lamp power supply and disconnect it from the isolation transformer.
- Do not attempt to open the lamphouse until the lamp has been switched off for at least 20 minutes. Then unscrew the screw securing the lamphouse and carefully swing it open on its hinges. Please refer to Figure 5-1.

CAUTION: Never touch the quartz bulb with your fingers! Handle the lamp only by its metal ends.

- Remove the knurled nut from the negative (non-engraved) terminal of the lamp and remove the lead wire.
- Carefully unscrew the lamp from the lamp socket.
- Take the new lamp from its box and remove the knurled nuts.
- Install the positive (engraved) terminal of the new lamp into the lamp socket by grasping the lamp at the negative (non-engraved) terminal and carefully screwing it in.
- Carefully secure the negative lead wire to the terminal using a new knurled nut.
- Check the exposure shutter for free movement. Switch on the mask aligner and turn the CONTACT lever to the contact position. Press the EXPOSURE button and check the shutter for correct operation. Return the CONTACT lever to the separation position and switch off the mask aligner.
- Close the lamphouse and secure it with the screw.
- Go to Section 5.2.2 and perform the Intensity and Uniformity Adjustments and Measurements.

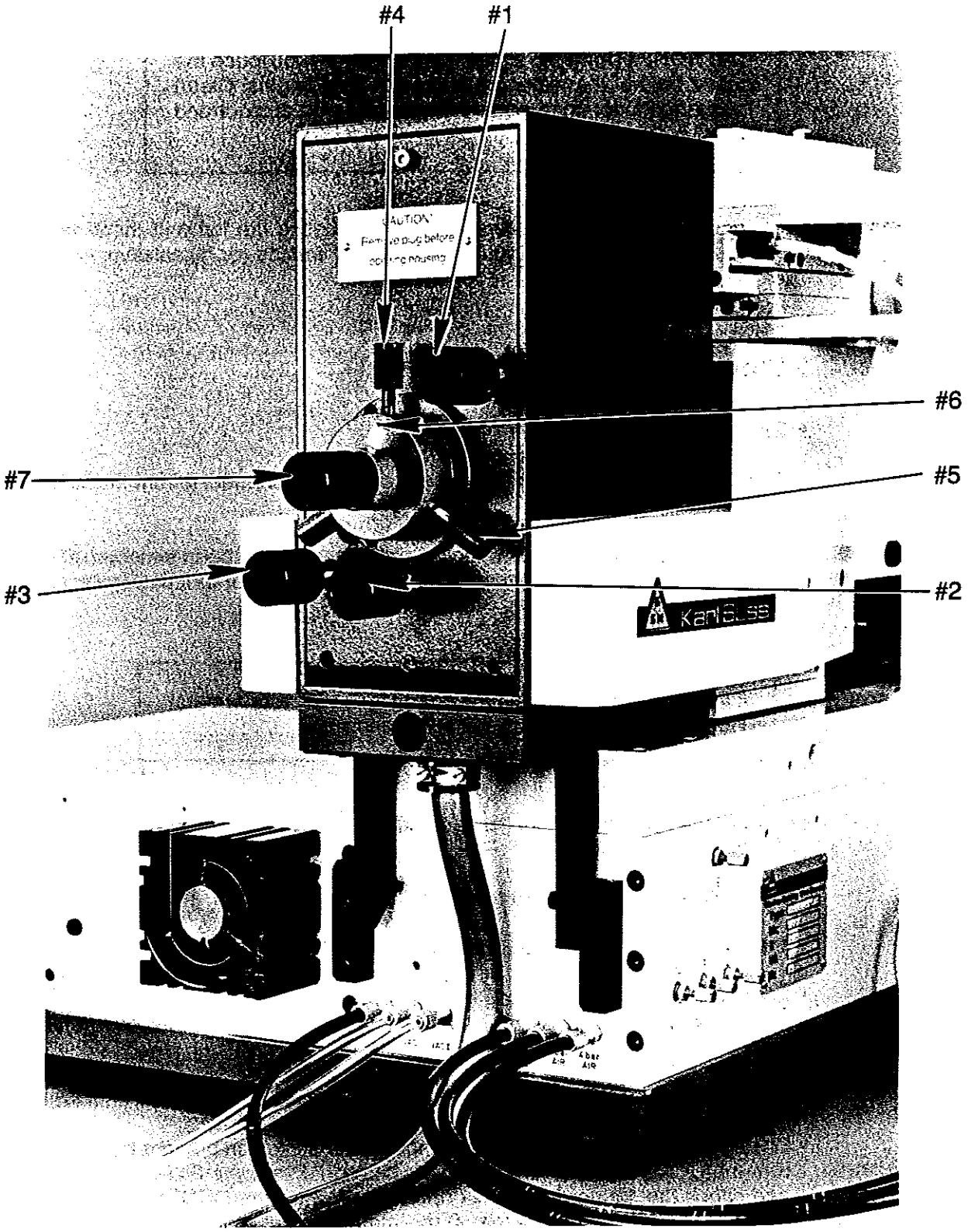


Figure 5-2 Lamphouse Standard/HP Showing Adjustments

5.2.2 Intensity and Uniformity Adjustments and Measurements: Standard and HP Models Only

The exposure lamp must always be adjusted for intensity and uniformity after it has been changed in order to insure uniform exposure across the entire exposure area. In addition, you should check the intensity and uniformity whenever you suspect wafers are not being evenly exposed.

5.2.2.1 Adjusting the Exposure Lamp: Standard and HP Models Only

All exposure lamp adjustments are done with the exposure lamp power supply in idle mode. In order to perform the adjustments you will need an intensity meter and the appropriate optical probe (365 nm or 405 nm). Follow these step by step instructions:

> **NOTE:** The high intensity produced by exposure lamps can cause eye damage. Personnel working with this equipment should wear eye protection to block ultraviolet and infrared radiation. KARL SUSS will not be responsible for injuries arising from incorrect or unprotected work with these systems.

- Insure that the mask aligner power button is in the OFF position.
- Switch on the nitrogen and compressed air sources (manometer box) and adjust the regulators to the proper settings.
- Switch on the exposure lamp power supply and ignite the exposure lamp by pressing the LAMP START button. Be certain that the power supply is set for idle mode. Allow the lamp to stabilize for 10-15 minutes.
- Switch ON the mask aligner.
- Turn the CONTACT lever to the contact position.
- Place a piece of black paper approximately 4″ x 4″ on the parallelity compensation plate.
- Set a long exposure time on the exposure timer and press the EXPOSE button.

The black knobs on the rear of the lamphouse are used to adjust the position of the exposure lamp, spherical mirror, and condenser lenses. Please refer to Figure 5-2.

- Turn knob #1 clockwise to adjust the condenser lens assembly toward the lamp until the lamp electrode and its reflected image become visible on the paper.
- Move the electrode image to left or right center of the field by vertical adjustment (knob #2) and rotation (knob #3) of the lamp.

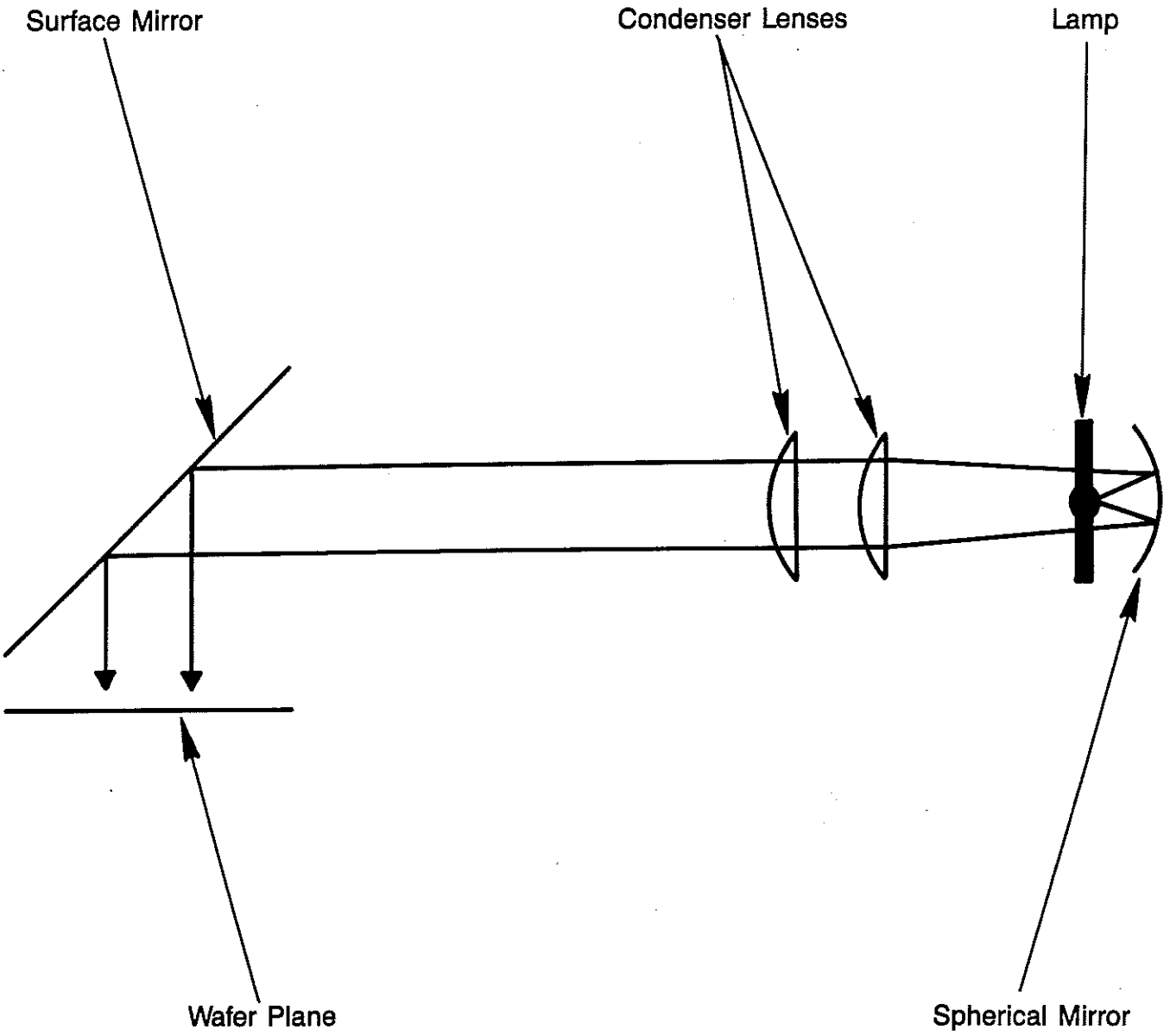


Figure 5-3 Exposure Optical System Standard/HP

- Move the reflected electrode image to the other side of the center of the field using knob #4 and knob #5.
- Loosen the knurled screw (#6), and using knob #7 adjust the mirror in or out until the electrode image and its reflected image are of equal size. Clamp, using screw #6.
- Adjust the position of the electrode image and its reflected image until they are just touching in the center of the field, using knobs #2, 3, 4, and 5.
- Using knob #1 adjust the condenser lens assembly away from the lamp until the exposure beam uniformly illuminates the exposure area.

> **NOTE:** As the condenser lens assembly is moved away from the lamp, intensity is reduced. Within a range where acceptable uniformity is obtained, this adjustment may be used to vary intensity.

5.2.2.2 Intensity and Uniformity Measurements: Standard and HP Models Only

If the intensity and uniformity adjustments in Section 5.2.2.1 were performed properly, the light intensity will be uniform at this point.

In order to insure that exposures will be satisfactory for uniform production results, it is important that the light intensity be within a 10% tolerance.

With the optical probe, measure the light intensity (see Figure 4-1) at different points of the wafer plane, for example at the 12, 3, 6, and 9 o'clock positions, at the center, and at several points in between. Using the high and low readings (H and L) ascertain that the uniformity, as calculated by the formula:

$$\text{Uniformity} = [(H-L)/(H+L)] \times 100\%$$

is less than 10%.

Once the uniformity is within the prescribed tolerance, calibrate the power supply as per Section 5.2.3.

5.2.3. Power Supply Calibration: Standard and HP Models Only

Once the new exposure lamp has been installed and adjusted for intensity and uniformity, the exposure lamp power supply must be recalibrated.

First it is necessary to calibrate the supply to the measurement obtained on the power meter with the optical probe in the center of the exposure field. Then the power supply is adjusted to the desired intensity output. Once calibrated, the reading on the power meter should track the reading on the power supply.

The power supply is set at 195 watts idle power at the factory. The lamp should be replaced when it reaches the maximum allowable power setting to avoid the possibility of a lamp explosion. The maximum allowable setting is 260 watts.

The SUSS MJB 3 Standard and MJB 3 HP models are supplied with either the SUSS Model 505 or the OAI model 762 or 764 power supply. You will find the appropriate power supply manual in the Appendix (Chapter 8).

For the SUSS Model 505, please refer to Section 2.4.4, "Optical Calibration", on page 14 of the SUSS Power Supply Manual.

For the OAI power supplies, please refer to Section 1.4 of the "Installation and Set Up" chapter on page 22 of the OAI Power Supply Manual.

5.3 Replacement and Adjustment of Exposure Lamp: UV400, UV300, and UV200 Models Only

The procedure for the replacement and the adjustment of the exposure lamp for the MJB 3 UV400, UV300 and UV200 models is described below. Please refer to Section 5.2 for instructions regarding the MJB 3 Standard and HP models.

> **CAUTION:** Under no circumstances should you touch the quartz bulb of the exposure lamp with your fingers. Clean inadvertently touched spots immediately with alcohol and a soft lintfree cloth.

The operator should have no trouble replacing and adjusting the lamp. If there are any questions please feel free to contact your KARL SUSS service representative.

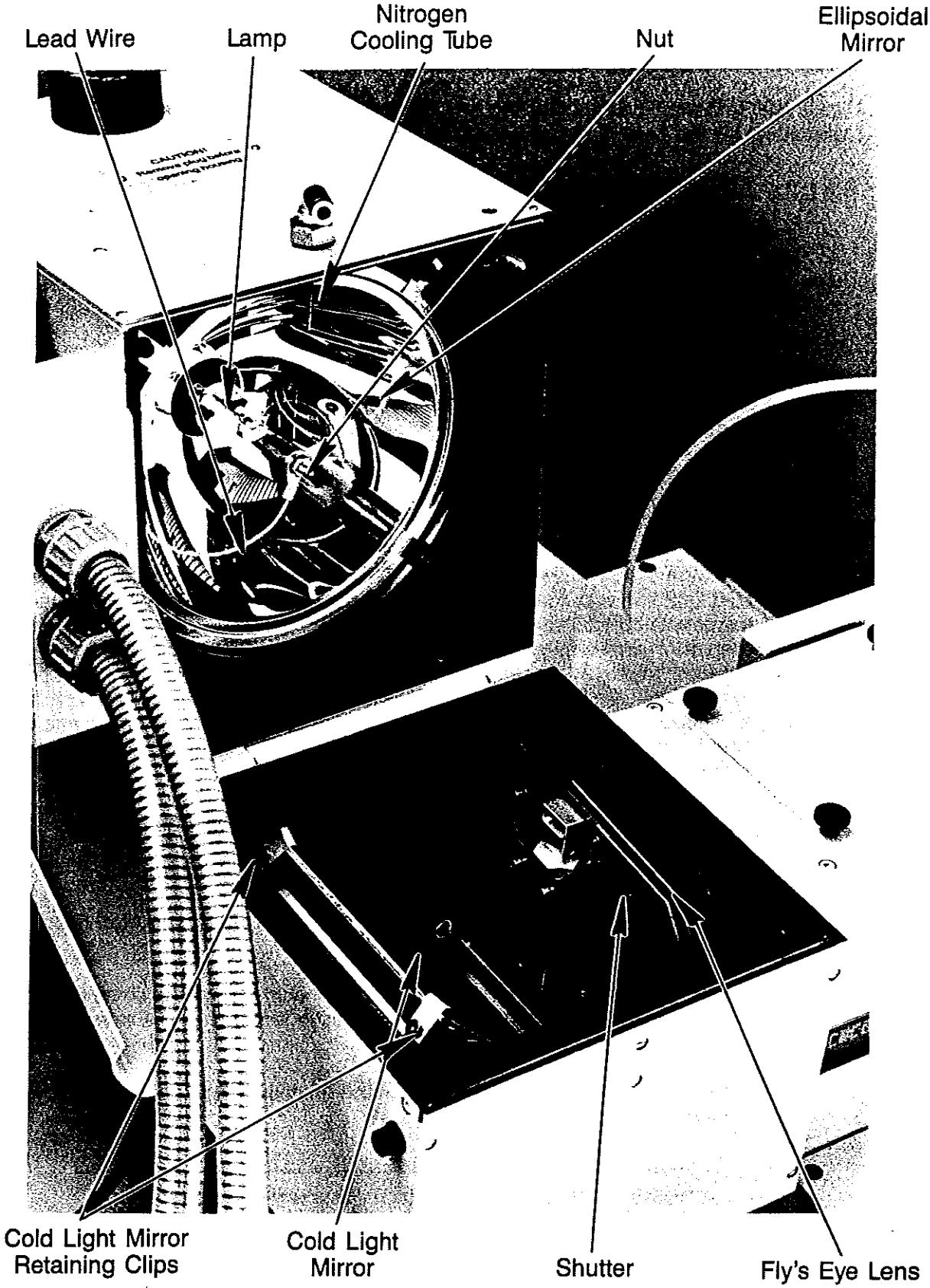


Figure 5-4 Lamphouse MJB 3 UV400/300/200

5.3.1 Lamp Replacement

Please refer to Section 5.3.1.1 for instructions regarding the MJB 3 UV400 and UV300 models. Instructions for the MJB 3 Model UV200 are contained in Section 5.3.1.2.

5.3.1.1 Lamp Replacement: UV400 and UV300 Models Only

These lamp replacement instructions are for the MJB 3 UV400 and UV300 models only. For the MJB 3 Model UV200 skip this section and go directly to Section 5.3.1.2.

- Switch off the mask aligner.
- Switch off the exposure lamp power supply and disconnect it from the isolation transformer.
- Do not attempt to open the lamphouse until the lamp has been switched off for at least 20 minutes. Then unscrew the screw securing the lamphouse and carefully swing it open on its hinges. Please refer to Figure 5-4.
- Examine the cold light mirror and clean it if necessary. In order to clean the cold light mirror properly, it must be removed from the lamphouse. Handle the mirror with care! Clean under hot running water using a soft sponge and liquid soap. Rinse *thoroughly*, carefully blow off the mirror with nitrogen and reinstall it in the lamphouse. The orientation of cold light mirrors #'s 1 and 2 on the holder is not critical, since both sides of the mirror are coated. However, cold light mirror #7 is coated only on one side. This side is indicated by an arrow on one edge of the mirror. The mirror must be mounted on the holder so that the coated side faces the lamp.

> **CAUTION:** Never touch the quartz bulb with your fingers! Handle the lamp only by its metal ends.

- Remove the nut from the positive terminal of the lamp (engraved end) and remove the lead wire. Keep the nut!
- Carefully unscrew the lamp from the socket. Should the adapter come out with the lamp, remove and reinstall it on the negative terminal of the new lamp (non-engraved end).
- Take the new lamp from its box and remove the knurled nuts, which are no longer needed.

> **NOTE:** The knurled nuts which come with the new lamp must *not* be used.

- Install the negative terminal (non-engraved end) of the new lamp in the lamphouse socket using the adapter, by grasping the lamp at the positive terminal (engraved end) and carefully screwing it in.

- Carefully secure the positive lead wire to the lamp base with the hexagon nut (8-32 thread UNC 3A).
- Check the position of the cooling tube so that it is placed towards the positive terminal (engraved end) of the lamp.
- Go to Section 5.3.2.

5.3.1.2 Lamp Replacement: UV200 Model Only

These lamp replacement instructions are for the MJB 3 Model UV200 only. For the MJB 3 UV400 and UV300 models, please see Section 5.3.1.1.

- Switch off the mask aligner.
- Switch off the exposure lamp power supply and disconnect it from the isolation transformer.
- Do not attempt to open the lamphouse until the lamp has been switched off for at least 20 minutes. Then unscrew the screw securing the lamphouse and carefully swing it open on its hinges. Please refer to Figure 5-4.
- Examine the cold light mirror and clean it if necessary. In order to clean the cold light mirror properly, it must be removed from the lamphouse. Handle the mirror with care! Clean under hot runing water using a soft sponge and liquid soap. Rinse *thoroughly*, carefully blow off the mirror with nitrogen and reinstall it in the lamphouse. Cold light mirror #8 is coated only on one side. This side is indicated by an arrow on one edge of the mirror. The mirror must be mounted on the holder so that the coated side faces the lamp.

> **CAUTION:** Never touch the quartz bulb with your fingers! Handle the lamp only by its metal ends.
>
> Note that the Cd/Xe lamps used for UV200 are installed in the lamphouse in opposite polarity to the Hg lamps used for UV400 and UV300.
>
> Further, note that Cd/Xe lamps are under approximately 3 atm pressure even when cold. Wear protective eyewear and exercise care!

- Remove the nut from the negative terminal of the lamp and remove the lead wire. Keep the nut!
- Carefully unscrew the lamp from the socket. Should the adapter come out with the lamp, remove and reinstall it on the positive terminal of the new lamp.
- Take the new lamp from its box and remove the knurled nuts, which are no longer needed.

NOTE: The knurled nuts which come with the new lamp must *not* be used.

- Install the positive terminal of the new lamp in the lamphouse socket using the adapter by grasping the lamp at the negative terminal and carefully screwing it in.
- Carefully secure the negative lead wire to the lamp base with the hexagon nut (8-32 thread UNC 3A).
- Check the position of the cooling tube so that it is placed towards the negative terminal of the lamp.
- Check that the external cooling fan operates and the exhaust connection at the back of the lamphouse is secure.
- Go to Section 5.3.2.

5.3.2 Lamphouse Reassembly and Pneumatic Adjustments: UV400, UV300, and UV200 Models Only

- Close the lamphouse and secure it with its screw.
- Adjust the nitrogen flow for cooling of the lamp base using throttle #17 which is located on the rear of the machine (see Figure 5-5). Close the throttle by turning it clockwise, then open counter clockwise about 1/2 to 1 turn for a nitrogen input pressure of approximately 2 bar.

CAUTION: Throttle numbers may differ on older machines. Please consult your pneumatic plan if in doubt.

- Adjust the air flow for cooling of the heat sink using throttle #16. The throttle should be open about 5 turns for an air input pressure of approximately 4 bar.
- Go to Section 5.3.3 and perform the intensity and uniformity adjustments.

5.3.3 Intensity and Uniformity Adjustments and Measurements: UV400, UV300, and UV200 Models Only

The exposure lamp must always be adjusted for intensity and uniformity after it has been changed in order to insure proper cooling and uniform exposure across the entire exposure area. In addition, you should check the intensity and uniformity whenever you suspect wafers are not being evenly exposed.

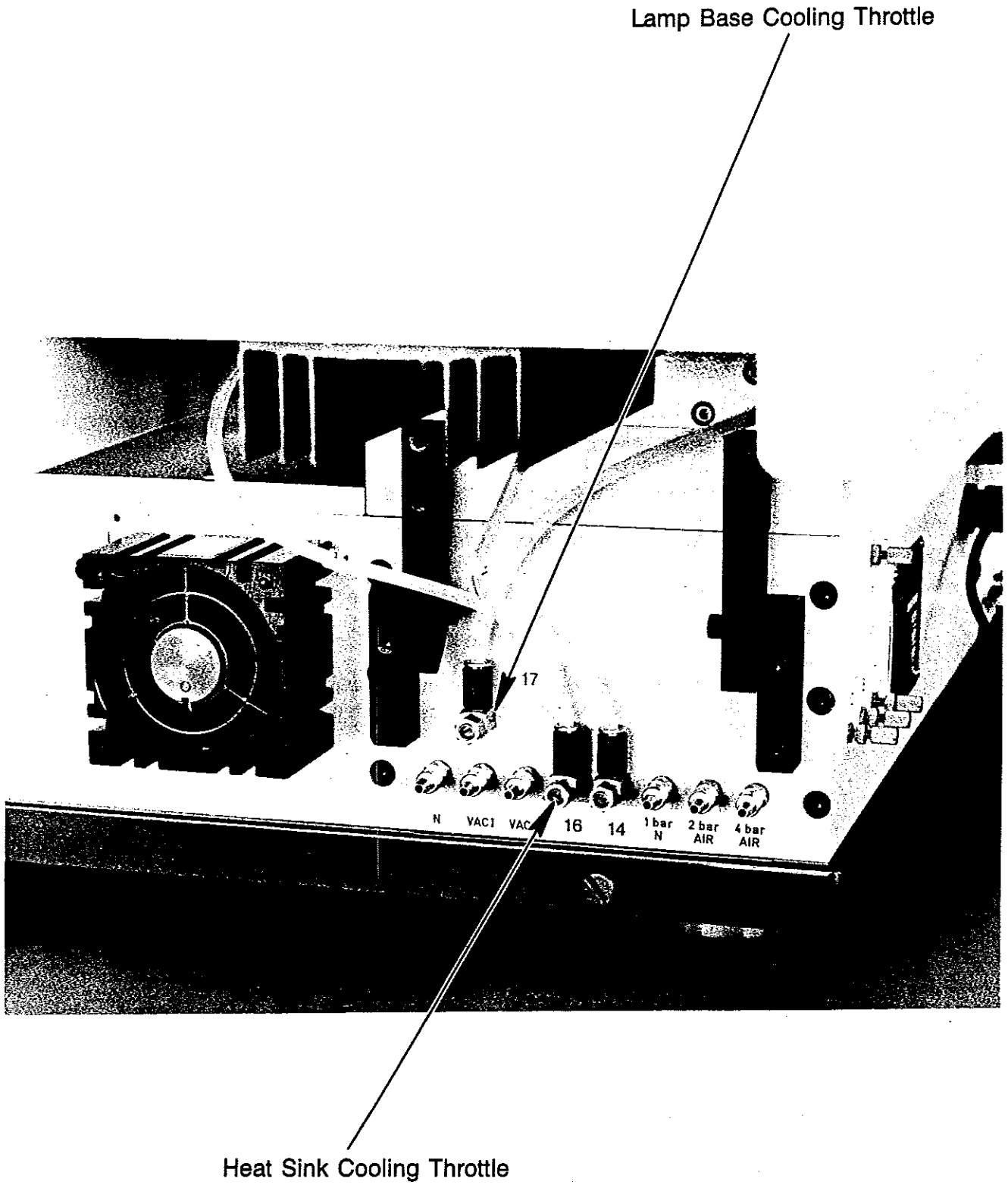


Figure 5-5 Back Side of Machine

5.3.3.1 *Adjusting the Exposure Lamp: UV400, UV300, and UV200 Models Only*

All exposure lamp adjustments are done with the exposure lamp power supply in idle mode. In order to perform the adjustments you will need an intensity meter and the appropriate optical probes (365 nm, 405 nm, 310 nm, or 220 nm wavelength). Follow these step by step instructions:

> **NOTE:** The high intensity energy produced by exposure lamps can cause eye damage. Personnel working with this equipment should wear eye protection with suitable filtration to block ultraviolet and infrared radiation. KARL SUSS will not be responsible for injuries arising from incorrect or unprotected work with these systems.

- Insure that the mask aligner power button is in the OFF position.
- Switch on the nitrogen and compressed air sources, which provide cooling for the lamphouse. Adjust the regulators to the proper settings.
- Switch on the exposure lamp power supply and ignite the exposure lamp by pressing the LAMP START button. Be certain the power supply is set for idle mode. Allow the lamp to stabilize for 10-15 minutes.
- Switch ON the mask aligner.
- Turn the contact lever to the contact position.
- Place a piece of black paper, approximately 4″ x 4″, on the parallelity compensation plate to avoid scratching its surface. Place the optical probe on the paper (see Figure 4-1).
- Set a long exposure time on the exposure timer and press the EXPOSURE button.

The three knobs located on the lamphouse are used to adjust the position of the exposure lamp in the ellipsoidal mirror. Please refer to Figure 5-6.

The red knob on the lamphouse shifts the lamp vertically and thus primarily controls intensity. The green knob shifts the lamp in the Y direction, and the blue knob shifts the lamp in the X direction. Their primary purpose is to adjust the uniformity of illumination.

- Maximize the reading on the power meter by first shifting the lamp vertically using the red knob. Then do the same in the Y and X directions using the green and blue knobs.
- Alternately placing the probe at the right and left hand edges of the illuminated area, use the green knob to shift the lamp in the Y direction until the meter gives the same reading at both locations.
- Alternately placing the probe at the front and rear edges of the illuminated area, use the blue knob to shift the lamp in the X direction until the meter gives the same reading at both locations.
- Re-check the vertical adjustment (red knob).

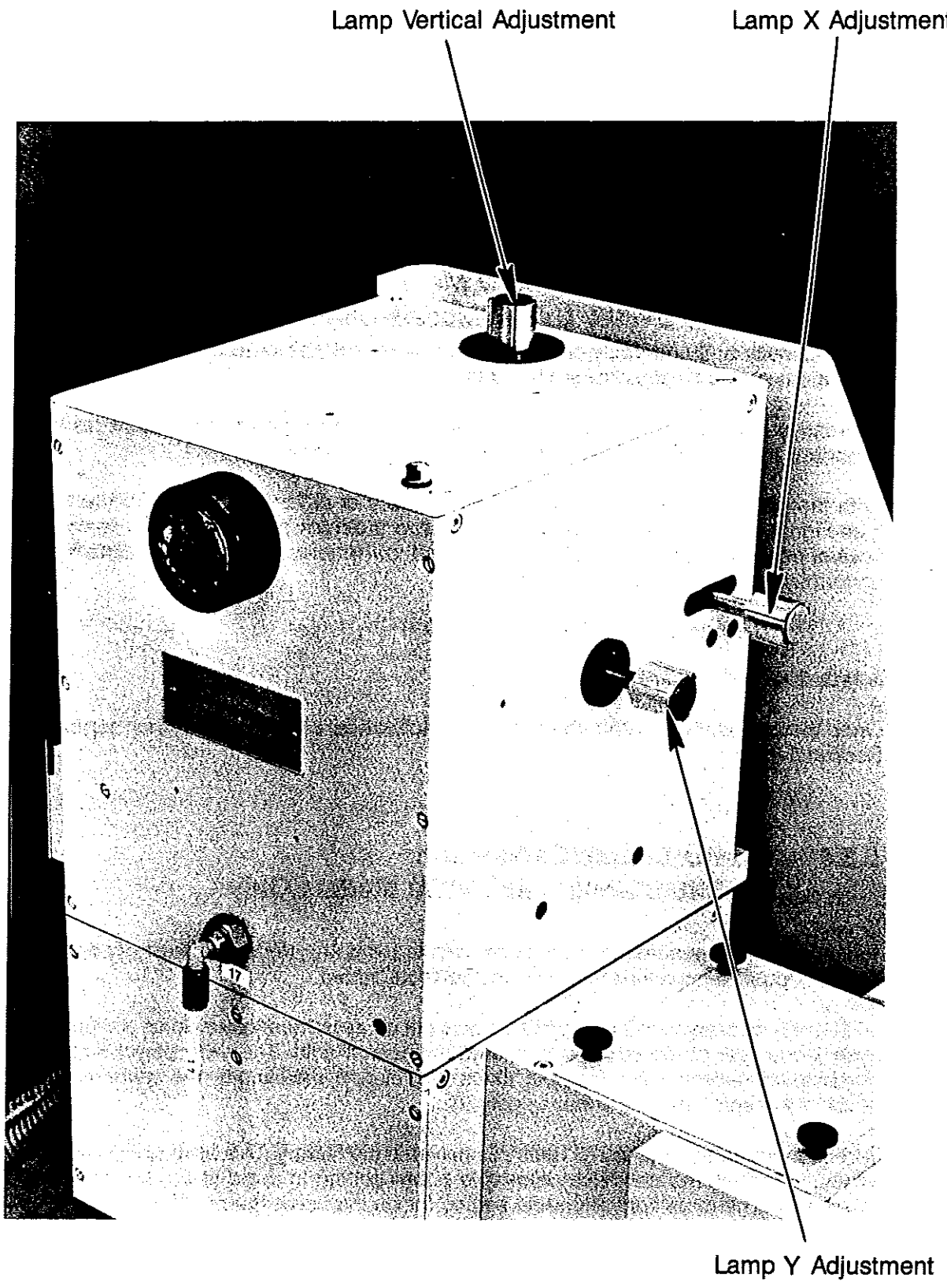


Figure 5-6 Lamphouse Showing Adjustments
MJB 3 UV400/300/200

CAUTION: The red knob on the lamphouse must *only* be used to maximize the intensity of the exposure lamp. If you wish to adjust the intensity for process purposes either adjust the power supply output or use proper filters. Using the red knob to decrease the intensity will result in a build up of excess heat in the lamphouse which could lead to a lamp explosion.

5.3.3.2 Intensity and Uniformity Measurements: UV400, UV300, UV200 Models Only

If the intensity and uniformity adjustments in Section 5.3.3.1 were performed properly, the light intensity will be uniform at this point.

In order to insure that exposures will be satisfactory for uniform production results, it is important that the light intensity be within a 5% tolerance.

With the optical probe, measure the light intensity at different points of the wafer plane (see Figure 4-1), for example at the 12, 3, 6, and 9 o'clock positions, at the center, and at several points in between. Using the high and low readings (H and L) ascertain that the uniformity, as calculated by the formula:

$$\text{Uniformity} = [(H-L)/(H+L)] \times 100\%$$

is less than 5%.

Once the uniformity is within the prescribed tolerance, calibrate the power supply as per Section 5.3.4.

5.3.4 Power Supply Calibration: UV400, UV300, and UV200 Models Only

Once the new exposure lamp has been installed and adjusted for intensity and uniformity, the exposure lamp power supply must be recalibrated.

First it is necessary to calibrate the supply to the measurement obtained on the power meter with the optical probe in the center of the exposure field. Then the power supply is adjusted to the desired intensity output. Once calibrated, the reading on the power meter should track the reading on the power supply.

The power supply is set at 275 watts idle power at the factory. The lamp should be replaced when it reaches the maximum allowable power setting to avoid the possibility of a lamp explosion. The maximum allowable setting for an exposure time of 10 seconds or less is 400 watts. For a 25 second or longer exposure time, the maximum is 360 watts. A proportional setting is used for exposure times between 10 and 25 seconds.

The SUSS MJB 3 UV400, UV300, and UV200 models are supplied with either the SUSS Model 505 or 507X or the OAI Model 762 or 764 power supply. You will find the appropriate power supply manual in the Appendix (Chapter 8).

For the SUSS power supplies, please refer to Section 2.4.4, "Optical Calibration", on page 14 of the SUSS Power Supply Manual.

For the OAI power supplies, please refer to Section 1.4 of the "Installation and Set-Up" Chapter on page 22 of the OAI Power Supply Manual.

5.4 Exposure Optical System: UV400, UV300, and UV200 Models

The UV400, UV300 and UV200 exposure optics are of similar design. They consist of an exposure lamp, ellipsoidal mirror, cold light mirror, fly's eye lens, condenser lenses, diffraction reducing lens plate, surface mirror and front lens (see Figure 5-7).

A detailed description of the optical system follows in Section 5.4.1. Section 5.4.2 outlines the components which differ from one wavelength range to another. Sections 5.4.3 and 5.4.4 detail the procedures for changing from one wavelength range to another.

5.4.1 Optical System Components

a. **Exposure Lamp**—In the case of UV400 and UV300, the exposure lamp is a 350W super pressure mercury short-arc lamp. The spectral lines emitted by the lamp which are of interest here are those at 436 nm, 405 nm, 365 nm, 335 nm and 313 nm.

   In the case of UV200, the exposure lamp is a 350W super pressure Cd/Xe short-arc lamp. This lamp emits spectral lines in the 210-230 nm wavelength region, in addition to other lines at longer wavelengths.

b. **Ellipsoidal Mirror**—The exposure lamp is mounted in an ellipsoidal collecting mirror, at one focus of the ellipsoid. The ellipsoidal mirror collects the radiation emitted by the lamp and focuses it at the second focus of the mirror. The ellipsoidal mirror is the same for all wavelength ranges.

c. **Cold Light Mirror**—The cold light mirror transmits the unwanted longer wavelength radiation to the heat sink located at the second focus of the ellipsoidal mirror under the cold light mirror, and reflects the shorter wavelength radiation (cold light) to the fly's eye lens. The cold light mirror is specific to each wavelength range.

d. **Fly's Eye Lens**—The fly's eye lens disperses the light uniformly and directs it to the condenser lenses. The fly's eye lens is made of Herasil for the UV400 and UV300 systems and Suprasil (synthetic quartz) for the UV200 system.

e. **Condenser Lenses**—The condenser lenses collimate the exposure light. The position of the condenser lenses in the mirrorhouse tube affects intensity and uniformity. A scale is mounted on the right side of the mirrorhouse tube. The recommended position of the condenser lenses for the UV400 and UV300 systems is both lenses together and centered at 40 mm from the lamphouse. For the UV200 system the recommended positions are 10 mm for the first lens and 30 mm for the second. The position of the condenser lenses may be adjusted

if necessary to obtain better uniformity. Like the fly's eye lens, the condenser lenses are made of Herasil in the case of UV400 and UV300 and Suprasil (synthetic quartz) in the case of UV200.

f. **Filter Holder**—The filter holder is located between the condenser lenses and the diffraction reducing lens plate. In the UV400 system it may be used to mount filters of various types for work with negative resist or to reduce intensity (neutral density filters). In the UV300 system a 365 nm interference filter is mounted in the holder. The position of the filter holder is not critical.

g. **Lens Plate**—The purpose of the lens plate is to reduce diffraction effects in the printed image. The position of the lens plate, like that of the condenser lenses, affects intensity and uniformity. The recommended position of the lens plate is 85 mm for UV400 and UV300 and 25 mm (position of the clamping screw) for UV200. The lens plate is specific to each wavelength range.

h. **Surface Mirror**—The surface mirror changes the direction of the exposure beam from horizontal to vertical. It is important that the metallized side of the mirror face the beam. The surface mirror is the same for all wavelength ranges.

i. **Front Lens**—The front lens provides final collimation and uniformity of the exposure beam. It is specific for each wavelength range.

5.4.2 Optical Components by Model

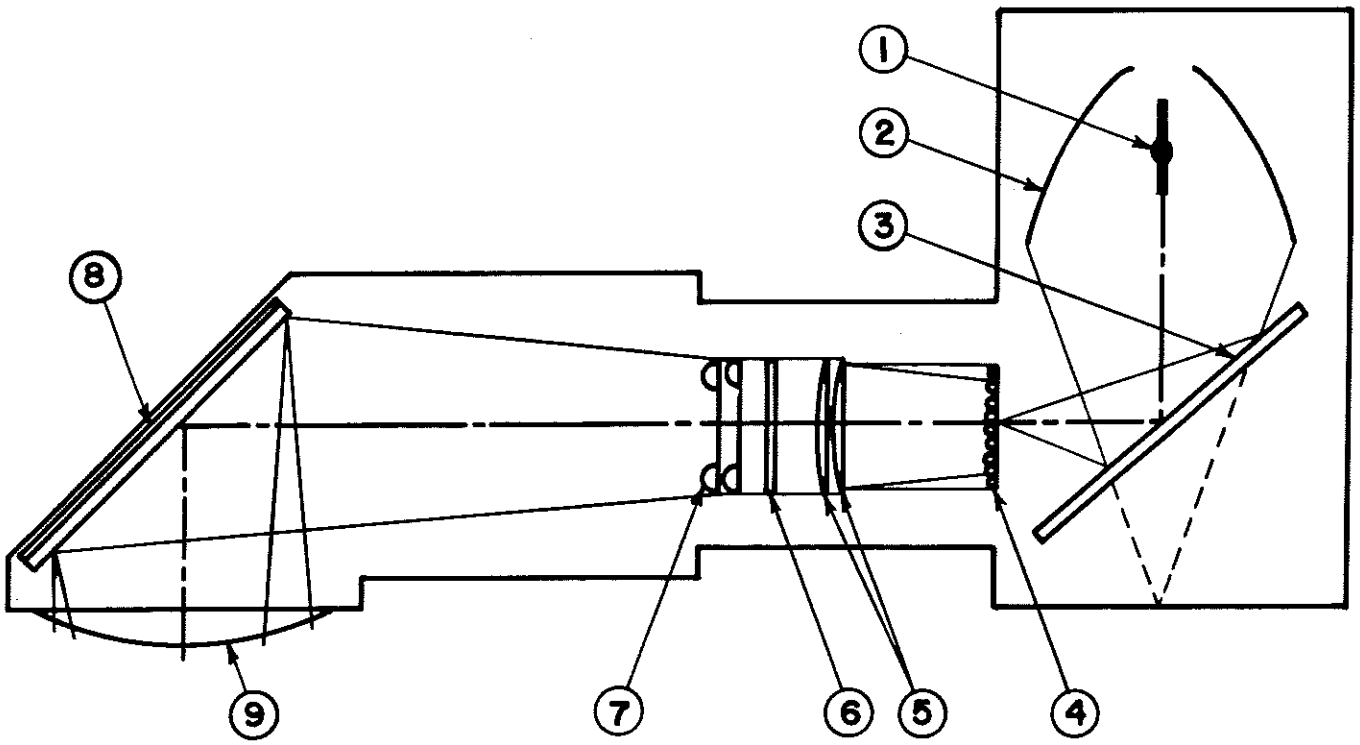
As described in Section 5.4.1, the fly's eye lens and condenser lenses are fabricated of Herasil for UV400 and UV300 machines, and of Suprasil for UV200 machines. However, the Suprasil components can be used for all wavelength ranges, while the Herasil components may only be used for UV400 and UV300.

5.4.2.1 Model UV400 Optical Components

- **Cold Light Mirror:** #1 or #7. The number of the cold light mirror is marked on one corner. Cold light mirror #1 is specific to UV400, while cold light mirror #7 may be used for UV400 and UV300.
- **Lens Plate:** 12 double lenses arranged in a triangle configuration, fabricated of Herasil.
- **Front Lens:** Transparent.

5.4.2.2 Model UV300 Optical Components

- **Cold Light Mirror**: #2 or #7. The number of the cold light mirror is marked on one corner. Cold light mirror #2 is specific to UV300, while cold light mirror #7 may be used for UV400 and UV300.
- **Interference Filter**: 60 mm diameter round filter (365 nm).



1. Lamp
2. Elllipsoid Mirror
3. Coldlight Mirror
4. Fly's Eye Lens
5. Condenser Lenses
6. Frame for Filters
7. Diffraction Reducing Lens Plate
8. Surface Mirror
9. Front Lens

Figure 5-7 Exposure Optical System MJB 3 UV400/300/200

- **Lens Plate**: 12 single lenses arranged in a triangle configuration, fabricated of Herasil.
- **Front Lens**: Black.

5.4.2.3 Model UV200 Optical Components

- **Cold Light Mirror**: #8. The number of the cold light mirror is marked on one corner.
- **Lens Plate**: 12 double lenses arranged in a triangle configuration, fabricated of Suprasil.

> **NOTE:** The Suprasil lens plate may also be used for UV400.

- **Front Lens**: Herasil.

5.4.3 Changing from One Wavelength Range to Another: UV400 and UV300 Models Only

5.4.3.1 Changing from UV300 to UV400 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Cold Light Mirror

- Unless equipped with cold light mirror #7, cold light mirror #2 must be replaced with cold light mirror #1, as follows:
- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #2.
- Place the cold light mirror #1 on the mount and tighten the retaining clips.

> **CAUTION:** Do not overtighten the retaining clips.

- Close the lamphouse and secure it with its screw.

Mirrorhouse

- Remove the screws securing the cover on top of the mirrorhouse tube and remove the cover.

- Remove the mirrorhouse balance weights.
- Loosen the screws securing the condenser lenses, filter holder and the lens plate holder.
- Slide the components to the rear and remove the lens plate from its holder.
- Place the UV400 lens plate (see Section 5.4.2.1) in the holder and slide it forward to 85 mm from the lamphouse wall.
- Remove the interference filter from the filter holder.
- Position the condenser lenses centered at 40 mm from the lamphouse wall.
- Tighten the screws securing the condenser lenses, filter holder and the lens plate holder.
- Replace the mirrorhouse cover and fasten it with its screws.
- Replace the mirrorhouse balance weights.

Front Lens

- Remove the black front lens by pulling it to the left out of its slide.
- Insert the transparent front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV400 wavelength range, it will be necessary to change the sensor for the constant intensity power supply. The type of sensor is marked on the plug connecting it to the power supply. A 365 nm or 405 nm detector is used for both SUSS and OAI Power Supplies. In each case the sensor is a dual channel type. The first number marked on the plug is channel 1, the second channel 2. If the machine was purchased with both UV400 and UV300 optics then the sensor incorporates a detector for each wavelength range. If a sensor with a detector for UV400 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.4.3.2 Changing from UV400 to UV300 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Cold Light Mirror

- Unless equipped with cold light mirror #7, cold light mirror #1 must be replaced with cold light mirror #2, as follows:
- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #1.
- Place the cold light mirror #2 on the mount and tighten the retaining clips.

> **CAUTION:** Do not overtighten the retaining clips.

- Close the lamphouse and secure it with its screw.

Mirrorhouse

- Remove the screws securing the cover on top of the mirrorhouse tube and remove the cover.
- Remove the mirrorhouse balance weights.
- Loosen the screws securing the condenser lenses, filter holder and the lens plate holder.
- Slide the components to the rear and remove the lens plate from its holder.
- Place the UV300 lens plate (see Section 5.4.2.2) in the holder and slide it forward to 85 mm from the lamphouse wall.
- Insert the interference filter into the filter holder and slide it forward against the lens plate.
- Position the condenser lenses centered at 40 mm from the lamp house wall.
- Tighten the screws securing the condenser lenses, filter holder and the lens plate holder.
- Replace the mirrorhouse cover and fasten it with its screws.
- Replace the mirrorhouse balance weights.

Front Lens

- Remove the transparent front lens by pulling it to the left out of its slide.
- Insert the black front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV300 wavelength range, it will be necessary to change the sensor for the constant intensity power supply.

The type of sensor is marked on the plug connecting it to the power supply. For SUSS power supplies a 320 nm detector is used; for OAI power supplies a 310 nm detector is used. In each case the sensor is a dual channel type. The first number marked on the plug is channel 1, the second channel 2. If the machine was purchased with both UV400 and UV300 optics then the sensor incorporates a detector for each wavelength range. If a sensor with a detector for UV300 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.4.4 Changing from One Wavelength Range to Another: UV200 Model Only

5.4.4.1 Changing from UV200 to UV300 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Exposure Lamp

- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Remove the Cd/Xe lamp (see Section 5.3.1.2).
- Insert the Hg lamp (see Section 5.3.1.1).
- Remove the power supply leads terminal cover on the back of the lamphouse.
- Interchange the connections of the power supply leads.
- Replace the power supply leads terminal cover.

Cold Light Mirror

- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #8.
- Place the cold light mirror #2 or #7 on the mount and tighten the retaining clips. Please see Section 5.3.1.1 for the correct orientation of cold light mirror #7.

CAUTION: Do not overtighten the retaining clips.

- Close the lamphouse and tighten it with its screw.
- Disconnect the external cooling fan for the lamphouse. (This fan is not used with UV400 or UV300).

Power Supply

- Remove the screws from the power supply cover and slide the cover back until the switch marked "Cd/Xe—Hg" is visible.
- Move the switch to the "Hg" position.
- Replace the power supply cover and secure it with its screws.

Mirrorhouse

- Remove the mirrorhouse balance weights.
- Remove the screws securing the half shell covers around the mirrorhouse tube.
- Remove the microscope.
- Remove the screws securing the surface mirror mounting plate and remove it, together with the surface mirror.
- Remove the screw securing the lens plate adjustment arm to the slot in the mirrorhouse.
- Screw the tool provided into the lens plate and withdraw the lens plate through the front of the mirrorhouse.
- Screw the tool into the UV300 lens plate and insert the lens plate through the front of the mirrorhouse.
- Insert the screw into the lens plate adjustment arm, position it at 25 mm from the lamphouse wall and tighten the screw.
- Replace the surface mirror mounting plate together with the surface mirror.
- Replace the microscope.
- Remove the filter holder from the mirrorhouse tube by sliding it to the left.
- Insert the round 60 mm diameter interference filter into the holder.
- Replace the filter holder.
- Replace the half-shell covers on the mirrorhouse tube and secure them with their screws.
- Replace the mirrorhouse balance weights.

Front Lens

- Remove the Herasil front lens by sliding it to the left out of its slide.
- Insert the black front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV300 wavelength range, it will be necessary to change the sensor for the constant intensity power supply. The type of sensor is marked on the plug connecting it to the power supply. A 320 nm detector is used for UV300. The sensor is a dual channel type. The first number marked on the plug is channel 1, the second is channel 2. If the machine was purchased with both UV200 and UV300 optics then the sensor incorporates a detector for each wavelength range. If a sensor with a detector for UV300 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.4.4.2 Changing from UV200 to UV400 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Exposure Lamp

- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Remove the Cd/Xe lamp (see Section 5.3.1.2).
- Insert the Hg lamp (see Section 5.3.1.1).
- Remove the power supply leads terminal cover on the back of the lamphouse.
- Interchange the connections of the power supply leads.
- Replace the power supply leads terminal cover.

Cold Light Mirror

- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #8.
- Place the cold light mirror #1 or #7 on the mount and tighten the retaining clips. Please see Section 5.3.1.1 for the correct orientation of cold light mirror #7.

CAUTION: Do not overtighten the retaining clips.

- Close the lamphouse and tighten it with its screw.
- Disconnect the external cooling fan for the lamphouse. (This fan is not used with UV400 or UV300.)

Power Supply

- Remove the screws from the power supply cover and slide the cover back until the switch marked "Cd/Xe—Hg" is visible.

- Move the switch to the "Hg" position.
- Replace the power supply cover and secure it with its screws.

Front Lens

- Remove the Herasil front lens by pulling it to the left out of its slide.
- Insert the transparent front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV400 wavelength range, it will be necessary to change the sensor for the constant intensity power supply. The type of sensor is marked on the plug connecting it to the power supply. A 365 nm or 405 nm detector is used for UV400. The sensor is a dual channel type. The first number marked on the plug is channel 1, the second is channel 2. If the machine was purchased with both UV200 and UV400 optics then the sensor incorporates a detector for each wave length range. If a sensor with a detector for UV400 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.4.4.3 Changing from UV300 to UV200 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Exposure Lamp

- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Remove the Hg lamp (see Section 5.3.1.1).
- Insert the Cd/Xe lamp (see Section 5.3.1.2).
- Remove the power supply leads terminal cover on the back of the lamphouse.
- Interchange the connections of the power supply leads.
- Replace the power supply leads terminal cover.

Cold Light Mirror

- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #2 or #7.
- Place the cold light mirror #8 on the mount and tighten the retaining clips. Please see Section 5.3.1.2 for the correct orientation of cold light mirror #8.

CAUTION: Do not overtighten the retaining clips.

- Close the lamphouse and tighten it with its screw.
- Connect the external cooling fan for the lamphouse. (This fan is not used with UV400 or UV300.)

Power Supply

- Remove the screws from the power supply cover and slide the cover back until the switch marked "Cd/Xe—Hg" is visible.
- Move the switch to the "Cd/Xe" position.
- Replace the power supply cover and secure it with its screws.

Mirrorhouse

- Remove the mirrorhouse balance weights.
- Remove the screws securing the half-shell covers around the mirrorhouse tube.
- Remove the microscope.
- Remove the screws securing the surface mirror mounting plate and remove it, together with the surface mirror.
- Remove the screw securing the lens plate adjustment arm to the slot in the mirrorhouse.
- Screw the tool provided into the lens plate and withdraw the lens plate through the front of the mirrorhouse.
- Screw the tool into the UV200 lens plate and insert the lens plate through the front of the mirrorhouse.
- Insert the screw into the lens plate adjustment arm, position it at 25 mm from the lamphouse wall and tighten the screw.
- Replace the surface mirror mounting plate together with the surface mirror.
- Replace the microscope.
- Remove the filter holder from the mirrorhouse tube by sliding it to the left.
- Remove the round 60 mm diameter interference filter from the holder.
- Replace the filter holder.
- Replace the half-shell covers on the mirrorhouse tube and secure them with their screws.
- Replace the mirrorhouse balance weights.

Front Lens

- Remove the black front lens by sliding it to the left out of its slide.
- Insert the Herasil front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV200 wavelength range, it will be necessary to change the sensor for the constant intensity power supply. The type of sensor is marked on the plug connecting it to the power supply. A 220 nm detector is used for UV200. The sensor is a dual channel type. The first number marked on the plug is channel 1, the second is channel 2. If the machine was purchased with both UV200 and UV300 optics then the sensor incorporates a detector for each wavelength range. If a sensor with a detector for UV200 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.4.4.4 Changing from UV300 to UV400 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Cold Light Mirror

- Unless equipped with cold light mirror #7, cold light mirror #2 must be replaced with cold light mirror #1, as follows:
- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #2.
- Place the cold light mirror #1 on the mount and tighten the retaining clips.

> **CAUTION:** Do not overtighten the retaining clips.

- Close the lamphouse and secure it with its screw.

Mirrorhouse

- Remove the mirrorhouse balance weights.
- Remove the screws securing the half-shell covers around the mirrorhouse tube.
- Remove the microscope.

- Remove the screws securing the surface mirror mounting plate and remove it, together with the surface mirror.
- Remove the screw securing the lens plate adjustment arm to the slot in the mirrorhouse.
- Screw the tool provided into the lens plate and withdraw the lens plate through the front of the mirrorhouse.
- Screw the tool into the UV400/UV200 lens plate and insert the lens plate through the front of the mirrorhouse.
- Insert the screw into the lens plate adjustment arm, position it at 25 mm from the lamphouse wall and tighten the screw.
- Replace the surface mirror mounting plate together with the surface mirror.
- Replace the microscope.
- Remove the filter holder from the mirrorhouse tube by sliding it to the left.
- Remove the round 60 mm diameter interference filter from the holder.
- Replace the filter holder.
- Replace the half-shell covers on the mirrorhouse tube and secure them with their screws.
- Replace the mirrorhouse balance weights.

Front Lens

- Remove the black front lens by sliding it to the left out of its slide.
- Insert the transparent front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV400 wavelength range, it will be necessary to change the sensor for the constant intensity power supply. The type of sensor is marked on the plug connecting it to the power supply. A 365 nm or 405 nm detector is used for UV400. The sensor is a dual channel type. The first number marked on the plug is channel 1, the second channel 2. If the machine was purchased with both UV400 and UV300 optics then the sensor incorporates a detector for each wavelength range. If a sensor with a detector for UV400 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.4.4.5 Changing from UV400 to UV200 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Exposure Lamp

- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Remove the Hg lamp (see Section 5.3.1.1).
- Insert the Cd/Xe lamp (see Section 5.3.1.2).
- Remove the power supply leads terminal cover on the back of the lamphouse.
- Interchange the connections of the power supply leads.
- Replace the power supply leads terminal cover.

Cold Light Mirror

- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #1 or #7.
- Place the cold light mirror #8 on the mount and tighten the retaining clips. Please see Section 5.3.1.2 for the correct orientation of cold light mirror #8.

> **CAUTION:** Do not overtighten the retaining clips.

- Close the lamphouse and tighten it with its screw.
- Connect the external cooling fan for the lamphouse. (This fan is not used with UV400 or UV300.)

Power Supply

- Remove the screws from the power supply cover and slide the cover back until the switch marked "Cd/Xe—Hg" is visible.
- Move the switch to the "Cd/Xe" position.
- Replace the power supply cover and secure it with its screws.

Front Lens

- Remove the transparent front lens by pulling it to the left out of its slide.
- Insert the Herasil front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV200 wavelength range, it

will be necessary to change the sensor for the constant intensity power supply. The type of sensor is marked on the plug connecting it to the power supply. A 220 nm detector is used for UV200. The sensor is a dual channel type. The first number marked on the plug is channel 1, the second is channel 2. If the machine was purchased with both UV200 and UV400 optics then the sensor incorporates a detector for each wavelength range. If a sensor with a detector for UV400 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.4.4.6 Changing from UV400 to UV300 Optics

Switch off the exposure lamp power supply and disconnect it from the isolation transformer. Allow at least 20 minutes for the lamp to cool.

Cold Light Mirror

- Unless equipped with cold light mirror #7, cold light mirror #1 must be replaced with cold light mirror #2, as follows:
- Loosen the lamphouse retaining screw and swing open the lamphouse on its hinges.
- Loosen the screws holding the cold light mirror retaining clips and remove the cold light mirror #1.
- Place the cold light mirror #2 on the mount and tighten the retaining clips.

  CAUTION: Do not overtighten the retaining clips.

- Close the lamphouse and secure it with its screw.

Mirrorhouse

- Remove the mirrorhouse balance weights.
- Remove the screws securing the half-shell covers around the mirrorhouse tube.
- Remove the microscope.
- Remove the screws securing the surface mirror mounting plate and remove it, together with the surface mirror.
- Remove the screw securing the lens plate adjustment arm to the slot in the mirrorhouse.
- Screw the tool provided into the lens plate and withdraw the lens plate through the front of the mirrorhouse.
- Screw the tool into the UV300 lens plate and insert the lens plate through the front of the mirrorhouse.

- Insert the screw into the lens plate adjustment arm, position it at 25 mm from the lamphouse wall and tighten the screw.
- Replace the surface mirror mounting plate together with the surface mirror.
- Replace the microscope.
- Remove the filter holder from the mirrorhouse tube by sliding it to the left.
- Insert the round 60 mm diameter interference filter into the holder.
- Replace the filter holder.
- Replace the half-shell covers on the mirrorhouse tube and secure them with their screws.
- Replace the mirrorhouse balance weights.

Front Lens

- Remove the transparent front lens by sliding it to the left out of its slide.
- Insert the black front lens into the slide.

Intensity Sensor

- If the installed sensor does not have a detector for the UV300 wavelength range, it will be necessary to change the sensor for the constant intensity power supply. The type of sensor is marked on the plug connecting it to the power supply. A 320 nm detector is used for UV300. The sensor is a dual channel type. The first number marked on the plug is channel 1, the second channel 2. If the machine was purchased with both UV400 and UV300 optics then the sensor incorporates a detector for each wavelength range. If a sensor with a detector for UV300 is not installed in the machine, please contact the factory.

Reconnect the exposure lamp power supply.

Refer to Section 5.3.3, Intensity and Uniformity Adjustments and Measurements, and recalibrate the power supply.

5.5 Spare Parts

5.5.1 Basic Spare Parts Kit

A list of spare parts (light bulbs, grease, etc.) for basic equipment maintenance for the MJB 3 may be found in the appendix. This kit may be purchased from the factory.

If your maintenance personnel have been trained by KARL SUSS, you may wish to purchase an MJB 3 Spare Parts Kit, which provides many items and parts with which you can do emergency repairs. A listing of the contents of this kit may be found in the appendix.

6 INSTALLATION

6.1 General

A few weeks prior to shipment of your equipment you will receive an installation package from KARL SUSS. Figure 6-1 is a checklist which should be used to ensure that installation of the equipment will be accomplished smoothly. Figure 6-2 is a machine "footprint" which may be used to allocate space required.

6.2 Receiving the Shipment

KARL SUSS will give an estimated date of arrival before shipping the MJB 3 Mask Aligner to your facility. If there are any special requirements at your site concerning the receipt of large shipments, please inform us immediately. Upon arrival of the shipment, the crates and packages should be inspected for signs of damage. If any damage is apparent, immediately notify the shipping carrier and KARL SUSS.

6.3 Installing the Equipment

The MJB 3 Mask Aligner is to be installed by a KARL SUSS service representative. The parts of the system, in their crates, may be transferred to the installation location if desired, but they should not be unpacked until the service representative arrives.

6.4 Clearances Required for Crate

The equipment is shipped in a crate 34 inches (85 cm) wide by 51 inches (130 cm) long by 28 inches (70 cm) high, each crate weighing approximately 550 pounds (250 kg). The receiving doors should be wide enough to allow the crates to be moved inside the building for unpacking.

Checklist for Machine Installation

NAME _____

COMPANY _____

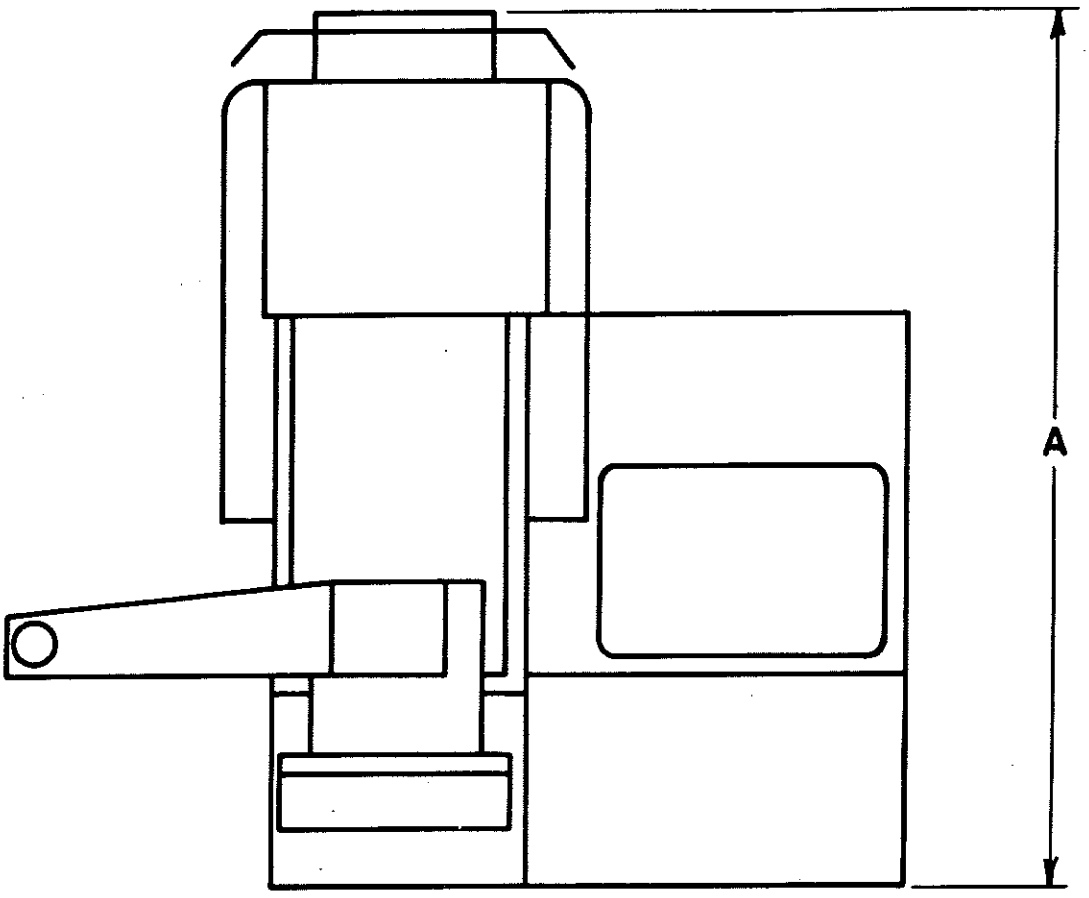
MACHINE _____

The following should be provided by the customer:

1. Power meter for setting lamp _____
2. Provided through 1/4" hose _____
   a. 85 psi air to machine location _____
   b. 30 psi nitrogen to machine location _____
   c. 24" vacuum to machine location _____
3. Two 1/4" hose tees _____
4. Two 110 volt grounded outlets _____
5. Masks and wafers to be used on machine _____

At the time of installation, the lab should be set up to a point that test prints can be made and evaluated.

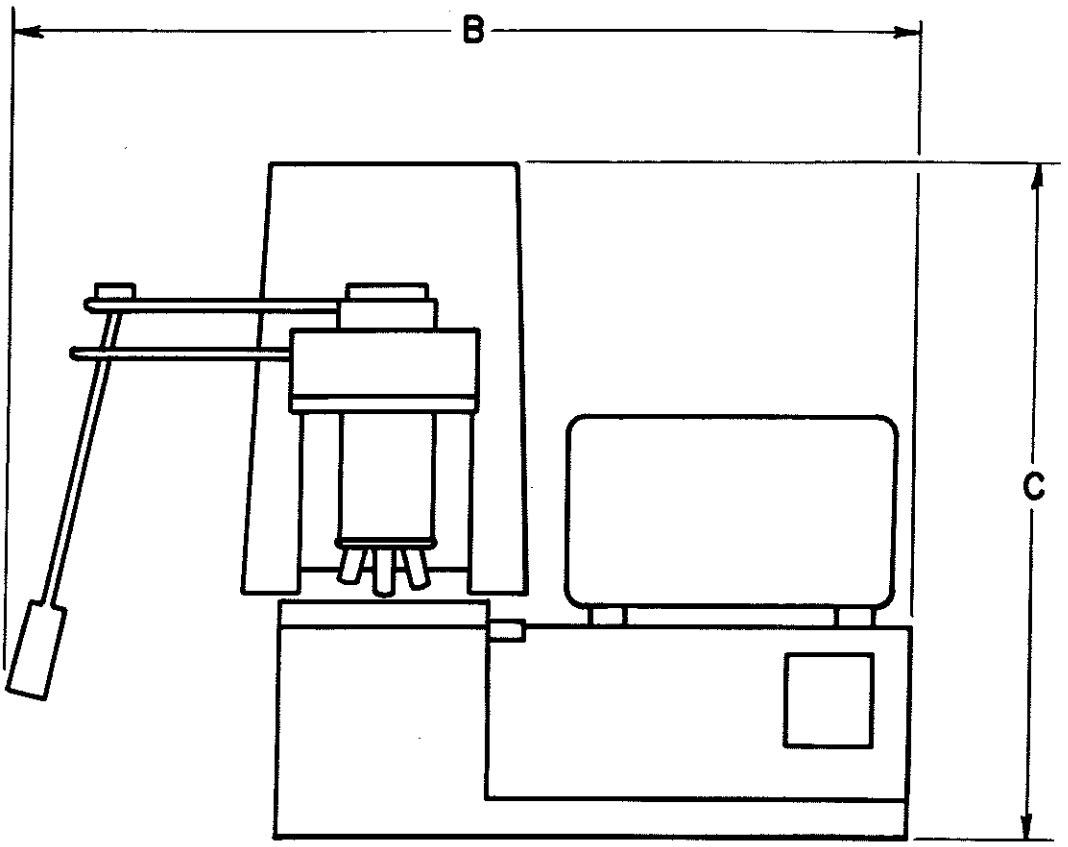
Figure 6-1 Checklist for Machine Installation



DIMENSIONS

	DEPTH A
MJB3 STANDARD HP	700 mm (27.6 in)
MJB3 UV400/300	800 mm (31.5 in)
MJB3 UV200	820 mm (32.3 in)

Figure 6-2 SUSS MJB 3 Footprint



	DIMENSIONS	
	HEIGHT C	WIDTH B
MJB3 STANDARD HP	550 mm (21.7 in)	625 mm (25 in)
MJB3 UV400/300	550 mm (21.7 in)	625 mm (25 in)
MJB3 UV200	550 mm (21.7 in)	625 mm (25 in)

Figure 6-2 SUSS MJB 3 Footprint

6.5 Environmental Requirements

The MJB 3 Mask Aligner should be located in a vibration-free area that is also as free as possible from dust and acid fumes. The area must be maintained at a room temperature between 66 F (19 C) and 75 F (24 C) and at a relative humidity of 45-50%.

The equipment may be affected by static electricity from the operator. Therefore, it should be installed in an area where the floor covering does not generate a static charge.

Please refer to Chapter 4 for other suggestions regarding environmental quality control.

The equipment must be installed at least three inches from the wall to allow for ventilation. In addition, all utilities are connected to the back of the unit. (Please refer to Figures 6-3 and 6-4). Although the machine can usually be serviced in place, in some cases it is necessary to move it 24 inches (60 cm) from the wall for access.

6.6 Power Requirements

The MJB 3 requires two grounded (3 pronged) 115 volt/ 60 hz outlets:

- one at 20 amps for the machine electronics.
- one at 20 amps to power the isolation transformer which is connected to the lamp power supply.

6.7 Other Utility Requirements

Requirements for nitrogen, vacuum, and compressed air are as follows:

- Nitrogen: about 30 psi or 2 bar
- Vacuum: more than 24″ of Hg or less than 150 torr or -0.8 to -1.0 bar
- Compressed air: about 90 psi or 6 bar

It is important to use dry nitrogen and to eliminate any water in the compressed air lines.

In addition, the MJB 3 UV200 requires a 4″ exhaust connection to the rear of the lamphouse.

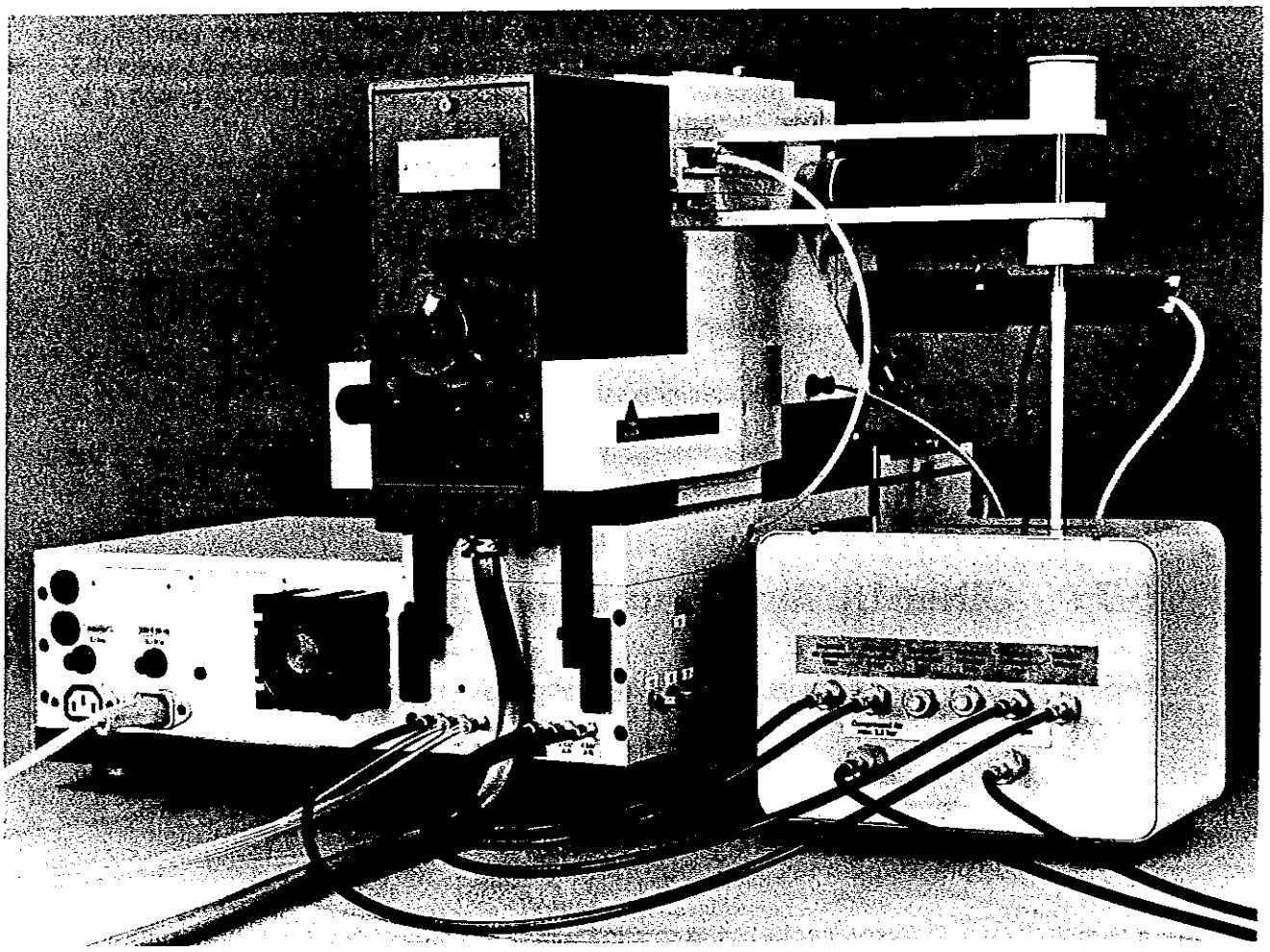


Figure 6-3 Pneumatic Connections with Manometer Box Standard/HP

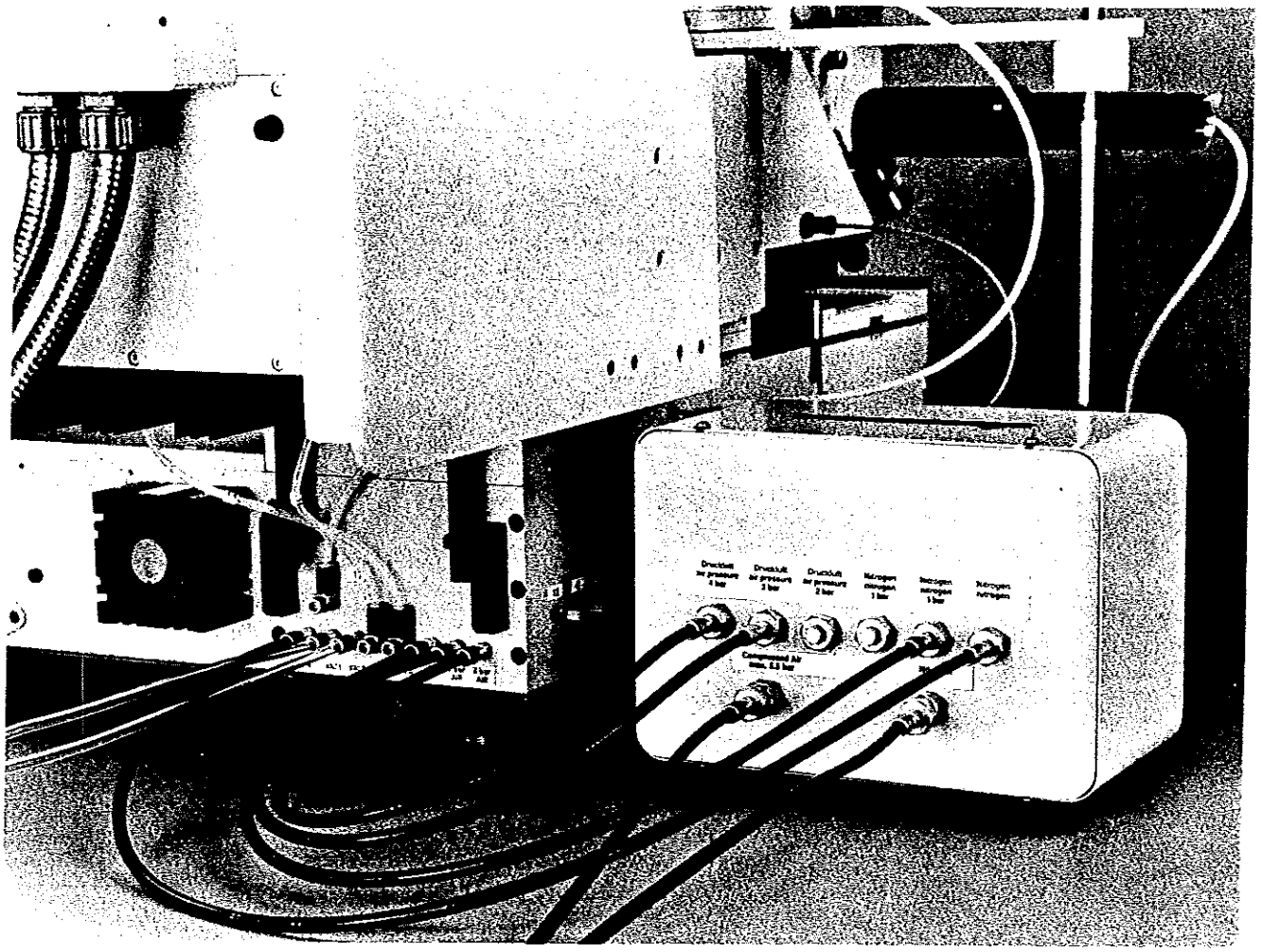


Figure 6-4 Pneumatic Connections with Manometer Box UV400/300

7 WARRANTY AND LIMITATIONS

7.1 Warranty

In most cases, KARL SUSS mask aligners carry a six month warranty covering labor, material, and workmanship. This warranty may vary for different regions around the world. Please consult the specific warranty terms outlined in your quotation and invoice for particulars.

7.1.1 Limitations

The warranty is limited to:

- equipment unpacked and installed by KARL SUSS service representatives.
- equipment that is used and operated in accordance with the operator's manual.
- equipment that is properly maintained on a regular basis as described in the operator's manual.

7.1.2 Exclusions

The warranty excludes:

- damage while in shipment.
- any items that are subject to wear during normal operation of the equipment, such as exposure lamps, maskholders, chucks, and the rubber lips for vacuum chucks.

7.1.3 Exposure Lamp Explosions

If an exposure lamp explosion should occur, please return the lamp socket and several of the glass fragments to KARL SUSS. We will contact the lamp manufacturer and try to determine the cause of the explosion. If the failure of the lamp is due to faulty workmanship or material, we will replace the lamp at no cost.

Consequential damage to the optics or lamphouse due to a lamp explosion is not covered by this warranty. It is important that you follow all lamp starting, adjustment, and cooling procedures, and that you do not exceed the recommended life of the lamp. We strongly recommend that you use exposure lamps provided by KARL SUSS only. Lamp explosions are nearly always caused by improper adjustment and/or operation of the exposure lamp.

8 APPENDIX

Microscope Descriptions

SUSS Normalfield Microscope M400

The SUSS M400 microscope (Figure 8-1) consists of the microscope head, (either binocular or trinocular), eyepieces, microscope body, illuminator, objective revolver and objectives. The microscope may be equipped with either a 3 objective or 4 objective revolver depending on the range of magnification desired. The SUSS M400 is offered in two versions: brightfield only and a brightfield/darkfield/interference contrast combination. Interference contrast and darkfield operation are only possible with certain objectives. (See Figure 8-2).

Microscope Head and Eyepieces

A binocular or trinocular head is available. The eyepieces may be exchanged by simply removing one set from the eyepiece tubes and replacing them with another set. An image is obtained in the trino-tube by pulling out the lever located on the left side of the head. The choice of eyepieces is dependent on the magnification desired. (See Figure 8-2).

Microscope Body

The microscope body contains a half mirror which reflects the microscope illumination onto the object and transmits the object image to the eyepiece image plane. In the brightfield/darkfield/interference contrast version, the microscope body also incorporates a slide containing the analyzer which is used for interference contrast illumination.

Objective Revolver

A 3 objective or 4 objective revolver is available. There are detents for each objective position. The revolver is rotated by grasping the revolver (not the objectives!) and turning it to the detent.

Illuminator

The illuminator utilizes a 15W lamp which is powered from an adjustable transformer. Please note that settings greater than "6" on the transformer should only be used for brief periods as this will drastically reduce the life of the lamp. An iris diaphragm is built into the body of the illuminator which can be used to obtain an optimum image.

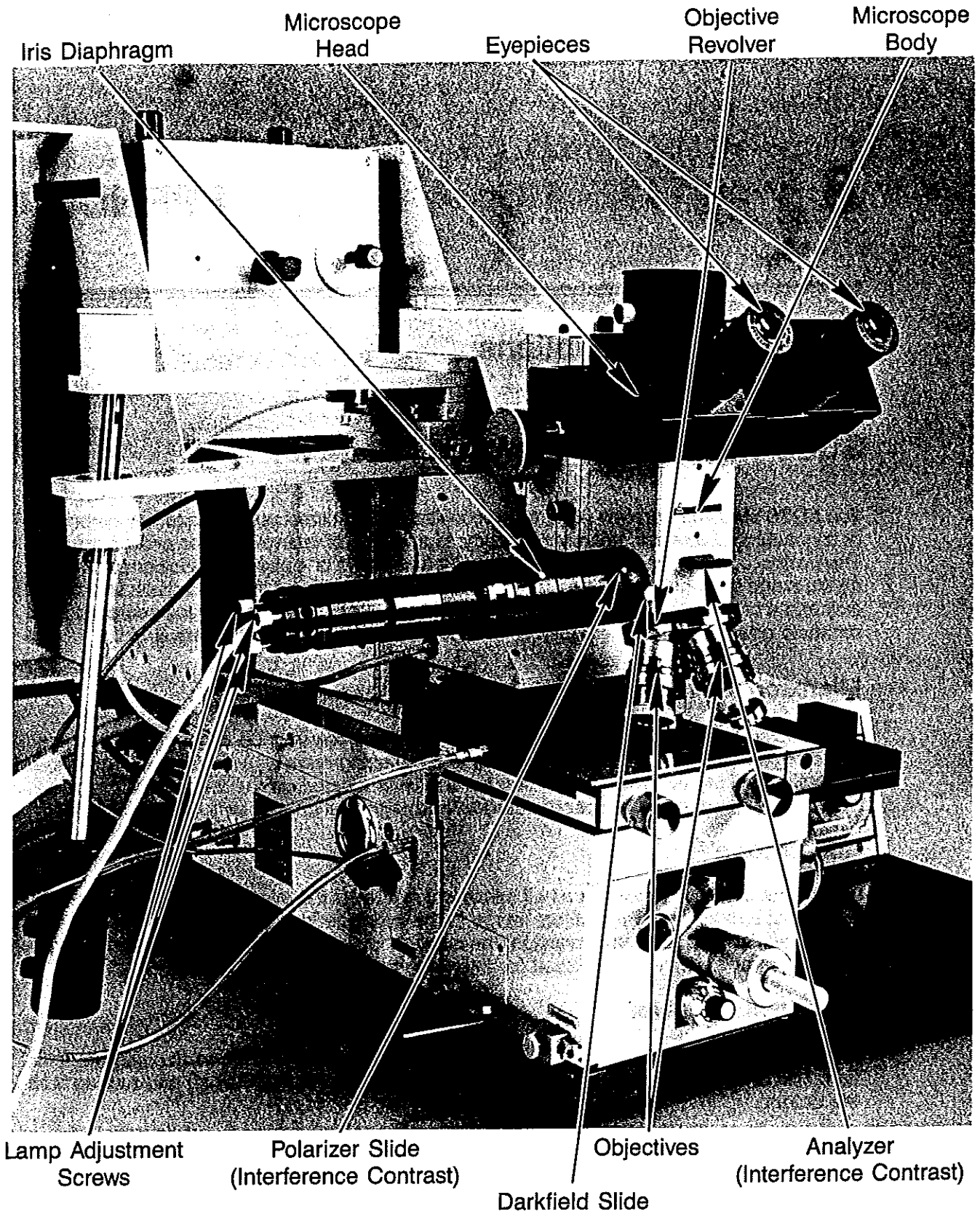


Figure 8-1 Normalfield Microscope M400

Objectives	10x Eyepieces				12.5x Eyepieces				16x Eyepieces				25x Eyepieces*			
Mag/Aperture	1	2 mm	3 mm	4 µm	1	2 mm	3 mm	4 µm	1	2 mm	3 mm	4 µm	1	2 mm	3 mm	4 µm
NPL 5X/0.9 (BF/IC)	50	12	3.6	60	60	12	3.6	40	80	12	3.2	40	125	12	2.0	40
5.5X (BF/DF)	90	10	2.0	100	110	10	2.0	80	140	10	1.8	60	230	10	1.1	40
NPL 10X/0.20 (BF)	100	17	1.8	15	125	17	1.8	10	160	17	1.6	10	250	17	1.0	10
NPL 10X/0.20P (BF/IC)	100	13.5	1.8	15	125	13.5	1.8	15	160	13.5	1.6	10	250	13.5	1.0	10
LL20X/0.40 (BF)	200	10.1	0.9	4	250	10.1	0.9	3	320	10.1	0.8	3	500	10.1	0.5	3
LL20X/0.40P (BF/IC)	200	10.1	0.9	4	250	10.1	0.9	3	320	10.1	0.8	3	500	10.1	0.5	3
H20X/0.40 (BF)†	200	8.2	0.9	4	250	8.2	0.9	3	320	8.2	0.8	3	500	8.2	0.5	3
H32X/0.60 (BF)†	320	4	0.6	4	400	4	0.6	3	510	4	0.5	3	800	4	0.3	

Objectives for observation in:

BF = Brightfield

IC = Interference Contrast

DF = Darkfield

1 = Magnification

2 = Working distance

3 = Field of View

4 = Depth of Focus

* Use of 25x eyepieces is not recommended

† These objectives are corrected for viewing through a mask.

Figure 8-2 Magnification and Optical Data SUSS M400 Microscope

In addition, on the brightfield/darkfield/interference contrast version, there are two slides built into the illuminator body. The first contains the polarizer plate which is used in conjunction with the analyzer to obtain interference contrast illumination. The polarizer may be rotated to obtain an optimum image using the lever. The second contains the darkfield stop which is inserted into the light path to obtain darkfield illumination.

To exchange the illumination lamp, slide the lamp socket out from the illuminator body. Exchange the lamp and re-insert the lamp socket into the illuminator body. The three screws on the lamp socket may be used to center the lamp filament. All three screws should be positioned so that approximately 5 mm of thread is exposed.

Darkfield Illumination (If equipped)

To obtain darkfield illumination, proceed as follows:

1. Rotate the revolver to bring the darkfield objective (5.5x) to the observation position.
2. Insert the darkfield stop into the illuminator light path by pulling the slide toward the operator.
3. Insure that the polarizer and analyzer are not in the light path (See "Interference Contrast Illumination").

Interference Contrast Illumination (If equipped)

To obtain interference contrast illumination proceed as follows:

1. Rotate the revolver to bring an interference contrast objective (5xIC, 10xIC or 20x IC) to the observation position.
2. Insert the analyzer into the light path by pulling the analyzer slide out of the microscope body toward the operator.
3. Insert the polarizer into the illumination light path by pulling the polarizer slide toward the operator.
4. Insure that the darkfield stop is not in the light path. (See "Darkfield Illumination").
5. Rotate the polarizer using the lever to obtain an optimum image.

Objectives

Objectives may be of the brightfield, interference contrast or darkfield type. (See Figure 8-2). The higher magnification objectives have a restricted depth of focus which allows observation of the mask and wafer only in contact position or at a small separation distance. Please note that the positions of the interference contrast objectives or the darkfield objectives should not be exchanged in the revolver.

SUSS Splitfield Microscope M200

The SUSS M200 microscope (Figure 8-3) consists of the microscope head (either binocular or trinocular), eyepieces, microscope body, illuminator, and objectives. The choice of eyepieces and objectives depends on the magnification desired. The SUSS M200 is of-

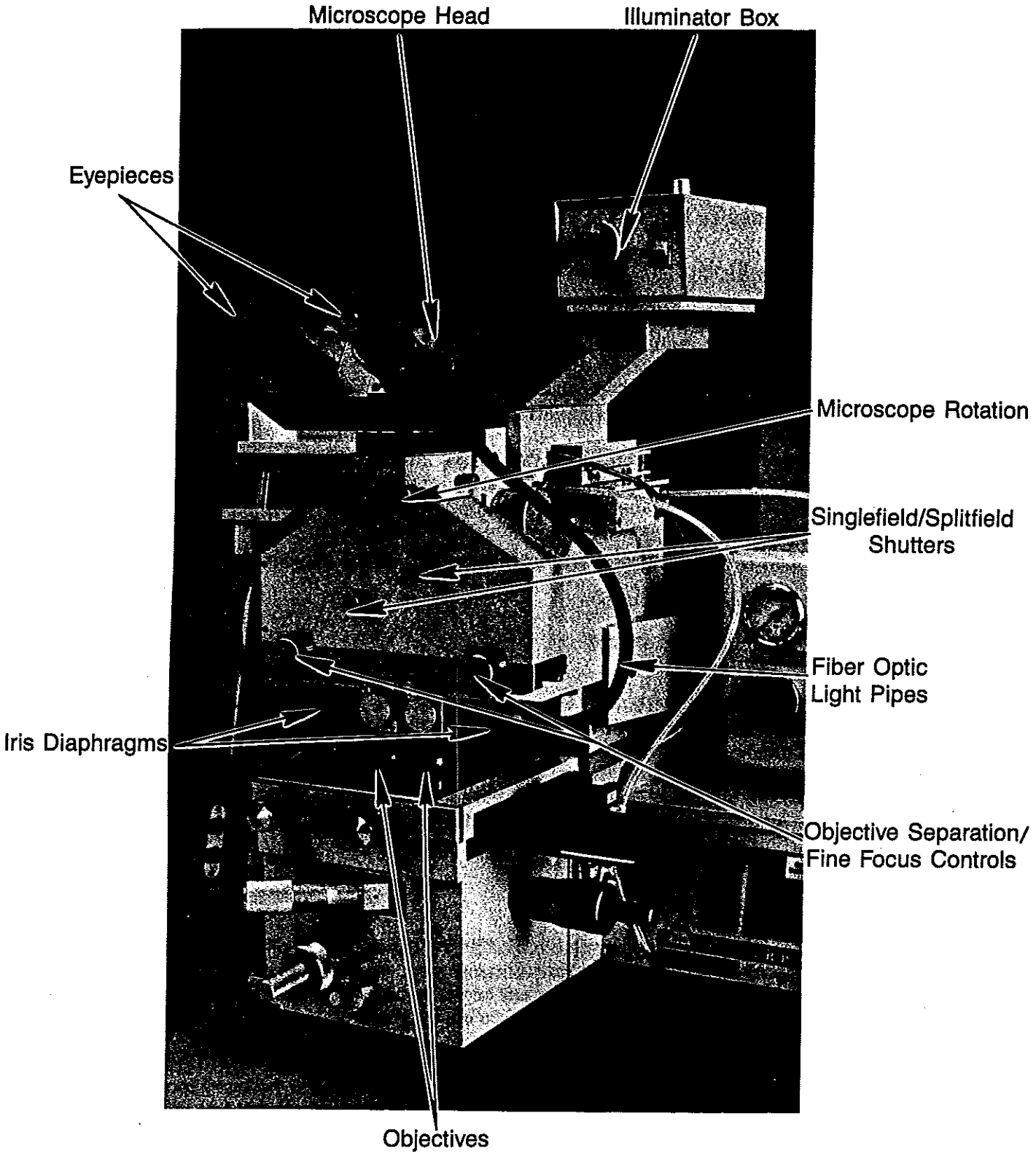


Figure 8-3 Splitfield Microscope M200

fered in three versions: brightfield only, brightfield/darkfield, and brightfield/interference contrast. Darkfield and interference contrast operation are only possible with certain objectives. (See Figure 8-5).

Microscope Head and Eyepieces

A binocular or trinocular head is available. The eyepieces may be exchanged by simply removing one set from the eyepiece tubes and replacing them with another set. An image is obtained in the trino-tube by pulling out the lever located on the left side of the head. The choice of eyepieces is dependent on the magnification desired. Rotation of the microscope may be performed by turning the knurled screw located under the microscope head.

Microscope Body

The microscope body contains prisms, optical shutters for selection of either singlefield or splitfield operation, and half mirrors which reflect the microscope illumination onto the object and transmit the object image to the eyepiece image plane. In the interference contrast version the microscope body also incorporates a slide containing the analyzer which is used for interference contrast illumination.

There are two small knurled knobs located on the front of the microscope body. Each light path of the microscope incorporates a shutter separately adjustable by these knobs. These permit selection of the image to be viewed:

1. Left hand half image and right hand half image (Splitfield).
2. Full left hand image.
3. Full right hand image.

The distance between the objectives may be adjusted continuously between 26 mm and 100 mm using the two knurled knobs located on the bottom of the microscope body. In addition, a minimum distance of 14 mm or a maximum distance of 120 mm can be attained by two optional pivoting attachments. Both the sharpness of the microscope image and the scale of magnification are retained when changing the distance between the objectives. Fine adjustment of the image sharpness is effected by the same knobs.

Illuminators

Two types of illuminators are available. For brightfield operation only, two fiber-optic light guides connected to a lamphouse are normally used. For darkfield or interference contrast operation, two 15W direct illuminators are normally used. In both cases the brightness is controlled by an adjustable transformer. Two iris diaphragms are built into the body of the illuminators which can be used to obtain an optimum image.

To exchange the illumination lamps of the direct illuminators, slide the lamp socket out from the illuminator body. Exchange the lamp and re-insert the lamp socket into the illuminator body. The three screws on the lamp socket may be used to center the lamp filament. All three screws should be positioned so that approximately 5mm of thread is exposed.

The illumination lamp of the fiber optic illuminator is easily replaced by removing the lamphouse cover.

Darkfield Illumination (If equipped)

To obtain darkfield illumination, adapters with pivotable central stops are inserted into the illuminator light path. The normal objectives are replaced by brightfield/darkfield objectives (5.5X) with concentric condensers. Conversion from the brightfield to the darkfield mode and vice versa is effected by swinging the central stops in or out of the light path, respectively.

Interference Contrast Illumination (If equipped)

For interference contrast illumination, the unit is equipped with revolvable polarizers, objectives with Wollaston prisms, and an analyzer built into the microscope body. To obtain interference contrast illumination, proceed as follows:

1. Insert the analyzer into the light path by pulling the analyzer slide out of the microscope body towards the operator.

2. Insert the polarizers into the illuminator light path by pulling the polarizer slides toward the operator.

3. Rotate the polarizers using the levers to obtain an optimum image.

Objectives

Objectives may be of the brightfield, interference contrast, or darkfield type. (See Figure 8-5). Please note that each set of objectives is individually adjusted to the microscope. Therefore, their positions should not be exchanged. Replacement of a set of brightfield objectives with another set of higher magnification is possible, however, replacement with another set of lower magnification may result in some deterioration in image quality. In this case the microscope should be returned to Karl Suss for readjustment.

SUSS Splitfield Revolver Microscope M230

The SUSS M230 Microscope (Figure 8-4) consists of the microscope head (either binocular or trinocular), eyepieces, microscope body, illuminator, two objective revolvers, and six objectives. The eyepiece and objective combinations result in a range of magnification of 66-400X (See table). The SUSS M230 is available only in a brightfield version.

Microscope Head and Eyepieces

A binocular or trinocular head is available. The eyepieces may be exchanged by simply removing one set from the eyepiece tubes and replacing them with another set. An image is obtained in the trino-tube by pulling out the lever located on the left side of the head. The choice of eyepieces is dependent on the magnification desired. Rotation of the microscope may be performed by turning the knurled screw located under the microscope head.

Microscope Body

The microscope body contains prisms, optical shutters for selection of either singlefield or splitfield operation, and half mirrors which reflect the miroscope illumination onto the object and transmit the object image to the eyepiece image plane.

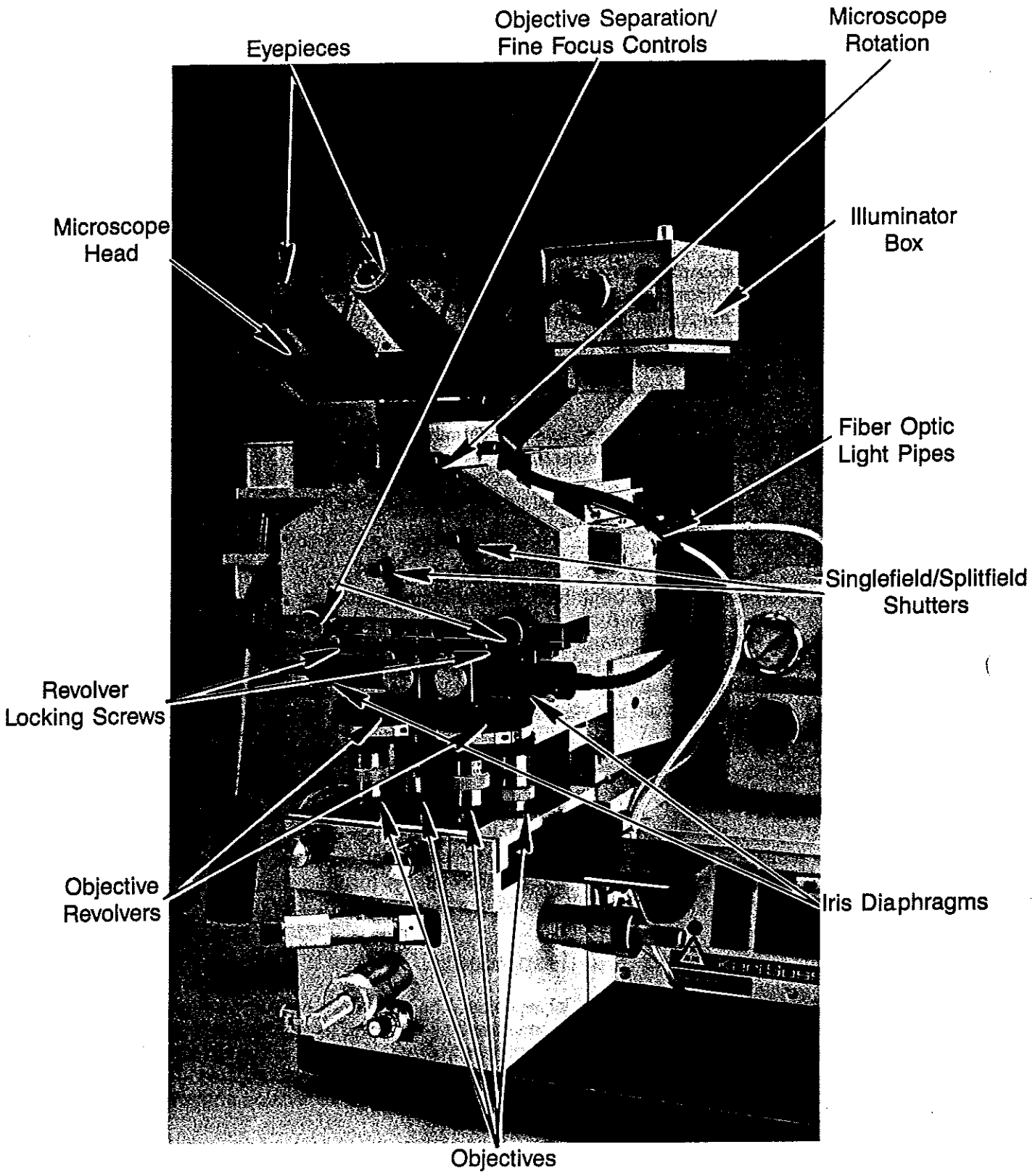


Figure 8-4 Splitfield Revolver Microscope M230

	SUSS M200 Splitfield Microscope												SUSS M230 Splitfield Microscope with Multiple Nosepiece					
Objective	**2x**		**3.5x**		**5.5x**		**6.5x**		**10x**		**11x**		**3.5x**		**10x**		**20x**	
Numerical Aperture			0.08		0.15		0.18		0.20		0.25		0.08		0.20		0.40	
Eyepiece	6.3x	10x	6.3x	10x	6.3x	10x	6.3x	10x	6.3x	10x	6.3x	10x	6.3x	10x	6.3x	10x	6.3x	10x
Field of view 0 in mm	3.5	3.5	1.5	1.5	1.2	1.2	1	1	0.95	0.95	0.65	0.65	1.7	1.7	1.05	1.05	0.3	0.3
Total Magnification	30x	50x	75x	120x	95x	145x	110x	170x	120x	185x	170x	275x	66x	105x	110x	170x	250x	400x
Depth of focus (μm)	600	500	90	70	45	35	35	30	30	25	13	10	80	60	30	20	5	5
Working distance in mm	32		13		14		13		18		4		12		17		13	
Brightfield	x		x		x		x		x		x		x		x		x	
Darkfield	x		-		x		-		-		-		—		-			
Interference Contrast	-		-		-		-		x		-		-		-		-	

Figure 8-5 Magnification and Optical Data SUSS M200/M230 Microscopes

There are two small knurled knobs located on the front of the microscope body. Each light path of the microscope incorporates a shutter separately adjustable by these knobs. These permit selection of the image to be viewed:

1. Left hand half image and right hand half image (Splitfield).
2. Full left hand image.
3. Full right hand image.

The distance between the objectives may be adjusted continuously between 26 mm and 100 mm using the two knurled knobs located on the bottom of the microscope body. There are also two locking screws which may be used to lock the position of each revolver, preventing the separation distance from changing when rotating the revolver.

Both the sharpness of the microscope image and the scale of magnification are retained when changing the distance between the objectives. Fine adjustment of the image sharpness is effected by the same knobs used to vary the separation distance.

Objective Revolvers

Each revolver incorporates detents for each objective position. The revolver is rotated by grasping the revolver (not the objectives!) and turning it to the detent.

Illuminators

Two fiber optic light guides connected to a lamphouse are used. The brightness is controlled by an adjustable transformer. Two iris diaphragms are built into the body of the illuminators which can be used to obtain an optimum image.

The illumination lamp is easily replaced by removing the lamphouse cover.

Objectives

Three pairs of objectives are normally supplied: 3.5X, 10X and 20X. The 20X objectives have a restricted depth of focus which allows observation of the mask and wafer only in contact position. Therefore the 3.5X and 10X objectives should be used for alignment and the 20X objective for checking alignment. Please note that each objective is individually adjusted to the microscope. To retain parfocality of the objectives they should not be removed from the revolvers. (See Figure 8-5).

Infrared Viewing System for Backside Alignment (Optional)

General

Your SUSS MJB 3 is equipped with a video camera, monitor and special tooling, enabling printing of features on one side of wafers aligned to features on the other (see Figure 1-6).

The key to this system is a special chuck incorporating one or more lamps to supply infrared radiation for transmission through the wafer. This special chuck requires its own transport slide, which is easily interchanged with the standard transport slide.

The special chuck may be of either vacuum chamber or standard design. The vacuum chamber design incorporates a quartz plate which is glued to the metal chuck surface, with the lamps located below it. Standard IR chucks incorporate cutouts in the chuck to accommodate the lamps.

For applications using wafers larger than 1" diameter, the lamps are located in the transport slide, and chucks may be interchanged in the same way as conventional ones.

For applications using wafers of 1" diameter and less, a single lamp is built into the chuck and the transport slide must be changed when changing wafer diameter.

Operation

To operate the SUSS MJB 3 in the infrared mode, proceed as follows:

Switch on the video camera, monitor and the IR illumination power supply.

1. Place the wafer on the chuck with the wafer features face down. The wafer may be mounted on an IR transparent carrier, i.e. quartz, glass or Al_2O_3.

2. Insert the wafer and chuck into the stage and bring the wafer to separation position for alignment (see Section 2.3.2 and 2.3.3).

3. Position a microscope objective over one of the lamps and press the foot switch. This will supply current to the lamps.

4. Observe the image on the video monitor and rotate the microscope focus adjustment to obtain the clearest image. Depending on application, it may be helpful to use the normal microscope illumination to illuminate the mask. Also adjust the illumination level of the IR lamps to obtain the best image. Under normal circumstances, a 5x or 10x objective will provide the best combination of resolution and depth of focus.

5. Perform the alignment in the usual way (see Section 2.3.3) using the image on the video monitor.

6. When satisfactory alignment has been obtained, proceed as outlined in Sections 2.3.4 (Exposure) and 2.3.5 (Unloading the Substrate).

Remarks Regarding Manual Alignment

Manual Alignment is typically performed at an alignment gap which fully exploits the depth of focus of the microscope used. This ensures the least chance of damage to the mask or the substrate during alignment.

The depth of focus of a microscope is directly related to its magnification. For a typical alignment gap of about 20 microns, which is a reasonably safe distance between mask and wafer for most applications, the magnification is limited to about 180X, which may not be sufficient to obtain the level of alignment accuracy required. However, increasing the magnification to, say, 400X drastically reduces the depth of focus to about 3 microns. For all practical purposes, it is impossible to perform alignment at such a small gap.

The line and space resolution of an alignment microscope of the maximum practical magnification (180X) is about 1.5 microns. Fortunately, it is not necessary to recognize submicron features in order to achieve submicron alignment accuracy. Instead, we use a different approach.

The human eye has a remarkable ability to recognize symmetry. The challenge in designing appropriate alignment marks therefore consists of finding schemes where some kind of symmetry is apparent using high contrast patterns. The simplest example is placing a small cross inside a large cross. The line width of the small cross is not significant if both sides of the cross can be seen without excessive eye movement. The distance between the edge of the smaller line and the larger line when both crosses are aligned is critical, however. This distance must be larger than the minimum feature size for the given line and space resolution of the microscope, and at the same time it has to be as small as possible.

The absolute minimum distance is about 2 microns, typical values being between 3 and 5 microns, depending on contrast and edge quality. If the distance between the small line and the large line is 3 microns, a 0.5 micron misalignment will result in a 3.5/2.5 intensity ratio as read by the eye. This is a significant amount, the larger gap being 40% brighter than the smaller gap.

In proximity printing, the alignment gap and exposure gap are of the same order of magnitude, and so are usually handled with the same objective/eyepiece combination. In contact printing, however, since the exposure gap is considerably smaller than the alignment gap, an objective/eyepiece combination with a small depth of focus can be used to verify the alignment at exposure position before the exposure takes place. A revolver microscope using at least two different objectives is the ideal tool for this purpose.

In this case, a second adjustment key with smaller dimensions (for example, a 1 micron distance between the smaller and the larger lines) can be employed if desired, to make checking the alignment in exposure position easier. For the highest alignment accuracy, it is likely that the operator will have to alternate repeatedly between the separation and contact positions, even if the aligner itself has no shift.

Regrettably, there is no simple way around the problem of performing alignment with insufficient magnification.

Basic Spare Parts Kit

Part No. 250SP012
—6.3A Fuse
—2.5A Fuse
—S35ZN Switch
—2341 24-30V 1W Lamp
—Hoffmann 62645 2-8MM Key Set
—410 Grease
—0.5A Fuse 5 x 20 Din 41571

Part No. 61000264
— 6V 15W Illuminator Bulb

Spare Parts Kit: SUSS MJB 3 Standard and HP Models Only

Part No. 250SP014
—Negative Lamp Cable L70
—KC4/24V Kuhnke Relay
—441203 Signal Lamp
—24V 50MA Panel Lamp MA 56
—2.5A Fuse
—6.3A Fuse
—S35ZN Switch
—K50.204 4 x 0.65 Tubing
—K50.007 M5 5 x 1 Tube Coupling
—K52.090 Elbow
—K50.130 Elbow M5 5 x 1
—K50.010 Straight Coupling
—K47.220 Throttle Valve M5SW12
—K65.127 Kuhnke Valve
—Soft Tubing .3/1 Dia. KSM
—410 Grease
—310 Grease
—340 Grease
—CRC Grease

Part No. 61000264
—6V 15W Illuminator Bulb

Spare Parts Kit: SUSS MJB 3 UV400, UV300 AND UV200 Models Only

Part No. 250SP015
—Positive Cable B-22.2.17
—Negative Cable (UV200 only) 260PW001
—KC4/24V Kuhnke Relay
—441203 Signal Lamp
—24V 50MA Panel Lamp MA 56
—2.5A Fuse
—6.3A Fuse
—S35ZN Switch
—K50.007 M5 5 x 1 Tube Coupling
—K65.127 Kuhnke Valve
—K50.204 4 x 0.65 Tubing
—K52.090 Elbow
—K50.130 Elbow M5 5 x 1
—K50.010 Straight Coupling
—K47.220 Throttle Valve M5SW12
—Soft Tubing .3/1 Dia. KSM
—410 Grease
—310 Grease
—340 Grease
—CRC Grease

Part No. 61000264
—6V 15W Illuminator Bulb