SUSS MA 56M

MASK ALIGNER

Operator's Reference Manual

Model No. ______________ Serial No. ______________
Date of Manufacture______________________________

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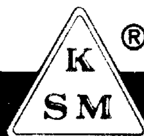
This Operator's Reference Manual is subject to review and/or revision.



Karl Suss

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1 GENERAL DESCRIPTION AND PRINCIPLES OF OPERATION

The SUSS MA 56 is a mask alignment and exposure system which offers unsurpassed, highly economical production capabilities for wafers up to 125 mm in diameter. It combines high productivity and superior economy of operation in an extraordinarily flexible system which can be easily adapted to fit your particular process requirements.

Due to its modular construction and robust precision mechanics, the SUSS MA 56 is particularly easy to maintain and service. All functional groups are readily accessible and complete subassemblies are easily modified or replaced.

In addition to these functional considerations, the streamlined, ergonomic design of the MA 56 makes it a pleasure to operate. All controls are comfortably placed for ease of operation and are clearly identified. Padded, contoured armrests are located for maximum operator comfort. Wafer alignment is simple, quick, and precise due to the smoothly functioning alignment stage manipulators.

Chapter 1 of this manual is divided into four sections. In Section 1.1 you will follow a wafer through one cycle of a typical operational procedure. (Step by step details will be covered in Chapter 2.) Section 1.2 outlines the alignment and exposure modes. In Section 1.3 you will learn how to identify the various subassemblies of the MA 56. You can also take advantage of several convenience features which are described in Section 1.4.

1.1 A Brief Orientation

The SUSS MA 56 is composed of two operational sections, the aligner and the wafer loader. The wafer loader portion includes the output wafer plate and the prealignment plate. The aligner portion consists of the wafer transport system, the alignment stage, the exposure chuck, the wedge error compensation head, the microscope, and the exposure mechanism.

The operation of the MA 56 is very straightforward and easy to learn. First you place a wafer on the prealignment plate against the positioning pins. (Please refer to Figures 1-1, 1-2, and 1-3 as you follow the text.) You then load a mask onto the maskholder and the maskholder onto the alignment stage. After selecting the desired alignment and exposure program, you press the START ALIGNER button.

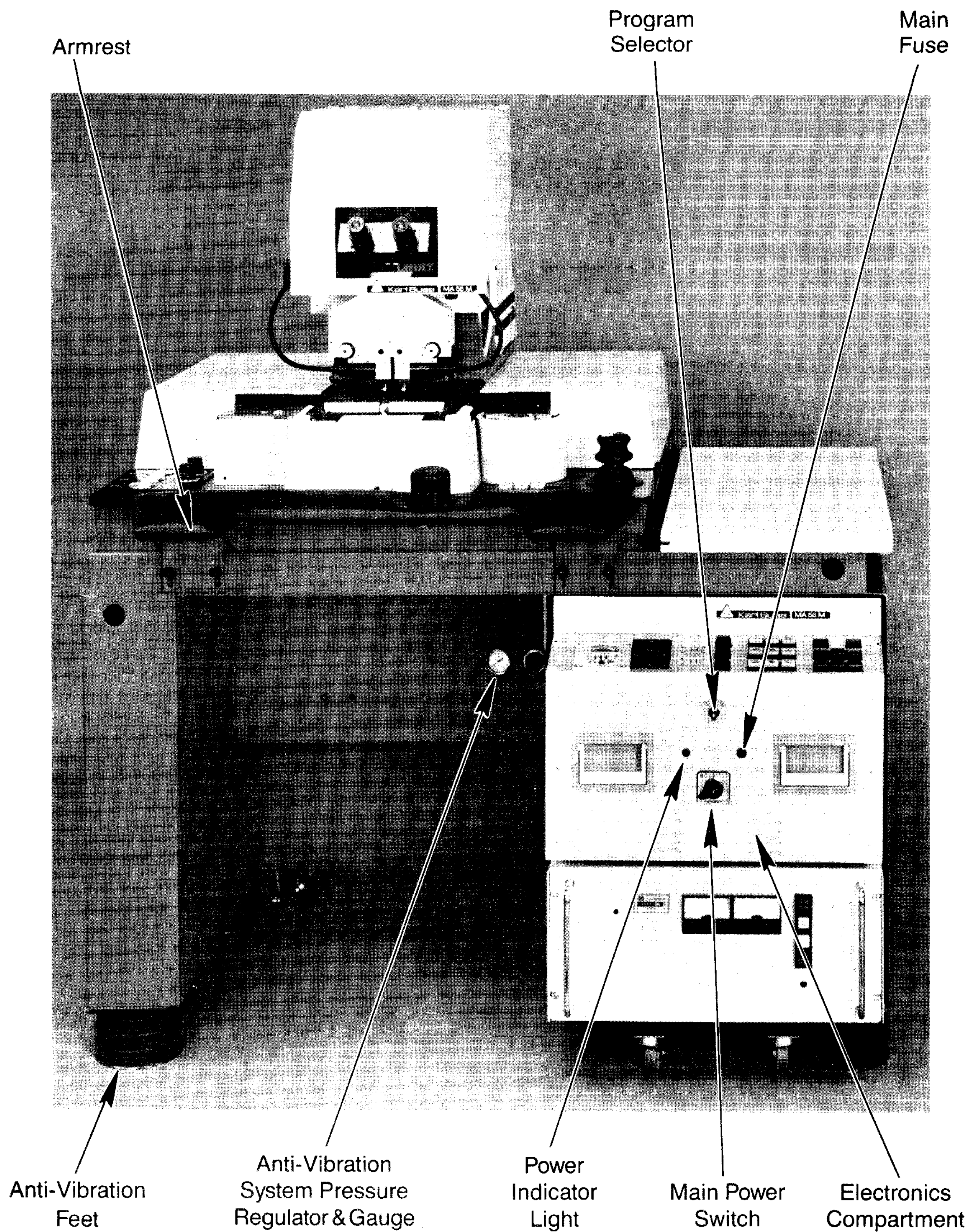
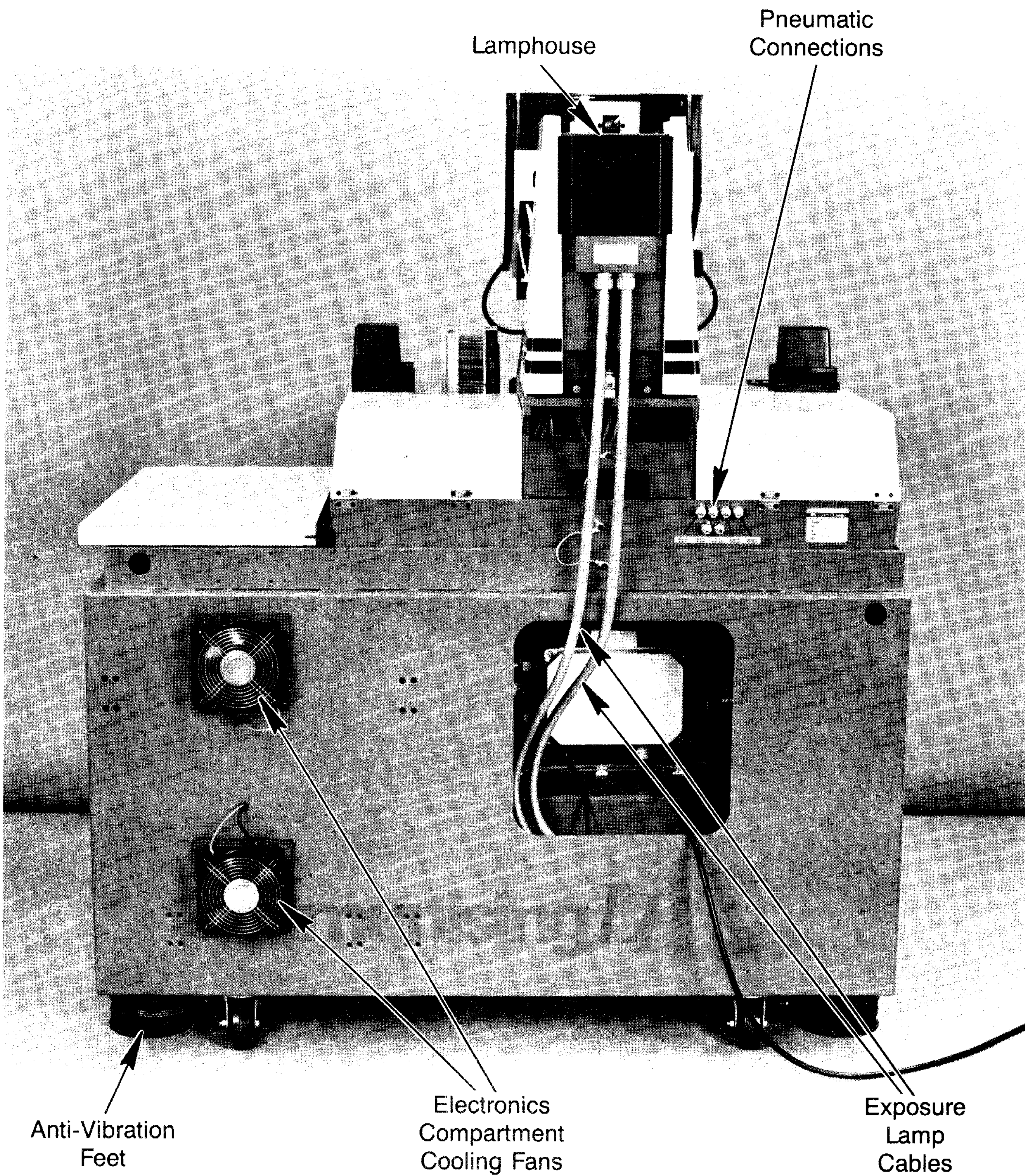


Figure 1-1 Front of Machine



Machine illustrated is an MA 56 cassette to cassette model.

Figure 1-2 Rear of Machine

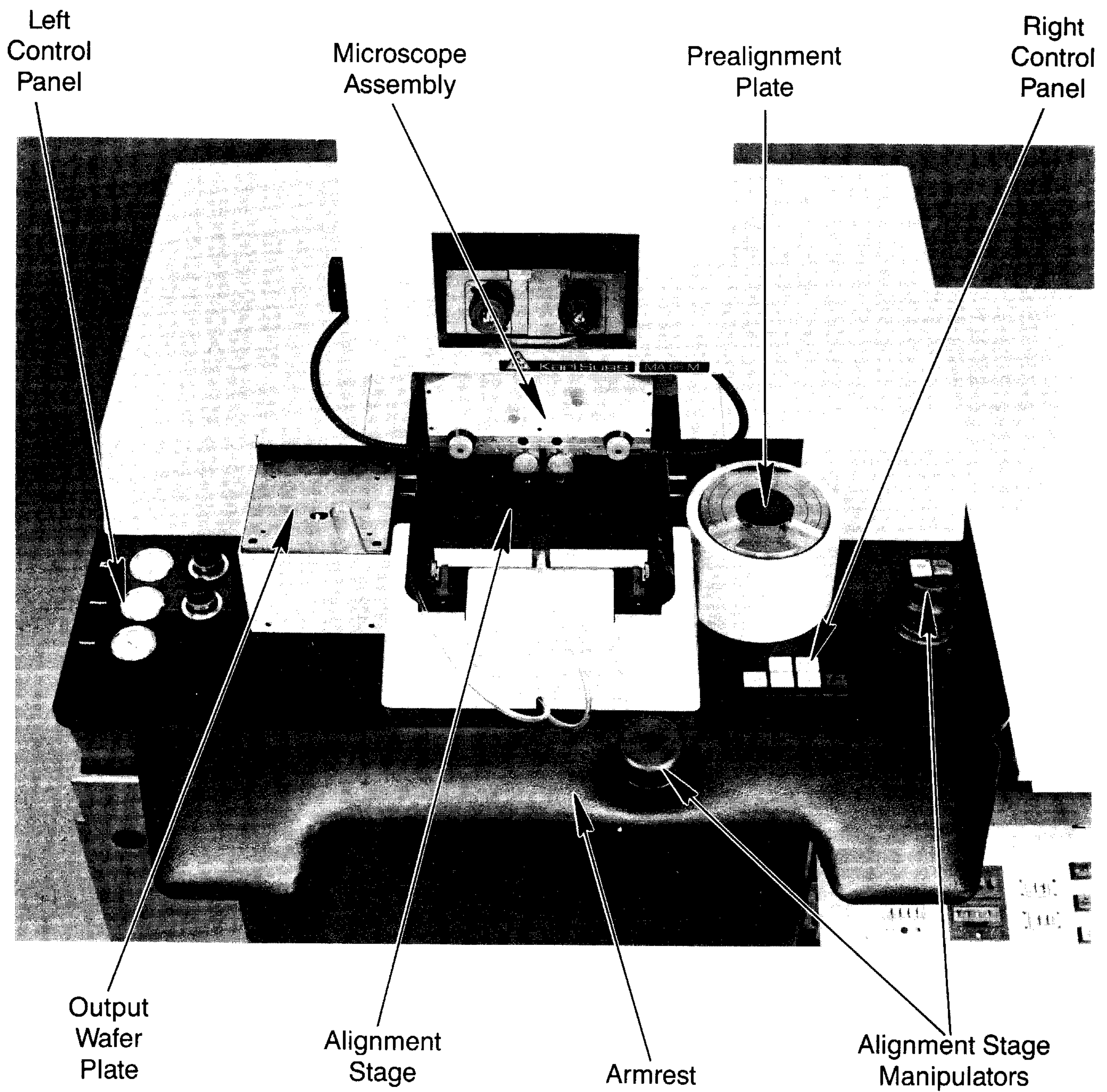


Figure 1-3 Machine Subassemblies

The wafer transport system moves to its right-most position with its right pickup arm over the unexposed wafer. The prealignment plate then transfers the wafer to the right pickup arm where it is held by vacuum. (At the same time, if there is an exposed wafer on the exposure chuck, it is removed by the pickup arm on the left side of the wafer transport system.) The wafer transport system now moves to its left-most position where the exposure chuck moves up to accept the unexposed wafer from the right pickup arm. (If there is an exposed wafer on the left pickup arm, it is simultaneously placed on the output wafer plate.) The wafer transport system now moves to its center position, and the wedge error compensation head moves the exposure chuck and wafer up into parallel contact with the mask. (The MA 56 incorporates a unique option: precision reference balls may be inserted between the edges of the wafer and the mask during the wedge error compensation process, thereby eliminating any possible damage to the mask or wafer.)

If you have chosen a program that includes mask to wafer alignment, the wedge error compensation head now moves down to the alignment gap you have selected, while maintaining parallelity between mask and wafer. You can now easily align the mask to the wafer using the microscope and alignment stage manipulators. When the alignment is correct, press the ALIGN button on the X-Y manipulator. The wedge error compensation head now moves the exposure chuck and wafer into contact with the mask (if a contact program was chosen) or to the selected exposure gap (if the proximity program was chosen). If you confirm the alignment in the exposure position to be satisfactory, press the EXPOSE button (which is also located on the X-Y manipulator) to initiate exposure.

Once the expose button is pressed, the microscope lifts up and the mirrorhouse slides forward to position the exposure optics over the wafer. The shutter then opens to expose the wafer for the time set on the timer.

When exposure is complete, the mirrorhouse retracts, the microscope moves back down, and the exposure chuck returns to its lower position. The wafer transport system moves to its right-most position and another cycle commences. (Please see Section 2.5 for step by step descriptions.)

1.2 Alignment/Exposure Modes

The SUSS MA 56 provides four exposure modes, with "first mask" and "with alignment" options for each mode. This provides you with the flexibility of eight combinations to match your particular processing requirements. Your selection depends on whether you wish to make a contact or proximity exposure and if you wish to stop the machine during its cycle to allow for mask to wafer alignment. You program your choice during the set-up procedure described in Section 2.3.

1.2.1 Vacuum Contact Exposure

In the vacuum contact mode, once the wafer is in contact with the mask and the exposure cycle has been initiated, a rubber seal is brought up from the exposure chuck to create a chamber between the exposure chuck and the mask, and the air in the chamber is evacuated. The vacuum holding the wafer to the exposure chuck is removed. This results in the most intimate contact possible between the wafer and the mask. In this mode you can achieve the highest levels of resolution. The vacuum in the chamber may or may not be adjustable, depending on your machine's options.

1.2.2 Hard Contact Exposure

In the hard contact exposure mode, once the wafer is in contact with the mask and the exposure cycle has been initiated, the vacuum holding the wafer to the exposure chuck is removed and nitrogen is introduced under the wafer, pressing the wafer against the mask. This pressure can be easily adjusted to suit the particular process.

1.2.3 Proximity Exposure

The proximity exposure mode allows the MA 56 to perform wedge error compensation and exposure without mask to wafer contact, thereby eliminating the possibility of mask damage due to contact with the wafer. This results in greatly increased mask life and lower mask costs. During wedge error compensation, three precision 1.5 mm diameter reference balls are inserted between the edges of the mask and the wafer. After parallelity adjustment, the balls are automatically removed and the wafer is brought to the alignment or the exposure position, depending on the mode selected. Both the alignment and exposure gaps are easy to set.

1.2.4 Soft Contact Exposure

You can initiate the soft contact exposure mode in either of two ways. By placing the program selector switch in the CONTACT position and removing the nitrogen pressure under the wafer, the only force pressing the wafer to the mask is that exerted by the wedge error compensation head. Alternately, you may place the program selector switch in the PROXIMITY position and select an exposure gap that will place the wafer in slight contact with the mask. Both of these procedures will be explained in detail in Section 2.3.2.d.

1.2.5 First Mask Exposure

Use the first mask mode whenever there is no requirement for manually aligning the mask to the wafer. (The precise wafer transport system will still transport the wafer from the prealignment plate to the chuck with an accuracy of ± 5 microns.) After you set the operating parameters and place the wafer on the prealignment plate, the MA 56 transports the wafer to the chuck, exposes it, and deposits it on the output wafer plate.

1.2.6 Exposure With Alignment

The alignment mode is substantially the same as Section 1.2.5 above, except it gives you the opportunity to align the mask to the wafer. After the wafer has been placed on the exposure chuck, but before exposure takes place, you can easily align the mask to the wafer using the microscope and alignment stage manipulators. (The alignment stage is an extremely precise mechanism that allows the mask to be moved in 0.2 micron increments.) You may alternate between the alignment gap and the exposure gap (or contact, if using a contact program) as many times as you desire. When the alignment is satisfactory, press the EXPOSE button and the MA 56 exposes and removes the wafer as described above.

1.3 The Subassemblies of the MA 56

The MA 56 is made up of various subassemblies. They are as follows (please refer to Figures 1-1, 1-2, 1-3):

a. Prealignment Plate—The prealignment plate accepts the unexposed wafer and transfers the wafer to the wafer transport system at the proper time in the process cycle.

b. Wafer Transport System—The wafer transport system incorporates two pickup arms and performs two transport functions simultaneously. The left pickup arm removes the exposed wafer from the exposure chuck by vacuum and transports it to the output wafer plate. At the same time the right pickup arm accepts the unexposed wafer from the prealignment plate and transports it to the exposure chuck.

c. Wedge Error Compensation Head—The exposure chuck is contained in the wedge error compensation head. Once the wafer is deposited on the exposure chuck, the wedge error compensation head raises the chuck and wafer to the mask. The chuck and the wedge error compensation head float and when the wafer makes contact with the mask any wafer taper or bow is compensated for. When the mask and wafer are parallel, the chuck locks in position and, if an alignment program was chosen, lowers the wafer to the selected alignment separation distance.

d. Alignment Stage—The heart of the machine is the alignment stage. This unit holds the maskholder and mask, and is movable in the X, Y, and Theta (rotational) directions for alignment. It also contains the Z axis movement which raises and lowers the wedge error compensation head to position the exposure chuck at the proper alignment and exposure gaps. It provides shift-free operation in all directions and allows minimum alignment movements of 0.2 microns and minimum vertical movements of 1.0, 2.5, or 5.0 microns, depending on the particular machine.

e. Lamphouse—The lamphouse is easily accessible and contains the exposure lamp and the custom optical components which direct the light to the wafer. Light is conducted from the exposure lamp via an ellipsoidal mirror and a cold light mirror, which filters the long wave radiation produced by the bulb and deflects the "cold" ultraviolet light required for exposure through the wafer exposure system. The SUSS exposure system with diffraction reducing optics provides extraordinarily high resolution over the entire exposure area, resulting in steep resist edges and small diffraction effects. The optical system is custom matched to the customer's process requirements and so the particular configuration varies from machine to machine. Several types of filters are available and provided where required. The lamphouse also contains two shutters. One shutter opens to initiate the wafer exposure. The second shutter closes to complete the exposure. Both shutters then return to their starting positions. This system assures that the entire wafer receives the same amount of exposure energy.

f. Output Wafer Plate—The output wafer plate accepts the exposed wafer from the left pickup arm. The wafer can then be removed from the plate with tweezers.

g. Microscope—The MA 56 is equipped with a SUSS Splitfield Microscope. The microscope allows you to observe the field through either the left or right objective only, or through both at the same time. The objective spacing can be easily varied by rotating two small knurled knobs on the front of the microscope body. The same knobs individually control the fine focus of each objective. Illumination is provided by a control box and the intensity is variable. Each illuminator has its own aperture control for even greater flexibility.

h. Microscope Hood—The microscope hood and its mounting assembly contain the drive motors which allow microscope movement in the X, Y, and Theta (rotational) directions, as well as the coarse focus controls for the microscope.

i. Alignment Stage Manipulators—These manipulators control the motion of the alignment stage and/or the microscope in relation to the wafer. The X-Y manipulator is mounted on the right control panel and the Theta manipulator is mounted on the armrest. The speed of the alignment stage and/or microscope moves is proportional to the extent of movement of the manipulators.

j. Left Control Panel—The left control panel contains the vacuum, air pressure and nitrogen pressure gauges, and the air pressure and nitrogen regulators.

k. Right Control Panel—The right control panel contains the X-Y manipulator and the primary program control buttons: MASK, MICROSCOPE, START ALIGNER, STEP ALIGNER, RESET ALIGN, and STOP. These functions are discussed in detail in Section 2.1.2.

l. Electronics Drawer—The program selector switch, main power switch, fuse, and indicator lamp are located on the front panel of the electronics drawer, and the remainder of the machine control switches are on the sloping top panel. All of the control electronics are located inside this drawer which is mounted on rollers for easy access in the event service is necessary. The remainder of the control switches are discussed in Section 2.1.4.

1.4 Special Features

Through the switches on the top of the electronics compartment, you have access to several special features of the MA 56 which allow changes in the program to be made conveniently and quickly. These features contribute greatly to the flexibility of the machine. They are described below:

a. WITHOUT CASSETTE LOADER—This feature disables the wafer transport and prealignment plate unit, allowing you to manually place a wafer on the exposure chuck and operate the aligner section only.

b. NITROGEN PURGE—A NITROGEN PURGE feature is provided to flush the exposure area during exposure. It should be used when processing negative resists, and is easily adjustable to suit your particular requirements.

c. LAMP TEST—With the LAMP TEST feature you can conveniently open the exposure lamp shutter to perform lamp uniformity and intensity checks.

For a more detailed description of these special features please see Section 2.1.4.