5.4

Humphrey Autorefractor

Section 1. Introduction

The Humphrey Automatic Refractor is a truly automatic instrument that provides a fast, accurate objective refraction in seconds. All Humphrey Refractor models offer automatic alignment and automatic tracking of the patient's eye. You preselect the variable vertex distance and the cylinder convention. You may also set the Refractor to add plus sphere power automatically to relax accommodation to determine precise refractive correction.

The Refractor takes acuities unaided. When the patient looks into the Refractor, the instrument presents an acuity chart. This allows for taking the initial acuity. After the objective refraction cycle, the Refractor automatically places the lens correction before the patient's eye, and the acuity chart is viewed through it for final acuity. Refractor models 560 and 570 isolate any line on the acuity chart to prevent confusion and speed up Rx verification. The digital display instantaneously shows the results of the refraction, and the Rx may be printed out with a single button push.

In the objective reading mode, all Humphrey Automatic Refractor models offer unparalleled speed, accuracy, and ease of use. Models 560 and 570 also offer the flexibility of subjective refinement. A children's chart, subjective refinement of the sphere power, and glare testing are available on the model 560. The model 570 offers a red/green target for subjective sphere refinement, the Jackson cross cylinder and precision astigmatic measurement tests for refining cylinder and axis, as well as glare testing.

Learning to Use the Humphrey Automatic Refractor

The Automatic Refractor is easy to use. The operator takes only a few simple steps to align the patient, and then the instrument's autotracking mechanism takes over. A single push of the READ button initiates the refraction cycle, and a single push of the PRINT button prints the patient's prescription.

Subjective determination of sphere, cylinder, and axis is also performed with a push of a button and a few simple controls, following principles well known to anyone who has experience with refraction using a phoropter and trial lenses.

Section 2. Operation Summary

Objective Refraction: All Models

An objective refraction may be performed using the READ or MODE sequences in the same manner on all three Refractor models. READ permits the taking of initial and final acuities or the measurement of a single eye. It is the sequence you should use if you plan to make a subjective refinement of the refraction. MODE initiates the automatic reading sequence for both eyes and is fully automatic, but it permits objective measurement only.

Set Up the Refractor

- If this is the first refraction of the day, remove the dust cover and lens cover and turn the Refractor on.
- If this is not the first refraction of the day, press CLEAR before beginning to refract a new patient.
- Use the cylinder convention button to select a + or - cylinder convention.
- Use the VERTEX button to set the vertex distance.
- Use the AUTO + button to turn Auto Plus™ on or off.
- If you have a Model 570 and want to use the companion eye system for this patient, press TARGET and ↑ until C-EYE is illuminated on the visual acuity target display.

Position the Patient

- Make sure the patient is seated comfortably with his or her chin and forehead resting firmly in the patient support assembly.
- Use the chin rest knob to raise or lower the chin rest until the patient's eyes are lined up with the silver marker on the forehead rest.

Align the Refractor

- If you are using READ, press R. EYE or L. EYE to indicate the eye to be tested.

- If you are using MODE, press MODE and the reading head will automatically move to the right eye.
- Ask the patient to look at the acuity chart while you look at the patient's eye through the viewing window.
- Use the control ball to position the blinking green alignment light in the middle of the pupil and let go. The Refractor will then make an automatic vertex adjustment for the patient. You should observe that the instrument has positioned the green light between the two yellow lights.

Perform an Objective Refraction with READ

- Take the initial acuity (optional).
- Press READ.
- Take the final acuity (optional).
- When the Refractor has completed its measurement cycle, press PRINT.

Perform an Objective Refraction with MODE

- Once you have pressed MODE and checked the alignment as described above, the instrument will refract the right eye automatically.
- When the instrument automatically moves to the left eye, adjust the control ball to align the reading head for that eye.
- Simply wait a few seconds until the instrument has measured the second eye and printed out the results automatically.

Optional Subjective Refraction: Model 560

Adjust the Spherical Power

- Wait until the end of the objective measurement cycle and the objective sphere, cylinder, and axis readings appear on the numeric readout.
- Take the visual acuity.
- Use the + SPH and - SPH buttons to add or subtract spherical power in .25 D increments. The changes you are making in spherical power will appear on the numeric readout.
- Take the final acuity.
- Press PRINT.

Determining the Spherical Equivalent

- Wait until the end of the objective measurement cycle or until you have made a subjective adjustment in the refraction, and the sphere, cylinder, and axis readings appear on the numeric readout.

Section 3. Model 550 Instrument Description

Before beginning to use the Automatic Refractor, you should familiarize yourself with the components of your particular model. Many of the operating features are the same for all three models, but not all options are available on all models. Table 3-1 shows the Automatic Refractor features available. You may find it helpful to refer to this table to verify the features and their operation for your instrument.

Table 3-1. Automatic Refractor Features

Feature	Model 550	560	570
Automatic alignment	•	•	•
Unaided visual acuity measurement	•	•	•
Corrected visual acuity measurement	•	•	•
Objective refraction measurement	•	•	•
Automatic sequence mode	•	•	•
Selectable accommodation relaxation control	•	•	•
Ocular reflex index	•	•	•
Selectable vertex distance	•	•	•
Plus or minus cylinder convention	•	•	•
Digital display of results	•	•	•
Hard copy printout of all measurements	•	•	•
Automatic pupillary distance calculation	•	•	•
Portability	•	•	•
Snellen acuity target	•	•	•
Numeric acuity target		•	•
Children's acuity target		•	
Sphere refinement		•	•
Automatic spherical equivalence		•	•
Acuity line isolation		•	•
Glare testing		•	•
Binocular fixation control			•
Cylinder and axis refinement			•
Jackson cross cylinder target			•
Precision astigmatic measurement (PAM) cylinder target			•
Duochrome target			•
Automatic recall for old and new Rx comparisons			•

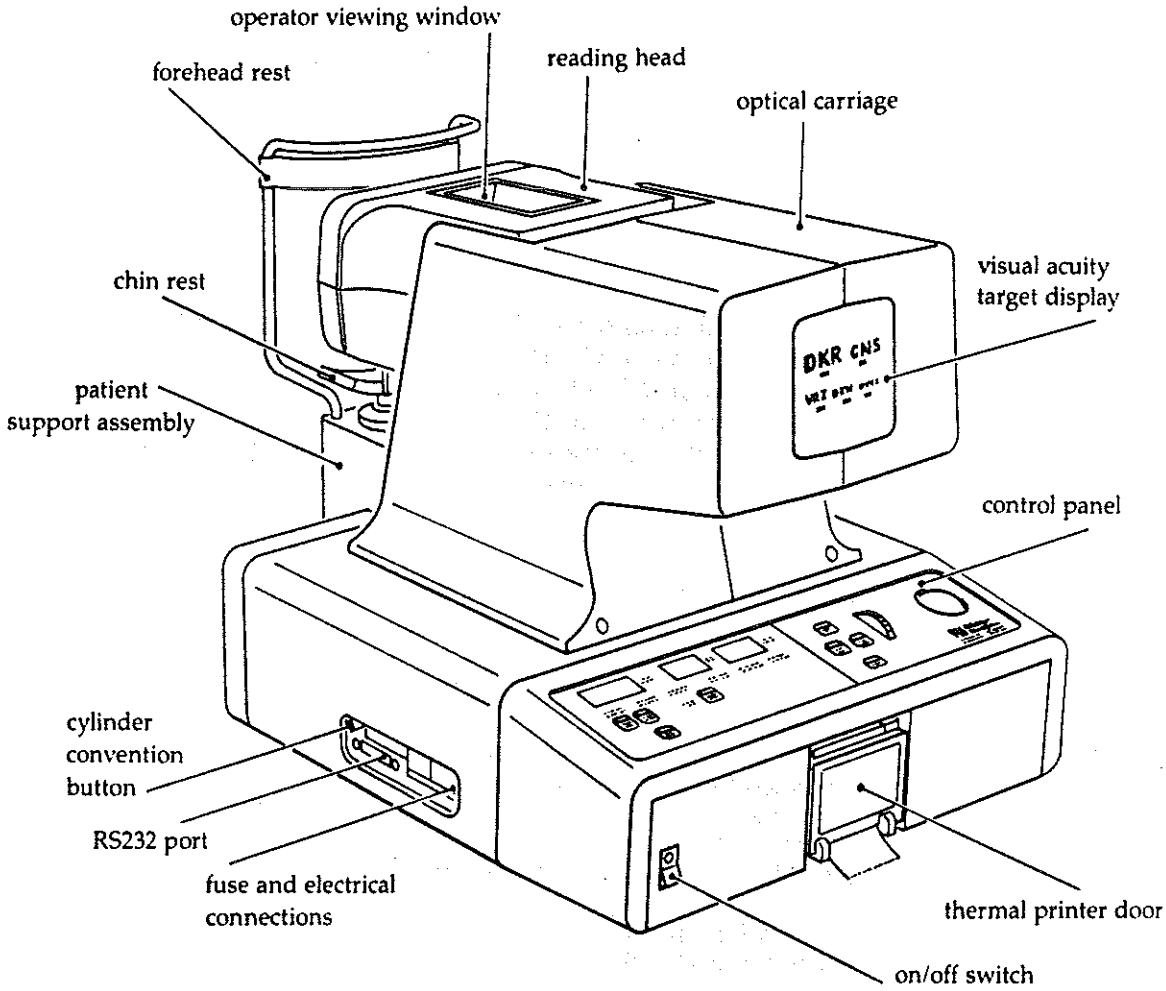


Figure 3-1. *The Humphrey Automatic Refractor Model 550*

The Refractor is customarily described in terms of the patient side and the operator side. The key features of the Model 550 are shown in figure 3-1.

Note: To move the Refractor, hold it by its base and the patient support assembly. Never attempt to move or lift the Refractor by the reading head or optical carriage.

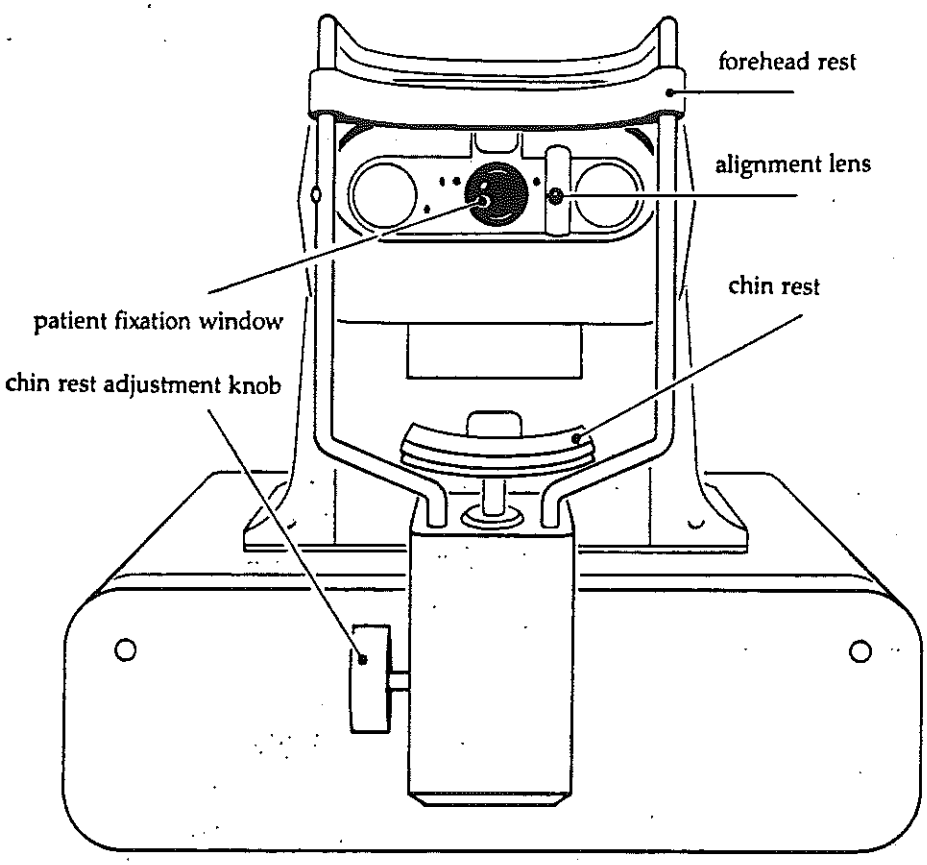


Figure 3-2. *Patient side of the Model 550*

The Patient Side

The patient side of the Refractor consists of the chin and forehead rests, known as the patient support assembly, and the reading head windows. As figure 3-2 shows, the window in the center of the patient side of the Refractor is the patient fixation window. When the Refractor is in the measurement cycle, the patient looks through this window with the eye to be measured and fixates on the target.

The viewing window just above the patient fixation window is used by the operator, not the patient, and will be described along with the operator side of the Refractor. The alignment lens is part of the Refractor's automatic alignment system.

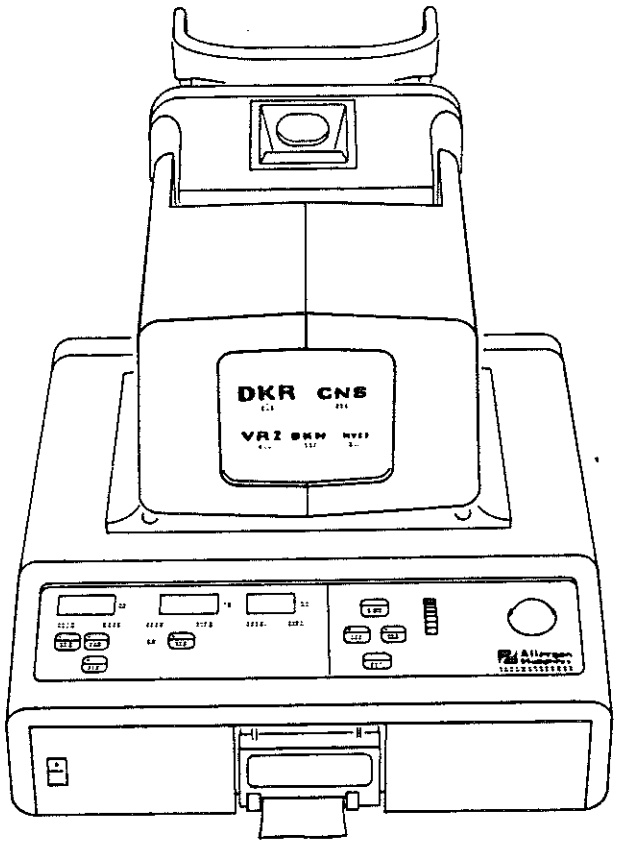


Figure 3-3. *Operator side of the Refractor Model 550*

The Operator Side

The operator's side of the Refractor contains the power switch, the thermal printer, the operator's control panel, and the visual acuity target display. The cylinder convention button is to the operator's left on the side of the instrument next to the fuse switch (see figure 3-3).

The power switch is located on the base of the Refractor to the left of the thermal printer. When the power is on, a red ON light appears on the control panel. The Refractor can be left on throughout the day. Whenever the instrument is turned on but is not used for more than 65 seconds, it goes into standby mode. In this mode the Refractor turns off nonessential functions, such as lights, to conserve energy. After another 65 seconds in standby mode, or about two minutes after the instrument was last used, the Refractor's memory clears automatically. You can reactivate the instrument by touching any control button.

The Refractor's thermal printer provides a quiet printout of the objective measurement and other information for both eyes. When a

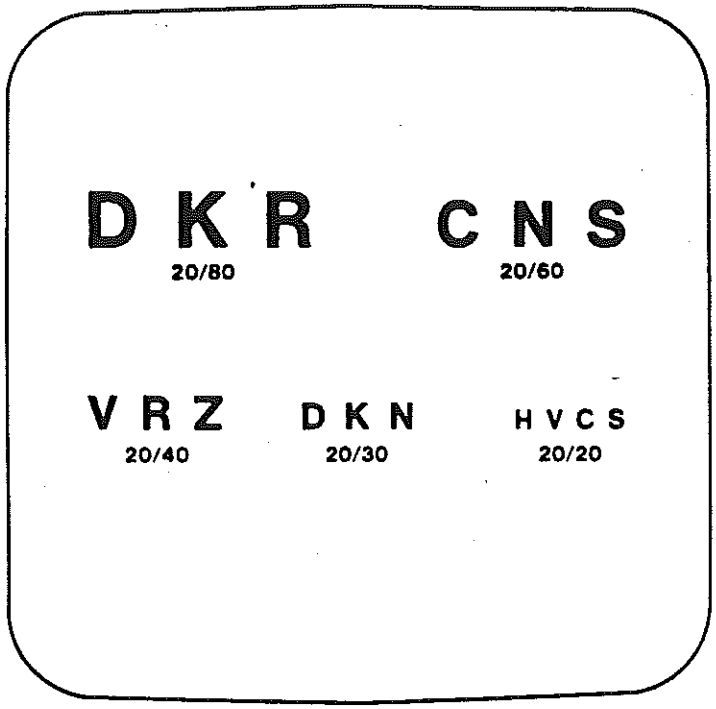


Figure 3-4. *Model 550 visual acuity target*

printout is complete, be sure to tear the printout tape up and to the right against the serrated upper lip of the printer.

The Cylinder Convention Button

A single depression of the cylinder convention button changes the cylinder convention from plus to minus, or the reverse. Either + or - will appear in the CYL section of the control panel's numeric readout to indicate the cylinder convention setting. Once the cylinder convention is set, the Refractor will retain that setting even when it is turned off and on again.

The Viewing Window

The viewing window allows the operator to observe the patient's eye in order to align the reading head while the patient is looking through the patient fixation window. While a measurement is being taken, the patient should look straight ahead at the fixation light, not up through the viewing window.

The Visual Acuity Target Display

The visual acuity target displays the standard Snellen chart (see figure 3-4). Available acuity lines range from 20/20 to 20/80.

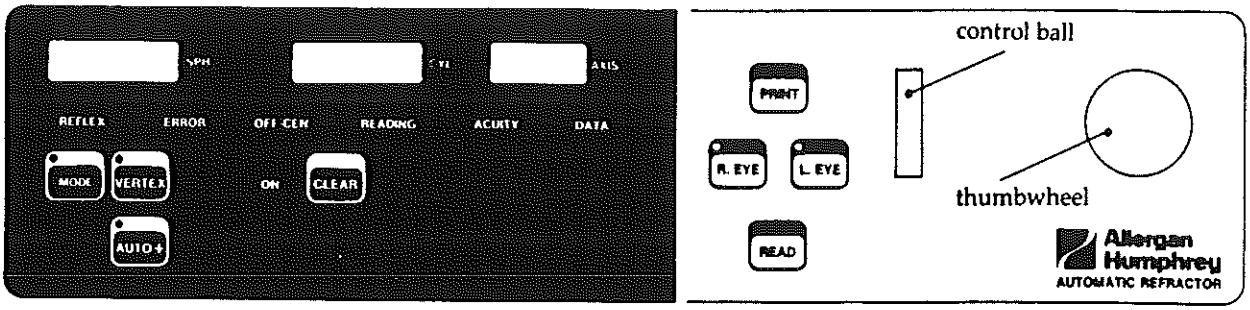


Figure 3-5. *Model 550 control panel*

The Numeric Display

The numeric display appears along the top on the left side of the control panel (figure 3-5). It contains the labels SPH, CYL, and AXIS, and normally the spherical power, cylindrical power, and cylinder axis are displayed here once the Refractor has taken a measurement.

Whenever you change the vertex setting, the new setting is momentarily displayed in the SPH window. Error messages also appear in this window. (See Section 9, Troubleshooting, for a listing of error messages.)

The Control Ball and Thumbwheel

The rotating control ball set in the right side of the control panel directs the position of the reading head left or right and up or down. It also initiates the Refractor's autotracking mechanism, which automatically keeps the reading head aligned with the patient. If the patient moves significantly during a measurement, the autotracking system may stop. To reinitiate autotracking, simply move the control ball slightly. (See Section 6, Preparing to Refract, for more details about using this control.)

Ordinarily, the Refractor makes a vertex adjustment for the patient automatically. If patient head movement or some other factor interferes with the automatic alignment process, the thumbwheel to the left of the control ball can also be used to move the reading head in and out. The thumbwheel should be used only after the control ball and only if the operator sees that the automatic alignment system is not quite on target (see Section 6).

The Message Lights

The six message lights are located on the control panel just below the numeric display and above the buttons. They are visible only when they are illuminated.

REFLEX

When a reading is in progress, the REFLEX message flashes if the reflex value is below 1.5. When the reading is complete, REFLEX will be lit steadily if the value has remained low. Reflex values under 1.5 may indicate poor data (see Section 7). To check a low reflex value, reposition the patient in the instrument, check the room light, ask the patient to keep his or her eyes wide open, and measure again.

ERROR

When the ERROR message lights, a numeric code indicating the nature of the error will appear in the sphere or cylinder numeric display positions. Some of these errors can be corrected by the operator (see Section 9, Troubleshooting).

OFF-CEN

When the READ or MODE buttons are pushed and the instrument is off center with respect to the patient, the OFF-CEN message will be illuminated. Correct the patient's position and the instrument alignment. If you are using READ, press READ again. If you are using MODE, simply reposition the control ball.

READING

The READING message indicates that the instrument is taking a measurement. Wait until the light goes off and the ACUITY light comes on before moving to the next step or making any changes.

ACUITY

When the Refractor is first turned on, ACUITY is the only message light visible. It tells the operator that the acuity chart is currently displayed to the patient.

DATA

The DATA message lights when the Refractor receives positive acknowledgement via the RS232 port. This means, for example, that the Refractor has sent the results of a measurement cycle to an office computer and received acknowledgment of a successful transmission.

The Control Panel Buttons

The control panel buttons are used to prepare and operate the instrument before, during, and after a measurement has been taken. In the Model 550 they are divided into two categories: operation buttons and set-up buttons.

Operation Buttons

The six operation buttons are found on all Automatic Refractor models. They are labelled R. EYE, L. EYE, PRINT, READ, CLEAR, and MODE.

Pressing the button for either the right or left eye moves the Refractor's reading head into position to measure the designated eye. The red indicator light in the button illuminates to indicate the eye selected. If you want to stop the Refractor while the reading cycle is in progress, pressing the button for the eye being tested will abort the measurement.

The READ button initiates a measurement cycle. It can be used if initial and final acuities are to be taken or if subjective verifications will be made. The button is raised to make it easy to find.

Pressing the PRINT button produces a printout of the most recent measurement. To make a second copy for patient records, simply press the button again when the first printout is finished. You may make as many printouts as you like.
The +/- cylinder convention and the vertex distance can be changed before or after a printout is made.

The CLEAR button erases the previous refraction from the Refractor's memory. We recommend that you press CLEAR after each patient. The Refractor clears automatically when it is first turned on and again about two minutes after a printout is made if the instrument isn't used during that time.

The MODE button initiates the automatic reading sequence mode. If it is the first button you push after CLEAR, the Refractor automatically moves to the patient's right eye, aligns, takes a measurement, moves to the left eye and repeats the sequence, and prints the results for both eyes.

Set-Up Buttons

The two set-up buttons are used to set the vertex distance and to turn Auto Plus on or off for each refraction.

Use the VERTEX button to change the vertex distance from 13.50 mm to 0.00 mm and back again. The default distance is 13.50 mm (button indicator light off). The button indicator is lit whenever the vertex distance is set to 0.00 mm.

The default setting for the Auto Plus feature is off. Pressing the AUTO + button turns Auto Plus on and

Section 4. Model 560 Instrument Description

Before beginning to use the Automatic Refractor, you should familiarize yourself with the components of your particular model. Many of the operating features are the same for all three models, but not all options are available on all models. Table 4-1 shows the Automatic Refractor features available. You may find it helpful to refer to this table to verify the features and their operation for your instrument.

Table 4-1. Automatic Refractor Features

Feature	Model 550	560	570
Automatic alignment	•	•	•
Unaided visual acuity measurement	•	•	•
Corrected visual acuity measurement	•	•	•
Objective refraction measurement	•	•	•
Automatic sequence mode	•	•	•
Selectable accommodation relaxation control	•	•	•
Ocular reflex index	•	•	•
Selectable vertex distance	•	•	•
Plus or minus cylinder convention	•	•	•
Digital display of results	•	•	•
Hard copy printout of all measurements	•	•	•
Automatic pupillary distance calculation	•	•	•
Portability	•	•	•
Snellen acuity target	•	•	•
Numeric acuity target		•	•
Children's acuity target		•	
Sphere refinement		•	•
Automatic spherical equivalence		•	•
Acuity line isolation		•	•
Glare testing		•	•
Binocular fixation control			•
Cylinder and axis refinement			•
Jackson cross cylinder target			•
Precision astigmatic measurement (PAM) cylinder target			•
Duochrome target			•
Automatic recall for old and new Rx comparisons			•

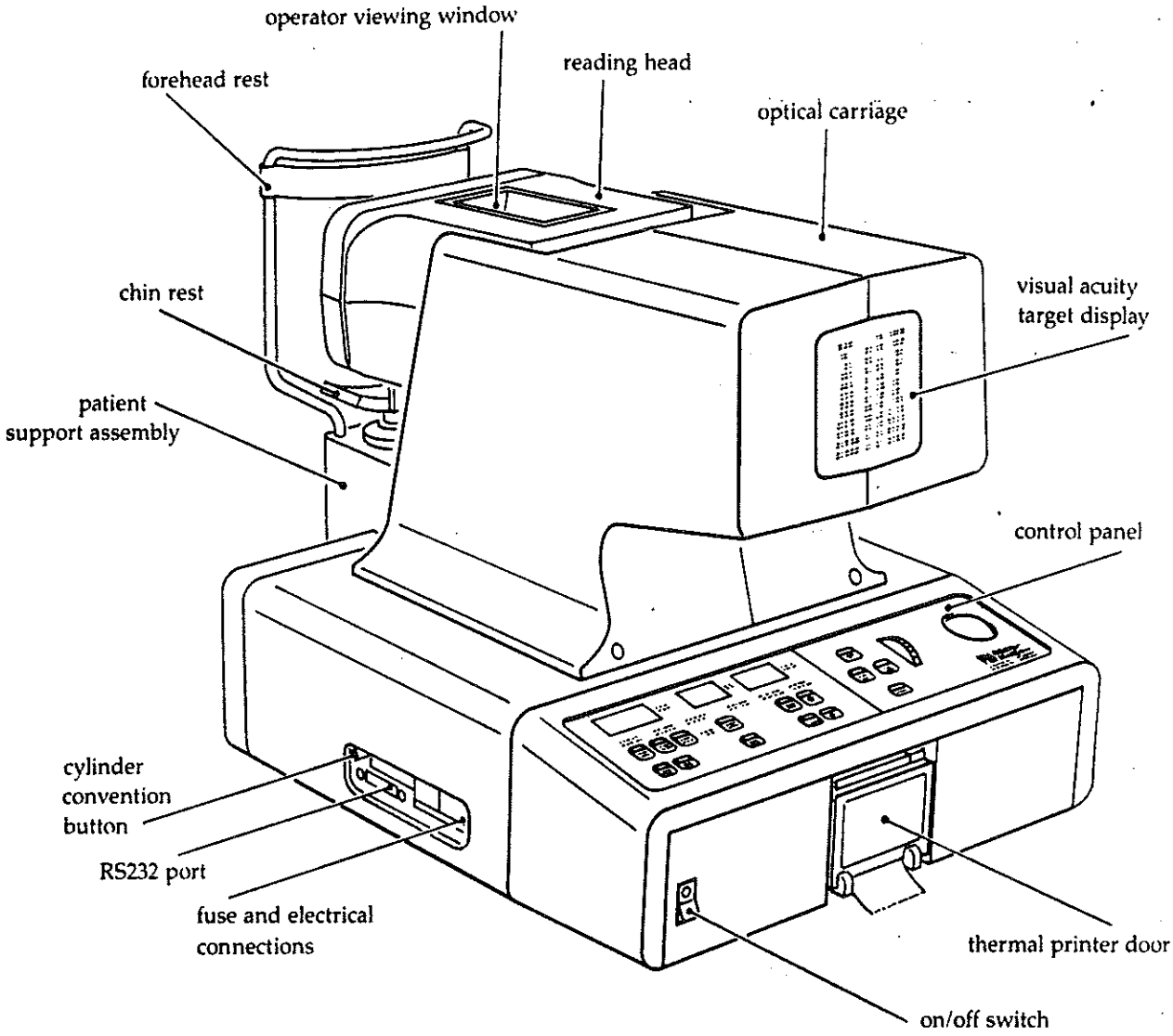


Figure 4-1. *The Humphrey Automatic Refractor Model 560*

The Refractor is customarily described in terms of the patient side and the operator side. The key features of the Model 560 are shown in figure 4-1.

Note: To move the Refractor, hold it by its base and the patient support assembly. Never attempt to move or lift the Refractor by the reading head or optical carriage.

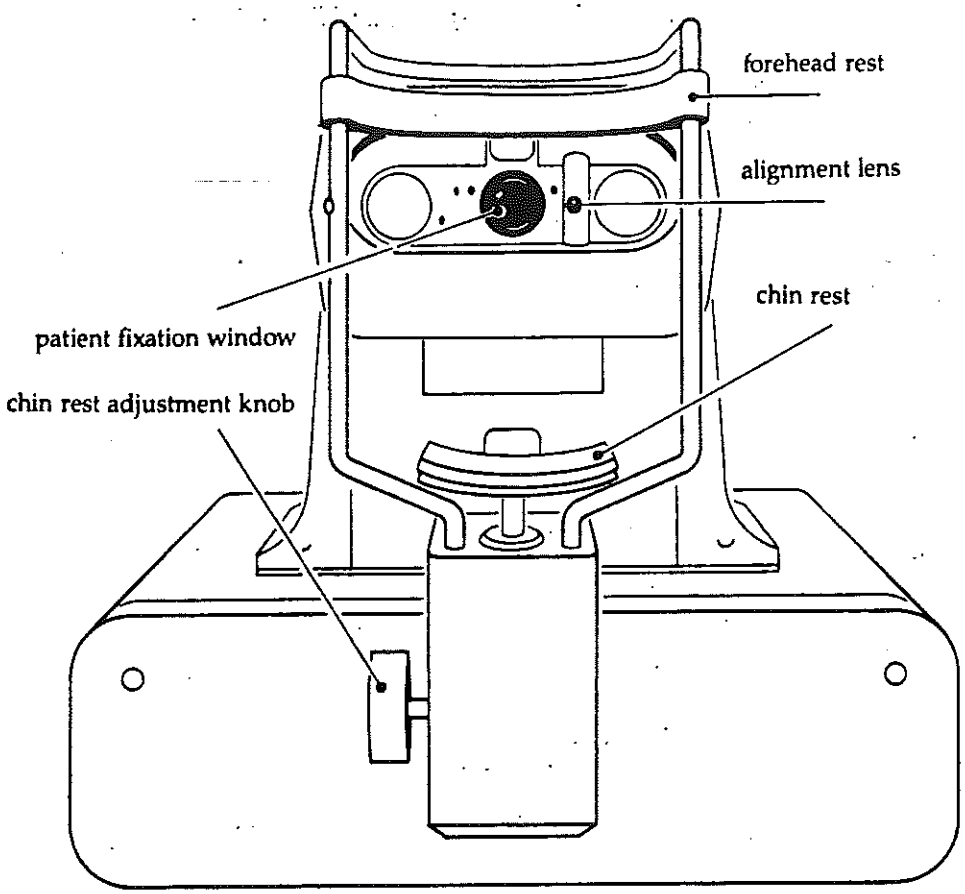


Figure 4-2. *Patient side of the Model 560*

The Patient Side

The patient side of the Refractor consists of the chin and forehead rests, known together as the patient support assembly, and the reading head windows (see figure 4-2). The window in the center of the patient side of the Refractor is the patient fixation window. When the Refractor is in the measurement cycle, the patient looks through this window with the eye to be measured and fixates on the yellow light.

The viewing window just above the patient fixation window is used by the operator, not the patient, and will be described along with the operator side of the Refractor. The alignment lens is part of the Refractor's automatic alignment system.

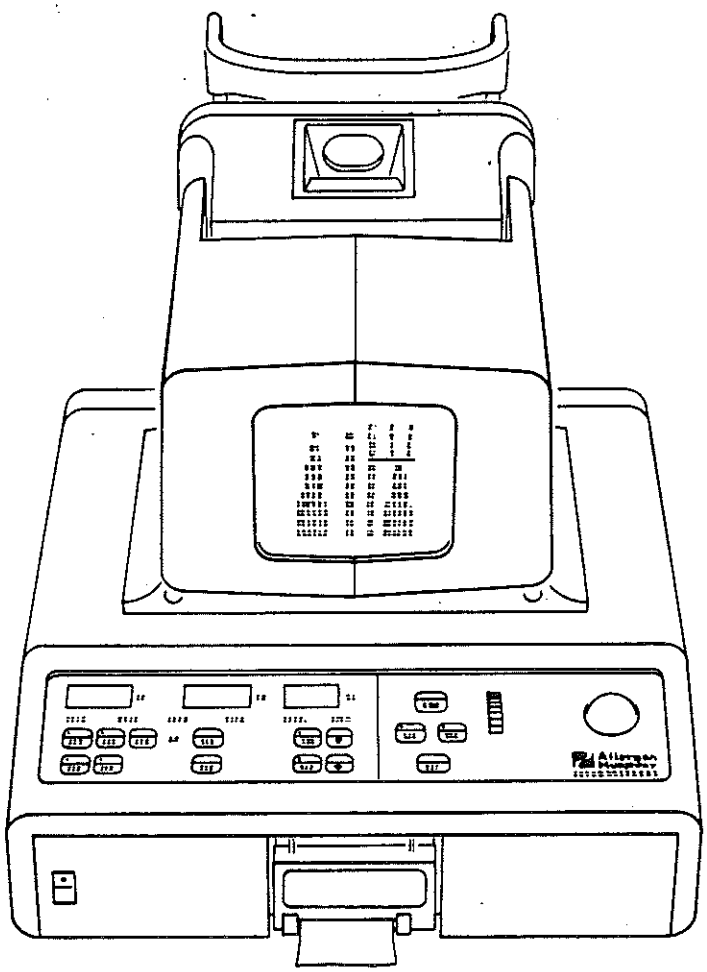


Figure 4-3. *Operator side of the Refractor Model 560*

The Operator Side

The operator side of the Model 560 includes the power switch and printer, the operator's control panel, and the visual acuity display, which makes it possible for the operator to see what the patient is viewing. The cylinder convention button is to the operator's left on the side of the instrument next to the fuse switch (see figure 4-3).

The power switch is located on the base of the Refractor to the left of the thermal printer. When the power is on, a red ON light appears on the control panel. The Refractor can be left on throughout the day. Whenever the instrument is turned on but is not used for more than 65 seconds, it goes into standby mode. In this mode the Refractor turns off nonessential functions, such as lights, to conserve energy. After another 65 seconds in standby mode, or about two minutes after the instrument was last used, the Refractor's memory clears automatically. You can reactivate the instrument by touching any control button.

The Refractor's thermal printer provides a quiet printout of the objective measurement and other information for both eyes. When a printout is complete, be sure to tear the printout tape up and to the right against the serrated upper lip of the printer.

The Cylinder Convention Button

A single depression of the cylinder convention button changes the cylinder convention from plus to minus, or the reverse. Either + or - will appear in the CYL section of the control panel's numeric readout to indicate the cylinder convention setting. Once the cylinder convention is set, the Refractor will retain that setting even when it is turned off and on again.

The Viewing Window

The viewing window allows the operator to observe the patient's eye in order to align the reading head while the patient is looking through the patient fixation window. While a measurement is being taken, the patient should look straight ahead at the fixation light, not up through the viewing window.

The Visual Acuity Target Display

The model 560 visual acuity target offers a Snellen chart with numbers included, a child's chart, and a glare target (see figure 4-4). When the Refractor is turned on, the 20/40 line of the Snellen chart is illuminated on the operator side and also displayed to the patient. When a measurement is complete, the acuity line the patient is viewing is also illuminated on the operator's display. The available acuity lines range from 20/15 to 20/200.

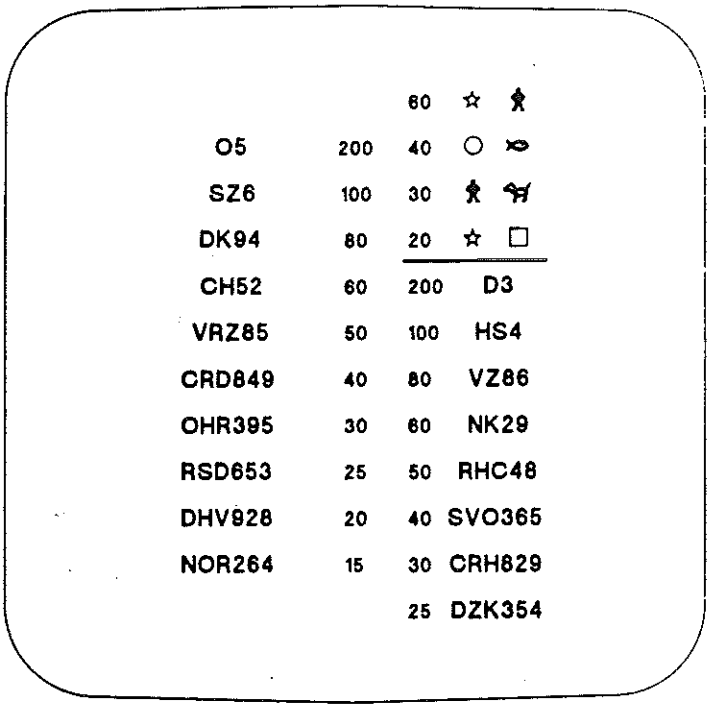


Figure 4-4. *Model 560 visual acuity target*

The Numeric Display

The numeric display appears along the top on the left side of the control panel (figure 4-5). It contains the labels SPH, CYL, and AXIS, and normally the spherical power, cylindrical power, and cylinder axis are displayed here once the Refractor has completed a measurement.

Whenever you change the vertex setting, the new setting is momentarily displayed in the SPH window. Error messages also appear in this window. (See Section 9, Troubleshooting, for a listing of error messages.)

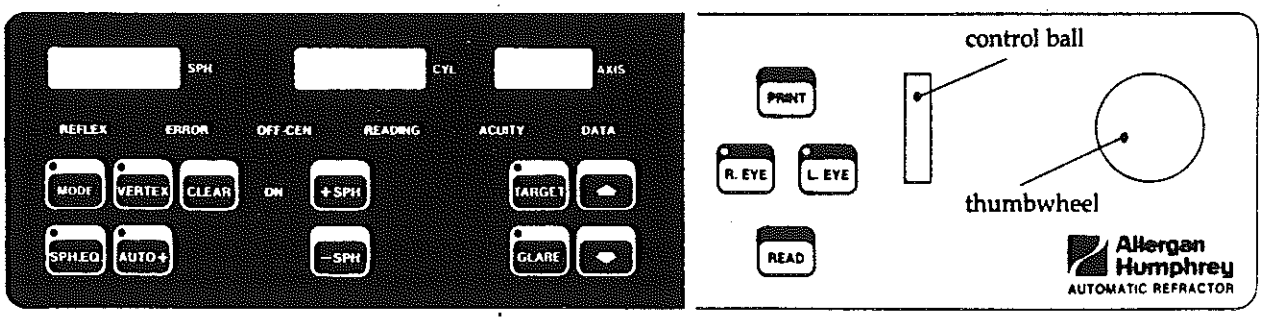


Figure 4-5. *Model 560 control panel*

The Control Ball and Thumbwheel

The rotating control ball set in the right side of the control panel directs the position of the reading head left or right and up or down. It also initiates the Refractor's autotracking mechanism, which automatically keeps the reading head aligned with the patient. If the patient moves significantly during a measurement, the autotracking system may stop. To reinitiate autotracking, simply move the control ball slightly. (See Section 6, Preparing to Refract, for more details about using this control.)

Ordinarily, the Refractor makes a vertex adjustment for the patient automatically. If patient head movement or some other factor interferes with the automatic alignment process, the thumbwheel to the left of the control ball can also be used to move the reading head in and out. The thumbwheel should be used only after the control ball and only if the operator sees that the automatic alignment system is not quite on target (see Section 6).

The Message Lights

The message lights are located below the numeric display and above the buttons. The models 550 and 560 have the same message lights. They are visible only when they are illuminated.

REFLEX

When a reading is in progress, the REFLEX message flashes if the reflex value is below 1.5. When a reading is complete, REFLEX will be lit steadily if the value has remained low. Reflex values under 1.5 may indicate poor data (see Section 7). To check a low reflex value, reposition the patient in the instrument, check the room light, ask the patient to keep his or her eyes wide open, and measure again.

ERROR

When the ERROR message light comes on, a numeric code indicating the nature of the error will appear in the sphere or cylinder numeric display positions. Some of these errors can be corrected by the operator (see Section 9, Troubleshooting).

OFF-CEN

When the READ or MODE buttons are pushed and the instrument is off center with respect to the patient, the OFF-CEN message will be illuminated. Correct the patient's position and the instrument alignment. If you are using READ, press READ again. If you are using MODE, simply reposition the control ball.

READING

The READING message indicates that the instrument is taking a measurement. Wait until the light goes off and the ACUITY light comes on before moving to the next step or making any changes.

ACUITY

When the Refractor is first turned on, ACUITY is the only message light visible. It tells the operator that the acuity chart is currently displayed to the patient.

DATA

The DATA light appears when the Refractor receives positive acknowledgement via the RS232 port. This means, for example, that the Refractor has sent the results of a measurement cycle to an office computer and received acknowledgment of a successful transmission.

The Control Panel Buttons

The control panel buttons are used to prepare and operate the instrument before, during, and after a measurement has been taken. In the Model 560 they are divided into four categories: operation buttons, set-up buttons, visual acuity target buttons, and subjective verification buttons.

Operation Buttons

The six operation buttons are found on all Automatic Refractor models. They are labelled R. EYE, L. EYE, READ, PRINT, CLEAR, and MODE.

Pressing the button for either the right or left eye moves the Refractor's reading head into position to measure the designated eye. Whenever you switch from one eye to another, the visual acuity target is reset to the 20/40 line. The button indicator lights for the eye selected. If you want to stop the Refractor while a reading cycle is in progress, pressing the button for the eye being tested will abort the measurement.

The READ button initiates a measurement cycle. It can be used if initial and final acuities are to be taken or if subjective verifications will be made. The button is raised to make it easy to find.

Pressing the PRINT button produces a printout of the most recent measurement. To make a second copy for patient records, simply press the button again when the first printout is finished. You may make as many printouts as you like.
The +/- cylinder convention and the vertex distance can be changed before or after a printout is made.

The CLEAR button erases the previous refraction from the Refractor's memory. We recommend that you press CLEAR after each patient. The Refractor clears automatically when it is first turned on and again approxinately two minutes after a printout is made if the instrument is not used during that time.

The MODE button initiates the automatic reading sequence mode. If it is the first button you push after CLEAR, the Refractor automatically moves to the patient's right eye, aligns, takes a measurement, moves to the left eye and repeats the sequence, and prints the results for both eyes.

Set-Up Buttons

The two set-up buttons are used to set the vertex distance and to turn the Auto Plus feature on or off for each refraction.

Use the VERTEX button to change vertex distances. The default distance is 13.50 mm (button indicator off). The button indicator is lit whenever a value other than 13.50 is selected. The first button push displays the current vertex in the SPHERE numeric display position. Successive presses change the setting as follows:

13.50 15.00 16.50 0.00 10.50 12.00

The default setting for the Auto Plus feature is off. Pressing the AUTO + button turns Auto Plus on and lights the indicator light. When Auto Plus is used, AUTO + ON appears on the printout.

Visual Acuity Target Buttons: Model 560

The visual acuity target buttons are TARGET, ↑, ↓, and GLARE. If you think of the visual acuity target as having three independent sections, it is easy to understand the uses of these buttons. The three sections are the Snellen chart with letters and numbers, the child's target, and the glare target (see also Section 7, Refracting).

When the Refractor is first turned on, the 20/40 line of the Snellen chart is illuminated on the operator side and displayed to the patient. Each press of ↑ or ↓ moves the visual acuity lines shown to the patient up or down one line. The acuity line the patient is viewing is also illuminated on the operator's display.

A single press of the TARGET button switches from the Snellen chart to the child's chart. ↑ and ↓ are used to move from line to line within the child's chart. When the child's chart is in use, the indicator light in the TARGET button is illuminated. Pressing the TARGET button again returns you to the Snellen chart.

One press of the GLARE button switches from the Snellen or child's target to the low contrast glare target. The indicator light in the GLARE button will be illuminated. Press the GLARE button again to turn on the glare light which surrounds the glare target. The indicator light will blink while the glare light is on. ↑ and ↓ are used to move from line to line within the glare target. This test should be used at the end of the objective refraction, or if a subjective refinement is performed, at the end of that process. Press the button a third time to return to the Snellen chart.

Subjective Verification Buttons

The Model 560 allows the operator to make a subjective verification and refinement of the objective spherical power Rx using the + SPH, - SPH, and SPH. EQ. buttons.

Pressing the sphere equivalent button converts the sphere and cylinder readings to spherical equivalence. The optics in the instrument are moved to the sphere equivalent value, and this value will appear in the printout with the label SPH EQ. Pressing the button again turns off the indicator light and converts back to the previous sphere and cylinder display.

The plus or minus sphere buttons are used to refine the sphere power subjectively. Each press of one of the buttons changes the objective Rx by plus or minus .25 diopters of sphere power. The subjectively altered Rx will flash in the SPH window on the numeric display.

Accessory Kit and Tools

An accessory kit is included with your Refractor. This kit includes:

- An *Operator's Manual.* This is your reference book for the Allergan Humphrey Automatic Refractor.
- A dust cover. This should be placed over the Refractor at the end of each day.

Section 5. Model 570 Instrument Description

Before beginning to use the Automatic Refractor, you should familiarize yourself with the components of your particular model. The Model 570 is the most advanced Automatic Refractor, and it offers the most features. It is the only Automatic Refractor with complete subjective refraction capability. Table 5-1 shows the Automatic Refractor features available. You may find it helpful to refer to this table to verify the features and their operation for your instrument.

Table 5-1. Automatic Refractor Features

Feature	Model 550	560	570
Automatic alignment	•	•	•
Unaided visual acuity measurement	•	•	•
Corrected visual acuity measurement	•	•	•
Objective refraction measurement	•	•	•
Automatic sequence mode	•	•	•
Selectable accommodation relaxation control	•	•	•
Ocular reflex index	•	•	•
Selectable vertex distance	•	•	•
Plus or minus cylinder convention	•	•	•
Digital display of results	•	•	•
Hard copy printout of all measurements	•	•	•
Automatic pupillary distance calculation	•	•	•
Portability	•	•	•
Snellen acuity target	•	•	•
Numeric acuity target		•	•
Children's acuity target		•	
Sphere refinement		•	•
Automatic spherical equivalence		•	•
Acuity line isolation		•	•
Glare testing		•	•
Binocular fixation control			•
Cylinder and axis refinement			•
Jackson cross cylinder target			•
Precision astigmatic measurement (PAM) cylinder target			•
Duochrome target			•
Automatic recall for old and new Rx comparisons			•

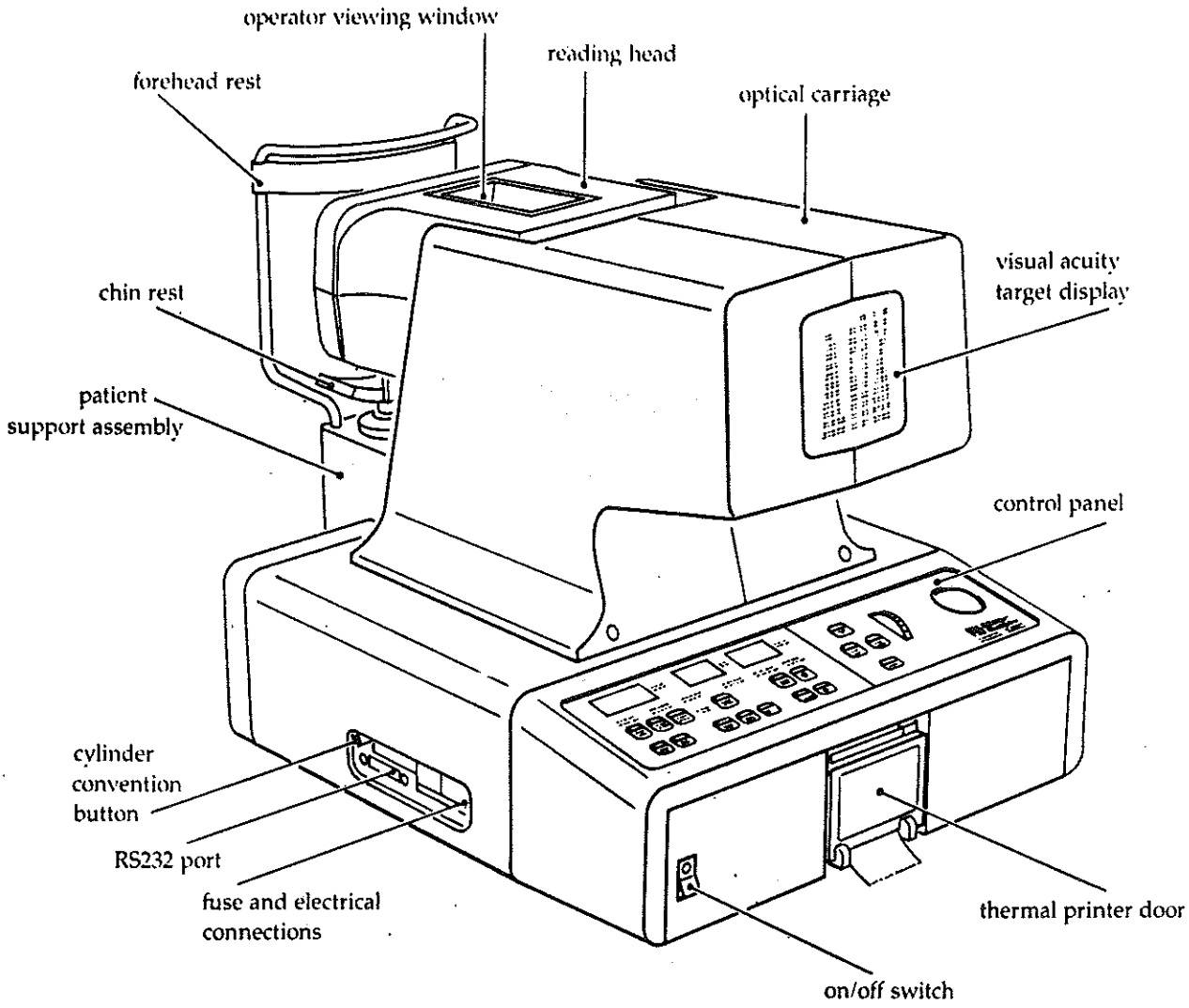


Figure 5-1. *The Humphrey Automatic Refractor Model 570*

The Refractor is customarily described in terms of the patient side and the operator side. The key features of the Model 570 are shown in figure 5-1.

Note: To move the Refractor, hold it by its base and the patient support assembly. Never attempt to move or lift the Refractor by the reading head or optical carriage.

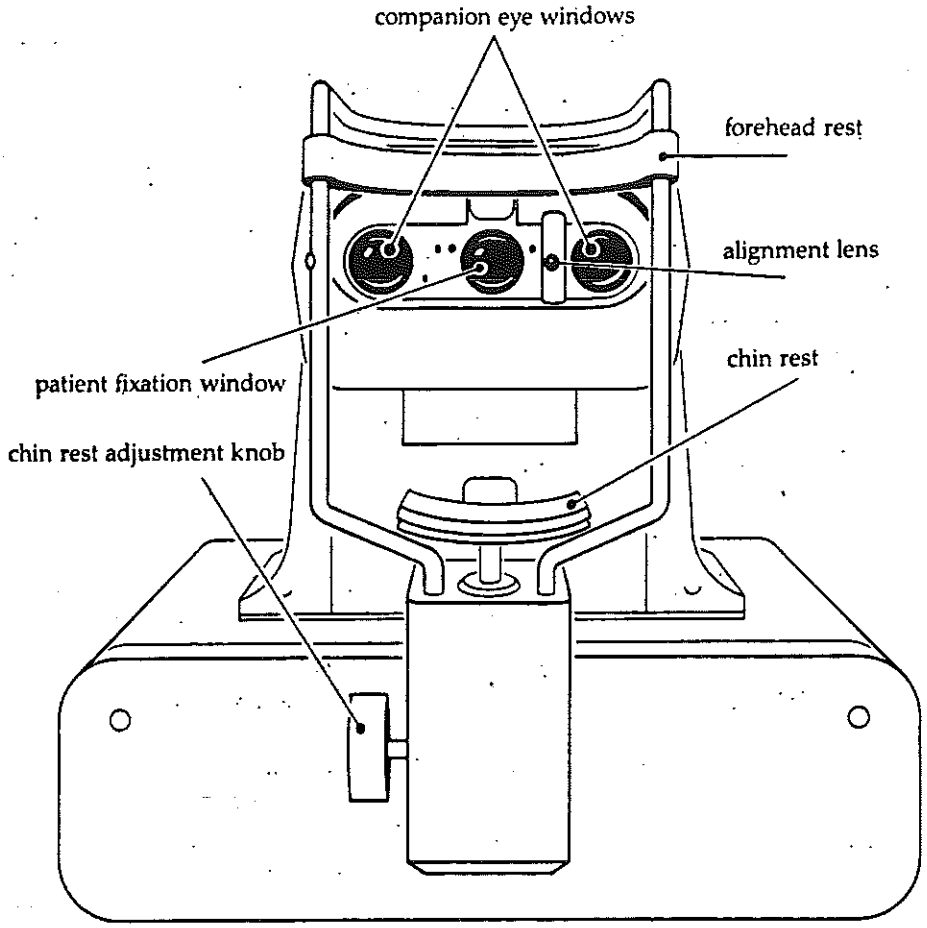


Figure 5-2. *Patient Side of the Model 570*

The Patient Side

The patient side of the Refractor consists of the chin and forehead rests, which together are referred to as the patient support assembly, and the reading head windows. The alignment lens is part of the Refractor's automatic alignment system. The 570 differs from other Refractor models in the configuration of its reading head windows. In addition to the patient fixation and viewing windows, the reading head of the Model 570 has two companion-eye windows (see figure 5-2).

The companion-eye system helps control convergence and accommodation by providing a fixation target for the non-tested eye. While the measured eye looks through the fixation window, the eye not being tested can look at the companion-eye fixation target, a plain white box shaped like the acuity target. This allows the patient to experience binocular vision and improves fixation in some cases. It is best to use the companion-eye system only when the eye not being measured needs to be stimulated by fixating on a target.

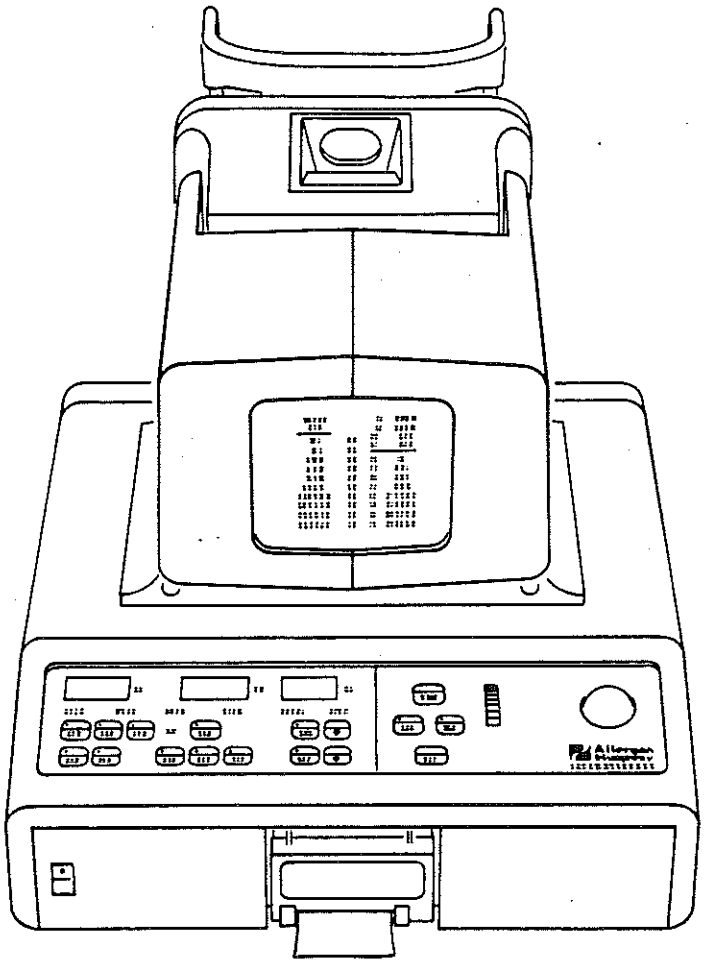


Figure 5-3. *The operator side of the Refractor Model 570*

Operator Side

The operator side of the Model 570 contains all of the features found on the other two models, along with a number of additional buttons and message lights (see figure 5-3). As with the other models, the power switch is located on the base of the Refractor to the left of the thermal printer. When the power is on, a red ON light appears on the control panel. The Refractor can be left on throughout the day. Whenever the instrument is turned on but is not used for more than 65 seconds, it goes into standby mode. In this mode the Refractor turns off nonessential functions, such as lights, to conserve energy. After another 65 seconds in standby mode, or about two minutes after the instrument was last used, the Refractor's memory clears automatically. You can reactivate the instrument by touching any control button.

The Refractor's thermal printer provides a quiet printout of the objective measurement and other information for both eyes. When a printout is complete, tear the printout tape up and to the right against the serrated upper lip of the printer.

The Cylinder Convention Button

The cylinder convention button is to the operator's left on the side of the instrument next to the fuse switch. A single depression of the button changes the cylinder convention from plus to minus, or the reverse. Either + or - will appear in the CYL section of the control panel's numeric readout to indicate the cylinder convention setting. Once the cylinder convention is set, the Refractor will retain that setting even when it is turned off and on again.

The Viewing Window

The viewing window allows the operator to observe the patient's eye in order to align the reading head while the patient is looking through the patient fixation window. While a measurement is being taken, the patient should look straight ahead at the fixation light, not up through the viewing window.

The Visual Acuity Target Display

The model 570 visual acuity target display offers six sections for different types of testing (figure 5-4). The Snellen chart includes numbers and acuity lines ranging from 20/15 to 20/200. When the Refrac-

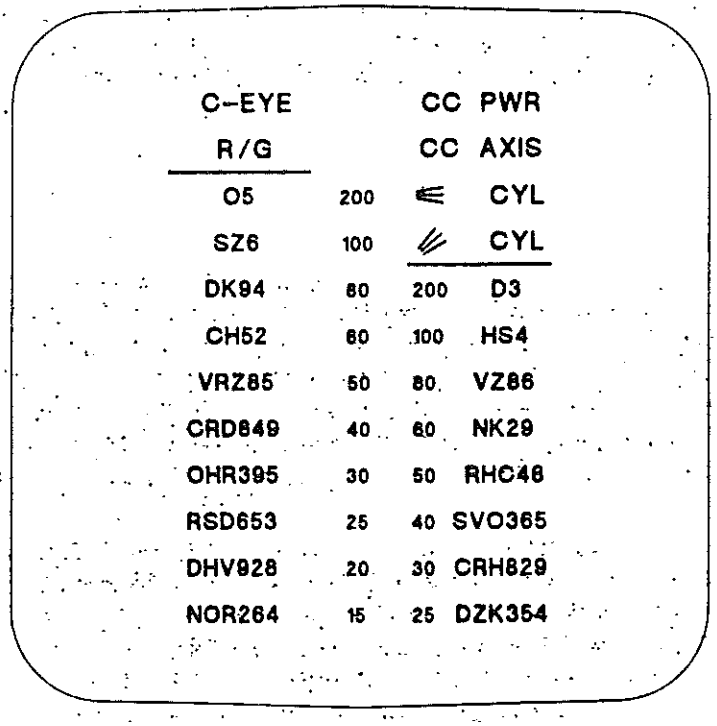


Figure 5-4. *Model 570 visual acuity target*

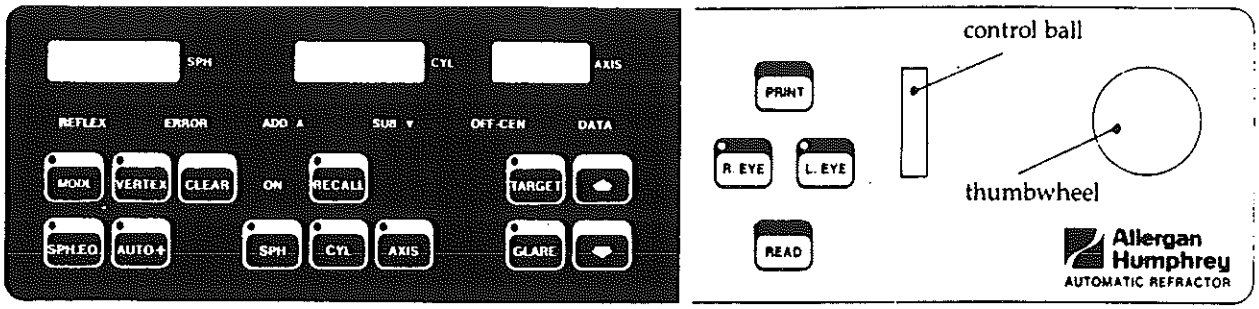


Figure 5-5. *Model 570 control panel*

tor is turned on, the 20/40 line of the Snellen chart is visible to the patient and illuminated on the operator's display. Once a measurement is complete, the acuity line the patient is viewing is again illuminated on the operator's display.

The Model 570 also displays a red/green target, precision astigmatic measurement and Jackson cross cylinder targets

The Numeric Display

The numeric display appears along the top on the left side of the control panel (figure 5-5). It contains the labels SPH, CYL, and AXIS, and normally the spherical power, cylindrical power, and cylinder axis are displayed here. These labels blink when the displayed value differs from the objective reading.

Whenever you change the vertex setting, the new setting is momentarily displayed in the SPH window. Error messages also appear in this window. (See Section 9, Troubleshooting, for a listing of error messages.)

The Control Ball and Thumbwheel

The rotating control ball set in the right side of the control panel directs the position of the reading head left or right and up or down. It also initiates the Refractor's autotracking mechanism, which automatically keeps the reading head aligned with the patient. If the patient moves significantly during a measurement, the autotracking system may stop. To reinitiate autotracking, simply move the control ball slightly. (See Section 6, Preparing to Refract, for more details about using this control.)

Ordinarily, the Refractor makes a vertex adjustment for the patient automatically. If patient head movement or some other factor interferes with the automatic alignment process, the thumbwheel to the left of the control ball can also be used to move the reading head in and out. The thumbwheel should be used only after the control ball and only if the operator sees that the automatic alignment system is not quite on target (see Section 6).

The thumbwheel on the model 570 can also be used to change the sphere, cylinder and axis values. To make a change, push the button for the value you wish to change, and when the indicator in the button lights, turn the thumbwheel forward or back to add or subtract from the value. Your changes will appear in the numeric display next to SPH, CYL, or AXIS. (For details, see Section 7.)

Message Lights

The message lights are located below the numeric display and above the buttons. They are visible only when they are illuminated.

REFLEX

When a reading is in progress, the REFLEX message flashes if the reflex value is below 1.5. When a reading is complete, REFLEX will be lit steadily if the value has remained low. Reflex values under 1.5 may indicate poor data (see Section 7). To check a low reflex value, reposition the patient in the instrument, check the room light, ask the patient to keep his or her eyes wide open, and measure again.

ERROR

When the ERROR message lights comes on, a numeric code indicating the nature of the error will appear in the sphere or cylinder numeric display positions. Some of these errors can be corrected by the operator (see Section 9, Troubleshooting).

ADD ∧ and SUB ∨

The ADD ∧ and SUB ∨ messages appear during the Jackson Cross cylinder test to tell the operator how to change the cylinder axis and power.

OFF-CEN

When the READ or MODE buttons are pushed and the instrument is off center with respect to the patient, the OFF-CEN message will be illuminated. Correct the patient's position and the instrument alignment. If you are using READ, press READ again. If you are using MODE, simply reposition the control ball.

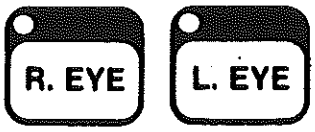
DATA

The DATA message appears during the measurement cycle to indicate that the instrument is acquiring data. Wait until the message goes off before moving on to the next part of the refraction. The DATA message also appears when the Refractor is sending data to a computer system and receives positive acknowledgment of successful transmission via the RS232 port.

The control panel buttons are used to prepare and operate the instrument before, during, and after a measurement has been taken. On the Model 570 they are divided into four categories: operation buttons, set-up buttons, visual acuity target buttons, and subjective verification buttons.

Operation Buttons

The six operation buttons are found on all Automatic Refractor models. They are labelled R. EYE, L. EYE, READ, PRINT, CLEAR, and MODE.



Pressing the button for either the right or left eye moves the Refractor's reading head into position to measure the designated eye. Whenever you switch from one eye to another, the visual acuity target is reset to the 20/40 line. The button indicator lights for the eye selected. If you want to stop the Refractor while a measurement cycle is in progress, pressing the button for the eye being tested will abort the measurement.

The READ button initiates a measurement cycle. It can be used if initial and final acuities are to be taken or if subjective verifications will be made. The button is raised to make it easy to find.

Pressing the PRINT button produces a printout of the most recent measurement. To make a second copy for patient records, simply press the button again when the first printout is finished. You may make as many printouts as you like.
The +/- cylinder convention and the vertex distance can be changed before or after a printout is made.

The CLEAR button erases the previous refraction from the Refractor's memory. We recommend that you press CLEAR after each patient. The Refractor clears automatically when it is first turned on and again about two minutes after a printout is made if the instrument is not used during that time.

The MODE button initiates the automatic reading sequence mode. If it is the first button you push after CLEAR, the Refractor automatically moves to the patient's right eye, aligns, takes a measurement, moves to the left eye and repeats the sequence, and prints the results for both eyes.

Set-Up Buttons

The two set-up buttons are used to set the vertex distance and to turn the Auto Plus feature on or off for each refraction.

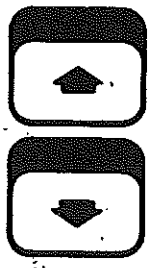
Use the VERTEX button to change vertex distances. The default distance is 13.50 mm (button indicator off). The button indicator is lit whenever a value other than 13.50 is selected. The first button push displays the current vertex in the SPHERE numeric display position. Successive presses change the setting as follows:

13.50 15.00 16.50 0.00 10.50 12.00

Pressing the AUTO + button turns Auto Plus on and lights the indicator light. When Auto Plus is used, AUTO + ON appears on the printout. The default setting for the Auto Plus feature is off.

Visual Acuity Target Buttons: Model 570

The visual acuity target buttons are TARGET, ↑, ↓, and GLARE. The TARGET button is used in conjuction with ↑ and ↓ to reach various sections of the visual acuity target. When you are using any area of the visual acuity target other than the Snellen chart, the indicator light in the TARGET button will be illuminated.



When the Snellen chart is being used, each press of ↑ or ↓ moves the visual acuity lines shown to the patient up or down one line. The acuity line the patient is viewing is illuminated on the operator's display.

All of the uses of the target button described here are presented as if you are beginning from the Snellen chart. Pressing the TARGET button once switches from the Snellen to the red/green target. The indicator light will come on when the R/G target is in use.

Pressing TARGET twice switches to the first Jackson cross cylinder target. When you are ready to use the second Jackson cross cylinder target, press ↑. Pressing TARGET twice and then pressing ↓ takes you to the PAM section of the visual acuity target. Pressing TARGET returns you to the red/green chart. Pressing TARGET again returns you to the Snellen chart.

To use the companion-eye system, press the TARGET button, and then press ↑ until C-EYE is illuminated. The companion eye target will be presented to the patient and the chart will revert to the 20/40 line of the Snellen chart. To turn the companion-eye system off, press TARGET and ↑ to reach C-EYE again. The line will no longer be illuminated and the companion-eye system will be turned off.

One press of the GLARE button switches from the Snellen chart to the low contrast glare target. The indicator light in the GLARE button will be illuminated. Press the button again to turn on the glare light which surrounds the glare target. The indicator light will blink while the glare light is on. ↑ and ↓ are used to move from line to line within the glare target. This test should be used at the end of the objective refraction, or if a subjective refinement is performed, at the end of that process. Press the button a third time to return to the Snellen chart.

Subjective Verification Buttons

Unlike the 550 and 560, the Model 570 can be used to perform a thorough subjective refraction in addition to the objective refraction. Therefore, several subjective verification buttons are found on the Model 570 only. See Section 7, Refracting, for details on the uses of these buttons during the Refractor's measurement cycle.

Pressing SPH turns on the sphere button indicator light and makes it possible to use the thumbwheel to change the objective sphere reading of the instrument. The indicator also lights automatically and the thumbwheel is engaged when the operator is using the red/green target.

Pressing CYL turns on the cylinder button indicator light and makes it possible to use the thumbwheel to change the objective cylinder reading of the instrument. The indicator also lights automatically and the thumbwheel is enabled when the power portion of the Jackson cross cylinder test is in use.

Pressing AXIS turns on the axis button indicator light and makes it possible to use the thumbwheel to change the objective cylinder axis reading of the instrument. The indicator will also light automatically and the thumbwheel is enabled when the axis portion of the Jackson cross cylinder test is in use.

Pressing the sphere equivalent button converts the sphere and cylinder readings to spherical equivalence. The optics in the instrument are moved to the sphere equivalent value, and this value will appear in the printout with the label SPH EQ. Pressing the button again turns off the indicator light and converts back to the previous sphere and cylinder display.

When a subjective change has been made in the sphere, cylinder, or axis values, the RECALL button allows you to toggle between the objective Rx and the subjective Rx. Each press of the RECALL button moves the optics between the subjective and objective findings. This allows quick comparison between the objective Rx and the most recent subjective change. When the instrument is displaying the subjective value, the SPH, CYL, or AXIS indicator lights will blink, depending on which value received the subjective change.

Accessory Kit and Tools

An accessory kit is included with your Refractor. This kit includes:

- An *Operator's Manual*. This is your reference book for the Allergan Humphrey Automatic Refractor.
- A dust cover. This should be placed over the Refractor at the end of each day.
- A lens cover. This should be fitted over the lenses on the patient side of the Refractor at the end of the day.
- A power cord. The power cord receptacle is located on the left side of the Refractor.
- Thermal printer paper rolls. A few extra rolls are provided. Use only Humphrey thermal paper in your Refractor printer. Contact the Allergan Humphrey parts department to place an order for more paper rolls. A roll is approximately 120 feet long.
- Texpad alcohol wipes. These can be used to clean the chin rest, forehead rests, and print head. **Never use alcohol wipes to clean the reading head windows.**

- Extra chin rest paper
- Camera lens cleaning tissue and solution. These are needed to clean the patient fixation windows.
- A small camel hair brush for dusting the fixation windows
- A 3/32" Allen wrench. This wrench is used to secure or remove headrest screws located under the headrest support.
- Fuses, 3 amp for 100/117 volts. Replacement fuses are included in the kit. Additional fuses can be obtained from the Allergan Humphrey parts department.

In addition to the supplies in the kit, you may find it useful to have the following items on hand in the office:

- A wrench to secure or remove the wheels on the power table
- Tweezers to help in replacing the fuse
- Patient brochures. Allergan Humphrey provides at cost brochures that describe the Refractor in clear, simple terms. These brochures are particularly useful in introducing new patients to your practice and to the Refractor.

Section 6. Preparing to Refract

Before you begin to refract, you should decide whether you want to use the READ or MODE sequences to perform an objective refraction or, if you have a Model 560 or Model 570, whether you plan to perform a subjective refraction. READ permits the taking of initial and final acuities or the measurement of a single eye. It is also the sequence you should use if you plan to make a subjective refinement of the refraction. MODE initiates the automatic reading sequence for both eyes and is fully automatic, but it permits objective measurement only.

There are three steps to preparing to refract with the Automatic Refractor: set up the Refractor, position the patient, and align the Refractor.

Set Up the Refractor for Testing

At the end of each day the lens cover should be put over the lenses on the patient side of the Refractor and the dust cover should go over the whole instrument, so if this is your first patient of the day, take off the dust and lens covers and turn the Refractor on. The instrument will immediately begin to perform its automatic test of internal circuits to verify correct operation. When the ACUITY light appears on the control panel, internal checks are complete and the Refractor is ready to use.

The instrument can be left on throughout the day. Whenever it is turned on but is not used for more than 65 seconds, it goes into standby mode. In this mode, the Refractor turns off nonessential functions, such as lights, to conserve energy. You can reactivate the instrument by touching any control button.

Note: If the ERROR indicator appears when you first turn the Refractor on, turn the instrument off, wait a moment, and turn it back on. If the indicator appears again, see Section 9, Troubleshooting.

If this is not your first refraction of the day, be sure to press CLEAR to erase the previous measurement from the Refractor's memory. It is good practice to press CLEAR after each refraction is complete and all measurements have been printed. This will clear the memory and prepare the instrument for the next patient. The

Refractor's memory does clear automatically after the instrument has been in standby mode for 65 seconds, or a little over two minutes after the last use. Until then, however, memory is not cleared and will retain the last measurement taken.

When the ACUITY light appears, check the set-up buttons and indicator lights to see if there is anything you want to change. The default settings the Refractor presents when it is turned on are a 13.50 mm vertex setting and Auto Plus off. Plus or minus cylinder convention will be indicated by + or - in the CYL display and is the setting the Refractor had when it was last turned off. The first visual acuity chart displayed is the Snellen chart. Models 560 and 570 begin with the 20/40 line illuminated.

Auto Plus

Automatic plussing should be used with all patients who have the ability to accommodate to ensure that their accommodation is relaxed. Auto Plus automatically "fogs" the patient at the end of the objective refraction in order to help relax the accommodation. To turn the Refractor's Auto Plus feature on, press the AUTO + button and the indicator light will light.

Cylinder Convention

To change the cylinder convention, press the cylinder convention button on the left side of the instrument next to the fuse switch. Either + or - will appear in the CYL display to indicate the setting.

Vertex

Use the VERTEX button to change vertex distances. The button indicator lights whenever the setting is other than 13.50 mm. For most spectacle and spectacle overrefraction measurements, use 13.50 mm. For contact lens overrefractions, use 0.00 mm.

Model 550

The button changes the vertex distance from 13.50 mm to 0.00 mm and back again.

Models 560 and 570

The first button push displays the current vertex distance in the SPHERE numeric display position. Successive presses change the setting as follows:

13.50 15.00 16.50 0.00 10.50 12.00

All of the Refractor models offer the standard Snellen chart. The 560 and 570 offer additional targets. Choose the visual acuity target you want to use for this patient.

Model 550

The model 550 displays the standard Snellen chart. Acuity lines range from 20/20 to 20/80, and the target is fixed.

Model 560

The 560 displays the Snellen chart with numbers and letters first and always begins with the 20/40 line illuminated. Available acuity lines range from 20/15 to 20/200.

The 560 also has a child's chart. To use this target, press TARGET. The child's chart will be displayed and the indicator light in the TARGET button will light.

Model 570

Like the 560, the 570 displays the Snellen chart first and begins with with the 20/40 line illuminated. Available acuity lines range from 20/15 to 20/200. Each line includes both letters and numbers. The Model 570 also has a red/green target, two types of cylinder targets, and a companion-eye target. When any target other than the Snellen chart is in use, the TARGET button indicator light will be on.

To call up the R/G target, press the TARGET button once. To return to the Snellen chart, press TARGET three times.

Model 570 Companion-Eye Target

To turn on the companion-eye system, press TARGET and then ↑ until until C-EYE is illuminated on the visual acuity target display. Then press TARGET to reach the target you want to use for testing. The companion-eye system will stay on. This system helps control convergence and accommodation in some patients by providing a fixation target for the non-tested eye. The companion-eye target is a plain white box shaped like an acuity target. It is best to use the companion-eye system only when the eye not being measured needs to be stimulated by fixating on a target.

To turn the companion-eye target off, press TARGET and ↑ to return to C-EYE. The illumination of that line on the visual acuity target display will go off to let you know the companion-eye system is not activated.

Position the Patient

The patient should be seated comfortably on the patient side of the Refractor facing the operator (see figure 6-1). Raise or lower the power table to bring the chin rest level with the patient's chin. The operator may either sit or stand during the measurement cycle.

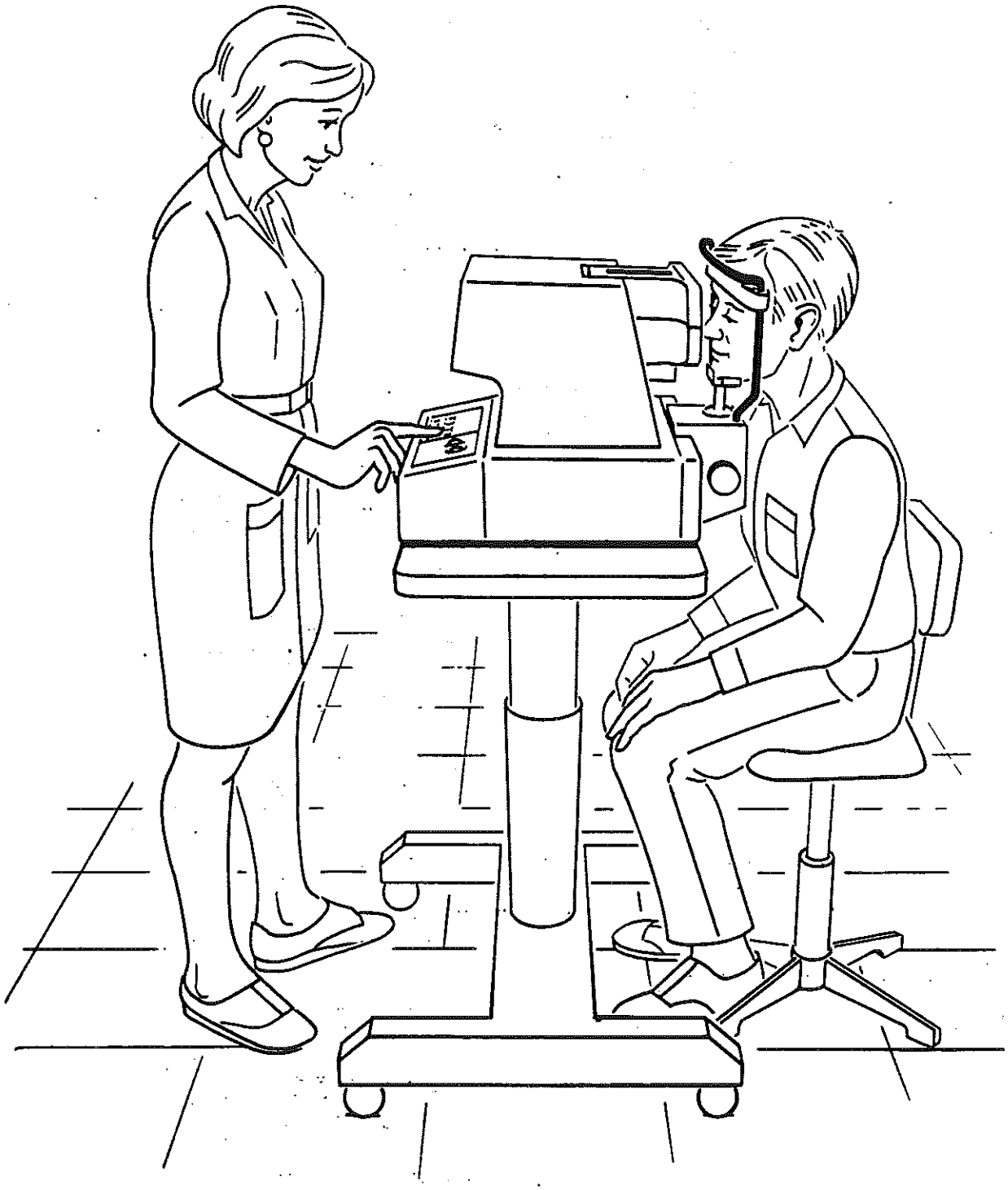


Figure 6-1. *Operator and patient positions*

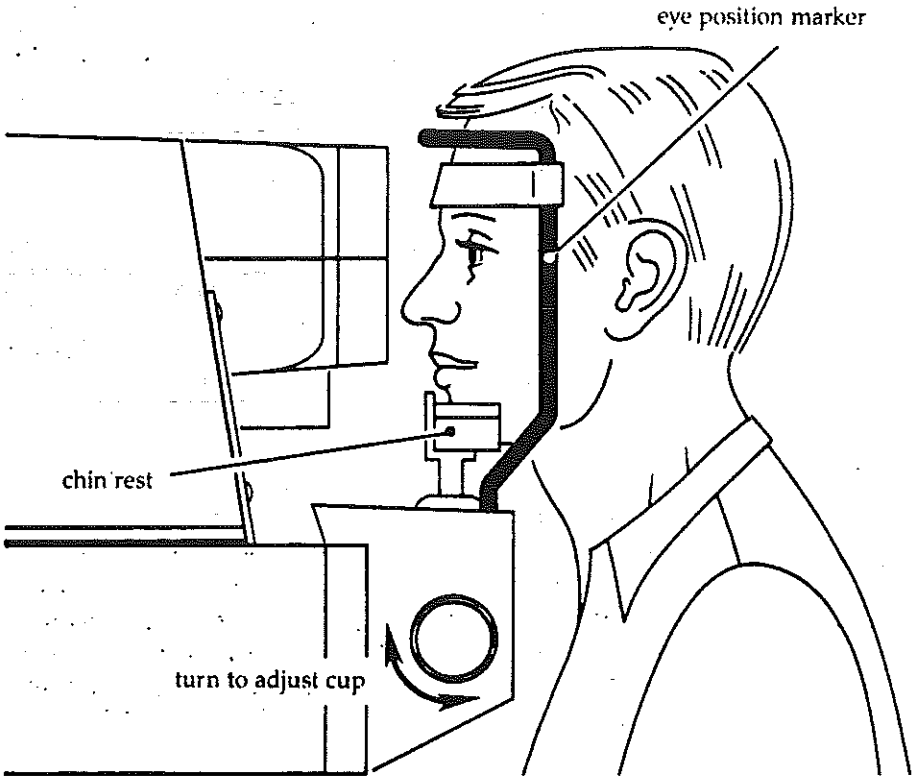


Figure 6-2. *Patient positioned correctly*

Because it is necessary for the patient to hold still while the Refractor is in operation, make sure the chin rest is at a comfortable height and the patient's forehead is pressed firmly against the forehead rest. The patient's eyes should be at the same level as the silver marker on the side of the forehead rest (see figure 6-2). If necessary, raise or lower the chin rest by turning the knob on the side of the chin rest base.

Align the Refractor

When the patient is seated comfortably and is properly positioned, it is time to align the Refractor for reading. Once you have become proficient, this initial alignment process will take only a few seconds. The Refractor's automatic tracking mechanism does most of the work and will maintain alignment once a measurement begins.

The Refractor's reading head comes to rest in a center position when the instrument is first turned on or when you press CLEAR. Begin the alignment process for a READ cycle by pressing R. EYE or L. EYE to designate the first eye to be refracted. This will move the optics head to the chosen eye. If you are using MODE, the head will move the the right eye automatically.

Ask the patient to hold still and look at the fixation light. You should see the designated eye through the viewing window, and if

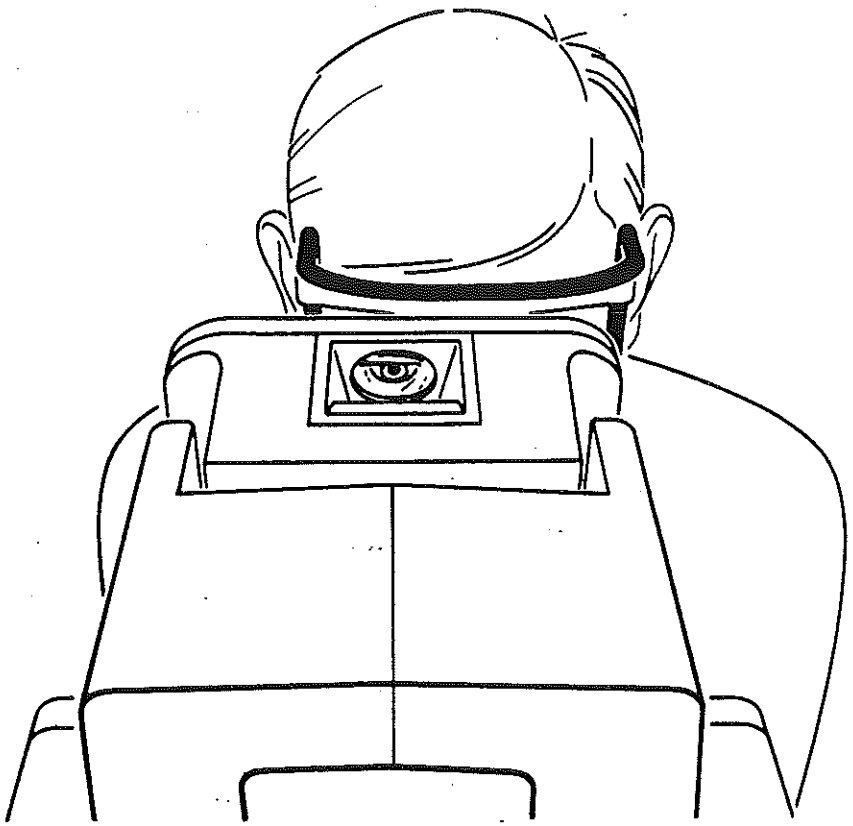


Figure 6-3. *Looking through the viewing window*

the chin rest is set at the proper height, the flashing green alignment light will be reflected from the patient's cornea (figure 6-3).

The control ball is used for initial alignment. When you move the ball, two yellow alignment lights are reflected from the patient's cornea. The goal is to position the flashing green alignment light in the middle of the pupil and on the same plane and horizontal line as the two yellow alignment lights (figure 6-4).

Begin by moving the control ball until the flashing green light is positioned in the patient's pupil between the two yellow lights. Let go of the control ball. After a one-second delay, the reading head will go into its autotracking mode and the green alignment light should stop flashing. The Refractor then makes an automatic vertex adjustment for the patient.

If the green light appears to be in the same plane as the yellow lights, the alignment process is complete. If the three alignment lights are not all on the same plane, the thumbwheel to the left of the control ball can be used to adjust the instrument-to pupil distance by moving the reading head in or out. If the green light appears to be in a plane in front of the yellow lights, turning the thumbwheel toward the patient will push the green light away from you. Turning the thumbwheel down pulls the light closer to you.

When alignment is complete, the Refractor's autotracking mechanism will take over and the green light will stop flashing. Press READ. If the OFF- CEN light appears during a refraction, this

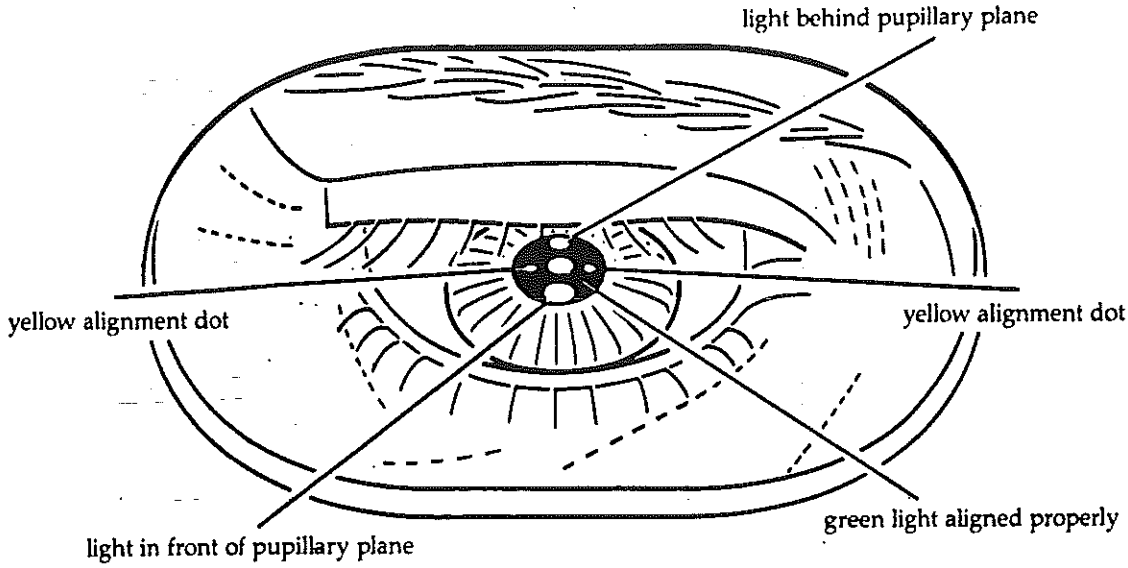


Figure 6-4. *Aligning the Refractor*

means that the patient has moved and the instrument is off center with respect to the patient. Correct the alignment by repositioning the control ball.

If you are using MODE, the optics head automatically moves to the left eye once the right eye has been measured, and you should adjust the control ball again. If you are using READ and want to measure the second eye, press R. EYE or L. EYE to move the head, and then align the instrument for the second eye.

Alignment and IOL Overrefraction

Automatic Refractor results are used in many practices as a guide in suture removal after cataract surgery and IOL implantation. The Automatic Refractor's automatic alignment system gives it a definite advantage with IOL patients. Because finding the best possible alignment position is one of the most critical factors in getting a good measurement with an IOL patient, be sure to follow the instructions in Section 6 for aligning the patient very carefully.

Note: This alignment procedure also provides for accurate readings with difficult patients. For those with small pupils or cataracts, the autotracking system will move until it receives the best possible retinal reflex. It will also move to stay with the wandering eyes of children or the elderly.

Section 7. Refracting

The refracting sequence will vary with the patient, individual office procedure, and your particular Automatic Refractor model. It is recommended that you establish refracting guidelines for your office staff in order to incorporate the Refractor into your practice most efficiently.

The instrument can refract most patients quite quickly and can be operated under most lighting conditions. However, subdued, ambient illumination is recommended for difficult patients because it increases patient comfort and facilitates maximum pupil size. For patients with very small pupils, the process may be slightly more time-consuming. In such cases, be especially careful to make the alignment exact, and ask the patient to keep very still during the measurement cycle. The use of mydriatics may make refraction possible with patients who cannot be measured because of extremely small pupils or cloudy media.

Cycloplegia for adult patients is generally unnecessary because of the Refractor's unique automatic plussing process at the end of the measurement cycle. In fact, clinical studies have demonstrated that cycloplegia in adults may result in less accurate readings. The use of cycloplegia is recommended for some, but not all, children under 13 years of age. For these children, cycloplegic drops may prevent some overminusing.

The objective refractive measurement is performed using the READ or MODE buttons in the same manner with all three Refractor models and will be described first. Descriptions of taking visual acuities, and of subjective refinement of the objective finding with the 560 and 570 will follow. Glare testing is described at the end of the section.

Objective Refraction with READ

An objective refraction using the READ sequence permits the taking of initial and final acuities or the measurement of a single eye. It is also the sequence you should use if you plan to go on to refine the measurement subjectively.

To perform an automatic, objective refraction using the READ button, make sure the instrument is aligned with the designated eye as described in Section 6. Tell the patient to look straight ahead at the letters or pictures. Remember, some patients may be unable to see the largest letters, but if the patient looks straight ahead, the Refractor will be able to take a measurement.

Press READ. Tell the patient to watch the target. The Refractor, still in its autotracking mode, will continue to follow the patient's eye. Lenses will be placed in front of the patient's eye automatically.

At the end of the main refracting sequence, the letter chart will reappear. If Auto Plus is off, the measurement is complete. If Auto Plus is on, tell the patient to keep watching the letters as they get blurry and then clear. While the instrument is measuring, the operator will see the READING message (models 550 and 560) or DATA message (Model 570) on the control panel. When the ACUITY light comes on again, the refraction is complete. At this time the patient will again see the letter chart.

The Refractor's measurements for sphere, cylinder, and axis will be displayed in the numeric readout on the control panel. You may press PRINT to make a copy of the measurement now, or wait until after the second eye is measured and print out measurements for both eyes at once.

If the patient moves substantially during a measurement, the autotracking system may stop. Usually, it is possible to reinitiate autotracking by moving the control ball slightly. Occasionally, it may be necessary to perform the realignment process again.

The REFLEX message is illuminated on the control panel when the reflex value is below 1.5. This value is a measure of the amount of light reflected from the retina. Low reflex values may be caused by small pupils, cloudy media, heavily pigmented retinas, or bright room lights. Low values do not necessarily mean the refractive data are faulty but that they should be reviewed with that possibility in mind.

Reflex values may also vary between the two eyes. If the difference is more than a factor of about two, or if you want to check a low reflex value, reposition the patient in the instrument, check the room light, ask the patient to keep the tested eye open wide, and measure again.

When you are satisfied with the measurement of the first eye, press either L. EYE or R. EYE to go on to measure the other eye.

If, for some reason, it is necessary to stop in the middle of a reading sequence, simply press R. EYE or L. EYE, depending on the eye being measured. The Refractor will stop the measurement but will remain in position to measure that eye again when you and the

patient are ready to continue. It may be necessary to realign the patient before continuing.

When all measurements are complete, press PRINT. Tear the completed printout tape off by pulling it up and to the right against the serrated lip of the printer. Multiple copies can be produced with consecutive presses of the PRINT button.

You may change the cylinder convention (+ or -) and the vertex distance after the refraction is completed and before the printout is made. This new information will appear on the printout, as will the pupillary distance, which the Refractor calculates automatically. (See Section 8, The Printout).

Objective Refraction with MODE

An objective refraction using the MODE automatic reading sequence measures both eyes and is fully automatic.

To perform an objective refraction using the MODE button, MODE must be the first button you push after CLEAR or the automatic sequence will not proceed. Make sure the instrument is aligned as described in Section 6. Once alignment is complete, tell the patient to look straight ahead at the letters or pictures. Remember, some patients may be unable to see the largest letters, but if the patient looks straight ahead, the Refractor will be able to take a measurement.

As the patient watches the target, the Refractor's automatic tracking system will continue to follow the patient's eye. Lenses will be placed in front of the patient's eye automatically.

At the end of the refracting sequence, the letter chart will reappear. If Auto Plus is off, the measurement is complete. If Auto Plus is on, tell the patient to keep watching the letters as they get blurry and then clear. While the instrument is measuring, the operator will see the READING message (models 550 and 560) or DATA message (Model 570) on the control panel. When the ACUITY light comes on again, the refraction is complete, and the Refractor's measurements for sphere, cylinder, and axis will be displayed in the numeric readout on the control panel.

The reading head will then automatically move to the left eye. Once again, take a few seconds to align the instrument following the instructions in Section 6. The instrument will then refract the left eye.

As soon as the measurement is complete, the Refractor will begin to print the results for both eyes. Tear the completed printout tape off by pulling it up and to the right against the serrated lip of the printer. Multiple copies can be produced with consecutive presses of the PRINT button, or you may change the cylinder convention (+ or -) and the vertex distance and press PRINT to produce a new printout based on these new settings. The Refractor automatically calculates pupillary distance and this value will appear at the bottom of the printed results for each eye. (See Section 8, The Printout).

If the patient moves substantially during a measurement, the autotracking system may stop. Usually, it is possible to reinitiate autotracking by moving the control ball slightly. Occasionally, it may be necessary to begin again by pressing CLEAR and then MODE.

The REFLEX message is illuminated on the control panel when the reflex value is below 1.5. This value is a measure of the amount of light reflected from the retina. Low reflex values may be caused by small pupils, cloudy media, heavily pigmented retinas, or bright room lights. Low values do not necessarily mean the refractive data are faulty but that they should be reviewed with that possibility in mind.

Reflex values may also vary between the two eyes. If the difference is more than a factor of about two, or if you want to check a low reflex value, reposition the patient in the instrument, check the room light, ask the patient to keep the tested eye open wide, and measure again.

If, for some reason, it is necessary to stop in the middle of a reading sequence, simply press R. EYE or L. EYE, depending on which eye you are measuring. The Refractor will stop and clear the data for that eye only so you will not lose data for both eyes. To continue, proceed as in the READ cycle.

Objective IOL Overrefraction

Automatic Refractor results are used in many practices as a guide in suture removal after cataract surgery and IOL implantation. The Automatic Refractor's automatic alignment system gives it a definite advantage with IOL patients. Because finding the best possible alignment position is one of the most critical factors in getting a good measurement with an IOL patient, be sure to follow the instructions in Section 6 for aligning the patient very carefully.

Taking the Initial and Final Acuity: All Models

A patient's visual acuity may be measured before refraction, after the objective refraction, or, with models 560 and 570, after subjective refinement of the objective refraction. Acuity measured prior to refraction is called the initial acuity. The Refractor sets its lens powers to zero while taking initial acuity. Acuity measured after refraction is called the final acuity. Acuities cannot be taken if you are using the automatic reading sequence initiated with the MODE button.

To determine initial acuity on the Model 550, first make sure that the sphere and cylinder powers on the numeric display read zero. If they don't, press R. EYE or L. EYE and realign. Ask the patient to look at the fixed chart and read the smallest line he or she can. In general, it is best then to ask the patient to look at the next smallest

line and guess at the letters he or she is unsure about. You should make a notation of the initial acuity determined because this model of the Refractor does not record it for the printout.

To determine initial acuity on the models 560 and 570, first make sure that the sphere and cylinder powers on the numeric display read zero. If they don't, press R. EYE or L. EYE and realign. Ask if the patient can read the initial 20/40 line displayed. If not, press until you reach a line the patient can read. If the patient can read the initial line, press until a line is displayed that the patient cannot read. Unless it is obvious that the letters are too small, it is generally best to urge the patient to try to read the next smallest line and guess at the letters he or she is unsure of. The last line displayed is recorded on the printout as the initial acuity. If the patient's acuity was 20/40, this will not be printed unless the chart has been moved from its initial 20/40 position and then returned to it.

Once you have determined the intital acuity, press READ and the Refractor will perform its measurement cycle.

The final, that is the post-reading, acuity is determined exactly the same way as the initial acuity but with the Refractor's prescription in place. The 560 and 570 will record the final acuity. You must make a note of the acuity if you are using a Model 550.

Subjective Refraction: Models 560 and 570

Occasionally it is helpful to refine the instrument's objective findings subjectively. Subjective adjustment of the spherical portion of the objective refraction may be made with the Model 560. On the Model 570, a complete sphero-cylindrical refraction may be done, with or without the use of objective refraction as a starting point. No subjective refinement is possible with the Model 550.

When subjective verification and refinement procedures are performed, the printouts from models 560 and 570 will show these results in addition to the objective measurements. Spherical equivalents for soft contact lens patients can also be included.

Note: If the Refractor will not add any more power when you are increasing sphere or cylinder power, you have reached the limit of the instrument's power range. The power range varies with the vertex distance, the axis of the cylinder, and the combination of the sphere and cylinder powers. (For actual ranges see Section 11, Specifications.)

Spherical Adjustment with the Model 560

Adjustment of the spherical portion of the objective finding is done on the Model 560 using the +SPH and -SPH buttons. Each press of the +SPH button adds 0.25 diopters of spherical power to the objective refractive finding; each press of the -SPH button subtracts 0.25 diopters. The process is exactly like the one you would fol-

low using a phoropter or trial lenses. The standard guideline is to give the maximum plus spherical power consistent with optimal visual acuity. Subjective cylindrical refraction is not possible on the Model 560.

To perform a manual sphere refinement, wait until the end of the measurement cycle and the objective sphere, cylinder, and axis readings appear on the numeric readout. Measure the visual acuity. Use the + SPH button to add plus power in .25 D increments and the - SPH button to subtract power in .25 D increments.

One way of refining the sphere power using the Snellen chart begins by finding the smallest line of letters that the patient can read correctly. If adding more minus or plus power allows the patient to read even smaller lines, then make those power changes. Having found the sphere power that gives the best possible acuity, slowly add plus spherical power until the patient can no longer read the smallest line that was formerly readable. Stop and add back .50 D of minus power. This value is usually very close to the optimal sphere power. In any case, the spherical correction is proper by most standards if adding .25 D or .50 D plus sphere power noticeably blurs the chart, and adding minus power doesn't allow the reading of an even smaller line.

When you are satisfied with the subjective spherical adjustment, press PRINT. The Refractor printout will show both the objective and the subjective spherical power readings.

Spherical Equivalent

With soft contact lens patients and some patients who may not adapt well to a cylindrical correction, it is sometimes useful to determine the patient's acuity with only a simple spherical correction and no cylindrical power. Pressing the SPH. EQ. button will cause the instrument to present the spherical equivalent of the current refractive correction. This may be done after the objective or the subjective refraction. If the spherical equivalent is displayed when you print out the Refractor's readings, it will be shown on the printout.

Subjective Refraction with the Model 570

Complete sphero-cylindrical refraction may be done on the Model 570, with or without the use of objective refraction as a starting point. Spherical refraction may be done using a standard letter chart or a red-green target. Cylindrical refraction is done using the standard Jackson cross cylinder test, or the Humphrey precision astigmatic measurement (PAM) test. All of these procedures are performed at the practitioner's discretion.

Subjectively Refining the Sphere

To perform a manual sphere refinement with the Model 570, wait until the end of the measurement cycle and the sphere, cylinder, and axis readings appear on the numeric readout. Take the final acuity through the objective refraction, if you like. Spherical power may

then be adjusted while the patient views any of the available acuity lines, or the red/green target.

To switch over to manual control of spherical power push the SPH button. A small light on the button illuminates, indicating that the thumbwheel now controls sphere power. Turning the wheel away from you adds plus power; pulling it back adds minus. The changes in the power will be shown on the numeric display. The process is exactly like the one you would follow using a phoropter or trial lenses. The standard guideline is to give the maximum plus spherical power consistent with optimal visual acuity.

One way of refining the sphere power using the Snellen chart begins by finding the smallest line of letters that the patient can read correctly. If adding more minus or plus power allows the patient to read even smaller lines, then make those power changes. Having found the sphere power that gives the best possible acuity, slowly add plus spherical power until the patient can no longer read the smallest line that was formerly readable. Stop and add back .50 D of minus power. This value is most often the optimal sphere power. In any case, the spherical correction is proper by most standards if adding .25 D or .50 D plus sphere power noticeably blurs the chart, and adding minus power doesn't allow the reading of an even smaller line.

To adjust spherical correction using the red/green duochrome target, press TARGET once to call up the red/green target. Make sure the indicator light is lit in the SPH button so the thumbwheel will control sphere power. A useful way of finding the proper sphere is to add plus spherical power until the patient reports that the letters on the red side are definitely sharper than those on the green. Then slowly add minus power in .25 D steps until the two sides appear equally clear. When the letters on the red side appear blurry, that indicates too much minus sphere. When the letters on the green side appear blurry, that indicates too much plus sphere. Check to see that the final spherical finding is correct by adding back .25 D of plus power. The letters should blur slightly on the green side and sharpen slightly on the red.

Determine final acuity. If you are not going on to determine the cylindrical power subjectively, press PRINT. The instrument will record both objective and subjective sphere, cylinder, and axis findings, and their associated visual acuities on the printout. If you are going on to determine spherical equivalent or cylindrical power, you can wait until you have completed all measurements before making a printed record.

Spherical Equivalent. With soft contact lens patients and some patients who may not adapt well to a cylindrical correction, it is sometimes useful to determine the patient's acuity with only a simple spherical correction and no cylindrical power. Pressing the SPH. EQ. button will cause the instrument to present the spherical equivalent of the current refractive correction. This may be done after the objective or the subjective refraction. If the spherical equivalent is displayed when you print out the Refractor's readings, it will be shown on the printout.

The Precision Astigmatic Measurement Test

The precision astigmatic measurement (PAM) test is one of two options offered on the Model 570 for verifying and refining cylinder power and axis. It uses two specialized test targets, each of which allows the measurement of a specific component of the cylindrical error. After finding both cylinder and axis powers using the PAM test, you should go back and make a final check of the sphere power. (See Appendix A for a discussion of the principles on which the PAM test is based.)

To call up the PAM test, push TARGET twice and then push ↓. This will move you to the first PAM target ⋐ on the visual acuity target display. The numeric display on the control panel will show the power of the cylinder component being tested. The patient will see the three PAM target lines. The part of the PAM target that is not in use will be blurred and faintly visible to the patient in the background. Tell the patient to concentrate on the three-line target in the foreground. One line should look the sharpest and the other two blurry. The goal of the test is to make the center line darkest and the outer two lines equally gray or blurry.

Step 1. Tell the patient to look at the three-line target in the foreground and ask: "Which line is the darkest and sharpest?" If the middle line is darkest and sharpest, skip step 2. If either of the outer lines is darkest and sharpest, or if the middle line and an outer line are equally dark and sharp, complete step 2 and then move on.

Step 2. If the bottom line is darkest or as dark as the middle line. move the thumbwheel down (towards you) until the patient reports the center line is darkest and sharpest. The power increments in .25 D steps. The changes you are making will be shown in the numeric display on the control panel.
If the top line is darkest or as dark as the middle line, turn the thumbwheel away from you until the patient reports the center line is darkest and sharpest.
Hint: move the thumbwheel in the direction of the line the patient sees as darkest: forward for the top line, down if the bottom line looks darkest.

Step 3. Ask the patient: "Excluding the middle line, are the outer two lines equally gray and blurry, or is one darker than the other?"
If the two outer lines are equally gray and blurry, the test is complete.
If one outer line is darker than the other, move the thumbwheel in the direction of the darker line (forward for the upper line, back for lower) until the two outer lines are equally gray and blurry. It should only be necessary to move about .25 D. The middle line should remain the darkest and sharpest.

Step 4. Press ↓ to access the second PAM target ⫽ . The display window will show the power of the cylinder component now being tested. Follow the same procedure you used with the first PAM target until the middle line is darkest

and sharpest and the outer two lines are equally gray and blurry.

The following guidelines apply: When one of the outer lines is the darkest of the three, it will require a change of at least .75 D to get to the endpoint. When one of the outer lines is just as dark as the center line, it will require approximately 0.50 D change to get to the endpoint. Usually, changes of cylinder power will not be greater than .75 D after objective refraction. If the patient has difficulty with the test at any time during the PAM procedure, return to the red/green target or the Snellen chart and adjust the spherical power for optimum clarity, and then proceed with PAM.

The Jackson Cross Cylinder Test

The Jackson cross cylinder (JCC) test is the Model 570's second optional test for verifying and refining cylinder power and axis. It is used to determine the patient's astigmatic prescription subjectively and is the method conventionally used in phoroptor and in trial frame refractions. After finding cylinder and axis powers using the JCC test, make a final check of the sphere power.

The JCC test is divided into two portions, determination of the axis, and determination of power.

Axis. It is best to begin the JCC test with axis and then go on to refine the cylindrical power. You may then want to return to make small adjustments in the axis and perhaps make a final check of the power.

Table 7-1. Jackson Cross Cylinder Power and Objective Acuity

If Objective Refraction Acuity Is:	Accessing CC Power or CC Axis Moves Acuity Line To:	Jackson Cross Cylinder Power Used Is:
20/15 20/20 20/25	20/40	+/- .37 D
20/30	20/50	
20/40	20/60	
20/50	20/80	+/- .50 D
20/60	20/100	
20/80	20/200	+/- .75 D
20/100 20/200 20/400	20/400	

To bring the JCC test up on the visual acuity display, press TARGET twice to reach the CC AXIS line. This line will be illuminated on your display, and the indicator light in the AXIS button will light. The Refractor will present the appropriate Snellen line to the patient automatically. This line is determined on the basis of the patient's final objective acuity according to the rules shown in Table 7-1. To determine the axis:

Step 1. Pressing the AXIS button on the control panel flips between JCC lens position one and two. Ask the patient to compare the two positions of the JCC lens by asking: "Which lens makes the letters better focused and easier to read, lens number one, or lens number two ?"
Depending on the position of the JCC lens, either ADD ∧ or SUB ∨ will be illuminated on the control panel.
If the patient sees the target more clearly when ADD ∧ is lit, change the cylinder axis by turning the thumbwheel forward (away from you) adding approximately 15 degrees. The changes in axis will be shown on the numeric display.
If the patient sees the target more clearly when SUB ∨ is lit, change the cylinder axis by moving the thumbwheel down, subtracting approximately 15 degrees from the current axis value.*

Step 2. When you have added or subtracted 15 degrees based on the patient's response, again ask the patient to compare the two positions of the lens as you flip it by pressing the AXIS button. Proceed as in step 1, making smaller changes in axis as you approach the correct value. At the correct axis, the patient will report seeing equally well with both lens positions, although it is not necessary to receive that response. It is sufficient when the patient's responses indicate a rotation of the axis back toward the final setting whenever the axis is a few degrees to either side of the that setting.

*For cylinder values of 1 D or under, make initial axis changes of approximately 10 to 15 degrees. For cylinder values over 1 D, make smaller changes of approximately 5 degrees.

Power. Once the axis has been determined, press ↑ to reach the CC PWR line on the visual acuity target. The CYL button will light on the control panel and the line will be illuminated on your display. The Refractor will automatically present the appropriate Snellen line to the patient. To verify the cylinder power:

Step 1. Pressing the CYL button on the control panel flips between JCC lens position one and two. As you did in determining the axis, ask the patient to compare two positions of the JCC lens by asking: "Which lens makes the letters better focused and easier to read, lens number one, or lens number two ?" Again, depending on the position of the JCC lens, either ADD ∧ or SUB ∨ will be illuminated on the control panel. If the patient sees the target more clearly when ADD ∧ is lit, change the cylinder power by turning the thumbwheel forward (away from you). The changes will be shown on the numeric display. In most cases it will be sufficient to add power in .25 D or .50 D increments.*

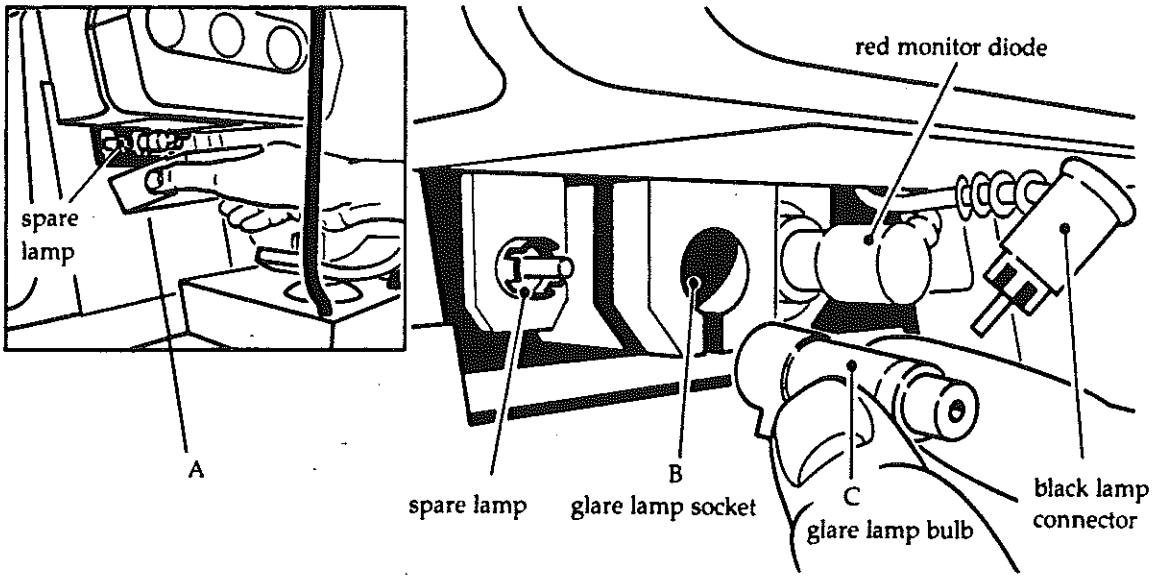


Figure 10-3. *Replacing the glare lamp bulb*

To change the lamp, remove the glare lamp cover (A) by squeezing the sides of the cover to detach it from the housing ridge that holds it and gently pulling it toward you (see figure 10-3). Unplug the black glare lamp connector which is connected to the glare lamp bulb in the center (B). To remove the old bulb, push in on it gently and rotate it a quarter turn counterclockwise to release it. Then pull it straight out.

Your Refractor is shipped with an extra glare lamp bulb (C) that is stored to the left of the glare bulb that is in use. Pull the new bulb straight out of its holder and insert it in the lamp socket, rotating it a quarter turn to the right. Reconnect the plug and replace the cover. Do not touch the red monitor diode cable to the right of the glare lamp. Disturbing it can cause the new glare lamp to fail. New glare lamp bulbs can be ordered from the Allergan Humphrey parts department.

Cleaning the Print Head

If the print on your printouts begins to seem faded or too light, the print head may need to be cleaned. To clean the print head, open the printer door. The thermal print head is a small strip of silvery gray metal set on the back of the printer door (see D in figure 10-1). Wipe the front edge of the print head with an alcohol wipe. Do not rub or scrape the print head itself because you may damage it. Allow time for the alcohol to evaporate before closing the printer door or the printouts will be smeared.

Note: The print head may be hot immediately after a printout has been made. Wait a few minutes before cleaning it.

Cleaning the Print Drive Roller

When the printer paper does not feed correctly, the print drive roller may need to be cleaned. Open the printer door and continue to push down on the latch until the drive roller pivots out of the instrument. Remove the paper. Use an alcohol wipe to clean the rubber drive roller. Allow enough time for the alcohol to evaporate before closing the printer door.

Section 10. Maintenance and Service

The Allergan Humphrey Automatic Refractor is easy to maintain. If there are any questions about maintenance, call the Allergan Humphrey Customer Service Department at (800) 341-6968 (in USA) or (800) 222-9830 (California only), or your nearest Allergan Humphrey representative. See Section 12 for instructions on repairs to be done under warranty.

Cleaning the Instrument

To clean the housing of your Refractor, use a mild cleaner on a cloth to wipe the exterior surface, excluding the windows. Never spray a cleaner directly on the Refractor. Fit the lens cover over the lenses on the patient side of the Refractor at the end of each day and place the dust cover over the entire instrument. Try to avoid placing the Refractor under direct sunlight. Between patients, a gauze pad moistened with alcohol may be used to clean the headrest, and the chin rest paper can be replaced.

Cleaning the Patient Fixation Windows

The lens in the patient fixation window has a special coating that is easily scratched; therefore careful cleaning is imperative. The fixation window and the companion eye windows (Model 570) should be checked regularly for dust and prints because a dirty lens can cause erroneous readings. A particularly high sphere or cylinder reading can be the result of dirt on the patient fixation window.

To clean the window, first use a camel hair brush to gently remove the dust from the lens. Then dampen a lintless camera lens tissue with a camera lens cleaning solution and *gently* wipe the lens surfaces to remove smudges or fingerprints.

Operator-Correctable Error Code Messages

When the ERROR message lights, a numeric code will be displayed in the SPH or CYL numeric display window. These codes are explained below.

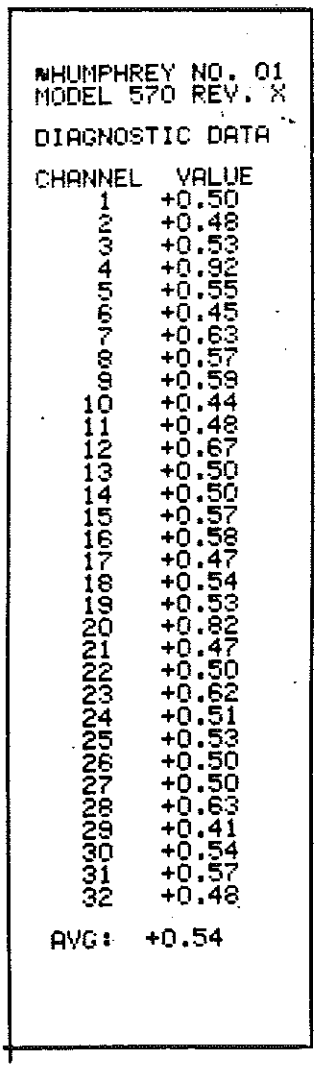
Code	Meaning	Action
Blinking ERROR light when Refractor is first turned on	Memory test has failed	Turn the Refractor off and then on again. If ERROR light continues to blink, call Customer Service.
100	Sphere or cylinder error	Press CLEAR and remeasure. If the error code repeats, call Customer Service.
102	Patient misaligned, too low or too high	Adjust chin rest up or down.
120 121	Internal problem Internal problem	Press CLEAR and try to measure again. If the error code repeats, call Customer Service.
130	Too much light has been reflected back to the instrument.	Press CLEAR, realign the patient and the instrument, and try to measure again.
140	Glare lamp failure	Replace the glare lamp.
300 - 370	Instrument self-test failure	Turn the Refractor off and then on again. If the error code persists, call Customer Service.

Section 9. Troubleshooting

For customer service, please call (800) 341-6968 (outside California), (800) 222-9830 (California only), or (415) 895-9110 (Canada).

Operating Difficulties

Symptom	Possible Correction
Refractor won't turn on	Make sure the AC power cord is firmly plugged into the instrument and into a live wall outlet.
	Check fuse. If required, replace with one of an identical rating.
DATA or REFLEX lights flash when you turn the Refractor on.	Call Customer Service.
The display is blank but the ON light is lit	The instrument is in standby mode. Pressing any button on the control panel will reactivate the Refractor.
Green light moves off pupil	Repeat alignment procedure, carefully following each step recommended in Section 6.
Control ball will not move optics head any further	Optics head has reached the limit of its autotracking range. Reposition the chin cup so less movement of the control ball is necessary. If the patient has a large pupillary distance, turn the patient's head to the side slightly.
OFF CENTER light comes on	Realign instrument and repeat measurement.



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*HUMPHREY NO. 01
MODEL 570 REV. X

DIAGNOSTIC DATA

CHANNEL   VALUE
      1    +0.50
      2    +0.48
      3    +0.53
      4    +0.92
      5    +0.55
      6    +0.45
      7    +0.63
      8    +0.57
      9    +0.59
     10    +0.44
     11    +0.48
     12    +0.67
     13    +0.50
     14    +0.50
     15    +0.57
     16    +0.58
     17    +0.47
     18    +0.54
     19    +0.53
     20    +0.82
     21    +0.47
     22    +0.50
     23    +0.62
     24    +0.51
     25    +0.53
     26    +0.50
     27    +0.50
     28    +0.63
     29    +0.41
     30    +0.54
     31    +0.57
     32    +0.48

 AVG:   +0.54
```

Figure 8-5. Diagnostic data printout

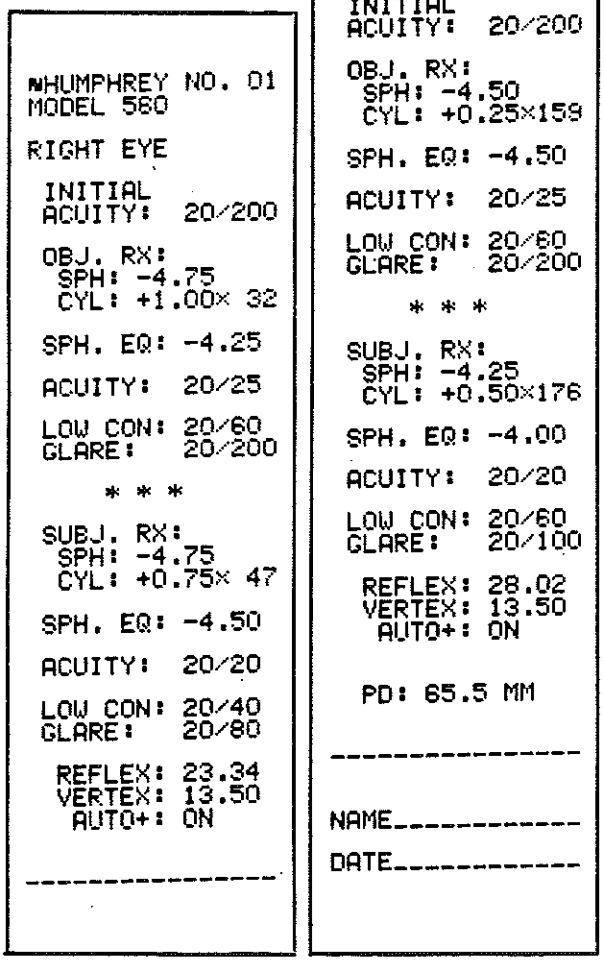

Figure 8-3. *Subjective refraction printout: Model 560*

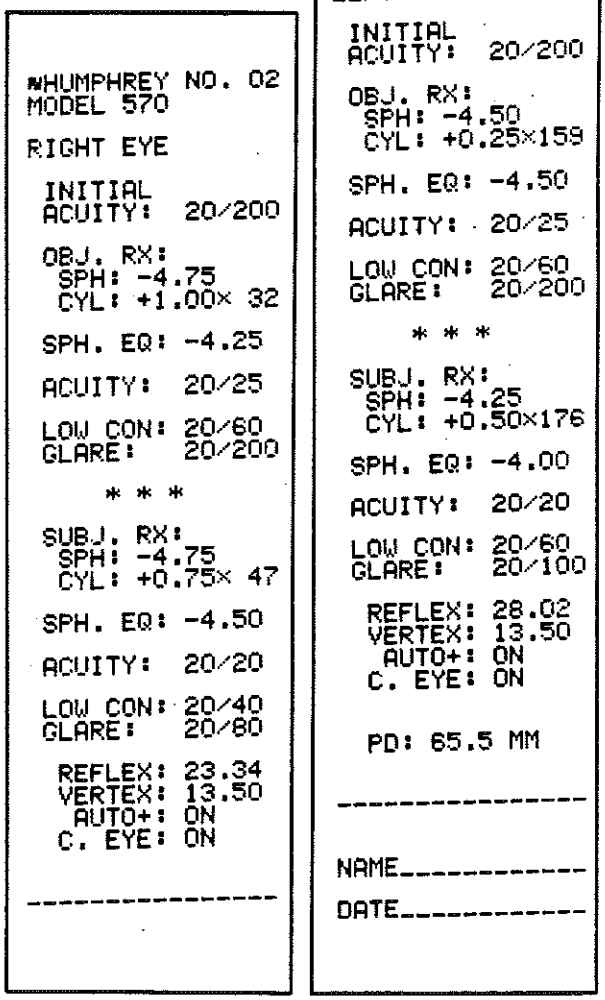

Figure 8-4. *Subjective refraction printout: Model 570*

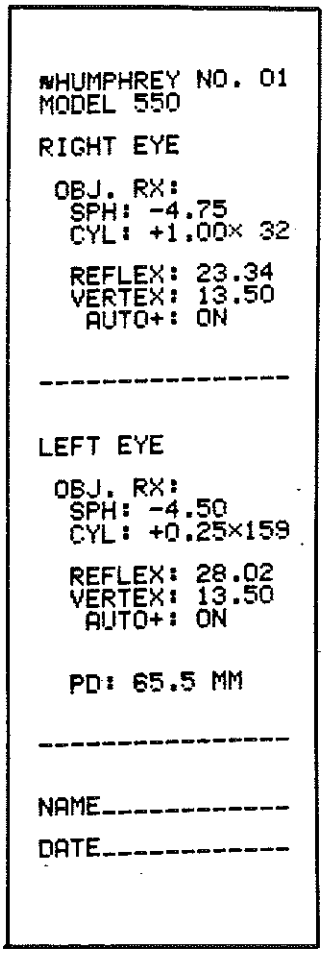

Figure 8-1. *Objective refraction printout: Model 550*

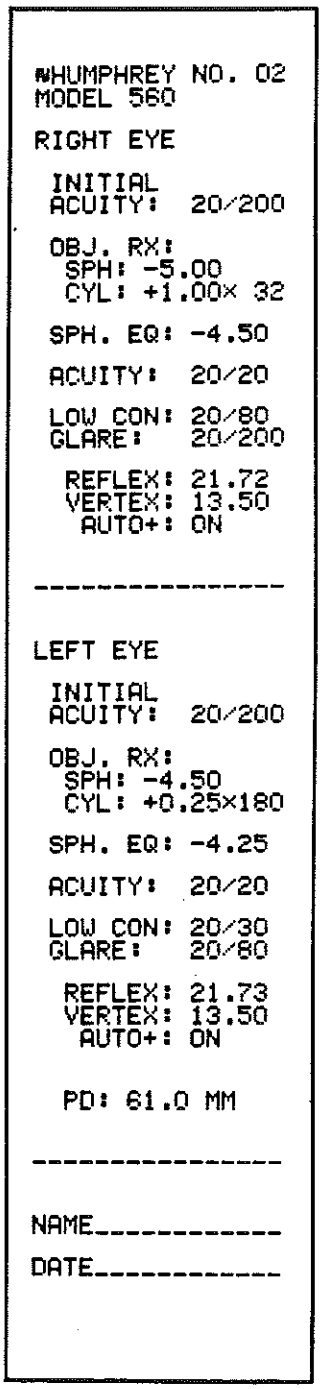

Figure 8-2. *Objective refraction printout: models 560 and 570*

Section 8. The Printout

Once a refraction is complete, the Refractor prints a hard copy of its measurements. If you have performed a refraction using the MODE button, the printout begins automatically as soon as measurements have been taken. If you have used the READ button, a single press of the PRINT button produces a printout.

To make multiple copies, press the PRINT button once for each additional copy. The cylinder convention and the vertex distance can be changed after the refraction is completed. If both eyes are tested, the Refractor will always print results for the right eye first. If only one eye is to be refracted, be sure to clear data from previous refractions, or data from the previous patient will be printed for the untested eye.

All Automatic Refractor printouts begin with a number that appears to the right of the company name and logo. This sequence number is assigned to each refraction in the order it is performed throughout the day. When the Refractor is turned on, the sequence number for the first refraction performed that day is 01. Subsequent refractions are assigned consecutive numbers up to 99. The Refractor model number is printed on the second line of the printout.

Other aspects of the printout vary according to the Refractor model and the refracting method used: objective measurement, objective measurement with subjective verification and refinement, and objective or subjective measurement with glare testing.

The Objective Measurement Printout: All Models

The Refractor printout for an objective measurement using either READ or MODE begins with the objective prescription for the eye(s) tested, including sphere, cylinder, and axis (see figure 8-1). This is the objective result determined during the automatic measurement cycle. The printout also shows the reflex value, whether Auto Plus was on or off, the vertex distance, and the pupillary distance.

Models 560 and 570 will print the initial and final acuity if either or both were taken (see figure 8-2). The initial acuity is shown only if the acuity line is moved from 20/40 before the READ button is pushed to begin an objective refraction. A final acuity value will be

If the patient sees the target more clearly when SUB ∨ is lit, subtract from the current cylinder power by moving the thumbwheel down.

Step 2. When you have added or subtracted power based on the patient's response, ask the patient to again compare the two positions of the lens as you flip it by pressing the CYL button. Proceed as in step 1 above until the patient reports seeing equally well with both lens positions, or until you have approached the proper cylinder power closely enough that when you add a little power (e.g., .25 D), the patient indicates that less power is needed, and when you subtract a little power the patient indicates that more should be added back.

*Those familiar with refraction using trial frames and phoropters will know that an adjustment in sphere power is usually required here also. The Refractor takes care of this adjustment automatically.

Comparing the Objective and Subjective Rx: Model 570

After you have made a subjective change in the sphere, cylinder, or axis values, it is possible to compare the subjective change to the objective Rx. To make this comparison, press RECALL. This will call up the objective values on the SPH, CYL, and AXIS numeric readout windows and return the optics to the objective Rx. The indicator light on the RECALL button will light when the objective Rx is in place.

Another press of the RECALL button will return the readout and the optics to the subjective values you selected. Because both the optics and the numeric display are recalled, both the patient and the operator are able to make the comparison.

Comparing the Patient's Previous and Objective Rx: Model 570

If the patient's previous prescription is known, it can be placed in the Refractor's optics after objective refraction and then compared to the objective reading. To enter the old sphere power, press the SPH button and turn the thumbwheel until the correct number appears in the SPH window of the numeric readout. Press CYL and enter the patient's previous cylinder power the same way. Then press AXIS and use the thumbwheel to enter the patient's previous axis value. Then press RECALL. This will display the objective values in the numeric readout windows and return the optics to the objective Rx. The indicator light in the RECALL button will be lit when the objective Rx is in place.

Another press of the RECALL button will return the readout and the optics to the Rx you entered. Because both the optics and the numeric display are recalled, both the patient and the operator are able to make the comparison.

The above steps can also be used any time you want to change sphere, cylinder, or axis values manually for subjective verification without using the subjective targets.