HERCULES

SIZING TESTER

BULLETIN PM-515A
(Supersedes PM-515)

The Hercules* Sizing Tester is based on the ink penetration test principle, with automatic endpoint determination. This instrument is especially designed for use as a mill control sizing test to accurately detect changes in sizing level. It offers the sensitivity of the ink flotation test, which has been a widely accepted sizing test in the paper industry, but has important additional advantages in fully reproducible results and shorter test times.

Using the Hercules Sizing Tester, routine sizing control tests can be run on samples ranging from lightweight papers to heavyweight boards. Special inks may be required for board grades.

Operating Principle of the Hercules Sizing Tester

The Hercules Sizing Tester, illustrated in Figure 1, is a greatly improved version of the Hercules Ink Photometer first developed in 1950. The basic principle of operation remains the same. Ink is placed on a sample of paper, and a photoelectric cell registers the drop in reflectance (brightness) of the opposite side of the sheet as the ink penetrates. When the reflectance drops to a predetermined level, an automatic timer is stopped to indicate the test time. The test results are completely reproducible since the endpoint is determined automatically by the photoelectric cell.

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Figure 1 This photograph of the Hercules Sizing Tester shows a sizing test in progress. The sample of paper can be seen in position at the top of the machine with the 10-ml. ink sample. The test time is indicated in seconds on the automatic timer at the bottom right of the tester.

Advantages of The Hercules Sizing Tester

The specific advantages of the Hercules Sizing Tester over previous laboratory and commercial instruments are –

- Much higher sensitivity to unbleached kraft grades makes the testing of linerboard and multiwall bag possible.
- Reflectance endpoint can be changed immediately to permit testing of a much wider range of basis weights.
- Heating of the sample area by the light source has been eliminated.
- Instruments are standardized to be fully interchangeable. Tiles for standardizing each instrument are provided.
- Automatic compensation is provided for variations in line voltage.
- Operator surveillance is not required after the test is started. The test endpoint is indicated by an automatic timer and signalled by a light and buzzer.

Typical test values on various grades of paper and board are listed in Table 1. Test conditions are usually selected to give a minimum test time of 30 seconds and a maximum of 10 minutes.

Table 1

TESTING OF VARIOUS PAPER AND BOARD GRADES USING THE HERCULES SIZING TESTER

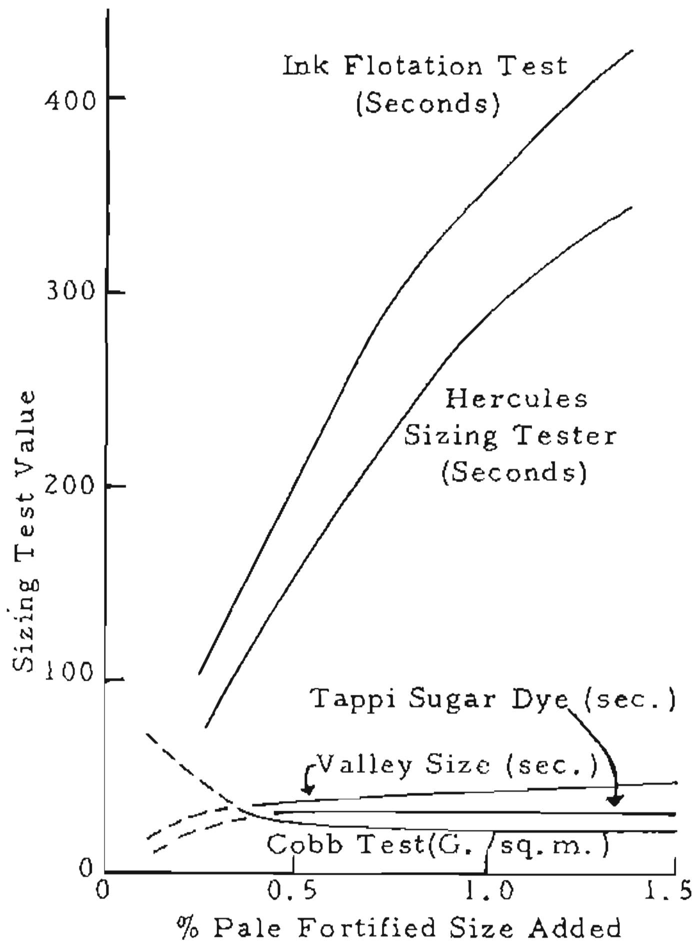
Paper or Board Sample	Type Ink Used	Reflectance Endpoint, %	Hercules Sizing Tester, Seconds
16-Lb. Bleached Bond	Hercules Test Ink No. 2	80	90
20-Lb. Bleached Bond	Hercules Test Ink No. 2	80	140
40-Lb. Unbleached Multiwall	Hercules Test Ink No. 2	80	429
150-Lb. Manila File Folder	10% Formic Acid Ink	80	405
42-Lb. Unbleached Linerboard	10% Formic Acid Ink	80	570
40-Lb. Unbleached Multiwall	0.2% NaOH Ink	60	60
115-Lb. Bleached Cup Stock	0.2% NaOH Ink	70	140
42-Lb. Unbleached Linerboard	0.5% NaOH Ink	80	200
69-Lb. Unbleached Linerboard	0.5% NaOH Ink	80	580
165-Lb. Bleached Coated Board	0.5% NaOH Ink	70	225
258-Lb. Bleached Uncoated Board	0.5% NaOH Ink	70	300

Advantages of An Ink Penetration Test

The major advantage of an ink penetration test as a mill control test for sizing is its sensitivity to changes in sizing levels compared to other sizing tests. Figure 2 shows the effect of increasing rosin size furnish on various sizing tests. These results show that several well-known sizing tests are not sensitive to changes in size furnish above 0.4 percent size added.

Figure 2 shows that the ink penetration tests (Hercules Sizing Tester and Ink Flotation) are the only tests which are sensitive enough to detect increased sizing when rosin size furnish is increased beyond a moderate level. Since actual sizing level of the paper is known to vary greatly due to changes in pulp, water, refining, and other variables, an ink penetration test makes it possible to reduce rosin size furnish when sizing tests are good, thus reducing sizing costs. Equally important, an ink penetration test detects a downward trend in sizing level much earlier than other tests and enables corrective measures to be taken before paper is lost due to poor sizing.

Figure 2
Effect of Rosin Size Furnish on Various Sizing Tests



Availability of Hercules Sizing Tester

As a service to the paper industry, the Hercules Sizing Tester is sold at moderate cost. Technical service assistance in its application as a paper mill sizing control test will be provided by Hercules technical sales representatives.

HER 18488 A 2200 3 68 32477
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HST-1A
(Supersedes HST-1)

DESCRIPTION OF THE HERCULES* SIZING TESTER

General

Developed specifically for the paper industry, the Hercules Sizing Tester enables an accurate, rapid, and highly reproducible determination of the level of sizing of paper. It may be used on all grades – from lightweight paper to heavyweight board.

The Hercules Sizing Tester is available in two models. The Model KA is for use with 117-volt, 60-cycle a.c., and the Model KB is for 117-volt, 50-cycle a.c. (primarily found overseas). Both models have undergone some minor parts changes in recent years and such changes, where applicable, are noted throughout this instruction manual. Regardless of any change, the basic operating principle is the same, and all parts remain standardized to make sizing test results comparable between different instruments.

The Hercules Sizing Tester, illustrated in Figure 1-1, is a greatly improved version of the Hercules* Ink Photometer first developed in 1950. The basic principle of operation remains the same. Ink is placed on a sample of paper, and a photoelectric cell registers the drop in reflectance (brightness) of the opposite side of the sheet as the ink penetrates. When the reflectance drops to a predetermined level, an automatic timer is stopped to indicate the test time. The test results are highly reproducible since the end point is determined automatically by the photoelectric cell.

Reflectance end points can be changed quickly on the instrument to accommodate the sizing level of paper being tested. Thus, a mill producing a wide range of basis weights, or sheets with widely varying levels of sizing, can adjust the reflectance end point to obtain test results within a reasonably short period of time.

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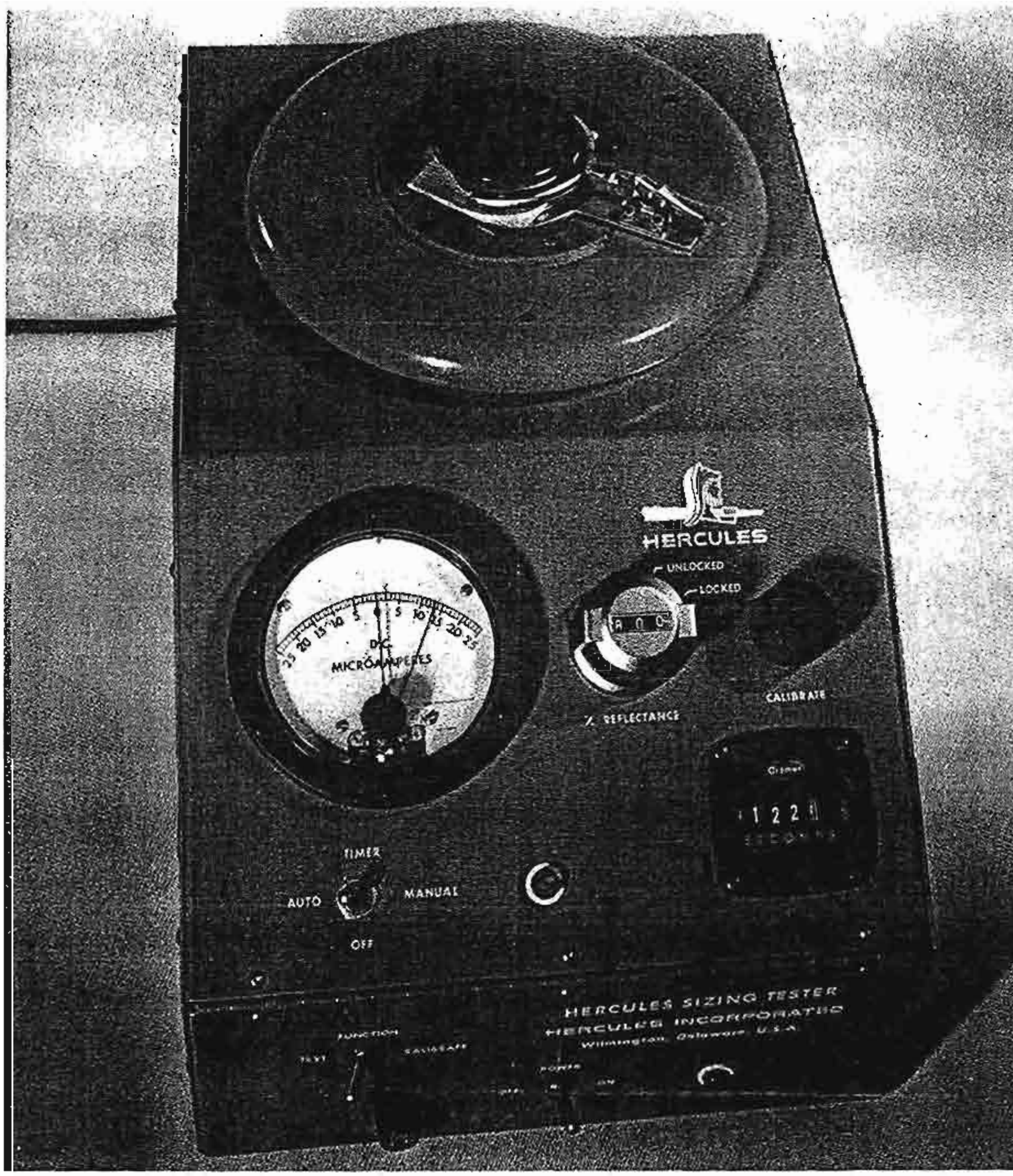

Figure 1-1. This photograph of the Hercules Sizing Tester shows a sizing test in progress. The sample of paper can be seen in position at the top of the instrument with the 10-ml ink sample. The test time is indicated by an automatic timer visible at the bottom right of the instrument.

The Hercules Sizing Tester may also be used for measuring the oil resistance of paper and board. The oil penetration test is based on the same principle and run in the same manner as the ink penetration test.

Circuit Description

Figure 1-2 presents a schematic diagram of the Sizing Tester's electrical circuit and components. (An additional schematic, including parts list, is provided in section HST-8A, Maintenance & Parts, of this manual.)

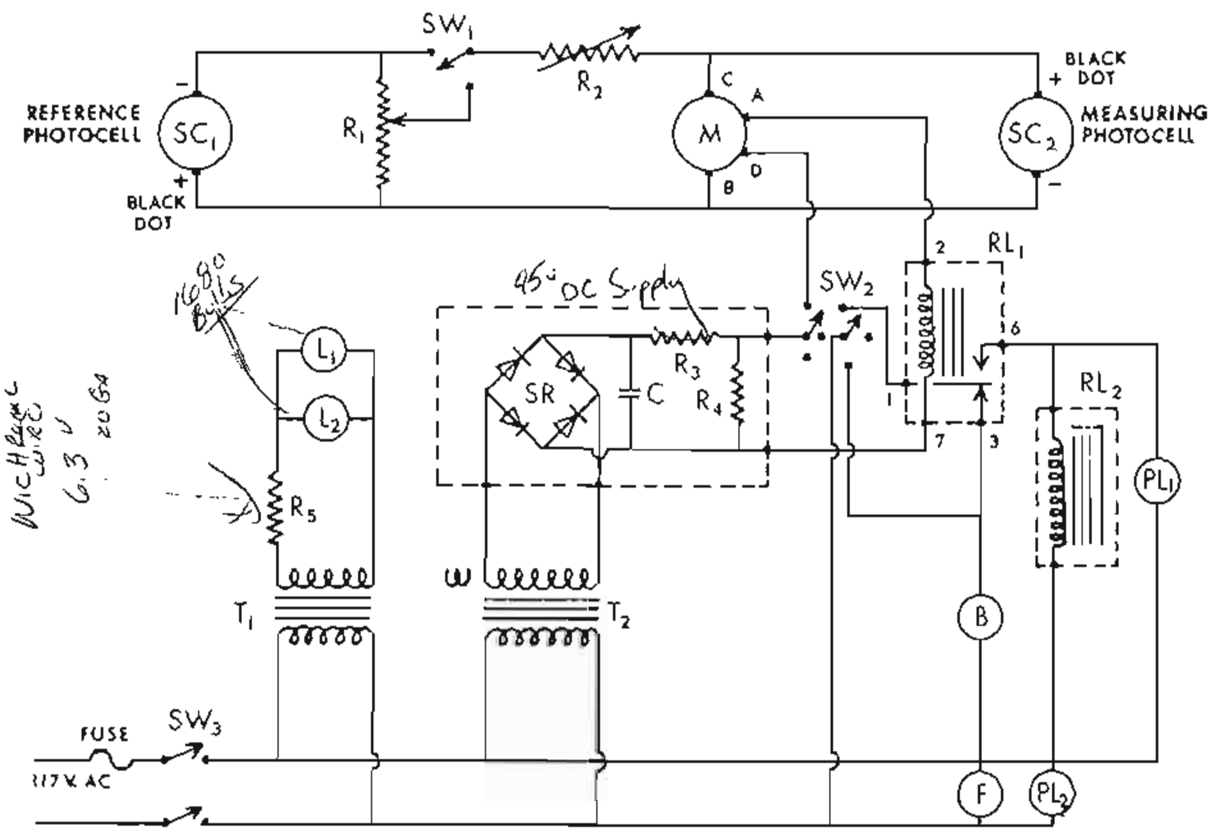

Figure 1-2. Sizing Tester Schematic

Referring to the schematic, a description of the Sizing Tester follows:

Illumination is provided by two 32-candlepower, 6.0-volt bulbs (G. E. No. 1680). These are powered by a constant-voltage, filament-type transformer which supplies 6.3-volt output relatively independent of line voltage fluctuations. (Transformer output may vary significantly with line frequency variations. This is rarely a problem with purchased electric power, but may occur with auxiliary power generation systems.) A series resistor reduces the voltage applied to the lamps to approximately 5.8 in order to lengthen their service life. Optical geometry provides 45° illumination and 90° viewing of the test specimen.

The optical reflectance of the test specimen is measured by a circuit having two silicon photocells. One (SC_2 in Figure 1-2) views only the bottom of the paper sample; the other (SC_1) views the lamp filaments. The two photocells are connected head to tail through a calibrating resistor (R_2). A microammeter (Meter Relay M) across the terminals of the measuring photocell, a precision potentiometer (R_1) across the terminals of the reference photocell, and a function switch (SW_1) complete the measuring circuit.

In the "calibrate" position the switch connects R_2 to the top of R_1, and in the "test" position, it connects R_2 to the slider of R_1. To conduct a test, SW_1 is placed in the calibrate position. A test sample is placed over the sample opening. R_2 is adjusted to give a zero reading of the meter. Now the output of SC_2 is just equal to that portion of the output of SC_1 flowing through R_2. Under this condition, the R_2 leg of the SC_1 load circuit and SC_2 effectively balance each other (note that current is flowing in the same direction in both these circuits) and no current flows through the meter.

The Tester is now calibrated to read the reflectance of the test specimen as 100 percent. SW_1 is now switched to the test position. Since a lower voltage is now applied to R_2, less of the SC_1 output current will flow through it, thus unbalancing SC_2. A voltage then develops across the meter to result in meter deflection. A test liquid (usually a dye solution) applied to the top surface of the paper sample penetrates it and causes progressive darkening of the sample undersurface which is viewed by SC_2. As darkening progresses, the output of SC_2 decreases. In time it will again equal the R_2 current from SC_1. The time required for balance to be reestablished is the test result. At this point the reflectance of the sample, as a percentage of its initial reflectance, is substantially equal to the percentage setting of R_1 (percent reflectance control).

The automatic cutoff and alarm circuit consists of a 95-volt d.c. supply,* relay contacts inside the meter relay, timer switch SW_2, SPDT relay RL_1, electric interval timer B, buzzer RL_2, and signal light PL_1. D.C. voltage is supplied to the relay circuit by transformer T_2, bridge rectifier SR, filter capacitor C, and voltage divider R_3 and R_4. This voltage is applied across the relay contacts of the meter and the coil of RL_1 when SW_2 is in the "auto" position. This switch position also directs line voltage to the switching contacts of RL_1. While the meter relay contacts are open (and they are while a test is in progress) relay RL_1 provides a closed a.c. circuit through the timer to make it run.

When the test end point is reached, no current will flow through the meter. The contacts in the meter relay will close, energizing the coil of RL_1 which switches the a.c. voltage from the timer to RL_2 and PL_1, stopping the timer and signaling the end of the test. RL_2 and PL_1 remain on until SW_2 is returned to the off position. SW_2 in the manual position disables the automatic cutoff and alarm circuits and enables manual control of the timer.

Considerable heat is dissipated by the lamps inside the optical housing, and it must be removed from the sample area. To remove sensible heat, a fan (F) draws room air into the optical housing through the filter underneath the optical housing cover. The air then discharges into the cabinet and escapes through the louvers and back opening. The fan has a nominal capacity of 33 cfm at 60 cycles and 20 cfm at 50 cycles. This air volume effectively prevents sensible heat transfer to the sample area.

*115-volt d.c. in Model KA Serial Nos. 1 through 28, and Model KB Serial Nos. 1 and 2.

To prevent radiant heat from reaching the sample, infrared-absorbing filters are inserted between the lamps and the sample area. These heat filters, Corning CSI-69, are part of the optical system. Their light pass band is a factor in the overall instrument spectral response. Similar protection and light pass are provided to the reference photocell with an identical filter material (CSI-69).

Spectral Response

The required sensitivity is achieved through use of silicon photocells rather than with the more commonly used selenium cells. The curve in Figure 1-3 shows the approximate overall spectral response of the Tester. This curve represents the product of light intensity, filter transmission, and photocell response using published values for these factors. The resulting curve peaks at 7000 millimicrons.

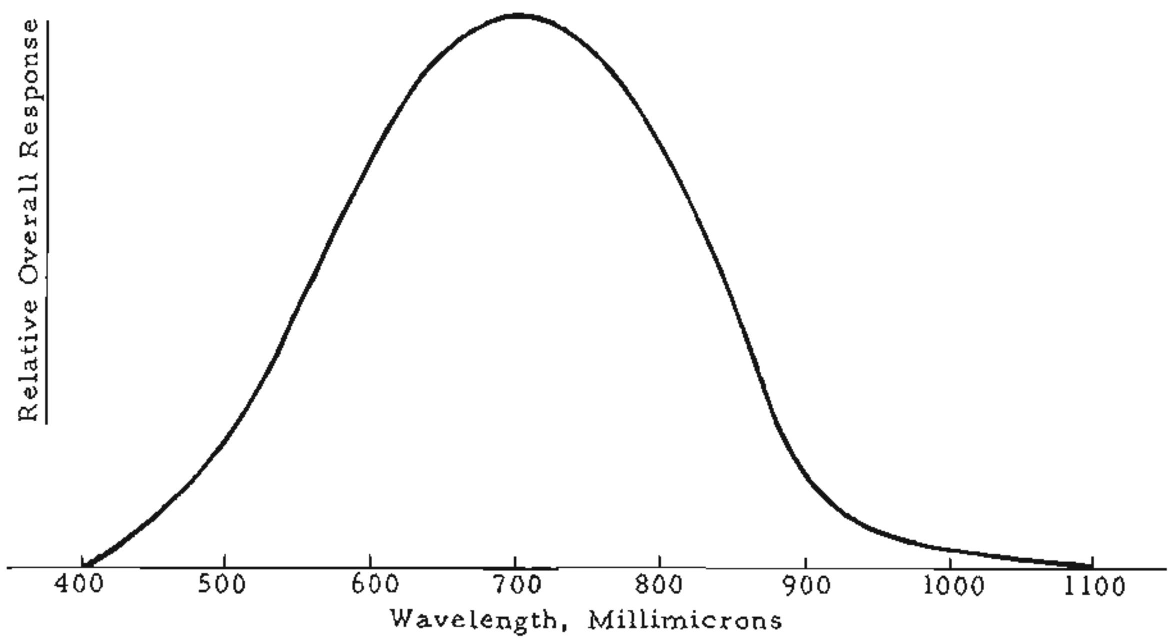

Figure 1-3. Spectral Response Curve.

For optimum performance, the test liquid should absorb heavily between 600 and 800 millimicrons. At this wavelength the instrument will sense maximum contrast between the penetrated and initial sample surface. A water-soluble dye (American Cyanamid Naphthol Green B Special Purified Dye) is available which meets this requirement very well. While this dye has near optimum spectral properties, other test solutions will meet the spectral requirements, provided they darken the sample markedly in the region of instrument response.

HST-2A
(Supersedes HST-2)

PROCEDURE FOR RUNNING A SIZING TEST

1. Plug Sizing Tester line cord into 117-volt, a.c. outlet.
2. Set power switch to ON position and allow instrument to warm up for a minimum of 15 minutes before attempting standardization.
3. Standardize with reference tiles once a day if in daily use, otherwise each time the Tester is used. (See HST-5A of this manual, Standardization, for details.)
4. Place paper sample in holder (side up will be in contact with ink). Align machine direction of paper parallel to handle of sample holder.
5. Position sample holder in retaining ring on top of optical housing.
6. Place black block or disc supplied with tester over sample.
7. Make sure that timer switch is OFF (center position). Reset timer by pressing reset button on face of timer.
8. Set function switch (toggle) to CALIBRATE position.
9. Position set point (red hand) of meter five or more scale divisions left of zero.
10. Adjust CALIBRATE knob for zero meter reading.
11. Move function switch to TEST position and reposition set point of meter to zero.
12. Set percent reflectance at desired end point. CAUTION: Be sure % REFLECTANCE knob is unlocked before turning. Forcing the knob to turn against the lock lever will damage the instrument and affect its standardization.* An 80% or lower end point is commonly used. A higher percent reflectance gives a shorter test and lighter end point, while a lower percentage gives a longer test and darker end point. (See section following, HST-3A, for details.)
13. Remove black block or disc from sample holder.
14. Pour 10 ml of test ink on sample and simultaneously move timer switch to AUTO position.
15. Place black disc over sample holder.
16. When test is complete, buzzer will sound, signal light will go on, and timer will stop.
17. Record test time and set timer switch to OFF to silence buzzer.
18. Remove sample holder, dump ink and sample, rinse and dry holder.

*The % REFLECTANCE knob lock lever protrudes from the base of the knob. For instruments with serial numbers KA-82 or KB-7 and lower, the reflectance knob is unlocked when the lever is in the five o'clock position and locked when in the seven o'clock position; for serial numbers KA-83 or KB-8 and higher, the reflectance knob is unlocked in the one o'clock position and locked in the two o'clock position.

HST-3A
(Supersedes HST-3)

SELECTION OF END POINT FOR MILL CONTROL SIZING TESTS

One of the major advantages of the Hercules* Sizing Tester is the provision for rapidly changing the percent reflectance end point to suit the sizing level of paper being tested. This means that a mill producing a wide range of basis weights, or sheets with widely varying levels of sizing, can adjust the reflectance end point to complete the test within a reasonable period of time.

General recommendations for selecting the end point on a given grade of paper are as follows:

1. The reflectance end point should be set at a level that will give at least a 30-second test time in order to obtain good reproducibility. Test times of 60 seconds or higher will give maximum precision.
2. Whenever possible, reflectance end points in the range of 50 to 80% should be used. Reflectance end points of 90% or higher give low meter deflection, and results are affected to a greater extent by paper variations or operator errors. Reflectance end points below 40% should not be used because most papers are almost saturated with ink at this reflectance level.

Typical test values on various grades of paper and board are listed in Table 3-1. Test conditions are usually selected to give a minimum test time of 30 seconds and a maximum test time of about 10 minutes. Special inks, or the use of a high-head sample holder, were required to give reasonable test times on some board grades.

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Table 3-1

TESTING OF VARIOUS PAPER AND BOARD GRADES
USING THE HERCULES SIZING TESTER

Paper or Board Sample	Type Ink Used	Reflectance End Point %	Hercules Sizing Tester, Sec Standard Holder	High-Head Holder
16-lb bond	Hercules Test Ink No. 2	80	90	–
20-lb bond	Hercules Test Ink No. 2	80	140	–
40-lb unbleached bag	Hercules Test Ink No. 2	80	429	–
150-lb manila file folder	10% Formic Acid Ink	80	405	–
42-lb unbleached linerboard	10% Formic Acid Ink	80	570	–
99-lb tabulating card stock	10% Formic Acid Ink	80	173	–
11-pt coated bleached board	10% Formic Acid Ink	85	209	110
14-pt coated bleached board	40% Formic Acid Ink	70	92	56
18-pt coated bleached board	40% Formic Acid Ink	70	153	85
24-pt coated bleached board	40% Formic Acid Ink	70	479	283
30-pt coated bleached board	40% Formic Acid Ink	70	708	522

HST-4A
(Supersedes HST-4)

PROCEDURE FOR RUNNING REFLECTANCE-TIME SIZING CURVES

A significant advantage of the Hercules* Sizing Tester over previous instruments is the provision for determining a complete reflectance versus time curve by operating the tester on manual control. In many cases, a reflectance-time curve will show differences in rate of ink penetration between the two sides of a sheet or between the surface of the sheet and its interior. This makes it possible to evaluate the effects of sizing two-sidedness, or the effects of surface treatment on sizing. This information can be of value in certain mill-sizing problems.

The procedure for running reflectance-time curves is as follows:

1. With the paper sample in place, calibrate the instrument in the manner prescribed and put the function switch in the **TEST** position.

2. Move the red hand on the meter approximately 15 scale divisions left of zero.

3. Set the % **REFLECTANCE** control to the highest value required, usually 95%.

4. Pour ink on the sample and simultaneously move the timer switch to the **MANUAL** position.

5. Observe the time when the meter needle crosses zero and record time. Without stopping the timer, reset the % **REFLECTANCE** control to a lower value, usually 90%.

6. When the meter needle again crosses zero, record the time and again reset the % **REFLECTANCE** control to a lower value. This should be continued at increments of 5 or 10% reflectance down to the range of 30 to 40%. Values below 30% are usually meaningless, since the paper sample is almost completely saturated at this reflectance.

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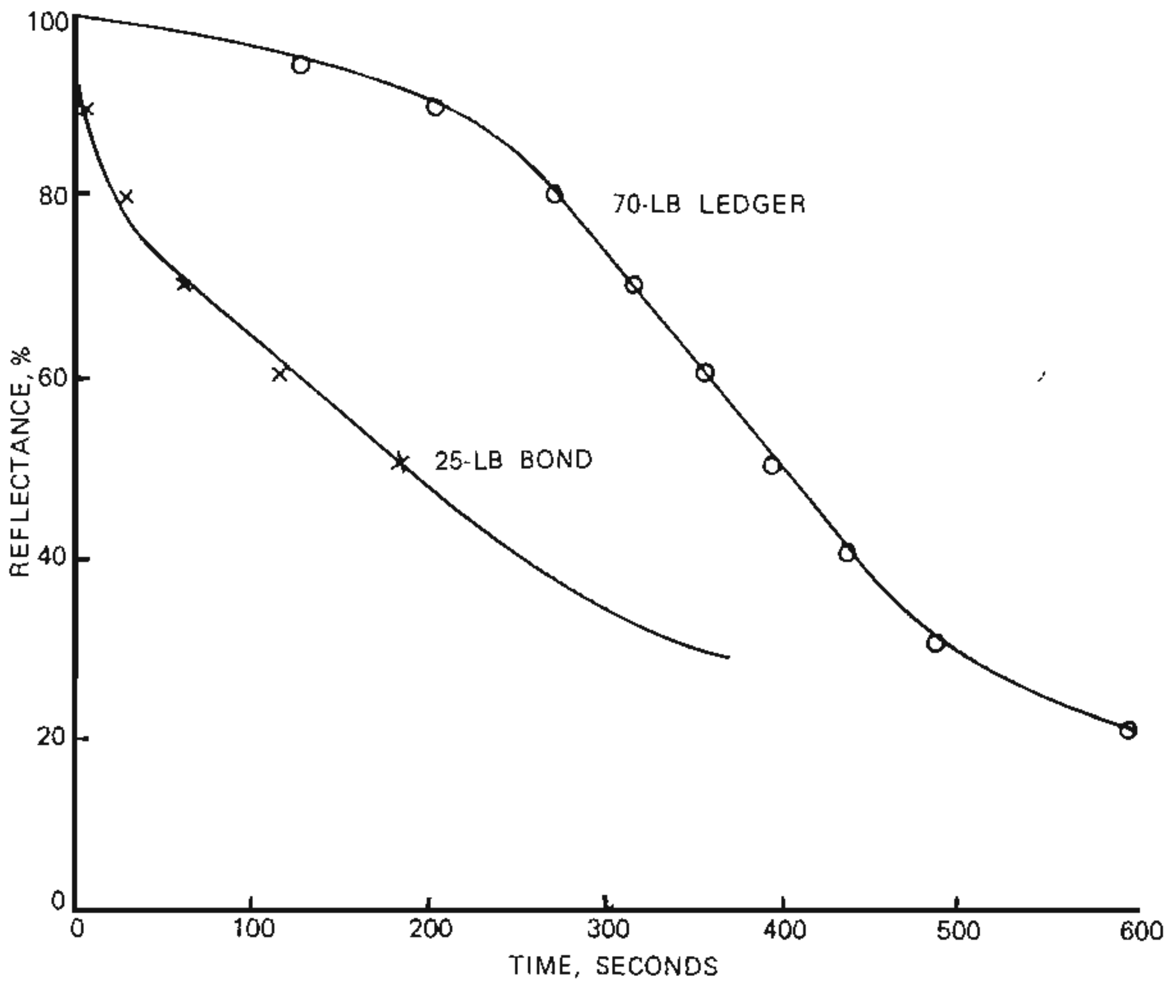
Typical reflectance-time curves are plotted in Figure 4-1. The shape of the curve will be governed by the basis weight of the sheet as well as by possible variations in sizing between the two sides of the sheet. It is suggested that in unusual sizing problems, complete reflectance curves be run on both sides of the sheet and compared with samples of satisfactory production.



HST-5A
(Supersedes HST-5)

STANDARDIZATION OF THE HERCULES* SIZING TESTER

Standardization Tiles

To ensure consistent performance and agreement in readings between different instruments, permanent optical working standards (white and green ceramic tiles) are provided with the Sizing Tester. These are used to check instrument sensitivity and overall optical and electrical linearity.

Sensitivity

Sensitivity is the response of the instrument to a standard white ceramic tile. If the bulbs and all glass surfaces of the Sizing Tester are in good condition, the amount of light reflected by the standard will be high and meter deflection will be large. Thus, to minimize random error that might be introduced during instrument calibration, be sure that meter deflection is large before proceeding with a sizing test.

To obtain maximum precision in results, meter deflection should be 80% or more of the value specified on the back of the white tile. If it is not, corrective action must be taken (see subsection titled Factors Affecting Standardization).

Linearity

Overall linearity reflects the capability of the instrument to accurately and consistently reproduce a given reflectance relationship. Instrument linearity is checked by determining the reflectance of the standard green tile as a percentage of the white tile. Tolerance limits are marked on the green tile. Since detecting a reflectance relationship is fundamental to the sizing test, the reproducibility of the instrument in this respect is crucial to its performance as an ink-penetration tester. The tester should be continued in service only if this check is within tolerance; otherwise, test results will be biased and will not agree with those obtained previously, or with those obtained on other instruments.

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Factors Affecting Standardization

The following are to be used only as troubleshooting guidelines should difficulty be encountered in standardizing the Sizing Tester. For detailed repair procedures, see Maintenance & Parts, sections HST-7A and HST-8A of this instruction manual.

1. Lamp Aging

   Inability to standardize the instrument is most frequently caused by lamp aging. With lamp aging, light intensity decreases, and spectral changes occur. The result is a progressive decrease in the sensitivity reading and an increase in the linearity reading. Hence, if either of these readings is not within the tolerances specified, the bulbs should be changed. Standardization failure generally dictates lamp replacement well before burnout, usually after about 80 hours' service.

2. Lamp Sockets

   The lamp sockets can deteriorate with age to cause decreased light output and lower sensitivity. If this occurs, replace the lamp sockets.

3. Position of Heat-Absorbing Filters and Optical Assembly

   If the heat-absorbing (glass) filters are removed for cleaning, be certain to replace them in the original position because improper positioning will cause incorrect readings. (This particular problem is limited to the earlier Sizing Testers in which retainer clips serve as the holder for the filters. In the more recent Testers, the retainer clips have been replaced by bracket-type holders, which assure proper positioning.) To check filter alignment, carefully view the lamps through the sample opening. If the lamp filaments can be seen without looking through the filters, reposition the filters to intersect the view of the filament.

   Incorrect readings can also occur if the optical assembly is not replaced properly during instrument maintenance. In replacing the optical assembly, proper placement is assured by using the lamp bulbs as a reference point. As viewed from the front of the Sizing Tester, the bulbs should be oriented to the four o'clock and ten o'clock positions.

4. % Reflectance Dial

   Standardization failure will result if the % REFLECTANCE knob was forced against its stops or if the knob has slipped on the potentiometer shaft. To check this, release the knob lock lever and turn the knob to its full clockwise position. (Do not force against the stops.) The dial should read between 99.8 and 00.2 at the high end of the readout range for Sizing Testers equipped with the Amphenol dial (serial numbers KA-82 or KB-7 and lower). For instruments equipped with the Spectrol dial (serial numbers KA-83 or KB-8 and higher), the correct reading is between 99.8 and 100.2 with the knob at its full clockwise position. If the percent reflectance readout is not within these specified tolerances, see HST-7A of this manual (Maintenance & Parts) for corrective measures.

5. Dirty Glass Surfaces

   Keep the glass surfaces clean. If the glass sample opening and the glass photocell covers become dirty, standardization will be affected. Dirty glass heat-absorbing filters will also affect standardization.

STANDARDIZATION PROCEDURE

1. Plug Sizing Tester line cord into 117-volt, a.c. outlet.

2. Move the red hand on the meter 15 to 20 scale divisions left of zero.

3. Set power switch to ON and allow the instrument to warm up for a minimum of 15 minutes before attempting further use.

4. Thoroughly clean the face of the white tile and place it directly on the cover glass of the sample opening. (Do not use the sample holder.)

5. With the function switch (toggle) in the CALIBRATE position, adjust the CALIBRATE knob for zero meter reading.

6. Set the percent reflectance to 85%. CAUTION: Be sure the % REFLECTANCE knob is unlocked before turning. Forcing the knob to turn against the lock will damage the mechanism and affect instrument standardization.*

7. Move function switch to TEST position and observe meter deflection. The needle will deflect to the right 12 to 25 microamperes. Record the reading. This is the Sensitivity reading.

8. The sensitivity reading should be 80% or more of the initial reading obtained when the instrument was new (or 80% of the value specified on the back of the white tile.) If the deflection is less than 80% of standard, stop and refer to Step 13 of this procedure.

9. Remove the white tile. Clean the face of the green tile and place it over the cover glass of the sample opening.

10. Leaving the function switch in TEST position, adjust the % REFLECTANCE knob until a zero meter reading is obtained.

*The lock lever protrudes from the base of the knob. For instruments with serial numbers KA-82 or KB-7 and lower, the knob is unlocked with the lever in the five o'clock position, and locked in the seven o'clock position. For serial numbers KA-83 or KB-8 and higher, the knob is unlocked in the one o'clock position, and locked in the two o'clock position.

11. Read the percent reflectance value noted on the dial of the % **REFLECTANCE** knob. Record this value. This is the linearity reading.

12. The percent reflectance of the green tile (linearity) should fall within the range marked on the back of the tile.* If outside this range, stop and refer to Step 13 of this procedure.

13. If proper standardization readings are not obtained, the following corrective measures are recommended. (See HST-7A of this manual, Maintenance & Parts, for details.)

    a. Replace lamp bulbs.

    b. Check position of heat-absorbing filters.

    c. Check orientation of lamps.

    d. Check for incorrect % **REFLECTANCE** dial indexing. (Refer to the subsection titled % Reflectance Dial.)

    e. Clean all glass surfaces.

    f. Replace lamp sockets.

*The green tiles supplied with some earlier model instruments are marked only with a single reflectance value and no tolerance limits are given. The prescribed tolerance limits are -0.5 and +1.5 reflectance units from this value.

HST-6A
(Supersedes HST-6)

PROCEDURE FOR PREPARING INKS

Inks suitable for use with the Hercules* Sizing Tester must meet the following requirements:

1. They must contain a dye which is not substantive to the fiber, in order that the dye will penetrate the sheet along with the liquid phase.
2. The composition and chemical properties of the inks must be precisely controlled.
3. The inks should not contain coagulants.

Most commercial inks do not meet all the above requirements. Consequently, special inks designed for use with the Sizing Tester are recommended. The procedure for preparing and testing these special inks follows.

Preparation of Hercules Test Ink No. 2

Materials

1. Distilled or demineralized water.
2. Cyanamid Naphthol Green B Special Purified Dye. (American Cyanamid Company, Organic Chemicals Division, Bound Brook, New Jersey.)
3. Formic acid – reagent grade.

Concentrations Used

1. Dye concentration – 1.25% based on final ink.
2. Formic acid – 1.00% based on final ink.

Procedure – 2,000 cc. batch of ink

1. Weigh out 25.0 ± 0.1 grams of Cyanamid Naphthol Green B Special Purified Dye and transfer to a large beaker or other container suitable for mixing.
2. Add approximately 1,500 cc. distilled or demineralized water and stir until all of the dye is dispersed.
3. Weigh out sufficient formic acid to equal 20.0 ± 0.1 grams of 100% formic acid. Add this to the dye solution and mix thoroughly.
4. Transfer solution to a 2,000-cc. volumetric flask and add demineralized or distilled water to a final volume of 2,000 cc. Mix thoroughly.

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Testing

1. Percent Formic Acid – Titrate an aliquot of the final ink solution with standardized NaOH to a pH 7.0 end point using an electric pH meter.

$$\% \text{ Formic acid} = \frac{4.6 \text{ x normality of standard NaOH x cc. of NaOH used}}{\text{cc. of ink titrated}}$$

Specification for Test Ink No. 2 = 0.96 – 1.04% Formic Acid.

2. Optical Density – If equipment is available, determine optical density at 705 millimicrons. Dilution to suit equipment (usually 1:500 or 1:1000). Record and establish control limits.

Shelf Life

Maximum recommended shelf life for Hercules Test Ink No. 2 is six weeks.

Preparation of 10 percent Formic Acid Ink

Materials

1. Distilled or demineralized water.
2. Cyanamid Naphthol Green B Special Purified Dye. (American Cyanamid Company, Organic Chemicals Division, Bound Brook, New Jersey.)
3. Formic acid – reagent grade.

Concentrations Used

1. Dye concentration 1.25% Cyanamid Naphthol Green B Special Purified Dye based on final ink.
2. Formic acid concentration – 10.0% based on final ink.

Procedure – 2,000 cc. batch of ink

1. Weigh out 25.0 ± 0.1 grams of Cyanamid Naphthol Green B Special Purified Dye and transfer to a large beaker or other container suitable for mixing.
2. Add approximately 1,500 cc. distilled or demineralized water and stir until all of the dye is dispersed.
3. Weigh out sufficient formic acid to equal 200 ± 1 grams of 100% formic acid. Add this to the dye solution and mix thoroughly.
4. Transfer solution to a 2,000-cc. volumetric flask and add demineralized or distilled water to a final volume of 2,000 cc. Mix thoroughly.

Testing

1. Percent Formic Acid – Titrate an aliquot of the final ink solution with standardized NaOH to a pH 7.0 end point using an electric pH meter.

$$\% \text{ Formic acid} = \frac{4.6 \text{ x normality of standard NaOH x cc. of NaOH used}}{\text{cc. of ink titrated}}$$

   Specification for 10% Formic Acid Ink = 9.8-10.2% Formic Acid.

2. Optical Density – If equipment is available, determine optical density at 705 millimicrons. Dilution to suit equipment (usually 1:500 or 1:1000). Record and establish control limits.

Shelf Life

Maximum recommended shelf life for 10% Formic Acid Ink is four weeks.

Higher Formic Acid Concentration Inks

Inks containing 20 to 60% formic acid may be used for testing of extremely hard-sized or heavyweight paper and board samples. The preparation is the same as outlined above for 10% formic acid ink with suitable adjustment of the amount of acid used and the percent formic acid specification.

The maximum recommended shelf life for 20 to 60% formic acid inks is two weeks.

Use of Water Containing Dye Only for Slack-Sized Papers

Some slack-sized or lightweight papers may give test end points of only a few seconds with Test Ink No. 2. For these grades, we recommend use of a 1.25% dye solution in distilled water only, without formic acid. Measure and record ink pH, as the pH of distilled water varies widely. Adjustment to a suitable pH standard may be necessary. If equipment is available, measure and record optical density at 705 millimicrons. Maximum recommended shelf life is six weeks.

Alkaline Inks

Because of poor stability of the dye in alkaline solution, we do not recommend alkaline inks for use with the Hercules Sizing Tester. The higher formic acid concentration inks should be used. A special high-head sample holder is available to reduce test times on hard-sized or heavyweight paper or board.

Oil Penetration Tests Using the Hercules Sizing Tester

The Hercules Sizing Tester also finds application for measuring the oil resistance of paper and board. A suitable oil-soluble dye (preferably green in color, since this gives best spectral response to the tester optical system) is dissolved in the oil penetrant desired. Oil penetration tests are run in the same manner as ink penetration tests.

HST-7A
(Supersedes HST-7)

ROUTINE MAINTENANCE OF THE HERCULES* SIZING TESTER

Air Filter

Restriction of air flow to the Sizing Tester optical assembly results in heat buildup that will affect instrument standardization and eventually damage its optical components. To prevent this, the foamed plastic air filter that is located beneath the optical assembly cover must be inspected periodically and, when indicated, either be cleaned or replaced.

Access to the air filter is obtained by removing the three screws (requires a 5/64-inch allen wrench) that are located around the top outer edge of the optical assembly cover plate. (See Figure 7-1.) Lift the cover plate and attached optical assembly and remove the filter by working it up over the plate (Figure 7-2). Wash the filter in a mild detergent solution, rinse, squeeze dry, and replace.

In reassembling the unit, be sure to fasten the cover in its original location. Use the optical assembly lamp bulbs as a reference point for proper cover plate orientation. As viewed from the front of the Sizing Tester, the two lamps on this assembly should be aligned at the 4 o'clock and 10 o'clock positions. (See Figure 7-3).

Cleaning of Glass Surfaces and Bulb Replacement

Both exterior and interior glass surfaces of the Sizing Tester should be cleaned regularly. When these surfaces accumulate dust, light is diffused, and the instrument fails the standardization check.

Cleaning of glass surfaces, bulbs, and bulb removal is best accomplished during inspection of the air filter, i.e., while the optical assembly is removed from its housing. At this time, remove the four screws located on the sample holder ring of the optical assembly cover plate. This will free the optical assembly from the cover plate and provide easy access to all optical components. (See Figures 7-4 and 7-5.)

Clean both sides of the sample opening glass, and also the two glass heat-absorbing filters that are bracket-mounted to the cover plate. Note: In earlier model Sizing Testers, as seen in Figure 7-6, the location and mounting arrangement of the glass filters differ. When cleaning the filters on earlier model instruments, be careful not to bend the retainer clips used for mounting them as this would affect filter positioning which, in turn, will affect instrument standardization. If bending does occur, straighten the clips so that the glass filters are centered directly over the lamps.

*Hercules Trademark

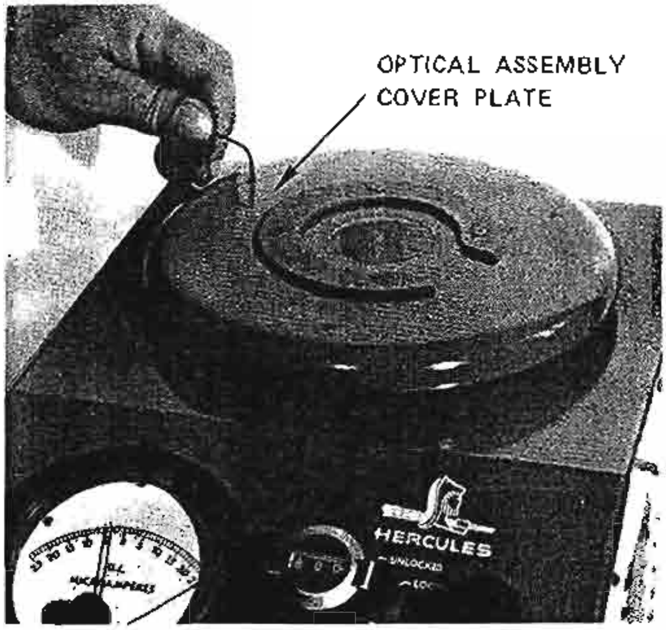


Figure 7-1.

Access to the air filter is obtained by removal of three screws.

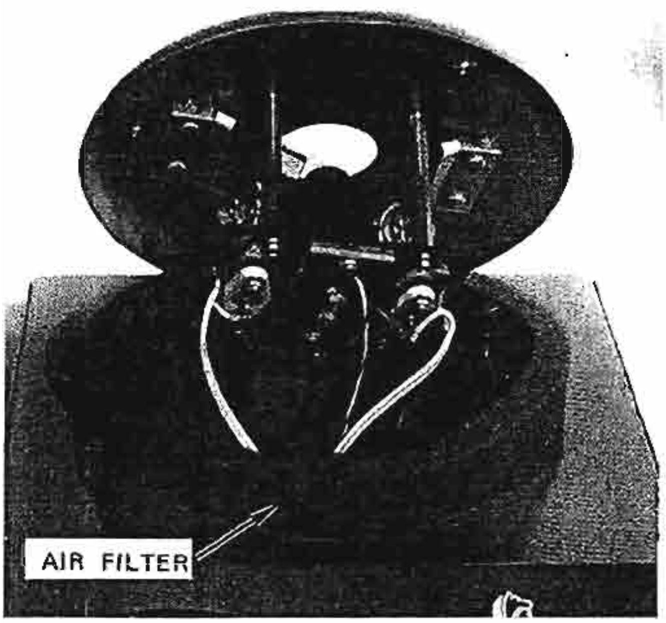


Figure 7-2.

The cover plate and attached optical assembly have been lifted and the air filter is exposed. Foam-type filter can be removed for cleaning by working it up over the cover plate.

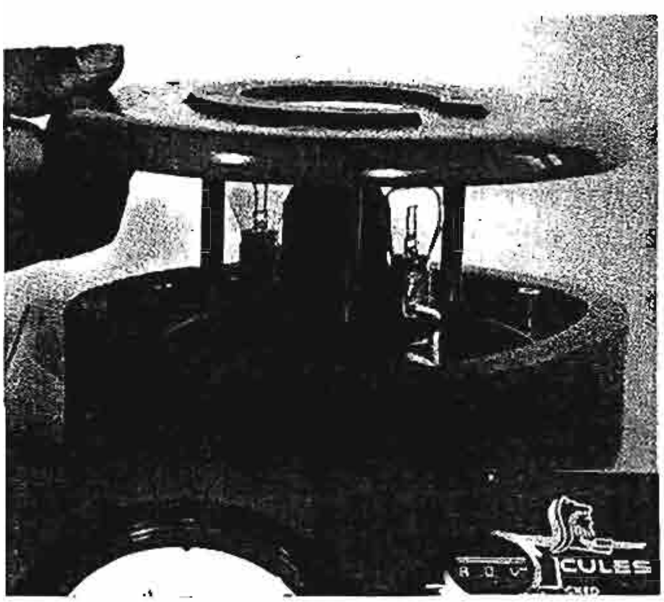


Figure 7-3.

In replacing the optical assembly, be certain to position the unit in its original location. Proper position (as shown by this photograph) is obtained by aligning the lamp bulbs at 4 o'clock and 10 o'clock, as viewed from the front of the Sizing Tester.

Clean the glass cover of the reference photocell. It is located on the side of the well that serves as the optical assembly housing (Figure 7-7).

Occasionally, it may be necessary to clean the measuring photocell that is located within the black optical tube. To gain access, remove the plastic mounting block that is secured to the bottom of the optical assembly base plate. (See Figure 7-8.) Lift the photocell and clean the face by wiping but do not wipe the interior of the black tube. Dust and lint should be blown from the tube interior; wiping can damage its black coating and cause faulty light absorption.

Bulb Procurement

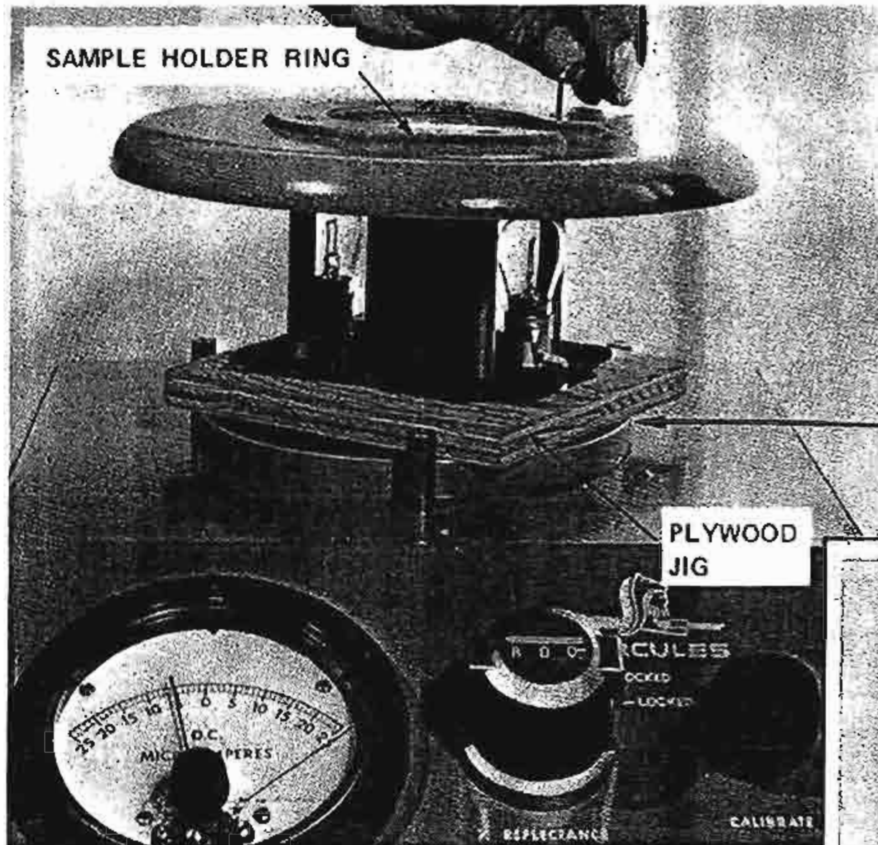
Two No. 1680 bulbs are used in the Sizing Tester. These are 6-volt, 32-candlepower, aircraft bulbs made by the Miniature Lamp Division, General Electric Company. These bulbs are not widely used and hence are not generally stocked by all distributors. For this reason a number of spare bulbs are supplied with the Tester. Additional replacements can sometimes be procured through a local miniature bulb distributor. If not available at a local source, they can be obtained from Hercules Incorporated, P. O. Box 1027, Kalamazoo, Michigan, 49005, in minimum quantities of 30 bulbs or more.

Access to Wiring and Electrical Components

The top panel of the Sizing Tester cabinet is hinged to the front panel. After removal of 11 screws (requires a 5/64-inch allen wrench) near the top edges of the cabinet sides and back, it can be lifted from the rear and swung open for easy access to all wiring and circuit components. Figure 7-9 shows the cabinet interior. Circuit functions are described in section HST-1A of this manual. A wiring diagram is included in section HST-1A and also in section HST-8A.

Buzzer Loudness Adjustment

The buzzer that produces the audible alarm at the end of the test is adjustable for loudness. The adjustment screw protrudes from the rear of the buzzer housing and is easily accessible through an opening in the rear of the cabinet. Turning the screw clockwise reduces loudness. A fraction of a turn should be sufficient in most cases. The buzzer can be disconnected by removing and taping one of the quick-disconnect leads at the buzzer.



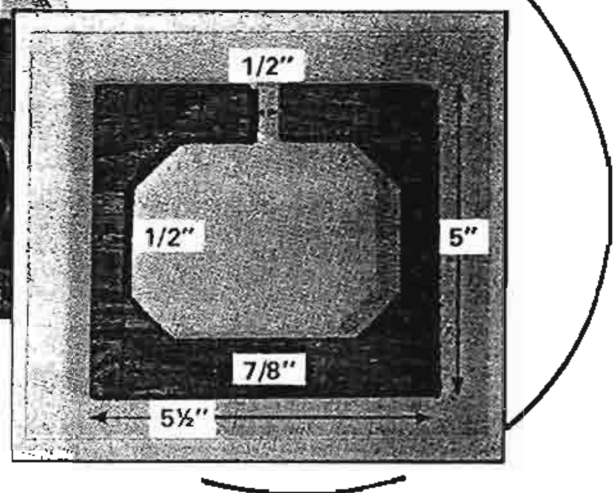


Figure 7-4.

Complete access to optical components is obtained by removal of four screws. A working jig (plywood) inserted between the optical housing and optical assembly base plate helps with handling and reduces possibility of damage to glass components when cleaning or replacing parts.

Figure 7-5.

Cover plate removed and optical assembly components exposed.

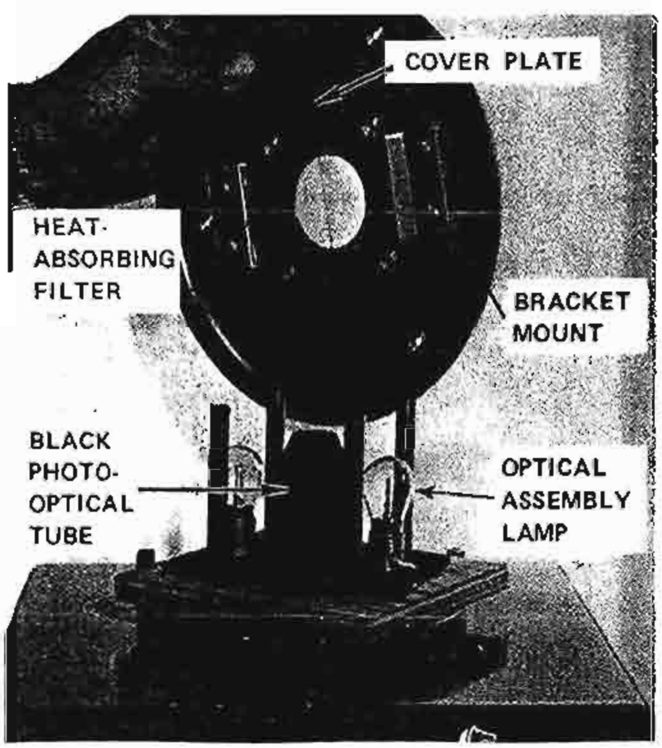
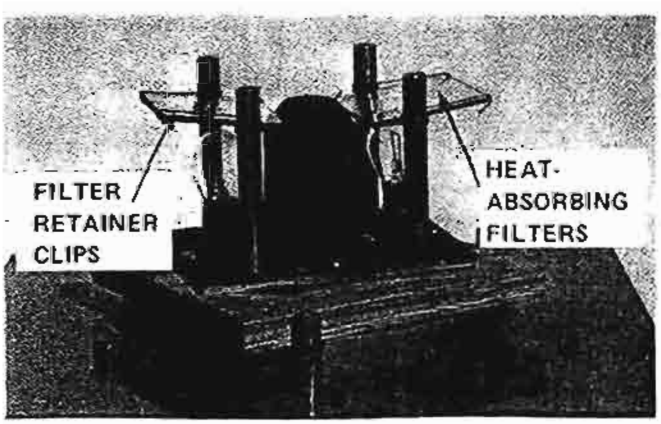


Figure 7-6.

Figure 7-6 shows the mounting arrangement and location of the glass filters for earlier model Sizing Testers.



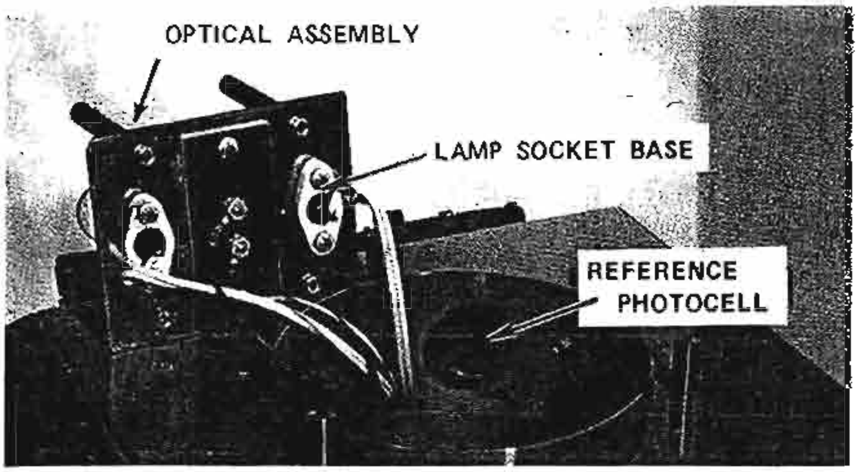


Figure 7-7.

Optical assembly removed from housing (well) and reference photocell exposed.

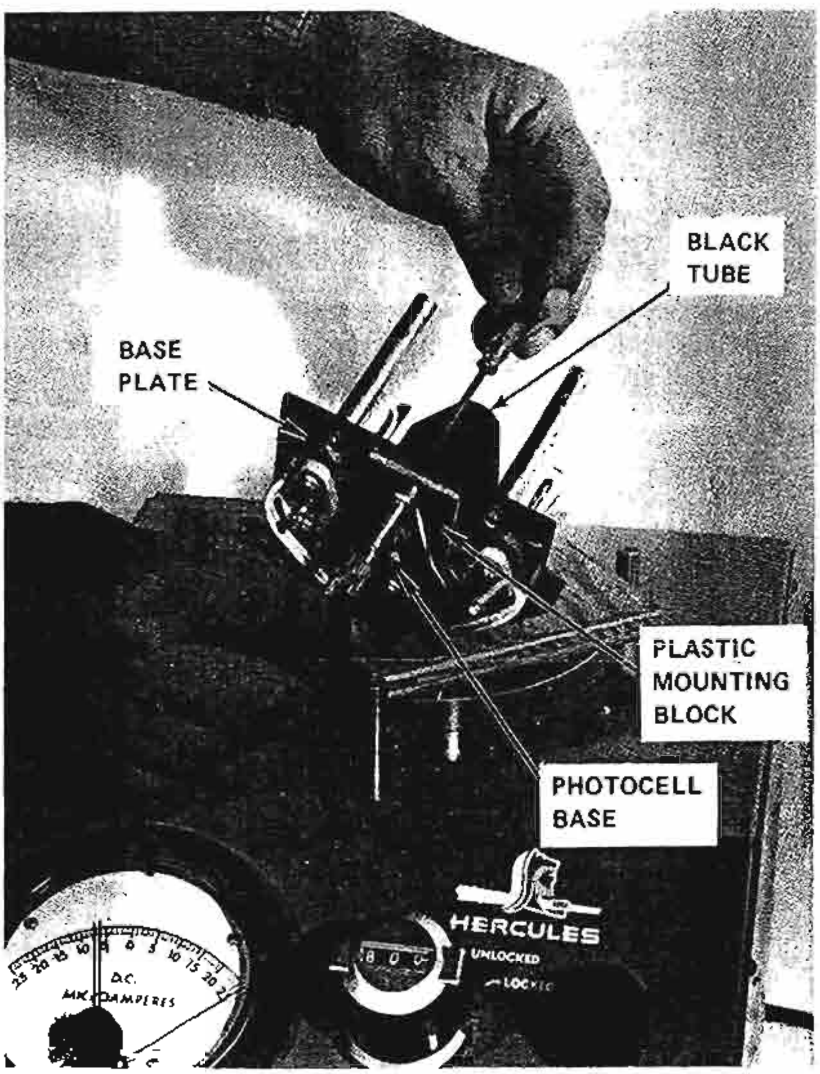


Figure 7-8.

Note: This is not a routine maintenance procedure. Occasionally, it may be necessary to clean the measuring photocell that is located within the black optical tube. To gain access, remove the plastic mounting block. Clean the face of the photocell by wiping but do not wipe the interior of the black tube.

Troubleshooting When Unable to Standardize Instrument

If the specified standardizations are not obtained, the following corrective measures are recommended. (Experience has shown these to be the likeliest causes of difficulty.)

(1) Bulb Aging

Replace bulbs following the directions given under the preceding subparagraph on glass cleaning and bulb replacement.

(2) Meter Zero Adjustment

With the power off, cover the sample opening with the black disc or other opaque object. Meter should read zero. If it does not, adjust the screw just below the set point knob on the meter face for zero reading. This adjustment should be made with no light reaching the photocells. If there is doubt about the exclusion of light, open the case and disconnect either the blue or the white-blue wire at the terminal block to right of the relay and proceed with the adjustment.

(3) Position of Heat-Absorbing Filters

Improper positioning of the two glass heat-absorbing filters can occur only with the earlier Sizing Testers in which retainer clips were used for mounting of the glass filters. In recent production units the heat filters are bracket-mounted and positioning presents no problems. See Figures 7-5 and 7-6.

Proper positioning is assured by viewing the filters through the sample opening. They should fully intersect the view of the lamps. If not, reposition the retainer clips or bend them as necessary to obtain proper alignment.

(4) Lamp Orientation

During removal of the Sizing Tester optical assembly for cleaning of the air filter or other maintenance procedure, it is possible to obtain improper positioning of the optical assembly when replacing it.

Proper positioning of this unit is assured by using the lamps as a reference point. As viewed from the front of the instrument, lamps should be located at approximately the 4 o'clock and 10 o'clock positions.

(5) Indexing of % REFLECTANCE Readout Dial

Two types of counting dials have been used as a % Reflectance readout on Hercules Sizing Testers. Early instruments used an Amphenol 1309 dial and later model instruments are equipped with a Spectrol 25-1-13 dial. The Amphenol dial knob is of aluminum, while the Spectrol knob is of black plastic.

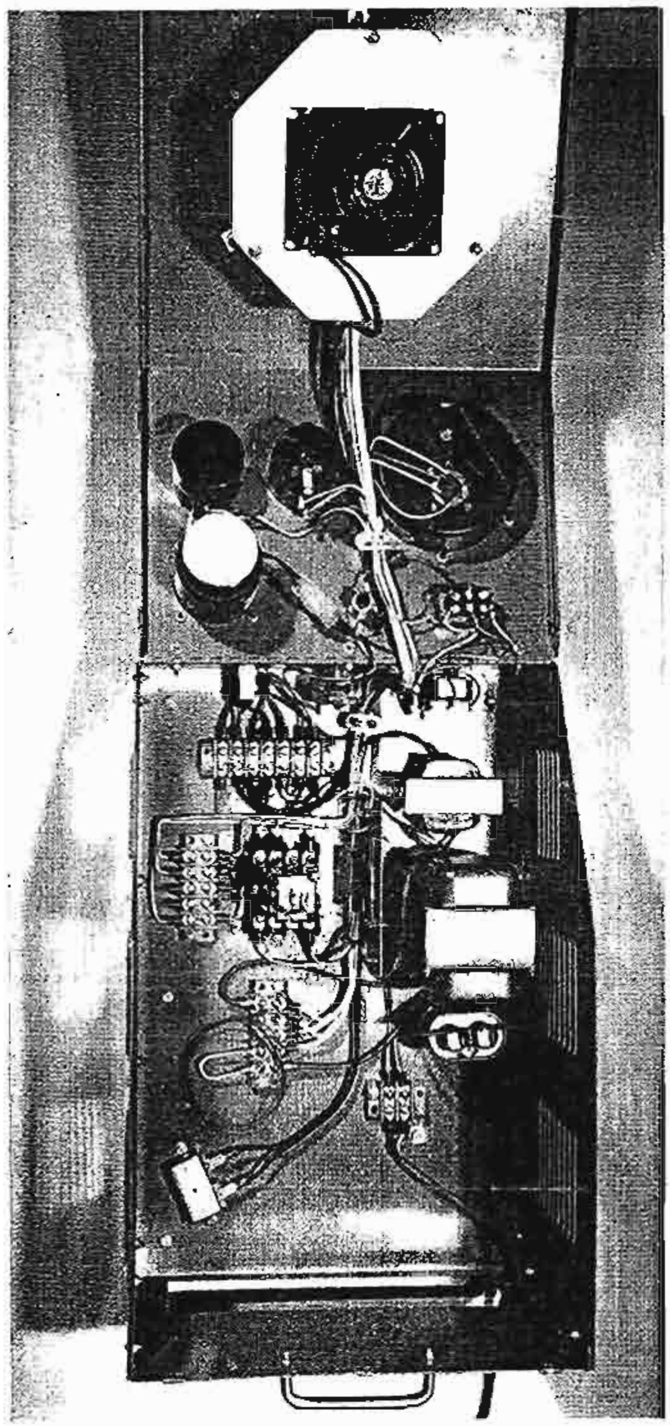


Figure 7-9. Interior view of the Hercules Sizing Tester.

An incorrect dial reading is usually attributable to damage caused by either forcing of the % REFLECTANCE knob against its stops, or failure to release the knob lock lever before turning.

Reassurance of correct dial readout is as follows:

(a) Amphenol Dial

The Amphenol dial is found on Sizing Testers bearing the Serial Numbers KA-82 or KB-7 and lower. In the full clockwise position the readout should be between 99.8 and 00.2. If not within tolerance, the probable cause for improper readout is slippage of the knob on its shaft. The slippage may be corrected by removing (1/16-inch allen wrench) the two dust plugs that cover the set screws on the knob. Tighten the set screws and replace the dust plugs.

For reindexing, remove the three small slotted screws at the base of the dial. Lift off the outer shell, set to 00.0, turn potentiometer to clockwise stop, and replace the outer shell. Check for 00.0 reading at the stop. Then, replace the three screws and check for correct reading and smooth operation. If difficulty persists, replace the entire dial assembly.

(b) Spectrol Dial

The Spectrol dial is found on Sizing Testers bearing the Serial Numbers KA-83 or KB-8 and higher. The correct readout for this dial is between 99.8 and 100.2 when the knob is turned to its full clockwise position. (Do not force against the stop.) If not within these readings, set readout to 100.0 and see if one of the knob set screws lines up with the access hole. If it does not, the knob has slipped on its shaft. Correct by loosening the two knob set screws and indexing to 100.0 at the clockwise stop.

If one of the set screws still does not line up with its access hole when the dial is set at 100.0, the counter itself may be out of adjustment. To correct this, set the knob lock lever in the brake position and force the knob in a direction that will correct the reading. This procedure may damage the gears inside the counter, in which case it will be necessary to replace the dial assembly.

(6) Glass Surfaces

Inspect glass surfaces and clean in accordance with instructions given in the preceding paragraphs.

(7) Lamp Socket Replacement

Remove three screws near top edge of optical cover plate and lift cover plate and attached optical assembly from optical housing. Remove the four screws that secure the cover plate to the four long posts. The screws holding the lamp sockets to the bottom plate are then easily accessible. After removing sockets, disconnect the wires, attach them to the new sockets, and reassemble.

(8) Erratic Meter Movement

Erratic or jerky meter movement may be caused by static electricity on the meter face, a dirty or worn calibration potentiometer, or defective lamp sockets. The last mentioned is the most improbable cause and should be checked after all other causes have been eliminated.

To check for static electricity, rub the face of the meter lightly with the fingers. A meter deflection obtained during rubbing indicates a static buildup. This can be corrected by treating the meter face with an antistatic solution. If not available locally, a suitable solution can be obtained from Hercules Incorporated, P. O. Box 1027, Kalamazoo, Michigan, 49005.

Erratic meter movement during calibration of the Sizing Tester indicates a defective potentiometer. If this occurs, replace the calibration potentiometer (Amphenol 2251B, 10,000 ohms).

As a last approach, replace lamp sockets in accordance with instructions given in the preceding paragraphs.

877 740-8121

MODEL KA serial 80 Hercules sizing tester

HST-8A
(Supersedes HST-8)

PARTS LIST

R_1 -	50-ohm, 0.1 percent Z.B. Linearity, 10-turn Potentiometer (Amphenol Model 205)
R_2 -	10,000-ohm, 0.25 percent Linearity, 10-turn Potentiometer (Amphenol 2251B or Spectrol 860)
R_3 -	7,000-ohm, 5-watt wirewound*
R_4 -	10,000-ohm, 5-watt wirewound
R_5 -	Selected -- 2 to 3 inches 20 gage chromel A wire (0.1 to 0.16 ohms)
C -	8-mfd., 250-volt Electrolytic
M -	Meter Relay, 25-0-25 microamp - low limit (API Model 455C)
RL_1 -	Relay, SPDT 5,000-ohm coil (Potter & Brumfield Kcp5, 5,000-ohm)
RL_2 -	Buzzer (Mallory Electromagnetic Type L 2143)
SW_1 -	SPDT Toggle Switch (C-H 8816K5)
SW_2 -	DPDT Toggle Switch (C-H 8821K5)
SW_3 -	DPST Toggle Switch (C-H 8823K5)
T_1 -	Transformer, Stepdown Voltage Regulating 6.3 volt, 10A (Sola Type 20-04-065 in Model KA and Sola Type 20-04-565 in Model KB)
T_2 -	Transformer, 125 volt, 50 ma. (Allied Radio Stock No. 54D1411)
SR -	Silicon Bridge Rectifier, 1.8A, 400 PRV. (IR 18DB4A)
SC_1, SC_2 -	Silicon Photocells (IR S2900E9. 5M)†
L_1, L_2 -	32 C.P. 6-volt Lamps (G.E. No. 1680) X
B - 25.67	Elapsed time Indicator (Cramer 636Y, 115 volt, 9999.9 second registration, 60 cycle in Model KA; 50 cycle in Model KB)

Lamps socket Part# 14 78.00 EACH
Bulbs (1680X) Part# 36-6.00 EACH

*5,000-ohm, 5-watt wirewound in Model KA Serial No. 1 through 28, and Model KB Serial No. 1 and 2.
†Some units employ Solar Systems No. 200C photocells. These are electrically equivalent, but terminal and mounting arrangements differ. Late models employ custom photocells of high efficiency.

F - Ventilating Fan - Rotron SP2B2

PL_1 - Neon Pilot Light Amber (Leecraft 32-2113T)

PL_2 - Neon Pilot Light Red (Leecraft 32-2111)

Fuse - MDL Fusetron 2 amp.

1-800 555 1212

Optical and auxiliary parts obtainable from Hercules Incorporated, P.O. Box 1027, Kalamazoo, Michigan 49005, are as follows:

- Heat-Absorbing Filters
- Glass Sample Window
- Foam Plastic Air Filter
- Standard Sample Holder
- High-Head Sample Holder
- Ceramic Standardization Tiles

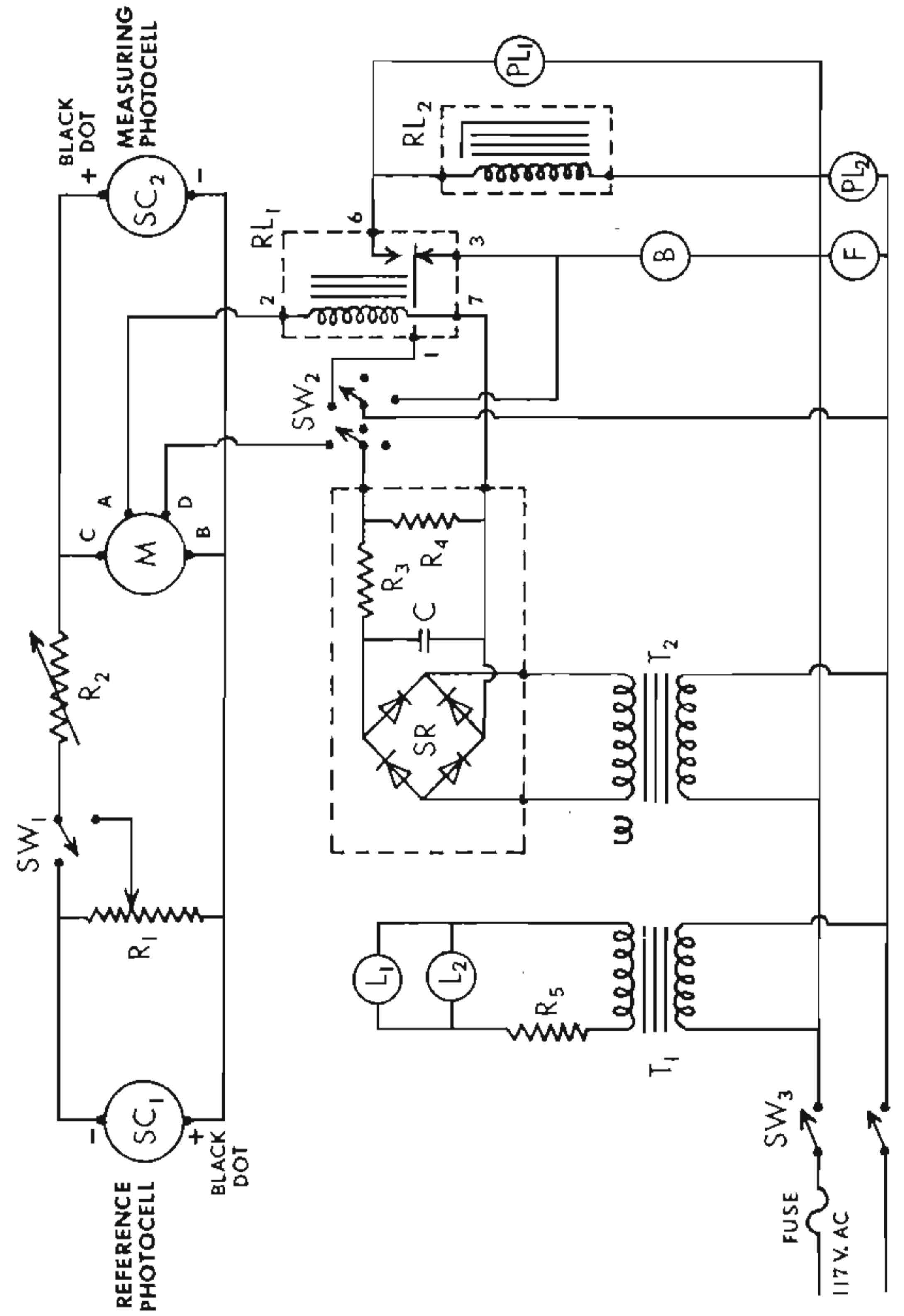


Figure 8-1. -- Hercules Sizing Tester Wiring Diagram