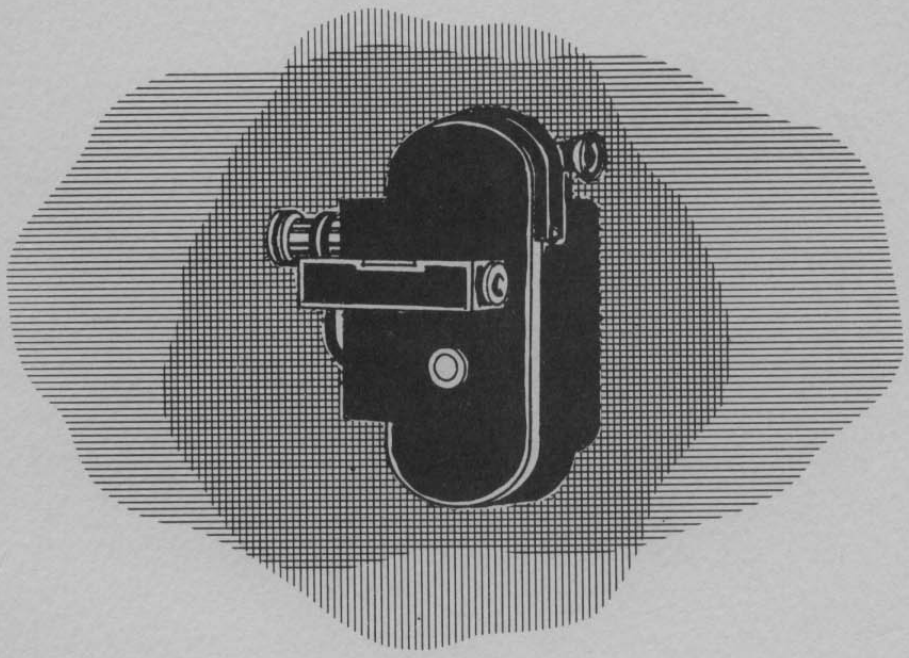
RONCHI RULINGS
AND THEIR USES



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RONCHI RULINGS AND THEIR USES

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Barrington, N.J.

This booklet is intended to give some practical ideas on the uses for Ronchi rulings. Some of the ideas include those sent in by our customers, and there are also those which we have added to make the booklet more complete. Although there are many more uses than those included here, it is hoped that, together with the readers' imagination, these ideas will act as a guide toward more and better uses to which these rulings can be applied.

WHAT ARE RONCHI RULINGS?

A typical Ronchi ruling is illustrated in figure 1, and it will be seen that such a ruling consists of evenly-spaced lines running parallel to each other. Here is where the similarity to other rulings stops; for in the case of a Ronchi ruling, the width of a line is exactly equal to the width of a space. There is a reason for this one-to-one ratio of line width to line spacing. When two identical Ronchi rulings are placed in contact with their respective lines running at right angles to each other, the spaces will then become small perfect squares. If the line and space widths were not the same, the resulting spaces as obtained above would not be squares, but rectangles.

Each ruling is reproduced photographically upon a glass plate, and the lines etched with acid. The original size of the finished rulings generally runs from 8 x 10 inches and up, smaller sizes being cut from the larger one. Since the etched surface composing the lines is exposed to wear, extreme care should be taken when handling Ronchi rulings. In fact, a good way to minimize the danger of wear is to apply a very light, even coating of lacquer or nail polish over the ruled side. The ruled surface of a Ronchi ruling may be safely cleaned with acetone, while the other side may be cleaned with Bon Ami or a standard lens cleaner.

Ronchi rulings are used commercially for preparing halftone negatives from continuous tone photographs (a photograph with a wide range of tones from white to black). A halftone negative, on the other hand, has as many tones as possible represented by dot size variations. To acquire various dot sizes in a wide range on a negative, the image formed by a camera lens must be forced onto the film through a "halftone screen". A halftone screen simply consists of two large sheets of Ronchi ruling at right angles to each other, the individual lines placed at an angle of 45 degrees to the side of the negative. Screens having as few as 32 lines per inch are commonly found in use. The usual range, however, is from 65 lines per inch, with the coarser screens used for making cuts to be reproduced on rough-surfaced papers and the finer screens for smoother papers.

To break the continuous image formed by the camera lens into systematically graded units, the halftone screen must be placed a specified distance from the film emulsion during the exposure, as shown in figure 2. Figure 3 illustrates the light from the copy photograph passing through an aperture of the halftone screen, after being focused onto the focal plane by means of the camera lens. The light spreads out in such a way so as the intensity falling on the film immediately in the screen aperture is at a maximum, but diminishes gradually in all directions from the center.

The dot diminishes from the center outward until the threshold level of the film is reached (where the intensity of light is too weak to activate the film), and results in nearly an abrupt cut-off. The dots, therefore, become varied in size since the distance from the center of the dot to the cut-off point will vary according to the light intensity reaching the screen.

In order to obtain the best dot graduation in a halftone negative, not only must the screen be at a specified distance in front of the film, but the lens aperture must be at a certain ratio to the lens-to-film distance. For average rulings, the ratio of lens-to-film distance over lens aperture equals 64, and the screen-to-film distance may be found by the expression

$$\frac{\text{Screen-to-Film Distance}}{\text{Screen Aperture}} = 64$$

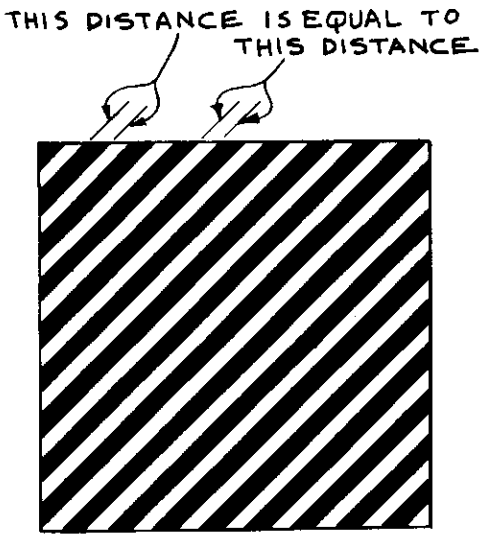

FIGURE 1. TYPICAL RONCHI RULING

For example, if two 120 lines per inch Ronchi rulings are used for a halftone screen, the screen aperture, or the size of each open square, will be 1/240th of an inch. The screen-to-film distance would then be equal to 64 x 1/240 or 8/30th of an inch.

After the screen-to-film distance has been found, the screen may then be mounted permanently at that distance from the film, measuring from the rulings and not from the surface of the glass. (For a higher accuracy, a correction of approximately one-third the thickness of the screen should be subtracted from the screen-to-film distance in order to allow for the refraction of light through the glass.) All that is required for a fixed screen-to-film distance is to maintain the 64 to 1 ratio by varying the lens aperture when the lens-to-film distance is changed.

The correct aperture may be found by the expression

$$\text{Aperture Stop} = \frac{64 \times FL}{D}$$

where

D = The lens-to-film distance
FL = The focal length of the camera lens (both D and FL measured in the same units)

For halftone photography, only cameras having a double extension bellows will produce quality work, although any camera may be adapted for experimental halftone copying if desired. For the best results, it is recommended to use a film with a very high contrast so that the delicate graduation in the halftone dot is not perceptable.

OTHER USES FOR RONCHI RULINGS

Ronchi rulings have been proven useful for many applications other than their original commercial use. For the sake of convenience, these other applications have been broken down into five major groups; Measuring, Optical Instruments, Lens Testing, Photography, and Miscellaneous applications.

Measuring With Ronchi Rulings - The first application for Ronchi rulings under measuring purposes is illustrated in figure 4A. It is simply a quick way to measure objects under a microscope without the bother of calibrating the lens system to a reticle. A Ronchi ruling is cut to approximately the same shape as that of a standard microscope slide (1 x 3 inches), and the object to be measured is placed directly on the ruled face of the slide. It is only necessary to calculate the width of the lines or spaces to have a convenient yard stick located right under the specimen when looking into the microscope. The following table giving line widths for various Ronchi rulings will prove useful.

Lines per Inch	Line Width	Lines per Inch	Line Width
40	0.0125"	85	0.0059"
50	0.0100"	100	0.0050"
55	0.0091"	110	0.0045"
60	0.0083"	120	0.0042"
65	0.0077"	133	0.0037"
75	0.0067"	150	0.0033"
80	0.0063"	175	0.0029"

NOTE: To convert inches to millimeters, multiply by 25.4.

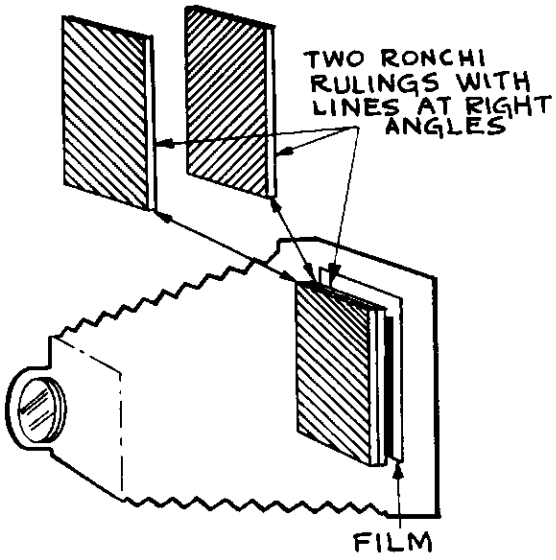

FIGURE 2. COMMERCIAL USE OF RONCHI RULINGS

A Ronchi ruling microscope slide may be used also for measuring the power of an unknown microscope eyepiece. This is done by using an eyepiece of known power while viewing the Ronchi ruling, and counting the number of lines in the field. Now, with the same objective, count the number of lines in the field when using the unknown ocular. To find the power of the unknown eyepiece, the following formula may be used:

$$\text{Unknown Power} = \frac{A \times B}{C}$$

where

A is the power of the known eyepiece.
B is the number of lines counted in the field of the known eyepiece, and
C is the number of lines counted in the field of the unknown eyepiece.

For example, if it is desired to find the power of a non-standard eyepiece with a known 15 power eyepiece, the line count may be as follows:

1. Lines counted with the known eyepiece (B) = 4.
2. Lines counted with the unknown eyepiece (C) = 12.

Therefore, the power of the unknown eyepiece equals $\frac{15 \times 4}{12}$, which is equal to 5X.

As a general rule, the above method will give an accurate indication of the unknown power. However, the fields of identical eyepieces are not always the same, since they may have different size field stops. It is best, therefore, to make several comparisons and average out the answers, or to compare the caluclated power with a known eyepiece of the same power.

Figure 4B illustrates a set-up for measuring objects too large to be adapted for measurement under a microscope. It consists of a low-powered magnifier mounted on a focusing stand, with a Ronchi ruling as an object stage. The stage may be mounted on an open frame in order to be lighted from below for transparent or translucent objects, or it may be mounted on a solid base as illustrated and lighted from above for opaque objects. A great variety of measurements may be made with this instrument, such as those listed below.

1. Measuring the number of dots per inch in a halftone print.
2. Measuring engravings, such as stamps, for printing differences, or for checking the placing of surcharges and overprints. Checking for watermarks may also go under this category.
3. Measuring the grain size of abrasives, soils, and the various types of powders.
4. Measuring small machined parts, such as the radius of curvature of needle points or the widths of honed microtome blades.
5. Measuring the thread count of woven material.
6. Measuring and cutting resistance wire that has several ohms resistance per inch.
7. Measuring and comparing fingerprints.

Another useful measuring application for Ronchi rulings is to determine the image magnification of an enlarger or a projector. Figure 4C shows an enlarger with a Ronchi ruling mounted in the negative carrier. To find the magnification at any one setting of the enlarger, simply focus the pattern on a white sheet of paper and count the number of lines obtained per inch. (A pencil line, one inch long, marked on the paper beforehand is quite convenient). Divide the number of lines per inch projected by the enlarger into the number of lines per inch on the Ronchi ruling. The figure obtained is the image magnification. For example, if a 50 lines per inch Ronchi ruling is used, and the projected image contains 12.5 lines per inch, the image magnification is 50/12.5, or 4X. A Ronchi ruling of from 40 to 50 lines per inch is recommended for this purpose, since the lines projected from these coarse rulings are easier to count. Along the same idea, the degree of magnification in a home-built photomicrography set-up can easily be determined with a Ronchi ruling. This can be especially valuable if the

picture is enlarged later with an enlarger. A picture of the Ronchi ruling taken under the same conditions as the object, and enlarged in the same way, makes possible absolute measurements on the picture.

For extremely accurate measurements of small relative movements, or displacements, two Ronchi rulings and an ordinary barrier type photocell may be used. One ruling is solidly attached to a stand which is in a fixed position, and a second ruling, identical to the first, is fastened to the object whose displacement is to be measured. Next, light from a bright source is made parallel by a condensing system and projected through the two gratings. The relative light intensity; and when a black line covers a white line, or space, the light intensity is at a minimum. Thus, when a Ronchi ruling of 150 lines per inch is used in both places, a displacement of 1/300 of an inch will change the intensity from a maximum to a minimum. It should be possible to measure accurately at

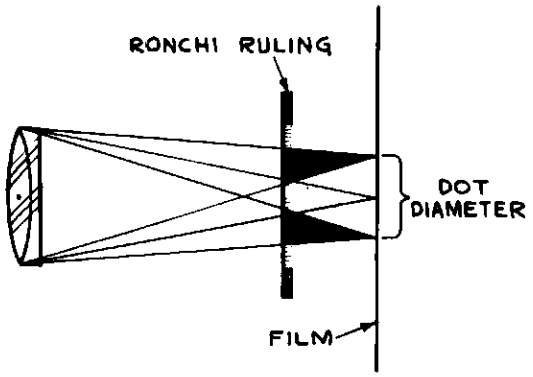

FIGURE 3. DOT FORMATION

least 1/10 of that figure or 1/3000 of an inch by calibrating the indicator unit of the photocell. Of course, the direction of displacement must be perpendicular to the lines on the rulings.

Such a set-up may be used for a great number of purposes; such as for the determination of thermal expansion coeffecients of solids, for recording compressibility, or even as an indicating unit for a homemade seismograph. A two-or-three-dimensional displacement can be determined with several set-ups attached to the object in different locations so as to record the movement in different directions.

Ronchi rulings may also be used for testing a person's visual acuity. Several sizes of rulings are mounted in frames with a diffused light source behind them (A 60-watt bulb enclosed in a metal box with a ground-glass aperture will do for the light source.) The subject is placed at a distance of 10 inches from the ruling, as measured from the eyes, and the different rulings

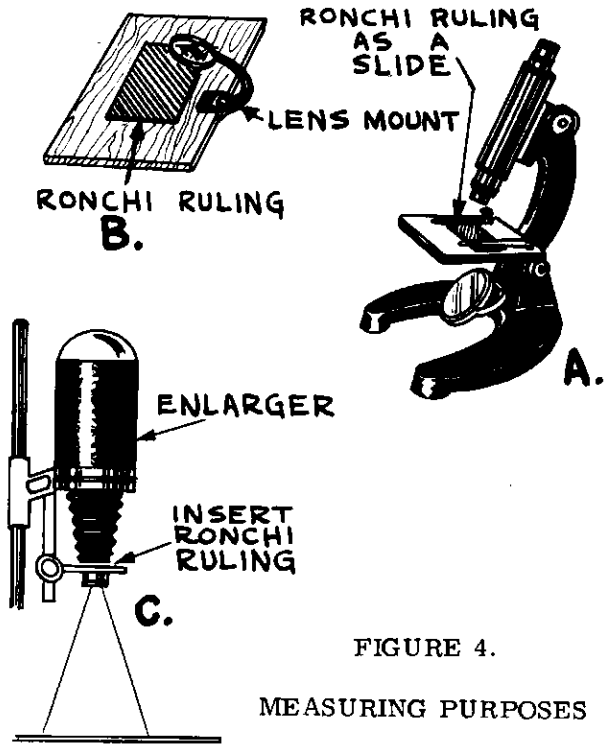

FIGURE 4.

MEASURING PURPOSES

are presented to him starting from the coarser lines to the finer lines. The finest ruling the subject can distinctly resolve into separate lines will give his visual acuity in lines per inch at a distance of 10 inches. This, of course, is only an approximation of the subjects acuity, since the actual value may fall somewhere between the finest ruling he can resolve and the next ruling on.

A Ronchi ruling of 50 lines per inch may be used for subdividing or calibrating the scales on graph paper. For example, if it is desired to plot a curve on a piece of graph paper having 10 lines per inch, the smallest divisions on the graph paper may be further divided into 5 parts by aligning the Ronchi ruling with the lines on the paper. If a 5-power magnifier is used in connection with the Ronchi ruling, then the subdivisions will appear as large as the original divisions on the paper.

Optical Instruments - One of the original uses for Ronchi rulings in optical instruments is illustrated in figure 5A. Here, the ruling is used as a wavelength scale in a spectroscope and is located in the focal plane of the telescope eyepiece. The ruling size depends upon the spectrum size obtained and upon the slit width of the spectroscope, although for most applications a ruling of 150 lines per inch is satisfactory. Small calibration marks should be added, with the help of a magnifying glass, every ten or twenty lines to aid in reading the spectrum lines. To use this type of wavelength scale, it is necessary to know the wavelength of at least three spectrum lines; one at each end of the spectrum,

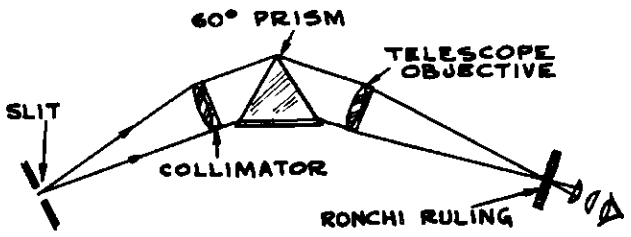

FIGURE 5-A.

SPECTROSCOPE WAVELENGTH SCALE

and one somewhere near the center. It is then relatively easy to interpolate the wavelength of any spectrum line appearing between the known points. However, any calculation made on this basis can only be of an approximate nature, since the variation in wavelength by spectrum position is generally not a linear function.

Ronchi rulings may also be used in connection with spectroscopes as elementary diffraction gratings. Figure 5B shows a simple experimental diffraction spectroscope consisting of an entrance slit, a collimator lens, a 175 lines per inch Ronchi ruling, and a viewing system. For a maximum displacement, the lines on the ruling should be parallel to the entrance slit. Actually, the spectrum produced by one of these gratings is not accurate or sharply defined, but such an instrument has the advantage of showing clearly the periodic variation of intensity in the different orders of diffraction. Standard diffraction gratings, as used in commercial instruments, have rulings from 15,000 to 30,000 lines per inch, and it can be seen that a 175 lines per inch Ronchi ruling is indeed a coarse grating by comparison. However, it is possible to make a fairly good diffraction grating from a Ronchi ruling by reducing one photographically, provided care is taken in the developing process.

If a 4 x 4 inch Ronchi ruling is reduced by a standard 35mm. camera so that it only measures 1/2 x 1/2 inches on the negative, the reduction would be 8 times. If the Ronchi ruling used for copy consisted of 133 lines per inch, the resultant ruling on the negative would then contain 8 times 133 or 1064 lines per inch. This is actually fine enough for experimenting with homemade diffraction spectroscopes.

Figure 5C illustrates an interesting diffraction spectroscope which is quite similar to the one illustrated in figure 5B except for the addition of a right-angle prism. This type of spectroscope is particularly well-suited for medium gratings such as the 1064 lines per inch ruling just mentioned. The right-angle prism serves two purposes: (1) it makes the instrument more convenient to work with; and (2) by revolving the prism around point P, it becomes possible to select any portion of the spectrum and bring it into the center of the field of view. By adding another, wider slit in front of the telescope lens as illustrated, the undesired portions of the spectrum may be masked out.

If a Ronchi ruling of 100 or 175 lines per inch is used as a diffraction grating in either of the two types of spectroscopes mentioned above, further interesting experiments may be performed. For example, by covering all but two of the open lines of the grating, one may see, and even photograph, a double-slit diffraction pattern. Likewise, if three rulings on the Ronchi gratings are exposed, a triple-slit pattern may be observed. This process may be continued up to about 6 exposed rulings until the extremely fine secondary lines in the diffraction pattern cannot be seen. Two parallel razor blades may be used as a variable slit to blank out the undesired rulings of the Ronchi grating.

Ronchi rulings are also useful for checking and calibrating the widths of spectrometer and spectroscopic entrance slits, or they may even be used as the entrance slit by masking out all but the desired spaces with opaque. Figure 5D illustrates a spectroscope using a Ronchi ruling as a multiple-entrance slit, such an instrument being used mainly to observe interference patterns. Interference patterns may also be observed in the microscope by placing two Ronchi rulings of different divisions under the objective and revolving one relative to the other.

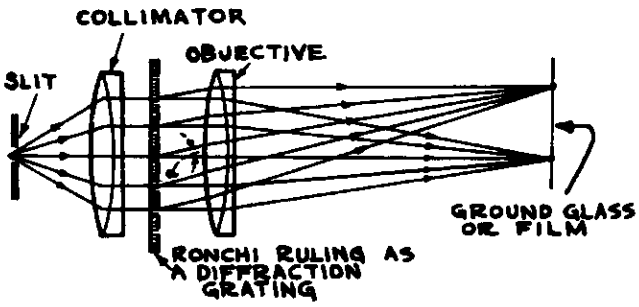

FIGURE 5-B. ELEMENTARY

DIFFRACTION SPECTROSCOPE

At times it becomes necessary to check the photometric accuracy of a photocell system against a standard system or against a new photocell unit. This type of test may be performed quite easily by using two Ronchi rulings as illustrated in figure 5E. Here, the Ronchi rulings act as variable neutral transmission

screens when one is rotated relative to the other. A neutral transmission screen simply cuts down the amount of light transmitted through it in order that an optical device may be tested for sensitivity. The test of a photocell unit may be set-up somewhat as follows:

1. Mount two 50 lines per inch Ronchi rulings so that the lines on one completely cover the spaces of the other. Very little light should

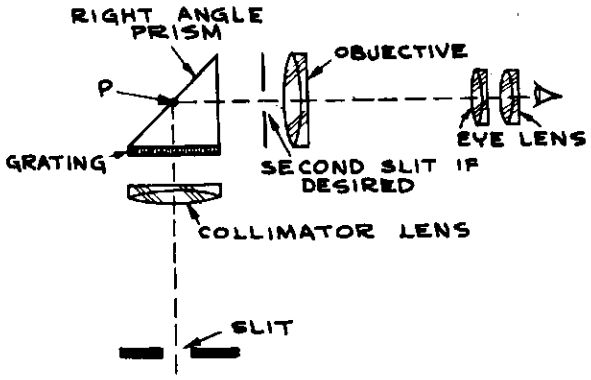

FIGURE 5-C. SELECTIVE

DIFFRACTION SPECTROSCOPE

pass through the resultant screen. Set the screen between a light source and the device to be tested as illustrated.

2. Slowly rotate one ruling with respect to the other until the photocell relay clicks in place, or until a definite indication is given that the device is operating.

3. Note the angle one ruling makes with the other and compare it with the angle made by the rulings when a standard is used as an indicator. A neutral transmission constructed in this fashion may also be used as a transmission standard when using a precision photometer, or for checking small optical differences in transmission paths.

A form of optical level may be made with a Ronchi ruling of 50 lines per inch by inserting the ruling in a telescope eyepiece in place of a reticle. If the telescope is then aimed at a known level object and the rulings made parallel to that object, a good comparison level is obtained. Similarly, the telescope may be mounted on a tripod, leveled with a bubble gauge, and used in this fashion as an optical level; provided that the Ronchi ruling can also be leveled parallel to the tripod top.

Another interesting use for a Ronchi ruling is in the construction of an elementary star spectroscope. All that it amounts to, actually, is mounting a 175 lines per inch ruling directly in front of a telescope objective. If the telescope is then aimed at a distant star, multiple images of the star will be seen according to their spectrum positions and color. Actually, the spectrum obtained in this way is strictly limited by the relatively coarse rulings, but it will give an idea as to the general nature of the star observed.

Lens Testing - Perhaps the most well-known use of Ronchi rulings in the field of optics is in connection with lens and mirror testing. Indeed, Ronchi rulings do provide for simple and direct tests of the quality of a lens or a lens system.

If a 50 lines per inch Ronchi ruling is held next to the eye and a lens held at its focal length away from the eye, the pattern observed when looking at a distant light source will give an easily read indication of the amount of spherical aberration present. The patterns obtained may look similar to those illustrated in figure 6A. A simple lens will generally show a family of hyperbolas, while a well-corrected lens will show a pattern of straight and parallel lines. Similarly, other lens aberrations such as the departure of the lens from a figure of revolution will be readily noticed.

Another well-known test concerning Ronchi rulings is the Ronchi mirror test, similar in nature to the Foucault knife-edge test. Figure 6B illustrates the general set-up for such a test. The light is projected onto the mirror in the form of a series of parallel bands, since it first passes through a ground-glass diffusing screen and then through a portion of a Ronchi ruling. The parallel bands are then returned through the same ruling after reflection from the mirror. If the eye is placed into position slightly behind the focal length of the mirror, the mirror will seem to have a series of stripes across it (interference bands), and the patterns will be somewhat as illustrated in figure 6B.

Pattern I indicates a perfect spherical surface, with all the lines straight and evenly spaced.

Pattern II indicates a spherical surface with a "turned-down edge", a serious fault.

Pattern III indicates a good parabolic surface, as each of the lines have a slight parabolic curve to them.

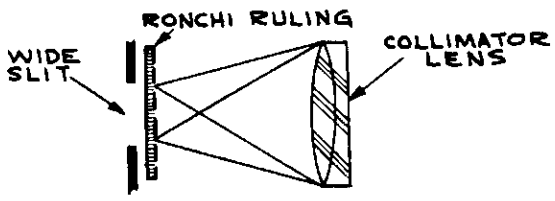

FIGURE 5-D.

MULTIPLE ENTRANCE SLIT

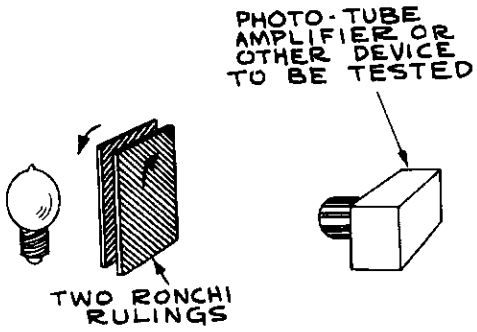

FIGURE 5-E.

NEUTRAL TRANSMISSION SCREEN

Pattern IV indicates the surface to be that of an oblate spheriod, another fault for simple reflecting telescopes.

Besides the patterns shown, others may be seen such as a close grouping of lines in one sector of the mirror's surface which indicates the presence of an island or a land. These and many other patterns may be found in standard textbooks dealing with the subject of telescope mirror making.

It is also possible to test lenses with the Ronchi method by placing a good first-surfaced mirror behind the lens in order to return the light beam. Of course, this only applies to positive lenses; negative lenses can be tested without the additional mirror surface. In either case, the patterns obtained while testing lenses will be similar in appearance to those just discussed.

To test compound lens systems, such as camera lenses, projection lenses, and enlarger lenses, leave the lens in the system for which it was designed and test the system as a whole. For example, a slide projector or an enlarger may be tested easily by inserting a Ronchi ruling into the negative or slide carrier and observing the projected image. In a good system, the projected lines should appear parallel to each other and be perfectly sharp at the edges of the field, as shown in figure 6C. A camera lens should be tested by taking a series of pictures at different aperture settings. The camera may be focused on a Ronchi ruling from a distance of about 20 times the focal length of the lens, and the exposures taken on an extremely fine grain film. A set of Ronchi rulings running in grades from coarse to fine should be available, and a series of shots taken using a different ruling each time; the negative on which the finest group of lines can be distinguished represents the resolving power of that particular combination of lens, aperture setting, and film. The following table gives the relation between the Ronchi ruling size and the number of lines per millimeter obtained on the negative when the ruling is at a distance of 20 times the focal length of the lens.

Lines Per Inch On Ronchi Rulings	Lines Per Millimeter Or Negative	Rating*
40	32	Poor
50	40	Fair
55	44	Average
60	48	Good
65	52	Good
75	60	Very Good
80	63	Very Good
85	68	Excellent
100	80	Theoretical

*This rating is of general nature only

To count the number of lines per millimeter appearing on a test negative, a low power microscope (about 50 power) is recommended. For further information on how to test photographic lenses, see the National Bureau of Standards Circular No. 533, METHOD FOR DETERMINING THE RESOLVING POWER OF PHOTOGRAPHIC LENSES.

Photographic Processes - Many photographers use Ronchi rulings to test fine-grain film emulsions and fine-grain developers. When it is desired only to test for sharp contrast (clean, smooth line separations), a Ronchi ruling may be placed ruled side down on the unexposed film and exposed as a contact print. The developed negative may then be studied under a low power microscope to see if the divisions between the lines and spaces are sharp and regular. However, if it is desired to know the film resolution in lines per millimeter, a process similar to the one described for testing camera lenses must be resorted to. Here, it is necessary to have a good camera lens with a known resolution, and tightly controlled condition of lighting and developing.

Figure 7A illustrates a novel way to make moving photographs or double pictures on one print. An enlarger is prepared to make a print

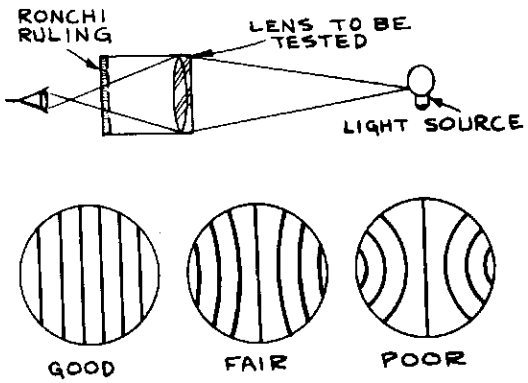

FIGURE 6-A.

SPHERICAL ABERRATION TEST

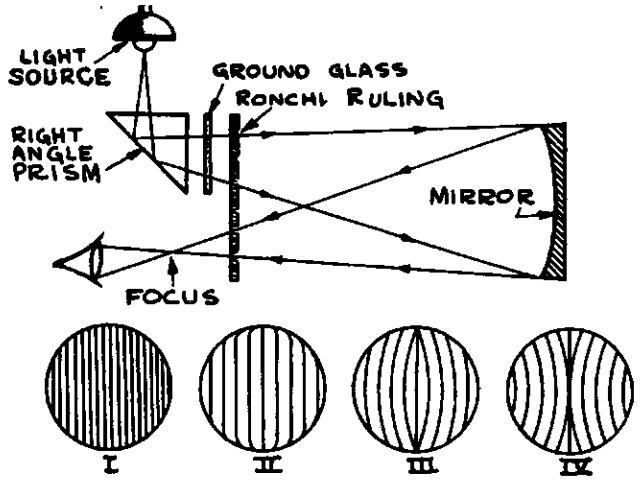

FIGURE 6-B. RONCHI MIRROR TEST

in the normal fashion, but before the exposure is made, a large size Ronchi ruling is placed over the enlarging paper with the ruled side down. A normal exposure is then made, allowing a bit more extra light to account for the glass part of the Ronchi ruling. Next, the Ronchi ruling is carefully moved over a distance equal to the width of one line so that the ruled lines now cover the portions of the paper previously exposed. Another picture may now be exposed and the print developed in the normal way. To view a print made in this way, a Ronchi ruling of the same size used to make the print must be mounted a small distance in front of the photograph, with the ruled lines going in the same direction as when the picture was taken. A slight movement of the eyes perpendicular to the rulings will change the picture, or move your field of view to the next picture. If the two pictures made were of a normal sequence type, such as two frames selected from a motion picture film, the resulting print will seem to move when viewed in the proper manner. On the other hand, if two unlike photographs were exposed, then the resulting print will be a double photograph used mainly for advertisement.

Another interesting stunt that can be pulled with Ronchi rulings is making background patterns for small articles to be advertised. This can be accomplished with a standard enlarger and a pair of Ronchi rulings. Various stock enlargements of the patterns produced when two rulings are rotated with respect to each other can be used, as well as a single Ronchi pattern, and when a nice background is desired, there it is! Figure 7B illustrates on possibility.

By placing a 133 lines per inch Ronchi ruling face down on a sheet of enlarging paper before a print is made, a reasonable imitation of a line drawing or etching will result. Similarly, by placing two coarse rulings, faces together, at right angles to each other several millimeters above the enlarging paper, a halftone print will result which will be suitable for silk screen reproduction. A halftone made in this fashion will, of course, be a positive print.

Incidently, while all this enlarging is going on, it may be necessary to use a dodger, and even this may be made from a Ronchi ruling. Such a dodger is illustrated in figure 7C, and since it is composed of equal lines and spaces, it is semi-transparent; and thus offers more control over stubborn negatives.

If a three-color banded filter is placed in front of a camera lens, and a Ronchi ruling of 100 lines per inch is placed a short distance in front of the film plane, an elementary set-up for additive color photography is obtained. (A three-color banded filter is one which has red, green, and blue stripes of equal area running parallel to each other.) Next, a ground glass screen is placed in the film plane of the camera, behind the Ronchi ruling, and the lens focused on a source of white light. For each space in the ruling, a red, a green, and a blue line will appear on the ground glass. If panchromatic film is substituted for the ground glass, given a balanced exposure, and developed by the reversal method, an additive color positive expressed in black and white lines will be obtained. By placing the developed film back into its original position and illuminating it from the rear with a source of white light, there will appear on a screen placed in front of the set-up many minute lines of red, green and blue. These

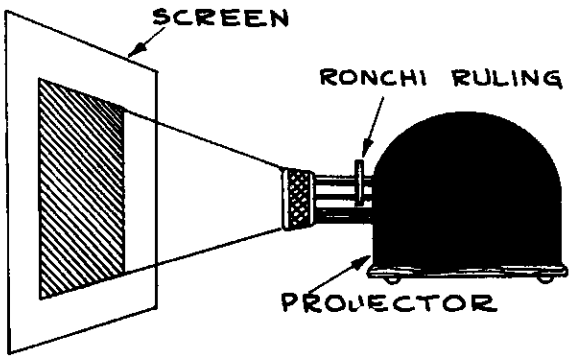

FIGURE 6-C.

TESTING A PROJECTOR SYSTEM

lines, when viewed at a distance, will blend together to make white light giving the screen a pure white appearance.

Likewise, a photograph taken of a colorful object with such a set-up will appear on the screen in its original colors, since the three colored lines will correspond in density to the intensities of the colors entering the lens. Of course, the color will only be obtained if the reversal negative is used with an identical optical system for projection as was used when the negative was originally made.

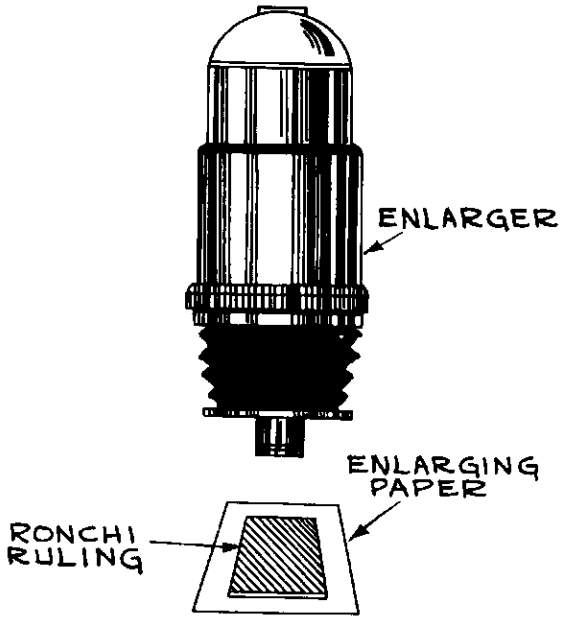

FIGURE 7-A.

HOW TO MAKE DOUBLE PICTURES

Another useful idea on the application of Ronchi rulings to the field of photography is the construction of a small pocket size rangefinder suitable for close-up shots at ranges from about three feet down to several inches. First, a Ronchi ruling is mounted over a mirror with the ruled lines up in order that there will be a space between the rulings and the reflecting surface of the mirror. The ruled lines should be protected by a thin sheet of glass or celluloid, and the whole unit mounted in a small sheet metal or wooden container.

By looking into the mirror through the ruling, a number of black and white interference bands will be seen, the number of lines present depending upon three things:

1. The number of lines per inch on the Ronchi ruling.
2. The distance between the ruling and the mirror surface, and
3. The distance between the eye and the ruling.

Since the first two quantities are fixed, the third may be found by simply counting the number of bands seen at a certain distance.

The instrument should be calibrated by mounting it at different distances from a camera, counting the number of lines through the viewfinder, and then measuring the lens-to-subject distance. From the data found, a calibration table may be made up expressing the number of lines counted and the lens-to-subject distance for that particular number of lines. In use, the rangefinder is laid in the same plane as the object to be photographed, and the lens-to-subject distance found from the table. If the photographer has a favorite copying stand, or close-up table, the rangefinder may be mounted directly on the subject stage to eliminate the possibility of losing it. It will also be found that the instrument is very handy and the method much faster than direct measurement of the distnace, especially when doing a great deal of close-up work.

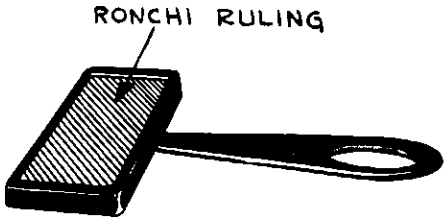

FIGURE 7-C. ENLARGING DODGER

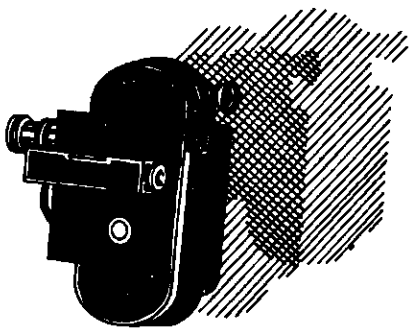

FIGURE 7-B.

TYPICAL BACKGROUND PATTERN

Miscellaneous Uses - A simple method for determining the surface flatness of practically any object is illustrated in figure 8. A finely-ruled Ronchi ruling (about 120 lines per inch) is placed face down on the surface to be tested, and a strong white light is placed in the position illustrated. If the surface is perfectly smooth, an

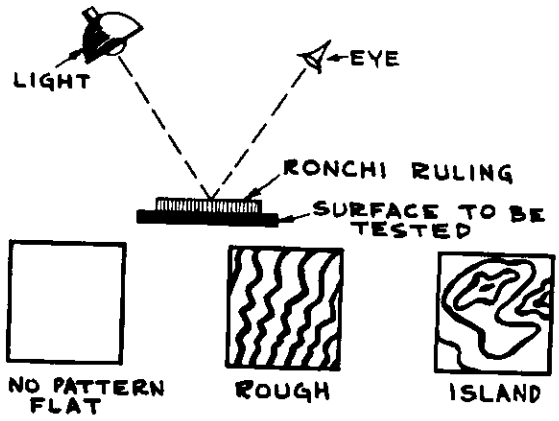

FIGURE 8.

TESTING FOR SURFACE FLATNESS

even grey tone will be seen when looking at the ruling. However, if the surface is not perfectly flat, interference bands will be set up, and the patterns seen will look similar to those illustrated in the figure. Likewise, if it is desired to read the impressions made by a pencil through a writing sheet onto a desk blotter, or onto the sheet underneath, simply place a finely-ruled Ronchi ruling over the blotter with a light source located as shown in figure 8. The impressions formed by the pencil will be easily legible when the lines on the ruling are running perpendicular to the way in which they are being viewed.

Ronchi rulings can also be used to align the horizontal and vertical linearity of television receivers in conjunction with a test bar generator instead of with a mirror. The eyepiece used for this test consists of two parallel 100 lines per inch Ronchi rulings. By moving the rulings closer together or further apart, it is possible to control the number of interference bands seen, and thus make them identical in number to the bars on the television screen. Good linearity is indicated when the black interference bands can be made to coincide with the white bars on the screen, making the whole screen appear black.