The GENERAL RADIO EXPERIMENTER

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ELECTRICAL COMMUNICATIONS TECHNIQUE AND ITS APPLICATIONS IN ALLIED FIELDS

In This Issue

A NEW STROBOSCOPE FOR SPEED MEASUREMENTS

THE ability of the stroboscope* to slow down or stop motion has found many applications in industry, and one of these, the measurement of speed, has justified the design of a small unit especially adapted to it. Speed is measured with the stroboscope by adjusting the flash rate until the rotating object appears stationary, and reading the flash rate off a scale which may be calibrated directly in r.p.m.

Of the common industrial processes none is more dependent on accurate speed maintenance than the spinning operations in all kinds of textiles. Uniformity and high quality in the finished product depend directly on the maintenance of uniform spindle speed. Policing of spindles has not been convenient, owing to the difficulty of making contact to the end of the shafts, and to the large number of spindles involved. With the small stroboscope (strobotac) the problem disappears. The first spindle on a row is set at the proper speed, and the operative walks down the frame, leaving the strobotac speed setting unchanged. As the spot light strikes each spindle in turn it will appear to revolve slowly either forward or backward. Belts are quickly adjusted to make the spindle appear stationary, and the operative moves on. In this manner constant speed checks can be maintained on a large number of spindles by a single operative.

Stroboscopic methods for the measurement of speed of reciprocating or

*General Radio *Experimenter*, December, 1932.

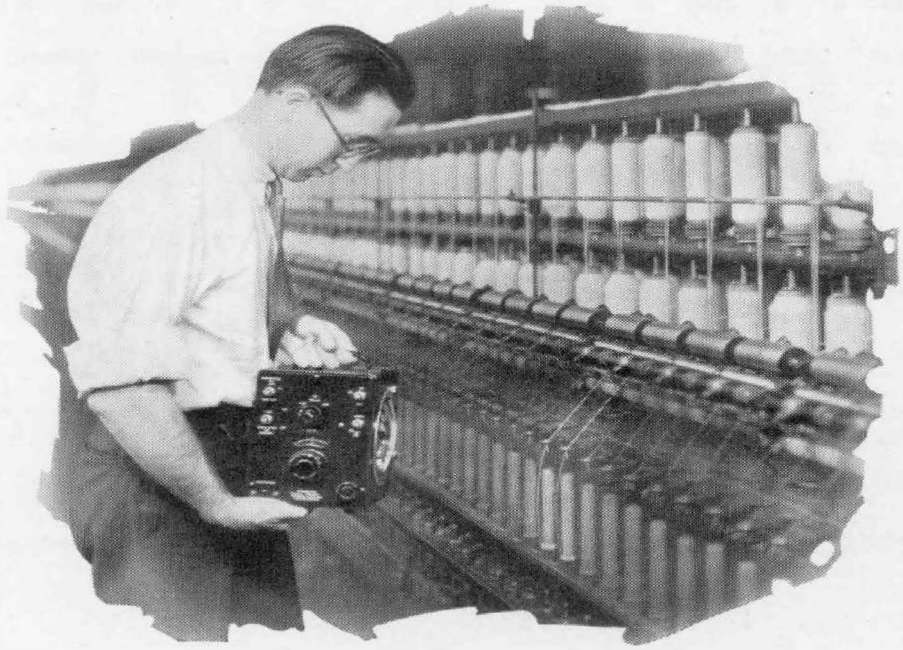

FIGURE 1
Spindle speed is quickly checked with the strobotac. When it is set for the right speed properly adjusted spindles will appear stationary

rotating machinery have numerous important advantages. Since no mechanical contact is required with the mechanism being studied and no power whatsoever is absorbed from that mechanism, the making of the measurement does not in any way alter the performance of the machine. This is frequently of great importance. For instance, in many types of machinery it is difficult or impossible to attach a mechanical or dynamometer tachometer to the moving shaft. In fact, it is frequently impossible even to approach the moving parts within several feet and, of course, ordinary tachometers cannot be used at all with reciprocating parts. Furthermore, in the case of many small and delicate mechanisms, any of the ordinary types of tachometer may cause a reduction in speed or may actually stall the equipment.

For such applications, a stroboscopic tachometer is invaluable. It requires no contact with the moving parts of the machine and may, in fact, be held some distance away. The General Radio Company is now announcing an instrument designed primarily for this type of work. The TYPE 631-A Strobotac is small and light and all parts are contained in a single case, including the lamp, triggering oscillator, etc. The strobotac is provided with a direct-reading, illuminated, revolutions-per-minute scale and provision is also made for control at the line frequency or by an external contactor, so that the instrument may also be used for the same purposes as other stroboscopes.

The TYPE 631-A Strobotac has a flashing range extending from 600 flashes per minute to over 12,000. The calibration is adjusted by means of a vibrating reed which is controlled by the alternating line voltage. Setting of the trimmer adjustments so that the reed appears to stand still when the strobotac dial is set at 900 and 3600 adjusts the whole calibration so that the unit is then direct reading. This check is easily and quickly made and compensates for drifts in line voltage, aging of tubes, and other factors which might otherwise impair the calibration.

FIGURE 2. TYPE 631-A Strobotac

The strobotac may also be used to obtain highly accurate measurements of the slip of induction motors. For this purpose, the strobotac is controlled by the power-line frequency and the slip of the motor may be counted directly. A similar method can be used to observe hunting and transients in synchronous motors.

While the intensity of illumination available is, of course, much less than is obtained from the TYPE 548-A Stroboscope, sufficient light is obtained for the stroboscopic observation of small mechanisms. The light is concentrated on the object being studied by means of a parabolic reflector. Among the many things which can be observed are such phenomena as vibration in valve springs, failure of a roller to follow a cam, etc.

The strobotac is illustrated in Figure 1. When it is held before the operative so that the reflector points forward, all controls are on the right side of the instrument, which results in maximum convenience of operation. The instrument is equipped with a handle and provision is made for fastening a tripod socket to the bottom.

The strobotac may be triggered off in three different manners. In the first place, it can be controlled by the knob on the panel which reads directly in r.p.m. and which is used for speed measurements. In the second place, the equipment can be controlled by an external contactor to provide absolute synchronism with the observed mechanism. This method of control also adapts the stroboscope for the adjustment of clocks, etc. The instrument may also be controlled by the power-line frequency. The various methods of control are made immediately available by merely snapping the toggle switches on the panel of the instrument. Only a source of 115-volt, 60-cycle alternating current is required to operate the strobotac.

— H. H. SCOTT

The TYPE 631-A Strobotac is a joint development of Harold S. Wilkins, of the Engineering Department of the General Radio Company, and Dr. Harold E. Edgerton and Kenneth Germeshausen of the Massachusetts Institute of Technology.

The price of the strobotac is $92.50 net, including tubes.

CATALOG DATA

Speed Range: 600—4000 r.p.m.
2400—16,000 r.p.m.
Accuracy: ±2%.
Weight: 12 pounds.
Dimensions: 6½ inches by 9 inches by 10 inches.
Operates: From 115-volt 60-cycle mains.
Power Required: 25 watts.
Price: $92.50.
Code Word: BRAVO.

COLOR COMPARATOR

THE problem of color matching has been of increasing urgency in industry for a number of years. Not only are new correlations between color and other qualities of materials being discovered, but color is being more extensively used in manufacturing, especially of consumer goods, and the problems of quantity production require accurate maintenance of color for large batches of goods and between successive batches. The use of color as an indication of condition in cooking is familiar, but industrial applications of the same sort are growing more numerous. These apply not only to processing, but to grading of materials and, even in some instances, to medical diagnosis.

Increasing use of colored materials in industry creates a great need for a quantitative method of reproducing colors. Under mass-production methods all of the upholstery of a car may not be made from the same lot of material. Successive lots, therefore, must match closely. Similarly, the sleeves and fronts of a lot of shirts might be made from different shipments of cloth, and there have been instances when the mismatch was not discovered until the shirts had been made up. The opportunities for financial loss and impairment of good will between fabricators and suppliers in such a situation are obvious.

Color matching in most industrial plants still depends upon the skill and the color judgment of an experienced operative unassisted by instrumentation. This method of matching is open to rather serious objections. In cases of disagreement there is no impartial basis for a decision, and the nature of the problem offers many opportunities for disagreement. The effect of the nature of the lighting on apparent color is familiar. Differences of weave and finish also introduce difficulties in matching, even to the trained observer.

FIGURE 1. TYPE 725-A Color Comparator. Color intensity is indicated as a meter reading. Filters are shifted by means of the knob at the upper left. The pilot lamp indicates which filter is in position

The complexity of the problem results from the fact that color stimulus reaching the eye is a summation of many factors which the eye has no power to differentiate. There are hundreds of widely different stimuli which would be described identically if seen separately. When samples are observed side by side, reasonably small differences can be distinguished, but the limitations of such matching are sufficient to represent a serious industrial problem.

Three factors combine to make up the complete psychological impression of color which the eye perceives. Most obvious of these is hue, that is, the position of the predominant response in the visible spectrum. Brilliance is the eye's estimate of the total reflection from the object. It is a measure of the "darkness" of the color, and if the object reflected all colors equally—that is, were white—the scale of brilliance would run from white to black. The third factor, saturation, is a measure of the intensity of the hue. A white object, having no predominant color, would have a zero saturation. An absolutely pure primary color would have maximum saturation.

The experienced eye unconsciously evaluates all of these factors within limits, but an objective method which would be independent of lighting, fatigue, and individuality possesses obvious advantages. The problem of color measurement is in many ways analogous to that of wave analysis. The color stimulus represents a complex waveform containing many components over a wide spectrum. The problem consists of measuring the relative intensity of these various components. Such a measurement takes into consideration all three subjective characteristics—hue, brilliance, and saturation.

The most complete and scientifically satisfactory method of color analysis which has been developed is concededly the Hardy Analyzer manufactured by the General Electric Company. This instrument surveys the entire visible spectrum with a highly selective optical filter, consisting of a prism and an optical slit, and measures the intensity of each frequency in the complex waveform in the same manner as wave analyzers are used at low frequencies. The construction of the instrument is, of course, essentially different in detail, although functionally similar. For example, where, in the examination of voltage, its magnetic effect is used to deflect a meter, in color analyzers the intensity of reflection is gauged by means of a light sensitive surface.

The complete analysis of color, while essential for standardization and for precise measurements, suffers a disadvantage on the score of cost and complication of operation when considered as a shop instrument.

The engineering firm of Barss, Knobel & Young have evolved a simplification of the analyzer principle in color measurement which rests on the fact, attested by the majority of color physicists, that any gradation of color can be exactly reproduced by recombination from three primary colors—red, green, and blue. The application of this principle has made colored moving pictures feasible, and all color effects obtained in modern chromo-cinema technique are founded on this principle.

In the Barss, Knobel & Young Color Comparator, which the General Radio Company is manufacturing, reflection is measured in three frequency bands selected from the complex waveform by filters. This results in a compact and easily operated instrument in which the sample is placed over the viewing aperture and the reading of a meter noted as the filters are successively moved into place. In examining any color three meter readings will be obtained corresponding to the red, blue, and green regions, respectively. When these readings are identical for two samples, the samples are identical in hue, saturation, and brilliance—that is, will appear to match under any conditions of lighting when viewed by reflected light.

Importance of the method of lighting a color sample is generally recognized, and a uniform lighting source is an essential beginning for such an instrument. When all samples are viewed by the same light the differences due to lighting are, of course, eliminated. It is also essential that the light intensity be constant at all times. In an alternating-current operated instrument this means that a precise voltage regulator must be included in the instrument.

Since light is reflected from material in somewhat different ways, depending upon its direction of incidence in relation to the weave direction, large errors may be incurred if this factor is not provided for in the design of the instrument. In the Type 725-A Comparator an optical system has been devised which eliminates this error entirely and makes the reading of the instrument substantially independent of the way in which the sample is laid on the viewing aperture.

The optical system has also been laid out so as to avoid errors due to glare in the reflection from the sample. This is accomplished by focussing the light slightly beyond the sample so that it is subjected to a diffuse illumination.

Functionally then, the instrument consists of a light source, a series of filters, a light sensitive surface, and a meter. The light sensitive material used has sufficient output so that a meter can be used directly without amplifiers. Light is directed through a lens system and the filter to the sample, which it strikes as monochromatic light, and is reflected to a photocell system so constructed as to integrate precisely the reflection from all directions, making the response entirely independent of the character of the surface.

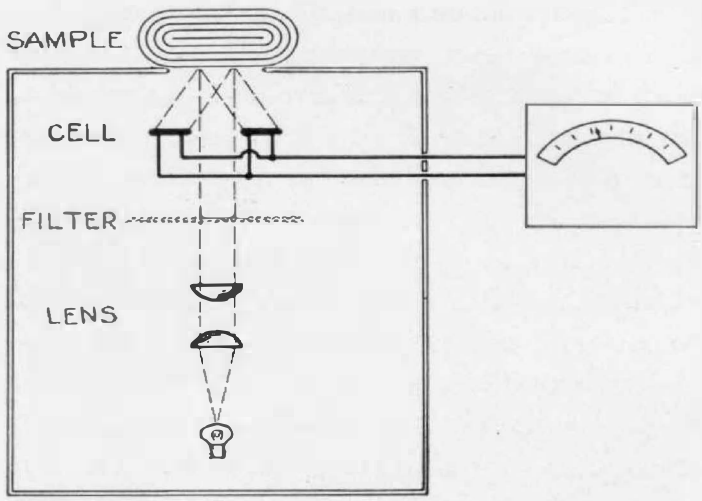

FIGURE 2. Light reflected from the sample to the photocell is transformed into electrical energy and indicated on the meter

In operation, the instrument is set up and calibrated with a magnesium-oxide sample over the viewing aperture. The shunts controlled by the knobs at the right are set to give the standard meter deflection for each filter. The sample is then placed over the aperture and the meter read with each filter successively in position. The three meter readings resulting completely describe the color.

The color comparator has other applications than the measurement of colors. It can be used to measure the opacity of paper by measuring the difference in reflection between the paper with a white backing and with a black backing. Brightness also can be measured by the color meter. In this measurement the definition and method of the Institute of Paper Chemists is followed.

The complete color comparator is shown in Figure 1. Although no amplifiers are required, a meter of relatively low current sensitivity and, consequently, of considerable ruggedness is used. The meter scale is wide and open, permitting easy reading for the determination of small color differences. A voltage regulator is built into the instrument insuring constancy of the light source. Rapid calibration against a standard is provided for. The comparator is entirely operated from the alternating current mains.

— C. T. Burke

CATALOG DATA

Power Supply: 115-volt, 50-60 cycle a-c line. A voltage regulator is included for holding the illumination to a constant value. Adequate fuse protection is provided. The total power consumption is 75 watts.

Dimensions: (Length) 16 inches by (width) 12 inches by (height) 12 inches, over-all.

Net Weight: 40 pounds.

Type	*Code Word*	*Price*
725-A	SABER	**$550.00**

IT'S NOT THE HEAT, IT'S THE HUMIDITY

At this time of year we receive many letters recounting difficulties — high power factor, low leakage resistance — which are directly due to the prevailing high humidity. Since it's the weather, not much can be done about it, unfortunately.

Even though direct absorption of moisture is negligible, the formation of a film on the surface lowers the insulation resistance and, when subjected to alternating potentials, introduces a material loss. Among insulators there are great differences in moisture effect due to surface characteristics. Roughness or pores at molecular dimensions are the important factors. Such ceramics as isolantite are coated to reduce absorption. An insulating material which water does not wet is usually only slightly affected by surface moisture because the water collects in discrete drops and does not cover the whole surface. The yellow bakelite, XN-262 Natural, used in the cases of our Types 505 and 509 Condensers and in many other places where high insulation resistance and low dielectric loss are desired, owes its remarkable freedom from the effects of surface moisture to this property.

Unfortunately, some of the best dry materials show the worst absorption characteristics. Mica and quartz, both crystalline and fused, show larger decreases in their insulation resistance with moisture than many other insulators having much lower volume resistivities. This characteristic serves to decrease the difference between these insulators and others of lower volume resistivity as the humidity of the surrounding air is increased. In fact, it is quite possible, under the effects of high humidity, for quartz insulation to have a lower resistance and larger power factor than many ordinary ceramics.

The TYPE 222 Precision Condensers are now available with fused quartz insulation. In an atmosphere of low relative humidity, such a condenser has a figure of merit, $R^{\omega}C^{2}$, of 0.003 x 10^{-12} as compared with about 0.04 x 10^{-12} for isolantite. Its insulation resistance is about 100 megamegohms for quartz insulation and about 1 megamegohm for isolantite. Under the action of high humidity, a quartz insulated condenser may become poorer in respect to both insulation resistance and power factor than one with isolantite insulation, their insulation resistances reducing to perhaps 1000 megohms, while their figures of merit increase to perhaps 0.1 x 10^{-12}. There appears to be no specific remedy for this effect of humidity on insulation except local heating or air conditioning. The extent to which such a conducting film forms is dependent both upon the temperature of the insulator with respect to the ambient temperature and upon the characteristics of the surface itself. An insulator which is maintained only a few degrees above room temperature will be very little affected by even a high degree of relative humidity. On the other hand, large amounts of moisture will collect upon insulators which are a few degrees lower than the surrounding temperature.

TYPE 107 DIRECT-READING VARIABLE INDUCTORS

The table below supersedes the ranges given for the TYPE 107 Inductors in the January, 1935, *Experimenter*. These inductors are now fitted with a direct-reading calibration on the dial. The accuracy of reading is 1% of full scale.

	Self-Inductance		*Mutual*
Type	*Series*	*Parallel*	*Inductance*
107–J	7– 50 μh	1.7–12.5 μh	0–10.8 μh
107–K	60–500 μh	15–125 μh	0–110 μh
107–L	0.6– 5 mh	0.15–1.25 mh	0–1.1 mh
107–M	6– 50 mh	1.5–12.5 mh	0–11 mh
107–N	60–500 mh	15–125 mh	0–110 mh

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