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A SEMI-AUTOMATIC MONITOR OF CYANIDE SOLUTION STRENGTH FOR GOLD ORE DISSOLUTION

by

G.G. Eichholz* and C.A. Josling**

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SYNOPSIS

A semi-automatic device has been constructed that can be used to check the solution strength of cyanide solutions. It consists of a wheel on which a gold-foil bearing glass slide is mounted. The wheel moves the gold foil through the solution under test and intercepts a light beam. As the gold foil is attacked by the cyanide solution its light absorption diminishes. The successive increase in transmitted light intensity is recorded and gives a measure of gold dissolution rate. Curves have been obtained to show the effect of cyanide concentration and oxygen content on dissolution rates.

Details are presented of the construction of the unit, and some practical operating procedures are outlined.

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Direction des mines

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INDICATEUR SEMI-AUTOMATIQUE DE LA CONCENTRATION D'UNE SOLUTION CYANURÉE EN MATIÈRE DE DISSOLUTION DU MINERAI D'OR

par

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RÉSUMÉ

Un dispositif semi-automatique a été mis au point, et on peut l'utiliser pour vérifier la concentration de solutions cyanurées. Il s'agit d'une roue sur laquelle est fixée une lame de verre recouverte d'une feuille d'or. La roue entraîne la feuille d'or dans la solution soumise à l'analyse et intercepte un faisceau lumineux. A mesure que la feuille d'or est attaquée par la solution cyanurée, l'absorption de la lumière diminue. L'augmentation successive de l'intensité de la lumière transmise est enregistrée et sert à mesurer la vitesse de dissolution de l'or. Nous avons obtenu des courbes qui indiquent les effets de la concentration en cyanure ainsi que de la teneur en oxygène sur les vitesses de dissolution.

Le présent bulletin fournit des détails sur la construction de l'appareil; il indique également certains procédés pratiques de fonctionnement.

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INTRODUCTION

One of the important, though often neglected, factors in the extraction of gold by cyanidation is the actual dissolving strength of the cyanide solution. This depends in a complex fashion on the cyanide ion concentration, the amount of free oxygen contained, and the degree of "fouling", i.e., the presence or absence of compounds detrimental to the dissolution of gold. For this reason it has proved most practical to introduce a method for the testing of solution strength that depends directly on a determination of the rate of attack on a standard gold sample. This is the gold-leaf test method, developed by McCreedy and Gow (1, 2) and used widely as a simple means of testing cyanide solutions.

In this method one square centimetre of gold leaf is attached to the bottom of a moistened cork stopper, which is then fitted into the end of a 20-ml test tube containing a 10-ml solution sample. The test tube is shaken under reproducible conditions and the dissolution of gold is followed visually to establish the time of complete dissolution. Depending on the strength of the solution this time may range from a few minutes to several hours.

In order to overcome the need for continuous observation of the dissolving sample and to simplify the procedure, a semi-automatic device has been developed that is simple to set up and may lend itself to installation in the actual plant circuit. It consists of a slowly rotating wheel that supports a gold-leaf-bearing glass slide and passes it through a light beam once every revolution. As the gold leaf is dissolved, the light intensity transmitted increases and a record of successive light flashes transmitted serves as a simple indication of the rate of dissolution. By this means it is possible to determine relative solution strength within a few minutes, without the need for a constantly attending operator. The device is easy to operate and lends itself to simple routine tests of solution strength by an unskilled operator.

DESCRIPTION OF EQUIPMENT

The monitor equipment consists of a rotating wheel, driven by any small synchronous motor, a small dial light, a photocell, and any strip-chart recorder with a sensitivity of the order of 100 millivolts full-scale. In the Mines Branch units assembled for test purposes, the wheel was mounted in a glass or plastic tank. The photograph, Figure 1, shows the equipment set up for the tests described in this report, with a pH meter in the middle for control.

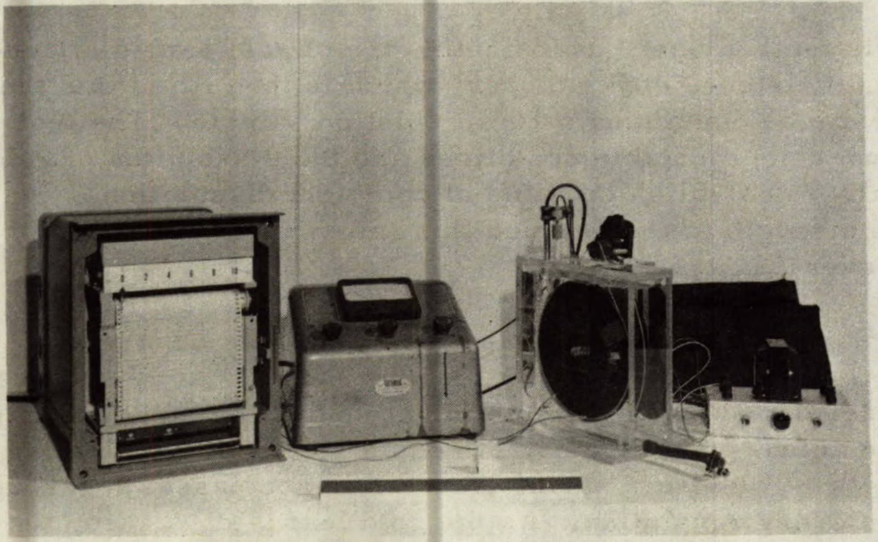

Figure 1. Photograph of cyanide monitor (with pH meter).

The wheel, made of Lucite and painted black, can be driven either by a string drive, as shown, or by a friction drive on the rim. The motor used was a Telechron 4RPM timer motor, but any other slow synchronous motor or gramophone motor could be adapted. Figure 2 is a drawing of the plastic tank shown in Figure 1; again, many variations would be equally satisfactory. The light source and detector are not shown in Figure 2. A 110 V dial lamp, type S6, 6 watts, has been used as a cheap and readily available light source.

A rectangular area of the wheel is left transparent and is framed by the strips supporting the sample slide. This consists of a thick microscope cover glass on which the gold-foil sample has been mounted with silicone grease. Details of the procedure for mounting the sample are given in Appendix A.

The light detector is mounted in the opposite side of the tank, to detect the light transmitted by the gold-foil sample as it crosses the light beam. Two types of light detector have been used:

1. A photovoltaic or silicon "solar" cell, such as the Hoffman type 110C solar cell, 1 cm^2 in area;

2. A photoconducting cell, such as the National Semiconductors cadmium sulphide cell, type NSL-53*.

The solar cell can be used to drive directly a 100mV d-c strip chart recorder, such as the Varian type G11A. The photoconductivity cell is cheaper and more sensitive than the solar cell, but requires a driving voltage and rectifier to actuate the recorder. Details of the circuit required and a comparison of sensitivities of the light detectors are given in Appendix B.

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*Available from National Semiconductors Ltd., 230 Authier Street, Montreal 9, Que.

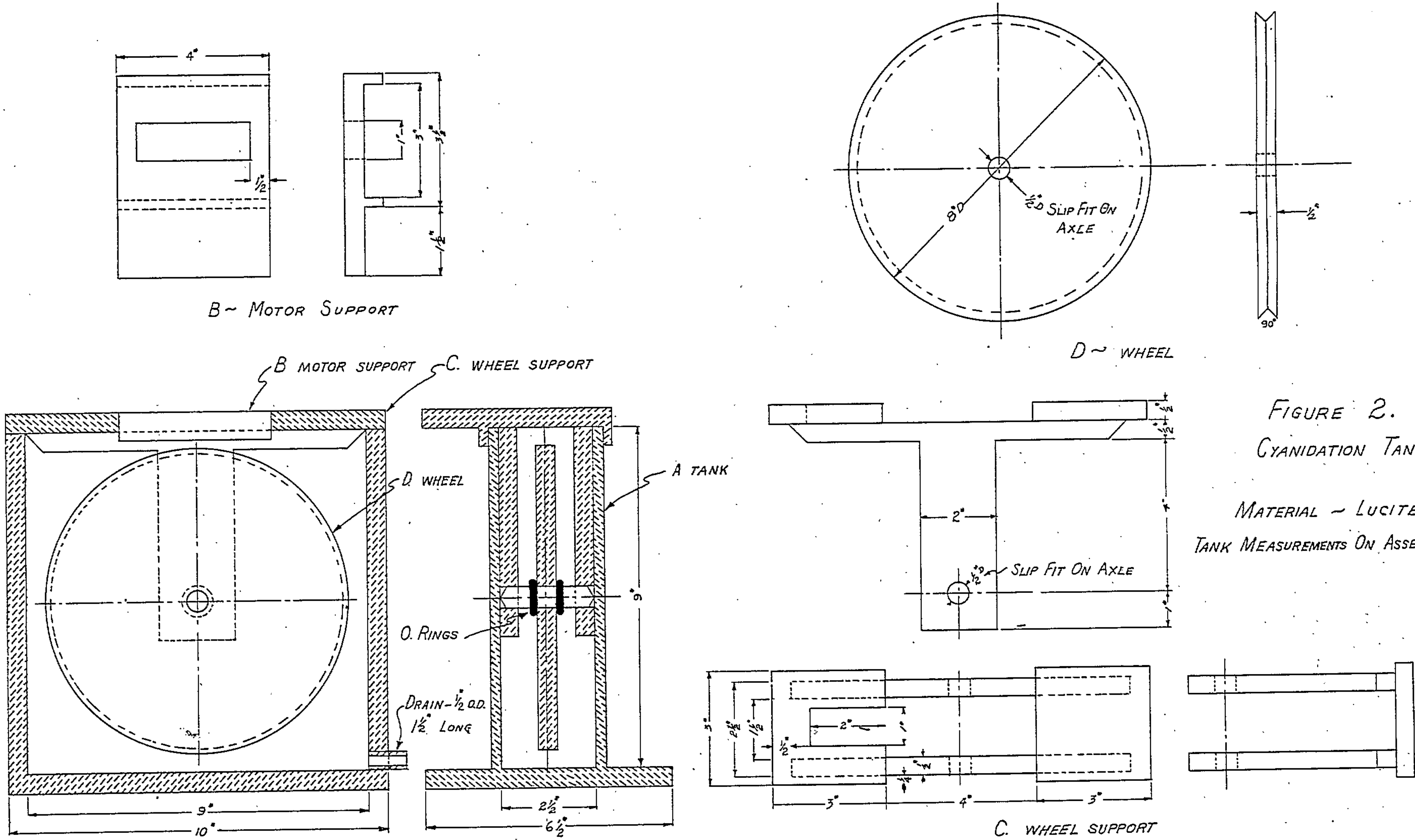

FIGURE 2.
CYANIDATION TANK

MATERIAL ~ LUCITE
TANK MEASUREMENTS ON ASSEMBLY VIEW

OPERATING DETAILS

The unit supplies well-standardized conditions for monitoring the dissolving power, provided the mounting of the gold foil has been done carefully. For routine plant tests, a number of sample slides can be prepared in advance and can be inspected easily for uniformity in appearance. The dissolving power itself can be derived from the rate of increase in the recorder spikes. Figure 3 shows a typical recorder trace for a strong solution, and Figure 4 a similar trace for a weak one. It is immediately obvious that the slope of the curves can be used as a measure of the dissolving power; this can be done either graphically by using a plastic overlay with the desired slope and possibly acceptable limits of deviation, or numerically by simply counting the number of spikes between, say 10 and 70 mV on the chart. The greater the number of spikes the weaker the solution.

This latter criterion has been used to plot the next two figures, Figure 5 illustrating the effect of cyanide concentration on the rate of dissolution, and Figure 6 showing the effect of varying oxygen content on the dissolving power. The dissolution rate is expressed as the inverse of the number of spikes in the selected deflection interval. The oxygen content was measured as per cent saturated oxygen content, using a Thomas oxygen meter (3). These figures show the relative ease with which one can obtain operational data on solution characteristics with a monitor of the type described. Figure 5 also shows clearly that there is a limiting cyanide concentration beyond which no further significant increase in the dissolution rate can be observed.

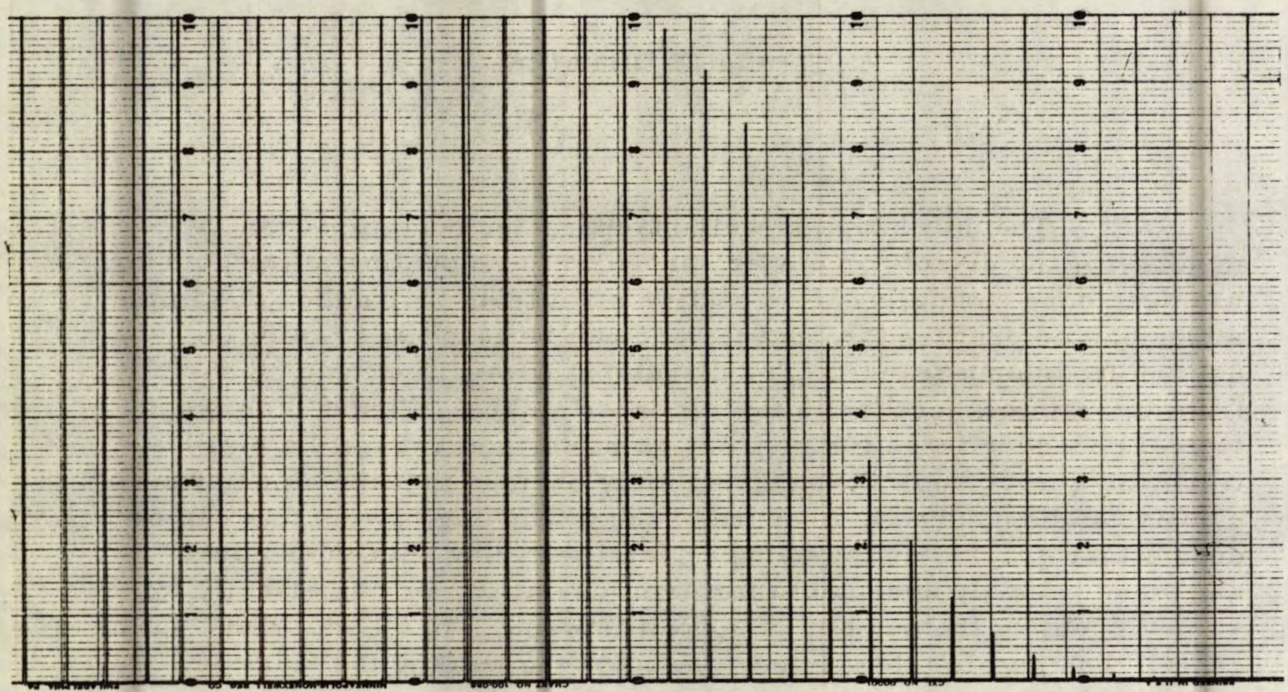

Figure 3. Typical recorder trace - KCN, 210 mg/l.

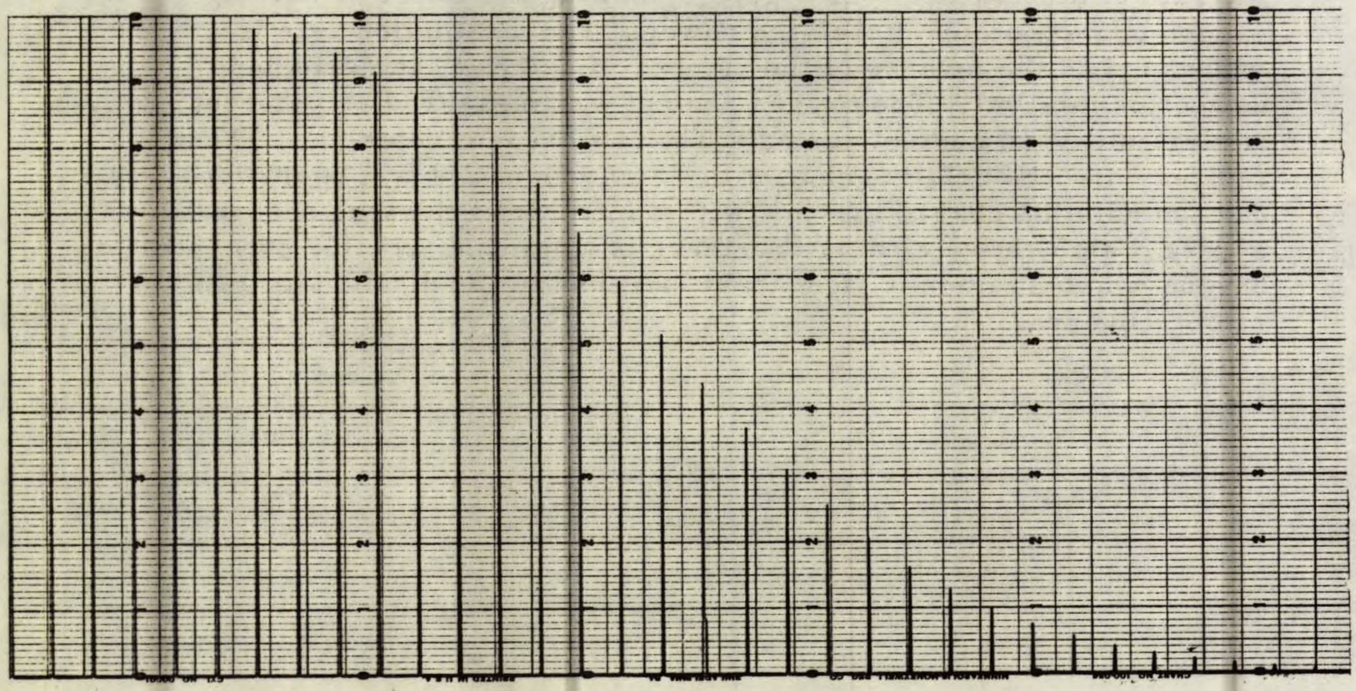

Figure 4. Typical recorder trace - KCN, 60 mg/l.

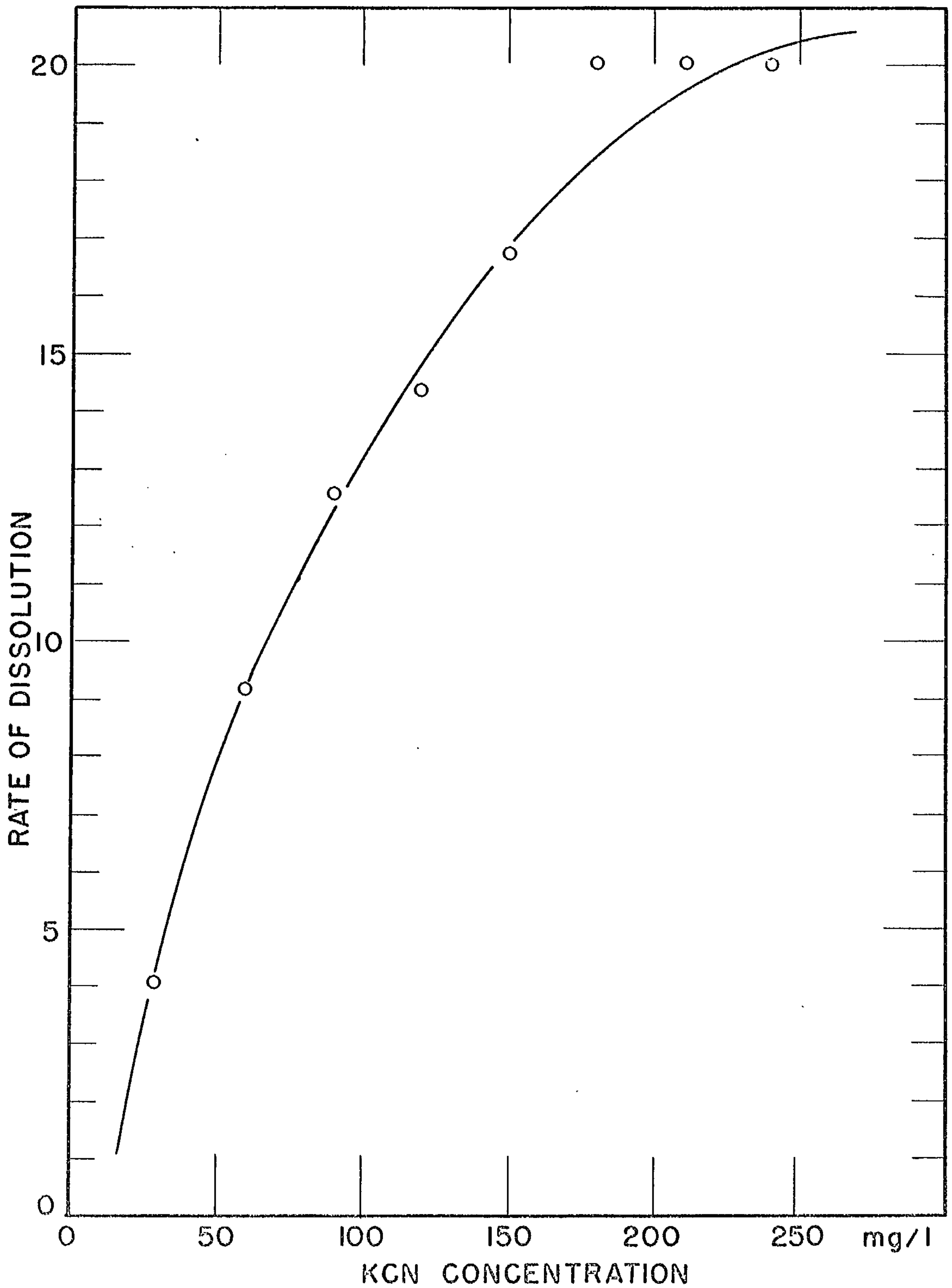

FIGURE 5. EFFECT OF CYANIDE CONCENTRATION ON DISSOLUTION RATE.

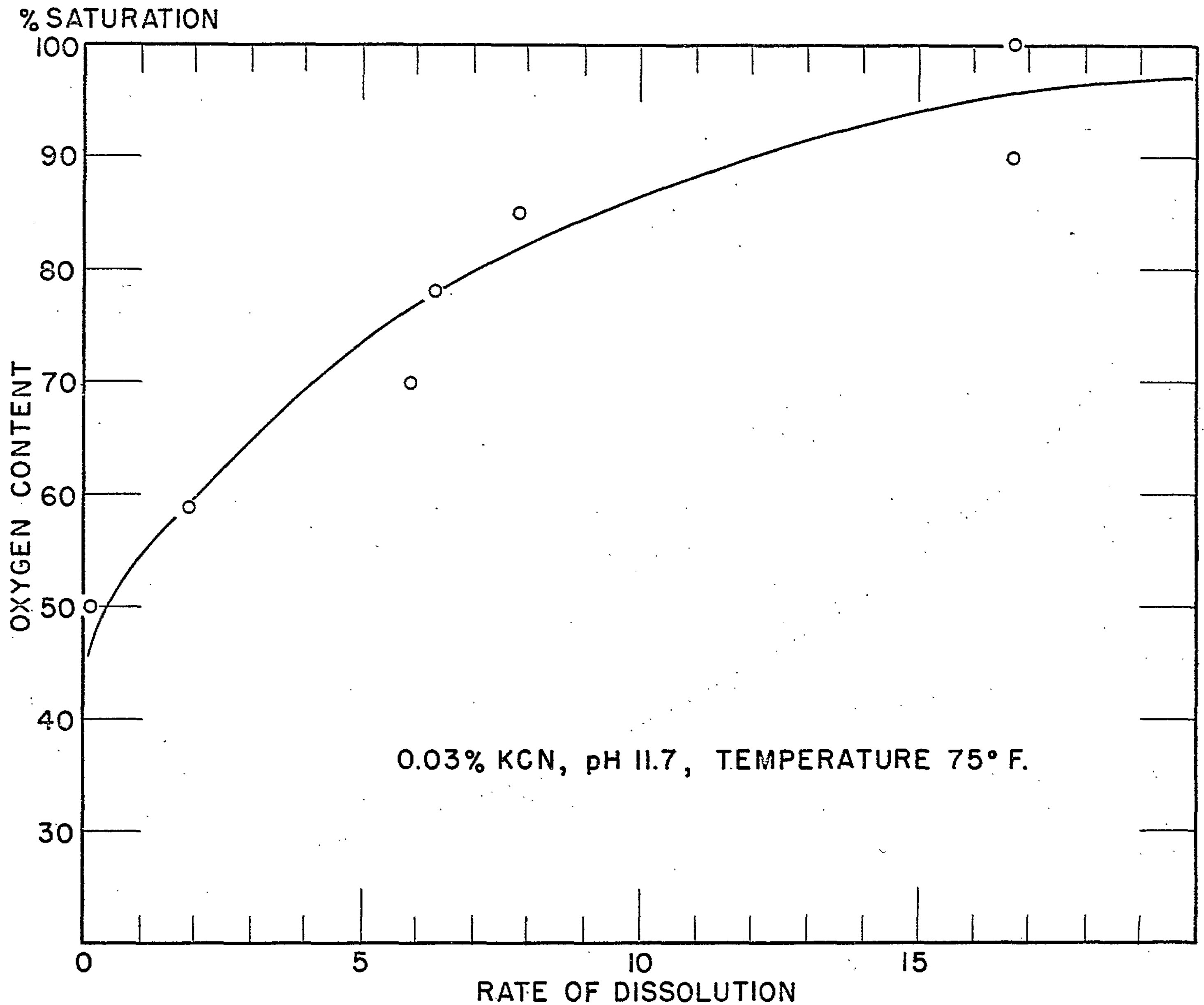

FIGURE 6. EFFECT OF OXYGEN CONCENTRATION ON GOLD LEAF DISSOLUTION.

CONCLUSIONS

The monitor described is a simple device, which can be set up at many gold mills to check the strength of cyanide solutions. No special skill is required to operate it and it is an easy matter to obtain a record of solution strength at periodic intervals, say once a shift, and thus observe directly any major changes in the cyanide solution. It can be set up and operated at minimal cost, requiring only the simplest type of chart recorder. Its use may give an early warning of any unusual or undesirable conditions affecting the strength of cyanide solutions.

ACKNOWLEDGEMENTS

The advice and assistance of Mr. H.H. McCreedy are gratefully acknowledged. Mr. J.V. Krzyzewski obtained the comparison results on the various light detectors.

REFERENCES

1. H.H. McCreedy, C.C. Clark and W.A. Gow. "The Use of the Gold-Leaf Test to Check the Effects of Certain Possible Contaminants of Cyanide Solutions". Mines Branch Investigation Report IR 61-25, Dept. of Mines and Technical Surveys, Ottawa, April 1961.

2. H.H. McCreedy and W.A. Gow. "Two Modified Control Methods for Cyanide Solutions". Mines Branch Report EMI 61-10 (unpublished), Dept. of Mines and Technical Surveys, Ottawa, December 1961.

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APPENDIX A

PREPARATION OF GOLD-FOIL SAMPLES

The gold leaf used is standard sign-painters' gold leaf, available at most drafting supply stores in books of 24 leaves for about $2. The glass slides used are microscope cover glasses, Corning rectangular No. 2, 40 x 22 mm, such as Cenco type 66526, Fisher type 12-529, or Canlab type 60-482. Of varying adhesives tried, Dow-Corning silicone grease (No. QC-2-0057) proved the most satisfactory.

The following procedure has been found most convenient:

1. Spread the silicone grease on the slides as thinly as possible with the finger, then wipe with Kleenex using moderate pressure. This leaves a thin film of grease, sufficient to hold the gold foil.

2. Use a square brass frame slightly smaller than the gold leaf, and place it over the leaf. This holds the leaf flat and avoids wrinkling, which occurs otherwise due to the static charge on the greased glass slides.

   (Note: Gold leaf must be handled in an area free from air currents, as the slightest draft will crumble or fold the leaf. Even quick movements of the hands near the leaf will destroy it.)

3. Hold the slides by the thumb and index finger about 3/4 inch above the leaf and drop them carefully into position, greased side down. Do not bring the slide close to the gold, as the pull due to static electricity has been found to be strong enough to draw the foil from the brass frame or to tear it.

The gold leaf is not uniform in thickness; hence random placing of the slides would be unsatisfactory. It is recommended that the slides be placed as shown in Figure 7, since the leaf usually appears to be more uniform in thickness near the corners.

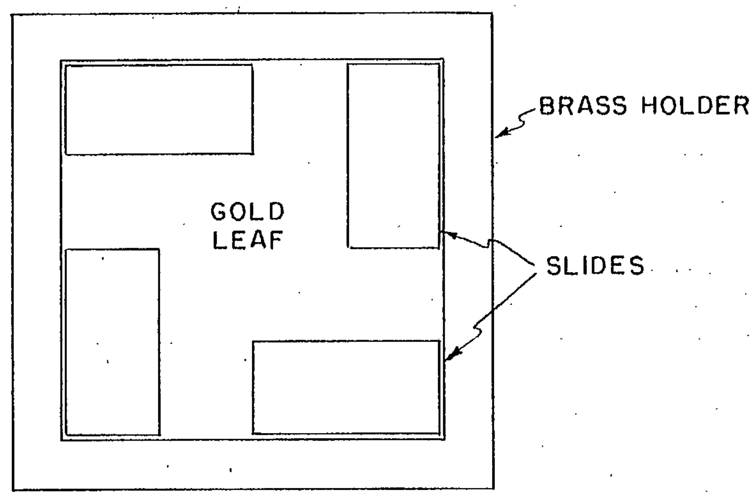

Figure 7. Placing of slides on gold leaf.

4. After the slides have been placed on the leaf, cut around them with a sharp needle or razor blade, using light pressure. Lift one edge up with the needle or blade and make sure that it does not slip, as a scratched foil is useless. The slides must be handled by the edges only.

A supply of slides can be made up at a time, but they should be stored, glass-side down, in a dust-proof container.

APPENDIX B

COMPARISON OF LIGHT-SENSITIVE DETECTORS

To keep the monitor system as simple as possible, a simple light detector is desirable. For this reason and for economy, it was decided to use either a silicon solar cell or a cadmium sulphide photoconductive cell. The solar cell is self-contained and requires no separate voltage supply, but it is slightly more expensive than the CdS cell. The latter requires an applied alternating voltage, but its lower cost more than offsets the added cost of a transformer and rectifier.

To check the relative sensitivities, comparative tests were run, using an S 6 dial lamp run from a Variac variable transformer as the light source. The solar cell was a Hoffman type 110 C, 1 cm^2 area, unit with a 4300-ohm load across the terminals.

Two types of CdS cells were tested: an unsealed cell, NSL type 26 P, and a sealed circular cell, NSL type 53. The NSL 26 P was used with a 27-ohm resistor across the recorder terminals. The test circuit for the CdS cells is shown in Figure 8.

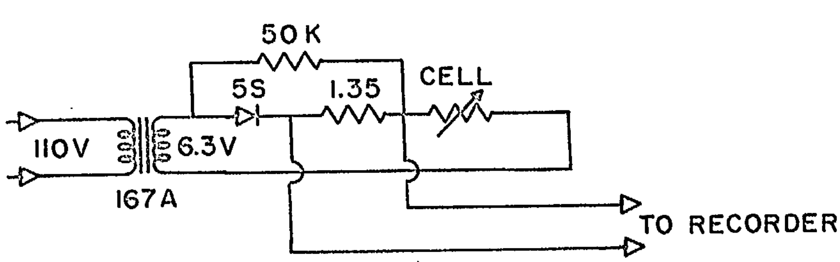

Figure 8. Test circuit for CdS cells

The response curve for the three detectors is shown in Figure 9. It is evident that, except for the lowest light intensities, the photoconductive cells have higher sensitivity. This can be further increased by the use of a higher applied voltage.

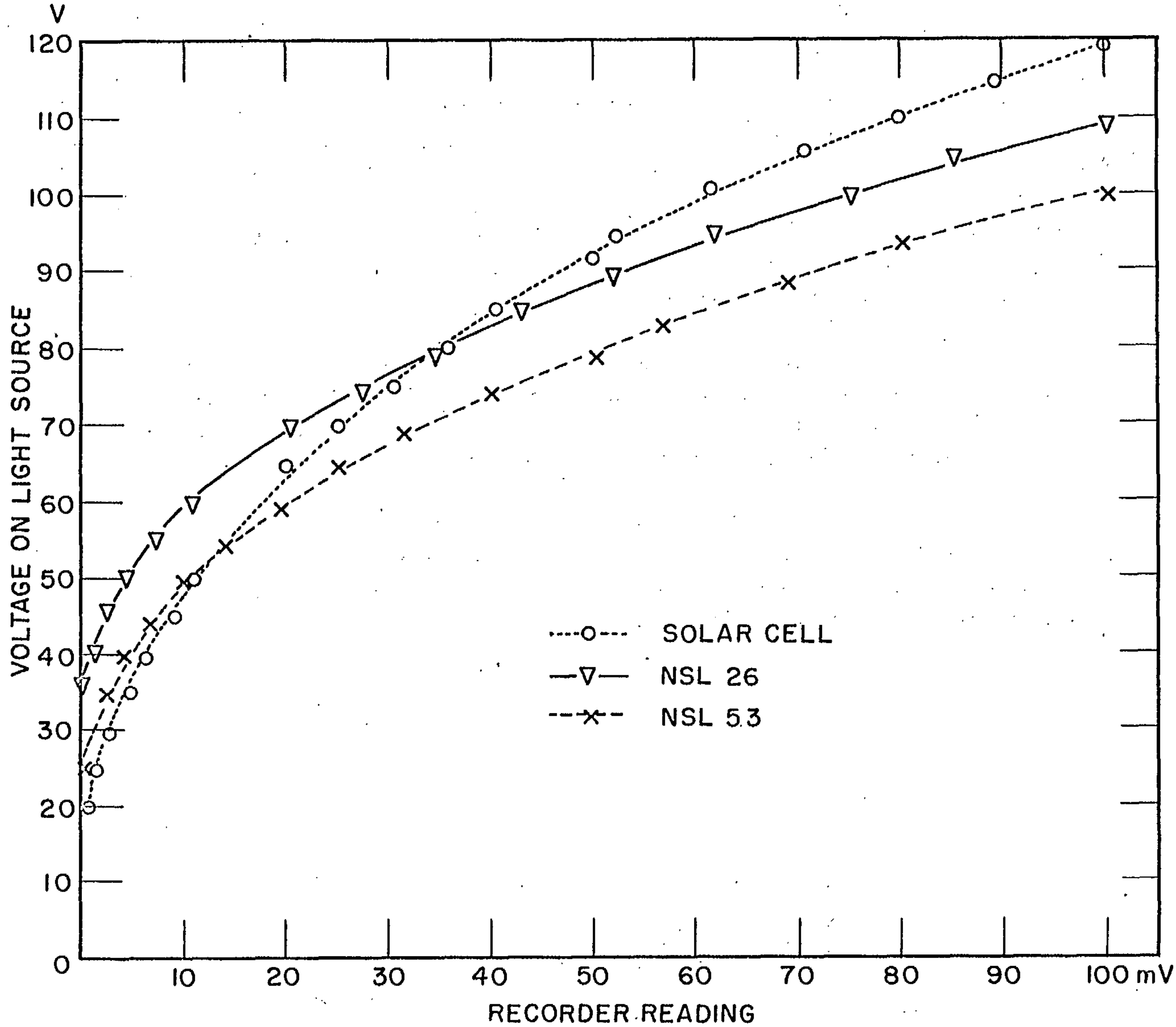

FIGURE 9. COMPARISON OF PHOTOCELL RESPONSE CURVES.

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