The detector in the K-2 apparatus has been modified (Fig. 1). The spring and the system of two shells screwed into one another make it possible to press the wad with a constant force against the surface being tested. It is expedient to make the electrode from 1Kh18N9 stainless steel or zinc. Copper is unsuitable for this purpose since it forms a couple with aluminum if there is a defect in the film, and it then gives a rather high opposing emf. The diagram of the K-2 apparatus is shown in Fig. 2.

2-4 v dry batteries can be used as the electric current source for the apparatus. The magnitude of the current registered by the apparatus may vary considerably depending on the density of the wad, the voltage and the temperature at which the tests are carried out, and on other factors influencing the resistance of the circuit. Therefore, the apparatus must be calibrated i.e., one must determine the critical value of the current; if this value is exceeded the coating is considered to be unsuitable. As a standard for the calibration of the apparatus we used freshly cleaned aluminum connected in series with a resistance (10000 ohm) which represented the oxide film.

Since the K-2 apparatus contains a source of direct current, it is possible to use electrolytes which have no corrosive effect on aluminum alloys. A 0.1% solution of sodium or potassium bichromate was used as the electrolyte. Although the electrolyte selected for the tests is absolutely harmless to the film, at a high concentration and prolonged contact (more than 15 sec) it may leave stains on the surface of the parts tested. Therefore, the electrolyte drops which remain on the surface of the film after the test must be wiped off with dry cotton.

When the apparatus is used, one must open the contacting cartridge, remove the paper plug and wash all the parts of the shell with water and dry them with a filter paper once a day. The contact surface of the detector must be cleaned before each test.

The proposed apparatus is highly sensitive and gives good results in operation. It can be used not only for determining defects in the continuity of the film but also for detecting other defects.

POROSITY MEASUREMENTS OF CHROMIUM COATINGS BY A METHOD OF IMPRESSING WITH MERCURY

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The porosity of chromium plating is measured by means of the following methods: by measuring enlarged microphotographs of the surface with a planimeter, by means of contact prints, by determining the increased weights of a sample saturated in paraffin, by measuring the conditions of oil absorption, by means of an electron microscope and by the photoelectric method. However, all these methods do not provide a sufficiently accurate estimation of the porosity of the coating [1].

In recent years an adsorption method of evaluating protective coatings [2] was developed. This method is based on the property of porous films to adsorb gaseous and liquid substances which do not react chemically with the film. This method provides the possibility of calculating the total volume of pores and the distribution of the volume with respect to the effective radii of the pores, if the radii are in the limits of 20 to 400 A. This method, however, is very complicated from the point of view of the equipment required, making its use under shop conditions difficult.

We developed a method of studying the porosity of chromium coatings by pressing in mercury with a porometer [3]. By means of this method it is possible to determine the volume of pores with an effective radius ranging from 350 thousand to a few angstrom.

The porometer consists of a massive steel bomb which holds a glass dilatometer with the sample. The

TABLE 1

Radius and Volume of Pores in Relation to the Pressure of Mercury in the Porometer

Pressure in the porometer, kg/cm²	Diameter of pores, μ	Volume of pores, %			
		1st sample	2nd sample	3rd sample	4th sample
1.26	60.0	—	—	—	—
2.26	33.5	2.0	0.7	0.7	—
4.23	17.6	3.1	2.7	1.3	0.6
6.28	12.0	3.3	3.3	2.0	0.6
11.26	6.7	4.7	4.7	2.0	1.4
16.24	4.7	4.7	4.7	2.0	2.0
25.85	2.9	5.3	4.7	2.7	2.0
.50.44	1.5	5.5	5.5	2.7	2.4
100.43	0.7	5.5	5.5	2.7	2.6
200.43	0.4	6.0	5.8	2.7	2.6
301.26	0.2	6.0	5.8	2.7	2.6
401.26	0.1	6.0	5.8	3.4	3.2

TABLE 2

Relative Evaluation of Chromium Coatings Porosity Measured by Various Methods

Method of determining porosity	Sample number			
	1st	2nd	3rd	4th
Mercury pressure, %	6.0	5.8	3.4	3.2
Filling the pores with paraffin, %	3.75	1.85	1.28	1.18
Measuring microphotographs with a planimeter (% of the visible area of pores to the total area of the sample)	23.0	14.0	11.7	10.4

dilatometer is filled with mercury. The pressure in the bomb is then raised, first by means of compressed nitrogen and then by means of oil (porometer PA-5 provides an operating pressure of 5000 kg/cm²). Mercury penetrates under pressure into the pores of the sample and the changed volume of mercury in the dilatometer is measured by means of the variation of the electrical resistance of a calibrated platinum wire.

St. 2 brand steel cylinders 10 mm in diameter and 100 mm high were used as samples for testing. The samples were chromium plated in an electrolyte which contained 250 g/liter of H_2SO_4 at a cathode current density of $D_k = 60$ amp/dm². The electrolyte temperature was for the 1st sample 36°C, for the second 47°C, for the third 58°C, and for the fourth 66°C. The anode treatment was carried out in the same electrolyte with a current density $D_a = 42$ amp/dm². The treatment lasted 10 min. The thickness of the chromium coating was ~400 μ.

Before measuring the porosity of the chromium deposits a plain uncoated steel sample was tested. The experiment revealed an absence of pores in the steel sample. The results of the porosity measurements of the chromium coating are given in Table 1.*

The data in Table 1 show that the maximum operating pressure required for filling the pores with mercury does not exceed in these experiments 400 kg/cm². With a further increase in pressure no changes in the volume of mercury were observed. The minimum radius of pores under these conditions is equal to 0.1 μ.

The data thus obtained show that the increase of the electrolyte temperature from 36 to 66°C produces a reduction of the pores' volume to about one half (from 6.0 to 3.2%).

For a relative evaluation of various methods of measurement, the porosity of samples obtained under identical conditions of electroplating was determined by means of the planimetric method and by the rise in weight when the pores were filled with paraffin (Table 2).

Above data show that all the three methods provide the same type of relationship between porosity and temperature which is in complete agreement with the data quoted in literature [4].

A comparison of the method of pressing in mercury and the method of filling the pores with paraffin, shows that the latter method provides reduced values.

Thus, the method of pressing in mercury provides a sufficiently accurate estimate of the total volume of the pores, and the distribution of their volumes with respect to their radii. This method can be used for studying the porosity of other metals which do not form amalgams.

*Porosity measurements by means of the porometer were made by V. F. Karel'skaya.

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CONSTANT HUMIDITY IN CORROSION CHAMBERS OPERATING WITH A TEMPERATURE CYCLE

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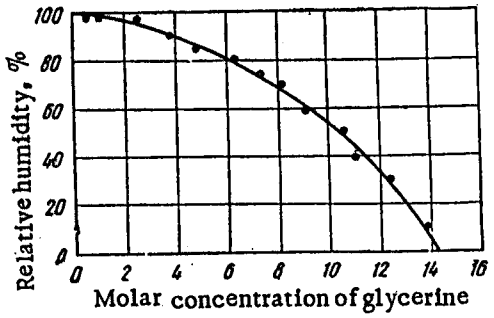
In order to speed up corrosion tests which simulate tropical conditions, it is desirable to establish in the atmosphere a water vapor tension whose value would change but little with temperature. Saturated solutions of salts and solutions of sulfuric acid are not suitable for the purpose, since the vapor tensions produced by these solutions are greatly affected by temperature.



Relation of the air relative humidity over glycerine solutions to the molar concentration of glycerine at 20 ± 1°C.

Glycerine solutions are more suitable for this purpose, since they provide small vapor tension variations with temperature thus ensuring greater consistency of test results. This assertion is confirmed by the nature of the relative humidity variations. Moreover, the glycerine solutions are not corrosive with respect to any metal except tin, and the value of the relative humidity produced by them rises smoothly with increased concentrations of glycerine solution in water (see figure).

Thus, glycerine concentration variations in the range of 0.5 to 1.5 mole produced (at a constant temperature of 20°C) changes of relative humidity of ± 1.2%. Changes of temperature between 20 and 40°C at concentrations of 0.5, 1.0 and 1.5 mole of glycerine in water produced variations in the relative humidity of air of 1.2, 2.1 and 5.9% respectively.

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