THE CORROSION OF ALUMINUM IN
BORIC ACID SOLUTIONS

A Thesis

By

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Submitted to the Graduate School of the
Agricultural and Mechanical College of Texas in
partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

January 1956

Major Subject Chemical Engineering

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ACKNOWLEDGMENTS

This project was initiated by Dr. R. V. Andrews and all experimental work was performed under his supervision. The author is indebted to Dr. Andrews for his assistance.

Grateful acknowledgment is made to Dr. J. D. Lindsay for his many helpful suggestions in connection with both the experimental investigations and the preparation of the thesis.

The writer wishes to thank the Aluminum Company of America for furnishing the sheet aluminum used in this research.

Thanks are due Mr. W. W. Smith for his assistance in the preparation of the photomicrographs.

Thanks are also due Mr. O. M. Taylor for his aid in the construction of the experimental apparatus.

Finally, the author wishes to express his thanks to the Chemistry Department and the Chemical Engineering Department of the A & M College of Texas for teaching assistantships in these departments which provided the financial support for the author's post-graduate studies.

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ABSTRACT

An investigation of the corrosion of aluminum in boric acid solutions was made. The total immersion, continuous agitation method of testing was used.

Commercially pure aluminum and two aluminum alloys were exposed to various concentrations of boric acid solutions at various temperatures. Metal samples were removed at selected time intervals and the corrosion rate was measured by a change in weight.

The corrosion rates obtained were compared for the various alloys, boric acid concentrations and temperatures.

Several photomicrographs and photomacrographs of the aluminum specimens were prepared as an aid in determining the type of corrosion encountered.

SECTION I - INTRODUCTION

Corrosion, the destruction of a metal by chemical or electrochemical reaction with its environment, is the direct cause of immense equipment replacement costs every year. The indirect cost of corrosion, such as that resulting from plant shut-downs for repair of corroded equipment increases the cost still further.

In many cases the service life of metallic equipment in contact with a corrosive environment could be materially increased through the judicious use of a different alloy. Also, a slight variation in operating conditions such as temperature or concentration is often justified because of a resultant increase in corrosion resistance of the process equipment.

The industrial plant with no corrosion problems is indeed a rarity. Even a non-chemical plant using relatively inert chemicals is frequently plagued by corrosion of equipment. Such is the case with many nuclear reactor installations.

Because of the high neutron absorbtivity of boron, boron and its compounds are used in the control of nuclear reactors. Boric acid in solution is a convenient means of supplying boron for this purpose.

Aluminum, however, exhibits low neutron absorbtivity. Therefore, repairs may be made on aluminum equipment used in a nuclear reactor installation without fear of lingering radiation.

Hence, aluminum tubing is often used to convey the boric acid solutions into the nuclear reactor. The damage to the nuclear reactor resulting from a failure in the aluminum tubing within the reactor would, of course, be very great. Were the tubing to fail outside the reactor efforts to control the reactor by means of the boric acid solution would be seriously impaired if not futile.

It is of importance, therefore, to have a knowledge of the corrosion resistance of aluminum and its alloys to boric acid solutions of various concentrations and temperatures.

The purpose of this research was to investigate the corrosion of commercially pure aluminum and two aluminum alloys in boric acid solutions.

The metals used were Alcoa 2S-H14, Alcoa Alclad 3S-O and Alcoa 24S-T3. The first two characters in the metal designation refer to the alloy. 2S is commercially pure aluminum, Alclad 3S is a surface layer of a copper, manganese, zinc and aluminum alloy on a different aluminum alloy of copper, silicon, iron and manganese. The letters and numbers after the dash in the code designation refer to the temper of the metal. H14 refers to a cold-worked temper, O an annealed temper, and T3 a temper produced by an initial solution heat treatment followed by cold-working. For a more complete discussion of these designations, reference is made to "Alcoa Aluminum and Its Alloys", a publication of the Aluminum Company of America (1).

Throughout the remainder of this thesis the alloys used will be designated by 2S, 3S and 24S.

In order to duplicate closely actual plant conditions, the total immersion, continuous agitation method of testing was used.

Several baths, each at a constant temperature, but covering a range of temperatures from room temperature to 90°C were employed. In addition, boric acid solutions in concentrations to saturation were prepared for use at each temperature chosen.

A number of metal samples were prepared for each bath. Samples were removed from the baths at selected time intervals and examined for corrosion by measuring the change of weight.

The corrosion rates obtained were compared for the various alloys, boric acid concentrations and temperatures.

At the outset of this work it was hoped that an examination of the experimental data would help to throw light on the present theories of aluminum corrosion. It is believed that the work contained in this thesis is a significant contribution to the theory of aluminum corrosion.

SECTION II - SURVEY OF THE LITERATURE

Early Studies in Corrosion

Corrosion phenomena have been a problem to man since pre-historical times. Man's discovery of metals (the first metal used was probably copper) could only barely precede the recognition of corrosion.

For many centuries, however, there seems to have been little curiosity regarding the causes of corrosion. The first significant contribution to the theory of corrosion was made in 1819 by an anonymous French scientist, thought to be Thénard (28). He studied the corrosion of zinc by acid and attributed the fact that impure zinc is more rapidly attacked than the relatively pure varieties to an electrical effect set up between the zinc and the impurities present.

In 1824 Sir Humphry Davy (12) in a study of corrosion prevention of copper ship bottoms suggested connecting the copper with iron or zinc. This is an early application of the principle we know today as cathodic protection.

Faraday and Schönbein (13) in 1836 studied the effect of the protective oxide film on iron immersed in dilute and concentrated nitric acid. They found that a strip of iron was rendered passive to attack by dilute nitric acid when it was first immersed in concentrated nitric acid to allow a protective film to form.

Corrosion of Aluminum

Probably the first investigator to study the corrosion of aluminum was Watson Smith (26) who, in 1904, examined the action on aluminum by various inorganic acids and salts. He noticed that aluminum dust was vigorously attacked by nitric acid at room temperature, but that both dilute and concentrated nitric acid had little effect on aluminum sheet below 50°C. He attributed this phenomenon to the formation of a protective film on the aluminum sheet, and on this basis recommended aluminum as being suitable for cooking utensils.

From extensive studies, Bailey (8) concluded that the corrosion of aluminum by water was increased by the presence of impurities in the metal or by a rise in temperature of the water. He further stated that except at a relatively high or low pH of the corrodent, the corrosion products were exclusively Al_2O_3 or $Al(OH)_3$. In a discussion of Bailey's work Rosenhain (25) added that corrosion of aluminum is increased at the point of suspension of the samples, whether glass or metal hooks were used.

Waché (32) found that the corrosion rate of aluminum varies considerably with the content of impurities in the metal and especially with their distribution; the lowest rate being when the impurities were best distributed.

Müller and Löw (20) in their studies of aluminum corrosion by hydrochloric acid found that the purest aluminum available (99.999%) was extremely resistant to corrosion, being noticeably attacked only at an acid concentration of 4N or higher.

Vogel (31) conducted immersion tests of aluminum in various acid, alkali and salt solutions at several temperatures. He reported that the rate almost always increased with the temperature and that pure aluminum was most resistant among the alloys tested.

Hackerman (16) reported that aluminum corrosion rates in water increase with temperature, but usually go through a maximum which is often reached at about 80°C.

Champion (10) shows that for the case of aluminum in a normal potassium chloride solution, the corrosion rate in the early stages increases linearly with the amount of metal corroded and decreases linearly with the corrosion after a certain loss of metal has occurred. He stated that the corrosion-time curves are more reproducible on the basis of the amount of metal corroded than on a time basis.

McKee and Brown (19) studied the resistance of aluminum to corrosion in solutions containing various anions and cations. They concluded that the corrosion resistance of aluminum appears to be influenced to an appreciable extent by the stability of the oxide film and by the solubility of the corrosion products.

Protective Film on Aluminum

Bryan (9) concluded that the film of oxide or hydroxide was responsible for the corrosion resistance of aluminum. Since $Al(OH)_3$ is relatively insoluble over a wide pH range, he surmised that the film plays an important part in reducing corrosion not only in neutral solutions, but also in weakly acidic and basic solutions.

Jenny and Lewis (17) state that the adherence of the film to aluminum is so good that it is scarcely possible to remove the film by mechanical means.

Pitting of Aluminum

Aziz (7) has contributed greatly to the knowledge of pitting in aluminum corrosion. He used radioactive cobalt and lead ions in solution to study the distribution of local cathodes on aluminum alloy specimens which were actively pitting, and to study the processes of film breakdown and repair on aluminum-alloy specimens after introducing them into a corrosive environment. In the study of pitting, radioactive ions were introduced into the solution after pitting of the sample had proceeded for a predetermined length of time. The tracer was then permitted to plate out onto local cathodes, and, after washing and drying, autoradiographs of the surface were prepared. Results indicate that after a pit is a few hours old it is surrounded by a ring of cathodic surface and outside this is an annular ring of passive surface which prevents lateral expansion of the corrosive attack, the remainder of the surface being cathodic. His results further indicate that, on contact with the solution, the surface oxide film breaks down and is then repaired by reaction with the solution.

Corrosion of Aluminum by Boric Acid Solutions

Various references are available on the corrosion of aluminum by boric acid solutions. In many cases, however, contradictory or confusing statements are given.

Rabald (22) states that 99.5% aluminum is "practically resistant" to boric acid solution at 20°C and "fairly resistant" at the boiling point. No mention is made of concentration.

According to Uhlig (29), "Boric acid solutions in all concentrations up to saturation have negligible action on aluminum alloys". It is noticed in this reference no mention is made of the effect of temperature.

In one of its publications the Aluminum Company of America (2) states that boric acid has little effect on aluminum and that aluminum is used as a material of construction in boric acid plants. However, the concentration of the boric acid is not given, and it is possible that dry boric acid is the substance in question since no mention of a solution is made.

Ritter (23) states that very pure aluminum (99.5%) in concentrated boric acid solutions is not attacked at 20°C and only slightly attacked at 100°C. He gives a quantitative rate of 0.03 grams per square meter per day for commercially pure aluminum in a 4% boric acid solution at 20°C.

Andrews (5) indicated that some attack is encountered in using boric acid solutions in aluminum tubing at nuclear reactor installations and that the rate of attack varied considerably with different alloys.

Special Effects in Aluminum Corrosion

Several investigators who have studied the corrosion of aluminum as a function of time have reported significant breaks in the corrosion-time curves.

Andrews (6) in studying the film formation of aluminum immersed in water noticed peaks in the curve at about two week intervals.

Vernon (30) in investigating the effect of the film build-up by different alloys in water reported breaks in the curves at the end of 40 and 60 days.

Strom, et al. (27) studied the reproducibility of data of aqueous corrosion of aluminum. He concluded that the data were reproducible except at 12 and 25 days.

Thus it is seen that while many aspects of corrosion have been studied, much needed research remains to be performed in this field.

SECTION III - THEORETICAL CONSIDERATIONS

General

The tendency for metals to corrode may be explained thermodynamically. Whem most metals form compounds there is an ensuant decrease in free energy. In other words there is every reason to anticipate that most metals should seek a more stable form, i.e. to corrode. Therefore, the question is not, "Why do metals corrode?", but rather, "Why are common metals relatively inert and non-reactive?".

While all corrosion is essentially electrochemical in nature, a distinction will be made in this thesis between chemical attack and electrochemical attack. An attack which involves only the metal and corrodent will hereafter be referred to as chemical. An attack involving the metal, oxide film and corrodent will be referred to as electrochemical.

Protective Films

Most metals have the characteristic of forming adhering and mechanically strong surface films of oxide or occasionally hydroxide. In the case of aluminum the protective film thickness is of the order of 1×10^{-6} cm. (17).

The rate of reaction of metals depends, therefore, on the permeability of the coating to the reactants, presupposing a film which is insoluble and non-reactive with its environment. A porous film is certainly less protective than a non-porous one. Piling and Bedworth (21) showed that for oxidation if the ratio Md/mD (where M is the molecular weight of the oxide and D its density, m is the atomic weight of the metal multiplied by the number of metal atoms in the oxide formula, and d is the metal density) is greaty than unity, the oxide coating is protective; when less than unity it is non-protective; i.e., a value of the ratio greater than unity indicates a non-porous oxide film.

Several values of the ratio Md/mD were calculated and are given in Table I for comparison.

TABLE I

POROSITY OF METALLIC OXIDE FILMS

Metal	Oxide	$\frac{Md}{mD}$*
Calcium	CaO	0.64
Aluminum	Al_2O_3	1.24
Chromium	Cr_2O_3	2.03

* Refer to page 10 for a description of this ratio

Although a coating may be protective when first formed, a limiting thickness is often reached at which the coating cracks. In some instances fragmenting of the coating occurs because the lateral stresses in the oxide eventually exceed the binding force of the coating. This is true in the case of aluminum. Since aluminum oxide, if unconstrained, would occupy a much larger volume than the aluminum destroyed in producing it, the film may remain in a stressed state, liable to fracture.

From these considerations it may be deduced that the corrosion of aluminum (and other metals whose oxide films exhibit similar properties) is brought about by a repeated breaking down of the protective oxide film. This exposes the bare metal to the oxidant and the process recommences.

If the oxidant is aqueous an equilibrium moisture concentration would be expected in the protective film. Jenny and Lewis (17) show that for the case of aluminum the water content of the film produced in aqueous solutions of weak acids is about fifteen per cent.

It is reasonable to suppose that as the lateral stresses mentioned above increase an occasional water molecule will be driven out. If enough water molecules are driven from a particular locality in the film there will result a fissure at that locality. This, too, would expose the bare metal to the corrosive agent.

Therefore for aluminum in contact with aqueous oxidizing agents, there are two contributing causes of chemical corrosion, viz.

(1) The mechanical break-down of the oxide film due to lateral stresses in the film

(2) Expulsion of water molecules in the protective film, creating a fissure in the film

Electrochemical Attack

In the previous discussion it was assumed that a break in the film permitted corrosion of the exposed metal by chemical attack. In an aqueous solution this is not completely true. Actually an electric current will flow between the oxide scale as cathode and the bare metal as anode. The current will remain strong only if oxygen has access to the cathodic surface, where it will react in the following manner:

$$\frac{1}{2}\ O_2 \quad + \quad H_2O \quad + \quad 2e \longrightarrow 2(OH)^-$$

At the anodic area the metal (using aluminum as an example) will pass into solution according to the equation

$$Al \longrightarrow Al^{+++} + 3e$$

Finally, when the ions meet, the aluminum ions combine with the hydroxide ions to form the insoluble aluminum hydroxide.

It is interesting to note that while this electrochemical corrosion ultimately will bring about a combination of aluminum with oxygen, it differs from direct oxidation. The aluminum goes into solution at one place, the oxygen is taken up at a second place and the oxide or hydroxide is formed at a third place. Thus the solid corrosion products do not form a protective film. Consequently the electrochemical corrosion begun at a break in the film tends to proceed unchecked until finally it is brought under control as a result of direct protective oxidation. As a general rule electrochemical corrosion and chemical corrosion occur concurrently at a break in the film.

Electric currents are also generated at the junction of two different metals in corrosive media. In general the less noble metal acts as the anode or corroded metal while the more noble metal is the cathode or protected metal.

The contact of two dissimilar metals producing a galvanic action may be due to a coating of one metal on another as in the cases of galvanized iron and clad aluminum, or to nonhomogeneity in the metal itself, frequently observed in alloys.

Aluminum is anodic to many of the other common metals. This means that galvanic attack is likely to occur on aluminum when it is in contact with dissimilar metals, whether the metal contact is a result of alloying or clading.

Consideration should also be given to incomplete physical homogeneity, for parts under stress show a different electrochemical potential from those free from stresses. This explains the accelerated corrosive action often observed at cold-worked areas of metals.

Electrochemical action on the metal, regardless of the cause, has the effect of localized attack. When these areas of localized attack are small as compared with the whole metal surface, they are referred to as pits. This localized corrosion will proceed unchecked until the cause of the galvanic action has been eliminated.

Thus a galvanic action resulting from a coating of one metal on another will continue until the coating has been removed.

Similarly electrochemical attack on a localized area of metal inhomogeneity will continue until the area is homogeneous.

The Effect of Joint Action

Corrosion is understood to be the destruction of metal by chemical or electrochemical actions. Erosion, on the other hand, refers to destruction by mechanical agents. In practice both forms of attack are frequently associated, the result being that the wear is accelerated. As an example, lead at 25°C in stagnant 10% hydrochloric acid is reduced at a rate of 63 mils per year. When the acid is stirred at a linear tip speed of the blade of only 6.5 feet per minute the loss increased to 260 mils per year, other conditions remaining the same.

Throughout the remainder of this thesis the term corrosion will be used to mean the joint action of corrosion and erosion.

SECTION IV - DESCRIPTION OF APPARATUS

General

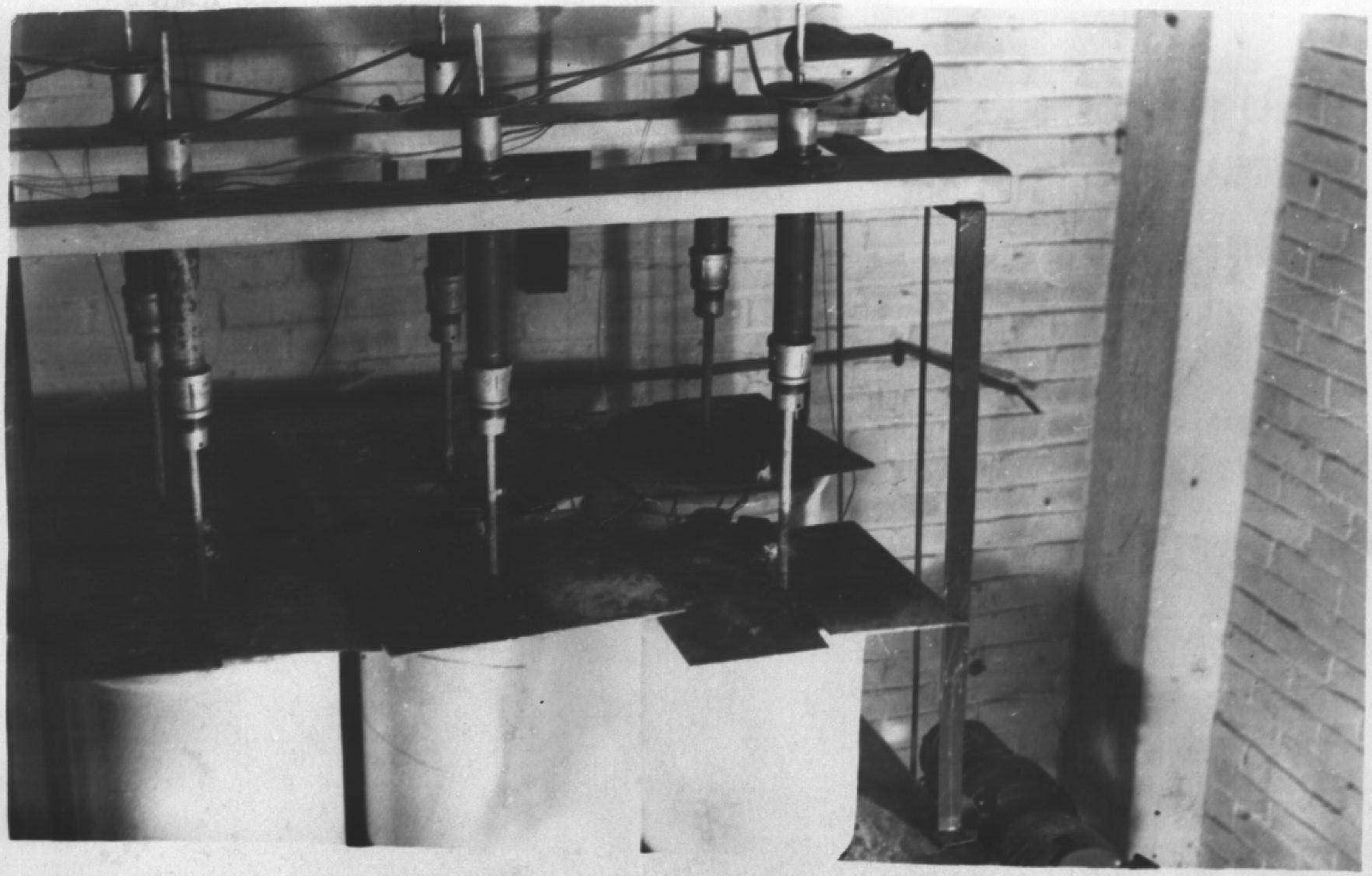
The basic design of the testing apparatus followed that suggested by the American Society for Testing Materials (3). The testing apparatus is shown in Photograph 1. Photograph 2 shows the panel board, temperature recorder, and relay cabinet. With the exception of the temperature recorder and relay cabinet, the entire apparatus was assembled on a wooden table 108 inches long by 33 inches wide and 30 inches high.

Testing Baths

Twelve earthenware crocks were used as testing baths. The ten gallon size crock was found to be an ideal size, but six and eight gallon crocks were also used. The test samples, stirring system, and temperature controlling and measuring devices were positioned in the baths as shown in Figures 1 and 2. To lessen evaporation losses the baths were fitted with removable pressed wood covers. These covers are not shown in the Figures.

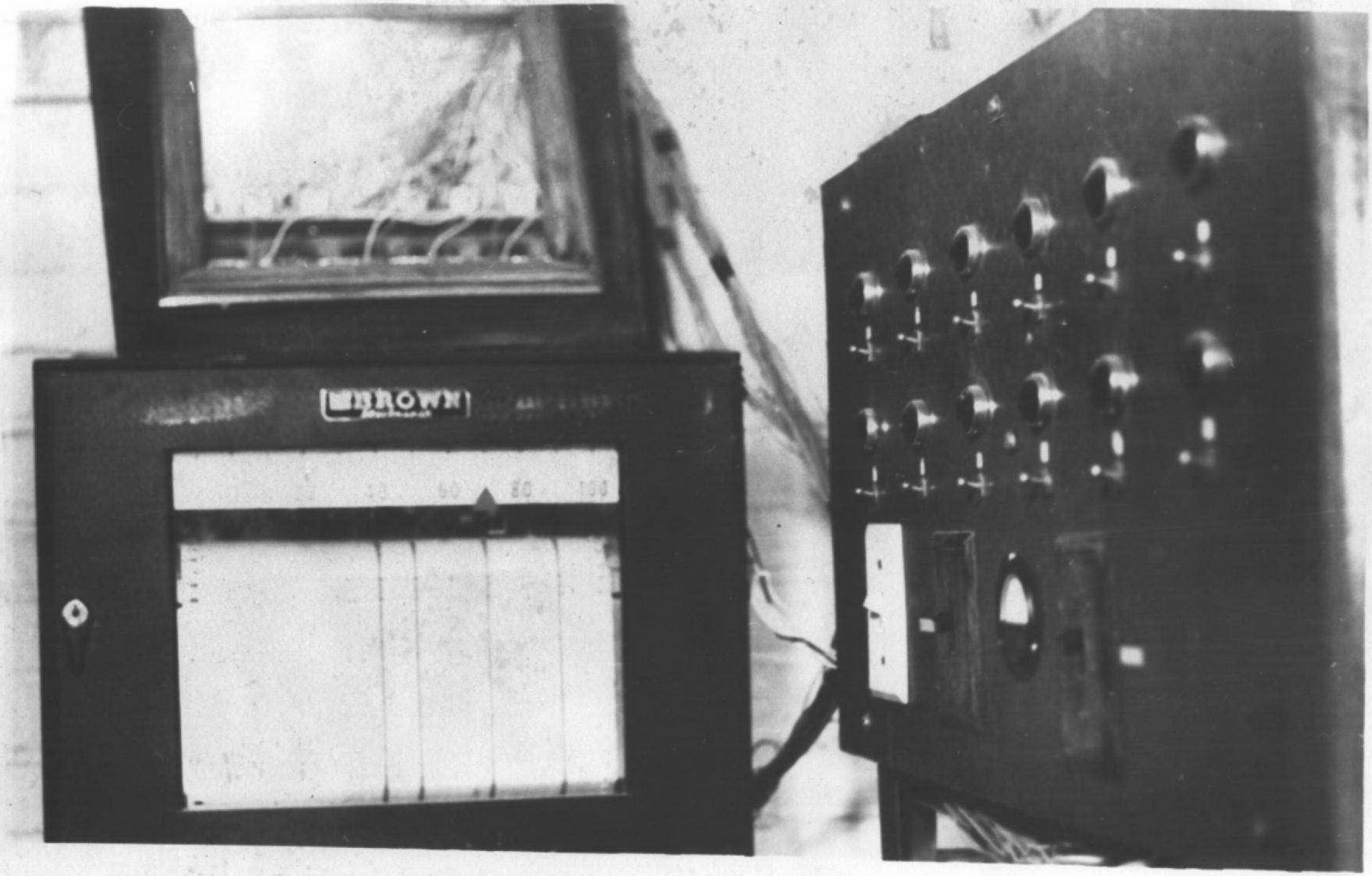
Suspension of Samples

The suspension system originally employed consisted of four pressed wood discs mounted on a wooden shaft. The diameter of the discs was approximately ten inches. Projecting radially from the periphery of the discs were a number of one-sixteenth inch tapered wooden dowels. The discs were so positioned vertically than the distance between the two top discs and between the two bottom discs was the same as the



PHOTOGRAPH 1

TESTING APPARATUS



PHOTOGRAPH 2

RELAY CABINET, TEMPERATURE RECORDER AND PANEL BOARD

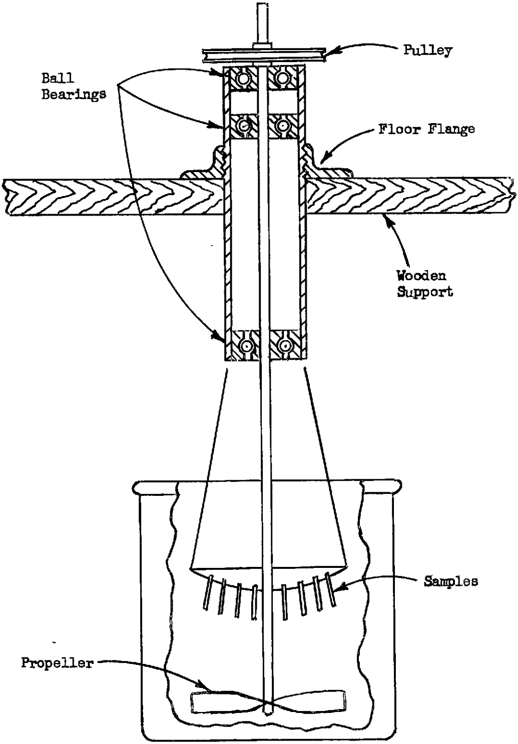


FIGURE 1
STIRRING MECHANISM AND SUSPENSION SYSTEM

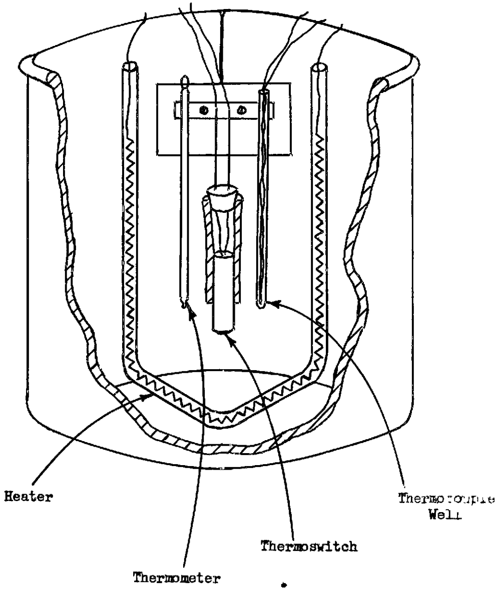


FIGURE 2

TEMPERATURE MEASURING AND CONTROL EQUIPMENT distance between the two mounting holes in the specimens. The coupons were held in place on the tapered dowels by a rubber band stretched over the two dowels. To further aid in holding the specimens in place a length of cotton string was used to encircle each tier of specimens. The rack was rotated through the test solutions.

To make the suspension system impervious to water all wooden parts were painted with three coats of Tygon paint.

This system was found to have faults in both the design and the materials of construction used. In the event of a power failure to the heating element of one of the hot concentrated acid baths, the boric acid would begin to crystallize. As the cooling process continued the crystals would build up to such a degree as to hinder the movement of the samples through the baths. Finally the samples would be swept off the pressed wood discs. Such a series of events actually occured in two of the baths. Since the samples in the baths were identified by position only, this necessitated the preparation, weighing and measuring of new samples for the two baths. Also, the Tygon coated pressed wood was unable to withstand the combination of heat and moisture encountered in the testing baths.

Therefore, after fourteen days of operation the testing was interrupted to permit the rebuilding of the suspension system. The system finally employed is shown in Figure 2.

The samples were threaded on cotton string with a one-fourth inch by one-fourth inch length of fire-polished glass tubing as a spacer between successive coupons. A length of glass tubing approximately twelve inches long was threaded on the string as an aid in keeping the samples separated. The samples were suspended well below the liquid surface in the crocks, and the string was passed under the pressed wood cover and fastened to the table. The samples were easily removed by untying the string. This system was very satisfactory in all respects.

Stirring Mechanism

Figure 1 shows the shaft, pulley, and bearing portion of the stirring system. Originally the pressed wood discs described earlier were fastened on the lower portion of the shaft. After the final suspension system was installed this same shaft was fitted with a propeller as shown in Figure 2. This propeller was made from a 1" x 8" x $\frac{1}{32}$" strip of stainless steel.

An angle iron and wooden support was constructed to support the stirring system. This support, which is shown in Photograph 1, was fastened to the table with C-clamps. The wood member of the support was about thirty-six inches above the table top. Ball bearings were mounted in pipe fittings which were screwed into the floor flange on the wooden support. A three and one-half inch Micarta aircraft type pulley was fastened to the wooden shaft above the top ball bearing.

The twelve stirring pulleys were connected by means of a one-fourth inch round continuous leather belt. This belt passed around various guide and idler pulleys to the motor pulley. The belt and pulley system is shown in Figure 3 and Photograph 1.

The motor used was a one-third horsepower gear motor with a shaft speed of 7.5 revolutions per minute. A smaller motor would undoubtedly have been adequate, but no other motor of the proper size and speed was

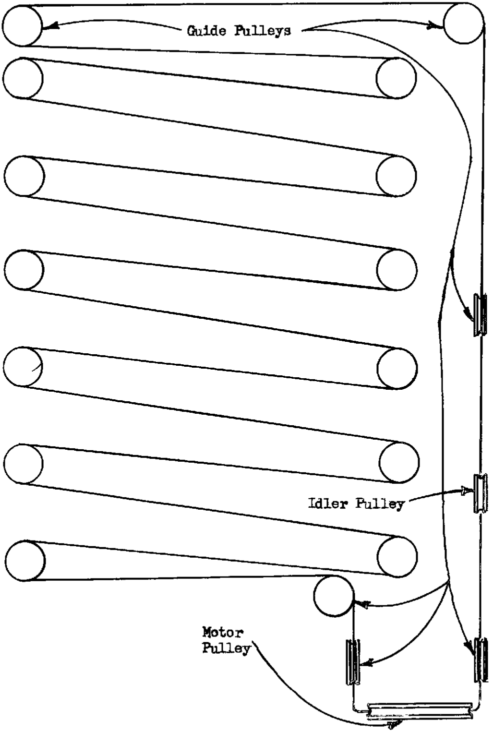


FIGURE 3

TOP VIEW OF BELT AND PULLEY SYSTEM

available. This motor provided a stirring shaft speed of about twenty-two revolutions per minute.

Temperature Controlling and Measuring System

Figure 2 shows the placement in the baths of the controlling and measuring system. A wiring diagram of the control system is shown in Figure 4.

The heater was made of a thirty-one foot length of 24 B&S Nichrome wire. This wire was wound into a coil and placed in a four foot length of Pyrex glass tubing. The tubing with the coil of wire inside was heated and bent to a convenient shape to fit into the testing bath. This heater provided a power output of about 250 watts at 117 volts. Two of the heaters connected in parallel were placed in the 90°C baths.

The thermoregulator used was a Fenwal cartridge type, adjustable, normally closed Thermoswitch, catalogue no. 17000. This regulator is manufactured by Fenwal, Inc., Ashland, Massachusetts.

The regulators were originally enclosed in a rubber tubing sleeve as shown in Figure 2. This sleeve was used to prevent the acid solution from entering the cartridge. It was later found desirable to use a 100 ml. glass (Nessler) tube as a well. Transformer oil was used in the well as a heat transfer medium. This arrangement afforded a temperature control of ± 2°C.

To provide flexibility in the selection of a thermoregulator in future operation of the equipment a double-pole, double-throw relay was used between the heater and the Thermoswitch. The relay also served to limit the current to the Thermoswitch. The relays were placed in a

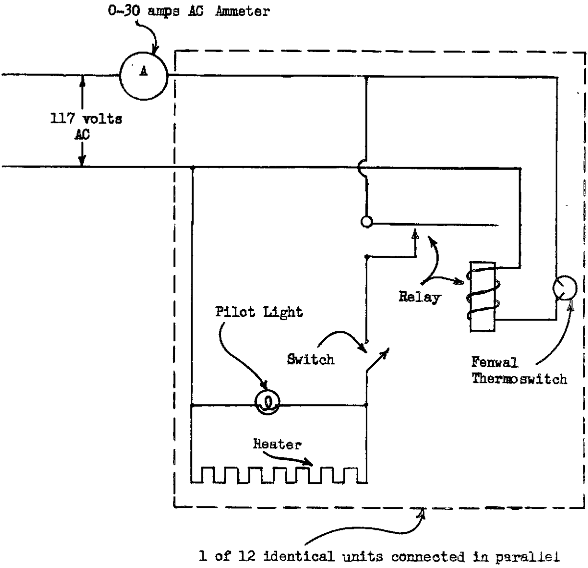


FIGURE 4

WIRING DIAGRAM OF TEMPERATURE CONTROL SYSTEM cabinet atop the temperature recorder as shown in Photograph 2.

The temperature of each bath was continuously recorded by a twelve point Brown "Electronik" Recorder. The iron-constantan thermocouples connected to this recorder were placed in the baths as shown in Figure 2.

Mercury-in-glass thermometers were placed in each bath as an additional temperature measuring device.

Panel Board

The panel board is shown in Photograph 2. This board contained the pilot lights and switches for each heater as well as a motor switch, a master switch for the heater circuit, a master switch for the control circuit, and an ammeter for measuring the current to the heater and control circuits.

SECTION V - EXPERIMENTAL PROCEDURE

Preparation of Samples

The test samples were cut from 3S-0 Alclad, 24S-T3, and 2S-H14 sheet aluminum. The nominal composition and density of each of these metals is given in Appendix I. The aluminum was cut into strips with a treadle operated sheet metal shear. The approximate size of the samples was three inches by three-fourths inch. Those samples which deviated from this size by more than 0.05 inch in either length or width were discarded. Approximately one-fourth inch from each $\frac{3}{4}$" side and midway between the 3" sides a $\frac{5}{32}$" mounting hole was punched using a sheet metal punch. A minimum of three hundred coupons of each of the three alloys were prepared.

Cleaning, Weighing and Measuring of Samples Prior to Exposure

As recommended by Uhlig (29), the coupons were degreased by immersion in acetone followed by a ten minute dip in a phosphoric-chromic acid bath. Finally the coupons were washed with distilled water and dried with acetone.

Since it was desired to duplicate closely actual plant operating conditions, the specimens were given no mechanical treatment which might alter the original surface of the metal.

The coupons were weighed on a magnetically damped analytical balance which had a sensitivity of 0.1 mg.

The length and width of each sample was measured to 0.01 inch using an engineers' scale. The thickness of each alloy was measured at several points with an indicating thickness gage which measured thickness to 0.001 inch and the average of these measurements was taken as the thickness of the alloy.

Identification of Samples

After being weighed and measured each sample was placed in a numbered envelope. As each sample was removed from its envelope and placed on the suspension system its position was noted. Other than the number appearing on the envelope the position of the coupon was the only means of identification employed.

Sixty coupons (twenty of each of the three alloys) were placed in each bath.

Recording of Data

Appendix II contains copies of the original data sheets.* The copies are presented in the same form as that used in the original data sheets.

The first column is the sample number. This number corresponds to the one on the envelope mentioned above. The data are arranged in numerical sequence. The absence of a number indicates that the sample in question was swept off the suspension system. The identification of the samples placed in each of the baths is shown in Appendix II.

The second column identifies the sample as to alloy.

The third, fourth and fifth columns contain, respectively, the length, width and thickness in inches of each sample.

The sixth and seventh columns contain the weight in grams before

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* A microfilm of the original data is on file in the Cushing Memorial Library, A & M College of Texas, College Station, Texas.

and after exposure, respectively. The eighth column is the weight loss in grams.

The ninth and tenth columns contain, respectively, the date on which the sample was introduced into the acid solution and the date of removal. The eleventh column shows the time of exposure in days. In all cases samples were introduced to and removed from the acid solutions at eight o'clock p.m. so that only whole (24 hour) days were involved.

In computing the exposure time allowance was made for the period of suspended operation necessitated by the replacement of the original suspension system. All samples were originally exposed to the solutions on July 1, 1955. On July 15, 1955 all samples were removed except those which had previously been removed for examination and those which were swept from the two baths as mentioned in Section IV - Description of Apparatus.

The remaining original samples were again placed in the acid solutions on September 1, 1955. New samples for the two baths mentioned above were introduced to the acid solutions on September 4, 1955.

The twelfth column is the surface area of each sample in square inches. The area of the edges of the specimen was included and the area lost due to the mounting holes was excluded from the surface area measurement.

The last column gives the corrosion rate in mils per year. The rate was determined with the aid of the nomograph in Appendix III.

Corrosive Solutions

The solutions were prepared using USP XIV grade crystalline boric acid produced by the Pacific Coast Borax Company. The analysis of this boric acid is given in Appendix IV.

The necessary amount of acid for each bath was weighed to 0.01 pound and placed in the crocks. Five gallons of distilled water was then poured into each crock.

In order that a constant amount of water in the baths could be maintained, a depth gauge was made for each bath. The liquid level was checked at frequent intervals and distilled water was added as needed.

The temperatures chosen for the baths were 40°C, 50°C, 70°C and 90°C. Three baths were kept at each of these temperatures.

The concentration of the solutions used in the various baths were fixed by taking a fraction of the concentration at saturation at the temperature of the series. The amount of boric acid dissolved at saturated conditions was determined from the Solubility Tables of Lange's "Handbook of Chemistry" (17). The fractions used throughout were uniformly $\frac{1}{3}$ and $\frac{2}{3}$ of saturation as well as saturation at each temperature.

A tabulation of all bath temperatures and concentrations is given in Appendix II.

Cleaning and Weighing of Samples After Exposure

In order to remove corrosion products from the corroded specimens, the cleaning procedure recommended by Champion (11) and Robertson (24) for aluminum and aluminum alloys was used. The coupons were first immersed in concentrated nitric acid at room temperature for ten minutes. Next they were immersed in a phosphoric-chromic acid solution at room temperature for ten minutes. Finally the coupons were washed with distilled water and dried with acetone.

Each sample was then weighed to 0.1 mg. The weight was recorded and the sample was returned to its numbered envelope for possible future reference.

Preparation of Photomicrographs and Photomacrographs

Photomicrographs and photomacrographs were made of several specimens according to the procedure outlined by the American Society for Testing Materials (4). These photographs are contained in the Discussion of Results.

The photomicrographs were taken using a Bausch and Lomb laboratory microscope equipped with a vertical illuminator. A Leitz Micro-Ibso attachment and a Leica III F camera completed the photomicrograph equipment. A photograph of this assembled apparatus is shown in Appendix V. Magnification was determined by photographing through the microscope the opening of a micrometer caliper and measuring this opening on the final print.

The photomacrographs were taken with a Leica III F camera fitted with a Leitz "BOOWU" close-up attachment. Oblique lighting was provided with photoflood lamps in reflectors.

Operating Difficulties Encountered

As mentioned under Section IV - Description of Apparatus the original suspension system had to be replaced. This was the major difficulty encountered.

As previously mentioned round leather belting was used to transmit power from the motor to the stirring shaft. The ends of the belting were originally joined together with a staple-type belt hook. The belt hook was inserted in two small holes punched near the ends of the belt. These holes so weakened the belt that the tension on the belt caused the hook to tear loose occasionally. When this happened the stirring system remained inoperative until a repair could be made. For this reason another type of belt fastener was needed. After experimentation with several types of fasteners it was found that Moran's steel belt couplings were ideally suited. No further difficulties with the belt system were encountered after installation of the Moran's couplings.

In one bath (the bath operated at 50°C and an acid concentration of 0.32 pounds per gallon) the glass tube used as a well for the Thermoswitch broke near the bottom of the tube. Therefore, the transformer oil used as a heat transfer medium entered the bath. This fact was not noticed until after the conclusion of the testing.

In the bath operated at 90°C with a saturated boric acid solution, the corrosive conditions caused excessive damage to the miscellaneous apparatus in the bath. The wood shaft of the stirring mechanism disintegrated and the pressed wood covers warped badly. Also, the insulation on the electrical wires leading to the heating elements was destroyed. Testing was therefore discontinued in this bath after seven days of operation.

The effect of the above operating difficulties on the experimental results will be discussed under Discussion of Results.

SECTION VI - DISCUSSION OF RESULTS

General

The purpose of this project was to determine the variation of the corrosion rate of aluminum in boric acid solution with four independent variables. The four variables were time, temperature, boric acid concentration and aluminum alloy.

Variation of Corrosion Rate With Time

The variation of corrosion rate with time is presented graphically in Figures 5 through 16. Each Figure represents one alloy at one temperature with acid concentration as the parameter.

The corrosion rate was obtained from the expression

$$\text{M.P.Y.} = \frac{22,289\ W}{D\ A\ T}$$

where the corrosion rate, M.P.Y., is in mils loss of metal per year over the entire exposed surface; the weight loss, W, in grams; the density of the metal, D, in grams per cubic centimeter; the surface area of the coupons, A, in square inches; and the time of attack, T, in days. A nomograph relating these variables is given in Appendix III.

The corrosion rate as expressed above is an average rate over the period of attack up to the time of removing the specimen. This method of expressing the rate of corrosion is recommended by Fontana (14) and is becoming more universally adopted as a method of expressing results. Although the instantaneous rate could be determined from the data obtained, the average rate is employed in this thesis as more convenient and according to the trend in technical journals. It will hereafter be referred to as rate.

FIGURE 5

CORROSION RATE VS. TIME OF 2S ALUMINUM IN BORIC ACID SOLUTIONS AT 40°C

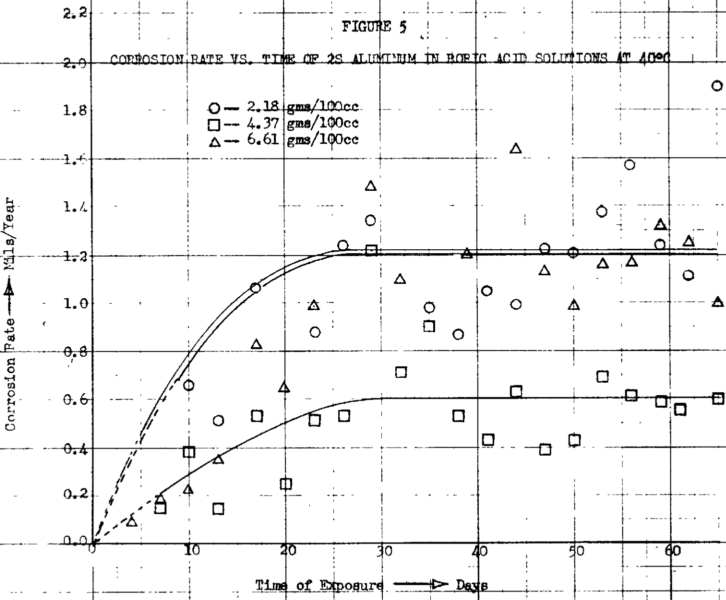
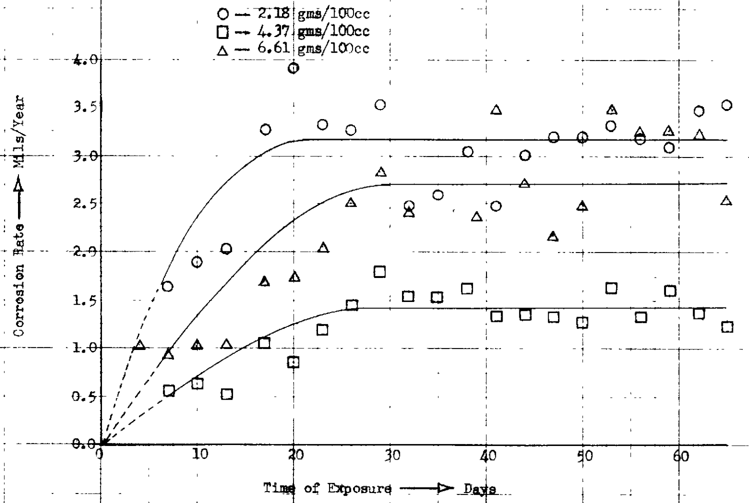


FIGURE 6

CORROSION RATE VS. TIME OF 3S ALUMINUM IN BORIC ACID SOLUTIONS AT 40°C



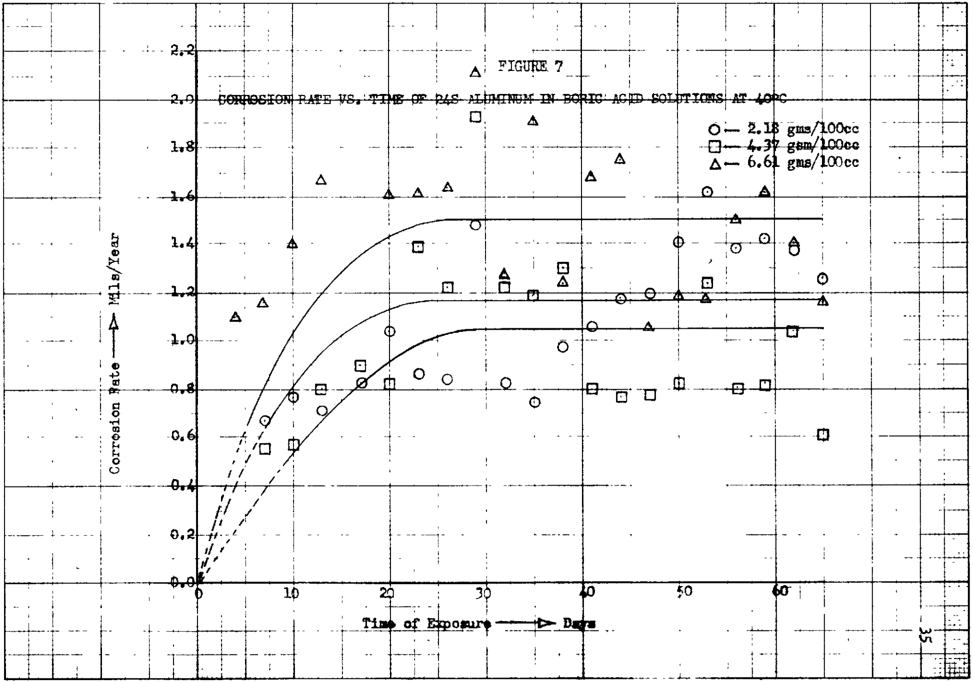


FIGURE 7

CORROSION RATE VS. TIME OF 24S ALUMINUM IN BORIC ACID SOLUTIONS AT 40°C

FIGURE 8

CORROSION RATE VS. TIME OF 2S ALUMINUM IN BORIC ACID SOLUTIONS AT 50°C

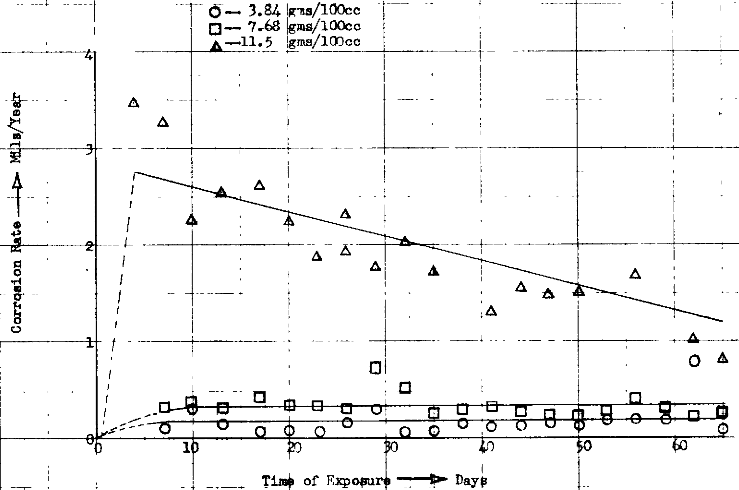
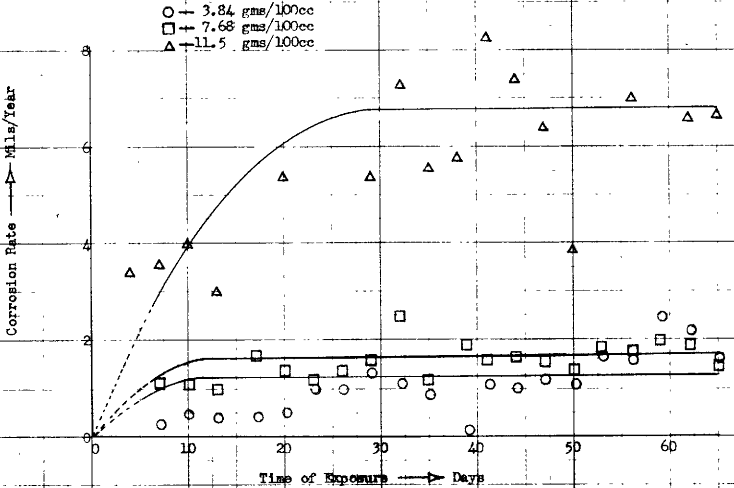


FIGURE 9

CORROSION RATE VS. TIME OF 3S ALUMINUM IN BORIC ACID SOLUTIONS AT 50°C



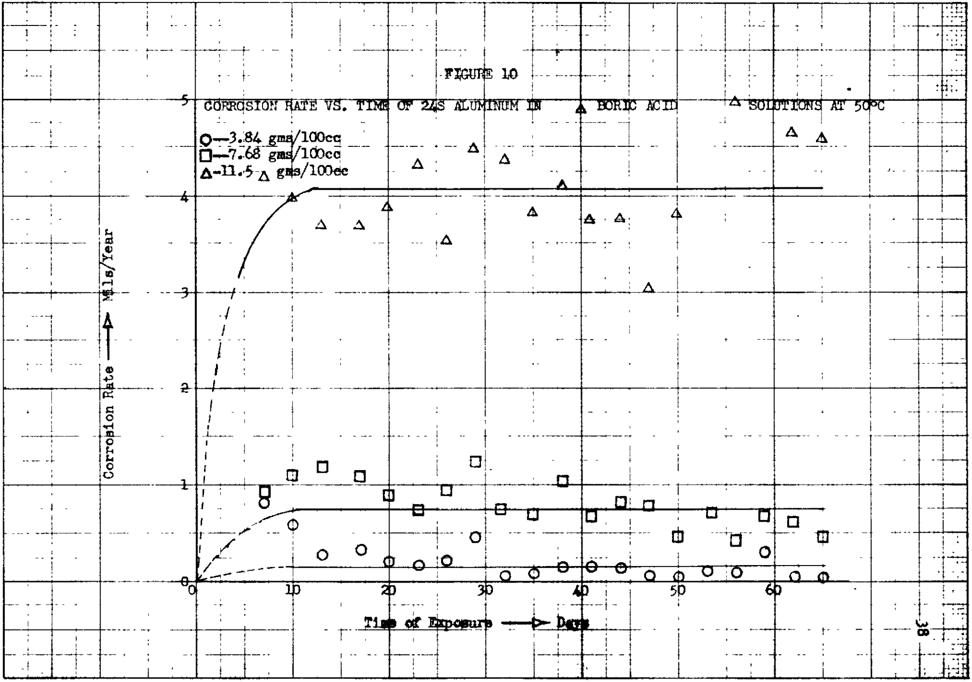


FIGURE 10

CORROSION RATE VS. TIME OF 24S ALUMINUM IN BORIC ACID SOLUTIONS AT 50°C

FIGURE 11

CORROSION RATE VS. TIME OF 2S ALUMINUM IN BORIC ACID SOLUTIONS AT 70°C

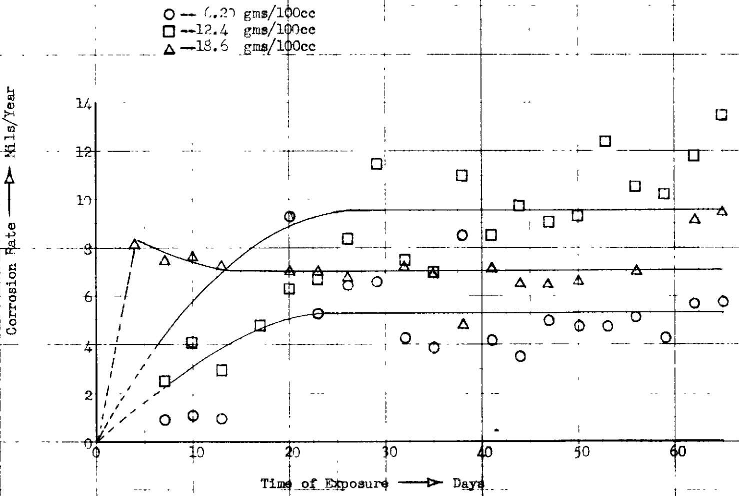


FIGURE 12

CORROSION RATE VS. TIME OF 3S ALUMINUM IN BORIC ACID SOLUTIONS AT 70°C

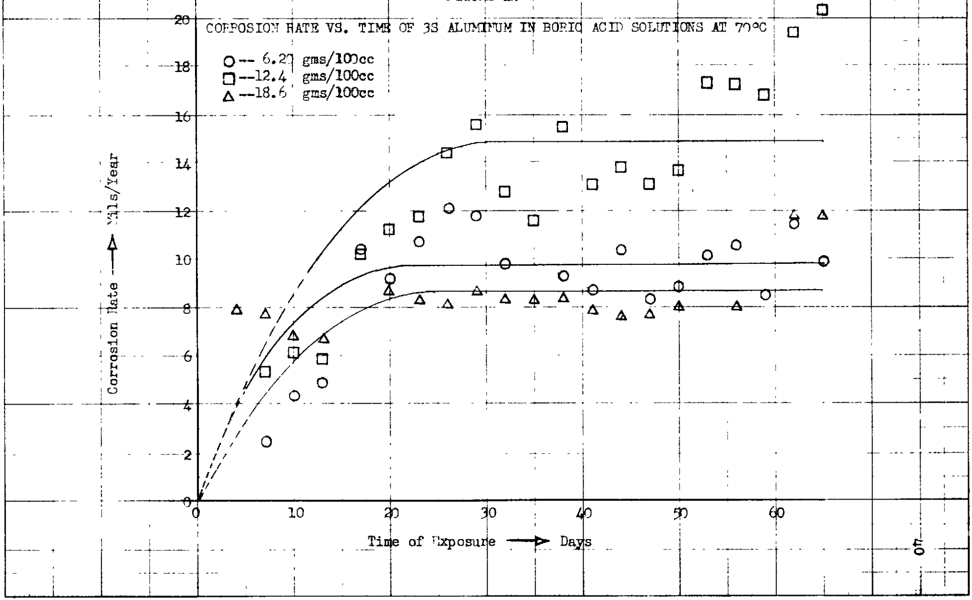


FIGURE 13

CORROSION RATE VS. TIME OF 24S ALUMINUM IN [illegible] ACID SOLUTIONS AT [illegible]0°C

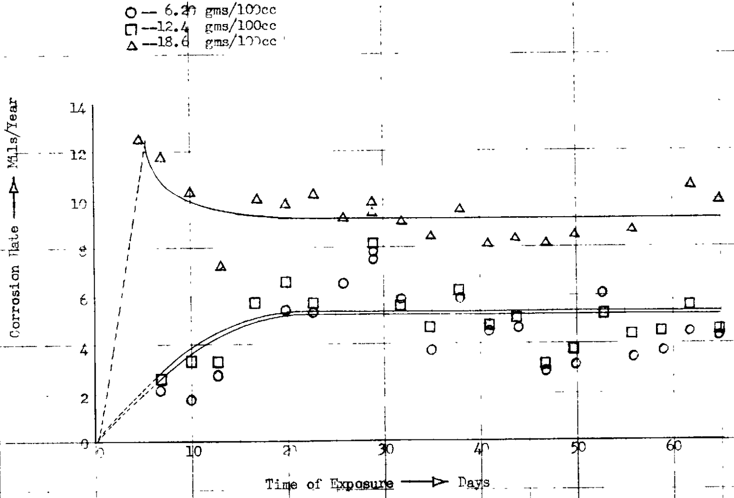


FIGURE 14

CORROSION RATE VS. TIME OF 2S ALUMINUM IN BORIC ACID SOLUTIONS AT 90°C

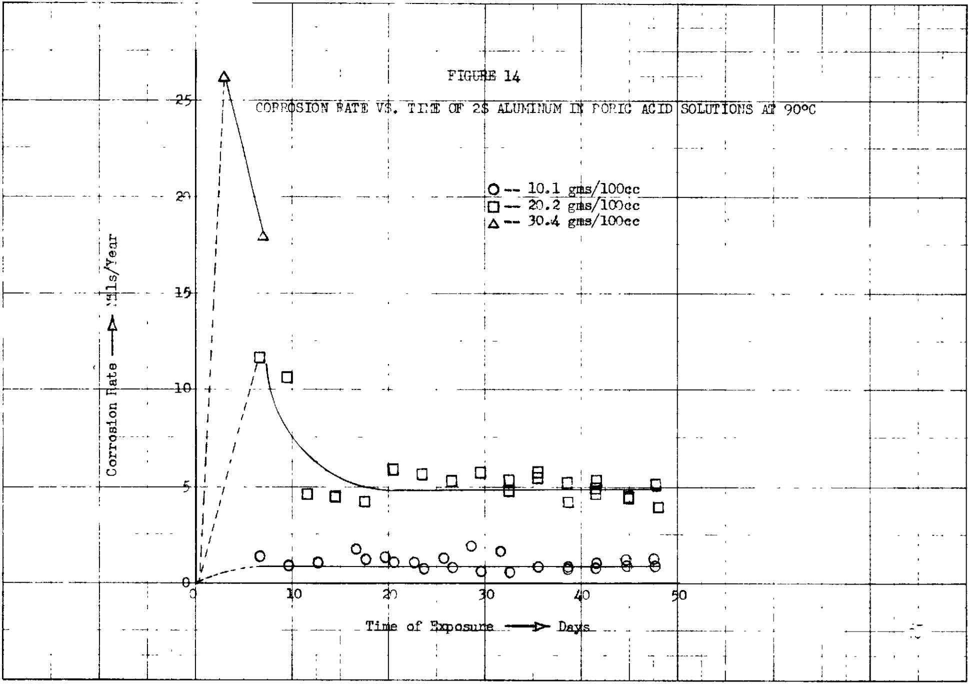


FIGURE 15

CORROSION RATE VS. TIME OF 3S ALUMINUM IN BORIC ACID SOLUTIONS AT 90°C

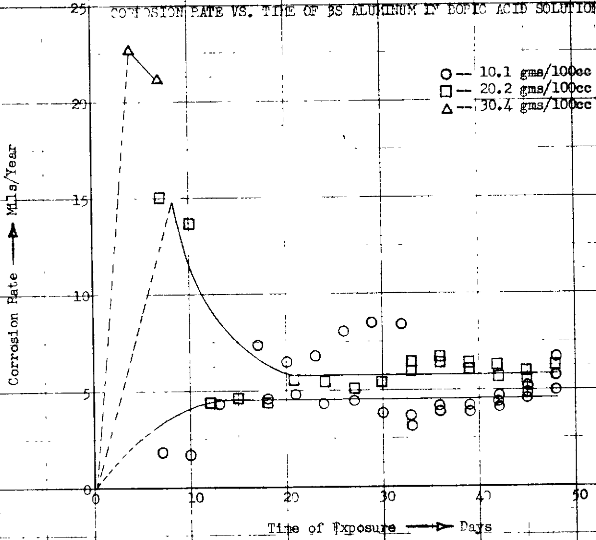
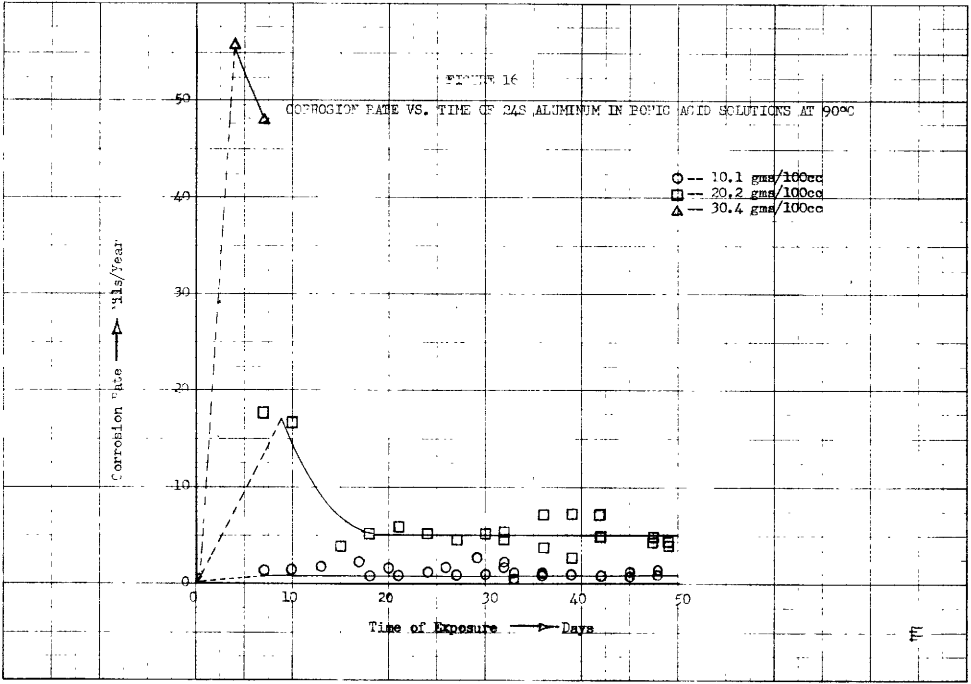


FIGURE 16

CORROSION RATE VS. TIME OF 24S ALUMINUM IN BORIC ACID SOLUTIONS AT 90°C



In most cases in Figures 5 through 16, the rate showed a gradual increase with time up to about twenty days. After this initial build-up period the rate levelled off to a fairly constant value. This constant value of rate, represented by the straight line portion of the curves was calculated by the method of least squares.

In all cases the curves were extrapolated to the origin, which assumes a corrosion rate of zero at zero time.

It should be pointed out that if the individual points were connected, an almost cyclic curve would result. This cyclic curve would oscillate around the straight line curve which is shown. This cyclic variation seems to be characteristic of aluminum corrosion and will be discussed in further detail in a later paragraph of this section.

As mentioned in Section IV - Description of Apparatus, the suspension system was replaced after fourteen days. Since no sharp breaks in the rate-time curves could be discerned at fourteen days, it is concluded that the interruption of testing necessitated by the replacement of the suspension system had very little, if any, effect on the corrosion rate.

Similarly, no breaks in the curves corresponding to the periods of inoperation of the stirring mechanism are evident. It is concluded, therefore, that this operating difficulty also had a negligible effect on the corrosion rate.

In several cases (Figures 11, 13, 14, 15 and 16) there was a high initial attack followed by a decrease in rate and a final levelling-off. This phenomenon seems to be present only at the higher bath temperatures and acid concentrations. It is possible that this high initial rate is a result of an oxide film which initially is not impervious to the higher acid concentrations and temperatures. As the attack of the metal continues, however, the film will thicken and become relatively impervious.

In the case of 2S aluminum at 50°C in a saturated boric acid solution (Figure 8), the rate-time curve decreased with a reasonably uniform slope throughout the attack period. A possible explanation for this phenomenon will be presented in a later paragraph of this section.

The constant rate values obtained from each alloy at each concentration and temperature are presented in tabular form in Table II. For the 2S aluminum at 50°C in a saturated boric acid solution (Figure 8) the constant rate value was taken as the initial value of the rate. Constant rate values for the three alloys at 90°C and saturated conditions are not given. As explained in Section V - Experimental Procedure, testing in the bath at the above conditions was discontinued after seven days of operation due to the partial destruction of the testing apparatus by the severe corrosive conditions. Therefore, there was insufficient data from which to obtain a constant rate value from this bath.

Variation of Corrosion Rate With Temperature and Acid Concentration

The constant rate values for each alloy are plotted as a function of concentration with temperature as the parameter in Figures 17 through 19.

It is noticed that the rate generally increases with temperature up to 70°C. In all cases there is a marked decrease in rate at 90°C. This is in line with the observation made by Hackerman as mentioned in Section II - Survey of the Literature.

For the case of 2S and 3S aluminum at 70°C, there is a sharp decrease in rate at saturation concentrations. This is probably due to a precipitation

TABLE II

CORROSION RATES OF ALUMINUM AND ALLOYS IN BORIC ACID SOLUTIONS

Alloy	Temperature °C	Acid Concentration gms/100cc	Rate * mils/yr.
2S	40	2.18	1.22
2S	40	4.37	.60
2S	40	6.61 (sat.)	1.21
2S	50	3.84	.18
2S	50	7.68	.34
2S	50	11.5 (sat.)	2.85
2S	70	6.20	5.50
2S	70	12.4	9.58
2S	70	18.6 (sat.)	5.44
2S	90	10.1	.87
2S	90	20.2	4.94
3S	40	2.18	3.16
3S	40	4.37	1.41
3S	40	6.61 (sat.)	2.70
3S	50	3.84	1.27
3S	50	7.68	1.60
3S	50	11.5 (sat.)	6.71
3S	70	6.20	9.75
3S	70	12.4	14.83
3S	70	18.6 (sat.)	6.49
3S	90	10.1	4.50
3S	90	20.2	5.79
24S	40	2.18	1.17
24S	40	4.37	1.05
24S	40	6.61 (sat.)	1.50
24S	50	3.84	.15
24S	50	7.68	.74
24S	50	11.5 (sat.)	5.16
24S	70	6.20	5.32
24S	70	12.4	5.22
24S	70	18.6 (sat.)	9.50
24S	90	10.1	.80
24S	90	20.2	5.09

*For a discussion of how this value was obtained, reference is made to page 45.

FIGURE 17

CORROSION RATE VS. CONCENTRATION FOR 2S ALUMINUM

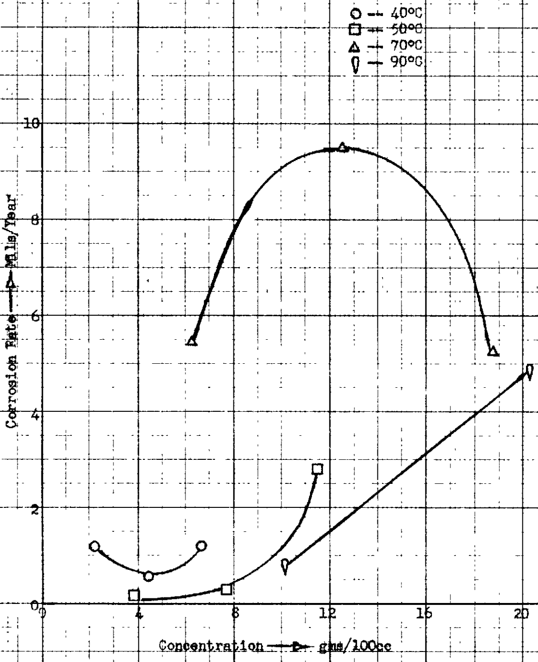


FIGURE 18

CORROSION RATE VS. CONCENTRATION FOR 3S ALUMINUM

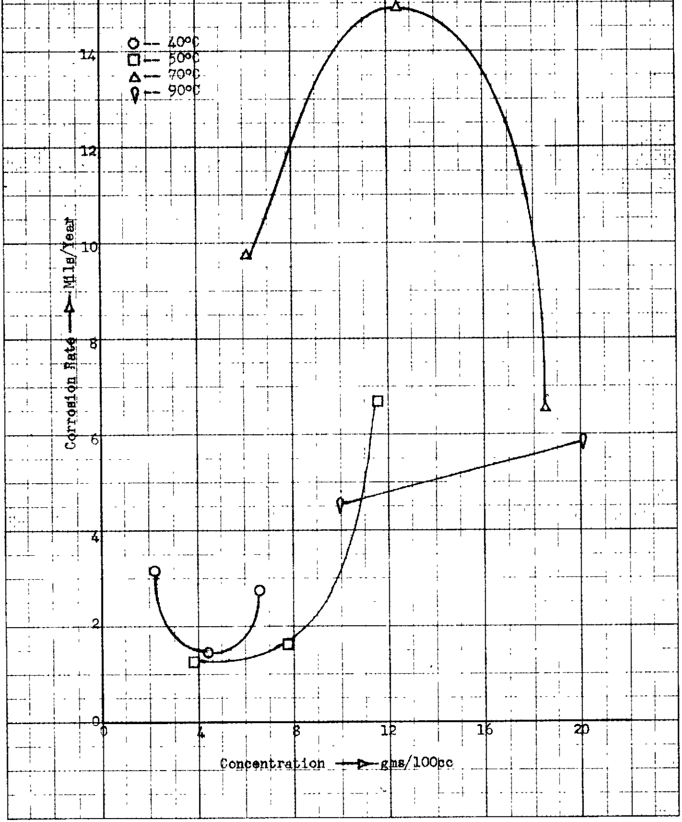
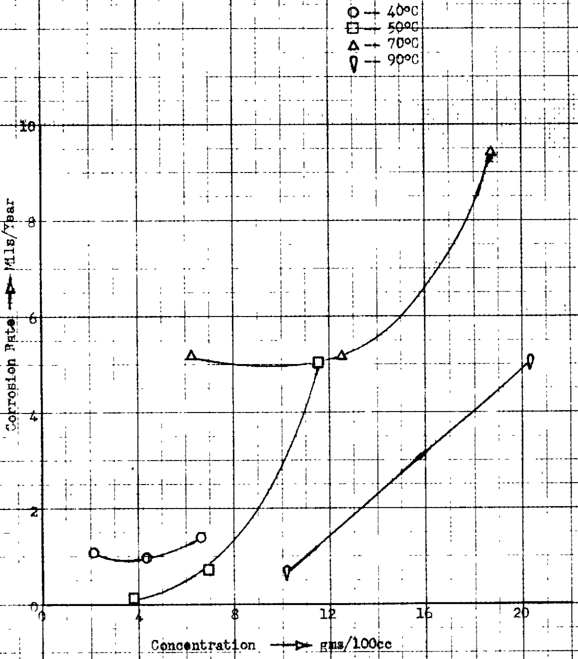


FIGURE 19

CORROSION RATE VS. CONCENTRATION FOR 24S ALUMINUM



of boric acid on these metals as a result of minor temperature fluctuations. As the bath temperature decreased slightly, a precipitation of boric acid would occur on any rough surface. The corroded coupons presented a rough surface for this precipitation. The boric acid which was precipitated on the metal would tend to protect the surface from further attack. As the surface continued to be further roughened in the corrosion process, more boric acid would precipitate onto the roughened portions. It is believed that this effect is responsible for the negative rate-time slope of 2S aluminum at 50°C and a saturation concentration (Figure 8).

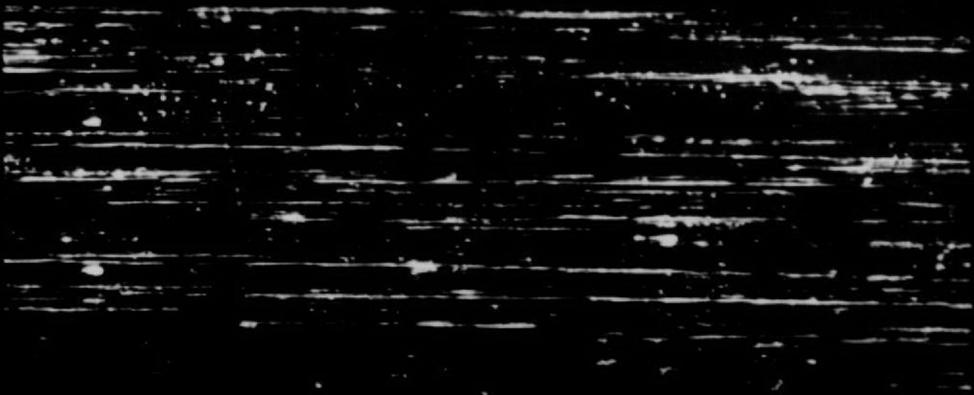
The rate-concentration curve for 24S aluminum at 70°C does not show this decrease with concentration. A possible explanation for this will be given later in this section.

It is noticed that the rate for all alloys at 50°C and $\frac{1}{2}$ saturation is lower than would be expected. As mentioned in Section V - Experimental Procedure, the glass thermoregulator well which was filled with oil broke in one of the baths, permitting oil to enter the solution. Obviously this oil afforded a degree of protection to the aluminum in this one bath.

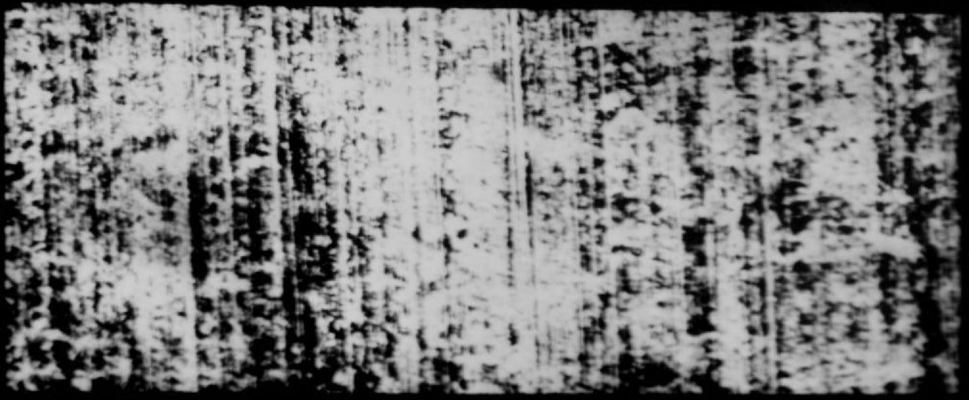
Discussion of Photomicrographs and Photomacrographs

Various photomacrographs and photomicrographs of the aluminum specimens are presented in Photographs 3 through 11. These photographs are not intended to represent average or typical specimens, but rather to indicate the type and the severity of attack encountered. In all photographs of the specimens all three alloys are shown. In all cases the three alloys shown in each photograph were exposed to the same conditions for the same period of time.

2S



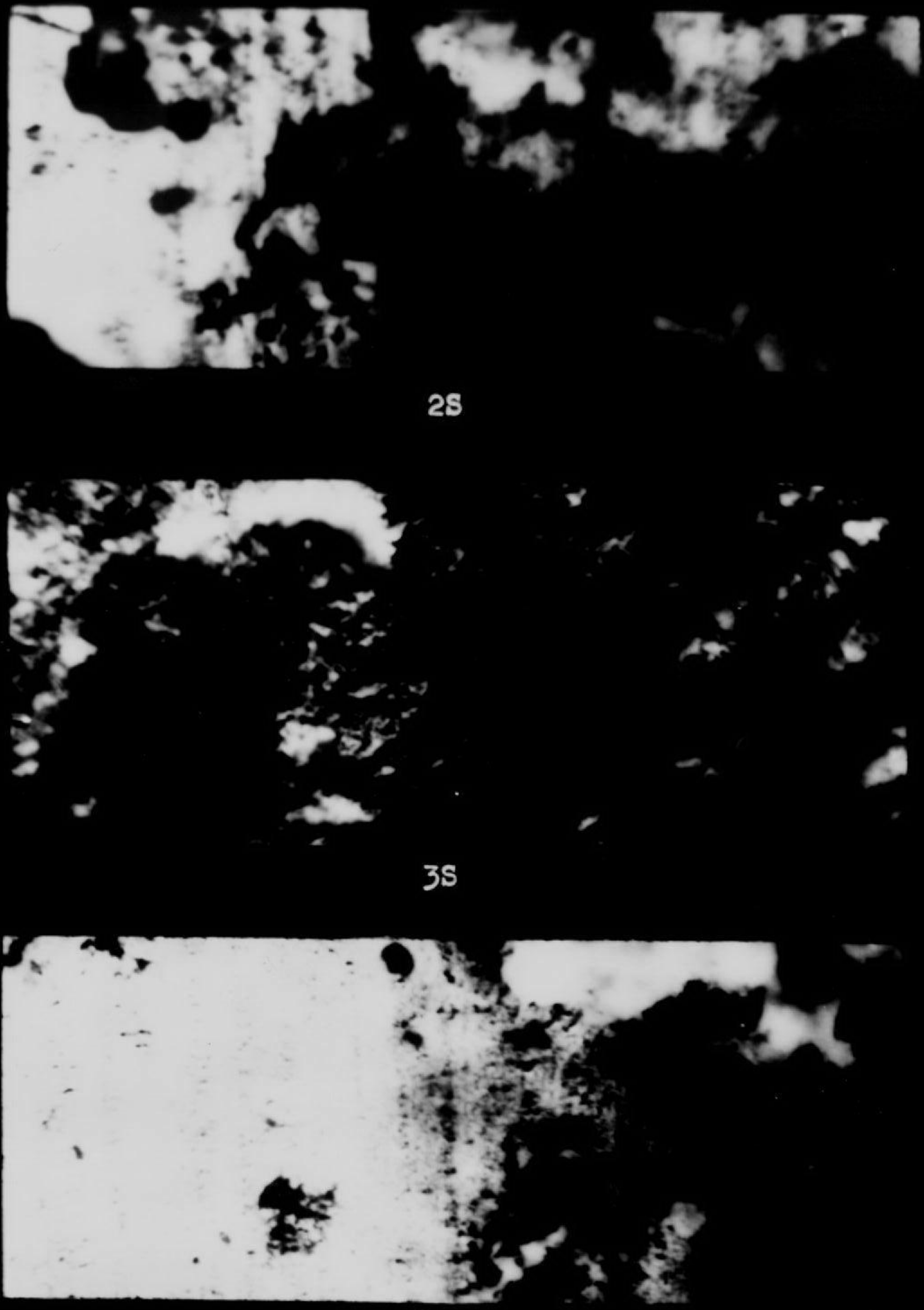
3S



24S

PHOTOGRAPH 3

PHOTOMICROGRAPHS OF UNCORRODED SPECIMENS (X150)



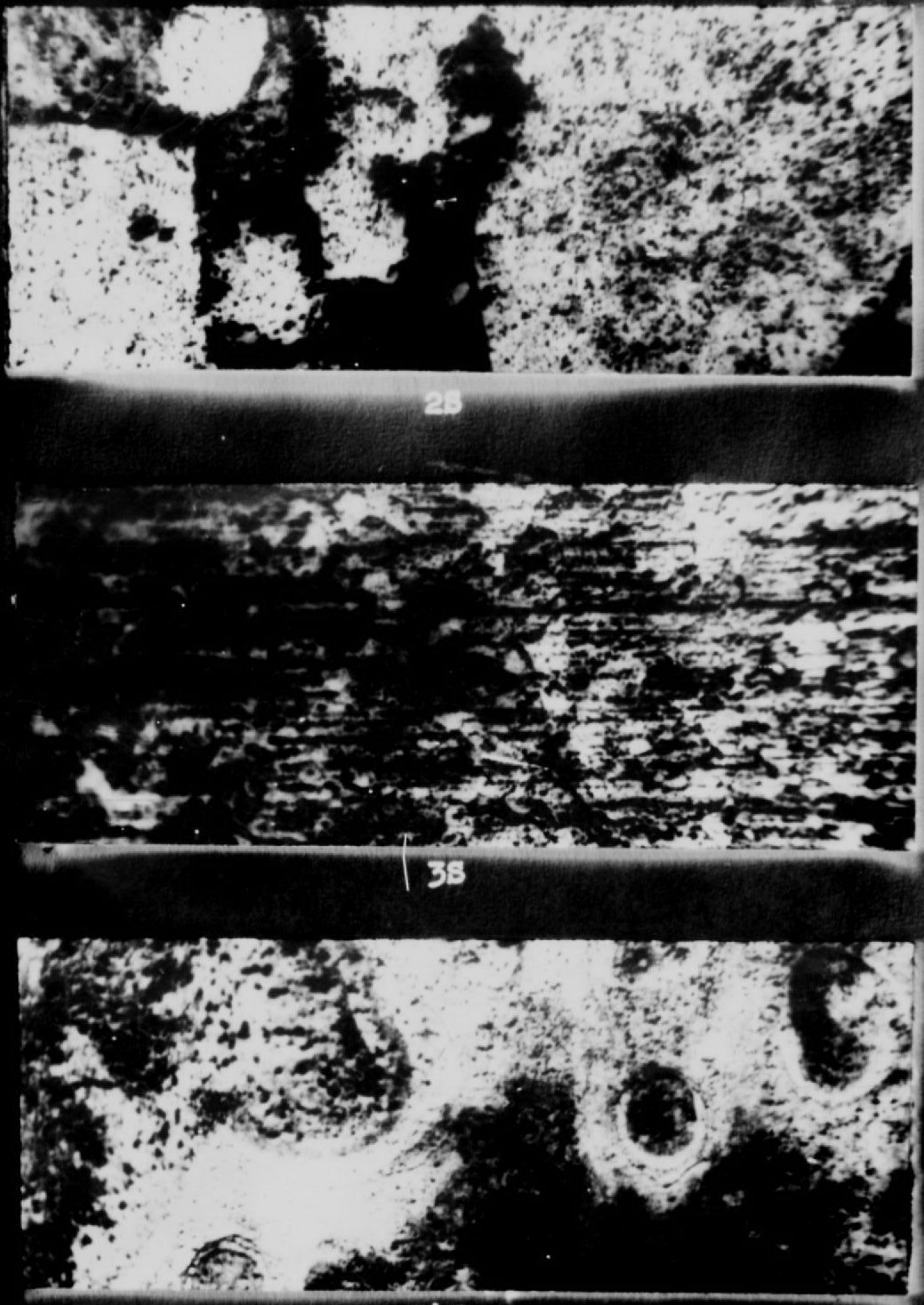
2S

3S

24S

PHOTOGRAPH 4

PHOTOMICROGRAPHS OF CORRODED SPECIMENS
EXPOSED FOR 47 DAYS AT 70°C AND 6.20 gms/100cc (X150)



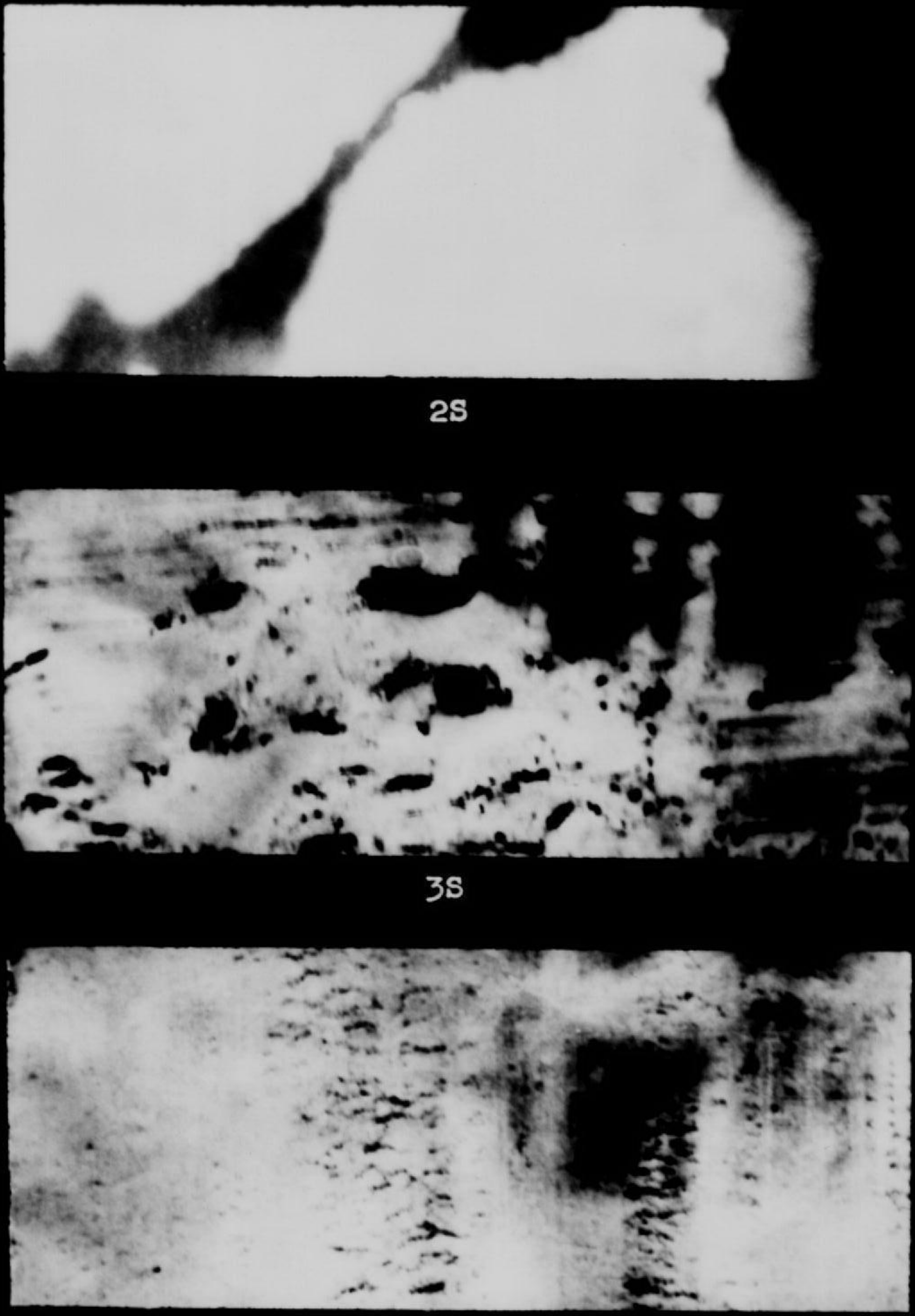
2S

3S

24S

PHOTOGRAPH 5

PHOTOMICROGRAPHS OF CORRODED SPECIMENS
EXPOSED FOR 7 DAYS AT 90°C AND 20.4 gms/100cc (X150)



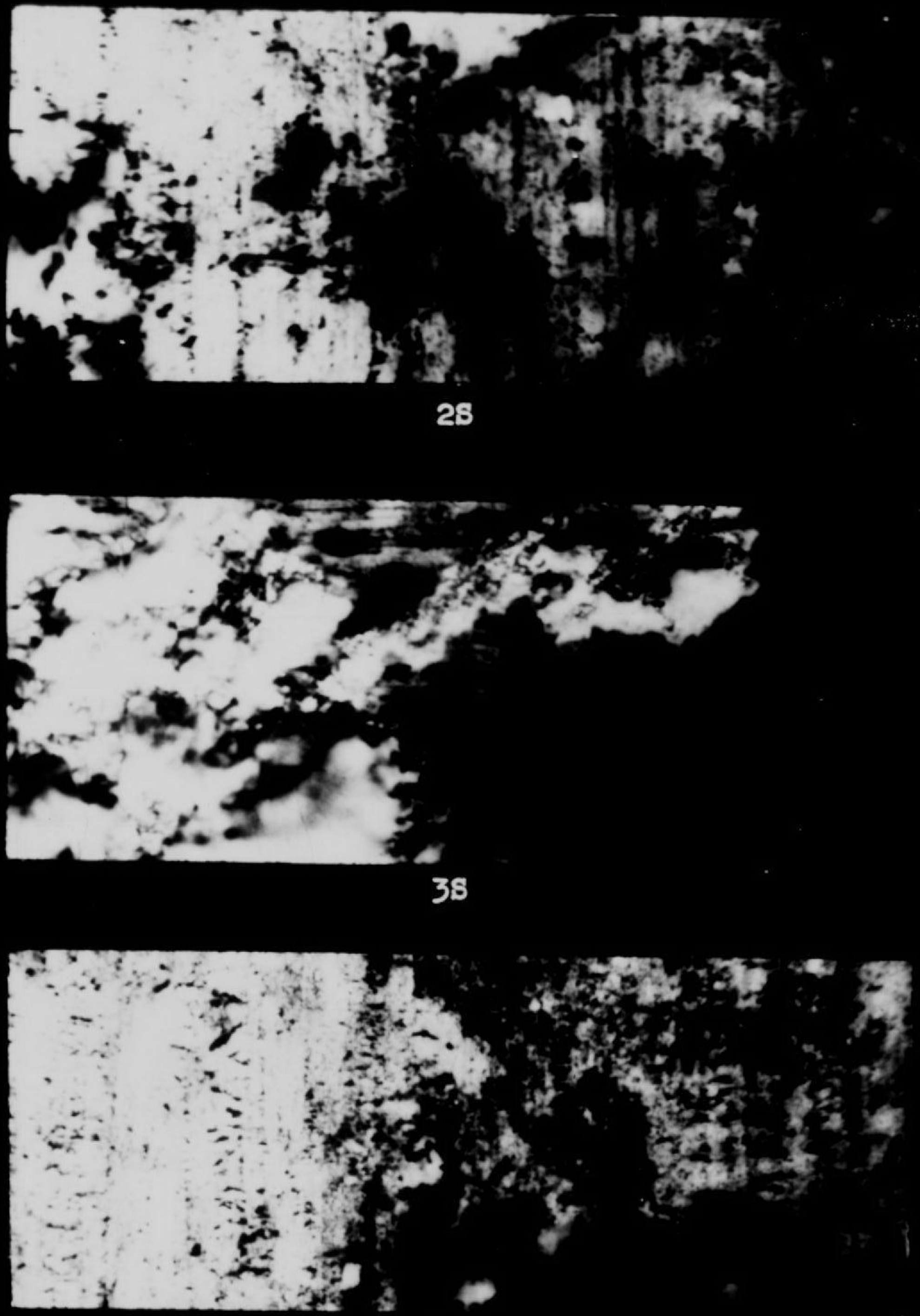
2S

3S

24S

PHOTOGRAPH 6

PHOTOMICROGRAPHS OF CORRODED SPECIMENS
EXPOSED FOR 50 DAYS AT 70°C AND 12.4 gms/100cc (X150)



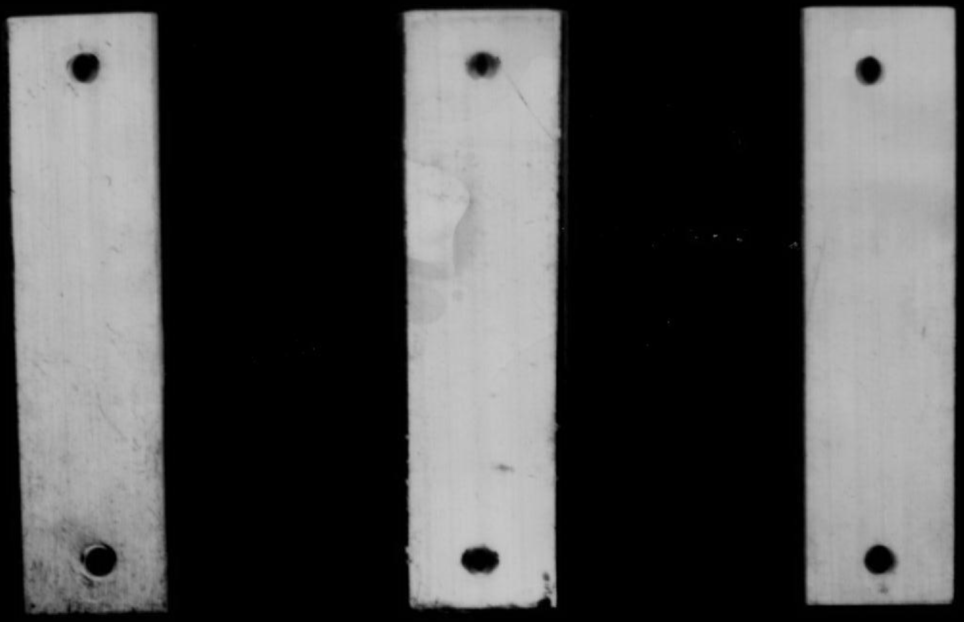
2S

3S

24S

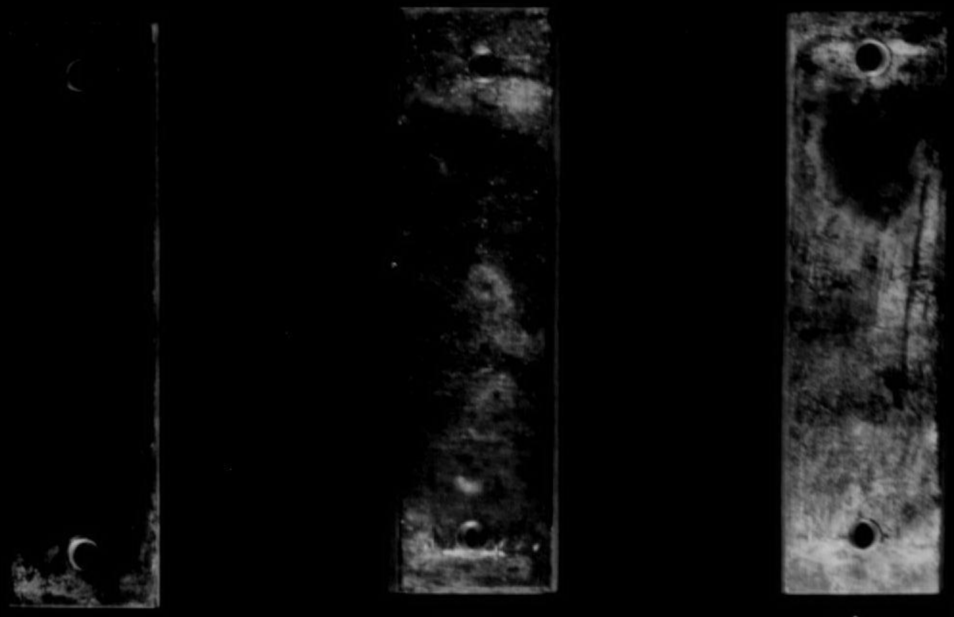
PHOTOGRAPH 7

PHOTOMICROGRAPHS OF CORRODED SPECIMENS
EXPOSED FOR 50 DAYS AT 70°C AND 6.20 gms/100cc (X150)



2S 3S 24S

EXPOSED FOR 13 DAYS AT 40°C AND 2.18 gms/100cc

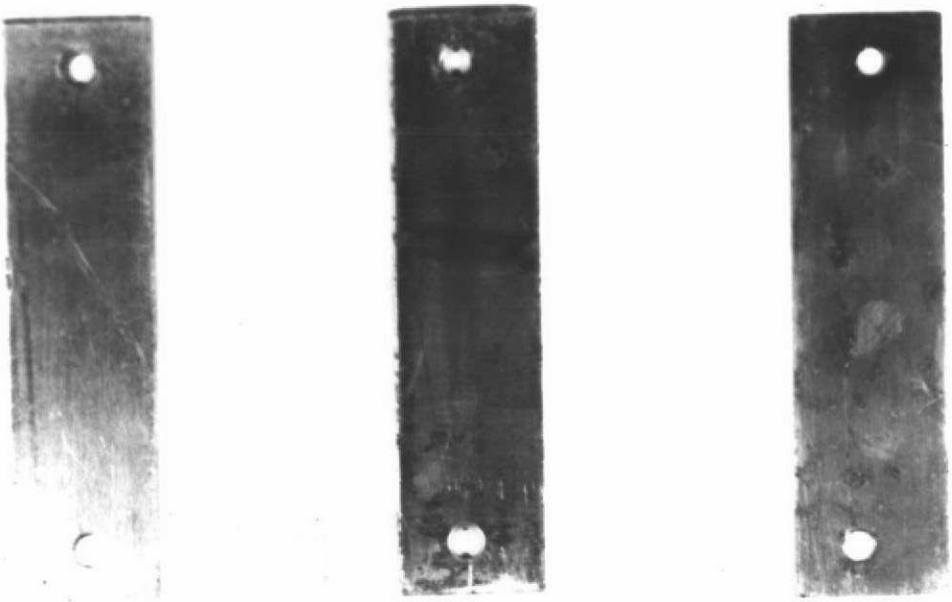


2S 3S 24S

EXPOSED FOR 7 DAYS AT 90°C AND 20.2 gms/100cc

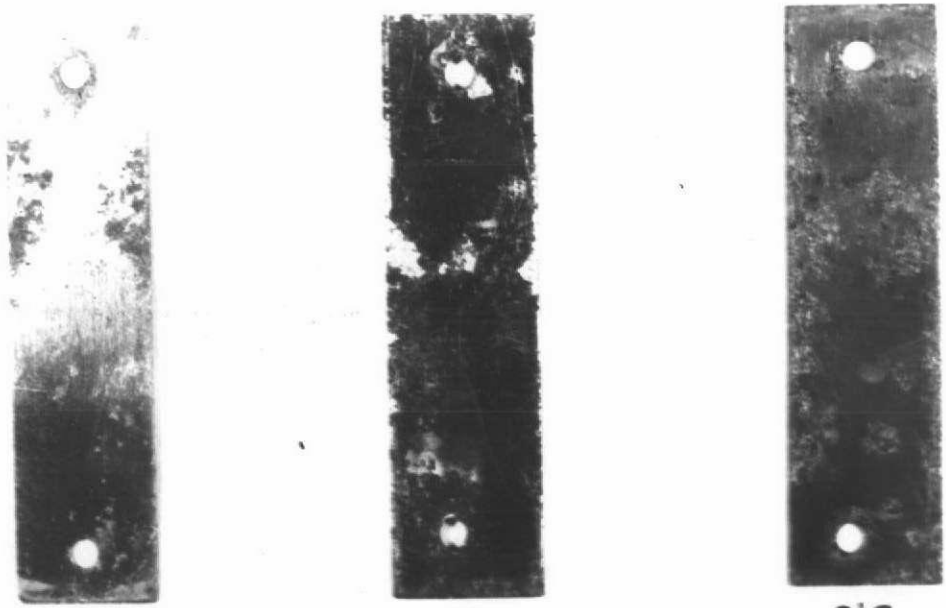
PHOTOGRAPH 8

PHOTOMACROGRAPHS OF CORRODED SPECIMENS (actual size)



2S 3S 24S

EXPOSED FOR 47 DAYS AT 40°C AND 6.61 gms/100cc

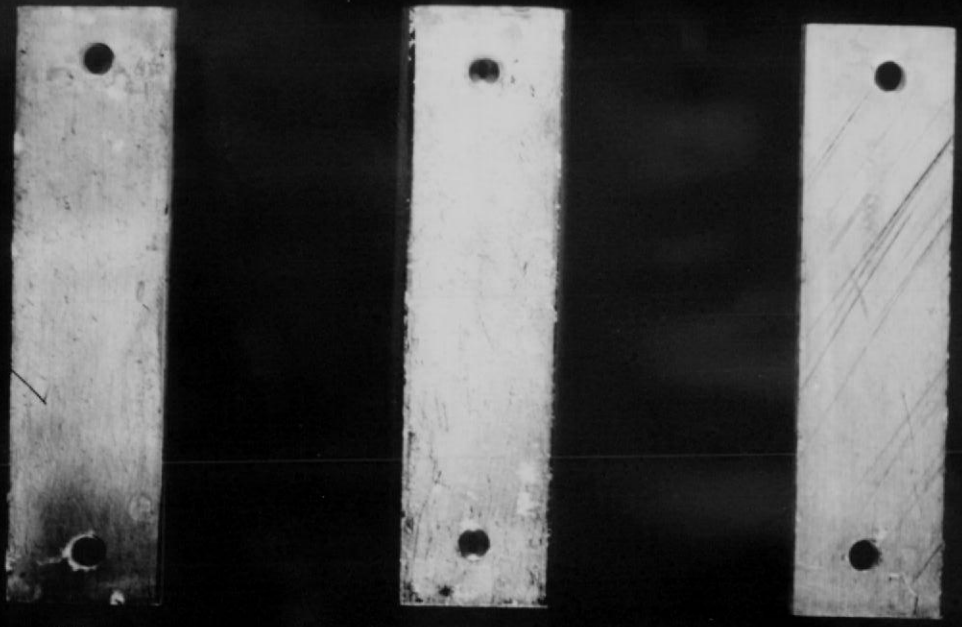


2S 3S 24S

EXPOSED FOR 47 DAYS AT 70°C AND 6.20 gms/100cc

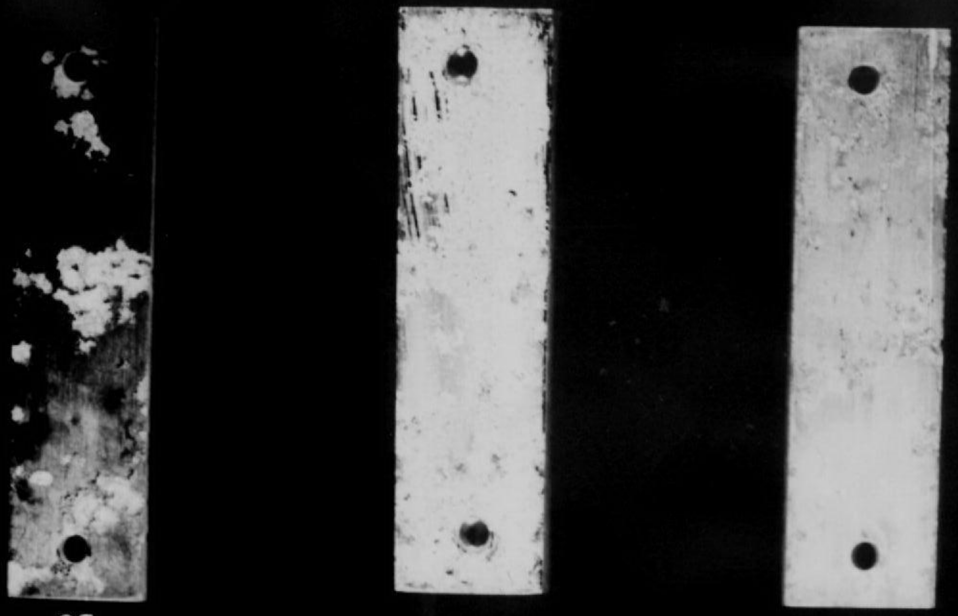
PHOTOGRAPH 9

PHOTOMACROGRAPHS OF CORRODED SPECIMENS (actual size)



2S 3S 24S

EXPOSED FOR 13 DAYS AT 70°C AND 12.4 gms/100cc

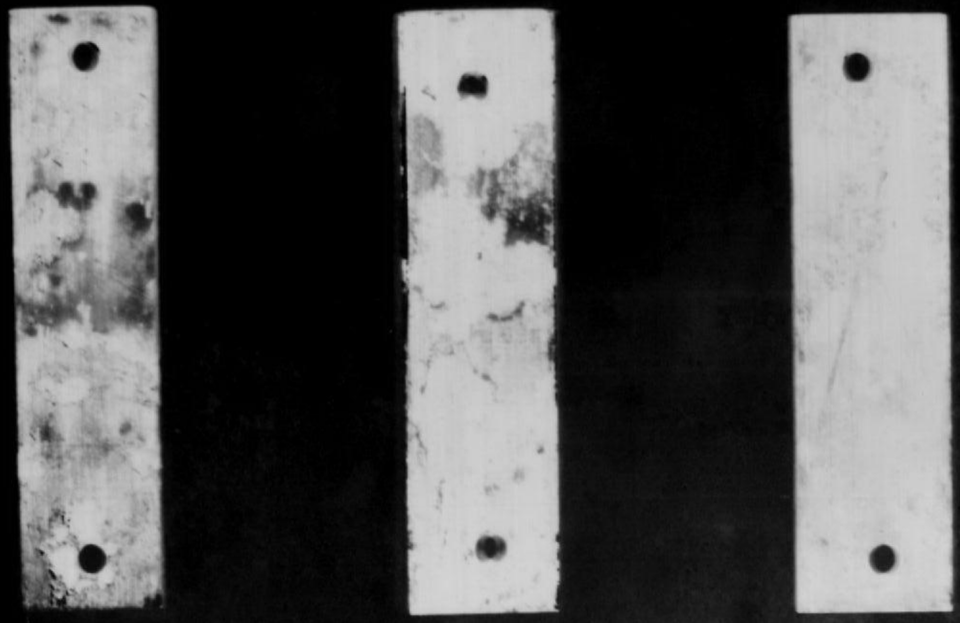


2S 3S 24S

EXPOSED FOR 50 DAYS AT 70°C AND 12.4gms/100cc

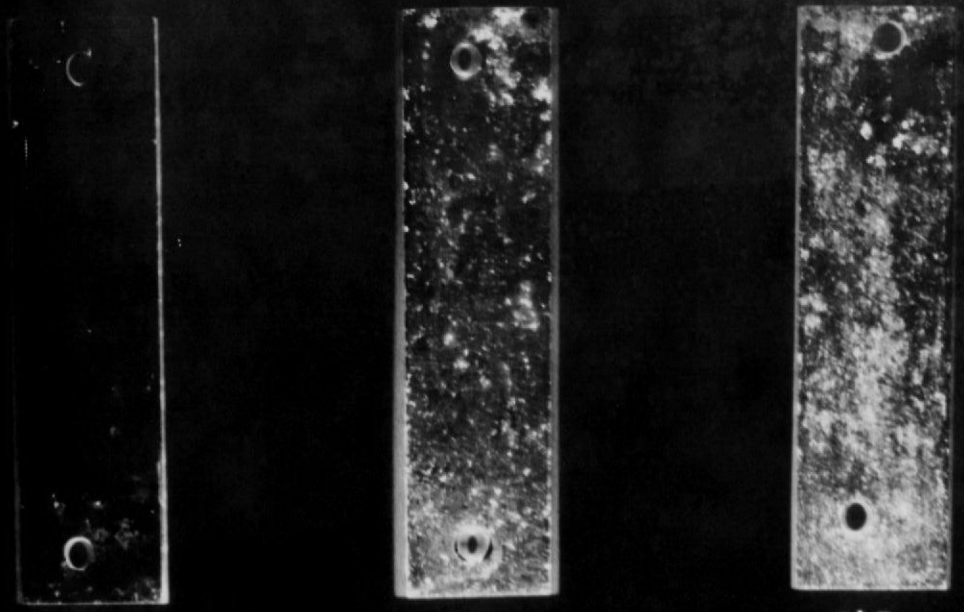
PHOTOGRAPH 10

PHOTOMACROGRAPHS OF CORRODED SPECIMENS (actual size)



2S 3S 24S

EXPOSED FOR 47 DAYS AT 70°C AND 12.4 gms/100cc



2S 3S 24S

EXPOSED FOR 47 DAYS AT 70°C AND 18.6 gms/100cc

PHOTOGRAPH 11

PHOTOMACROGRAPHS OF CORRODED SPECIMENS (actual size)

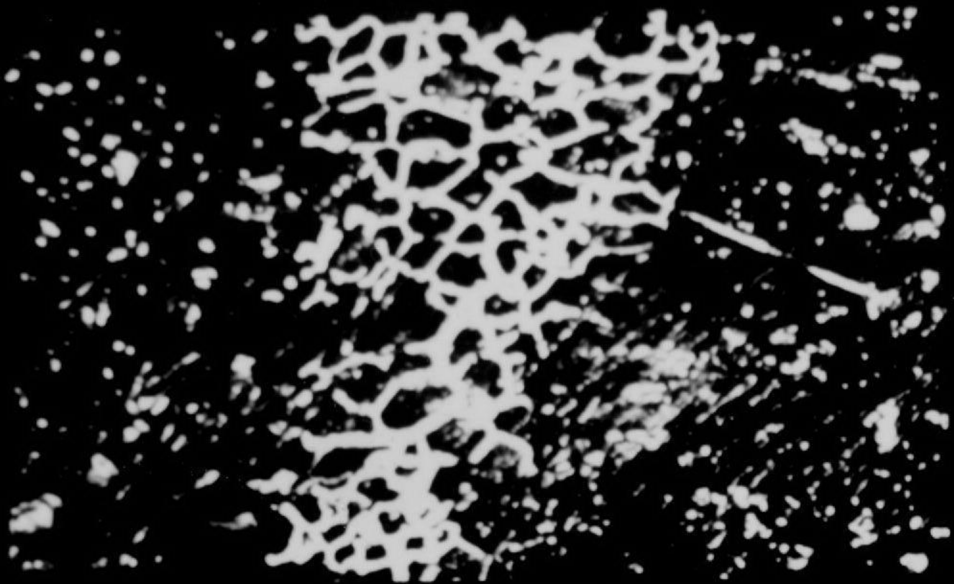
Particular notice is directed to the photomicrographs of 24S aluminum in Photographs 4, 6, and 7. It sppears that the grain of the metal is discernible in these photographs. This grain is not apparent in the photomicrographs of the other two alloys studied.

As a means of comparison, reference is made to Photograph 12. The upper photograph is a reproduction of a photomicrograph showing intercrystalline corrosion in sheet aluminum as given by Fuss and Anderson (15). The lower photograph of Photograph 12 is a photomicrograph of the 24S sample of Photograph 11. Several points of similarity between the two photographs of Photograph 12 are visible. From an examination of Photograph 12 it appears that the corrosion of 24S aluminum is intercrystalline in nature.

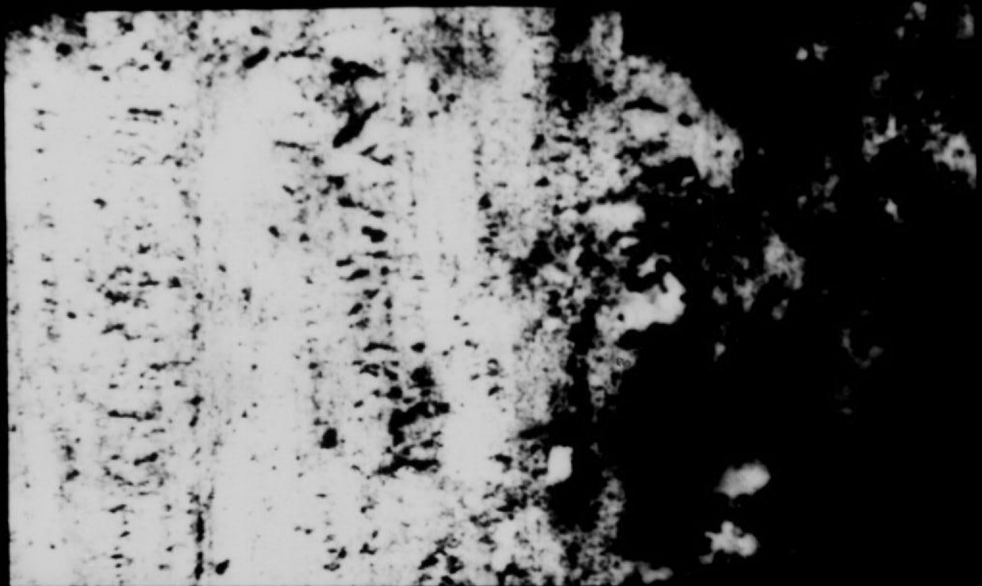
There may be less of a tendency for boric acid in saturated solutions to crystallize out on the smoother surface of 24S aluminum where there appears to be intercrystalline attack than on the 2S and 3S aluminum where there is pitting attack. If this were the case there would not be the protection offered by the boric acid crystals to the aluminum surface as in the case of 2S and 3S aluminum. This possibly explains the absence of the drop in the rate-concentration curve of 24S aluminum (Figure 17) as mentioned above.

Special Considerations

As previously mentioned the individual points of the rate-time curves are of a cyclic nature. It is believed that this cyclic effect is due to local areas of film break-down. As discussed in Section III - Theoretical Considerations, fracturing of the protective film is likely to occur when



ALUMINUM INTERCRYSTALLINE CORROSION
PHOTOMICROGRAPH OF FUSS AND ANDERSON



PHOTOMICROGRAPH OF 24S ALUMINUM EXPOSED FOR 50 DAYS
IN BORIC ACID SOLUTION AT 70°C AND 6.20 gms/100cc

PHOTOGRAPH 12
PHOTOMICROGRAPHS OF CORRODED SPECIMENS (X200)

the lateral stresses of the film force out water at local reas. It is reasonable to assume that these local areas of exposed metal are responsible for the cyclic variation of the rate-time curves. As the protective film is fractured, a local area of metal becomes unprotected and undergoes rather severe attack until the break in the film can be repaired.

Also noticed on examination of the rate-time curves of Figures 5 through 16 are several pronounced peaks. In most cases these peaks occur after about 29, 41 and 55-60 days of exposure. As mentioned in Section II - Survey of the Literature, other investigators have observed similar peaks after approximately the same exposure time, even though different conditions and corrodents were used. It is believed these peaks are due to accelerated attack brought about by a rather extensive film break-down. It would seem that the time of this break-down is not influenced by temperature, alloy or the chemical characteristics of the corrodent.

SECTION VII - CONCLUSIONS

As a result of the experimental investigation of the subject of Corrosion of Aluminum in Boric Acid Solution, the following conclusions were reached:

1. The corrosion rate generally increases with temperature up to about twenty days and then levels off to a constant rate.
2. The rate increases with temperature up to 70°C and decreases to 90°C.
3. The rate increases with concentration. However, the rate in a saturated solution is often less than would be expected, which is probably due to a precipitation of the acid crystals brought about by minor temperature fluctuations.
4. The 3S and 24S alloys are attacked more than the 2S aluminum at all concentrations and temperatures investigated.
5. While the 2S and 3S aluminum suffer chiefly pitting corrosion, it appears that the 24S aluminum undergoes intercrystalline attack.
6. The testing apparatus used in this investigation provided a convenient means of corrosion testing by the total immersion test.

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APPENDIX

APPENDIX I

NOMINAL COMPOSITION AND DENSITY OF ALUMINUM ALLOYS

The nominal compositions for each alloy used in the investigations are given in per cent. Unless a percentage range is shown, the figure is the maximum per cent of the alloying element.

These figures were obtained from the Aluminum Company of America (1).

APPENDIX I

NOMINAL COMPOSITION OF ALUMINUM ALLOYS

Alloy	Aluminum	Copper	Iron	Silicon	Magnesium	Manganese	Zinc	Chromium	Other Elements Each	Other Elements Total
2S	99.0% min.	0.20	....	....	....	0.05	0.10	....	0.05	0.15
Alclad 3S										
Core	Remainder	0.21	0.70	0.60	....	1.0-1.5	0.10	....	0.05	0.15
Cladding	Remainder	0.10	....	....	....	0.10	0.75-1.25	....	0.05	0.15
24S	Remainder	3.8-4.9	0.50	0.50	1.2-1.8	0.3-0.9	0.10	0.10	0.05	0.15

DENSITY

Alloy	gms/cm^3
2S	2.71
Alclad 3S	2.74
24S	2.76

APPENDIX II

EXPERIMENTAL DATA

The copies of the original data sheets are presented in the same form as that used in the originals.

The first column is the sample number. This number corresponds to the one on the individually numbered sample envelopes mentioned in Section V - Experimental Procedure. The data are arranged in numerical sequence. The absence of a number indicates that the sample in question was swept off the suspension system. The sample numbers exposed to each set of conditions are as follows:

Numbers (incl)	Temperature °C	Acid Concentration gms/100cc
1-30, 361-390	40	2.18
31-60, 391-420	40	4.37
61-90, 421-450	40	6.61
91-120, 451-480	50	3.84
121-150, 481-510	50	7.68
151-180, 511-540	70	6.20
181-210, 541-570	70	12.4
211-240, 571-600, 721-780	90	10.1
241-270, 601-630, 781-840	90	20.2
271-300, 631-660	90	30.4
301-330, 661-690	70	18.6
331-360, 691-720	50	11.5

The second column of the experimental data identifies the sample as to alloy.

The third, fourth and fifth columns contain, respectively, the length, width and thickness in inches.

The sixth and seventh columns contain the weight in grams before and after exposure, respectively. The eighth column is the weight loss in grams.

The ninth and tenth columns contain, respectively, the date on which the sample was introduced into the acid solution and the date of removal. The eleventh column shows the time of exposure in days. In all cases samples were introduced to and removed from the acid solutions at eight o'clock p.m. so that only whole (24 hour) days were involved.

In computing the exposure time allowance was made for the period of suspended operations necessitated by the replacement of the original suspension system. All samples were originally exposed to the solutions on July 1, 1955. On July 15, 1955 all samples were removed except those which were swept from the baths as mentioned in Section IV - Description of Apparatus.

The remaining original samples were again placed in the acid solutions on September 1, 1955. New samples for the two baths mentioned above were introduced to the acid solutions on September 4, 1955.

The twelfth column is the surface area of each sample in square inches.

The last column gives the corrosion rate in mils per year. The rate was determined with the aid of the nomograph in Appendix III.

APPENDIX II
EXPERIMENTAL DATA

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
1	2S	3.02	.76	.034	3.2710	3.2638	.0072	7/1/55	7/4/55	3	4.804	4.06
2	3S	3.04	.74	.074	6.2237	6.2164	.0073	7/1/55	7/8/55	7	5.146	1.65
3	24S	3.02	.76	.035	3.4168	3.4140	.0028	7/1/55	7/8/55	7	4.813	.676
4	2S	3.04	.77	.034	3.3085	3.3046	.0039	7/1/55	7/1/55	10	4.897	.650
5	3S	3.03	.77	.074	6.2916	2.3794	.0122	7/1/55	7/1/55	10	5.225	1.90
6	24S	3.03	.73	.035	3.3079	3.3035	.0044	7/1/55	7/11/55	10	4.645	.771
7	2S	3.03	.77	.034	3.2669	3.2561	.0108	7/1/55	9/4/55	17	4.881	1.06
8	3S	3.04	.76	.074	6.2783	6.2430	.0353	7/1/55	9/4/55	17	5.180	3.26
9	24S	3.01	.78	.035	3.5544	3.5458	.0086	7/1/55	9/4/55	17	4.919	.837
10	2S	3.02	.75	.034	3.2677	3.2527	.0150	7/1/55	9/7/55	20	4.743	1.29
11	3S	3.04	.76	.074	6.2127	6.1629	.0498	7/1/55	9/7/55	20	5.180	3.91
12	24S	3.00	.77	.035	3.4951	3.4828	.0123	7/1/55	9/7/55	20	4.842	1.04
13	2S	3.03	.76	.034	3.2512	3.2394	.0118	7/1/55	9/10/55	23	4.820	.867
14	3S	3.04	.77	.074	6.3615	6.3122	.0493	7/1/55	9/10/55	23	5.241	3.32
15	24S	3.00	.77	.035	3.5241	3.5123	.0118	7/1/55	9/10/55	23	4.842	.863
16	2S	3.04	.74	.034	3.2321	3.2134	.0187	7/1/55	9/13/55	26	4.713	1.24
17	3S	3.04	.78	.074	6.4466	5.3910	.0556	7/1/55	9/13/55	26	5.304	3.28
18	24S	3.01	.79	.035	3.5283	3.5148	.0135	7/1/55	9/13/55	26	4.979	.847
19	2S	3.02	.72	.034	3.1544	3.1507	.0037	7/1/55	7/14/55	13	4.560	.508
20	3S	3.03	.78	.074	6.4551	6.4371	.0180	7/1/55	7/14/55	13	5.287	2.03
21	24S	3.01	.75	.035	3.4327	3.4273	.0054	7/1/55	7/14/55	13	4.736	.714
22	2S	3.02	.78	.034	3.2944	3.2709	.0235	7/1/55	9/16/55	29	4.926	1.34
23	3S	3.04	.76	.074	6.2855	6.2206	.0649	7/1/55	9/16/55	29	5.180	3.51
24	24S	3.00	.76	.035	3.5113	3.4860	.0253	7/1/55	9/16/55	29	4.781	1.48
26	3S	3.03	.78	.074	6.3626	6.3109	.0517	7/1/55	9/16/55	32	5.287	2.49
27	24S	3.01	.78	.035	3.5655	3.5494	.0161	7/1/55	9/19/55	32	4.919	.832
28	2S	3.01	.75	.034	3.2399	3.2202	.0197	7/1/55	9/22/55	35	4.727	.980
29	3S	3.04	.78	.074	6.4654	6.4072	.0582	7/1/55	9/22/55	35	5.304	2.60
30	24S	3.01	.77	.035	3.5532	3.5376	.0156	7/1/55	9/22/55	35	4.868	.754
31	2S	3.03	.77	.034	3.3593	3.3587	.0005	7/1/55	7/8/55	7	4.881	.143
32	3S	3.04	.78	.074	6.3713	6.3687	.0026	7/1/55	7/8/55	7	5.304	.571
33	24S	3.02	.77	.035	3.5592	3.5569	.0023	7/1/55	7/8/55	10	4.874	.549
34	2S	3.02	.77	.034	3.2545	3.2539	.0016	7/1/55	7/11/55	10	4.865	.384

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
35	3S	3.03	.78	.074	6.4039	6.4010	.0029	7/1/55	7/11/55	10	5.287	.646
36	24S	3.00	.78	.035	3.4709	3.4679	.0034	7/1/55	7/11/55	10	4.092	.564
37	2S	3.03	.73	.034	3.1386	3.1334	.0052	7/1/55	9/4/55	17	4.636	.537
38	3S	3.04	.76	.074	6.2453	6.2337	.0116	7/1/55	9/4/55	17	5.180	1.07
39	24S	3.00	.76	.035	3.4536	3.4446	.0090	7/1/55	9/4/55	17	4.781	.900
40	2S	3.02	.77	.034	3.3045	3.3016	.0029	7/1/55	9/7/55	20	4.865	.244
41	3S	3.04	.78	.074	6.3007	6.3897	.0110	7/1/55	9/7/55	20	5.304	.852
42	24S	3.01	.78	.035	3.5441	3.5342	.0099	7/1/55	9/10/55	20	4.919	.827
43	2S	3.04	.72	.034	3.0976	3.0911	.0065	7/1/55	9/10/55	23	4.560	.510
44	3S	3.04	.75	.074	6.0737	6.0565	.0172	7/1/55	9/10/55	23	5.117	1.20
45	24S	3.00	.78	.035	3.5093	3.4903	.0190	7/1/55	9/10/55	23	4.902	1.39
46	2S	3.02	.77	.034	3.2594	3.2511	.0083	7/1/55	9/13/55	26	4.865	.538
47	3S	3.04	.78	.074	6.4451	6.4205	.0246	7/1/55	9/13/55	26	5.304	1.46
48	24S	3.00	.71	.035	3.2351	3.2178	.0173	7/1/55	9/13/55	26	4.477	1.22
49	2S	3.02	.74	.034	3.2172	3.2171	.0011	7/1/55	7/14/55	13	4.682	.147
50	3S	3.04	.79	.074	6.4749	6.4704	.0045	7/1/55	7/14/55	13	5.366	.525
51	24S	3.01	.75	.035	3.4516	3.5544	.0061	7/1/55	7/15/55	13	4.736	.807
52	2S	3.03	.75	.034	3.2474	3.2268	.0204	7/1/55	9/16/55	29	4.759	1.22
53	3S	3.03	.79	.074	6.4748	6.4407	.0341	7/1/55	9/16/55	29	5.349	1.80
54	24S	3.03	.77	.035	3.5309	3.4976	.0333	7/1/55	9/16/55	29	4.890	1.93
55	2S	3.02	.77	.034	3.3019	3.2885	.0134	7/1/55	9/19/55	32	4.865	.707
56	3S	3.04	.78	.074	6.4540	6.4219	.0321	7/1/55	9/19/55	32	5.304	1.55
57	24S	3.02	.77	.035	3.5008	3.4777	.0231	7/1/55	9/19/55	32	4.874	1.22
58	2S	3.03	.77	.034	3.2538	3.2350	.0188	7/1/55	9/22/55	35	4.881	.904
59	3S	3.04	.78	.074	6.4433	6.4083	.0350	7/1/55	9/22/55	35	5.304	1.54
60	24S	3.00	.76	.035	3.4588	3.4346	.0342	7/1/55	9/22/55	35	4.781	1.19
61	2S	3.04	.78	.034	3.3251	3.3249	.0002	7/1/55	7/5/55	4	4.959	.0828
62	3S	3.04	.79	.074	6.4527	6.4500	.0026	7/1/55	7/5/55	4	5.366	1.03
63	24S	3.01	.77	.035	3.5191	3.5165	.0026	7/1/55	7/5/55	7	4.868	.110
64	2S	3.03	.77	.034	3.2504	3.2496	.0008	7/1/55	7/8/55	7	4.881	.192
65	3S	3.04	.78	.074	6.4722	6.4665	.0041	7/1/55	7/8/55	7	5.225	.920
66	24S	3.02	.77	.035	3.5400	3.5336	.0048	7/1/55	7/8/55	7	4.874	1.16
67	2S	3.03	.76	.034	3.2325	3.2305	.0014	7/1/55	7/8/55	10	4.820	.228
68	3S	3.04	.78	.074	6.4439	6.4366	.0066	7/1/55	7/11/55	10	5.304	1.02

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
69	24S	3.02	.77	.035	3.4915	3.4832	.0083	7/1/55	7/11/55	10	4.874	1.40
70	2S	3.03	.75	.034	3.2585	3.2503	.0082	7/1/55	9/4/55	17	4.759	.831
71	3S	3.03	.78	.074	6.2882	6.2696	.0186	7/1/55	9/4/55	17	5.287	1.70
72	24S	3.01	.77	.035	3.5070	3.4943	.0128	7/1/55	7/14/55	13	4.868	1.67
73	2S	3.03	.75	.034	3.0877	3.0802	.0075	7/1/55	9/7/55	20	4.759	.645
74	3S	3.04	.79	.074	6.4467	6.4241	.0226	7/1/55	9/7/55	20	5.366	1.73
75	24S	3.02	.78	.035	3.5676	3.5483	.0183	7/1/55	9/7/55	20	4.935	1.61
76	2S	3.02	.76	.034	3.2992	3.2860	.0132	7/1/55	9/10/55	23	4.804	.983
77	3S	3.04	.79	.074	6.4445	6.4122	.0323	7/1/55	9/10/55	23	5.366	2.05
78	24S	3.02	.78	.035	3.5397	3.5173	.0224	7/1/55	9/10/55	23	4.935	1.62
79	2S	3.04	.73	.034	3.1770	3.1744	.0026	7/1/55	7/14/55	13	4.636	.355
80	3S	3.04	.79	.074	6.4655	6.4230	.0425	7/1/55	9/13/55	26	5.366	2.50
81	24S	3.02	.78	.035	3.5442	3.5187	.0255	7/1/55	9/13/55	26	4.935	1.64
82	2S	3.0[illegible]	.74	.034	6.4467	6.3937	.0244	7/1/55	9/16/55	29	4.682	1.48
83	3S	3.03	.78	.074	6.4567	6.4837	.0530	7/1/55	9/16/55	29	5.287	2.84
84	24S	3.00	.77	.035	3.5031	3.4659	.0372	7/1/55	9/16/55	29	4.842	2.12
85	2S	3.02	.76	.034	3.2637	3.2434	.0203	7/1/55	9/19/55	32	4.804	1.09
86	3S	3.04	.77	.074	3.3358	6.2864	.0494	7/1/55	9/19/55	32	5.241	2.42
87	24S	3.03	.75	.035	3.4407	3.4170	.0237	7/1/55	9/19/55	32	4.767	1.29
88	2S	3.02	.78	.034	3.3358	3.3158	.0200	7/1/55	9/22/55	35	4.926	.954
89	3S	3.04	.79	.074	6.4454	6.4396	.0088	7/1/55	7/14/55	13	4.366	1.04
90	24S	3.00	.78	.035	3.5420	3.5022	.0398	7/1/55	9/22/55	35	4.902	1.91
91	2S	3.03	.72	.034	3.1590	3.1586	.0004	7/1/55	7/8/55	7	4.575	.103
92	3S	3.02	.79	.074	6.4223	6.4213	.0010	7/1/55	7/8/55	7	5.331	.221
93	24S	3.01	.74	.035	3.4390	3.4358	.0032	7/1/55	7/8/55	7	4.675	.804
94	2S	3.03	.73	.034	3.1389	3.1378	.0011	7/1/55	7/11/55	10	4.636	.302
95	3S	3.04	.79	.074	6.4421	6.4394	.0027	7/1/55	7/11/55	10	5.366	.514
96	24S	3.03	.74	.035	3.3766	3.3733	.0033	7/1/55	9/4/55	10	4.706	.576
97	2S	3.0[illegible]	.78	.034	3.3073	3.3067	.0006	7/1/55	9/4/55	17	4.926	.589
98	3S	3.04	.70	.074	5.7866	5.7766	.0038	7/1/55	9/4/55	17	4.805	.382
99	24S	3.00	.77	.035	3.4823	3.4790	.0033	7/1/55	9/4/55	17	4.842	.330
100	2S	3.02	.77	.034	3.2915	3.2910	.0055	7/1/55	9/7/55	20	4.865	.0422
103	2S	3.03	.77	.034	3.2758	3.2651	.0008	7/1/55	9/10/55	23	4.881	.5084
104	3S	3.04	.75	.074	6.1707	6.1565	.0142	7/1/55	9/10/55	23	5.117	.990

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
105	24S	3.03	.77	.035	3.4540	3.4516	.0024	7/1/55	9/10/55	23	4.890	.175
106	2S	3.02	.77	.034	3.2269	3.2243	.0026	7/1/55	9/13/55	26	4.865	.169
107	3S	3.00	.74	.074	6.0340	6.0191	.0149	7/1/55	9/13/55	26	4.989	.944
108	24S	3.00	.78	.035	3.5287	3.5254	.0033	7/1/55	9/13/55	26	4.902	.212
109	2S	3.03	.76	.034	3.2971	3.2960	.0011	7/1/55	7/14/55	13	4.820	.144
110	3S	3.03	.76	.074	6.2749	6.2722	.0027	7/1/55	7/14/55	13	5.162	.330
111	24S	3.02	.76	.035	3.4427	3.4405	.0022	7/1/55	7/14/55	13	4.813	.289
112	2S	3.02	.76	.034	3.2580	3.2527	.0053	7/1/55	9/16/55	29	4.804	.312
113	3S	3.03	.76	.074	6.1323	6.1089	.0234	7/1/55	9/16/55	29	5.162	1.28
114	24S	3.00	.78	.035	3.4640	3.4560	.0080	7/1/55	9/16/55	29	4.902	.462
115	2S	3.03	.77	.034	3.3137	3.3130	.0007	7/1/55	9/19/55	32	4.881	.0368
116	3S	3.04	.76	.074	6.1619	6.1411	.0208	7/1/55	9/19/55	32	5.180	1.03
117	24S	3.01	.77	.035	3.4981	3.4968	.0013	7/1/55	9/19/55	32	4.868	.0687
118	2S	3.02	.71	.034	3.0177	3.0165	.0012	7/1/55	9/22/55	35	4.499	.0626
119	3S	3.02	.75	.074	6.0117	5.9941	.0176	7/1/55	9/22/55	35	5.100	.810
120	24S	3.03	.78	.035	3.5676	3.5655	.0021	7/1/55	9/22/55	35	4.951	.0996
121	2S	3.03	.77	.034	3.3009	3.3000	.0014	7/1/55	7/8/55	7	4.881	.337
122	3S	3.04	.76	.074	6.3824	6.3777	.0047	7/1/55	7/8/55	7	5.180	1.09
123	24S	3.03	.73	.035	3.3196	3.3159	.0037	7/1/55	7/8/55	7	4.645	.937
124	2S	3.02	.74	.034	3.1949	3.1930	.0019	7/1/55	7/11/55	10	4.682	.333
125	3S	3.04	.76	.074	6.4256	6.4188	.0068	7/1/55	7/11/55	10	5.180	1.08
126	24S	3.01	.77	.035	3.5236	3.5171	.0065	7/1/55	7/11/55	10	4.868	1.10
127	2S	3.04	.74	.034	3.2216	3.2174	.0042	7/1/55	9/4/55	17	4.713	.431
128	3S	3.03	.78	.074	6.4044	6.3867	.0177	7/1/55	9/4/55	17	5.287	1.62
129	24S	3.03	.78	.035	3.5438	3.5326	.0112	7/1/55	9/4/55	17	4.951	1.09
130	2S	3.03	.77	.034	3.2682	3.2640	.0042	7/1/55	9/7/55	20	4.881	.354
131	3S	3.04	.78	.074	6.4459	6.4283	.0176	7/1/55	9/7/55	20	5.304	1.36
132	24S	3.02	.78	.035	3.5037	3.4931	.0106	7/1/55	9/7/55	20	4.935	.883
133	2S	3.02	.77	.034	3.2519	3.2472	.0047	7/1/55	9/10/55	23	4.865	.345
134	3S	3.04	.80	.074	6.4868	6.4701	.0167	7/1/55	9/10/55	23	5.428	1.10
135	24S	3.02	.79	.035	3.5593	3.5492	.0101	7/1/55	9/10/55	23	4.996	.722
136	2S	3.02	.77	.034	3.2200	3.2153	.0047	7/1/55	9/13/55	26	4.865	.305
137	3S	3.04	.74	.074	6.2535	6.2316	.0219	7/1/55	9/13/55	26	5.055	1.37
138	24S	3.00	.74	.035	3.3544	3.3405	.0139	7/1/55	9/13/55	26	4.659	.943

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
139	2S	3.03	.76	.034	3.2698	3.2674	.0024	7/1/55	7/14/55	13	4.820	.315
140	3S	3.04	.80	.074	6.4772	6.4689	.0083	7/1/55	7/14/55	13	5.428	.967
141	24S	3.02	.78	.035	3.5046	3.4953	.0093	7/1/55	7/14/55	13	4.935	1.19
142	2S	3.04	.76	.034	3.2873	3.2747	.0126	7/1/55	9/16/55	29	4.836	.739
143	3S	3.04	.78	.074	6.3897	6.3611	.0286	7/1/55	9/16/55	29	5.304	1.53
144	24S	3.02	.79	.035	3.6072	3.5853	.0219	7/1/55	9/16/55	29	4.996	1.24
145	2S	3.02	.76	.034	3.2571	3.2471	.0100	7/1/55	9/19/55	32	4.804	.535
146	3S	3.04	.78	.074	6.4500	6.3987	.0513	7/1/55	9/19/55	32	5.304	2.48
147	24S	3.01	.78	.035	3.5556	3.5413	.0143	7/1/55	9/19/55	32	4.919	.748
148	2S	3.02	.72	.034	3.0049	3.0000	.0049	7/1/55	9/22/55	35	4.560	.252
149	3S	3.03	.79	.074	6.2643	6.2376	.0267	7/1/55	9/22/55	35	5.349	1.17
150	24S	3.02	.76	.035	3.4562	3.4419	.0143	7/1/55	9/22/55	35	4.813	.697
151	2S	3.03	.74	.034	3.2353	3.2220	.0035	7/1/55	7/8/55	7	4.697	.875
152	3S	3.04	.78	.074	6.2530	6.2250	.0280	7/1/55	7/11/55	10	5.304	4.34
153	24S	3.01	.78	.035	3.5761	3.5671	.0090	7/1/55	7/8/55	7	4.919	2.15
154	2S	3.03	.78	.034	3.3562	3.3498	.0064	7/1/55	7/11/55	10	4.943	1.07
155	3S	3.03	.76	.074	6.1673	6.1560	.0113	7/1/55	7/8/55	7	5.162	2.56
156	24S	3.01	.79	.035	3.5637	3.5533	.0104	7/1/55	7/11/55	10	4.979	1.72
158	3S	3.04	.80	.074	6.4594	6.3428	.1166	7/1/55	9/4/55	17	5.428	10.4
159	24S	3.00	.77	.035	3.5136	3.4922	.0214	7/1/55	7/14/55	13	4.842	2.80
160	2S	3.04	.77	.034	3.2774	3.1670	.1104	7/1/55	9/7/55	20	4.897	9.28
161	3S	3.04	.72	.074	5.6973	5.5873	.1100	7/1/55	9/7/55	20	4.930	9.19
162	24S	3.00	.77	.035	3.4763	3.4124	.0639	7/1/55	9/7/55	20	4.842	5.42
163	2S	3.03	.77	.034	3.2887	3.2165	.0722	7/1/55	9/10/55	23	4.881	5.29
164	3S	3.02	.80	.074	6.4417	6.2803	.1614	7/1/55	9/10/55	23	5.393	10.7
165	24S	3.03	.77	.035	3.5513	3.4776	.0737	7/1/55	9/10/55	23	4.890	5.38
166	2S	3.03	.77	.034	3.2599	3.1603	.0996	7/1/55	9/13/55	26	4.881	6.45
167	3S	3.00	.74	.074	6.0671	5.8768	.1903	7/1/55	9/13/55	26	4.989	12.1
168	24S	3.01	.78	.035	3.5247	3.4254	.0993	7/1/55	9/13/55	26	4.919	6.48
169	2S	3.04	.77	.034	3.3195	3.3122	.0073	7/1/55	7/14/55	13	4.897	.942
170	3S	3.03	.76	.074	6.2671	6.0482	.2189	7/1/55	9/16/55	29	5.162	12.0
171	24S	3.01	.75	.035	3.4078	3.2838	.1240	7/1/55	9/16/55	29	4.736	7.42
172	2S	3.03	.76	.034	3.1808	3.0678	.1130	7/1/55	9/16/55	29	4.820	6.64
173	3S	3.04	.79	.074	6.4048	6.1813	.2235	7/1/55	9/16/55	29	5.366	11.8
174	24S	3.02	.76	.035	3.4942	3.3632	.1310	7/1/55	9/16/55	29	4.813	7.72

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
175	2S	3.03	.78	.034	3.3122	3.2120	.1002	7/1/55	9/19/55	32	4.943	5.22
176	3S	3.00	.73	.074	6.0620	5.8745	.1875	7/1/55	9/19/55	32	4.928	9.77
177	24S	3.03	.76	.035	3.4602	3.3504	.1098	7/1/55	9/19/55	32	4.829	5.83
178	2S	3.03	.78	.034	3.3131	3.2319	.0812	7/1/55	9/22/55	35	4.943	3.86
179	3S	3.02	.75	.074	6.1126	6.0740	.0386	7/1/55	9/22/55	13	5.084	4.81
180	24S	3.03	.75	.035	3.4573	3.3821	.0752	7/1/55	9/22/55	35	4.767	3.71
181	2S	3.04	.78	.034	3.3387	3.3292	.0105	7/1/55	7/8/55	7	4.959	2.49
182	3S	3.04	.75	.074	6.1300	6.1069	.0231	7/1/55	7/8/55	7	5.117	5.32
183	24S	3.03	.78	.035	3.5092	3.4987	.0105	7/1/55	7/11/55	7	4.951	2.49
184	2S	3.02	.77	.034	3.2549	3.2310	.0239	7/1/55	7/11/55	10	4.865	4.03
185	3S	3.04	.75	.074	6.2830	6.2455	.0375	7/1/55	7/11/55	10	5.117	6.14
186	24S	3.01	.77	.035	3.4726	3.4536	.0190	7/1/55	7/11/55	10	4.868	3.21
187	2S	3.03	.78	.034	3.3266	3.2680	.0586	7/1/55	9/4/55	17	4.943	5.73
188	3S	3.03	.78	.074	6.4279	5.3144	.1135	7/1/55	9/4/55	17	5.287	10.4
189	24S	3.01	.76	.035	3.4955	3.4381	.0574	7/1/55	9/4/55	17	4.797	5.79
190	2S	3.03	.77	.034	3.2555	3.1802	.0753	7/1/55	9/7/55	20	4.881	6.33
191	3S	3.04	.75	.074	6.1690	6.0301	.1389	7/1/55	9/7/55	20	5.117	11.2
192	24S	3.02	.76	.035	3.4478	3.3722	.0756	7/1/55	9/7/55	20	4.813	6.46
193	2S	3.03	.77	.034	3.2811	3.1893	.0918	7/1/55	9/10/55	23	4.881	6.70
194	3S	3.00	.74	.074	6.1093	5.9457	.1636	7/1/55	9/10/55	23	4.989	11.7
195	24S	3.02	.77	.034	3.4674	3.3906	.0768	7/1/55	9/10/55	23	4.874	5.63
196	2S	3.04	.73	.034	3.1187	2.9949	.1238	7/1/55	9/13/55	26	4.651	8.42
197	3S	3.04	.73	.074	6.1012	5.8758	.2254	7/1/55	9/13/55	26	4.992	14.3
198	24S	3.00	.78	.035	3.5373	3.4361	.1012	7/1/55	9/13/55	26	4.902	6.53
199	2S	3.02	.77	.034	3.2183	3.1961	.0222	7/1/55	7/14/55	13	4.865	2.88
200	3S	3.04	.78	.074	6.2956	6.2469	.0487	7/1/55	7/14/55	13	5.304	5.82
201	24S	3.00	.76	.035	3.4825	3.4573	.0252	7/1/55	7/14/55	13	4.781	3.33
202	2S	3.04	.73	.034	3.1691	2.9795	.1896	7/1/55	9/16/55	29	4.651	11.5
203	3S	3.02	.76	.074	6.1708	5.8882	.2826	7/1/55	9/16/55	29	5.146	15.6
204	24S	3.00	.75	.035	3.4333	3.2925	.1408	7/1/55	9/16/55	29	4.920	8.11
205	2S	3.04	.73	.034	3.1825	3.0475	.1350	7/1/55	9/16/55	32	4.651	7.47
206	3S	3.04	.79	.074	6.4123	6.1455	.2668	7/1/55	9/19/55	32	5.366	12.8
207	24S	3.02	.74	.035	3.3437	3.2454	.0983	7/1/55	9/19/55	32	4.690	5.38
208	2S	3.04	.75	.034	3.2469	3.1045	.1424	7/1/55	9/22/55	35	4.774	7.01

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
209	3S	3.04	.76	.074	6.1686	5.9124	.2562	7/1/55	9/22/55	35	5.180	11.6
210	24S	3.02	.77	.035	3.5160	3.4190	.0970	7/1/55	9/22/55	35	4.874	4.67
211	2S	3.03	.72	.034	3.1166	3.1112	.0054	7/1/55	7/9/55	7	4.575	1.39
212	3S	3.04	.79	.074	6.4704	6.4622	.0082	7/1/55	7/8/55	7	5.366	1.79
213	24S	3.02	.76	.035	3.4182	3.4122	.0060	7/1/55	7/11/55	7	4.813	1.47
214	2S	3.04	.70	.034	3.0581	3.0524	.0057	7/1/55	7/11/55	10	4.467	1.06
215	3S	3.04	.70	.074	6.3796	6.3684	.0112	7/1/55	7/11/55	10	5.304	1.74
216	24S	3.01	.74	.035	3.3777	3.3688	.0089	7/1/55	7/11/55	10	4.675	1.57
217	2S	3.04	.78	.034	3.2980	3.2800	.0180	7/1/55	9/4/55	17	4.959	1.76
218	3S	3.04	.78	.074	6.4713	6.3907	.0806	7/1/55	9/4/55	17	5.304	7.35
219	24S	3.00	.72	.035	3.3473	3.3257	.0216	7/1/55	9/4/55	17	4.538	2.30
220	2S	3.02	.77	.034	3.1994	3.1832	.0162	7/1/55	9/7/55	20	4.865	1.37
221	3S	3.03	.79	.074	6.4420	6.3575	.0845	7/1/55	9/7/55	20	5.349	6.50
222	24S	3.00	.77	.035	3.5542	3.5349	.0193	7/1/55	9/7/55	20	4.842	1.64
223	2S	3.03	.76	.034	3.2743	3.2591	.0152	7/1/55	9/10/55	23	4.820	1.13
224	3S	3.03	.74	.074	5.9700	5.8735	.0965	7/1/55	9/10/55	23	5.038	6.85
225	24S	3.00	.76	.035	3.4906	3.4658	.0248	7/1/55	9/13/55	26	4.781	1.64
226	2S	3.03	.76	.034	3.2790	3.2584	.0206	7/1/55	9/13/55	26	4.820	1.35
227	3S	3.02	.72	.074	5.9410	5.8164	.1246	7/1/55	9/13/55	26	4.898	8.04
228	24S	3.00	.76	.035	3.4939	3.4691	.0248	7/1/55	9/13/55	26	4.781	1.64
229	2S	3.02	.77	.034	3.2617	3.2525	.0092	7/1/55	7/14/55	13	4.865	1.19
230	3S	3.03	.76	.074	6.2837	6.2484	.0353	7/1/55	7/14/55	13	5.162	4.32
231	24S	3.02	.78	.035	3.5483	3.5357	.0126	7/1/55	7/14/55	13	4.935	1.62
232	2S	3.03	.73	.034	3.1017	3.0696	.0321	7/1/55	9/16/55	29	4.636	1.97
233	3S	3.02	.78	.074	6.3599	6.1994	.1605	7/1/55	9/16/55	29	5.270	8.63
234	24S	2.99	.77	.035	3.5425	3.4951	.0474	7/1/55	9/16/55	29	4.825	2.79
237	24S	3.00	.75	.035	3.3789	3.3397	.0392	7/1/55	9/19/55	32	4.720	2.14
238	2S	3.03	.73	.034	3.1633	3.1334	.0299	7/1/55	9/19/55	32	4.636	1.66
239	3S	3.03	.76	.074	6.2016	6.0341	.1675	7/1/55	9/19/55	32	5.162	8.34
240	24S	3.01	.76	.035	3.4230	3.3897	.0333	7/1/55	9/19/55	32	4.797	1.78
241	2S	3.04	.78	.034	3.3148	3.2656	.0492	7/1/55	7/8/55	7	4.959	11.6
242	3S	3.02	.80	.074	6.4486	6.3800	.0686	7/1/55	7/8/55	7	5.393	15.0

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
243	24S	3.01	.78	.035	3.5768	3.5029	.0739	7/1/55	7/8/55	7	4.919	17.7
244	2S	3.03	.77	.034	3.2799	3.2167	.0632	7/1/55	7/11/55	10	4.881	10.7
245	3S	3.02	.76	.074	6.0922	6.0064	.0858	7/1/55	7/11/55	10	5.146	13.7
246	24S	3.00	.72	.035	3.3007	3.2086	.0921	7/1/55	7/11/55	10	4.538	16.7
271	2S	3.02	.76	.034	3.2295	3.1836	.0459	7/1/55	7/4/55	3	4.804	26.2
272	3S	3.04	.78	.074	6.4635	6.4049	.0586	7/1/55	7/5/55	4	5.304	22.7
273	24S	2.98	.78	.035	3.4617	3.3294	.1323	7/1/55	7/5/55	7	4.870	55.8
274	2S	3.03	.78	.034	3.3445	3.2693	.0752	7/1/55	7/8/55	7	4.943	17.9
275	3S	3.02	.79	.074	6.3878	6.2923	.0955	7/1/55	7/8/55	7	5.331	21.1
276	24S	2.99	.77	.035	3.5556	3.3582	.1974	7/1/55	7/8/55	7	4.825	48.0
301	2S	3.03	.76	.034	3.2731	3.2539	.0192	7/1/55	7/5/55	4	4.820	8.19
302	3S	3.03	.77	.074	6.2951	6.2749	.0202	7/1/55	7/5/55	4	5.225	7.95
303	24S	3.00	.77	.035	3.4877	3.4578	.0299	7/1/55	7/5/55	4	4.842	12.7
304	2S	3.04	.78	.034	3.2874	3.2559	.0315	7/1/55	7/8/55	7	4.959	7.47
305	3S	3.04	.76	.074	6.3174	6.2834	.0340	7/1/55	7/8/55	7	5.180	7.72
306	24S	3.00	.77	.035	3.5174	3.4687	.0487	7/1/55	7/8/55	7	4.842	11.8
307	2S	3.03	.78	.034	3.2845	3.2384	.0461	7/1/55	7/11/55	10	4.943	7.66
308	3S	3.03	.79	.074	6.3341	6.2899	.0442	7/1/55	7/11/55	10	5.349	6.80
309	24S	2.97	.77	.035	3.4796	3.4188	.0608	7/1/55	7/11/55	10	4.793	10.4
312	24S	2.97	.78	.035	3.4880	3.3864	.1016	7/1/55	9/4/55	17	4.853	10.1
313	2S	3.02	.77	.034	3.2856	3.2017	.0839	7/1/55	9/7/55	20	4.865	7.06
314	3S	3.03	.78	.074	6.3981	6.2874	.1107	7/1/55	9/7/55	20	5.287	8.62
315	24S	3.00	.78	.035	3.5434	3.4260	.1174	7/1/55	9/7/55	20	4.902	9.85
316	2S	3.04	.76	.034	3.2440	3.1487	.0953	7/1/55	9/10/55	23	4.836	7.05
317	3S	3.04	.77	.074	6.2409	6.1203	.1206	7/1/55	9/10/55	23	5.241	8.22
318	24S	3.02	.72	.034	3.3310	3.1977	.1333	7/1/55	9/10/55	23	4.568	10.4
320	3S	3.03	.78	.074	6.3031	6.2470	.0561	7/1/55	7/14/55	13	5.287	6.72
321	24S	3.00	.74	.035	3.3888	3.3124	.0764	7/1/55	7/14/55	13	4.659	10.4
322	2S	3.03	.78	.034	3.2769	3.2200	.0569	7/1/55	7/14/55	13	4.943	7.28
323	3S	3.02	.79	.074	6.4031	6.2668	.1363	7/1/55	9/13/55	26	5.331	8.10
324	24S	3.01	.72	.035	3.4898	3.3455	.1443	7/1/55	9/13/55	26	4.919	9.30
325	2S	3.04	.78	.034	3.2394	3.1323	.1071	7/1/55	9/13/55	26	4.959	6.84
327	24S	3.02	.78	.035	3.5204	3.3535	.1669	7/1/55	9/16/55	29	4.935	9.58
329	2S	3.02	.76	.074	6.1888	6.0327	.1561	7/1/55	9/16/55	29	5.146	8.61

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
330	24S	3.00	.78	.035	3.5477	3.3776	.1701	7/1/55	9/16/55	29	4.902	9.84
331	2S	3.04	.76	.034	3.2881	3.2799	.0082	7/1/55	7/5/55	4	4.836	3.49
332	3S	3.04	.78	.074	6.4287	6.4200	.0087	7/1/55	7/5/55	4	5.304	3.37
333	24S	3.00	.78	.035	3.5609	3.5463	.0146	7/1/55	7/5/55	4	4.902	6.12
334	2S	3.03	.75	.034	3.2420	3.2290	.0133	7/1/55	7/8/55	7	4.759	3.29
335	3S	3.03	.75	.074	6.2809	6.2656	.0153	7/1/55	7/8/55	7	5.100	3.53
336	24S	3.02	.78	.035	3.5478	3.5302	.0176	7/1/55	7/11/55	7	4.935	4.20
337	2S	3.04	.76	.034	3.2616	3.2483	.0133	7/1/55	7/11/55	10	4.836	2.26
338	3S	3.03	.76	.074	6.2825	6.2641	.0184	7/1/55	7/11/55	10	4.162	3.93
339	24S	3.02	.78	.035	3.5633	3.5395	.0238	7/1/55	7/11/55	10	4.935	3.97
340	2S	3.02	.75	.034	3.2242	3.1984	.0258	7/1/55	9/4/55	17	4.743	2.63
342	24S	3.00	.78	.035	3.4892	3.4518	.0374	7/1/55	9/4/55	17	4.902	3.69
343	2S	3.04	.75	.034	3.2423	3.2161	.0262	7/1/55	9/7/55	20	4.774	2.25
344	3S	3.04	.78	.074	6.3727	6.3037	.0690	7/1/55	9/7/55	20	5.304	5.35
345	24S	2.99	.76	.035	3.3954	3.3506	.0448	7/1/55	9/7/55	20	4.765	3.87
346	2S	3.04	.76	.034	3.2782	3.2527	.0255	7/1/55	9/10/55	23	4.836	1.88
348	24S	3.02	.76	.035	3.4261	3.3679	.0582	7/1/55	9/10/55	23	4.813	4.32
349	2S	3.02	.76	.034	3.2702	3.2508	.0194	7/1/55	7/14/55	13	4.804	2.55
350	3S	3.03	.78	.074	6.4294	6.4045	.0249	7/1/55	7/14/55	13	5.287	2.96
351	24S	3.02	.78	.035	3.5441	3.5154	.0287	7/1/55	7/14/55	13	4.935	3.68
352	2S	3.04	.77	.034	3.3067	3.2705	.0362	7/1/55	9/13/55	26	4.897	2.34
354	24S	3.02	.78	.035	3.5403	3.4854	.0549	7/1/55	9/13/55	26	4.935	3.52
355	2S	3.04	.73	.034	3.1579	3.1294	.0285	7/1/55	9/13/55	26	4.651	1.93
358	2S	3.04	.74	.034	3.2244	3.1950	.0294	7/1/55	9/16/55	29	4.713	1.77
359	3S	3.03	.77	.074	6.2212	6.1223	.0989	7/1/55	9/16/55	29	5.225	5.36
360	24S	2.99	.77	.035	3.5118	3.4355	.0763	7/1/55	9/16/55	29	4.825	4.48
361	2S	3.01	.75	.034	3.2399	3.2202	.0187	7/1/55	9/22/55	35	4.717	.980
362	3S	3.02	.74	.034	3.1933	3.1743	.0190	7/1/55	9/22/55	38	4.697	.868
363	24S	2.99	.79	.035	3.5250	3.5030	.0220	7/1/55	9/25/55	38	4.825	.978
364	2S	3.03	.78	.034	3.2906	3.2655	.0262	7/1/55	9/25/55	41	4.943	1.05
365	3S	3.03	.77	.074	6.3499	6.2848	.0651	7/1/55	9/25/55	41	5.225	2.48
366	24S	3.01	.73	.035	3.5517	3.5255	.0262	7/1/55	9/28/55	41	4.919	1.06
367	2S	3.04	.77	.034	3.3045	3.2783	.0262	7/1/55	10/1/55	44	4.897	.990
368	3S	3.03	.78	.074	6.3447	6.2586	.0861	7/1/55	10/1/55	44	5.287	3.01

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
369	24S	3.00	.76	.035	3.5195	3.4889	.0306	7/1/55	10/1/55	44	4.781	1.18
370	2S	3.03	.78	.034	3.2824	3.2473	.0351	7/1/55	10/4/55	47	4.943	1.23
371	3S	3.02	.79	.074	6.3660	6.2677	.0983	7/1/55	10/4/55	47	5.331	3.20
372	24S	2.98	.78	.034	3.4649	3.4313	.0336	7/1/55	10/4/55	47	4.870	1.20
373	2S	3.03	.73	.034	3.1370	3.1016	.0344	7/1/55	10/7/55	50	4.636	1.21
374	3S	3.04	.75	.074	6.2584	6.1578	.1006	7/1/55	10/7/55	50	5.117	3.20
375	24S	3.00	.76	.035	3.3978	3.3564	.0414	7/1/55	10/7/55	50	4.781	1.41
376	2S	3.04	.73	.034	3.1635	3.1220	.0415	7/1/55	10/10/55	53	4.651	1.37
377	3S	3.04	.74	.074	6.1722	6.0633	.1089	7/1/55	10/10/55	53	5.055	3.31
378	24S	2.99	.77	.035	3.4662	3.4152	.0510	7/1/55	10/10/55	53	4.825	1.62
379	2S	3.02	.77	.034	3.1653	3.1127	.0526	7/1/55	10/13/55	56	4.865	1.57
380	3S	3.02	.75	.074	6.2262	6.1149	.1113	7/1/55	10/13/55	56	5.084	3.18
381	24S	3.03	.76	.035	3.4317	3.3858	.0459	7/1/55	10/13/55	56	4.829	1.38
382	2S	3.03	.78	.034	3.2671	3.2225	.0446	7/1/55	10/16/55	59	4.943	1.24
383	3S	3.03	.78	.074	6.4088	6.2904	.1185	7/1/55	10/16/55	59	5.287	3.10
384	24S	3.02	.76	.035	3.4387	3.3890	.0497	7/1/55	10/16/55	59	4.813	1.42
385	2S	3.02	.78	.034	3.2371	3.1953	.0418	7/1/55	10/19/55	62	4.926	1.11
386	3S	3.03	.80	.074	6.4607	6.3180	.1427	7/1/55	10/19/55	62	5.411	3.46
387	24S	3.02	.75	.035	3.4687	3.4190	.0497	7/1/55	10/19/55	62	4.752	1.37
388	2S	3.03	.77	.034	3.3196	3.2455	.0741	7/1/55	10/22/55	65	4.881	1.90
389	3S	3.03	.79	.074	6.4362	6.2863	.1499	7/1/55	10/22/55	65	5.349	3.51
390	24S	2.99	.78	.035	3.4783	3.4290	.0493	7/1/55	10/22/55	65	4.886	1.26
391	2S	3.03	.76	.034	3.2616	3.2497	.0119	7/1/55	9/25/55	38	4.820	.534
392	3S	3.04	.76	.074	6.1975	6.1582	.0393	7/1/55	9/25/55	38	5.180	1.64
393	24S	2.99	.77	.035	3.5221	3.4932	.0289	7/1/55	9/25/55	38	4.825	1.30
394	2S	3.04	.76	.074	6.4160	6.3806	.0354	7/1/55	9/28/55	41	4.836	.436
395	3S	3.04	.77	.074	6.4160	6.3806	.0354	7/1/55	9/25/55	41	5.241	1.35
396	24S	3.00	.77	.035	3.5014	3.4819	.0195	7/1/55	9/25/55	41	4.842	.807
397	2S	3.03	.77	.034	3.2580	3.2416	.0164	7/1/55	10/1/55	44	4.881	.627
398	3S	3.04	.79	.074	6.4241	6.3852	.0389	7/1/55	10/1/55	44	5.366	1.36
399	24S	3.00	.76	.035	3.3996	3.3797	.0199	7/1/55	10/1/55	44	4.781	.776
400	2S	3.04	.78	.034	3.3032	3.2920	.0112	7/1/55	10/1/55	47	4.959	.395
401	3S	3.04	.78	.074	6.3908	6.3505	.0403	7/1/55	10/1/55	47	5.304	1.33
402	24S	3.00	.78	.035	3.5627	3.5408	.0219	7/1/55	10/4/55	47	4.902	.782

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
403	2S	3.03	.76	.034	3.2605	3.2478	.0127	7/1/55	10/7/55	50	4.820	.434
404	3S	3.04	.75	.074	6.3560	6.3163	.0397	7/1/55	10/7/55	50	5.117	1.28
405	24S	2.97	.77	.035	3.4624	3.4382	.0242	7/1/55	10/7/55	50	4.793	.831
406	2S	3.03	.77	.034	3.2455	3.2237	.0218	7/1/55	10/10/55	53	4.881	.693
407	3S	3.03	.76	.074	6.3514	6.2964	.0550	7/1/55	10/10/55	53	5.162	1.65
408	24S	3.02	.76	.035	3.4345	3.3965	.0380	7/1/55	10/10/55	53	4.752	1.24
409	2S	3.03	.74	.034	3.0960	3.0764	.0196	7/1/55	10/10/55	56	4.697	.612
410	3S	3.03	.79	.074	6.4369	6.3883	.0486	7/1/55	10/13/55	56	5.349	1.34
411	24S	3.01	.75	.035	3.4881	3.4622	.0259	7/1/55	10/13/55	56	4.736	.803
412	2S	3.04	.78	.034	3.3637	3.3428	.0209	7/1/55	10/16/55	59	4.959	.588
413	3S	3.04	.76	.074	6.3479	6.2880	.0599	7/1/55	10/16/55	59	5.180	1.61
414	24S	3.00	.78	.035	3.5634	3.5343	.0291	7/1/55	10/16/55	59	4.902	.826
415	2S	3.04	.76	.034	3.2476	3.2274	.0202	7/1/55	10/19/55	62	4.836	.554
416	3S	3.02	.80	.074	6.4465	6.3910	.0555	7/1/55	10/19/55	62	5.393	1.36
417	24S	3.02	.75	.035	3.4439	3.4067	.0372	7/1/55	10/19/55	62	4.752	1.04
418	2S	3.04	.74	.034	3.2108	3.1886	.0222	7/1/55	10/22/55	65	4.713	.595
419	3S	3.03	.79	.074	6.5017	6.3492	.0525	7/1/55	10/22/55	65	5.349	1.24
420	24S	3.00	.77	.035	3.5046	3.4814	.0232	7/1/55	10/22/55	65	4.842	.606
421	2S	3.02	.77	.034	3.2162	3.1892	.0270	7/1/55	9/25/55	38	4.865	1.20
422	3S	3.03	.77	.074	6.2659	6.2091	.0568	7/1/55	9/25/55	38	5.225	2.35
423	24S	3.00	.78	.035	3.5510	3.5229	.0281	7/1/55	9/25/55	38	4.902	1.24
424	2S	3.05	.72	.034	3.1538	3.0937	.0501	7/1/55	9/25/55	41	4.605	2.18
425	3S	3.02	.78	.074	6.2894	6.1982	.0912	7/1/55	9/25/55	41	5.270	3.45
426	24S	3.01	.74	.035	3.4406	3.4012	.0394	7/1/55	9/25/55	41	4.675	1.69
427	2S	3.04	.77	.034	3.2735	3.2305	.0430	7/1/55	10/1/55	44	4.897	1.64
428	3S	3.02	.79	.074	6.3900	6.3127	.0773	7/1/55	10/1/55	44	5.331	2.71
429	24S	3.00	.75	.035	3.4586	3.4143	.0443	7/1/55	10/1/55	44	4.720	1.75
430	2S	3.03	.78	.034	3.2851	3.2531	.0320	7/1/55	10/4/55	47	4.943	1.13
431	3S	3.04	.76	.074	6.3275	6.2633	.0642	7/1/55	10/4/55	47	5.180	2.17
432	24S	3.02	.76	.035	3.5815	3.5522	.0293	7/1/55	10/4/55	47	4.813	1.06
433	2S	3.03	.78	.034	3.2862	3.2567	.0295	7/1/55	10/7/55	50	4.943	.983
434	3S	3.04	.77	.074	6.3313	6.2518	.0795	7/1/55	10/7/55	50	5.241	2.49
435	24S	3.01	.76	.035	3.4499	3.4131	.0368	7/1/55	10/7/55	50	4.797	1.19
436	2S	3.04	.77	.034	3.3053	3.2687	.0366	7/1/55	10/10/55	53	4.897	1.16

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
437	3S	3.04	.76	.074	6.2835	6.1674	.1161	7/1/55	10/10/55	53	5.180	3.48
438	24S	3.01	.78	.035	3.5426	3.5057	.0369	7/1/55	10/10/55	53	4.919	1.17
439	2S	3.04	.77	.034	3.3028	3.2637	.0391	7/1/55	10/13/55	56	4.897	1.17
440	3S	3.03	.76	.074	6.2992	6.1845	.1137	7/1/55	10/13/55	56	5.162	3.23
441	24S	3.00	.78	.035	3.5633	3.5132	.0501	7/1/55	10/13/55	56	4.902	1.50
442	2S	3.03	.78	.034	3.2922	3.2454	.0468	7/1/55	10/16/55	59	4.943	1.32
443	3S	3.03	.78	.074	6.3389	6.2152	.1237	7/1/55	10/16/55	59	5.287	3.26
444	24S	2.99	.77	.035	3.5560	3.4999	.0561	7/1/55	10/16/55	59	4.825	1.62
445	2S	3.02	.72	.034	3.0627	3.0199	.0428	7/1/55	10/19/55	62	4.560	1.25
446	3S	3.04	.77	.074	6.3285	6.2013	.1272	7/1/55	10/19/55	62	4.241	3.22
447	24S	2.99	.78	.035	3.4652	3.4141	.0511	7/1/55	10/19/55	62	4.853	1.40
448	2S	3.03	.77	.034	3.2802	3.2416	.0386	7/1/55	10/22/55	65	4.881	.998
449	3S	3.04	.78	.074	6.2980	6.1915	.1065	7/1/55	10/22/55	65	5.304	2.54
450	24S	3.00	.77	.035	3.4902	3.4458	.0444	7/1/55	10/22/55	65	4.842	1.16
451	2S	3.03	.77	.034	3.2552	3.2518	.0034	7/1/55	9/25/55	38	4.881	.151
452	3S	3.03	.74	.074	6.2484	6.2484	.0000	7/1/55	9/25/55	38	5.038	.000
453	24S	3.01	.76	.035	3.4989	3.4955	.0034	7/1/55	9/25/55	38	4.797	.154
454	2S	3.04	.78	.034	3.3209	3.3179	.0030	7/1/55	9/25/55	41	4.959	.121
455	3S	3.02	.75	.074	6.1058	6.0790	.0268	7/1/55	9/28/55	41	5.084	1.06
456	24S	3.01	.78	.035	3.5665	3.5628	.0037	7/1/55	9/28/55	41	4.919	.151
457	2S	3.03	.74	.034	3.1762	3.1727	.0035	7/1/55	10/1/55	44	4.697	.139
458	3S	3.02	.75	.074	6.1367	6.1103	.0264	7/1/55	10/1/55	44	5.084	.971
459	24S	2.99	.76	.035	3.5185	3.5147	.0038	7/1/55	10/1/55	44	4.765	.149
460	2S	3.04	.74	.034	3.1965	3.1921	.0044	7/1/55	10/4/55	47	4.713	.163
461	3S	3.04	.74	.074	6.1655	6.1321	.0334	7/1/55	10/4/55	47	5.055	1.15
462	24S	3.01	.75	.035	3.4710	3.4689	.0021	7/1/55	10/4/55	47	4.736	.0777
463	2S	3.04	.78	.034	3.3152	3.3116	.0036	7/1/55	10/7/55	50	4.959	.119
464	3S	3.02	.72	.074	5.9031	5.8716	.0315	7/1/55	10/7/55	50	4.898	1.06
465	24S	3.01	.78	.035	3.5679	3.5664	.0015	7/1/55	10/7/55	50	4.919	.0502
466	2S	3.04	.78	.034	3.3771	3.3712	.0059	7/1/55	10/10/55	53	4.959	.184
467	3S	3.04	.78	.074	6.3912	6.3365	.0547	7/1/55	10/10/55	53	5.304	1.60

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
468	24S	3.02	.78	.035	3.4565	3.4525	.0040	7/1/55	10/10/55	53	4.935	.126
469	2S	3.04	.77	.034	3.3676	3.3620	.0056	7/1/55	10/13/55	56	4.897	.168
470	3S	3.03	.79	.074	6.4319	6.3755	.0564	7/1/55	10/13/55	56	5.349	1.55
471	24S	3.00	.76	.035	3.5164	3.5128	.0036	7/1/55	10/13/55	56	4.781	.111
472	2S	3.04	.76	.034	3.2315	3.2248	.0067	7/1/55	10/16/55	59	4.836	.193
473	3S	3.00	.74	.074	6.0566	5.9693	.0873	7/1/55	10/16/55	59	4.989	2.44
474	24S	3.02	.78	.035	3.5491	3.5397	.0094	7/1/55	10/16/55	59	4.935	.265
475	2S	3.04	.77	.034	3.2683	3.2390	.0293	7/1/55	10/19/55	62	4.897	.794
476	3S	3.02	.76	.074	6.1416	6.0588	.0828	7/1/55	10/19/55	62	4.156	2.13
477	24S	3.02	.77	.035	3.4516	3.4497	.0019	7/1/55	10/19/55	62	4.874	.0517
478	2S	3.03	.78	.034	3.2811	3.2775	.0036	7/1/55	10/22/55	65	4.943	.0922
479	3S	3.00	.75	.074	6.0768	6.0145	.0623	7/1/55	10/22/55	65	5.051	1.56
480	24S	3.00	.78	.035	3.5557	3.5544	.0013	7/1/55	10/22/55	65	4.902	.0335
481	2S	3.04	.78	.034	3.3166	3.3094	.0072	7/1/55	9/25/55	38	4.959	.312
482	3S	3.04	.78	.074	6.2125	6.1658	.0467	7/1/55	9/25/55	38	5.304	1.90
483	24S	3.00	.78	.035	3.5542	3.5306	.0236	7/1/55	9/25/55	38	4.902	1.04
484	2S	3.04	.77	.034	3.3315	3.3233	.0082	7/1/55	9/2/55	41	4.897	.335
485	3S	3.02	.76	.074	6.1626	6.1238	.0388	7/1/55	9/28/55	41	5.146	1.51
486	24S	3.03	.78	.035	3.5534	3.5372	.0162	7/1/55	9/28/55	41	4.951	.656
487	2S	3.03	.77	.034	3.2646	3.2570	.0076	7/1/55	10/1/55	44	4.881	.290
488	3S	3.04	.79	.074	6.4418	6.3954	.0464	7/1/55	10/1/55	44	5.366	1.61
489	24S	3.02	.78	.035	3.4539	3.4324	.0215	7/1/55	10/1/55	44	4.935	.815
490	2S	3.04	.78	.034	3.2957	3.2894	.0063	7/1/55	10/4/55	47	4.959	.222
491	3S	3.04	.78	.074	6.4515	6.4056	.0459	7/1/55	10/4/55	47	5.304	1.51
492	24S	3.01	.77	.035	3.5537	3.5323	.0214	7/1/55	10/4/55	47	4.868	.769
493	2S	3.03	.76	.034	3.2795	3.2728	.0067	7/1/55	10/7/55	50	4.820	.228
494	3S	3.03	.76	.074	6.3032	6.2607	.0425	7/1/55	10/7/55	50	5.162	1.35
495	24S	3.00	.79	.035	3.5501	3.5364	.0137	7/1/55	10/7/55	50	4.963	.454
496	2S	3.02	.77	.034	3.2160	3.2070	.0090	7/1/55	10/10/55	53	4.865	2.87
497	3S	3.03	.80	.074	6.4435	6.3807	.0628	7/1/55	10/10/55	53	5.411	1.80
498	24S	3.00	.78	.035	3.5793	3.5569	.0224	7/1/55	10/10/55	53	4.902	.708
499	2S	3.03	.77	.034	3.2237	3.2099	.0138	7/1/55	10/13/55	56	4.881	.414
500	3S	3.01	.76	.074	6.0935	6.0373	.0562	7/1/55	10/13/55	56	5.129	1.61
501	24S	3.00	.78	.035	3.4973	3.4830	.0143	7/1/55	10/13/55	56	4.902	.427

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
502	2S	3.03	.78	.034	3.2725	3.2603	.0122	7/1/55	10/16/55	59	4.943	.344
503	3S	3.03	.79	.075	6.4580	6.3844	.0736	7/1/55	10/16/55	59	5.349	1.92
504	24S	3.03	.76	.035	3.4536	3.4304	.0232	7/1/55	10/16/55	59	4.829	.670
505	2S	3.03	.78	.034	3.2758	3.2668	.0090	7/1/55	10/19/55	62	4.943	.242
506	3S	3.03	.77	.074	5.2592	6.1846	.0215	7/1/55	10/19/55	62	5.225	1.89
507	24S	3.00	.74	.035	3.3965	3.3750	.0215	7/1/55	10/19/55	62	4.659	.612
508	2S	3.04	.74	.034	3.1404	3.1304	.0100	7/1/55	10/22/55	65	4.713	.269
509	3S	3.03	.76	.074	6.1613	6.1023	.0590	7/1/55	10/22/55	65	5.162	1.44
510	24S	2.99	.78	.035	3.4729	3.4554	.0175	7/1/55	10/22/55	65	4.886	.452
511	2S	3.03	.75	.034	3.2364	3.0563	.1801	7/1/55	9/25/55	38	4.759	8.50
512	3S	3.02	.76	.074	6.0974	5.8775	.2199	7/1/55	9/25/55	38	5.146	9.26
513	24S	3.01	.75	.035	3.4243	3.2942	.1301	7/1/55	9/25/55	38	4.736	5.96
514	2S	3.04	.72	.034	3.0875	2.9941	.0934	7/1/55	9/28/55	41	4.590	4.18
515	3S	3.03	.78	.074	6.4406	6.2123	.2283	7/1/55	9/28/55	41	5.287	8.68
516	24S	3.00	.78	.035	3.5632	3.4535	.1097	7/1/55	9/28/55	41	4.902	4.48
517	2S	3.04	.76	.034	3.1824	3.0905	.0919	7/1/55	10/11/55	44	4.836	3.55
518	3S	3.03	.78	.074	6.4492	6.1875	.2617	7/1/55	10/1/55	44	5.287	10.3
519	24S	3.02	.78	.035	3.5538	3.4304	.1234	7/1/55	10/1/55	44	4.935	4.68
520	2S	3.02	.77	.034	3.2190	2.0800	.1390	7/1/55	10/4/55	47	4.865	5.00
521	3S	3.02	.78	.074	6.4599	6.2096	.2503	7/1/55	10/4/55	47	5.270	8.32
522	24S	3.02	.77	.035	3.5549	3.4761	.0788	7/1/55	10/4/55	47	4.874	2.83
523	2S	3.03	.76	.034	3.2877	3.1498	.1379	7/1/55	10/7/55	50	4.820	4.70
524	3S	3.02	.76	.074	6.2815	6.0043	.2772	7/1/55	10/7/55	50	5.146	8.86
525	24S	3.02	.78	.035	3.5574	3.4616	.0958	7/1/55	10/7/55	50	4.935	3.19
526	2S	3.04	.76	.034	3.2747	3.1257	.1490	7/1/55	10/10/55	53	4.836	4.78
527	3S	3.04	.76	.074	6.3010	5.9614	.3396	7/1/55	10/10/55	53	5.180	10.1
528	24S	3.02	.78	.035	3.5640	3.3715	.1925	7/1/55	10/10/55	53	4.935	6.06
529	2S	3.02	.79	.034	3.2969	3.1219	.1750	7/1/55	10/13/55	56	4.987	5.15
530	3S	3.04	.78	.074	6.4420	6.0631	.3789	7/1/55	10/13/55	56	5.304	10.5
531	24S	3.00	.78	.035	3.5513	3.4367	.1146	7/1/55	10/13/55	56	4.902	3.43
532	2S	3.04	.77	.034	3.2880	3.1392	.1488	7/1/55	10/16/55	59	4.897	4.24
533	3S	3.02	.79	.074	6.4258	6.1022	.3236	7/1/55	10/16/55	59	5.331	8.45
534	24S	3.02	.78	.035	3.5505	3.4194	.1311	7/1/55	10/16/55	59	4.935	3.71

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
535	2S	3.02	.76	.034	3.2490	3.0426	.2064	7/1/55	10/19/55	62	4.804	5.69
536	3S	3.00	.74	.074	6.0013	5.5722	.4291	7/1/55	10/19/55	62	4.989	11.4
537	24S	3.00	.78	.035	3.5237	3.3571	.1666	7/1/55	10/19/55	62	4.902	4.49
538	2S	3.04	.78	.034	3.3508	3.1232	.2276	7/1/55	10/22/55	65	4.959	5.79
539	3S	3.04	.77	.074	6.4313	6.0234	.4079	7/1/55	10/22/55	65	5.241	9.87
540	24S	3.01	.78	.035	3.5664	3.3999	.1665	7/1/55	10/22/55	65	4.919	4.28
541	2S	3.02	.73	.034	3.1816	2.9454	.2362	7/1/55	9/25/55	38	4.621	11.0
542	3S	3.04	.75	.074	6.2015	5.8340	.3675	7/1/55	9/25/55	38	4.117	15.5
543	24S	3.02	.72	.035	3.2788	3.1501	.1287	7/1/55	9/25/55	38	4.568	6.10
544	2S	3.03	.74	.034	3.2006	3.0026	.1980	7/1/55	9/25/55	41	4.697	8.46
545	3S	3.03	.78	.074	6.3605	6.0160	.3445	7/1/55	9/28/55	41	4.287	13.1
546	24S	3.03	.75	.035	3.4563	3.3505	.1058	7/1/55	9/28/55	41	4.747	4.44
547	2S	3.04	.74	.034	3.2000	2.9557	.2443	7/1/55	10/1/55	44	4.713	9.70
548	3S	3.02	.80	.074	6.4347	6.0372	.3975	7/1/55	10/1/55	44	5.393	13.8
549	24S	3.00	.78	.035	3.5243	3.3924	.1319	7/1/55	10/1/55	44	4.902	5.03
550	2S	3.04	.73	.034	3.1545	2.9146	.2399	7/1/55	10/4/55	47	4.651	9.03
551	3S	3.03	.79	.074	6.3244	5.9233	.4011	7/1/55	10/4/55	47	5.349	13.1
552	24S	3.01	.78	.035	3.5522	3.4638	.0864	7/1/55	10/4/55	47	4.919	3.07
553	2S	3.04	.70	.034	3.0066	2.7536	.2530	7/1/55	10/7/55	50	4.467	9.29
554	3S	3.03	.79	.074	6.3512	5.9107	.4405	7/1/55	10/7/55	50	5.349	13.6
555	24S	3.00	.78	.035	3.5613	3.4507	.1106	7/1/55	10/7/55	50	4.902	3.71
556	2S	3.04	.78	.034	3.2989	2.9274	.3715	7/1/55	10/10/55	53	4.959	12.3
557	3S	3.03	.78	.074	6.3587	5.7690	.5897	7/1/55	10/10/55	53	5.287	17.3
558	24S	3.00	.73	.035	3.3337	3.1747	.1590	7/1/55	10/10/55	53	4.599	4.36
559	2S	3.04	.77	.034	3.2752	2.9268	.3484	7/1/55	10/13/55	56	4.897	10.5
560	3S	3.03	.78	.074	6.4501	5.8326	.6175	7/1/55	10/13/55	56	5.287	17.2
561	24S	3.01	.78	.035	3.5626	3.4189	.1437	7/1/55	10/13/55	56	4.919	4.29
562	2S	3.04	.77	.034	3.3355	2.9760	.3595	7/1/55	10/16/55	59	4.897	10.2
563	3S	3.03	.76	.074	6.2988	5.6778	.6210	7/1/55	10/16/55	59	5.162	16.8
564	24S	3.01	.76	.035	3.4482	3.2946	.1536	7/1/55	10/16/55	59	4.797	4.47
565	2S	3.04	.78	.034	3.3129	2.8704	.4425	7/1/55	10/19/55	62	4.959	11.8
566	3S	3.03	.76	.074	6.2124	5.4579	.7545	7/1/55	10/19/55	62	5.162	19.4
567	24S	3.01	.75	.035	3.4251	3.2224	.2027	7/1/55	10/19/55	62	4.736	5.70

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
568	2S	3.03	.77	.034	3.2900	2.7673	.5227	7/1/55	10/22/55	65	4.881	13.5
569	3S	3.02	.76	.074	6.2780	5.4538	.8242	7/1/55	10/22/55	65	5.146	20.3
570	24S	3.00	.76	.035	3.4505	3.2869	.1737	7/1/55	10/22/55	65	4.781	4.59
661	2S	3.04	.74	.034	3.1767	3.0440	.1327	7/1/55	9/19/55	32	4.713	7.23
662	3S	3.02	.76	.074	6.2232	6.0554	.1678	7/1/55	9/19/55	32	5.146	8.39
663	24S	2.99	.78	.035	3.5318	3.3586	.1732	7/1/55	9/19/55	32	4.886	9.12
664	2S	3.02	.74	.034	3.1661	3.0273	.1388	7/1/55	9/22/55	35	4.682	6.97
665	3S	3.00	.72	.074	5.9194	5.7450	.1744	7/1/55	9/22/55	35	4.867	8.32
666	24S	3.00	.76	.035	3.4684	3.2950	.1734	7/1/55	9/22/55	35	4.781	8.53
667	2S	3.03	.75	.034	3.2155	3.1113	.1042	7/1/55	9/25/55	38	4.759	4.75
668	3S	3.00	.73	.074	6.0524	5.8631	.1893	7/1/55	9/25/55	38	4.928	8.32
669	24S	3.02	.75	.035	3.4560	3.2458	.2102	7/1/55	9/25/55	38	4.752	9.57
670	2S	3.03	.75	.034	3.2647	3.1052	.1695	7/1/55	9/28/55	41	4.759	7.15
671	3S	3.03	.80	.074	6.4619	6.2413	.2106	7/1/55	9/28/55	41	5.411	7.81
672	24S	3.02	.76	.035	3.5443	3.3505	.1940	7/1/55	9/28/55	41	4.813	8.08
673	2S	3.03	.74	.034	3.1723	3.0087	.1636	7/1/55	11/1/55	44	4.697	6.50
674	3S	3.02	.79	.074	6.4384	6.2217	.2167	7/1/55	10/1/55	44	5.331	7.62
675	24S	3.01	.76	.035	3.5323	3.3170	.2153	7/1/55	10/1/55	44	4.797	8.40
676	2S	3.04	.74	.034	3.2282	3.0517	.1765	7/1/55	10/4/55	47	4.713	6.55
677	3S	3.03	.76	.074	6.2523	6.0264	.2259	7/1/55	10/4/55	47	4.162	7.66
678	24S	3.02	.78	.035	3.5492	3.3166	.2326	7/1/55	10/4/55	47	4.935	8.25
679	2S	3.04	.78	.034	3.3250	3.1252	.1998	7/1/55	10/7/55	50	4.959	6.62
680	3S	3.03	.76	.074	6.2181	5.9668	.2513	7/1/55	10/7/55	50	5.162	8.00
681	24S	3.02	.77	.035	3.5360	3.2818	.2542	7/1/55	10/7/55	50	4.874	8.58
682	2S	3.03	.76	.034	3.2428	3.0126	.2302	7/1/55	10/13/55	56	4.820	7.03
683	3S	3.04	.78	.074	6.2552	4.9666	.2886	7/1/55	10/13/55	56	5.304	8.00
684	24S	3.01	.77	.035	3.5670	3.2776	.2894	7/1/55	10/13/55	56	4.868	8.74
685	2S	3.04	.74	.034	3.1762	2.8521	.3241	7/1/55	10/19/55	62	4.713	9.14
686	3S	3.02	.79	.074	6.4358	5.9595	.4763	7/1/55	10/19/55	62	5.331	11.8
687	24S	3.00	.75	.035	3.4077	3.0292	.3785	7/1/55	10/19/55	62	4.720	10.6
688	2S	3.04	.74	.034	3.1835	2.8337	.3498	7/1/55	10/22/55	65	4.713	9.40
689	3S	3.04	.78	.074	6.2885	5.7962	.4923	7/1/55	10/22/55	65	5.304	11.8
690	24S	3.01	.76	.035	3.4652	3.0875	.3777	7/1/55	10/22/55	65	4.797	9.97

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
691	2S	3.04	.73	.034	3.1751	3.1387	.0364	7/1/55	9/19/55	32	4.651	2.01
692	3S	3.03	.77	.074	6.4210	6.2730	.1480	7/1/55	9/19/55	32	5.225	7.28
693	24S	3.01	.75	.035	3.4243	3.3440	.0803	7/1/55	9/19/55	32	4.736	4.37
694	2S	3.04	.74	.034	3.1843	3.1500	.0343	7/1/55	9/22/55	35	4.713	1.71
695	3S	3.04	.76	.074	6.2687	6.1464	.1223	7/1/55	9/22/55	35	5.180	5.55
696	24S	3.02	.75	.035	3.4135	3.3364	.0771	7/1/55	9/22/55	35	4.752	3.81
697	2S	3.03	.74	.034	3.1416	3.0622	.0794	7/1/55	9/25/55	38	4.697	3.65
698	3S	3.03	.78	.074	6.3990	6.2579	.1411	7/1/55	9/25/55	38	5.287	5.78
699	24S	3.00	.73	.035	3.3532	3.2654	.0878	7/1/55	9/25/55	38	4.599	4.13
700	2S	3.04	.74	.034	3.1923	3.1613	.0310	7/1/55	9/28/55	41	4.713	1.32
701	3S	3.03	.78	.074	6.4199	6.2029	.2170	7/1/55	9/28/55	41	5.287	8.22
702	24S	3.01	.71	.035	3.2265	3.1426	.0839	7/1/55	9/28/55	41	4.492	3.75
703	2S	3.04	.73	.034	3.1590	3.1203	.0387	7/1/55	10/1/55	44	4.651	1.55
704	3S	3.00	.77	.074	6.1919	5.9890	.2029	7/1/55	10/1/55	44	5.174	7.38
705	24S	3.01	.74	.035	3.4070	3.3130	.0940	7/1/55	10/1/55	44	4.675	3.76
706	2S	3.03	.76	.034	3.1993	3.1582	.0411	7/1/55	10/4/55	47	4.820	1.49
707	3S	3.02	.75	.074	6.1676	5.9819	.1857	7/1/55	10/4/55	47	5.084	6.39
708	24S	3.00	.77	.035	3.5043	3.4204	.0839	7/1/55	10/4/55	47	4.842	3.04
709	2S	3.04	.78	.034	3.3126	3.2671	.0455	7/1/55	10/7/55	50	4.959	1.51
710	3S	3.02	.76	.074	6.2803	6.0366	.2437	7/1/55	10/1/55	50	5.146	7.78
711	24S	3.02	.75	.035	3.4140	3.3032	.1108	7/1/55	10/7/55	50	4.752	3.83
712	2S	3.03	.78	.034	3.3472	3.2904	.0568	7/1/55	10/13/55	56	4.943	1.68
713	3S	3.02	.79	.074	6.3641	6.1102	.2539	7/1/55	10/13/55	56	5.331	6.98
714	24S	3.01	.74	.035	3.3792	3.2203	.1589	7/1/55	10/13/55	56	4.675	4.98
715	2S	3.04	.72	.034	3.1156	3.0806	.0350	7/1/55	10/19/55	62	4.590	1.01
716	3S	3.02	.77	.074	6.2826	6.0250	.2576	7/1/55	10/13/55	62	5.208	6.54
717	24S	3.01	.76	.035	3.4533	3.2853	.1680	7/1/55	10/19/55	62	4.797	4.64
718	2S	3.04	.78	.034	3.3617	3.3303	.0314	7/1/55	10/22/55	65	4.959	.802
719	3S	3.03	.77	.074	6.2627	5.9910	.2717	7/1/55	10/22/55	65	5.225	6.58
720	24S	2.99	.76	.035	3.5016	3.3295	.1721	7/1/55	10/22/55	65	4.765	4.57
721	2S	3.02	.72	.034	3.1401	3.1270	.0131	9/4/55	9/22/55	18	4.560	1.31
722	3S	3.02	.79	.074	6.4440	6.3901	.0539	9/4/55	9/22/55	18	5.331	4.61
723	24S	3.02	.78	.035	3.4920	3.4844	.0076	9/4/55	9/22/55	18	4.935	.705
724	2S	3.02	.73	.034	3.1769	3.1631	.0138	9/4/55	9/25/55	21	4.621	1.17

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
725	3S	3.03	.76	.074	6.2585	6.1951	.0634	9/4/55	9/25/55	21	5.162	4.80
726	24S	3.00	.78	.035	3.5558	3.5463	.0095	9/4/55	9/25/55	21	4.902	.784
727	2S	3.02	.74	.034	3.2511	3.2396	.0115	9/4/55	9/28/55	24	4.682	.841
728	3S	2.98	.76	.074	6.0438	5.9800	.0638	9/4/55	9/28/55	24	5.079	4.30
729	24S	2.98	.78	.035	3.5416	3.5260	.0156	9/4/55	9/28/55	24	4.870	1.10
730	2S	3.02	.76	.034	3.2939	3.2809	.0130	9/4/55	10/1/55	27	4.804	.823
731	3S	3.00	.75	.074	6.1376	6.0648	.0728	9/4/55	10/1/55	27	5.051	4.38
732	24S	2.96	.79	.035	3.5057	3.4911	.0146	9/4/55	10/1/55	27	4.897	.910
733	2S	3.03	.77	.034	3.2404	3.2291	.0113	9/4/55	10/4/55	30	4.881	.633
734	3S	3.02	.74	.074	6.1257	6.0560	.0697	9/4/55	10/4/55	30	5.022	3.81
735	24S	2.97	.79	.035	3.5163	3.5028	.0135	9/4/55	10/4/55	30	4.913	.753
736	2S	3.03	.76	.034	3.3032	3.2915	.0117	9/4/55	10/7/55	33	4.820	.604
737	3S	3.02	.79	.074	6.4099	6.3421	.0678	9/4/55	10/7/55	33	5.331	3.17
738	24S	2.99	.75	.035	3.4939	3.4795	.0144	9/4/55	10/7/55	33	4.704	.763
739	2S	3.02	.78	.034	3.2461	3.2353	.0108	9/4/55	10/7/55	33	4.926	.546
740	3S	2.99	.72	.074	5.9758	5.9062	.0696	9/4/55	10/7/55	33	4.851	3.58
741	24S	3.01	.79	.035	3.5566	3.5470	.0096	9/4/55	10/7/55	33	4.979	.480
742	2S	3.03	.77	.034	3.3514	3.3316	.0198	9/4/55	10/10/55	36	4.881	.926
743	3S	3.02	.78	.074	6.3775	6.2806	.0968	9/4/55	10/10/55	36	5.270	4.19
744	24S	3.00	.75	.035	3.5124	3.4982	.0142	9/4/55	10/10/55	36	4.720	.687
745	2S	3.03	.72	.034	3.1939	3.1770	.0169	9/4/55	10/10/55	36	4.575	.845
746	3S	3.03	.76	.074	6.2648	6.1722	.0926	9/4/55	10/10/55	36	5.162	4.10
747	24S	3.02	.74	.035	3.3948	3.3781	.0167	9/4/55	10/10/55	36	4.690	.814
748	2S	3.06	.73	.034	3.1472	3.1289	.0183	9/4/55	10/13/55	39	4.683	.324
749	3S	3.03	.77	.074	6.2885	6.1795	.1090	9/4/55	10/13/55	39	5.225	4.40
750	24S	2.99	.76	.035	3.4390	3.4221	.0169	9/4/55	10/13/55	39	4.765	.747
751	2S	3.03	.77	.034	3.3456	3.3280	.0176	9/4/55	10/13/55	39	4.881	.760
752	3S	3.02	.78	.074	6.4303	6.3357	.0946	9/4/55	10/13/55	39	5.270	3.79
753	24S	3.02	.79	.035	3.5228	3.5103	.0125	9/4/55	10/13/55	39	4.996	.527
754	2S	3.03	.72	.034	3.0908	3.0673	.0235	9/4/55	10/16/55	42	4.575	1.01
755	3S	3.02	.78	.074	6.2727	6.1557	.1270	9/4/55	10/16/55	42	5.270	4.72

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
756	24S	3.01	.77	.035	3.4582	3.4400	.0132	9/4/55	10/16/55	42	4.868	.531
757	2S	3.04	.73	.034	3.1669	3.1451	.0218	9/4/55	10/16/55	42	4.651	.917
758	3S	3.02	.72	.074	5.9018	5.7943	.1075	9/4/55	10/16/55	42	4.898	4.30
759	24S	3.02	.74	.035	3.3913	3.3740	.0173	9/4/55	10/16/55	42	4.690	.722
760	2S	3.03	.78	.034	3.3623	3.3415	.0208	9/4/55	10/16/55	42	4.943	.824
761	3S	3.02	.76	.074	6.1512	6.0456	.1056	9/4/55	10/16/55	42	5.146	4.02
762	24S	3.02	.75	.035	3.4114	3.3950	.0164	9/4/55	10/16/55	42	4.752	.675
763	2S	3.03	.79	.034	3.3204	3.2964	.0241	9/4/55	10/19/55	45	5.004	.880
764	3S	3.03	.77	.074	6.2703	6.1353	.1350	9/4/55	10/19/55	45	5.225	4.72
765	24S	3.00	.77	.035	3.4478	3.4273	.0205	9/4/55	10/19/55	45	4.842	.775
766	2S	3.02	.77	.034	3.1832	3.1578	.0254	9/4/55	10/19/55	45	4.865	.954
767	3S	3.02	.73	.074	6.0191	5.8780	.1411	9/4/55	10/19/55	45	4.960	5.20
768	24S	2.99	.74	.035	3.3024	3.2793	.0231	9/4/55	10/19/55	45	4.644	.909
769	2S	3.03	.73	.034	3.1417	3.1147	.0270	9/4/55	10/19/55	45	4.636	1.06
770	3S	3.03	.80	.074	6.2968	6.1583	.1385	9/4/55	10/19/55	45	5.411	4.68
771	24S	3.01	.77	.035	3.4893	3.4621	.0272	9/4/55	10/19/55	45	4.868	1.02
772	2S	3.04	.74	.034	3.1628	3.1395	.0233	9/4/55	10/22/55	48	4.713	.848
773	3S	3.00	.74	.074	5.9707	5.8250	.1457	9/4/55	10/22/55	48	4.989	5.00
774	24S	2.98	.78	.035	3.4783	3.4581	.0202	9/4/55	10/22/55	48	4.870	.712
775	2S	3.04	.74	.034	3.2202	3.1782	.0240	9/4/55	10/22/55	48	4.713	.873
776	3S	3.03	.78	.074	6.4562	6.2796	.1766	9/4/55	10/22/55	48	5.287	5.72
777	24S	2.99	.78	.035	3.5382	3.5100	.0282	9/4/55	10/22/55	48	4.886	.990
778	2S	3.04	.73	.034	3.1545	3.1238	.0307	9/4/55	10/22/55	48	4.651	1.13
779	3S	3.03	.79	.074	6.4468	6.2391	.2077	9/4/55	10/22/55	48	5.349	6.64
780	24S	2.99	.78	.035	3.5377	3.5000	.0377	9/4/55	10/22/55	48	4.886	1.32
781	2S	3.84	.74	.034	3.2063	3.0895	.1168	9/4/55	10/10/55	36	4.713	5.65
782	3S	3.02	.78	.074	6.3755	6.2244	.1511	9/4/55	10/10/55	36	5.270	6.54
783	24S	3.02	.78	.035	3.5051	3.3453	.1598	9/4/55	10/10/55	36	4.935	7.39
784	2S	3.03	.72	.034	3.0767	2.9846	.0911	9/4/55	10/13/55	39	4.575	4.21
785	3S	3.02	.78	.074	6.2564	6.0973	.1591	9/4/55	10/13/55	39	5.270	6.38
786	24S	3.01	.79	.035	3.5407	3.4777	.0630	9/4/55	10/13/55	39	4.979	2.66
787	2S	3.04	.73	.034	3.1668	3.0541	.1127	8/4/55	10/13/55	39	4.651	5.11
788	3S	3.03	.78	.074	6.3977	6.2432	.1545	9/4/55	10/13/55	39	5.287	6.17
789	24S	3.02	.79	.035	3.5658	3.3915	.1743	9/4/55	10/13/55	39	4.996	7.37

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
790	2S	3.03	.78	.034	3.3303	3.2115	.1188	9/4/55	10/16/55	42	4.943	4.71
791	3S	3.03	.77	.074	6.3091	6.1415	.1671	9/4/55	10/16/55	42	5.225	6.27
792	24S	3.02	.76	.035	3.4460	3.2663	.1797	9/4/55	10/16/55	42	4.913	7.30
793	2S	3.03	.79	.034	3.2596	3.1369	.1227	9/4/55	10/16/55	42	5.004	4.80
794	3S	3.02	.78	.074	6.3841	6.2159	.1682	9/4/55	10/16/55	42	5.287	6.24
795	24S	3.02	.76	.035	3.4675	3.2871	.1804	9/4/55	10/16/55	42	4.813	7.34
796	2S	3.03	.76	.034	3.2716	3.1469	.1247	9/4/55	10/16/55	42	4.820	5.07
797	3S	3.02	.78	.074	6.2604	6.1107	.1497	9/4/55	10/16/55	42	5.270	5.56
798	24S	3.00	.79	.035	3.5275	3.4010	.1275	9/4/55	10/16/55	42	4.963	4.99
799	2S	3.03	.72	.034	3.1042	2.9906	.1136	9/4/55	10/19/55	45	4.575	4.54
800	3S	3.04	.75	.074	6.1705	6.0123	.1582	9/4/55	10/19/55	45	5.117	5.65
801	24S	3.00	.79	.035	3.5748	3.4597	.1151	9/4/55	10/19/55	45	4.963	4.23
802	2S	3.05	.73	.034	3.1559	3.0387	.1172	9/4/55	10/19/55	45	4.667	4.58
803	3S	3.03	.74	.074	6.1268	5.9698	.1590	9/4/55	10/19/55	45	5.038	5.78
804	24S	3.01	.76	.035	3.4240	3.3011	.1229	9/4/55	10/19/55	45	4.797	4.68
805	2S	3.03	.77	.034	3.3433	3.2007	.1426	9/4/55	10/22/55	48	4.881	5.00
806	3S	3.02	.76	.074	6.1373	5.9463	.1910	9/4/55	10/22/55	48	5.146	6.36
807	24S	3.01	.78	.035	3.5513	3.4443	.1070	9/4/55	10/22/55	48	4.919	3.73
808	2S	3.02	.74	.034	3.1755	3.0713	.1042	9/4/55	10/22/55	48	4.682	3.82
809	3S	3.02	.78	.074	6.4527	6.2370	.2157	9/4/55	10/22/55	48	5.270	7.00
810	24S	3.01	.78	.035	3.5799	3.4641	.1158	9/4/55	10/22/55	48	4.919	4.03
811	2S	3.04	.73	.034	3.1303	3.0984	.0319	9/4/55	9/16/55	12	4.651	4.69
812	3S	3.02	.77	.074	6.2033	6.1699	.0334	9/4/55	9/16/55	12	5.208	4.39
813	24S	3.03	.78	.035	3.5581	3.5264	.0317	9/4/55	9/16/55	12	4.951	4.38
814	2S	3.04	.74	.034	3.1794	3.1405	.0389	9/4/55	9/19/55	15	4.713	4.52
815	3S	3.03	.77	.074	6.3729	6.3284	.0445	9/4/55	9/19/55	15	5.225	4.67
816	24S	3.01	.78	.035	3.5677	3.5326	.0351	9/4/55	9/19/55	15	4.919	3.92
817	2S	3.02	.76	.034	3.2884	3.2434	.0450	9/4/55	9/22/55	18	4.804	4.27
818	3S	3.03	.79	.074	6.3301	6.2766	.0535	9/4/55	9/22/55	18	5.349	4.56
819	24S	3.03	.77	.035	3.5264	3.4705	.0559	9/4/55	9/22/55	18	4.890	5.22
820	2S	3.04	.78	.034	3.3153	3.2415	.0738	9/4/55	9/25/55	21	4.959	5.83
821	3S	3.04	.78	.074	6.3275	6.2524	.0751	9/4/55	9/25/55	21	5.304	5.55
822	24S	3.00	.77	.035	3.4821	3.4080	.0741	9/4/55	9/25/55	21	4.842	6.00

APPENDIX II (continued)

	Alloy	Length	Width	Thick.	Wt. 1	Wt. 2	Loss	In	Out	Time	Area	Rate
823	2S	3.03	.76	.034	3.2760	3.1979	.0781	9/4/55	9/22/55	24	4.820	5.56
824	3S	3.02	.79	.074	6.4108	6.3260	.0848	9/4/55	9/28/55	24	5.331	5.45
825	24S	3.00	.77	.035	3.4932	3.4183	.0749	9/4/55	9/28/55	24	4.842	5.29
826	2S	3.03	.78	.034	3.3359	3.2492	.0867	9/4/55	10/1/55	27	4.943	5.33
827	3S	3.02	.76	.074	6.1548	6.0677	.0871	9/4/55	10/1/55	27	5.146	5.16
828	24S	3.00	.77	.035	3.5088	3.4354	.0734	9/4/55	10/1/55	27	4.842	4.62
829	2S	3.03	.76	.034	3.2737	3.1636	.1001	9/4/55	10/4/55	30	4.820	5.70
830	3S	3.03	.77	.074	6.2707	6.1667	.1040	9/4/55	10/4/55	30	5.225	5.45
831	24S	3.01	.74	.035	3.3850	3.2956	.0804	9/4/55	10/4/55	30	4.675	5.23
832	2S	3.04	.77	.034	3.3292	3.2292	.0950	9/4/55	10/7/55	33	4.897	4.84
833	3S	3.03	.75	.074	6.1110	5.9812	.1298	9/4/55	10/7/55	33	5.100	6.34
834	24S	3.02	.75	.035	3.4267	3.3261	.1006	9/4/55	10/7/55	33	4.752	5.27
835	2S	3.04	.74	.034	3.1672	3.0714	.0958	9/4/55	10/7/55	33	4.713	5.07
836	3S	3.03	.78	.074	6.4534	6.3293	.1241	9/4/55	10/7/55	33	5.287	5.86
837	24S	3.02	.76	.035	3.4468	3.3613	.0855	9/4/55	10/7/55	33	4.813	4.42
838	2S	3.03	.77	.034	3.3065	3.1902	.1163	9/4/55	10/10/55	36	4.881	5.43
839	3S	3.03	.78	.074	6.3713	6.2234	.1479	9/4/55	10/10/55	36	5.287	6.39
840	24S	3.01	.78	.035	3.5428	3.4619	.0809	9/4/55	10/10/55	36	4.919	3.76

APPENDIX III

NOMOGRAPH FOR OBTAINING CORROSION RATE

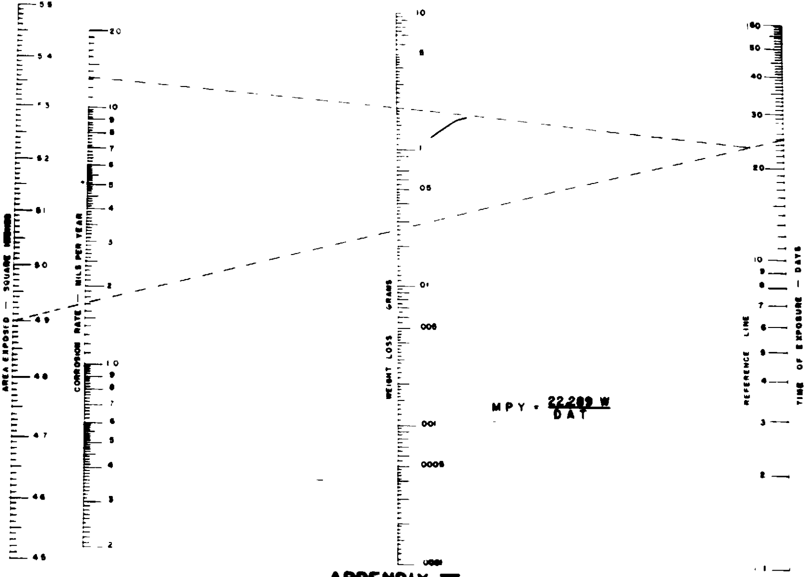
The nomograph relates the variables in the equation

$$\text{M.P.Y.} = \frac{22{,}289\ W}{D\ A\ T}$$

where M.P.Y. is the corrosion rate in mils per year. This rate is an expression of the volumetric quantity of metal removed. W is the weight loss in grams, D the density of the metal in grams per cubic centimeter, A the area of the specimen in square inches and T the time of exposure in days.

Since aluminum and its alloys were the only metals to be used in this nomograph, and since the densities of aluminum alloys 2S, 3S and 24S vary from each other by a maximum of 2%, the density was taken as constant for the three alloys and incorporated in the constant term of the equation above. This eleminated one scale of the nomograph, and it is believed the accuracy gained by this scale elimination more than compensates for the inaccuracy introduced by assuming a constant density for the three alloys.

By way of illustration, a sample problem is shown on the nomograph. A sample of aluminum with a surface area of 4.9 square inches is exposed to a corrodent for 25 days. The resultant weight loss is 0.026 grams. What is the corrosion rate in mils per year? The area exposed (4.9 square inches) is connected with the time of exposure (25 days). The point of intersection of this line with the reference line is connected to the weight loss (0.026 grams) and the corrosion rate is read as 1.71 mils per year.



APPENDIX III

NOMOGRAPH FOR OBTAINING CORROSION RATES

APPENDIX IV

ANALYSIS OF BORIC ACID

The boric acid analysis was obtained from the Pacific Coast Borax Company, producers of the boric acid.

APPENDIX IV

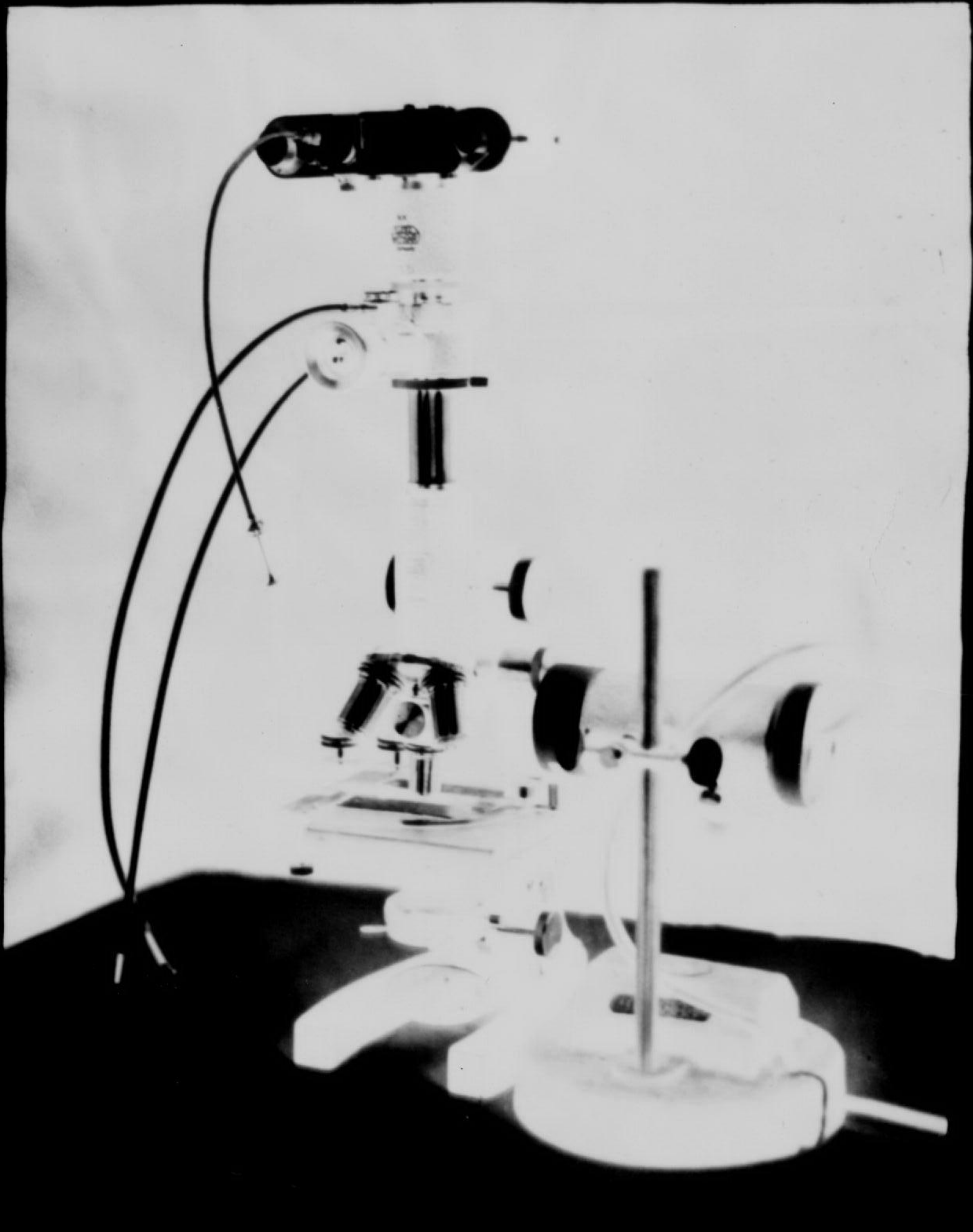
ANALYSIS OF P.C.B.C. USP BORIC ACID

CONSTITUENT		PERCENT
Boric Acid (H_3BO_3)		99.94
Sulphur Trioxide (SO_3)		0.009
Sodium Chloride (NaCl)		0.002
Calcium Carbonate ($CaCO_3$)		0.000
Ferric Oxide (Fe_2O_3)		0.0003
Magnesium Oxide (MgO)		0.000
Lead Oxide (PbO)	Less than	0.0001
Copper Oxide (CuO)	" "	0.0001
Arsenic Trioxide (As_2O_3)	" "	0.0001
Manganese Oxide (MnO)	" "	0.0001
Nickel Oxide (NiO)	" "	0.0001
Cobalt Oxide (CoO)	" "	0.0001
Heavy Metals as Pb (Tested by U.S.P. Method)	" "	0.0005

APPENDIX V

PHOTOMICROGRAPH EQUIPMENT

The photomicrograph equipment consisted of a Bausch and Lomb laboratory microscope equipped with a vertical illuminator. A Leitz Micro-Ibso microscope attachment and a Leica IIIF camera were fitted onto the microscope.



APPENDIX V

PHOTOMICROGRAPH EQUIPMENT

6587

THE CORROSION OF ALUMINUM IN
BORIC ACID SOLUTIONS

A Thesis

By

HENRY KINSOLVING BASS, JR.

Submitted to the Graduate School of the
Agricultural and Mechanical College of Texas in
partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

January 1956

Major Subject Chemical Engineering