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REPORT NO. 316/34

HEAT TREATMENT AND CORROSION RESISTANCE OF STAINLESS STEEL

INDEXED

BY

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May 6, 1936

WATERTOWN ARSENAL
WATERTOWN, MASS.

Rock Island Arsenal Laboratory

REPORT NO. 36-1454

SUBJECT Heat Treatment and Corrosion Reistance of Stainless Steel

AUTHOR M. P. Christensen, E. Met.
J. C. Linnberg, Eng. Aide

DATE May 6, 1936

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ROCK ISLAND ARSENAL LABORATORY REPORT

OF

DATE 8-6-36

AB. NO. 36-1454

Heat Treatment and Corrosion Resistance of Stainless Steel.

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FILING

In this investigation to determine the variation in corrosion resistance of certain stainless steels with change of metallurgical condition, it was found that:

1. Two metallurgical types of stainless steel will satisfy most Ordnance demands. These are the so-called 18-8 and the 13-06 types which are the Chromium-Nickel austenitic steels and the Plain Chromium-Hardenable steels, respectively.

2. These are available in four grades and are here designated by the type numbers of the American Iron and Steel Institute, as follows:

A.I.S.I. Symbol	Type
302	Plain 18-8
303	Free Machining 18-8
403	Plain 13-06
416	Free Machining 13-06

3. Design requirements of strength and ductility will usually dictate the type to be used. Where strength is a minor factor and corrosion resistance predominant, Types 302 and 303 should be used.

4. Where strength is the most important factor, corrosion must be sacrificed and Types 403 and 416 are recommended.

5. To develop optimum properties, both with respect to strength and corrosion, all four grades must be properly heat treated.

ACCEPT

INFORMATION

REJECT

REMARKS

6. Types 302 and 303 are the austenitic 18% Chromium, 8% Nickel Steel and are NOT HARDENABLE but must be FULLY ANNEALED by quenching in a suitable medium from a temperature considerably above the critical temperature if optimum corrosion resistance is expected.

7. Tempering types 302 and 303, at a temperature of 600° F., will materially enhance their corrosion properties. Passivation treatment in dilute nitric acid offers little improvement in corrosion properties over the FULLY ANNEALED condition and because of its cost and inconvenience, should be discontinued.

8. Types 403 and 416 are the straight 13% Chromium, Low Carbon (.06 - .12 Max.) hardenable alloys and should not be used in the annealed state but should be properly hardened by quenching and correctly tempering to insure a maximum of corrosion resistance and aminimum loss of ductility.

9. Only a slight difference is noted in the corrosion properties of Types 302 and 303 but if any difference exists, it favors Type 302. This is also true of Types 403 and 416 with the preference accruing to 403. A tentative specification has been prepared for the procurement of these steels and the details of heat treatment and fabrication are therein set forth. This tentative specification, RIAS 86, is here appended.

10. There has been developed at Rock Island Arsenal, a high film strength mineral base cutting oil which materially aids in the fabrication of these steels, especially in such difficult operations as broaching, shaping and drilling.

RECOMMENDATIONS

1. Where a Proof Stress of less than 40,000 pounds per square inch and greater than 20,000 pounds per square inch is adequate, it is recommended that steel TYPE 303 be adopted, especially where corrosion resistance is of first importance.

2. Where Proof Stress in excess of 40,000 pounds per square inch and as high as 80,000 pounds per square inch, and where good corrosion resistance is desirable, it is recommended that Type 416 be specified.

3. It is recommended that all Ordnance drawings calling for Stainless Steel be so delineated that no doubt can arise as to the type desired, and it is recommended that the Free Machining Grades be adopted (303 and 416).

4. Drawings specifying Type 303 should be titled as follows:

STEEL, STAINLESS, TYPE 303
TUBE (OR FULLY AND ALL D

in the Physical Property box, in the upper right hand corner of such drawings, the following properties should appear:

Proof Stress	35,000#/sq.in. Min.
Tensile Strength	90,000#/sq.in. Min.
Elongation	40% Min.
Reduction of Area	55% Min.

A Heat Treatment box should be provided in the upper left hand corner of such drawings with the following information:

If not purchased fully annealed:

Heat to 1825° F.-1 Hr./Inch of Thickness.
Quench in water.
Temper at 500° F.-1 Hr./Inch of Thickness.

5. Drawings specifying Type 416 should be delineated as follows:

STEEL, STAINLESS, TYPE 416
HEAT TREATED.

In the Physical Property box, in the upper right hand corner of such drawings, the following properties should appear:

Proof Stress	70,000#/sq.in. Min.
Tensile Strength	100,000#/sq.in. Min.
Elongation	20% Min.
Reduction of Area	40% Min.
Brinell Hardness	321 Max.

A Heat Treatment box should be provided in the upper left hand corner of such drawings with the following information:

Purchase annealed. Machine and treat as follows:

Heat to 1800° F. - 1 Hr./Inch of Thickness.
Quench in Oil.
Temper at 600° F. - 1 Hr./Inch of Thickness.

5. It is recommended that the appended tentative specification for Stainless Steels be promulgated for Ordnance use since it has been necessary to procure these steels under Navy Specification 46S16a in order that physical properties might be prescribed. Only one of these steels may be procured under U. S. Army Specification 57-107 B, and the absence of a flexible clause in this specification makes it impossible to prescribe the desired physical properties; therefore, the steel, so purchased, may be checked for chemistry only. The following table indicates the equivalents of the grades under Navy Specification 46S16a, the American Iron and Steel Institute symbols and the designations as shown in U. S. Army Specification 57-107 B:

Grade per Navy 46S16a	A.I.S.I. Symbol	Designation 57-107 B
1	302	None
2	326	None
3	403	None
4	440	None
5	420	61235
6	416	None
7	303	None

The above conversion table is proposed as a guide to Stainless Steels adopted by the Navy Department and in the appended specification, the American Iron and Steel Institute symbols are used since in trade practice these are more widely recognized than any other known designation. <u>These symbols are recommended for adoption by the Ordnance Department.</u> Since so little difference is noted in the corrosion resistance of Type 303 and 302 or 416 and 403, and since the machinability of the former types is so markedly superior, it is recommended that these types be given preference in their consideration as an Ordnance material (303 and 416).

7. It is recommended that no treatment resulting in a Brinell hardness in excess of 321 be attempted in the fabrication of the Hardenable Types 403 or 416, except when grinding is contemplated.

8. It is further recommended that the high film strength cutting oil developed at Rock Island Arsenal be used in the machining of the several types of Stainless Steel here recommended.

[illegible]ction

Pursuant to instructions in the 7th indorsement to Ordnance Office File 400.112/1309 (MIA 400.112/301), steels purchased under Rock Island Arsenal Tentative Specification M[illegible]-41, used in the manufacture of the 75 mm. Pack Howitzer Recoil Mechanisms M1A4, together with other representative Stainless Steels in connection with Ordnance Office File 473.61/788 (MIA 473.612/38), were studied in an effort to determine the most suitable Stainless Steel for general ordnance application. This study consisted of the following problems:

1. The determination of physical properties of commercially available types, before and after suitable heat treatment.

2. The change in corrosion resistance with change of heat treatment.

3. The machineability of the several types under optimum conditions of heat treatment and corrosion resistance.

4. The details necessary for the formulation of an adequate and flexible specification.

5. The development of a cutting compound or oil which would aid in the machining of Stainless Steels.

6. A comparison of the so-called free-machining and non-free machining types from the standpoint of corrosion, strength, machineability and procurement.

METHOD

In order that comparison of the several properties might adequately represent the materials available in the American Market, steels were ordered originally from three different companies. Steels were ordered against chemical specification of the American Iron and Steel Institute, with the specification as to the surface condition and metallurgical state cited in the purchase order.

The three companies circularized were: Crucible Steel Company of America, Carpenter Steel Company and Allegheny Steel Company. Since the value of the several items was relatively small, the trade practice

of charging $5.00 for each Certified Chemical and Physical Test Report made it undesirable to ask for those check analyses by the manufacturer.

In order that the variation of physical properties with change in bar size might be determined, each type of steel was ordered in 1" and 3" rounds. Due to this variety of sizes and types and in spite of the wide plus tolerances in each case, the several manufacturers had some difficulty in furnishing the small quantities desired. One company, the Allegheny Steel Company, failed to make its bid until so late that it was felt that the progress of the investigation would be delayed and, therefore, only two manufacturers are represented in the test results here reported.

Table I shows a copy of the requisitions as placed for this material. Table II shows a condition of the material as actually received.

Once the material had been secured, it was cut into appropriate bar lengths and the heat treatment for the several specimens was accomplished at once, using Brinell Hardness to detect the changes in physical properties until such a time as the several chemical and physical tests could be completed. Table III shows the heat treatment schedule of the several samples compared.

Table IV shows the chemical composition of the several types tested and it will be noted that Specimen 4 - 403 C is not of the type asked for in the purchase order but is the High Carbon or Cutlery Steel type of material designated as ND 51235 in U. S. Army Specification 57-107 B (AISI 420). This is an accidental analysis and the chemical determination was made too late to detect the error and to secure the correct material from the manufacturer. It, however, is an advantage in this report since it gives some comparative information concerning a type of steel which has long been in use in the Ordnance Department, and the conclusions drawn in this report show that straight 13% Chromium-Low Carbon type of material has a decided advantage over this higher Carbon material.

Thus, there are seven items of steel in each of the two lots investigated. When all the specimens had been treated, they were machined into their respective corrosion samples and tensile test bars.

Preparation of Corrosion Specimens.

The following is the procedure for the preparation and testing of the corrosion specimens from Items 1, 3, 4, 6 and 7 which were fabricated from the 1" round material:

Before any machining was undertaken, Brinell, Rockwell and Scleroscope hardness values were determined on all the steels in the as-received condition. Corrosion specimens were then prepared from each type of material, including a separate specimen for the salt spray test and for atmospheric exposure test. All specimens were fabricated according to the instructions in Navy Specification 46S18a.

Specimens were machined on a lathe, tool marks being removed with a mill file and file marks removed with a "00" emery cloth. Final polish with "00" emery cloth was secured while the specimen was turning in the lathe at the rate of 440 revolutions per minute.

The specimens prepared from the as-received material are designated by the letter "A" preceding the type number and followed by the company symbol "K" or "C" for Crucible and Carpenter, respectively. This is clearly shown in Table III.

The second set of specimens prepared were designated by the letter "C" preceding the type number and followed by "C" or "K" and indicates the "C" type of heat treatment shown in Table III.

A third and fourth set were prepared and these are designated by the letter "E" and "H", the meaning of which is set forth in Table III.

Upon completion of the corrosion specimens and after proper identification, they were carefully washed with benzol and ethyl alcohol to remove all grease and oil deposits. One set of thirty-four specimens was then placed on the outdoor exposure rack where it was to be observed at thirty-day intervals for a period of one year in an effort to detect the progression of corrosion under these conditions.

The second set of thirty-four specimens was divided into two groups. The Type 302 and 303 specimens were "passivated" by treatment in 20% nitric acid (20% by wt.) for a period of twenty minutes. They were then washed

with hot water, mounted on a glass plate and placed in the salt spray cabinet where they were carefully observed at frequent intervals to determine the first signs of corrosion. One set of determinations was made without the "passivation" treatment and no difference could be detected in the salt spray performance. This finding is confirmed in Watertown Arsenal Report 316/28.

The 403 and 416 specimens which constituted the second group of the second set of thirty-four were placed in the salt spray cabinet on glass plates without the passivation treatment. The salt solution used at Rock Island Arsenal consists of 20% (by wt.) sodium chloride solution atomized by compressed air. The specimens were carefully examined at four-hour intervals and after each examination, the specimen position in the box was rotated so that any "dead space" might equally effect all of the coupons under test.

The first specimens to fail were of the straight Chromium Types 403 and 416 after about fifteen hours, and fifty hours were required for the first sign of failure in Types 302 and 303.

After salt spray had effected a majority of the samples, they were removed from the cabinet, washed with water to eliminate salt solution and were rated according to physical appearance on a purely qualitative basis. Pit holes were then removed from the specimen, they were repolished as described above and the test was repeated. Salt spray corrosion tests are reported in Tables V for Types 302 and 303, and VI for Types 403 and 416.

Photographs are also appended showing the surface condition of these several salt spray specimens and while they lack the vividness of the visual inspection, they do serve to corroborate the results here reported. The individual specimens shown in the photographs are marked with the symbols of Table III and are grouped so that the 302 and 303 specimens are together for comparison; and the 403 and 416 are shown jointly on the other photographs.

Table VII shows the Brinell, Rockwell and Scleroscope hardness values on the 302 and 303 types. It will be noted that the annealing treatment has, in most cases, lowered the hardness of this material. It will also be noted that specimen A302K has a high value of 277 Brinell. This is direct evidence that this material was cold rolled.

Table VIII shows the hardness values of the straight Chromium 403 and 416 types and the changes due to heat treatment are readily followed from the changes in these hardness values. It will be noted that a peak hardness value of 495 Brinell was obtained in Specimen H403K, and 477 Brinell in the specimen designated E403K. Referring to the chemistry in Table IV, it will be noted that this is not truly a 403 type but is rather a 420 or WD 51235 Cutlery Steel which was furnished by the manufacturer by mistake. This higher hardness is associated with the extra carbon present in the Cutlery Steel.

It will also be noted in Table VI that the 403K specimens all occupy the last positions in the corrosion table. The only one occupying a lower position is the hot rolled, as-rolled A7-416K which is quite to be expected since the hot rolled condition generally favors intergranular corrosion.

A further correlation of the physical properties with corrosion characteristics is obtained by studying Table IX which sets forth the properties obtained from the several heat treatments of the four grades of steel studied.

Table X shows the corrosion properties of four grades of steel at sixty days exposure to the weather. Table XI and its companion recapitulation shows the rating of several 18-8 types of steel together with the metallurgical condition upon which the rating is made.

Table XII and its recapitulation sheet shows the rating of the 416 and 403 types together with their metallurgical condition upon which the rating is made.

DISCUSSION

A study of Table VII, VIII and IX will show the answer to problem 1 of page 5 in the Introduction, relating to the physical properties before and after heat treatment. It is extremely difficult to make a breakdown analysis of these tables but an attempt has been made to set forth in the Recommendations and Conclusions such apparent findings as are available from the study of these several tables.

The answer to problem 2 is found in a study of Tables III, V, VB, VI, VIB, XI and XII. Problem 2 relates to the relation of corrosion resistance to changes in heat treatment. A study of the above tables reveals the several factors involved and a complete study makes possible the

correlation of these facts. Here again, it is very difficult to breakdown an analysis which would yield the most precise information, but an attempt has been made to do this in the Recapitulation sheets attached to Tables V and VI, XI and XII.

The answer to problem 3 is briefly set forth in Table XIII which shows the machineability rating of the several steels under their several heat treated conditions. This phase of the study has not been completed and the information must be taken as tentative only. However, certain general conclusions may be arrived at. First, that the machineability of the 18-8 type of steel is much poorer than that of the 13-06 type. It is further true that the 13-06 type is greatly improved under the conditions of heat treatment that yields a hardness in the range of 320 - 350 Brinell. It is, however, not recommended that these steels be used at ratings higher than 321 Brinell.

The answer to problem 4 is found in the attached tentative specification which sets forth, in detail, the requirements of the several types of steel here recommended. It is believed adequate for most Ordnance applications. The only suggested addition would be the use of Type 52100 as a hard bearing steel. Corrosion resistance will not compare with the better of the stainless steels but the high hardness makes possible those structures where the stainless steel would not have sufficient bearing properties to make a satisfactory unit. The attached specification is intended to supersede RIXS-41 which was prepared before the detail information was available at this Arsenal.

The answer to problem 5, concerning the development of a cutting compound to aid in the machining of stainless steel, will be found in another Rock Island Arsenal laboratory report under preparation. This report sets forth the details of the development of a cutting compound of the high film strength type in which organic addition agents are added in percentages up to ten and then cut back to such proportions which result in oils having adequate film strength for the machining problem under consideration. In the case of the stainless steels, it has been found necessary to add sulphur as well as the organic addition agent. The comparison suggested in problem 6 has been completely handled under the Findings and Recommendations at the beginning of this report.

The most outstanding result of the investigation is the sharp demarcation in corrosion resistance of the straight Chromium steels when the carbon content exceeds .12% maximum. This is illustrated in corrosion specimens E403K, H403K, C403K and A403K. This steel has long been

used in Ordnance applications as a corrosion resistant steel chiefly because of the high hardness obtainable.

A check determination was made on some material of current procurement having an analysis of the A.I.S.I. 420 (WD 51255) in the as-received condition and after heat treatment, and in both cases, the material was considerably poorer in corrosion resistance than any of the specimens studied in this investigation. (See Photograph No. 1)

The next important finding had to do with the 302 and 303 steels in which a study of several tables reveals the marked dropping off of corrosion resistance as the physical properties are increased by such metallurgical treatment as normalizing and hot rolling. This means that if the best properties are to be expected of the 18-8 steels, they must be used in the FULLY ANNEALED condition which implies a drastic quench which will entrap the highly resistant Austenitic structure. Improved properties can be obtained by hot rolling, cold rolling and by appropriate normalizing treatment, but the sacrifice in corrosion resistance for this very slight gain in physical properties certainly does not justify its use in these questionable metallurgical states.

The third important finding is associated with the 403 and 416 steels which can be very definitely improved in their physical properties by suitable heat treatment. It will be noted in Table VIA that salt spray corrosion of Type 403 and 416 show the 403 to be superior to 416. The outdoor or atmospheric exposure shows 416 to be superior to 403. It is also quite obvious that the heat treated condition of both of these steels is far superior to any other metallurgical condition from the corrosion standpoint.

This is the basis for the recommendation that these steels be used in the heat treated condition. Since Type 416 offers much in the way of machineability, it was thought advisable to investigate the physical properties of the several heat treated conditions a little more carefully than the other types here studied.

It will be noted in Table IX that Type 416C or the Carpenter Steel Company composition and 416K, the Crucible Steel Company composition, show a marked improvement in their proof stresses as the temperature of tempering is raised to 950° F. The recommendation for tempering at 600° F. begs the question somewhat, but the temperature of 600° F. was chosen as an arbitration between the brittle characteristics of the low temper and the condition which will cause carbide precipitation at or above 950° F. While

tempering at 950° F., from the data here presented, is obviously the ideal temperature, other composition variations have shown that this is approaching the temperature range in which the carbide precipitation takes place and a loss in corrosion resistance may be expected. In an effort to keep away from this critical temperature range, the recommendation of 600° F. was made as a tempering temperature. These steels may be used untempered.

The finding that the austenitic Types 302 and 303 may be improved in their corrosion resistance by a tempering treatment is something not easily explained and it is believed that it warrants further investigation. Whether this be an isolated finding or whether it is the usual property cannot be known unless further investigation is made.

In preparing the Rock Island Arsenal Tentative Specification attached to this report, the practical aspects of shop treatment and fabrication were taken into consideration as well as metallurgical and corrosion resistance characteristics of the several steels. The specification includes five types commonly used by the Ordnance Department in the past. The specification comprehends them in the several condition which, for one reason or another, would be an advantage in shop fabrication. Thus, where parts are to be machined directly from bar stock and the finished article is to be subjected to no treatment whatsoever, it is recommended that Type 302 or Type 303 be used. These may be procured under the specification, inspected for compliance with respect to the Fully Annealed Condition and then put through the shop procedure with no further concern as to heat treatment.

Where, however, re-forging or hot work is required, it is obviously necessary to re-treat such parts. There is, therefore, included Type 302H, which is a hot-rolled product. Specifications are made rather open so that they are not restrictive and this hot-rolled material may be procured, re-forged and then treated as recommended.

Types 302C and 303C are included in the specification so that where Turret Lathe operations are comprehended, it would be possible to take this more closely controlled material, fabricate the parts at a relatively high rate of speed and then subsequently heat treat them to procure the maximum corrosion resistance. Naturally, the extra dimensional and finish tolerances imply the higher price but this is justified by the saving in the machining operations.

Types 304* and 305* were added to the specification in an effort to secure a material which would have good welding quality. At temperatures of from 800° F. to 1500° F., a change takes place in these steels which makes them less resistant to corrosion. It is now generally accepted that this change is due to precipitation of carbides in the grain boundaries. The magnitude of this change will depend much upon the length of time these steels are held at the above temperature range and upon the composition of the steels themselves. The greatest insurance in the reduction of carbide precipitation is to keep the carbon in the steel as low as possible. This requires a more rigid specification with respect to the carbon and this more rigid specification implies an increased price. It is, therefore, added to the specification as a separate and distinct item and the extra cost is only justified where welding is contemplated and where re-treatment is not possible.

Type 430* and 430F* were added to the Straight Chromium types of steel for the same reason. Since the Straight Chromium types are hardenable when the Carbon exceeds .12% and the Chromium is less than 12.5%, any welding operation will produce a brittle zone, not necessarily in the weld but adjacent to the weld where the metal mass has produced a quenching or chilling effect. Straight Chromium steels are generally less expensive than the Chromium-Nickel type. Where heat treatment after welding of these hardenable type alloys is contemplated, it is unnecessary to use Type 430* or 430F*, but where such heat treatment is not possible and where the lower priced Straight Chromium is desirable, these types have been added and it is recommended that they be used in such applications. Compositions shown in the specification for 430* and 430F* have been so adjusted that these steels are not hardenable and thus, when welded, will not produce any brittle zone and poor corrosion resistance. Type 430* and F* are also ideal materials for deep drawing, fabrication, cupping operations and excessive bends.

It will also be noted that Types 403 and 416 have been added to the specification in the treated condition, that is, Quenched and Tempered, and the physical properties are those recommended in the beginning of this report as properties properly appearing on drawings.

Brinell hardness ranges have been fixed at the top limit so that machinability is possible though difficult and thus, in these hardened alloys, we have a type where fabrication from the bar is possible just as it is in the case of Types 302 and 303. Naturally, the treated

condition implies an increased cost, amounting to about $1.50 per hundred pounds. Generally speaking, the most economical condition in which to purchase the hardenable type is 403S and 416S, the hot rolled condition, and the specification provides a hardness range which will make machinability relatively good.

1936 was the first year that Type 403 (13% Cr.) lost its position of second place in production statistics. Type 302 (18-8) is still the leading stainless but Type 430 (17% Cr.) has superseded Type 403, 430 now occupying second place and 403 third place in the tonnage statistics. Comparing 1939 production with 1936, we find the following: 302 - 31,074 tons vs. 33,114 tons; 403 - 14,552 tons vs. 8,340 tons; 430 - 10,127 tons vs. 11,256 tons. Ease of fabrication and less restrictive specifications are the only apparent reasons for this change.

Type 420 was added to the specification chiefly because it is still specified on a number of Ordnance drawings but procurement of this type of steel during the past year indicates that it is becoming more and more difficult to secure and its stainless properties are highly questionable. The only real merit it offers is high physical properties and high hardnesses but it is believed that SAE 52100 would be a good substitute for this steel. Both have relatively low corrosion resistant properties but somewhat better than ordinary mild steel. The higher hardenability of the Chromium steel SAE 52100 insures more consistent performance in such fabrication as balls, ball races, rollers and roller bearings. Used in connection with Types 403 and 416, SAE 52100 makes an excellent bearing steel.

CONCLUSIONS

1. Free-machining, Austenitic Stainless Steel Type 303 is an ideal steel for the fabrication of most of the internal parts of the recoil mechanism of the 75 mm. Pack Howitzer, M1A4. Of the seventeen parts fabricated from this type of steel, no difficulty was had in the machining operations with the exception of some small tapped holes but the use of a high film strength cutting oil relieved this situation and the fabrication was completed without further difficulty.

2. Type 416 is ideally suited for the fabrication of those parts requiring higher physical properties than are obtainable with Type 303. These parts, the yoke, recoil cylinder, recuperator cylinder and piston rod were

fabricated from the free-machining type of steel and hardnesses in excess of 321 Brinell were fabricated with some slight difficulty in the small holes.

5. Since both types are used in the fabrication of these internal parts, a specification which comprehends them both has been proposed for tentative acceptance.

M. P. Christensen

M. P. Christensen, Asst. Met.

J. C. Linnberg

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Approved
Civilian in Charge of
Laboratory.

Approved
Officer in Charge of
Laboratory.

TABLE I

Form of Requisition
Used to Purchase 18-8
and 13-06 Stainless
Steels Used in Test

Description of Material
Stainless Steel (18-8) A.I.S.I. Type 302 Chemicals to apply: Cold Rolled to 380-410 Brinell Hardness: 1" ± 1/8" diameter 3" ± 1/2" diameter
Stainless Steel (18-8 Mo) A.I.S.I. Type 303 Chemicals to apply: Hot Rolled As Rolled 1" ± 1/8" diameter
Stainless Steel (Hardenable) A.I.S.I. Type 403 Chemicals to apply: Hot Rolled Annealed: 1" ± 1/8" diameter 3" ± 1/2" diameter
Stainless Steel (Hardenable) A.I.S.I. Type 416 Chemicals to apply: Hot Rolled Annealed 1" ± 1/8" diameter Hot Rolled As Rolled 1" ± 1/8" diameter

TABLE II

Condition As Received

Item	A.I.S.I. No.	Size Inches Round	Actual Condition As Received
1	302 (18-8)	1	Cold Rolled As Rolled
2	302 (18-8)	3	Cold Rolled As Rolled
3	303 (18-8)	1	Hot Rolled As Rolled
4[1]	403 (13-06)	1	Hot Rolled Annealed
5	403 (13-06)	3	Hot Rolled Annealed
6	416 (13-06)	1	Hot Rolled Annealed
7[2]	416 (13-06)	1	Hot Rolled As Rolled

1. Item 4, 403X, actually Type A.I.S.I. 420 (.D 51235)

2. Carpenter Steel Company Item 7 is, without doubt, identical with Item 6, although ordered As Rolled (i.e. Normalized).

TABLE III

Heat Treatment of All Corrosion Specimens
Prepared from Carpenter and Crucible Steels

Item No.	Heat Treatment
A 302 C & K	ld Rolled As Rolled (as received)
C 302 C & K	Fully annealed by quenching in H_2O from 1825° F.
E 302 C & K	Fully annealed by quenching in H_2O from 1825° F. Tempered at 500
H 302 C & K	Fully annealed by quenching in H_2O from 1825° F. Tempered at 950
A 303 C & K	Hot Rolled As Rolled (as received)
C 303 C & K	Fully annealed by quenching in H_2O from 1825° F.
E 303 C & K	Fully annealed by quenching in H_2O from 1825° F. Tempered at 500
H 303 C & K	Fully annealed by quenching in H_2O from 1825° F. Tempered at 950
A 403 C & K	Hot Rolled Annealed (as received)
C 403 C & K	Annealed by furnace cooling from 1475° F.
E 403 C & K	Hardened by oil quenching from 1825° F. Tempered at 500.
H 403 C & K	Hardened by oil quenching from 1825° F. Tempered at 950.
A 416 C & K	Hot Rolled Annealed (as received)
C 416 C & K	Annealed by furnace cooling from 1475° F.
E 416 C & K	Hardened by oil quenching from 1825° F. Tempered at 500.
H 416 C & K	Hardened by oil quenching from 1825° F. Tempered at 950.
A 7-41.6 C & K	Hot Rolled As Rolled (as received)

K = Crucible
C = Carpenter

TABLE IV

Chemical Analysis of 18-8 (302 & 303) and 13-06 (403 & 416) Stainless Steels.

Item No.	Symbol	Company		Chromium	Nickel	Carbon	Manganese	Sulphur	Phosphorus	Silicon	Selenium	Molybdenum
1	A302C	Carpenter		17.9	9.58	.10	.45	.01	.014	.45		
	A302K	Crucible		18.1	9.08	.20	.51	.01	.012	.40		
2	A302C	Carpenter		18.3	9.08	.05	.33	.008	.010	.48		
	A302K	Crucible		18.3	8.78	.20	.50	.011	.010	.59		
3	A303C	Carpenter	FM	18.9	8.43	.10	.79	.050	.053	.68	.25	
	A303K	Crucible	FM	17.9	8.68	.13	.48	.030	.050	.65		.85
4	403C	Carpenter		12.4		.07	.46	.008	.010	.40		
	403K	Crucible		13.5		.37	.35	.02	.02	.44		
5	403C	Carpenter		12.2		.11	.44	.010	.015	.30		
	403K	Crucible		12.1		.13	.46	.014	.015	.20		
6	416C	Carpenter	FM	13.8		.18	.44	.250	.014	.38		
	416K	Crucible	FM	14.0		.20	.37	.18	.012	.35		.80
7	416C	Carpenter	FM	13.7		.17	.40	.100	.010	.35		
	416K	Crucible	FM	14.4		.17	.42	.022	.014	.34		.80

FM - Free Machining.

TABLE VA

Tabulation of Results of Three
Salt Spray Tests on
18-8 (Types 302 - 303) Stainless Steels

Specimens Exhibiting Most Resistance
to Corrosion are at Head of Series

Order of Corrosion Resistance	Set #1 66 Hrs. in Salt Spray	Set #2 60 Hrs. in Salt Spray	Set #3 70 Hrs. in Salt Spray	Average Rating	Average Numerical Rating
1	H302K	H302K	H302K	H302K	1
2	E302K	E302K	H303K	E302K	2.3
3	H303K	H303K	E302K	H303K	2.6
4	H302C	E302C	E302C	E302C	5
5	E303K	E303K	C303K	H302C	5.3
6	C303K	H302C	H302C	E303K	5.6
7	E302C	C302C	E303K	C303K	6.6
8	C302C	E303C	C302C	C302C	7.6
9	C302K	C303K	C302K	C302K	9.3
10	E303C	C302K	A302C	E303C	10
11	A202K	A302C	A303K	A302C	11
12	A302C	A303K	E303C	A303K	11.3
13	C303C	H303C	H303C	H303C	13
14	H303C	C303C	A303C	C303C	14
15	A303C	A303C	C303C	A303C	14.6
16	A302K	A302K	A302K	A302K	16

TABLE VB

Salt Spray Corrosion Recapitulated by Types and Companies
According to Metallurgical Condition

Best from Top to Bottom and from Left to Right

First	Second	Third	Fourth
(1) H302K (950° F.)	(2.6) H303K (950° F.)	(5) E302C (500° F.)	(10) E303C (500° F.)
(2.3) E302K (500° F.)	(5.6) E303K (500° F.)	(5.3) H302C (950° F.)	(13) H303C (950° F.)
(9.3) C302K (As Quenched)	(6.6) C303K (As Quenched)	(7.6) C302C (As Quenched)	(14) C303C (As Quenched)
(16) A302K (Cold Rolled)	(11.3) A303K(H.R.As Rec'd)	(11) A302C (Cold Rolled)	(14.6)A303C(H.R.As Rec'd)
Crucible Steel Company	Crucible Steel Company	Carpenter Steel Company	Carpenter Steel Company

Outstanding Anomalies: (a.) Tempered 18-8 steels are superior to as quenched condition in salt spray comparison.

(b.) Differences in behavior of steels of different manufacturers.

TABLE VI A

Tabulation of Results of Three
Salt Spray Tests on
13-06 (Types 403 - 416) Stainless Steels

Specimens Exhibiting Most Resistance
to Corrosion are at Head of Series

Order of Corrosion Resistance	Set #1 16 Hrs. in Salt Spray	Set #2 20 Hrs. in Salt Spray	Set #3 25 Hrs. in Salt Spray	Average Rating	Average Numerical Rating
1	H416C	H416C	H416C	H416C	1
2	E403C	E403C	E403C	E403C	2
3	H403C	H403C	H403C	H403C	3
4	C403C	E416C	E416C	E416C	5.6
5	A403C	C403C	A416K	C403C	5.3
6	A416K	A416C	A403C	A416K	6
7	A416C	A416K	C403C	A403C	6.3
8	H416K	A403C	A416C	A416C	7
9	E416C	H416K	H416K	H416K	8.6
10	C416C	E416K	C416K	E416K	10.3
11	E416K	C416K	E416K	C416K	11
12	C416K	C416C	C416C	C416C	11.3
13	A 7-416C	A 7-416C	A 7-416C	A 7-416C	13
14	E403K	H403K	H403K	H403K	14.3
15	H403K	E403K	E403K	E403K	14.6
16	C403K	C403K	C403K	C403K	16
17	A403K	A403K	A403K	A403K	17
18	A 7-416K	A 7-416K	A 7-416K	A 7-416K	18

TABLE VIB

Salt Spray Corrosion Recapitulated by Types and Companies
According to Metallurgical Condition

Best from Top to Bottom and from Left to Right

First	Second	Third	Fourth
(2) E403C (500°F.)	(1) H416C (950°F.)	(6) A416K (H.R.As Rec'd)	(14.3) H403K (950°F.)
(3) H403C (950°F.)	(5.6) E416C (500°F.)	(8.6) H416K (950°F.)	(14.6) E403K (500°F.)
(5.3) C403C (An.1475°F.)	(7) A416C (H.R.Annealed)	(10.3) E416K (500°F.)	(16) C403K (An.1475°F.)
(6.3) A403C (H.R.As Rec'd)	(11.3) C416C (An.1475°F.)	(11) C416K (An.1475°F.)	(17) A403K (H.R.As Rec'd)
	(13) A 7-416C (H.R.An.)	(18) A7-416K (H.R.As Rolled)	
Carpenter Steel Company	Carpenter Steel Company	Crucible Steel Company	Crucible Steel Company

Outstanding Anomalies: A416K - Very much out of place;
403K Series lowest due to high Carbon content
(AISI 400 - WD 21235)

Hardness Values of 16-6 (Types 302 - 303)
Corrosion specimens used in salt spray tests.

Symbol	Metallurgical condition		Brinell	Rockwell	Sclerescope
A302C	Cold rolled as received		135	81 B	22
A302A	Cold rolled as received		277	28 C	42
C302C	Q.-1825°F.	T.-None	143	83 B	21
C302A	Q.-1825°F.	T.-None	192	92 B	26
E302C	Q.-1825°F.	T.-500° F.	143	84 B	21
E302A	Q.-1825°F.	T.-500° F.	179	91 B	24
H302C	Q.-1825°F.	T.-950° F.	143	81 B	20
H302A	Q.-1825°F.	T.-950° F.	183	92 B	25
A303C	S.H. As received		179	88 B	27
A303A	S.H. As received		174	82 B	26
C303C	Q.-1825°F.	T.-None	170	88 B	23
C303A	Q.-1825°F.	T.-None	156	84 B	22
E303C	Q.-1825°F.	T.-500° F.	156	86 B	24
E303A	Q.-1825°F.	T.-500° F.	153	85 B	23
H303C	Q.-1825°F.	T.-950° F.	159	87 B	24
H303A	Q.-1825°F.	T.-950° F.	156	83 B	27

Q. - Quenched.
T. - Tempered.

Hardness Values of 15-05 (Types 403 - 416)
Corrosion Specimens used in Salt Spray Tests

Symbol	Metallurgical Condition	Brinell	Rockwell	Sclerascope
A403C	Hot Rolled As Received	207	93 B	31
A403K	Hot Rolled As Received	187	86 B	28
C403C	Annealed 1475° F.	153	77 B	20
C403K	Annealed 1475° F.	166	85 B	20
Z403C	Q.-1825°F. T.-500° F.	364	37 C	47
Z403K	Q.-1825°F. T.-500° F.	477	46 C	50
H403C	Q.-1825°F. T.-950° F.	364	38 C	46
H403K	Q.-1825°F. T.-950° F.	495	49 C	52
A416C	Hot Rolled Annealed	174	87 B	25
A416K	Hot Rolled As Received	166	82 B	23
C416C	Annealed 1475° F.	149	79 B	23
C416K	Annealed 1475° F.	156	83 B	22
Z416C	Q.-1825°F. T.-500° F.	321	30 C	40
Z416K	Q.-1825°F. T.-500° F.	321	33 C	38
H416C	Q.-1825°F. T.-950° F.	340	34 C	43
H416K	Q.-1825°F. T.-950° F.	364	36 C	45
A7-416C	Hot Rolled Annealed	179	88 B	25
A7-416K	Hot Rolled As Rolled	302	29 C	44

Q. - Quenched.
T. - Tempered.

TABLE IA

Heat Treatment and Physical Properties of
302, 303, 403 and 416 Type Stainless Steels
Manufactured by Carpenter Steel Company

Item	Symbol	Size Stock	Heat Treatment	
1	A302C	1"	Cold rolled as rolled (as received).	
	S302C	1"	Fully annealed by quenching in H_2O from 1825°F.	Tempered at 600°F.
2	A302C	3"	Cold rolled as rolled (as received).	
	C302C	3"	Fully annealed by quenching in H_2O from 1825°F.	
	S302C	3"	Fully annealed by quenching in H_2O from 1825°F.	Tempered at 600°F.
	H302C	3"	Fully annealed by quenching in H_2O from 1825°F.	Tempered at 950°F.
3	A303C	1"	Hot rolled as rolled (as received).	
	S303C	1"	Fully annealed by quenching in H_2O from 1825°F.	Tempered at 600°F.
4	A403C	1"	Hot rolled annealed (as received).	
5	A403C	3"	Hot rolled annealed (as received).	
6	A416C	1"	Hot rolled annealed (as received).	
7	A7-416C	1"	Hot rolled as rolled (as received) (Probably annealed.).	
	C7-416C	1"	Annealed by cooling in furnace from 1475° F.	
	S7-416C	1"	Quenched in oil from 1825° F. Tempered at 600° F.	
	H7-416C	1"	Quenched in oil from 1825° F. Tempered at 950° F.	

	Yield Point	Tensile Strength	Proof Stress	Elongation	Reduction of Area	Brinell	Rockwell	Scleroscope
	49,000	85,000	23,750	64.2	80.6	163	82 B	22
00°.	42,000	89,000	32,500	69.6	78.9	146	79 B	21
	55,000	93,000	43,750	54.6	67.0	156	81 B	22
	37,000	85,500	27,500	69.4	75.5	137	73 B	19
0°F.	55,000	89,100	27,500	73.0	78.5	146	75 B	24
00°.	45,000	95,000	25,000	70.0	77.5	143	71 B	21
	57,000	104,000	37,500	55.6	58.3	183	89 B	29
00°.	Not sufficient material for determination of the physical properties in this condition.							
	87,000	104,000	70,000	25.2	45.3	207	92 B	32
	84,000	102,100	57,500	23.3	42.4	212	14 C	28
	60,000	96,000	27,500	24.2	62.7	170	84 B	21
	61,000	88,000	27,500	25.0	62.0	179	87 B	24
	46,000	78,000	9,000	32.0	63.5	149	77 B	22
	104,000	124,500	37,500	9.8	27.3	321	30 C	45
	124,000	148,500	95,000	13.6	43.0	332	34 C	46

Table IX (Continued)

Heat Treatment and Physical Properties of
302, 303, 403 and 416 Type Stainless Steels
Manufactured by Crucible Steel Company.

Item	Symbol	Size Stock	Heat Treatment
1	A302A	1"	Cold rolled as rolled (as received).
	C302A	1"	Fully annealed by quenching in H_2O from 1825° F. Tempered at 500° F.
2	A302A	3"	Cold rolled as rolled (as received).
	C302A	3"	Fully annealed by quenching in H_2O from 1825° F.
	D302A	3"	Fully annealed by quenching in H_2O from 1825° F. Tempered at 500° F.
	H302A	3"	Fully annealed by quenching in H_2O from 1825° F. Tempered at 950° F.
3	A303A	1"	Hot rolled as rolled (as received).
	C303A	1"	Fully annealed by quenching in H_2O from 1825° F. Tempered at 500° F.
4	A403A	1"	Hot rolled annealed (as received).
5	A403A	3"	Hot rolled annealed (as received).
6	A416A	1"	Hot rolled annealed (as received).
	A7-416A	1"	Hot rolled as rolled (as received).
	C7-416A	1"	Annealed by cooling in furnace from 1475° F.
	D7-416A	1"	Quenched in oil from 1825° F. Tempered at 500° F.
	H7-416A	1"	Quenched in oil from 1825° F. Tempered at 950° F.

	Yield Point	Tensile Strength	Proof Stress	Elongation	Reduction of Area	Brinell	Rockwell	Scleroscope
	110,400	136,000	67,500	28.5	51.3	269	29 C	42
t 800°F.	47,[illegible]	110,750	16,000	50.0	57.2	187	88 B	29
	66,[illegible]	106,700	52,500	54.6	66.3	202	90 B	32
	65,7[illegible]	107,750	37,500	52.0	56.2	196	89 B	30
t 600°F.	56,[illegible]	107,000	37,500	52.4	56.7	202	88 B	30
t 950°F.	60,[illegible]	106,150	50,000	48.6	48.4	207	89 B	31
	48,[illegible]	99,250	27,500	61.8	66.7	174	85 B	24
t 1000°F.	42,[illegible]	96,750	31,250	63.4	65.4	170	82 B	26
	60,[illegible]	88,700	15,000	26.9	57.2	187	90 B	27
	60,[illegible]	84,400	50,000	29.1	71.8	174	86 B	21
	50,[illegible]	88,650	29,000	28.0	63.0	163	83 B	23
	104,[illegible]	164,600	50,000	96.0	22.4	302	29 C	42
	54,000	82,600	42,500	28.0	60.5	166	83 B	24
	101,[illegible]00	159,100	45,000	10.8	31.1	321	29 C	43
	119,[illegible]00	162,800	85,000	14.2	39.0	332	33 C	48

TABLE X

Rating of 18-8 and 15-06
Outdoor Corrosion Specimens
After 60 Days in Weather

Group I Very Difficult to Grade		Group II Difficult to Grade		Group III Easily Graded	
1	H303K	13	H416K	24	M403K
2	H302C	14	H303C	25	H403K
3	M302C	15	H416C	26	A403C
4	H302K	16	C416K	27	A302K
5	M302K	17	A416K	28	C403C
6	C302C	18	C303C	29	A416C
7	A302C	19	M416K	30c	A7-416C
8	C303K	20	M416C	31	A7-416K
9	C302K	21	H403C	32	C416C
10	M303K	22	M403C	33	A403K
11	M303C	23	A303C	34	C403K
12	A303K				

TABLE XI

Rating of 18-8 Outdoor Corrosion
Specimens After 60 Days in Weather
(Metallurgical Condition from Table III)

Numerical Rating	Symbol	Metallurgical Condition	
1	H303K	[illegible]-1825° F.	T.-950° F.
2	H302C	[illegible]-1825° F.	T.-950° F.
3	M302C	[illegible]-1825° F.	T.-500° F.
4	H302K	[illegible]-1825° F.	T.-950° F.
5	M302K	[illegible]-1825° F.	T.-500° F.
6	C302C	[illegible]-1825° F.	T.-None
7	A302C	Cold Rolled	
8	C303K	[illegible]-1825° F.	T.-None
9	C302K	[illegible]-1825° F.	T.-None
10	M303K	[illegible]-1825° F.	T.-500° F.
11	M303C	[illegible]-1825° F.	T.-500° F.
12	A303K	Hot Rolled As Received	
13	H303C	[illegible]-1825° F.	T.-950° F.
14	C303C	[illegible]-1825° F.	T.-None
15	A303C	Hot Rolled As Received	
16	A302K	Cold Rolled.	

TABLE XI (CO. P'D)

Corrosion Recapitulation By Types and Companies According to Metallurgical Condition

Best from Top to Bottom and from Left to Right

First	Second	Third	Fourth
(2) H302C (950°F.)	(1) H303K (950°F.)	(4) H302K (950°F.)	(11) A303C (500°F.)
(3) H302C (500°F.)	(8) C303K (As Quenched)	(5) H303K (500°F.)	(13) H303C (950°F.)
(6) C302C (As Quenched)	(10) H303K (500°F.)	(9) C302K (As Quenched)	(14) C303C (As Quenched)
(7) A302C (Cold Rolled)	(12) A303K (H.R.As Rec'd)	(16) A302K (Cold Rolled)	(15) A303C (H.R.As Rec'd)
Carpenter Steel Co.	Crucible Steel Co.	Crucible Steel Co.	Carpenter Steel Co.

Outstanding Anomalies: H303K which is best of all tested; A302K poorest of all tested; the inversion in Third Group, and the generally poor resistance of the selenium free-machining type.

TABLE III

Rating of 18-06 Outdoor Corrosion Specimens after 60 Days in Weather. (Metallurgical Condition from Table III)

Numerical Rating	Symbol	Metallurgical Condition
1	H416K	A.-1825° F. T.-950° F.
2	H416C	A.-1825° F. T.-950° F.
3	C416A	Annealed 1475° F.
4	A416A	Hot Rolled As Received.
5	H416A	A.-1825° F. T.-500° F.
6	A416C	A.-1825° F. T.-500° F.
7	H403C	A.-1825° F. T.-950° F.
8	H403C	A.-1825° F. T.-500° F.
9	H403K	A.-1825° F. T.-500° F.
10	H403K	A.-1825° F. T.-950° F.
11	A403C	Hot Rolled As Received.
12	C403C	Annealed 1475° F.
13	A416C	Hot Rolled Annealed.
14	A7-416C	Hot Rolled Annealed.
15	A7-416K	Hot Rolled As Rolled.
16	C416C	Annealed 1475° F.
17	A403K	Hot Rolled As Received.
18	C403K	Annealed 1475° F.

TABLE III
(Continued)

Corrosion Recapitulation By Types and Companies
According to Metallurgical Conditions

Best from Top to Bottom and from Left to Right

First	Second	Third	Fourth
(1) B416K (950° F.)	(7) B403C (950° F.)	(2) B416C (950° F.)	(9) B403K (500° F.)
(5) C416K (Annealed 1475°)	(8) B403C (500° F.)	(6) B416C (500° F.)	(10) B403K (950° F.)
(4) A416K (H.R. As Rec'd)	(11) A403C (H.R. As Rec'd)	(13) A416C (H.R. Annealed)	(17) A403K (H.R. As Rec'd)
(5) B416K (500° F.)	(12) C403C (An. 1475° F.)	(14) A7-416C (H.R. Annealed)	(18) C403K (An. 1475° F.)
(15) A7-416K (H.R. As Rolled)		(16) C416C (An. 1475° F.)	
Crucible Steel Co.	Carpenter Steel Co.	Carpenter Steel Co.	Crucible Steel Co.

Outstanding Anomalies: 403K Series very poor, probably because of high Carbon (Type 420).
416K Series and 416C Series better than Non-Free Machining Types?

Table VIII

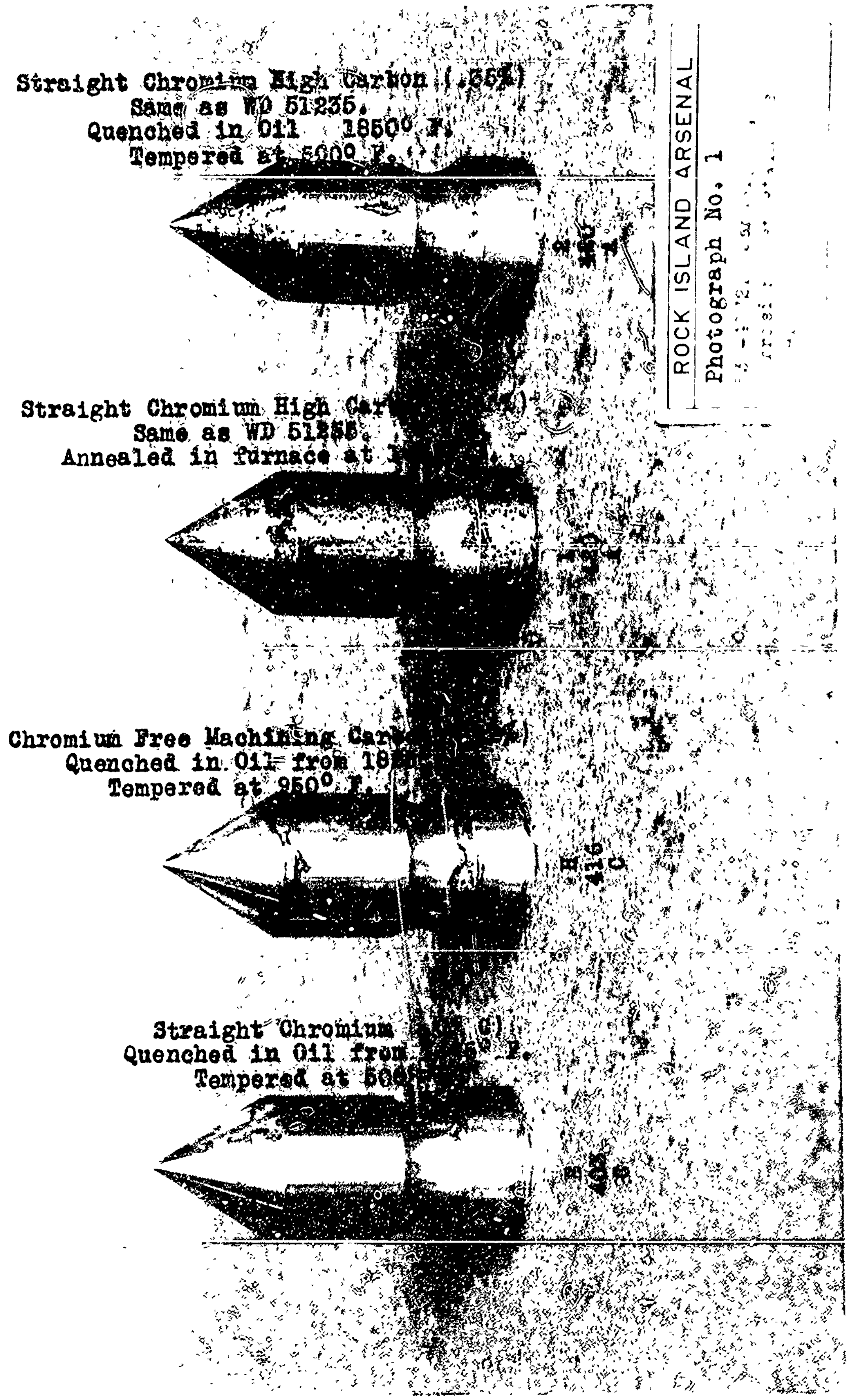
Relative Machinability of 18-8
and 13-06 Stainless Steels.
(For Heat Treatment See Table III.)

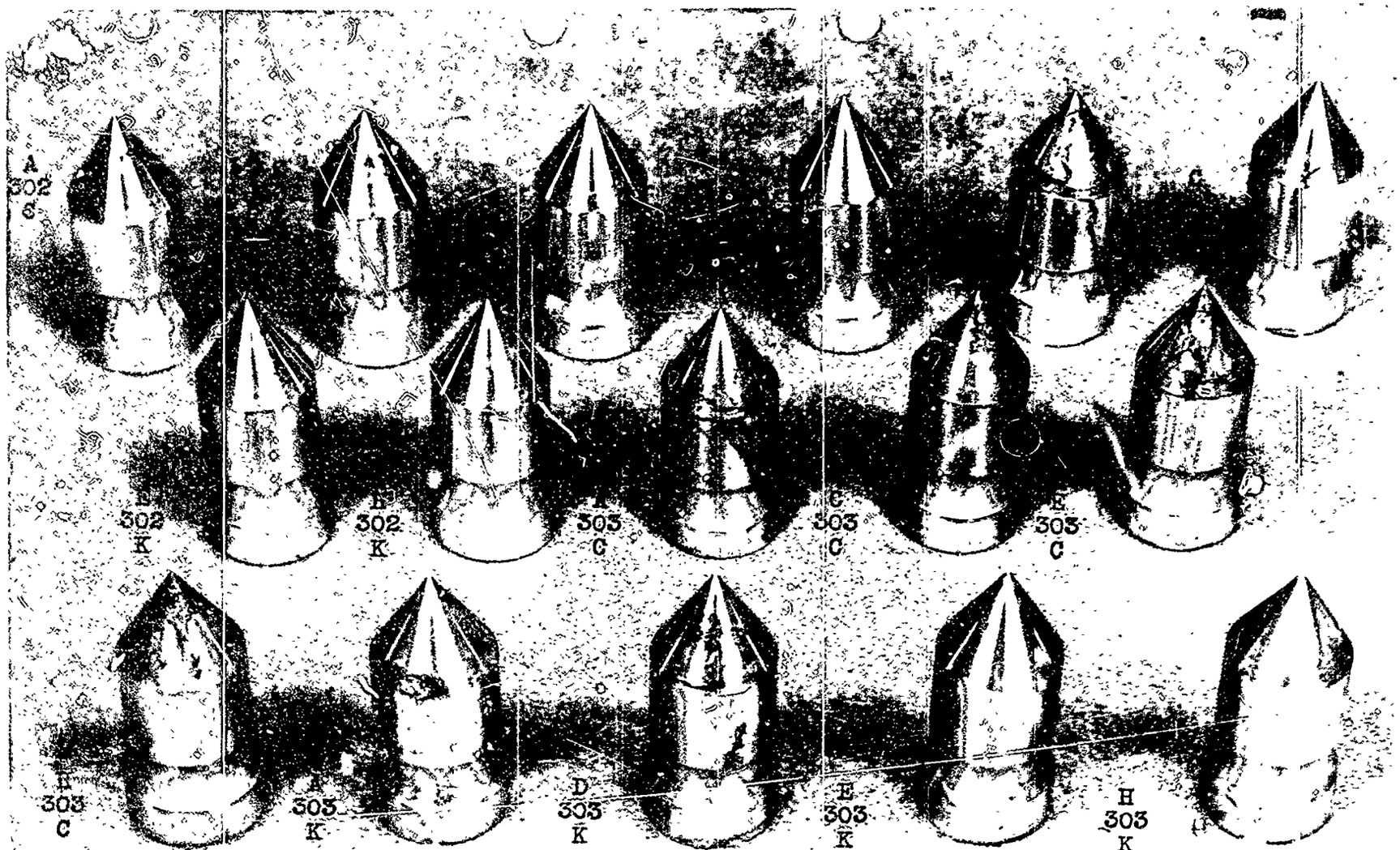
1.	C416 C & K	8.	A403 C & K	15.	H416 C & K
2.	A416 C & K	9.	A302 C & K	16.	H403 C
3.	A 7-416 C & K	10.	H303 C & K	17.	H403 C
4.	A303 C & K	11.	C302 C & K	18.	A403 K[1]
5.	H303 C & K	12.	H302 C & K	19.	H403 K[1]
6.	C303 C & K	13.	H302 C & K		
7.	C403 C & K	14.	H416 C & K		

[1] Almost impossible to machine due to excessive hardness.

No difficulty was encountered in fabricating corrosion and tensile specimens from the 18-8 and 13-06 type stainless steels, except in two cases, these being with the 403K type steel which had been hardened (actually Type 420), received from Crucible Steel Company.

The 18-8 items, as noted in Table VII, are below 200 Brinell hardness in all conditions of heat treatment; while the 13-06 items possess a maximum hardness of 364 (disregarding H403K and A403K). See Table VIII.


Straight Chromium High Carbon (.35%)
Same as WD 51235.
Quenched in Oil 1850° F.
Tempered at 500° F.
Straight Chromium High Car
Same as WD 51235.
Annealed in furnace at
Chromium Free Machining Car
Quenched in Oil from 18
Tempered at 950° F.
416
Straight Chromium
Quenched in Oil from
Tempered at
ROCK ISLAND ARSENAL
Photograph No. 1

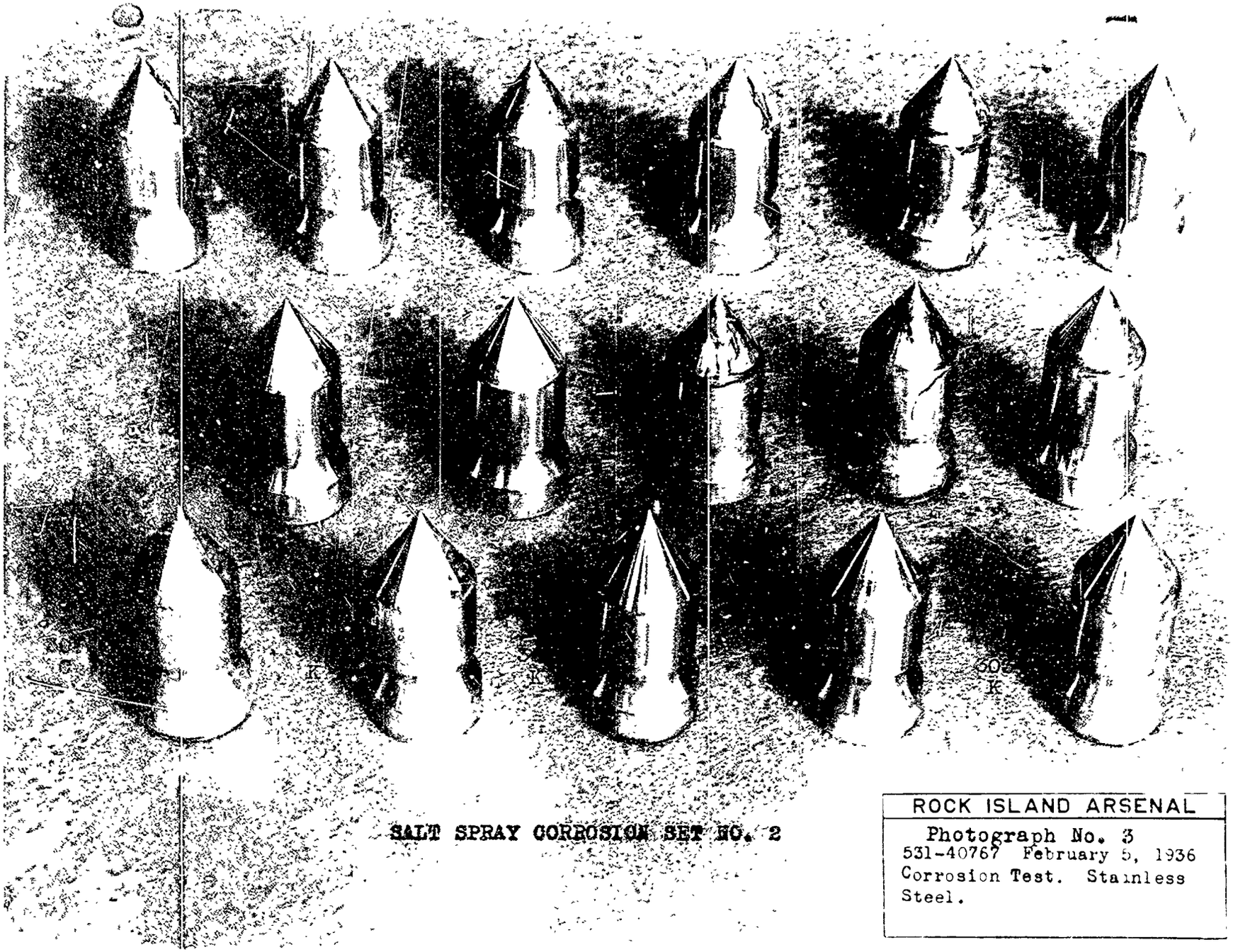


SALT SPRAY CORROSION SET NO. 1

ROCK ISLAND ARSENAL

Photograph No. 2

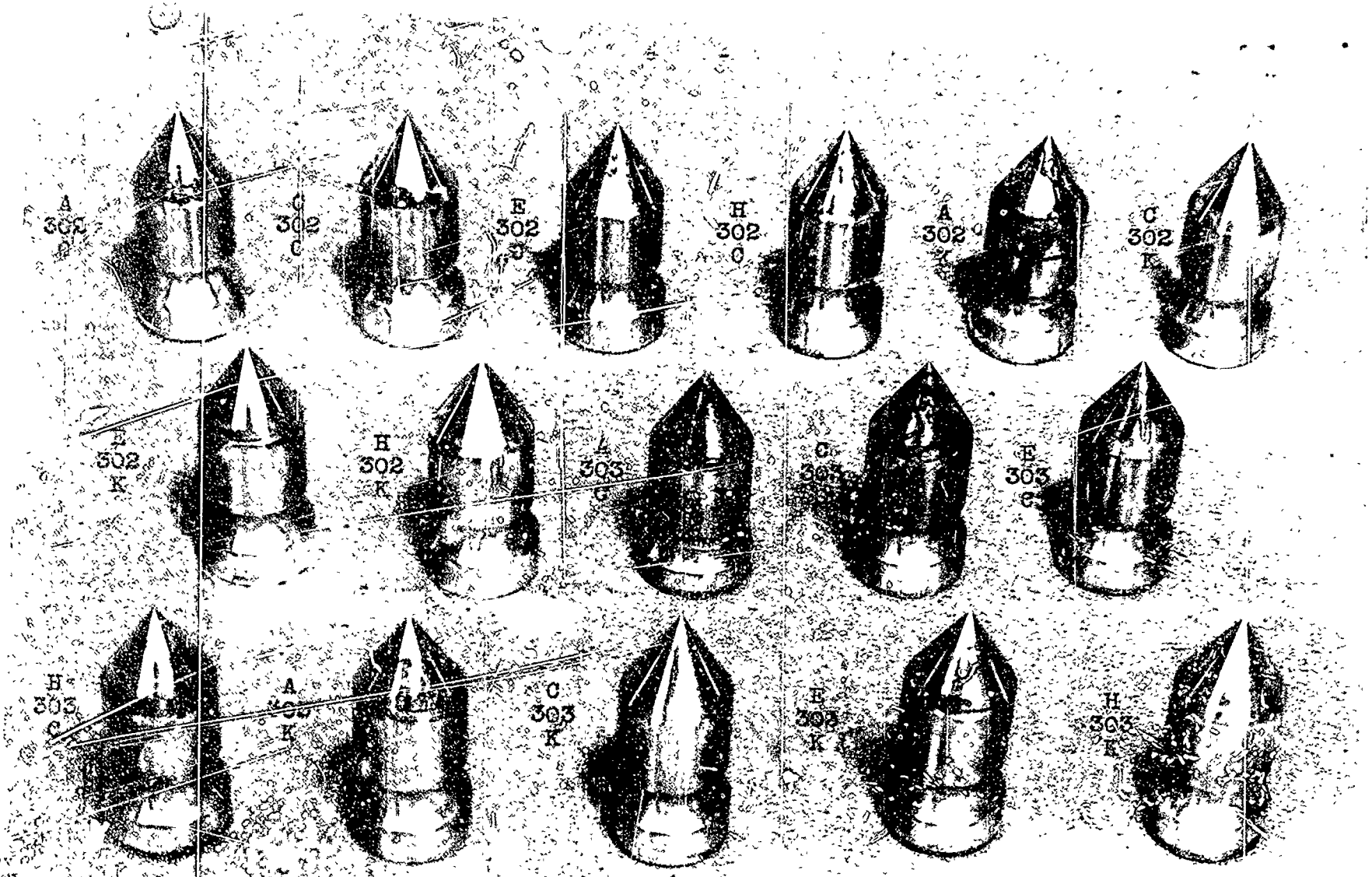
531-4-725 January 21, 1.5c
Corrosion Test. Stainless
Steel.



SALT SPRAY CORROSION SET NO. 2

ROCK ISLAND ARSENAL

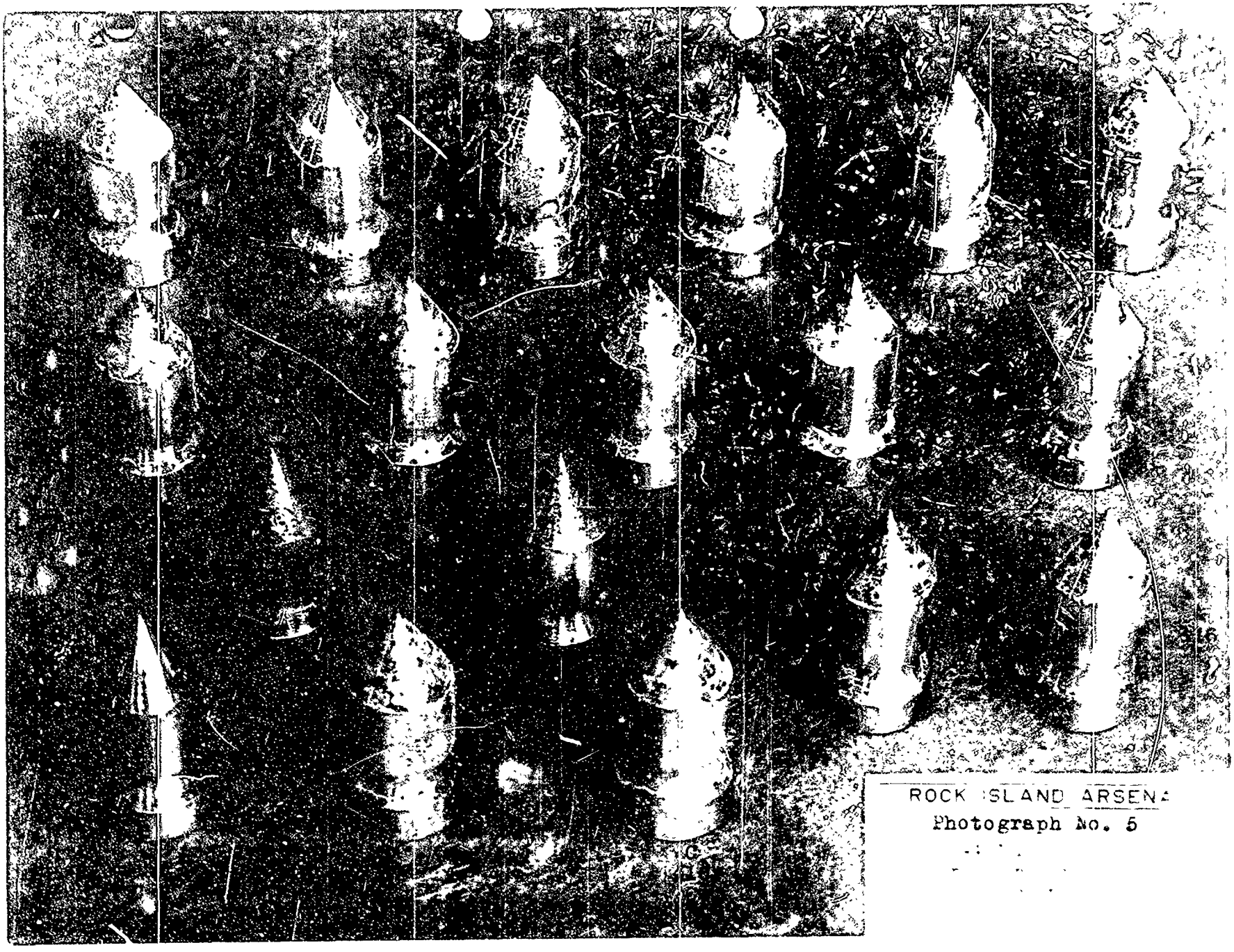
Photograph No. 3
531-40767 February 5, 1936
Corrosion Test. Stainless Steel.



SALT SPRAY CORROSION SET NO. 3

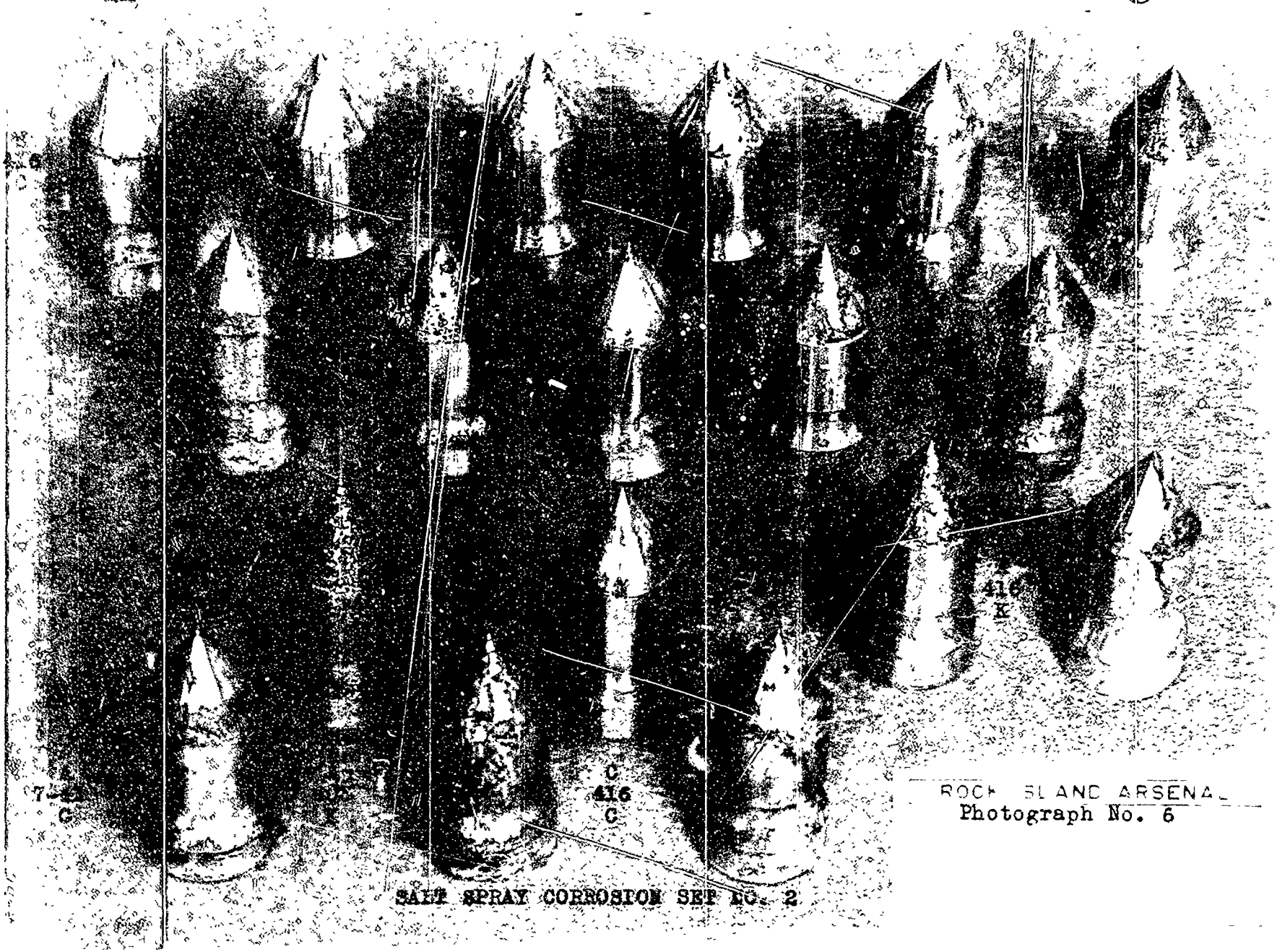
ROCK ISLAND ARSENAL

Photograph No. 4



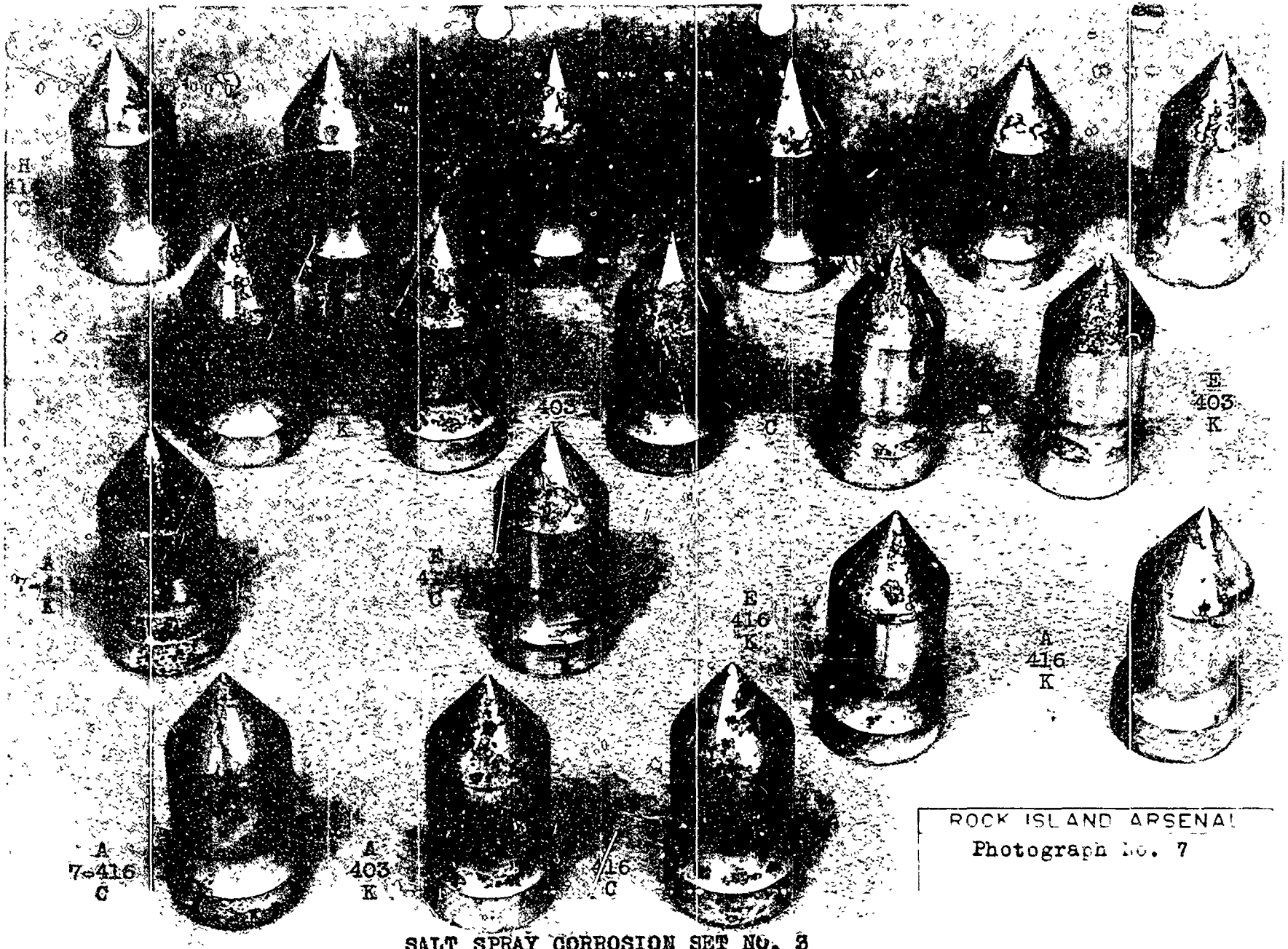
ROCK ISLAND ARSENAL

Photograph No. 5



SALT SPRAY CORROSION SET NO. 2

ROCK ISLAND ARSENAL
Photograph No. 6



ROCK ISLAND ARSENAL
Photograph No. 7

SALT SPRAY CORROSION SET NO. 3

Rock Island Arsenal
Tentative Specification

June 22, 193-

STEEL, STAINLESS*, BILLETS, BARS, RODS, SHEETS, STRIPS, PLATES, TUBES AND FORGINGS.

I. General Specifications.

1. The following specifications in effect on date of invitation of bids form a part of this specification:

Federal	QQ-M-151	Metals, General Specification for Inspection of.
U.S.Army	100-2	Standard Specification for Marking Shipments.

II. Grades, Types, Classes, Etc.

1. Stainless Steel under this specification shall be of the Classes Types, Grades and Conditions set forth in Table I and shall be designated in the contract or purchase order according to their respective Type and Symbol numbers as detailed in Table I. Briefly, they are:

Class	Type[1]	Grade
Chromium-Nickel	302	Not Hardenable.
" "	304	Not Hardenable, Welding Quality.
" "	303	Not Hardenable, Free Machining Quality.
" "	303W	Not Hardenable, Free Machining-Welding Quality.
Chromium (plain)	403	Hardenable.
" "	430W	Not Hardenable, Welding Quality.
" "	416	Hardenable, Free Machining.
" "	430FW	Not Hardenable, Free Machining-Welding Quality.
" "	420	Hardenable.
Special	Special	Special

[1] See Table I for detail Type and Symbol Numbers.

*The term "Stainless" implies nothing beyond the corrosion resistant requirements of this specification.

TABLE I

TYPES, GRADES, CLASSES, ETC.

Class	Type and Symbol	Grades and Metallurgical Characteristics	Description Cr.	Ni.	C.	Condition
Chromium Nickel	302	Not Hardenable -	18	8	.20 Max.	Fully Annealed (Quenched).
	302H	Good Corrosion Re-	18	8	.20 "	Hot Rolled.
	302C	sistance When Fully	18	8	.20 "	Cold Finished.
	304W	Annealed.	18	8	.08 "	Welding Quality Fully Annealed (...
	303	Free Machining. Not	18	8	.20 "	Fully Annealed (Quenched).
	303H	Hardenable. Good cor-	18	8	.20 "	Hot Rolled.
	303C	rosion Resistance	18	8	.20 "	Cold Finished.
	303W	When Fully Annealed.	18	8	.08 "	Welding Quality Fully Annealed (Qu...
Straight Chromium	403H	Hardenable. Good	13	-	.12 "	Hot Rolled, Normalized.
	403C	Corrosion Resistance	13	-	.12 "	Cold Finished.
	403T	When Heat Treated.	13	-	.12 "	Heat Treated (Quenched and Temper...
	430W		17	-	.12 "	Welding Quality.
	416H	Free Machining. Hard-	13	-	.12 "	Hot Rolled.
	416C	enable. Good Corrosion	13	-	.12 "	Cold Finished.
	416T	Resistance When Heat	13	-	.12 "	Heat Treated (Quenched and Temper...
	430FW	Treated.	17	-	.12 "	Welding Quality.
	420H	High Hardenability.	13	-	.35 Min.	Hot Rolled.
	420C	Poor Corrosion Re-	13	-	.35 "	Cold Finished.
	420T	sistance Even When Heat Treated.	13	-	.35 "	Heat Treated (Quenched and Temper...
*	Special As Designated.	Special	To be Cited in Contract or Purchase Order.			As Specified.

For list of Symbols and General Properties of other Stainless compositions, see ... Paragraph VII...2 or consult Manufacturers Representative.

ion

abrication (Except Welding) from Bar, Rod, Sheet, Plate or Tube.
orging or other Hot Work Requiring Re-Treatment.
ial Finish or Dimensional Tolerances.
ed Construction Where Re-Treatment is not possible.

abrication (Except Welding) Where Machinability is Paramount.
orging or other Hot Work Requiring Re-Treatment.
ial Finish or Dimensional Tolerances.
ed Construction Where Re-Treatment is not possible.

abrication, Re-Forging or other Hot Work, to be followed by a Hardening Heat
ial Finish or Dimensional Tolerances. (Treatment.
Fabrication Where Machinability can be sacrificed for Dimensional precision.
ded for Welded Construction and Deep Drawing Operations.

abrication, Re-forging or other Hot Work, to be followed by a Hardening Heat
cial Finish or Dimensional Tolerances. (Treatment.
abrication Where Machinability can be sacrificed for Dimensional precision.
ded for Welded Construction and Deep Drawing Operations.

abrication, Re-Forging or other Hot Work, to be followed by a Hardening Heat
ial Finish or Dimensional Tolerances. (Treatment.
abrication by Grinding.

dnance Application not Covered by Types above

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2. This specification comprehends the following fabric... forms of stainless steel:

Form 1 - Billets.	Form 5 - Strips.
Form 2 - Bars.	Form 6 - Plates.
Form 3 - Rods.	Form 7 - Tubes.
Form 4 - Sheets.	Form 8 - Forgings.

III. Material and Workmanship.

1.(a) The ingots from which the material is made in satisfaction of this specification shall be produced by the electric furnace or crucible process.

(b) Sufficient discard shall be taken from each ingot to insure freedom from injurious piping and undue segregation.

2.(a) Material furnished under this specification shall be free from seams, laminations, blisters, excessive and detachable scale or any other injurious defect.

(b) All sheets, plates, strips (except coils) shall be flat, straight and have a smooth, dull finish, unless otherwise specified in the contract or purchase order.

(c) Material ordered pickled shall be wholly free from scale.

(d) Cold finished material shall have a smooth, bright finish.

IV. General Requirements.

1. Billets, rods, bars and forgings shall be reduced from ingots by hot rolling, pressing or hammering. Surface defects shall be removed by chipping, grinding or other approved methods before final rolling or forging.

2. The material shall contain no welds.

3. BIDDERS ARE REQUIRED TO STATE THE BRAND NAME AND CHEMICAL COMPOSITION OFFERED AT THE TIME OF MAKING PROPOSALS.

4. Certified chemical analyses and physical test reports will not be required unless so specified in the contract or purchase order.

5. Billets are defined as sections 4" x 4" or of equivalent area.

6. Bars are defined as sections less than 4" x 4" or less than that equivalent area.

7. The uniform classification of sheets, plates and strips is shown in Table II.

TABLE II

Uniform Classification of Sheets, Plates and Strips

Product	3-1/2" or Less	Wider Than 3½", Less Than 6"	Wider Than 6", Less Than 24"	24" to 48"	Wider Than 48"
Plates	None	None	0.250 Thick and up.	0.250 Thick and up.	0.1875 Thick and up.
Sheets Hot Rolled	None	None	None	0.059 Thick to 0.250	0.059 Thick to 0.1875
Sheets Hot Rolled Annealed	Less Than 0.250 Thick	Less Than 0.034 Thick	Less Than 0.059 Thick	Less Than 0.059 Thick	Less Than 0.059 Thick
Sheets Cold Rolled	12" to 24" wide Less than 0.028 Thick			All Thicknesses	
Strips Cold Rolled	Less Than 12" Wide All Thicknesses		12" to 24" 0.029 Thick and up.	None	None
Strips Hot Rolled	0.025 to 0.250	0.035 to 0.250	0.059 to 0.250	None	None

NOTE:- Material 6" and narrower, and 0.250 thick and thicker shall be ordered as bar stock.

V. Detail Requirements.

1. Chemical Composition and Physical Properties.

(a) Unless otherwise specified in the contract or purchase order, material furnished under this specification shall conform to chemical analyses and physical properties set forth in Table III.

TABLE III

CHEMICAL ANALYSES AND PHYSICAL PROPERTIES
BARS, RODS, PLATES, BILLETS AND FORGINGS
(UNLESS OTHERWISE SPECIFIED IN CONTRACT OR PURCHASE ORDER.)

Type and Symbol	% Carbon	% Manganese	% Phosphorus	% Sulphur	% Silicon	% Nickel	% Chromium	% Copper	
302	.20 Max.	.50 Max.	.03 Max.	.03 Max.	.50 Max.	7.0 Min.	17.0 Min.	.50 Max.	.1
302H	.20 "	.50 "	.03 "	.03 "	.50 "	7.0 "	17.0 "	.50 "	.1
302C	.20 "	.50 "	.03 "	.03 "	.50 "	7.0 "	17.0 "	.50 "	.1
304	.08 "	.50 "	.03 "	.03 "	.50 "	7.0 "	17.0 "	.50 "	.1
303	.20 "	.70 "	.15 "	.1	.50 "	.50 "	7.0 "	17.0 "	.50 "
303H	.20 "	.70 "	.15 "	.1	.50 "	.50 "	7.0 "	17.0 "	.50 "
303C	.20 "	.70 "	.15 "	.1	.50 "	.50 "	7.0 "	17.0 "	.50 "
303E	.08 "	.70 "	.15 "	.1	.50 "	.50 "	7.0 "	17.0 "	.50 "
403H	.12 "	.60 "	.03 "	.03 "	.40 "	.50 Max.	13.0 Max.	.50 "	.1
403C	.12 "	.60 "	.03 "	.03 "	.40 "	.50 "	13.0 "	.50 "	.1
403T	.12 "	.60 "	.03 "	.03 "	.40 "	.50 "	13.0 "	.50 "	.1
430F	.12 "	.60 "	.05 "	.03 "	.50 "	.50 "	16.0 Min.	.50 "	.1
416	.12 "	.60 "	.15 "	.50 "	.50 "	.50 "	13.0 Max.	.50 "	Not
416H	.12 "	.60 "	.15 "	.50 "	.50 "	.50 "	13.0 "	.50 "	
416C	.12 "	.60 "	.15 "	.50 "	.50 "	.50 "	13.0 "	.50 "	
416T	.12 "	.60 "	.15 "	.50 "	.50 "	.50 "	13.0 "	.50 "	
430FA	.12 "	.60 "	.03 "	.40 "	.50 "	.50 "	16.0 Min.	.50 "	
420H	.35 Min.	.60 "	.03 "	.03 "	.50 "	.50 "	13.0 Max.	.50 "	.1
420C	.35 "	.60 "	.03 "	.03 "	.50 "	.50 "	13.0 "	.50 "	.1
420T	.35 "	.60 "	.03 "	.03 "	.50 "	.50 "	13.0 "	.50 "	.1
Special	As cited in Contract or Purchase Order.								

Note 1. When Phosphorus exceeds .04%, Sulphur shall not exceed .06%.
" 2. Bidder to state percentage and element or elements offered for non-seizing and free-machining properties.
" 3. Sheets and Strips only - 180° flat back over one thickness without cracking.

% Copper	% Others		Proof Stress P.S.i.	Yield Strength P.S.i.	Ultimate Strength P.S.i.	% Elongation	% Reduction of Area	Max Brl
.60 Max.	.10 Max	All Sizes	30,000 Max.	40,000 Min.	90,000 Min.	40 Min.	55 Min.	18
.60 "	.10 "	" "	25,000 Min.	-	-	-	-	26
.60 "	.10 "	" "	25,000 Min.	-	-	-	-	32
.60 "	.10 "	" "	30,000 Max.	-	80,000 Min.	35 Min.	50 Min.	18
.60 "	Note 2	" "	40,000 Max.	40,000 Min.	90,000 Min.	45 Min.	50 Min.	18
.60 "	" "	" "	25,000 Min.	-	-	-	-	26
.60 "	" "	" "	25,000 Min.	-	-	-	-	32
.60 "	" "	" "	30,000 Max.	-	80,000 Min.	45 Min.	50 Min.	18
.60 "	.10 Max.	" "	To be capable of heat treatment to Brinell 387 Min., 269 Max., As					
.60 "	.10 "	" "	To be capable of heat treatment to Brinell 387 Min., 321 Max., As					
.60 "	.10 "	" "	70,000 Min.	90,000 Min.	120,000 Min.	15 Min.	55 Min.	36
.60 "	.10 "	" "	Shall not be capable of hardening to more than Brinell 248 Max.					
.60 "	Note 2	" "	To be capable of heat treatment to Brinell 387 Min., 269 Max., As					
.60 "	" "	" "	To be capable of heat treatment to Brinell 387 Min., 269 Max., As					
.60 "	" "	" "	To be capable of heat treatment to Brinell 387 Min., 269 Max., As					
.60 "	" "	" "	70,000 Min.	90,000 Min.	120,000 Min.	15 Min.	55 Min.	36
.60 "	" "	" "	Shall not be capable of hardening to more than Brinell 248.					
.60 "	.10 Max.	" "	To be capable of heat treatment to Rockwell "C" Hardness 50 Min.					
.60 "	.10 "	" "	To be capable of heat treatment to Rockwell "C" Hardness 50 Min.					
.60 "	.10 "	" "	Not Specified	200,000 Min.	250,000 Min.	10 Min.	25 Min.	4
		"	As specified in Contract or Purchase Order.					

sing and

acking.

2

e th	% Elongation	% Reduction of Area	Hardness Brinell	Cold Bend
Min.	40 Min.	55 Min.	180 Max.	Note 3
	-	-	269 Max.	" 3
	-	-	321 Max.	" 3
Min.	35 Min.	50 Min.	180 Max.	" 3
Min.	45 Min.	50 Min.	180 Max.	" 3
	-	-	269 Max.	" 3
	-	-	321 Max.	" 3
Min.	45 Min.	50 Min.	180 Max.	" 3

to Brinell 387 Min., 269 Max., As Received.
to Brinell 387 Min., 321 Max., As Received.
Min. 15 Min. 55 Min. 387 Max. As Rec'd.
g to more than Brinell 248 Max.

to Brinell 387 Min., 269 Max., As Received.
to Brinell 387 Min., 269 Max., As Received.
to Brinell 387 Min., 269 Max., As Received.
Min. 15 Min. 55 Min. 387 Max. As Rec'd.
ng to more than Brinell 248.

to Rockwell "C" Hardness 50 Min. Brin. 269 Max. As Rec'd.
to Rockwell "C" Hardness 50 Min. Brin. 269 Max. As Rec'd.
Min. 10 Min. 25 Min. 444 Min. As Rec'd.

onnage Order.

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(b) Be it noted that in Table III a Special Class type and Grade is provided so that procuring agencies may secure any stainless steel not comprehended under Table III of this specification

(c) Any detail requirement not included in this specification and deemed necessary for the procurement of satisfactory stainless material shall be incorporated in the contract or purchase order.

2. Permissible Variations. Unless otherwise specified in the contract or purchase order, all material purchased under this specification shall conform to the standard permissible variations for size, weight, check analyses, gauge, thickness, flatness, camber and straightness as recognized by American Steel Manufacturers' Standard Practice and as set forth in the Association of American Steel Manufacturers' publications and the American Iron and Steel Institute publications.

VI. Methods of Inspection and Test.

1. Chemical Analyses.

(a) Chemical analyses may be made at the option of the Government inspector by him or through him at any Government Laboratory or other designated representative, and without cost to the contractor.

(b) The number of tests and the selection of samples shall be left to the discretion of the Government inspector, and shall follow the details set forth in Federal Specification QQ-M-151.

2. Physical Properties. The Government inspector shall satisfy himself that the material furnished by the contractor complies with the requirements of Table III of this specification by performing such tests as he deems necessary to insure compliance.

3. Bend Test. Bend tests on sheets, strips and plates shall be performed at the option of the Government inspector.

4. Yield Strength. The yield strength shall be determined as the stress in pounds per square inch calculated for the load at which an elongation of 0.005 per inch of gauge length occurs. This elongation may be determined by the "dividers method" or by the extensometer method.

5. Proof Stress. Proof stress shall be determined by applying a stress of 5,000 pounds per square inch less than the required minimum proof stress and noting the permanent elongation, if any, after the release of stress. Additional stresses shall be applied in increments of 2,500 pounds per square inch until a permanent elongation of 0"0001 per inch of gauge length has been exceeded. The last load reading taken prior to the point where a permanent elongation of 0"0001 per inch of gauge length is exceeded shall be recorded as the proof load, and from this the proof stress shall be calculated Proof Stress is defined as that stress in pounds per square inch or original cross-section which a material is capable of withstanding without resulting in a permanent elongation of more than 0"0001 per inch of gauge length after complete release of stress Proof stress shall be determined by using an extensometer capable of a direct reading of 0"0001.

6. Brinell and Rockwell Tests. The inspector shall make sufficient Brinell and Rockwell hardness tests to determine if the material furnished by the contractor complies with the requirements of Table III of this specification.

7. Corrosion Tests. Material furnished under this specification shall meet the requirements of corrosion resistance set forth in Table IV of this specification. At his option, the Government inspector may perform such corrosion tests to determine if the contractor complied with this detail requirement of the specification.

8. Permeability Tests. Unless otherwise specified in the contract or purchase order, magnetic permeability will not be determined.

9. Rejection. Material not meeting the requirements of this specification or those of the contract or purchase order shall be rejected and the contractor notified. Material which shows injurious defects while being fabricated shall be rejected and the contractor notified. The contractor is permitted fifteen days from the time of notification to make such check determinations as are necessary and he shall be required to replace the material within thirty days after first notification unless an agreement to the contrary is made between the contractor and the procuring agency.

VII. Packing and Marking.

1. Identification. All material furnished under this specification shall be identified by the manufacturer's melt or heat number and each billet, bar, rod, sheet, strip, plate,

TABLE IV

CORROSION RESISTANCE REQUIREMENTS

Type	Type Specimen*	Corrosion Requirement
302	1	24 Hours continuous exposure to salt spray (No. 1) without rusting
302H	-	No requirement.
302C	-	No requirement.
304W	1	24 Hours continuous exposure to salt spray (No. 1) without rusting
303	1	20 Hours continuous exposure to salt spray (No. 1) without rusting
303H	-	No requirement.
303C	-	No requirement.
303W	1	20 Hours continuous exposure to salt spray (No. 1) without rusting.
403H	-	No requirement.
403C	-	No requirement.
403T	1	14 Hours continuous exposure to salt spray (No. 1) without rusting.
430W	1	14 Hours continuous exposure to salt spray (No. 1) without rusting
416H	-	No requirement.
416C	-	No requirement.
416T	1	10 Hours continuous exposure to salt spray (No. 1) without rusting.
430FW	1	10 Hours continuous exposure to salt spray (No. 1) without rusting.
420H	-	No requirement.
420C	-	No requirement.
420T	1	5 Hours continuous exposure to salt spray (No. 1) without rusting.
Special	1	As designated in the Contract or Purchase Order.

*The corrosion specimen shall be that designated as Type 1 and the details of fabrication and its dimensions are shown in Plate I, attached.

Salt Spray (No. 1) shall consist of a thoroughly atomized water solution of sodium chloride containing 20% of the salt (NaCl) by weight, the atomized vapor to be maintained at or near room temperature during the exposure test for the number of hours prescribed above. The spray shall circulate freely in a tank so designed that there shall be no direct impingement of the spray on the specimens and the condensed vapor shall not recirculate through the aspirators.

bars or forging shall be legibly stamped with the Type Number designated in the contract or purchase order and as shown in the corresponding type under Table II.

2. The invoice, packing slip or manifest of shipment shall indicate the Type or Symbol, the manufacturer's Brand Name, the contract or purchase order number, the heat number, the specification number, the form and weight of the material furnished.

3. Material shall be packed for shipment in accordance with commercial practice for acceptance by common or other carrier for safe transportation at lowest cost to place of delivery.

4. All other details of packing and marking shall be as prescribed in the requirements of U. S. Army Specification 100-2.

VIII. Notes.

1. Composition Type 302 in the fully annealed condition is recommended for direct fabrication of parts where high corrosion resistance is desirable. Type 302 H is recommended where re-forging or other hot work is contemplated and should always be followed by a treatment to secure maximum corrosion resistance. This treatment consists in quenching the material from a temperature of 1800° F. to 2000° F. in water. This treatment may be followed by a tempering heat of 600° F. Type 302 C is a cold finished material and is provided where special dimensional and finish tolerances are desirable and is recommended for turret lathe operations but should be followed by the annealing heat treatment as prescribed under 302 H. Type 304W is a composition having a low carbon content which makes it suitable for welded construction and is specially recommended where re-heat treatment is not possible after welding. Type 303, the free machining variant of Type 302, is recommended where difficult machining is contemplated and where a slight sacrifice of corrosion resistance is possible. 303 H and 303 C are similar to Type 302 H and 302 C and should be treated in the same manner. They are, however, free machining types and their corrosion resistance is slightly inferior to their 302 analogies.

2. Other types and symbols and their metallurgical and chemical characteristics are shown in Table V. This table is intended as a guide to procure material of a composition other than those set forth in the body of this specification.

TABLE 7

Chemical Compositions of Types and Symbols
Other Than Those Detailed in This Specification

Type No.	Carbon	Chromium	Nickel	Silicon	Copper	Molybdenum	Manganese	Tungsten	Others
301	.12-.20	15-17	5-7						
301X	.10-.20	16-18	7-8.50						
302B	.08-.20	17-19	7-9.50	2-3					
*302	.08-.20	17-19	7-9.50						
*303	.08-.20	17-19	7-9.50			.15 Min.			Sul hur and/or Se-
*304	.11 Max.	17-19	7-9.50						(nium - .15)
305	.08-.20	18-20	8-10						
306	.11 Max.	18-20	8-10						
307	.08-.20	19-22	9-12						
308	.11 Max.	19-22	9-12						
309	.20 Max.	22-26	11-13						
310	.25 Max.	24-26	19-21						
311	.25 Max.	19-21	24-26						
312	.25 Max.	27-31	8-10						
315	.15 Max.	17-19	7-9.50		1-1.50	1-1.50			
316	.10 Max.	16-19	14 Max.			2-4			
320	.20 Max.	17-19	7-9.5						Ti. Equals 4 x ( )
321	.20 Max.	18-20	8-10						Ti. Equals 4 x ( )
325	.25 Max.	7-10	19-23		1-1.50				
327	.25 Max.	25-30	3-5						
329	.10 Max.	25-30	3-5			1-1.50			
330	.25 Max.	14-16	33-36						
340		9-11					9-11		
341		24-26					3-5		
342		10-12	17-19						
343	1.0 Max.	12	20					3	
344		2-4	21-23						
345	.15 Max.	17-19	8-12						Cb. (8 to 1 x ( )
346	.15 Max.	18-20	8-12						Cb (8 to 10 x ( )

*Steels Cited in Specification.

TABLE V
(Continued)

Type No.	Carbon	Chromium	Nickel	Silicon	Copper	Molyb-denum	Manga-nese	Tungsten	Others
347	.15 Max.	17-19	8-12						Cb. & Ta. Over 10 x Carbon
348	.15 Max.	18-20	8-12						Cb. & Ta. Over 10 x Carbon
401	.08-.20	9-12		.50-3.5					
*403	.12 Max.	11.5-13							
405	.08 Max.	11.5-13.5							Aluminum .10-.20
406	.12 Max.	12-14							Aluminum 4-4.50
410	.12 Max.	12-14							
411A	.12 Max.	12-14		1	1				
412	.08-.20	12-15		.50-3.5					
414	.12 Max.	12-15	.50-2.5						
414F	.12 Max.	12-15	.50-2.5 Plus Sulphur, Selenium or Molybdenum.						
*416	.12 Max.	11-13	Plus Sulphur, Selenium or Molybdenum.						
418	.12 Max.	12-15						2.5-3.5	
*420	.12 Min.	12-15							
421	.12-.18	12-15	.50-2.5						
425	.12 Max.	14-16							
426	.12 Max.	14-16		1	1				
*430	.12 Max.	16-18							
*430F	.12 Max.	16-18	Plus Sulphur, Selenium or Molybdenum.						
431	.12 Max.	16-18	.50-2.5						
431F	.12 Max.	16-18	.50-2.5 Plus Sulphur, Selenium or Molybdenum.						
432	.12 Max.	16-18		.50 Max.	.50 Min.				
434A	.12 Max.	16-18		1	1				
435	.12 Max.	16-18		1	1				
436	.08-.20	16-18		.50-3.50					
438	.12 Max.	16-18						2.5-3.5	
439	.50-.65	8						8	
440	.12 Min.	15-18							
441	.12 Min.	15-18	.50-2.5						
442	.35 Max.	18-23							
444	.08-.20	18-23		.50-3.50					
446	.35 Max.	23-30							
501A	.25-.31								
501B	.20-.16								
501C	.15-.11								
501D	.10 Max.								

3. Type 403 H, T and C are the hardenable straight chromium types of stainless steel. Their corrosion resistance is slightly inferior to that of the 302 and 303 types but the improved physical properties makes them highly desirable for certain fabrication. Because of their hardenable tendencies, they are not recommended for welded construction. For this purpose Type 430FW has been added. Its composition limits are so adjusted that this material will not harden upon welding and hence not lose its corrosion resistant properties. Type 403 H and C should always be followed by a heat treatment if optimum corrosion resistance is to be expected.

4. Type 416H, T and C are the Free Machining Straight Chromium steels of the hardenable type and are analogous to 403 types and should be treated in the same manner. Their corrosion resistance is slightly inferior to 403 types but the improved machineability, due to the addition of certain chemical elements makes them desirable where high strengths are necessary. Since the 416 series is hardenable, they are not recommended for welded construction. For this purpose, Type 430FW has been added and its composition limits are so adjusted that it may be welded with a minimum loss in corrosion resistance.

5. Type 420H, C and T are high Carbon stainless steels of the Cutlery Type, having a high degree of hardenability but relatively poor corrosion resistance and they are recommended only where high hardness is necessary. Steel of the Type SAE 52100 is a good substitute for this stainless steel, having a higher hardenability and better physical properties. Its corrosion resistance is only slightly poorer and neither steel can be called truly "stainless".

6. SPECIAL STAINLESS designated in this specification is included so that procuring agencies, not able to secure material meeting their requirements from the other five types herein set forth, may use this special designation as a flexible clause to permit procurement of such material under this specification. It is suggested that the type numbers set forth in Table V be used in connection with this Special Stainless designation.

Notice: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise

as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

NOTE: Copies of this specification may be obtained from the Office of the Chief of Ordnance, Washington, D. C.

Appendix I

CORROSION SPECIMEN TYPE 1

1. Form and Dimensions

The form and dimensions of Corrosion Specimen Type 1 shall conform to the details shown in Figure 1:

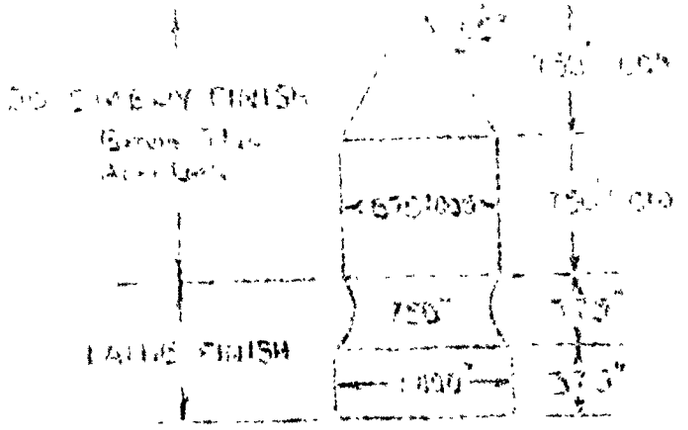

Figure 1

2. Preparation for Test

(a) Rough machine to within 1/64" of dimensions shown in Figure 1.
(b) Finish machine without cutting compound or lubricant.
(c) Remove tool marks with a worn 12" smooth flat mill file.
(d) Remove file marks with new, iron-free, dry, No. 00 emery cloth, while specimen rotates at a speed of about 400 RPM.
(e) Wash with benzol.
(f) Wash with water-free methyl or ethyl alcohols.
(g) Dry in air blast.

3. Performance of Test

(a) Introduce specimen into salt spray tank on glass plate so tilted that no condensed vapor will accumulate at base of specimen.
(b) Adjust continuous spray.
(c) Observe specimen at intervals of 5 hours until the prescribed time has elapsed, noting hours to failure if failure occurs.
(d) If failure occurs, re-machine the specimen, removing not less than 0.010 from the exposed surfaces and repeat Preparation for Test (2) above.
(e) Re-expose the specimen as directed in 3(a), (b) and (c).
(f) Failure upon re-exposure shall be cause for rejection.

PLATE I
(Continued)

4. Report of Corrosion Test
(a) If material is found to be satisfactory under "3" above, it shall be reported as follows:

Passed _____ Hour Salt Spray Exposure.

(b) If material fails under "3" above, it shall be reported as follows:

Failed Salt Spray Exposure After _____ Hours.