CASTABILITY OF DENTAL CASTING GOLD ALLOY

A Procedure for evaluation of castability developed under order number DSA-120-76-F-BG36 for the Defense Personnel Support Center.

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Certain commercial materials and instruments are identified in this report to adequately specify the experimental procedure. In no instance does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that the material or instrument identified is necessarily the best available for this purpose.

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INTRODUCTION

This report describes a procedure developed for measuring the castability of dental casting gold alloys and presents a proposed castability requirement and test method. The report is made up of three parts. Part I, which consists of the preliminary report prepared in May 1977, describes the procedure for measuring castability and gives results obtained on four "specification type" alloys, three of which were suggested by the Defense Personnel Support Center, and on two alloys of lower noble metal content. Part II contains data on additional alloys including a fourth alloy suggested by the Defense Personnel Support Center and several alloys for porcelain-fused-to-metal applications. Also included in Part II are data on the effects that variations in procedures and casting conditions have on castability and a discussion of the proposed castability requirement and test method. Part III consists of the proposed castability requirement and test method in specification form.

CASTABILITY OF DENTAL CASTING GOLD ALLOY

Part I

The development of a method for evaluating the castability of dental casting gold alloys was undertaken to provide a test procedure which will distinguish between alloys that have routinely produced satisfactory castings in military dental facilities and alloys which have proven to be unsatisfactory in castability. Characteristics to be incorporated in the test procedure were:

1. The procedure should be primarily a measurement of the capability of the alloy to fill the mold.
2. The test should use equipment and facilities generally available to the dental gold industry.
3. The test procedure should simulate dental prosthetic laboratory procedure.
4. The pattern and mold employed should be easily reproducible in different laboratories.
5. The method for evaluating the finished casting should be objective and preferably uncomplicated.

Various procedures have been used for measuring the castability of alloys. For example, Asgar (1) has described a method using a spiral shaped wax pattern. Sorensen and Ingersoll (2) used a stainless steel mold in the shape of a six spoked wheel with thin web sections between the spokes to measure fluidity of casting gold alloys. A recent publication by Vincent, Stevens and Basford (3) describes a method of measuring casting ability using a pattern with a range of rod diameters.

Method and Materials

After experimenting with several different specimen designs, a pattern made from polyester sieve cloth was selected for use in development of the castability test, Figure 1. This material has several advantages (1) the pattern comprising a rectangular piece of the sieve cloth, a wax runner bar, and a wax sprue can be prepared with little difficulty, (2) the sieve cloth can be burned out with the usual procedure for wax patterns, (3) the sieve cloth is manufactured to comply with opening dimension requirements of ASTM E11-70 and is therefore uniform in size, (4) since the sieve cloth is available in a range of sizes, the test specimen can be easily varied to accomodate different types of alloys if necessary, (5) the mesh pattern provides a simple objective method for determining a castability value.

The procedure for assigning a numerical value for "castability" to the cast specimen is very simple. The combination of pattern size and mesh size used, Figure 1, provides a pattern with 100 open squares and 210 segments where a segment is defined as the part of a sieve filament perpendicular to and connecting two adjacent parallel sieve filaments. Evaluation of the cast specimen can be made by direct examination, but particularly where a large number of castings are to be evaluated, it has been found more convenient to prepare a photomicrograph of the specimen, make a xerox copy of the photomicrograph and make the evaluation on the xerox copy. If necessary the photomicrograph or the specimen can be examined to determine the completeness of any segment which cannot be seen clearly in the copy.

A sample evaluation is shown in Figure 2. The number of segments in the casting is counted, divided by 210 and multiplied by 100 to obtain the percentage of complete segments. This percentage is designated as the castability value.

As an alternative the number of complete squares could be counted to obtain a castability number. In general the value obtained by counting squares is slightly below the value based on segments. Although there is little choice between the two procedures, the segment count was selected since it is more sensitive to small differences than is the squares count. (Loss of one segment always reduces the segment evaluation by approximately 0.5, but loss of one segment may reduce the squares count by 0, 1 or 2 depending on location of the segment.)

For the series of tests covered in Part I of this report six alloys including two with low precious metal content were used. The alloys were cast by two techniques, "hygroscopic expansion" and "thermal expansion". The alloys, other materials, and conditions employed are listed in Tables 1 and 2. The choice of casting conditions, which is somewhat arbitrary, was designed to determine the relative castibility when all of the alloys are subjected to the same treatment. An acceptable alternative would be to adjust the casting temperature to each alloy, for example, to some set temperature interval above the liquidus or to the temperature recommended by the manufacturer.

Results

Table 3 gives castability values for the six alloys cast by the two techniques. The values, based on the percentage of complete segments, are averages of five castings for each combination of alloy and technique. Figures 3a through 3f show typical castings (that is, a casting with a castability value near the average) for each of the alloys when made by the thermal expansion technique. Figures 4a through 4e show a typical range of variations for five duplicate specimens; in this example, for five specimens of alloy H made by the hygroscopic technique.

Discussion

The results indicate that there are differences in castability among the six alloys tested and between the hygroscopic (H) and thermal expansion (B) techniques. In the thermal expansion series, alloys A and C have average values much larger than does alloy P, Table 3 and Figures 3a, b, f. In the hygroscopic series, the differences between the average castability number for alloy A and the averages for the other alloys are large, Table 3. The standard deviations of some "duplicate" specimens (for example specimens B-B, M-B, P-B and C-H) indicate that the differences between averages must be large to be significant. The causes of these wide variations are not yet known. Although attempts were made to control factors such as mold preparation, burnout temperature and time, casting temperature and casting machine speed, it may be that more precise control or the casting of a greater number of "duplicate" specimens will be required to reduce the uncertainty of the results.

One of the problems with tests for castability including the method described in this report is that small variations in the casting equipment or procedures may cause significant variations in the results obtained. Because of this, the test procedure may be more reliable as a comparative rather than an absolute or independent measurement procedure. This would mean that evaluation of an unknown alloy could best be accomplished by comparing results for the unknown with results for a known satisfactory alloy cast at the same time under the same conditions rather than comparing the unknown to a specific castability number.

Additional studies of the effect of variables such as casting temperature and further statistical evaluation of the significance of the variations in results are needed. This work is in progress.

One of the major difficulties in evaluating the testing procedure has been the unavailability of any samples of gold alloys which have been found to give unsatisfactory castability performance in use. Until data on such alloys are available there will be uncertainty as to the level at which limits for castability should be set.

Summary

A method for objective evaluation of the castability of dental alloys has been developed. The method employs easily reproducible specimen patterns and uses procedures and equipment generally used in dental prosthetic laboratories. Results obtained so far indicate that it may be necessary to reduce the variability to make the proposed test suitable for specifications purposes. Another problem is the impossibility of correlating the test procedure with practical usage until samples of alloys which have been found unsatisfactory in use are available.

References

1. Asgar, Kamal, Metal Castings in Dentistry, in Wachtel, L. W., editor, Symposium: Dental Biomaterials - Research Priorities, 1973. DHEW Publication No. (NIH) 74-548, pp 27-44.

2. Sorensen, S. E. and Ingersoll C. E. A Method for Determining Fluidity of Casting Gold Alloys, Abstract No. 191, IADR Program and Abstracts of Papers, 44th General Meeting, March 1966.

3. Vincent, P. F., Stevens, L. and Basford, K. E. A Comparison of the Casting of Precious and Non-Precious Alloys for Porcelain Veneering. J. Pros. Dent. 37(5):527-36, May 1977.

Table 1. Alloys (Part I)

Alloy	Code	Manufacturer
Ney-Oro B-2	B	J. M. Ney Company
Harmony Line, Hard	H	Williams Gold Refining Company, Inc.
"C" Bridge	C	J. Aderer, Inc.
A6	A	Howmedica, Inc.
Midas	M	Jelenko, Penwalt Corp.
Paliney C-B	P	J. M. Ney Company

Table 2. Casting Materials, Equipment and Conditions

Pattern

Test Portion:	1 mm opening (No. 18)* polyester sieve cloth, 10 x 10 squares, dipped in Kerr Debubblizer
Runner bar:	6 gage 1/2 round, 2 pieces
Sprue:	6 gage round, 6mm length

Mold

Investment:	Beauty Cast, Whip-Mix Corp., W/P ratio 15/50, vacuum mix, 20 sec.
Ring:	Whip-Mix, 32 x 48 mm
Asbestos:	1 layer, wet
Setting and Burnout Conditions:	Hygroscopic expansion (Code H) 30 min in water bath, burnout next day, 1 hr to 482°C (900°F), 1 hr at 482°C
	Thermal expansion (Code B) bench-set, burnout next day, 1 hr to 649°C (1200°F), 1 hr at 649°C

Casting

Weight of alloy:	9 g (6 d wt)
Machine:	Howmedica Electromet, induction melting
Temperature:	1079°C (1975°F) read on graphite crucible
Speed:	400 rpm

*The nominal wire diameter listed in ASTM E11-70 for 1.00 sieve cloth is 0.580 mm. The measured diameter of the filaments in the sieve cloth used was 0.496 ± 0.007 mm.

Table 3. Castability of Dental Alloys

Specimen Code	Alloy	Technique	Castability (%) Average	S.D.
A-B	Howmedica A-6	Thermal	100.0	0.0
C-B	Aderer "C"	Thermal	91.7	5.5
H-B	Harmony, Hard	Thermal	69.3	6.6
B-B	Ney-Oro B-2	Thermal	67.1	21.2
M-B	Midas	Thermal	62.8	16.4
P-B	Paliney C-B	Thermal	29.2	17.8
A-H	Howmedica A6	Hygroscopic	95.0	1.6
C-H	Aderer "C"	Hygroscopic	59.1	22.4
H-H	Harmony, Hard	Hygroscopic	48.9	9.7
P-H	Paliney C-B	Hygroscopic	43.1	13.3
M-H	Midas	Hygroscopic	42.9	9.1
B-H	Ney-Oro B-2	Hygroscopic	40.7	5.6

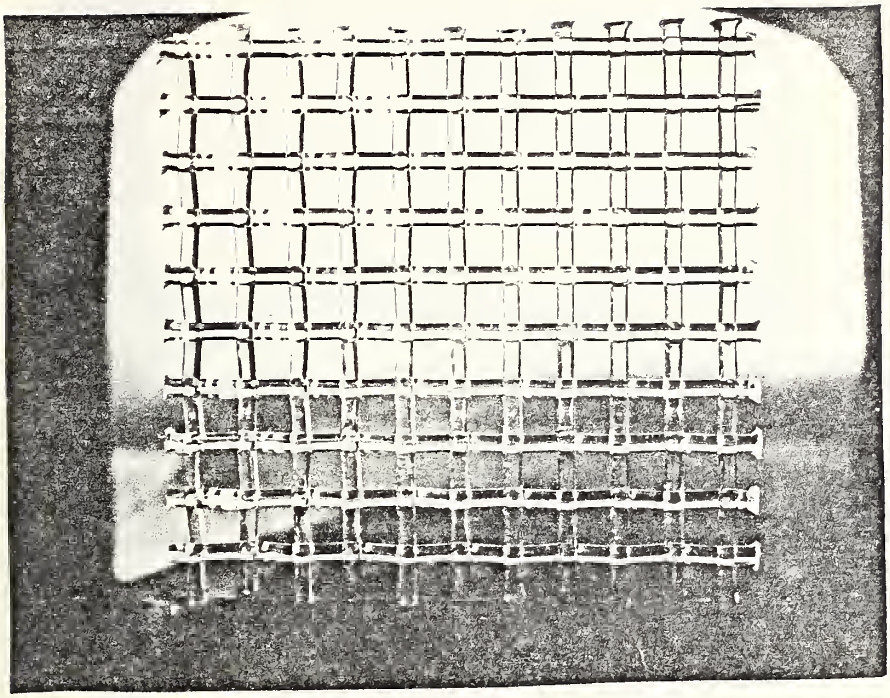
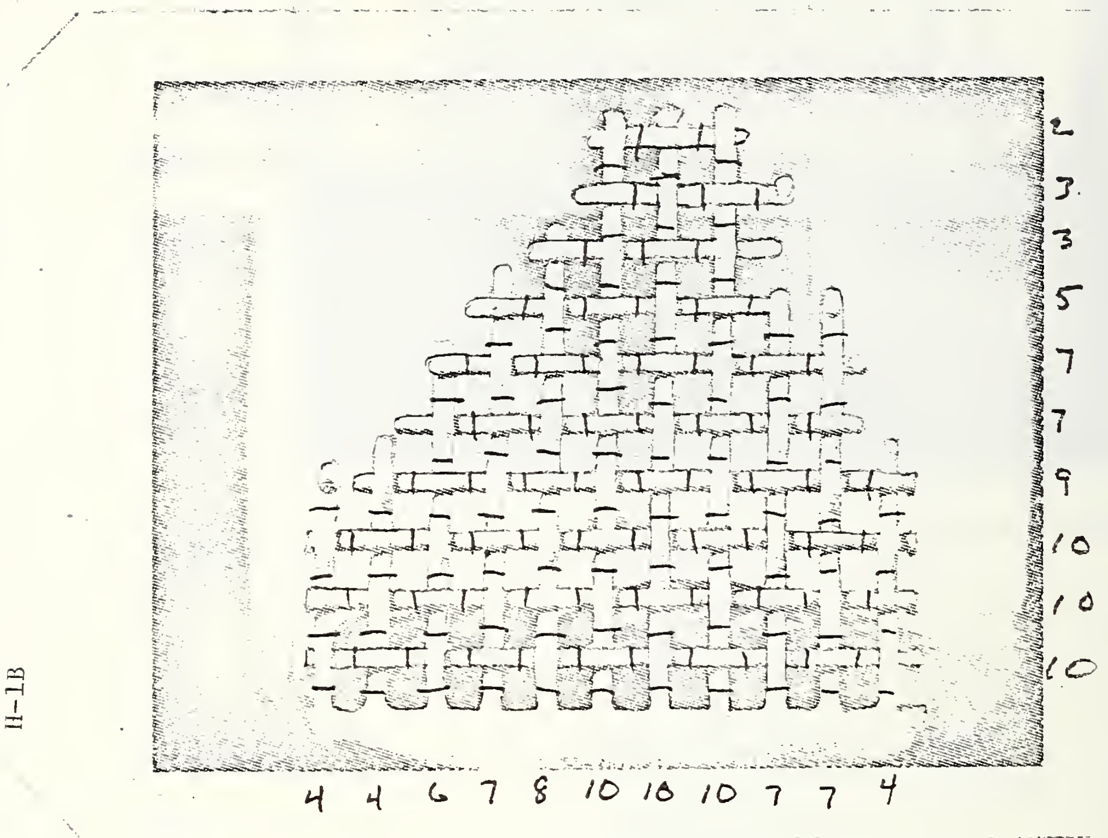


Figure 1. Pattern made of polyester sieve cloth. Magnification 5X.



Segments:

Vertical	77
Horizontal	66
Total	143

Castability:

$$\frac{143 \times 100}{210} = 68.1$$

Figure 2. Example of castability evaluation work sheet. (See fig. 3c for photograph of casting.)

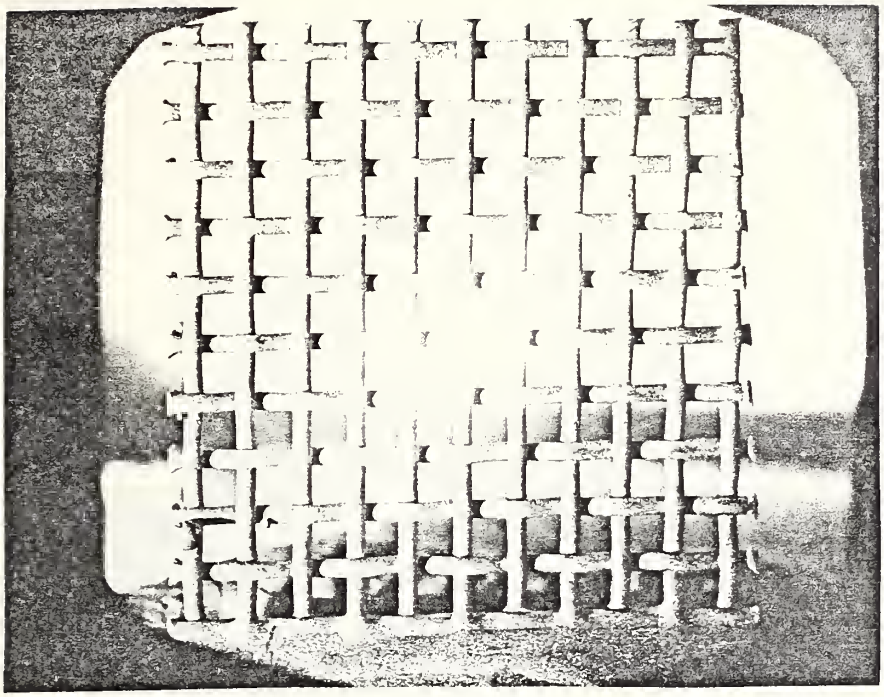


Figure 3a. Typical specimen of Howmedica A6 thermal expansion series
Average castability 100.0; Spec. A1B 100.0

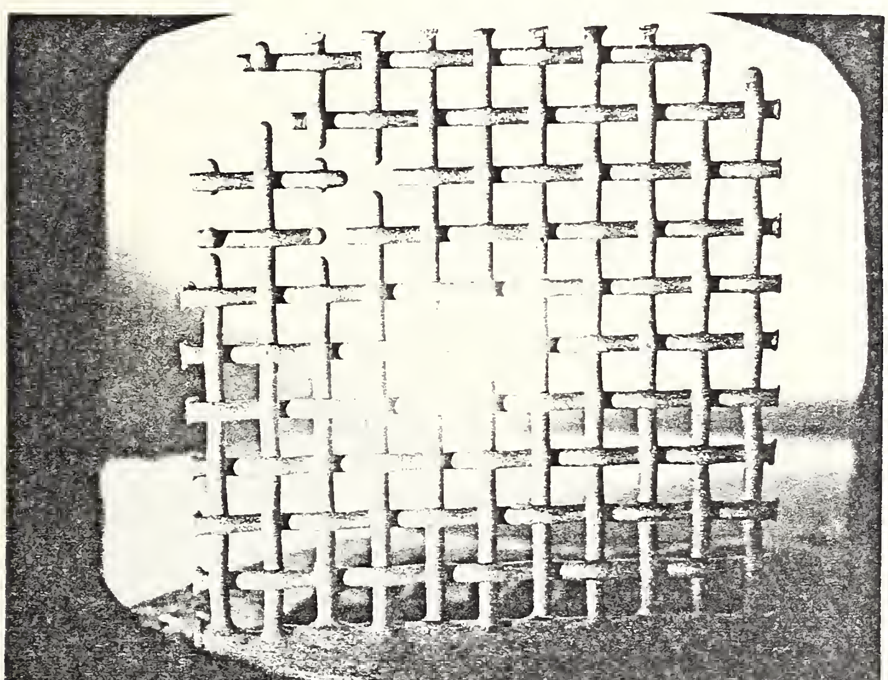


Figure 3b. Typical specimen of Aderer "C" thermal expansion series.
Average castability 91.7; Spec. C4B 91.4.

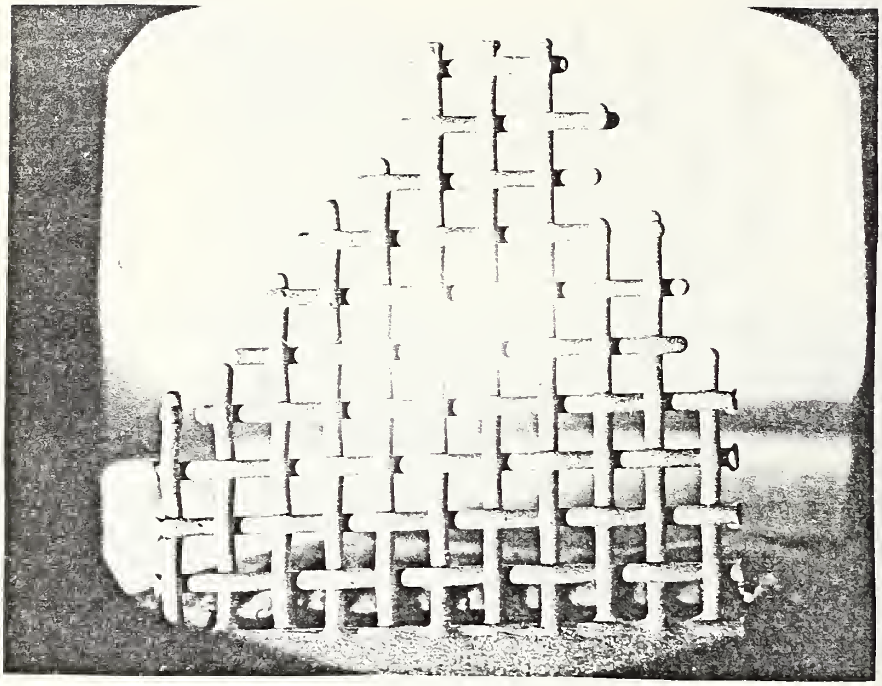


Figure 3c. Typical specimen of Harmony thermal expansion series. Average castability 69.3; Spec. H1B 68.1.

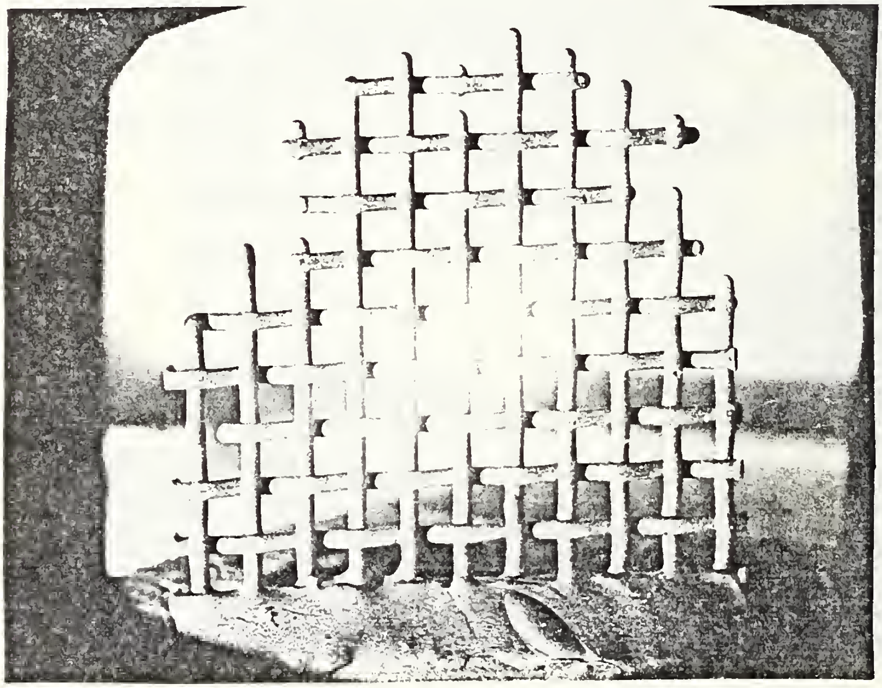


Figure 3d. Typical specimen of Ney-ORA B-2 thermal expansion series. Average castability 67.1; Spec. B1B 73.3.

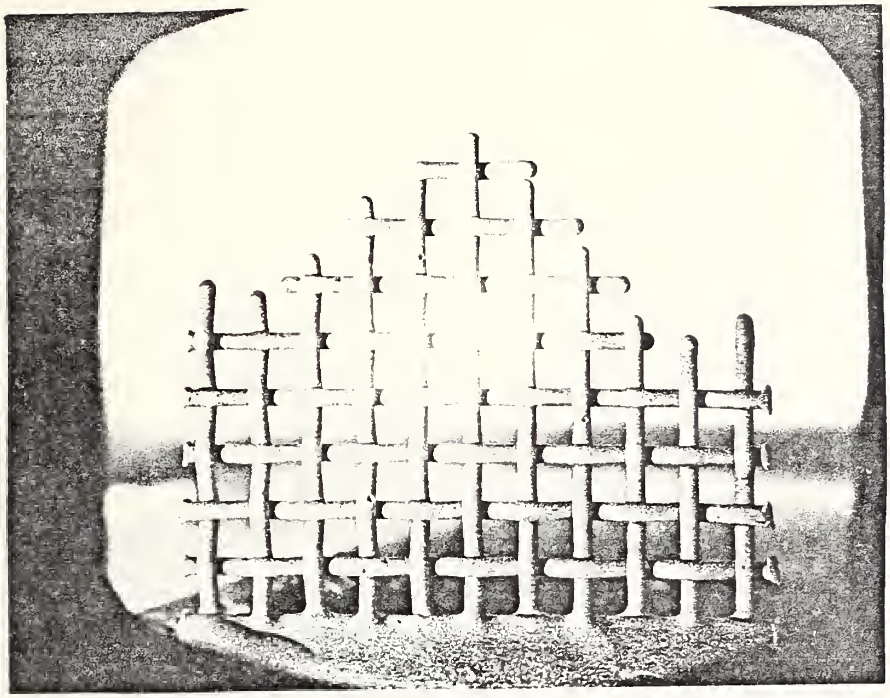


Figure 3e. Typical specimen of Midas thermal expansion series. Average castability 62.8; Spec. M3B 60.5.

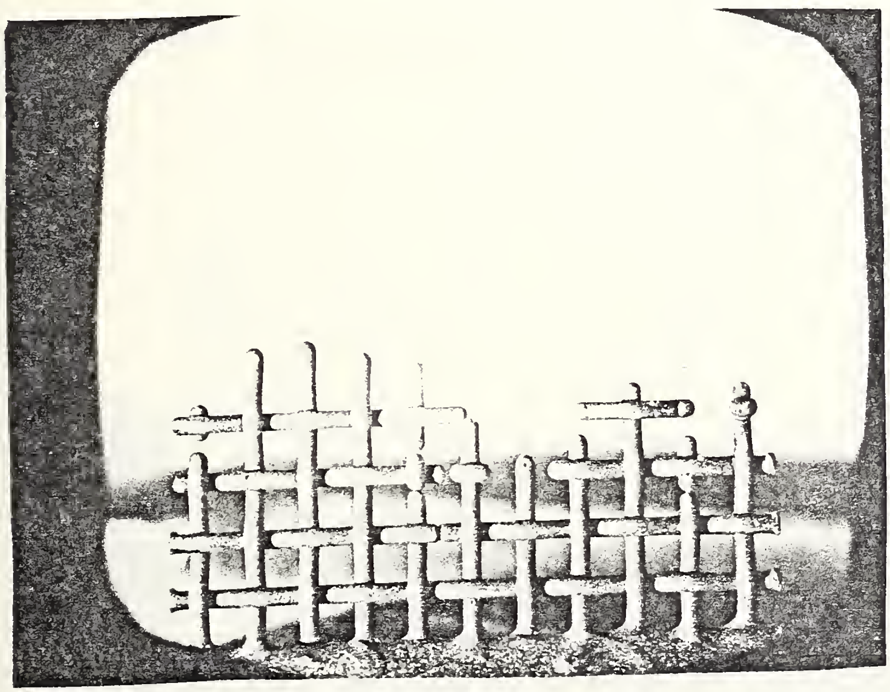


Figure 3f. Typical specimen of Paliney C-B thermal expansion series. Average castability 29.2; Spec. P4B 33.8.

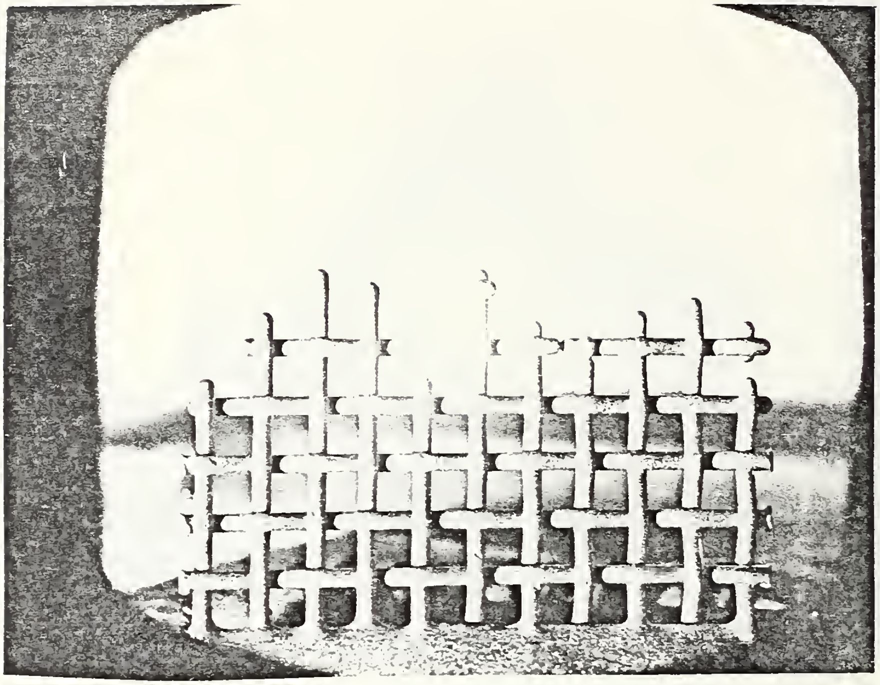


Figure 4a. Specimen of Harmony hygroscopic series H1H, castability 49.0.

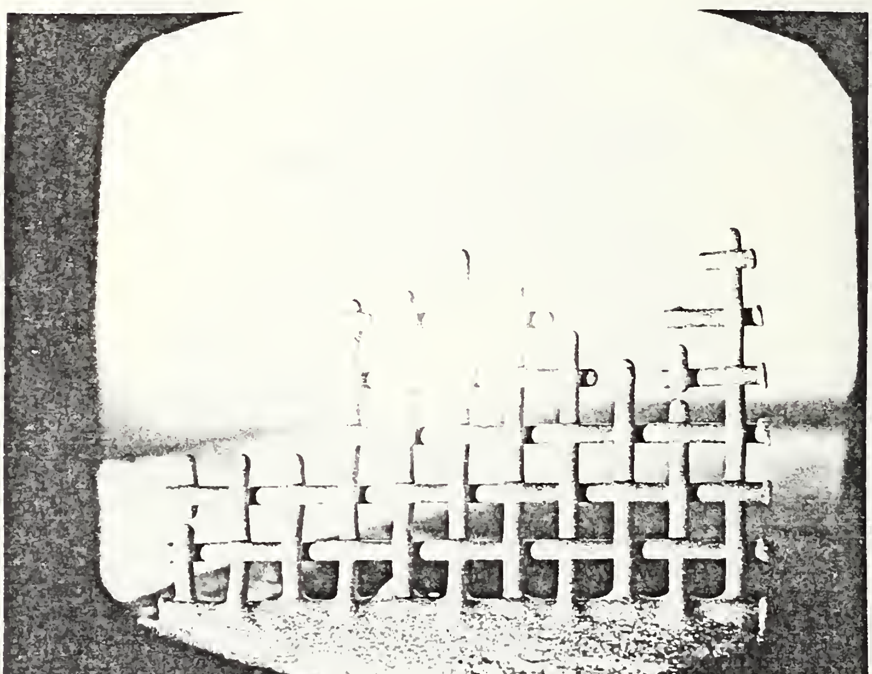


Figure 4B. Specimen H2H, castability 37.1.

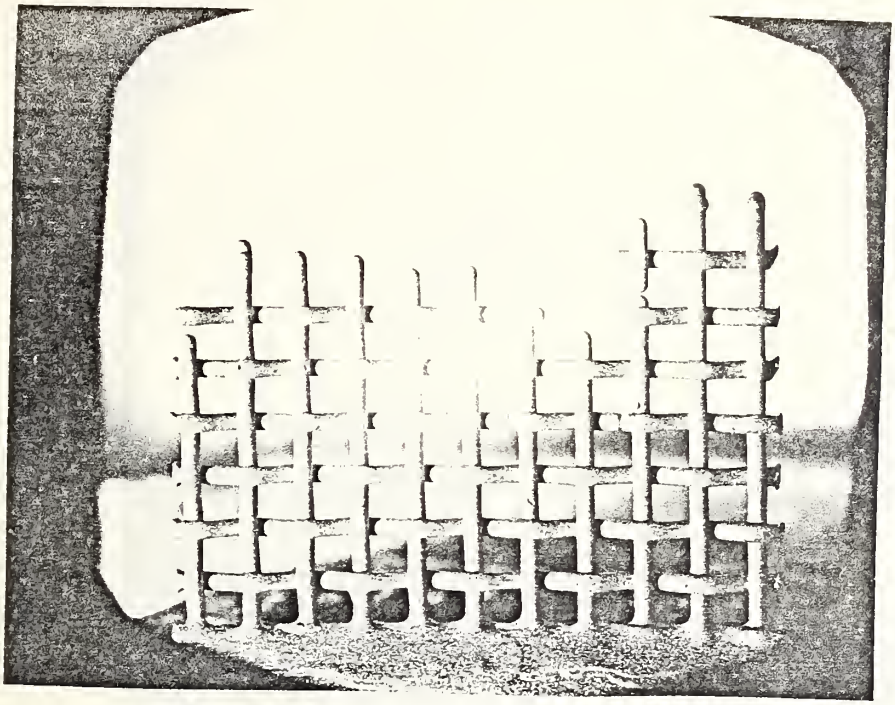


Figure 4c. Specimen H3H, castability 62.4.

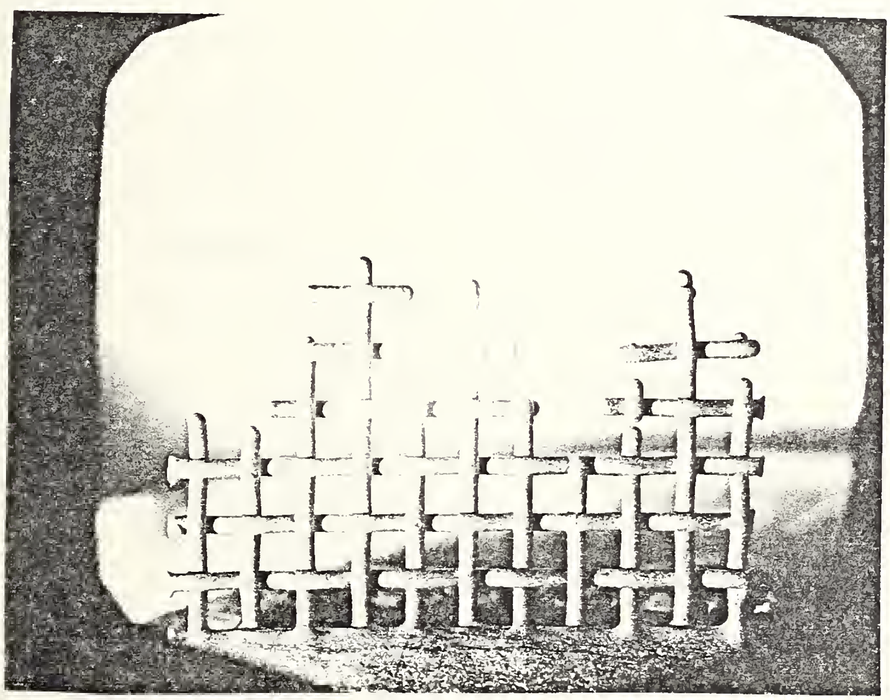


Figure 4d. Specimen H4H, castability 42.9.

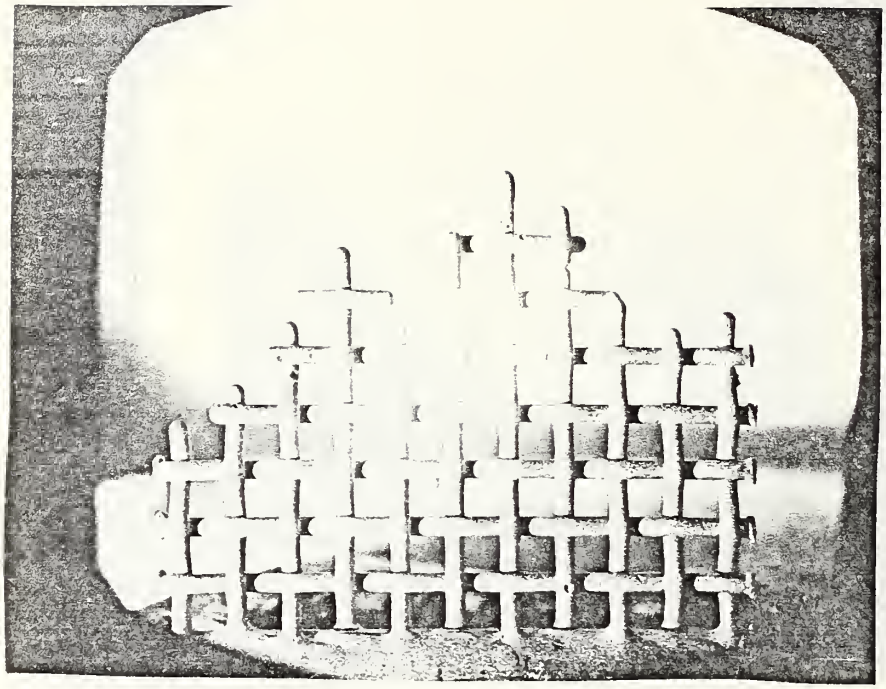


Figure 4e. Specimen H5H, castability 52.9.

Castability of Dental Casting Gold Alloy

Part II

This part of the report includes:

(1) data relating to effects on castability of variations in some of the procedures and conditions used in the preparation and casting of test specimens,

(2) data on some alloys (Table 4) used for porcelain-fused-to-metal (PFM) applications and on one Type III gold alloy (Table 4) not included in Part I, and

(3) discussion of the proposed castability requirements and test procedure.

During the time of development of the test for castability, research on alloys for porcelain-fused-to-metal crown and bridge castings was also in progress in the laboratory, and the castability test was used in this investigation. Some of the data on the PFM alloys are included to demonstrate the applicability of the castability test to different types of alloys and to point out some of the effects of casting conditions on castability.

Effect of casting temperature

The effect of casting temperature over a range extending approximately 40°C (75°F) below and 70°C (125°F) above the proposed test temperature was investigated for one gold alloy, Ney-Oro B-2, using the thermal expansion technique (Table 2). Temperature of the alloy at the time of casting was determined, as indicated in Part I, by the optical pyrometer system supplied with the casting machine used (Table 2). The data in Table 5 indicate that over the range investigated the castability values for the gold alloy do not show a large variation with casting temperature*.

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*All of the castability values in Table 5 are higher than the value of 67.1 in Table 3 for the same alloy cast under similar conditions. Although the reason for this difference is not known it was noted that the average of 67.1 includes one particularly low value of 33.8

The effect of casting temperature was much more apparent in a series of castings of four PFM alloys. For this series of castings the alloys were "superheated" to casting temperatures ranging from 111°C (200°F) to 278°C (500°F) above the liquidus temperature of the alloy as reported by the manufacturers. Table 6 shows that for these PFM alloys, in almost every instance castability values increased as casting temperature was increased. Also for all of the alloys the highest castability values were obtained when the alloy was cast at a temperature higher than that recommended by the manufacturer.

Effect of mold temperature

The effect of mold temperature on the castability of PFM alloys is shown in Table 7. Castabilities at mold or burnout temperatures of 816°C (1500°F) and 927°C (1700°F) were compared. In every comparison the average value is higher at the higher burnout temperature. This is consistent with the results for gold alloys shown in Table 3 where five of the six alloys have higher castability values for the thermal expansion techniques with a burnout temperature of 649°C (1200°F) than for the hygroscopic technique with a burnout temperature of 482°C (900°F).

Effect of melt soak time

The molten alloy was routinely held at casting temperature for 60 seconds before casting. To determine whether the length of this holding period or melt soak time had a significant effect on castability, a series of castings was made with a 90 second melt soak time. Data for this series (made by the hygroscopic technique) are given in Table 8. Values from Table 3 of castability for specimens made with a 60 second melt soak time are shown for comparison. In five of the six alloys for which both 60 and 90 second melt soak times were used, higher average castability values were obtained after a 90 second melt soak time. The reason for the decrease in castability of the Howmedica specimens at 90 seconds is not known. Testing of additional specimens would be required to determine whether or not this difference is actually dependent on melt soak time. The castability of one Type III dental gold casting alloy, Firmilay, not included in Part I is shown in Table 8.

Effect of sprue length

The effect of sprue length on castability values was investigated for one alloy (Howmedica A6). As shown in Table 9 when specimens of this alloy made with sprue lengths of 12 mm were compared with specimens with 6 mm sprue lengths, the differences were not significant. The average for the 12 mm sprue length specimens were slightly higher than for the 6 mm specimens, but the difference is not large relative to the standard deviations for specimens of either 6 or 12 mm sprue length (Table 9).

Use of 24K gold castings for verification of test procedure

Because the castability value of an alloy depends upon testing conditions as well as upon the properties of the alloy, some means of verifying that the testing conditions are as specified is meeded. One method of evaluating the entire combination of procedure, test equipment and casting conditions is to make castings of a standard test material. Twenty-four karat gold was selected as a readily available standard test material. Since the casting characteristics of 24K gold differ somewhat from those of dental gold alloys, it is necessary to use a higher casting temperature and a longer melt soak time than for the alloys. With these modifications in procedure, castability values for the 24K gold are within the range of values obtained for the dental gold alloys as shown in Table 10. It is believed that with the required modifications, the procedure for making 24K gold castings remains close enough to the proposed test procedure to provide a valid verification of test conditions.

Discussion of proposed castability requirement and test method

It must be emphasized that the proposed castability requirement and test methods are based only on alloys which are considered to cast satisfactorily. No samples of alloys which had been found, in service, to have unsatisfactory castability characteristics were available. The proposed limit for castability is therefore set at a level which will pass the tested alloy but will reject alloys which are inferior to the tested alloys in castability.

The proposed test method is based on the hypothesis that while it may be possible to adjust temperatures and other conditions so that complete castings can be made from any gold alloy that complies with the composition and other requirements of present specifications, it is reasonable to require that the alloys can be cast satisfactorily by a procedure that falls within the range of normal dental laboratory practice. For this reason, for example, the test method calls for specific burnout and casting temperatures to be used for all alloys, thus tending to reject alloys which would require unusually high temperature for casting.

The proposed test method employs a hygroscopic rather than a thermal expansion casting technique because data (Table 3) show that the hygroscopic technique is generally a more severe test of castability than is the thermal expansion technique with its higher burnout temperature.

The use of polyester sieve cloth* as a pattern material insures that uniform patterns can be produced in different testing laboratories. The pattern dimensions and sieve size (1 mm opening or No. 18) were chosen so that satisfactory gold alloys will produce a casting that is only partially complete when the specified procedure is used. Thus the range of the proposed test

* Polyester sieve cloth obtained from Nalgene Labware Division/Nalge Co., P. O. Box 365, Rochester, NY 14602

method is wide enough to evaluate gold alloys that are either significantly inferior or significantly superior to those covered in this report.

Many details of the test method such as the sprue length, the ring liner of one layer of asbestos, the orientation of the pattern during casting, the melt soak time, the length of the casting machine arm, the speed of rotation of the casting machine and the method of cleaning the casting are specified primarily for uniformity of procedure rather than for merit of the particular procedural detail. Data relating to some of these, sprue length (Table 9) and melt soak time (Table 8) suggest that small deviations from the specified procedures will not greatly affect the castability values, but close adherence to the specified procedures is recommended.

In the proposed castability requirements and method, castability has been specified and calculated not as a percentage but as a decimal fraction to avoid suggesting that a satisfactory alloy should have a castability of 100%. As indicated above the specified test specimen and procedures were intentionally selected so that castability values of less than 100% (or 1.00) are obtained for alloys considered to be satisfactory in service.

Table 4

Additional Alloys (Part II)

Alloy	Type	Manufacturer
Firmilay	Type III gold alloy	J. F. Jelenko and Co.
Jelenko O	High noble PFM	J. F. Jelenko and Co.
Cameo	Medium noble PFM	J. F. Jelenko and Co.
Biobond	Non precious PFM	Dentsply International, Inc.
NP-2	Non precious PFM	Howmedica, Inc.
Ceramalloy	Non precious PFM	Ceramco, Inc.
Jelbon	Non precious PFM	J. F. Jelenko and Co.

Table 5

Effect of Casting Temperature on Castability of Gold Alloy

Ney B-2, 649°C (1200°F) burnout

Casting Temperature °C	°F	Castibility %	S. D. %
1038	1900	96	5
1093	2000	81	17
1149	2100	100	00

Table 6. Effect of Casting Temperature on Castability of Porcelain-Fused-to-Metal Crown and Bridge Alloys

Alloy	Liquidus (Mfr. Data)		Mfr Rec'd Casting Temp		Experimental Casting Temp		Superheat		Castability
	°C	°F	°C	°F	°C	°F	°C	°F	%
Jelenko O	1177	2150	1260	2300	1288	2350	111	200	30
"		"		"	1371	2500	194	350	60
"		"		"	1454	2650	278	500	92
Cameo	1260	2300	1316	2400	1371	2500	111	200	18
"		"		"	1454	2650	194	350	55
"		"		"	1538	2800	278	500	90
Biobond	1288	2350	1510	2750	1399	2550	111	200	38
"		"		"	1482	2700	194	350	75
"		"		"	1566	2850	278	500	93
NP-2	1385	2525	1510	2750	1510	2750	125	225	22
"		"		"	1579	2875	194	350	66
"		"		"	1649	3000	264	475	63

Table 7. Effect of Mold Temperature on Castability of Porcelain-Fused-to-Metal Crown and Bridge Alloys

Alloy	Liquidus (Mfr. Data) °C	Liquidus (Mfr. Data) °F	Mfr. rec. Casting Temp °C	Mfr. rec. Casting Temp °F	Experimental Casting Temp °C	Experimental Casting Temp °F	Superheat °C	Superheat °F	Mfr. Rec. Mold Temp °C	Mfr. Rec. Mold Temp °F	Exp. Mold Temp °C	Exp. Mold Temp °F	Castability %
Jelenko O	1177	2150	1260	2300	1274	2325	97	175	704	1300	816	1500	29
											927	1700	62
Cameo	1260	2300	1316	2400	1371	2500	111	200	704	1300	816	1500	17
											927	1700	25
NP-2	1385	2525	1510	2750	1510	2750	125	225	816	1500	816	1500	34
											927	1700	66
Ceramalloy	1182	2160	1260	2300	1274	2325	92	165	788	1450	816	1500	20
											927	1700	81
Jel Bon	1232	2250	1343	2450	1343	2450	111	200	760	1400	816	1500	60
											927	1700	77

Table 8

Effect of "Melt Soak" Time on Castability

Alloy	Soak Time S	Castability %	S.D. %
Howmedica A6	60	95	2
	90	59	14
Aderer C	60	59	22
	90	89	3
Harmony, Hard	60	49	10
	90	67	9
Paliney C-B	60	43	13
	90	50	12
Midas	60	43	9
	90	60	25
Ney-Oro B2	60	41	6
	90	63	16
Firmilay	60	--	--
	90	57	13

Burnout: 482°C (900°F)

Casting Temp: 1079°C (1975°F)

Table 9

Effect of Sprue Length on Castability

Howmedica A-6: 482°C (900°F) burnout

1079°C (1975°F) casting temperature

Sprue Length	Castability	S.D.
6 mm	59	14
12 mm	66	14

Table 10

Castability of 24K Gold

4 min. melt soak time

1107°C (2025°F) casting temperature

Relation of casting time to on-off cycle of induction melting	Castability %	S.D. %
Random	45.9	15.6
Cast at initiation of on period	62.8	11.4

Castability of Dental Gold Alloy

Part III

Castability Test

Requirement - The castability of the alloy shall not be less than 0.40 when tested as described in the method below.

Method - The pattern used for the castability test shall be made from a section of polyester sieve cloth complying with the dimensional requirements of ASTM E11-70 for 1.00 mm sieves with the exception that filament diameter shall be 0.50 mm. The sieve cloth section (Fig. 5) shall consist of a square of 100 openings. A runner bar made of 6 gage (4.2 mm diameter) round wax shall be waxed to one edge of the sieve cloth section. The runner bar shall enclose the sieve filament (or "wire") on one edge of the sieve cloth section but shall not extend into the openings of the sieve cloth. A 6 gage round sprue 6 mm in length shall be attached to the center of the runner bar at a right angle to the bar and in the plane of the sieve cloth section.

The pattern shall be positioned as shown in Fig. 5 in a 32 x 48 mm ring lined with one layer of wet asbestos and shall be invested using a Type II investment complying with ANSI/ADA Specification No. 2. The ring shall be indexed to indicate the pattern orientation. The ring shall be allowed to set for 30 min in a water bath at 37°C and shall then be removed from the bath and allowed to set at room temperature and 100% humidity for 16 to 24 hours.

The pattern shall be burned out by heating the ring to 485°C over a period of one hour and holding at 485°C for one hour.

The casting shall be made using 9.3 g (6 dwt) of alloy in an induction type centrifugal casting machine at a speed of 400 rpm and with an arm length of 200 mm from the center of rotation to the far end of the casting ring. The alloy shall be heated to 1080°C, held at this temperature for 60 seconds, the ring transferred to the casting machine with the sieve cloth mold cavity vertically disposed, and the casting made immediately.

The casting shall be devested using 50 μm alumina in an air abrasive unit and examined to determine the number of complete segments where a segment is defined as that part of a sieve filament connecting two adjacent intersection points. A segment shall be considered to be complete if the cross section is full size over the full distance from intersection to intersection, Fig. 6. Counting of complete segments shall be done either by examination of the casting with low power magnification (5 to 10x) or by examination of photographs or Xerox copies of photographs at this magnification, Fig. 7. If photographs or copies are used, direct examinations of the casting shall be made to determine completeness or incompleteness of any segments that cannot be seen clearly in the photograph or copy.

The castability value is the number of complete segments in the casting divided by the number of segments in the pattern:

$$\frac{\text{Number of complete cast segments}}{210} = \text{castability}$$

The reported value shall be the average for a series of five castings.

Verification of Equipment and Procedures - Equipment and procedures to be used for making castability specimens shall be verified by making castings of 24K gold. Procedures used for making 24K castings shall be as described in the method above with the following exceptions: (1) The 24K gold shall be heated to 1107°C (2025°F) and held at this temperature for 240 seconds before casting.

(2) If the induction melting apparatus cycles on and off at the end of this 240 second period, the casting machine shall be started at the initiation of an "on" portion of the cycle.

If the average castability value for a series of 5 castings of 24K gold is not less than 0.40 and not more than 0.90, the equipment and procedures shall be considered to be satisfactory. If the average castability of the 24K gold specimens is not within this range, details of the equipment and procedures shall be investigated, particularly burnout and casting temperatures, and corrected as necessary so that castings within the range of 0.40 to 0.90 are produced.

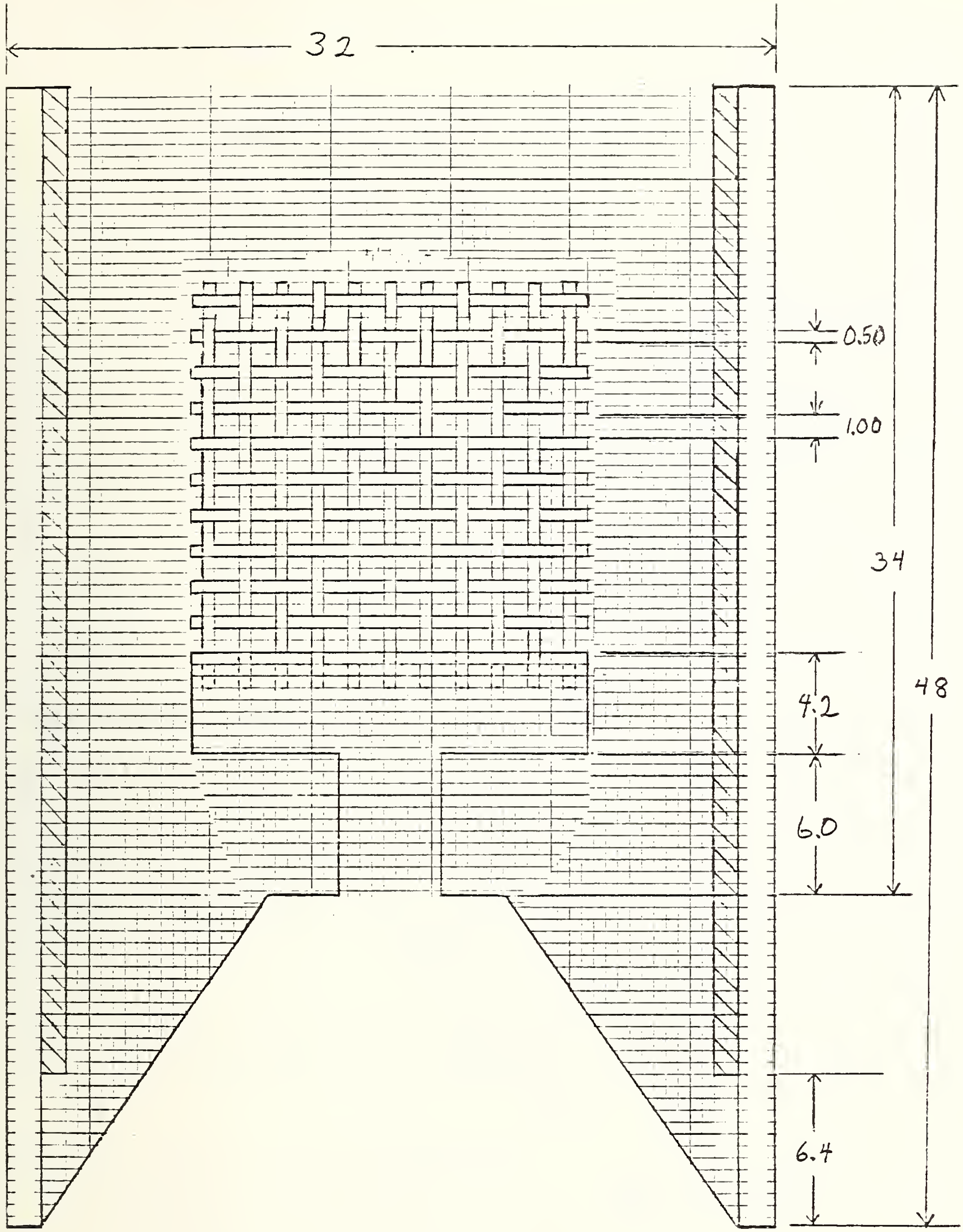


Figure 5. Ring and invested pattern for castability test.
Dimensions in millimeters.

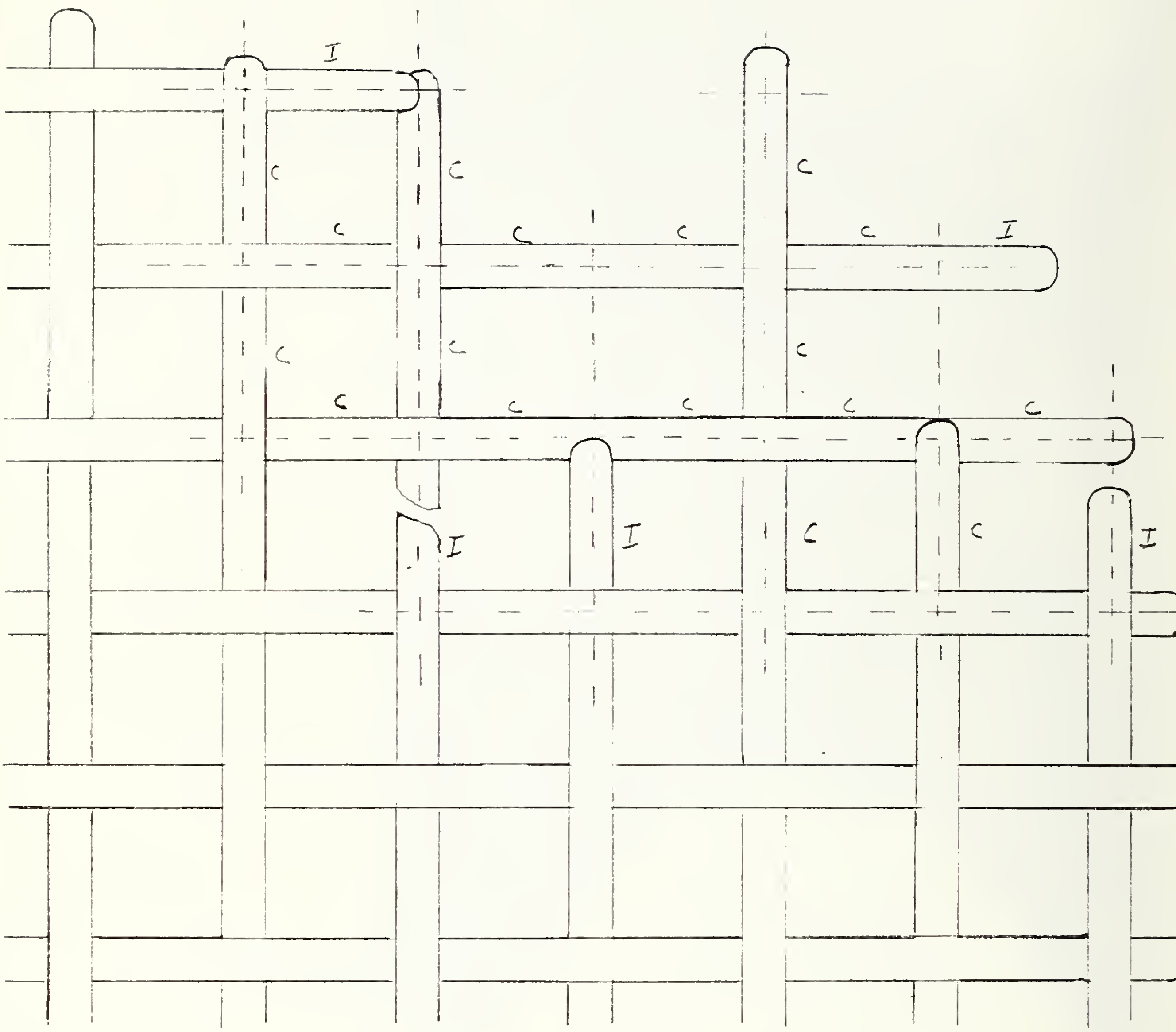
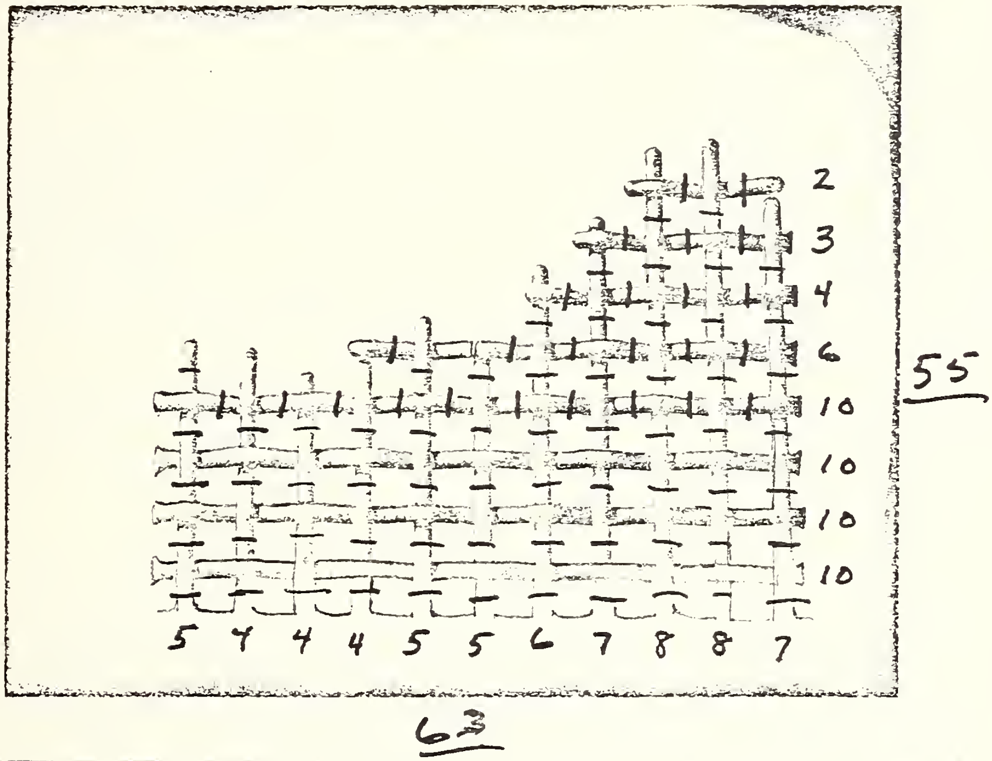


Figure 6. Examples of complete (C) and incomplete (I) segments.



Segments:

Vertical 63

Horizontal 55

Total 118

Castability: $\frac{118}{210} = 0.56$

Figure 7. Example of castability evaluation.

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report describes a procedure developed for measuring the castability of dental casting gold alloys and presents a proposed castability requirement and test method. The report is made up of three parts. Part I, which consists of the preliminary report prepared in May 1977, describes the procedure for measuring castability and gives results obtained on four "specification" type alloys, three of which were suggested by the Defense Personnel Support Center, and on two alloys of lower noble metal content. Part II contains data on additional alloys including a fourth alloy suggested by the Defense Personnel Support Center and several alloys for porcelain-fused-to-metal applications. Also included in Part II are data on the effects that variations in procedures and casting conditions have on castability and a discussion of the proposed castability requirement and test method. Part III consists of the proposed castability requirement and test method in specification form.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Castability; dental casting alloys; dental materials; gold alloys; test method for castability.

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