BROWN & WATTS

Tests of Oxyacetylene Welds

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TESTS OF OXYACETYLENE WELDS

BY

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THESIS

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Elmer Arthur Brown and George William Watts

ENTITLED Tests of Oxyacetylene Welds

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Mechanical Engineering

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STRENGTHS OF OXYACETYLENE WELDS IN CAST IRON.

I. Introduction.

This part of the thesis was undertaken to supplement the work previously done on the subject by H. H. Constant at the University of Illinois, 1912. It is deemed needless to present the results of the work already done as such data was compiled by the above named experimenter. The immediate purpose of the thesis was to investigate the efficiency of oxyacetylene welds in cast iron subjected to tension. Tension tests were used because cast iron practically always fails in tension, and it would be practically impossible to make a compression test show anything since the weld would be required merely to keep the welded parts from slipping which would require very little force. Efforts were made to keep all conditions as to quality of iron, welding rod, and flux used constant.

II. Apparatus & Arrangement.

The apparatus used for the welding consisted of the following parts arranged as shown in Fig. 1; B, Fouche blowpipe, connected on the oxygen side to a pressure reducing valve C located on the oxygen tank D, and on the acetylene side to a hydraulic back pressure valve E which is in turn connected to a tank of compressed dissolved acetylene. The oxygen used was furnished by the Linde Co., and the acetylene by the Commercial Acetylene Co. The pressures used on the blowpipe were those recommended by the makers. One size of head was used on the blowpipe throughout the test as the iron was approximately of one thickness.

ARRANGEMENT OF APPARATUS AS DESCRIBED IN SECTION II. PAGE 1.

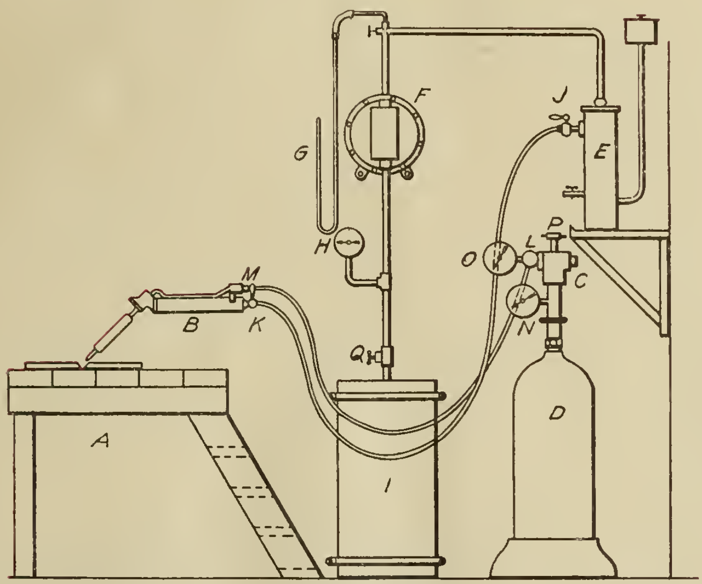
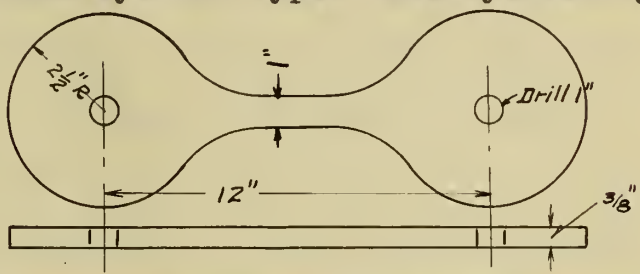


FIG. 1. GENERAL ARRANGEMENT OF OXYACETYLENE WELDING APPARATUS.

No records were kept as to the amounts of gases and welding rod used.

III. Specimens.

The specimens tested were of a good grade of gray cast iron poured by the University foundry. The specimens used were made at two pourings, care being taken that the specimens taken at each pouring were taken from the same tap. The specimens, as shown by the sketch, were of the eye bar type. The eye bar type was used on account of the difficulties encountered with any other method of gripping that would give



a uniformity of stress over the entire section. A large eye was used inorder to keep the specimen from breaking in the eye, it having been found that this was the point of greatest weakness of such sections. The gripping was done by drilling holes in the eyes, and inserting pins supported by straps which in turn were supported by other pins resting on the crossheads of the testing machine. The stretch of the straps coupled with the roll of the pins permitted the pull to be transmitted axially to the specimen. The specimens were broken in tension, welded, and broken again. This was done in order that actual conditions be duplicated as nearly as possible. In some cases where the specimen broke outside of the weld, the piece was welded and pulled a second time. All tests were run on an Olsen 100,000 pound testing machine. The cross sectional area of the specimen was taken both before and after welding, and in the cases where the specimen broke outside of the weld

the area was taken again. The ultimate load was noted in each case. No perceptable elongation was noted.

IV. Welding.

Before any welds were made on the test specimens, the operators made a number of welds on other pieces of cast iron in order to become familiar with the operation of the apparatus. In making these welds, standard practice was followed as nearly as possible. The specimens after being broken in the testing machine were beveled on both sides in order to make sure that the specimen was welded clear through. This made it easier to weld since the area of the weld to be made at any one time was materially reduced. After welding on one side, the specimen was turned over and the weld was completed by welding the other side. The welding stick used was a pure grade of high silicon iron made by the Oxweld Acetylene Company of Chicago. It was necessary to use a flux in order to prevent an oxide forming, or in case it was formed to reduce it. The flux increases the fluidity of the metal and floats off impurities such as sand, dirt and scale. The flux used was a compound prepared by the writers according to the following formulae as given by R. Ganjon and P. Rosemberg.-

.50 pound carbonate of soda.

.50 " bicarbonate of soda.

.15 " borax.

.05 " percipitated silica.

In starting the weld, the specimen is first brought to nearly a white heat across the entire breadth of the weld, then flux was

put on until the entire weld was covered lightly with it. Starting at one end of the weld, the metal was melted and welding rod added until the notch was completely filled and slightly built up clear across the specimen. After welding one side, the specimen was turned over and the other side welded in a similar manner. Particular care was taken to prevent blowholes formed by the boiling of the metal. When a blow hole was noticed, the welding rod was plunged into the molten metal near the blow hole and this portion of the metal scraped away. After completing the weld, the blowpipe was played on the hot metal back of the weld to relieve strains set up by the unequal heating of the metal in the weld and that back of the weld. This also prevented brittle metal by the rapid cooling of the highly heated metal in the weld proper. After cooling, the welds were tested.

V. Results.

In order to get a comparison between the welded and the unwelded metal, two efficiencies were used; first load efficiency, and second, stress efficiency. The efficiency that measures the value of the welding process is the ratio of the load that the welded piece will carry to that of the unwelded piece. This efficiency is important because it is practically that which is met with in practice including as it does all variables, such as poor alignment, blowholes, injuring of metal due to first break, reduction of area and burnt metal. The stress efficiency is the ratio of the stresses developed in the welded piece to that of the unwelded. To find this efficiency, the stress developed in the original breaking was first computed by dividing

the load by the area at the break. The stress to which the welded piece was subjected was similiarly computed. The ratio of this stress to the former gives stress efficiency.

VI. Conclusions.

Cast iron is not ductile or malleable ~~and in no sense elastic~~. Therefore the liability of failure under shrinkage and internal strains is great. By giving castings a proper preheating and reheating treatment ,this tendency may be lessened. Due to the extreme fluidity of cast iron, which is further accentuated by the character of the flux used, it was necessary to weld the metal in a horizontal position, otherwise the metal would have flowed to the lowest point tending to produce adhesion to the comparatively cold sides of the weld. As the welder becomes familiar with the use of the welding apparatus,it is very easy t o control the flow of the molten metal by careful manipulation of the welding rod; so that as far as the general appearance is concerned the weld may appear perfect.

Since the metal added to the weld should be at least as good as the original,the strength of the joint should be one hundred percent if it were not for certain defects. It is evident that in many cases where welding is needed the metal has been overstressed in many places, particularly at the point of break. This point is particularly applicable to the specimens tested since the cross section was nearly uniform throughout its length. The fact that many of the specimens broke several inches from the weld at a load and stress much less than that of the original would be ample proof of this statement.

Breaks due to this original stressing cannot be charged to the weld. Causes of failure which may be charged to the weld are; burning, misalignment, and cooling strains. Burning may be eliminated by using a slightly reducing flame. The method by which this flame may be obtained is described in a pamphlet published by the Oxweld Acetylene Company.

"When the blowpipe is first lighted the acetylene is greatly in excess. The flame is of abnormal volume, a dirty yellow color and of uniform consistency. This is the reducing type in an exaggerated degree. By increasing the oxygen pressure the size of the flame is lessened and gradually a white zone of greater luminosity appears near the blowpipe tip. This luminous zone is not yet clearly defined. The flame is still of abnormal size and is streaky in its appearance. The extent of the reducing or carbonizing action of the flame is judged practically by the size and definition of the luminous zone. When the luminous zone becomes more clearly defined and takes the form and color of a bluish white incandescent cone or pencil, the streakiness is diminished and the flame approaches neutral."

From the fact that but three of the specimens broke in or near the weld,- and at least one of these breaks was due to a blowhole,- it would seem that burning of the metal is a minor defect. Poor alignment does not seem to be important for it was noticed that several of the specimens which were very poorly aligned gave very high efficiencies. Cooling strains seem to be the important element. This is evidenced by the large number of breaks occuring a very short distance outside of the weld.

These strains could be materially eliminated by preheating and slow cooling of the metal.

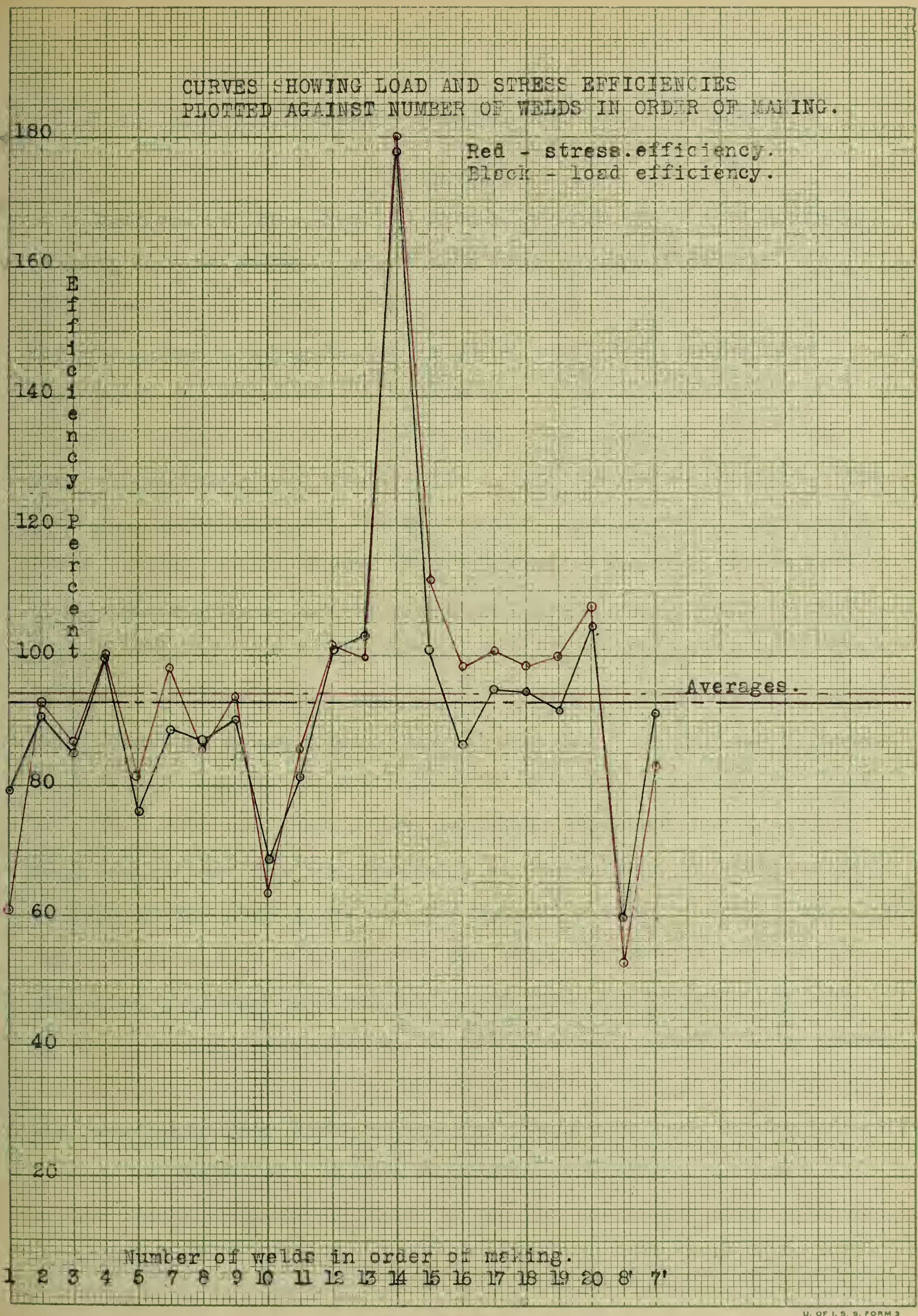
Curves have been plotted with load efficiencies and stress efficiencies as ordinated and number of welds, in the order of making, as abscissae. From these the average efficiency has been calculated, and plotted as shown. The fact that the stress efficiency is about two per-cent higher than the load efficiency can be attributed to the fact that in the first breaking the average sectional area is larger than in the second. It was probable that in those cases where the efficiency ran much over one hundred per-cent the original specimen was a poor casting, due either to blowholes or weak metal, and these defects were later eliminated by the welding. Since in every case where the welded specimen broke at a section larger than did the original specimen, the break was seen to come at or near the edge of the weld, it follows that the metal had been injured in the welding. Although an average efficiency of over ninety per-cent was obtained, the fact that several efficiencies ran below eighty per-cent would indicate that the efficiency of the average welder should not be rated higher than seventy-five per-cent under ideal donditions.

DATA SHEET.

No. of Piece	Area in sq. inches: original	Area in sq. inches: weld	Area in sq. inches: break	Ultimate strain lbs.: original	Ultimate strain lbs.: weld	Position of fracture. & Remarks.
1	.425	.552	.552	11910	9400	At edge of weld.
2	.401	.484	.393	10410	9430	3/32" blowhole.
3	.402	.451	.393	11210	9475	3/4" from weld
4	.408	.535	.402	8580	8540	1/2" " "
5	.416	.380	.389	10650	8080	1/4" out., Blowhole.
7	.451	.500	.408	11700	10370	1 1/4" out.
8	.340	.420	.382	8720	8450	At edge of weld.
9	.442	.431	.425	11510	10390	3/8" from edge.
10	.403	.452	.436	10000	6840	1/2" " " .
11	.420	.473	.400	10825	8800	At edge of weld.
12	.410	.420	.406	10600	10720	1/2" from edge.
13	.407	.490	.422	10650	10950	3/4" " "
14	.405	.427	.400	6070	10780	1/8" " "
15	.446	.514	.403	11485	11580	
16	.435	.473	.381	10375	8930	3/4" out.
17	.404	.443	.381	11040	10440	3/8" "
18	.444	.539	.426	12765	12070	3/8" " crooked
19	.436	.479	.398	11930	10900	1/4" " "
20	.408	.451	.397	10650	11140	7/8" "
#8'	.340	.517	.382	8720	5160	5/8" "
#7'	.451	.562	.493	11700	10650	1/8" "

7' & 8' are results obtained from welding 7 & 8 a second time.

Stress at Ultimate. Lbs./sq. in.:		Efficiency %.	
Original.	Weld.	:Load.	Stress.
28000	17000	79	60.8
26000	24000	90.6	92.4
27900	24100	84.5	86.5
21200	21200	99.5	100.0
25600	20800	75.9	81.2
25900	25400	88.5	98.1
25900	22100	86.9	85.4
26050	24400	90.1	93.8
24800	15700	68.4	63.4
25750	22000	81.3	85.4
25900	26400	101.2	101.6
26200	26000	102.9	99.4
15000	37000	177.5	108.0
15800	28700	100.9	111.5
23900	234000	86.2	98.0
27300	27400	94.6	100:5
28750	283[illegible]0	94.5	98.5
27400	27400	91.2	100.0
26100	28100	104.8	107.5
25700	13500	59.2	52.5
25900	21600	91.1	83.5


CURVES SHOWING LOAD AND STRESS EFFICIENCIES
PLOTTED AGAINST NUMBER OF WELDS IN ORDER OF MAKING.
Red - stress efficiency.
Black - load efficiency.
Averages.
Efficiency Per cent
180
160
140
120
100
80
60
40
20
Number of welds in order of making.
1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 19 20 8' 7'
U. OF I. S. S. FORM 3

TENSION TESTS OF COMMERCIAL OXYACETYLENE WELDS IN STEEL.

I. Introduction.

Previous to this time all available data as to the strengths of oxyacetylene welds in steel have been representative of job shop practice. In order to widen the scope of this data concerning the strengths of oxyacetylene welds in steel ,the writers have undertaken to make a fairly comprehensive test of the welds as executed by the best of expert welders. Bulletin No.45 of the Engineering Experiment Station of the University of Illinois, "The Strength Of Oxyacetylene Welds In Steel" by Herbert L. Whittemore gives in detail what may be expected from welds made by the most proficient amateurs, and the results therein stated will be used for comparison. The welds tested in this investigation were made by expert welders in the employ of the Oxweld Acetylene Co., at their plant in Chicago Ill., under the supervision of the writers. Since the procuring of the best welds was of the utmost importance in these tests,the most modern apparatus was used, and plenty of time was allowed for the execution of the welds. In order to get an idea of the time spent and the materials used in making the welds, data pertaining to these phases was taken throughout the welds. The specifications as included herein give the essential points of the treatment afforded the welded specimen. Where it is deemed necessary,the writers will give additional note s on the details of the treatment. The tests of the specimens were made at the laboratory of Applied Mechanics, at the University of Illinois, under the direct supervision of Professor Moore, of the Engineering Experiment Station.

II. Specifications.

Material:-Flange steel plate manufactured by the open hearth process.

Chemical Properties:-The steel shall conform to the following requirements as to chemical composition,-

Manganese		0.30% - 0.60%
Phosphorous	(acid)	0.05%
	(basic)	0.04%
Sulphur		0.05%

Physical Properties:-The steel shall conform to the following requirements as to tensile properties,-

Tensile strength, pounds per sq. inch 55,000 to 65,000.

Yield point, minimum pounds per sq. inch - 50% tensile strength.

Size and Thickness of Plates:-The test pieces shall be cut from plates 52 1/2" x 18" and shall be of the following thicknesses,- 1/8", 1/4", 1/2" and 1". There shall be the following number of plates for each thickness,-

Thickness.	Plates required.
1/8"	2
1/4"	2
1/2"	3
1"	2

Preparation of Plates:-Each plate of each thickness shall be marked X, Y or Z, depending upon the number in the series. Each plate shall then be sheared into five strips, A B C D and E as per attached blue print. (Fig.1.) Each piece must be stamped distinctly with it's letter o n each end. Pieces B C and D shall then be cut along the lines W-W. (Fig.2) This should preferably be done with a shaper or planer in order that a beveled edge of 45 degrees be obtained for welding. Do <u>not</u> use a cutting blowpipe on this operation.

Welding:-Strips B, C, and D of each plate shall be welded along

the line W-W. The welding shall be performed with Oxweld standard apparatus, and the welding heads selected shall be the standard size for that particular section of metal. Oxygen from Linde-Air-Products Co., and acetylene generated from Union Carbide in Oxweld Low-Pressure generator shall be used. The same method of welding in this test shall be employed by the welder for each plate. Care must be exercised to see that the blowpipe manipulations and operations do not vary. A record shall be kept of the workman executing the welds. The welding shall be carried forward continuously. The welding shall be carried on in such a manner that it will not be necessary to go back over the weld at any time in an attempt to overcome defects. Pure Norway iron wire of single strands and the proper size shall be used for filling material.

Measurment of Gases and Time:-The amount of oxygen used shall be determined by weight or difference in pressure in the cylinder. (It was determined by weight in this case.) The amount of acetylene used shall be determined by a wet meter. The volumes used on each strip, the amount of welding wire and the time required shall be recorded.

After Welding Treatment:-After welding, allow strip B to cool normally in air protected from draughts. Cut strip B intotwo pieces, B_1 and B_2 along line X-X by means of cutting blowpipes. Heat part B_2 to 800 degrees c. and cool for twentyfour hours in lime and powdered asbestos. Strip C when welding is finished shall be heated to an even temperature of about 800 degrees and then quenched in cold water. Then reheat evenly to 800 degrees and cool slowly in lime and asbestos. After strip D has been welded, heat the joint to an even white heat by means of the blowpipe and hammer until in

cooling it is attracted by a magnet. Allow the weld to cool normally in the air, protected from draughts and then cut the strip D into two pieces, D_1 and D_2 along lines Y-Y with the cutting blowpipe. Heat piece D_2 to 800 degrees and cool slowly in lime and asbestos.

Cutting of Coupons from Welded Strips:-Pieces A, B, B_2, C, D, D_2, E, when proper welding and after treatment has been given, then shall be cut into three coupons, each, by means of cutting blowpipe and numbered 1 to 21 as shown in Fig.3. Test pieces (originals) 2, 19 and 21 shall be heated to 800 degrees c., and cooled slowly in lime and asbestos. Every plate of each thickness shall be cut into 21 coupons as per Fig.3, but only one plate of each thickness shall have the 21 coupons as per Fig.4.

SUMMARY OF TEST PIECES.#

Thickness.	No. of Milled Coupons.	No. of Plain Test Pieces.	Total No. of Test Pieces.
1/8"	Nos.1-21 plate #1	Nos.1-21 plate #2	42
1/4"	Nos.1-21 plate #1	Nos.1-21 plate #2 Nos.1-21 plate #3	63
1/2"	Nos.1-21 plate #1	Nos.1-21 plate #2	42
1"	Nos.1-21 plate #1	Nos.1-21 plate #2	42

18 specimens of each thickness were tested.

Marking and Inspection:-The stamping of the test pieces was done by the writers acting as representatives of the University Of Illinois Engineering Experiment Station.

Variation from Specifications:-Regarding the heat treatment of the welds, this was carried out as per specifications, with one exception. Instead of placing the various plates in the oven for annealing and then cutting them up, it was thought best to cut them up first and then anneal them. The main reason for doing this was that the heavier plates could be handeled much more easily. This might have an important bearing on the results produced by annealing, since a cutting blowpipe was used in cutting out the coupons, for if they were annealed before cutting up the effect of the annealing would be done away with along the sides of the specimen by the intense heat of the cutting operation. It being impossible to obtain 1/8" flange steel,a No.10 blue annealed sheet steel was used. All steel used was obtained from the regular stock of the Joseph T. Ryerson & Son Co., Chicago Ill. Due to lack of time,the writers tested only one plate of each thickness. Coupons Nos.10, 11 and 12 for each plate were not tested.

Note:-These specifications are, with few exceptions, a copy of those written by Mr. Bryce, Chief Engineer of the Oxweld Acetylene Co., in conjunction with Professor Moore.

III. COST DATA & TIME.

The time taken for the welds together with the amounts of materials used during the welding can be readily determined from the data sheets (included) which were taken during the welding of the specimens. The time and gas consumption for the welding of these specimens was considerably higher than for commercial practice. The main reason for this is that in these tests we used a 45 degree bevel instead of about sixty degrees as is the ordinary bevel used in commercial welding. In commercial welding, the angle of the bevel is usually just sufficient to enable the operator to penetrate the flame to the bottom of the weld. Another reason for this increase was the desire of the welders to produce especially good welds. As noted on the cost data sheets, the welding head was not working properly part of the time, due to a globule of steel lodging in the gas passage, and this increased the time required for some welds. In ordinary commercial work, it seems to be the practice of some workmen to increase the pressure of the oxygen supply and in this way to hurry up the work. This increased pressure means a flame of greater intensity and danger of burnt metal. In these tests, the pressures as recommended by the makers of the blowpipe were followed as closely as possible.

IV. Testing.

The specimens were subjected to tension in a Riehle 100,000 pound testing machine. The test coupons were prepared for testing as called for in the specifications. In order to measure the elongation of the specimen, marks, at intervals of one inch for a distance of eight inches, were made along the body of the specimen. The area of the weld as well as the area of the specimen was determined before breaking. The area of the break was likewise noted. The yield point and the maximum load were obtained from the curve as made by the autographic attachment. Standard wedge grips were used. The grips automatically line the specimen in one direction, and the faces of the cross heads were used to line them in the other direction. All data obtained will be found listed on separate data sheets, and shown graphically by the various curves.

V. Calculations.

From the point of view of the user, the value of the weld is measured by it's efficiency as well as by it's ease of application. There are two types of welds: namely, those in which the weld may be built up or enlarged and those which require machining to size after the weld has been completed. For the first of these, a so-called load efficiency is used. This efficiency is the ratio of the load that the welded piece will bear to that load which an unwelded piece of the same size (as the stock of the welded piece) will bear. This evidently excludes cross sectional area of the weld. In figuring load efficiency, pieces of identically the same cross sectional area (except for weld) should be used. In this test, variations from this condition made certain modifications necessary.

An average load for the three unwelded untreated pieces was taken, and a correspondingly average area. For any variation of area occurring on the other pieces,(either welded or unwelded and treated) it was simply necessary to multiply this average load by the ratio of the area of the piece in question to the average area. This would give the load that the piece in question might be expected to hold if it were not welded or treated. The load efficiency for this piece is the ratio of the load as measured by the machine to this computed load.

VI. Results.

Specimens:-As received all of the welded specimens were more or less warped, this being more pronounced in the thinner specimens than in the thicker specimens. The effect of this warping, however, was not noticable since in every case the efficiency was well over one hundred per cent. In every case,the cross sectional area of the weld was greater than that of the stock.

Defects:-With but one exception there seemed to be no burnt welds, burning being gaged by the appearance of bluish spots in the fracture. In several of the one inch specimens,the primary cause may be attributed to the slipping of the weld (due to adhesion rather than welding) along the bevel. With the exception of the burnt weld,all fractures occurring in the weld gave metal having the same appearance. No blowholes were found in the entire series of welds.

Elongation and Yield Point:-Regardless of the postiion of the break,all specimens broke at a stress greater than the stress at the yield point of the original metal. In every case noted the yield point, as required by the specifications, occurred at a point greater than 50% of the ultimate as found in the unwelded untreated specimens as well as in the welded. The curves based upon stress at the yield point are of the same general type as the curves bases upon ultimate stress; that is, the various treatments accorded the specimens had the same effect upon both stresses.
The effect of thickness (of plates) upon the stress at yield point is small as shown by the following average stress at yield point; 1/8"-30,100 pounds per sq. inch, 1/4"-34,514 pounds per sq. inch, 1/2"-29,847 pounds per sq. inch, and 1"-30,122 pounds per sq. inch.

The most efficient method of treatment of treatment of the welds as regards yield point, as shown by the curves, is hammering. This treatment was particularly efficient in the 1/8" and 1/4". The hammering was not as effective in the thicker pieces (1/2" and 1") as in the thinner pieces. This may be attributed to the decreasing effect of blows of the hammer. In those pieces in which the specimen was first hammered and then annealed, the effect of hammering was inappreciable since the stress in this case was no higher than that in which annealing only was employed.

The curves bases on elongation show that welding decidely decreases the per cent elongation. This would indicate that tests of repeated stress and impact would be valuable since the elasticity of the metal has evidently been decreased. Annealing, as shown by the curves, increases the elasticity; on the other hand, hammering decreases the elasticity. In the eighth and quarter inch pieces in which most of the breaks occurred outside of the weld, the elasticity of the piece was not impaired as it was in the thicker pieces where practically all of the breaks occurred in the weld.

Explanation:-When the plates were first rolled the steel was given a hard surface without reducing the ductility. The welding with its high temperatures and comparatively rapid cooling would have a tempering effect on the steel, thus decreasing the ductility. Those plates which were annealed would in part be relieved of the stresses set up due to this rapid cooling thereby restoring the ductility of the the original metal in part. The hammering by giving a closer grained structure increased the elastic limit.

Ultimate Stress:-Sheets A, B, C and D show graphically the maximum stresses developed in the specimens. As shown by these curves, a noticable effect is the weakening effect that annealing has upon the unwelded pieces, as well as upon the welded. It is to be expected that since hammering increased the yield point it would likewise the ultimate stress. The average values of the ultimate stress of the various thicknesses are,-1/8"-48,600 pounds per sq. inch, 1/4"-48,600 pounds per sq. inch, 1/2"-45,600 pounds per sq. inch, and 1"-43,400 pounds per sq. inch. This decrease in ultimate stress is due to the increasing difficulty of making good welds, and moreover the heating is more localized thereby setting up internal strains. Hammering, as can be seen from the curves, decidely increases the ultimate stress, but is of no consequence when applied with annealing.

Efficiency:-The curves show that both stress and load efficiency vary inversely as the thickness, showing that the thicker welds are the more difficult to make. The average load efficiencies of the welded pieces are,-109.2% for 1/8", 96% for 1/4%, 90.7% for 1/2", and 80.3% for 1" material. The average stress efficiencies are,-103.6% for 1/8", 90.3% for 1/4", 80% for 1/2" and 72.3% for 1" material. These efficiencies show the rapid increase of the difficulties of welding of welding and defects as the thickness increases. It is, moreover, apparent that stress efficiency becomes the important efficiency in the thicker weldssince for these pieces it is decidely lower than the load efficiency. This stress efficiency should always be used in figuring the probable load that a piece about to be welded will sustain. This conservative method of figuring has the added advantage that it is unnecessary to build the weld up to any predetermined size or make allowances for

slippage of welds.

VII. COMPARISON OF EXPERT TO JOB SHOP WELDS.

Mr. Whittemore's first series of tests were based on 1/4" flange steel plates. In this series of tests various deviations from standard practice were made. With the possible exception of the case in which butt welds were made, these deviations seemed to have no noticable effect. His average stress efficiency for the 1/4" plate was 69.25% while that of the experts was 90.3%. In the latter case no variations in welding were made from standard practice, but several different treatments of the welded pieces were made. In Mr. Whittemore's tests, the relatively high efficiency of the butt welds was explained by the fact that the flame was confined almost entirely to the surface of the weld which prevented the deterioration of the metal as noted in the beveled welds. In tests made by the writers, the beveled welds gave no evidences of deterioration, and moreover allowed a considerably higher welding rate. The observations of the writers would seem to indicate that there is greater liability of the center of a butt weld being unwelded than of a beveled weld. It would, therefore, seem that there would be no object in the making of butt welds, at least in expert practice. Moreover, it is evident that it would be impossible to execute reliable butt welds on the thicker plates, due to the difficulty of penetrating the fracture. A further consideration in favor of the bevel weld is the addition of the high grade welding wire which possesses higher qualities than does the original plate. While the worth of a weld is measured by average efficiency of a series of tests, its reliability is measured by the minimum efficiency. The average minimum efficiency of the

former welds was 52.4%, a variation of 24.4% from the average. In the latter case the average minimum efficiency was 79.0%, giving a variation of 12.5% from the average. It is this consistency on the part of expert welds which makes them relatively more valuable than the best amateur welds rather than the increased average efficiency over job shop welds.

In the second series of tests, Mr. Whittemore used 1/8" plate, both portions of the plate being beveled at 45 degrees. In this series, as in the former, several different treatments were used. With one exception, all treatments were valueless. In one set the weld was hammered frequently as the welding progressed. In the testing, varied results were obtained, but the general average was lower than that of the other pieces. The conclusion was reached that the increased density due to hammering was more than counteracted by the subsequent annealing effect of the welding flame as welding was resumed. A similar conclusion was reached in the present tests in which the weld was subjected to hammering after which it was annealed. These values were no better than those obtained by simply annealing the weld. A step further was taken in which the piece was simply hammered. These results showed an increase in the stresses at yield point and at ultimate. Such results show that hammering is the desirable treatment for oxyacetylene welds in steel.

The average efficiency obtained by Mr. Whittemore in this series was 76.3% with a minimum of 60.5%, giving a variation of 20.7%. In the present series of tests the average efficiency was 103.6% with a minimum of 88.4%, giving a variation of 14.65%. This series confirms the conclusions reached in the first series.

VIII. GENERAL CONCLUSIONS.

Mr. Whittemore reached the conclusion that forging, aside from increasing the strength of the welds, also increases the ductility of the fused metal. In the present series of tests, the results obtained show that the reverse is true as regards the ductility, The yield point was practically independent of the efficiency in both cases, and did not vary appreciably from the yield point of the material. Another conclusion reached by the former was that the adding of filler to increase the thickness was but a partial remedy for increasing the strength of the weld because the adjacent metal was always overheated. The latter tests brought out, further, that exceedingly high efficiencies could be obtained on thin plates by adding filler, pointing to the conclusion that overheating played no important part. It would seem that this overheating plays an increasingly important part in the welding of thicker plates since the efficiency fell as the thickness of plates increased even though the plates were built up. This might be attributed to the fact that while the area for radiation remains the same the region of intense heat is greatly increased.

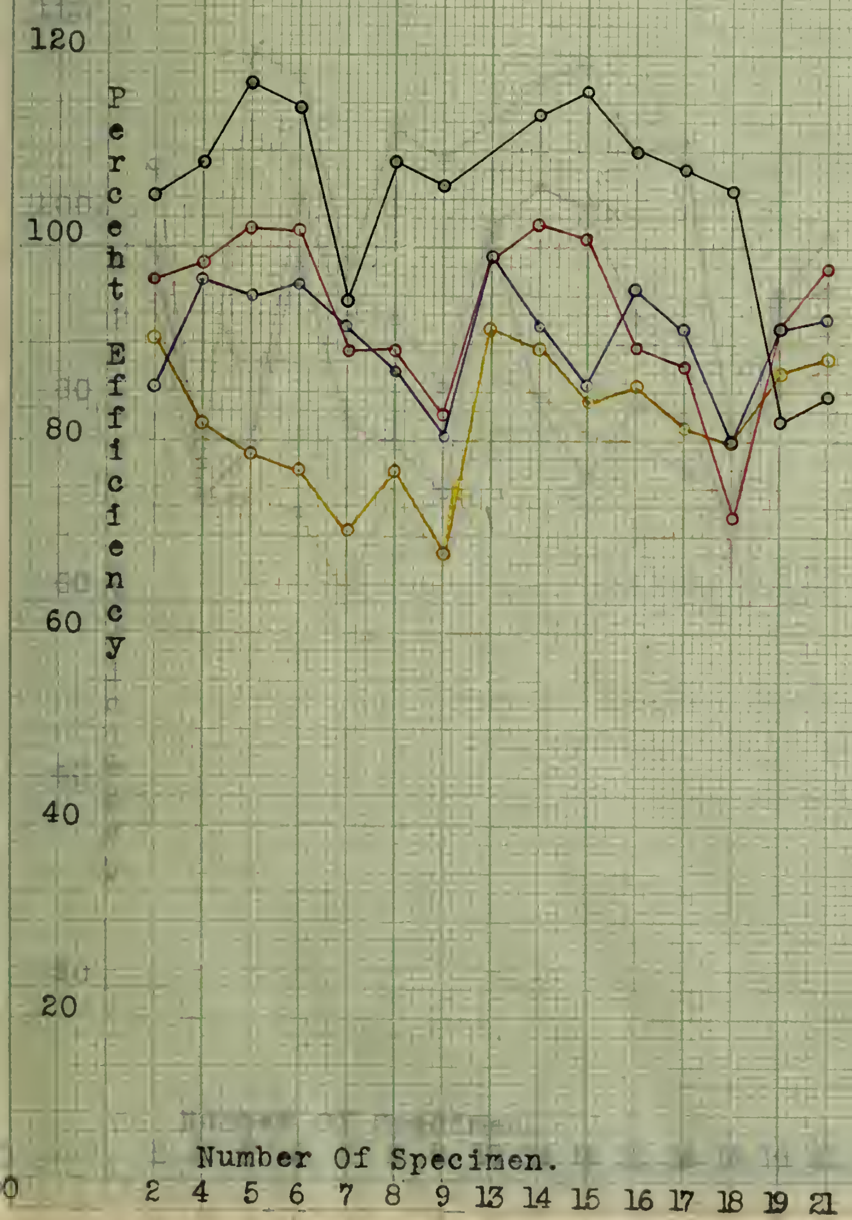
In his final conclusion, Mr. Whittemore claims that a stress efficiency of 100% is unsupportable. The present tests, showing an average efficiency of 100% for 1/8" plates, does not bear out this claim, but it would doubtless be unsafe to base calculations on such efficiencies, a conservative extimate being about 95% providing the welders be proficient and plenty of time is taken for the work. As the thickness increases from 1/8" to 1/4", 1/4" to 1/2", and from 1/2" to 1" this efficiency of 95% should be decreased about 10% per interval.

From the above tests it has been shown that the quality of the metal has been affected. One of the most serious defects noted was the decreased ductility, particularly in the thicker specimens. It is well known that ductility indexes the ability of steel to withstand shock and repeated stress. It would, therefore, appear that further tests partaking of the nature of impact and repeated stress should be run before final conclusions as to general value of oxyacetylene welds are drawn.

CURVES SHOWING LOAD EFFICIENCIES

Black - 1/8" plate
Red - 1/4" "
Violet- 1/2" "
Yellow- 1" "

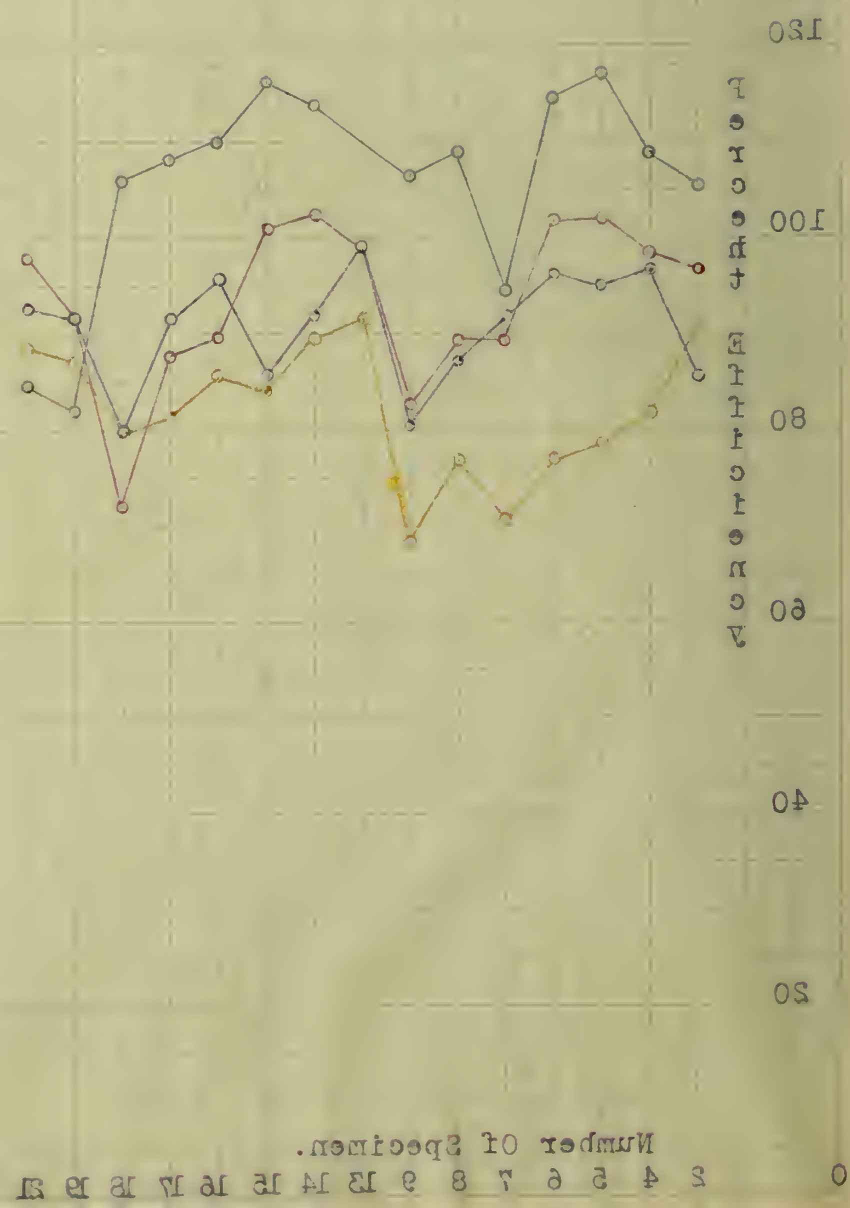
Specimens no. 2, 19, 21 unwelded, heat-treated.
" " 4, 5, 6 welded.
" " 7, 8, 9 welded, heat-treated.
" " 13, 14, 15 welded, hammered.
" " 16, 17, 18 welded, hammered, heat-treated

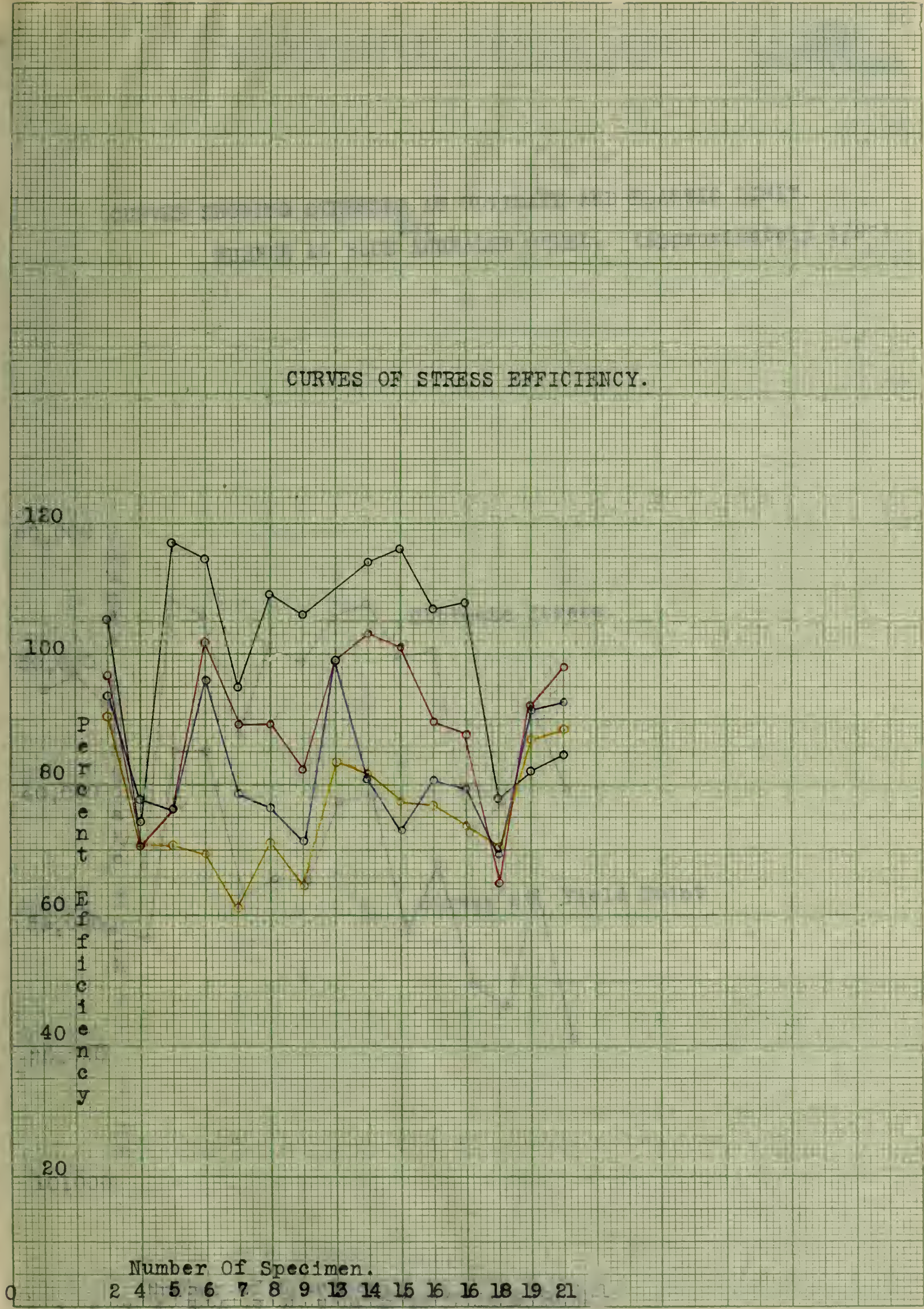


CURVES SHOWING LOAD EFFICIENCIES

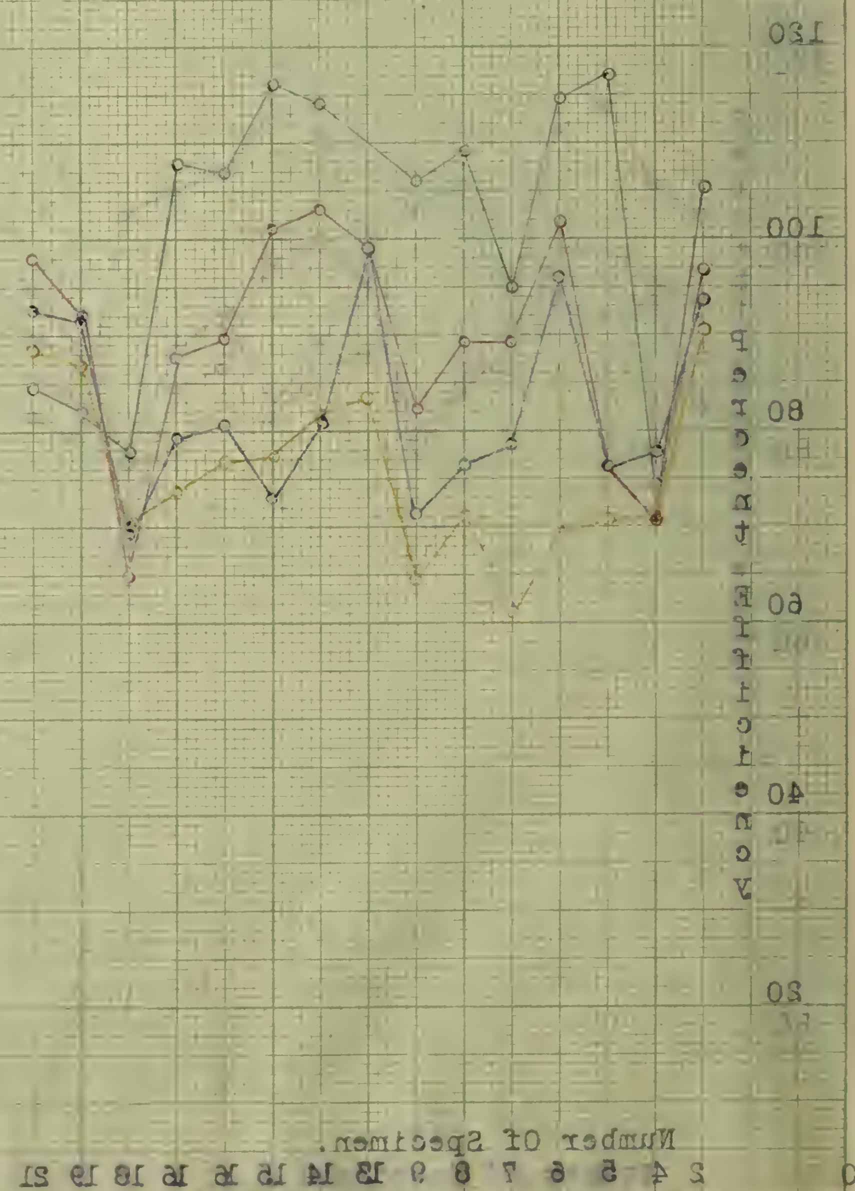
Black - 1/8" plate
Red - 1/4" "
Violet- 1/2" "
Yellow- 1" "

Specimens no. 2, 19, 21 unwelded, heat-treated.
" " 4, 5, 6 welded.
" " 7, 8, 9 welded, heat-treated.
" " 13, 14, 15 welded, hammered.
" " 16, 17, 18 welded, hammered, heat-treate

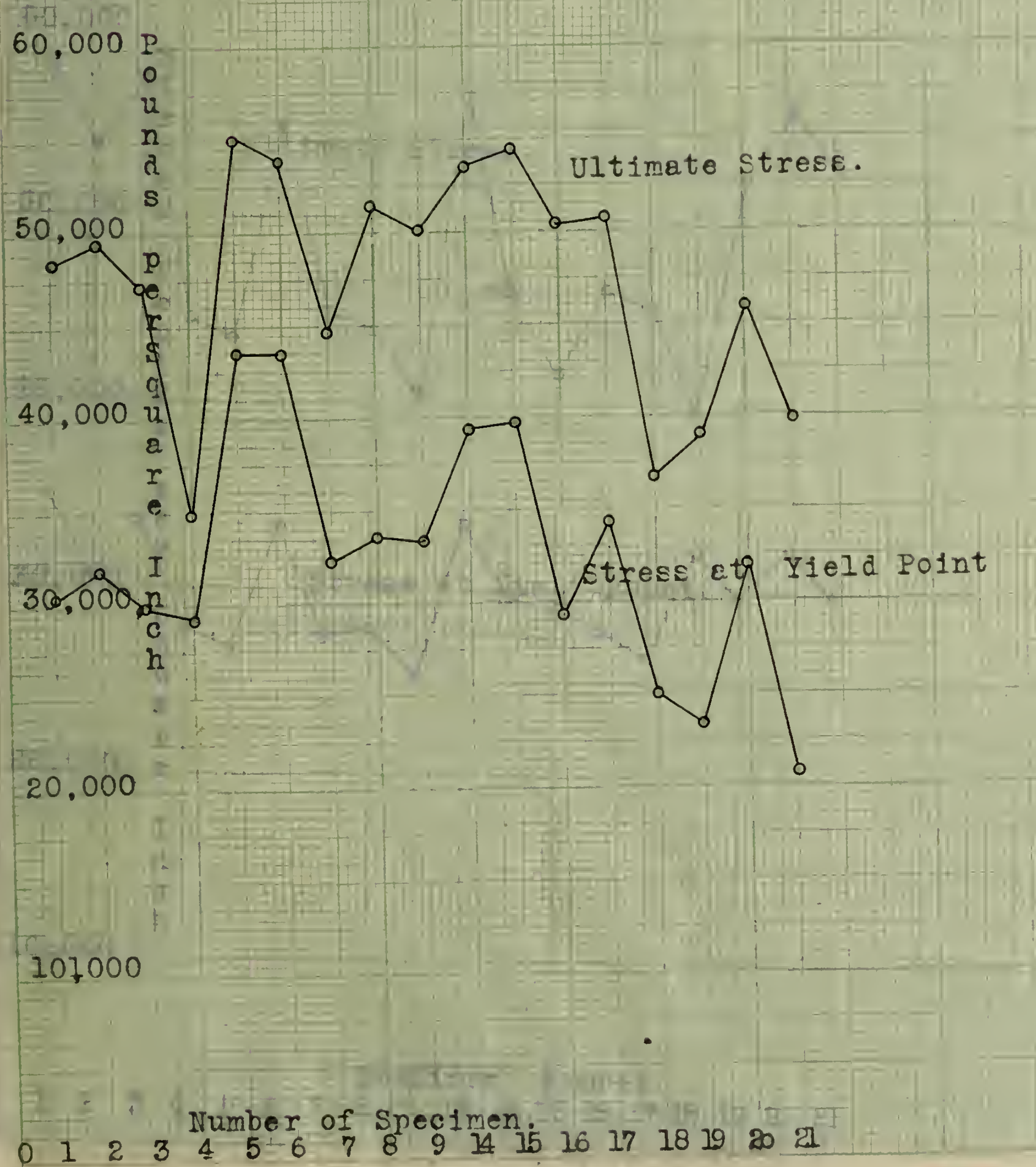



CURVES OF STRESS EFFICIENCY.
120
100
80
60
40
20
0
Percent Efficiency
Number Of Specimen.
2 4 5 6 7 8 9 13 14 15 16 16 18 19 21

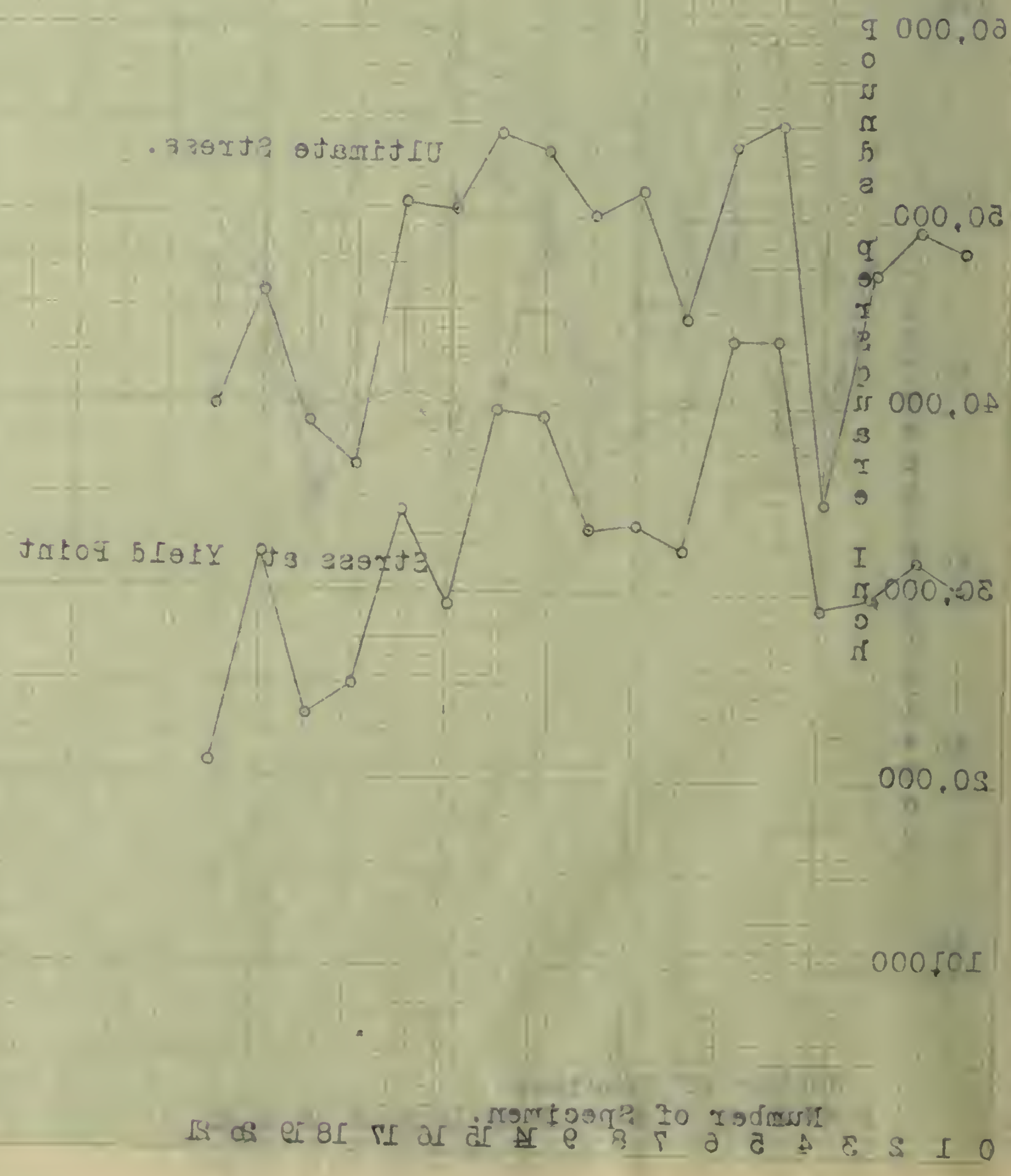
CURVES OF STRESS EFFICIENCY.

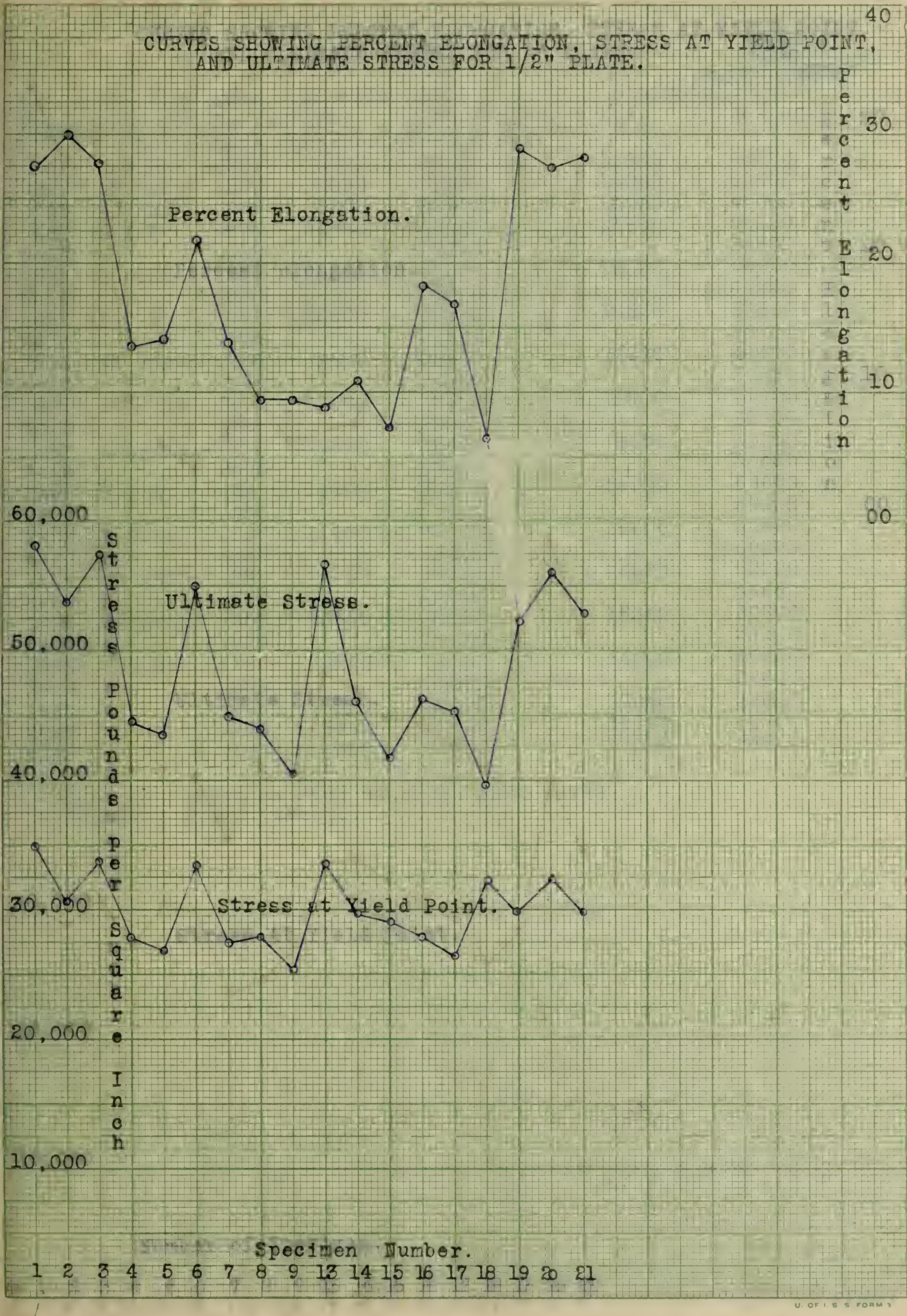


CURVES SHOWING STRESSES AT ULTIMATE AND ELASTIC LIMIT.
for
NUMBER 10 BLUE ANNEALED STEEL. (Approximately 1/8")

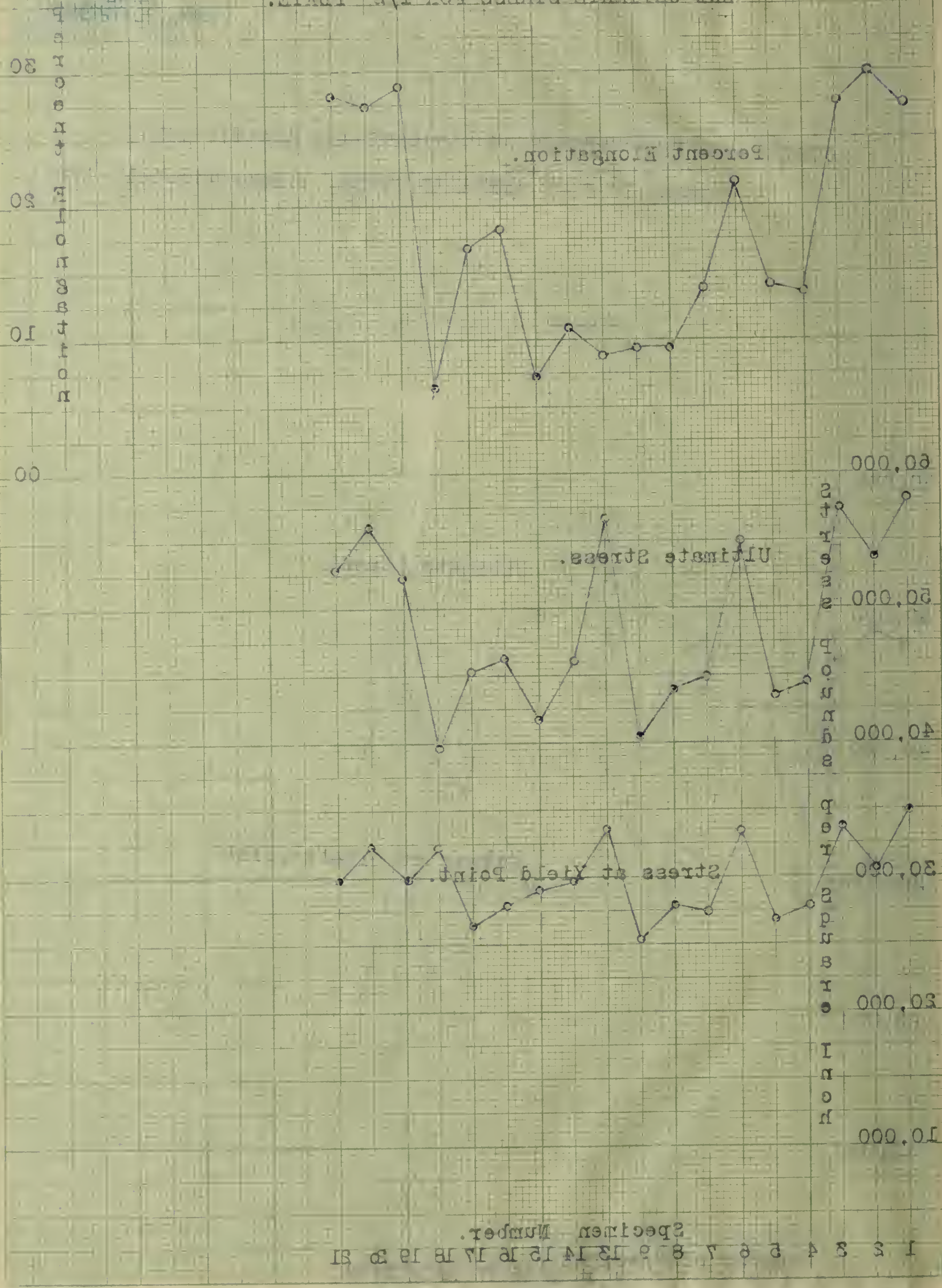


CURVES SHOWING STRESSES AT ULTIMATE AND ELASTIC LIMIT.
for
NUMBER 10 BLUE ANNEALED STEEL. (Approximately 1/8")

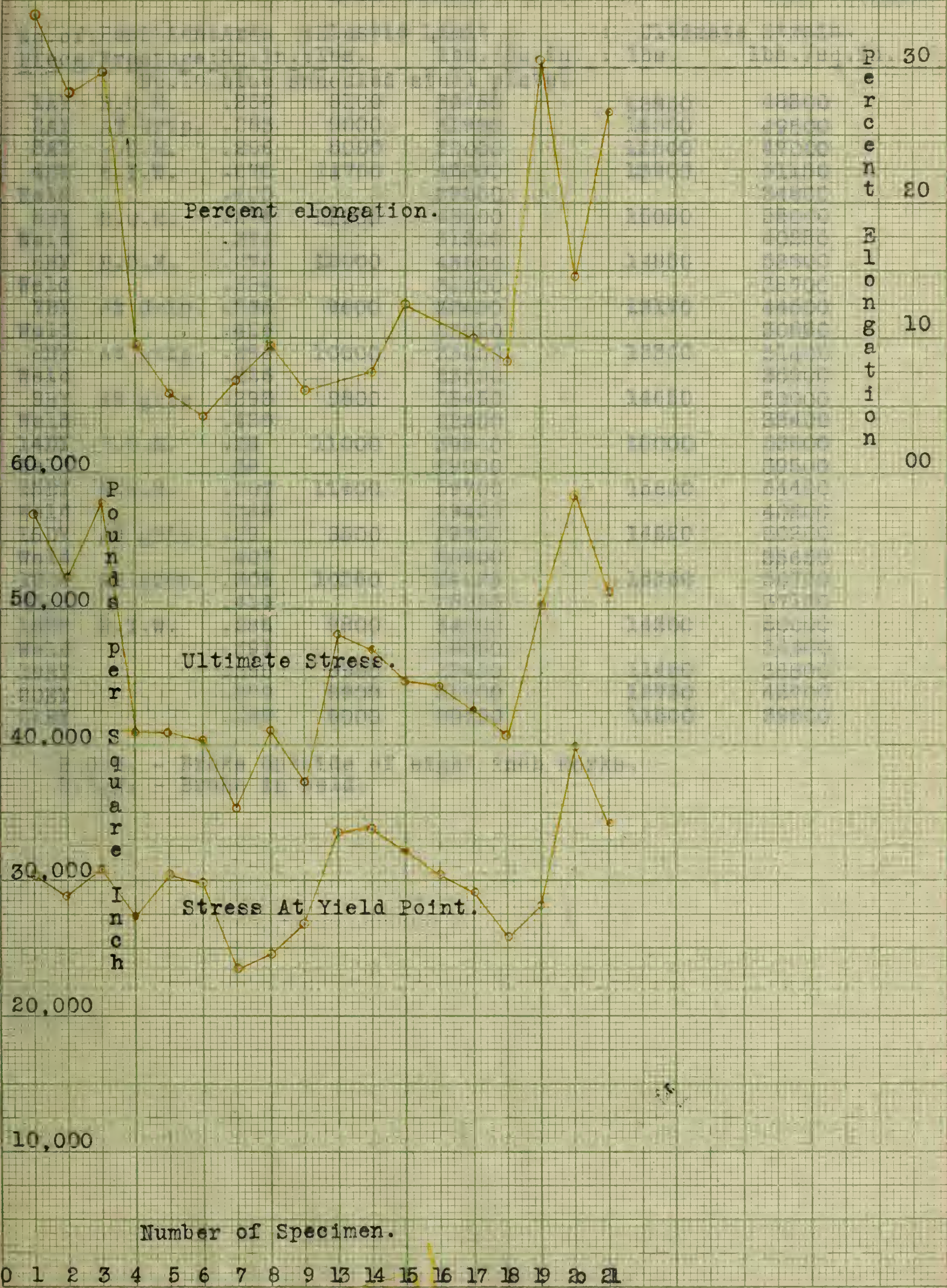


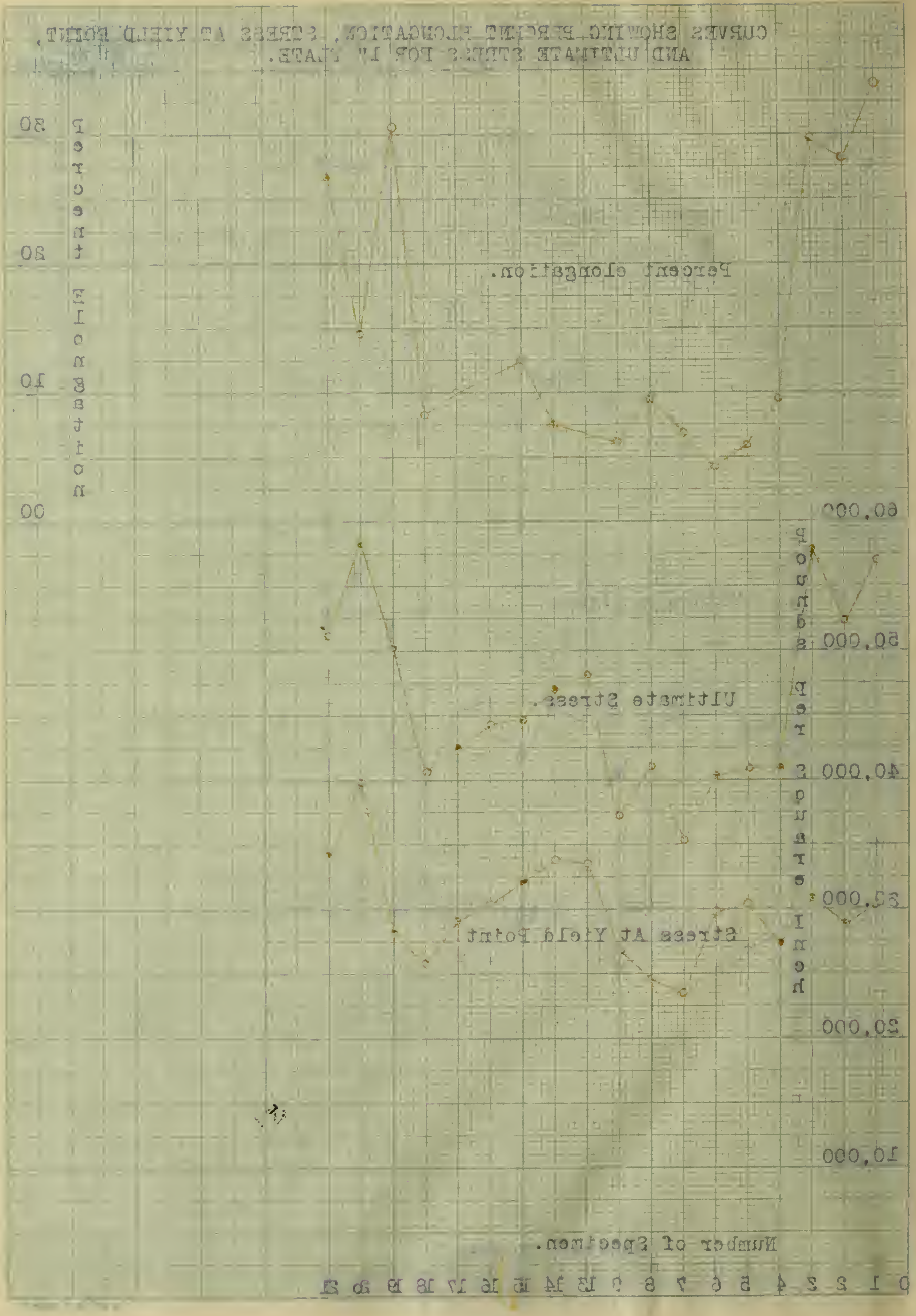

CURVES SHOWING PERCENT ELONGATION, STRESS AT YIELD POINT, AND ULTIMATE STRESS FOR 1/2" PLATE.
Percent Elongation.
Ultimate Stress.
Stress at Yield Point.
Stress Pounds per Square Inch
Percent Elongation
60,000
50,000
40,000
30,000
20,000
10,000
40
30
20
10
00
Specimen Number.
1 2 3 4 5 6 7 8 9 13 14 15 16 17 18 19 20 21
U. OF I. S. S. FORM 3

CURVES SHOWING PERCENT ELONGATION, STRESS AT YIELD POINT, AND ULTIMATE STRESS FOR 1/2" PLATE.



CURVES SHOWING PERCENT ELONGATION, STRESS AT YIELD POINT, AND ULTIMATE STRESS FOR 1" PLATE.





CURVES SHOWING PERCENT ELONGATION, STRESS AT YIELD POINT, AND ULTIMATE STRESS FOR 1" PLATE.
Percent Elongation
30
20
10
00
Percent elongation.
Pounds per Square Inch
60,000
50,000
40,000
30,000
20,000
10,000
Ultimate Stress.
Stress At Yield Point.
Number of Specimen.

DATA SHEET.

No. of Piece	Position Fracture	Area Sq. in.	Elastic Limit lbs.	lbs./sq.in.	Ultimate Strain. lbs.	lbs./sq.in.
		No. 10 blue annealed steel plate.				
1AY	B.O.M.	.266	8100	30450	12850	48300
2AY	AT Grip.	.283	9000	31900	14000	49500
3AY	B.O.M.	.266	8000	30000	12500	47000
4BY	B.I.W.	.272	11700	43000	13900	51150
Weld		.400		29250		34800
5BY	B.O.M.	.274	11900	43500	15050	55000
Weld		.374		31800		40250
6BY	B.O.M.	.276	12000	43500	14850	53800
Weld		.384		31200		38700
7BY	At Grip.	.296	9600	32450	13170	44500
Weld		.426		22550		30850
8BY	At grip.	.298	10000	33600	15300	51400
Weld		.426		23500		35900
9BY	At grip.	.293	9800	33450	14650	50000
Weld		.439		22300		33400
14DY	B.O.M.	.28	11000	39300	15000	53600
Weld		.38		29000		39500
15DY	B.O.M.	.287	11400	39700	15600	54400
Weld		.388		29400		40200
16DY	At grip.	.29	8500	29300	14520	50200
Weld		.407		20900		35650
17DY	At grip.	.302	10350	34225	15360	50700
Weld		.414		25000		37100
18DY	B.I.W.	.286	9800	34300	14300	50000
Weld		.391		25050		36600
19EY		.295	6900	23400	11450	38800
20EY		.279	8900	31900	12750	45700
21EY		.289	6000	20750	11500	39500

B.O.M. - Broke outside of eight inch marks.
B.I.W. - Broke in weld.

Elongation.		Efficiency %.	
in. in 8"	%	stress.	Load.
0.72	9	105.2	105.2
0.8.93	11.6		
1.85	10:6		108.7
		74	
1.17	14.6	117	117
0.72	9.0	114.5	114.5
		94.8	94.8
		109	109
		106	106
0.90	11.25	114	114
1.20.	15.00	116	116
		107	107
		108	108
			106
		78	
		82	82
0.74	9.26		
		84.7	84.7

DATA SHEET.

No. of Piece	Position: Fracture	Area Sq. in.	Elastic Limit lbs.	Elastic Limit Lbs./sq.in.	Ultimate Strain lbs.	Ultimate Strain Lbs./sq.in.
		1/4" Flange Steel Plate.				
1AY	B.O.M.	.54	20800	38500	30050	55700
2AY		.572	20000	35000	30650	53600
3AY	B.I.M.	.552	20900	37800	30300	54900
4BY		.513		39600		54600
Weld	B.I.W.	.718	20300	28250	28000	39000
5BY		.515		40800		57100
Weld	B.I.W.	.697	21000	30100	29400	42200
6BY		.511		391000		56250
Weld	B.O.M.	.71	20000	28150	28750	40600
7BY		.507		32800		49500
Weld	B.O.M.	.741	19900	26800	30000	40500
8BY		.591		34200		49300
Weld	B.O.W.	.753	20200	26800	29200	38750
9BY		.60		24800		45600
Weld	B.O.M.	.742	18400	30660	27400	36900
13DY		.524		42400		54900
Weld	B.O.M.	.676	22200	32800	28700	42500
14DY		.525		44150		57200
Weld	B.O.M.	.707	23200	32800	30000	42400
15Dy		.531		39500		56100
Weld	B.O.M.	.695	21000	30200	29800	42850
16DY		.586		32700		49750
Weld	B.O.M.	.728	19200	26400	29100	40000
17DY		.587		31150		48550
Weld	B.O.W.	.654	18300	27850	28500	43600
18DY		.598		28400		39800
Weld	B.I.W.	.664	17000	25600	23800	35900
19EY	MI	.591	18000	30450	30200	51160
20EY	B.I.M.	.554	21850	39400	30830	55650
21EY		.574	20300	35400	31100	54250

Elongation. In. in 8"	%	Efficiency. stress.	Load.
1.45	18.1		
2.85	35.6	96.8	96.8
2.2	27.5		
0.78	9.75	70.5	98.5
1.4	17.5	76.2	102
0.8	10	101.8	101.8
1.25	15.62	89.2	89.2
1.6	20	89.2	89.2
0.7	8.75	82.5	82.5
0.47	5.87	99	99
0.78	9.75	103	103
0.67	8.37	107	101
0.83	10.3	89.5	89.5
1.85	22.5	87.7	87.6
0.37	4.62	64.8	71.8
2.8	35	92	92
2.42	30.2		92
2.4	30	98	98
2			

DATA SHEET.

No. of Piece	Position Fracture	Area Sq.in.	Elastic Limit. lbs.	Elastic Limit. lbs./sq.in.	Ultimate Strain. lbs.	Ultimate Strain. lbs./sq.in.
		1/2" Flange Steel Plate.				
1Ay	B.I.M.	1.036	36100	34900	60000	58000
2AY		1.061	32400	30500	56900	53600
3AY		1.o38	35000	33700	59440	57300
4BY	B.I.W.	1.010		34600		55200
Weld		1.254	34900	27800	55800	44400
5BY	B.I.W.	1.050		33300		54200
Weld		1.309	35000	26800	57000	43500
6BY	B.O.W.	1.012		33400		55000
Weld		1.213	338[illegible]0	27850	55700	45800
7BY	B.I.W.	1.082		32100		52700
Weld		1.280	35000	27300	57500	44900
8BY	B.I.W.	1.110		31400		49550
Weld		1.252	34900	27900	55000	43900
9BY	B.I.W.	1.110		29000		46000
Weld		1.26L	32200	25300	51000	40500
13DY	B.I.M.	1.014		33500		56600
Weld		1.160	34000	29300	57500	49550
14DY	B.I.W.	1.020		33900		52400
Weld		1.161	34500	29600	53500	46100
15DY	B.I.W.	1.o47		34200		48950
Weld		1.227	35700	29100	51240	41750
16DY	B.I.W.	1.100		33000		54600
Weld		1.300	36200	27900	60200	46250
17DY	B.I.W.	1.110		30600		52200
Weld		1.27D	33900	26500	58000	45300
18DY	B.I.W.	1.100		32700		45750
Weld		1.275	36000	32000	50300	39500
19EY		1.115	33100	29700	58200	52200
20EY		1.070	34600	32300	60000	56000
21EY		1.120	33200	2965o	59100	52800
					591	

Elongation. In. in 8".	Elongation. %	Efficiency. % Stress.	Efficiency. % Load.
2.19	27.4		
2.37	29.6	93.8	93.8
2.22	27.75		
1.08	13.5	77.8	96.7
1.13	14.1	76.1	94.9
1.73	21.65	96	96.1
1.10	13.76	78.6	91.9
0.75	9.37	76.8	87
0.75	9.37	71.5	80.3
1.73	21.60	99.1	99.1
0.71	8.87	80.7	91.9
0.51	6.37	73.1	85.6
1.46	18.2	81.0	95.5
1.35	16.9	79.3	91.5
0.50	6.25	69.2	80
2.30	28.8	91.5	91.5
2.19	27.4		
2.25	28.1	92.5	92.5

DATA SHEET.

No. of Piece	Position Fracture	Area Sq.in.	Elastic Limit lbs.	Lbs./sq.in.	Ultimate Strain lbs.	Lbs./sq.in.
		One Inch Flange Steel Plate.				
1AY		1.317	40000	30400	74800	57000
2AY		1.57	45000	28700	82000	52200
3AY		1.243	38000	30750	71800	57600
4BY		1.317				47100
Weld		1.52	41500	27300	62000	40800
5BY		1.333				45300
Weld	B.I.W.	1.48	45000	30400	60400	40800
6BY		1.487				44350
Weld	B.I.W.	1.64	49000	29800	66000	40250
7BY		1.52				40750
Weld	B.I.W.	1.76	41000	23400	62000	35200
8BY		1.55				44250
Weld	B.I.W.	1.675	41000	24500	68600	41000
9BY		1.587				39300
Weld	B.I.W.	1.68	45000	26800	62400	37100
13DY		1.49				53000
Weld	B.I.W.	1.64	55000	33500	78900	48100
14DY		1.48				51600
Weld	B.I:W.	1.63	55000	33750	76500	47000
15DY		1.333				47550
Weld	B.I.W.	1.42	45500	32000	64390	44650
16DY		1.483				49200
Weld	B.I.W.	1.65	50000	30300	73000	44200
17DY		1.53				46850
Weld	B.I.W.	1.688	49000	29000	71700	42500
18DY		1.54				46000
Weld	B.I.W.	1.745	45000	25800	71000	40600
19EY		1.605	44900	28000	80700	50200
20EY		1.39	55000	39700	81200	58400
21EY		1.614	45000	34100	82200	51000

Elongation. in. in 8".	%	Efficiency %. stress.	load.
2.7	33.8		
2.25	28.1	90.5	90:5
2.36	29.5		
0.75	9.4	70.7	81.9
0.47	5.9	70.7	78.7
		69.7	77
0.55	6.9	61	70.6
0.75	9.4	71	76.9
0.49	6.13	64.3	68.2
1.00		83.4	91.6
		81.4	89
1.00	12.5	77.5	84
0.		76.8	85.5
0.82	10.0	73.7	81.2
0.65	8.1	70.4	80
2.43	30.4	87	87.2
2.15	26.8	88.4	88.5

Log Sheet #1

At OXWELD ACETYLENE CO.
CHICAGO.

Welding Test

Observers E. A. BROWN
G. W. WATTS

			X B	X C	X D	Y B	Y C	Y D	
1	Date		4-1-15 →						
2	Operator		C. OLSON →			E. OLSON →			
3	Blowpipe used		OXWELD #2 →						
4	Size Welding Head		#5 →						
5	Material Welded		#10 BLUE ANNEALED STEEL SHEET →						
6	Thickness of Stock	in.	″ →						
7	Length of Weld	in.	15	7½	15	15	7½	15	
8	Angle of Bevel	deg.	NONE →						
9	Time, Start		10:15 05	10:52 15	11:13 30	12:56 00	1:41 15	2:03 15	
10	" Stop		10:45 00	11:03 10	11:43 35	1:29 45	1:55 15	2:33 15	
11	" Welding	min.	29 55	10 55	30 05	33 45	14 00	30 00	
12	Welding Wire		⅛" NORWAY IRON →						
13	" " used	lb.-oz.							TOTAL 0-13
14	Stock, Before Welding	lb.-oz.	10-4	5-1	10-5	10-5	5-2	10-5	
15	" After "	lb.-oz.	10-7	5-3	10-7	/	/	/	
16	" Added	lb.-oz.	3	2	2				
17	Acetylene Supply		OXWELD 200# DUPLEX GENERATOR →						
18	" Start	cu. ft.	149.6	154.1	155.9	160.7	165.8	167.8	
19	" Stop	cu. ft.	154.0	155.8	160.5	165.6	167.7	172.1	
20	" Used	cu. ft.	4.4	1.7	4.6	4.9	1.9	4.3	
21	" Pressure	in. water	11 →						
22	Oxygen Supply		100 CU. FT. LINDE CYLINDER →						
23	" Start	lb.-oz.	120-8	120-2	120-0	119-9	119-1	118-14	
24	" Stop	lb.-oz.	120-2	120-0	119-9	119-1	118-14	118-8	
25	" Difference	lb.-oz.	0-6	0-2	0-7	0-8	0-3	0-6	
26	" Used	cu. ft.	4.2	1.4	4.9	5.6	2.1	4.2	
27	" Pressure	lb./sq.in.	12 →						
28	Room Temperature	deg. fahr.	68	68	68	68	68	68	

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Log Sheet #2

At OXWELD ACETYLENE CO.

CHICAGO

Welding Test

Observers E. A. BROWN
G. W. WATTS

			X B	X C	X D	Y B	Y C	Y D
1	Date		4-1-15 →					
2	Operator		C. OLSEN →			E. OLSEN →		
3	Blowpipe Used		OXWELD #2 →					
4	Size Welding Head		#7 →					
5	Material Welded		FLANGE STEEL PLATE →					
6	Thickness of Stock	in.	1/4 →					
7	Length of Weld	in.	15	7 1/2	15	15	7 1/2	15
8	Angle of Bevel	deg.	45 →					
9	Time, Start		3:05^{50}	9:38^{10}	10:33^{50}	4:29^{30}	9:00^{00}	12:53^{30}
10	" Stop		4:16^{05}	10:04^{45}	11:15^{00}	5:22^{45}	9:30^{40}	1:33^{10}
11	" Welding	min.	1:10^{15}	26^{35}	41^{10}	53^{15}	30^{40}	39^{40}
12	Welding Wire		1/8" NORWAY IRON WIRE, TWO-STRAND STRAIGHT					
13	" " Used	lb.-oz.	0-7	0-6	0-8	0-8	0-5	0-10
14	Stock, Before Welding	lb.-oz.	20-4	9-9	19-5	19-10	10-3	20-0
15	" After "	lb.-oz.	20-11	9-13	19-10	20-01	10-7	20-8
16	" Added	lb.-oz.	0-7	0-4	0-5	0-6	0-4	0-8
17	Acetylene Supply		OXWELD 200# DUPLEX GENERATOR →					
18	" Start	cu. ft.	172.4	207.0	213.9	189.1	201.1	224.3
19	" Stop	cu. ft.	189.1	213.9	224.3	201.0	207.0	235.4
20	" Used	cu. ft.	16.7	5.9	10.4	10.9	6.9	11.1
21	" Pressure	in. water	10 3/4 →					
22	Oxygen Supply		100 CU. FT. LINDE CYLINDER →					
23	" Start	lb.-oz.	172-4	115-5	114-13	117-0	116-0	113-13
24	" Stop	lb.-oz.	189-1	114-13	113-13	115-15	115-5	112-12
25	" Difference	lb.-oz.	1-7	0-8	1-0	1-1	0-11	1-1
26	" Used	cu. ft.	16.1	5.6	11.2	11.9	7.7	11.9
27	" Pressure	lb./sq. in.	16 →					
28	Room Temperature	deg. fahr.	55 →					
			X			X	X	

NOTE:-
X — THE WELDING HEAD USED IN THESE TESTS WAS NOT WORKING PROPERLY.

Log Sheet #3

At. OXWELD ACETYLENE CO.

CHICAGO

Welding Test

Observers. J.P. McWILLIAMS

			X	X	X	Y	Y	Y	Z	Z	Z
			B	C	D	B	C	D	B	C	D
1	Date		4-17-15	4-16-15	4-17-15	4-15-15	4-15-15	4-15-15	4-17-15	4-16-15	4-16-15
2	Operator		E. OLSON →								
3	Blowpipe Used		OXWELD #2 →								
4	Size Welding Head		#10 →								
5	Material Welded		FLANGE STEEL PLATE								
6	Thickness of Stock	in.	½								
7	Length of Weld	in.	15	7½	15	15	7½	15	15	7½	15
8	Angle of Bevel	deg.	45 →								
9	Time, Start		9:17^{00}	11:04^{00}	11:11^{30}	3:46^{30}	11:08^{15}	1:07^{20}	2:39^{00}	1:36^{00}	9:01^{00}
10	" Stop		10:23^{00}	11:38^{00}	12:20^{00}	5:05^{00}	11:40^{20}	2:15^{00}	3:39^{00}	2:17^{30}	10:05^{00}
11	" Welding	min.	1:06^{00}	29^{00}	1:08^{30}	1:18^{30}	32^{05}	1:07^{40}	1:00^{00}	41^{30}	1:04^{00}
12	Welding Wire		¼" NORWAY IRON WIRE →								
13	" " used	lb.-oz.	2-1	0-14	1-15	1-11	0-13	2-4	2-1	1-1	1-10
14	Stock, Before Welding	lb.-oz.	39-1	15-4	38-1	39-2	19-8	39-4	37-0	18-11	38-0
15	" After "	lb.-oz.	40-5	15-14	39-11	40-6	20-2	40-10	38-4	19-4	38-15
16	" Added	lb.-oz.	1-4	0-10	1-10	1-4	0-10	1-6	1-4	0-9	0-15
17	Acetylene Supply		OXWELD 200# DUPLEX GENERATOR →								
18	" Start	cu. ft.	949.5	925.6	994.5	840.0	773.8	791.2	1061.4	1036.0	885.0
19	" Stop	cu. ft.	994.5	946.3	1036.0	885.0	791.1	840.0	1099.6	1061.4	925.6
20	" Used	cu. ft.	45.0	20.7	41.5	45.0	17.3	48.8	38.2	25.4	40.6
21	" Pressure	in. water	10½ →								
22	Oxygen Supply		200 CU. FT. LINDE CYLINDER →								
23	" Start	lb.-oz.	142-14	145-4	138-12	146-7	137-7	150-10	132-10	135-4	142-3
24	" Stop	lb.-oz.	138-12	143-3	135-4	142-3	136-0	146-7	129-9	132-10	138-11
25	" Difference	lb.-oz.	4-2	2-1	3-8	4-4	1-7	4-3	3-1	2-10	3-8
26	" Used	cu. ft.	46.2	23.1	39.2	47.6	16.1	46.9	34.3	29.4	39.2
27	" Pressure	lb./sq.in.	21 →								
28	Room Temperature	deg. fahr.	70	70	70	70	70	70	64	64	64

Log Sheet......#4..........

At..OXWELD ACETYLENE CO.,

.........CHICAGO.....

Welding Test

Observers....J.P. McWILLIAMS

....

			B	C	D
1	Date		4-14-15	4-15-15	4-14-15
2	Operator		E. OLSEN →		
3	Blowpipe Used		OXWELD #2 →		
4	Size Welding Head		#12 →		
5	Material Welded		FLANGE STEEL PLATE		
6	Thickness of Stock	in.	3/4 →		
7	Length of Weld	in.	15	7 1/2	15
8	Angle of Bevel	deg.	45 →		
9	Time, Start		1:11:20	9:12:15	3:45:30
10	" Stop		2:38:00	9:46:00	5:04:00
11	" Welding	min.	1:26:40	33:45	1:18:30
12	Welding Wire		1/4" NORWAY IRON WIRE →		
13	" " Used	lb.-oz.	2-3	2-6	3-6
14	Stock, Before Welding	lb.-oz.	57-7	28-12	57-12
15	" After "	lb.-oz.	60-3	30-4	60-6
16	" Added	lb.-oz.	2-12	1-8	2-10
17	Acetylene Supply		OXWELD 200# DUPLEX GEN.		
18	" Start	cu. ft.	577.3	726.4	652.2
19	" Stop	cu. ft.	652.2	773.7	726.3
20	" Used	cu. ft.	74.9	47.3	74.1
21	" Pressure	in. water	10 1/4 →		
22	Oxygen Supply		100 CU. FT. LINDE CYL.	200 CU. FT. LINDE CYL.	
23	" Start	lb.-oz.	122-11	142-3	148-14
24	" Stop	lb.-oz.	115-15	137-7	142-3
25	" Difference	lb.-oz.	6-12	4-12	6-11
26	" Used	cu. ft.	75.7	53.2	75.0
27	" Pressure	lb./sq. in.	25 →		
28	Temperature of Room	deg. fahr.	62	62	62

Plates of soft steel, 4 feet 4½ inches x 18 inches
For thickness of different plates see sheet #2.

Fig. 1

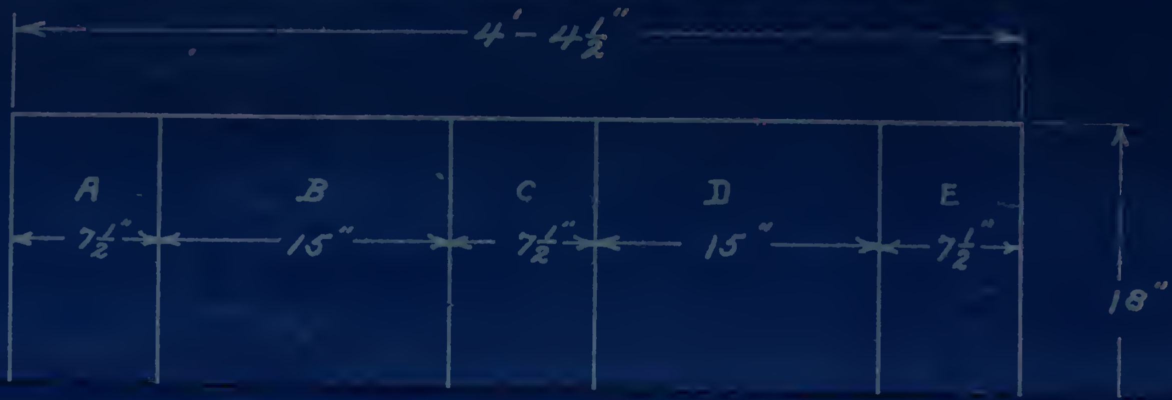
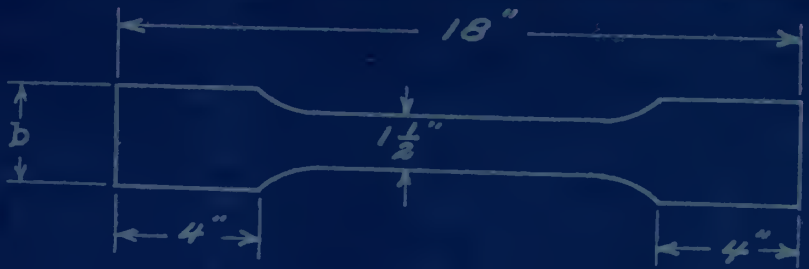


Fig. 4

b, width of test piece



Mill sides of each test piece to form specimen for tension test. This is omitted for some plates, see Sheet 2.

Operations to be performed on each plate.

For plates required see sheet 2.

TESTS OF OXYACETYLENE WELDING JOINTS

SHEET 1.

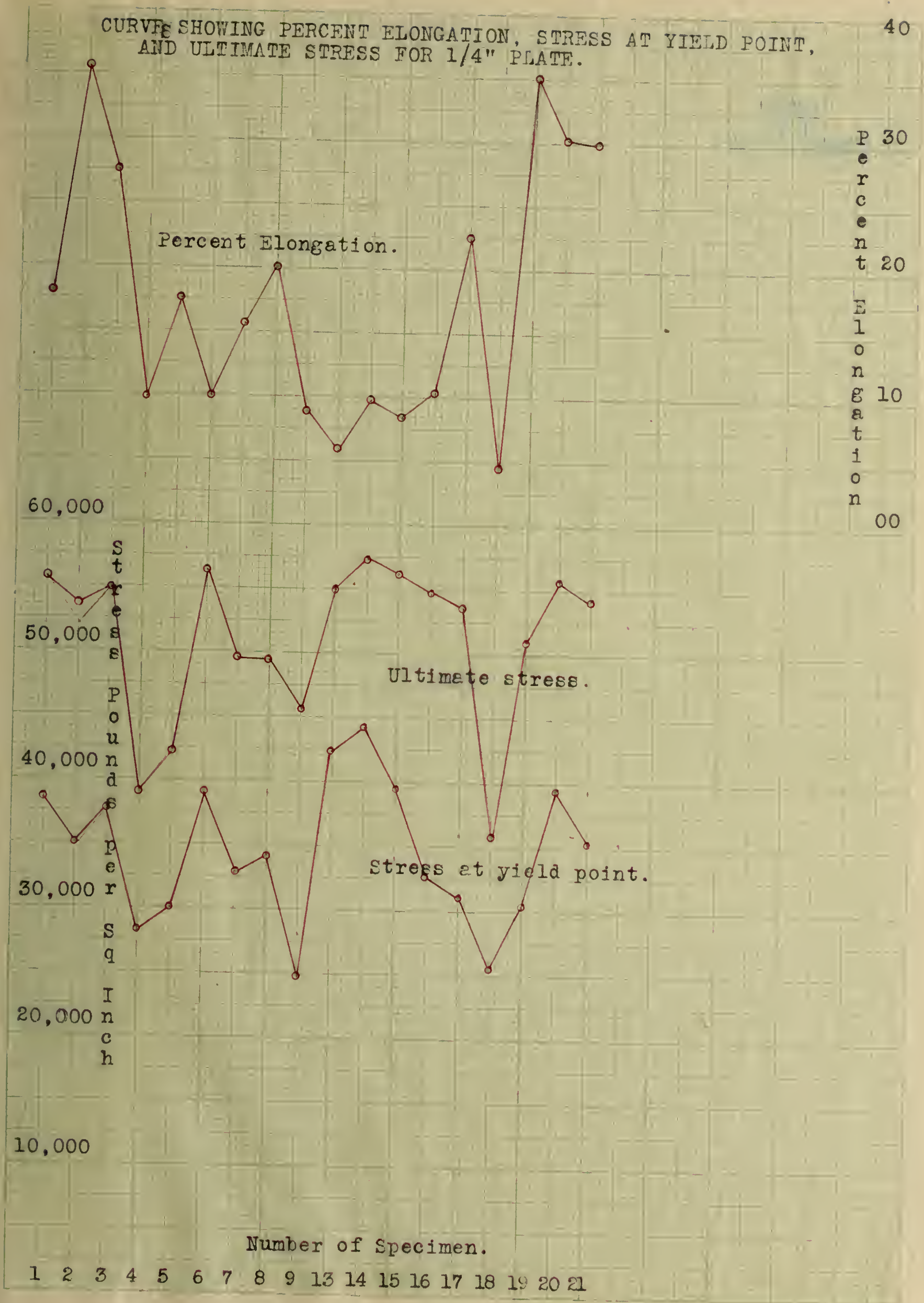
Log Sheet #5

At OXWELD ACETYLENE CO.
CHICAGO

Welding Test

Observers J. P. McWILLIAMS

			X B	X C	X D	Y B	Y C	Y D
1	Date		4-17-15	4-17-15	4-19-15	4-2-15	4-14-15	4-3-15
2	Operator		E. OLSON →					
3	Blowpipe Used		OXWELD #2 →					
4	Size Welding Head		#15 →					
5	Material Welded		FLANGE STEEL PLATE →					
6	Thickness of Stock	in.	1. →					
7	Length of Weld	in.	15	7½	15	15	7½	15
8	Angle of Bevel	deg.	45 →					
9	Time, Start		4:12 15	7:22 00	8:40 30	2:25 30	10:12 00	8:42 30
10	" Stop		6:32 30	8:31 00	11:00 15	4:24 30	11:14 30	10:50 00
11	" Welding	min.	2:20 15	1:09 00	2:19 45	1:59 00	1:02 30	2:07 30
12	Welding Wire		¼" NORWAY IRON WIRE →					
13	" " Used	lb.-oz.	5-11	3-1	5-14	6-3	3-1	6-2
14	Stock, Before Welding	lb.-oz.	74-0	36-10	72-6	72-14	34-12	72-3
15	" After "	lb.-oz.	78-11	38-12	76-11	77-8	38-2	76-11
16	" Added	lb.-oz.	4-11	2-2	4-5	4-10	3-6	4-8
17	Acetylene Supply		200# DUPLEX OXWELD GENERATOR →					
18	" Start	cu. ft.	1100.0	1251.8	1323.5	235.5	500.9	366.9
19	" Stop	cu. ft.	1251.8	1323.5	1482.2	366.7	576.1	500.9
20	" Used	cu. ft.	151.8	71.7	158.7	131.2	75.2	134.0
21	" Pressure	in. water	10 →					
22	Oxygen Supply		200 CU. FT. LINDE CYLINDER →			100 CU. FT. LINDE CYLINDER →		
23	" Start	lb.-oz.	153-1	148-11	152-11	121-0 122-6	121-4	119-5 123-1
24	" Stop	lb.-oz.	138-15	142-2	138-3	111-14 119-9 9-2 2-13	115-2	113-1 116-14 6-4 6-3
25	" Difference	lb.-oz.	14-2	6-9	14-8	11-15	6-7	12-7
26	" Used	cu. ft.	158.3	73.6	162.5	133.8	72.2	134.4
27	" Pressure	lb./sq.in.	30 →					
28	Temperature of Room	deg. fahr.	62	60	66	60	62	60


CURVES SHOWING PERCENT ELONGATION, STRESS AT YIELD POINT, AND ULTIMATE STRESS FOR 1/4" PLATE.
Percent Elongation.
Ultimate stress.
Stress at yield point.
Stress Pounds per Sq Inch
60,000
50,000
40,000
30,000
20,000
10,000
Percent Elongation
40
30
20
10
00
Number of Specimen.
1 2 3 4 5 6 7 8 9 13 14 15 16 17 18 19 20 21