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SILICON WEB PROCESS DEVELOPMENT

SECOND QUARTERLY REPORT

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C. S. Duncan, R. G. Seidensticker,
J. P. McHugh, P. D. Blais, and J. R. Davis, Jr.
Westinghouse Research & Development Center
Pittsburgh, Pennsylvania 15235

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Westinghouse R&D Center
1310 Beulah Road
Pittsburgh, Pennsylvania 15235

TECHNICAL CONTENT STATEMENT

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ABSTRACT

Thirty-five (35) furnace runs were carried out during this quarter, of which 25 produced a total of 120 web crystals. Lengths in excess of two meters and widths over 27 mm were achieved. A variety of lid and susceptor configurations have been used to modify the thermal geometry of the system in an effort to grow wider and longer web crystals of high quality.

The two main thermal models for the dendritic growth process have been completed and are being used to assist the design of the thermal geometry of the web growth apparatus. The first model, a finite element representation of the susceptor and crucible, has been refined to give greater precision and resolution in the critical central region of the melt. The second thermal model, which describes the dissipation of the latent heat to generate thickness-velocity data, has been completed. Both models have been validated by comparison of predicted results with experimental data; both are in excellent agreement with reality. The second model also gives temperature distributions in the growing web so that it can be applied to the evaluation of thermally generated stress in the crystal.

Width versus length data generated for dendritic web crystals indicate that the widening rates of the crystal are related to the lid design, however, the differences between most of the lid configurations are relatively small. More importantly, the data indicates that even in the current system which has only a 76 mm diameter crucible, ultimate widths of dendritic web crystals should be in the 30 to 40 mm range. Thickness measurements on the crystals being grown are in excellent agreement with the predictions of the thermal model, and modifications of the lid designs to increase the growth velocity are being investigated.

As longer and wider web is being grown, strain in some crystals has been noted. In these cases growth runs are intentionally terminated because of crystal warpage, rather than because of temperature fluctuations as in the past. Residual stress measurements based on crystal splitting are being made in some of the crystals being grown and these results will be correlated with predictions of the thermal models. The models will then be used to generate susceptor lid configurations producing smaller thermal stresses in the growing crystal.

In addition to the residual stress measurements, both x-ray topographic and etching examinations have been made on web crystals. To date, the results confirm earlier conclusions that most dislocations are generated in either the initial button or in the bounding dendrites. These studies are being continued to correlate crystal perfection with the growth conditions and with solar cell performance.

Dendritic web samples have been fabricated into solar cells using a standard cell configuration and a standard process for a N^+-P-P^+ configuration. The data indicates that web material can make very good solar cells with AM1 efficiencies greater than 14%. In a given fabrication run, cells made from a given crystal have almost identical characteristics. Further, analysis of the cell characteristics indicates that N^+-P junction on web cells is of extremely high quality. Work is presently in progress to correlate the cell performance with the material quality. Studies are also underway to develop improved processing techniques for dendritic web material.

The detailed engineering design was completed for a new dendritic web growth facility of greater width capability than previous facilities. Fabrication of component parts and assembly have begun.

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1. INTRODUCTION

The overall intent of this program is to further develop the dendritic web crystal growth process to the extent that it supports the economic goals of the Large Area Silicon Sheet Task of the Low-Cost Silicon Solar Array Project.

The ability of this process to produce crystals for high efficiency solar cells, 14 percent AM-1 or higher, is well known and has been demonstrated in pilot production and in this program. The prior state of development of the process did not, however, have sufficient throughput to satisfy the cost goals of the LSSA Project.

Consequently, a key goal of this program is to increase the throughput of the process in terms of greater width (to 7.5 cm), greater speed (to 7.5 cm/min) and greater length (to >10 meters) within the web thickness range of 100 to 200 μm. These goals are being sought via two growth facilities: an existing facility which is undergoing continued development and a new facility now in the construction and assembly phase.

The existing facility has produced crystals to 2.7 cm width and 3 meters length. Growth rates for useful material in the range of 100 to 200 μm thickness have reached 2.5 cm/min although some experimental growth at rates as high at 10 cm/min have been achieved for very thin web. The goal of this phase of the program is to achieve a growth width equal to the 5 cm dimensional capacity of the facility and a growth rate of 5 cm/minute. Both facilities have provision for adding polycrystalline silicon feed material to the melt for achieving a quasi-continuous growth.

The new facility, when completed, will have capacity to meet the full throughput goals stated above. The growth run experiments with both facilities will be used to identify the necessary on-line process parameter measurements and control.

Computer thermal models are a critical factor in the successful development of the process. The models are verified and refined initially by temperature measurements of sensors located in the thermal system and subsequently by correlation with actual web growth results. As the program progresses, a large volume of data is being generated and related to growth conditions, crucible system geometry, crystal quality, etc.

During the process development period with both facilities the web crystals grown will be used for several purposes. The growth is routinely selected and evaluated in terms of its dimensional, crystalline, electronic, and solar cell properties. For solar cell evaluation a "standard" fabrication procedure suitable for web crystals is used. Crystals are also provided for another program goal which is developing improved solar cell fabrication techniques especially suited to web crystals. Finally, selected web crystals and solar cells are being sent to JPL.

Growth runs will also be performed to determine the interaction of controlled amounts of selected impurities with growth conditions and parameters. This evaluation will be performed in a third web growth facility which is also used for other web programs.

As the program progresses, an economic analysis will be developed and updated in response to continued process development.

2. TECHNICAL DISCUSSION

Experimental Web Growth

The major objectives of the work during this reporting period have been (1) to improve the thermal geometry as required to increase web width, (2) to gather baseline thermal data both for system characterization and for input to the thermal modeling, (3) to verify experimentally the results of the thermal modeling, and (4) to grow web material for evaluation and solar cell processing.

During this reporting period, 35 furnace runs were made, of which 25 were productive web growth runs. A total of 120 identified web crystals were grown. Pertinent data for each is tabulated in Section 6.1. Continuous lengths of over two meters and widths over 27 mm were obtained.

The experimental procedures in the web growth runs have involved systematic variations in lid and susceptor configurations so as to alter heat losses and thus refine the thermal geometry of the melt in an effort to grow wider web crystals. In order to strengthen the data base, configurational features, e.g., slot geometry, are sometimes used which are not necessarily expected to be productive from a web throughput point of view, but provide valuable information as part of a systematic series of changes. We feel that this approach provides an extended data base which will be very beneficial in the long run. In addition, this approach permits us to test and verify the results of the thermal modeling. Thus, we have established a consistency between experiment and modeling results which give confidence in the usefulness of the modeling for guidance in future design changes.

As longer and wider web crystals have been grown, we have observed in some cases crystal deformation due to thermally induced strain. This has resulted in prematurely terminating the crystal growth while the web was still widening. Thus the full width capabilities of our experimental configurations have not yet been realized. This factor introduces an extra thermal requirement in the design of experimental configurations in addition to maximizing web width. The origin of the thermally induced strain and strategies for minimizing its harmful effects are discussed in more detail later in this report.

Crucibles fabricated by Amersil Corp. have been obtained and used during this period. These have substantially improved run-to-run reproducibility by minimizing the variations in fit between crucible and susceptor which had plagued us previously.

Thermal Modeling Related to Dendritic Web Growth

In the present development program two separate thermal models are being developed as design tools to facilitate the development of appropriate crucible and susceptor configurations. The first model, which calculates the three dimensional temperature distribution in the susceptor and melt, has as its goal the development of a temperature distribution conducive to the growth of wide dendritic web. The second model, which analyzes the dissipation of the latent heat of fusion both to the web itself and to the supercooled melt, has as its main goal the development of a slot geometry conducive to increased growth velocity. This model also provides the basic temperature data necessary for an analysis of any thermally induced stress in the growing ribbon.

During this quarter, the first model was completed and temperature distributions were calculated for a series of lid slot geometries, some of which are shown in Fig. 1. These initial results showed considerable scatter in the temperature plot, a "grain" which was attributed to the rather coarse net of connections used to model the radiation transfer from the melt surface. The melt surface was modeled as a rather large number of elements, and several elements were grouped to a single radiation link. Initially, it was thought that the "grain"

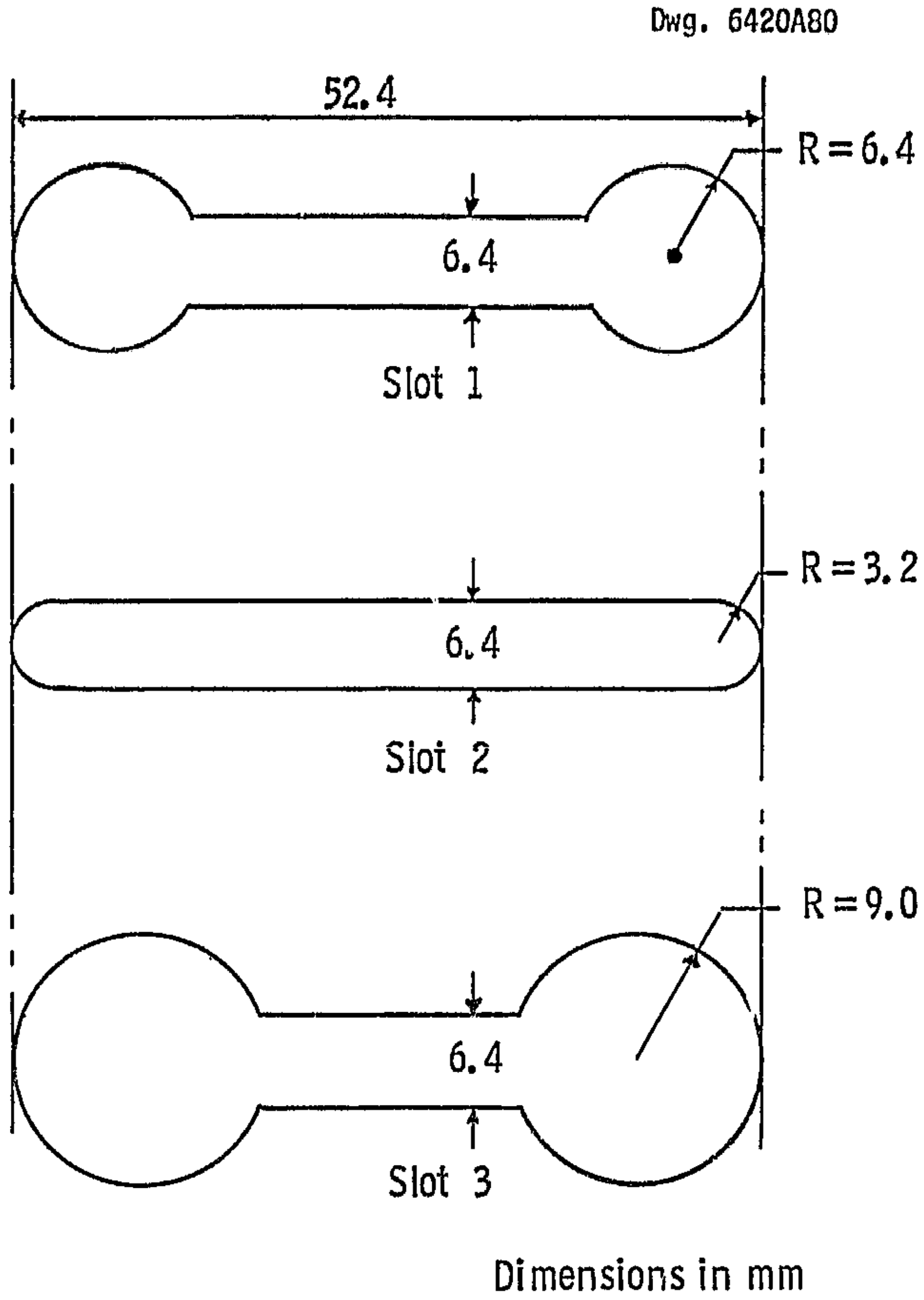

Fig. 1 — Lid slot geometries

in the output could be tolerated and reasonable results obtained by averaging the points. In one instance, however, the calculations showed an unmistakable temperature minimum in the temperature profile when there was no physical reason for such a minimum to occur. Since a modest amount of precision if not accuracy was desired, especially near the center of the melt, the model was refined by making radiation links to every surface node. These three links represented the radiation transfer to the slot, to the lid, and to the wall of the susceptor above the melt. When this modified version of the model was run, the scatter in the temperature profiles was essentially eliminated and the unexpected minimum was not observed. Two typical melt surface temperature profiles are shown in Fig. 2. One of the profiles is for the lid geometry with slot 1, and the other profile is for slot 5, a modification of slot 2 where the total length has been increased to 70 mm. Also shown in Fig. 2 is the temperature profile along a radius perpendicular to the slot. This profile is essentially the same for both slots. It can be seen that the temperature profile parallel to the slot is essentially flat for 1 to 1.5 cm either side of center, which is consistant with the observation that the web continues to widen even at 27 mm total width.

It should be noted that the temperatures plotted in Fig. 2 are "adjusted temperatures;" the computed temperatures have been adjusted to give 1685°K at the center of the slot. Although measured temperatures in the susceptor wall have been used as the boundary conditions for the model there is some uncertainty in the actual thermocouple calibrations, etc. and the actual calculated temperatures differ by about 6° from the measured temperatures in a system. From a thermal model standpoint, this differential is not significant, and considering the uncertainties in the thermal constants of the materials, especially the heat transfer from the molybdenum susceptor to the silicon melt, this agreement seems excellent.

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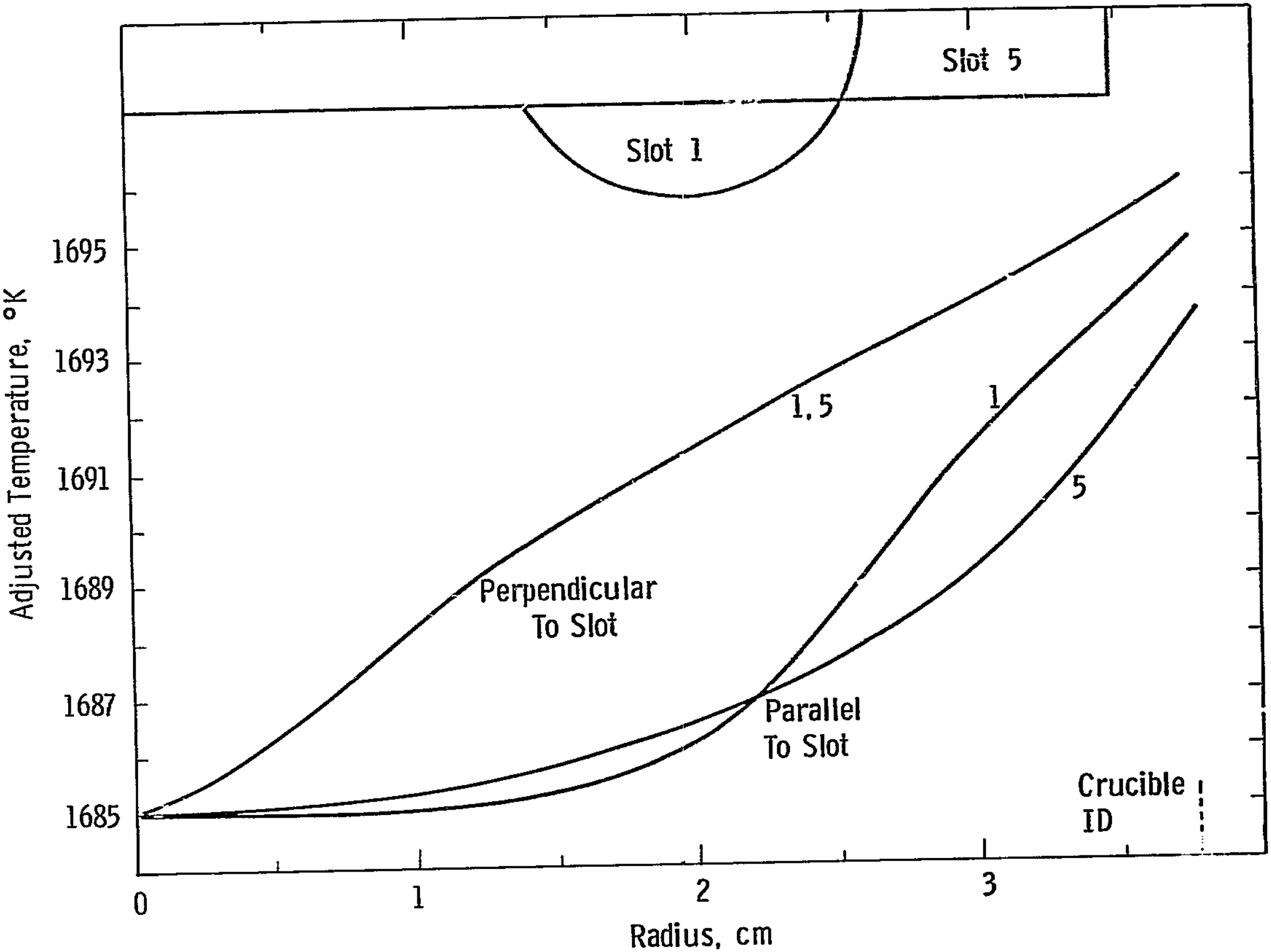

Fig. 2 — Calculated temperatures on melt surface

These results seem to validate the thermal model and it can now be used as a design tool for further development of susceptor and lid configurations. Two extensions of the model are presently under development. The first is a circular crucible and susceptor similar to the present design but with a 106 mm diameter crucible instead of the present 79 mm crucible; the susceptor dimensions are unchanged (see Drawings 1689B31, items 1 and 2, and Drawing 8520D49). In addition, an elongated crucible and susceptor are being modeled (Drawings 8520D52 and 1691B62).

The second thermal model describes the modes of dissipation of the latent heat of freezing in order to develop thermal designs for faster growth. As with any ribbon growth technique, part of the latent heat is dissipated through the growing ribbon itself. In addition, since dendritic web grows from a supercooled melt, some of the latent heat is dissipated to the liquid silicon. Both heat loss modes have been modeled, and a thickness-velocity curve has been generated for a lid configuration which has actually been used to grow web. A comparison of the experimentally observed thickness-velocity data with the predictions of the model is shown in Fig. 3. It can be seen that the agreement between theory and experiment is excellent, which gives a high degree of confidence both for the overall model and for the individual components of the model.

The particular lid design for the case shown in Fig. 3 was the starting geometry in a series of experiments on the effect of beveling the edges of the slot. The lid was relatively thick (8 mm) and had no bevel on the slot. As can be seen, this low heat loss condition gave relatively slow growth, e.g., a 150 μm web would grow at only 1.3 cm/min. A 3 mm x 3 mm bevel on the slot increased this velocity to about 2 cm/min, and a 6 mm x 6 mm bevel increased the velocity to about 3.5 cm/min. In addition to such parameters as the effective lid thickness (slot bevel), the thermal model also indicates that other parameters such as lid temperature, top shield temperature, slot width, melt level below lid, etc. can be used to tailor the temperature profile in the growing web.

Curve 692282-A

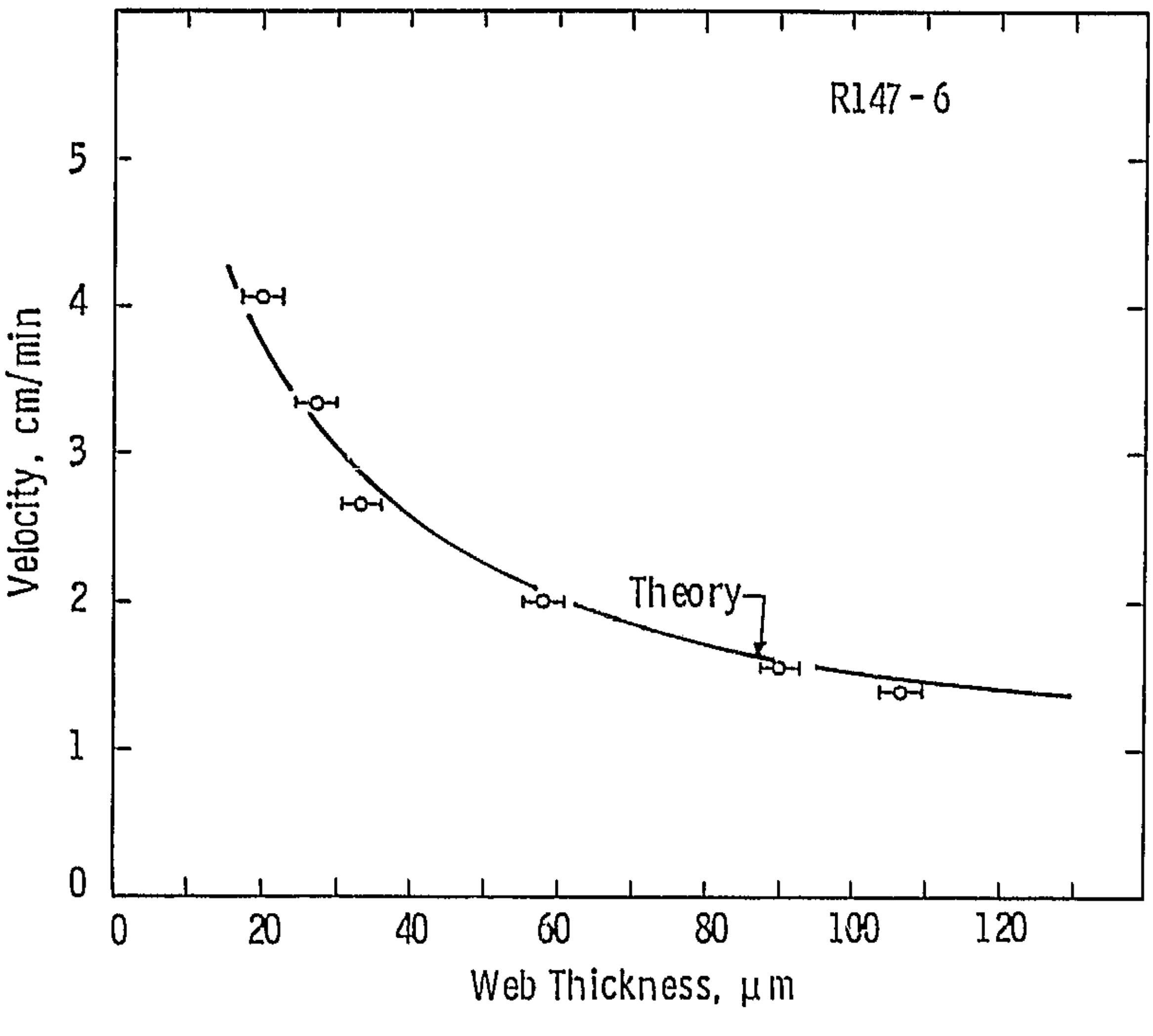

Fig. 3 — Thickness - velocity behavior

Since these factors all produce a multitude of other interactions in the growth behavior, continued study and development is necessary to arrive at a configuration which could be considered optimum.

Mechanical and Dimensional Characterization

In keeping with the program emphasis on the growth of wide dendritic web, much of the material characterization has been dimensional. The widening rate of the crystals is of particular interest, as well as the steady state width for a given system configuration. The widening rate data for the crystals grown during the quarter is shown in Table 1, both in terms of dW/dL and dW/dt. There is a moderate amount of scatter in the data, but some trends can be discerned. First, the first crystals pulled during a run tend to have the fastest widening rates. This apparently has to do with the level of the melt below the crucible lid which in turn affects the heat loss from the meniscus. Second, crystals pulled from melts having beveled slots in the lid widen faster than crystals pulled through unbeveled slots. This apparently is the result of modification of the heat loss from the meniscus at the edges of the dendritic web. The variations in slot geometry should have little effect on the temperature distribution near the center of the melt as a whole, but could have a somewhat greater effect on the heat loss from the meniscus regions. A variety of slot designs are being considered for other reasons and the effect on the widening rate will be studied.

Perhaps more important than the widening rate itself, is the tendency for the crystals to reach a steady state width. In most instances, the dendritic webs are continuing to widen when growth is purposely terminated. Although in some instances a tendency for steady state width is seen, most widening behavior is exemplified by the width-length curve shown in Fig. 4 for crystals R172-4 and R172-6. This result is consistant with the calculated melt temperature profile for slot 5 shown in Fig. 2. Even with a 76 mm diameter crucible, the

Table 1

Dendritic Web Widening Rates

Crystal Number	Widening Rate $10^3 \times \frac{dW}{dL}$	Thickness μm	Widening Rate $10^3 \times \frac{dW}{dt}$ cm/min	Remarks
140-1	7.25	210	16.0	
140-6	6.45	152	13.4	
141-1	7.35	315	15.3	
141-2	6.68	215	13.9	
141-4	7.40	203	15.4	
147-3	7.05	127	11.7	7.9 mm thick lid with 6.4 x 57.2 mm straight slot; no bevel in slot.
147-4	6.15	130	9.5	"
147-5	5.50	116	8.36	"
149-1	6.65	127	12.9	12.7 mm dia. holes added to above slot.
149-4	5.70	125	9.5	"
150-6	7.67	121	16.1	"
151-5	8.95	124	16.1	"
151-7	9.10	114	16.4	"
151-9	7.90	124	13.1	"
152-1	9.20	193	17.7	Lid as above with 3 x 3 mm beveled slot.
152-2	8.35	175	16.1	"
153-1	8.25	188	16.0	"
153-3	8.16	132	15.8	"

Table 1 (cont.)

Dendritic Web Widening Rates

Crystal Number	Widening Rate $10^3 \times \frac{dW}{dL}$	Thickness μm	Widening Rate $10^3 \times \frac{dW}{dt}$ cm/min	Remarks
154-1	8.14	150	15.0	
154-2	7.92	150	14.3	
154-3	6.14	155	11.9	
154-6	5.76	165	9.6	
156-1	6.90	160	13.4	Dogbone slotted lid; 6.3 mm wide terminated by 12.7 mm dia. holes on 44.5 mm centers; 3 x 3 mm bevel. (oxide problems)
156-2	4.80	168	9.3	
156-3	5.54	150	10.5	
157-1	7.78	165	15.1	"
157-3	7.78	140	15.1	
157-4	4.80	122	8.7	
160-1	8.65	210	18.0	"
160-2	8.67	165	16.8	
160-3	7.80	170	14.0	
163-1	8.30	146	15.6	Straight slot, 6.4 mm wide by 66.6 mm long. No Level.
163-2	7.00	120	12.6	
165-1	7.80	145	15.1	
165-2	6.40	162	11.5	"

Table 1 (cont.)

Dendritic Web Widening Rates

Crystal Number	Widening Rate $10^3 \times \frac{dW}{dL}$	Thickness µm	Widening Rate $10^3 \times \frac{dW}{dt}$ cm/min	Remarks
170-1	7.76	173	15.1	Straight slot, 6.4 mm wide by 66.6 long. No bevel.
170-2	6.67	130	12.9	
170-3	7.30	128	13.1	
171-2	6.10	148	11.8	Slot as above, but beveled at ends.
171-3	6.10	150	11.8	
172-4	7.00	160	14.0	Straight slot, 7.4 mm wide by 66.6 mm long, beveled at slot ends only.
172-6	8.10	150	14.6	
173-2	7.70	165	15.0	
173-4	7.10	113	15.6	"
173-5	7.06	113	13.5	

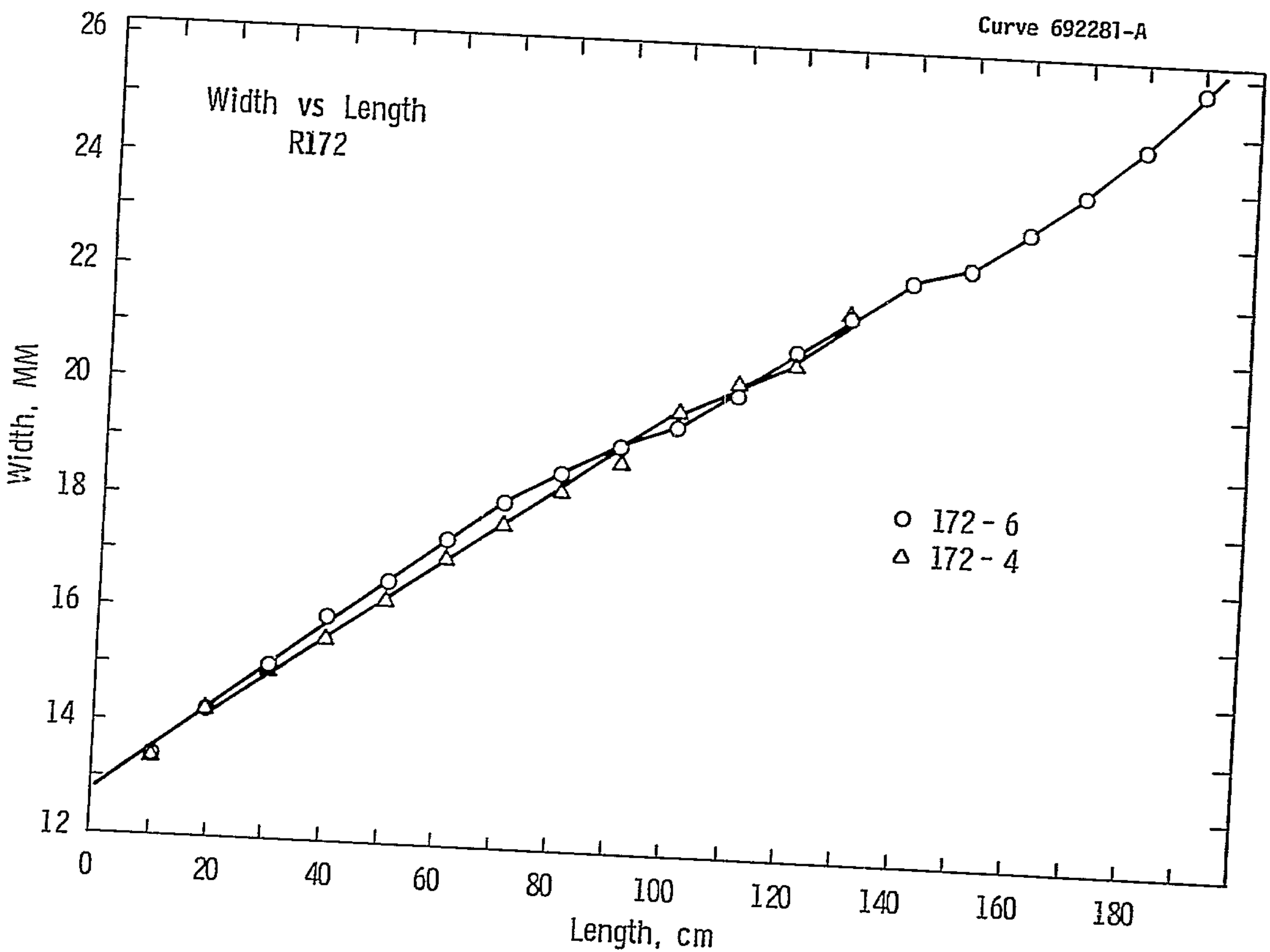

Fig. 4 — Typical dendritic web widening

ultimate steady state width for dendritic web has not yet been reached. Data from runs where some curvature is seen in the W-L curve leads to an estimate of 30 to 40 mm as the steady state width for the present system. This would be consistant with the calculated thermal profiles.

Web Thickness

The thickness of a web crystal growing at a given velocity depends on the supercooling of the melt and on the ability of the web itself to radiate heat. Both of these factors were included in the thermal modeling for the velocity-thickness calculations, and it was found that such factors as the lid thickness and bevel on the slot should have a strong effect. Web thickness measurements have, therefore, been directed toward validating the thermal model; specific data is given in Table 1 with the widening rate data and in the run summary, Appendix 6.1. For practical reasons, the growth velocity for most runs is adjusted to give crystal thicknesses between 100 and 200 μm.

Residual Stress

Strain in dendritic web crystals is becoming an increasingly important consideration as longer and wider crystals are being grown. Early in the program, the growth of many crystals terminated spontaneously because of what we believe to be convectively generated temperature fluctuations in the melt. With improvement in thermal conditions, this phenomenon has become rare and instead some crystals develop a warp and twist after several meters of growth and the pull must be terminated in order to remove the crystal through the withdrawal duct. This behavior is suggestive of the thermally generated stress found by people working with other ribbon growth techniques in that the problem is accentuated in wider crystals. An excellent general discussion of the phenomenon is given in the Mobil-Tyco Annual Progress Report of September, 1976.[1]

Briefly, a non-linear temperature profile along the length of the growing ribbon can cause stresses which in turn can produce both plastic and elastic deformations in the ribbon. These stresses are functions of both the ribbon width and the higher derivatives of the temperature profile. For example, a major component of the axial stress is given by

$$\sigma_{zz} = \frac{\alpha Y W^2}{6} \left(1 - 3\frac{y^2}{W^2}\right) \frac{d^2T}{dz^2}$$

where α is the thermal expansivity, Y is Young's modulus, W is the half width of the ribbon, the z coordinate is along the length of the ribbon and the y coordinate is in the plane of the ribbon perpendicular to z. Other stress components depend on higher derivatives and also have a higher power in the width dependence. Thus as wider ribbons are grown, thermal stresses should become of increasing importance. In order to reduce the stress in the growing crystal, the curvature of the temperature profile must be reduced. Other ribbon growth techniques accomplish this flattening of the temperature gradient by the use of after heaters; in the dendritic web technique, the thermal analysis developed for increasing the velocity also shows that a great deal of control over the temperature profile is possible by careful design of the susceptor cover. In fact, in some instances, the second derivative, d^2T/dz^2 is actually negative over a portion of the crystal near the melt; the hot slotted lid actually is heating the web.

The experimental study of the residual stress in dendritic web crystals has only recently been started. The technique which has been used to characterize any residual stress in the dendritic web is the well known method of measuring the curvature of a ribbon which has been split down the center. The relevant equation is

$$\sigma = \frac{YW}{4} b_2$$

where σ is the stress (before splitting, the ribbon has a tension σ at the edges, and a compression $-\sigma$ at the center), Y is Young's modulus, W is the total width of the ribbon and b_2 is the coefficient in quadratic expression for the width of the split as a function of length

$$y = b_0 + b_1 x + b_2 x^2$$

Here y is the separation between the two halves of the crystal and x is a coordinate along the length of the crystal. Fitting the experimental data to this quadratic form removes a variety of experimental uncertainties such as the origin of the crack, and any possible tilt in the x axis or constant separation of the two pieces of the crystal. In practice, the actual data shows a coefficient of determination of 0.998 or better, indicating an excellent agreement of the experiment to the assumed model. Data for some of the web samples is shown in Table 2. The stress values seem to be generally smaller than reported for other ribbon growth techniques. Although it may be a fortuitous result, the crystal with the lowest residual stress was grown with a lid which should have had a smaller d^2T/dz^2 than the other lids. Further design studies and experiments along this direction are being undertaken.

Table 2

Crystal No.	Width cm	Thickness μm	Growth Speed cm/min	Residual Stress dynes/cm^2	Residual Stress psi
R136-9	1.60	188	1.94	2.4×10^8	3480
R153-1	1.65	170	1.94	2.0×10^8	2915
R160-2	2.28	165	1.94	2.1×10^8	3090
R165-4	1.52	84	1.94	1.9×10^8	2712
R172-5	1.46	173	1.80	1.0×10^8	1522

Crystal Perfection Studies

To date, only a limited amount of study has been given to the crystalline perfection of the dendritic web crystals. A limited number of x-ray topographs and etching studies have been done, however, and so far the results are in agreement with the observations of earlier investigators.[2-6] Dislocations apparently arise primarily from two sources: the button portion of the crystal, and as bursts in the bounding dendrites. Various possible techniques will be investigated for reducing these imperfections in the crystal. Although the thermal stress may be a significant factor in the degeneration of the web crystals, other mechanisms involving dislocations cannot be ruled out, and these studies will be continued at an accelerated pace.

Solar Cell Studies

Since solar cells are the anticipated end product of a dendritic web crystal growth process, solar cell studies are being conducted as part of the overall growth program. Two general tasks are being undertaken in the solar cell area: 1) the use of a standard cell design and fabrication process to provide an evaluation of the material on a semi-routine basis and 2) an investigation of techniques for improving the efficiency of solar cells made on dendritic web.

The solar cell design chosen as a standard for material evaluation is one that has been in use for some while in other studies.[7] The general design of the test device is shown in Fig. 5. This design was originally intended for making standard test cells on Czochralski material, and contains a number of test devices in addition to the 1 cm square cell in the center of the pattern. When this mask is used for fabricating devices on dendritic web material, only the central portion of the patterns is used. A typical dendritic web cell and a "baseline" cell on a Czochralski wafer are shown in Fig. 6.

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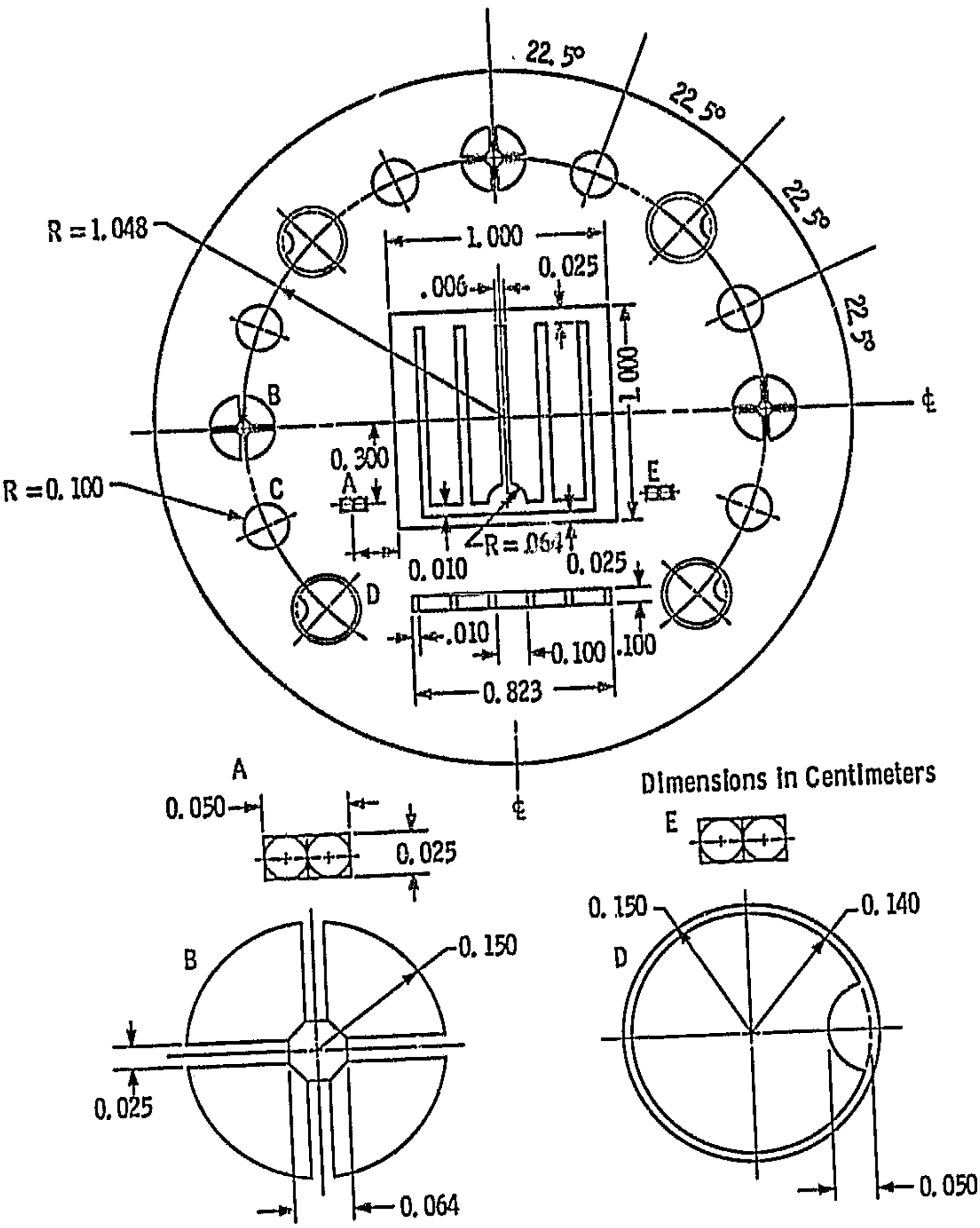

Fig. 5 — Standard solar cell and test pattern design

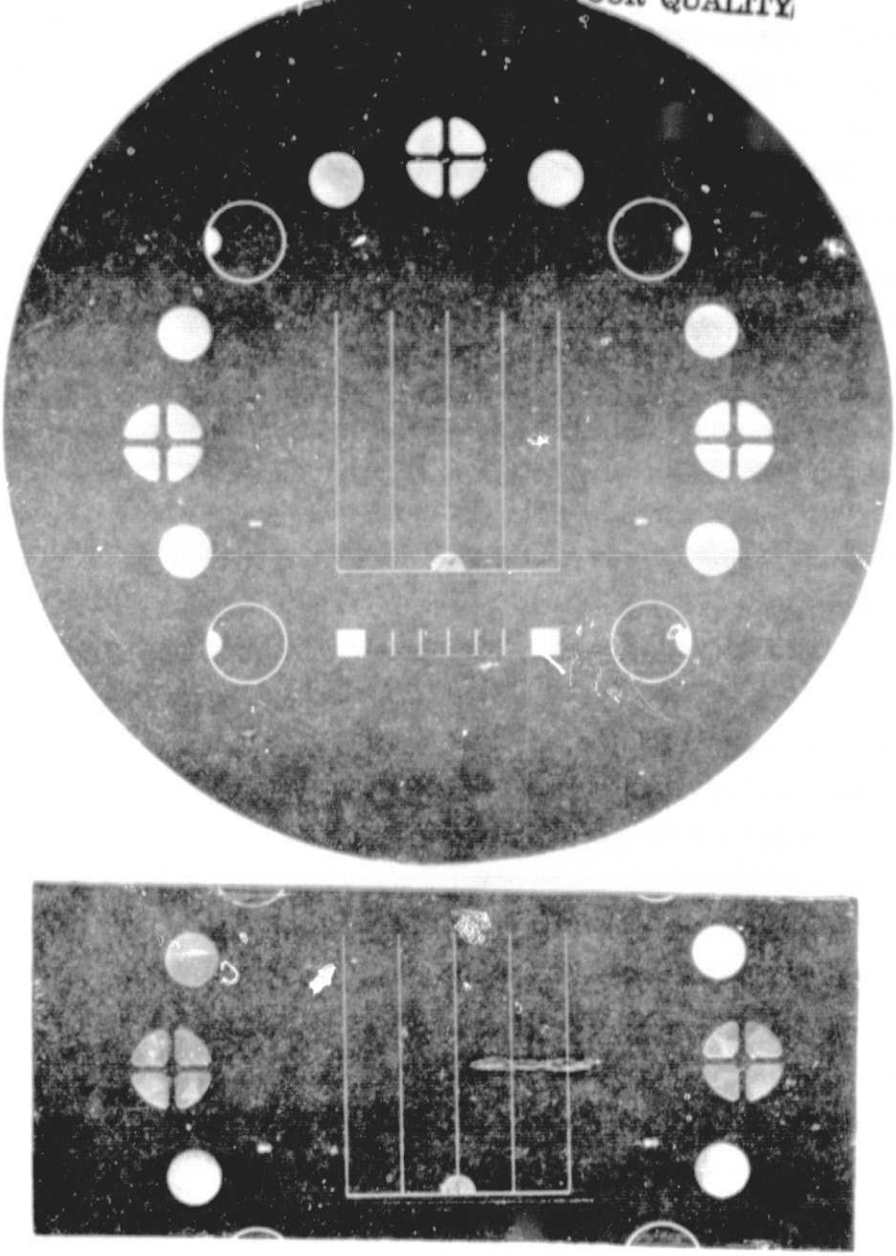

Fig. 6 Dendritic Web and Baseline Czochralski Cells

The device processing technique being used for cell fabrication is also very similar to that being used for other studies, with several small changes appropriate to the web material being processed. First, the web surface is in a highly perfect condition as grown, so no other surface preparation other than an oxide removing rinse is done. More importantly, since the material being grown on this program is of the order of 150 μm thick (6 mils), the cell structure includes a P^+ layer on the back surface to provide a minority carrier reflecting back surface field (BSF). The entire process is summarized in the sample run sheet shown as Fig. 7. In a given fabrication run, the individual cell blanks are identified so that material from several crystals can be run and separately identified. Also included in every run are five Czochralski wafers run as baseline material to give a check on the processing reproducibility.

Once the cells are fabricated, they are measured under simulated AM1 illumination and the data fed to a computerized data bank for reduction and printout of the device characteristics. A typical printout is shown in Fig. 8. The Baseline cells are identified by a "B" in their ID, and dendritic web cells by an "R" (except for 1R* which is a standard cell for calibrating the light source). An asterisk by the ID means that sample was not used in calculating the group averages. ISC is the short circuit current; VOC the open circuit voltage; IP the peak power; FF the fill factor, EFF is the efficiency and OCD is a lifetime measured from the diode decay of the device. The other data, LOG(IO), N, and R are parameters used in fitting the data to a standard model. The computer program computes the parameter averages and standard deviations for the baseline cells and the experiment cells and also gives percent of baseline for the experiment cell averages.

Generally, the solar cells fabricated on this program are measured without an anti-reflectance (AR) coating; if an AR coating is used, it is noted on the data printout. Several sets of cells have

Web grown silicon N+/P/P+ Solar Cells (Back Side, P+ identified by number)

Start Date:	PROCESSING LOG	Run or Sample RIBON
Material:		
Quantity: / Engr. P. Blais	9C40 RIBON 77	

Date Tech.	Process	Special Instructions, Measurements, etc.	Disp. C	Disp. E
	Identification	Scribe serial numbers on either side of web near one end to identify P+ side of structure		
	CLEAN (1)	$HF:H_2O$ (1 to 10 ratio) dip 15 sec. H_2O_2 - NH_4, H_2O_2 - HCℓ		
	BORON DIFF. (2)	Boron Deposition, BBr_3 @ 960°C 2-20-2 min. Numbered side up. Very slow pull (5 min/2 inches)		
	REMOVE OXIDE (3)	3:1 (H_2O:HF) until all oxide is removed R_s = ________ Ω/□ (Target value = 60 Ω/□)		
	CVD SiO_2 (4)	Deposit 5000 Å CVD oxide @ 850°C on back (numbered) side. Slow cool by reducing power very slowly (10 min.)		
	ETCH SILICON (5)	Mask CVD SiO_2 with apeizon wax etch silicon on bare side, strip wax, H_2SO_4 @ 90°C for 5 min. 44 cc HF + 26 cc HNO_3 + 29 cc Acetic 5°C, Etch time = 5-10 sec Etch silicon between 5 to 8 μm deep Check Conductivity Type		
	CLEAN (6)	$HF:H_2O$ (1 to 10 Ratio) dip 5 sec. H_2O_2 - NH_4, H_2O_2 - HCℓ		
	POCℓ$_3$ DIFFUSION (7)	Diffusion Temp. 825°C Time 50 min. Source Temp. = 0°C Flow Rates 200 cc/min - N_2/Source; 1560 cc/min - N_2 Carrier 62.5 cc/min O_2 Slow cool by pulling 3 inches/5 min.		
	REMOVE OXIDE (8)	Strip deposition oxide 3:1 (H_2O:HF) Measure, R_s = ________ Ω/□ (Target value = 60 Ω/□)		
	CLEAN (9)	H_2SO_4 : H_2O_2 87°C, 5 min. Strip all oxides in darkness with buffered HF. 10/1 H_2O/HF Dip 10 sec		
	METAL (10)	Top Side (side not numbered) only Ti 1500 Å 20 Å/sec Pd 500 Å 10 Å/sec Ag 20000 Å 40 Å/sec		
	PHOTO RESIST (11)	Mask #1 (contact grid) Waycoat IC, 4000 rpm, h = 1.7 μm Exposure time = 3 sec (I_d = 0.2 μa)		
	ETCH METAL (12)	Ag-20-60 H_2O_2 & Ammonium Hydrox.-10-15 sec. Pd + 30 cc HCℓ + 10 cc HNO_3-5 sec Ti-150 cc H_2O + 60cc HCℓ + 30cc Ammonium Fl. 5 sec		
	CLEAN (13)	H_2SO_4 at 75°C - 3 min Rinse in D.I. H_2O		
	METAL BACK (14)	Ti 1500 Å - Pd 500 Å Back side is numbered Ag 20 KA		
	SINTER (15)	Temperature 550 °C Time 15 Min. Atmosphere = H_2, 500cc/min.		
	PHOTO-RESIST (16)	Mask #2 (Mesa) Waycoat SC, 7000 rpm, h - 4.0 μm Exposure time = 15 sec (I_2 = 0.6 μa), Apiezon wax back side		
	ETCH SILICON (17)	44 cc HF + 26 cc HNO_3 + 29 cc Acetic 5°C, Etch time = 5-10 sec Etch silicon between 5 to 8 μm deep, Talystep_____μm.		
	TEST (18)			

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Fig. 7. Solar Cell Run Sheet

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70621R RIBON 1003 RETEST W071 00 000
RIBON 10/20/77 AM1: PO=91.60MW/CM^2 AR COATING

ID	ISC	VOC	IP	LOG(IO)	N	R	FF	EFF	OCD
1R*	22.50	.549	20.11	-6.162	2.03	-.34	.712	9.30	.00
1B	31.00	.579	28.77	-8.419	1.40	.21	.765	14.51	15.60
2B	32.50	.583	30.19	-8.527	1.38	.28	.764	15.31	19.50
3B	31.00	.569	28.72	-8.216	1.42	.14	.763	14.24	12.35
4B*	23.90	.524	14.99	-4.686	2.86	10.86	.345	4.56	.00
5B.*	31.40	.547	28.90	-6.697	1.76	-1.67	.807	14.65	13.00
1R	30.40	.561	28.32	-8.950	1.26	.49	.762	13.75	9.10
5R	29.30	.542	26.72	-6.945	1.67	-.27	.746	12.53	4.94
6R	29.80	.539	26.94	-6.498	1.81	-.29	.732	12.44	1.82
8R	29.60	.538	24.92	-4.011	3.62	-2.73	.677	11.40	3.38
AVERAGES: 70621R BASELINE W071 00 000									
	31.50	.577	29.23	-8.387	1.40	.21	.764	14.69	15.82
STD	.71	.006	.68	.129	.01	.06	.001	.45	2.92
70621R RIBON 1003 RETEST									
	29.78	.545	26.72	-6.601	2.09	-.70	.729	12.53	4.81
STD	.40	.009	1.21	1.758	.90	1.22	.032	.83	2.71
PERCENT OF BASFLINE									
	94.5	94.5	91.4	121.3	149	*****	95.5	85.3	30.4
STD%	3.4	2.6	6.4	22.5	67	814.2	4.3	8.5	25.9

Fig. 8 Sample Data Print-Out

been measured before and after a standard AR coating of 850 Å of SiO and the results indicate that the efficiency of the cell is increased by 41.2 ± 2%. A cell with an AM1 efficiency of 10.2% uncoated, will thus yield a 14.4% cell when coated. Therefore, in order to facilitate comparison of our data with cell data from other sources, we will report cell efficiencies converted to AR coated values unless otherwise noted.

Several general conclusions can be stated from the data generated so far. First, within a cell fabrication run, data from a given dendritic web crystal clusters very tightly. This would indicate that solar cell parameters are a valid means for characterizing the web material. Cell data from a given crystal processed in different runs is somewhat more scattered, but still is representative of the crystal. Second, dendritic web can be processed into extremely good solar cells; some crystals yield devices with greater than 14% AM1 efficiency. Conversely, web samples chosen from crystals with obvious defects such as lineage or mosaic structure yield cells with only about 10.3% efficiency. Moderate quality material yields cells in the 12 to 13 percent range. Studies are now in progress to correlate solar cell performance with the structural perfection of the starting material.

The second aspect of the solar cell program is to develop processing techniques for dendritic web which will yield solar cells with higher efficiency. The current approach to this task is to consider that the processing of dendritic web is the same as for Czochralski material if due account is taken of the generally smaller thickness of the web. Studies so far indicate that the actual junction on the web is of extremely high quality. Attention is, therefore, being given to the matter of the back surface P^+ layer. Presently this is being fabricated by a boron diffusion process, which has an industry reputation for some variability. A process based on an aluminum doped back surface is under investigation. This process has the promise of greater reproducibility as well as possibly providing optical as well as electrical reflection at the cell back surface. Since solar cells with greater than 14% efficiency have already been processed with the boron technique, enhanced optical reflectivity could bring this figure above 15%. Currently, equipment and materials are being set up to implement this process.

Facility Design and Construction

Design has been completed for a new web growth facility which will have dimensional capacity for web widths to four inches. Mechanical and electrical design of the system closely follows the concept of the most recent existing facility and is scaled up where needed to satisfy the greater dimensional requirements. The thermal design of the system is based upon thermal models and recent experience. Fabrication of components and assembly are in progress.

A conceptual design has been developed to permit, at some possible future time, conversion of the new facility from low frequency induction heating to more conventional and lower cost resistance heating.

The existing web growth facility is in the process of being modified to permit web growth of width up to three inches.

3. PLANS FOR THE NEXT PERIOD

Systematic changes in susceptor and lid configuration aimed at maximizing web width and minimizing thermally induced strain will be continued, utilizing guidance from the thermal modeling results.

The experimental effort to date has utilized 75 mm diameter crucibles. Crucibles of 100 mm diameter have been ordered and will be tested in the near future.

Thermal models of two new crucible/susceptor configurations will be completed and applied to the design of appropriate hardware. The first new design will be a circular crucible/susceptor with a 100 mm ID crucible. The second will be an elongated susceptor for use in the new web growth facility. The second thermal model (model of latent heat dissipation) will be applied to the problem of reducing curvature in the temperature profile in the web. The object will be to reduce possible thermal stress in the growing crystal.

Much of the characterization of the dendritic web will still be of a dimensional character. In addition, measurement of residual stress in appropriate sample will be continued to evaluate the effect of lid design. Similarly measurement of crystalline perfection will be continued and expanded. Solar cell fabrication to characterize the dendritic web material will be continued.

The new web growth facility will be completed and placed in operation. The existing facility will be modified to provide greater capacity.

4. NEW TECHNOLOGY

No new technology occurred during this reporting period.

5. REFERENCES

1. A. D. Morrison, et al., "Large Area Silicon Sheet by EFG," Annual Progress Report, ERDA/JPL 94355/76-11, Sept. 15, 1976.

2. D. L. Barrett, et al., "Growth of Wide, Flat Crystals of Silicon Web," J. Electrochem. Soc. 118, 952 (1971).

3. S. O'Hara, "Dislocations in Webs of Germanium and Silicon," J. Appl. Phys. 35, 409 (1964).

4. S. O'Hara and G. H. Schwuttke, "Dislocation Reactions in Silicon Web-Dendrite Crystals," J. Appl. Phys. 2475 (1965).

5. T. N. Tucker and G. H. Schwuttke, "Growth of Dislocation Free Silicon Web Crystals," Appl. Phys. Lett. 9, 219 (1966).

6. T. N. Tucker, "Topography of Silicon Web Crystal Surfaces," Electrochemical Technology 4, 546 (1966).

7. R. H. Hopkins, et al., "Silicon Materials Task of the Low Cost Solar Array Project: Fifth Quarterly Report and Summary," ERDA/JPL 954331-77/1, (1977).

6. APPENDIX

6.1 Growth Run Detail Summary for This Reporting Period

6.2 Complete Set of Design Drawings for Silicon Web Growth Facility

GROWTH RUN DETAIL SUMMARY

Run No.	Web No.	ΔT °C	Pull Rate cm/min	Length cm	Width mm	Thickness μm	Comments
R-139	Dry run to test temperature stability and response time.						
R-140	1	4.4	2.2	75	12.5/16.7	203	Same configuration as R-138
	2	4.8	2.2	18	14.2	190	116.3 gm Si
	3	4.7	2.2	16	12.5/14	168	2 x 10^{17} DOPSIL pellet
	4	5.4	2.2	32	13.5/15.1	147	
	5	-	2.2	13	14.2/15.2	145	
	6	5.9	2.1	81	13/17.4	152	
	7	4.5	2.0	134	11.7/13	145	
R-141	1	4.8	2.1	59	12.6/16.6	250	Same configuration as R-138
	2	4.7	2.0	75	12.7/16.4	212	110.3 gm Si
	3	5.0	2.0	39	15/15.8	160	2 x 10^{17} DOPSIL pellet
	4	3.9	2.0	84	14.7/20.2	212	
R-142	1	5.2	2.0	28	12/14.2	183	0.95 cm high x 2.70 cm long
	2	4.7	1.8	32	15/16.8	208	after shields added along slot
							114.9 gm Si
							2 x 10^{17} DOPSIL pellet
							Plagued by oxide deposition
R-143	Abort, inadequate power coil returned						Lid dwg. 2612C82-07
							119.3 gm Si
							2 x 10^{17} DOPSIL pellet
R-144	Power Failure						Same configuration as R-143
							119.6 gm Si
							2 x 10^{17} DOPSIL pellet
R-145	Dry Run, Check controls						
R-146	Dry Run, Frequency meter check of coil frequency						

GROWTH RUN DETAIL SUMMARY

Run No.	Web No.	ΔT °C	Pull Rate cm/min	Length cm	Width mm	Thickness μm	Comments
R-147	1	4.7	1.7	42	8.3/9.8	108	Same configuration as R-143
	2	4.8	1.7	41	8/9.2	115	118.2 gm Si
	3	*	1.7	77	9.2/13.7	133	2 x 10^{17} DOPSIL Pellet
	4	*	1.5	101	8.9/14.3	145	
	5	*	1.5	136	8.6/15.7	150	
	6	*	1.5-4.0	102	-	10.7-20	
R-148	1	3.9	1.7	8	9.5	170	Same configuration as R-143
	2	2.8	1.7	36	9.6/11.2	168	119.2 gm Si
	3	3.7	1.7	7	7.8	145	2 x 10^{17} DOPSIL Pellet
	4	3.7	1.7	29	9/10.2	163	
	5	3.3	1.7	17	9.4/10.2	165	
	6	-	2.1	12	9.4	93	
	7	4.3	1.7	12	13.2/13.5	163	
	8	3.7	1.8	31	9.8/10.4	125	
	9	3.8	1.8	15	9.6/9.9	113	
	10	-	1.7	56	8.6/10.8	118	
R-149	1	*	1.9	220	10.7/21.1	113	Lid dwg. 2612C82-08
	2	*	1.8	201	10.8/18.5	135	119.4 gm Si
	3	3.6	1.8	11	-	100	2 x 10^{17} DOPSIL pellet
	4	-	1.7	117	8/14.3	125	
R-150	1	3.6	1.8	18	8.8/9.8	150	Same configuration as R-149
	2	-	1.8	6	11.7	155	119.2 gm Si
	3	3.4	1.8	12	8.9/9.6	138	2 x 10^{17} DOPSIL Pellet
	4	3.6	1.8	22	6/7	110	
	5	-	1.7	24	9.3/10.2	138	
	6	3.0	1.7	71	8.2/13.6	121	
	7	3.6	1.5-3.3	92	7/10.6	114-30	Thickness vs. velocity run

* Strong drift of "hold" during growth.

GROWTH RUN DETAIL SUMMARY

Run No.	Web No.	ΔT °C	Pull Rate cm/min	Length cm	Width mm	Thickness μm	Comments
R-151	1	3.8	1.9	20	10.3/10.8	138	
	2	3.9	1.8	7	9.8	163	Six vent slots added to bottom of
	3	4.1	1.8	9	10.6/11.0	145	lid No.-08
	4	2.9	1.8	40	9/11.2	150	
	5	2.9	1.8	127	8/18.6	124	119.8 gm Si
	6	2.4	1.8	41	11.6/14.6	138	2 x 10^{17} DOPSIL Pellet
	7	2.5	1.8	89	11.4/18.0	111	
	8	2.5	1.7	6	8.9/9.3	109	
	9	2.5	1.7	132	10.5/20.3	123	
R-152	1	3.0	1.9	101	8.5/16.7	175	Slot beveled, .125 x .125 in.
	2	3.4	1.9	126	10.5/18.4	150	To lid No. -08.
	3	4.8	1.9	13	13.4/14	150	119.9 gm Si
	4	6.0	1.9	145	8.8/11.8	118	2 x 10^{17} DOPSIL Pellet
R-153	1	4.0	1.9	195	8.8/23.2	170	Same configuration as R-152
	2	-	1.9	20	8.8/9.3	108	120-1 gm Si
	3	3.3	1.8	143	10/19.3	163	2 x 10^{17} DOPSIL Pellet
	4	4.2	1.8-2.9	118	8.7/15.1	109-51	Thickness vs velocity run

GROWTH RUN DETAIL SUMMARY

Run No.	Web No.	ΔT °C	Pull Rate cm/min	Length cm	Width mm	Thickness μm	Comments
R-154	1	3.9	1.9	111	8.8/16.5	150	Accumulate more growth experience
	2	3.9	1.8	109	10.9/17.0	150	on repeat of same configuration as
	3	3.4	1.9/2.6	95	7.8/12.8	155/60	R-152 119.9 gms Si
	4	3.5	1.8	86	9.9/13.2	115	2 x 10^{17} DOPSIL pellet
	5		1.8	77	9.6/13.1	113	
	6	3.2	1.7/2.1	198	8.0/11.7	165/110	
R-155	1	5.5	2.0	41			Provide independent experience to
	2	5.2	2.0	95	8.7/13.5	200	2nd furnace operator. Same configuration
	3		2.0				as R-152
	4		2.0				
	5		2.0	20	9.9/11.1	150	
	6		2.0	101	9.4/17.0	113	
R-156	1	3.4	1.9	65	8.4/11.4	160	Test new lot of crucibles in known
	2	3.7	1.9	67	9.7/13.0	162	configuration, same as R-152
	3	2.7	1.9	57	10.4/13.3	146	119.5 gm Si
							2 x 10^{17} DOPSIL pellet
							Oxide in slot
R-157	1	3.2	1.9	217	9.7/26.2	165	Gather more growth data
	2	3.0	1.9	30	10/11.5	119	Measure melt surface temperatures
	3	2.8	1.8	221	8.6/20.2	140	Same configuration as R-152
	4	2.8	1.8/2.6	120	10.8/12.8	122/58	120.6 gm Si
							2 x 10^{17} DOPSIL Pellet

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GROWTH RUN DETAIL SUMMARY

Run No.	Web No.	ΔT °C	Pull Rate cm/min	Length cm	Width mm	Thickness μm	Comments
R-158	No web growth - Dry run to measure susceptor temperatures for modeling input.						
R-159	This run dedicated to measuring melt surface and melt bottom temperatures. The introduction of oxide during these manipulations negated susequent efforts to grow useful web.						
R-160	1	4.7	2.1	88	11.8/18.4	210	Test growth with higher melt level
	2	4.6	1.9	182	11.5/25.2	165	Same configuration as R-152
	3	2.7	1.8/1.5	167	9.4/18.5	170/220	134.7 gm Si
	4	3.1		Thickness vs. velocity run			2 x 10^{17} DOPSIL Pellet
R-161	1	3.1	1.9	102	11.5/17.2	220	Repeat run with high melt level
	2	3.4	1.9	74	10.7/14.5	183	Same configuration as R-152
	3	3.8	1.9	45	10.2/12.9	163	134.4 gm Si
	4	3.9	1.9	22	13.1/14.2	145	2 x 10^{17} DOPSIL Pellet.
	5	3.8	1.9	101	7.7/13.3	138	
R-162	Run aborted due to power failure after melting.						Test new lid configuration. Straight slot 6.67 cm long x 0.64 cm wide Lid no. -10.
R-163	1	2.6	1.9	154	11.6/22.6	146	Repeat of R-162
	2	2.3	1.8	119	11.1/17.6	120	133.2 gms. Si
	Run aborted due to loss of power.						2 x 10^{17} DOPSIL Pellet

GROWTH RUN DETAIL SUMMARY

Run No.	Web No.	ΔT °C	Pull Rate cm/min	Length cm	Width mm	Thickness μm	Comments
R-164	Abort; Si touched lid during melt down						Repeat R-162 lid configuration
R-165	1	3.7	1.9	160	11.1/22.1	145	Repeat R-162 lid configuration
	2			128	10.5/15.3		135.2 gms Si
	3	3.4		82	11.3/14.4		2 x 10^{17} DOPSIL pellet
	a	-	1.4	-	-	165	
	b	-	1.9	-	-	86	
	c	-	2.6	-	-	48	
	4			112	12.2/14.6		
	5			32			
R-166	Abort; Si touched lid during melt down						
R-167	1		2.4	29	11.7	388	Test effect of 6.4 x 6.4 mm bevel (45°)
	2		2.6	24	10.2/10.8	263	on long straight slot of above lid
	3		2.4	11	9.9/10.4	300	121.6 gm Si
	4		2.6	27	10.6/11.1	-	2 x 10^{17} DOPSIL pellet
	5		2.4/3.4	72	-	283/125	
	6		2.4	24	12.9/13.7	238	
R-168	Abort; Si touched lid during melt down						
R-169	1		2.4	22	10.5/11.7	338	Repeat of R-167 configuration
	2		2.4	43	10.2/12.4	285	118.6 gm Si
	3		-	37	12.6/13.2		2 x 10^{17} DOPSIL pellet
	a		2.1			365	
	b		2.6			208	
	c		3.4			110	
	4		2.4	12	12.2/12/6	173	
	5		-	12	11.5	-	
	a		2.4	-	-	210	
	b		2.9	-	-	118	

GROWTH RUN DETAIL SUMMARY

Run No.	Web No.	ΔT °C	Pull Rate cm/min	Length cm	Width mm	Thickness μm	Comments
R-170	1	2.7	1.9	83	11.2/17.1	173	Test new lid configuration:
	2	3.5	1.9	169	8.6/19.3	130	6.4 x 66.7 mm straight slot,
	3	4.0	1.8	140	10.0/19.9	128	beveled on ends only, beginning
	4	3.3	-	144	8.8/16.3	-	9.5 mm from ends
	a	-	1.8	-	-	100	118.9 gm Si
	b	-	1.7	-	-	113	2 x 10^{17} DOPSIL pellet
	c	-	1.9	-	-	90	
	d	-	2.2	-	-	70	
R-171	1	3.2	1.9	107	10.3/13.3	163	Bevel on above lid (R-170) slot
	2	4.8	1.9	99	13.3/16.6	148	extended additional 6.4 mm towards
	3	4.1	1.9	122	13.5/20.5	150	center
							113.6 gm Si, 2 x 10^{17} DOPSIL pellet
R-172	1	3.5	2.2	58	11.1/14.7	200	Test effect of wider slot. Slot of
	2	6.0	2.2	53	14.5/16.8	155	above lid (R-171) widened to 7.4 mm
	3	4.5	2.2	89	13.1/17.6	140	
	4	4.9	2.0	132	13.5/21.6	160	124.0 gm Si
	5	5.3	1.8	Thirded, Terminated		-	2 x 10^{17} DOPSIL pellet
	6	5.0	1.8	194	13.3/26.4	150	
R-173	1	4.4	2.0	39	11.5/14.3	273	Repeat of R-172
	2	3.4	2.0	212	11.5/27.2	165	
	3	4.8	2.2	18	13.3/14.3	130	123.1 gm Si
	4	4.3	2.2	174	12.7/23.4	113	2 x 10^{17} DOPSIL pellet
	5	3.9	1.9	181	9.4/22.0	113	

SILICON WEB PROCESS DEVELOPMENT

Research Memo 77-9C4-RIBON-M 4

DESIGN DRAWINGS FOR SILICON WEB GROWTH FACILITY

Date of Issue 22, September, 1977

C. S. Duncan

Contract No. 954654

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Westinghouse R&D Center
1310 Beulah Road
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	4	CHAMBER BOX WELDM'T	639F477	3			
	5	FRAME DET	639F478	4			
	6						
	7	WORK COIL VERT ADJ DET'S	8504D76	5			
	8	WORK COIL HORIZ ADJ DET'S	8504D77	6			
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	10	RIBON GUIDE ROLL MECH	8507D32	8			
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	25	RIBBON GUIDE DET'S	8520D34	23			
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	27	COIL DETAILS	8520D40	25			
	28	TOP PL COIL LIFT SUB-ASS'Y	8520D42	26			
	29	ROUND SUSCETOR DET	8520D49	27			

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NAME OF APPARATUS SILICON WEB FURNACE MOD-2

ENG'R S. DUNCAN

CHECKED BY AND DATE						
W. SUMPMAN		9-22-77				
DESIGN SPEC. D 903066		SUB. LETTER A	SUB. LETTER	SUB. LETTER	SUB. LETTER	SUB. LETTER
WESTINGHOUSE FORM 6541 J	PAGE 1 OF 3	SUB. LETTER	SUB. LETTER	SUB-LETTER	SUB. LETTER	SUB. LETTER

ROUTING					
FIREPROOF VAULT					

DRAWING LIST

INDEX	LINE	TITLE OF DRAWING	DRAWING NO.	PAGE			
	1	TOP COVER PL DET	8520D50	28			
	2	OVAL SUSCEPTOR DET	8520D51	29			
	3	TOP ROLLER SYS DET	8520D52	30			
	4	DETAILS	8520D61	31			
	5	WEB GUIDE DET'S	8520D69	32			
	6	DETAILS	8520D78	33			
	7						
	8						
	9						
	10	KNOB DETAILS	257C034	34			
	11	ROD HOUSING SUB ASSY	257C074	35			
	12	BACK COVER WELDM'T	257C251	36			
	13	ROUGHING PUMP ASSY	257C261	37			
	14	BR'G SUPPORT FRAME	2613C30	38			
	15	STORAGE REEL WELDM'T	2613C34	39			
	16	STORAGE REEL DET	2613C35	40			
	17	STORAGE REEL DET	2613C36	41			
	18	VACUUM ELBOW WELDM'T	2613C43	42			
	19	ROUND WORK COIL DET	2613C50	43			
	20	TAP REEL BRACKETS	2613C61	44			
	21	OVAL WORK COIL DET	2613C64	45			
	22	SUPPORT PL DET	2613C70	46			
	23	ROUND SHIELD DET	2613C71	47			
	24	OVAL SHIELD DET	2613C82	48			
	25	OVAL SUPPORT PL DET	2613C83	49			
	26	ROUND WORK COIL ASS'Y	2613C98	50			
	27	WEB GUIDE SUB-ASS'Y	2614C09	51			
	28	ROUND TOP SHIELD DET	2614C18	52			
	29	ROUND SUSCEPTOR COVER	2614C19	53			

STOCK ORDER (1ST S.O. ON WHICH INF. HAS BEEN SENT TO SHOP) | IDENTIFYING DATA - IN SPECIFYING THIS D NO. ON A STOCK ORDER THE ENGINEER MUST GIVE: —

NAME OF APPARATUS SILICON WEB FURNACE MOD-2

ENG'R S. DUNCAN

CHECKED BY AND DATE					
W. SUMPMAN	9-22-77				
DESIGN SPEC. D 903066	SUB. LETTER A	SUB. LETTER	SUB. LETTER	SUB. LETTER	SUB. LETTER
WESTINGHOUSE FORM 6541 J — PAGE 2 OF 3	SUB. LETTER	SUB. LETTER	SUB-LETTER	SUB. LETTER	SUB. LETTER

ROUTING					
FIREPROOF VAULT					

DRAWING LIST

INDEX	LINE	TITLE OF DRAWING	DRAWING NO.	PAGE		
	1	PUSH ROD ASS'Y	2614C20	54		
	2	OVAL WORK COIL ASS'Y	2614C23	55		
	3					
	4	ROUND CRUCIBLE DET	1689B31	56.		
	5	BLANK COVER PL'S	1690B07	57		
	6	SENSOR HOLDER ASSY	1691B12	58		
	7	OVAL CRUCIBLE DET	1691B62	59		
	8					
	9	WORK COIL STANDOFF	6414A97	60		
	10	ADJ. SCR SUB-ASS'Y	6416A16	61		
	11	DUCT GUIDE ASS'Y	6417A44	62		
	12	ROUND CRUCIBLE	6417A57	63		
	13	OVAL TOP SHIELD	8521D13	64		
	14	OVAL SUSCEPTOR COVER DET.	8521D14	65		
	15	SILICON WEB FURNACE CONCEPTUAL DESIGN FOR		66		
	16	CONVERSION TO RESISTANCE HEATING				
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					

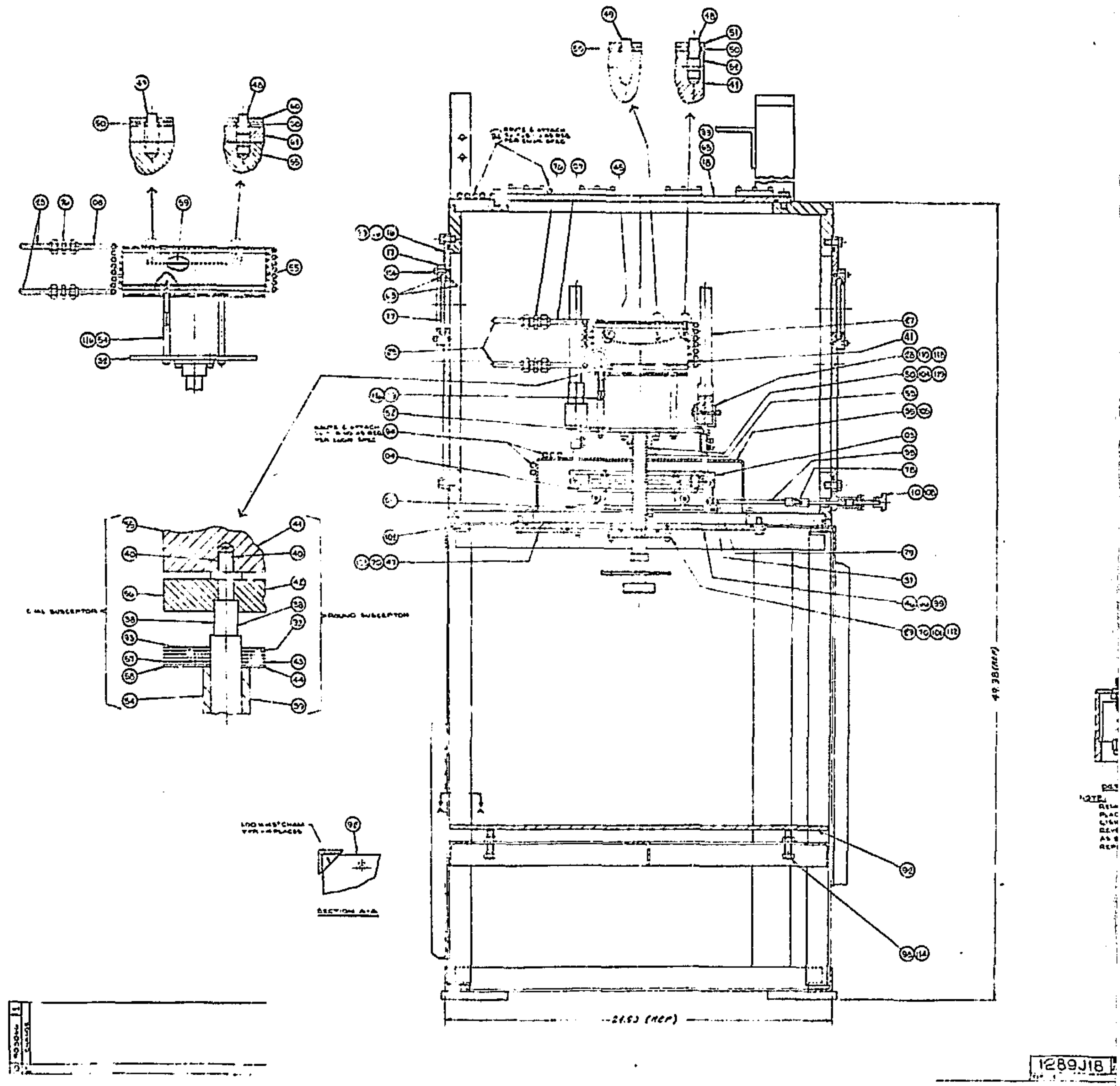
STOCK ORDER (1ST S.O. ON WHICH INF. HAS BEEN SENT TO SHOP) | IDENTIFYING DATA: IN SPECIFYING THIS D NO. ON A STOCK ORDER THE ENGINEER MUST GIVE: —

NAME OF APPARATUS SILICON WEB FURNACE MOD-2

ENG'R S. DUNCAN

CHECKED BY AND DATE					
W. SUMPMAN	9-22-77				
DESIGN SPEC. D 903066	SUB. LETTER A	SUB. LETTER	SUB. LETTER	SUB. LETTER	SUB. LETTER
WESTINGHOUSE FORM 6541 J — PAGE 3 OF 3	SUB. LETTER	SUB. LETTER	SUB-LETTER	SUB. LETTER	SUB. LETTER

FOLDOUT FRAME /



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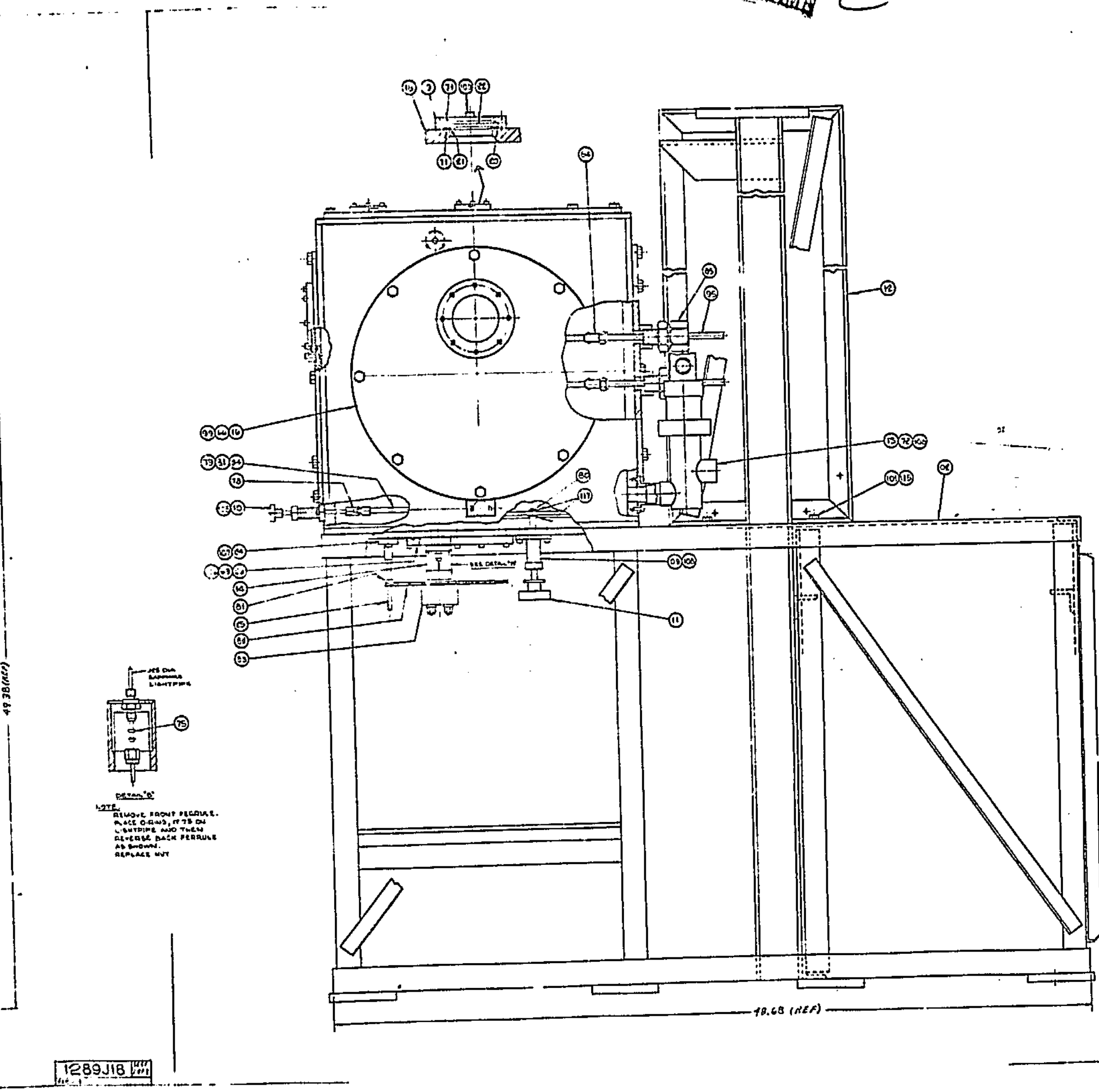
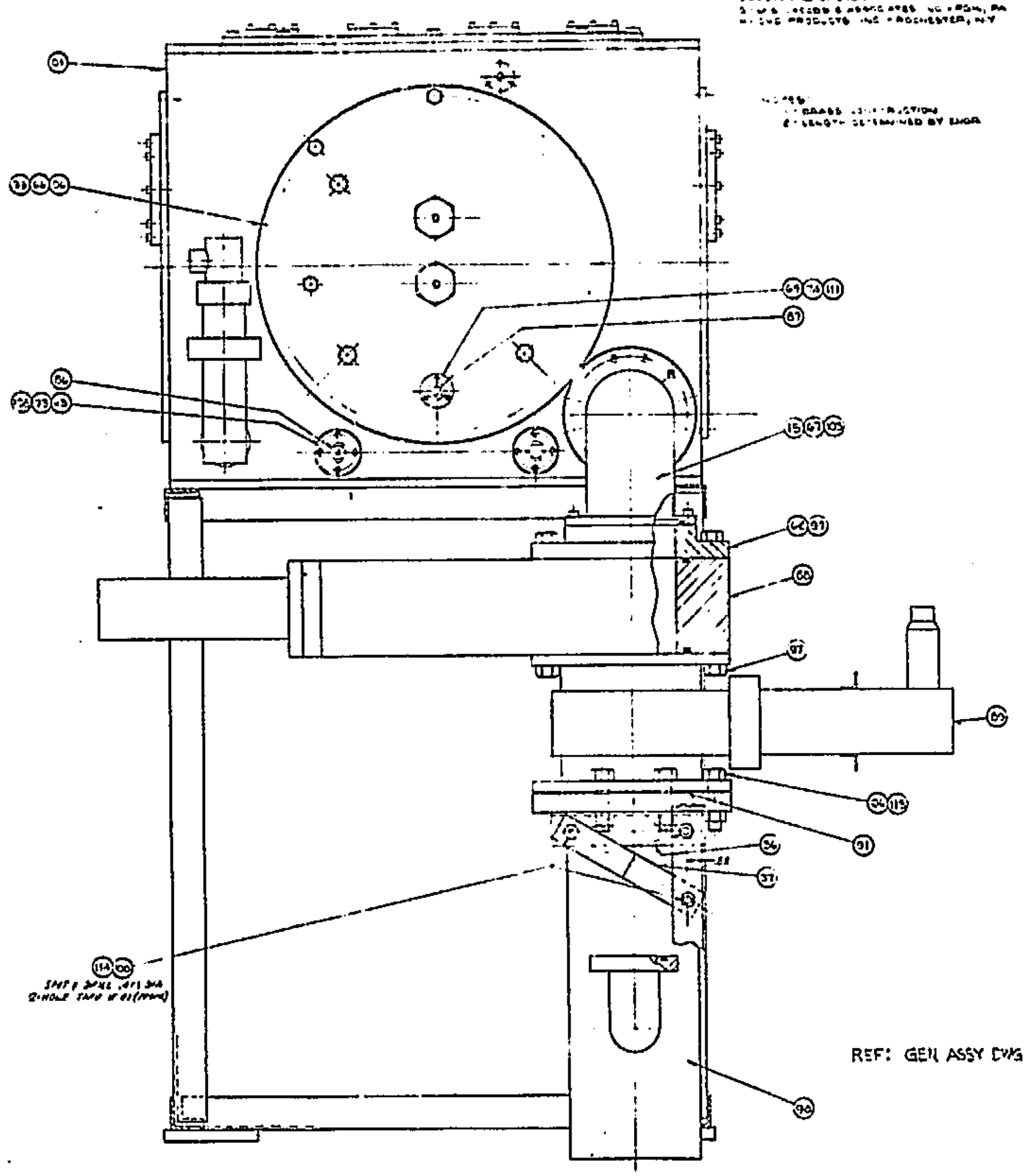


75
DETAIL "B"
NOTE
REMOVE FRONT FERRULE.
PLACE O-RING, IT 75 ON
LIGHTPIPE AND THEN
REVERSE BACK FERRULE
AS SHOWN.
REPLACE NUT
SEE DETAIL "B"
49.38 (REF)
48.68 (REF)
1289J18

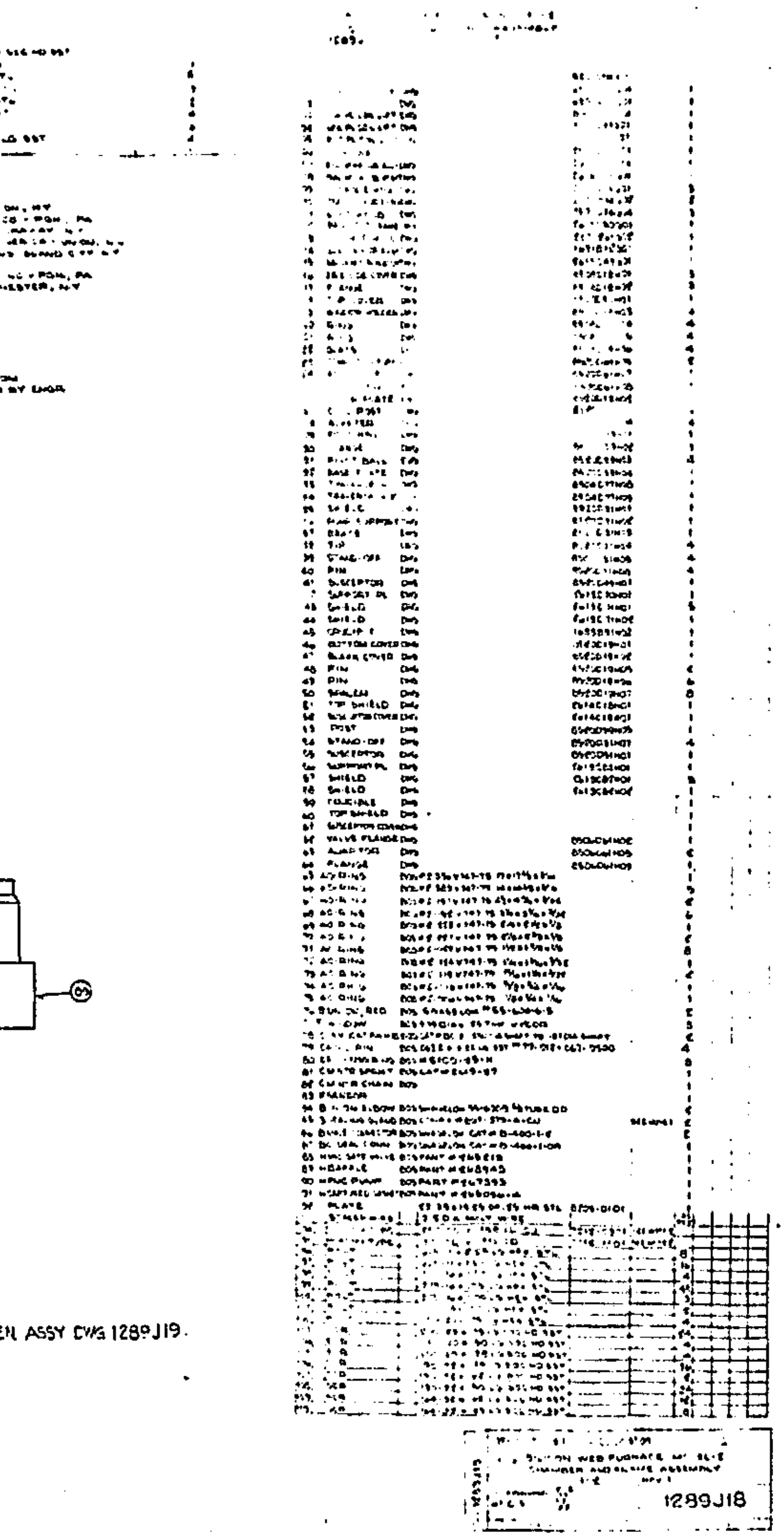
FOLDOUT FRAME

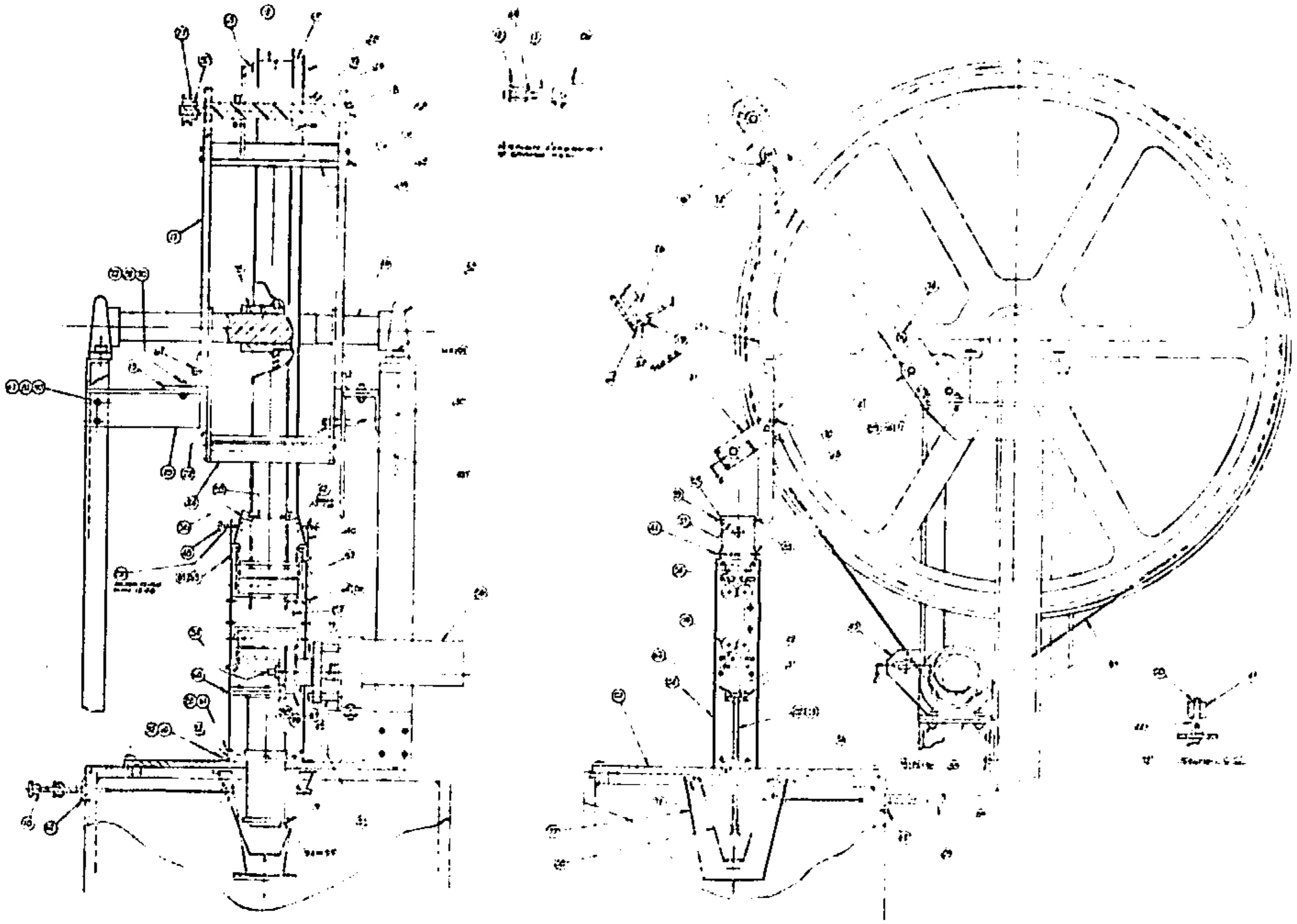
NOTES:
1. BRASS CONSTRUCTION
2. LENGTH DETERMINED BY ENGR

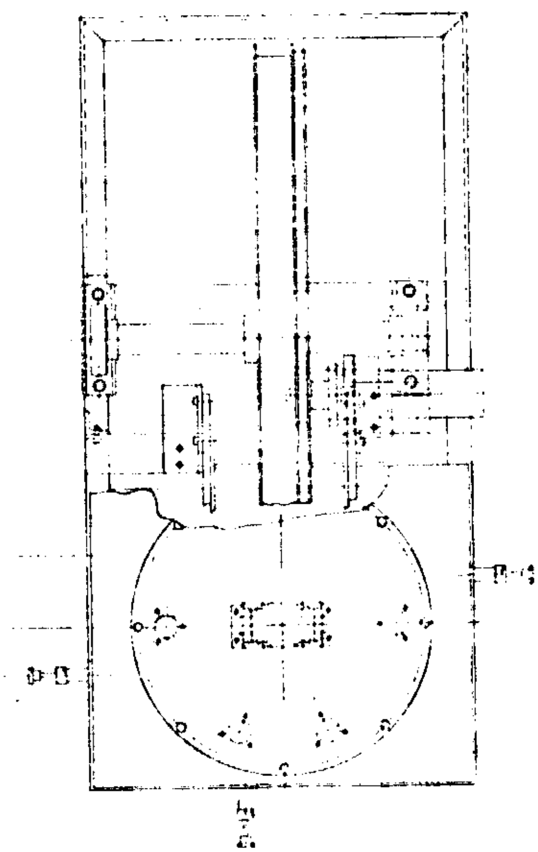


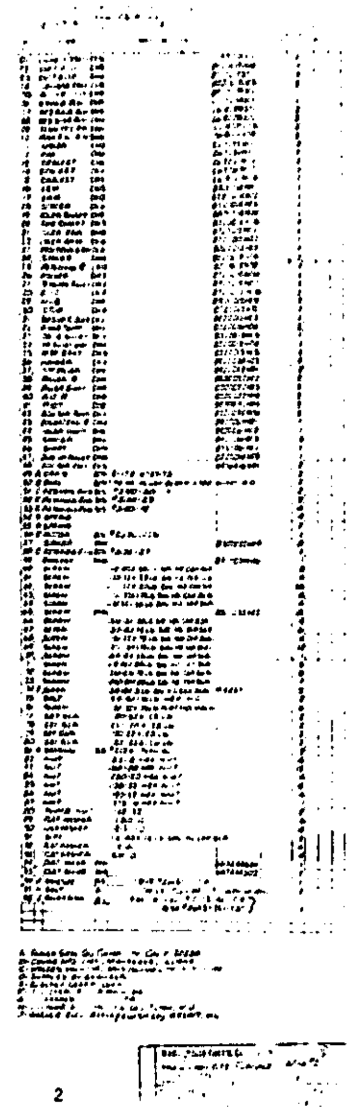
REF: GEN ASSY DWG 1289J19.

FOLDOUT FRAME 2









2

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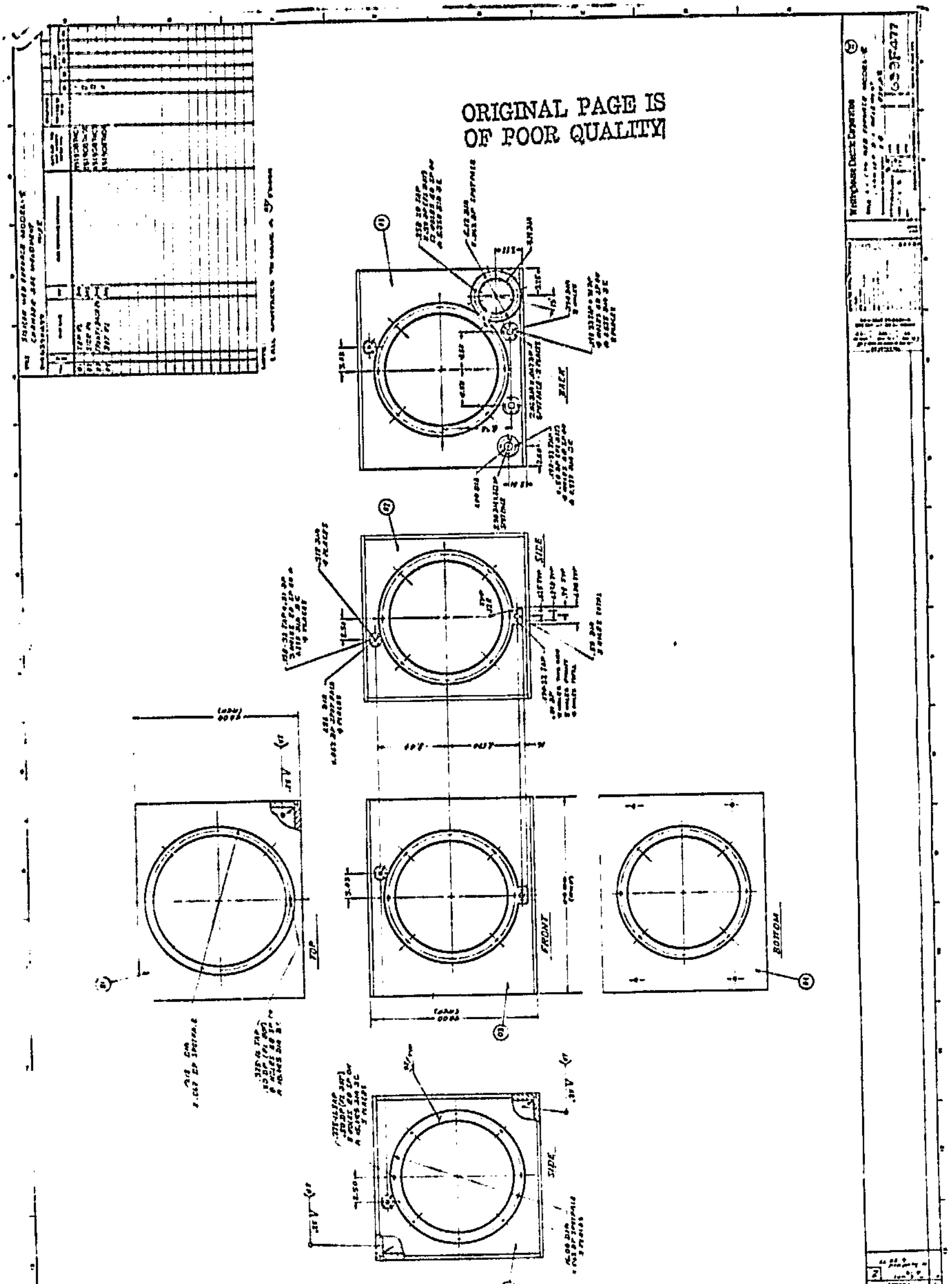

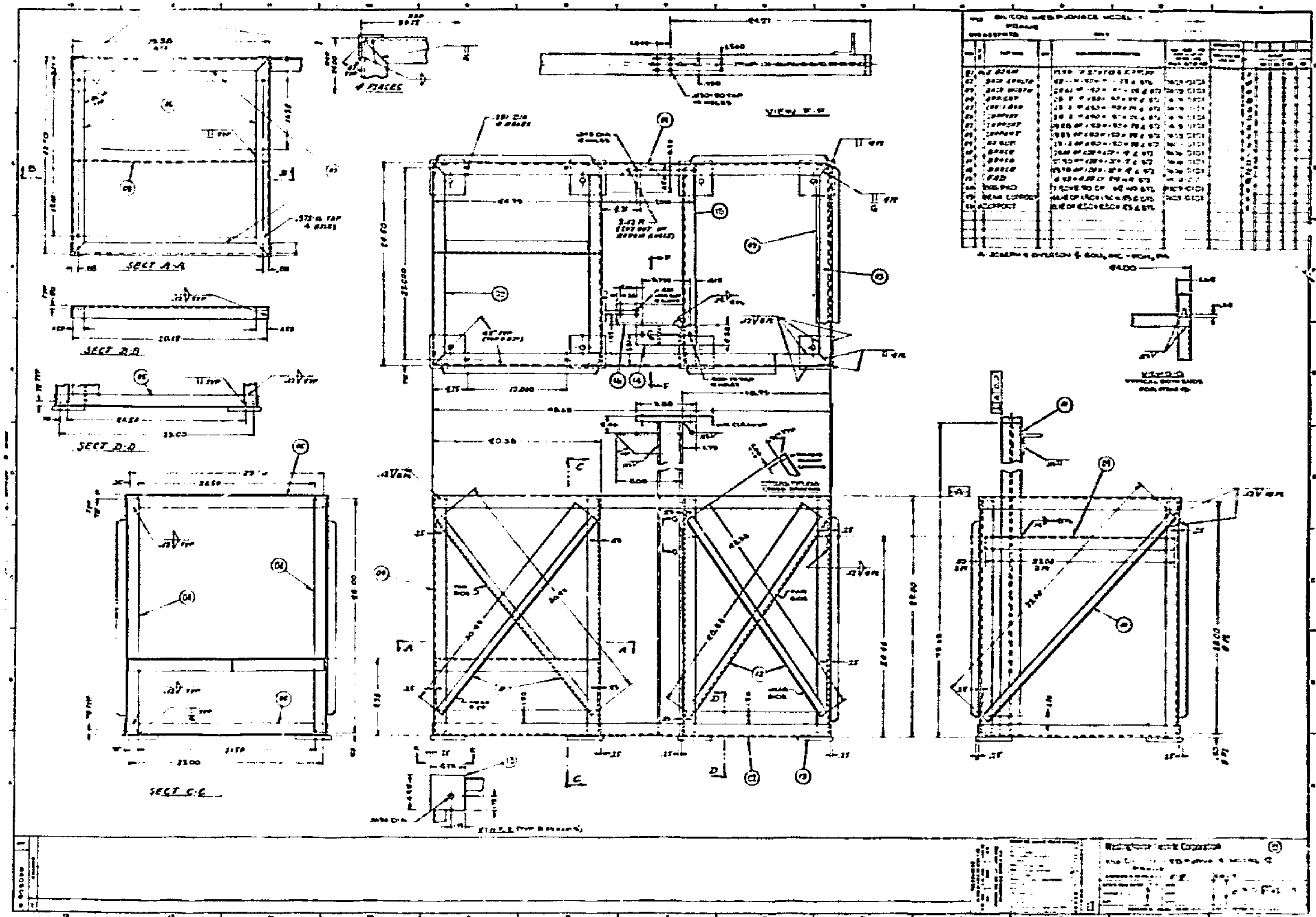
SECT A-A
SECT B-B
SECT D-D
SECT C-C
VIEW F-F
4 PLACES

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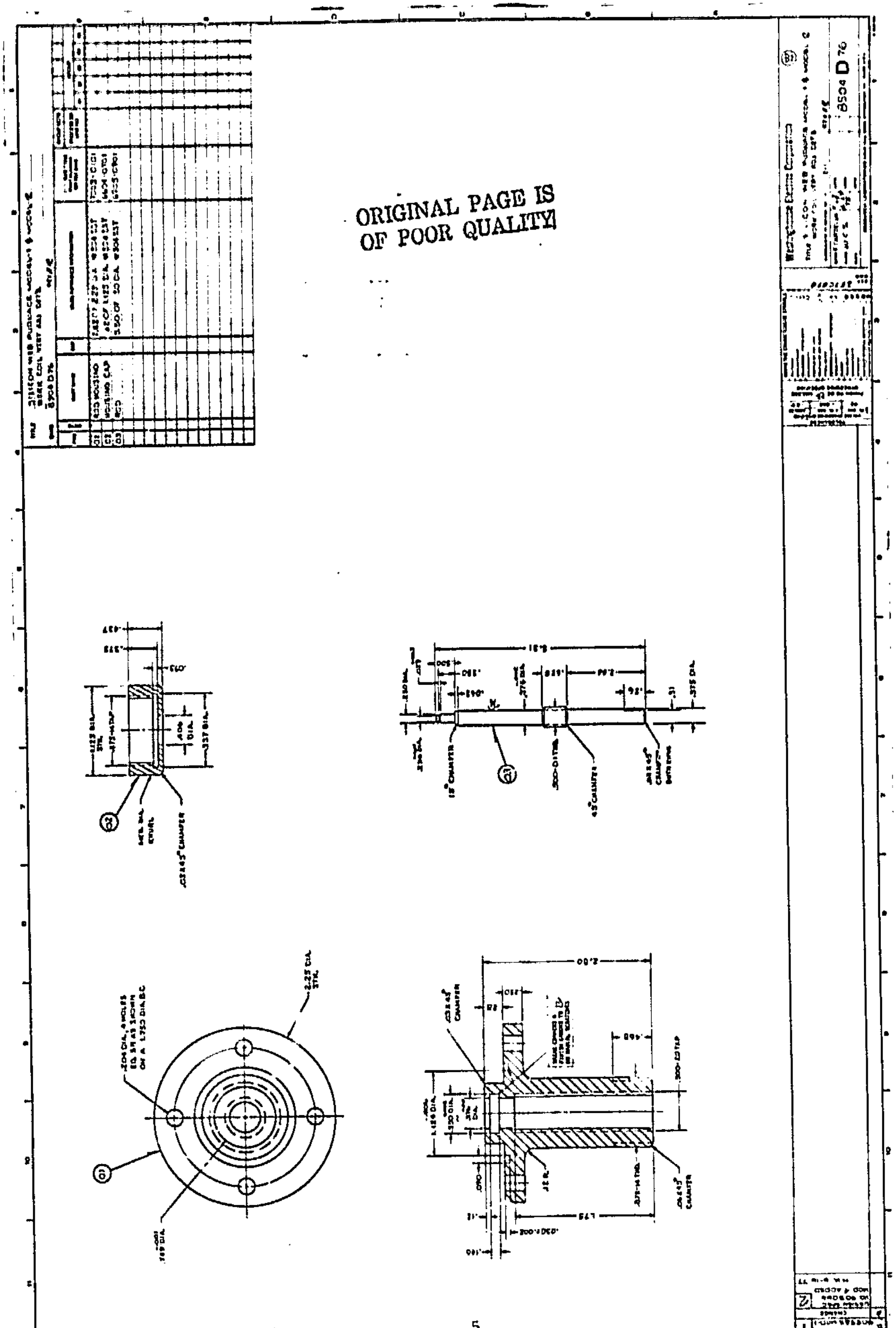
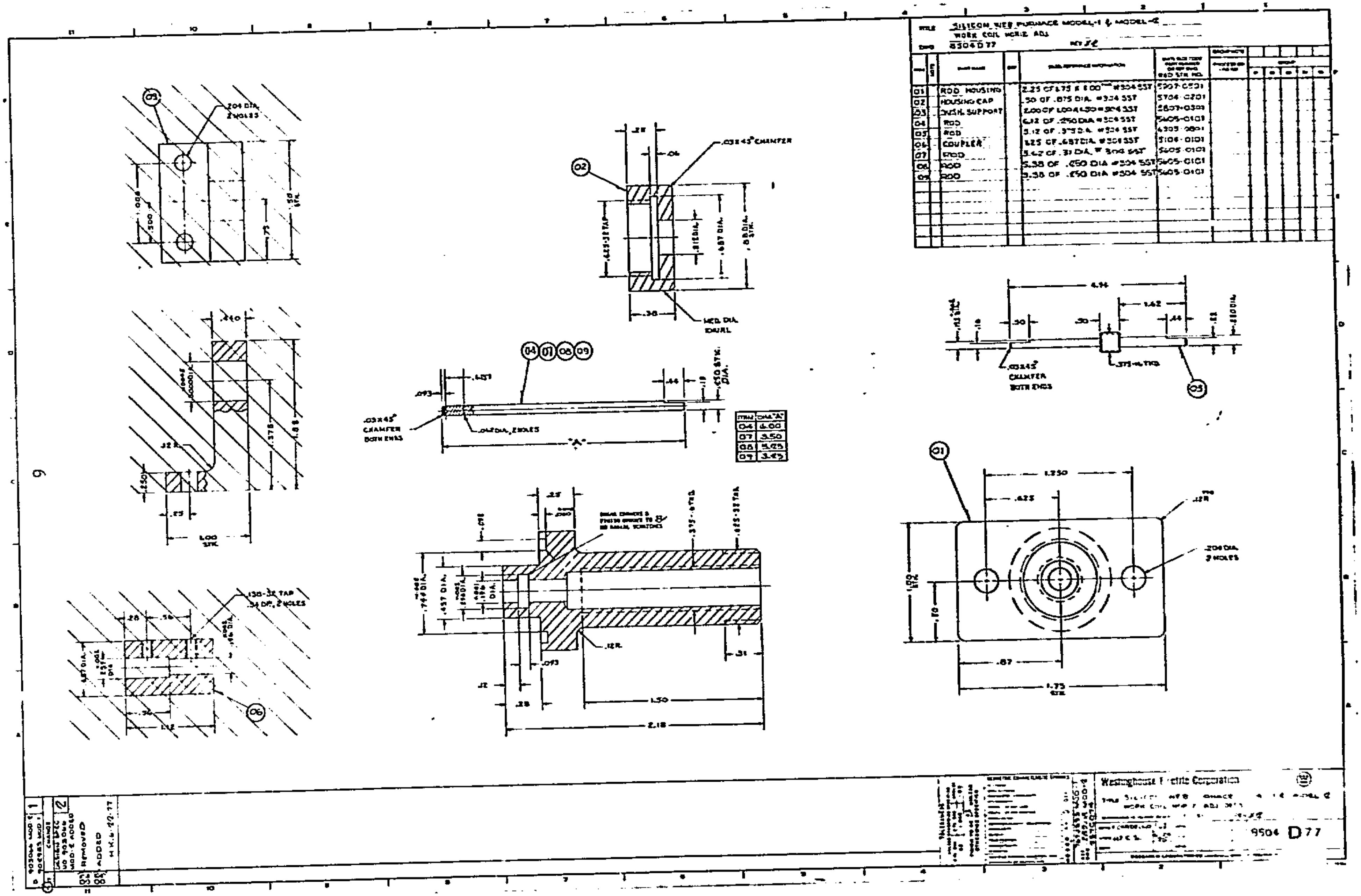
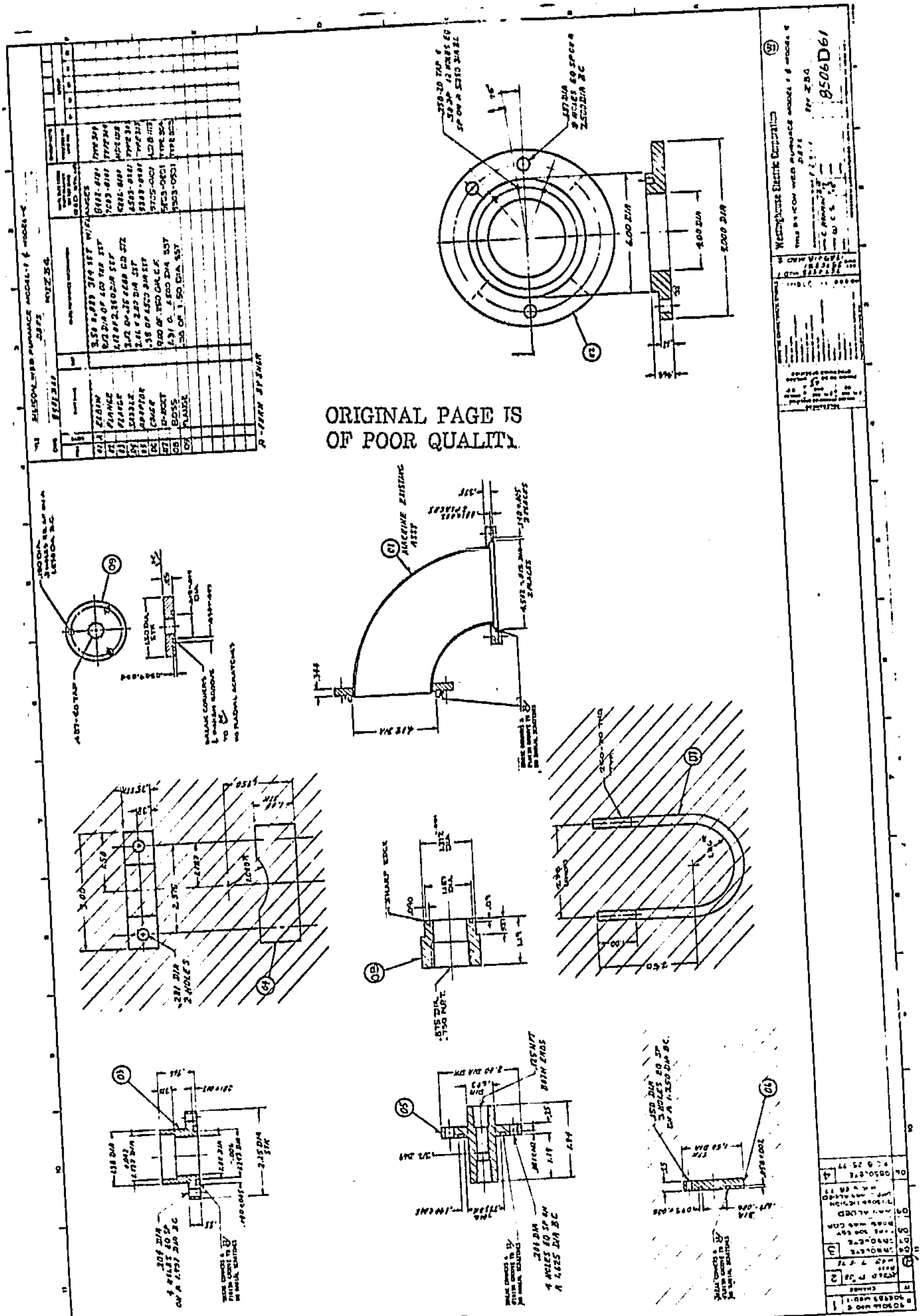




TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
WORK COIL HORIZ. ADJ.
DWG 8504D77

ITEM		PART NAME		MATERIAL REFERENCE INFORMATION	RAW STOCK NO.
01		ROD HOUSING		2.25 OF .875 X 1.00 #304 SST	5207-0501
02		HOUSING CAP		.50 OF .875 DIA. #304 SST	5704-0201
03		[illegible] SUPPORT		2.00 OF 1.00 X 1.50 #304 SST	[illegible]
04		ROD		6.12 OF .250 DIA. #304 SST	5405-0101
05		ROD		5.12 OF .375 DIA. #304 SST	4303-0801
06		COUPLER		.625 OF .687 DIA. #304 SST	5104-0101
07		ROD		5.62 OF .31 DIA. #304 SST	5405-0101
08		ROD		5.38 OF .250 DIA. #304 SST	5405-0101
09		ROD		5.38 OF .250 DIA. #304 SST	5405-0101

ITEM	DIM. "A"
04	6.00
07	3.50
08	5.25
09	3.25



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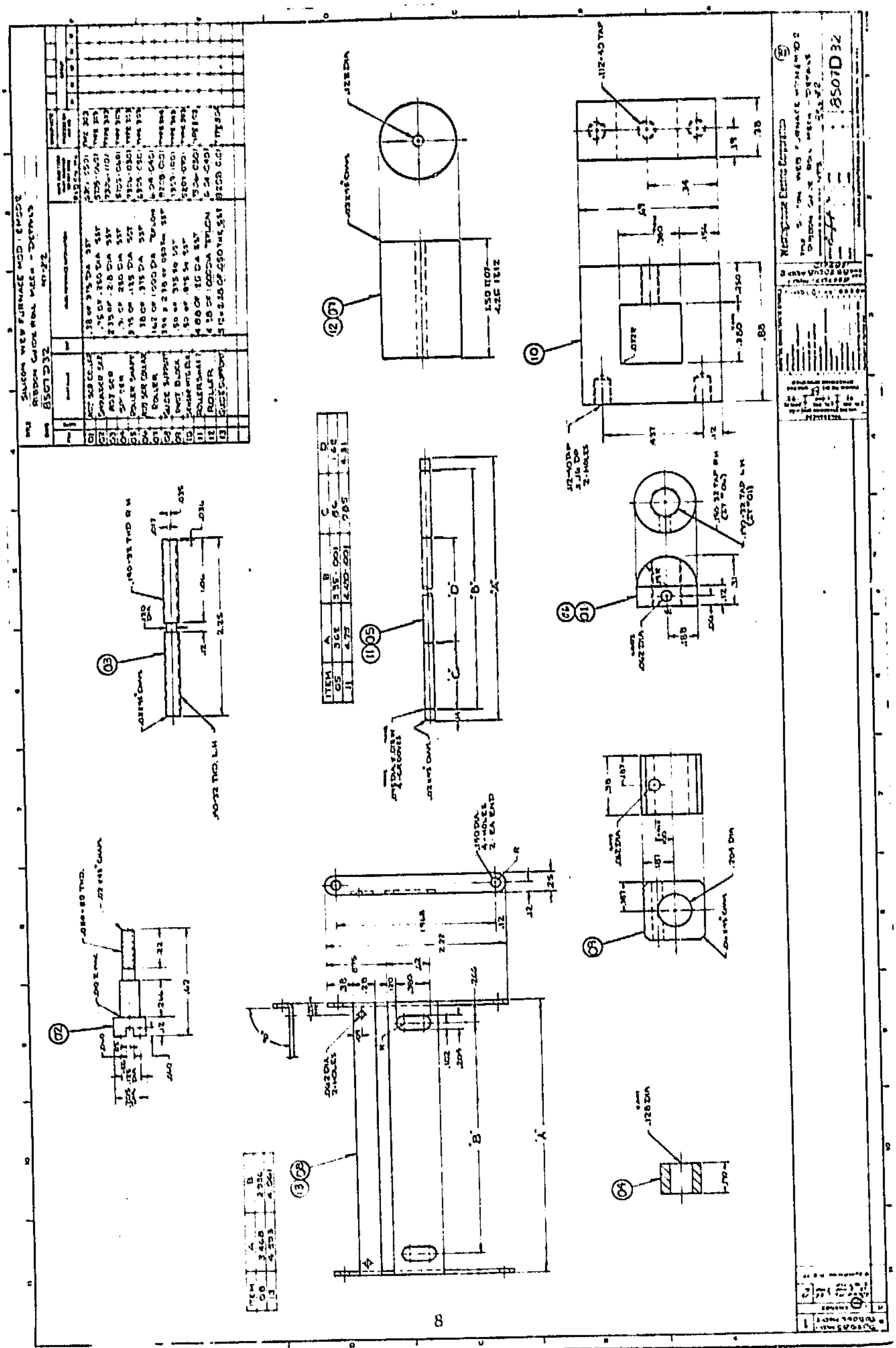

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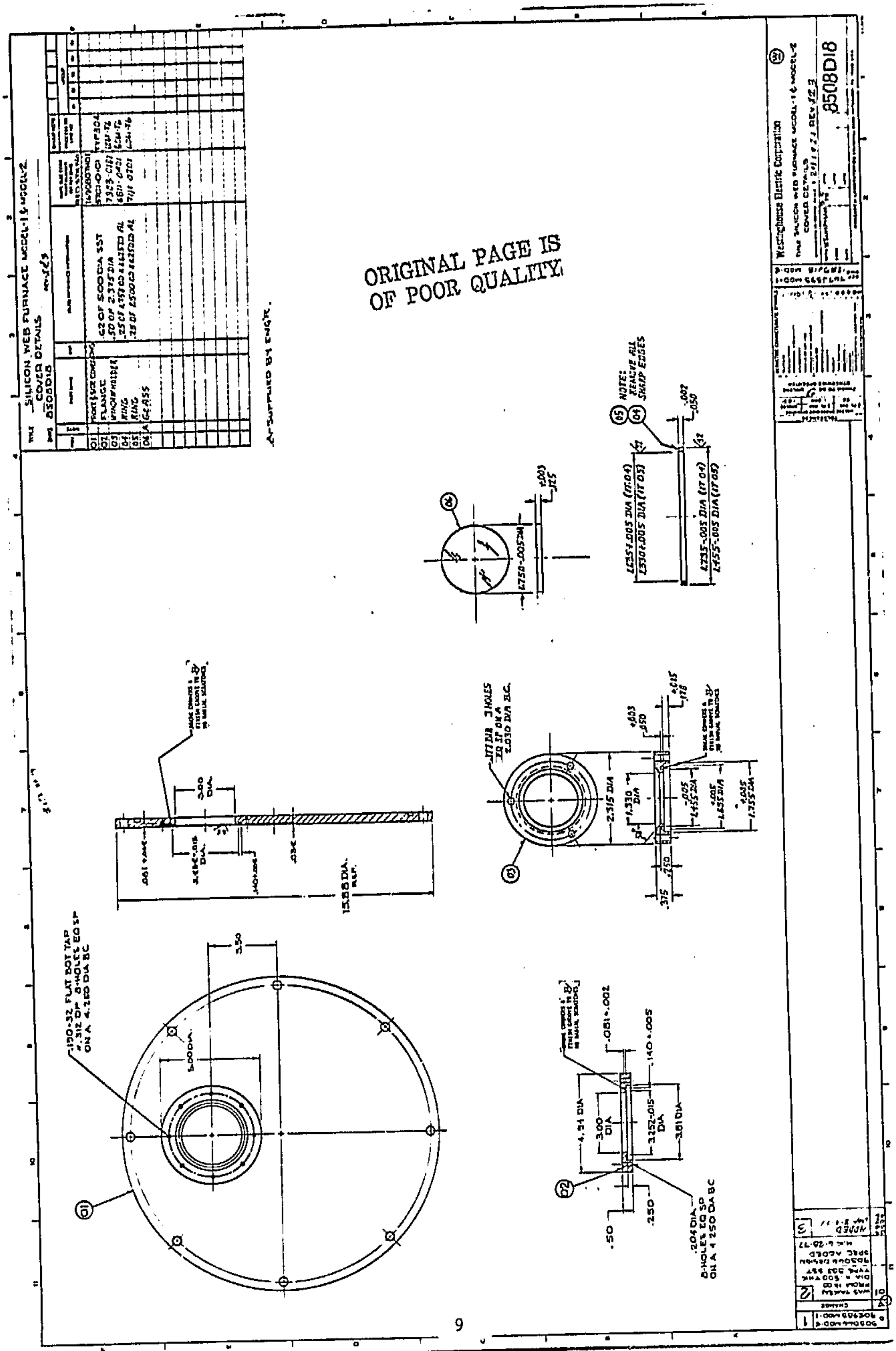
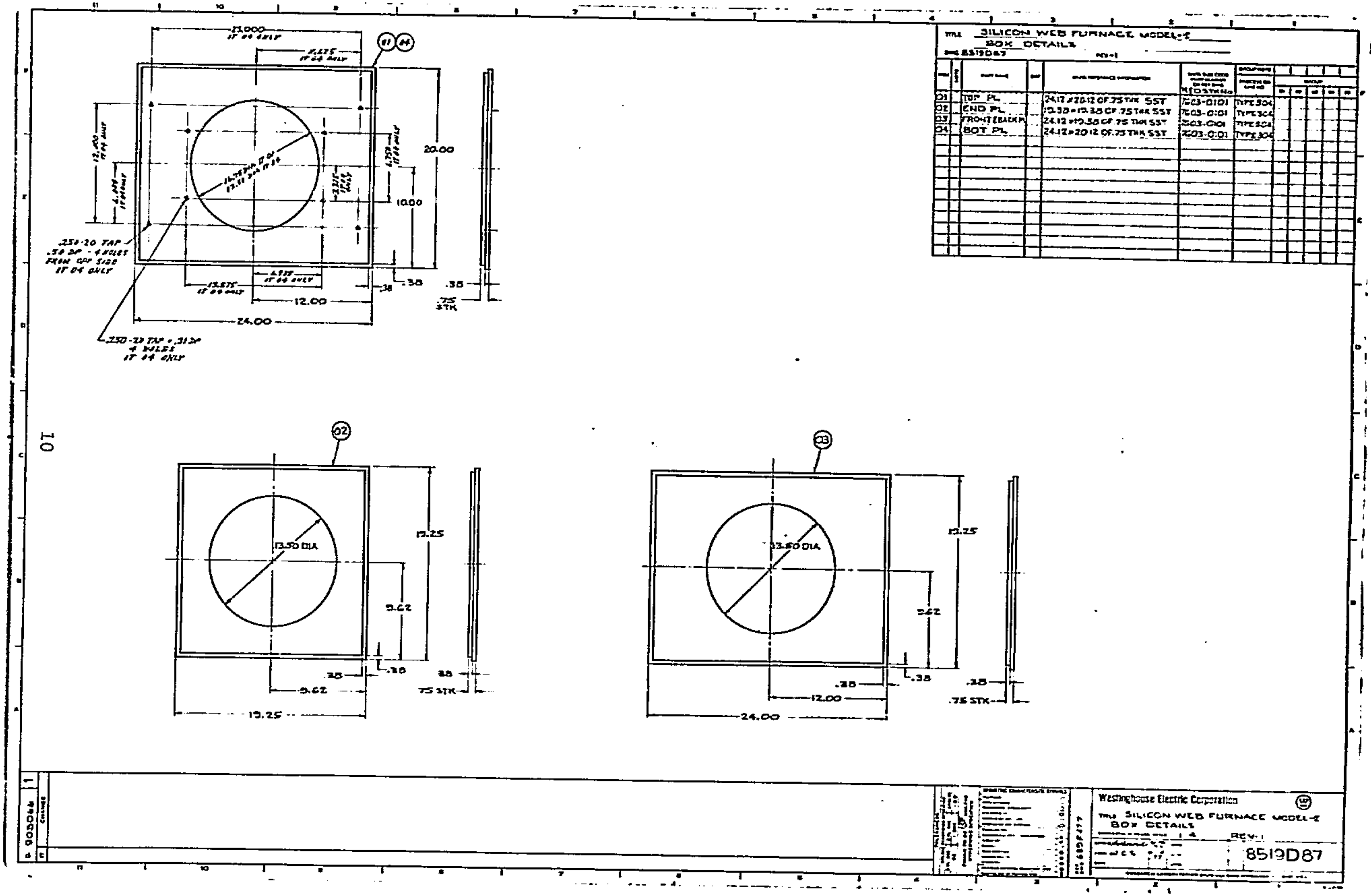
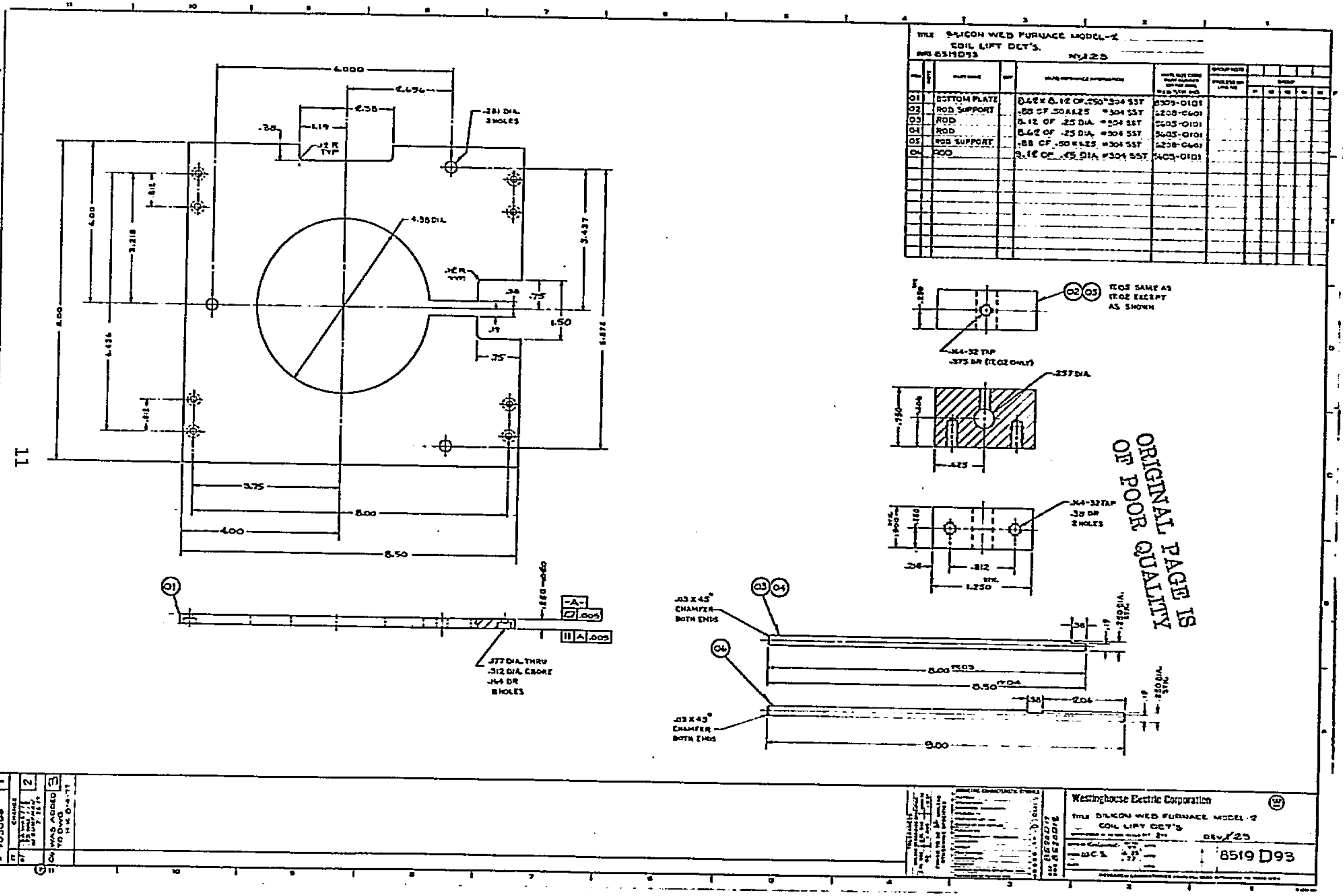
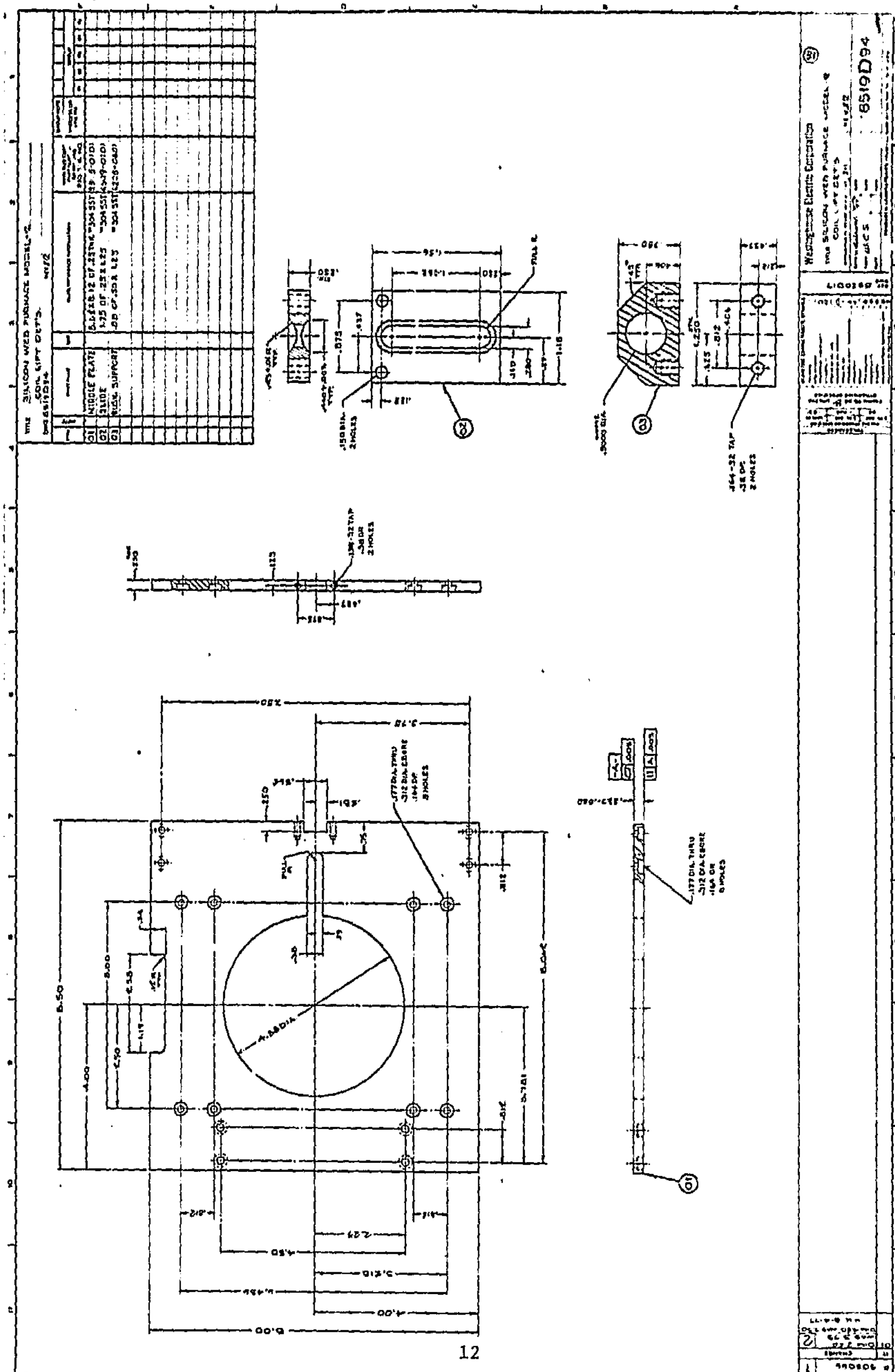


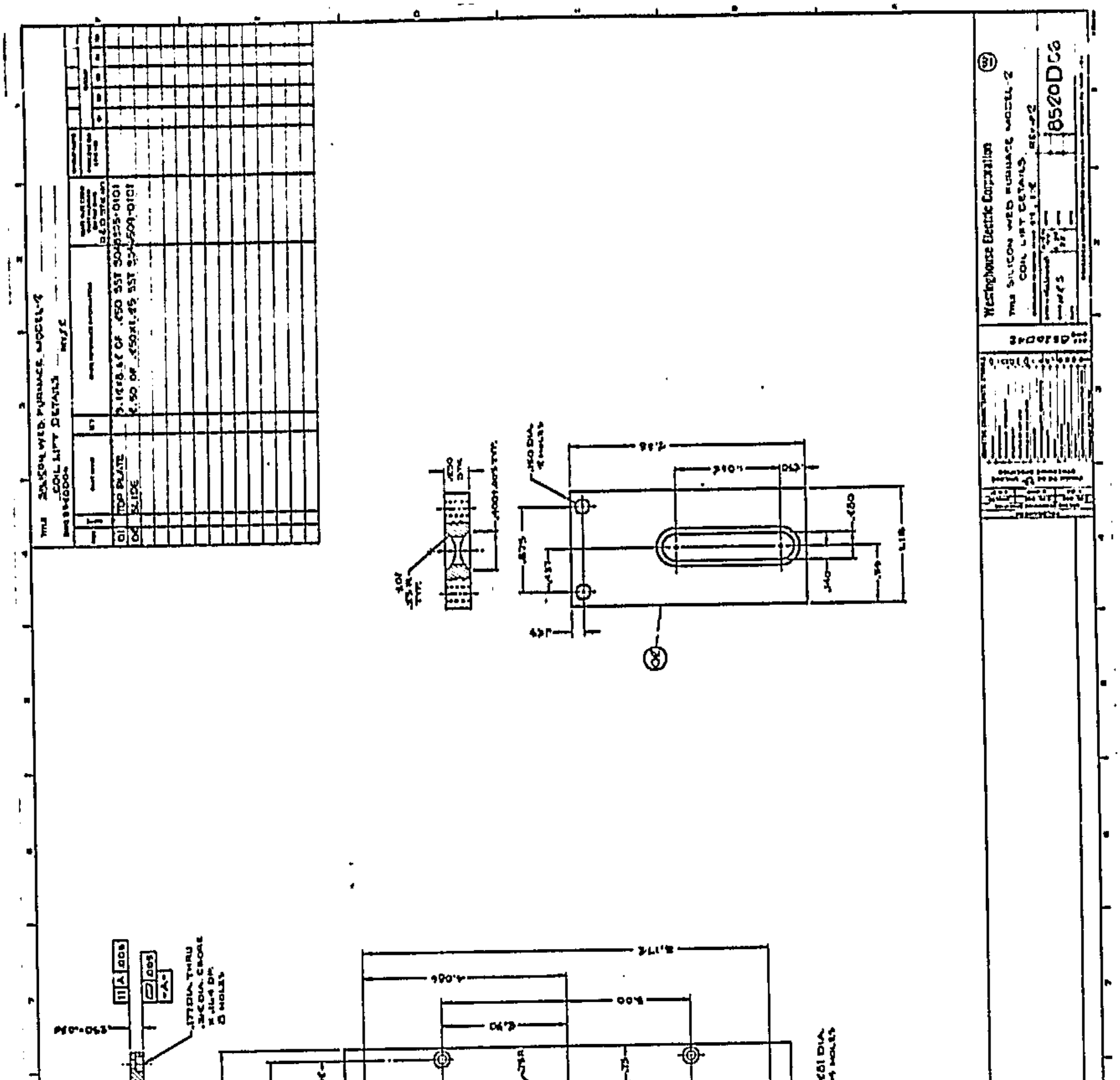

SILICON WEB FURNACE MODEL-E
BOX DETAILS
8519D87
01 TOP PL. 24.12 x 20.12 OF .75 THK SST 7603-0101 TYPE 304
02 END PL. 19.38 x 19.38 OF .75 THK SST 7603-0101 TYPE 304
03 FRONT & BACK PL. 24.12 x 19.38 OF .75 THK SST 7603-0101 TYPE 304
04 BOT PL. 24.12 x 20.12 OF .75 THK SST 7603-0101 TYPE 304
20.00
10.00
12.00
24.00
.38
.75 STK
.250-20 TAP / .50 DP - 4 HOLES FROM OPP SIDE IT 04 ONLY
.250-20 TAP x .31 DP 4 HOLES IT 04 ONLY
13.50 DIA
13.60 DIA
13.25
19.25
9.62
Westinghouse Electric Corporation
SILICON WEB FURNACE MODEL-E
BOX DETAILS
REV. 1
8519D87

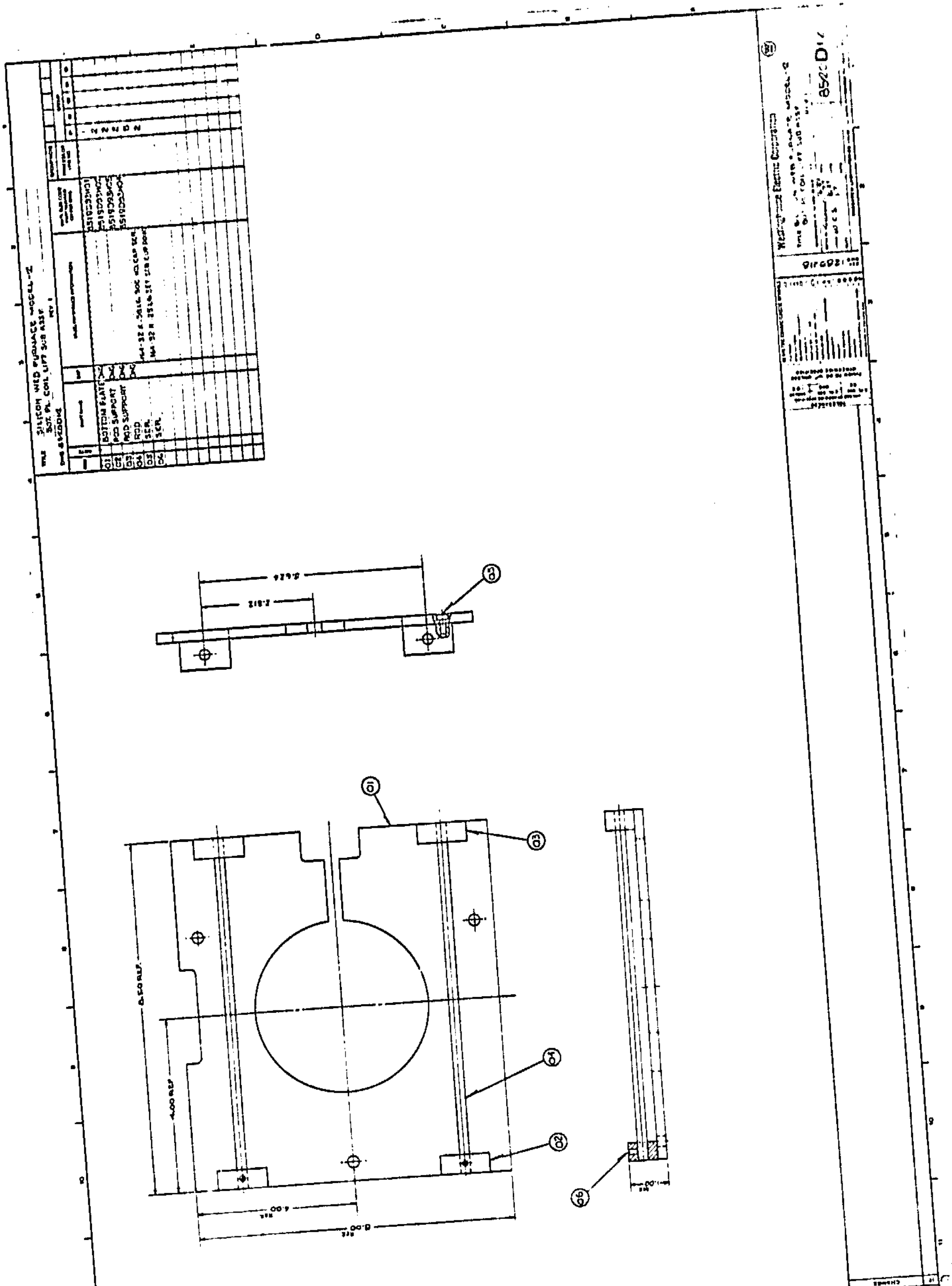


TITLE SILICON WEB FURNACE MODEL-2
COIL LIFT DET'S.
DWG 8519D93

01		BOTTOM PLATE		0.42 X 8.12 OF .250" 304 SST	8305-0101
02		ROD SUPPORT		.88 OF .50 X 1.25 #304 SST	6208-0601
03		ROD		8.12 OF .25 DIA. #304 SST	5605-0101
04		ROD		8.62 OF .25 DIA. #304 SST	5605-0101
05		ROD SUPPORT		.88 OF .50 X 1.25 #304 SST	6208-0601
06		ROD		9.12 OF .25 DIA. #304 SST	5605-0101


SILICON WEB FURNACE MODEL-2
COIL LIFT DET'S
Westinghouse Electric Corporation
8519D94


Westinghouse Electric Corporation
TITLE SILICON WEB FURNACE MODEL-2
COIL LIFT DETAILS
8520D56
01 TOP PLATE
02 SLIDE
.177 DIA. THRU
.312 DIA. CBORE
.164 DP.
8 HOLES
.281 DIA.
4 HOLES
.150 DIA.
2 HOLES
4.500 DIA.
.75R
6.50
4.00
3.781
8.062
4.50
3.50
7.00
9.00
2.848
5.756
8.172
4.066
6.30
5.00
.875
.437
.125
2.86
1.016
1.18



SILICON WEB FURNACE MODEL-II
SUT. PL. COIL LIFT SUB ASSY
01 BOTTOM PLATE
02 ROD SUPPORT
03 ROD SUPPORT
04 ROD
05 SCR.
06 SCR.
8.50 REF.
4.00 REF
2.812
8.624
Westinghouse Electric Corporation

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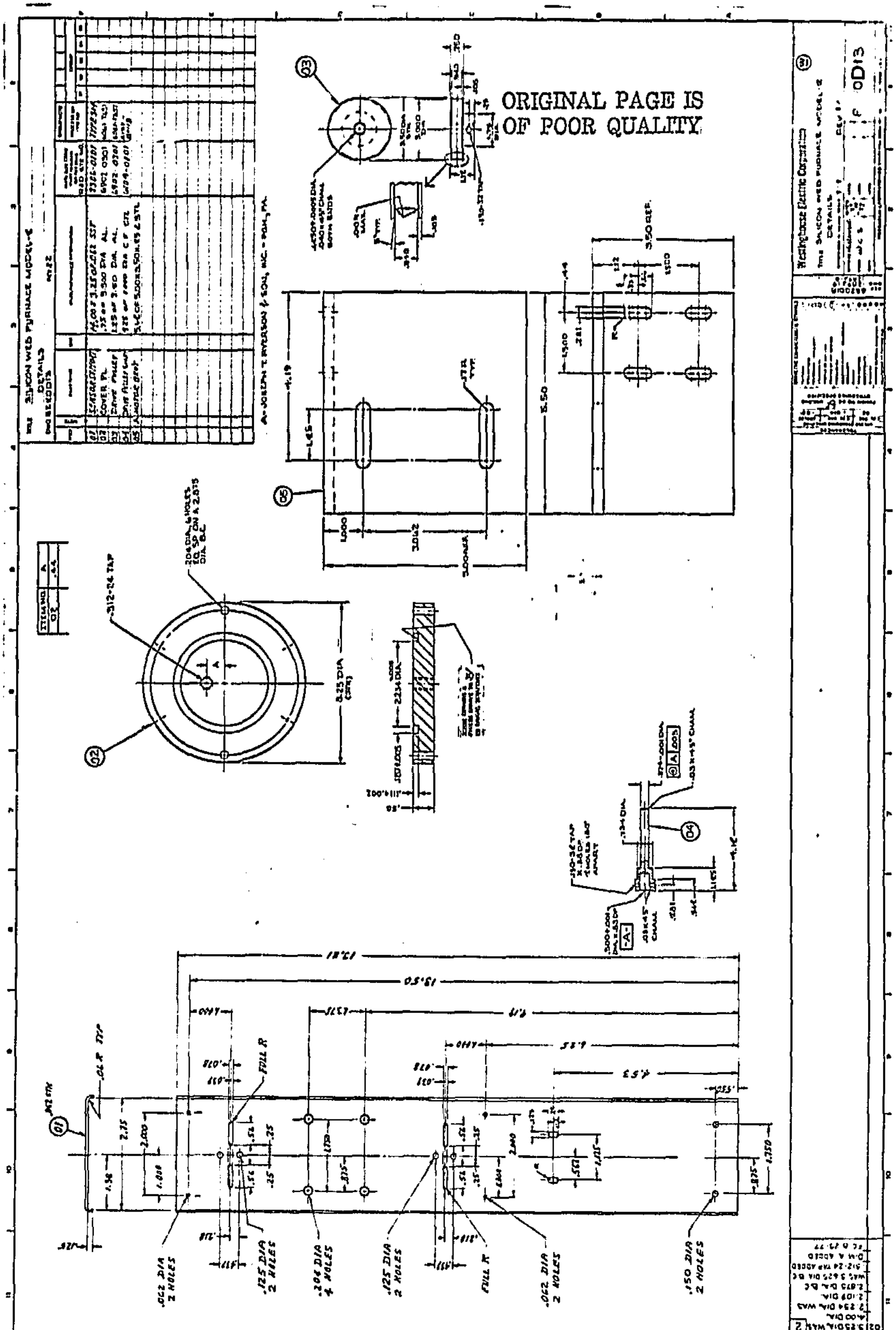
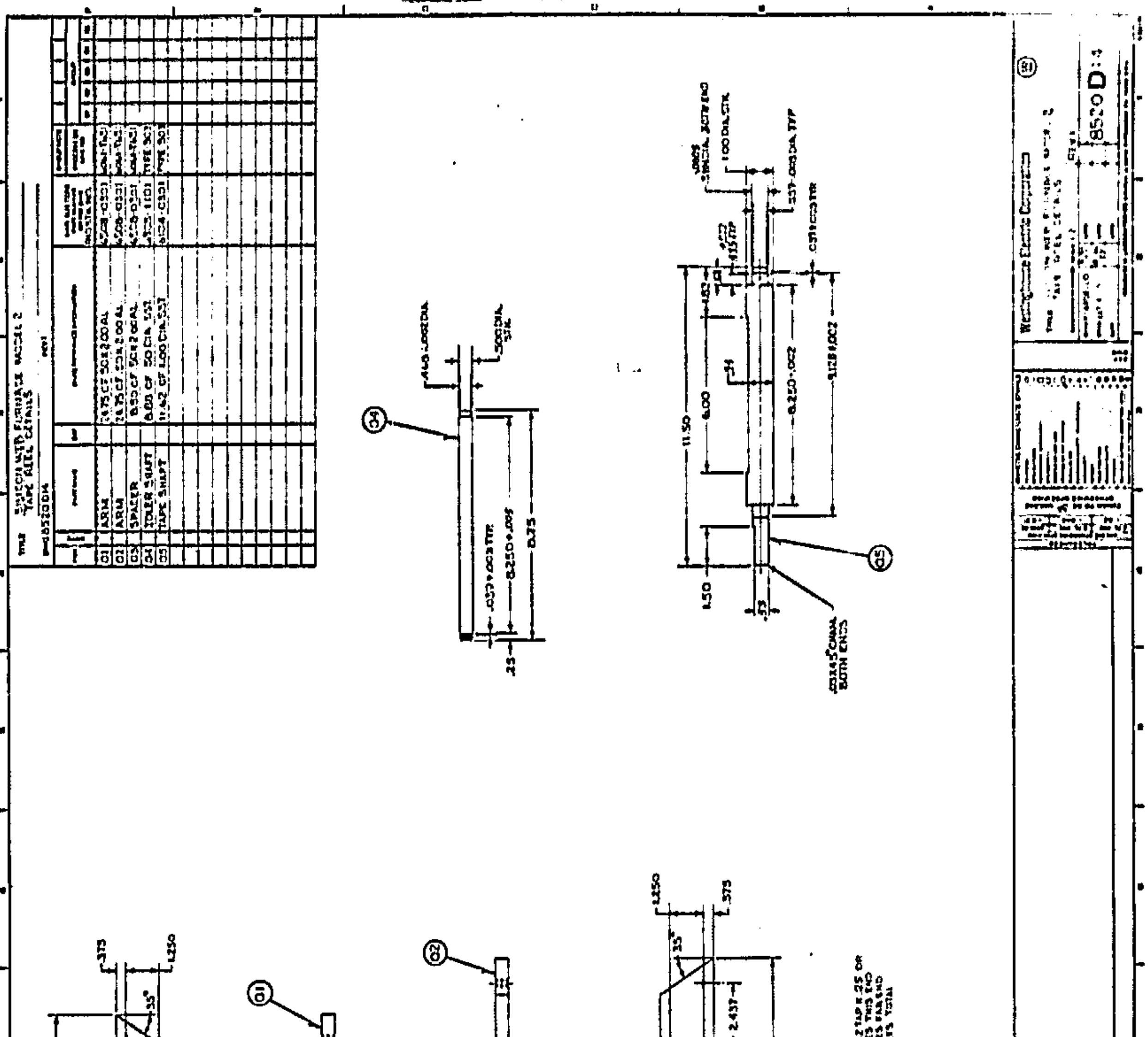
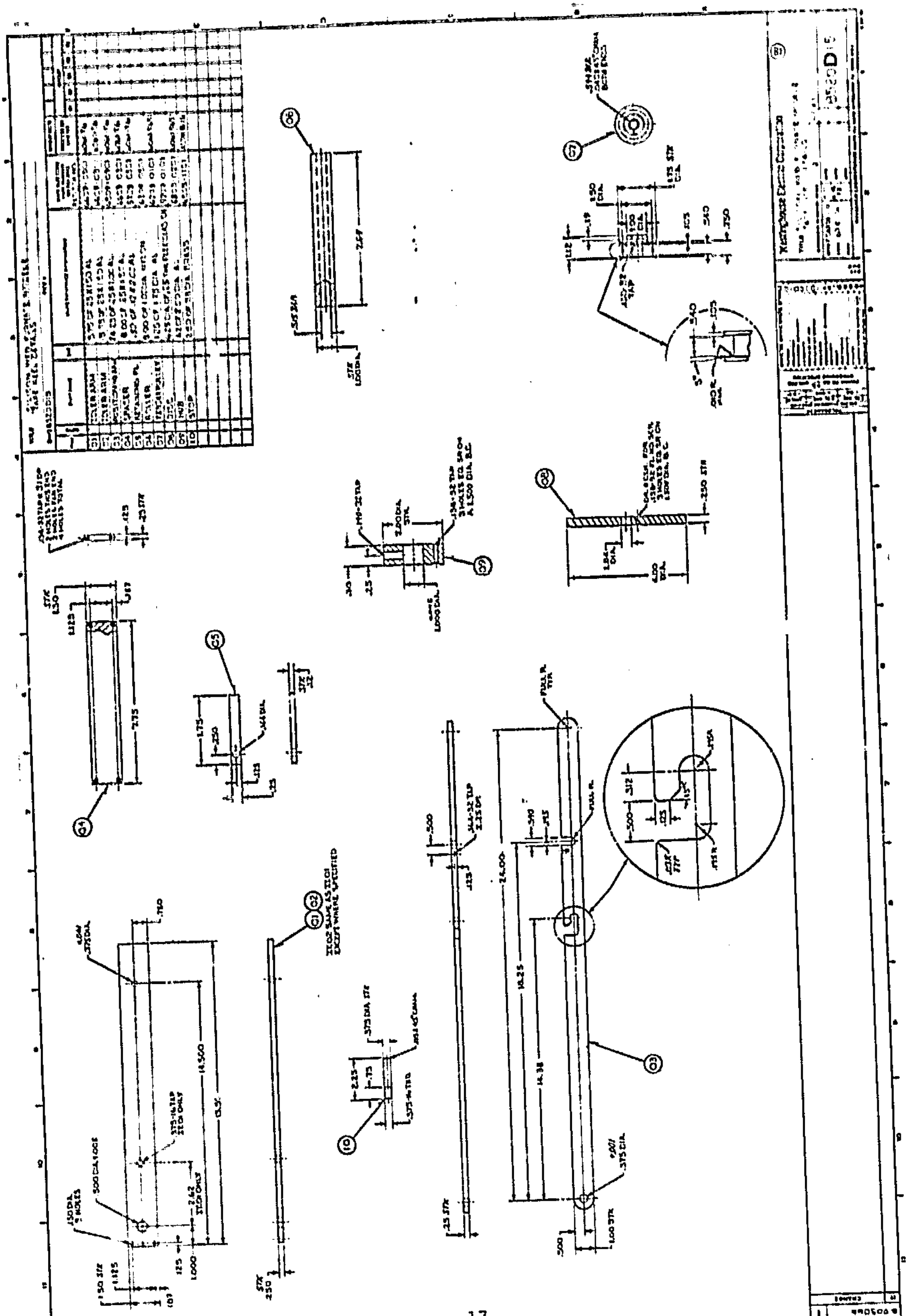
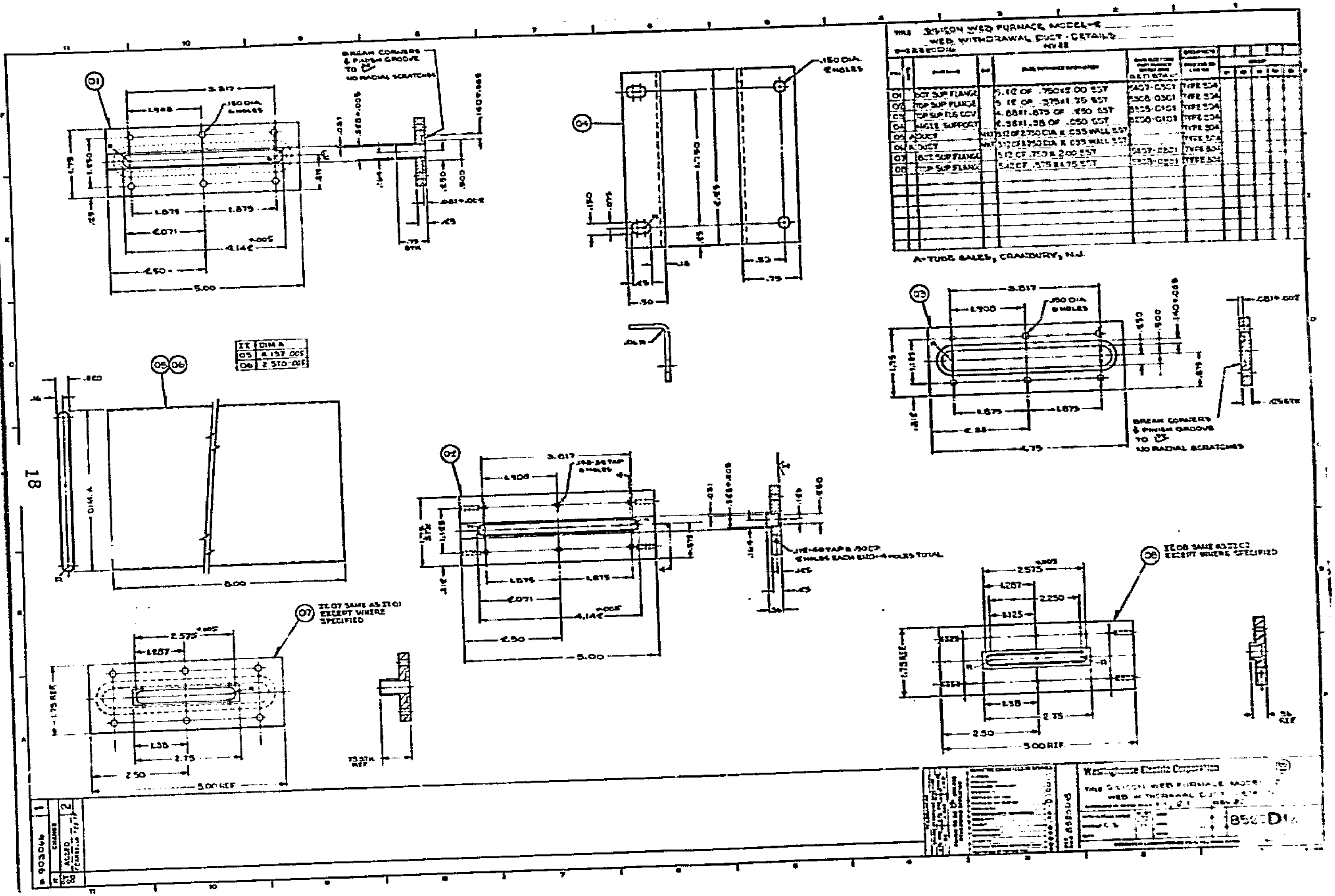
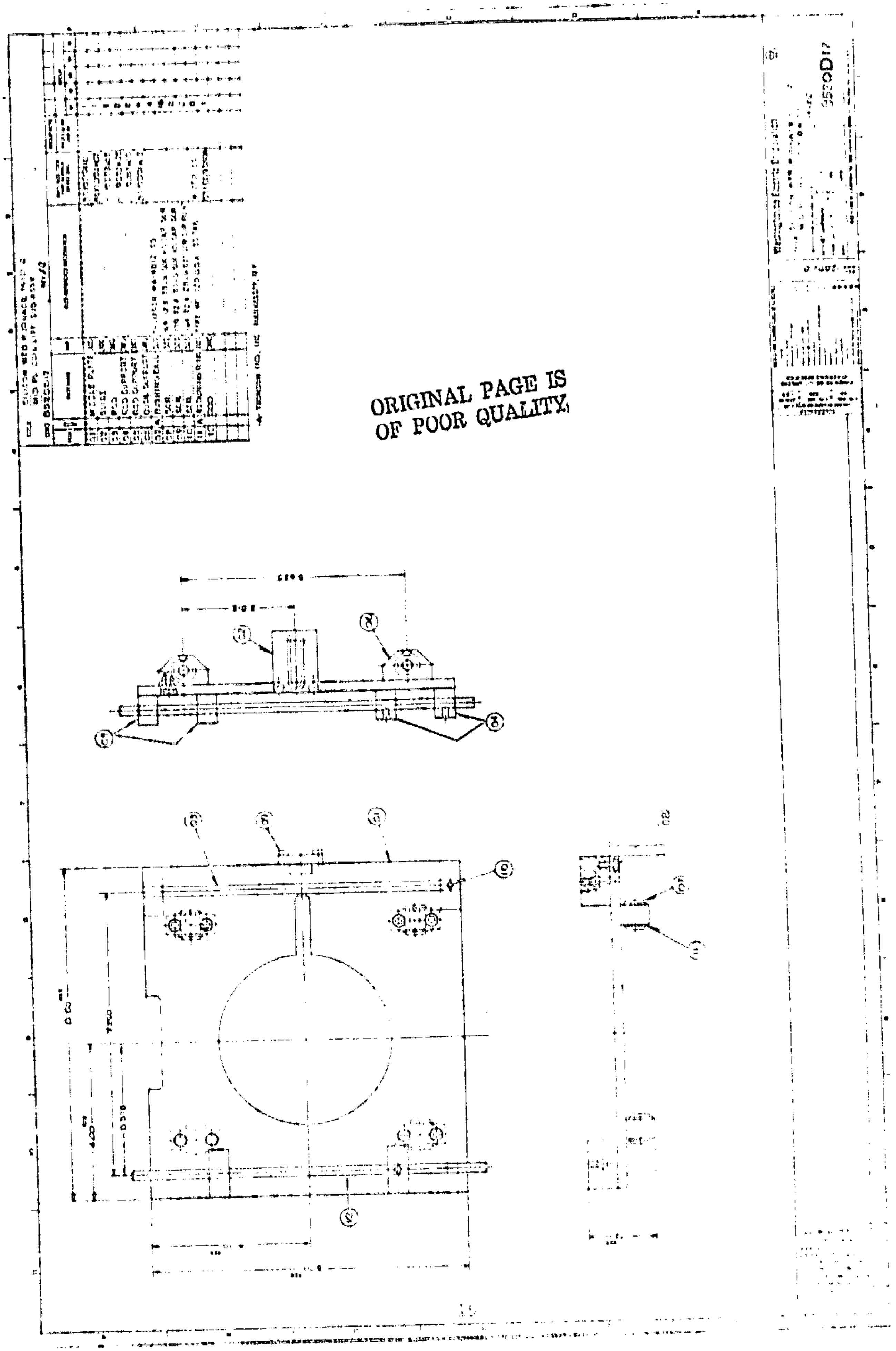



SWITCH WITH FURNACE MODEL 2
TAPE REEL DETAILS
01 ARM 24.75 OF .50 X 2.00 AL
02 ARM 24.75 OF .50 X 2.00 AL
03 SPACER 8.50 OF .50 X 2.00 AL
04 IDLER SHAFT 8.80 OF .50 DIA. SST
05 TAPE SHAFT 11.62 OF 1.00 DIA. SST
Westinghouse Electric Corporation
8520D14




SILICON WEB FURNACE MODEL-E
WEB WITHDRAWAL DUCT - DETAILS
A-TUBE SALES, CRANBURY, N.J.
BREAK CORNERS & FINISH GROOVE
NO RADIAL SCRATCHES
.150 DIA. 6 HOLES
IT 07 SAME AS IT 01 EXCEPT WHERE SPECIFIED
IT 08 SAME AS IT 02 EXCEPT WHERE SPECIFIED
5.00 REF
1.75 REF
DIM. A
Westinghouse Electric Corporation



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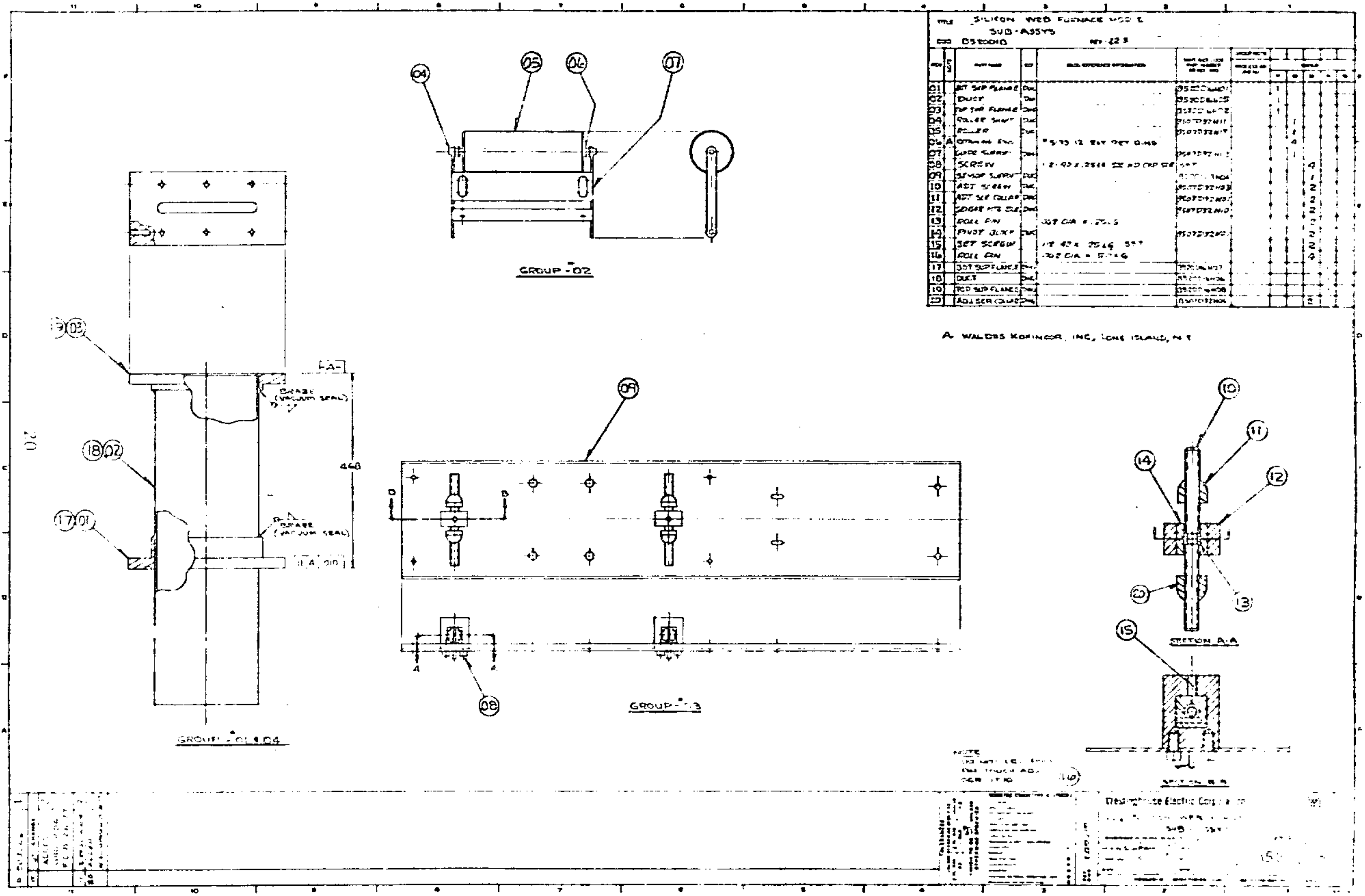
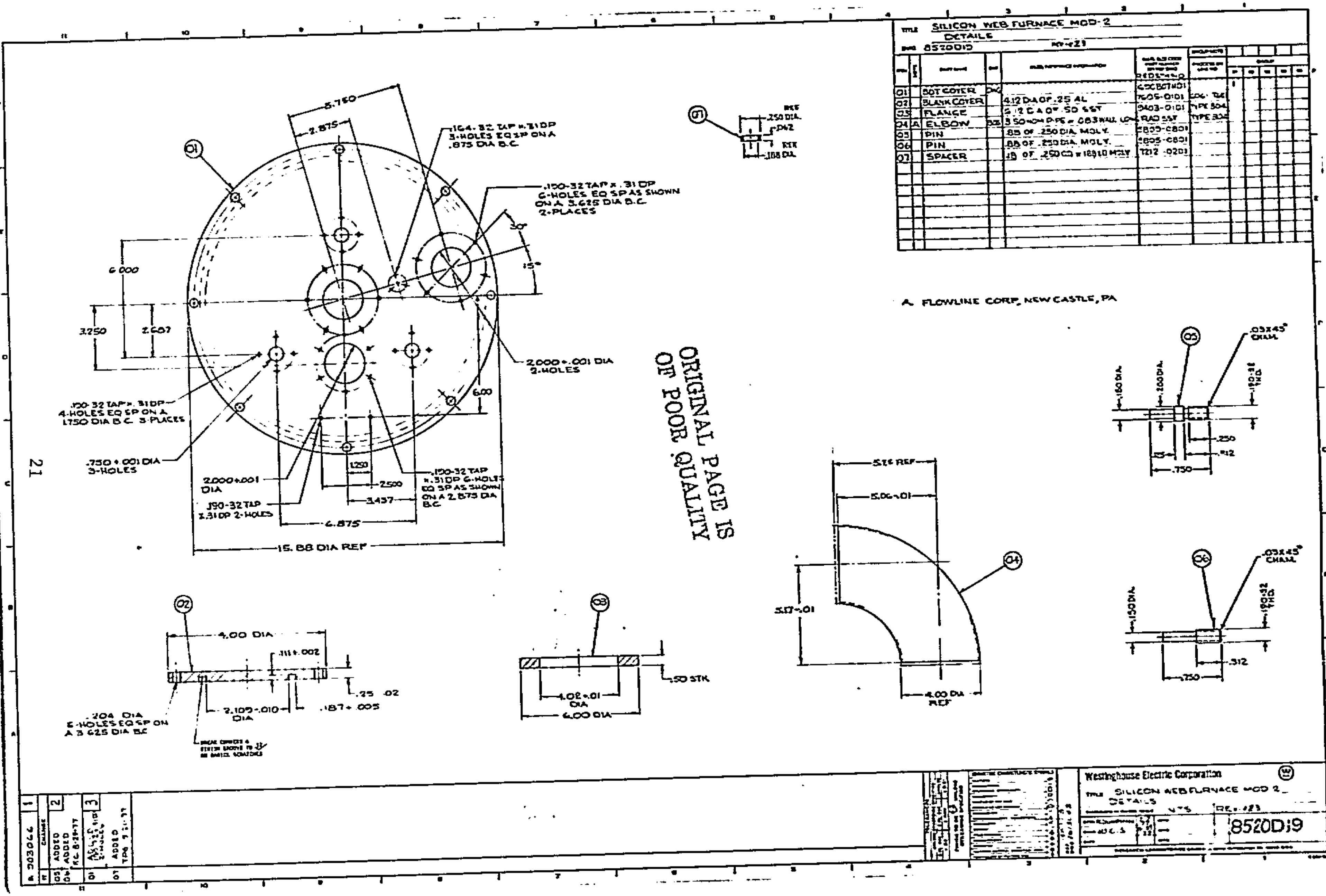
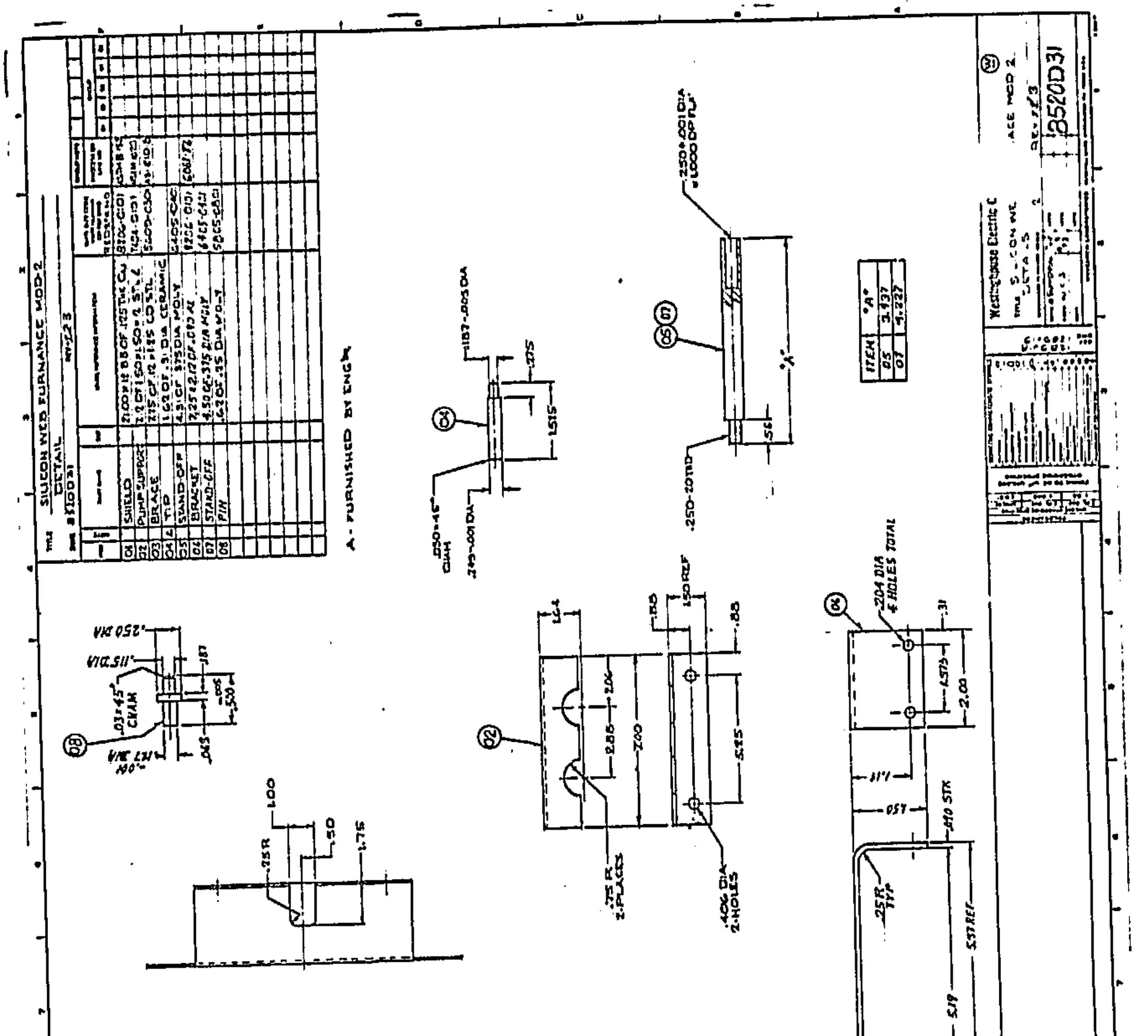
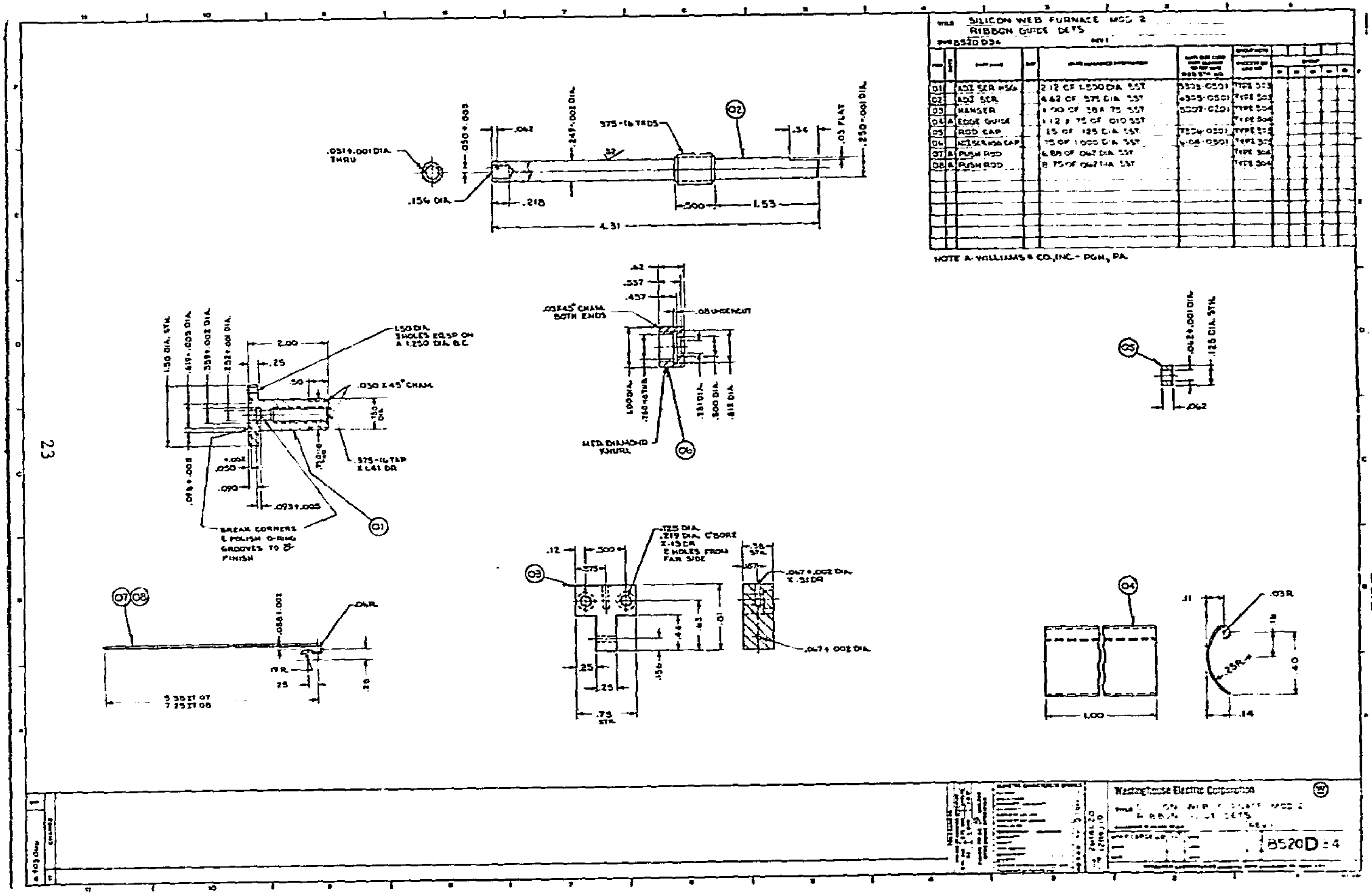

SILICON WEB FURNACE MOD 2
SUB-ASSYS
GROUP - 02
GROUP - 03
GROUP - 01 & 04
SECTION A-A
SECTION B-B
BRAZE (VACUUM SEAL)
A. WALDES KOHINOOR, INC., LONG ISLAND, N.Y.
Westinghouse Electric Corporation

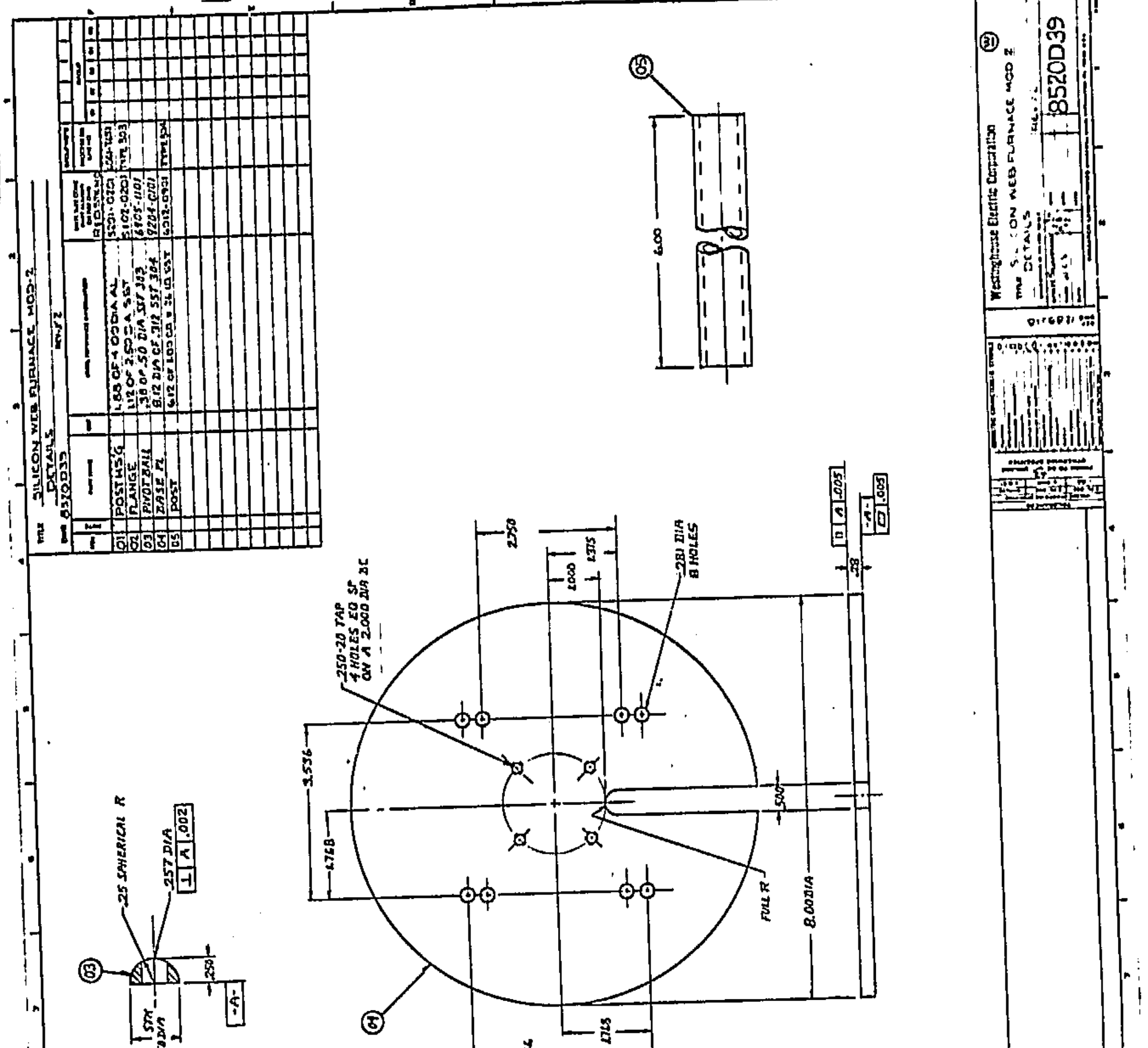


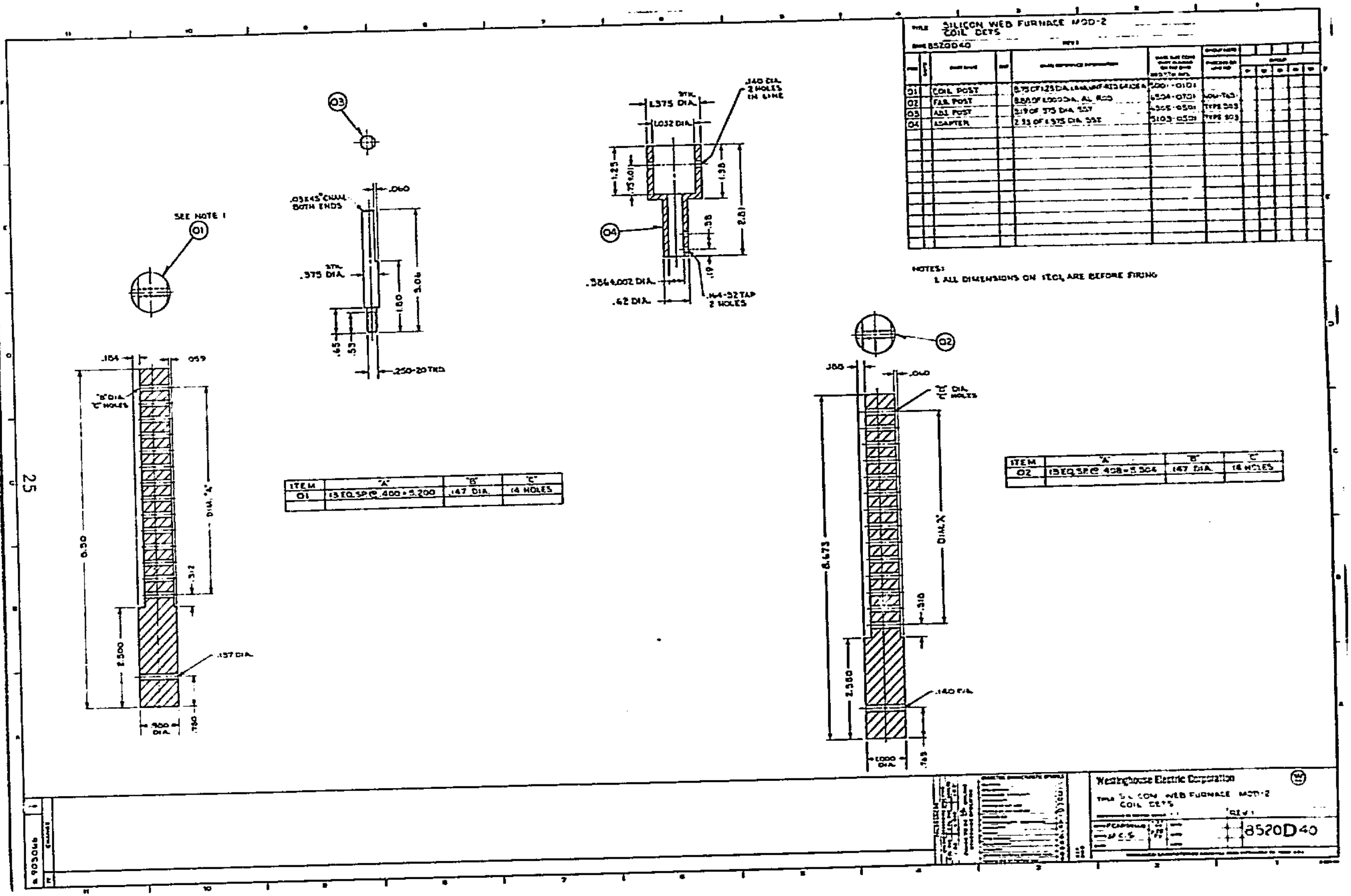
No.	Mod.	Part Name		Description	Part No.	Material
01		BOT COVER	DWG		4506B07H01	
02		BLANK COVER		4.12 DIA OF .25 AL	7605-0101	606-T6
03		FLANGE		6.12 C A OF .50 SST	9403-0101	TYPE 304
04	A	ELBOW		3.50 NOM PIPE x .083 WALL LONG RAD SST		TYPE 304
05		PIN		.88 OF .250 DIA. MOLY.	2805-0801	
06		PIN		.88 OF .250 DIA. MOLY.	2805-0801	
07		SPACER		.18 OF .250 OD x 18910 MOLY	1212-0201	


SILICON WEB FURNACE MOD-2
DETAIL
A - FURNISHED BY ENG
Westinghouse Electric C
8520D31



SILICON WEB FURNACE MOD 2
RIBBON GUIDE DETS
8520D34
01 ADJ SCR HSG 2.12 OF 1.500 DIA SST
02 ADJ SCR 4.62 OF .375 DIA SST
03 HANGER
04 A EDGE GUIDE
05 ROD CAP .25 OF .125 DIA SST
06 ADJ SCR HSG CAP
07 A PUSH ROD
08 A PUSH ROD
NOTE A- WILLIAMS & CO., INC.- PGH., PA.
.0514.001 DIA. THRU
.154 DIA.
375-16 THDS
.249-.002 DIA.
.250-.001 DIA.
.03 FLAT
.218
.500
1.53
4.31
1.50 DIA. STK.
1.50 DIA. 3 HOLES EQ SP ON A 1.250 DIA. B.C.
.030 X 45° CHAM.
.375-16 TAP X 1.41 DP
.0934.005
BREAK CORNERS & POLISH O-RING GROOVES TO FINISH
.03X45° CHAM. BOTH ENDS
.05 UNDERCUT
MED. DIAMOND KNURL
1.000 DIA.
.281 DIA.
.500 DIA.
.812 DIA.
.125 DIA. STK.
.062
.125 DIA. .219 DIA. C'BORE X .15 DP. 2 HOLES FROM FAR SIDE
.0674.002 DIA. X .31 DP
.0674 .002 DIA.
.75 STK.
.38 STK.
.04R.
.03R
.25R
1.00
.14
5.38 IT 07
7.75 IT 08
Westinghouse Electric Corporation
8520D34

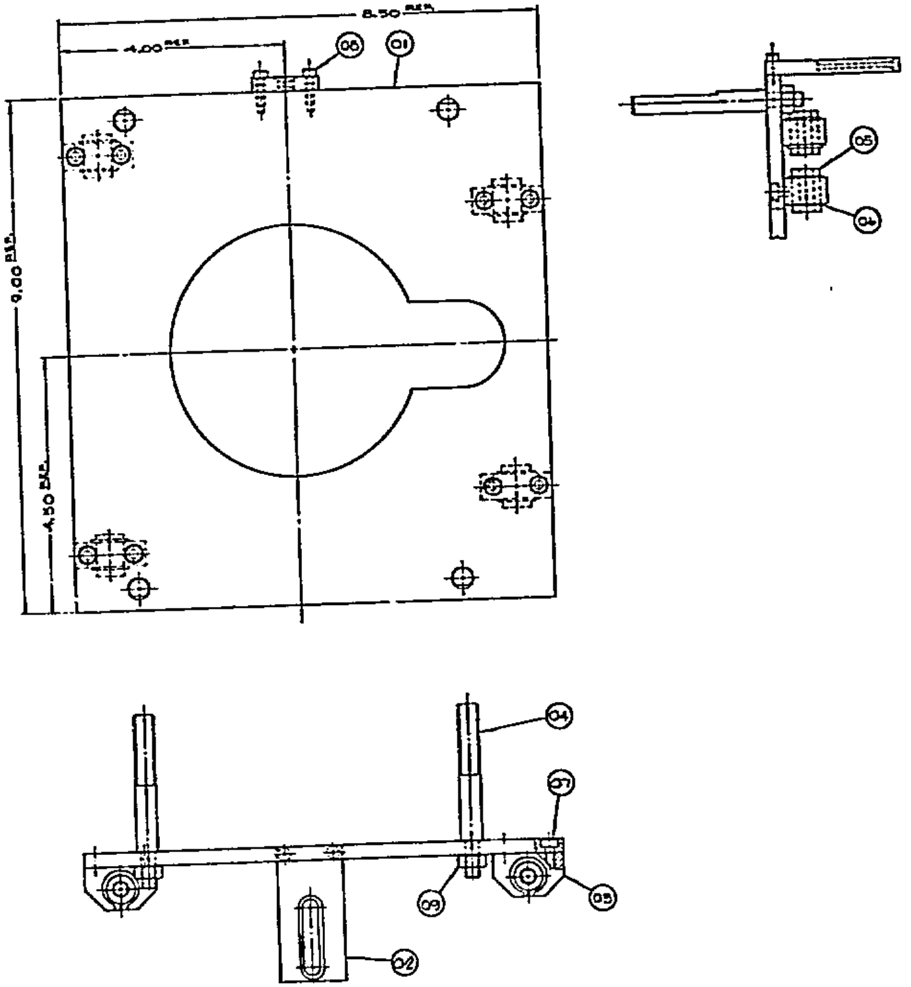

SILICON WEB FURNACE MOD-2
DETAILS
8520D39
POSTHSG
FLANGE
PIVOT BALL
BASE PL
POST
Westinghouse Electric Corporation
8520D39


SILICON WEB FURNACE MOD-2
COIL DETS
8520D40
01 COIL POST
02 FAB POST
03 ADJ POST
04 ADAPTER
NOTES:
1. ALL DIMENSIONS ON ITEM 1 ARE BEFORE FIRING
SEE NOTE 1
.03X45° CHAM. BOTH ENDS
.250-20 THD.
.140 DIA. 2 HOLES IN LINE
.3864.002 DIA.
.62 DIA.
#4-32 TAP 2 HOLES
"B" DIA. "C" HOLES
.157 DIA.
.140 DIA.
ITEM | "A" | "B" | "C"
01 | 13 EQ.SP.@ .400 = 5.200 | .147 DIA. | 14 HOLES
02 | 13 EQ.SP.@ .408 = 5.304 | .147 DIA. | 14 HOLES
Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-E
TOP PLATE COIL LIFT SUB ASSY.
REV #2

Item		Part Name		Reference Information	Drawing No.		Qty
01		TOP PLATE	DWG		8520D06H01		1
02		SLIDE	DWG		8520D06H02		1
03		BSHG SUPPORT	DWG		2519D94H03		4
04		ADJ POST	DWG		8520D40H03		4
05		ADJNG BALL	SCS	THOMSON #A-4812 SST			4
06		RTNG RING	SCS	TRDO #.035 THK SST PART#WH-250-SS			8
07		SCREW		.164-32#.38 SOC HD CAP SST			8
08		SCREW		.138-32#.50 SOC HD CAP SST			4
09		NUT		.250-20 HEX SST			4

A-THOMSON INDUSTRIES, INC.-MANHASSET, N.Y.

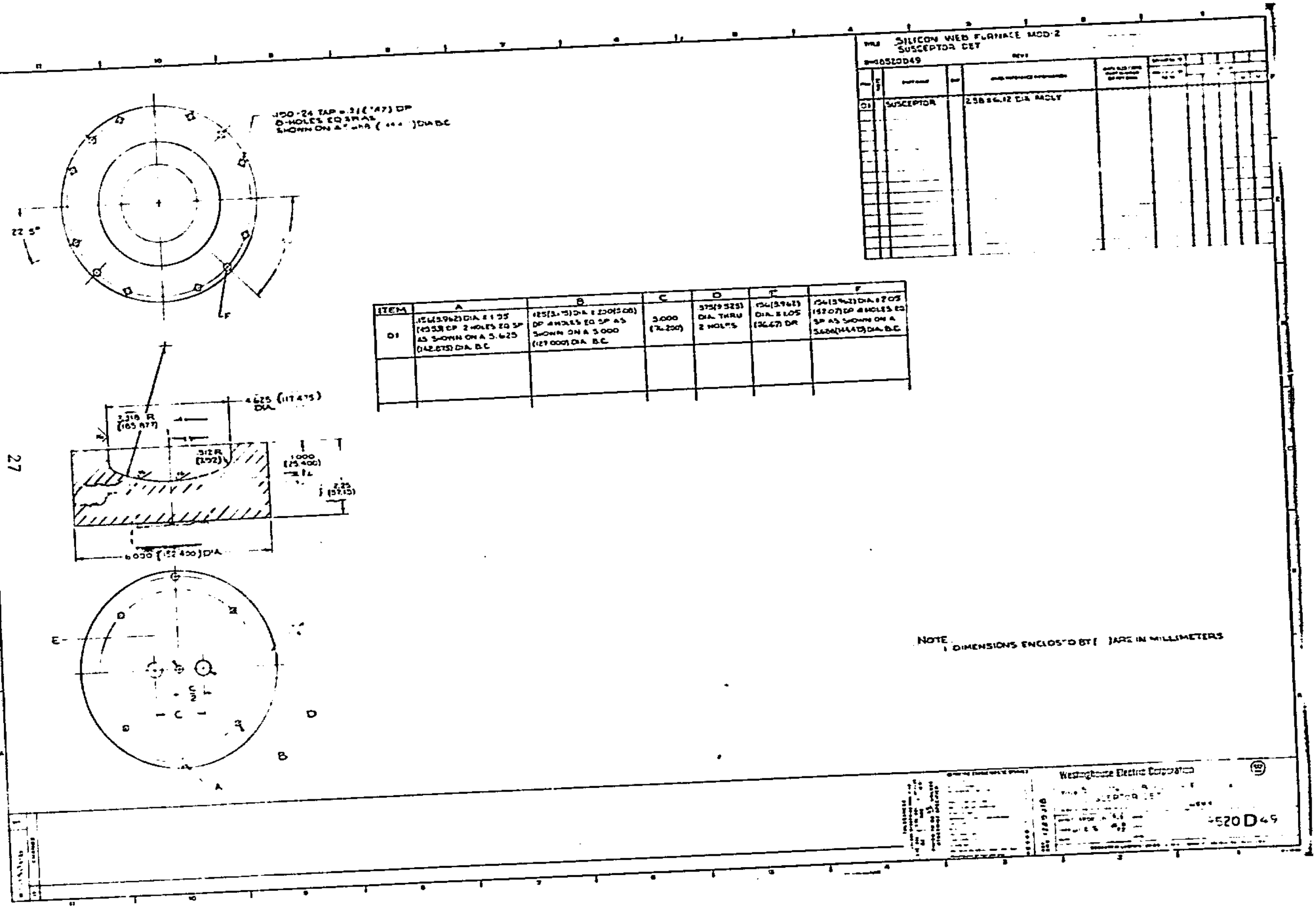


Westinghouse Electric Corporation

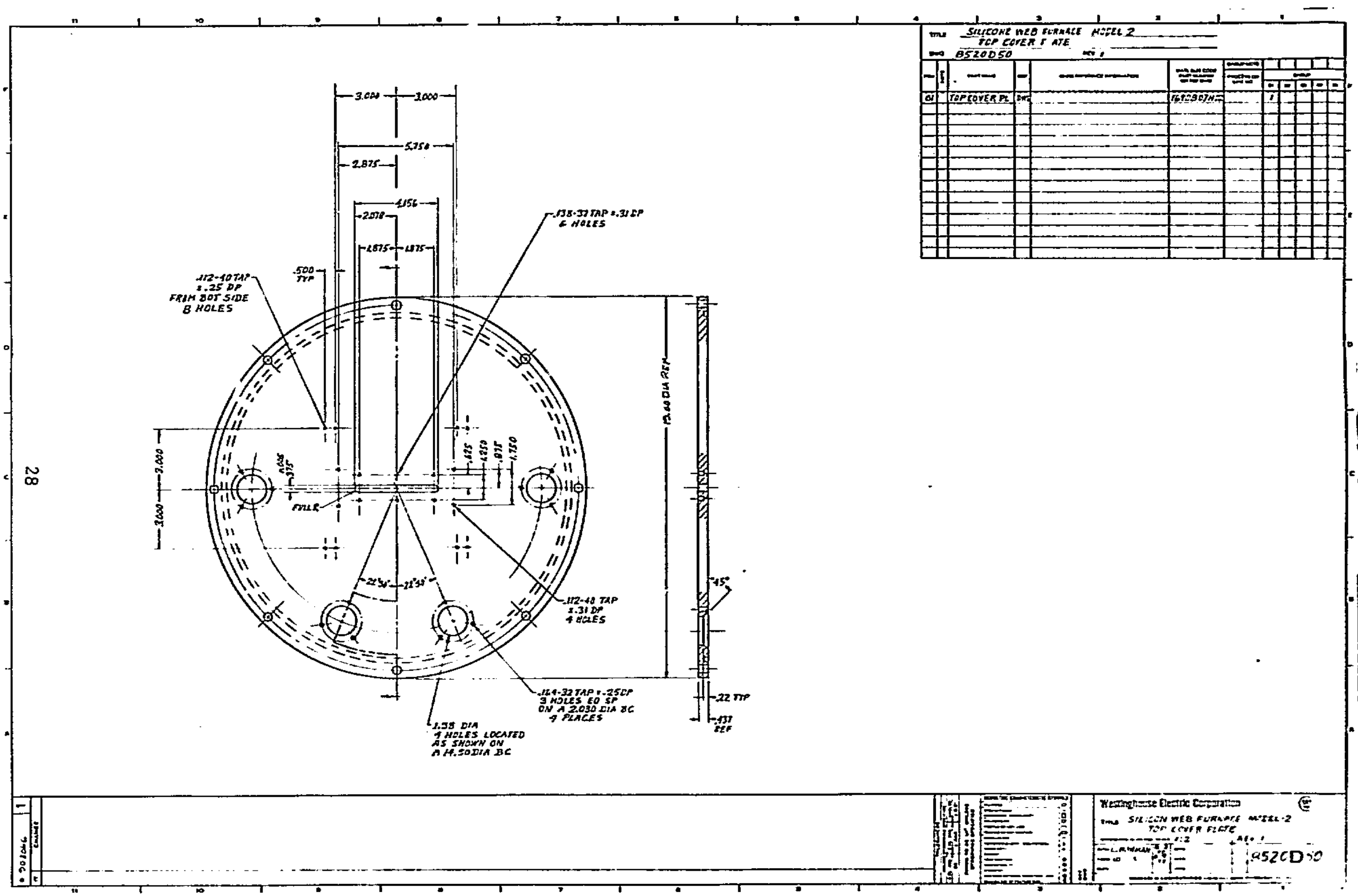
TITLE SILICON WEB FURNACE MODEL-E
TOP PLATE COIL LIFT SUB ASSY
REV #C

8520D42

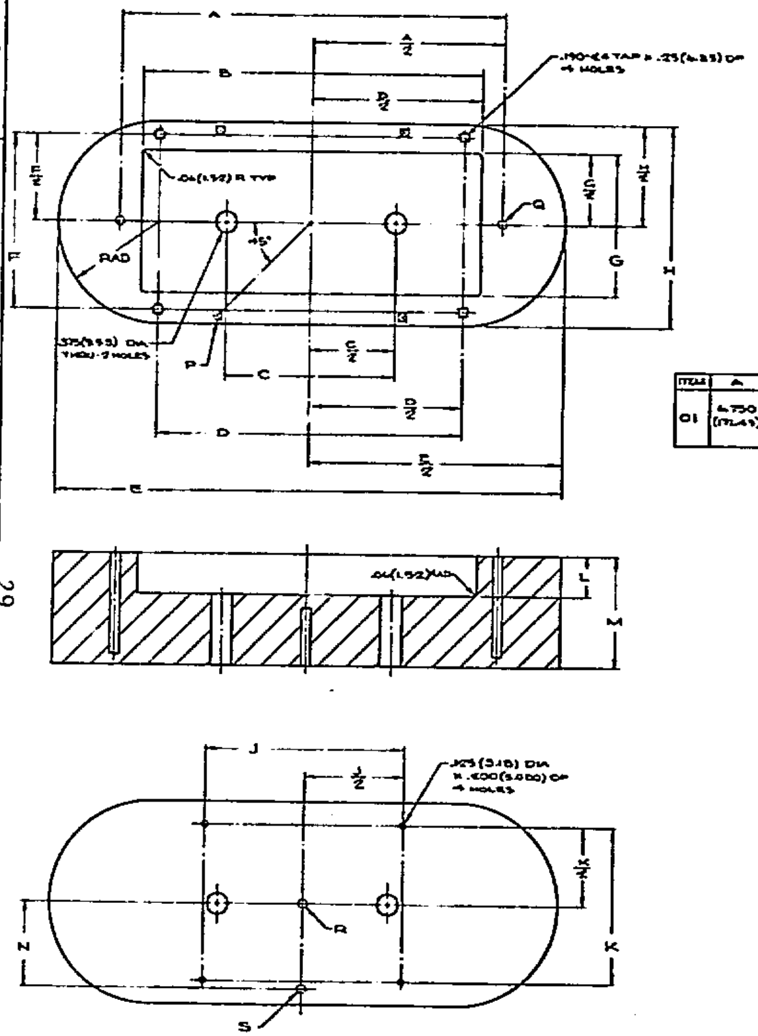
1209J18



ITEM	A	B	C	D	E	F
01	.156(3.962) DIA x 1.35 (45.53) DP 2 HOLES EQ SP AS SHOWN ON A 5.625 (142.875) DIA. B.C	.125(3.175) DIA x .200(5.08) DP 4 HOLES EQ SP AS SHOWN ON A 5.000 (127.000) DIA. B.C	3.000 (76.200)	.375(9.525) DIA. THRU 2 HOLES	.156(3.962) DIA x 1.05 (26.67) DP	.156(3.962) DIA x .2.05 (52.07) DP 4 HOLES EQ SP AS SHOWN ON A 5.686(144.43) DIA. B.C



SILICONE WEB FURNACE MODEL 2
TOP COVER PLATE
8520D50
01 TOP COVER PL
3.000
3.000
5.358
2.875
4.156
2.078
1.875
1.875
.500 TYP
.112-40 TAP x.25 DP FRIM BOT SIDE 8 HOLES
.138-32 TAP x.31 DP 6 HOLES
FULL R
.112-48 TAP x.31 DP 4 HOLES
.164-32 TAP x.25 DP 3 HOLES EQ SP ON A 2.030 DIA BC 4 PLACES
1.38 DIA 4 HOLES LOCATED AS SHOWN ON A 11.50 DIA BC
13.60 DIA REF
45°
.22 TYP
.437 REF
22°30'
22°30'
Westinghouse Electric Corporation
SILICON WEB FURNACE MODEL 2
TOP COVER PLATE
8520D50



ITEM	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S
01	6.750 (171.45)	6.000 (152.40)	3.000 (76.20)	5.375 (136.53)	8.97 (227.84)	3.062 (77.774)	2.500 (63.500)	3.56 (90.42)	3.536 (89.814)	2.750 (69.850)	.705 (17.903)	1.96 (49.78)	1.500 (38.100)	.156 (3.962) DIA x 1.76 (44.70) DP - 4 HOLES EQ SP ON A 4.625 (117.47) DIA. B.C.	.156 (3.962) DIA x 1.76 (44.70) DP 2 HOLES	.156 (3.962) DIA x 1.00 (25.40) DP	.156 (3.962) DIA x 1.66 (42.16) DP

TITLE SILICON WEB FURNACE MOD 2 SUSCEPTOR DETAIL

DWG 8520D51

ITEM		PART NAME		DESCRIPTION
01		SUSCEPTOR		312 x 3.69 x 2.26 MOLY

NOTE: DIMENSIONS ENCLOSED BY ( ) ARE IN MILLIMETERS

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD 2 SUSCEPTOR DETAIL

8520D51

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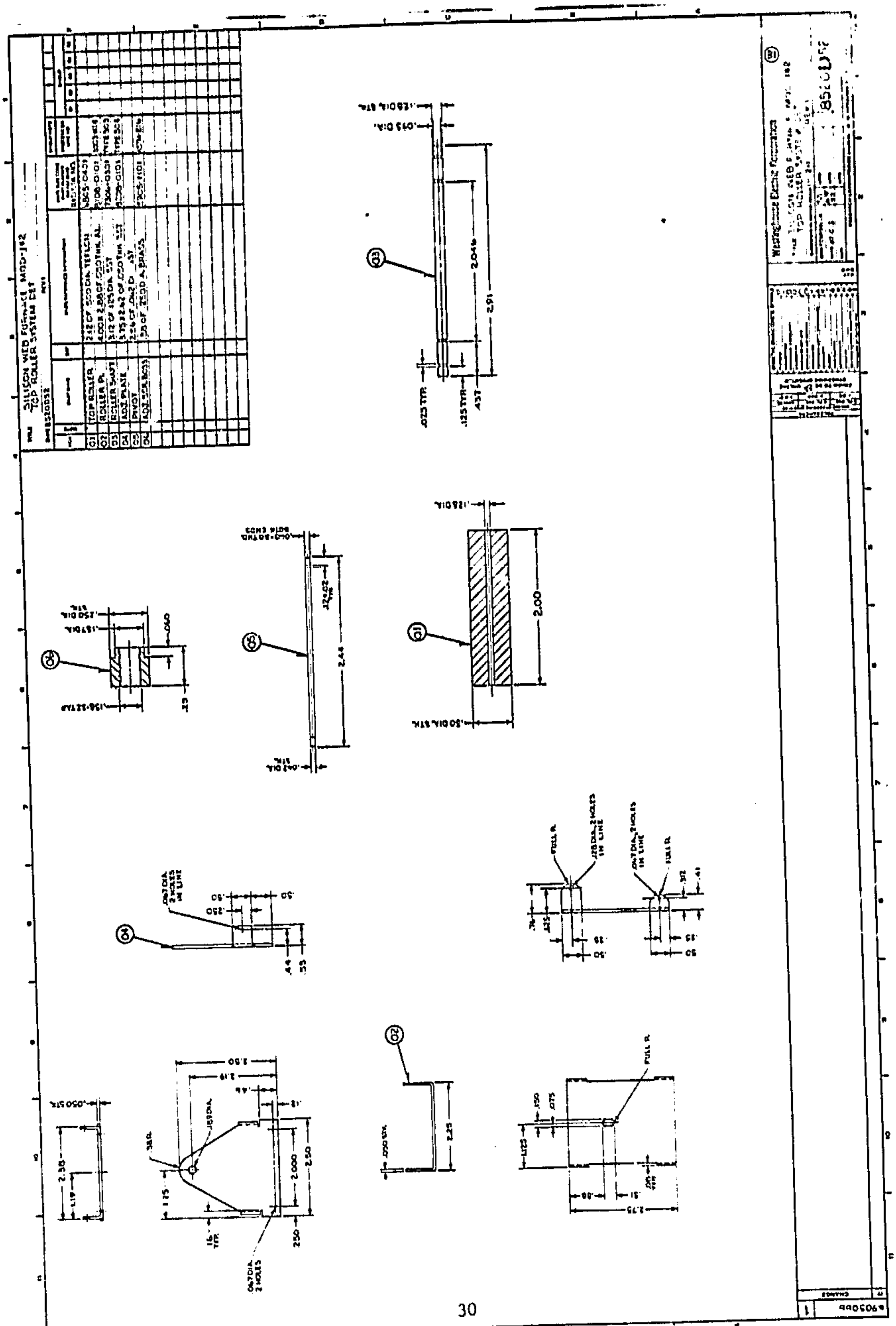
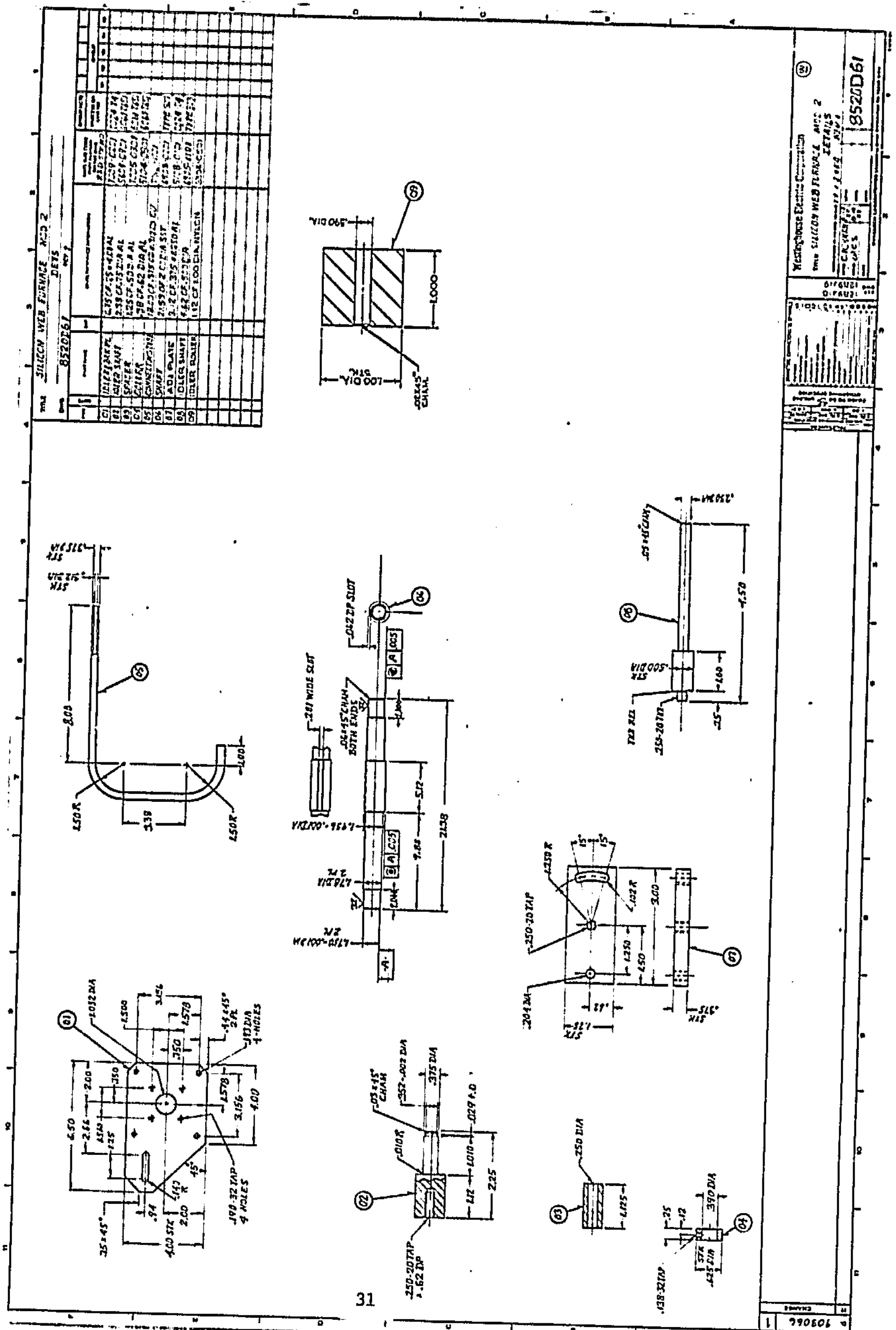
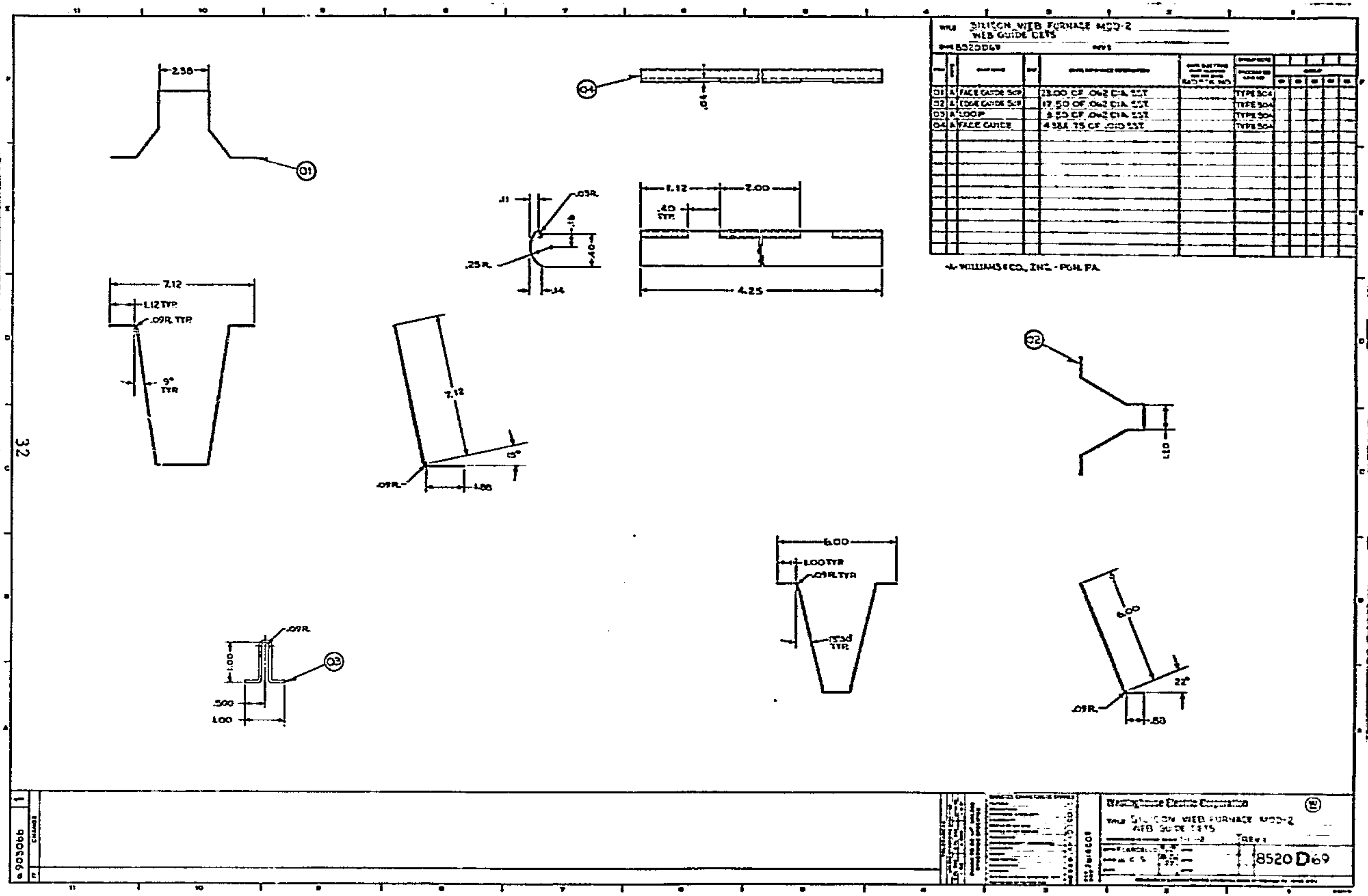
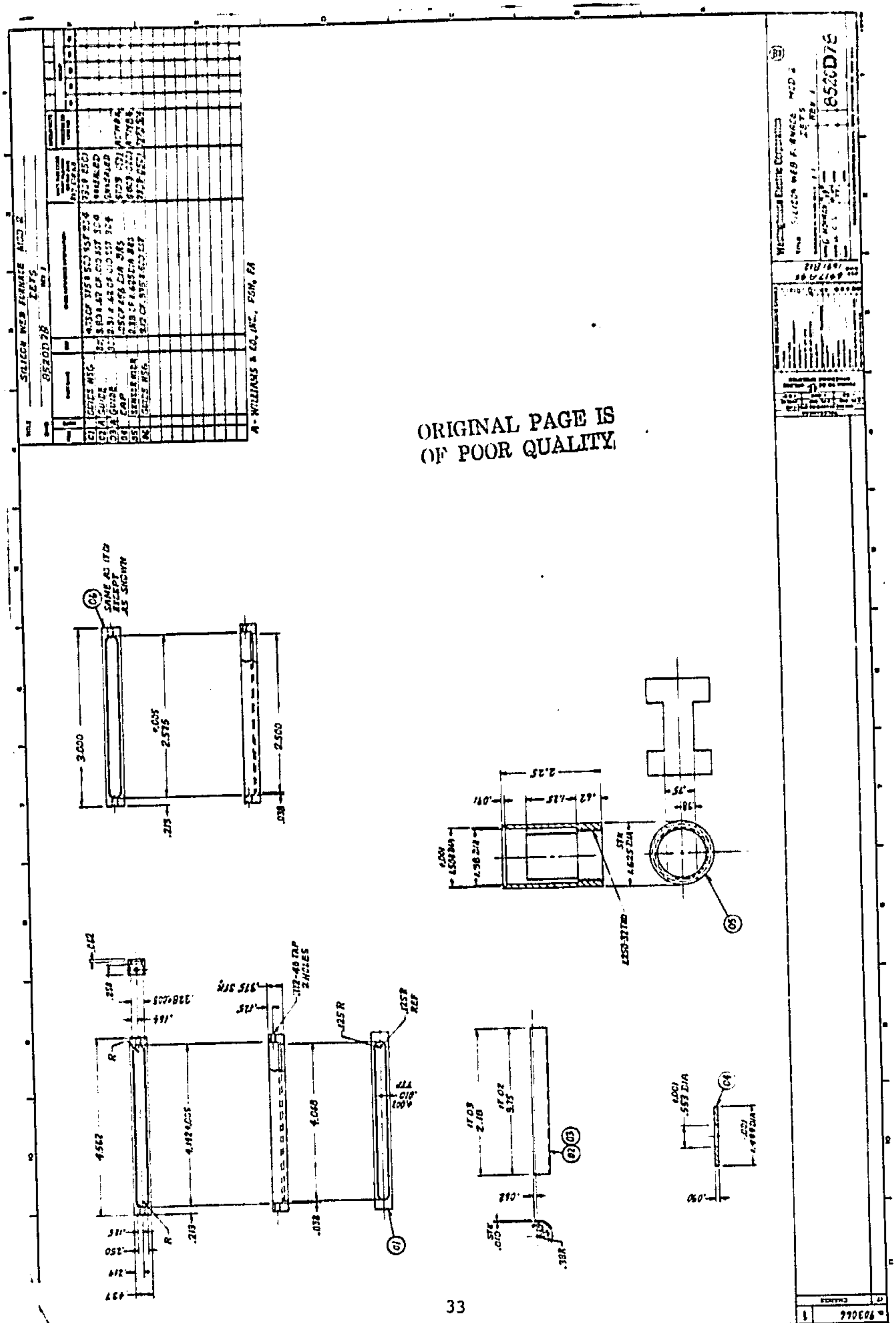



SILICON WEB FURNACE ACC 2
Westinghouse Electric Corporation
8520D61


SILICON WEB FURNACE MOD-2
WEB GUIDE KEYS
8520D69
01 A FACE GUIDE 23.00 OF .062 DIA SST TYPE 304
02 A EDGE GUIDE 17.50 OF .062 DIA SST TYPE 304
03 A LOOP 9.50 OF .062 DIA SST TYPE 304
04 A FACE GUIDE TYPE 304
WILLIAMS & CO., INC. - PGH. PA.
2.38
7.12
1.12 TYP
.09R. TYP
9° TYP
.09R.
1.88
15°
.11
.03R.
.18
.40
.25R.
.14
1.12
2.00
.40 TYP
4.25
.04
6.00
1.00 TYP
.09R. TYP
13.5° TYP
.09R.
.53
22°
.17
1.00
.500
Westinghouse Electric Corporation
8520D69



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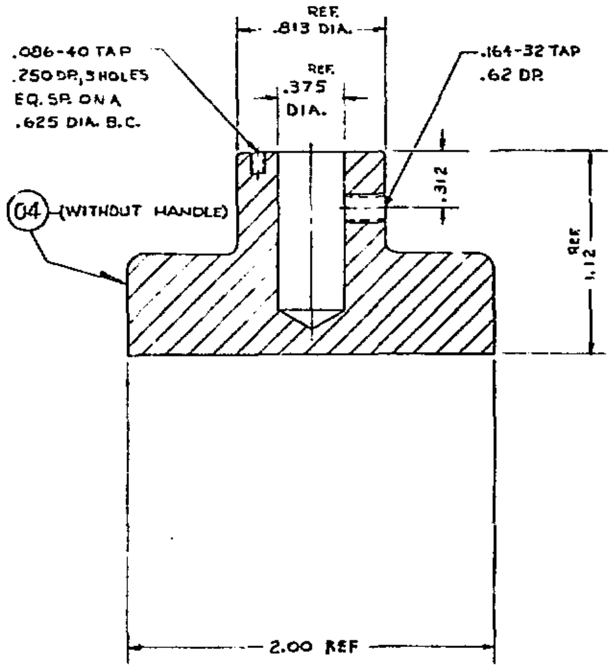
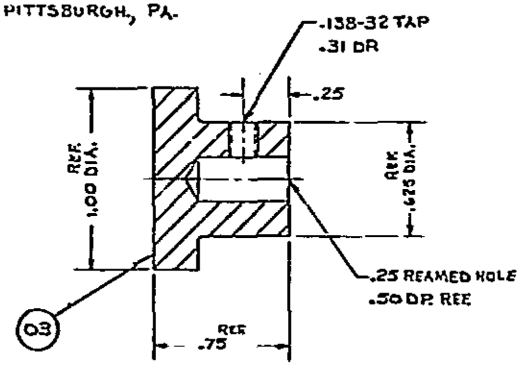
OF POOR QUALITY

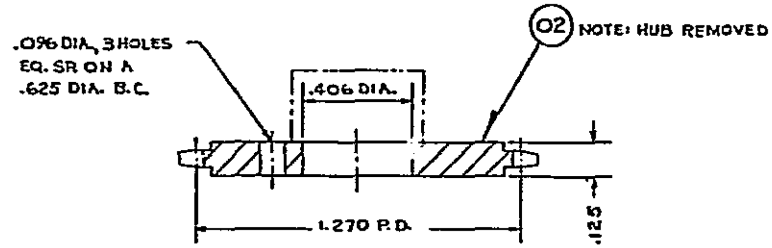
TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
KNOB DETAILS
DWG 257C034 REV 1 2 3

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESS OR LINE NO	GROUP 01	02	03	04	05
01	A	KNOB		REID # GH-1N NATURAL ANODIZED	FIN.						
02	B	CHAIN SPROCKET		PIC # EM5-27 303 SST NO. TEETH	27						
03	A	KNOB		REID # KKR 2A BLACK PENTRATE	FIN.						
04	A	KNOB		REID # G-3N NATURAL ANODIZED	FIN						

-A- REID TOOL SUPPLY CO., MUSKEGON, MICH.
-B- PIC, PITTSBURGH, PA.







LT	CHANGE
1	903066 MOD-2 / 902983 MOD-1
2	DESIGN SPEC NO 903066 MOD-2 ADDED H.K. 6-16-77
3	REMOVED ITEM 01 F.C. 8-25-77

TOLERANCES UNLESS OTHERWISE SPECIFIED: 2 PL DEC .02 / 3 PL DEC .005 / ANGLES ± 0°
FINISH TO BE 63 UNLESS OTHERWISE SPECIFIED

REF DWG 257C074

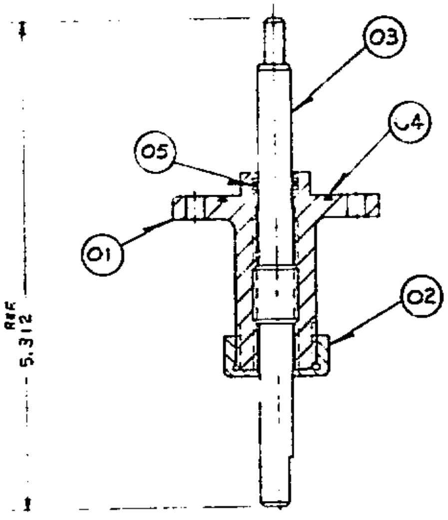
Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
KNOB DETAILS
DIMENSIONS IN INCHES—SCALE 2=1; 3=1 REV 1 2 3
DRFT F. CARDELLO 7-30-75
CHKD W.C.S. 7-30-75
257 C034
RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

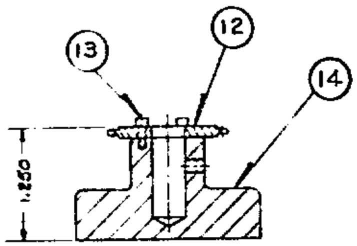
TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
ROD HOUSING SUB ASSY.

DWG 257C074 REV 1 2 3

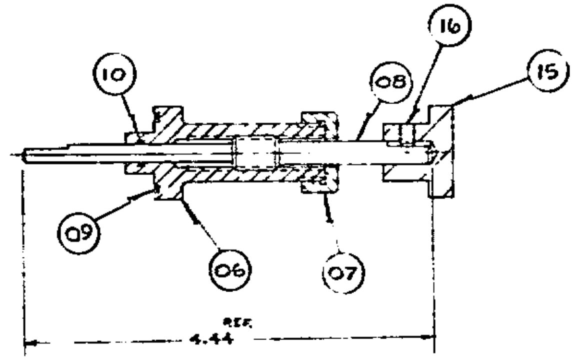
ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		ROD HOUSING	DWG		8504D76H01		1				
02		HOUSING CAP	DWG		8504D76H02		1				
03		ROD	DWG		8504D76H03		1				
04	A	O-RING	BOS	CAT. NO. 2-024 C557-70			1				
05	A	O-RING	BOS	CAT. NO. 2-110 C557-70			1				
06		ROD HOUSING	DWG		8504D77H01			1			
07		HOUSING CAP	DWG		8504D77H02			1			
08		ROD	DWG		8504D77H05			1			
09	A	O-RING	BOS	CAT. NO. 2-018 C557-70				1			
10	A	O-RING	BOS	CAT. NO. 2-008 C557-70				1			
11		KNOB	DWG		257C034H01				1		
12		CHAIN SPROCKET	DWG		257C034H02				1	1	
13		SCR.		.086-40 X .25 SOC. HD. CAP SCR.					3	3	
14		KNOB	DWG		257C034H04					1	
15		KNOB	DWG		257C034H03			1			
16		SET SCR.		.138-32 X .25 LG. STL.				1			



GR.01



GR.04



GR.02

CHANGE	
1	909ZS53 MOD-1 / 9092... MOD 2
2	DESIGN SPEC NO 903066 MOD-2 ADDED H K 6-16-77
3	REMOVED GROUP 03 F.L. 8 25 77

TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

REF DWG 767J573 MOD 1 / 789J18 MOD-2

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
ROD HOUSING SUB ASSY

DIMENSIONS IN INCHES · SCALE 1:1

REV 1 2 3

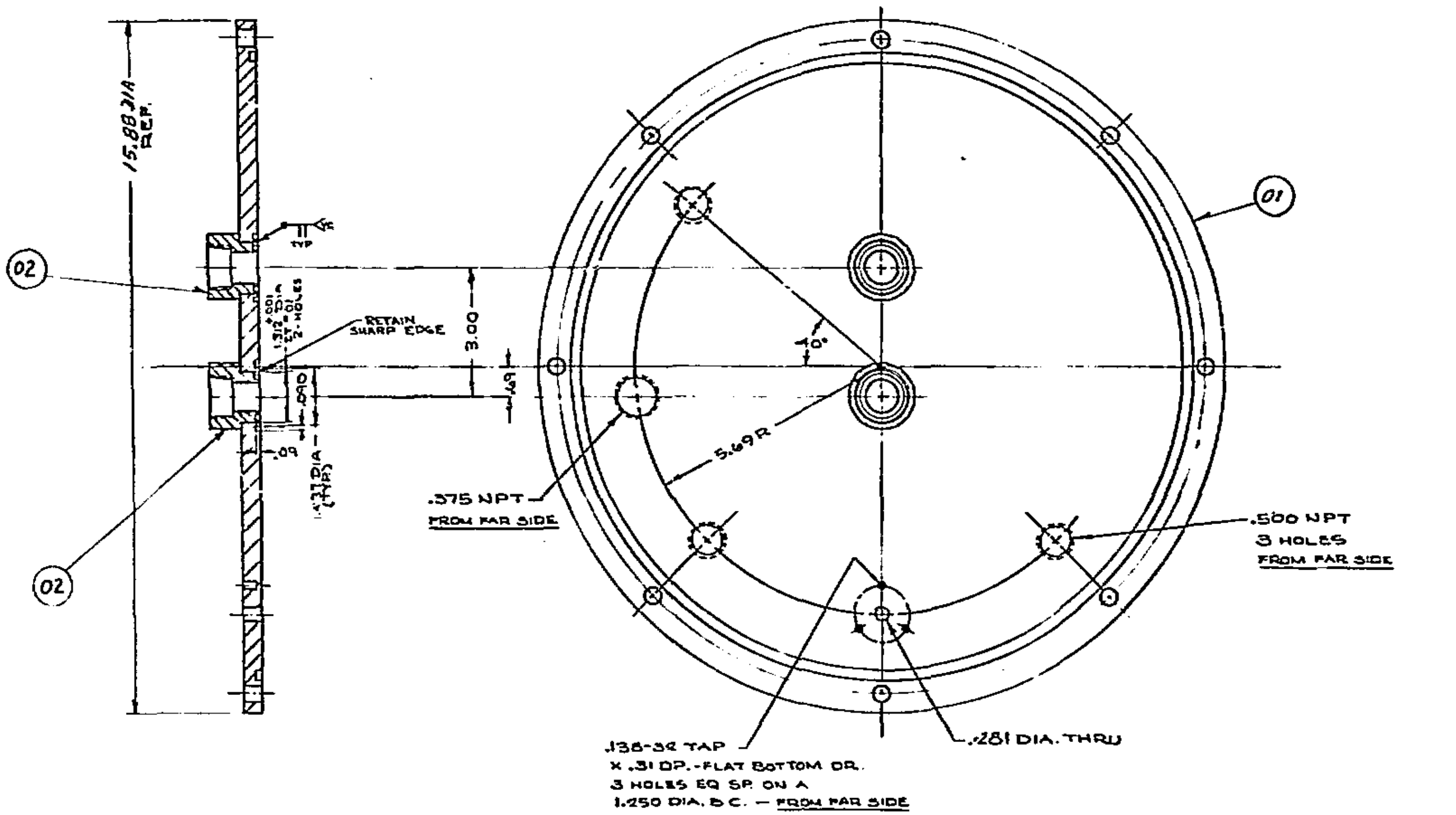
DFTR F. CARDELLO
CHKD W.C.S. 7-3 75

257 C 074

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
BACK COVER WELDMENT
DWG 257C251 REV-23

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		COVER	DWG		1690B07H01		1				
02		BOSS	DWG		8506D61H08		2				



Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2 BACK COVER WELDMENT

DIMENSIONS IN INCHES · SCALE 1/2 REV-23

DRTN C. HOHMAN · CHKD W.C.S.

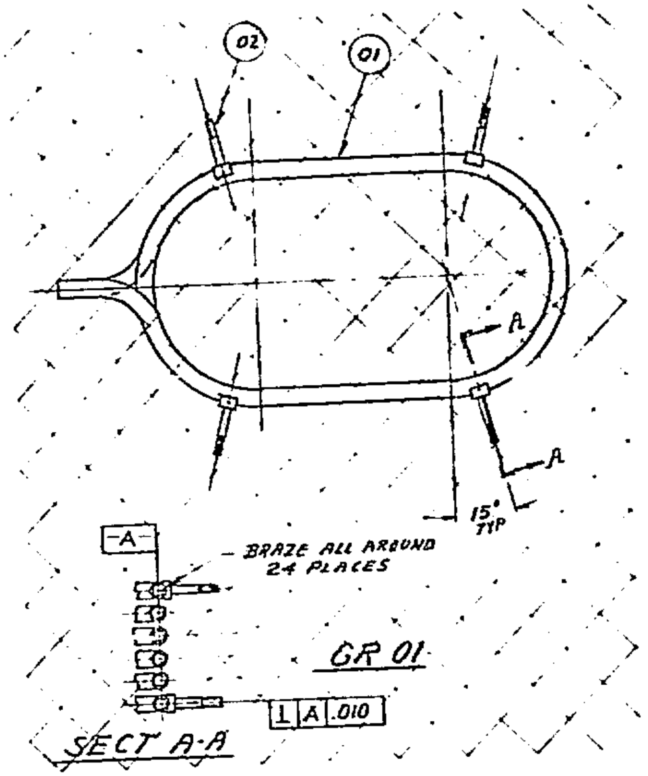
257C251

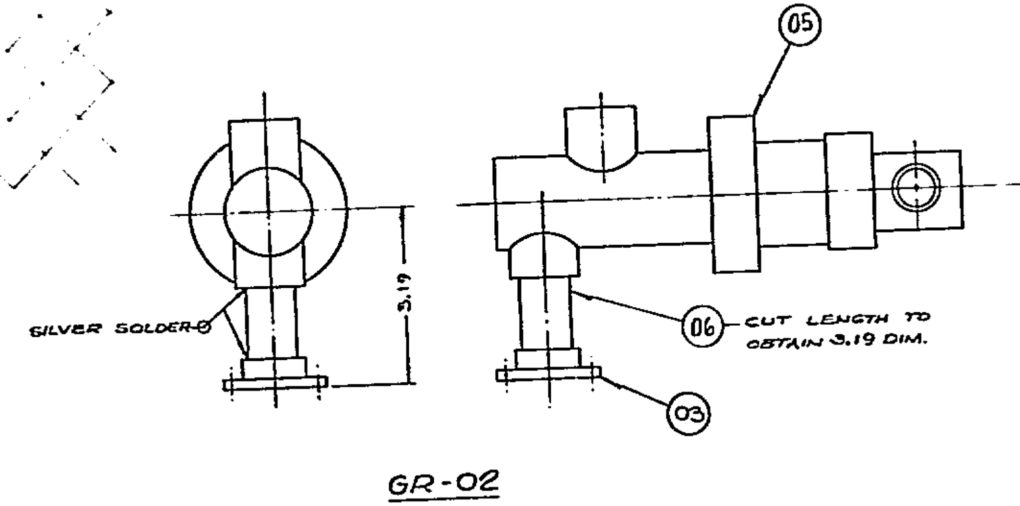
RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
COIL & ROUGHING PUMP SUB-ASSY.
DWG 257C261 REV #2

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE PROCESS OR LINE NO	GROUP 1	2	3	4	5
01		COIL	DWG		8506D56H11		1				
02		STAND-OFF	DWG		8506D58H02		24				
03		FLANGE	DWG		8506D61H03		1				
04	A	90° FITTING ELL	B05	1⅛ 101⅛ STYLE #HE-503 PART #2336 (FITTING TO SOLDER)			1				
05	B	SOLENOID VALVE	B05	1⅛" PART # 1254-85126-318			1				
06		TUBING		3.10 OF 1.125 OD x 1.000 ID CU	1012-0112		1				

Ⓐ = MUELLER BRASS Co., PGH., PA. (SALES OFFICE)
Ⓑ - VARIAN IND EQ GR., EUCLID, OHIO





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Westinghouse Electric Corporation
TITLE SILICON WEB FURNACE MODEL-1 & MODEL-2
COIL & ROUGHING PUMP SUB ASS'Y
REV #2
SCALE 1:2
DFTR C. HOHMAN
CHKD W.C.S.
257C261
RESEARCH LABORATORIES

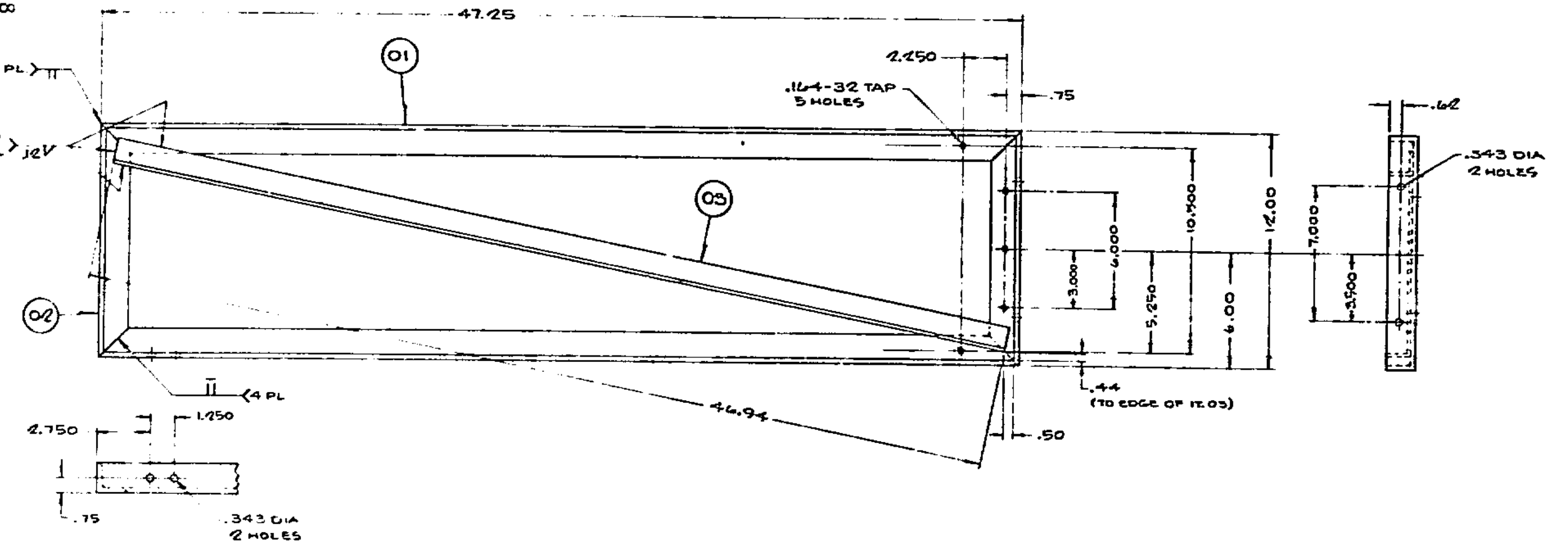
REF 787J573 MOD-1
DWG 1289J18 MOD-2

TOLERANCES UNLESS OTHERWISE SPECIFIED
FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED
GEOMETRIC CHARACTERISTIC SYMBOLS

	CHANGE	
GR-01	REMOVED	2
04	90° FITTING ELBOW R/E MOVED 903D06 DESIGN SPEC NO ADDED HK 6-28-77	
D	306983 MOD-1	1
	306(?) MOD-2	

TITLE SILICON WEB FURNACE MODEL-2
BEARING SUPPORT FRAME
DWG 2613C30 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG R&D STK NO	GROUP NOTE PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		SIDE		47.50 OF 1.50x1.50x.25 ∠ STL	7403-0101		2				
02		END		12.25 OF 1.50x1.50x.25 ∠ STL	7403-0101		2				
03		BRACE		47.12 OF 1.25x1.25x.12 ∠ STL	7405-0101		1				



CHANGE

TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

REF DWG 1287J18

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-2
BEARING SUPPORT FRAME
REV 1

DIMENSIONS IN INCHES SCALE

DRWN Kostowski

CHKD W C S.

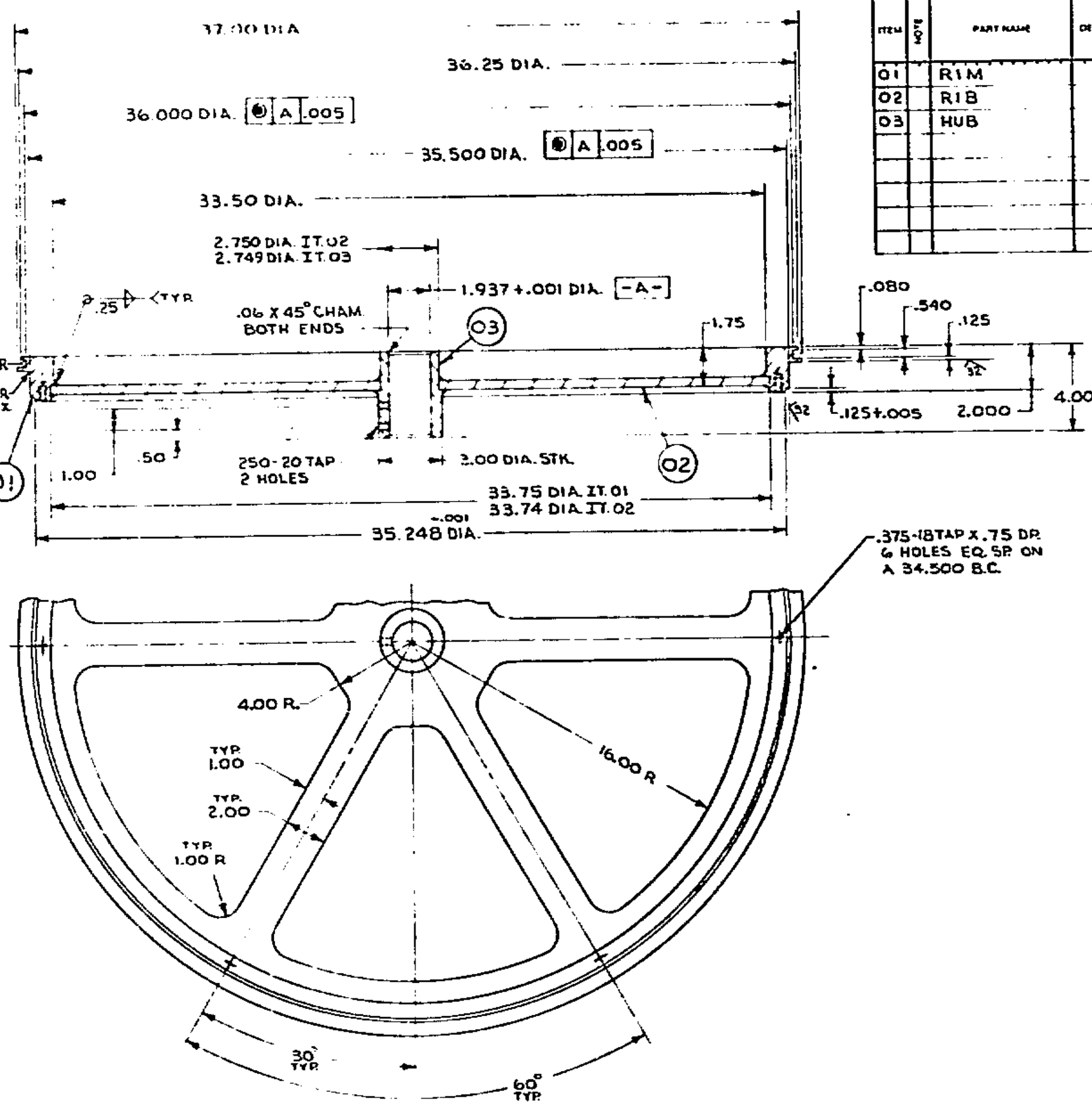
2613C30

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

TITLE ...ICON WEB FURNACE-MODEL-2
...ORAGE REEL DETAIL WELDMENT

DWG 2... 34 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE, TOE PART NUMBER OR REF DWG. R&D STK. NO.	GROUP NOTE: PROCESS OR LINE NO.	GROUP 01	02	03	04	05
01		RIM		MAKE FROM AL.		6061-T651	1				
02		RIB		34.00 X .38 TK. AL.	7904-0101	6061-T651	1				
03		HUB		4.25 OF 3.00 DIA. AL.	6102-0101	6061 T651	1				



CHANGE

TOLERANCES UNLESS OTHERWISE SPECIFIED: ANGLE ±.5°; 2 PL. DEC ±.02; 3 PL. DEC ±.005; FINISH TO BE 63 UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

REF DWG 1289J19

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE - MODEL-2
STORAGE REEL DETAIL WELDMENT
REV 1

DIMENSIONS IN INCHES SCALE 1:4

DRTM F. CARDELLO 7-21-72
CHKD W. C. S. 7-12-72
APPD
SUPV

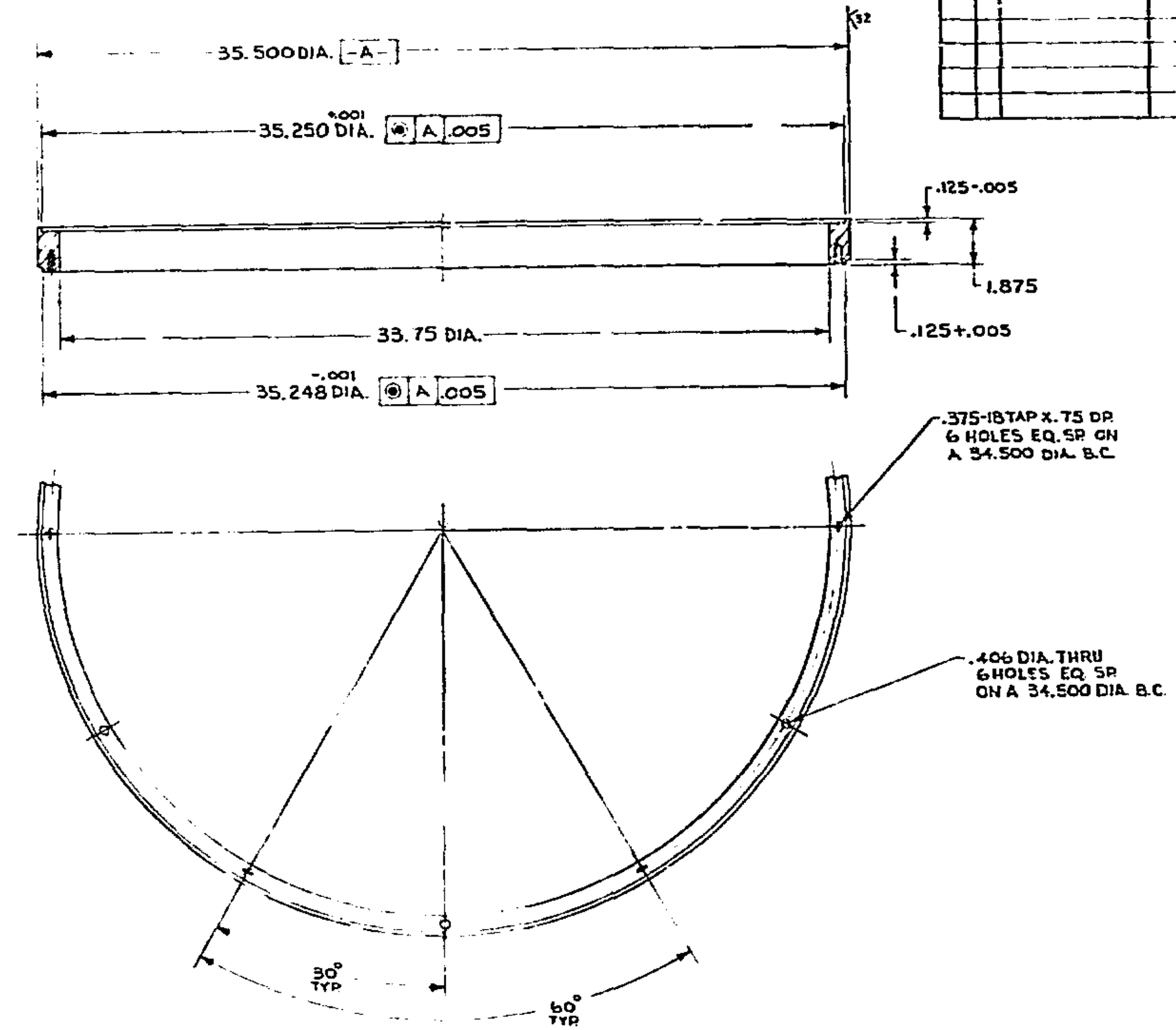
2613 C34

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 U.S.A.

TITLE SILICON WEB FURNACE - MODEL - 2
STORAGE REEL DETAIL

DWG 2613C35 REV 1

ITEM	NOTE	PART NAME	QTY	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE PROCESS OR LINE NO	G1	G2	G3	G4	G5
01		SPACER		MAKE FROM AL.	RED STK. NO.	6061-T651					



TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

REF DWG 1289J19

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL 2
STORAGE REEL DETAIL

DIMENSIONS IN INCHES SCALE 1:4

REV. 1

DRTN F. CARDELLO 6/21/77
CHKD W.E.S. 7/12/77

2613 C 35

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

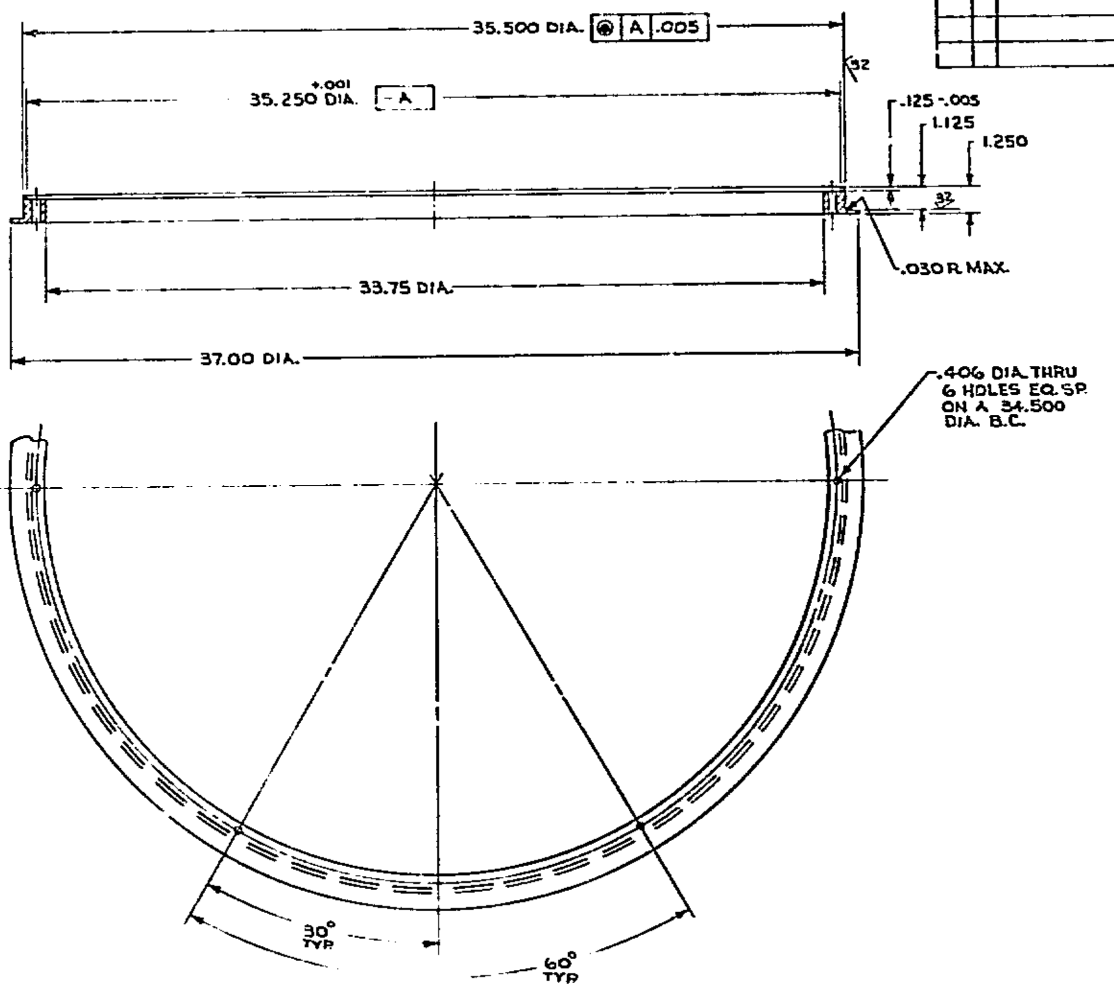
1 CHANGE

D 903066

TITLE SILICON WEB FURNACE - MODEL-2
STORAGE REEL DETAIL

DWG 2613C36 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG R&D STK. NO.	PROCESS OR LINE NO
01		RIM		MAKE FROM AL.		6061-T651



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Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE - MODEL 2
STORAGE REEL DETAIL

DIMENSIONS IN INCHES—SCALE 1:4

REV. 1

DRWN F. CARCELLO 6-21-77

CHKD CS 7-12-77

2613C36

REF DWG 1289J19

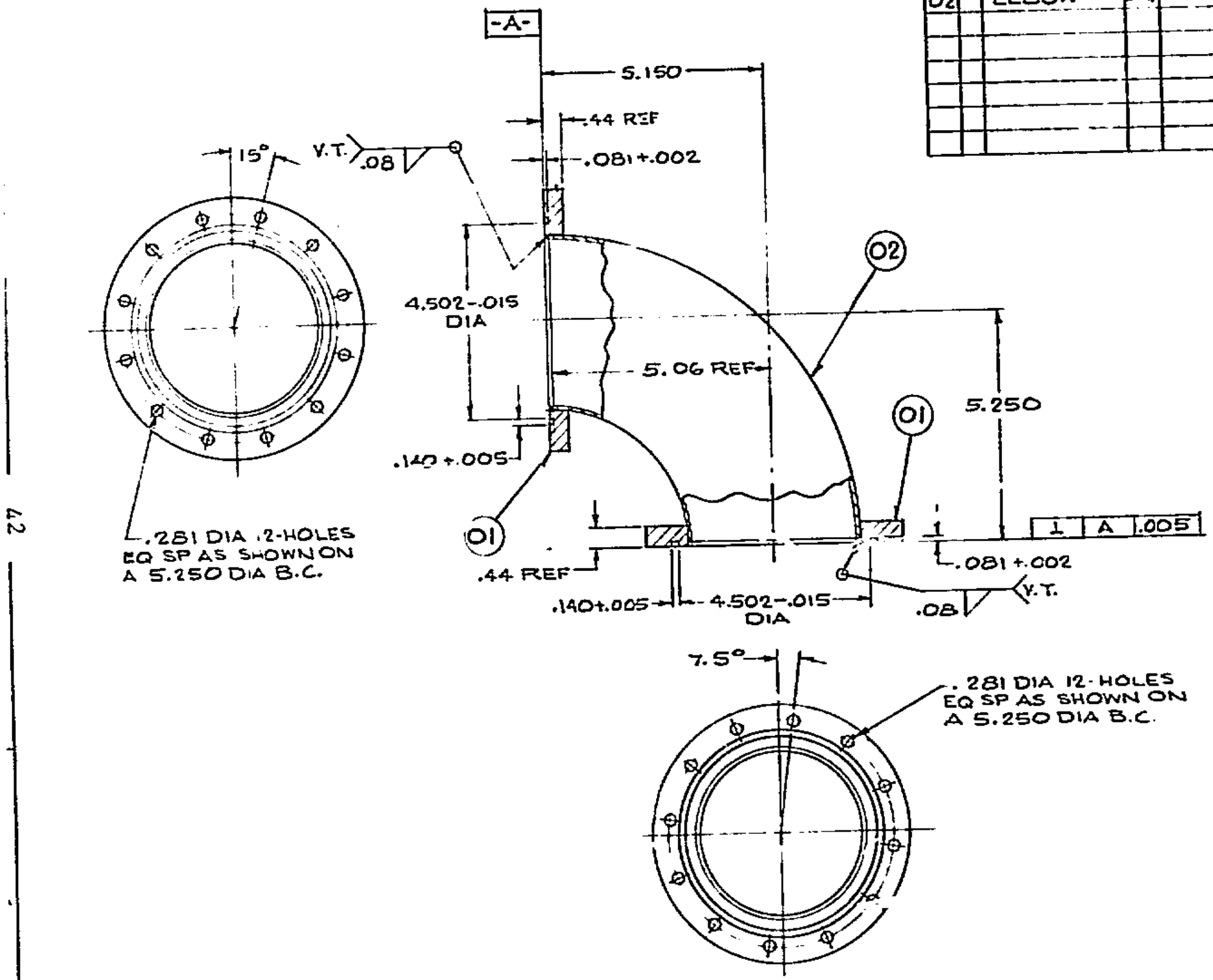
RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 U.S.A.

D 903066

CHANGE

TITLE SILICON WEB FURNACE MODEL-2
VACUUM ELBOW WELDMENT
DWG 2613C43 REV-1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		FLANGE	DWG		8520D19H03		2				
02		ELBOW	DWG		8520D19H04		1				



TOLERANCES UNLESS OTHERWISE SPECIFIED
FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED
GEOMETRIC CHARACTERISTIC SYMBOLS
REF DWG 1289J18

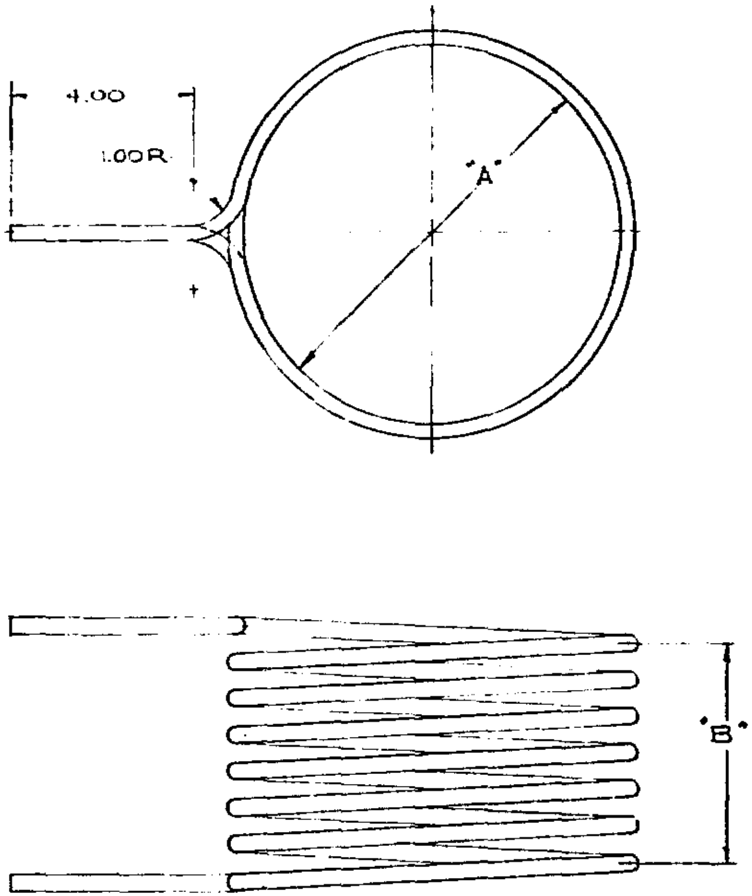
Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-2
VACUUM ELBOW WELDMENT
DIMENSIONS IN INCHES—SCALE 1:2
REV-1
DFTM V.SUMPMAN 7-8-77
2613C43
RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

1 CHANGE

TITLE SILICON WEB FURNACE MOD-2
ROUND WORK COIL DETAIL
DWG 2613C50 REV-1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO	C1	C2	C3	C4	C5
01		WORK COIL	HKF	.312 OD × .032 WALL Cu	RED STAND 7112-0701						



ITEM	"A"	"B"
01	6.75	9 SP @ .408 = 3.67

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
ROUND WORK COIL DETAIL
REV-1

DWN R. SUMPMAN 7-13-72

2613C50

REF DWG 2613C48

RESEARCH & LABORATORIES CHURCHILL BORO PITTSBURGH PA

TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

CHANGE

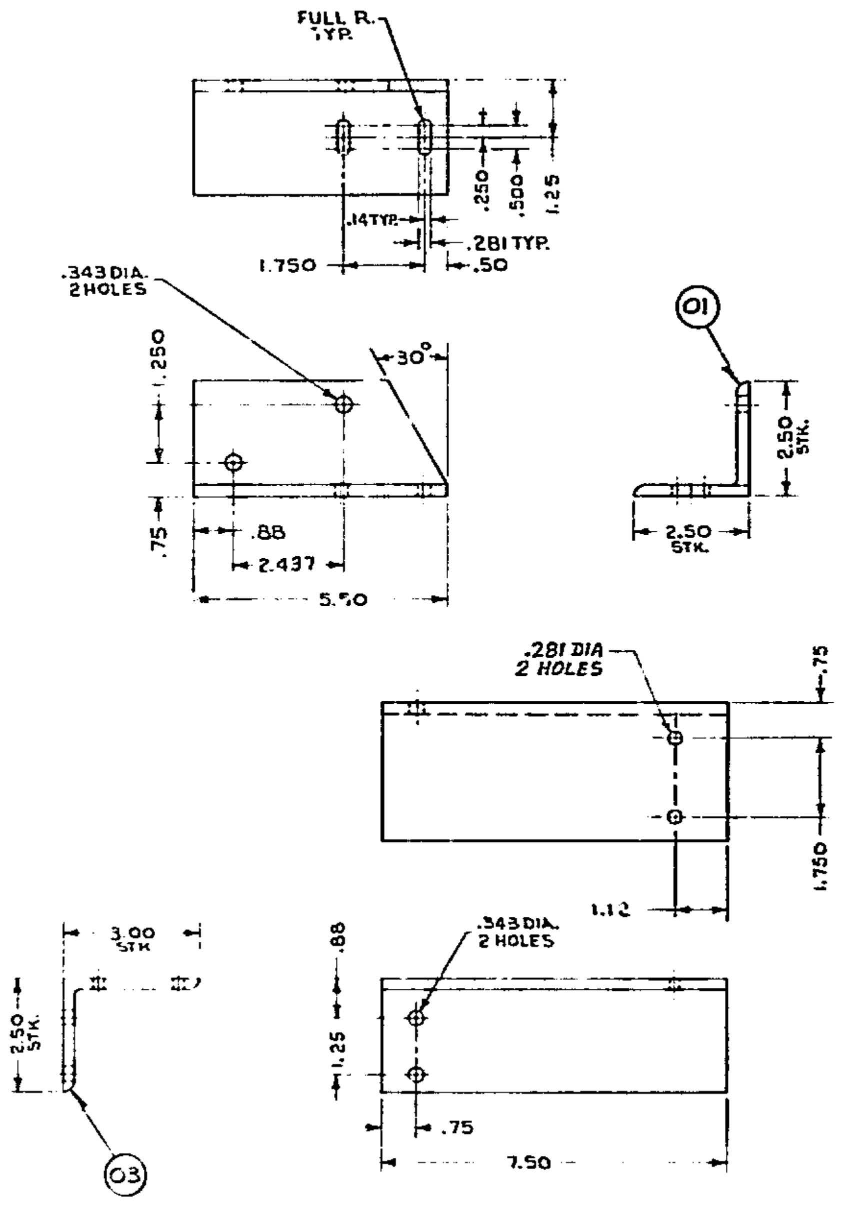
D 903066

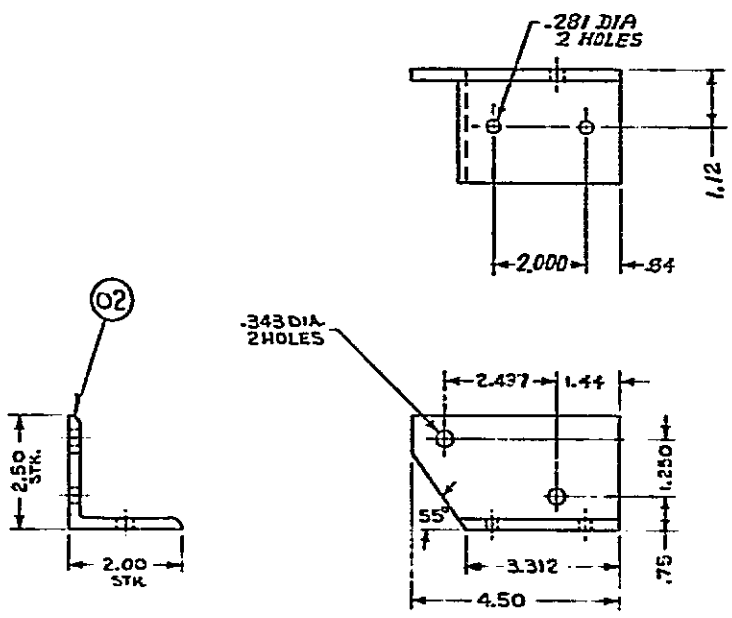
TITLE SILICON WEB FURNACE MOD.2
TAPE REEL BRACKETS

DWG 2613C61 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO	GROUP C1	C2	C3	C4	C5
01	A	BRACKET		5.62 OF 2.50X2.50X.25∠ STL.							
02	A	BRACKET		4.62 OF 2.50X2.00X.25∠ STL.							
03	A	BRACKET		7.62 OF 3.00X 2.50X.25∠ STL.							

A- JOSEPH T. RYERSON & SON, INC., PGH.PA.





TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

REF DWG 1289319

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD 2
TAPE REEL BRACKETS

DIMENSIONS IN INCHES SCALE 1÷2

REV. 1

DFTR F. CARCELLO

CHKD W. C. S.

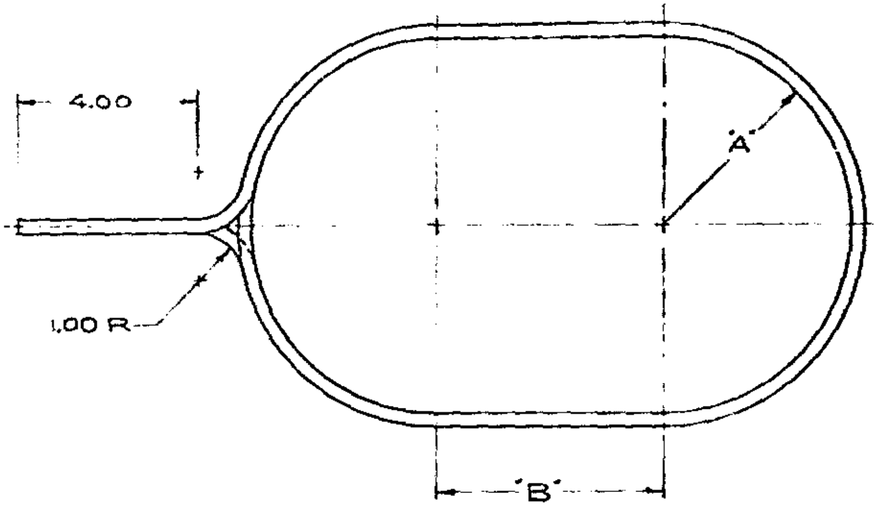
2613 C61

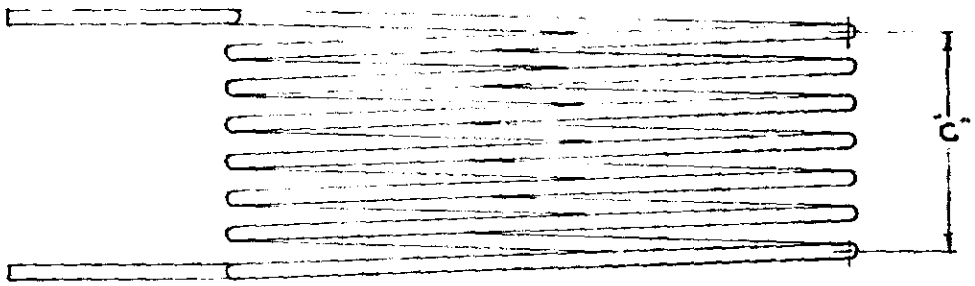
RESEARCH LABORATORIES

1 | CHANGE | D 903066

TITLE SILICON WEB FURNACE MOD-2
OVAL WORK COIL DETAIL
DWG 2613C64 REV-1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG R&D STK NO	GROUP NOTE PROCESS OR LINE NO	GROUP G1	G2	G3	G4	G5
01		WORK COIL	MKF	.312 OD × .032 WALL Cu	7112-0701						





ITEM	'A' RADIUS	'B'	'C'
01			

TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

REF DWG 2614C23

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
OVAL WORK COIL DETAIL

SCALE NTS REV-1

DRWN W. SLOPPMAN 7/77

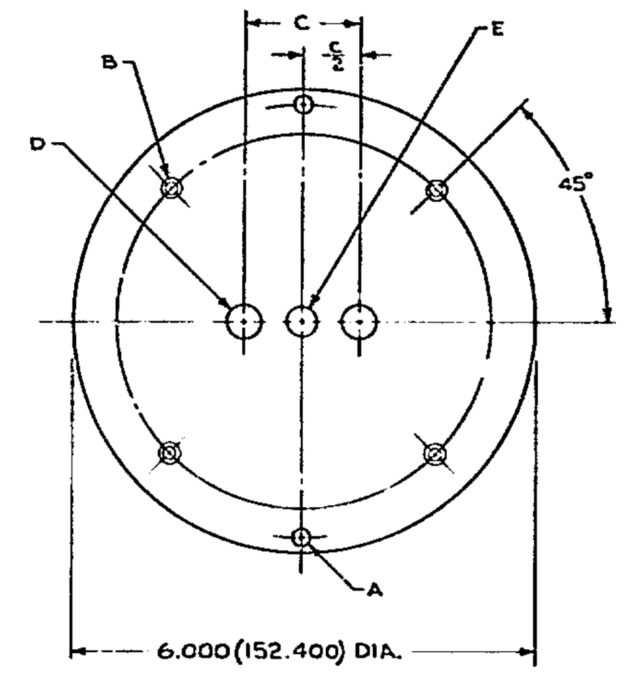
2613C64

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

1 D 903066 CHANGE

TITLE SILICON WEB FURNACE MOD-2
SUPPORT PLATE DETAILS
DWG 2613C70 REV 1

ITEM	NOTE	PART NAME	OFF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		SUPPORT PL.		6.12 DIA. OF .25 THK. MOLY.							



NOTE:
1. DIMENSIONS ENCLOSED BY ( ) ARE IN MILLIMETERS.

ITEM	A	B	C	D	E
01	.187(4.749) DIA. 2 HOLES EQ. SP. AS SHOWN ON A 5.625(142.875) DIA. B.C.	.125(3.175) DIA., .196(4.978) DIA. X .093(2.362) DP C'BORE 4 HOLES EQ. SP. AS SHOWN ON A 5.000(127.000) DIA. B.C.	3.000 (76.200)	.625(15.875) DIA. 2 HOLES	.300(7.62) DIA.

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
SUPPORT PLATE DETAILS

DIMENSIONS IN INCHES SCALE N.T.S. REV-1

DWN F. CARCELLO

CHKD W.C.S.

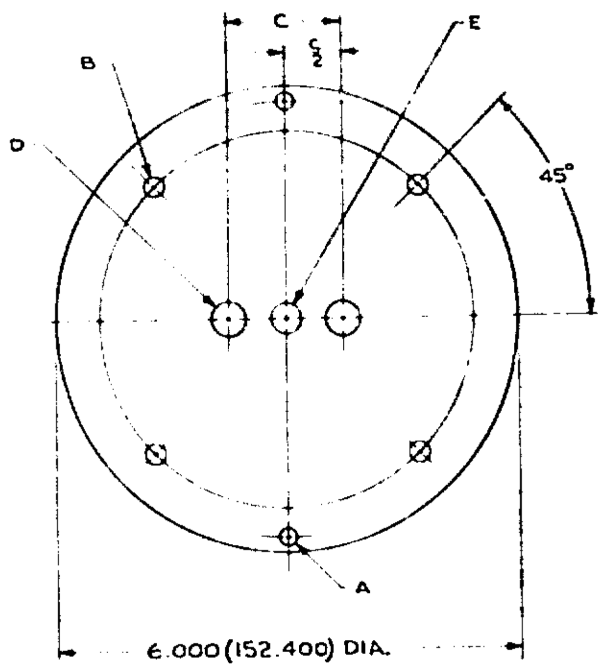
2613C70

REF DWG 1289J18

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

D903066 CHANGE 1

TITLE	SILICON WEB FURNACE MOD-2 SHIELD DETAILS				
DWG 2613C71	REV 2				
ITEM	NOTE	PART NAME	OFF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG
01		SHIELD		6.12 DIA. OF .005 THK MOLY.	
02		SHIELD		6.12 DIA. OF .020 THK MOLY.	



ITEM	A	B	C	D	E
01	.187(4.749) DIA 2 HOLES EQ SP AS SHOWN ON A 5.625(142.875) DIA B.C.	.218(5.537) DIA 4 HOLES EQ SP AS SHOWN ON A 5.000(127.000) DIA B.C.	3.000 (76.200)	.625(15.875) DIA. 2 HOLES	.300(7.62) DIA.
02	.187(4.749) DIA 2 HOLES EQ SP AS SHOWN ON A 5.625(142.875) DIA B.C.	.218(5.537) DIA 4 HOLES EQ SP AS SHOWN ON A 5.000(127.000) DIA B.C.	3.000 (76.200)	.625(15.875) DIA. 2 HOLES	.300(7.62) DIA.

NOTE:
1. DIMENSIONS ENCLOSED BY( ) ARE IN MILLIMETERS.

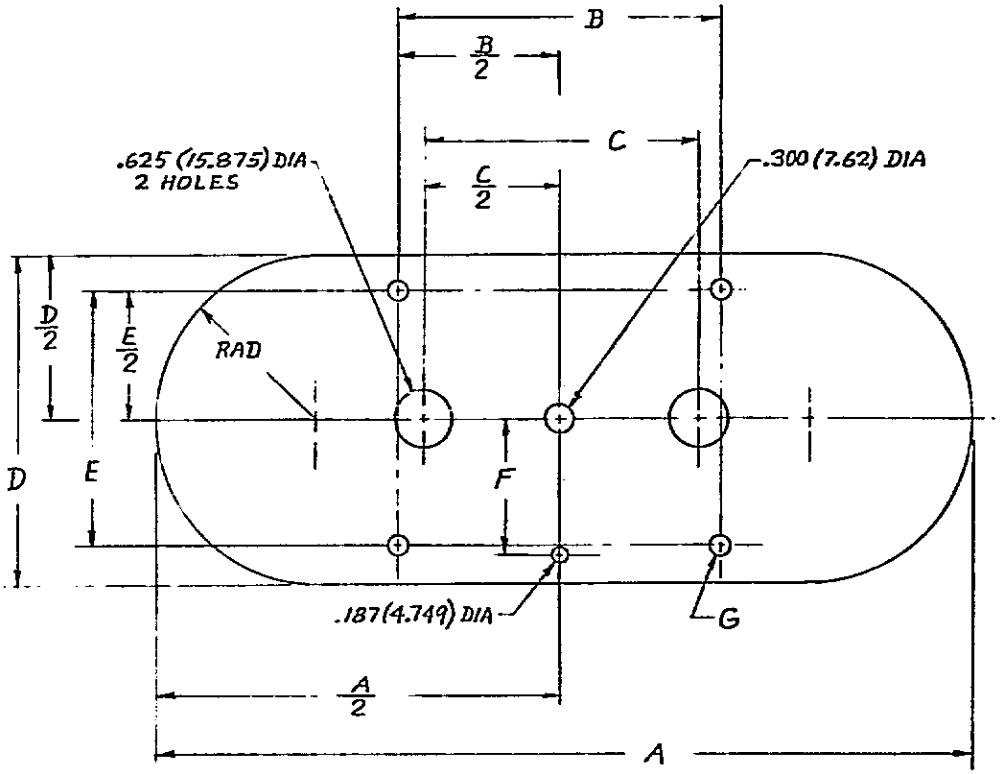
Westinghouse Electric Corporation
TITLE SILICON WEB FURNACE MOD-2 SHIELD DETAILS
NTS REV-2
DWN F. CARDELLO
CHKD W C S
2613 C 71
RESEARCH LABORATORIES

CHANGE: 2 ADDED TDG 3-20-77

C-2

TITLE SILICON WEB FURNACE - MOD. 2
SHIELD DET
DWG 2613C82 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO
01		SHIELD		9.12 x 3.62 OF .005 THK MOLY		
02		SHIELD		9.12 x 3.62 OF .020 THK MOLY		



IT	A	B	C	D	E	F	G
01	8.97 (227.84)	3.536 (89.814)	3.000 (76.20)	3.56 (90.42)	2.750 (~9.850)	1.500 (38.10)	.218 (5.537) DIA 4 HOLES
02	8.97 (227.84)	3.536 (89.814)	3.000 (76.20)	3.56 (90.42)	2.750 (69.850)	1.500 (38.10)	.218 (5.537) DIA 4 HOLES

NOTE:
DIMS ENCLOSED BY ( ) ARE IN MILLIMETERS

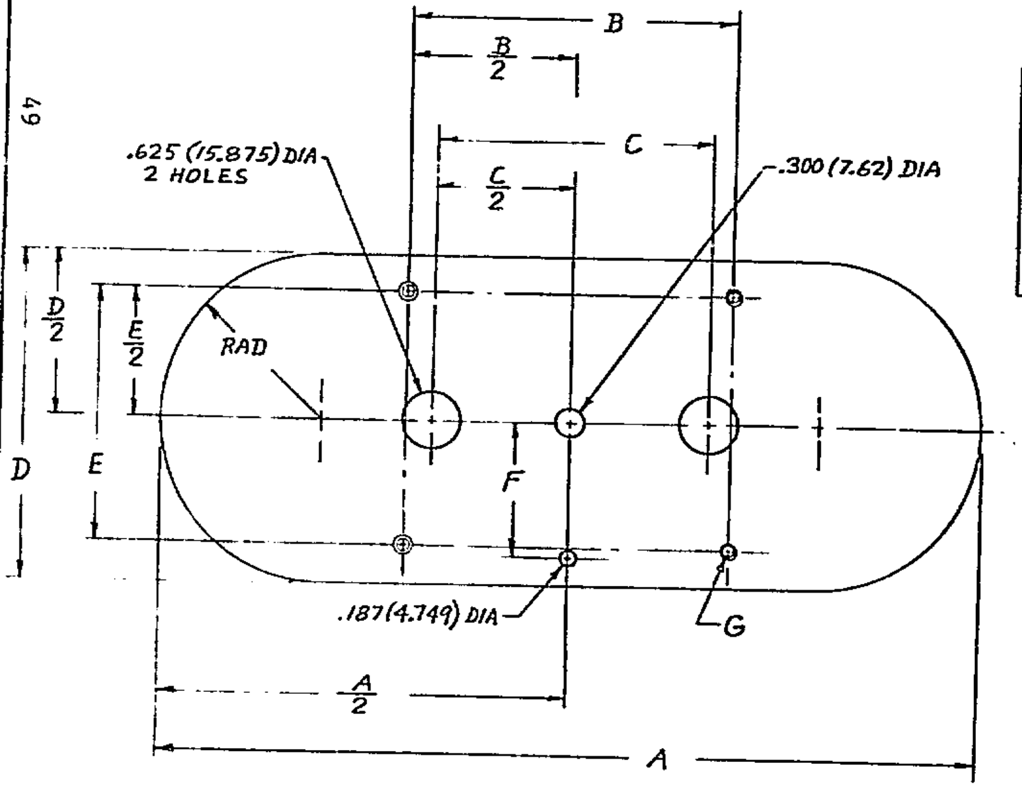
Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE - MOD. 2
SHIELD DET
SCALE 1:1 REV 1
DFTR C. HOHMAN 8-4-77
CHKD W.C.S. 8-5-77
DWG 2613C82
REF DWG 1289J18
CHANGE 1 D 903066

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

TITLE	SILICON WEB FURNACE - MOD. 2 OVAL SUPPORT PLATE DET					
DWG	2613C83	REV I				
ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO
01		SUP PL		9.12 x 3.62 OF .250 THK MOLY		

IT	A	B	C	I	E	F	G
01	8.97 (227.84)	3.536 (89.814)	3.000 (76.20)	3.56 (90.42)	2.750 (69.850)	1.500 (38.10)	.125(3.175) DIA. .196(4.978) DIA x .093(2.362) DP C'BORE 4 HOLES



ORIGINAL PAGE IS OF POOR QUALITY

NOTE:
DIMS ENCLOSED BY ( ) ARE IN MILLIMETERS

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE - MOD. 2 OVAL SUPPORT PLATE DET

SCALE 1:1 — REV I

DFTR C. HOHMAN — CHKD D.C.S

REF DWG 1289I8

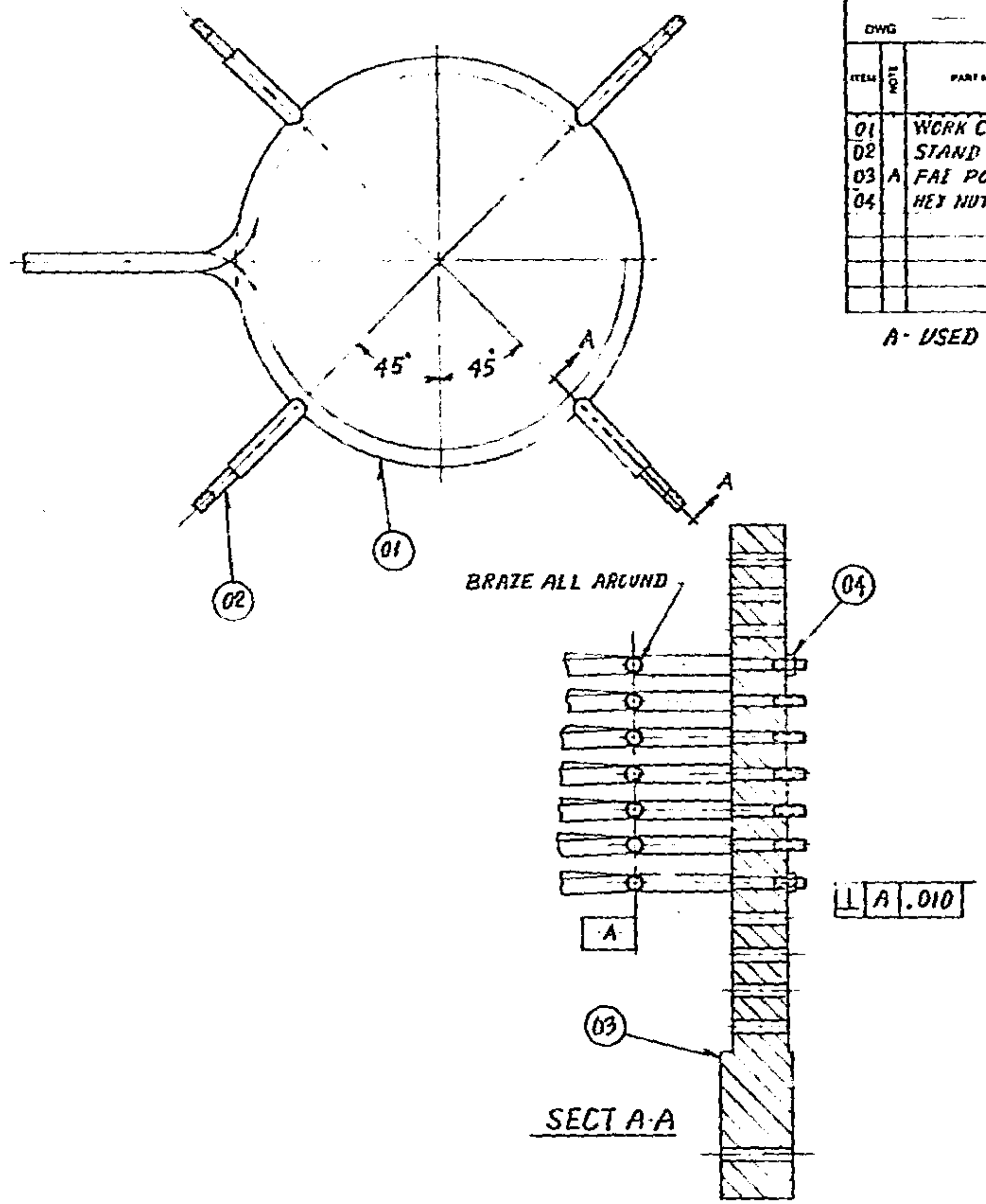
2613C83

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA USA

TITLE SILICON WEB FURNACE MOD 2
ROUND WORK COIL ASSY
DWG 2613C98 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		WORK COIL	DWG		2613C50H01		1				
02		STAND OFF	DWG		6414A97H01		40				
03	A	FAI POST	DWG		8520B40H02		4				
04		HEX NUT		.138-32 STL			40				

A- USED FOR FIXTURING ONLY



Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL 2
ROUND WORK COIL ASSY
REV 1

DRN C. HOHMEI

2613C98

REF DWG 1289-8

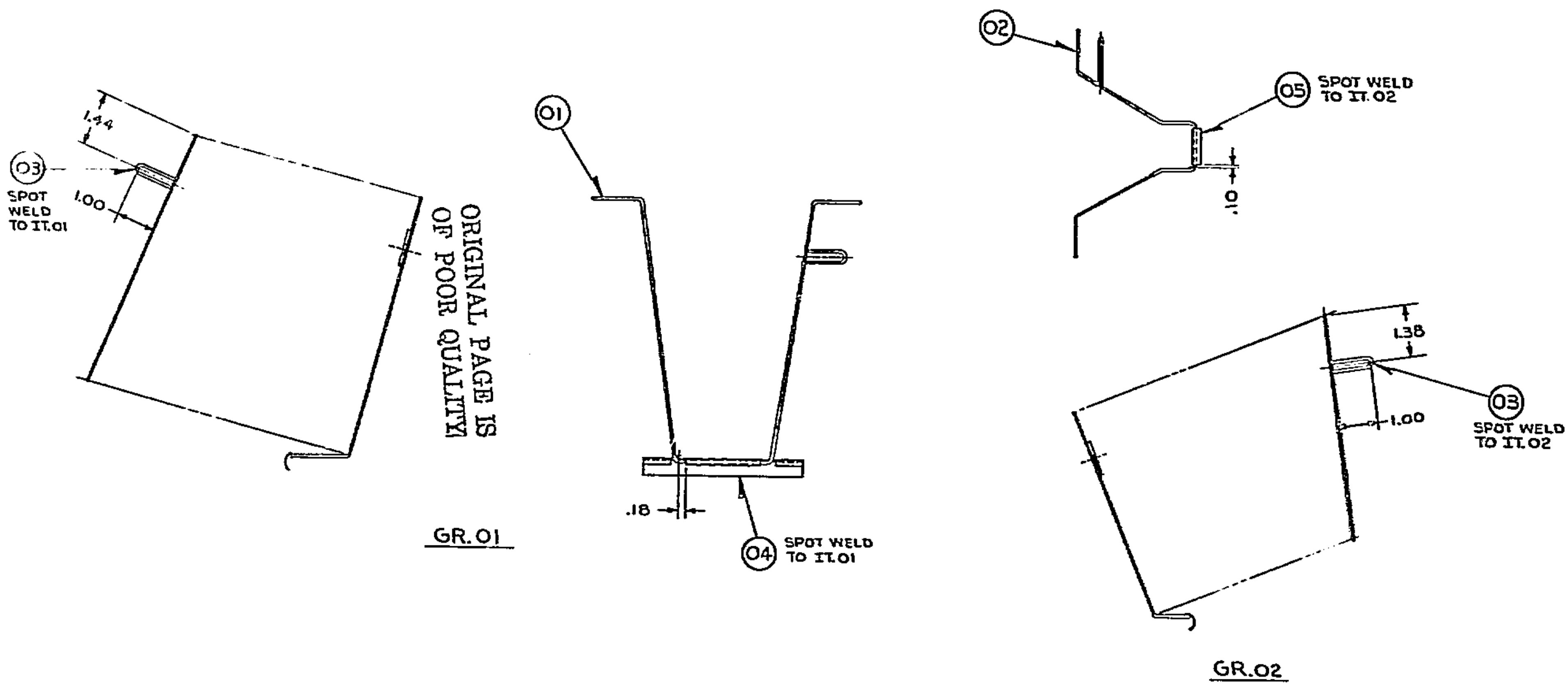
RESEARCH LABORATORIES

CHANGE 1

TITLE SILICON WEB FURNACE MOD-2
WEB GUIDE SUB ASSY

DWG 2614C09 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE PROCESS OR LINE NO	C1	C2	C3	C4	C5
01		FACE GUIDE SUP	DWG		8520D69H01		1				
02		EDGE GUIDE SUP	DWG		8520D69H02			1			
03		LOOP	DWG		8520D69H03		1	1			
04		FACE GUIDE	DWG		8520D69H04		1				
05		EDGE GUIDE	DWG		8520D34H04			1			



ORIGINAL PAGE IS OF POOR QUALITY

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
WEB GUIDE SUB ASS'Y

DIMENSIONS IN INCHES SCALE 1=2 | REV. 1

DRWN F.CARDELLO | CHKD W.C.S.

REF DWG 1289J19

2614 C09

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

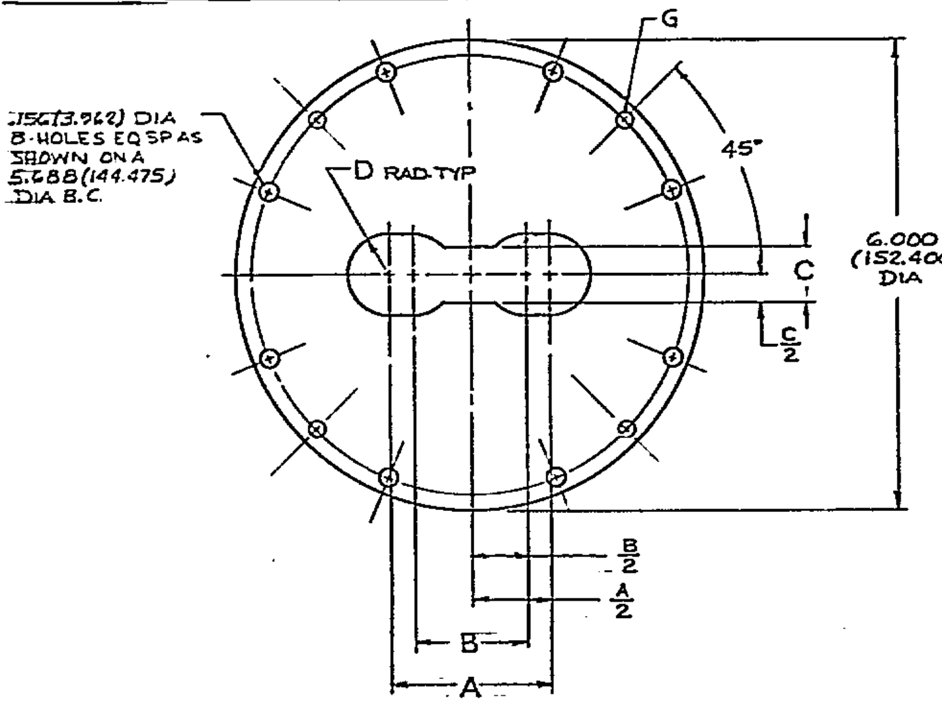
TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

CHANGE

D 903066



TITLE SILICON WEB FURNACE MOD-2
TOP SHIELD DET
DWG 2614C18 REV-1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESSOR LINE NO	G1	G2	G3	G4	G5
					REDSTK NO						
01		TOP SHIELD		6.12 DIA OF .06 THK MOLY	6813-0201						

NOTES:

1. DIMENSIONS ENCLOSED BY ( ) ARE IN

ITEM	A	B	C	D	E	F	G
01							.156(3.962)DIA 4-HOLES EQ SP ON A 5.688(144.475)DIA BC

Westinghouse Electric Corporation

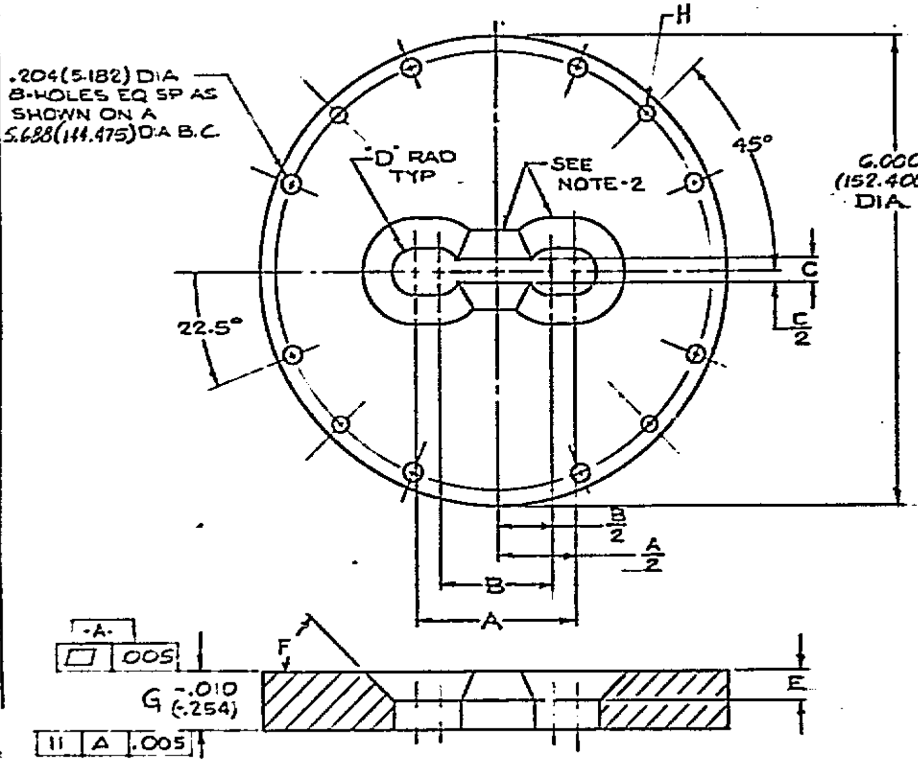
TITLE SILICON WEB FURNACE MOD-2
TOP SHIELD DET
N.T.S. REV-1
DRWN W. Simpson
2614C18

TOLERANCES UNLESS OTHERWISE SPECIFIED
FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED
GEOMETRIC CHARACTERISTIC SYMBOLS

CHANGE
1 5303066

TITLE SILICON WEB FURNACE MOD-2
SUSCEPTOR COVER
DWG 2614C19 REV-1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO	G1	G2	G3	G4	G5
01	A	COVER	B05	6.12 DIA OF .25 THK MOLY							



A - J.T. RYERSON & SON, INC, PGH, PA

NOTES:
1. DIMENSIONS ENCLOSED BY ( ) ARE IN MILLIMETERS.
2. POLISH & REMOVE ALL SHARP EDGES.

ITEM	A	B	C	D	E	F	G	H
01								.156(3.962) DIA 4-HOLES EQ SP AS SHOWN ON A 5.688(144.475) B.C.

Westinghouse Electric Corporation

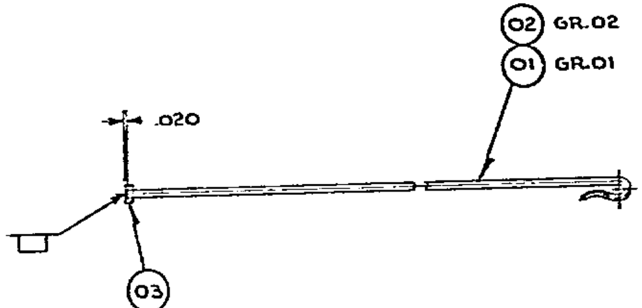
TITLE SILICON WEB FURNACE MOD-2
SUSCEPTOR COVER
SCALE N.T.S. REV-1
2614C19

RESEARCH LABORATORIES

53

TITLE SILICON WEB FURNACE MOD-2
PUSH ROD SUB ASSY'S

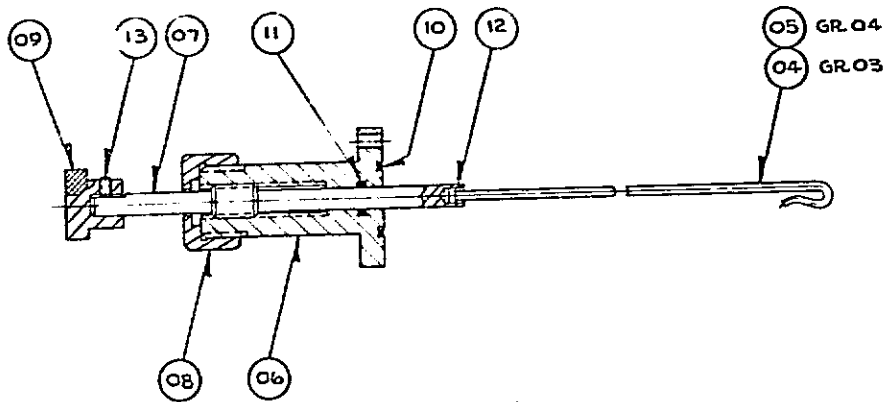
DWG 2614C20 REV 1



GR.01 & 02

ITEM	NOTE	PART NAME	DEP	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE PROCESS OR LINE NO	GROUP 01	GROUP 02	GROUP 03	GROUP 04	GROUP 05
01		PUSH ROD	DWG		8520D34H07		1				
02		PUSH ROD	DWG		8520D34H08			1			
03		ROD CAP	DWG		8520D34H05		1	1			
04		PUSH ROD ASSY	DWG		2614C20G01				1		
05		PUSH ROD ASSY	DWG		2614C20G02					1	
06		ADJ. SCR. HSG.	DWG		8520D34H01				1	1	
07		ADJ. SCR.	DWG		8520D34H02				1	1	
08		ADJ. SCR. HSG CAP	DWG		8520D34H06				1	1	
09		KNOB	DWG		257C034H03				1	1	
10	A	O-RING	BOS	.62 I.D. X .75 O.D. X .06 W. #2-106-V747	-75				1	1	
11	A	O-RING	BOS	.25 I.D. X .38 O.D. X .06 W. #2-010-V747	-75				1	1	
12	B	SPIROL PIN	BOS	.032 DIA. X .25 LG. PIC#CS-9					1	1	
13		SET SCR.		.138-32 X .25 LG. STL.							

-A- PARKER SEAL CO., LEXINGTON, KY.
-B- PIC DESIGN CORP., RIDGEFIELD, CT.



GR.03 & 04

TOLERANCES UNLESS OTHERWISE SPECIFIED
FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED
GEOMETRIC CHARACTERISTIC SYMBOLS

REF DWG 1289J19

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
PUSH ROD SUB ASSY'S

DRTN F CARDELLO 5-24-72
CHKD W. C. S. 5-26-72

REV. 1

2614 C 20

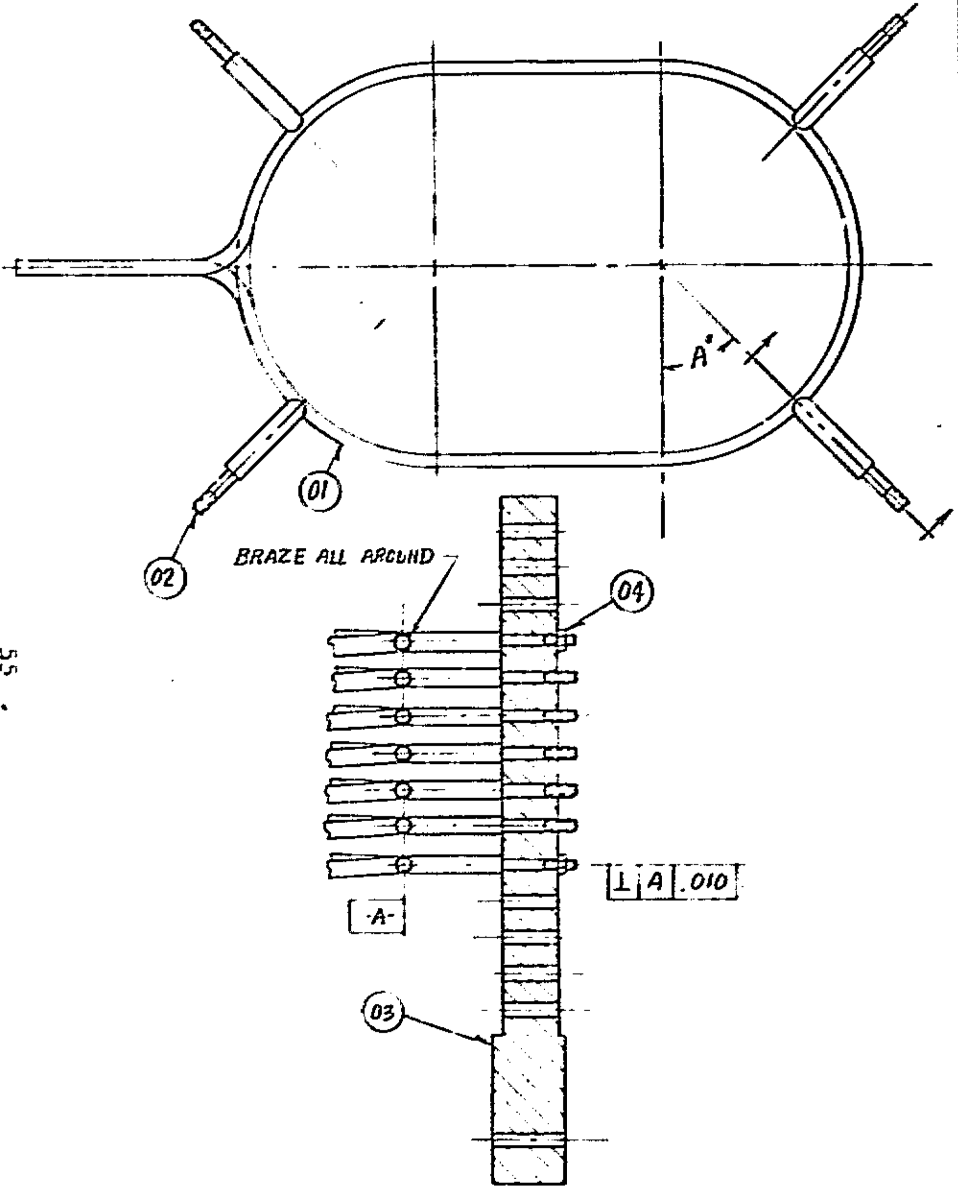
RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 U.S.A.

CHANGE
903066

TITLE SILICON WEB FURNACE
OVAL WORK COIL ASSY
DWG 2614C23 REV 1

ITEM	NOTE	PART NAME	DEF	SIZE; REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		WORK COIL	IX6		2613C64H01		1				
02		STAND-OFF	DNS								
03	A	FAB. POST	IX6								
04		HEX NUT		.138-32 7L							

A - USED FOR FIXTURING ONLY



Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
OVAL WORK COIL ASSY
1:1 REV 1

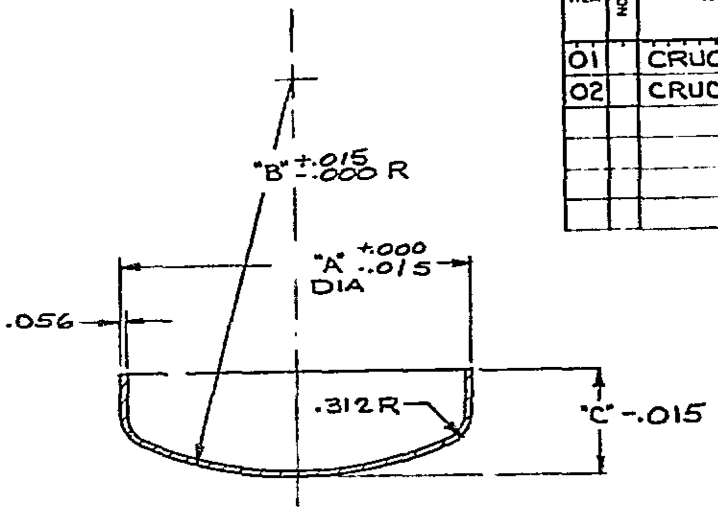
C. HOHMAN

2614C23

RESEARCH LABORATORIES

TITLE SILICON WEB FURNACE MOD-1&2
CRUCIBLE DET
DWG 1689B31 REV 2

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		CRUCIBLE		CLEAR QUARTZ GE TYPE 214	OR 204						
02		CRUCIBLE		CLEAR QUARTZ GE TYPE 214	OR 204						



ITEM NO.	A	B	C
01	3.128	3.500	.912
02	4.618	7.318	.975

IT.	CHANGE	
D.902983 MOD. 1 / D.903066 MOD. 2		1
02	ADDED RCARDELLO 8-1-77	2

TOLERANCES UNLESS OTHERWISE SPECIFIED
2 PL DEC ±.02 | 3 PL DEC ±.008 | ANGLES ±0.5°

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS: FLATNESS, STRAIGHTNESS, ROUNDNESS (CIRCULARITY), CYLINDRICITY, PROFILE OF ANY LINE, PROFILE OF ANY SURFACE, PARALLELISM, PERPENDICULARITY (SQUARENESS), ANGULARITY, RUNOUT, TRUE POSITION, CONCENTRICITY, SYMMETRY, MAXIMUM MATERIAL CONDITION (MMC), REGARDLESS OF FEATURE SIZE

REF DWG

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-1&2
CRUCIBLE DET

DIMENSIONS IN INCHES SCALE 2 REV-2

DFTM W. SUMPMAN 5-9-77 APPD
CHKD APPD
SUPV APPD

1689B31

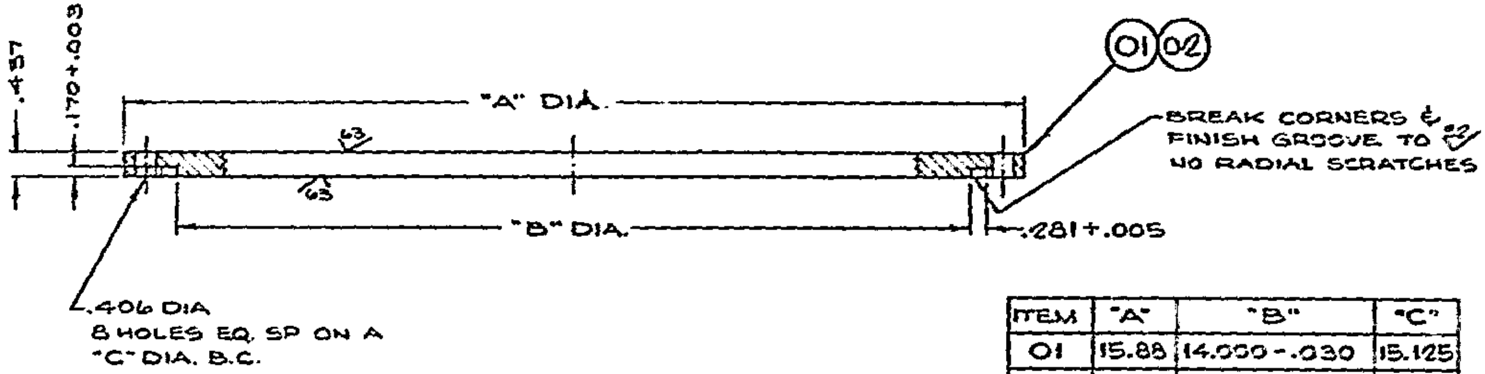
RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

TITLE SILICON WEB FURNACE MODEL-1E2

BLANK COVER PLATES

DWG 1690B07 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG R&D STK NO	PROCESS OR LINE NO	GROUP 01	02	03	04	05
01		BLK COVER PL		16.00 DIA OF .50 THK SST TYPE 304	3403-0101						
02		BLK COVER PL		19.12 DIA OF .50 THK SST TYPE 304	3403-0101						



ITEM	"A"	"B"	"C"
01	15.88	14.000-.030	15.125
02	19.00	16.955-.045	18.125

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-1E2

BLANK COVER PLATES

DIMENSIONS IN INCHES-SCALE

REV. 1

DFTM Kozlowski 6-14-77

CHKD W.C.S. 7-15-77

1690B07

REF DWG 1557C51, 8508D18, 5520D19ED50

TOLERANCES UNLESS OTHERWISE SPECIFIED

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS

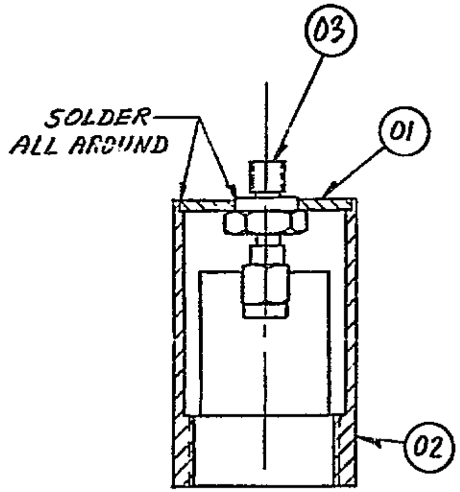
CHANGE

D 902082 MOD-1
903066 MOD-2

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

TITLE SILICON WEB FURNACE MOD-2
SENSOR HOLDER

DWG 1691B12 REV 1



ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE PROCESS OR LINE NO	GROUP C1	C2	C3	C4	C5
01		CAP	DWG		8520D78H04		1				
02		SENSOR HLDR	DWG		8520D78H05		1				
03	A	CONN.	BOS	SWAGELOK O-SEAL STR THD	B-200-1-OR		1				

A- PGH. VALVE & FITTING CO., PGH., PA.

D. 903066	1
IT.	CHANGE

TOLERANCES UNLESS OTHERWISE SPECIFIED: 2 PL. DEC ±.02; 3 PL. DEC ±.005; ANGLES ±0.5°

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

GEOMETRIC CHARACTERISTIC SYMBOLS: FLATNESS; STRAIGHTNESS; ROUNDNESS (CIRCULARITY); CYLINDRICITY; PROFILE OF ANY LINE; PROFILE OF ANY SURFACE; PARALLELISM; PERPENDICULARITY (SQUARENESS); ANGULARITY; RUNOUT; TRUE POSITION; CONCENTRICITY; SYMMETRY; MAXIMUM MATERIAL CONDITION (MMC); REGARDLESS OF FEATURE SIZE

REF DWG 1289J18

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
SENSOR HOLDER ASSY

DIMENSIONS IN INCHES—SCALE 1:1 REV 1

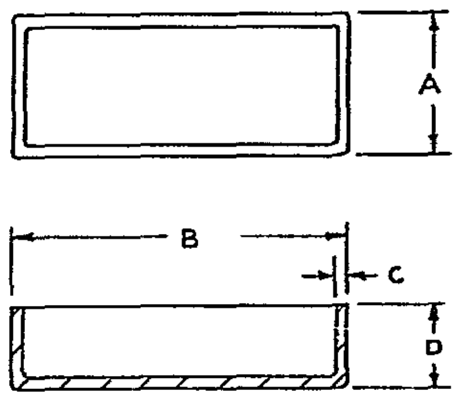
DFTM C. HOHMAN 9-26-77 APPD
CHKD W.C.S. 3-29-77 APPD
SUPV APPD

1691B12

RESEARCH LABORATORIES CHURCHILL BORO PITTSBURGH PA 15235 USA

TITLE SILICON WEB FURNACE MOD-2
OVAL CRUCIBLE DET
DWG 1691B62 REV 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MAT'L SIZE CODE PART NUMBER OR REF DWG	PROCESS OR LINE NO	C1	C2	C3	C4	C5
01		CRUCIBLE		CLEAR QUARTZ GE TYPE 214	GR 204						



ITEM NO	A	B	C	D
01	2.493	5.993	.056	.683

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TOLERANCES UNLESS OTHERWISE SPECIFIED: 2 PL DEC ±.02; 3 PL DEC ±.005; ANGLES ±0.5°

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

REF DWG 1289J18

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MOD-2
OVAL CRUCIBLE DET
REV-1

DFTR T GRADISEK 9-21-77
CHKD W. C.S 9-21-77

1691B62

RESEARCH LABORATORIES

D 903066 CHANGE 1

Westinghouse Electric Corporation RESEARCH LABORATORIES CHURCHILL BORO, PITTSBURGH, PA 15235, U.S.A.

TITLE SILICON WEB FURNACE MOD-2

WORK COIL STAND-OFF DET

REF DWG 2613C95

DFTN ///C.J. | APPD | SUB. 1

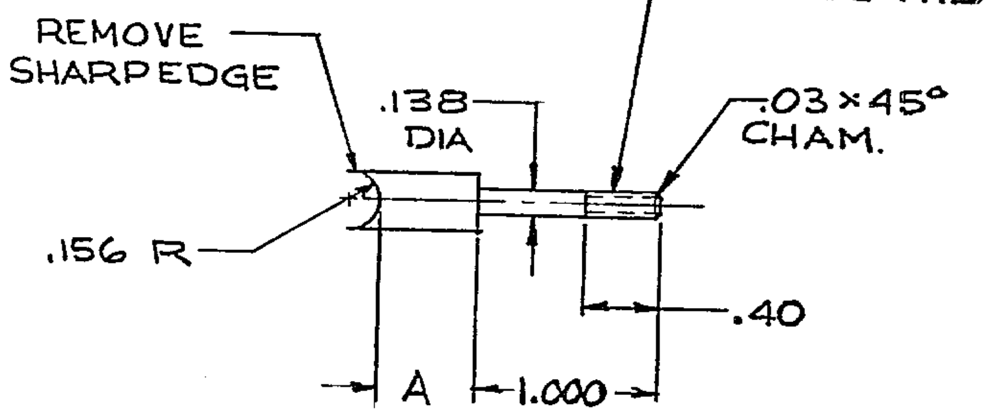
903066

TOLERANCES UNLESS OTHERWISE SPECIFIED		
2 PL. DEC.	3 PL. DEC.	ANGLES
±.02	±.005	±0.5°

FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED

DIMENSIONS IN INCHES—SCALE

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESS OR LINE NO.	GROUP 01	02	03	04	05
					RED STK NO						
01		STANDOFF		2.75 OF .312 DIA BR	6105-0501	ASTM B-16					



IT. NO.	A
01	1.40

6414 A97

Westinghouse Electric Corporation RESEARCH LABORATORIES CHURCHILL BORO, PITTSBURGH, PA. 15235, U.S.A.

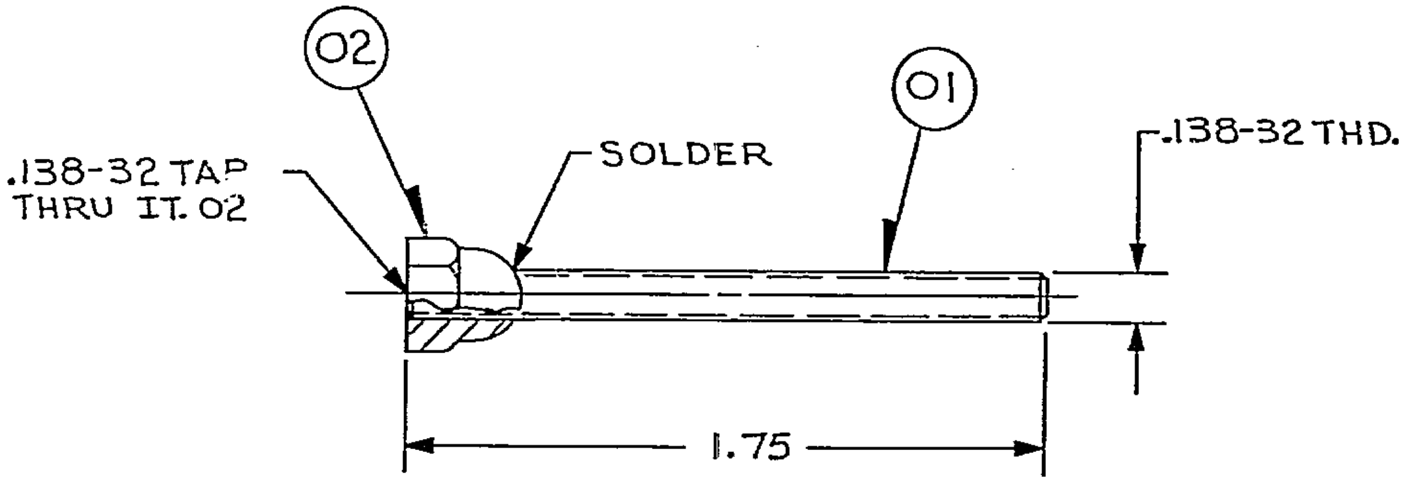
TITLE SILICON WEB FURNACE MOD-1&2
ADJ. SCR. SUB ASSY.

DFTM. F. CARDELLO | APPD N.C.S 8-5-77 | SUB. 1

D-903066

REF DWG	TOLERANCES UNLESS OTHERWISE SPECIFIED			FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED	DIMENSIONS IN INCHES—SCALE
	2 PL. DEC.	3 PL. DEC.	ANGLES		2=1
	±.02	±.005	±0.5°		

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG R&D STK. NO.	GROUP NOTE / PROCESS OR LINE NO.	GROUP 01	02	03	04	05
01		ALL THD.		1.88 OF .138-32 STL.	6506-0901		1				
02		ACORN NUT		.138-32 STL.			1				



6416 A16

Westinghouse Electric Corporation RESEARCH LABORATORIES CHURCHILL BORO, PITTSBURGH, PA. 15235, U.S.A.

TITLE SILICON WEB FURNACE MOD-2

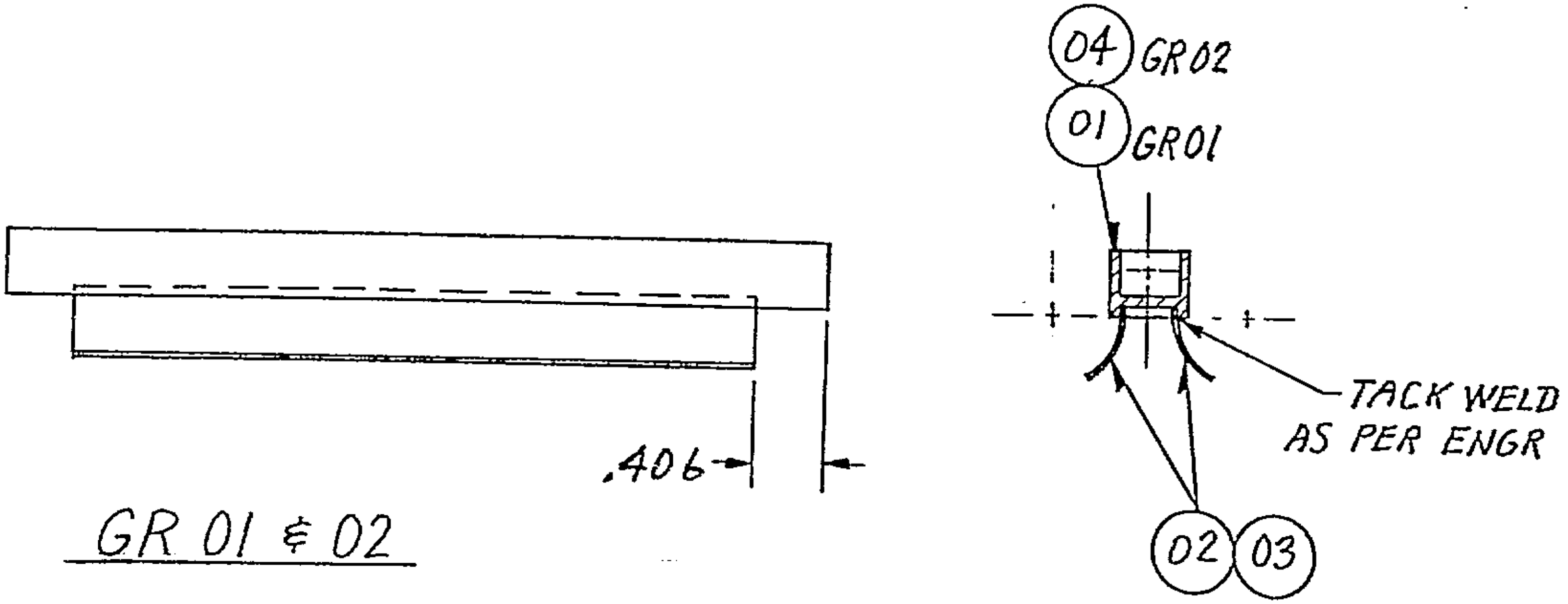
DUCT GUIDE

DFTM. C. HOHMAN — APPD W.C.S 8-29-77 — SUB. 1

D903066

REF DWG	TOLERANCES UNLESS OTHERWISE SPECIFIED: 2 PL. DEC.	3 PL. DEC.	ANGLES	FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED	DIMENSIONS IN INCHES—SCALE
1289J19	±.02	±.005	±0.5°		1:1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESS OR LINE NO.	GROUP 01	02	03	04	05
01		GUIDE HSG	DWG		8520D78H01		1				
02		GUIDE	DWG		8520D78H02		2				
03		GUIDE	DWG		8520D78H03			2			
04		GUIDE HSG	DWG		8520D78H06			1			



6417A44

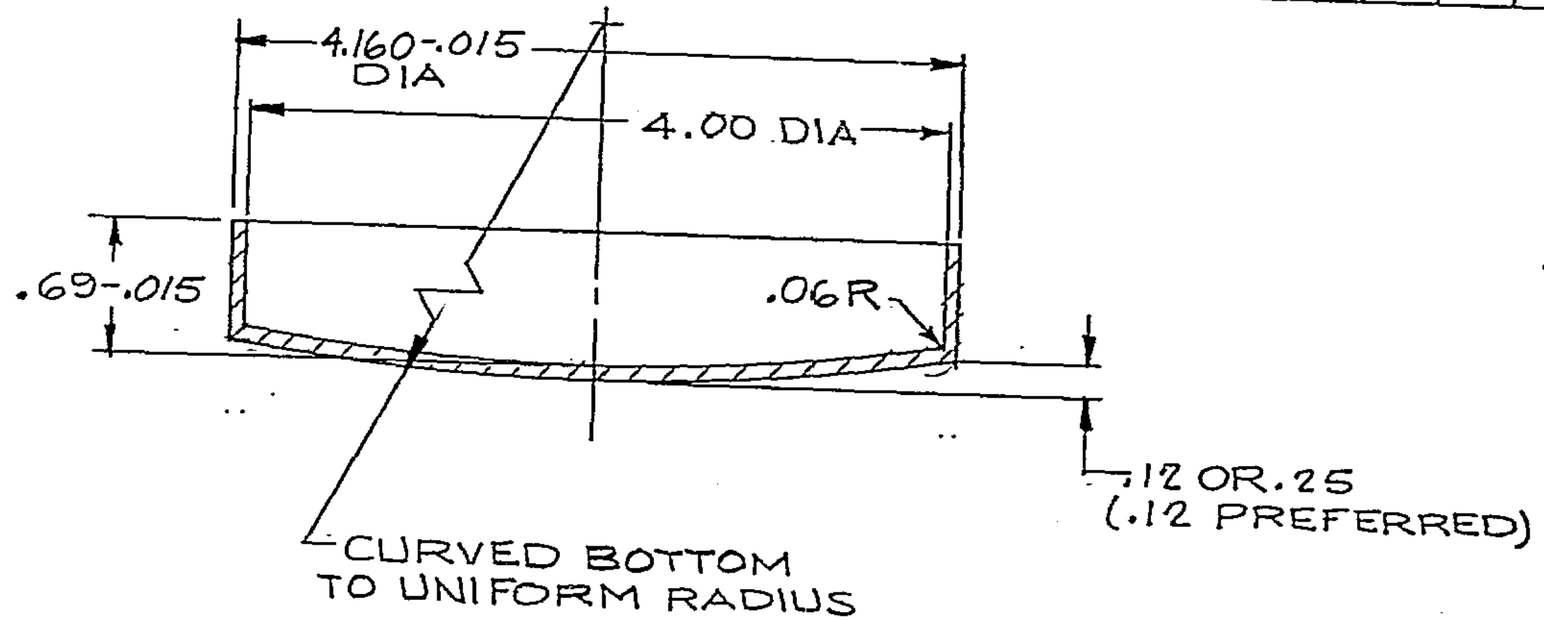
Westinghouse Electric Corporation RESEARCH LABORATORIES CHURCHILL BORO, PITTSBURGH, PA. 15235, U.S.A.

TITLE SILICON WEB FURNACE

CRUCIBLE

REF DWG	TOLERANCES UNLESS OTHERWISE SPECIFIED: 2 PL. DEC. ±.02; 3 PL. DEC. ±.005; ANGLES ±0.5°	FINISH TO BE ✓ UNLESS OTHERWISE SPECIFIED	DIMENSIONS IN INCHES—SCALE	DFTM W.C.S. 8-26-77; APPD.; SUB. 1

ITEM	NOTE	PART NAME	DEF	(SIZE) REFERENCE INFORMATION	MATL SIZE CODE PART NUMBER OR REF DWG	GROUP NOTE / PROCESS OR LINE NO.	GROUP 01	02	03	04	05
01		CRUCIBLE	MKF	AMERSIL CFQ T08							



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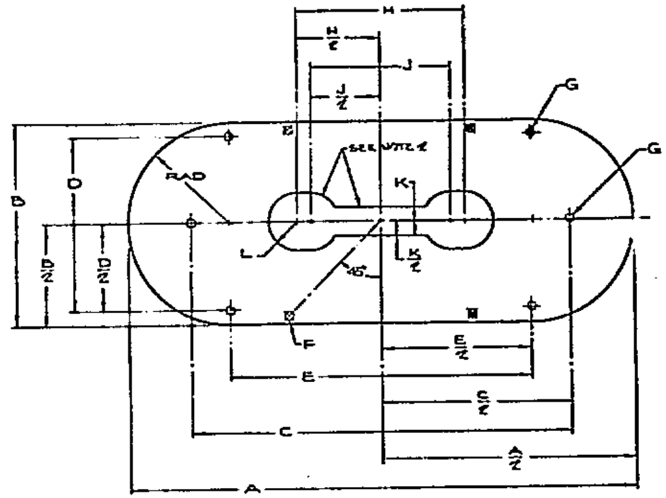
6417A57

TITLE SILICON WEB FURNACE MODEL-E
OVAL TOP SHIELD
DWG 8521D13

ITEM	PART NAME	MATERIAL SPECIFICATION	
01	TOP SHIELD	2.12X3.63 SP .04 THK MOLY	813-0031



ITEM	A	B	C	D	E	F	G	H	J	K	L
01	8.97 (227.84)	3.56 (90.42)	6.750 (171.45)	3.062 (77.774)	5.375 (136.53)	.156 (3.962) DIA - 4 HOLES EQ SP ON A 4.625 (117.47) DIA. B.C	.156 (3.962) DIA. 6 HOLES				

NOTES:
1. DIMENSIONS ENCLOSED BY ( ) ARE IN MILLIMETERS
2. POLISH & REMOVE ALL SHARP EDGES

Westinghouse Electric Corporation

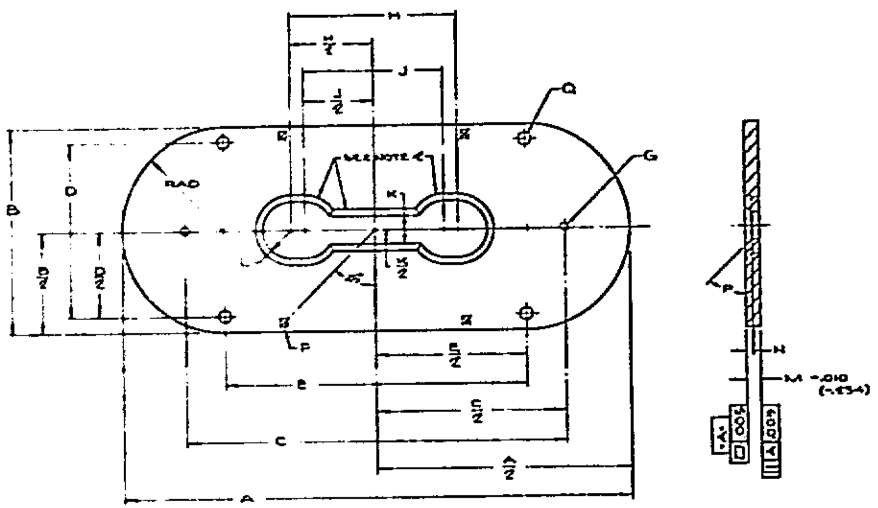
TITLE SILICON WEB FURNACE MODEL-E
OVAL TOP SHIELD

8521D13

TITLE	SILICON WEB FURNACE MODEL-E OVAL SUSCEPTOR COVER DET		
ITEM	PART NAME		MATERIAL
01	A COVER		[illegible] .25 THK MOLY

A - J.T. RYERSON & SON, INC. - PGH, PA.

NOTES:
1 DIMENSIONS ENCLOSED BY ( ) ARE IN MILLIMETERS
2 POLISH & REMOVE ALL SHARP EDGES

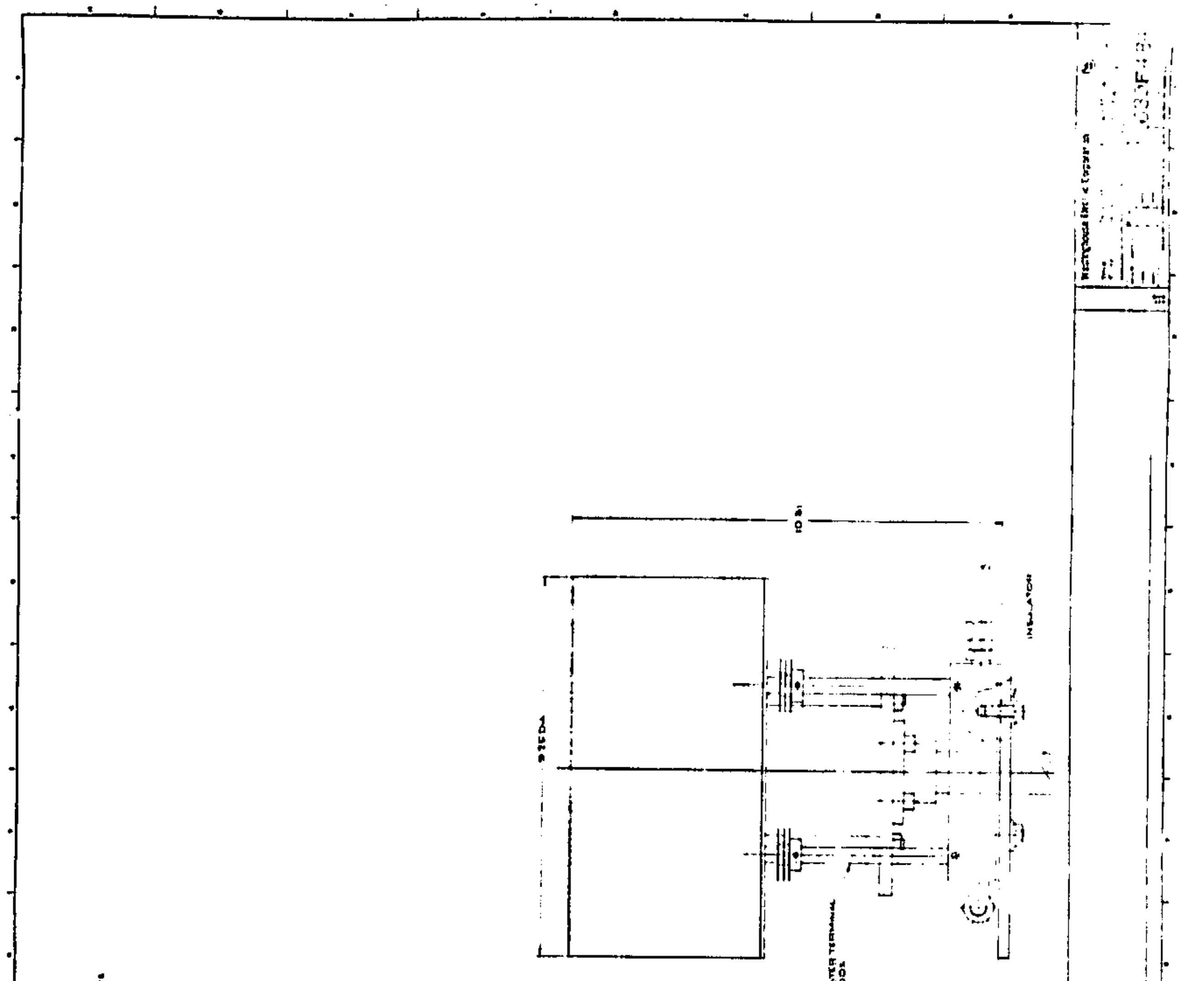


ITEM	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
01	8.97 (227.84)	3.9[illegible] ([illegible].42)	6.750 (171.45)	3.062 (77.774)	5.375 (136.53)	.156(3.962) DIA - 4 HOLES EQ SP ON A 4.625 (117.47) DIA B C	.156(3.962) DIA 2 HOLES					.250 (6.350)			.204 (5.18) DIA - 4 HOLES

Westinghouse Electric Corporation

TITLE SILICON WEB FURNACE MODEL-E OVAL SUSCEPTOR COVER DET REV 1

8521D14


INSULATOR
TOP SHIELDS
CRUCIBLE
SUSCEPTOR
BOTTOM SHIELDS