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PROTOTYPE COLOR FIELD SEQUENTIAL TELEVISION LENS ASSEMBLY

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FINAL REPORT

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HOUSTON, TEXAS 77058

UNDER CONTRACT NO. NAS 9-13688

ASTRO-ELECTRONICS DIVISION
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PREFACE

This is the final report on the project "Prototype Color Field Sequential Television Lens Assembly", performed for the Johnson Space Center of the National Aeronautics and Space Administration under Contract NAS 9-13688. It covers work performed from November 1973 through October 1974, and responds to the documentation requirements set forth in the Data Requirements List, Item 4 of the contract.

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SECTION I

INTRODUCTION AND SUMMARY

The Astro-Electronics Division (AED) of RCA submits to NASA this final report covering the design and development of a prototype Color Field Sequential Television Lens Assembly under Contract No. NAS 9-13688.

The primary purpose of this contract is to design, build, and evaluate a prototype modular lens assembly with a self-contained field sequential color wheel. The effort includes the design of a color wheel of maximum efficiency, the selection of spectral filters, and the design of a quiet, efficient wheel drive system.

This report discusses the design tradeoffs considered for each aspect of the modular assembly. Emphasis has been placed on achieving a design which can be attached directly to an unmodified camera, thus permitting use of the assembly in evaluating various candidate camera and sensor designs. A technique is described which permits maintaining high optical efficiency with such an unmodified camera. The recommended implementation of the color wheel assembly uses an edge-driven color wheel and a direct drive (no gearhead) cartridge motor.

A motor synchronization system has been developed which requires only the vertical synchronization signal as a reference frequency input. Equations and tradeoff curves have been developed to permit optimizing the filter wheel aperture shapes for a variety of different design conditions.

The completed hardware, delivered to JSC in October, 1974 consists of a color filter wheel module, an attached remote controllable zoom lens, and a control box which includes the electronics required to operate the color wheel and lens function motors.

The finished hardware demonstrates the viability of providing field sequential color operation in the form of a "kit" attachment for future space missions.

SECTION II

TECHNICAL DISCUSSION

A. PROGRAM OBJECTIVES

The major objectives of the program effort are as follows:

- Develop modular field sequential lens assembly which adaps B&W camera to color.
- Minimize mechanical and electrical interfaces to camera.
- Adapt to standard commercial ("C") mount if feasible.
- Study/optimize filter segment shapes.
- Study/trade-off motor and lens types.
- Fabricate, assemble, test, deliver with associated B&W camera.
- Provide engineering drawings and specifications to permit duplication.

The satisfactory completion of these objectives has provided a modular assembly which can be interfaced with minimal effort to a black and white camera. This in turn allows standardization of camera design for a spacecraft application (e.g., the Space Shuttle) while permitting the conversion to color if and when required by the simple attachment of a module to the existing hardware.

While the final cameras could anticipate such a module and be configured to optimize the interface, we have attempted to solve the more general case. That is, the development of a module which can be attached to any existing standard interface camera. Thus the completed unit could be used for laboratory evaluation of the relative performance characteristics of different cameras and sensor types. This restriction limits the theoretical optical efficiency which can be achieved. The mechanical design was developed to permit easy adaptation to an optimized interface camera with an attendant increase in optical throughput.

To demonstrate the finished performance, the program provides for a standard black and white camera to be supplied and tested with the color wheel module. A 1" (25.4 mm) vidicon format is anticipated as the maximum requirement for the Shuttle or similar space system. Similarly, a silicon target vidicon represents the lowest sensitivity sensor anticipated for use, and also possesses the low lag characteristics needed for field-sequential operation. Accordingly, we selected an MTI Model 55 camera for purchase and use. This camera includes a 1" format silicon vidicon, standard "C" mount lens interface, and remote sync provisions, and is considered to be typical of "standard" available cameras.

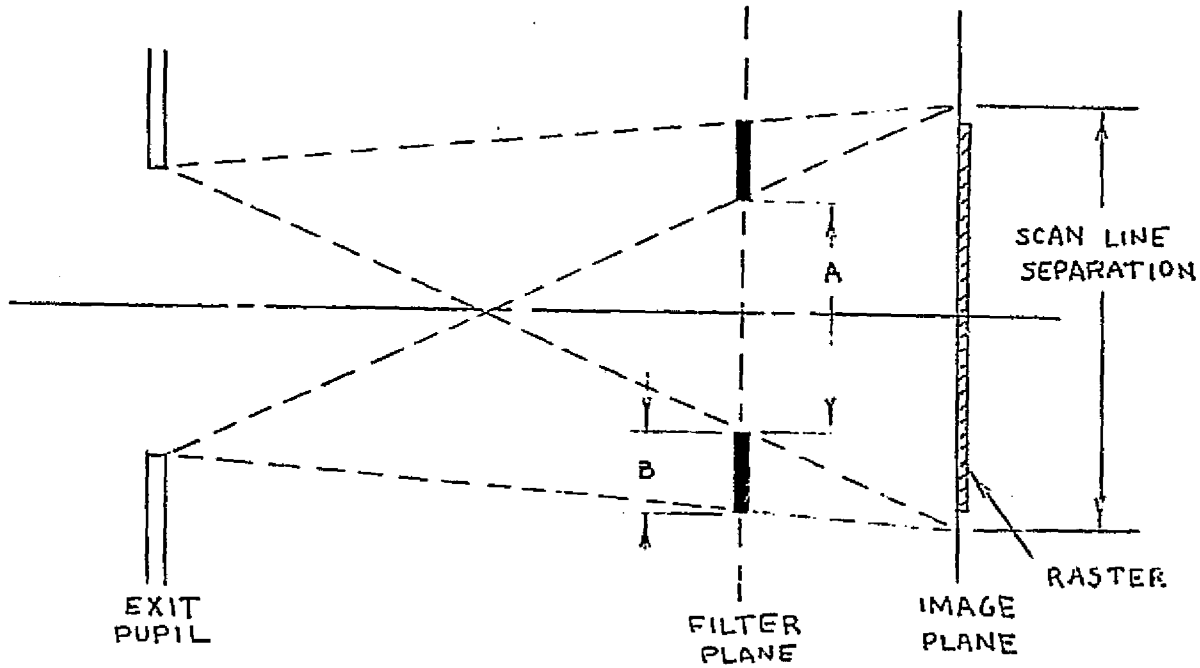
B. FILTER WHEEL DESIGN

An important consideration in the design of the Field Sequential Television Lens Assembly is the optimization of the mechanical shape and location of the color filter segments. The ideal goal is to provide maximum efficiency of exposure for a given set of constraints, while maintaining uniform exposure and zero crosstalk from one spectral filter to the other.

The sole function of the filter wheel is to provide color separation; that is, to arrange for light of only one spectral characteristic to strike any point on the faceplate between any two successive scans of the point by the scanning beam. Ideally, then, if the filters could be coplanar with the image plane, the filter mechanism would consist of an endless succession of rectangular filters, moving across the image plane at the same velocity as the scanning lines, with the motion so controlled that successive filter boundaries coincide with successive scan lines. As the filter plane is moved away from the image plane, it becomes necessary, in order to maintain color separation, to provide an opaque bar between adjacent filters of sufficient width to prevent any light from reaching the image plane at the instantaneous location of the scanning line. The resulting limitations can be appreciated with reference to Figure 1.

In Figure 1, scan line separation is shown by showing extrapolated locations of scan lines above and below the raster during retrace time. The required width (B) of each opaque bar is then determined, as shown, by the size of the exit pupil and its distance from the image plane, and by the distance of the filter plane from the image plane. The size of the filter opening (A) is determined by the same geometry, and filter efficiency is given by $A/(A+B)$. It is also clear from the geometry of Figure 1 that there is a maximum separation of filter plane and image plane at which color separation can be achieved.

Equations required to design maximum transmission efficiency filter wheels were initially developed in Appendix A of RCA Proposal No. 102004-A. The equations given in the proposal were modified to take into account the finite distance of lens exit pupil from the image plane.



$$\text{EFFICIENCY} = \frac{A}{A+B}$$

Figure 1. Theoretical Maximum Efficiency Geometry

These equations were written into a computer program, which was then designed to perform the iterative trial and error process required to achieve maximum transmission efficiency. In summary, the computer program does the following calculation:

Given:

(a) Raster size (width and height).

(b) Retrace time (as a percent of total scan interval).

(c) Distance of lens exit pupil from image plane.

(d) Distance of filter wheel from image plane.

(e) Number of sets of three (3) filters installed on filter wheel.

(f) Maximum lens opening (f-number).

(g) Maximum diameter of filter wheel apertures.

Using this information, the computer program will determine the significant design parameters for a filter wheel which will have maximum transmission efficiency while still insuring that the active scan line is always masked from direct illumination by the scene. The significant outputs of the program are:

(a) Separation of filter wheel rotation axis srom optical axis.

(b) Orientation of raster with respect to line joining filter wheel axis and optical axis.

(c) Transmission efficiency.

(d) Minimum diameter of filter wheel apertures.

While developing the computer program, a previously unobserved limitation on design parameters was discovered; namely:

$$R \sin P \geq \frac{Y\,(1-U/S) + U/Q}{2}$$

where R is separation of filter wheel axis from optical axis,

P is angle between line joining these two axes and scan line direction,

Y is raster height,

U is separation between filter wheel and image plane,

S is distance from lens exit pupil to image plane, and

Q is lens f-number at maximum lens opening.

This relationship effectively establishes a lower limit on the maximum diameter of the filter wheel aperture; but this limit cannot be expressed explicitly because of the trial-and-error nature of the computation.

Optimum filter wheel designs were obtained for a number of trial conditions. In all cases, the following were assumed:

Raster size is 0.375" by 0.500";

Retrace time is 10%;

Lens exit pupil distance from the image plane is 5"; and

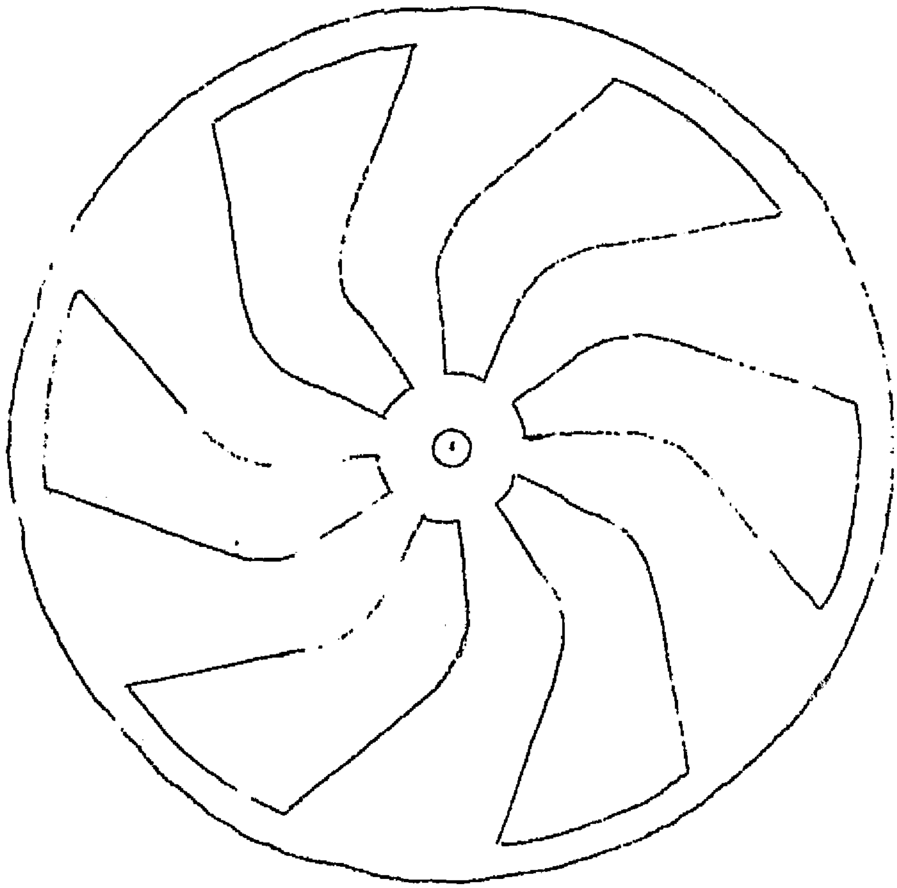
Maximum lens opening is f/2.

In all cases except the last three, the number of filter sets was assumed to be two. Output values are shown in Table 1 for a number of values of U (separation between filter wheel and image plane) and OD (maximum diameter of filter wheel aperture). Tabulated outputs are R and P as previously defined, minimum filter aperture diameter (ID), and transmission efficiency (E). The three designs marked with asterisks in Table 1 are shown drawn to scale in Figures 2, 3 and 4.

Additional parametric curves were then prepared, showing the tradeoffs as individual design parameters are varied.

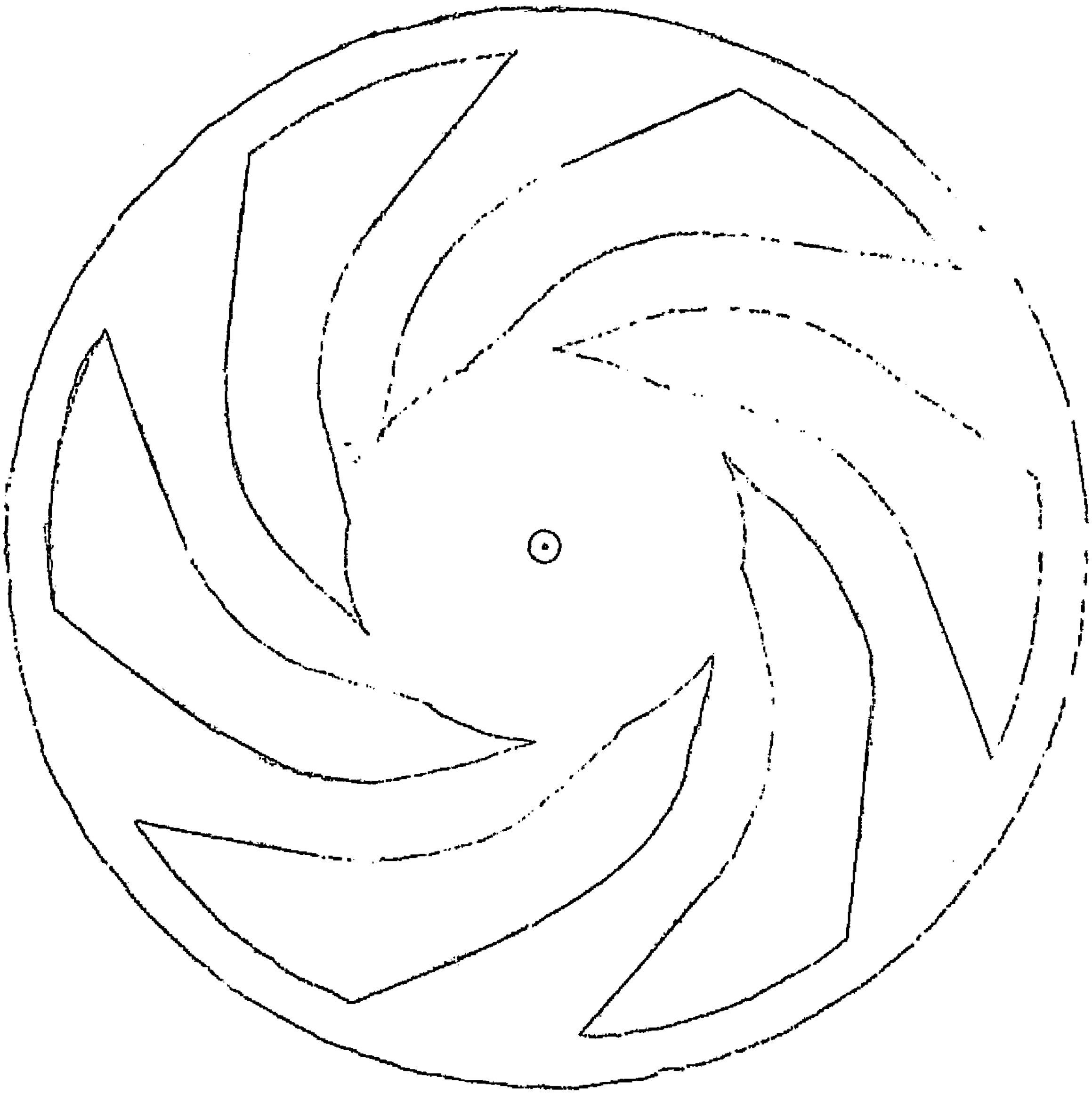
TABLE 1. TRIAL WHEEL DESIGNS

U \ OD		2 FILTER SETS					3 FILTER SETS
		MINIMUM	1.8"	1.87"	2.0"	2.2"	MINIMUM
.15	R	.486"	.561"		.669"	.777"	.662"
	P	27.7°	44.9°		54.3°	60.0°	21.1°
	ID	.311"	.454"		.706"	.950"	.688"
	E	54%	61%		66%	69%	60%
	OD	(1.649")					(1.99")
.20	R	*.494"	.551"	.589"	.659"	.767"	* .667"
	P	28.6°	43.1°	47.9°	53.7°	59.7°	21.7°
	ID	.304"	.410"	.500"	.664"	.908"	.672"
	E	49%	54%	56%	59%	63%	55%
	OD	(1.685")					(2.02")
.25	R	.502"	.541"		.649"	*.757"	.673"
	P	28.9°	40.4°		53.1°	59.4°	22.0°
	ID	.299"	.366"		.621"	.867"	.662"
	E	45%	48%		53%	56%	50%
	OD	(1.719")					(2.05")



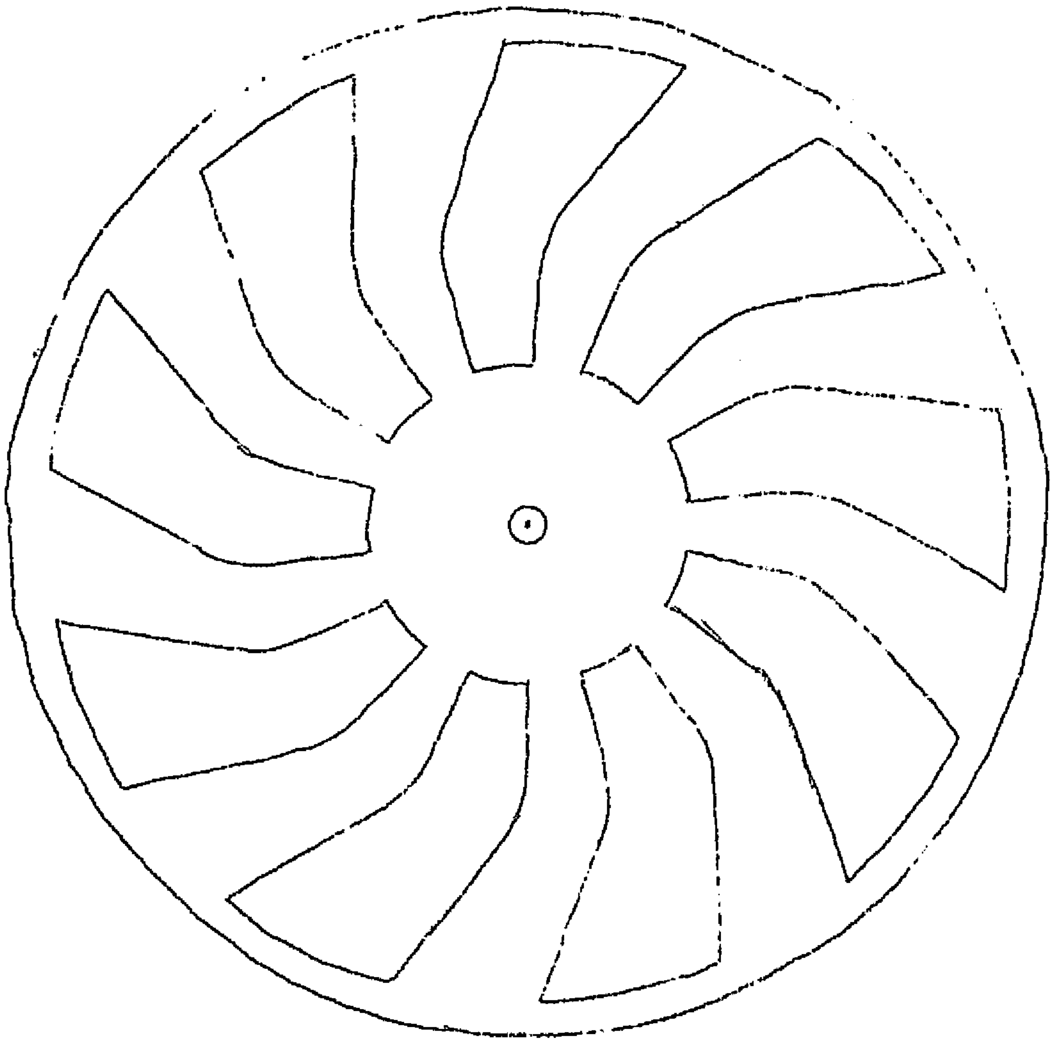
ID = 0.30"
OD ≐ 1.69"
EFF = 49%
WHEEL AXIS TO OPTICAL AXIS = 0.494"
CLEARANCE = 0.2"

Figure 2. Trial Wheel Design No. 1



ID = 0.87"
OD = 2.20"
EFF = 56%
WHEEL AXIS TO OPTICAL AXIS = 0.757
CLEARANCE = 0.25"

Figure 3. Trial Wheel Design No. 2



ID = 0.67"
OD = 2.02"
EFF = 55%
WHEEL AXIS TO OPTICAL AXIS = 0.667"
CLEARANCE = 0.2"

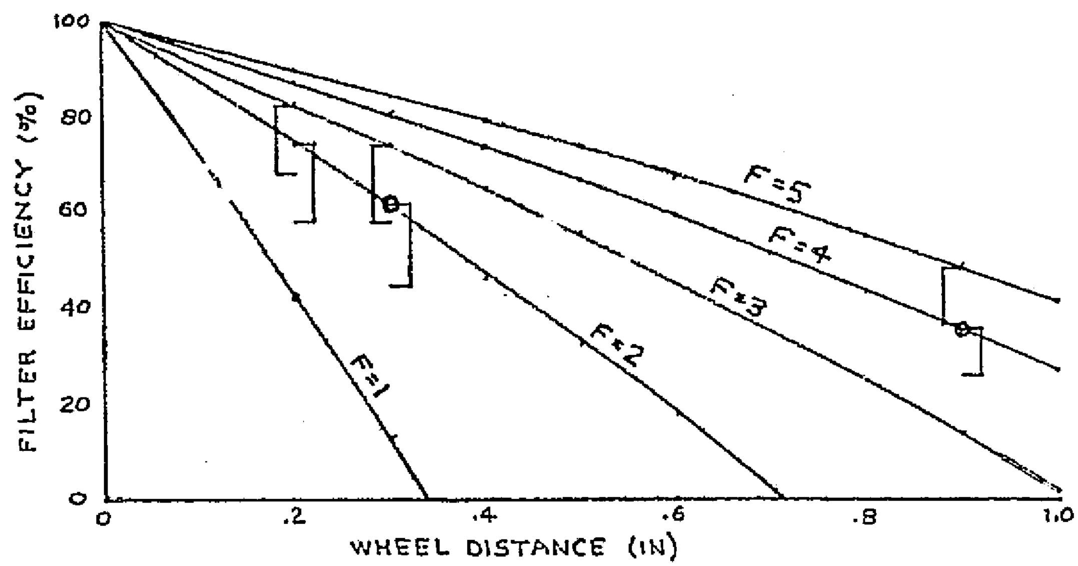
Figure 4. Trial Wheel Design No. 3

Based on the geometry of Figure 1, with a raster height of 0.375 inch, a duty cycle of 0.9 (10% retrace time) and an exit pupil to image plane distance of 5.728 inches (the value given for the 6 x 13T21 lens), maximum exposure efficiency is plotted in the upper half of Figure 5 as a function of separation between filter wheel and image plane for several values of f-number (f-number is approximately equal to exit pupil distance from image plane divided by exit pupil diameter). This graph clearly shows that for each f-number there is an upper limit on filter wheel distance at which complete color separation can be obtained.

Since overall integrated image plane illumination is proportional to filter efficiency and inversely proportional to the square of f-number, the values plotted in the upper half of Figure 5 have been divided by the square of f-number and replotted in the bottom half of Figure 5. The envelope of the solid lines is shown as a dashed line in this plot, and this represents a measure of the upper limit, as a function of filter distance from the image plane, of the integrated exposure which can be obtained in the image plane with complete color separation.

As has been noted, the graphs plotted in Figure 5 represent upper limits of light efficiency. The geometry upon which they are based (as shown in Figure 1) is appropriate only for a filter wheel of infinite diameter, however. The dependence of filter wheel efficiency on wheel diameter can be seen from the graphs of Figure 6. These have been plotted for the other system parameters as shown in the figure. The maximum efficiencies of 60.8% and 35.4% are shown as the circled points in Figure 5.

It is clear from Figure 6 that filter wheel efficiencies obtainable with reasonable (≈2 inches) wheel diameters are significantly, but not prohibitively, lower than theoretical maxima. In the upper half of Figure 5, brackets have been used to show this



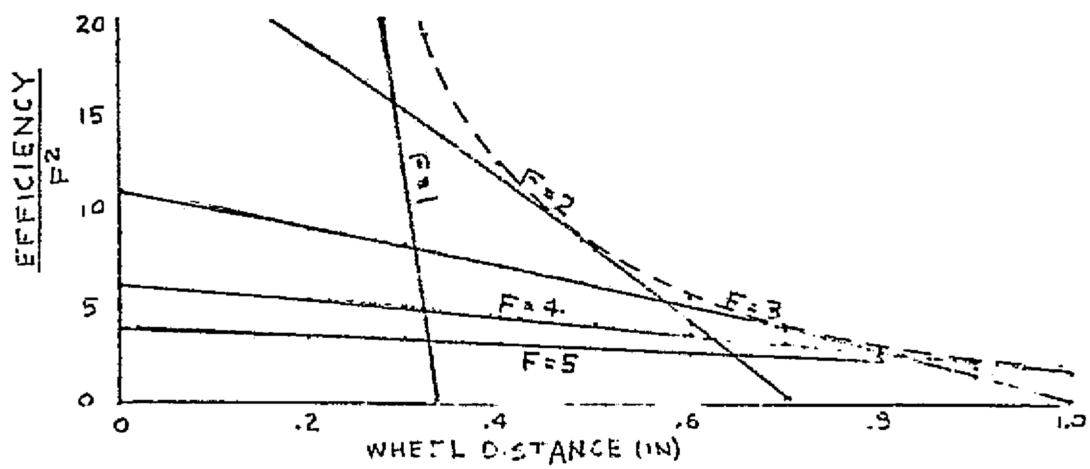
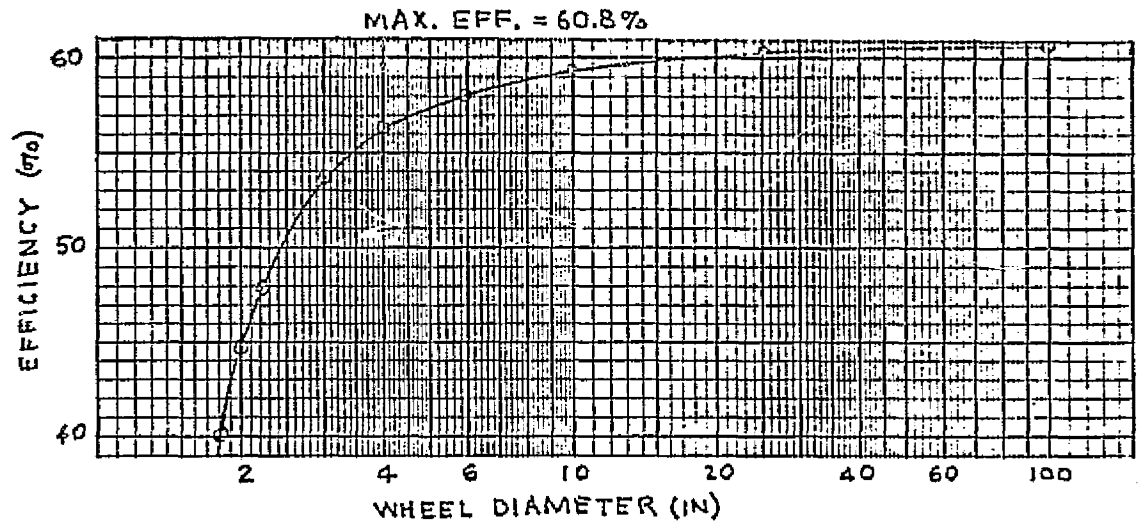


Figure 5. Limiting Efficiency as Function of F-Number and Wheel Distance

0.3" WHEEL DISTANCE

F = 2

6 FILTERS



0.9" WHEEL DISTANCE

F = 4

6 FILTERS

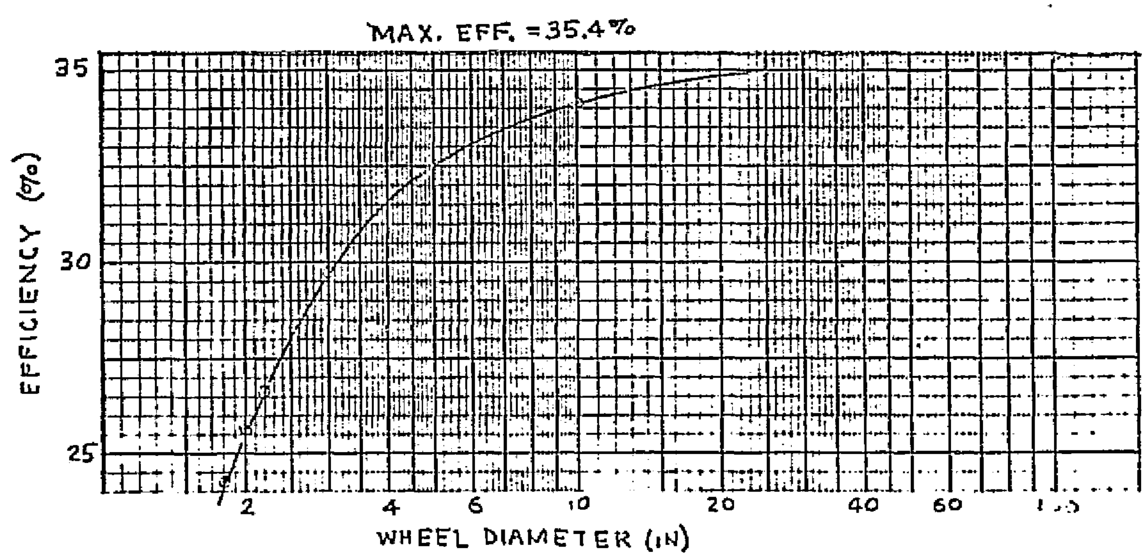


Figure 6. Efficiency vs. Wheel Diameter

loss for a number of filter distances and f-numbers. In each case, the top of the bracket indicates filter wheel efficiency with an infinite diameter wheel, and the bottom of the bracket gives efficiency with a wheel having a 2-inch maximum diameter of the filter opening.

Several additional trade-off studies have been performed. The parameters involved in these studies are shown in Figure 7. The location of the scanned raster relative to the filter wheel is shown. The distances from the wheel axis to the center of the raster/optical axis is R_1 and the angle between the line joining these axes and the horizontal raster direction is P. OD is the largest diameter of the filter openings, and ID is their smallest diameter. Exposure efficiency is found by swinging an arc through the filter openings with center at the wheel axis; efficiency is then given by arc length within an opening divided by arc length between two successive corresponding edges of filter openings.

The first trade-off studies involved filter diameter (OD) and number of filters per wheel (which may be any multiple of 3). In Table 2, the trade-off is tabulated at f/4 for a filter distance of 0.9 inch. OD varies from 1.6 to 2.2 inches, and the number of filters from 3 to 9. Exposure efficiency is expressed here as decimal; the value in parentheses is in each case the decimal efficiency divided by the square of f-number, and represents a measure of overall efficiency. In Table 3, corresponding data are plotted for a lens opening of f/2 and a filter distance of 0.2 inch. Examination of these figures shows that efficiency improves with increasing wheel diameter (as shown previously in Figure 6), but over the range of OD covered by the data, the variation is not dramatic. At the 0.9 inch filter distance, efficiency does not change significantly with number of filters, while at the 0.2 inch distance some improvement with decreasing number of filters is seen. Data for six

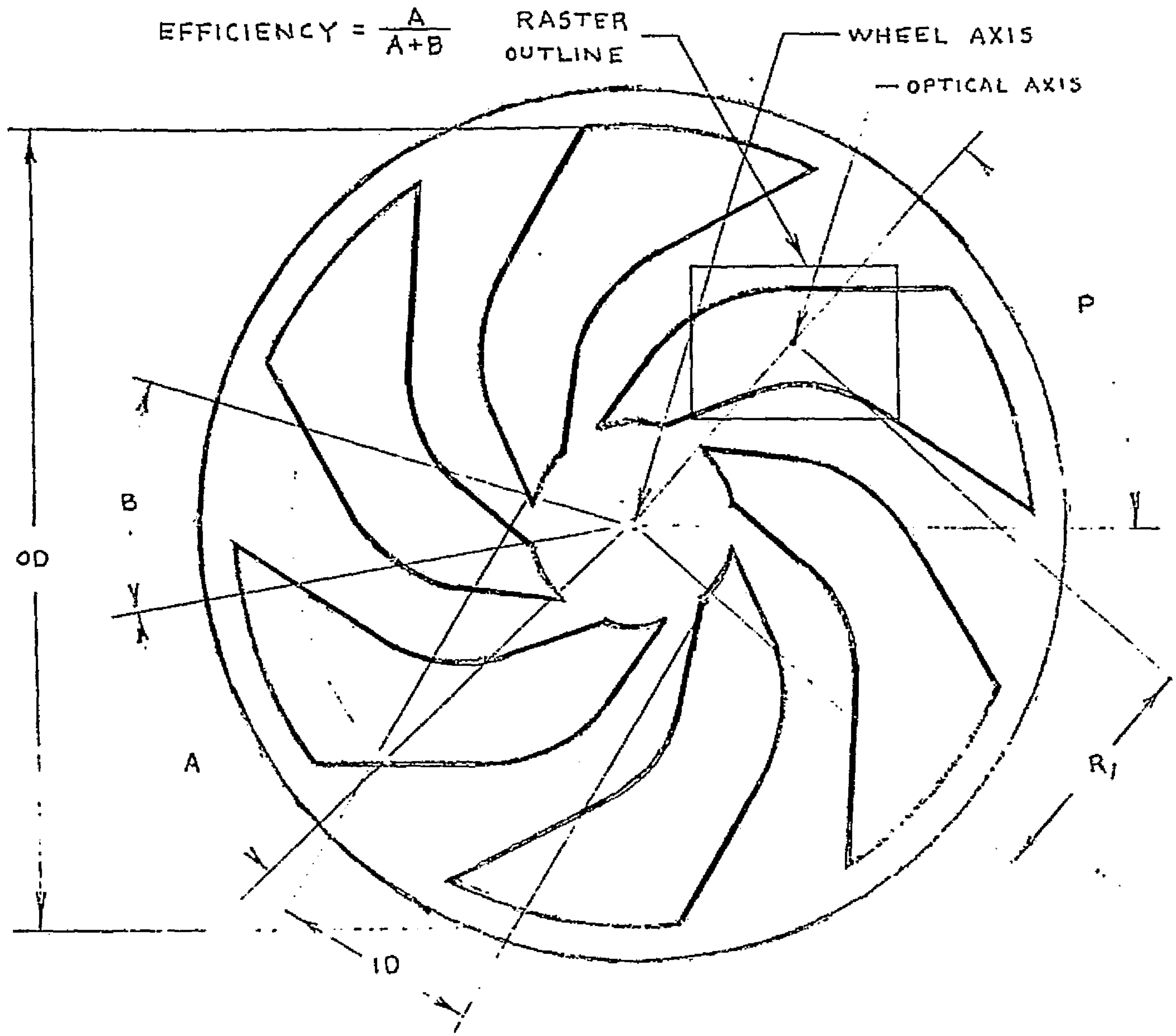


Figure 7. Filter Wheel Geometry

(6) filters at OD = 1.6 inches and for nine (9) filters at OD = 1.6, 1.8 and 2.0 inches are absent because these configurations are subject to different optimization criteria and are less efficient than direct extrapolation would predict. From Tables 2 and 3 we can conclude that if OD = 2 inches is a reasonable value in terms of space limitations, it is worthwhile considering larger wheels only if substantial (1 or 2 inches) increases in diameter can be tolerated. We can further conclude, with the help of Figure 8 which shows a typical 3-filter design, that efficiency advantages of 3- over 6-filter designs do not outweigh the mechanical disadvantages of complicated filter shape.

TABLE 2. FILTER DISTANCE 0.9"; F/4

OD	No. of Filters	Eff.	ID	R	P
1.6	3	.218 (.014)	.247	.441	63.4°
1.8	3	.235 (.015)	.512	.555	71.3°
	6	.242 (.015)	.293	.523	37.9°
2.0	3	.252 (.016)	.745	.665	75.1°
	6	.257 (.016)	.547	.631	53.7°
2.2	3	.267 (.017)	.964	.771	77.2°
	6	.267 (.017)	.798	.741	61.2°
	9	.271 (.071)	.694	.723	38.7°

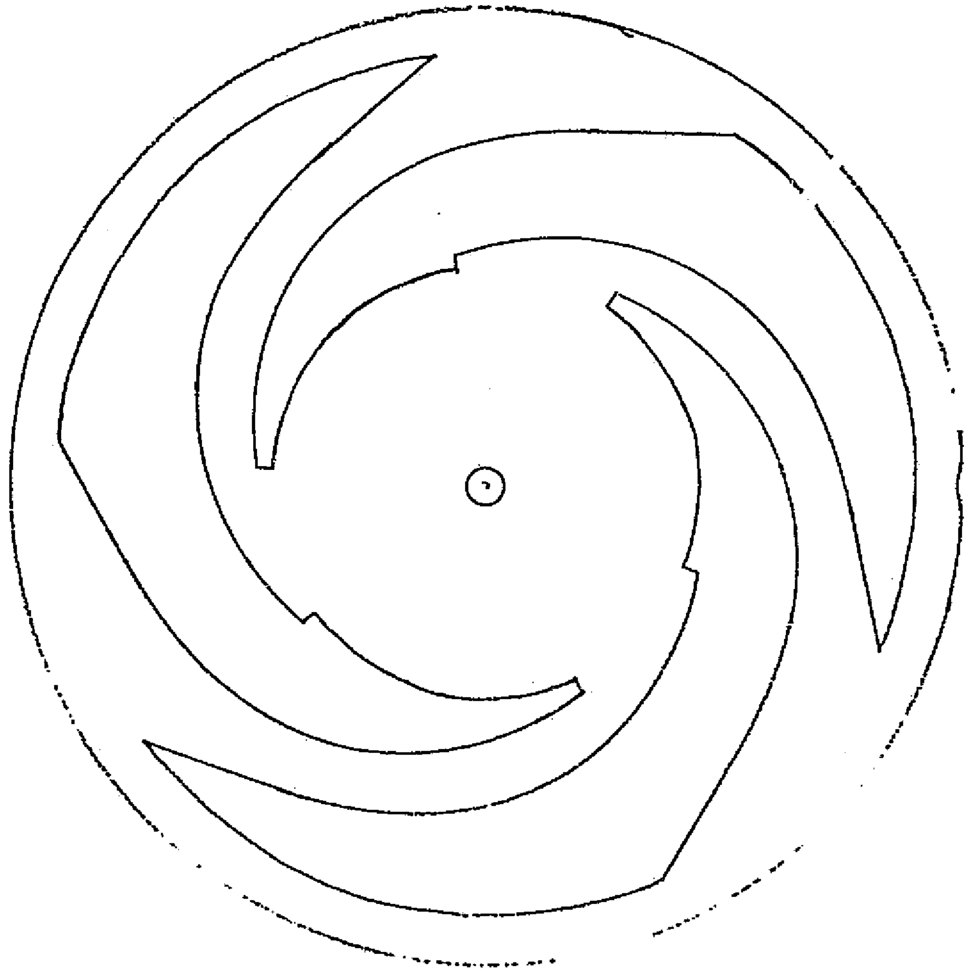


Figure 8. 3-Filter Wheel

TABLE 3. FILTER DISTANCE 0.2"; F/2

OD	No. of Filters	Eff.	ID	R	P
1.6	3	.521 (.130)	.372	.466	63.3°
1.8	3	.580 (.145)	.625	.579	69.7°
	6	.529 (.132)	.394	.548	41.9°
2.0	3	.613 (.153)	.858	.689	73.3°
	6	.585 (.146)	.648	.655	53.2°
2.2	3	.634 (.159)	1.082	.796	75.7°
	6	.618 (.155)	.893	.763	59.3°
	9	.593 (.148)	.788	.747	38.9°

Tradeoffs were also performed involving filter distance from the image plane and lens f-number, as shown in Table 4. It is clear from this data that the filter wheel should be placed as close as possible to the image plane (as is indicated also by Figure 5). It also appears that there is not a clear choice between f/4 and f/5 at the 0.9 inch filter distance, but design for f/2 at the shorter distances, despite the lower filter efficiencies, is significantly better in terms of overall efficiency.

The compatibility of designs for the same OD and number of filters, but for different filter distances and f-numbers, was also examined. In Figure 9, it is shown that a single control shape in the wheel can be used to accept masks designed for f/4 at 0.9 inch, f/2 at 0.3 inch and f/2 at 0.2 inch. These are three of the designs for which data is given in Table 4

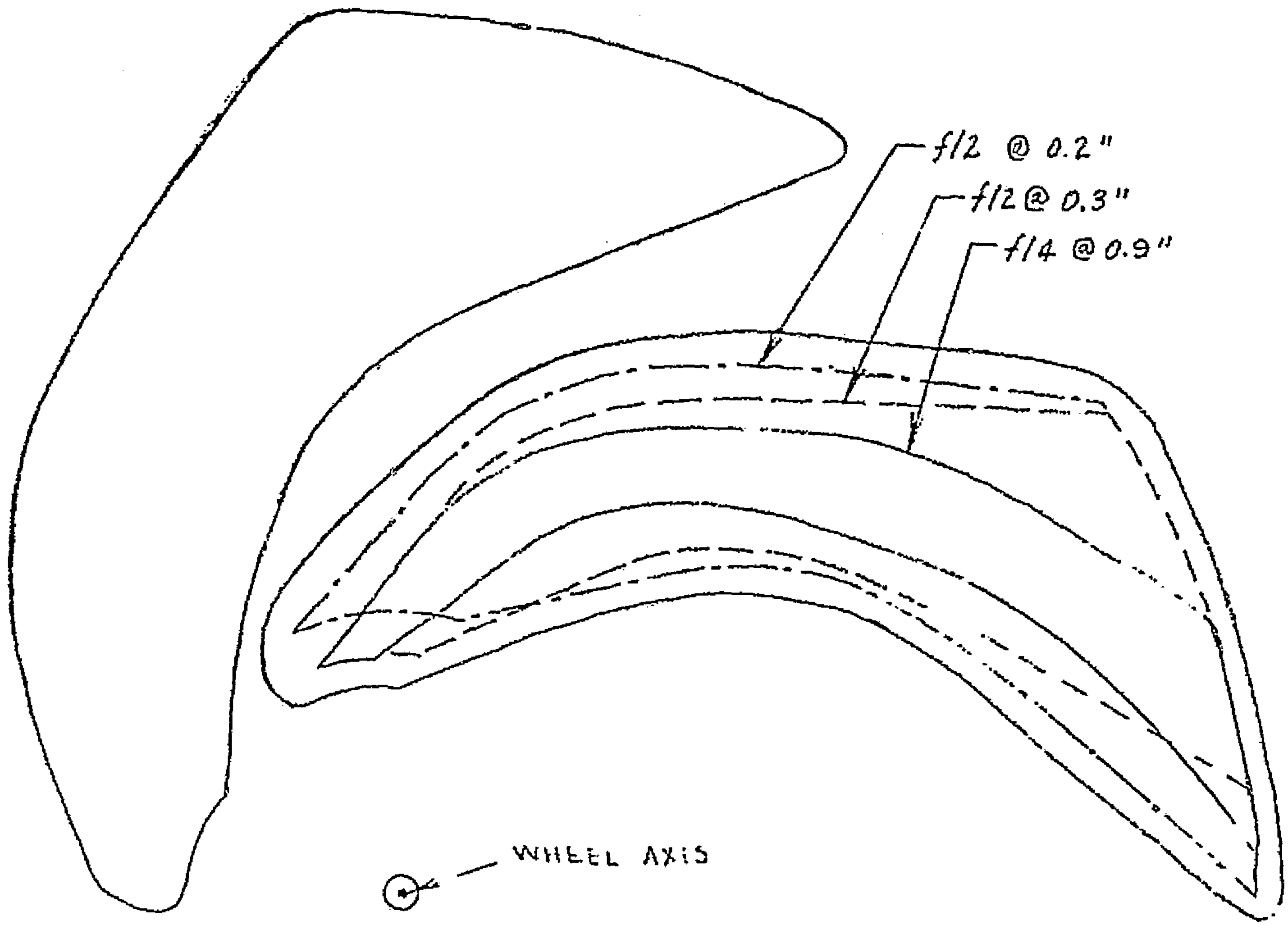


Figure 9. Mask Shapes

and are those which would probably be used at the designated distances.

TABLE 4. SIX FILTERS; OD = 2"

Filter Distance	f/no.	Eff.	ID	R	P
.9	4	.257 (.016)	.547	.631	53.7°
	5	.366 (.015)	.667	.659	58.0°
.3	2	.448 (.112)	.551	.633	51.1°
	3	.592 (.066)	.681	.663	54.5°
.2	2	.585 (.146)	.648	.655	53.2°
	3	.682 (.076)	.731	.675	54.9°

The effect of arbitrarily increasing the lens opening without changing the filter design was examined for the case of the f/4 opening with filter distance of 0.9 inch. The immediate result is of course that color separation is no longer complete, but the study is complicated by the fact that different points in the image plane are affected differently. Data are plotted in Figure 10 for five image plane locations: the center and the four corners of the raster. Each curve is a plot of instantaneous relative illumination at the image point as a function of filter wheel angular position. For each image point there are three curves: the solid curve for an f/4 illumination cone, the dashed curve for an f/3 illumination cone, and the dot-and-dash curve for an f/2.26 illumination cone. The phase of the filter wheel angular position coordinate was established for each point to compensate for the fact that the active scan line passes the different points at different times; the result is that the beginning and end of each curve correspond to the times that the scan line passes the point under consideration. When two curves occur near the beginning or end of the time plotted, it means that the point is illuminated simultaneously through two different filter segments.

Associated with each of the fifteen curves in Figure 10 is a set of three numbers separated by slashes. These three numbers represent, respectively, the integrated exposure of the point under consideration to energy transmitted through the preceding filter, the desired filter, and the following filter. The first and last numbers are therefore a measure of crosstalk, while the middle number is a measure of exposure to desired energy. The numbers used here are on the same scale, and therefore directly comparable, with the numbers for overall efficiency given in parentheses in Tables 2, 3, and 4.

As would be expected, the first and third numbers are always zero for operation at f/4, since the configuration was designed for complete color separation at this lens opening. However, even at f/3, the first and third numbers are significantly non-zero at only one of the five image points, this being the raster corner nearest the filter wheel axis. This means that image plane illumination can be almost doubled (0.028 vs. 0.016) at the cost of only a slight-probably negligible-amount of color crosstalk in one corner of the picture. The effects of further increasing the aperture to f/2.26 are clearly more severe in terms of color crosstalk, but until a definite upper limit on crosstalk is established, it is not certain that even this amount of crosstalk will degrade the color performance significantly.

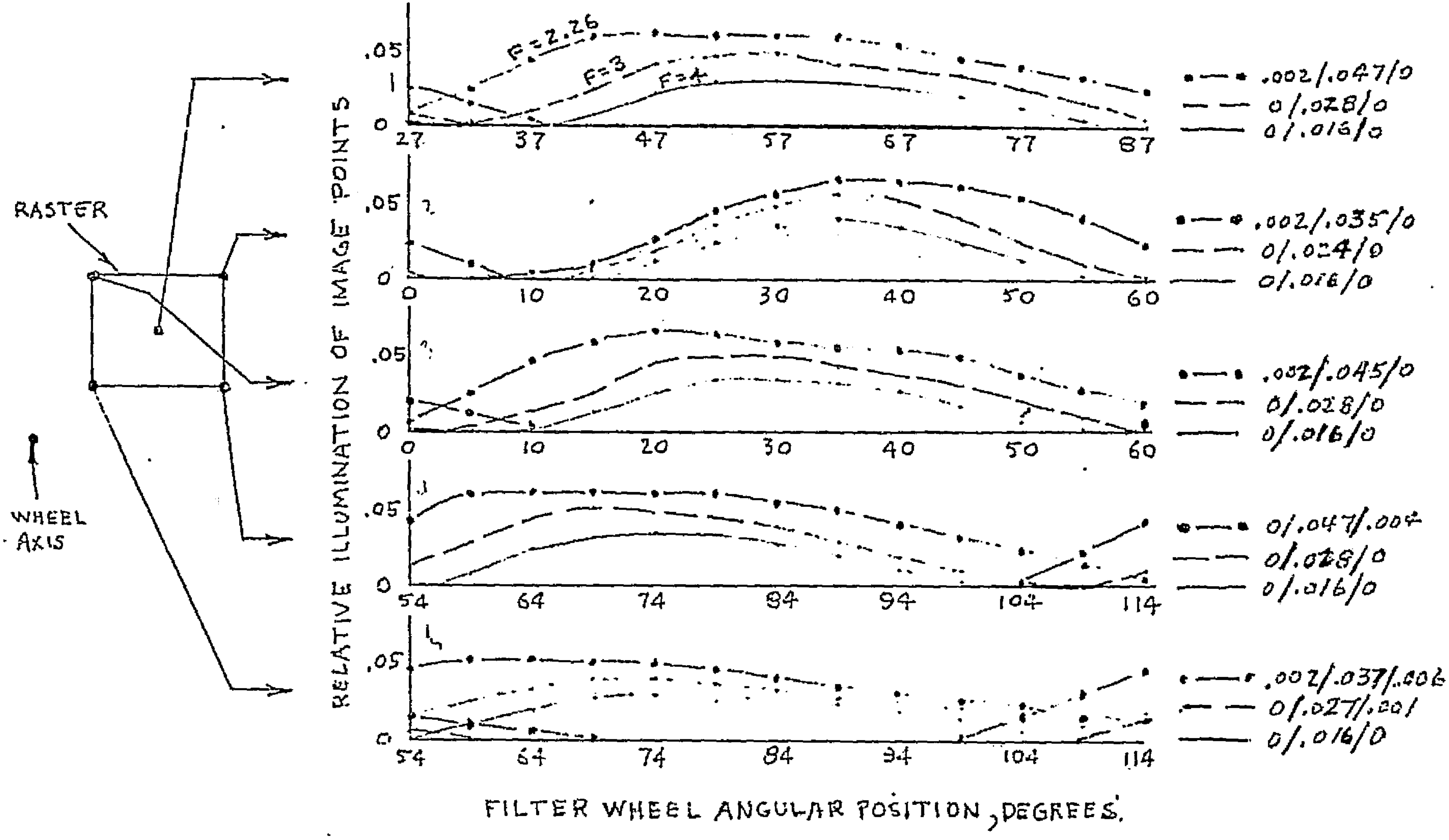


Figure 10. Effects of Increased Lens Opening (0.9" Spacing)

It should be noted that crosstalk may be reduced by use of smaller mask openings in the two channels which provide excessive radiant input. In that case, the results presented would be representative of red crosstalk into blue and green channels, but would be pessimistic for crosstalk from blue and green channels into the others.

The effects of misplacement of the filter wheel axis relative to the raster (errors in angle P of Figure 7) were also investigated. For the wheel designed to operate with an f/4 lens opening at a distance of 0.9 inch from the image plane, errors in this angular setting of 10 degrees in either direction produce shading (due to misalignment with the apertures) no greater than 4%, and crosstalk does not exceed 4%. For the filter wheel designed to operate with an f/2 lens opening at a distance of 0.2 inch from the image plane, 10 degree misalignments may produce shading errors as large as 15% and crosstalk as large as 10%; but for 5 degree errors in either direction neither of these errors will exceed 5%.

C. FINAL DESIGN

As will be shown in the lens selection/interface section, the effective "C" mount separation can be reduced to 0.6". The closest anticipated separation will be established by the sensor faceplate thickness with added mechanical clearance. For a silicon sensor, the effective optical distance from faceplate to focal plane is 0.113". A design value of 0.15" was chosen to provide mechanical clearance.

The filter wheel aperture dimensions were designed to accommodate the closest anticipated wheel/sensor spacing; mask overlays will provide the required shaping for increased spacing and/or transmission trimming.

Masking aperture shapes and geometry were calculated for the two limiting cases. Figure 11 shows the required shape for condition one (0.15" spacing). The calculated offset angle between the wheel axis and the optical axis is 59.1°, and the offset dimension is 0.750". The angular separation between the upper and lower boundaries is 41.85°; therefore, the optical efficiency can be calculated by comparison to the maximum aperture (60°):

$$\frac{41.85}{60.00} \times 100 = 69.75\%$$

The corresponding shape for condition two (0.6" spacing) is shown in Figure 12. The offset dimension (0.750") is unchanged; however, the required offset angle is now 64.9°. The angular efficiency for this case is:

$$\frac{22.66}{60.00} \times 100 = 37.8\%$$

Since the offset angle is different for the two cases (and for any other case between these two limits) an adjustment method must be provided. The housing design has been made circular to permit rotational adjustment after seating the "C" mount thread. This same adjustment can be used to accommodate the required offset difference angle by aligning the front housing to a different reference mark. For the optimized interface situation, it is assumed that the front housing will be fitted with a quick-disconnect bayonet mount, the separation distance will be fixed, and therefore no angular offset adjustment is required.

An additional consideration is the relative phasing of the filter wheel and the mask shape. The filter wheel opening, shown in Figure 13, was calculated to encompass the mask shape for the two limiting cases. The horizontal line at the top

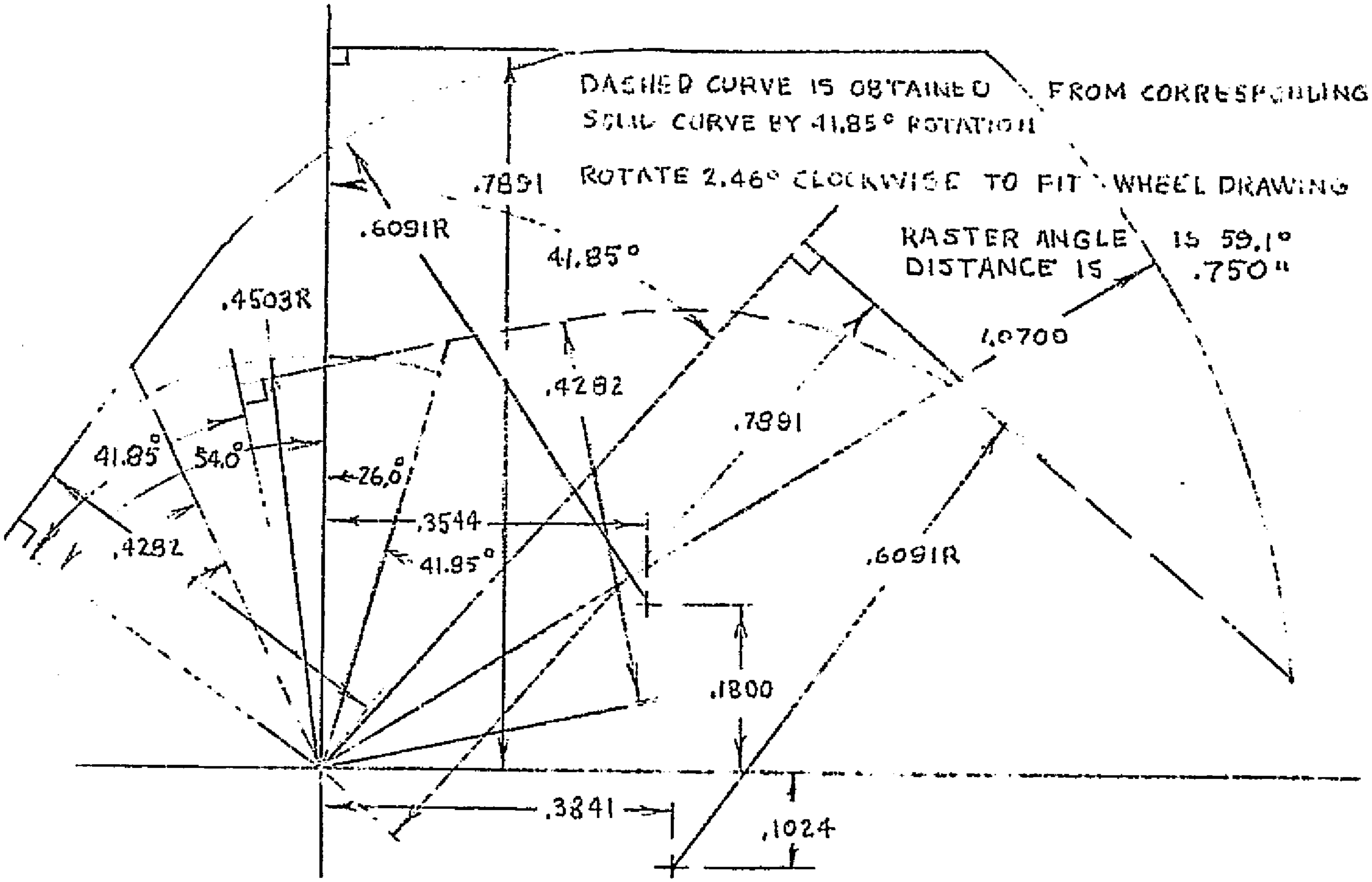


Figure 11. Mask Apertures, 0.15" Spacing

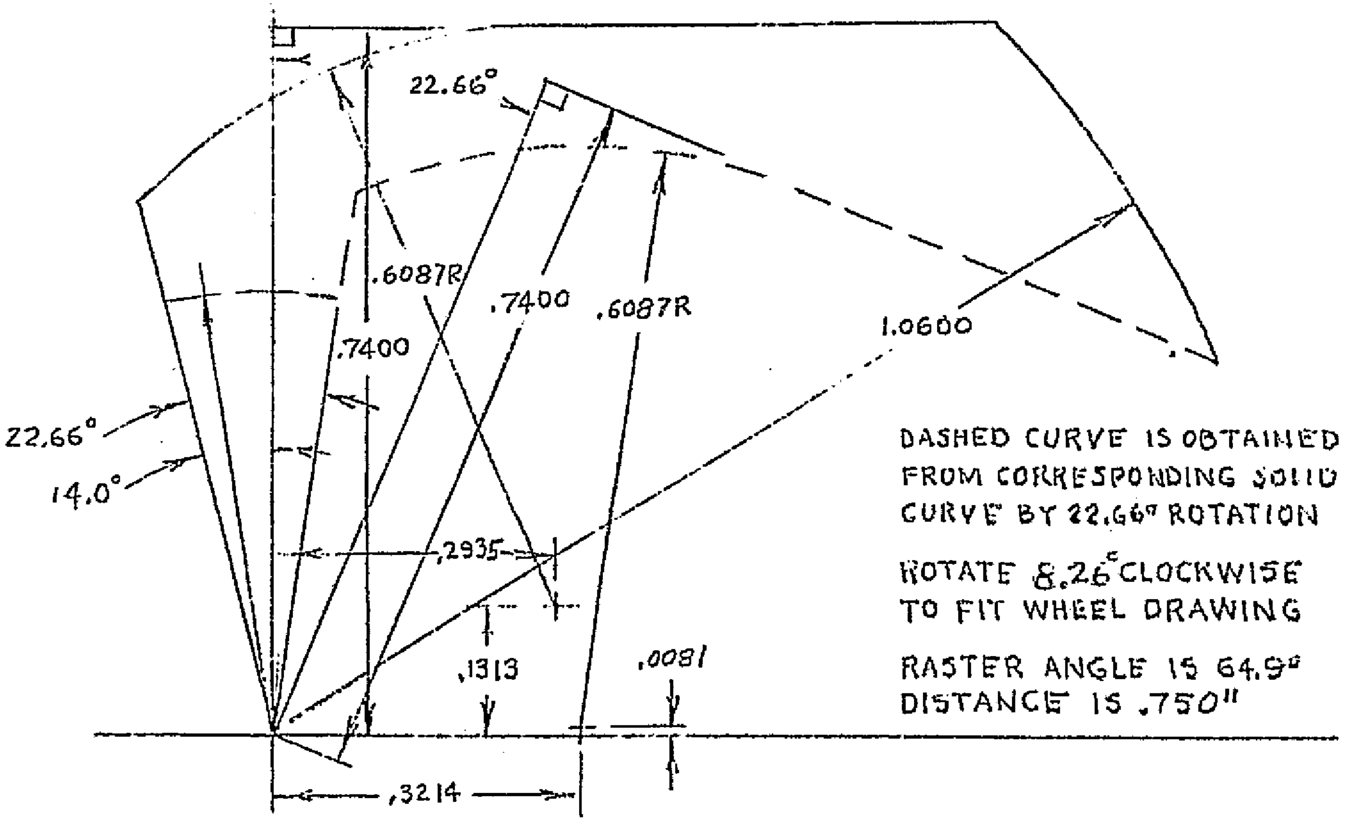


Figure 12. Mask Aperture, 0.6" Spacing

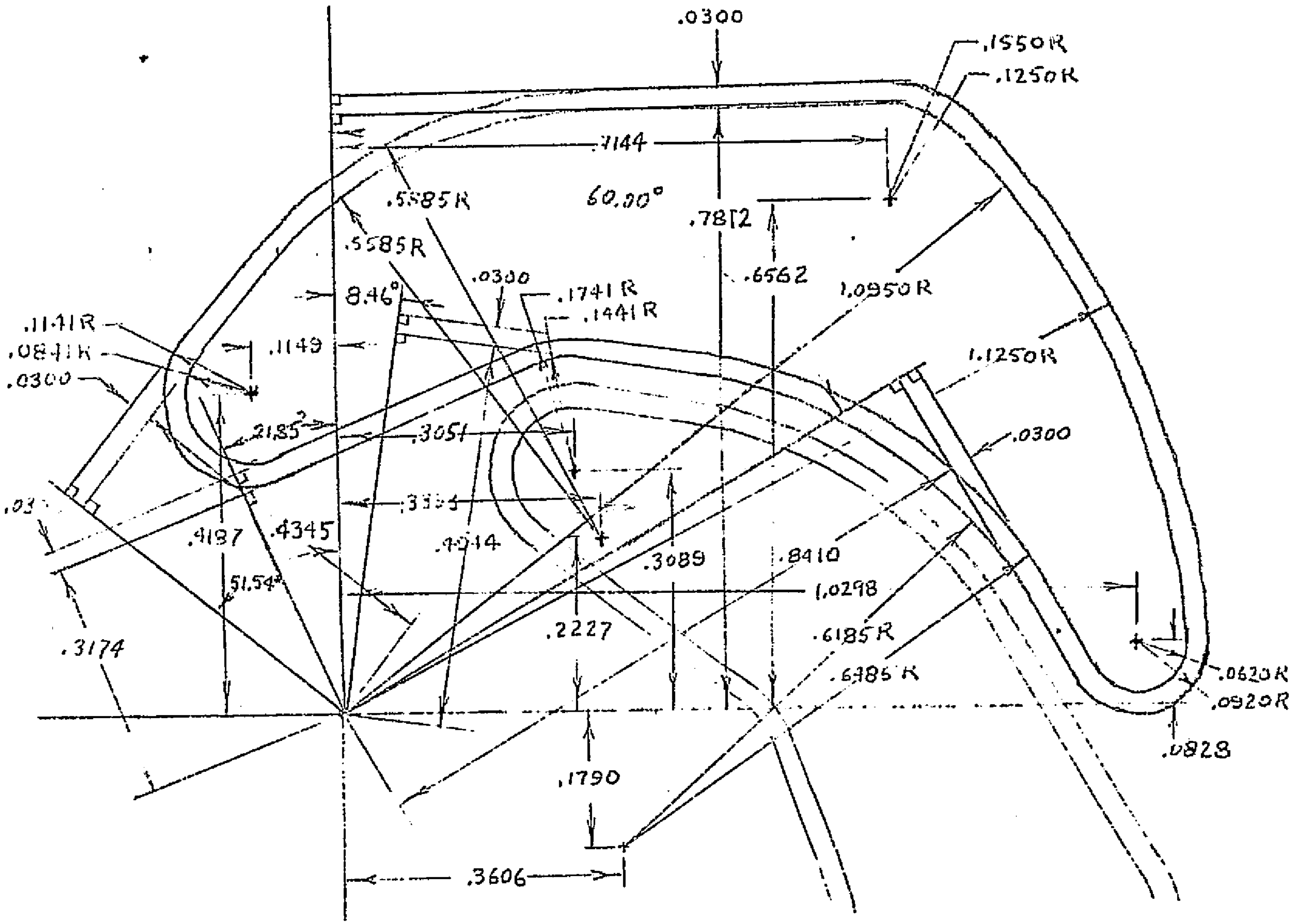


Figure 13. Filter Wheel Aperture

of each mask is designed to be parallel to the scan line at the top of the raster. To insert the 0.15" mask in the wheel aperture, while maintaining nominally symmetric clearance between the mask aperture and the wheel aperture, its reference axes are rotated 2.46° clockwise. This establishes a reference location for the wheel phase detector. If the housing (which contains the phase detector) is now rotated, to adjust the angular offset corresponding to a different aperture/sensor spacing, then the relative phase with respect to the horizontal mask line is similarly rotated.

In turn, this rotation could be corrected for by requiring a different nominal position of the wheel phase detector. Since the phase detector position is adjustable to compensate for system tolerances, additional adjustment range could be provided. An alternate method is to provide the compensating adjustment in the initial insertion of the aperture mask. This eliminates the requirement for readjusting the nominal phase detector position. Following this procedure, the 0.6" mask axes are thus rotated by 2.46° + (64.9° - 59.1°), or 8.26° clockwise. Figures 14 and 15 show the two filter masks inserted in the filter wheel openings at their respective angles.

In addition to the nominal mask shapes shown, additional masks are provided, for which the upper and lower boundaries are brought closer together while maintaining the same relative shape. This permits fine trimming of the relative sensitivity of each of the three spectral bands. Coarse balance is provided by using neutral optical density filter segments located in the rear face of the filter wheel.

D. LENS AND "C" MOUNT CONSIDERATIONS

The basic specification for a "C" mount lens interface is defined in USA STD PH22.76-1960. The parameter of importance

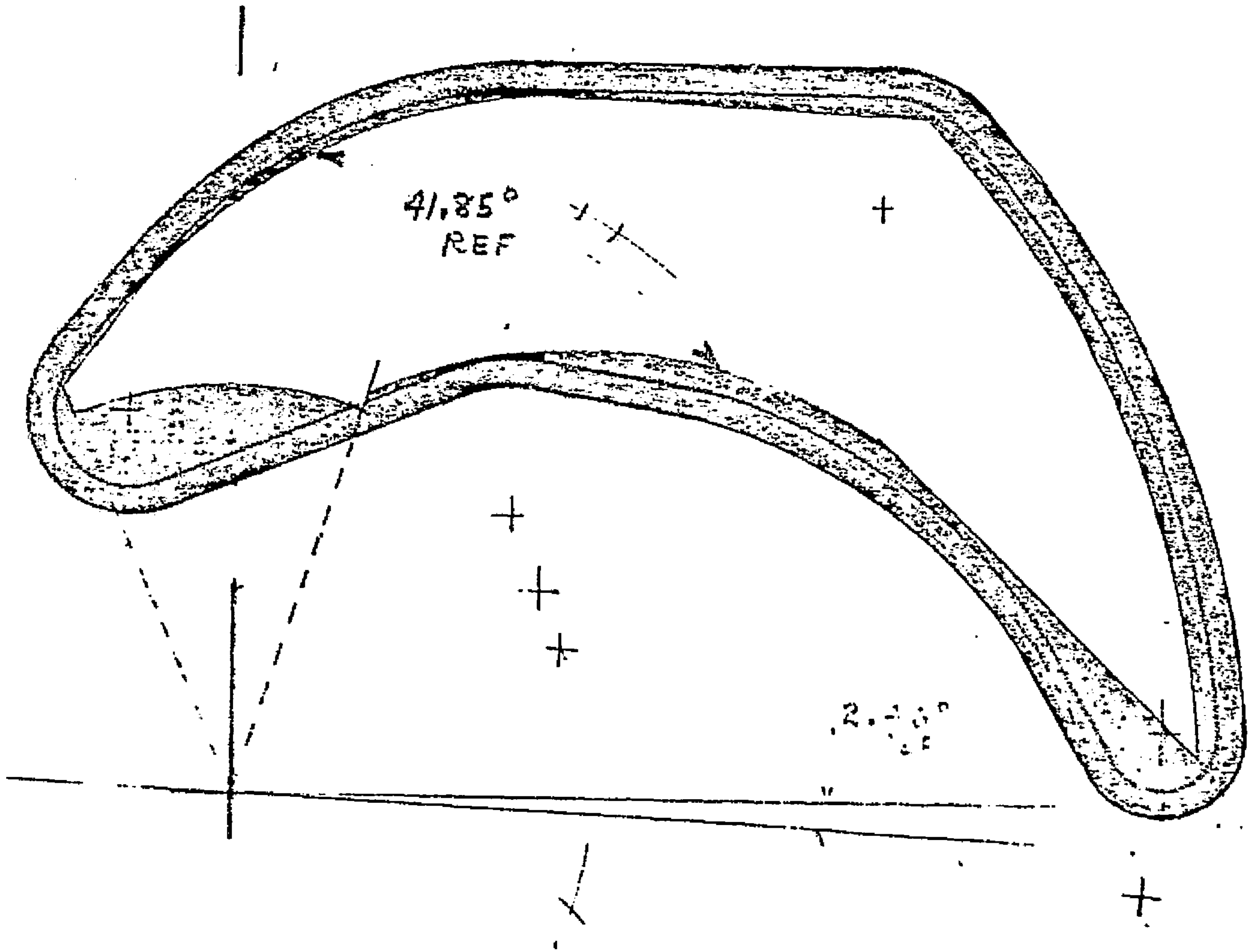


Figure 14. 0.15" Mask, Inset in Wheel Aperture

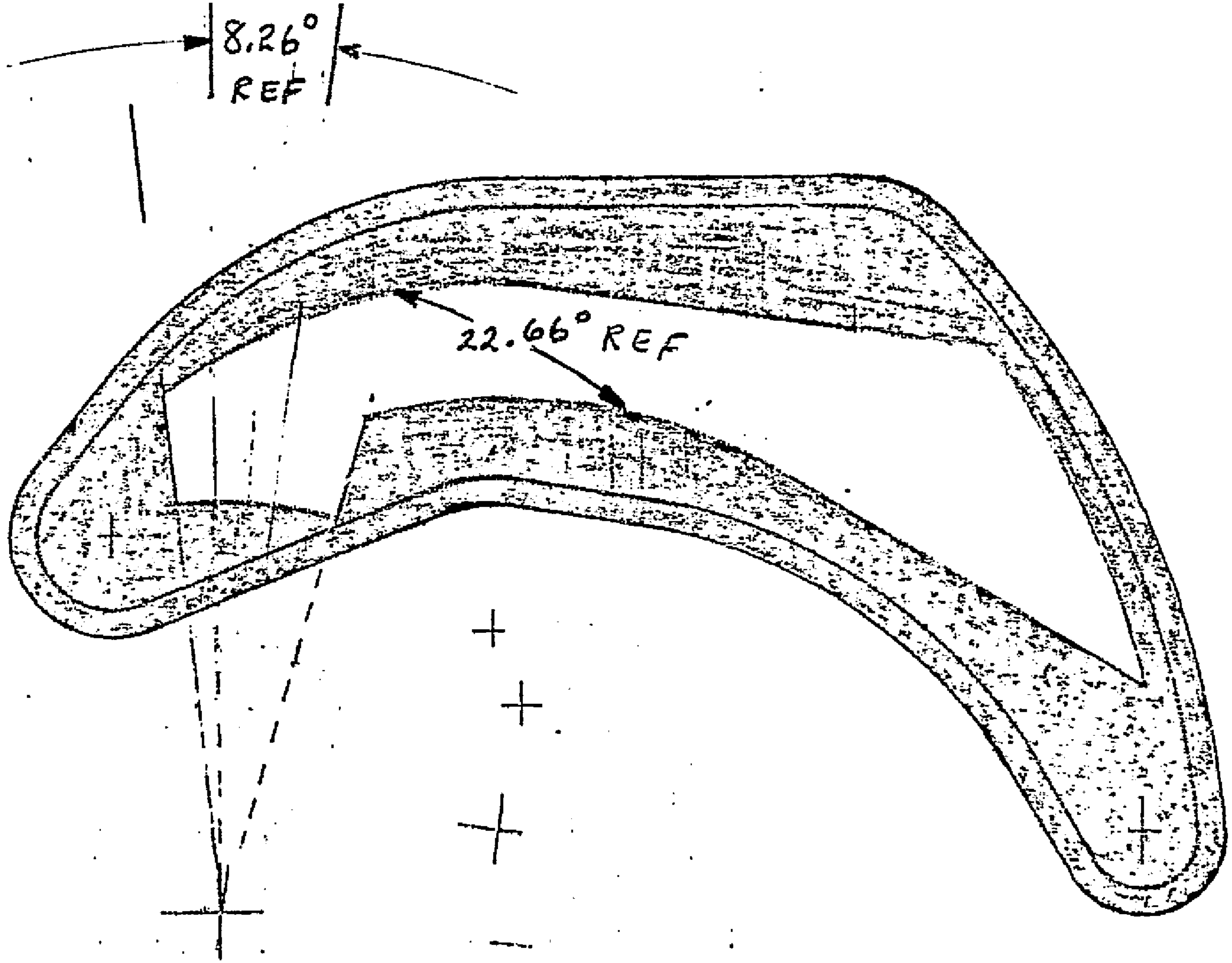


Figure 15. 0.6" Mask, Inset in Wheel Aperture

for this application is the focal distance from the mounting flange to the focal plane which is specified as 0.690° (17.5 mm). Therefore, any camera designed to accept a standard "C" mount lens will have its front flange seating surface set at this exact dimension from the sensor focal plane.

When we attach a color wheel module to such a camera, it must lie forward of the 0.69" dimension. Since many existing cameras do not include provisions for axial adjustment of the sensor focal plane we conclude that the lens used with such a system must be such as to provide a mechanical back focal length of 0.69" plus the thickness of the module. This represents a significant constraint in the choice of a suitable available lens. Further, as discussed in depth in the filter wheel design section of this report, increasing the filter aperture to sensor focal plane spacing imposes a decreasing limit on achievable optical throughput efficiency.

The program objectives to be considered in the lens selection are as follows:

(a)	IRIS	F/2 to F/22
(b)	Focal Length	12 MM to 75 MM (9° - 56° FOV)
(c)	Focus	1 Ft to Infinity
(d)	Format	0.625" Diagonal
(e)	Back Focal Distance	> 1.5"
(f)	Controls	Adaptable for Remote Drives
(g)	Construction	Space Qualifiable Design
(h)	Interchangeability	Lens/Wheel Assembly With Other Commercial Lenses

A survey of existing lens designs was performed to permit selection of an optimum match between the objectives and available designs. The assembled lens data is shown in Table 5. The Angenieux 13-78 mm lens initially appeared to be an optimum selection in terms of parameter compatibility. Further investigation showed; however, that this design is not yet in full production. An engineering model and two prototypes have been delivered for evaluation. Within the next year tooling will be completed and production models made available. This was not compatible with the present program delivery requirements; however, this lens should be considered for future applications. The best alternate selection appears to be the Angenieux 15-90 mm lens which is similar in design to the 12.5-75 mm version which was space qualified on the GCTA program.

In adapting the finished design of the field sequential lens assembly to future space cameras, it can reasonably be anticipated that they can be designed with the sensor mounted flush with the front camera flange. This allows maintaining close sensor to filter aperture spacing (with attendant increase in throughput efficiency), and relaxes the lens back focal length requirement. Since we desire to use the assembly initially with unmodified "C" mount designs, we have explored means to minimize the effects of the 0.69" flange to focal plane distance. Consider Figure 16 which shows the geometry involved. Rays "A" and "B" represent the limiting rays from the exit pupil of the lens as illustrated in Figure 1 (for simplicity of illustration, ray "A" is shown here horizontal; this does not affect the results). If we insert in the optical path a parallel face glass plate (Item 1) with the index of refraction n', incident rays will be deviated according to their angle of incidence. Ray "B" shown dashed represents the undeviated path without the glass plate. Ray "C" shows the path for a similar ray brought to focus at point P, with the glass plate inserted.

TABLE 5. LENS SELECTION

LENS PARAMETERS							
For-Mat	Focal Range MM	f.#	Mfr.	Field Angle	Near Focus Inches	Weight	Dia x Len Inches
16	17 - 68	2.2 - 22	Angenieux	41° - 11°	48	14 oz	2.05 - 4.55
16	12.5 - 75	2.2 - 22	Angenieux	54° - 9° 30'	48	1# 3 oz	2.32 - 6.2
16	9.5 - 57.5	1.6 - 22	Angenieux	68° - 13°	24	1# 13 oz	2.67 - 7.48
16	9.5 - 95	2.2 - 22	Angenieux	68° - 7° 30'	30	3#	3.5 - 8.95
16	12 - 120	2.2 - 22	Angenieux	56° - 6°	60	1# 14 oz	3.0 - 7.7
16	12 - 240	3.5 - 22	Angenieux	56° - 3°	60	4# 2 oz	3.94 - 9.8
16	13 - 100	2.0 - 22	Pan Cinor			4#	
16	12 - 120	2.2 - 22	Canon	56° - 6°		2# 3 oz	
VID	25 - 100	1.6 - 22	Canon		48	2# 10 oz	3.15 - 7.0
VID	15 - 120	1.3 - 22	Canon		60	8-5#	5.12 - 9.3
VID	15 - 150	2.8 - 22	Canon		60	2# 5 oz	3.2 - 7.3
VID	15 - 170	2.5 - 22	Canon		77	6# 4 oz	4.6 - 8.6
VID	16.5 - 95	2.0 - 22	Canon		60	2# 2 oz	3.0 - 7.1
VID	17 - 85	1.8 - 22	Pan Cinor				
VID	20 - 100	2.1 - 22	Pan Cinor				
VID	25 - 125	2.6 - 22	Pan Cinor				
VID	17 - 130	2.5 - 22	Pan Cinor				

TABLE 5. LENS SELECTION (Continued)

LENS PARAMETERS (Continued

For-mat	Focal Range MM	f.#	Mfr.	Field Angle	Near Focus Inches	Weight	Dia x Length Inches
VID	30 - 150	2.7 - 22	Wollensak			6.5# w/Motors	
VID	16 - 80	2.0 - 22	Schnieder				
VID	20 - 100	2.4 - 100	Schnieder			3#	
VID	25 - 150	3.5 - 22	Elgeer			3# 12 oz	
VID	20 - 80	1.8 - 22	Elgeer			2#	
V	16 - 160	1.6 - 22	TTH			17#	
V	16 - 160	3.2 - 22	TTH			5#	
V	Varitol 20	2.2 - 22	TTH			Large	
V	20 - 80	2.5 - 22	Angenieux	43 - 12	48	14 oz	
V	15 - 90	2.5 - 22	Angenieux	55 - 10	48	1# 7 oz	
V	12 - 120	2.6 - 22	Angenieux	67 - 7° 30	30	3#	
V	15 - 150	1.9 - 22	Angenieux	55°-6°	60	2#	
V	25 - 250	3.2 - 22	Angenieux	35 - 3° 30'	60	6#	
V	15 - 300	4.5 - 22	Angenieux	55 - 3°	60	4# 7 oz	
V	13 - 78	2.2 - 22	Angenieux	68°- 13°	24	3#	
V	18 - 130	2.2 - 22	Zoomar		48	4#	

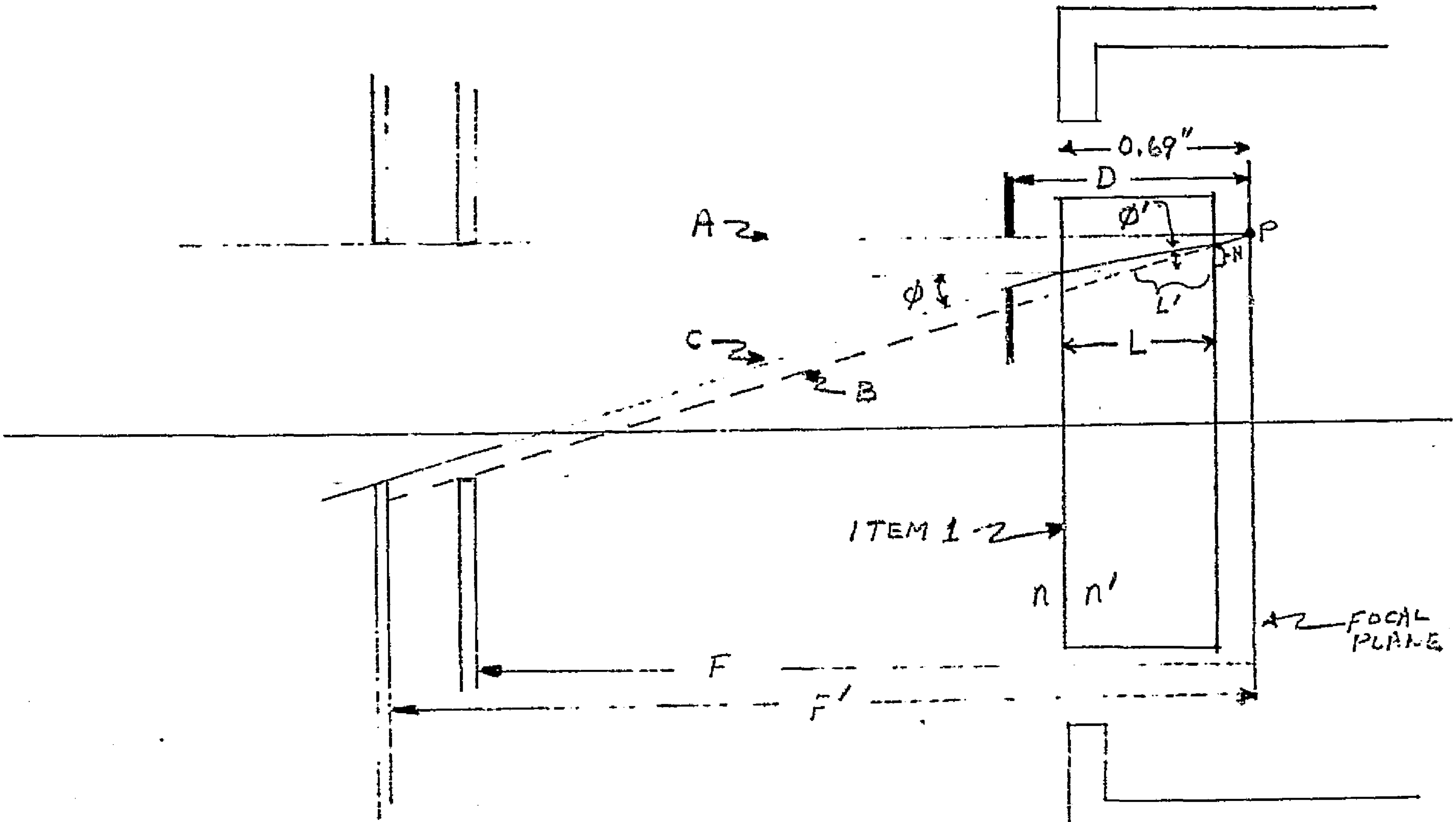


Figure 16. Geometry With Included Glass Plate

We calculate the effective length L' as follows:

$$H = L \tan \phi' \tag{1}$$

$$H = L' \tan \phi \tag{2}$$

so $$L' = \frac{L \tan \phi'}{\tan \phi} \tag{3}$$

$$L' = \frac{L \sin \phi'}{\sin \phi} \frac{\cos \phi}{\cos \phi'} \tag{4}$$

Using Snell's Law ($n \sin \phi = n' \sin \phi'$), (5)

$$L' = L \frac{n}{n'} \frac{\cos \phi}{\cos \phi'} \tag{6}$$

For small angles of ϕ (< 20°), $\cos \phi/\cos \phi'$ is greater than 0.97 and can be approximated by 1.0. Then Equation (6) can be simplified to:

$$L' = L \frac{n}{n'} \tag{7}$$

Typical optical glass index of refraction n' is 1.5. Thus, the effective length L' with the plate installed is 1/1.5 or 2/3 of the length L without the plate. The insertion of the plate has two beneficial results for this application. First, the filter aperture position for a given mechanical distance D is effectively reduced by L/3. This permits designing a smaller masking width, thus increasing the throughput efficiency. Second, the effective mechanical focal distance F is increased by L/3, thus providing increased clearance for the mechanical components of the color filter wheel assembly.

This technique was employed in the final configuration of the module assembly. A compensating glass plate, 0.650" thick, with index of refraction of 1.523 was used to provide an effective separation (filter aperture to focal plane) of 0.6".

E. MECHANICAL DESIGN

Two basic mechanical concepts were studied during this program; namely, an edge driven color wheel using a "cartridge" type motor, and an integral rotor-wheel using "pancake" motor. Investigations have been pursued to establish the tradeoffs in selecting an optimum approach. Initially, the pancake motor system appeared to have the greatest number of advantages. Subsequent continuation of the investigations led to the recommendation of the edge driven system as representing the more optimum implementation. Layout drawings for both systems were generated. The pancake motor concept layout is shown in Figure 17, while the cartridge motor concept is shown in Figure 18. A sample of an existing design pancake motor was obtained from the vendor (Schaeffer Magnetics) for evaluation of magnetic interference and interface effects.

The relative comparison of significant elements between the two systems is as follows:

1. Pancake Motor System

   a. Advantages

      - Minimum number of bearings (2)
      - No gear passes

   b. Disadvantages

      - Significant magnetic interference with sensor (can be shielded)

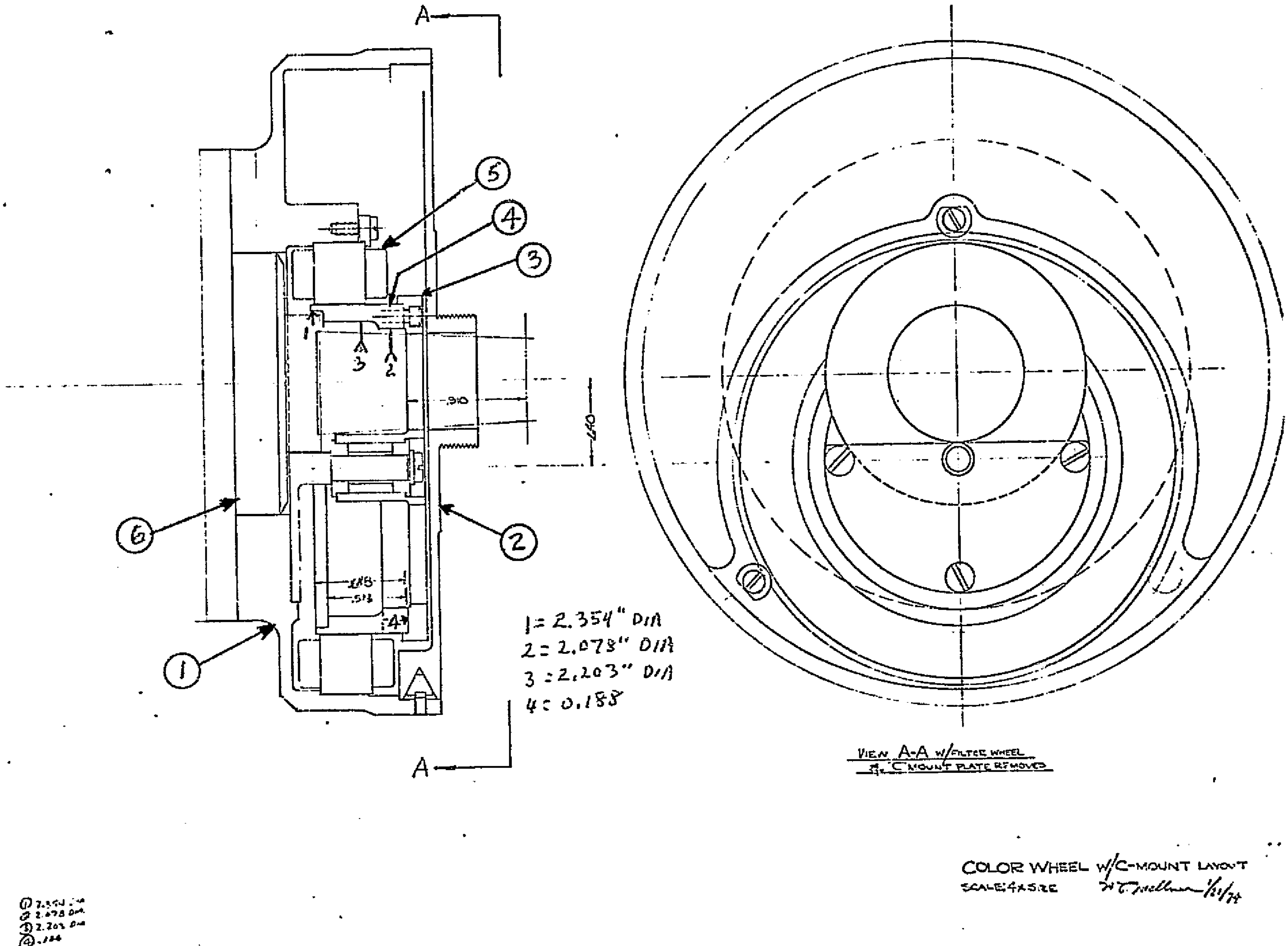


Figure 17. Pancake Motor Concept Layout

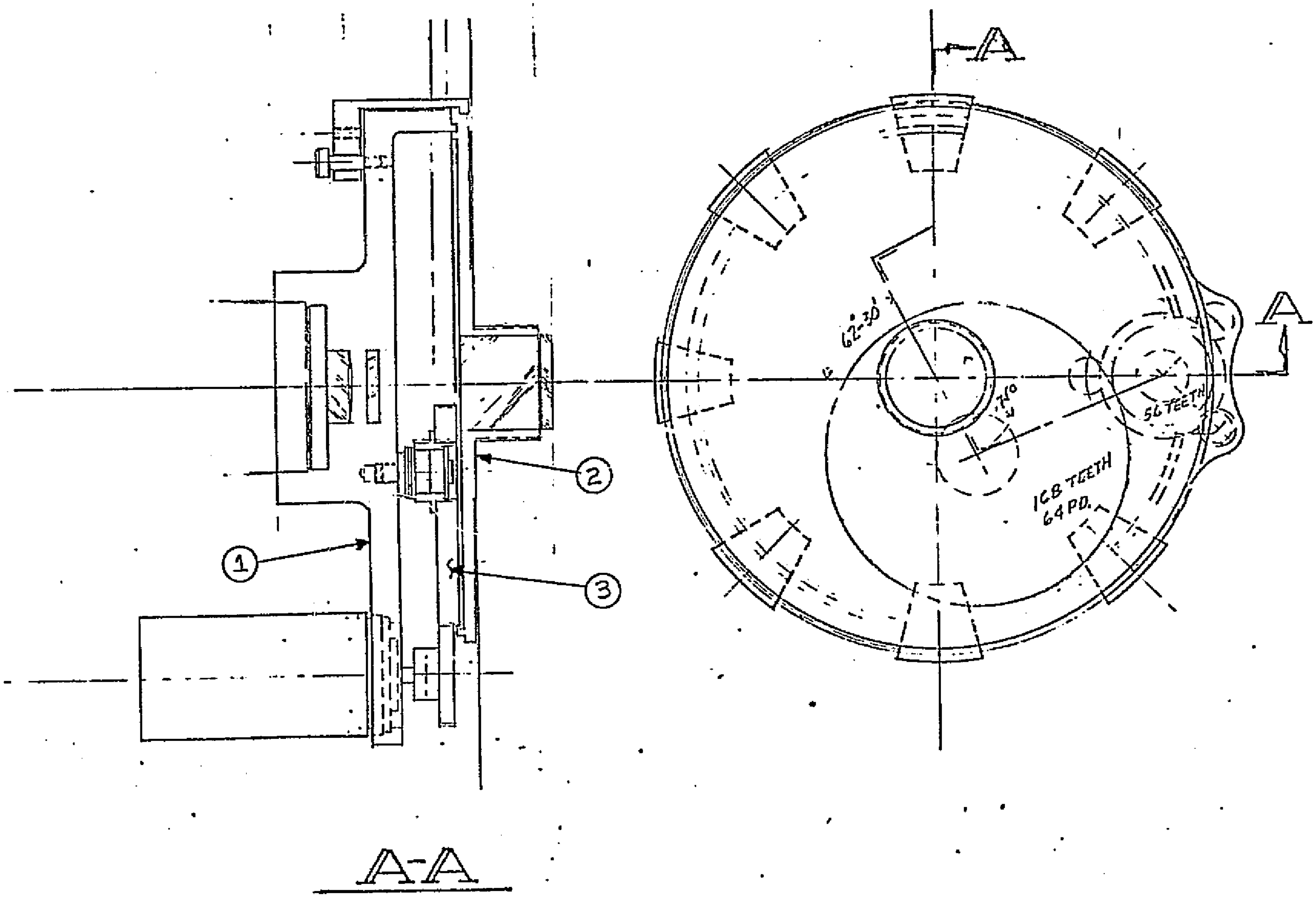


Figure 18. Cartridge Motor Concept Layout

- Possible magnetic interference if magnetic wheel position pickup used.
- Inflexible wheel diameter (constrained to available motor diameters).
- Large diameter of stator predicts greater weight.
- High motor vendor start up and repeat order unit cost.

2. Cartridge Motor System

   a. Advantages

   - No magnetic interference
   - Flexible wheel diameter (easily changed by new gear blank).
   - Lower weight
   - Motor start-up and repeat order unit cost significantly lower.

   b. Disadvantages

   - Two additional bearings
   - One gear pass

In addition to the above items, the fixed stator length of the available pancake motor is somewhat greater than the anticipated path length of the cartridge system. In turn, this tends to restrict the lens selection in terms of back focal length, although acceptable lenses have been identified. Operating power measurements on a sample pancake motor have also been somewhat greater than the equivalent cartridge motor, although this is not thought to be fundamental to the motor design. Experimental application of magnetic shielding to the pancake motor has reduced the interference effects to indiscernible levels; however, the cost is increased weight in the assembly.

Based on the above consideration the cartridge motor system was chosen as the prime candidate, and detailed design is based on this approach. The cartridge motor concept layouts show that the basic approach is feasible. If future applications were to justify the design expenditure required to overcome the shortcomings noted, it would be a viable approach.

Key items of the pancake assembly shown in Figure 17 are as follows:

1. Main Housing
2. "C" Mount Adapter
3. Filter Wheel
4. Hysteresis Ring Rotor
5. Motor Stator
6. Lens Mounting Flange

Items 1, 2, and 3 are similarly identified for the cartridge layout in Figure 18.

The angular position of the starting thread of the "C" mount is not controlled by specification, therefore, both layouts show a means for rotating the color wheel axis about the optical axis after seating the mating "C" mount thread. If the basic design is extended for future applications to a bayonet or other fixed position mounting attachment, the adjustment feature can be readily deleted without a major design change.

F. MOTOR SYNCHRONIZATION AND PHASING

The lens assembly is required to interface with standard cameras. It can be expected that such cameras can furnish "V" or "H" rate signals for motor sync reference but will not include provisions for adjusting the relative phase of the motor drive and a vertical field. Before proceeding with a final motor selection in terms of operating frequency and number of poles, we examined techniques for motor drive phasing to determine if any bounds need be placed on the selection.

Motor phasing techniques already developed, such as were used in the GCTA cameras (Contract NAS 9-11260) utilize a digital phase shift system to compare and adjust the relative phase of the color wheel and vertical blanking. When the motor sync system is included with the camera sync generator, the implementation was found to be straightforward for a particular value of motor frequency and number of poles (420 Hz and 8, respectively). For the present program the motor phasing system must be considered part of the lens assembly, operable from only the "V" or "H" reference.

The specific pancake motor under consideration was used as a test case; however, general conclusions are drawn from the results. The motor characteristics are:

36 Poles
180 Hz Input
600 RPM

$$1 \text{ pole pair} = \frac{360°}{18} = 20° \text{ shaft rotation}$$

$$1 \text{ pole pair} = 360° \text{ electrical drive shift}$$

Using the original GCTA phasing technique, 90° electrical shift would provide:

$$\frac{20}{360/90} = 5° \text{ position correction}$$

Assuming a six-segment wheel with phase references 180° apart, correction speed for a maximum initial error condition of 180° would be:

$$\frac{180°}{2 \times 5° \times 10 \text{ RPS}} = 1.8 \text{ seconds}$$

The original GCTA design utilized an 8 pole, 6300 RPM, 420 Hz motor with a 10.5/1 gear reduction. This design required 4.2 seconds for phase correction; however, the granularity of each correction step was 2.1° for a 90° shift of the voltage drive. The correction granularity represents a limit on the allowable unused area between wheel segments, and can be reduced by decreasing the amount of electrical shift for each correction step.

The shift is reduced from 90° to 45° by correction at double the original frequency. The tradeoff is in phase correction accuracy versus correction speed, which are in inverse ratio.

In selecting the sync rate to be used in the motor phase comparison, we must consider that the required motor drive frequency, while coherent with both "V" and "H" rates, is not necessarily an integral sub-multiple of the "H" rate. Therefore, a locked oscillator must be used to provide the reference frequency. Since the "V" rate is required for use in the wheel phase comparator it can also be used for the locked oscillator reference. Thus, only a single sync signal need be routed from the camera to the lens assembly.

A block diagram of the selected motor phasing system is shown in Figure 19. Required input signals are the camera "V" rate reference and the wheel position phase reference. The frequency dividers shown are for a 120 Hz motor. Other combinations can be accommodated by changing the division ratio. As shown, the pulse snatching for phase correction is performed at twice the minimum frequency, to provide 2.5P steps for each correction increment.

Using a cartridge motor and a 3/1 gear reduction at the rim drive, a motor speed of 1800 RPM is required. If the motor is designed with 8 poles, the input frequency is 120 Hz, and the block diagram is identical to Figure 19. If a 12 pole design is used, the input frequency required is 180 Hz. This can be achieved simply by changing divider "A" in the block diagram from a ÷3 to a ÷2. Similarly, other combinations can readily be accommodated by this system.

The detailed logic diagram for the color wheel motor control system is shown in Figure 20 and the related timing diagram is shown in Figure 21. Implementation of the logic functions was accomplished using CMOS logic elements to minimize power consumption.

With regard to the wheel position sensor, a number of different techniques were considered, as follows:

•	Optical	IR emitter and photodetector.
•	Magnetic	Hall effect packaged with amplifier.
•	Magnetic	Hall effect sensor and amplifier.
•	Magnetic	Permanent magnet - with induction coil - available with digital signal conditioning (di-Mag).

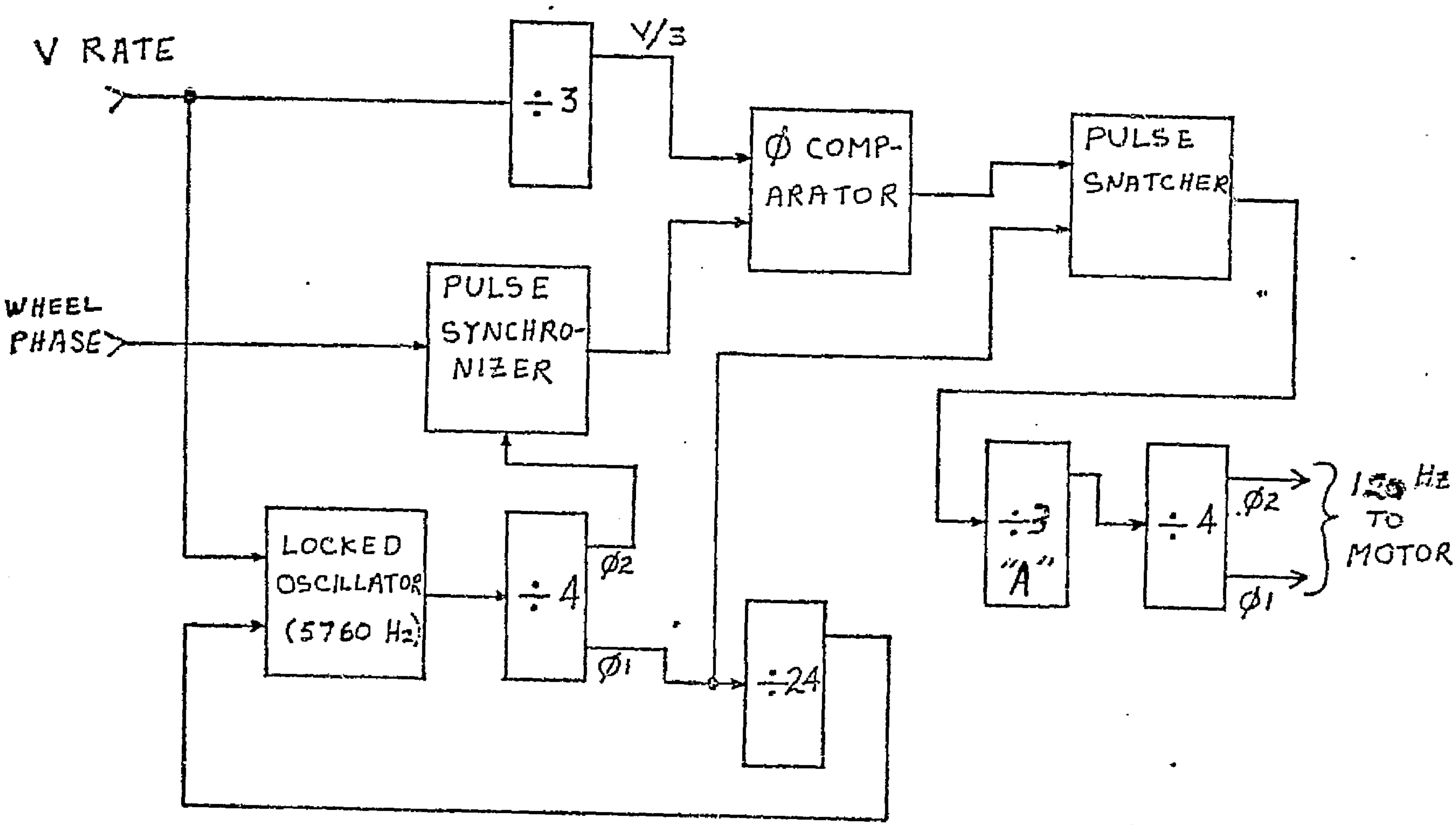


Figure 19. Color Wheel Logic Block Diagram

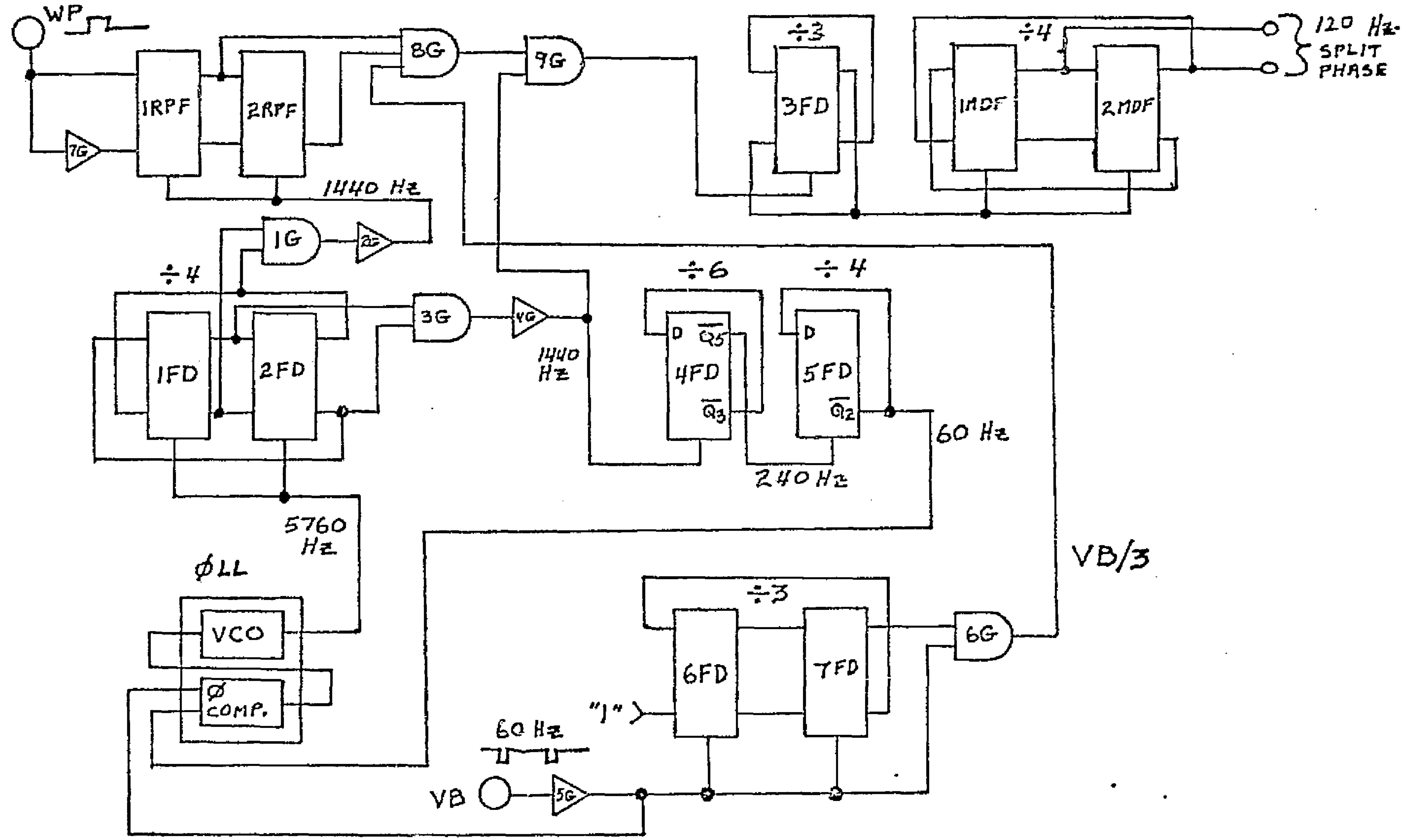


Figure 20. Color Wheel Motor Detailed Logic

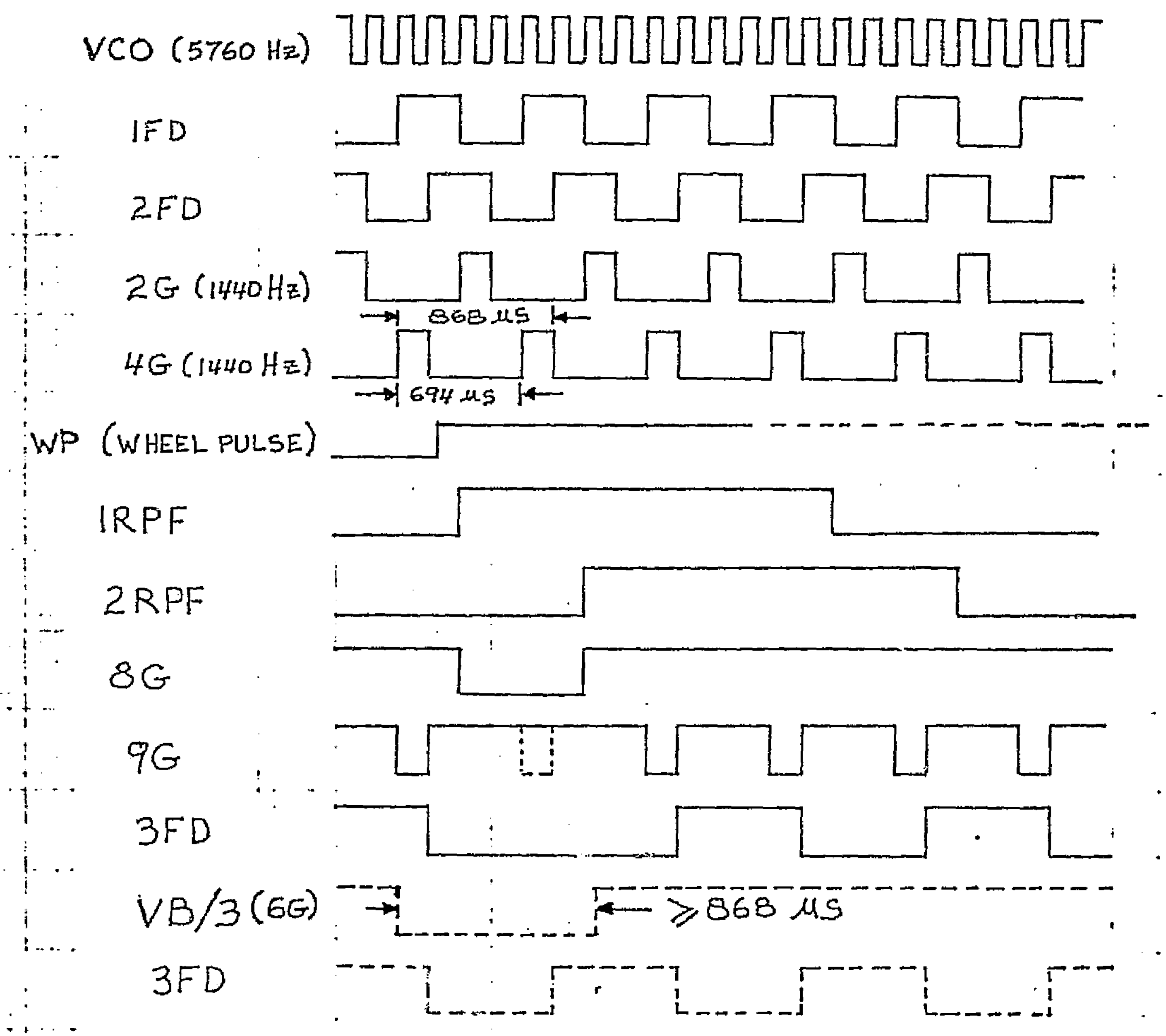


Figure 21. Color Wheel Motor Timing Diagram

The optical technique has previously been used to perform this function on the GCTA design. The most direct application is to place the source and sensor on opposing faces of the wheel. Since in the present design we are attempting to minimize the sensor/wheel spacing (to maximize throughput efficiency), it is undesirable to locate any portion of the phasing detector behind the wheel. It might be possible to overcome this problem by using a reflective optical technique; however, this is expected to be difficult to implement.

Hall effect devices have been applied as magnetic position indicators in brushless dc motor applications where the magnetic pole piece is inherent in the motor rotor. This technique could be applied here by installing a magnet near the perimeter of the wheel. Recently developed monolithic integrated circuits (e.g., Sprague ULN 3000M) contain a silicon Hall generator and integral amplifier in one small package. However, the Hall sensitivity of silicon is very low (33 mV/kilogauss) and an operating magnet strength of about 500 gauss is required. In addition to the problem of achieving this field strength in a small magnet, it raises the possibility of generating interference in the camera sensor. A GaAs Hall generator is approximately 100 times as sensitive as the silicon device; it could therefore be used with a proportionally smaller magnet. Such a device is not available in a single package; a separate amplifier would be required.

The final method considered is also magnetic, but requires only a ferrous metal perturbation (such as a soft iron slug) to generatore an output. It utilizes a small permanent magnet with a concentric induction coil. Passage of the ferrous metal past the pole piece creates an output by induction. Such a device, utilized in the final design, is available in a compact package with included digital interface conditioning under the trade name "Di-Mag", and appears to provide the greatest design freedom.

G. COLOR FILTER SELECTION

1. Introduction

The prototype lens assembly will be demonstrated with the MTI-55 TV camera employing a silicon vidicon. It is anticipated that the bulk of the demonstration as well as evaluation testing will be conducted in an indoor laboratory area where artificial lighting will be employed. This may well correspond to real world Shuttle usage where dark side of the earth operations will employ artificial lighting to permit some measure of direct observation as well as TV coverage.

When a combination usage is planned, a single, properly shaped, trim filter can correct a natural to artificial (or vice versa) condition. Since the case of artificial illumination is expected to require greatest overall system sensitivity, we used that case to compute the spectral filter characteristics, using a silicon target sensor. Provision is included for adding a separate color trim filter, in a holder attached to the front of the lens, to correct the relative R-B-G spectral sensitivities when natural illumination is used. The range of achievable individual filter passbands is large; however, the gamut of existing multi-layer film designs is considerably more restricted. The design is examined within the practical limits of existing interference filters.

Experimental determination of the optimum color wheel filter sequence was established early in the development phase of field sequential television in terms of the affect of image sensor lag. The optimum sequence was found to be R-B-G; that sequence was used for the present modular color wheel assembly development.

Complete details of the spectral filter tradeoffs are contained in the second Engineering Design Report previously submitted under this contract. Salient details are summarized here.

2. Reference Computation

In the process described in the following paragraphs, tungsten illumination at 3000°K is assumed. The colorimetry calculations then consist of cascading the spectral characteristics of tungsten, the sensor spectral responsivity, and all filters employed for spectral separation and ir rejection in each channel. Factors not considered but certainly contributory to color performance in a field sequential system are: incomplete erasure of sensor data in a single (1/60 second) scan due to scan line separation, and inherent retentivity of the target after scanning by the electron beam, i.e., lag. These factors, depending on the effective cross ection of the electron beam and the inherent characteristics of the silicon target, may be significant but are more simply treated experimentally.

A colorimetry reference was established by computing the spectral sensitivity of a high quality RCA broadcast camera. This camera employs three Plumbicons and is set-up for indoor operation with tungsten illumination, about 3000°K color temperature.

Spectral separation in this broadcast camera is accomplished with a dichroic prism. The overall spectral response for the three channels of this type camera is shown in Figure 22, where the peak response is normalized.

The numbers appearing under the curves of Figure 22 are normalizing factors required to provide equal peak response. Of course as adjusted in the camera for equal video amplitude on a neutral scene, normalization will require equal areas under the curves. Note that the green channel will have maximum and the blue channel minimum sensitivity.

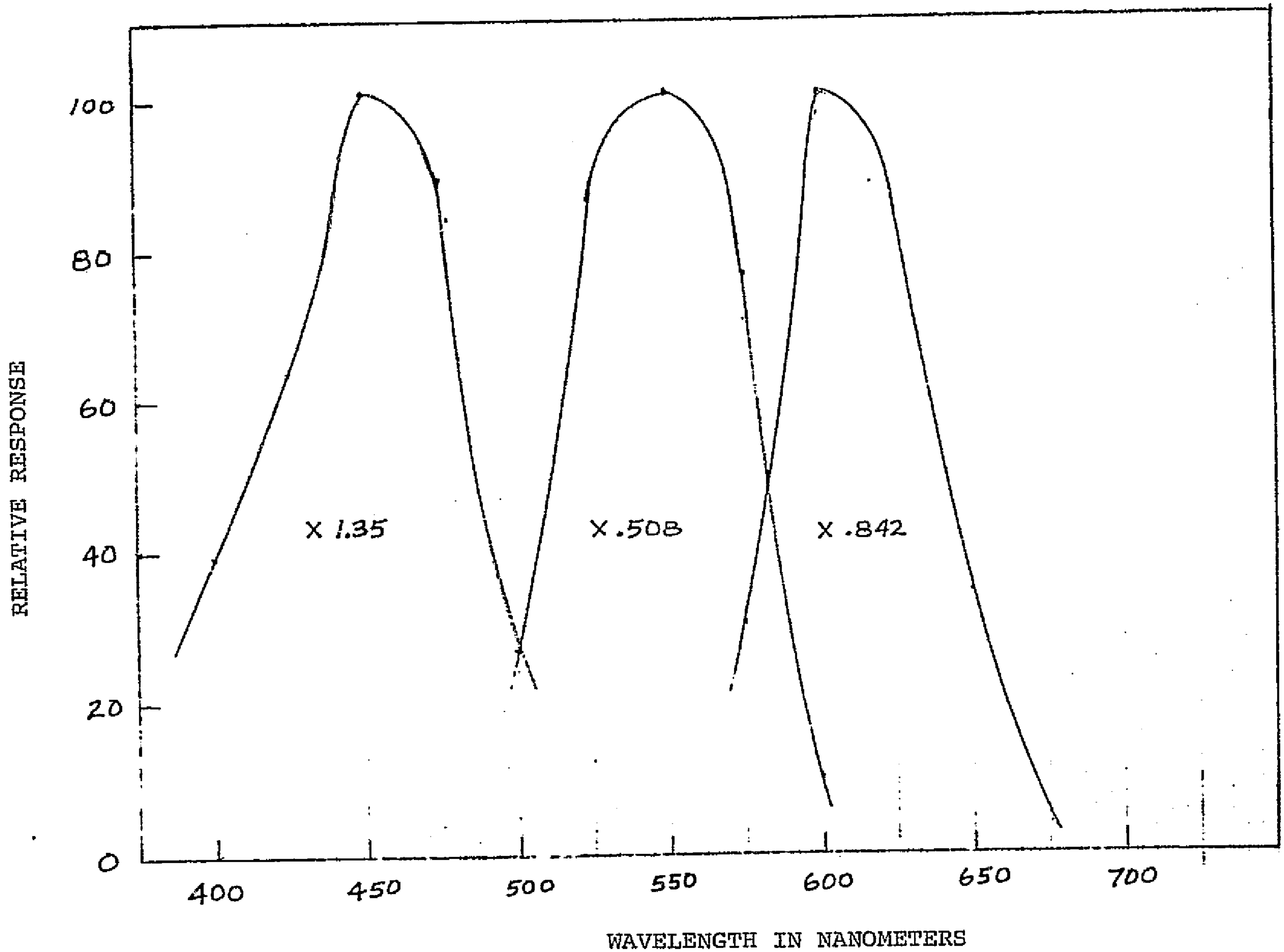


Figure 22. Overall Spectral Characteristics of Broadcast Camera

3. Color Filters for the Silicon Sensor

The RCA 4532 silicon vidicon has a spectral responsivity that is substantial over the entire visible spectrum and extending into the near ir. When cascaded with the 3000°K tungsten lighting the spectral response shows a continued rising characteristic towards the near ir region.

As a starting point the GCTA color wheel filters, cascaded with the 650 nanometer trim filter and ir rejection filter used on GCTA (RCA assembly drawing 2269728), were cascaded with the silicon at 3000°K response. As a direct result of the rising ir characteristics, the colorimetry of this type filter wheel, as used with silicon and artificial illumination, is considered unsatisfactory for several reasons. The blue channel response is too narrow causing a severe loss in sensitivity as well as poor blue color reproduction. The red response is too wide with excessive green channel overlap again leading to poor colorimetry.

As the next step at arriving at satisfactory colorimetry the red and blue filter characteristics were modified and a different ir rejection filter was assumed. The modified red channel was computed for a 590 nanometer short wavelength Schott glass, and a Fish-Schurman (F-S) 650 trim filter and Schott 1 millimeter HA-11 ir absorbing glass for long wavelength shaping. The characteristic of the ir absorption filter is particularly important when a silicon sensor is employed because of the extended long wave response of this type vidicon. The HA-11 response is less than 3 percent in the 800 to 900 nanometer range.

The computed blue channel response consisted of a F-S 495-C in cascade with a F-S ML-3025S for trimming. The HA-11 was not included in this computation since its effect on the blue channel is not significant. The 1 MM HA-11 was used for the green computation since it provides some band shaping in the long wavelength portion of the green spectrum.

The composite curves obtained were considered to be quite satisfactory from the colorimetry standpoint. Red-green crossover is comparable to that achieved with the high quality broadcast camera. The blue channel is somewhat narrow but is in the acceptable range. Normalizing factors (for equal peak response) are modest compared to that obtained with the original GCTA filter. Values of 1.0, 1.09, and 2.30 for the red, green, and blue channels respectively are indicative of the relative channel gain required, although adjustment will be made for equal areas rather than equal peak response.

As a final step in the filter specification process, an attempt was made to reduce the number of individual elements required. For this reason the 650 trim assumed for use in the red channel was replaced with the ML 3025-S used with the blue filter. Since this has the effect of extending the red response into the long wavelength end of the spectrum, the 1 MM HA-11 was replaced with the somewhat narrower 2 MM HA-11. The original GCTA green filter (RCA 2262639) was maintained. The overall spectral response of the camera is then as shown in Figure 23.

Note that the overall response is quite similar to that shown in Figure 12 although some slight narrowing of the blue channel has resulted and the red channel is somewhat more assymetrical. The peak response numbers are slightly closer together than before with the green showing the highest sensitivity. When the area normalization process is taken into account the red channel is most sensitive, with the green requiring 1.11 times and the blue requiring 1.97 times the gain of the red.

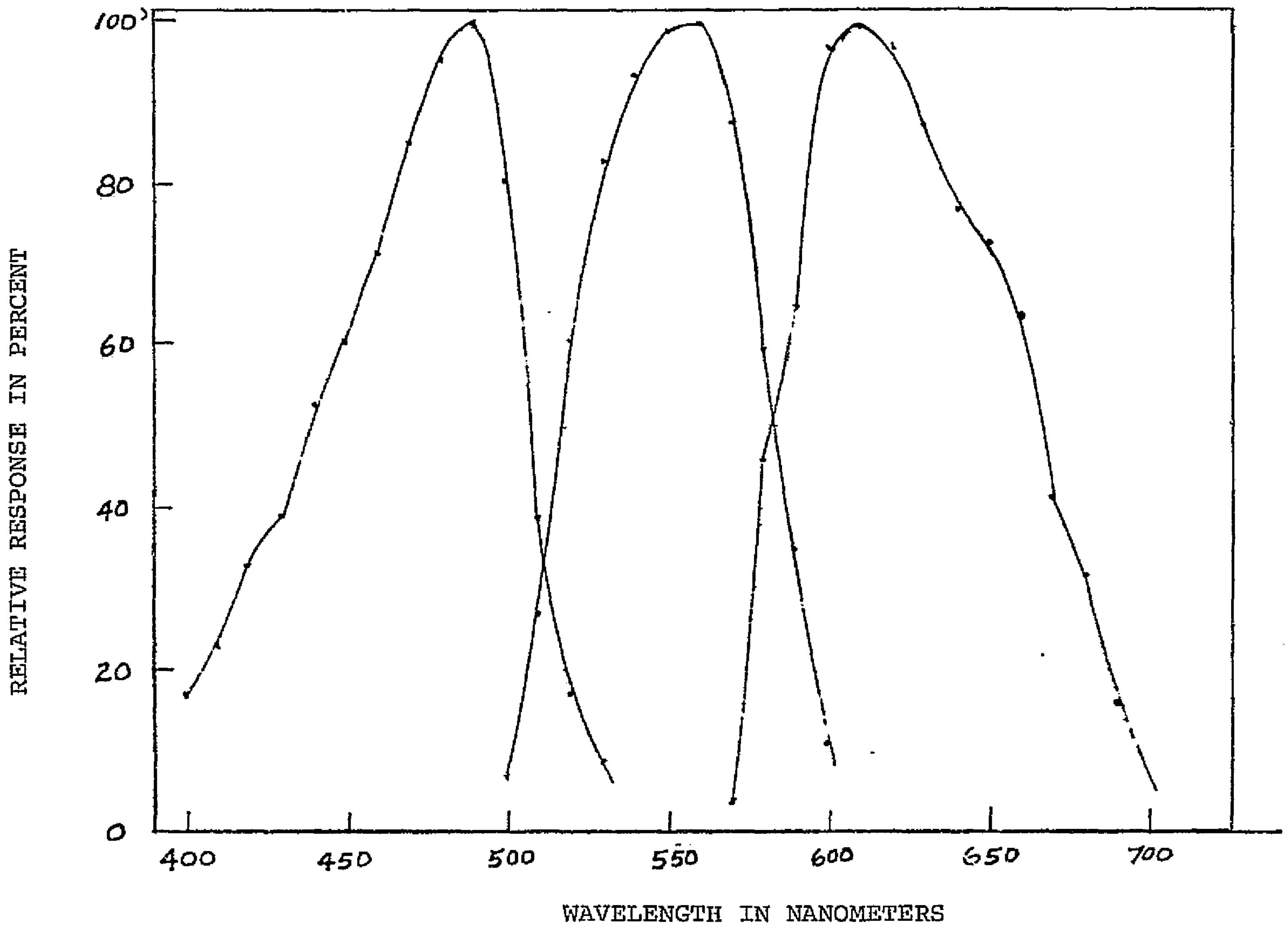


Figure 23. Final Version of Silicon Sensor Response With Revised Spectral Filters and 3000°K Illumination

The final filter specification then consists of a filter wheel with a red channel of Schott 570 glass, a green channel as specified for GCTA (RCA 2262639), and a blue channel of F-S 495-C. The specification control drawings for these filters (SK-2277732, 33, and 34) are included in the drawing section. The lens path will employ the F-S 3025-S trim filter and the 2 MM HA-11 ir rejection filter, (SK-2277746) also included in the drawing section. In addition, the red and green filter-wheel segments will incorporate .2 neutral density filters to aid in sensitivity normalization.

Further adjustment of relative gain is obtained by trimming the individual filter-wheel openings. (The trimming process is described in Section B of this report). If all filters are nominal the trimming adjustment will require a reduction by a factor of .81 for the red channel and .90 for the green channel.

H. WEIGHT ESTIMATE

The major component pieces of the color wheel module assembly are listed in Table 6. The associated dimensional drawings were used to calculate the predicted weight of each part by dividing them into geometric shapes. The calculated values are shown in Table 6, and are compared to measurements after fabrication. The front and rear housings will be fabricated of aluminum for the engineering model based on finish and handling considerations. The flight equivalent parts can be fabricated of magnesium with an attendant weight reduction of 35 percent.

I. PERFORMANCE DATA

After completion of fabrication and assembly of the color wheel module, a detailed test program was conducted to provide verification of performance parameters and/or comparison to the program objectives. Certain parameters, e.g., color crosstalk,

TABLE 6. WEIGHT BREAKDOWN

P/N	ITEM	CALCULATED UNIT (LABS)	CALCULATED SUB-TOTAL	MEASURED SUB-TOTAL	MTL
2283447-1	Rear Housing	.2378	.2378	.239	Al
2279971-1	Front Housing	.3517	.3517	.338	Al
2277726-1	Lens Retainer	.0858	.0858	.088	Al
2277718-1	Color Wheel Shaft	.0051	.0051	.0049	S.S.
2277722-1	Clamp	.0119	.0357	.0072	S.S.
2279958-1	Filter Wheel	.1156	.1156	-	S.S.
227773X-1	Filter Segment	.0037	.0441	-	Glass
2273224-1	Comp. Filter	.0287	.0287	-	Glass
58388	Magnetic Sensor	.022	.022	-	-
1971381-2	Motor	.217	.217	-	-
-	Hardware	.10	.10	-	-
2277717-501	Hub and Gear	.0194	.0194	-	-
	Color Wheel Assembly Total		1.2629		

Lens (6 x 15B) 1.167 lbs

Remote Function (100 grams each) .661 lbs are associated solely with the field sequential system. These were measured with the color wheel module installed. Other parameters, such as resolution, are common to the black and white system. These were measured with and without the color wheel module installed, and comparative data obtained. A test procedure (RCA TP-2279979) was generated to specify test methods and record data. The measured performance shows that the desired objectives have been satisfactorily achieved.

The more important data items are summarized below:

a) Resolution

Data was measured with the zoom lens attached directly to the camera, and then with the filter wheel module inserted and operating. The results are shown in Table 7.

TABLE 7. RESOLUTION DATA

RES LINE NO.	B&W	R-1	B-1	G-1	R-2	B-2	G-2
200	51	51	52	52	52	51	53
300	20	20	20	20	20	20	20
400	6	6	6	6	6	6	6

The deviations are negligible and within measurement accuracy, verifying that no resolution degradation is introduced by the filter wheel module.

b) Shading

Data was similarly obtained, with and without the filter wheel module. The results are shown in Table 8.

TABLE 8. SHADING DATA

POINT OF MEASURE-MENT	PERCENT B&W	SHADING FILTER MODULE
20% From Top	32	32.9
50% From Top	25.7	25.2
80% From Top	37	35.9
Vertical	14.9	14.9

Again, negligible change in shading performance is noted.

c) Video Field Balance

To verify the adjustment (trim) balance between the individual spectral filters, the data shown in Table 9 was obtained. The measurements confirm the ability of the filter aperture trim masks to be used in setting individual field signal amplitudes.

TABLE 9. VIDEO BALANCE

FIELD	P-P VIDEO (VOLTS)	% FROM NOMINAL
R 1	0.98	2
B 1	0.97	3
G 1	1.01	1
R 2	0.99	1
B 2	0.97	3
G 2	1.02	2

d) Jitter

The jitter caused by the rotation of the filter wheel is a measure of the parallelism achieved in assembling the individual filter segments to the filter wheel. An objective specification of 0.25 μs was established. Measurements showed no detectable jitter for five of the six segments. The sixth one measured 0.02 μs which is well within specification.

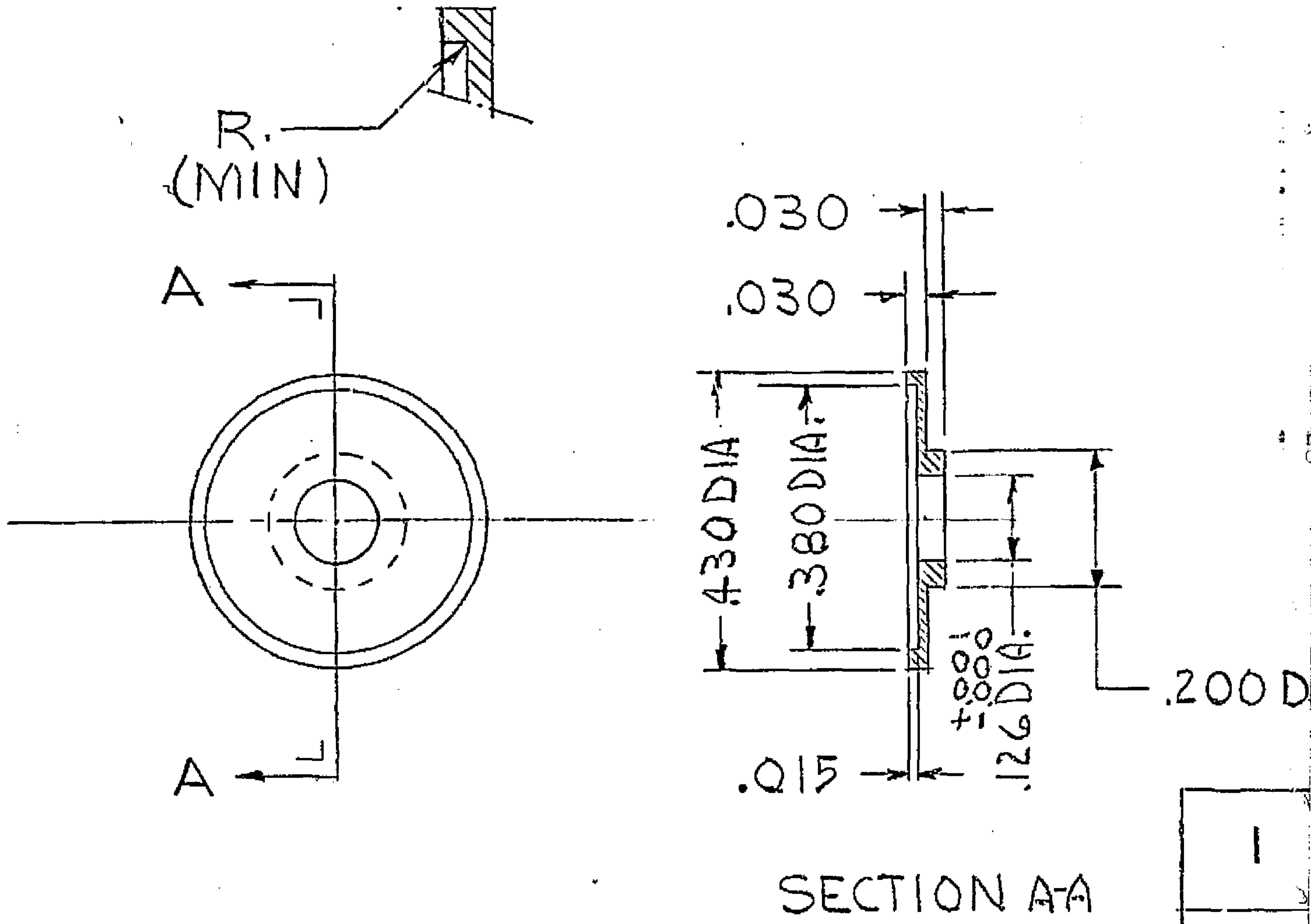
e) Filter Wheel Efficiency

The filter wheel efficiency was measured by recording the video signal for a particular color segment, with and without the wheel rotating. The previously calculated value for the 0.6" spacing case was 38 percent. The measured value was found to be 44 percent, slightly better than predicted. This difference may be attributable to tolerances in the mask fabrication, although the exact cause could not be determined.

SECTION III

ENGINEERING DRAWINGS

The following pages contain copies of the applicable engineering drawings for the various components and assemblies which constitute the color lens assembly and its associated control box.



NOTES

1. FINISH: PASSIVATE, 1980032

504	503	

CONTRA

COMMO

DRAWN

CHECKE

DESIGN

DASH N

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING.

TOLERANCES ON FINISHED DIMENSIONS UNLESS OTHERWISE SPECIFIED

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	±.02	±.005
ABOVE 6 TO 24	±.03	±.010
ABOVE 24	±.06	±.015

ANGULAR DIMENSIONS ±½°

SEE RCA PURCH SPEC FOR STOCK TOL

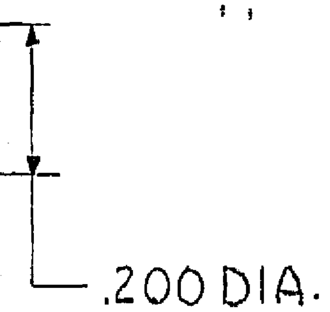
FIRST MADE FOR	
NEXT ASS'Y	USED ON
2263641-501	COLOR CAM.

~~ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING, AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.~~

RCA 577B/12-62 3000 PRINTED IN U.S.A. J. H. WEIL CO., PHILA., CRONAFLEX

SYM | WAS | 1974052

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVED



DASH NO	MATERIAL	SPEC.
1	ST. STL. ROD .438 DIA. QQ-S-763C CL.303 COND. A 2010521-50	8030020

MATERIAL SPECIFICATIONS

QTY REQD 504	QTY REQD 503	QTY REQD 502	QTY REQD 501	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

LIST OF MATERIALS

CONTRACT NO.	RADIO CORPORATION OF AMERICA CAMDEN, N.J. ASTRO ELECTRONIC DIV PRINCETON, N.J.		
COMMODITY CODE 5604	BUSHING, THRUST		
DRAWN J. Zanardini DATE Sept 12-69			
CHECKED R. Salm DATE Oct 15, 69	FOLDOUT FRAME 2		
DESIGN ACTIVITY APPD. DATE 16 Oct 69	CODE IDENT NO. 49671	SIZE B	1974052
	SCALE 4-1	WEIGHT —	SHEET 1 OF 1

ES AND LATING.
ENSIONS IED
3 PLACE DECIMALS ±.005
±.010
±.015
±½°
CK TOL

WAS

DASH NO.	MATERIAL BARDEN P/N SEE NOTE 1	DIMENSIONS (REF) BORE	O.D.	WIDTH	FLANGE O.D.	FLANGE WIDTH	LUBRICATION
1	SR2SSTA5	.1250	.3750	.1562	*	*	SEE NOTE 2
2	SFR2SSTA5	.1250	.3750	.1562	.440	.030	
3	SR2ASSTA5	.1250	.5000	.1719	*	*	
4	SFR133SSW5	.0937	.1875	.0937	.234	.031	
5	SR133SSW5	.0937	.1875	.0937	*	*	SEE NOTE 2
6	SR3SSW5	.1875	.5000	.1960	*	*	SEE NOTE 4
7	SR4SSW5	.2500	.6250	.1960	*	*	SEE NOTE 4

* WITHOUT FLANGE

NOTES:

1. BEARING MFG BY BARDEN CORP ZOO PARK AVE DANBURY CONNECTICUT.
2. BEARINGS SHALL BE WET VACKOTE LUBRICATED PER BALL BROS RESEARCH CORP PROCESS BPS15-1 USING LUBRICANT 36236. BEARINGS SHALL BE STORED IN SEALED CONTAINERS UNTIL USE.
3. MARK PART NO. RCA 1974400 & APPROPRIATE DASH NO. ON CONTAINERS.
4. LUBRICATE USING G300 SILICON GREASE. GREASE SHALL UNIFORMLY FILL MIN 20% MAX 30% OF THE VOID VOLUME WITHIN THE BEARING. BEARINGS SHALL BE STORED IN SEALED CONTAINERS UNTIL USED.

SEE TABLE

DASH NO.

QTY REQD	QTY REQD	QTY REQD	QTY RE
504	503	502	5

CONTRACT N

COMMODITY

DRAWN J.J. Ham

CHECKED W. Yubr

DESIGN ACT

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING.

TOLERANCES ON FINISHED DIMENSIONS UNLESS OTHERWISE SPECIFIED

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	±.02	±.005
ABOVE 6 TO 24	±.03	±.010
ABOVE 24	±.06	±.015

ANGULAR DIMENSIONS ±½°

SEE RCA PURCH SPEC FOR STOCK TOL

FIRST MADE FOR	
NEXT ASS'Y	USED ON
	COLOR CAMERA

~~ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING, AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.~~

SYM | 1974400

REVISIONS

SYM	ZONE	DESCRIPTION	DATE	APPROVED
A		ADDED DASH NUMBERS 6 & 7.	9-25-70	J.H.H.
B		REVISED PER ECN REV. B S.O. 1F5210. R.H.	15 April 71	

CATION

NOTE 2

NOTE 2

NOTE 4

NOTE 4

FOLDOUT FRAME

SEE TABLE	SEE NOTE 1 & TABLE	NOTE 2&4	NOTE 2&4
DASH NO.	MATERIAL	FINISH	SPECS.
	LIST OF SPECIFICATIONS		

ALTERED PART DWG.

QTY REQD	QTY REQD	QTY REQD	QTY REQD	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
504	503	502	501				LIST OF MATERIALS

ATE

IES AND PLATING.

ENSIONS FIED

3 PLACE DECIMALS
±.005
±.010
±.015
±½°

OCK TOL

CONTRACT NO.

COMMODITY CODE 5603

DRAWN J.J. Hamann DATE Feb. 27, 1970

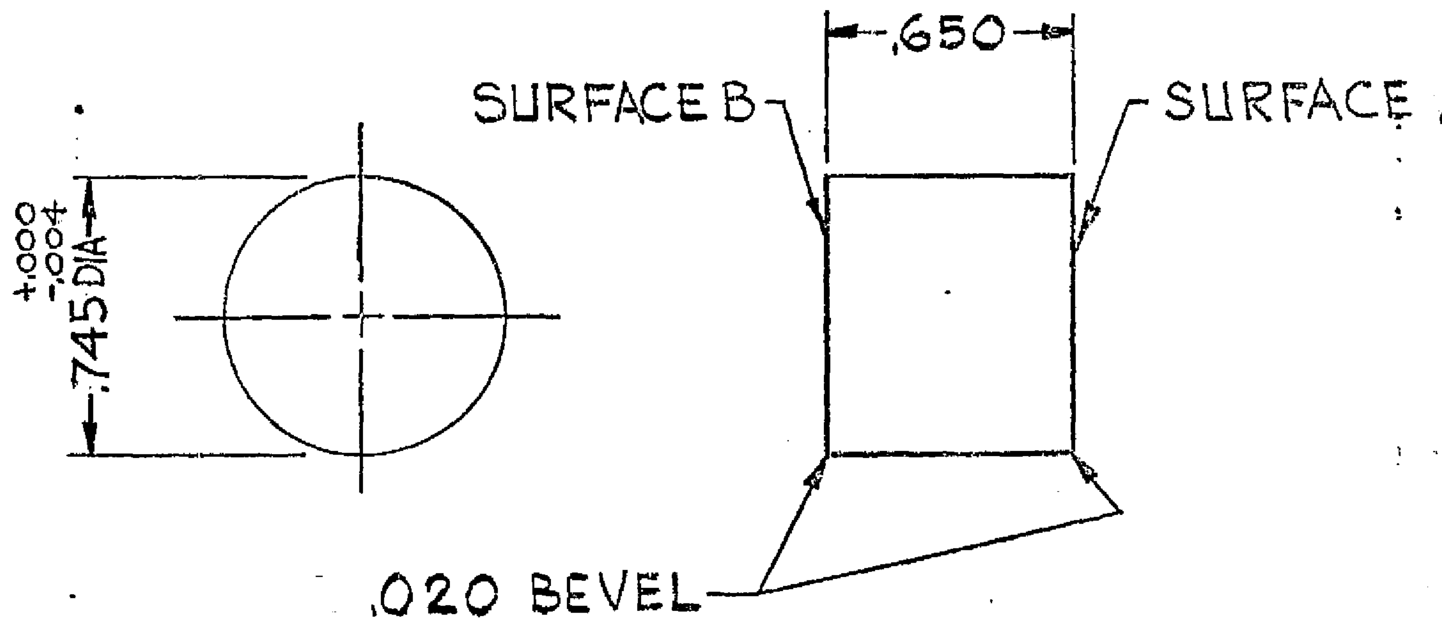
CHECKED W. Yurbski DATE May 6, 1970

DESIGN ACTIVITY APPD. DATE MAY 7-70

RADIO CORPORATION OF AMERICA
CAMDEN, N.J.
ASTRO-ELECTRONICS DIV., PRINCETON, N.J.

BEARING, LUBRICATED

CODE IDENT NO.	SIZE	
49671	B	1974400
SCALE —	WEIGHT	SHEET 1 OF 1



NOTES:

1. MATERIAL: OPTICAL CROWN GLASS (C-1) RETICLE GRADE, NOMINAL INDEX OF 1.523.
2. SURFACES QUALITY SHALL BE 60-40 OR BETTER, FACES SHALL BE FLAT TO 6 RINGS, FACES SHALL BE PARALLEL TO 3 MIN/ARC.
3. APPLY ANTI-REFLECTION COATING TO SURFACES A & B.

				X	
				AR	
				-1	COD IDEN
QTY REQD PER DASH NO.					

FOLDOUT FRAME) PRECEDING PAGE BLANK NOT FILMED

REVISION STATUS WHERE MORE THAN ONE SHEET			
SH	REV	SH	REV

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

RCA COMMODITY CODE:

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125 PER ANSI STD B46.1 — 1962

	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTH DIMENSIONS INCLUDE THI

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BASIC DIMENSIONS
UP TO 6
ABOVE 6 to 24
ABOVE 24
ANGULAR D
MATERIA

LTR

RCA 2417-3 (4-71) 7069

LTR | SK2273224

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

SURFACE A

FOLDOUT [illegible]

2

		X		8030022	SPEC. WORKMANSHIP		
		AR			SEE NOTE 1		
		-1					
ER DASH NO.			CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

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— 1962

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:			
BASIC DIMENSIONS	2 PLACE DECIMALS		3 PLACE DECIMALS
UP TO 6	± .02		± .010
ABOVE 6 to 24	± .03		± .015
ABOVE 24	± .06		± .020

ANGULAR DIMENSIONS ± ½°

MATERIAL: SEE TABLE

CONTRACT NO. NAS-13688 | REL

DRAWN BY R. Slifko DATE MAY 2, 1974

CHECKED BY M.C. Juschak DATE May 8, 1974

DESIGN ACTIVITY APPD Bert Soltoff DATE May 9, 1974

RCA

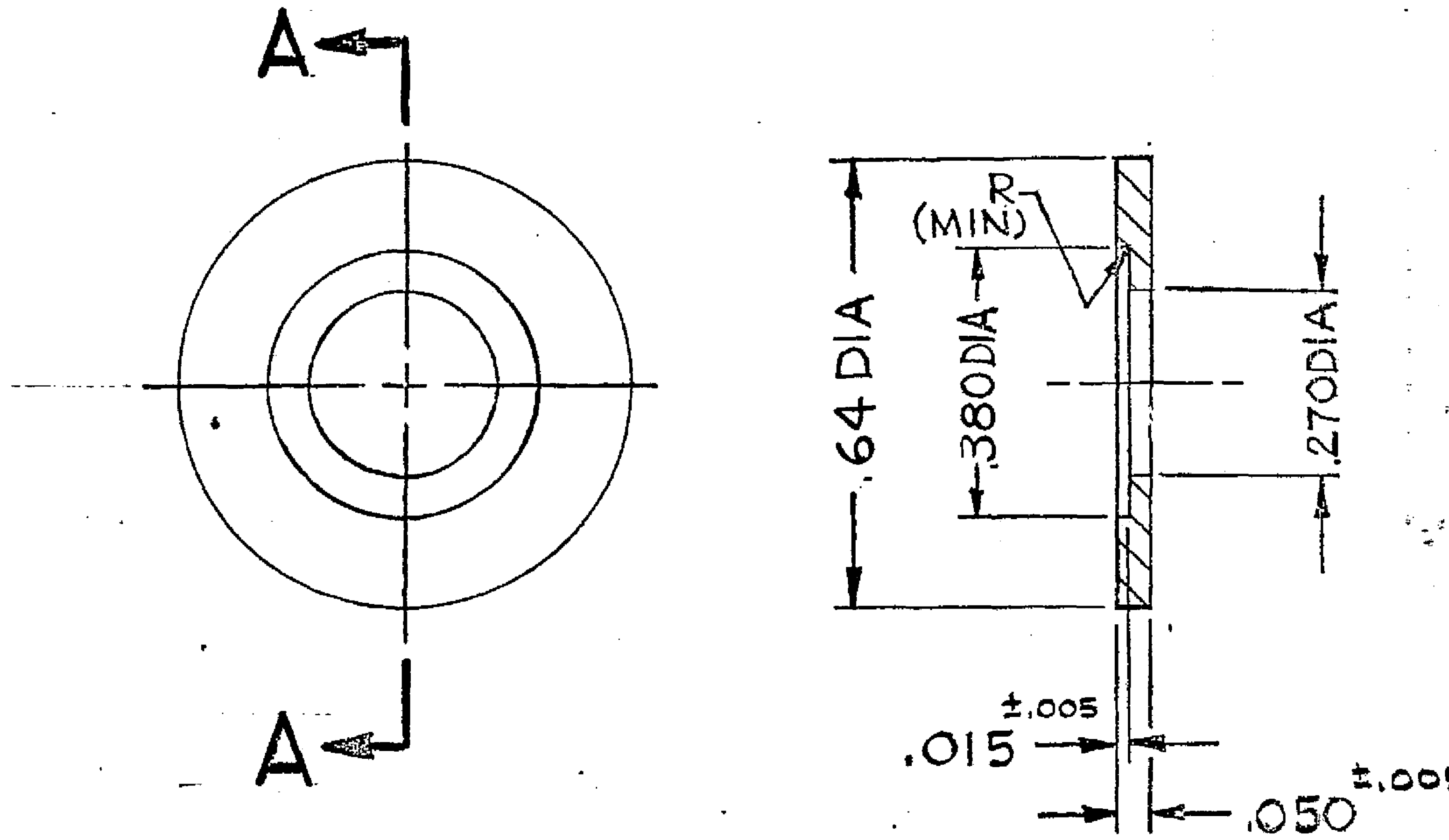
RCA CORPORATION | NEW YORK, NY

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

COMPENSATING FILTER

SIZE	CODE IDENT NO.	
B	49671	SK2273224

SCALE 2/1 WEIGHT | SHEET 1 OF 1



SECTION A-A

				AR	
				AR	
				-1	COD IDEN
QTY REQD PER DASH NO.					

FOLDOUT [redacted]

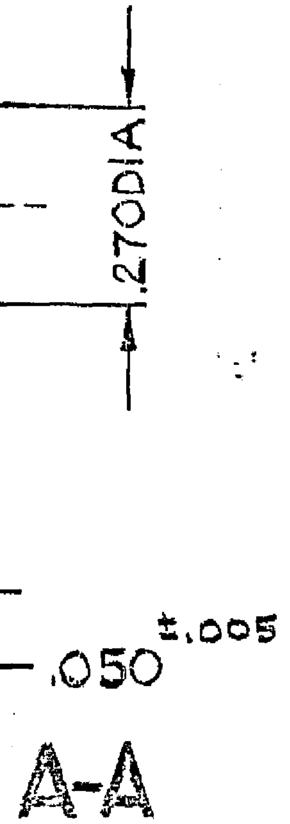
REVISION STATUS WHERE MORE THAN ONE SHEET				THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9	UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125√ PER ANSI STD B46.1 — 1962		UNLESS OTH DIMENSIONS INCLUDE THI
SH	REV	SH	REV	INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66			TOLE
							BASIC DIMENSIONS
							UP TO 6
					SK2279979	SHUTTLE T.V.	ABOVE 6 to 24
							ABOVE 24
				RCA COMMODITY CODE:	NEXT ASSY	USED ON	ANGULAR D
					FIRST APPLICATION		MATERIA

RCA 2417-3 (4-71) 7069

SK2273306

LTR

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



A-A

FOLDOUT [redacted] 2

	AR		1980032-1	PASSIVATE DIP		
	AR		2010521-80	ST. STL ROD .656 DIA.	QQ-S-764a	
	-1	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.
ER DASH NO.						

MATERIALS AND SPECIFICATIONS

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— 1962

LE T.V.
ON
N

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING			
TOLERANCES ON:			
BASIC DIMENSIONS	2 PLACE DECIMALS		3 PLACE DECIMALS
UP TO 6	± .02		± .010
ABOVE 6 to 24	± .03		± .015
ABOVE 24	± .06		± .020
ANGULAR DIMENSIONS ± ½°			
MATERIAL: SEE TABLE			

CONTRACT NO. NAS9-13688 REL

DRAWN BY R. Slifko DATE MAY 21, 1974

CHECKED BY Lewis E. Bradley DATE May 30, 1974

DESIGN ACTIVITY APPD DATE 28 AUG 74

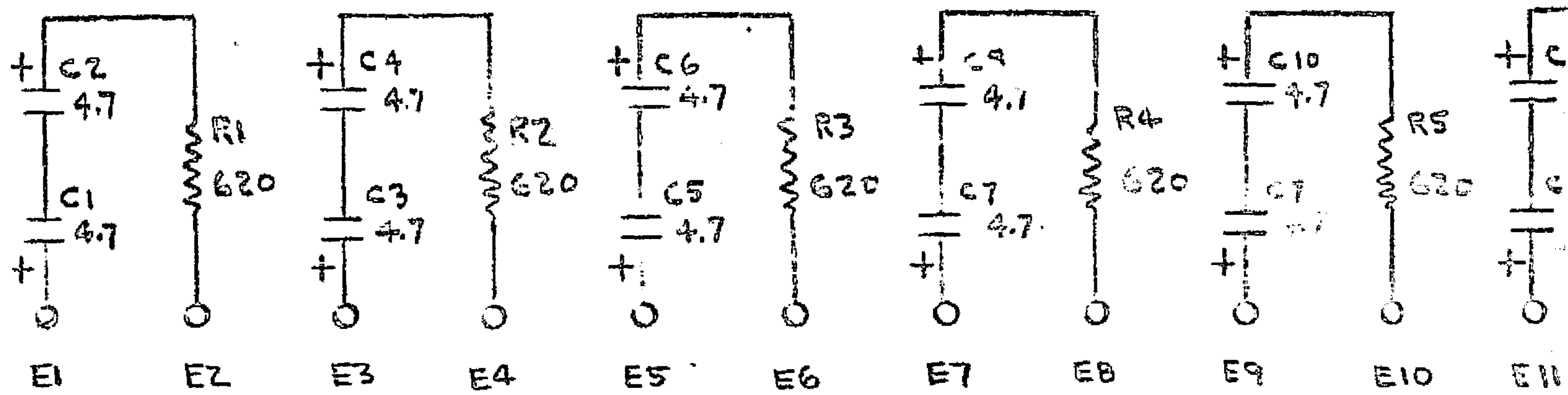
RCA CORPORATION | NEW YORK, NY

RCA ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

BUSHING, THRUST

SIZE	CODE IDENT NO.	
B	49671	SK2273306

SCALE 4/1 WEIGHT 2.6 GR. SHEET 1 OF 1



NOTES:
1. ALL CAPACITORS ARE IN MICROFARADS
2. ALL RESISTORS ARE IN OHMS

FOLDOUT FRAME

QTY REQD PER DASH NO.					IDENT

REVISION STATUS WHERE MORE THAN ONE SHEET

SH	REV	SH	REV

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

RCA COMMODITY CODE:

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

NEXT ASSY	USED ON
FIRST APPLICATION	

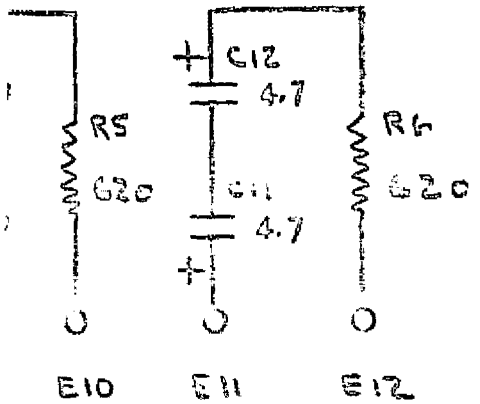
UP TO 6

MATERIAL

LTR

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED



FOLDOUT FRAME 2

DASH NO.		CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	NOTE NO.

MATERIALS AND SPECIFICATIONS

...IFIED

...NOT ...DING ... 1962

...ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND APPLY AFTER PLATING

UP TO 6	± .0[illegible]		± .010
[illegible]	± .0[illegible]		± .015
[illegible]	± [illegible]		± .0[illegible]

ANGULAR DIMENSIONS ± ½°

MATERIAL: SEE TABLE

CONTRACT NO.

DRAWN BY — DATE 4-[illegible]

CHECKED BY — DATE

DESIGN ACTIVITY APPD — DATE

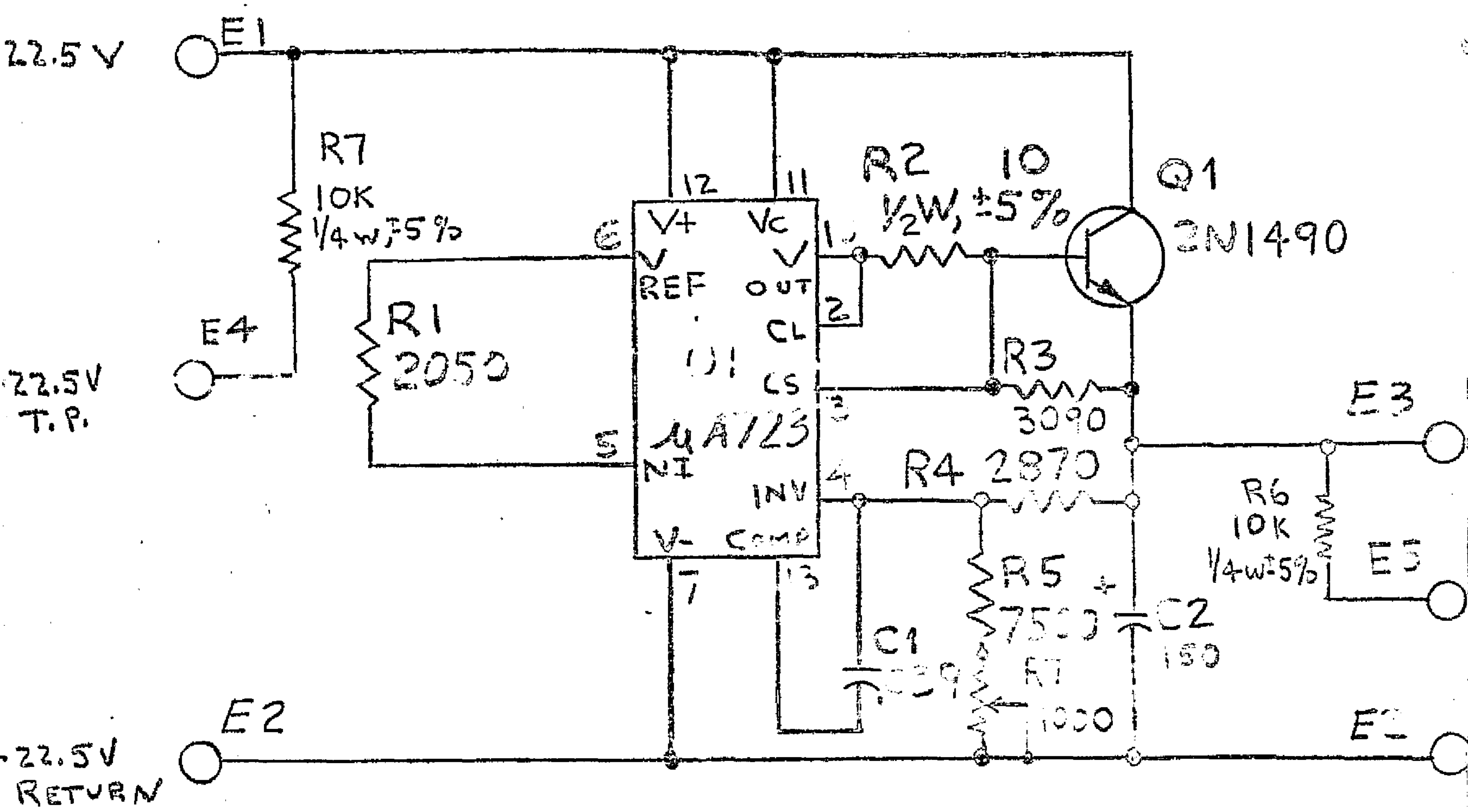
RCA CORPORATION — NEW YORK, NY

...ECTRONICS DIV. ... PLANT

...MATIC ...TOR ...BD. ...

SIZE B — CODE IDENT NO. 49671 — SK22[illegible]

SCALE — WEIGHT — SHEET 1 OF



NOTES:

1. ALL RESISTORS VALUES ARE IN OHMS, ±1%
2. ALL CAPACITORS ARE IN MICROFARADS
3. ADJUST R7 FOR 10.0 VOLTS AT E3

FOLDOUT FRAME 1

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

QTY REQD PER DASH NO.					CODE IDENT	

REVISION STATUS WHERE MORE THAN ONE SHEET			
SH	REV	SH	REV

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

RCA COMMODITY CODE:

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125 PER ANSI STD B46.1 -- 1962

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE DIMENSIONS ARE IN IN INCLUDE THICKNESS O

TOLERANCES O

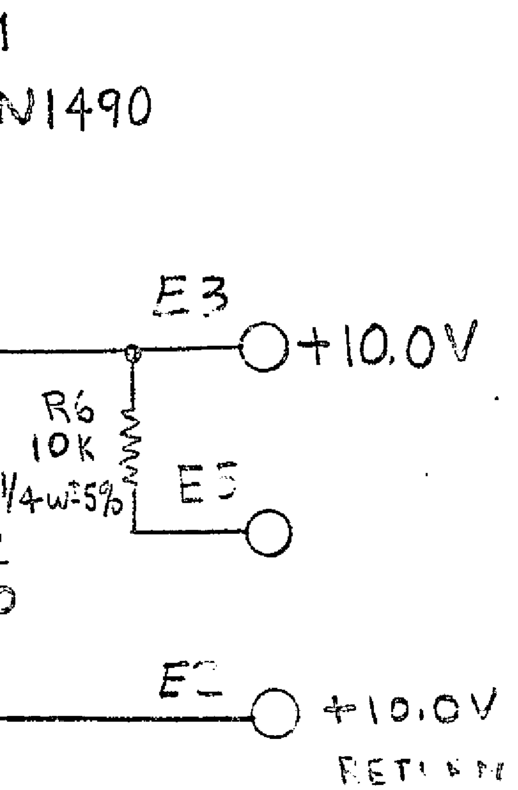
BASIC DIMENSIONS	DECIMALS
UP TO 6	± .02
ABOVE 6 to 24	± .03
ABOVE 24	± .06

ANGULAR DIMENSION

MATERIAL: SEE

2417-3 (4-71) 7069

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



FOLDOUT FRAME

DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION		SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

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NOT

ING

1962

ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

RATIO DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2°

MATERIAL: SEE TABLE

CONTRACT NO.

REL

DRAWN BY — DATE

CHECKED BY — DATE

DESIGN ACTIVITY APPD — DATE

RCA CORPORATION · NEW YORK, NY

RCA ...TRONICS DIV. ... PLANT

SCHEMATIC ... REGULATOR ...

SIZE	CODE IDENT NO.	
B	49671	SK2273-409

SCALE —— WEIGHT —— SHEET 1 OF 1

4 3 2

D

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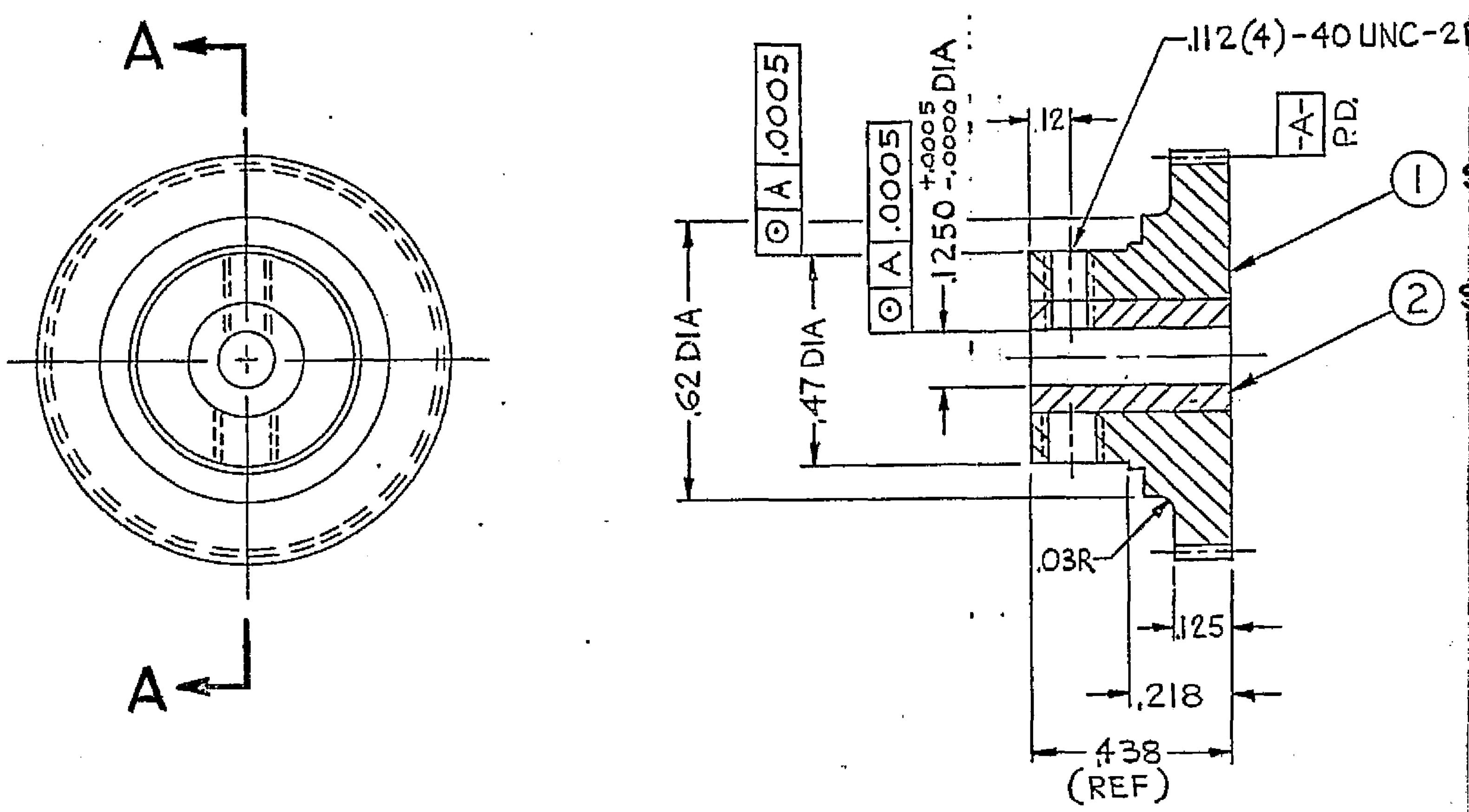


SECTION A-A

NOTES:

1. MATERIAL - CRES (TYPE 303) BAR .281 DIA QQ-S-764 a (2010521-30).
2. PRESS FIT ITEM 2 INTO ITEM 1.
3. WORKMANSHIP SHALL BE IN ACCORDANCE WITH PARTS LIST, ITEM 3.
4. TAG OR BAG PART NO. 49671-SK227717-501 PER MIL-STD-130.
5. ALTER ITEM 1 AS SHOWN.

FO

QTY REQD PER DASH NO.				CODE IDENT	IDENTIFYING

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .1	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

SK2279979	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

RCA COMMODITY CODE:

CONTRACT NAS9

DRAWN

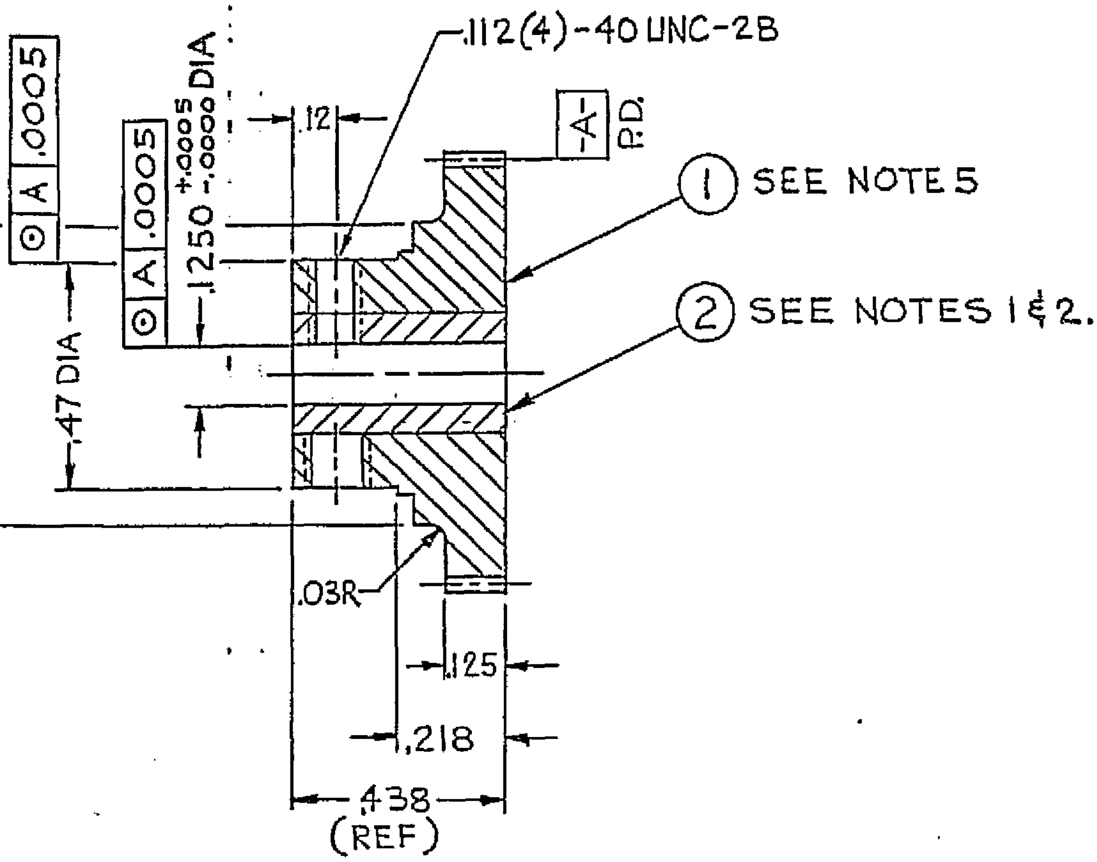
CHECKED

DESIGN A

FOLDOUT FRAME /

3 2 1

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED



SECTION A-A

FOLDOUT FRAME 2

FOR PARTS LIST SEE PL SK2277717

DIA

ANCE

717-501

QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

SK2279979	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS		3 PLACE DECIMALS
UP TO 6	± .02		± .010
ABOVE 6 TO 24	± .03		± .015
ABOVE 24	± .06		± .020

ANGULAR DIMENSIONS ± ½ °

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Slyfer DATE APR. 19, 1974

CHECKED DATE May 30, 1974

DESIGN ACTIVITY APPD. DATE

RCA CORPORATION | NEW YORK, NY

RCA ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

GEAR

SIZE	CODE IDENT NO.	
C	49671	SK2277717

SCALE 4/1 WEIGHT SHEET 1 OF 1

PARTS LIST

RCA

RCA CORPORATION | NEW YORK, NY

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J

REVISION DATE	
	PLSK2277717
REV LTR	
LIST TITLE:	GEAR
PREPARED BY	R. Slifko
DATE	MAY 18, 1974
CHECKED BY	Louis E. Gordon
DATE	May 30, 1974
DESIGN ACTIVITY APP'D	Bert M. Soltoff
DATE	May 30, 74
REL.	
CODE IDENT NO.	49671
SHEET	1 OF 2 SHEETS
CONTRACT NO.	NAS9-13688

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED	LTR	DESCRIPTION	DATE	APPROVED

INTERPRET SYMBOLS USED AS FOLLOWS:

UNITS OF MEASURE (UM)	QUANTITIES	SYMBOL
A — Inches B — Feet C — Yards D — Ounces E — Pints F — Quarts G — Gallons H — Barrels J — Pounds L — Pair M — Set N — Kit P — Roll R — Box, Case T — Each	X — Applicable document O — For ref only	U — Govt or customer furnished K — Govt or customer furnished and installed * — Vendor item, See specification or source control drawing.

RCA 2400-3 (8-68)

SIZE	CODE IDENT NO.	DRAWING NO.		
A	49671	SKPL2277717	-	2

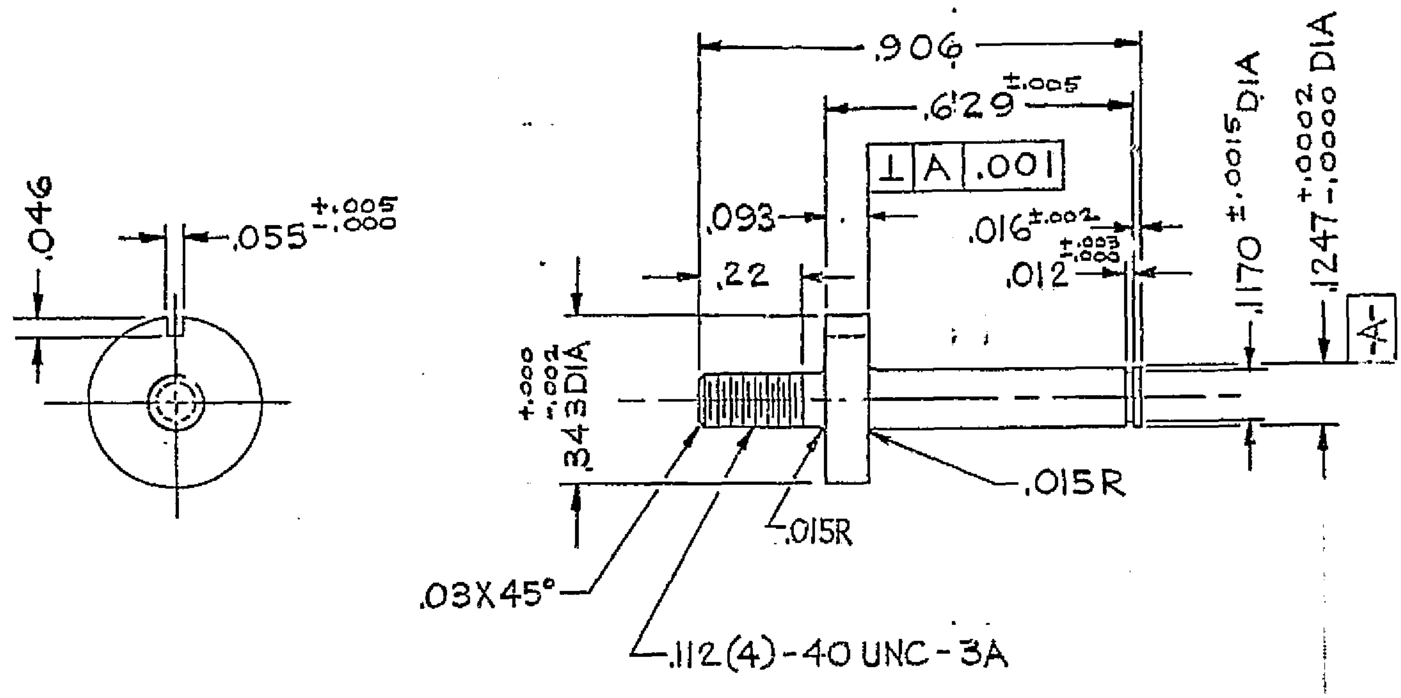
PARTS LIST

ITEM	QUANTITY REQUIRED -504	-503	-502	-501	TYPE	UM	CODE IDENT	PART OR IDENTIFYING NO.	*	NOMENCLATURE OR DESCRIPTION
1				1			00141	AB24-56		GEAR
2				1				SK2277717-2		BUSHING
3				X				8030022		SPEC, WORKMANSHIP

* DENOTES VENDOR ITEMS - SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING BEFORE ORDERING.
UM - IN COLUMN HEADING DENOTES UNITS OF MEASURE (USE STANDARD ABBREVIATION)
EXPLANATION OF SYMBOLS IN TYPE COLUMN
Z - DENOTES CONTROLLED ITEM (CLASSIFIED)
T - DENOTES TOOL DRAWING
FOR QUANTITY AND EFFECTIVITY REFER TO EFFECTIVITY BLOCK

CLASSIFICATION:

AED 5609 71



NOTES:

1. TAG OR BAG PART NO. 49671-SK2277718-1 PER MIL-STD-130.

			X			803
			AR			1980
			AR			2010
			-1		CODE IDENT	IDENTI
QTY REQD PER DASH NO.						

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

SK2283469	SHUTTLE T.V
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

RCA COMMODITY CODE:

CONT
NA
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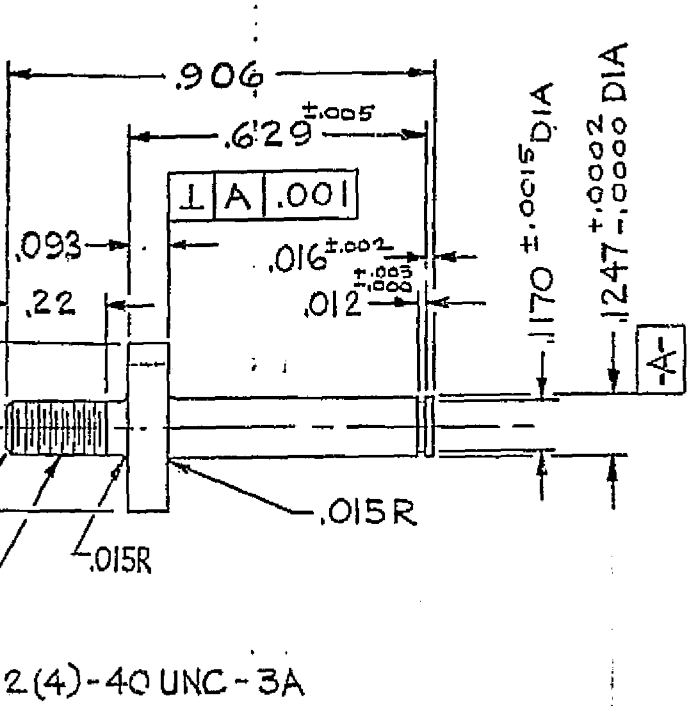
CHEC
DESI

FOLDOUT FRAME 1

RCA 2419-3 (4-71) 7074

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



TOLDOUT FRAME

7718-1

				X		8030022	SPEC. WORKMANSHIP		
				AR		1980032-1	PASSIVATE DIP		
				AR		2010521-42	CRES (TYPE 303) BAR .375 DIA	QQ-S-764a	
QTY REQD PER DASH NO.				-1	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THE DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
SK2283469	SHUTTLE T.V.

FIRST APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½ °

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Seifer DATE APR. 22, 1974

CHECKED [illegible] DATE May 31, 1974

DESIGN ACTIVITY APPD. [illegible] DATE 28 May 74

RCA — RCA CORPORATION | NEW YORK, NY

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

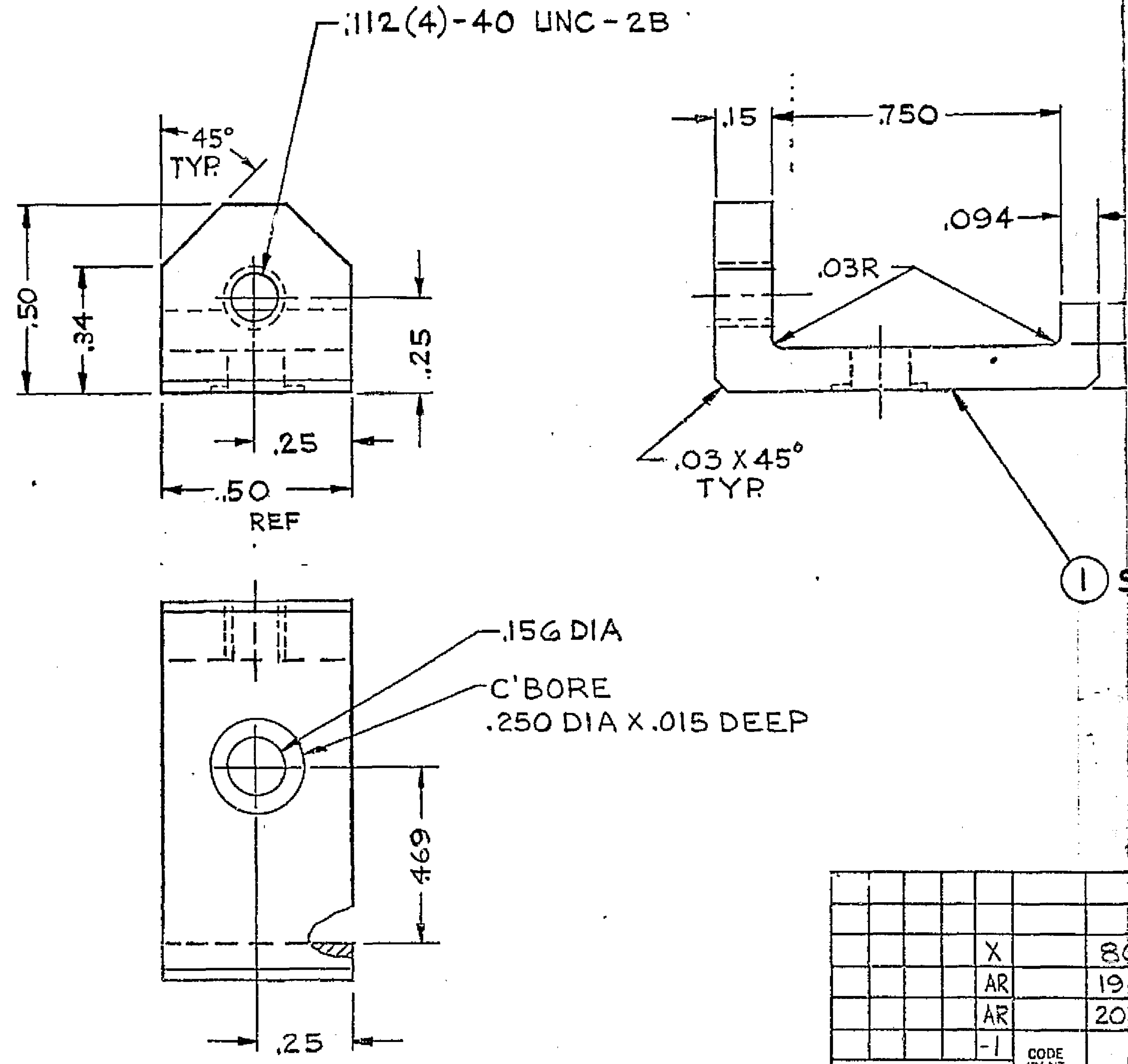
SHAFT, COLOR WHEEL

SIZE	CODE IDENT NO.	
C	49671	SK2277718

SCALE 4/1 WEIGHT SHEET 1 OF 1

4 3

D C B A



				X		8
				AR		19
				AR		20
				-1	CODE IDENT	
QTY REQD PER DASH NO.						

NOTES:

1. TAG OR BAG PART NO. 49671-SK2277722-1 PER MIL-STD-130.

FOLDOUT [redacted]

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962	
INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66	
THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9	
SK2279979	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

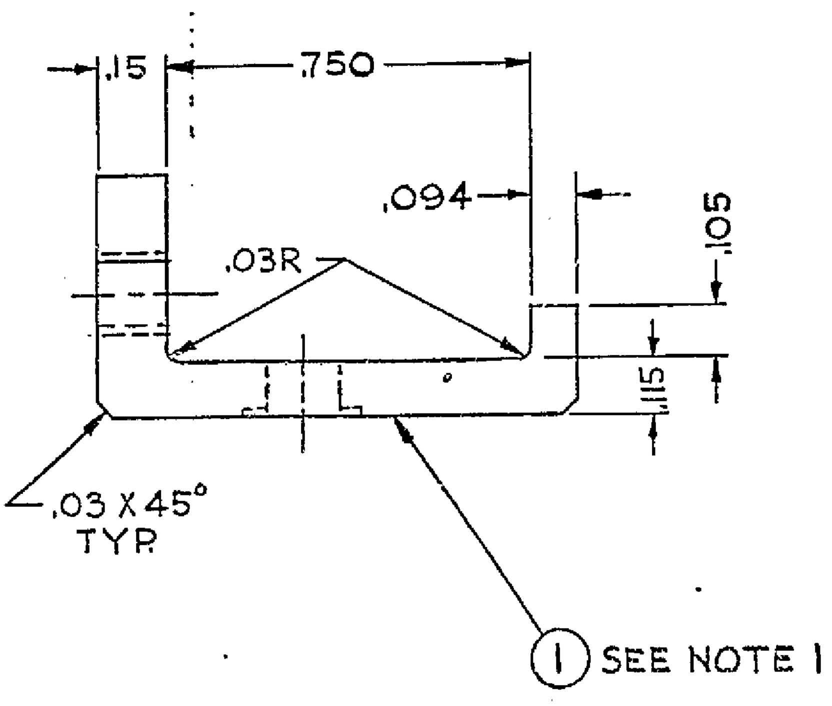
RCA COMMODITY CODE:

RCA 2419-3 (4-71) 7074

3 2 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADDED .250 DIA. C'BCREX .015DEEP RMH	9-24-74	D. [illegible]

-2B



A

A X .015 DEEP

FOLDOUT [illegible] 2

				X		8030022	SPEC. WORKMANSHIP		
				AR		1980032-1	PASSIVATING DIP		
				AR		2010462-232	CRES (TYPE 302) PLATE .50THK	QQ-S-766C(5)	
QTY REQD PER DASH NO.				-1	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THIS DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

SK2274979	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Sliffko DATE APR.23,1974

CHECKED DATE

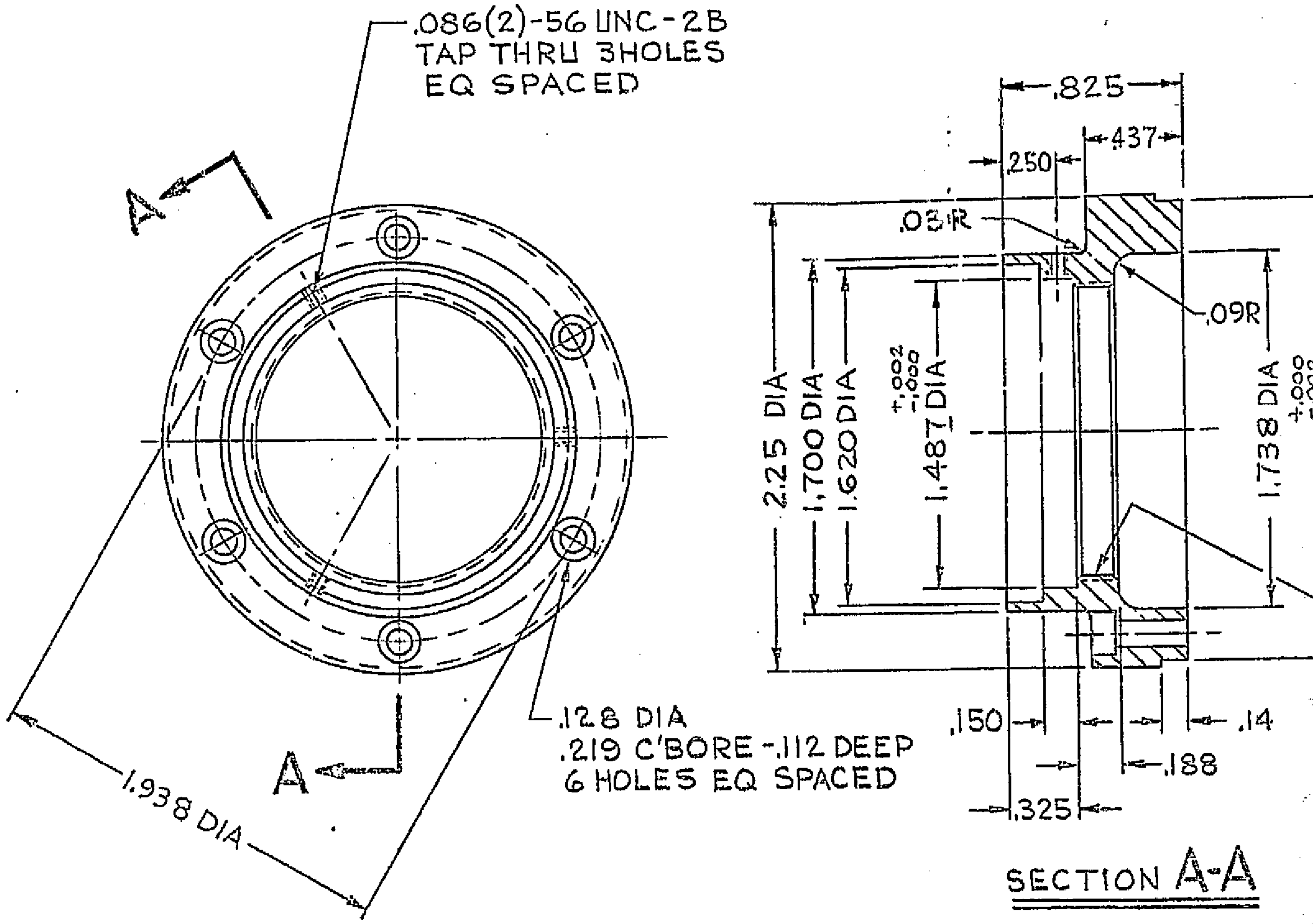
DESIGN ACTIVITY APPD. [signature] DATE 28 May 74

RCA — RCA CORPORATION | NEW YORK, NY — ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

CLAMP

SIZE	CODE IDENT NO.	
C	49671	SK2277722

SCALE 4/1 | WEIGHT | SHEET 1 OF 1



NOTES:

1. TAG OR BAG PART NO. 49671-SK2277726-1 PER MIL-STD-130.

				X			8
				AR			19
				AR			20
				-1	CODE IDENT		
QTY REQD PER DASH NO.							

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125 PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

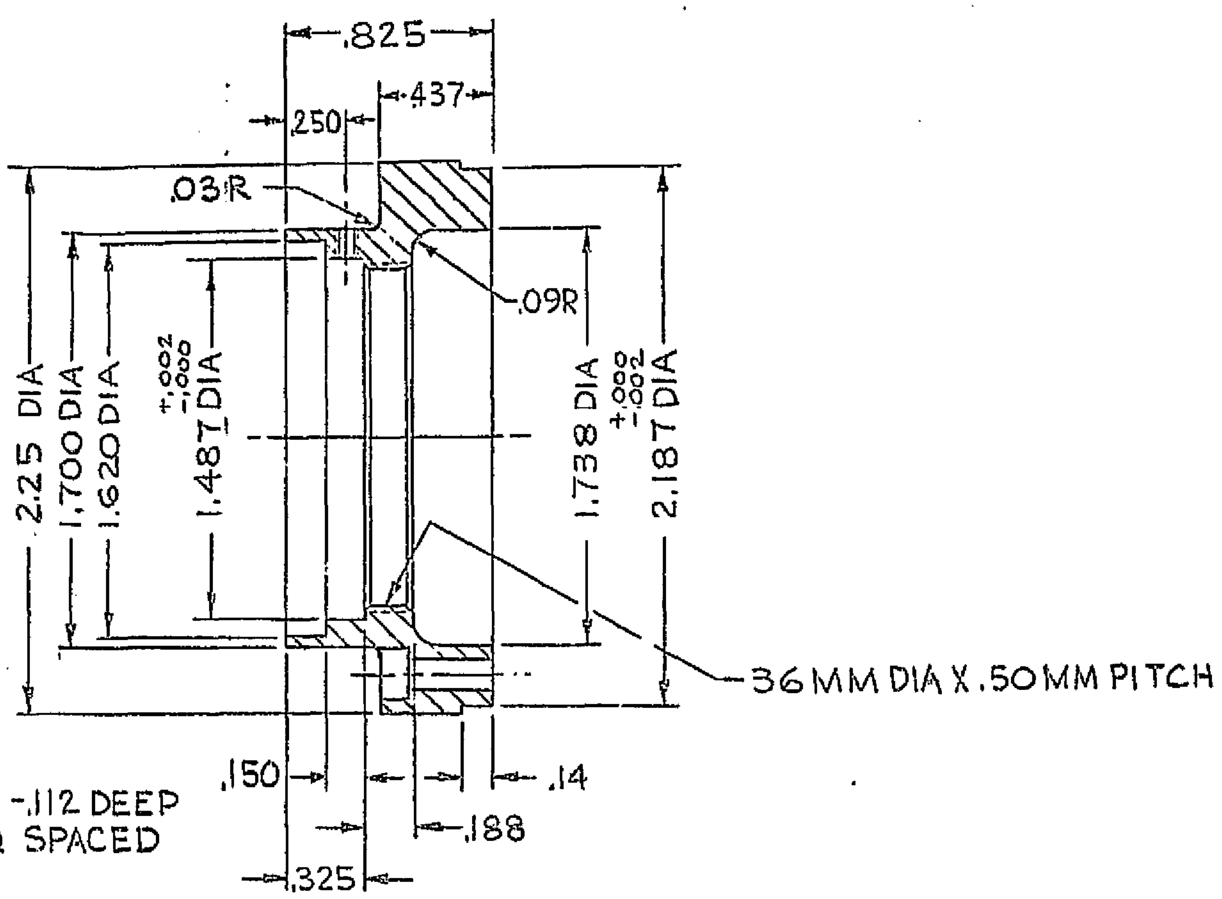
TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± ½ °		

SK2279979	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

RCA COMMODITY CODE:

FOLDOUT FRAME

RCA 2419-3 (4-71) 7074



SECTION A-A

FOLDOUT FRAME 2

7726-1

				X		8030022	SPEC. WORKMANSHIP		
				AR		1980039-1	BLACK ANODIZE	MIL-A-8625	
				AR		2010637-200	AL ALY BAR 2024-T4 2.375 DIA	QQ-A-225/6c	
				-1	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.
QTY REQD PER DASH NO.									

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

SK2276979	SHUTTLE T.V.
NEXT ASSY	USED ON

FIRST APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Slifko APR 25, 1974 DATE

CHECKED Eric E. Bradley May 30, 1974 DATE

DESIGN ACTIVITY APPD. DATE

RCA CORPORATION | NEW YORK, NY

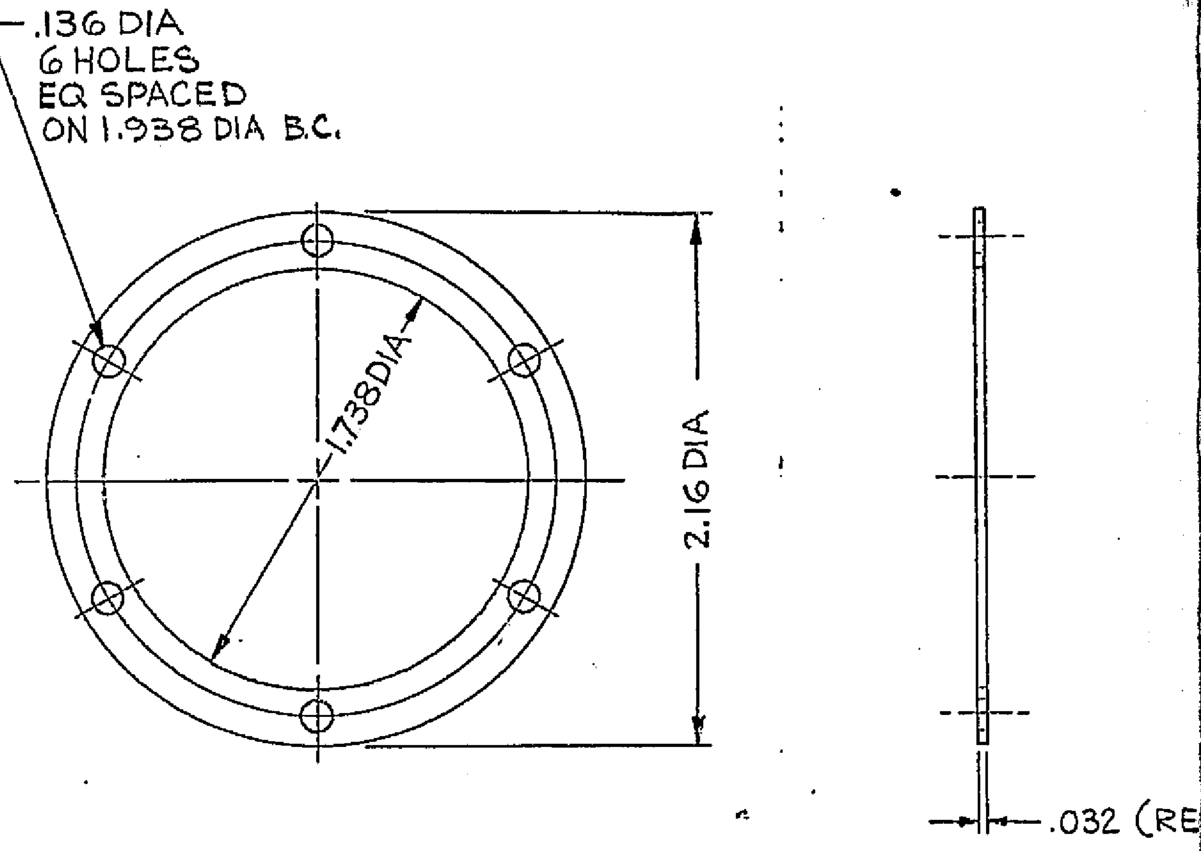
RCA ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

RETAINER - LENS

SIZE C | CODE IDENT NO. 49671 | SK2277726

SCALE 2/1 | WEIGHT | SHEET 1 OF 1

D



C

B

NOTES:

1. TAG OR BAG PART NO. 49671-SK2277728-1 PER MIL-STD-130.

			X			8
			AR			17
			-1	CODE IDENT		
QTY REQD PER DASH NO.						

A

FOLDOUT FRAME 1

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

SK2279979	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

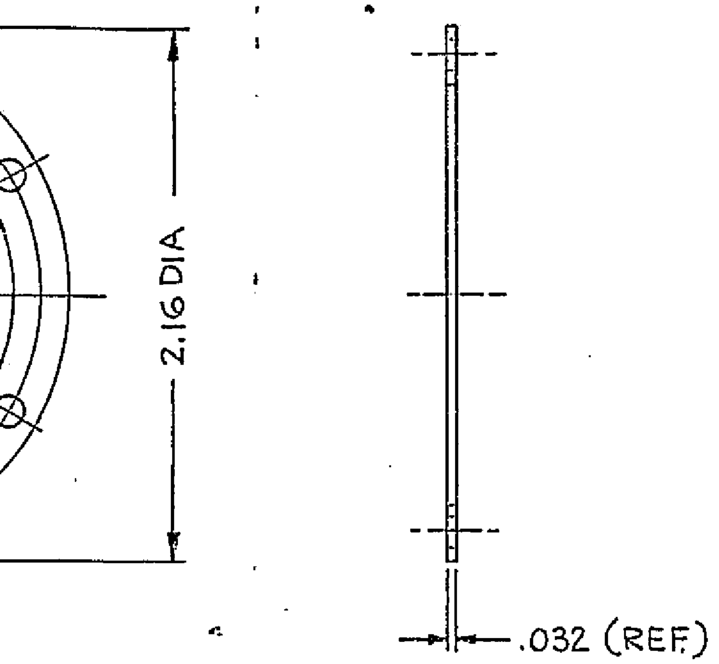
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:			
BASIC DIMENSIONS	2 PLACE DECIMALS		3 PLACE DECIMALS
UP TO 6	± .02		± .010
ABOVE 6 TO 24	± .03		± .015
ABOVE 24	± .06		± .020
ANGULAR DIMENSIONS ± 1/2 °			

RCA COMMODITY CODE:

RCA 2419-3 (4-71) 7074

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED



7728-/

FOLDOUT FRAME 2

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.
X		8030022	SPEC. WORKMANSHIP		
AR		1721943-211	AL ALY LAM. SHIM .032 THK	QQ-A-561	
-1					

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
SK2279979	SHUTTLE T.V.

FIRST APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½ °

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Slezbo DATE APR. 25, 1974.

CHECKED [illegible] DATE May 30, 1974

DESIGN ACTIVITY APPD. [illegible] DATE [illegible]

RCA

RCA CORPORATION | NEW YORK, NY

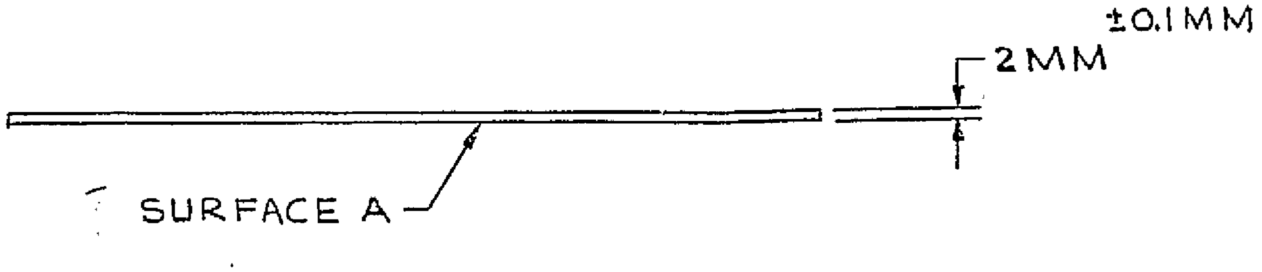
ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

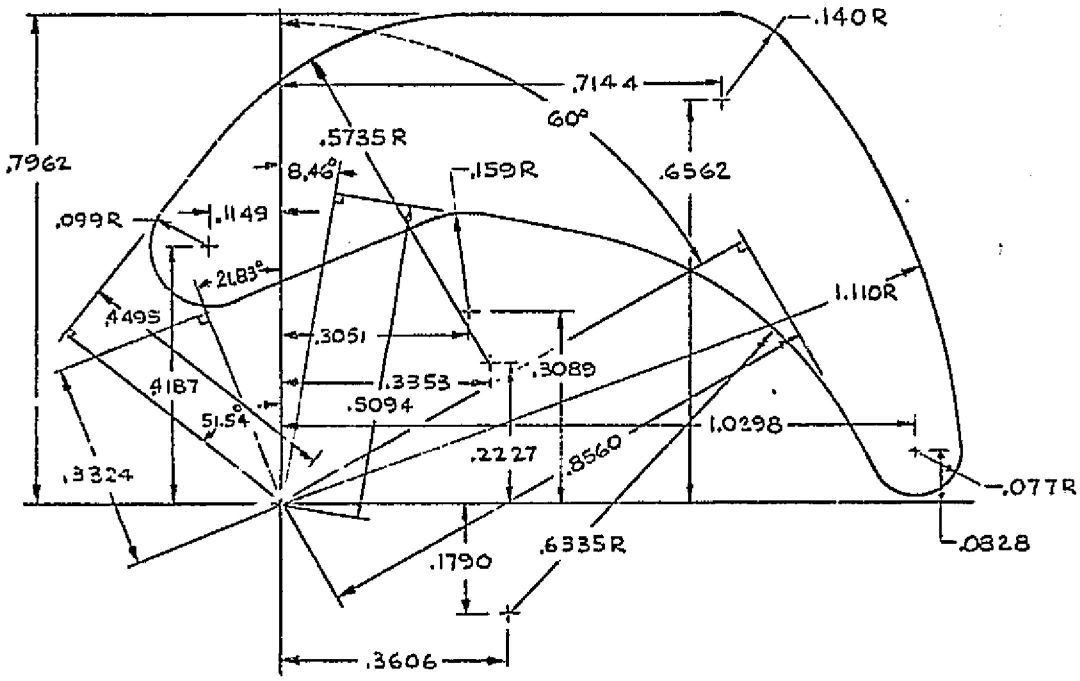
SHIM, LENS-RETAINER

SIZE	CODE IDENT NO.	
C	49671	SK2277728

SCALE 2/1 WEIGHT SHEET 1 OF 1

SK2277728





DASH No.	OPTICAL DENSITY VALUE
1	O
2	.1 ±.025
3	.2 ±.025
4	.3 ±.025
5	.4 ±.025
6	.5 ±.025

NOTE

1. MATERIAL: OPTICAL GLASS RETICLE GRADE. SURFACES QUALITY SHALL BE 60-40 OR BETTER. FACES SHALL BE FLAT TO 6 RINGS, FACES SHALL BE PARALLEL TO 3 MIN/ARC.

2. INCONEL NEUTRAL DENSITY COATINGS SHALL BE APPLIED TO SURFACE A, PROVIDING FILTER DENSITIES AS TABULATED.

			X		803	
			AR			
			-1	CODE IDENT	IDEN	
QTY REQD PER DASH NO						

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THIS DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD 9

SHUTTLE

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

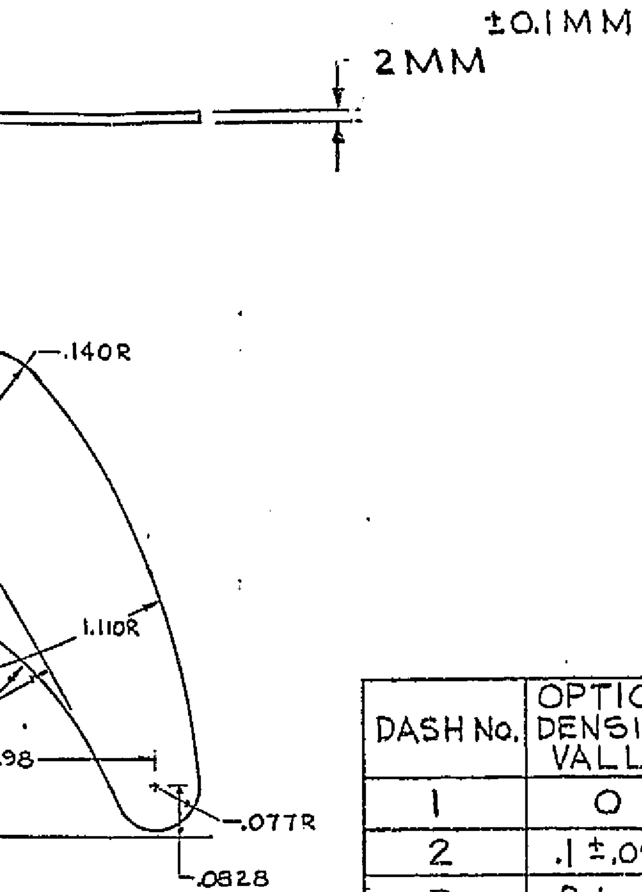
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2

RCA COMMODITY CODE

RCA 2419-3 (4-71) 7074

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



DASH No.	OPTICAL DENSITY VALUE	NOMINAL % T
1	0	100
2	.1 ±.025	79
3	.2 ±.025	63
4	.3 ±.025	50
5	.4 ±.025	40
6	.5 ±.025	32

FOLDOUT FRAME 2

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			X		8030022	SPEC. WORKMANSHIP		
			AR			SEE NOTE 1		
QTY REQD PER DASH NO			-1	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL STD 9

NEXT ASSY	USED ON
	SHUTTLE
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2

RCA COMMODITY CODE

CONTRACT NO. NAS9-13622 REL

DRAWN R. Sleffko DATE MAR 30 1974

CHECKED M.C. Gruchah DATE May 8, 1974

DESIGN ACTIVITY APPD. Bert M Soltoff DATE May 7, 1974

RCA CORPORATION · NEW YORK, NY

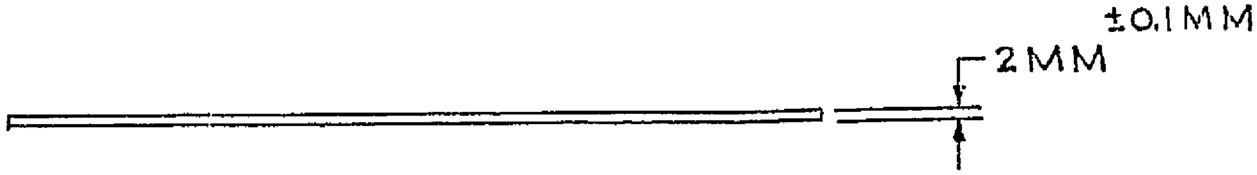
RCA ASTRO-ELECTRONICS DIV. PRINCETON, N.J. PLANT

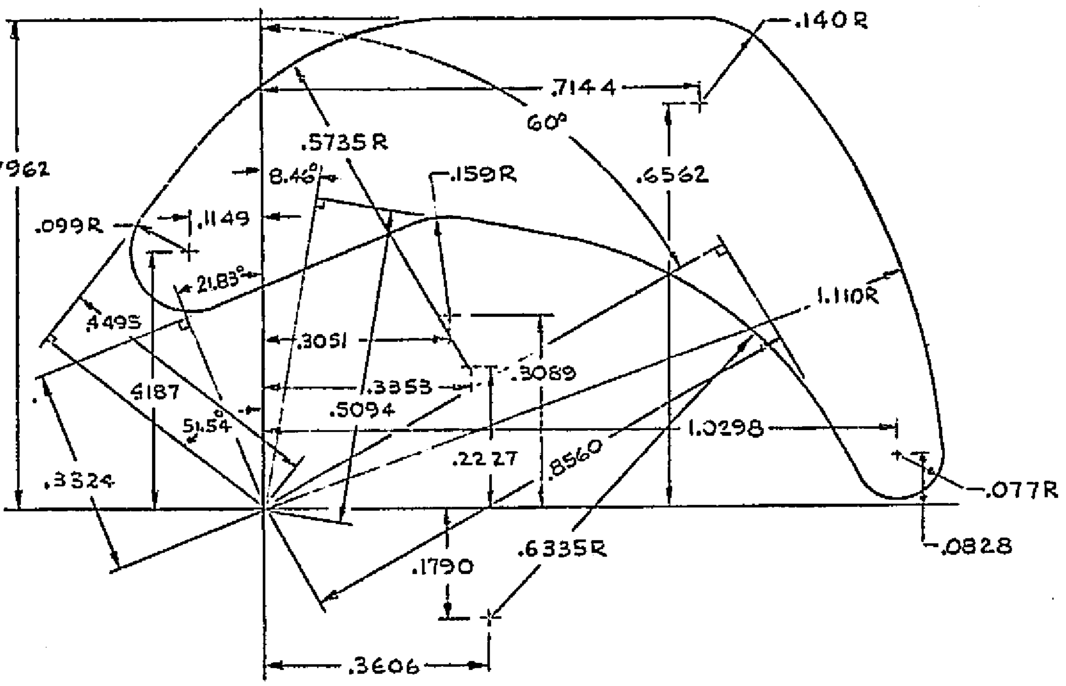
FILTER SEGMENT, NEUTRAL DENSITY

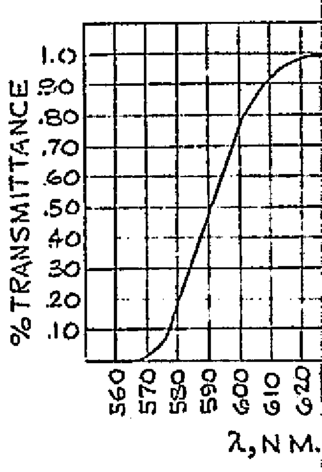
SIZE C | CODE IDENT NO. 49671 | SK2277731

SCALE NONE | WEIGHT | SHEET 1 OF 1

LTR
SK2277731







NOTE

1. MATERIAL: OPTICAL GLASS RETICLE GRADE.
SURFACES QUALITY SHALL BE 60-40 OR BETTER. FACES SHALL BE FLAT TO 6 RINGS, FACES SHALL BE PARALLEL TO 3 MIN/ARC.
GLASS SHALL BE SIMILAR TO SCHOTT OG590 HAVING SPECTRAL CHARACTERISTICS AS SHOWN ON GRAPH. WAVELENGTH FOR 50% TRANSMISSION POINT SHALL BE 590±10NM

			X		803	
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			-1	CODE IDENT		IDENTI
QTY REQD PER DASH NO.						

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± ½		

SHUTTLE T.V	
NEXT ASSY	USED ON
FIRST APPLICATION	

RCA COMMODITY CODE.

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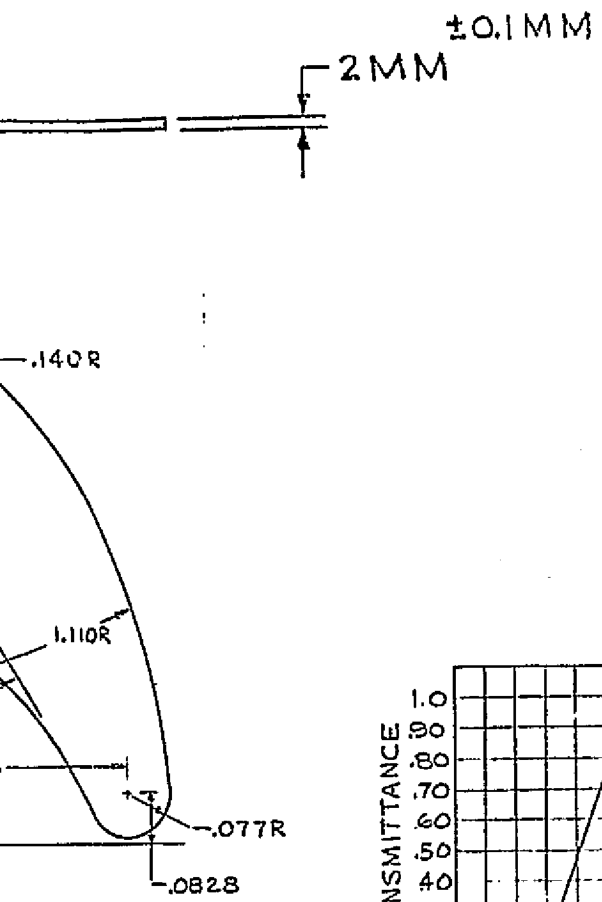
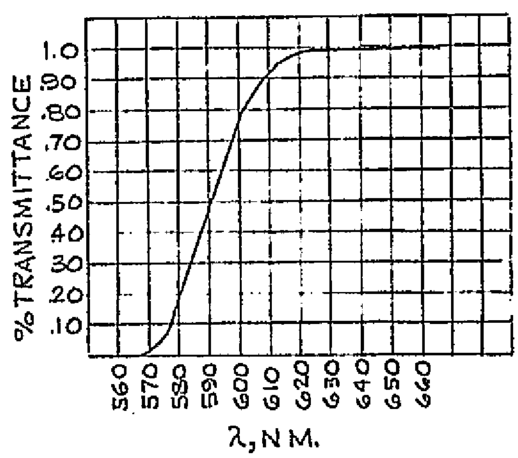
FOLDOUT FRAME /

RCA 2419-3 (4-71) 7074

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED





FOLDOUT FRAME

ADE.
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6
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G590
S
O %
10NM

				X		8030022	SPEC. WORKMANSHIP		
				AR			SEE NOTE 1		
QTY REQD PER DASH NO.				-1	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½

NEXT ASSY	USED ON
	SHUTTLE T.V.

FIRST APPLICATION

RCA COMMODITY CODE.

CONTRACT NO. NAS9-13688 REL

DRAWN R. Sleffer DATE APR. 30, 1974

CHECKED M. Fluschel DATE May 8, 1974

DESIGN ACTIVITY APPD. Bert M Soltoff DATE May 9, 74

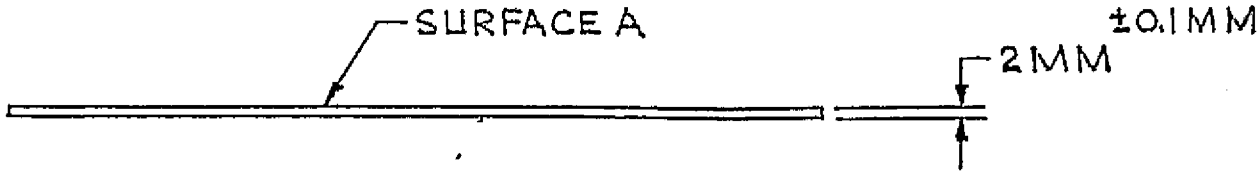
RCA CORPORATION | NEW YORK, NY

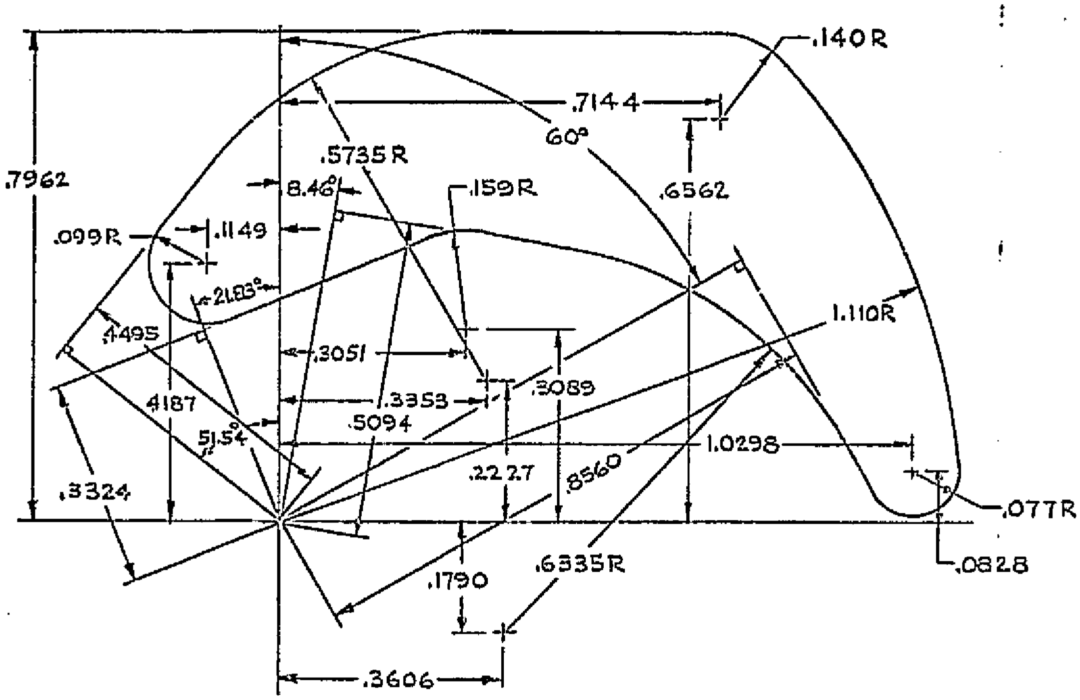
RCA ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

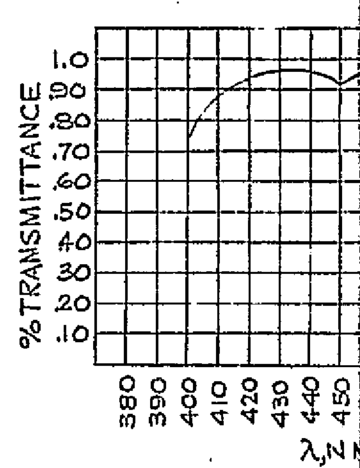
FILTER SEGMENT, RED

SIZE C | CODE IDENT NO. 49671 | SK2277732

SCALE NONE | WEIGHT | SHEET 1 OF 1







NOTE

1. MATERIAL: OPTICAL GLASS RETICLE GRADE. SURFACES QUALITY SHALL BE 60-40 OR BETTER. FACES SHALL BE FLAT TO 6 RINGS, FACES SHALL BE PARALLEL TO 3MIN/ARC.
2. SURFACE "A" SHALL HAVE AN INTERFERENCE COATING SIMILAR TO FISH-SCHURMAN ML495C, HAVING SPECTRAL CHARACTERISTICS AS SHOWN. MAX. AND MIN. WAVELENGTHS FOR 50% TRANSMISSION POINTS SHALL BE.

   400 NM ±10 NM
   480 NM ±10 NM

			X		8030
			AR		
			-1	CODE IDENT	IDENTIFYIN
QTY REQD PER DASH NO.					

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

	SHUTTLE T.
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± ½ °		

RCA COMMODITY CODE:

CONTRAC NAS

DRAWN

CHECKED

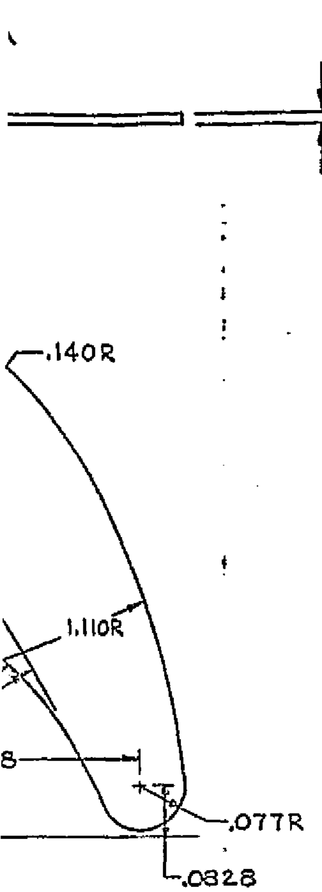
DESIGN A

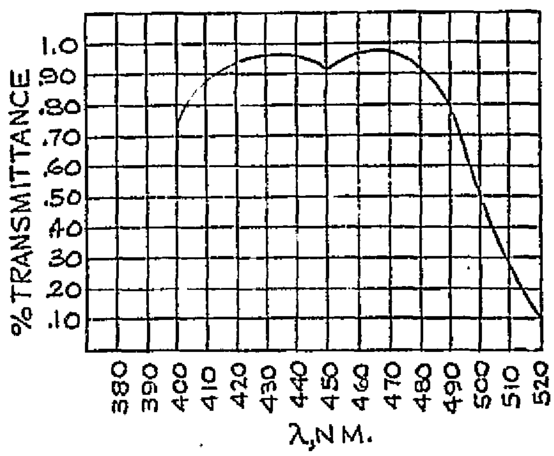
FOLDOUT FRAME

RCA 2419-3 (4-71) 7074

3 2 1

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED





FOLDOUT FRAME 2

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-O OR
) 6
L TO

495C,
S
OR

				X		8030022	SPEC. WORKMANSHIP		
				AR			SEE NOTE 1		
				-1					
QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2°

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Slifko DATE APR.30,1974

CHECKED M. P. Suschek DATE May 9,1974

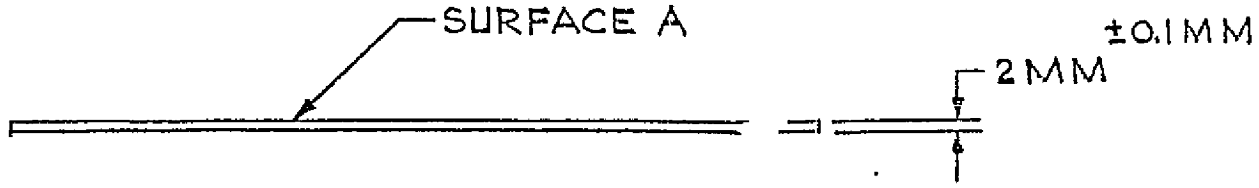
DESIGN ACTIVITY APPD. Bert M Soltoff DATE May 9, 1974

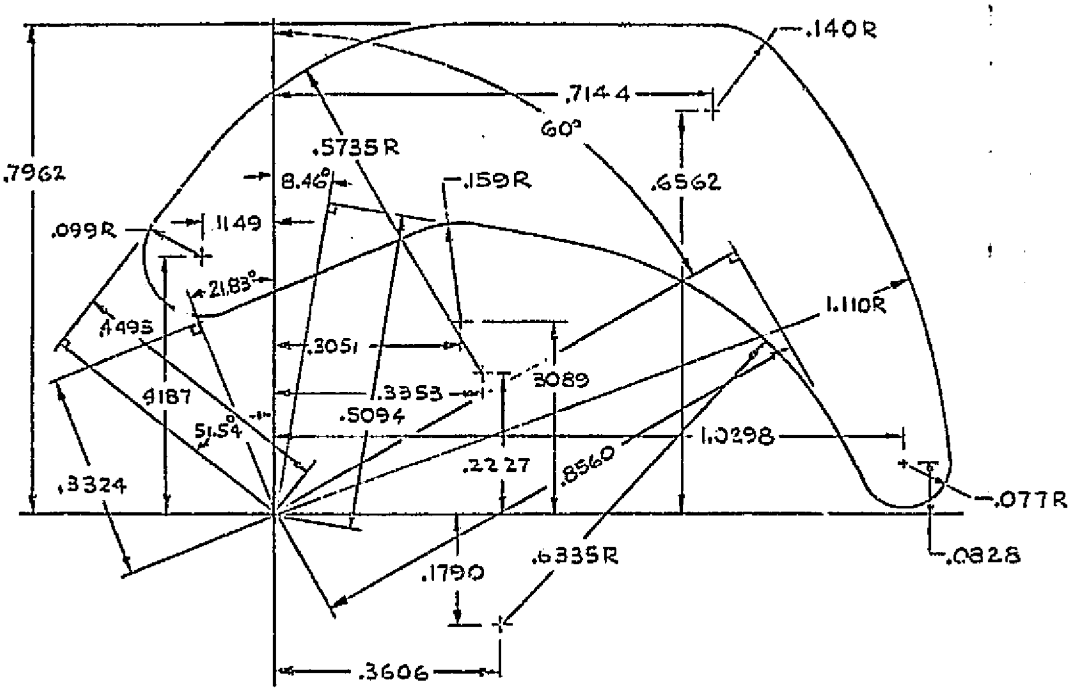
RCA — RCA CORPORATION NEW YORK, NY — ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

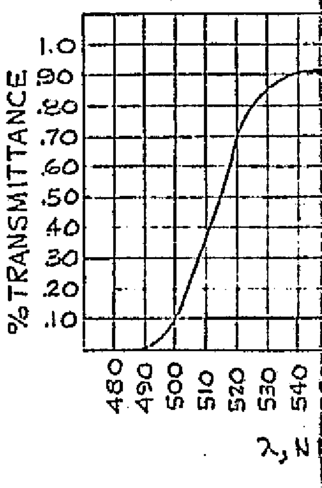
FILTER SEGMENT, BLUE

SIZE	CODE IDENT NO.	
C	49671	SK2277733

SCALE NONE WEIGHT SHEET 1 OF 1







NOTE

1. MATERIAL: OPTICAL GLASS RETICLE GRADE. SURFACES QUALITY SHALL BE 60-40 OR BETTER. FACES SHALL BE FLAT TO 6 RINGS, FACES SHALL BE PARALLEL TO 3 MIN/ARC.
GLASS SHALL BE SIMILAR TO SCHOTT OG515 HAVING SPECTRAL CHARACTERISTICS AS SHOWN ON GRAPH. SURFACE "A" SHALL HAVE AN INTERFERENCE COATING SIMILAR TO FISH-SCHURMAN ML 580 NM, HAVING SPECTRAL CHARACTERISTICS AS SHOWN. MAX. AND MIN. WAVELENGTHS FOR 50% TRANSMISSION POINTS SHALL BE:

515 NM ± 10 NM.
580 NM ± 10 NM.

			X		803(
			AR		
			-1	CODE IDENT	IDENTIF
QTY REQD PER DASH NO.					

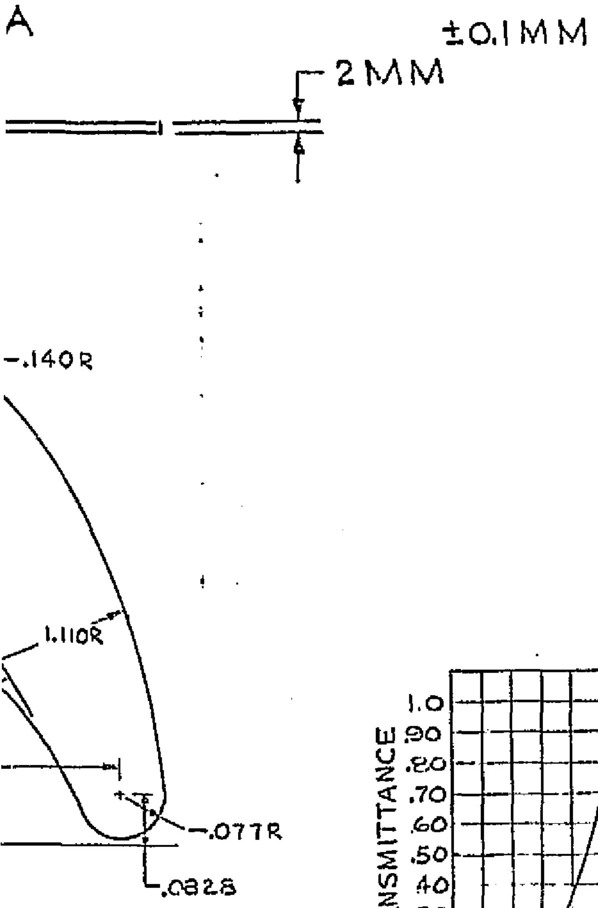
UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING	CONT NA
	TOLERANCES ON:	DRAW
INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66	BASIC DIMENSIONS / 2 PLACE DECIMALS / 3 PLACE DECIMALS	CHEC
THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9	UP TO 6 ± .02 ± .010	
	ABOVE 6 TO 24 ± .03 ± .015	
	ABOVE 24 ± .05 ± .020	
	ANGULAR DIMENSIONS ± ½	DESIG
NEXT ASSY / USED ON: SHUTTLE T.V.	RCA COMMODITY CODE:	Be
FIRST APPLICATION		

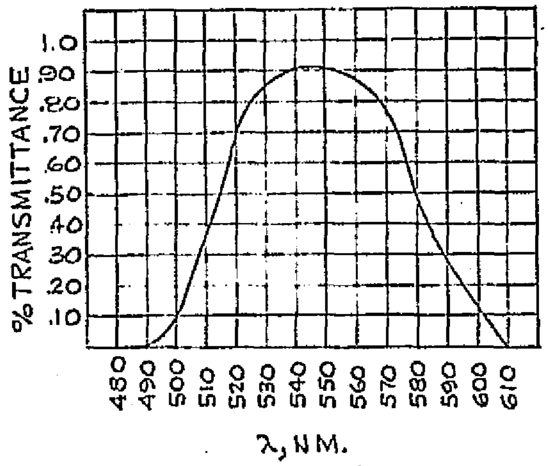
C-2 FOLDOUT FRAME /

RCA 2419 3 (4-71) 7074

ZONE	LTR	DESCRIPTION	DATE	APPROVED
		REVISIONS		

A





FOLDOUT [illegible]

ADE.
O OR
6
L TO

OG515
AS
HAVE
TO

				X		8030022	SPEC. WORKMANSHIP		
				AR			SEE NOTE 1		
				-1					
QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-S1069

	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .05	± .020
ANGULAR DIMENSIONS ± 1/2°		

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Seiffer DATE APR 30,1974

CHECKED M.C. Juschak DATE May 8,1974

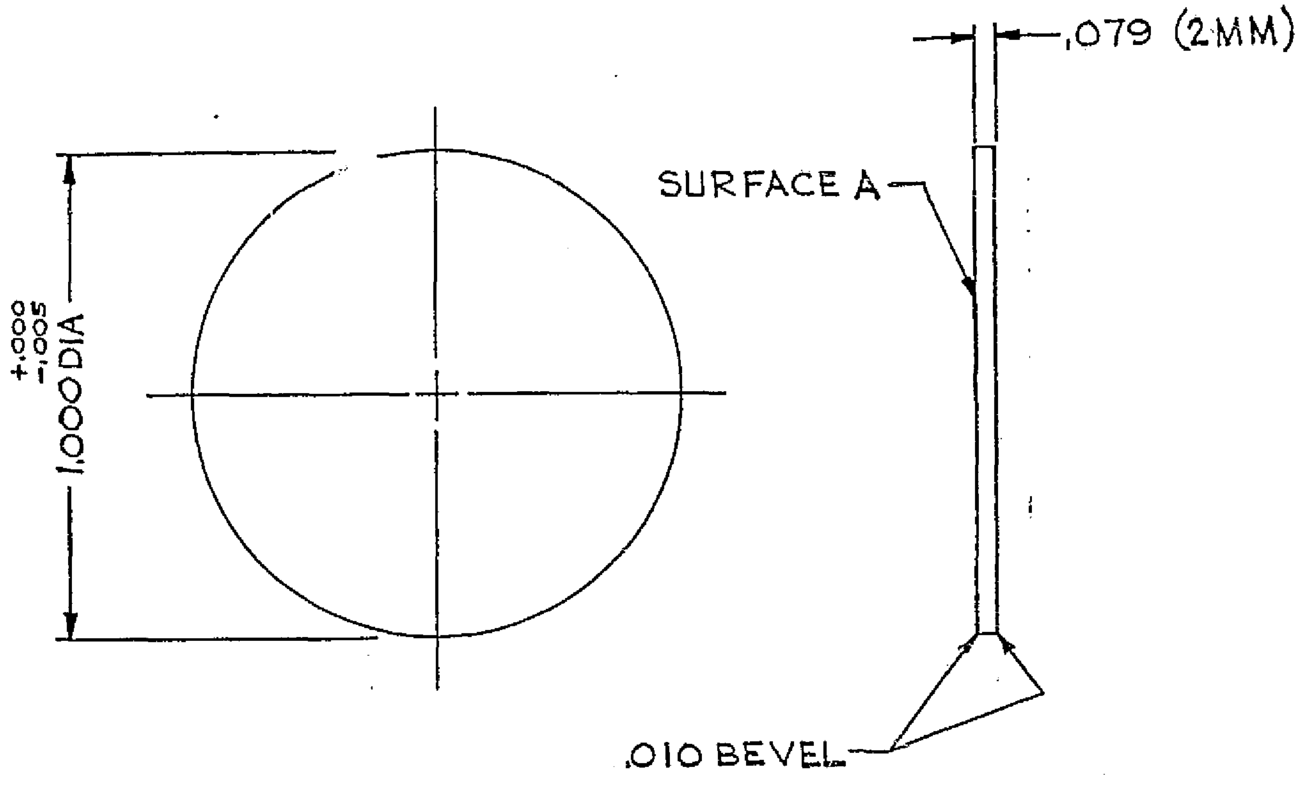
DESIGN ACTIVITY APPD. Bert M Soltoff DATE May 9,74

RCA CORPORATION NEW YORK, NY

RCA ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

FILTER SEGMENT, GREEN

SIZE	CODE IDENT NO.	
C	49671	SK2277734
SCALE NONE	WEIGHT	SHEET 1 OF 1



NOTES:

1. MATERIAL: SCHOTT HA11 FILTER GLASS
2. SURFACES QUALITY SHALL BE 60-40 OR BETTER. FACES SHALL BE FLAT TO 6 RINGS. FACES SHALL BE PARALLEL TO 3 MIN/ARC.
3. SURFACE "A" SHALL HAVE AN INTERFERENCE COATING SIMILAR TO FISH-SCHURMAN ML30255 (8/18/71).
4. RESULTANT FILTER SHALL HAVE NOMINAL TRANSMISSION FROM 415 TO 550 NM OF 85% ± 4 %. THE 50% TRANSMISSION POINTS SHALL BE.
   380 NM ± 10 NM
   645 NM ± 10 NM

FOLDOUT [redacted]

				X		8030022
				AR		
				-1	CODE IDENT	IDENTIFYING NO.
QTY REQD PER DASH NO.						

MA

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

	SHUTTLE T.V.
NEXT ASSY	USED ON
FIRST APPLICATION	

RCA COMMODITY CODE:

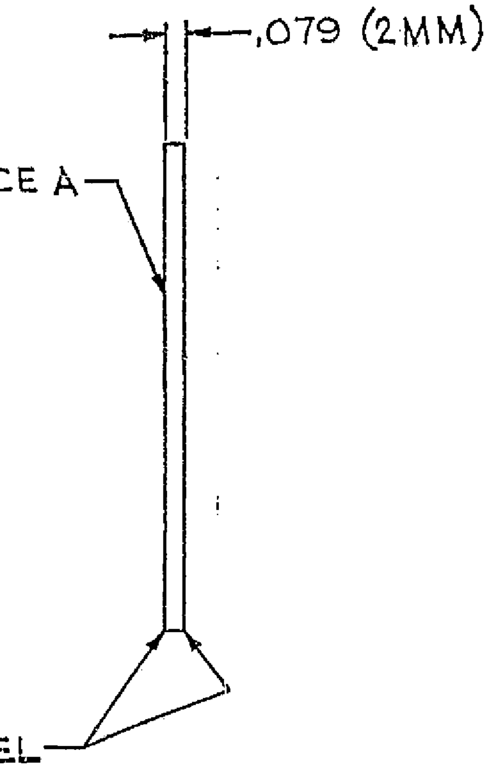
CONTRACT NO. NAS9-13

DRAWN R. Seiffer

CHECKED C.C. Juncheh

DESIGN ACTIVITY A Bert M. Scott

2419-3 (4-71) 7074



REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2

					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.
				X		8030022	SPEC. WORKMANSHIP		
				AR			SEE NOTE 1		
QTY REQD PER DASH NO.				-1					

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
	SHUTTLE TV
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½ °

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN R. Siffbo DATE MAY 9, 1974.

CHECKED T.C. Handel DATE May 9, 1974

DESIGN ACTIVITY APPD. Bert M. Soltoff DATE May 9, 1974

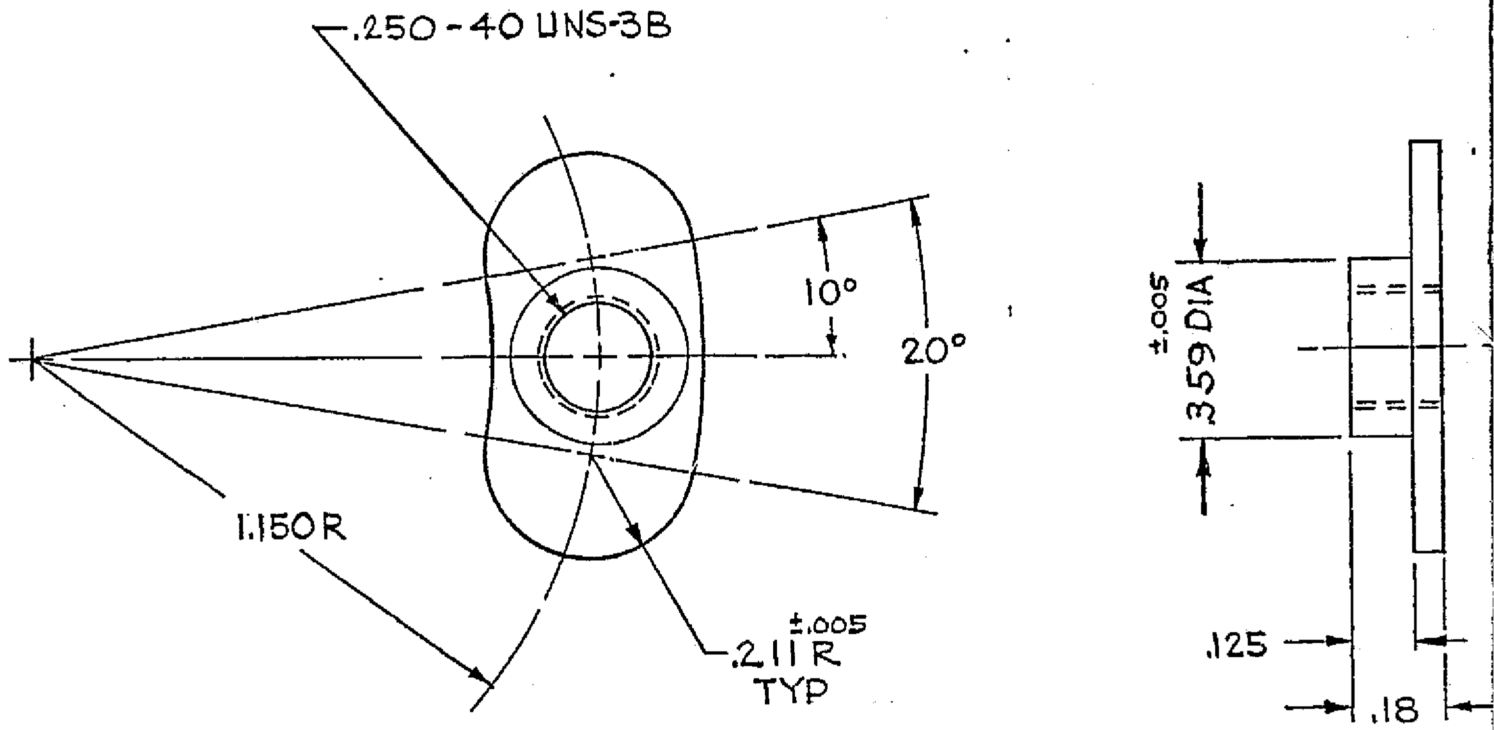
RCA CORPORATION I NEW YORK, NY

RCA ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

BAND PASS FILTER

SIZE	CODE IDENT NO.	
C	49671	SK2277742

SCALE 4/1 WEIGHT SHEET 1 OF 1



NOTES:

1. TAG OR BAG PART NO. 49671-SK2277761-1 PER MIL-STD-130.

				X			803
				AR			1980
				AR			20105
				-1		CODE IDENT	IDENT
QTY REQD PER DASH NO.							

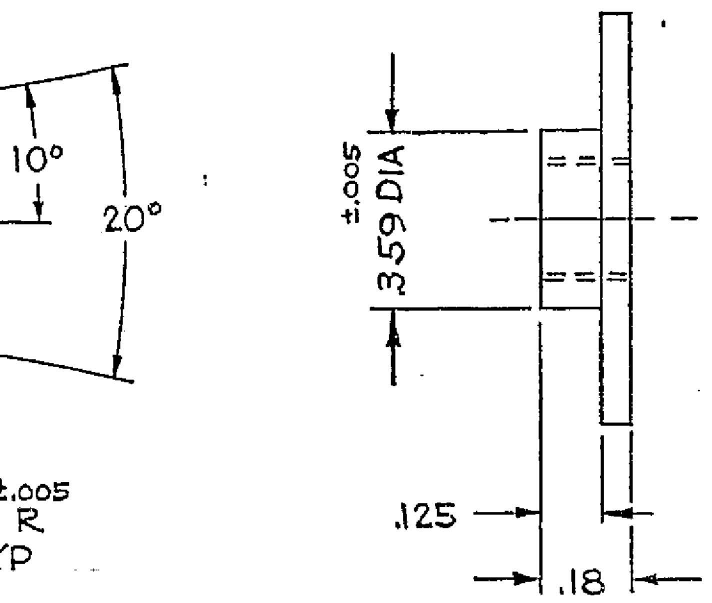
UNLESS OTHERWISE SPECIFIED THE SURF. FIN. OF MACHINED PARTS SHALL NOT EXCEED A MAX READING OF 125/ PER USAS B46.1-1962	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING		
	TOLERANCES ON:		
	BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
DIMENSIONS AND TOLERANCES PER USAS Y14.5-66	UP TO 6	± .02	± .010
THD DATA TO BE INTERPRETED USING HNDBK H28 AND MIL-STD-9	ABOVE 6 TO 24	± .03	± .015
	ABOVE 24	± .06	± .020
	ANGULAR DIMENSIONS ± ½°		
SK2279979 SHUTTLE T.V.			
NEXT ASSY / USED ON	RCA COMMODITY CODE:		
FIRST APPLICATION			

FOLDOUT FRAME

RCA 2419-3 (9-70)

ZONE	LTR	DESCRIPTION	DATE	APPROVED

REVISIONS



FOLDOUT FRAME

				X		8030022	SPEC, WORKMANSHIP		
				AR		1980032-1	PASSIVATING DIP		
				AR		2010556-250	CRES (TYPE 304) SHT, .250 THK	QQ-S-766c(5)	
				-1	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.
QTY REQD PER DASH NO.									

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURF. FIN. OF MACHINED PARTS SHALL NOT EXCEED A MAX READING OF 125/ PER USAS B46.1-1962

DIMENSIONS AND TOLERANCES PER USAS Y14.5-66

THD DATA TO BE INTERPRETED USING HNDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
SK2279979	SHUTTLE T.V.
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 REL

DRAWN K. Aliffo DATE MAY 15, 1974.

CHECKED Lewis E. Woodley DATE May 30, 1974

DESIGN ACTIVITY APPD. DATE 28 May 74

RCA

RCA CORPORATION | NEW YORK, NY

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

PLATE, SENSOR MOUNTING

SIZE	CODE IDENT NO.	
C	49671	SK2277761

SCALE 4/1 WEIGHT SHEET 1 OF 1

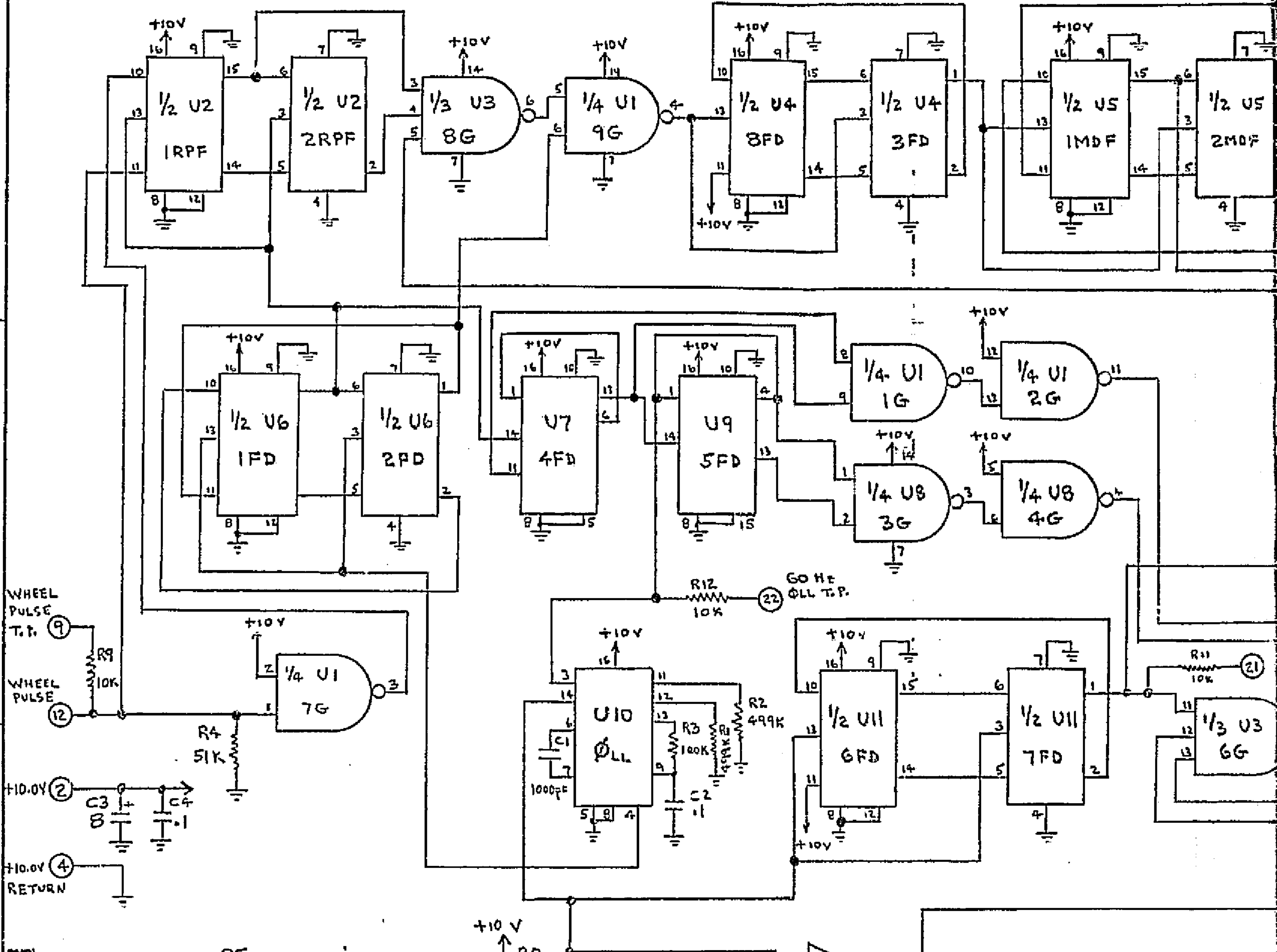
4 5

D

C

B

A



QTY REQD PER DASH NO.					CODE IDENT		IDENT

NOTES:

1. U1 & U8 ARE TYPE CD4011AE
2. U2, U4, U5, U6, U11 ARE TYPE CD4027AE
3. U3 IS TYPE CD4023AE
4. U7 & U9 ARE TYPE CD4018AE
5. U10 IS TYPE CD4046AE
6. U12 IS TYPE CD4050AE
7. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE STATED
8. ALL RESISTOR ARE IN OHMS UNLESS OTHERWISE STATED

FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125 PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

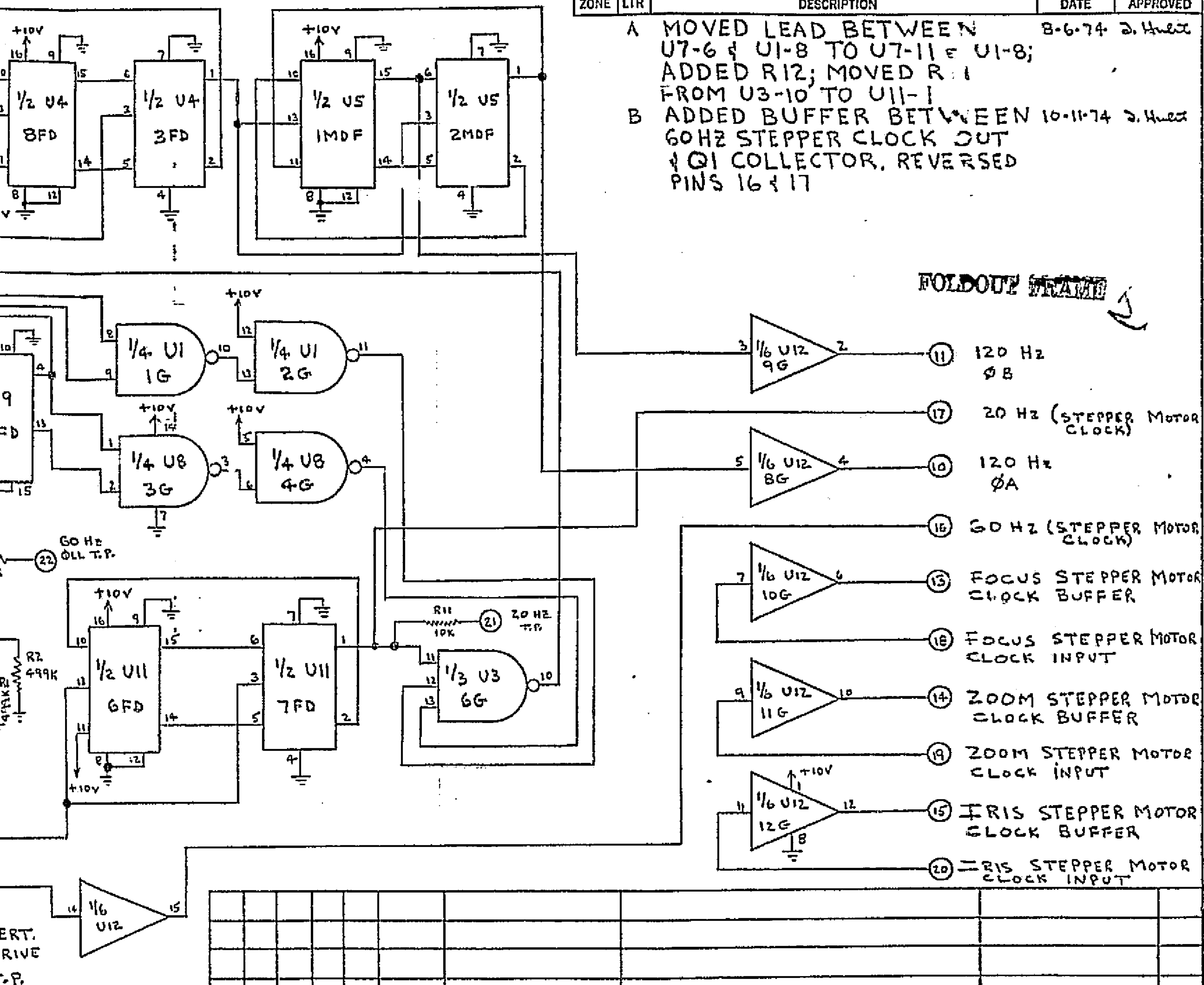
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± ½°		

RCA COMMODITY CODE:

RCA 2419-3 (4-71) 7074

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	MOVED LEAD BETWEEN U7-6 & U1-8 TO U7-11 & U1-8; ADDED R12; MOVED R 1 FROM U3-10 TO U11-1	8-6-74	D. Hulet
	B	ADDED BUFFER BETWEEN 60HZ STEPPER CLOCK OUT & Q1 COLLECTOR, REVERSED PINS 16 & 17	10-11-74	D. Hulet



FOLDOUT FRAME

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2 °

RCA COMMODITY CODE:

CONTRACT NO. NAS 9-13688 REL

DRAWN D. Hulet DATE 5-1-74

CHECKED DATE

DESIGN ACTIVITY APPD. DATE

RCA CORPORATION | NEW YORK, NY

RCA ASTRO ELECTRONICS PRINCETON, N.J. PLANT

SCHEMATIC
FILTER WHEEL DRIVE AND PHASING LOGIC - 2A1

SIZE	CODE IDENT NO.	
C	49671	SK 2277775

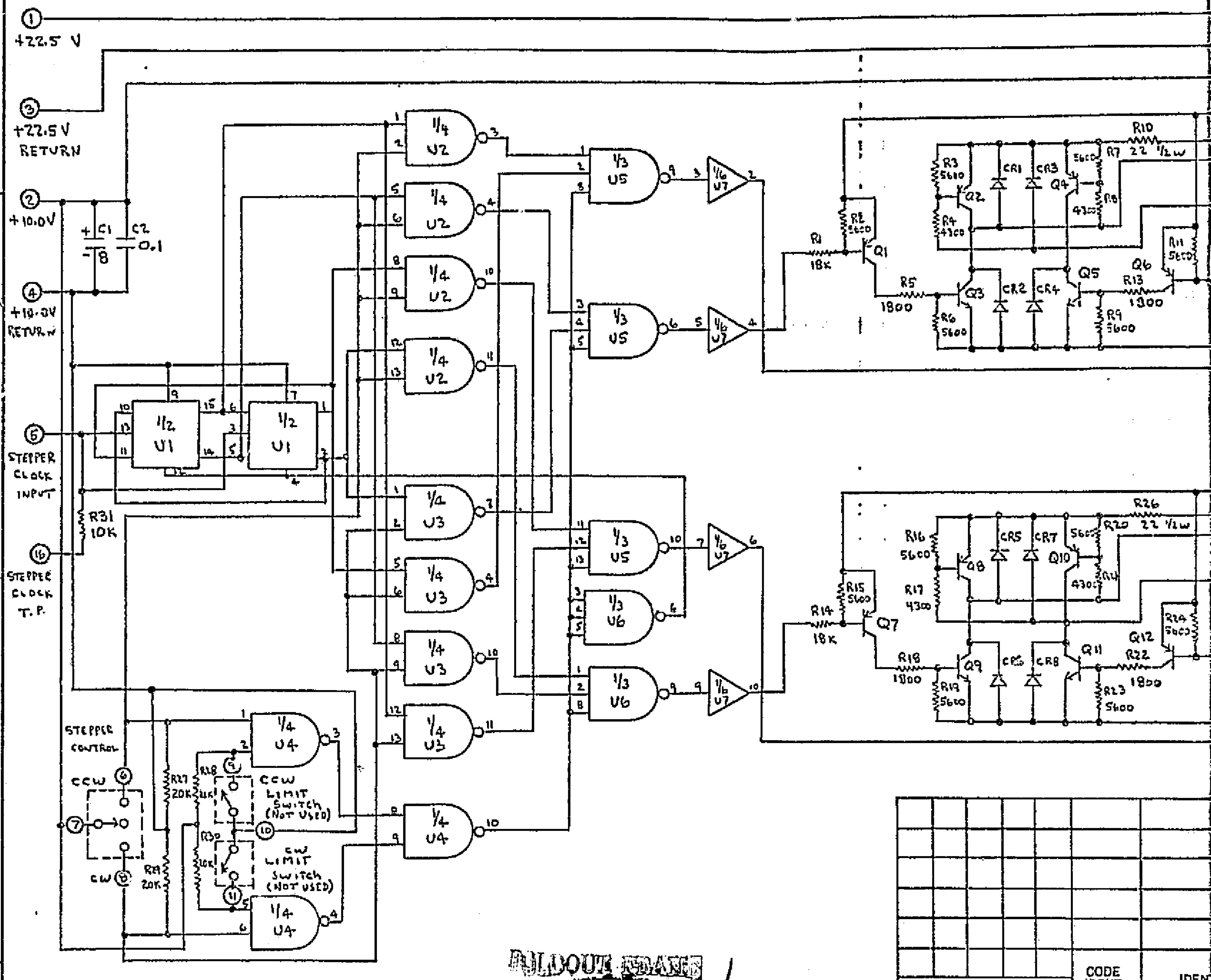
SCALE — WEIGHT — SHEET 1 OF 1

D

C

B

A



QTY REQD PER DASH NO.					CODE IDENT	IDEN

NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTOR VALUES ARE IN OHMS, 1/4 WATT, ±5%
2. UNLESS OTHERWISE SPECIFIED: ALL CAPACITOR VALUES ARE IN MICROFARADS
3. ALL DIODES ARE TYPE 1N645
4. Q1, Q3, Q4, Q6, Q7, Q8, Q9, Q12 ARE TYPE 2N2907A
5. Q2, Q4, Q10, Q11 ARE TYPE 2N2222A
6. U1 IS TYPE CD4027AE
7. U2, U3, U4, ARE TYPE CD4011AE
8. U5, U6 ARE TYPE CD4023AE
9. U7 IS TYPE CD4050AE

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

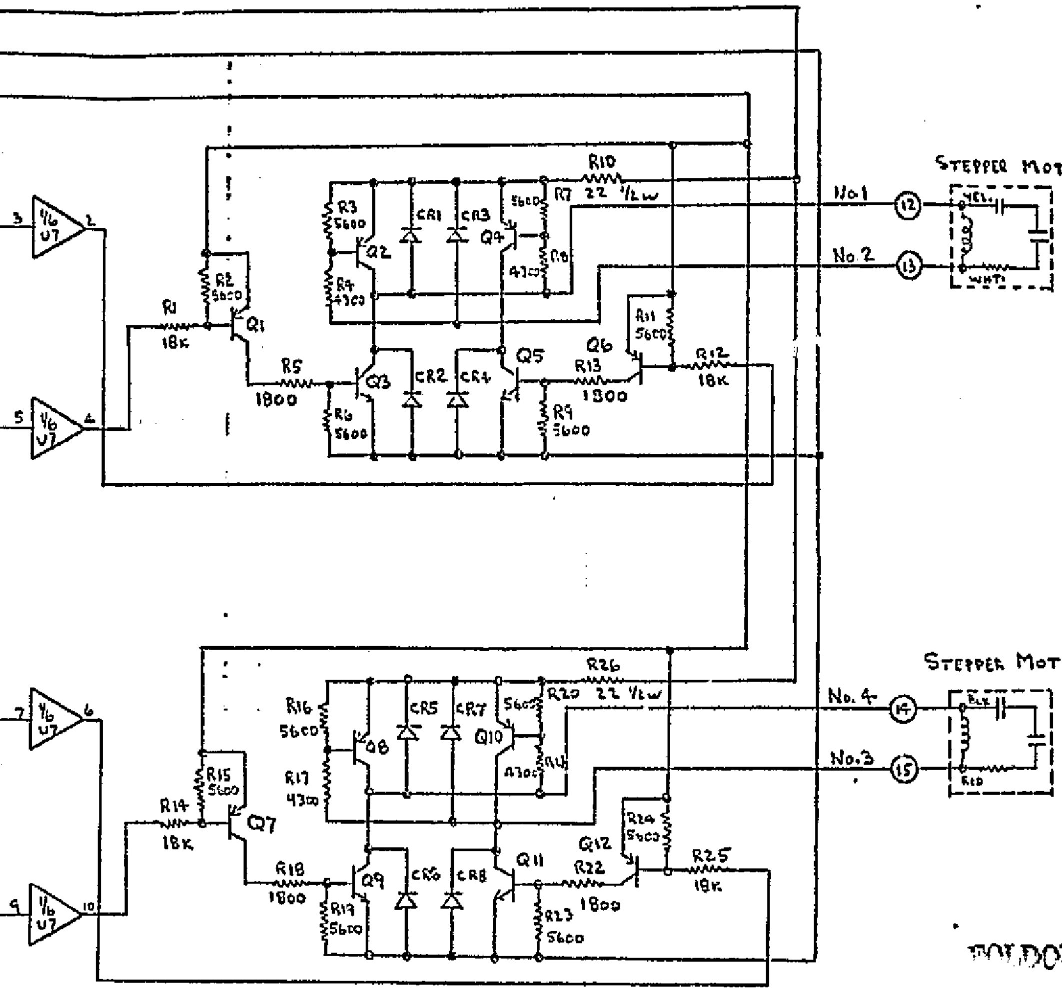
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020
ANGULAR DIMENSIONS ± 1/2 °		

RCA COMMODITY CODE:

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADDED Q7, R31 DESIGNATION; CHANGED VALUE OF C1 FROM 10 TO 8;	9-6-74	D. Hulit



NOTES:

10. STEPPER MOTOR LOGIC & DRIVER USED FOR LENS ZOOM, FOCUS, & IRIS DRIVES

11. I.C. POWER & GROUND CONNECTIONS

I.C.	+10.0 V	GROUND
U1	16	8
U2	14	7
U3	14	7
U4	14	7
U5	14	7
U6	14	7
U7	1	8

FOLDOUT FRAME

2

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-66

THD DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
ABOVE 6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± 1/2 °

RCA COMMODITY CODE:

CONTRACT NO. NAS9-13688 | REL

DRAWN D. Hulit DATE 5-9-74

CHECKED DATE

DESIGN ACTIVITY APPD. DATE

RCA CORPORATION | NEW YORK, NY

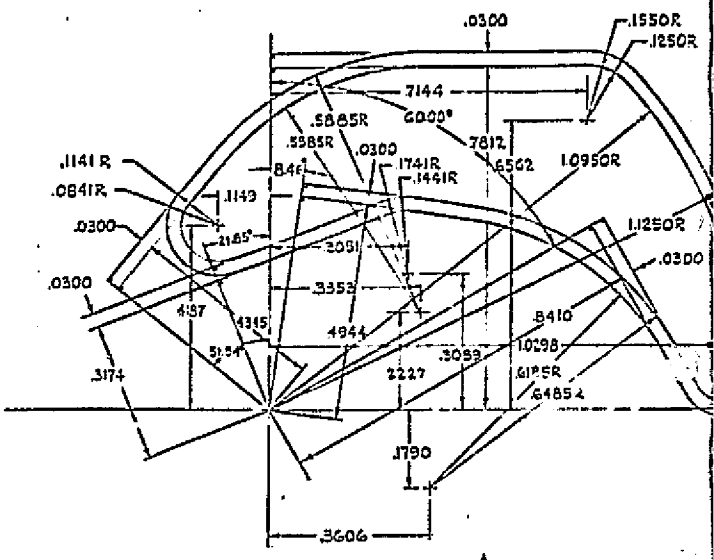
RCA ASTRO ELECTRONICS DIV. PRINCETON, N.J. PLANT

SCHEMATIC STEPPER MOTOR LOGIC & DRIVER BD. 2A3, 2A4, 2A5

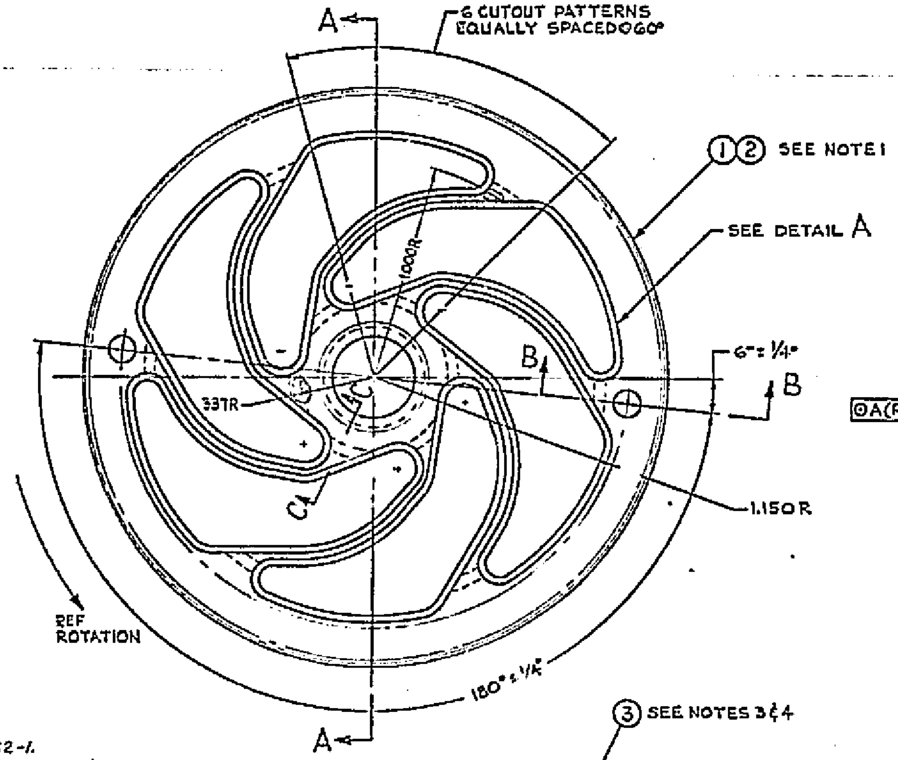
SIZE C | CODE IDENT NO. 49671 | SK2277776

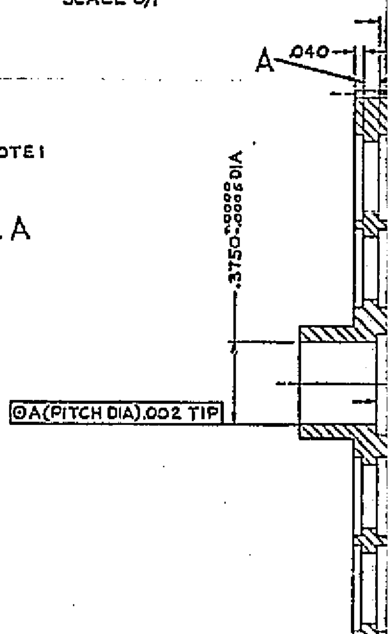
SCALE — | WEIGHT — | SHEET 1 OF 1

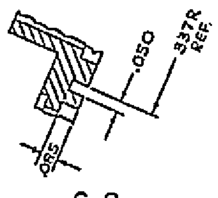
REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR



DETAIL A
SCALE 8/1

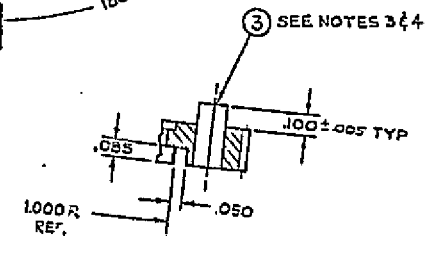






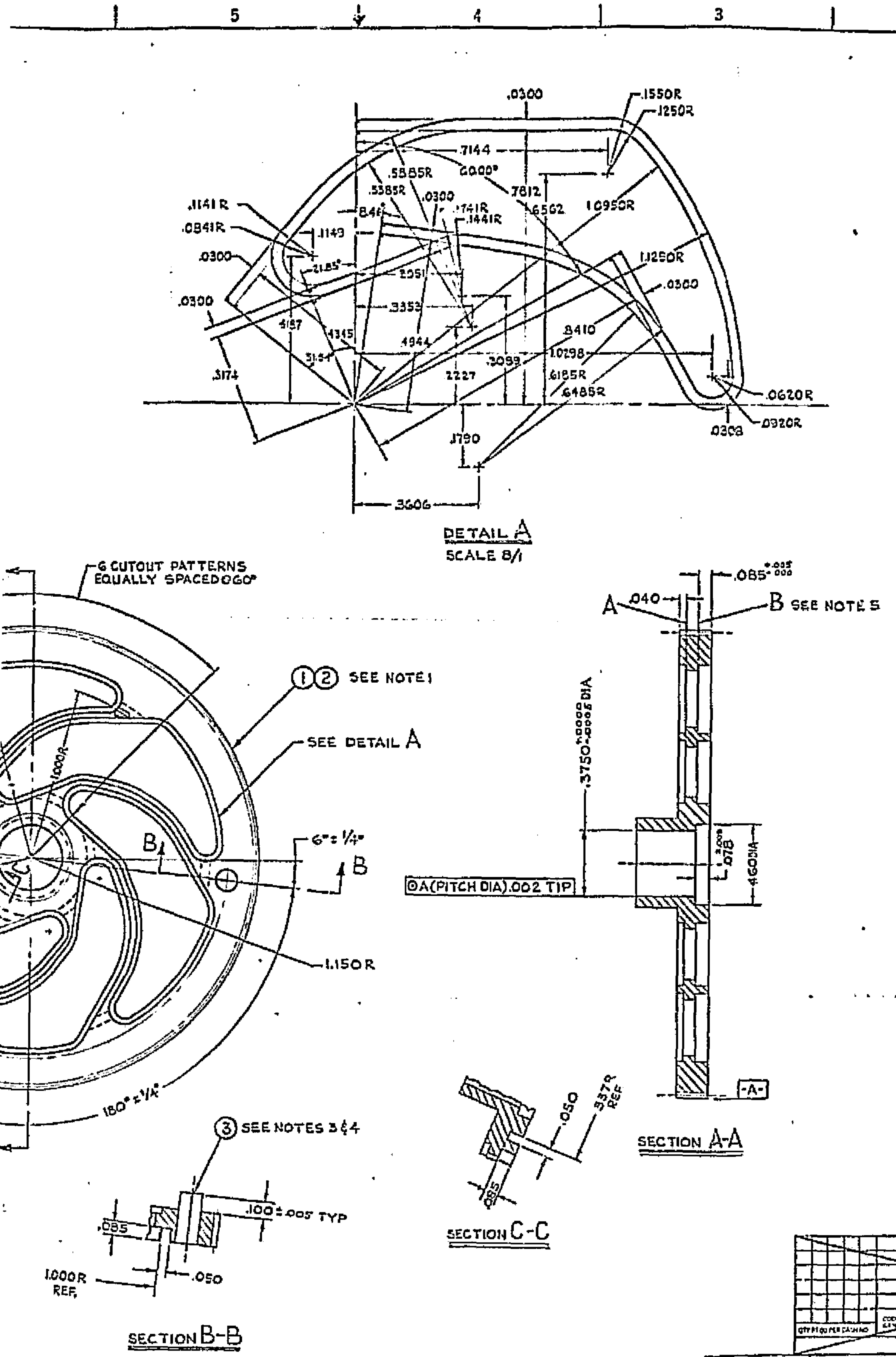
SECTION C-C

1. MAKE ITEM 2 FROM ITEM 1.
2. FINISH - PASSIVATING DIP, 1980032-1.
3. MATERIAL - DRILL ROD, CARBON STEEL (TYPE W1) .125 DIA 49671-2010103-124.
4. PRESS FIT ITEM 3 IN TO ITEM 2.
5. SURFACES A&B SHALL BE PERPENDICULAR TO .3750 BORE WITHIN .002 T.I.R. SURFACES A&B IN INDIVIDUAL CAVITIES SHALL BE FLAT TO WITHIN .001 T.I.R.
6. WORKMANSHIP SHALL BE IN ACCORDANCE WITH PARTS LIST, ITEM 4.
7. TAG OR BAG PART NO. 49671-SK2279958-501 PER MIL-STD-130.



SECTION B-B

FOLDOUT FRAME



FOLDOUT

FOR PARTS LIST SEE PL SK2279958

MATERIALS AND SPECIFICATIONS

NAS9-13898

RCA

WHEEL, FILTER

E | 49671 | SK2279958

PARTS LIST

RCA CORPORATION | NEW YORK, NY
ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J

REVISION DATE	
	PLSK2279958
REV LTR	
LIST TITLE:	WHEEL, FILTER
PREPARED BY / DATE	R. Slitko MAY 17, 1974
CHECKED BY / DATE	
DESIGN ACTIVITY APPD / DATE	Bertin Soltoff May 17, 1974
REL	
CODE IDENT NO.	49671
SHEET	1 OF 2 SHEETS
CONTRACT NO.	NAS-9-13688

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED	LTR	DESCRIPTION	DATE	APPROVED

INTERPRET SYMBOLS USED AS FOLLOWS:

UNITS OF MEASURE (UM)	QUANTITIES	SYMBOL
A — Inches, B — Feet, C — Yards, D — Ounces, E — Pints, F — Quarts, G — Gallons, H — Barrels, J — Pounds, L — Pair, M — Set, N — Kit, P — Roll, R — Box, Case, T — Each	X — Applicable document; O — For ref only	U — Govt or customer furnished; K — Govt or customer furnished and installed; ✲ — Vendor item, See specification or source control drawing.

Parts List Worksheet

RCA Astro Electronics

Next Higher Assembly No ____
Shop Order FB 5000
Contract NAS9-13688

Project SHUTTLE DV.
Prepared by R. SLIFER Date 8-26-1974
Checked by ____ Date ____

Assembly Number	Shop Order	Assembly Title	PL Number
SK2279958-501		WHEEL, FILTER	SK2279958-501

HG (4) 14-17	Suf (3) 10-13	20	24	Item No. 25-30	.04 31-35	.03 36-40	.02 41-45	.01 46-50	51	52-53	54-58	Part or Ident. Number 78		Nomenclature or Description 72	80
		L		1				1			2 41	G17-168	1	GEAR	2
		L		2				1				SK2279958-2	1	GEAR, ALTERED	2
		L		3				2				SK2279958-3	1	PIN	2
		L		4				X				8030022	1	SPEC, WORKMANSHIP	2
		L											1		2
		L											1		2
		L											1		2
		L											1		2
		L											1		2
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AE 316 7/71

PARTS LIST

RCA CORPORATION | NEW YORK, NY

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J

REVISION DATE	PLSK2279971	REV LTR

LIST TITLE:	PREPARED BY / DATE	REL	CODE IDENT NO.	SHEET
GEAR HOUSING, FRONT	R. Slifko MAY 6, 1974		49671	SHEET 1 OF 2 SHEETS
	CHECKED BY / DATE: Louis E. Bordley May 30 1974		CONTRACT NO. NAS9-13688	
	DESIGN ACTIVITY APPD / DATE: Bert M. Soltoff May 30, 1974			

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED	LTR	DESCRIPTION	DATE	APPROVED

INTERPRET SYMBOLS USED AS FOLLOWS:

UNITS OF MEASURE (UM)	QUANTITIES	SYMBOL
A — Inches, B — Feet, C — Yards, D — Ounces, E — Pints, F — Quarts, G — Gallons, H — Barrels, J — Pounds, L — Pair, M — Set, N — Kit, P — Roll, R — Box, Case, T — Each	X — Applicable document; O — For ref only	U — Govt or customer furnished; K — Govt or customer furnished and installed; * — Vendor item, See specification or source control drawing.

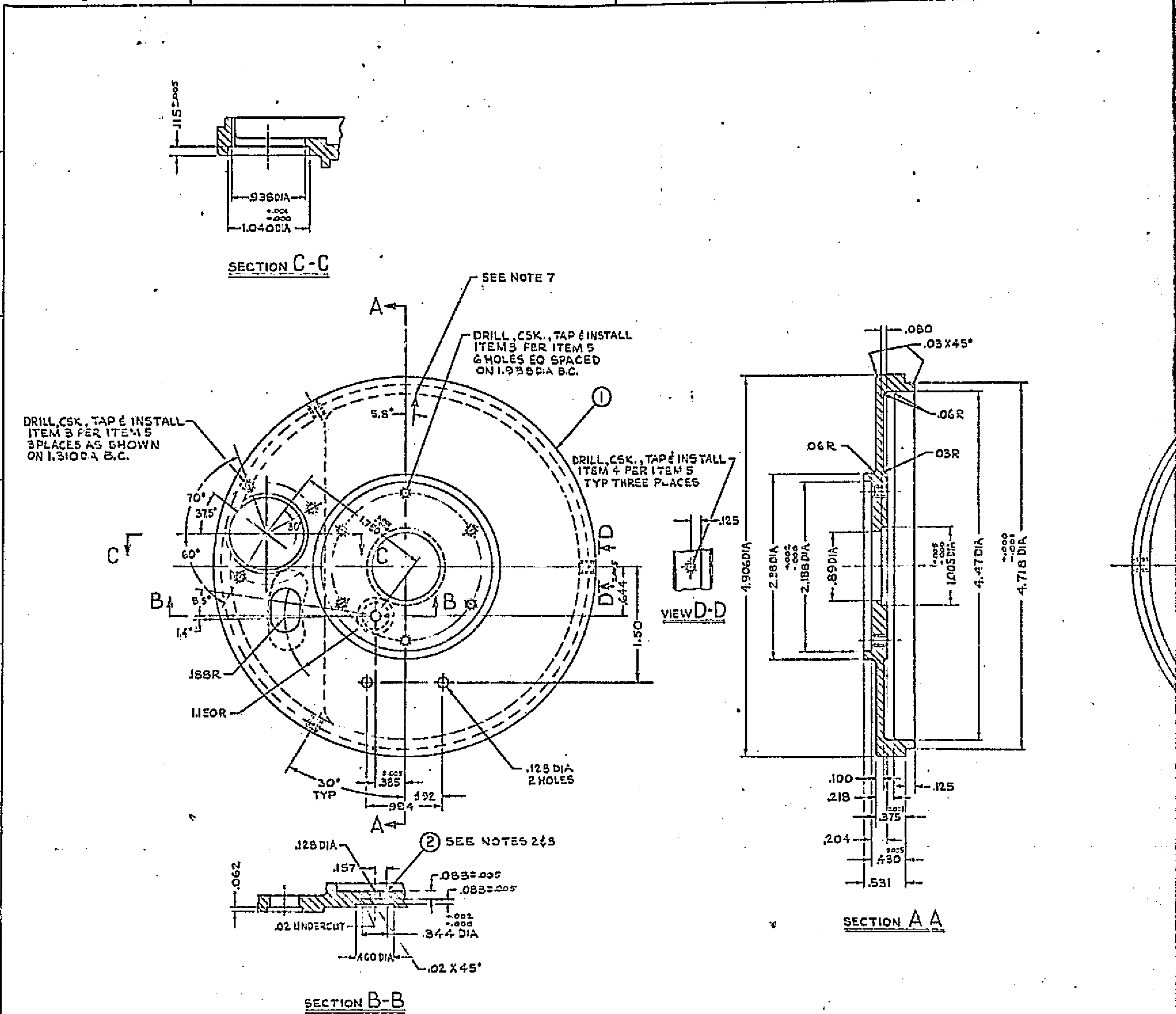
SIZE	CODE IDENT NO.	DRAWING NO.	REVISION	SHEET
A	49671	SKPL2279971	-	2

PARTS LIST

ITEM	QUANTITY REQUIRED -504	-503	-502	-501	TYPE	UM	CODE IDENT	PART OR IDENTIFYING NO.	*	NOMENCLATURE OR DESCRIPTION
1				1				SK2279971-1		GEAR HOUSING,FRONT
2				1			00141	C5-22		PIN,SPIROL
3				9				MS21209C0415		INSERT
4				3				MS21209C0415		INSERT
5				X				2020312		SPEC MANUF
6				X				8030022		SPEC WORKMANSHIP

* DENOTES VENDOR ITEMS. SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING BEFORE ORDERING.
UM - IN COLUMN HEADING DENOTES UNITS OF MEASURE (USE STANDARD ABBREVIATION)
EXPLANATION OF SYMBOLS IN TYPE COLUMN
Z - DENOTES CONTROLLED ITEM (CLASSIFIED)
T - DENOTES TOOL DRAWING
FOR QUANTITY AND EFFECTIVITY REFER TO EFFECTIVITY BLOCK

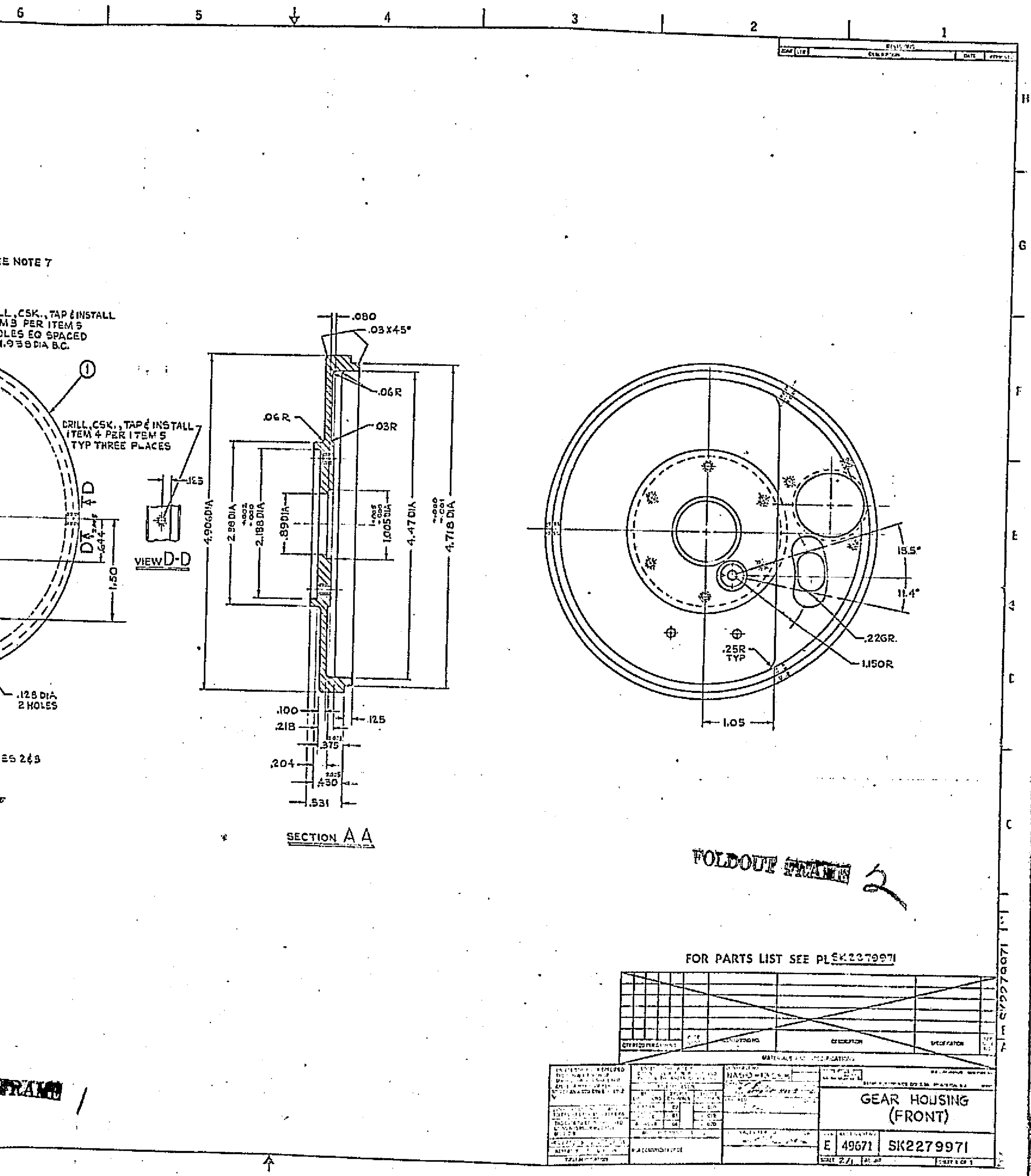
CLASSIFICATION:



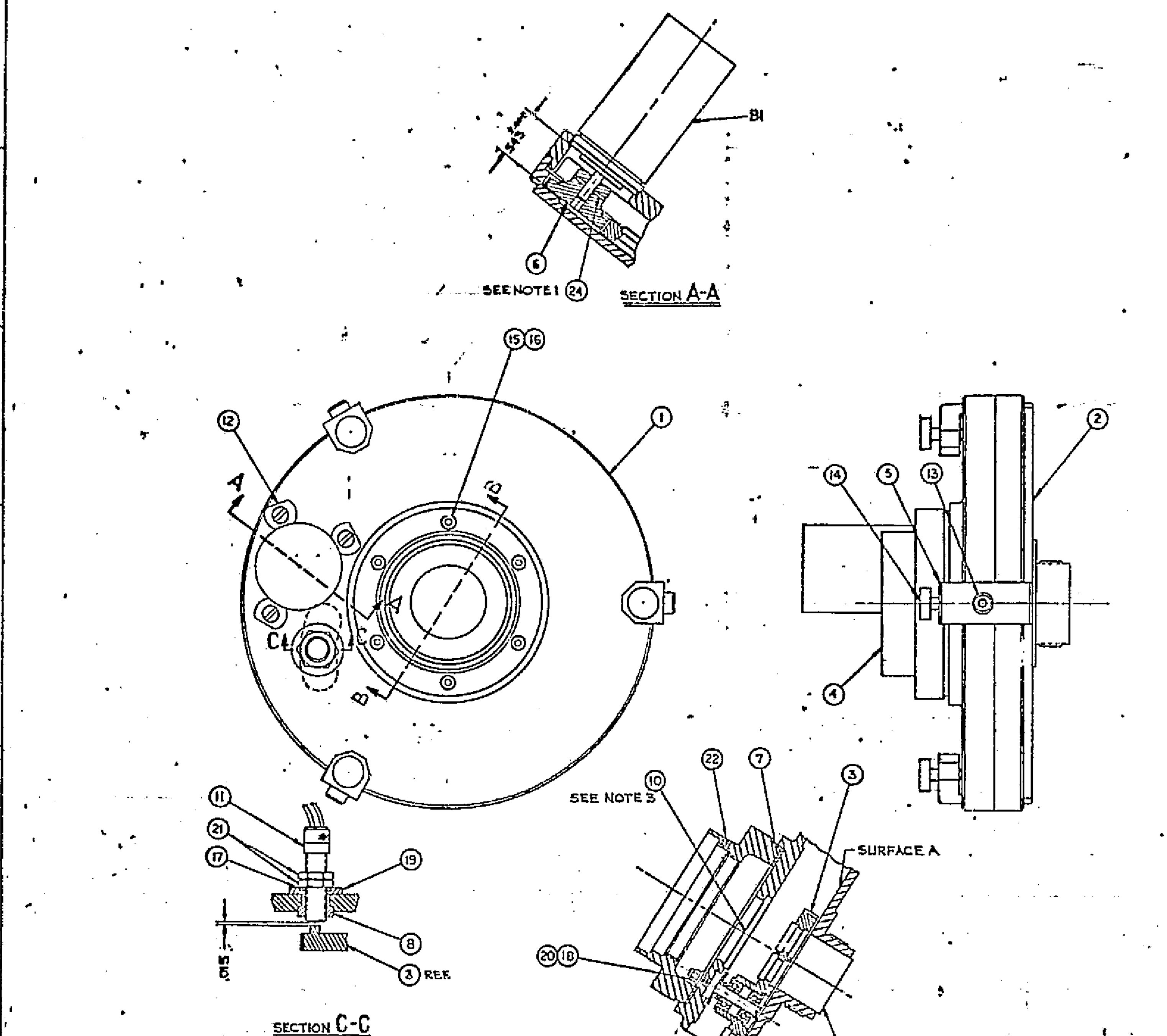
NOTES:

1. MATERIAL - ALUM ALLOY 2024-T4 QQ-A-250/4C .750 THK (49671-2010636-595)
2. DRILL .052±.001 DIA HOLE FOR ITEM 2.
3. PRESS FIT ITEM 2 INTO ITEM 1. SEAT FLUSH WITH .460 DIA C'BORE SURFACE.
4. FINISH- BLACK ANODIZE 1980043-1.
5. WORKMANSHIP SHALL BE IN ACCORDANCE WITH PARTS LIST, ITEM 5.
6. TAG OR BAG PART NO. 49671-SK2279971-501 PER MIL-STD-130.
7. ENGRAVE 1/32 WIDE LINE AND ARROWHEAD APPROXIMATELY AS SHOWN, AT SPECIFIED ANGLE. FILL WITH WHITE AFTER APPLYING FINISH.

FOLDOUT FRAME



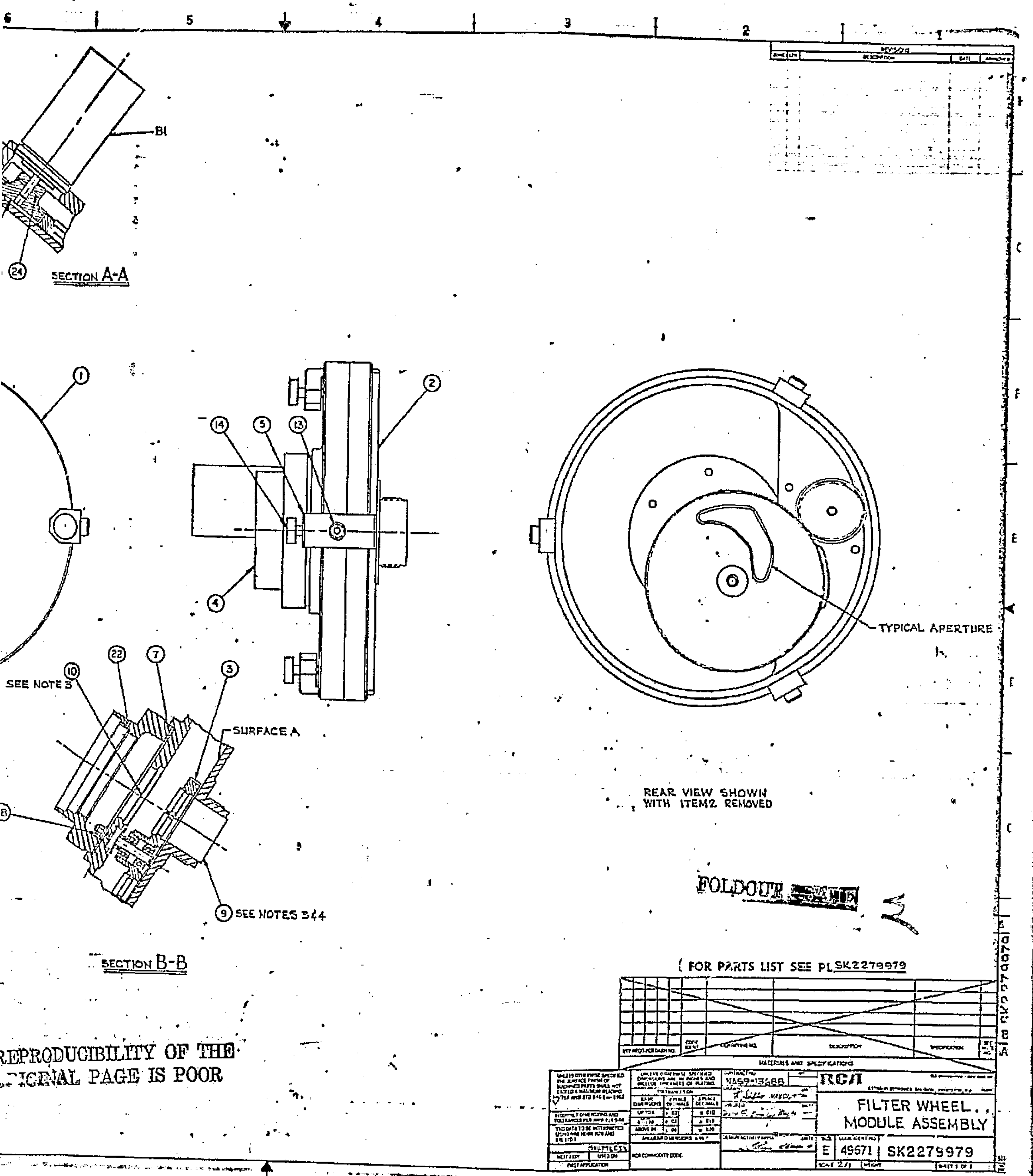
E NOTE 7
LL, CSK., TAP & INSTALL
M3 PER ITEM 5
OLES EQ SPACED
1.939 DIA B.C.
DRILL, CSK., TAP & INSTALL
ITEM 4 PER ITEM 5
TYP THREE PLACES
.125
VIEW D-D
D
D
.644
1.50
.128 DIA
2 HOLES
ES 2 & 3
.080
.03 X 45°
.06R
.06R
.03R
4.906 DIA
2.98 DIA
2.188 DIA
.890 DIA
1.005 DIA
4.47 DIA
4.718 DIA
.100
.218
.125
.375
.204
.430
.531
SECTION A A
15.5°
11.4°
.22GR.
1.150R
.25R
TYP
1.05
FOLDOUT FRAME 2
FOR PARTS LIST SEE PL SK2279971
MATERIALS AND SPECIFICATIONS
GEAR HOUSING
(FRONT)
E 49671 SK2279971
SK2279971
FRAME



NOTES:

1. SECURE GEAR, ITEM 6 IN POSITION USING SET SCREW, ITEM 23. DRILL .039 DIA HOLE USING PART DRILLED HOLE IN ITEM 6 AS A PILOT. PIN ITEM 6 TO MOTOR SHAFT USING ITEM 24. REMOVE SET SCREW, ITEM 23 AND DISCARD.
2. ROTATE MOTOR TO ADJUST GEAR CENTER DISTANCE. ADJUST FOR MIN .002 TO MAX .004 BACKLASH BETWEEN ITEMS 3 AND 4.
3. BOND ITEMS 9 AND 10 USING ITEMS 25, 26 AND 27 PER ITEM 29.
4. ITEM 9 TO BE FLUSH WITH SURFACE A.

FOLDOUT FRAME


SECTION A-A
B1
SECTION B-B
SEE NOTE 3
SURFACE A
SEE NOTES 3&4
TYPICAL APERTURE
REAR VIEW SHOWN WITH ITEM 2 REMOVED
FOLDOUT
FOR PARTS LIST SEE PL SK2279979
MATERIALS AND SPECIFICATIONS
NAS9-13688
RCA
FILTER WHEEL MODULE ASSEMBLY
E 49671 SK2279979

PARTS LIST	RCA — RCA CORPORATION NEW YORK, NY — ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J	REVISION DATE	PLSK2279979	REV LTR

LIST TITLE:	PREPARED BY / DATE	REL	CODE IDENT NO.	SHEET 1 OF 2 SHEETS
FILTER WHEEL MODULE ASSEMBLY	R. Slifko MAY 20, 1974		49671	
	CHECKED BY / DATE: Lewis E. Bodley May 30, 1974		CONTRACT NO.	
	DESIGN ACTIVITY APPD / DATE: Bert M. Soltoff May 30, 74		NAS9-13688	

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED	LTR	DESCRIPTION	DATE	APPROVED

INTERPRET SYMBOLS USED AS FOLLOWS:

UNITS OF MEASURE (UM)	QUANTITIES	SYMBOL
A — Inches, B — Feet, C — Yards, D — Ounces, E — Pints, F — Quarts, G — Gallons, H — Barrels, J — Pounds, L — Pair, M — Set, N — Kit, P — Roll, R — Box, Case, T — Each	X — Applicable document; O — For ref only	U — Govt or customer furnished; K — Govt or customer furnished and installed; * — Vendor item, See specification or source control drawing.

RCA 2400-3 (8 68)

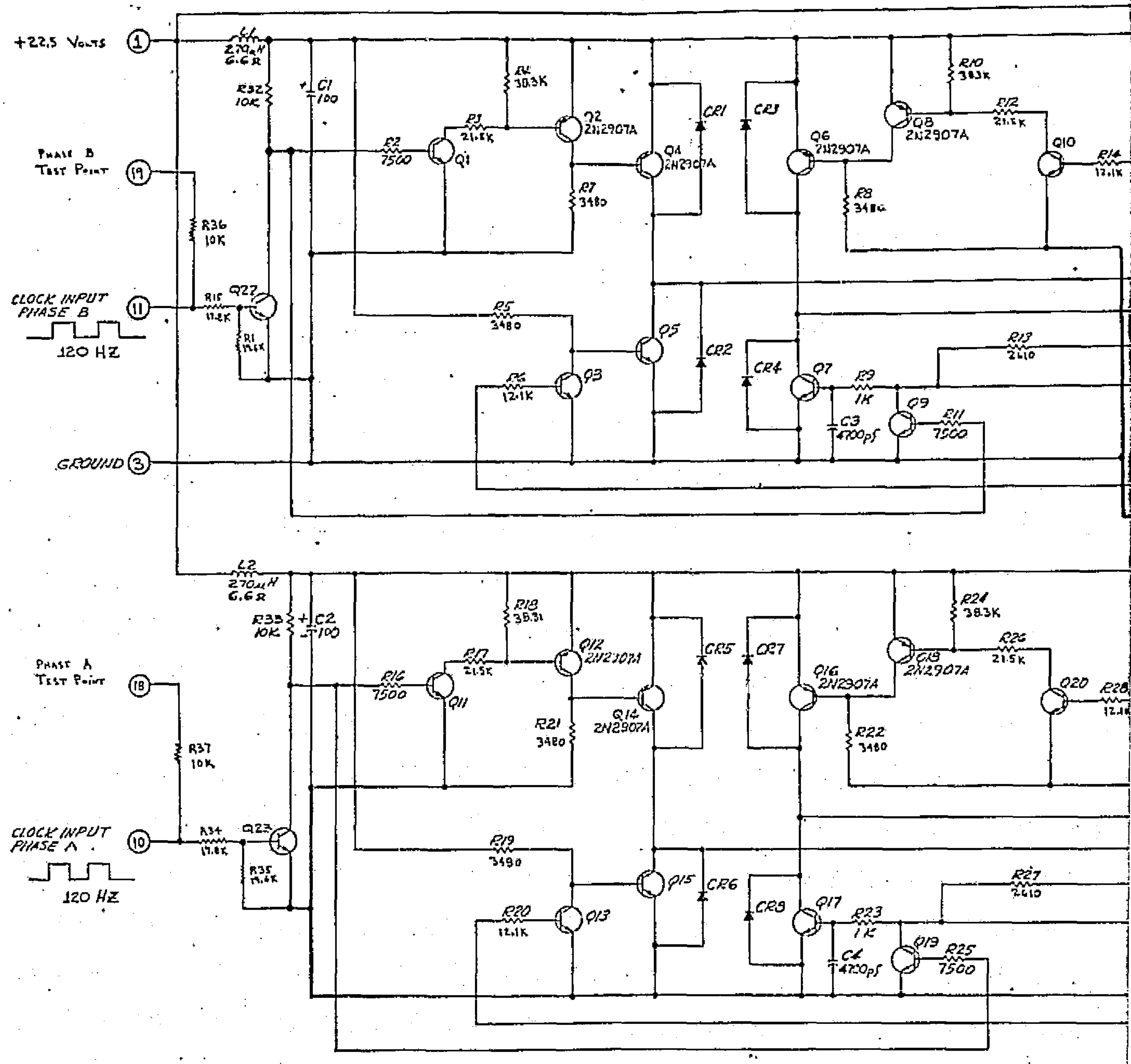
			SIZE	CODE IDENT NO.	DRAWING NO.	REVISION	SHEET
			A	49671	SKPL2279979	-	2

PARTS LIST

ITEM	QUANTITY REQUIRED -504	-503	-502	-501	TYPE	UM	CODE IDENT	PART OR IDENTIFYING NO.	*	NOMENCLATURE OR DESCRIPTION
6 1				1				1971381-2		MOTOR
1				1				SK2279971-501		GEAR HOUSING (FRONT)
2				1				SK2283447-1		GEAR HOUSING (REAR)
3				1				SK2283460-501		FILTER WHEEL ASSY
4				1				SK2277726-1		RETAINER, LENS
5				3				SK2277722-1		CLAMP
6				1				SK2277717-501		GEAR
7				1				SK2277728-1		SHIM, LENS-RETAINER
8				1				SK2277701-1		PLATE, SENSOR MOUNTING
9				1				SK2273224-1		FILTER, COMPENSATING
10				1				SK2277742-1		FILTER, BAND PASS
11				1			91692	58388		MAGNETIC SENSOR
12				3			00141	L3-1		CLEAT, MOTOR
13				3			00141	4410		SCREW, SHOULDER
14				3			00141	4010		SCREW, THUMB
15				6				NAS1352C04-10		SCREW
16				6				NAS1640-4		WASHER, LOCK
17				1			00141	D6-1		WASHER, WAVE SPRING
18				1				NAS620-4		WASHER, FLAT
19				1				SK2273306-1		BUSHING, THRUST
20				1				NAS1291C04M		NUT, SELF LOCKING
21				2			91692	633513		NUT, .250-40
22				3			00141	Y11-3		SCREW, SET
23				1			00141	Y11-8		SCREW, SET
24				1			00141	C5-15		PIN, SPIROL
25				AR				99354-171		RTV 560
26				AR				99354-128		T12 CATALYST
27				AR				90485-160		RTV PRIMER
28				X				8030022		SPEC WORKMANSHIP
29				X						SPEC BONDING

* DENOTES VENDOR ITEMS - SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING BEFORE ORDERING.
UM - IN COLUMN HEADING DENOTES UNITS OF MEASURE (USE STANDARD ABBREVIATION)
EXPLANATION OF SYMBOLS IN TYPE COLUMN
Z - DENOTES CONTROLLED ITEM (CLASSIFIED)
T - DENOTES TOOL DRAWING
[ ] - FOR QUANTITY AND EFFECTIVITY REFER TO EFFECTIVITY BLOCK

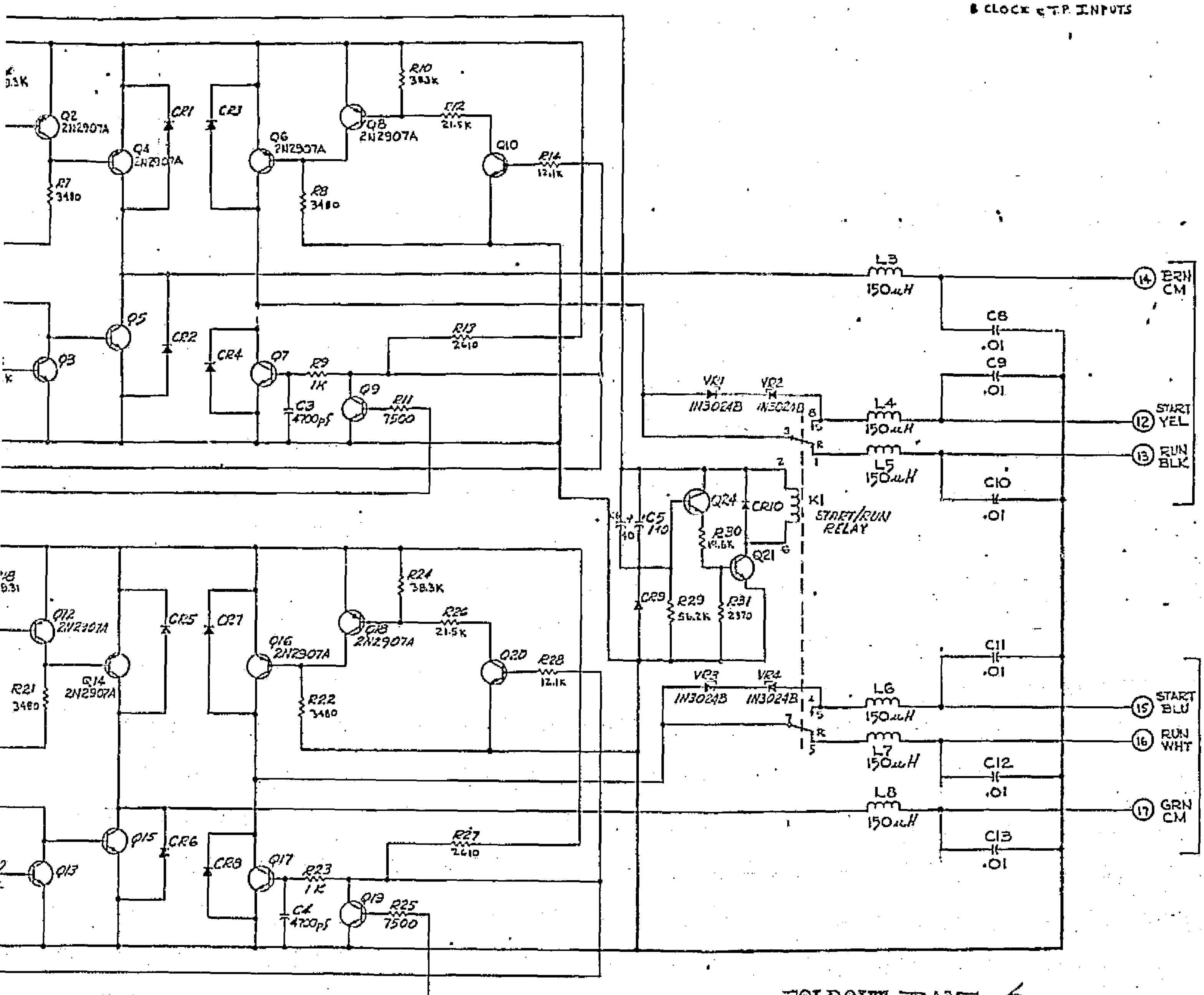
CLASSIFICATION:



FOLDOUT FRAME

NOTES:
1. UNLESS OTHERWISE SPECIFIED
ALL RESISTOR VALUES ARE IN OHMS.
ALL DIODES ARE 1N645.
ALL TRANSISTORS ARE 2N2222A.
ALL CAPACITOR VALUES ARE IN µF.

A ADDED ~~C6~~; REVERSED PHASE A, PHASE B CLOCK INPUTS; CHANGED PIN CONNECTIONS PHASE A PHASE B CLOCK & T.P. INPUTS



FOLDOUT FRAME 5

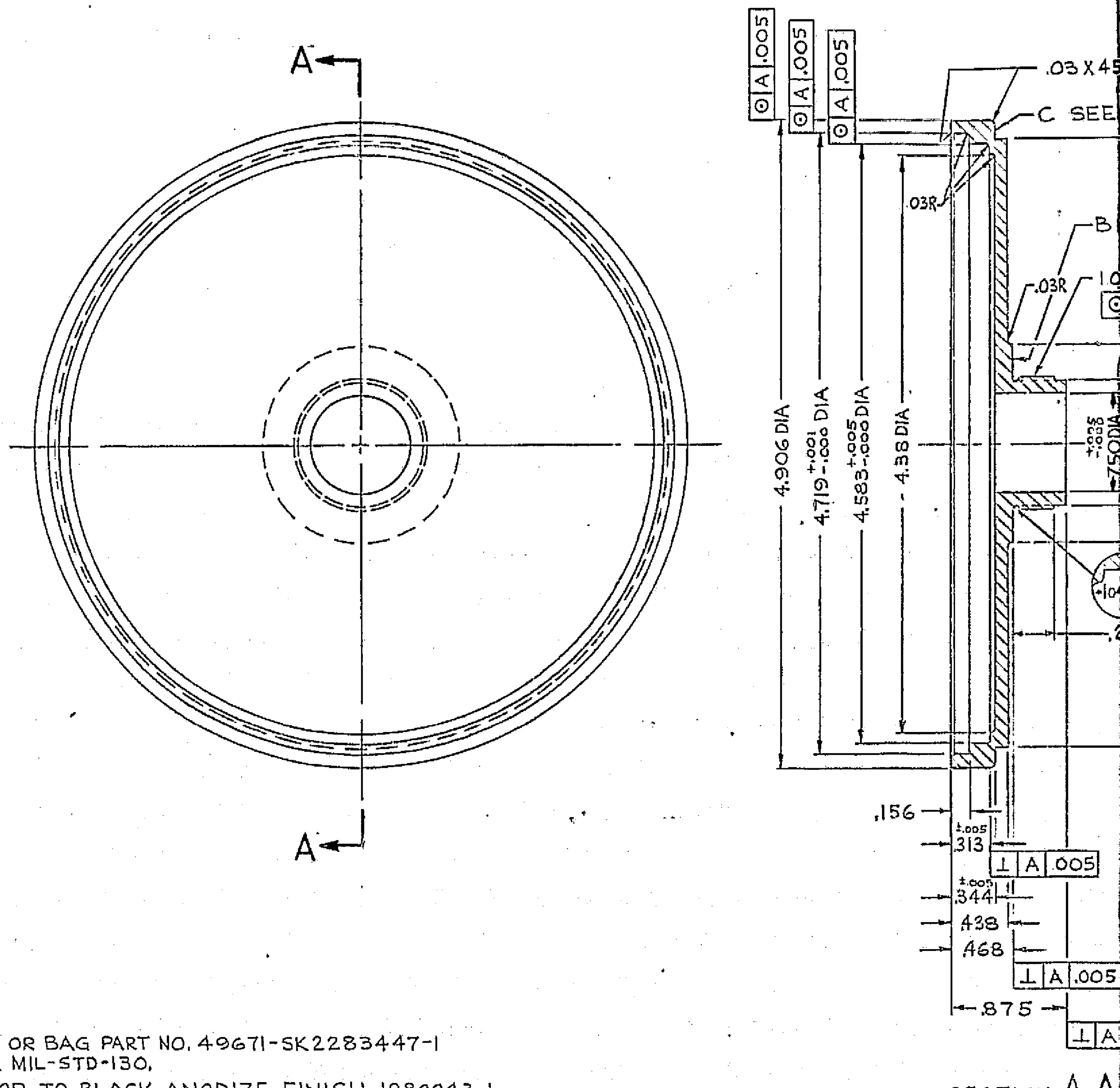
NAS 8-13690

RCA

SCHEMATIC

MOTOR DRIVE ELECTRONICS

E 49671 SK2279982



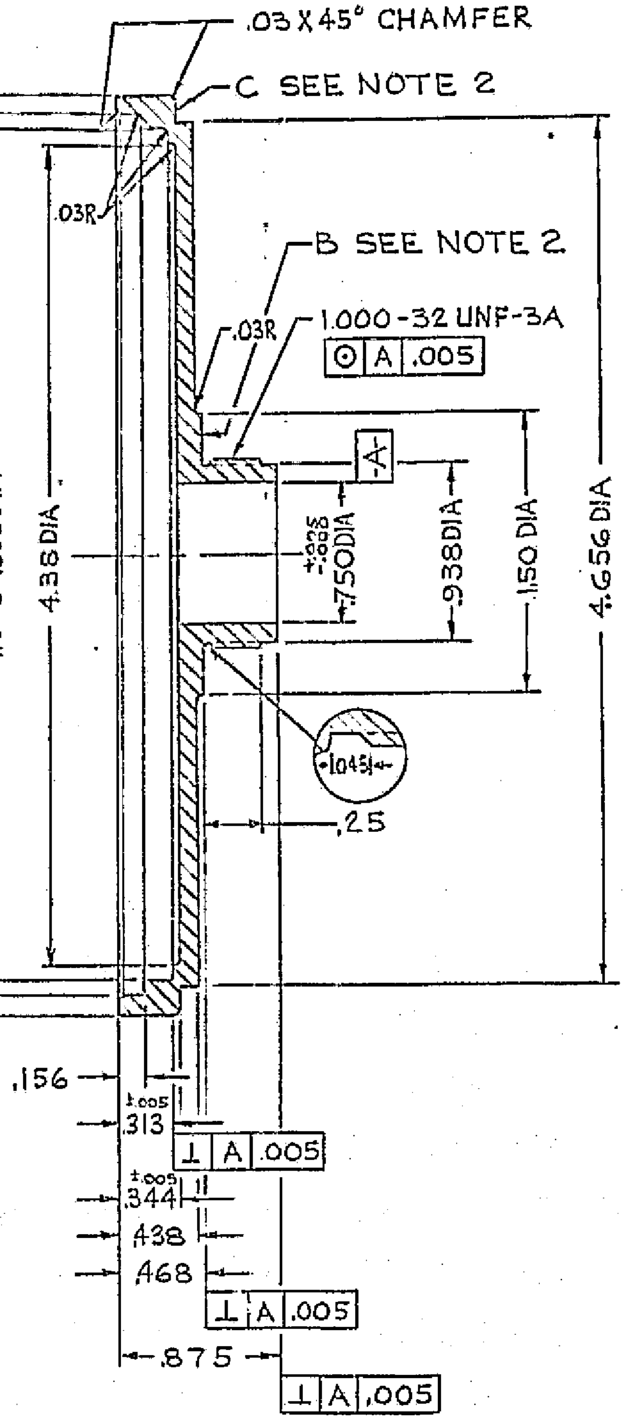
SECTION A-A

NOTES:

1. TAG OR BAG PART NO. 49671-SK2283447-1 PER MIL-STD-130.
2. PRIOR TO BLACK ANODIZE FINISH 1980043-1, MASK SURFACES B & C.
3. CHEMICAL TREATMENT FOR ALUM. PER 1980135-1.

FOLDOUT [redacted]

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADDED C SEE NOTE 2 ADDED B SEE NOTE 2 ADDED NOTES 2 & 3 RMH	9-24-74	



SECTION A-A

FOLDOUT FRAME 2

QTY REQD PER DASH NO.					CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.
				X		1980135-1	CHEM TREAT	MIL-C-5541B	
				X		8030022	SPEC. WORKMANSHIP		
				AR		1980043-1	BLACK ANODIZE		
				AR		2010636-597	AL ALY (2024-T4) PLATE 1.0THK	QQ-A-250/4c	
				-1					

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/ PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THIS DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL STD 9

NEXT ASSY	USED ON
SK2279979	SHUTTLE T.V.

FIRST APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	±.02	±.010
6 TO 24	±.03	±.015
ABOVE 24	±.06	±.020

ANGULAR DIMENSIONS ±½

RCA COMMODITY CODE

CONTRACT NO. NAS9-13688

DRAWN — DATE Apr 16, 1974

CHECKED — DATE May 23, 1974

DESIGN ACTIVITY APPD. — DATE

RCA — RCA CORPORATION · NEW YORK, NY — NJ PLANT

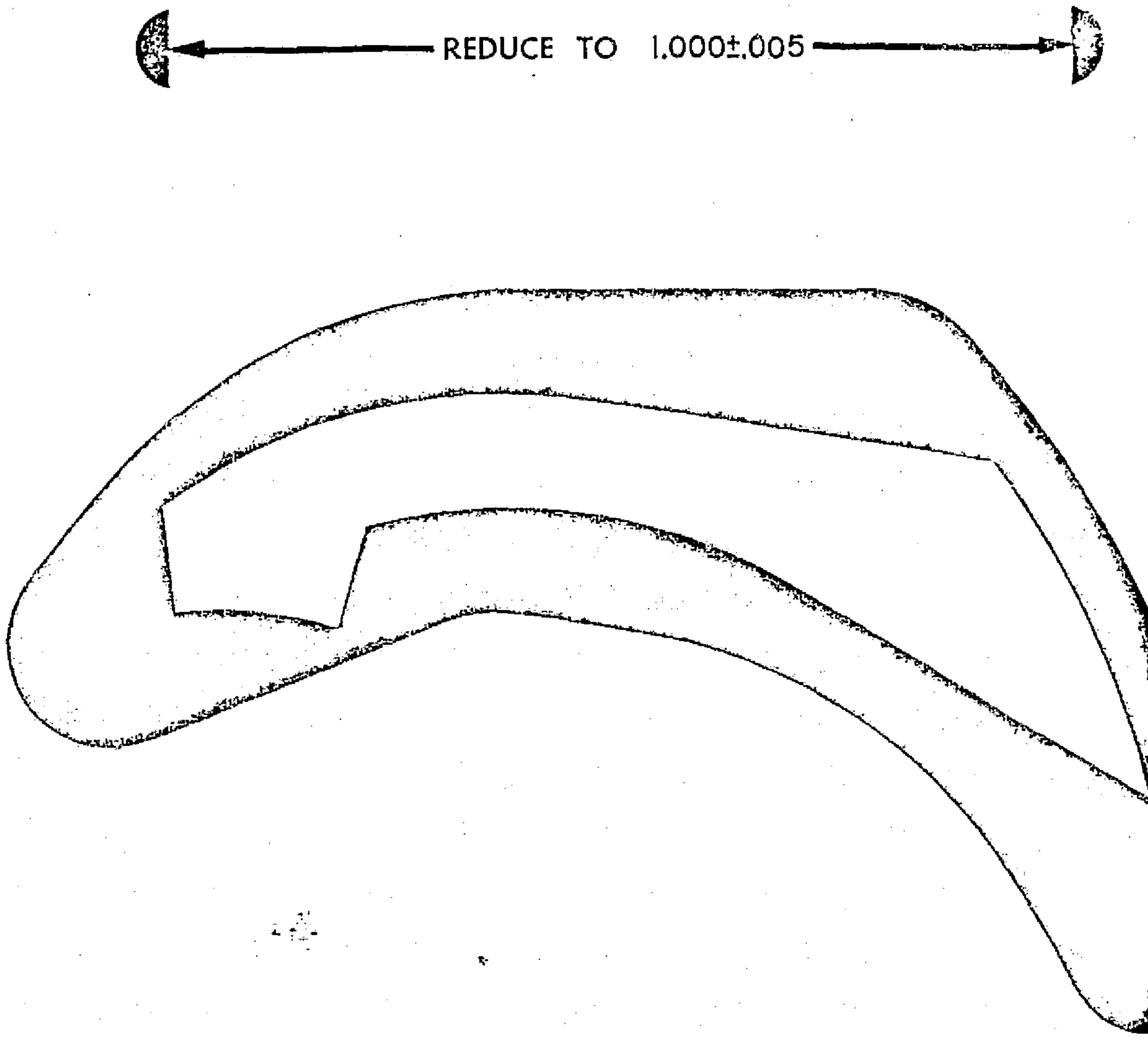
GEAR HOUSING (REAR)

SIZE D | CODE IDENT NO. 49671 | SK2283447

SCALE 2/1 | WEIGHT | SHEET 1 OF 1

SK2283447 | LTR A

DASH NO.	SPECIFICATION TABLE		
	MATERIAL	FINISH	SPECIFICATION



DASH-1

NOTES:

FOR ALL DASH NUMBERS

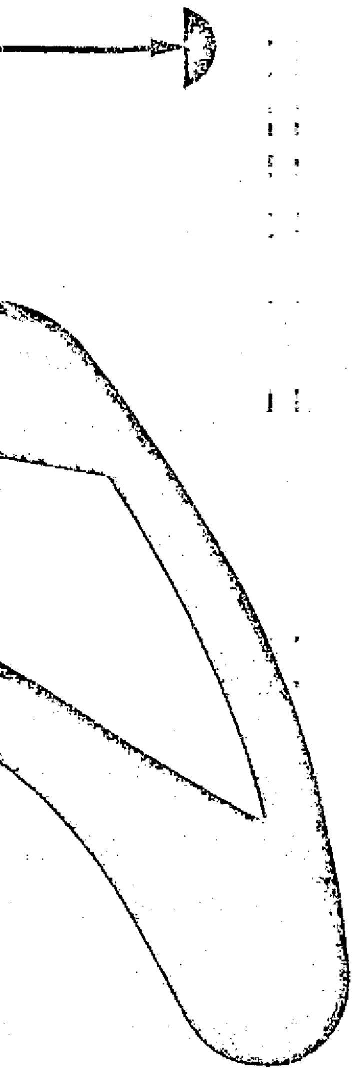
1. MATERIAL - PHOSPHOR BRONZE SHEET .006 THK, QQ-B-750 (2), 49671-2010016-156.
2. ETCH TO PATTERN INDICATED (AREAS IN BLACK DESIGNATE MATERIAL).
3. FINISH - CHEMICAL BLACK FOR BRASS 1980176-1.
4. TAG OR BAG PART NO. 49671-SK2283465-□ PER MIL-STD-130.

FOLDOUT FRAME

AND DATA TO BE INTERPRETED USING HNDBK H28 AND MIL STD 9
RCA COMMODITY CODE

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED



DASH NO	SHEET NO	% T
1	1	100
2	2	95
3	3	90
4	4	85
5	5	80
6	6	70

FOLDOUT FRAME

...O BE INTERPRETED USING ... AND MIL-STD 9

SECURITY CLASSIFICATION

UNLESS OTHERWISE SPECIFIED THE SURF FIN OF MACHINED PARTS SHALL NOT EXCEED A MAX READING OF 125 PER MIL STD 10

DIMENSIONS AND TOLERANCES PER MIL STD 8

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	.02	±.005
6 TO 24	.03	±.010
ABOVE 24	.06	±.015
ANGULAR DIMENSIONS ± 1/2		

MATERIAL

NEXT ASSY | USED ON

FIRST APPLICATION

...DITY CODE

CONTRACT NO NAS9-13688

DRAWN K. Shiffer MAY 15, 1974 DATE

CHECKED Louis E. Bailey May 30, 1974 DATE

DESIGN ACTIVITY APPD. Paul A. Dattoff May 17, 1974 DATE

RADIO CORPORATION OF AMERICA

ASTRO-ELECTRONICS DIVISION, PRINCETON, N J PLANT

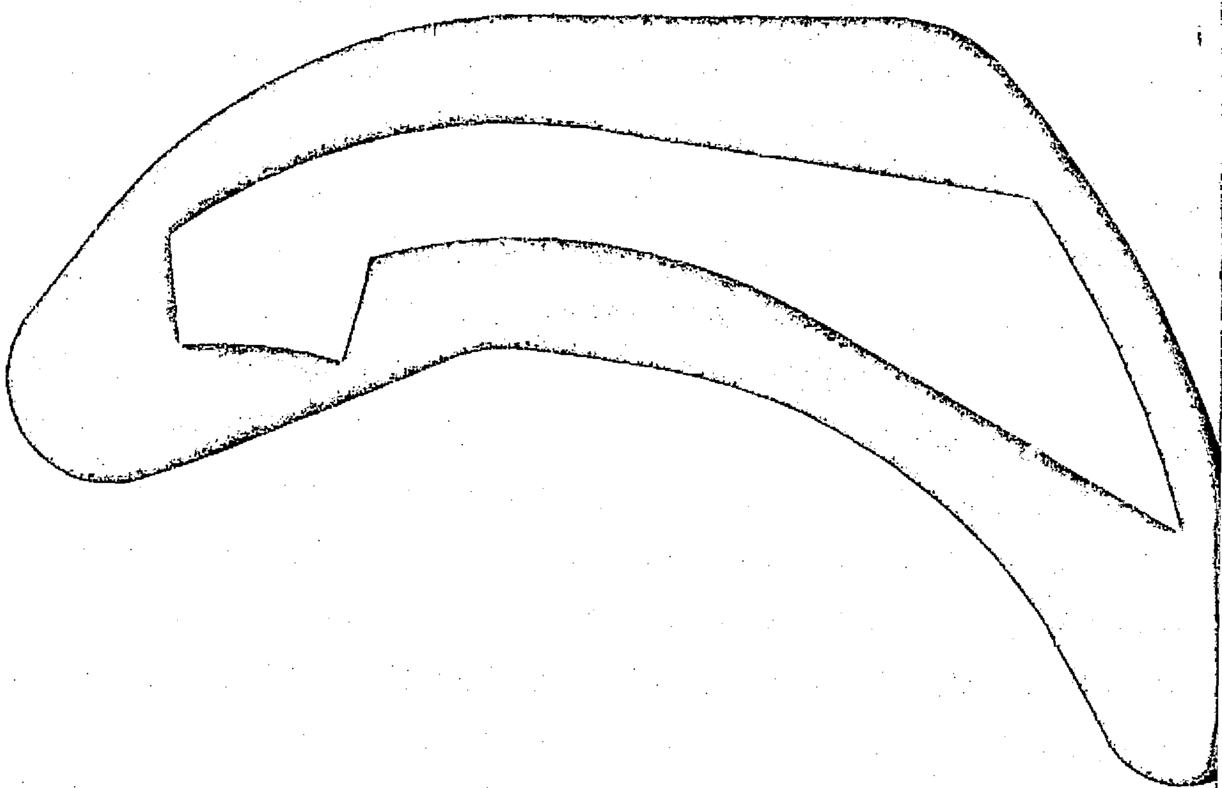
MASK FILTER
(.6 IN. SPACING)

SIZE D | CODE IDENT NO. 49671 | SK2283465

SCALE 10/1 | WEIGHT | SHEET 1 OF 6

SK2283465

REDUCE TO 1.000±.005

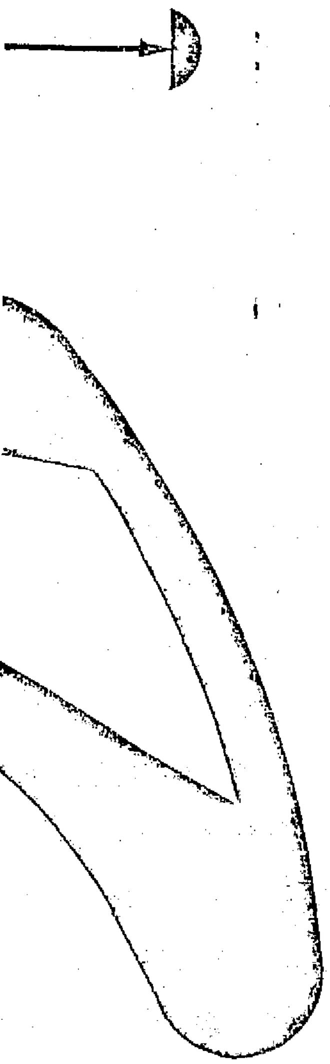


DASH-2

FOLDOUT FRAME

PRINTED IN U.S.A. (12 65) OGILVIE 675 7/5

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



FOLDOUT FRAME 2

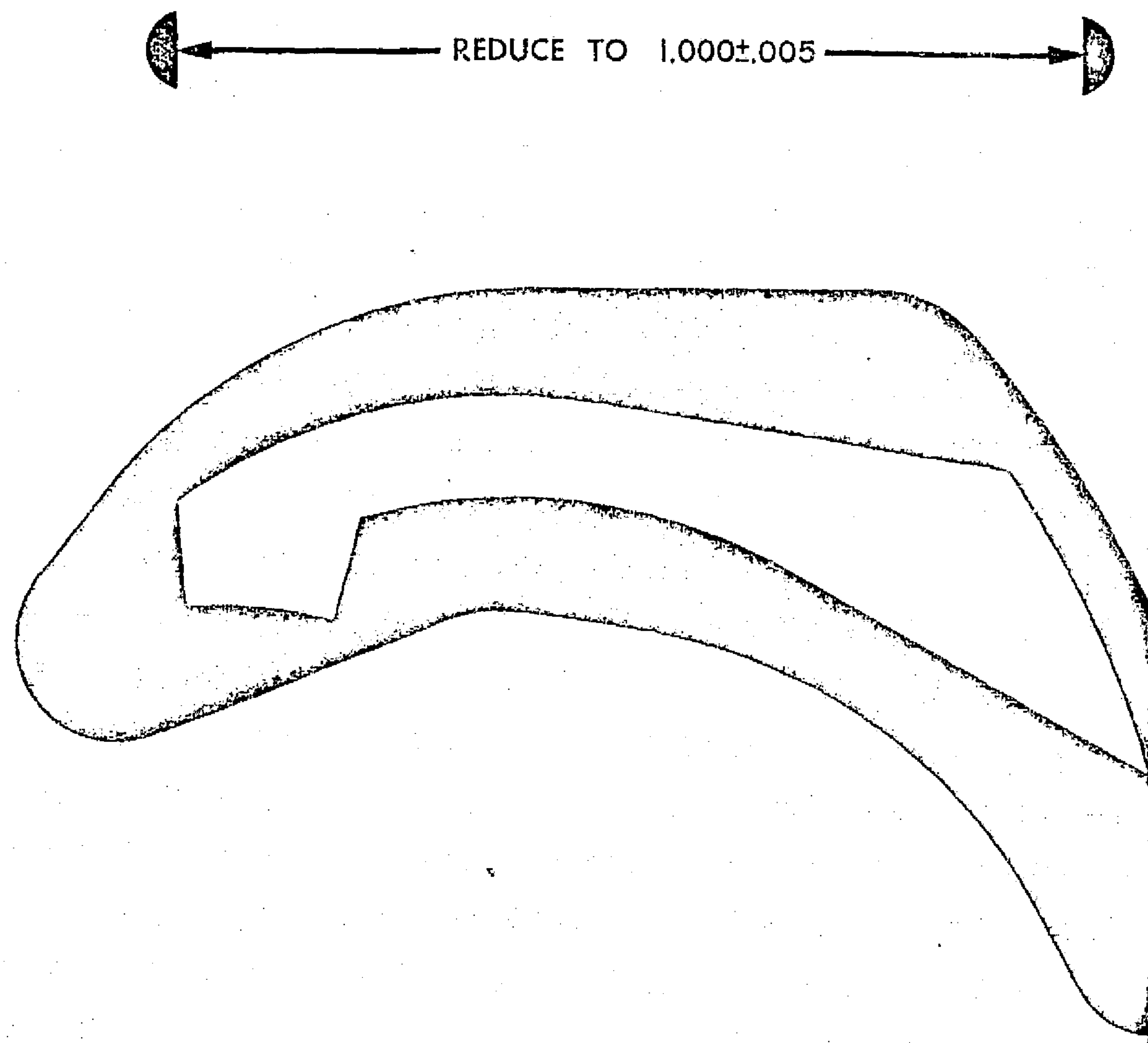
SIZE	CODE IDENT NO.	
D	49671	SK2283465
SCALE 10/1	WEIGHT	SHEET 2 OF 6

D

C

B

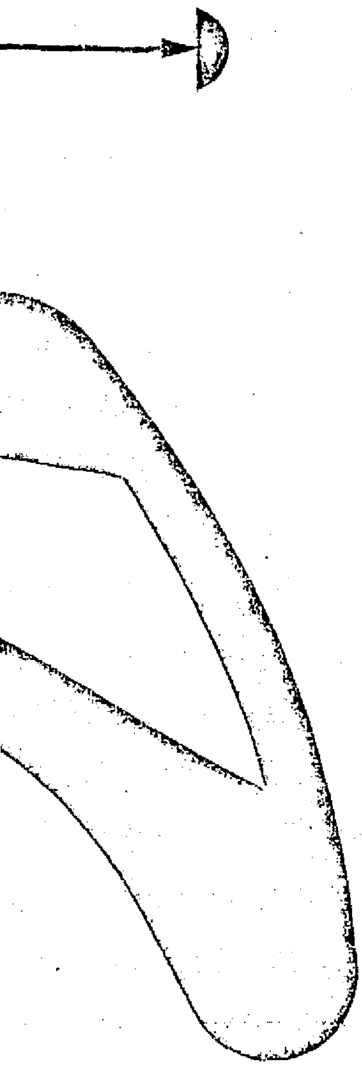
A



DASH-3

FOLDOUT FRAME 1

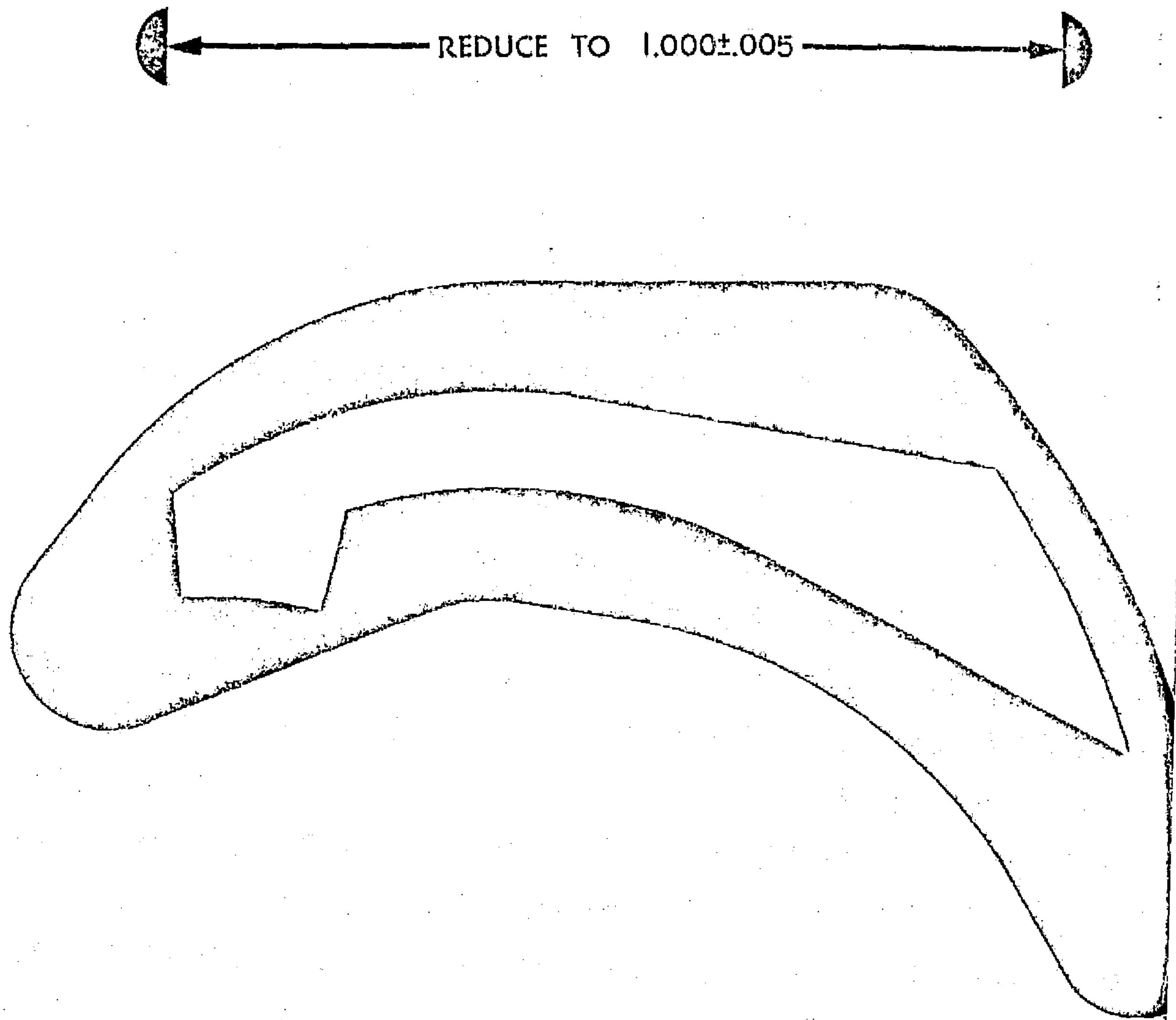
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



FOLDOUT FRAME 2

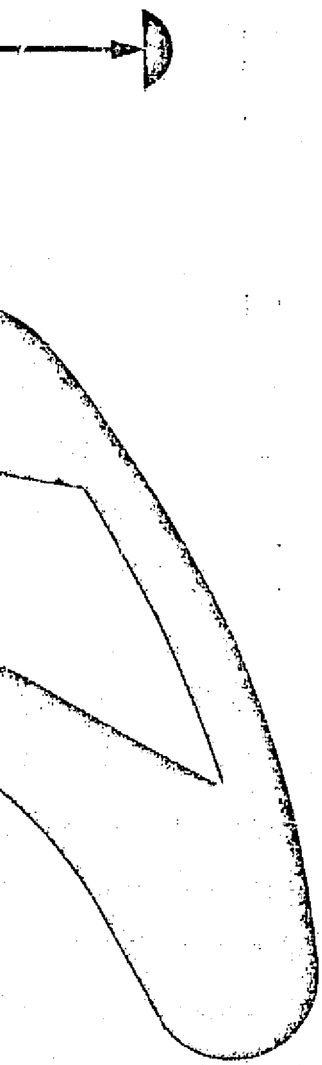
SIZE	CODE IDENT NO.	
D	49671	SK2283465
SCALE 10/1	WEIGHT	SHEET 3 OF 6

SK2283465



DASH-4

FOLDOUT FRAME



REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FOLDOUT FRAME 2

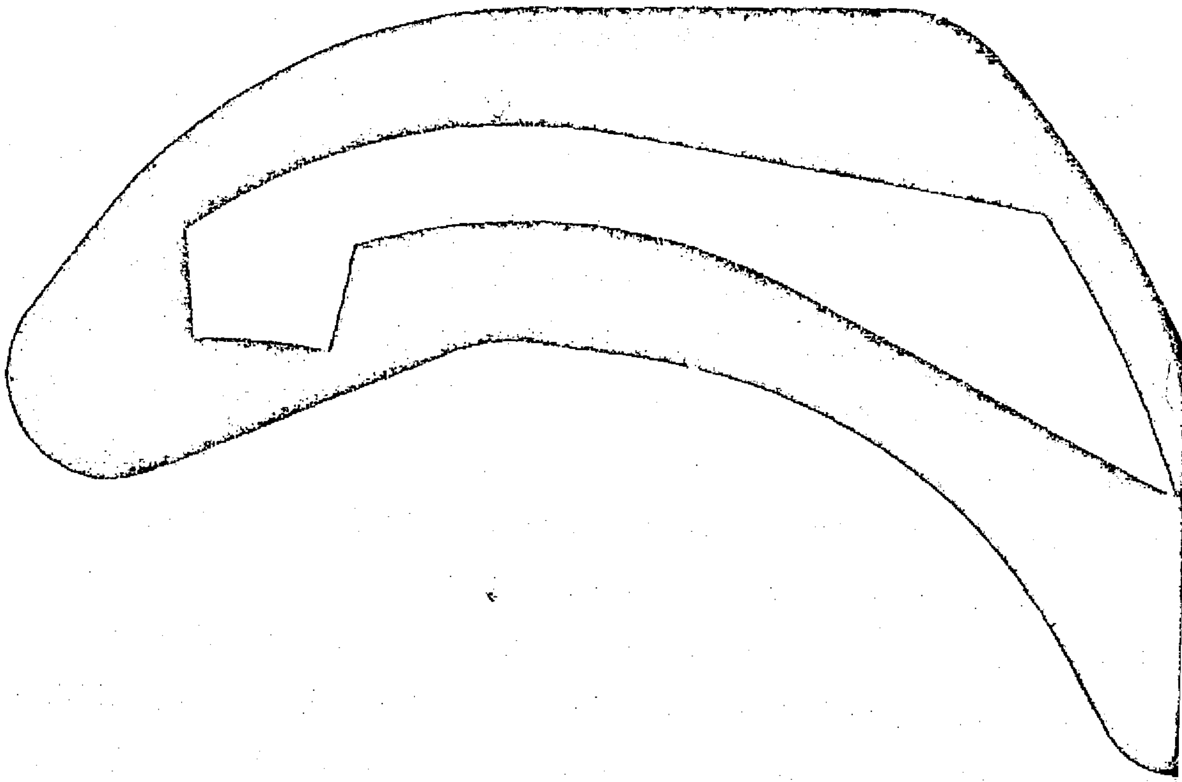
SIZE	CODE IDENT NO	
D	49671	SK2283465
SCALE 10/1	WEIGHT	SHEET 4 OF 6

8 7 6 5

D

REDUCE TO 1.000±.005

C



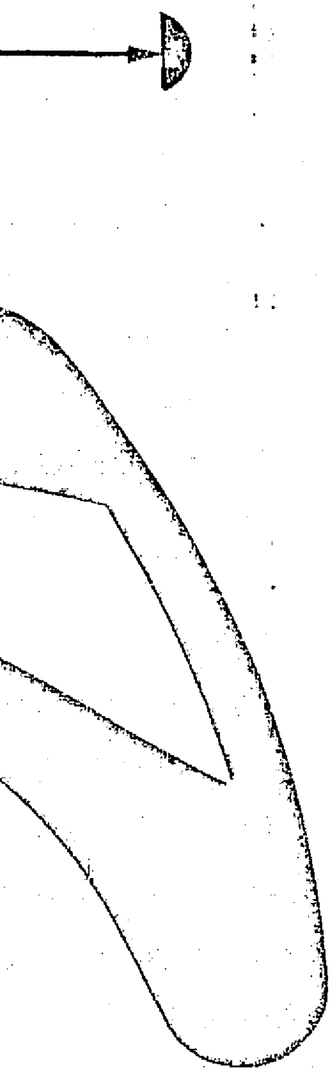
B

DASH-5

A

4 3 2 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

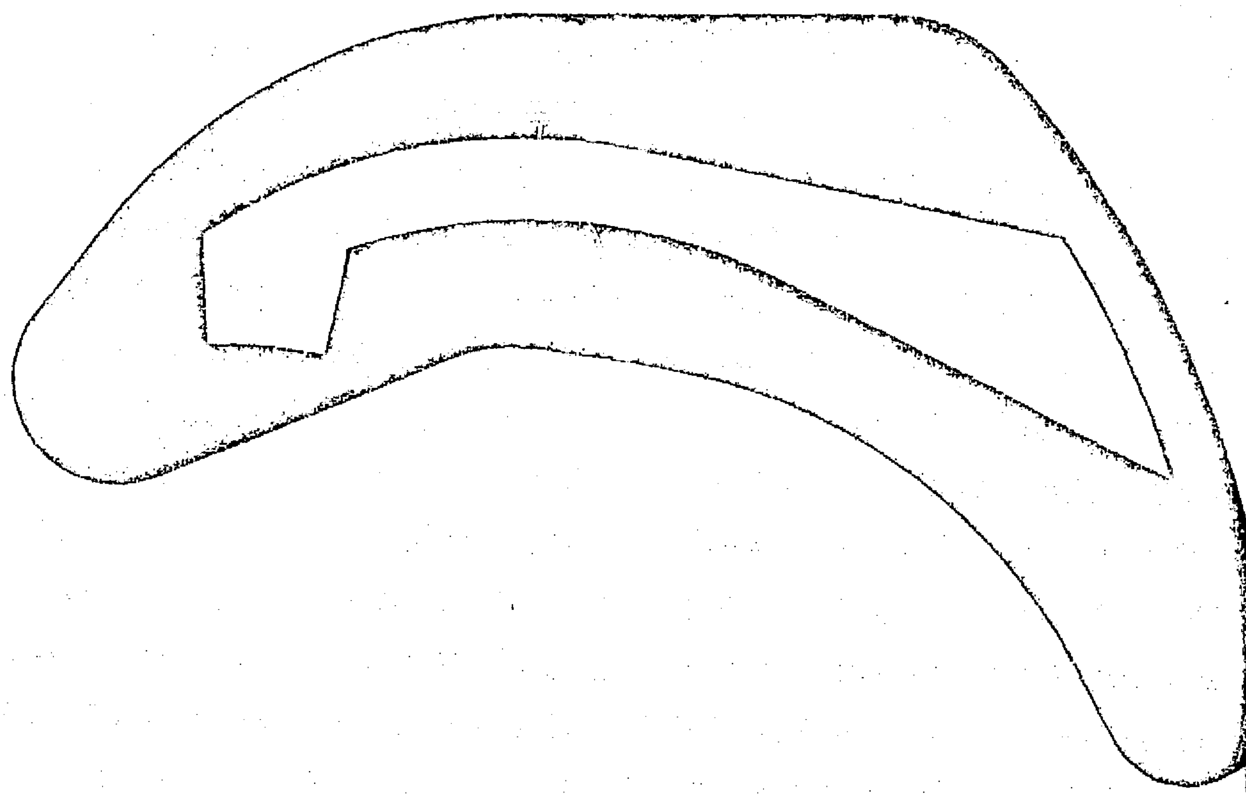


FOLDOUT FRAME

SIZE	CODE IDENT NO.	
D	49671	SK2283465
SCALE 10/1	WEIGHT	SHEET 5 OF 6

8 7 6 5

REDUCE TO 1.000±.005

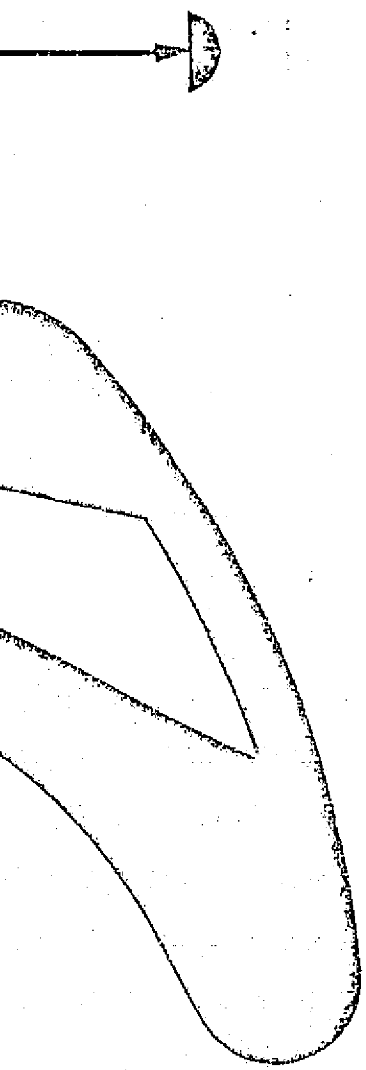


DASH-6

FOLDOUT FRAME

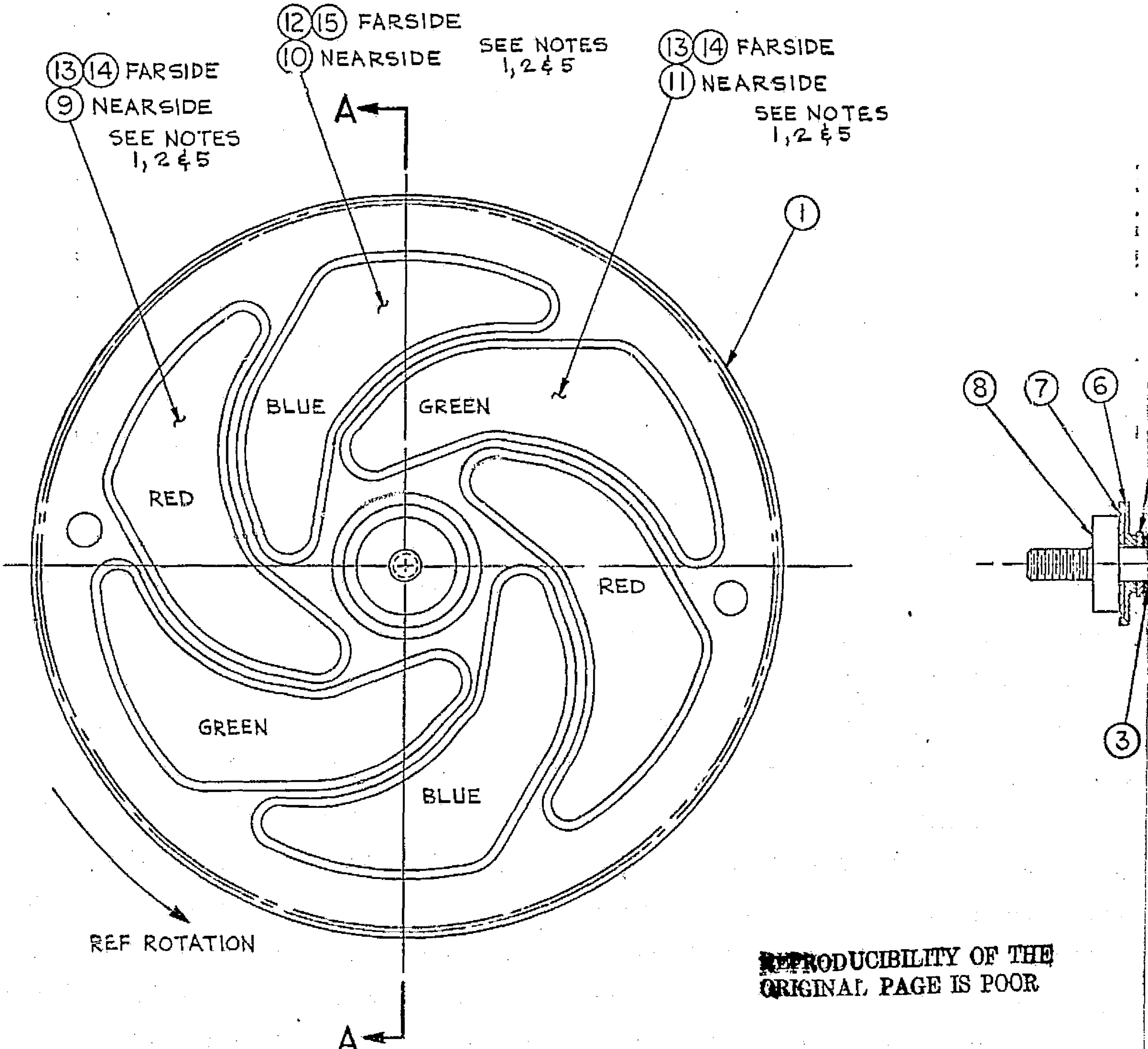
4 3 2 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



FOLDOUT FRAME 2

SIZE	CODE IDENT NO	
D	49671	SK2283465
SCALE 10/1	WEIGHT	SHEET 6 OF 6

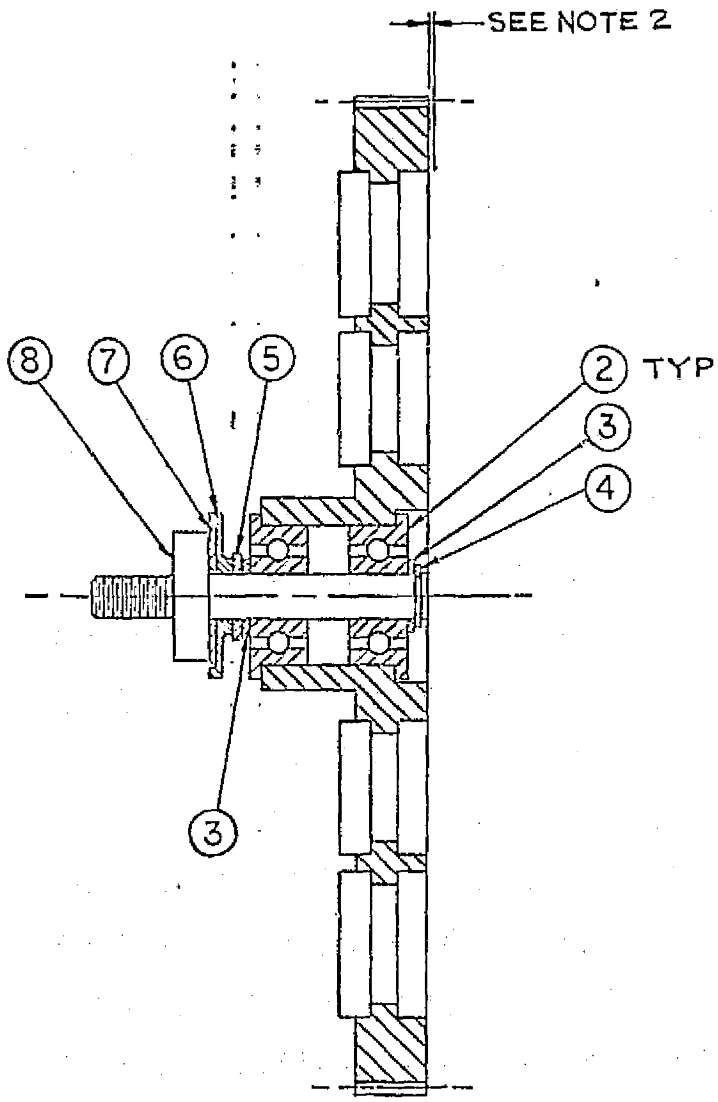


NOTES:

1. BOND ITEMS 9 THRU 15 TO ITEM 1, USING ITEMS 16, 17 AND 18 PER ITEM 20. VENT CAVITIES BETWEEN FILTERS BY LEAVING A VOID IN THE POTTING AT THE TOE OF THE SEGMENTS.
2. BOND ITEMS 14 AND 15 TO OUTER FACE OF ITEMS 12 AND 13. BUILDUP FROM WHEEL FACE .005 MAX.
3. ITEM 14 SELECTED TO BALANCE CHANNEL OUTPUTS PRIOR TO BONDING PER NOTES 1 & 2.
4. ADJUST SHIM (ITEM 5) TO PROVIDE 1.5LB.±.25 PRELOAD ON BEARINGS (ITEM 2).
5. ADJUST INDIVIDUAL FILTER POSITION DURING BONDING, SO THAT AFTER BONDING, THE MAXIMUM TRANSMITTED IMAGE SHIFT BETWEEN ANY TWO FILTER SEGMENTS SHALL NOT EXCEED 0.01 MM.

4 3 2 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



SECTION A-A

' OF THE
S POOR

N
DING,
SHIFT
NTS

FOR PARTS LIST SEE PL SK2283469

QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 66

THE DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

SK2279979	SHUTTLE T.V.
NEXT ASSY	USED ON

FIRST APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .010
6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ± ½°

RCA COMMODITY CODE.

CONTRACT NO. NAS9-13688 REL

DRAWN R. Stiffler MAY 14, 1974 DATE

CHECKED [illegible] May 14, 1974 DATE

DESIGN ACTIVITY APPD. [illegible] DATE

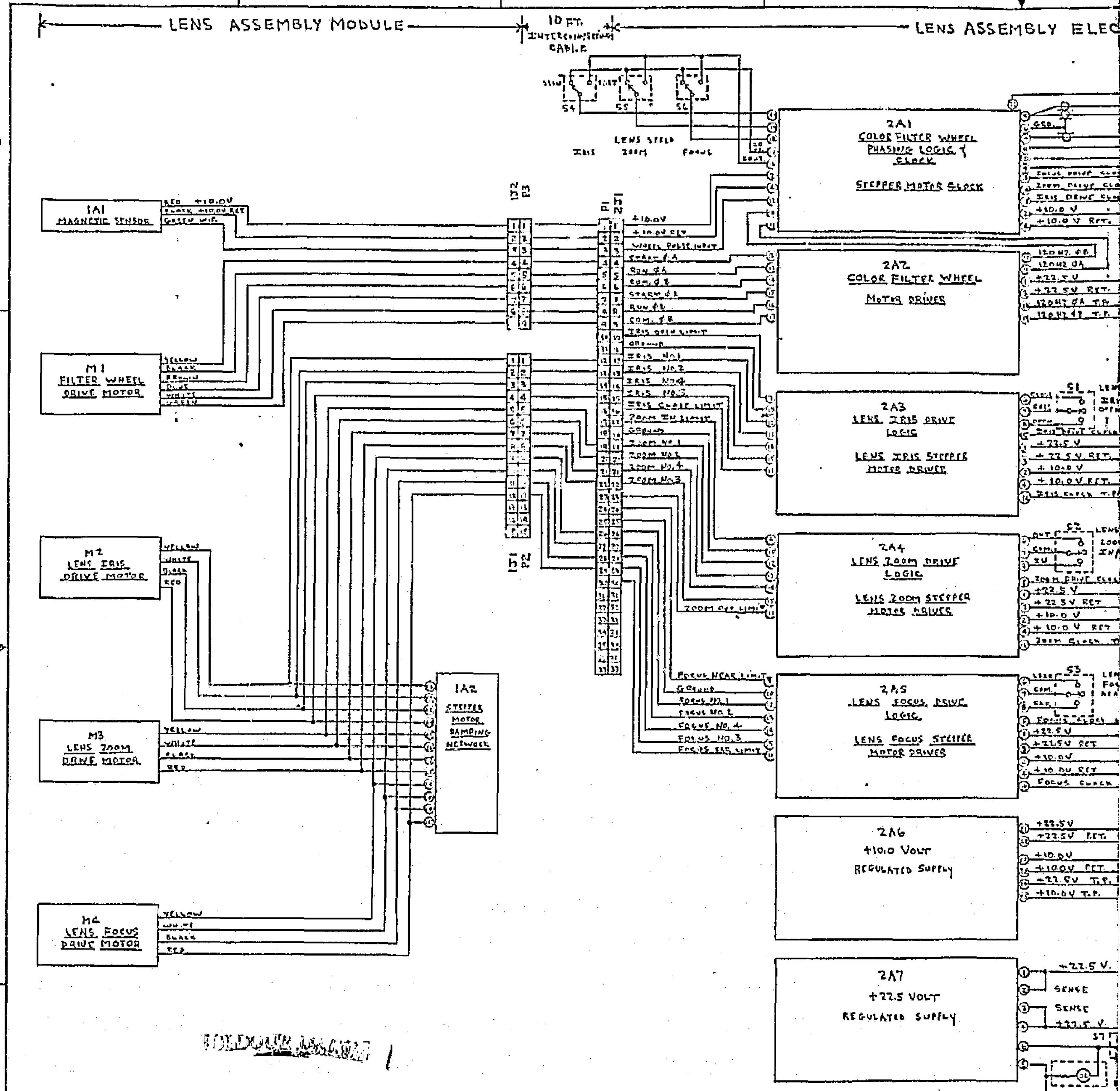
RCA — RCA CORPORATION · NEW YORK, NY

ASTRO-ELECTRONICS DIVISION, PRINCETON, N.J. PLANT

FILTER WHEEL ASSEMBLY

SIZE	CODE IDENT NO.	
D	49671	SK2283469

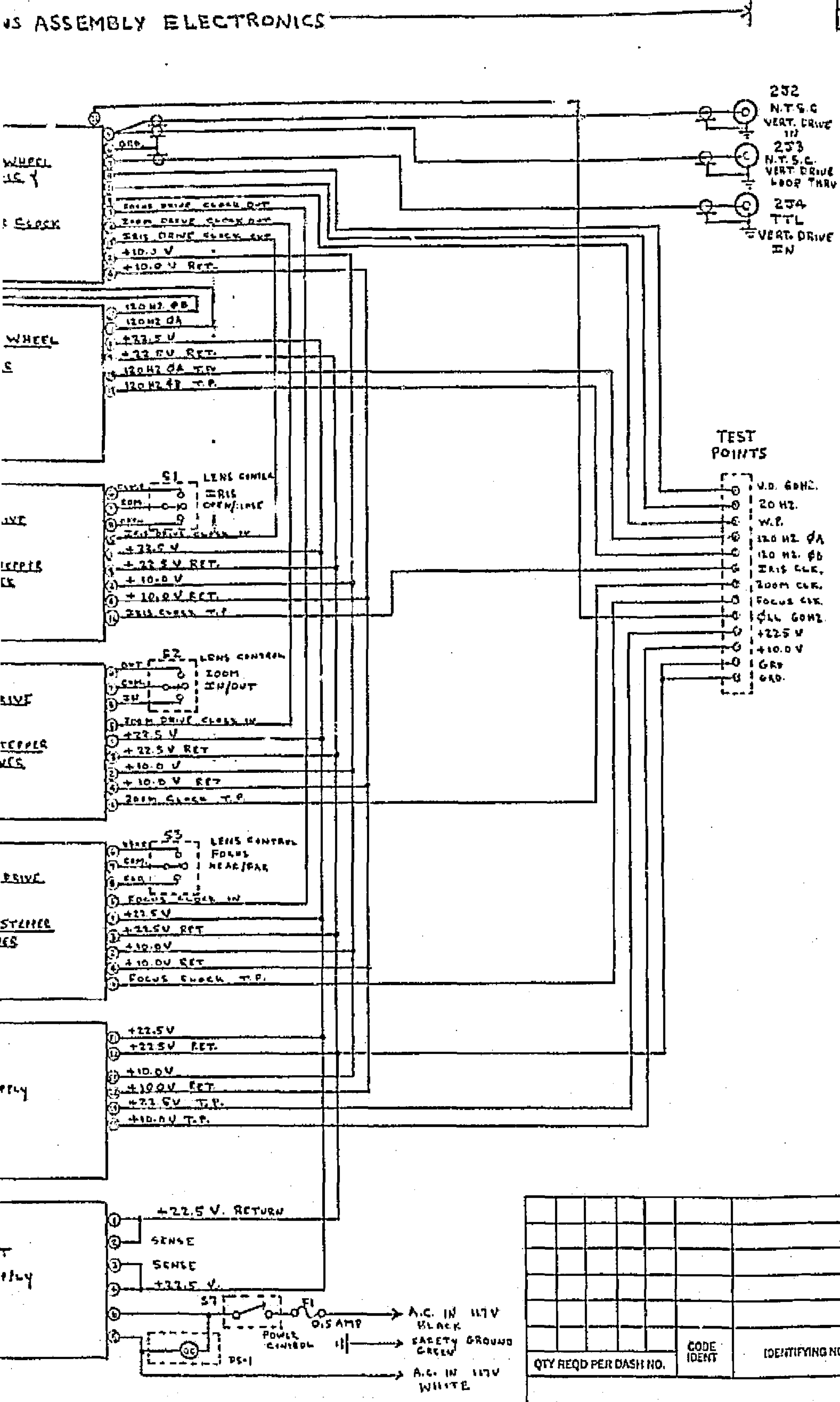
SCALE 4/1 WEIGHT SHEET 1 OF 1



NOTES:
1. LENS LIMIT SWITCHES NOT USED
2. S1 THROUGH S7 ARE MOUNTED ON FRONT PANEL
3. T.P.-1 THROUGH T.P.-13 ARE MOUNTED ON FRONT PANEL

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	REV	9-9-74	
	B	REVERSED DIRECTION OF S1 { S3 FUNCTIONS	10-11-74	



QTY REQD PER DASH NO.	CODE IDENT	IDENTIFYING NO.	DESCRIPTION	SPECIFICATION	SEE NOTE NO.

MATERIALS AND SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE SURFACE FINISH OF MACHINED PARTS SHALL NOT EXCEED A MAXIMUM READING 125/PER ANSI STD B46.1 — 1962

INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5 (6)

THE DATA TO BE INTERPRETED USING NBS HDBK H28 AND MIL-STD-9

NEXT ASSY	USED ON
FIRST APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES ON:

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .03	± .010
6 TO 24	± .03	± .015
ABOVE 24	± .06	± .020

ANGULAR DIMENSIONS ±½°

RCA COMMODITY CODE:

CONTRACT NO. NAS 9-13688 REL

DRAWN D. D. Holt DATE 4-26-74

CHECKED DATE

DESIGN ACTIVITY APPD. DATE

RCA — RCA CORPORATION | NEW YORK, NY — PLANT

INTERCONNECTION DIAGRAM COLOR FIELD SEQUENTIAL T.V. LENS ASSEMBLY

SIZE	CODE IDENT NO.	
D	49671	SK2283875

SCALE — SHEET 1 OF 1