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	TECHNICAL NOTE
	No. 1435
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	CYLINDERS WITH CUTOUTS
	V - CALCULATION OF THE STRESSES IN CYLINDERS
	• WITH SIDE CUTOUT
	By N. J. Hoff and Bertram Klein
	Polytechnic Institute of Brooklyn
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STRESSES IN AND GENERAL INSTABILITY OF MONOCOQUE CYLINDERS WITH CUTOUTS

V - CALCULATION OF THE STRESSES IN CYLINDERS

WITH SIDE CUTOUT .

By N. J. Hoff and Bertrem Klein

SUMMARY

Stresses were calculated by a numerical method in three reinforced monocoque cylinders subjected to pure bending. The cylinders were of circular cross section and were reinforced with 8 rings and either 8 or 16 stringers. There was a cutout on one side of each cylinder located symmetrically to the neutral plane and extending over 45°, 90°, or 135°. Satisfactory agreement was found between stresses calculated and those measured in part IV in the present series of investigations.

INTRODUCTION

In analytical investigations the reinforced monocoque cylinder is almost invariably assumed to be of constant section and reinforced with evenly spaced stringers and rings of constant cross-sectional properties. In reality, actual airplane structures often have openings for doors, windows, and so forth, and are reinforced locally near points of application of concentrated loads. It is believed that the stress problem of such nonuniform structures is best approached by numerical methods.

In a series of investigations carried out at the Polytechnic Institute of Brocklyn Aeronautical Laboratories an effort was made to apply Southwell's relaxation method (reference 1) to the calculation of the stresses in reinforced monocoque structures. Procedures were developed for reinforced flat and curved sheets (references 2 and 3) as well as for fuselage frames (references 4 and 5). Finally, numerical methods were used to determine the stresses in a reinforced monocoque cylinder having a symmetric cutout on the compression side (reference 6). The results obtained were in satisfactory agreement with experiments carried out earlier, which are described in reference 7. The present report deals with the problem of the stress distribution in a reinforced monocoque cylinder having a side cutout and subjected to pure bending. The results of the calculations are compared with the experiments described in reference 8. In the first step of the procedure the structure is divided into elements, and the elastic properties of the elements are determined. In the present problem a sheet panel with its bordering segments of stringers and rings was chosen as the element of the reinforced monocoque cylinder. When the loads are applied to the cylinder, the corners of the panels undergo, in general, displacements in arbitrary directions. For the purposes of this calculation the displacements are resolved into axial (in the direction of the axis of the cylinder), tangential (in the direction of the tangent to the ring), and radial components (in the direction of the radius of the ring). At the same time, the corners are, in general, rotated about axes of arbitrary direction, and this rotation is resolved into rotations about the axial, tangential, and radial directions.

In the so-called unit problem it is assumed that the four corners of the panel are rigidly clamped to some imaginary rigid body to prevent both displacement and rotation. Then the clamps are released at one corner to permit displacement or rotation in one direction only, and a displacement (or rotation) of unit magnitude is undertaken in that particular direction. Next the reaction forces and moments caused by the displacement (or rotation) undertaken are calculated for all the four corners.

After all the unit problems of the structure are solved, the results are combined in what are termed the "operations tables." These tables are a systematic presentation of the reactions at all the corner points corresponding to unit displacements of the corner points. It is then required to find a combination of all the displacement (and rotation) components corresponding to zero resultant force and moment at each corner point at which no external load is applied and to force and moment resultants equal and opposite to the loads at the points of application of the external loads. According to Southwell's suggestion, this combination of displacements is found by systematic step-by-step approximations. At the Polytechnic Institute of Brocklyn Aeronautical Laboratories such solutions by step-by-step approximations have been established for reinforced panel problems (references 2 and 3), but when the same approach was tried for the case of monocoque cylinders having symmetric cut-outs and subjected to pure bending, the number of steps needed became almost prohibitive. On the other hand, the solution by matrix methods of the system of linear equations represented by the operations tables together with the applied loads was possible with a reasonable expenditure of work.

In the present report, the displacements are calculated from the operations tables by means of a slightly modified version of Crout's method of solving matrix equations. (See reference 9.) The number of unknowns is 34, 36, and 30 in the case of the cylinders having 45°, 90°, and 135° cutouts, respectively. The numerical part of the work was carried out on semiautomatic electric calculating machines, and 10 digits were kept throughout the calculations. As an approximate rule, it may

be stated that matrices of the kind encountered in this work can be solved by an experienced calculator at the rate of 2 hours for each unknown quantity. This estimate does not allow for mistakes.

Once the displacements are known, the stresses can be easily calculated with the aid of the solutions of the unit problems and elementary considerations. Complete numerical calculations were carried out for three cylinders of the experimental series described in reference 8. Satisfactory agreement was found between theory and experiment, as may be seen from the comparison shown in the figures of the present report.

The authors acknowledge their indebtedness to Mr. Bruno A. Boley for his help in the theoretical aspects of the problem and to Mr. John G. Pulos, who took part in the calculations. The work was carried out under the sponsorship and with the financial assistance of the National Advisory Committee for Aeronautics.

SYMBOLS

8.	distance between adjacent rings
Α.	cross-sectional area of stringer augmented by its effective width of curved sheet
¢,8°,0°,8°,0°	rings of cylinder or quadrants of operations table
E	Young's modulus
G	shear modulus
L	length of ring segment between adjacent stringers
М	externally applied bending moment acting on cylinder
ĥn	ring influence coefficient
N	bending moment acting in plane of ring
Q	torque acting on rigid end ring
r	radius of monocoque cylinder
m, r	ring influence coefficients
R	radial shear force acting in plane of ring
t	thickness of sheet covering
tt, tr, tn	ring influence coefficients

т	tangential force acting in plane of ring
u	tangential displacement
v	radial displacement
¥	rotation
x	force acting in axial direction
Y	vertical shear force acting on rigid ring
at, ar, an	coefficients used in calculation of forces and moments caused by shear flow existing in panel
$\Gamma = Gt/2$	
η	vertical downward translation of rigid ring
θ	rotation of rigid ring in its own plane
£	axial displacement
۵	rotation of rigid ring about its horizontal diameter
$\Omega = Gta/4L$	

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STATEMENT OF PROBLEM AND ASSUMPTIONS

The three cylinders for which calculations were carried out are shown in figure 1. They are Cylinders 35, 39, and 40 of the present series and are described in reference 8. A number of structural changes were assumed for the purpose of calculations in order to decrease the work required for the solution of the problem.

Figure 2 shows the three cylinders in their modified forms. In reality, Cylinder 35 had 16 stringers, 7 of which were omitted in the simplified setup. The cross-sectional areas of the stringers eliminated, however, were distributed evenly between the adjacent stringers that were left in the structure. Similarly, two rings were omitted from the complete portions of the cylinder and the cross section of one was added to the adjacent ring bordering the cutout and the other to the rigid end ring of the cylinder. At the same time the length of the field extending from the cutout to the end ring was assumed to be 9.6429 inches. This field length is 12 times the actual ring spacing and thus it is an intermediate value between the true distance from cutout to end ring and the actual ring spacing. It was not considered advisable to use a field length of three times the ring spacing in the calculations because long fields are weak in shear.

Cylinders 39 and 40 were built with only eight stringers. Consequently, changes in the structural arrangement were assumed only in connection with the rings. The changes were of the same nature as in the case of Cylinder 35.

As in previous work, the bending and torsional rigidities of the stringers were disregarded. The rings were considered resistant to bending in their own plane but weak in bending out of their plane as well as in torsion. The extensional and shearing rigidities of the rings were considered. The sheet panels were assumed to resist shear only, and the shear stresses were assumed to be distributed uniformly. The resistance of the sheet to extension and compression was taken approximately into account by adding an effective width of sheet to the stringers. In the present calculations the total width of the sheet was considered effective, since the stresses were calculated for small loads when the sheet is in a nonbuckled state. An effective width of sheet equal to the width of the ring was added to the ring when its cross-sectional properties were calculated. Because of these assumptions only the three displacement components as well as the rotation component about an axis. parallel to the axis of the cylinder need be taken into consideration. Rotations about the tangential and radial axes are not resisted by either the stringer or the ring.

The vertical plane of a transverse section through the middle of the cylinder was regarded as a fixed reference plane relative to which the rigid end rings are tilted — and even twisted because of the asymmetric cutout — when the pure bending moments are applied to the end rings. The operations tables were set up for only one-quarter of the cylinder because the displacements in the four quarters are related by symmetry.

SETTING UP AND SOLVING THE OPERATIONS TABLES

A schematic arrangement showing the four quadrants of the operations tables for all three cylinders is given in table 1. As a rule, each entry in the operations tables (see, for instance, quadrant A, table 2) represents the magnitude and the sign of the generalized force, indicated at the left end of the row in which it appears, caused by the generalized unit displacement indicated at the top of the column. A generalized displacement is a displacement of the structure at a point in one of the directions of the axes, a rotation about one of these axes, or any combination of displacements and rotations of the structure at a group of points. A generalized force corresponding to a generalized displacement is the quantity - force, moment, or group of forces and moments - that gives the work done during the generalized displacement when multiplied by the generalized displacement. As was mentioned under STATEMENT OF PROBLEM AND ASSUMPTIONS, the structure is considered to be rigidly clamped as regards every other generalized displacement when the effect of any one generalized unit displacement is sought.

The generalized forces in a reinforced monocoque cylinder caused by generalized unit displacements can be calculated when the solution of the so-called four-panel problem is known. The solution was given in reference 6. It is given in a slightly more convenient form in figures 3 to 6 of the present paper. These figures show the forces and moments at each of the nine corner points that are caused by generalized unit displacements of the middle point. The expressions are given in a form suitable for calculations even when each stringer and ring segment has a different but constant section and each panel a different but constant thickness. When a panel is in a buckled state, a reduced value should be used for its effective shear modulus G_{eff} . When a panel is absent, its shear modulus, or thickness, should be put equal to zero. The values of the shear flow-force coefficients a_t , a_r , and a_n , as well as those of the influence coefficients tt, tr, tn, rr, ..., must be obtained from reference 5.

Figures 7 to 10 give the solution of the four-panel problem for the case in which the curvature is opposite to that shown in the preceding four figures. The calculations with which this report deals indicated the desirability of two such sets of diagrams in order to reduce the likelihood of numerical errors and errors of sign in the operations tables.

Because of the symmetry of both the structure and the loading with respect to the plane of a transverse section through the middle of the cylinder, displacements of corresponding points must be the same on rings A and A¹, B and B¹, and C and C¹. (See fig. 2.) Moreover, the loading is antisymmetric with respect to the horizontal plane containing the axis of the cylinder. Hence, displacements of corresponding points on stringers 1 and 1', 2 and 2', and so forth, must be antisymmetric. Their absolute magnitudes are equal and their signs can be determined from the following rules, which take care of the peculiarities of the sign conventions adopted: axial and radial displacements are of opposite sign, tangential displacements and rotations are of the same sign on the upper and lower halves of the cylinder. These symmetry considerations permit a reduction in the number of displacement quantities to be entered in the operations tables. Of the total of $4 \times 48 = 192$ possible generalized basic displacements in the case of Cylinder 39, a total of 108 could be omitted outright; 36 more displacements were considered only indirectly, as is shown by means of the following two typical examples.

When point B^4 - the point of intersection of ring B with stringer 4 - is moved in the positive axial direction, point B^4 must be moved the same distance in the negative axial direction because of the antisymmetry.

This combination of displacements causes twice as much shear strain in the panel bounded by rings A and B and stringers 4 and 4^t as would be caused by the displacement of point B4 alone. Consequently, the forces and moments appearing because of the shear at points A4 and B4 will be doubled.

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When point B4 is moved in the positive tangential direction, point B4 also must be moved the same distance in the tangential direction. Consequently, the shear strain in the panel bounded by rings A and B and stringers 4 and 4^t is again subjected to the double amount of shear strain just as in the case discussed previously. Moreover, segment 4-4* of ring B is rotated but not shortened, whereas in the case of a tangential motion of point B4 alone a shortening also would take place. Consequently, 48 independent displacement quantities remain to be entered in the operations tables. This number is further reduced because of the end conditions. In the experiment the end rings were heavy and were rigidly attached to heavy end plates. For this reason, in the theory the end rings were assumed perfectly rigid and points on the end rings were permitted to participate only in rigid body displacements. Thus $4 \times 4 = 16$ further individual generalized displacements are eliminated; and three rigid-body displacements are introduced - namely, a rotation w about the horizontal diameter, a rotation θ about the axis of the cylinder, and a vertical translation n of the end ring. Hence 35 unknown quantities remain.

When the pure bending moment is applied to the rigid end plate, the distribution of the forces to the stringers is not known. Obviously, it cannot be assumed according to the customary linear law because of the cutout in the structure. For this reason a rotation ω of the end ring was specified rather than a bending moment, and the corresponding bending moment was calculated only after the forces in the stringers were determined from the operations table. Hence, the forces and moments corresponding in the operations tables to the specified rigid body displacement ω were known quantities and had to be considered as the load terms in the equations. They are given in the last column of quadrants B and D of table 2.

It will be noted that the last two rows in the operations tables are denoted (1/2)Y (one-half the vertical shear force acting upon the end ring) and (1/2)(Q/r) (one-half the torque acting upon the end ring divided by the radius). This choice of the quantities to be entered in the last two rows results in a symmetric operations table.

The linear equations represented by the operations tables were then solved by a slightly modified version of Crout's method. In other words, the set of 34 displacement quantities causing forces and moments at all the points equal and opposite to those given in the last column of the operations tables (which are due to the specified rotation ω) was determined. These forces and moments listed in the last column are designated RHS to indicate right-hand-side members. It should be noted that two of the displacement quantities listed are the remaining two (unknown) rigid body displacements θ and η of the end ring. The generalized force corresponding to θ is a torque, that corresponding to η , a vertical shear force. Obviously, these two generalized displacements must be so chosen as to yield zero generalized forces when the external load applied to the cylinder is a pure bending moment. These two requirements are represented by the last two rows of the operations tables.

Similar considerations can be advanced in the case of the other two cylinders. The operations table of Cylinder 40 having the 135° cutout differs from table 2 only in quadrant D. This quadrant is given in table 3. In the case of Cylinder 35 all four quadrants are different. They are shown in table 4. In quadrant A of table 4 the columns of the tangential displacement and the rotation of point Bl correspond to two units each rather than to one. The doubling of these movements was undertaken in order to maintain the symmetry of the operations tables in spite of the assumptions regarding the simultaneous movements of points on the two sides of the horizontal plane of symmetry of the cylinder.

APPROXIMATE THEORY

Because of the great amount of work required for the solution of stress problems by the numerical method discussed, the possibility of using an approximate theory was investigated. The approximation amounted to neglecting all influences except that of the axial displacements. Physically the structure corresponding to the approximate theory would have rigid rings. Moreover, these rings would have to be supported in their own plane to provide reactions, since the shear forces and the torque acting upon the rings are not canceled in the approximate calculations.

The operations tables of the approximate theory are identical with those portions of the operations tables (tables 2 to 4) that involve only axial forces and displacements.

PRESENTATION AND DISCUSSION OF RESULTS

The displacements calculated for a rotation ω of the end ring amounting to 1×10^{-4} radian are presented in tables 5 to 7. The distortions of the rings corresponding to an applied bending moment of 20,000 inch-pounds are shown in figures 11 to 14.

The axial strains calculated from the displacements are plotted in figures 15 to 20, which also contain experimental results taken from reference 8 as well as calculated values corresponding to the approximate theory. The agreement between theory and experiment is

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satisfactory. The approximate theory is also in reasonable agreement with experiment in the complete portions of the cylinders. In the cutout portions the values calculated by the approximate theory are even slightly closer to the experimental points than the values obtained from the complete theory. The displacements calculated by the approximate theory are listed in table 8.

Figures 21 and 22 show the shear stresses in the sheet of the complete portions of the cylinders and the maximum bending stresses in the rings bordering the cutout. The absolute values of these stresses are very small. Moreover, they decrease in an oscillatory manner from the region of the neutral axis of the cylinder on the cutout side toward the neutralaxis location on the opposite side.

The bending moment required to cause a rotation of 1×10^{-4} radian of the rigid end ring with respect to the transverse plane of symmetry is 5075.45, 7845.90, and 4511.04 inch-pounds in the case of the cylinders having 45°, 90°, and 135° cutouts, respectively. It should be remembered that the construction of the cylinder with the 90° cutout was different from that of the other two.

CONCLUSIONS

During the course of the calculation of the stresses in three reinforced monocoque cylinders with side cutout, carried out by means of a numerical procedure developed in part IV in the present series of investigations, the following principal observations were made:

1. The problem can be stated mathematically by means of a set of simultaneous linear equations represented by the operations tables and the external loads. The operations tables can be set up without difficulty if use is made of the solutions of the four-panel problem contained in the present report, together with the coefficients presented in the tables and graphs given in NACA TN No. 999.

2. The equations can be solved by Crout's method at the rate of approximately 2 hours for each unknown quantity. This estimate does not allow for errors.

3. The calculated values of the normal strain in the stringers were in satisfactory agreement with the strains measured in the experiments of part IV of the present series of investigations.

4. The shear stress in the sheet and the bending stress in the rings were found to be very small.

5. An approximate method which considers only the axial displacements and thus does not satisfy all the equilibrium conditions gave results reasonably close to those obtained by the complete method.

Polytechnic Institute of Brooklyn Brooklyn N. Y., July 3, 1946

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TABLE 1 - SCHEMATIC ARRANGEMENT SHOWING THE FOUR QUADRANTS OF THE OPERATIONS TABLES FOR ALL THREE CYLINDERS

A	В
С	D

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	Ec4	^U C4	V _{C4}	¥c4	Š₿4	^U 84	۷ ₈₄	и _{В4}	5 _{c3}	u _{са}	V _{C3}	₩a	5 ₈₃	u _{B3}	¥ ₈₃	W _{B3}
X ₆₄	1179.6013728	11.577150	5.53227948	1.2284966	354,803906	11,57750	5.53227048	2284980	g,5766 22 9	11.57715	1.84489316	7284985	9,5700229	11.57715	1.84409318	1.2284986
Tc4	1).577150	43.7 25289	1.5108042	5.30127106	11,577150	41.906748	2,2293185	4,455384	11,577[5	12.2824313	1.5108042	03,3367	11.57715	13.995583	2.7293185	1.485128
R _{C4}	5.53227948	1.5108042	1.41480662	0.0759458	5.53227948	2.7795185	1.06530714	0.2305621	1.84409316	1.5105042	0.07897268	0,9769458	1.04409316	2, 2293185	0.35510738	0.2305621
N _{C4}	1.7284986	5,30 27 06	0.0769458	7.0392002	1,2254586	4,455384	0.2365621	0.4727787	1.2284985	0.5133567	0.0769458	0. 1499024	1,2284096	1,405 28	0,2365621	0. 1575929
X _{B4}	354.883966	11,57760	5,53227946	1,7284930	711.1977279	0	0	0	0.5756229	11,57715	1.84409316	2284986	23,9415572	0	0	0
	11.577(50	41,986749	2,2293485	4,455384	0	73.4294752	2.27850223	9.1741402	11.57715	13.995583	2.2293105	485128	8	19.0996664	2.27850223	0.5316707
R. 84	5,53227948	2,2293185	1.00530714	0.2365021	0	2.27850223	2.47451080	0.2327457	1.84409316	2.2293(85	0.35510236	0,736562		2,27850223	0.0395783	0.2327457
N _{B4}	1,2284986	4.4533540	0.236562	0.4727787	Q	9.1 1744402	0.2327457	3.92060749	1,2284986	1.485128	0,2365621	0,1575929	8	0,5316707	0.7327457	0.35251577
X _{ca}	9,5766229	11.57715	1.8440936	1,2284986	9,5766729	11,57715	1.84409310	2284986	1770.0247499	0	3.66846692	Q	364,4705889	0	3.68618632	0
T _{ca}	11.57715	12.2824313	1.5 08042	0.5133567	11.577150	13.995583	2.7293 85	1.485 28	0	31.4300975	Q	4,78791436	0	27,99 66	Q	2,970256
R _{C3}	1.844003(6	1.5108042	0.07897286	0.0769458	1.84409316	2,2293 85	0,35510238	0.2365621	3.60848632	Q	1.33583374	0	3,68818632	Û	0.71020476	0
N _{C3}	1.1284986	0.5133567	0.0719458	0. 499974	1.7284980	1.485128	0.2365521	0, 575929	. 0	4,78791436	0	2,1001926	0	2.970256	0	0.3151 <i>8</i> 58
X	9.5766229	11.57715	1.84409316	1,2284986	73,94/5572	0	0	0	351.4705889	0	3.6661662	Û,	607.7561707	0	0	0
T _{B3}	11.577150	13,995583	2.2293185	1,485 28	0	0.0996664	2.27850225	0.0316707	0	27,991(66	0	2,970256	. 0	53.5290068		8.56574332
Rea	1.84409316	2,2293185	0,35510238	0.2365621	0	2.27850223	0.0395783	0.2327457	3.68818632	D	0,71020476	0	. 0	<u>,</u>	2.43403256	0
N _{B3}	1.7784986	1.485128	0,2365021	0, 1575929	Q	0,5316707	D. 73 27457	0,35251577	Q	2,070256	Q	0.3151856	0	8.5657433	0	4.77332325

TABLE 2.- OPERATIONS TABLE FOR CYLINDER 39 WITH 45° CUTOUT.

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QUADRANT A

- INDICATES NEGATIVE NUMBER

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	.84409316 1.2284985
Tcz;	2.2293185 1.485128
R _{cs} 1,84409346 1,5408042 0.07897286 0.0789456 1,24409316 2,2239185	0.35510238 0.236562
N ₅₈ 1.2284986 0.5133567 0.0769458 0.1459924 1.2254986 1.485123	0.1365671 0,1575929
X _{B2} 9.5766729 (1.57715 (1.5440936 (23.04)5572 0	0 0
T ₈₂ 11,57715 13,995583 12,229385 1,485128 0 19,895684	2,27850223 0,5316707
R _{b2} .84489310 2.7293185 0.35510230 0.2365021 0 2.72950223	0.0395783 0.7377457
N _{B2} (.2284986 (.485123 0.7369621 0.1675979 0 0.5366707	0.7327457 0,35251577
X _{c1}	
R _{c1}	
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X _B	
R _{al}	
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Y_/2	

QUADRANT C

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	[₿] с2	U _{C2}	V _{C2}	*c2	Ę _{в2}	^U в2	V _{B2}	W ₈₂	^Ę сі	u _{cı}	V _{CI}	W _{CI}	Ę _{ві}	u BI	¥ _{ві}	₩ _{BI}	٩.	θ _A r	-RHS
X _{C4}										[·····				1					
Тся																	·		
R _{C4}																			
N _{C4}																			
Х _{В4}							.										6.678900204	0	94,65079167
В4																	31,37288093	37.7 758932	15. 12627543
- ^R в4				· · · · ·							· .						0.857401386	0	0,413391775
N _{B4}										ŀ				<u> </u>			3.329103305	4.002305972	1,605 10773
<u>^</u> cз	9.5766229	11.577150	, 84409316	1.2284986	· 9.5766229	11,577150	1,84409310	1,2224986		<u>_</u>	1			· ·	<u> </u>				
	11.577150	2.2024313	1,5108042	0.5133567	11.57715	3,995563	2,2293185	1,485128									S	Sec. 1	<u>.</u> (1)
R _{C3}	1.84409310	1.5108042	0.07897288	0,0760458	1.84409316	2.229365	0,35510238	0.236562)		<u> </u>	ļ								
ca	1,2264986	0.5133567	0.0709458	0,1499924	1.2284986	1.485128	0.2365621	0, 1575929		l						L			
^вз	9,5766229	11.577150	1.84409315	1.7284966	23.9415572	0	0	0		<u>_</u>	· .						16.124291456	.0	228,507224060
<u></u>	11.577/5	13.995583	2.2293185	1.485128	0	19,6996684	2,27850273	0,5316707					L	ļ			12.995072772	37,71758992	8,26550843
- R ₉₃	1.84409310	2.2293185	0.35510236	0.2365621	0	2.27850223	0,0395783	0.2327457						ļ		·	2.069950004	0´ ·	0,99806026
"ВЗ	1.7284986	1.485128	0.736562	0.1575929		0,5316707	0,2327457	0.35251577			<u> </u>	L			L		1,378959739	4,002365072	0.664858651

TABLE 2.- OPERATIONS TABLE FOR CYLINDER 39 WITH 45° CUTOUT. - Concluded

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QUADRANT B

----- INDICATES NEGATIVE NUMBER

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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C2	(70.0247499	Q	3,06618632	0	364.4705889	0	3, 6861863Z	0	9.5756229	11.577150	1, 84409316	. 2284086	9.5706229	11.57715	1.84409316	1,2284986		·	
<u>c</u> 2	p	31,4300976	0	4.78791436	0	27.991 165	0	2,970256	11,577 50	12,2824313	1.5108042	0.5133567	11.577(5	3.995583	2.2293185	1.485128			· ·
c 2	3.66816632	0	1, 33583374	Ð	3,58818632	0	0.71020476	0	1.84409315	1,510804Z	0,07897280	0,0759458	1.84409316	2,2293185	0.35510238	0,2365621			
c 2	0	4.76791436	0	2. 1891926	0	2.970256	Q	0,3151858	1.2284985	0.5133567	0.0769458	0.1490924	1.2284966	1.485128	0,2365621,	0, 1575729			
52	364.4705669	0	8,68818632	D	687.2561707	0	Ð,	Q	9,5766229	11.57715	1,84409316	,2284906	23,94(5572	0	0	0	16, 124291458	-Q	728.507214868
B2	0	27,991166	0	2.870256	0	53, 5298068	0	8,58574332	11,57715	13,995583	2.2203185	485128	Q	19,8996884	2,27850223	0,5316707	12.565072772	37.71758932	8,20551848
B2	3.66618632	0	0.71020470	0	D	D	2, 4349325	0	1.84409310	7.2293185	0.35540238	0.2385621	0	2.27850223	0,0395783	0.2327457	2,069050004	0	0.996016026
<u>82 i</u>	0	2.970256	0	0,3151858	0	8.58574332	0	4, 27332326	1.2284906	1.485128	0.2305621	0, 575929	0	0.5316707	0,2327457	0.35251577	1,578959759	4.002305977	0.654856651
<u>cı {</u>	9.5700229	11.57715	1.84400316	1.2784986	9.5760229	11.577150	1. 84409310	1.2284986	940.5570438	11,57715	,644093(6	1.2284986	300.7536174	11.577715	1.64400346	1.2284986			
er	11.57715	12.2824313	1.5108042	0,5133567	11.577150	3.995563	2.7293185	1,485128	11,57715	15.7150488	2.93203735	2,39395718	11.577150	3,995583	2.2293185	1.465 28			
<u>ci i</u>	1,8440936	1.5108042	0.07897288	0.0769458	1.844093/6	7.2293 85	0, 355 (0238	0,2365621	1,64409316	2,93263736	0.66791687	0,7020249	1,8440038	2,2293185	0.35510238	0.2365621			
<u>cı (</u>	1.2284986	0.5133567	0.0769458	0. 1409924	1.2284000	1.485128	0. 2365021	0. 1575929	1,2284986	2.39395718	0, 702 0249	1.0945963	1,2284965	1.485128	0.2305621	0, 1575929			
B1 (9.5766229	11.57715	84400316	1,2284966	23.94 5572	0	0	0	00.7535174	11.57715	1.84402316	,2284986	8 8.7507877	21 5430	3,688,6632	2.4509972	6.678900204	٥	91.65079167
81	11.577150	13.995583	7.2293185	1.485128	0	19, 6996684	1,27850273	0.5318707	1 577150	3.995563	2.2293105	,465/28	23. 15430	45.4383092	4370285	6.1471581	31.37288003	37.71758932	15, 17977543
<u>.</u>		2.2293185	0.35510238	0.2383621	0	2.77850223	0.0505783	1,2327457	1.84409510	2.2293185	0.35510738	0.2365621	3. 6064864	1,4370286	, 7643061	0.8270158	0.857401366	0	0.413391775
81	1,7284986	1.485 28	0.2365621	0. 1575929	0	0.5316707	0, 2327457	0.39751577	1.2284086	1.485128	0,236562)	0. 1575929	2 4569972	6.1471581	0.6270158	3.6056218	3,329103305	4.007365977	1 005110773
λs'	·		!														77.3905188	0	31,90061462
٧r,																		152 4713037	0
		170.0247499 22 0 22 0 22 0 32 364.4705669 32 0 32 3.6051653 32 0 32 0 32 0 32 1.5705629 32 1.57715 332 0 332 0 332 1.2284936 33 9.5706229 33 9.5706229 34 1.577150 35 1.7284936 35 1.7284936	170.0247499 0 2 0 31.430976 22 0 31.430976 22 0 4.75791436 22 0 4.75791436 22 0 4.75791436 23 364.4705699 0 22 0 27.6811863 0 23 0 2.70256 0 232 0 2.970256 0 232 0 2.970256 0 24 1.57715 12.2824313 21 11.57715 12.2824313 21 1.57715 13.08042 21 1.57715 13.08042 21 1.577150 13.995583 21 1.577150 13.995583 21 1.7254926 1.425128 22 . . 24 . . 25 . . . 26 	170.0247499 0 3,68816632 2 0 31,4300976 0 22 0 31,4300976 0 32 0 4.76791436 0 32 0 4.76791436 0 32 364.4705669 0 3.68818632 32 0 27,991186 0 32 0 2.970256 0 32 0 2.970256 0 32 0 2.970256 0 32 0 2.970256 0 32 0 2.970256 0 33 1.57715 1.8446036 31 1.5108042 0.0769728 32 1.2284986 0.5133567 0.0769488 33 9.5766229 11.57715 1.84400346 33 9.5766229 1.57715 1.84403346 33 1.577150 1.895583 7.2733165 33 1.577150 1.395563 2.2733165	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{c} 170.0247499 & 0 & 3.6881632 & 0 & 364.4705888 & 0 & 3.6801632 & 0 & 9.5766229 & 11.577150 & 0.4400316 & 72.64066 & 9.5766229 \\ \hline 22 & 0 & 31.4300976 & 0 & 4.70791436 & 0 & 77.991165 & 0 & 2.970256 & 11.577150 & 12.7824313 & 5108042 & 0.5133567 & 11.57715 \\ \hline 23 & 3.0681633 & 0 & 0.33553374 & 0 & 3.68418832 & 0 & 0.71020476 & 0 & 1.6440936 & 1.5108042 & 0.7059458 & 1.8440936 \\ \hline 22 & 0 & 4.76791436 & 0 & 7.1801926 & 0 & 2.970256 & 0 & 9.3151858 & 1.2264966 & 0.5133667 & 0.0769458 & 0.1460924 & 1.2284966 \\ \hline 34 & 4705869 & 0 & 3.68818632 & 0 & 667.7561707 & 0 & 0 & 9.5766229 & 11.57715 & 1.8440936 & 7.7991466 & 0 & 2.970256 & 0 & 9.515768229 & 11.57715 & 1.8440936 & 7.7293165 & 1.4840924 & 1.2284966 \\ \hline 32 & 364.4705869 & 0 & 3.68818632 & 0 & 667.7561707 & 0 & 0 & 0 & 9.5766229 & 11.57715 & 1.8440936 & 7.7293165 & 1.4840924 & 1.2284966 & 0.5133667 & 0.0769458 & 1.4840924 & 1.2284966 & 0.5133667 & 0.0769458 & 1.4840924 & 1.2284966 & 0.5133667 & 0.0769458 & 0.485922 & 0 & 0.515766229 & 0.5153667 & 0.0769458 & 0.485922 & 0 & 0.515766229 & 0.5153967 & 0.0769458 & 0.485922 & 0 & 0.51566229 & 0.5153967 & 0.55766229 & 0.5156621 & 0.1565621 & 0.1565621 & 0.1579929 & 0 & 0 & 0 & 0 & 0.7102047 & 0 & 0 & 0 & 0 & 0.733976 & 0.35590236 & 7.335572 & 0 & 0.53590236 & 0.53590236 & 7.335572 & 0 & 0.53590236 & 0.53590236 & 0.53590236 & 0.53590236 & 0.53590236 & 0.53590236 & 0.53590236 & 0.53590236 & 0.53590236 & 0.5359174 & 0.57715 & 0.4409316 & 7.2284965 & 9.5766229 & 0.5153967 & 0.7715 & 0.4409316 & 7.2284965 & 9.5766229 & 0.5153967 & 0.7715 & 0.4409316 & 7.2284965 & 9.5766229 & 0.5133567 & 0.779150 & 0.9759528 & 0.757150 & 0.4409316 & 7.2293165 & 0.35590236 & 0.53590738 & 3305716 & 0.77150 & 0.9759528 & 7.7233185 & 0.4570838 & 0.7505738 & 0.57916278 & 0.5795928 & 0.67916777 & 0.57150 & 0.5705728 & 0.57305738 & 0.57916787 & 0.5705728 & 0.57305738 & 0.57916787 & 0.5705728 & 0.57305738 & 0.57916787 & 0.5705728 & 0.5735577 & 0.5705728 & 0.5735577 & 0.5705727 & 0.5705727 & 0.5705728 & 0.57355533 & 7.7233185 & 0.459128 & 0.75$	$ \begin{array}{c} 22 & 170 \\ 0.247499 \\ 0 \\ 3,8661632 \\ 0 \\ 3,8661632 \\ 0 \\ 3,8661632 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,703426 \\ 0 \\ 3,702528 \\ 0 \\ 1,702049 \\ 1,7715 \\ 1,84400346 \\ 1,220498 \\ 0,702049 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,2704028 \\ 1,57715 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,57715 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,57715 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,57715 \\ 1,57715 \\ 1,54400346 \\ 1,2704028 \\ 1,2704028 \\ 1,57715 \\ 1,57715 \\ 1,84400346 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,2704028 \\ 1,270408 \\ 1,2$	22 170.0247490 0 3,68816632 0 3,68016632 0 9,5766229 1,577150 8,4400316 1,2784666 9,5766229 1,577150 8,4400316 1,2784666 9,5766229 1,577150 8,4400316 1,2784666 9,5766229 1,577150 8,4400316 1,2784666 9,5766229 1,577150 8,4400316 1,2784666 9,5766229 1,577150 8,4400316 1,2784666 9,5766229 1,577150 8,4400316 1,27715 1,94400346 1,577150 1,84400316 1,277150 1,94400346 1,577150 1,84400316 1,277150 1,94400346 1,277150 1,94400346 1,27284066 1,420224 1,2274906 1,445120 0,235510236 0,235510236 1,27284966 0,5133567 1,076428 1,4400346 1,2274906 1,445120 0,2365621 0,23550236 1,2274906 1,445120 0,23550236 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 1,2274906 <	$ \begin{array}{c} 22 & 170 & 0.247499 & 0 & 9, 68616637 & 0 & 0.4.7075689 & 0 & 9, 50612632 & 0 & 9.5766229 & 11.577150 & 8.04403161 & 7.764926 & 9.5766229 & 11.57715 & 1.944003161 & 7.764926 & 11.57715 & 1.944003161 & 7.764926 & 11.57715 & 1.944003161 & 7.764926 & 11.57715 & 1.94400316 & 7.764926 & 11.57715 & 1.94400316 & 7.764926 & 1.95715 & 1.94400316 & 7.764926 & 7.7764926 & 7.77764926 & 7.77764026 & 7.7764926 & 7.777$	22 170.0247490 0 3,6851653 0 264.4705689 0 3,68516632 0 9.5766229 11.577150 1.2440336 2.262436 9.5706229 11.57715 1.94400336 2.2703165 2.485128 2.485128 22 0 31.4500976 0 4.76791436 0 7.991166 0 2.970256 11.577150 1.94400336 2.2703165 3.925633 2.2703165 0.355607280 2.556021 22 0 4.76794056 0 2.970256 0 0.3151856 1.2204966 0.1400346 2.100024 0.1400346 2.2703165 0.32965021 0.171729 23 0 4.76794056 0 0.3151856 0 0.3151856 0.9576229 11.57715 1.84400346 2.2703465 1.457129 0.7789177175 0.3460336	22 170.0247490 0 9,86816532 0 9,56016532 0 9,7766223 11.577150 5,6440336 7,7254666 9,5766223 11.577150 5,6440336 7,7254666 9,5766223 11.577150 5,6440336 7,723466 9,776623 1,577150 5,6440336 7,723465 3,025043 2,2733165 3,025043 2,2733165 1,577150 5,6440336 7,723465 3,025043 2,2733165 1,577150 5,6440336 7,723465 3,025043 2,2733165 1,5771573 3,025043 1,577150 5,6440336 7,7234665 1,5771573 3,025043 1,5771573 3,025043 1,5771573 3,025043 1,5771573 3,045054 1,5771573 3,045054 1,5771573 3,045054 1,5771573 3,045054 1,5771573 3,045054 1,577150

QUADRANT D

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	5 ₆₄	^Ц с4	VC4	* c4	ξ ₈₄	U ₈₄	Y _{B4}	¥84	۶a	ч _{съ}	V _{C3}	W_3	503	U RS	У _{ВЪ}	¥ _{B3}
Xcs	1779.60137728	11,577150	5.53227948	1.7284966	54.893966	11.577150	5.53227948	1.2254966	9.5766229	11.57715	1,8440316	1.2284085	9.5766221	11.57716	1,84499316	1,2284900
Tc4	11.577150	43.7(25210	1.5/08042	5.30 27 06	11.577150	41,985740	2,2293185	4.455384	11,577/5	12.2824313	1,5108042	05133567	11,57715	13,995583	2.7293 85	1.485(2)
R _{c4}	5,53227948	1.5108042	1.41480662	0.0759458	5.53227948	2,2293165	1.05530714	0.2365621	84409316	1.5108042	0,07897266	8,0769458	1.84409310	2,2293185	0.35510238	0.2365621
N _{C4}	7284986	5,30 27 05	0.0769458	2,0392002	1.2284986	4,455384	0.2365621	0.4777787	1.2284986	0.5 33567	1.0769458	0. 499024	. 1,2284966	1,405 28	0.736562	0, 1575029
XBA	364.803966	11.577150	5,53227948	1,7784936	711.1977279	1	0	0	9.5766229	1,57715	1.84409316	2204986	23,945572	0	0	0
Тра	11,577 50	41.986749	2.7793185	4,455384	0	73 4294752	2.27850273	9.11741402	11.57715	13.995583	2.2293105	1.4851Z8	0	10, 5096684	2,27850223	0.6316707
R ₈₄	5,53227948	7.2293185	1,00530714	0.2365621	0	2,27850723	2.47451080	0.2327457	84409315	2.2293185	0.35510238	0.7365621		2,27850223	0.0395783	1.2327457
N ₈₄	1.22254986	4,4553840	0.2365621	0.4727787	.0	9.1744402	0.2327457	3 92060740	1,2284986	1,485128	0.2365621	0,1875920	Q	0.5316707	0.2327457	0.35251577
X _{C3}	9,5786229	11,57715	1,8440836	1,2284966	9,5756229	11.57715	1.04409316	2284086	170,0247499	0	3.66616637	0	364,4795880	0	3.00810632	D
т _{сэ} Т	11,57715	12.2824313	1,5108042	0.5133567	11.577150	13,995583	7.7293185	1.485128	0	31.4300976	0	4,76791436	0	27.991 (65	<u>0 ·</u>	2.870256
R _{C3}	1.8440936	1.510604Z	0.07897288	0.0760458	1.844093(6	2,2293185	0.35510238	0.2365621	3,008/0632	Q	1.33585374	0	3.66816632	0	0.71029478	0
N _{CJ}	1,2284986	0.5133567	0.0769458	0.1499924	1.2284986	1.465128	1,7365621	0,1575029	Q	4,78791436	0	2,1891926	0	2.970256	0	0,3151858
X _{B3}	9.5766229	11.577/5	1.84400316	.2284986	23.91(5572	0	Q	<u> </u>	304.4705889	0	3.0001002	Q.	807.2561707	0_	0	D
Твэ	11,577150	13.995583	2,2293185	1.485 28	0	19.8996684	1.17850723	0,5310707	0	27.991165	Q	2,970256	0	33.5298068	1	8,56574332
R _{B3}	1,84409318	2,2293185	0.355 0238	9.23655Z	Q	7.27850223	0.0595783	0,2327457	3.658(8632	Q	0.71020476	0	0	0	2,4343750	0
N _{B3}	1.2284986	1.485128	0.2365021	0. 1575929	0	0,53,6707	0.1327457	0.35251577	0	2,970256	0	0,3151858		8.5657433		4.77332326

TABLE 2.- OPERATIONS TABLE FOR CYLINDER 39 WITH 45° CUTOUT.

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QUADRANT A

- INDICATES NEGATIVE NUMBER

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NACA TN No. 1435

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

X _{CR}	<u> </u>	· · · · ·	9,5766229	11.57715 1.04405	6 1.2204906	9.5756229	11.57715	1.84,409316	7284986
Tc2			TI,577 5+	12.2024313 1.51080	2 0.5133567	11.577150	3.995583	2.2293485	485128
R _{C2}			Ti,84409316	1.5108042 0.07897	86 8,0769455	1.04409366	2,2298185	0.35510738	0.236562
N _{C2}			1.7284986	0.5133567 0.07694	8 0.1499924	1.2254966	1,485128	0,2365621	0,1576929
Xa2			9,5766229	11.57715 1.84409	1.2284986	23,94,5572	0	Q	0
T ₈₂			11,57715	13.995583 2.229318	5 1,485128	0	19.0996644	2.27850723	0.53(6707
R _{B2}			1.84489315	2.2293/85 0.355/0	38 0.2365021	0	7.77850273	0.0395/83	0.2327457
N _{B2}			1.2284986	1.485128 0.23656	1 0.1575929	D	0.5816707	0.2327457	0.35251577
X _{cl}									
TCI	· · · · ·								
R _{ci}							· .		
N _{cl} i									
X									
T _{B1}					1				
R									
NBI									
Y,/2						•			
10, <i>12/1</i>									

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QUADRANT C

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	Γ	ŧ _{c2}	U _{C2}	V _{C2}	W _{C2}	ξ ₈₂	U ₆₂	V _{B2}	¥ _{B2}	ξ _{CI}	u _{c1}	V _{CI}	W _{C1}	ŧ _{ві}	Цві	V _{B1}		N	<u>ه</u> ٢	-RHS
×	2				• •															
Ţ,	4														<u> </u>		<u> </u>			
R	4														<u> </u> -					
.N.														L	<u></u>	L	<u> </u>	ļ		
X	14								· 		· · · · ·		· · · ·		ļ	<u> </u>	Ļ	6.676900204	0	94.05070007
T	H.,													ļ	<u> </u>			31.37286003	37,7 75892	15, 12627643
	н				L	·		· .		• •· · · <u>·</u> ·			•	L			L	0.857401305		0,41339775
N.	м			·						·				<u> </u>	ļ		ļ	3.320103300	4,007305077	1.60510773
<u>×</u>	<u>a</u>	9.5766729	11.577150	04409310	1,2284968	9,5766729	11.57750	j. <u>84409396</u>	2784966		ļ			<u> </u>	 .				·····	
	<u>=</u>	11.577/50	12.2824313	.5108042	0,5133567	11.57715	3,99553	2,2293185	445128	 	<u> </u>			· ·	· ·	<u> </u>	,		-	: ·
R		T. 044 09310	1.5106042	9,07897280	0,0760458	1.84409940	2.229305	0,39510238	0,2355621					L					_	
N _c		1.1264966	0.5133567	0.0769468	0.1400024	1.7284986	1,405128	0,2305671	0, 1575979						ļ		L		··	
<u>×</u> _	22	9.5766229	11.577150	1.8440636	2754985	23.9415572	0	0	<u> </u>	<u> </u>					<u> </u>			18,124281456	<u> </u>	778,507724868
	-	11.57715	3.005565	2.2293165	1.405128	0	19.0996604	2 275 0273	0,5316707			ŀ		Ļ	Ļ	ļ	ļ	12,995077777	37,71756932	0,20550045
	ю[_	1.8440933	2 77 931 65	0.33510220	0.2306621	0	1.1765022	0,0005783	0,2327457		L			<u> </u>	L			2.06995000	Q.,	0.99809026
N,	92 J	1.7784006	1.485128	0.236562]	<u>a 1575929</u>	0	0.516707	0.2327457	1,5251577				L	L	<u> </u>		1	1.378959739	4,007365072	0.00185065

TABLE 2.- OPERATIONS TABLE FOR CYLINDER 39 WITH 45° CUTOUT - Concluded

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QUADRANT B

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTIOS

	C2	170.0247499	0	3.66618632	0	354,4705889	0	0.60018682	1	9.5765729	1.577150	1. 54401316	7284000	8.5766229	1.57715	1,84400318	.7184986			· · ·
_	2	0	3, 4000976	0	1.7879143	0	77,991,86	Q	7. 97075 6	11.577150	7,2074313	1,5105012	0.5133587	1.57715	3,905583	2.2203145	465128		<u>`</u>	
	CZ	3.66810632	0	1.33563374		3,00010032		0,71020476	D	1,8440930	1,5100042	1.0789728	0,0769458	1,04409396	2,7298185	1.355 0738	0.2365621			
	C2	Q	4.767940	5 0	2. 1891926	0	2,970258	0	1.3151856	1,2284906	0.5133567	8.0760458	0.1400024	1.2284905	1.405 28	0,236562L	0.1573729			
	82	364.4705849	Q.	0.650 8032	0	687.2961707		0	0	9.5766229	11.57715	.84400510	.2284900	23,949577	0	0	0	18, 174791450	0	728.5077240
	82	1	27 ₇ 00 166	0	2,870256	1	13, 2790036		5857437	11 5775	(3.905/63	2,2203165	455128	1	10.0000004	2,1785012	0.5316707	1. 595072772	7,7176422	0.700043
1	82	3.6051863	0	0.71020470	0	0	8	2. 4346325	1	1,6440936	2.7293185	0.3350738	0.236562)	1	2.2785022	0,0395783	1.7327457	2.059050084	<u> </u> Q	0.99601052
	82	Q	2,970256	0	1.315(854	Ð	8.5857433	0	4.27332328	1.2264966	1.455126	0,2305821	0.1675929	0	0.5316707	1.2327457	0.35251577	1.576939750	4.002300972	0.86485855
×	C1	9.570229	11,577(5	1.64405316	1.2784960	9,5766228	11.577150	, 6440B3H5	.2284086	04115670438	11,57715	. 64409315	,2784900	300.7535174	11.57716		1.7264966			
	¢L I	11,57715	12.2824313	1.5108042	1,5133507	JJ.577/90	13,095965	Z.7753185	1,485128	11,57715	15.7150488	2.93783735	2,3939571	11.577150	3.905583	2,2293185	1,465128			
F	cı .	1.0440136	1.5108042	0.0789/28	8.0709456	1,64409345	1,1246115	1,355 122	0.236582	1,844083/6	2,0326373	0.5679(687	9,7020249	1.844938	2,2293 85	h.35502Y	0,2305071			
N N	CI	1.2264986	0.5133567	0.0769458	1.1499924	1,2284986	1.405128	1,7365021	9,1575929	1.2284926	2.3839571	1, 7020249	0945963	1.2254956	1,485128	0.2365621	0, 1575979			
	B]	9,5700229	11.57715	1,8440036	1.2204900	23,9415572	0	0	<u> </u>	000.7530174	1).57715	0440036	.7284006	618.7587877	3 15430	1.068(203)	2.450972	5.07890000	Ø	94.05079107
	81	11.577(50	13,995583	2,2293185	1.465128		9.0996684	7.275 223	1,5316707	11.577150	13,995563	7,7793105	1.465128	23, 15430	6.68002	4370286	0.1471581	SH. 37260003	\$1,717560,52	15.12007513
F	51	1,84409548	7.7293185	0.33010230	0,7,58312)		2 77850273	0.0305763	0.730457	1.84483516	2,2293165	356 07 3	0.2305021	3.5551861	1.4370288	764300	0.0270/58	0.65740(366	0	0.41538677
	81	1,2284986	1,425128	12365021	0. (575929		0.5316787	0,2327457	1.3075677	1.2284086	1.465128	0,236562)	0. 1575929	1.669972	6.1471581	0.6270458	3.6056216	3.329 (03385	4.002305872	1.865/ 077
	∧ ≥			1	i	:				·							i	77.3965184		31,0001462
P./2	9/r		i	1	1	<u> </u>) • • • • • • • • • •			[L	· · · · · · · · · · · · · · · · · · ·		L	 	: 			12.4713037	0

QUADRANT D

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	₿ _{C2}	U _{C2}	VCR	W _{C2}	ξ ₈₂	U.BR	V _{B2}	W _{B2}	5,,,	u ⁿ i i	V _{B1}	W _{B1}	٩	۹۸۲	-RHS
X _{C4}											<u> </u>				
Tca															
R _{C4}									_						
N _{C4}															
X ₈₄												ļ	6.675500214	0.	94.65079167
Т _{В4}													377788993	57.71758932	15.12627543
R _{B4}									-			ļ	0.857401366	0	0.4 339177
N _{B4}		·								L	ļ		3.3204033 8 5	4.002365972	1.00511077
× <u> </u>	9,5766279	11.577160	844093	.7284996	0,5756229	11.577150	1.84409316	.2284996			ļ	<u> </u>			
<u></u> C3	11,577,50	2.7824313	1.5/08042	0,5133667	11.57716	3.005563	2,7293185	465125							
R _{C3}		1.5108042	0,0780728	0.0789458	1.84400310	2.2293186	0.33510738	0.2385621		<u> </u>		<u> </u>			
N _{C3}	2264986	0.5133567	0.0789458	0. <u>1409074</u>	1,7734906	1,455/28	0.2365621	1, 1575928		<u></u>		ļ			
<u>Х</u> вэ	1,5706279	1.577150	.54400316	1.2284980	73.9415572	0	0	0	· · ·• ·				18, 124291450	<u>0</u>	278,50772486
(B3	1,57715	13,992583	2,2293105	1.445128	. 0	19,0096684	2.17850223	1.5316707		l		_	2.995072772	57,71758931	6,200043
H _{B9}	1.84400305	2,2293 85	0,35510238	0.2305621	0	2.77850723	0395788	1.7327457			<u> </u>	ļ	2,05958004	0	0,9950,6421
N _{B2}	1 2284908	1.465128	0.1305621	0. 1575929		0.5316707	0.2177467	0,352515 77		<u> </u>	\downarrow		1.376959739	4,0023655//	0.00485865

TABLE 3." OPERATIONS TABLE FOR CYLINDER 40 WITH 135° CUTOLIT

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QUAUKANI B

INDICATES NEEATIVE N

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NATIONAL ADVISORY COMMITTEE FOR AERONALITICS

<u></u>						•									
X	040.5670438	11.57715	1.84409316	,7784986	304,7535174	11,57715	.84400316	1,2284966					•		
T _{C2}	11.57715	5.7150468	2.9326373	7.39395718	11,57715	3.905583	7.7293(85	.485128							
R _{C2}	84409316	2.93763735	0,6670(887	0,7020249	1,84409316	2,2293/85	35510238	0.2365621							
NCE	1,2284905	2.39505718	0,7020249	,0945963	1.1284986	1,485128	1,2365621	9, 1575929							
X _{B2}	300.7535174	1,57715	84409316	,2284086	601.3858534	11.57715	I, 844 <i>0</i> 0316	1,2204006	14,,3640343	1.5775	.84400316	,2784986			
TB2	11.57715	3,995583	2.2293185	,485128	11.57715	99.5347238	2,2293185	7, 1006 1532	11.577/5	5,9040864	0, 0491 8373	0534573			
R _{B2}	1,844093/5	2.2203485	0,355/0738	0,2365621	1.844005 5	2.7293185	2.07953616	0.2365621	1.84400306	0.0401037	0,31552400	0.4693078			
N ₈₂	1.2284986	1.485128	0,2365521	0, 1575920	1.1284090	7.10061532	1,2365421	4.11573030	1.2284986	0.9534573	D, 4 5030 78	0,5101 085 7			
Xci					4.3540343	11.577150		1.2284085	298.8440245	11.57715	5.53277945	2284900			
Tçi		• •	_		11.577150	5,9040654	0.64916373	1,9534573	11.57715	4427262	0.04918373	4.65293002			
Rci					1.8440936	0.04918373	1.31552468	0.4603078	5.53227048	0.84018373	40970372	0.4693078			
Nci					1.2284986	0.9534573	0,4696078	0,510,0867	1.2284985	4.66203002	0.4600078	3. 44802379			
Xai									• • • •						
T _{BI}											-				
R _{BI}															
NBI															
Y_/2					<u> </u>				-				· · · ·	· · · ·	
(Q,/2)/r															

QUADRANT D

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	24 ₈₁	2# ₈₂	Ę _{BZ}	⁰ в2	Y	W ₈₂	5 _{c2}	^U c2	Vcz	V.c2	ξ ₈₃	u _{ee}	۷ _{B3}	W _{B3}	₿ _{C3}	u _{c3}	V _{C3}	W _{C3}
T	51.0772816	11.23007484	17.1543	11.8081706	0.49636746	1.9008146												
N	11,23097464	7.9162748	1.4508972).9060146	0.936(354	1.0202 734												
X _{B2}	73.543	2.4569972	640.74809	11.57715	1.844093(6	7784986	CJZ.5525472	11.6701415	0.9171462	1,2945633	47.6551144	0	8	0	19.1532450	11.0701416	0.91784620	0,2985833
T _{B2}	1.8001700	1.9009146	11.57715	10. 4045707	4.78452633	14.01338468	11.8701418	7.11065647	0.5592470	1 10 92777	8	72.6433025	15.94 168084	10,85475158	11.6701418	7.11065447	1, 3592470	0. 18192727
R	0,09836748	0.93861394	1.84408318	14.76452633	4.60220514	1.77 56578	0.91784628	0.3582470	0.04398434	0.01430646	0	15,94160964	2.9174059	1,52788418	9.9178452	0.9992470	1,04396434	0.01430546
N _{B2}	1,908046	1.0202 734	1,2254066	14.01338486	1.77150579	5.132718547	0.290043	6. 18 W2727	1.0143084	1.0048 540 905	9	N.83475456	1.52788440	0.562867183	0.2565633	0.16192727	0.0143054	D, D04664890 5
X _{C2}			252,8975472	11.8701416	0.91764020	1 2065633	534,6906746	1.6701416	0.91784626	0.2985833	19.1532458	11.8701416	8.91784628	0.2985656	19. 532458	11.6701416	0,9176462	0.2900033
			11.6701416	7.11065847	0.5592470	0. 10 97727	11.6701416	AD. 37057847	1.931096	5.0314177	11.1701416	7.1108564	0.5592470	0, 18192777	11.8701418	3 9, 1365 7 53	7.677657	5.39705463
R _{C2}			0.9170462	0.5502470	0.04396434	0,01430646	0.91784628	6.931898	1.07725134	4324046	0,91784828	0.5592470	0.04390436	0,01430646	0.178462	7.677857	46.572	0,76155734
N		<u>'</u>	8,2965633	0.18192727	0.01430640	0,0046540925	0.2985833	5.63314177		57700089	1.7955633	0.18192727	0.01430645	0.0046546905	0.2085003	3.39795445	1.7655734	0.2906578
X _{BJ}			47.8851144	8	U	Q	19.1532458	1.6701418	0.91784628	0,7985233	038.4025477	0	0	0	431.2528581	8.0529916	2,76193944	0.9299153
T 😜			0	72.64336253	15.94 (68964	0.85475150	11.5701418	7.11085807	0.5502470	0. 18192727	0	13.00007	17.55520780	5 49051288	0.85209(6	21, 10624147	1.6700715	.66705627
R _{B3}			ρ	5.94 68964	2.94740390	1,52788448	0.01764620	0.5592470	0.04330464	0.01430646	. 0	12,55520765	4.55730752	1.53500871	2,7512394	1.6700715	0.39906572	1,22225382
N _{B3}	· · ·		0	10,85475158	1.52700418	0,582807183	0,2965633	0, 18192727	0.01430846	0. 0646546 905	Û	13.40651288	1.53500371	5,290311447	0,0201(53	1.85/055/7	1.12725380	0. 1022475805
X _{C3}			19, 1537458	11.67014/6	0.01764628	0,2965833	19. 1537456	11.6701416	0.01764628	1298500	(3),2528581	0.0929616	2.7619394	0,9299153	M06.678049	0.05295/6	1,76193844	1,9299(53
Tes			11.6701416	7,11083047	0.5592470	0. 18192727	11.6701416	36. 13857193	7.677637	5.30705468	0.0020010	21.10024147	1,0700715	1.06708527	0.002209/8	1.04572727	5, 94925865	8,02703605
R _{ca}		•	0.91784628	0.5592479	0.0439843	0.01430646	0.9178460	7.077637	1.46637226	0.76155734	2,7619394	1.6700715	0.30905572	0,22225362	1.7619394	5.99925865	2,601,602,1	0.730/5058
Nga			0.2985833	0.18192727	0.01430646	0.0046546905	0.2905633	5.39705468	0.76150754	0.29005761	0.929953	1.66703327	0.2222362	0. 1622475900	0.0209153	8.0270900	0.73045056	2.6721909906

TABLE 4.- OPERATIONS TABLE FOR CYLINDER 35 WITH 90° CUTOUT

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QUADRANT A

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NATIONAL ADVISORY COMMITTEE FOR AERONALITICS

X _{B4}						· ·			23.0415572	. 0	0	0	9.5766220	11.57715		,2204986
T _{B4}			•						0.	19.8909004	2,27650223	0.53 6707	11.57715	3.995563	2,2293405	.465125
Rad				 				-	D	2.2765022	0.0305783	0,23274560	1.04408315	2.2203185	1355/023	0,73656206
N _{B4}									θ	0.5316707	0.2327666	0.39296577	1.2284988	1.485128	8.23656200	0,15758290
X _{C4}									9.3766229	11,57715	1,84402816	1.2284956	0.5705220	11.57715	. 84400318	1264966
T _{C4}		=							11.57715	13.995363	2.2293185	1.485128	11,577 5	2.2024313	1.5106042	0.5133567
R _{C4}									1.64409310	2.2293/80	0.351023	0.23656605	1.8440831	1.5106047	0,07197288	0.07694582
NCA	 							-	1.2284006	1,485128	0,23655200	0, 15738290	1,2284900	0,5133367	0,0769,50	0.14099 24
X _{B5}									,						-	
Тва													,			
R _{B5}									•							
N _{B8}		_	-								·					
X _{cs}				 			-		-						·	
Tci							i —							••••		
Rcs	;			 												
N _{CS}				 	1											
¥,/2				 	<u></u>		1	-	· · · · ·	·						
Q./2/	:			 	····· ··· ··		t	<u>, , (</u>			j			•		
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T _{BI}																	33,95778161	37.71758034	16.37236254
N _{BI}																	3.60332545	4,002305970	1,73735488
X _{BZ}																:	8, 15043188	Ç	212.9082457
TBZ										1							12.1257845	28.35302955	10.7(604998
Rez																	2.29180564	2,250305754	1. 10500672
N ₈₂																	1.935040654	2.741373512	0,9334044
X _{C2}																			
Tca																			
R _{C2}																		_	
N _{C2}																			•
X _{B2}	23.04.0072	Û	0	0	9.5766229	11,577(5	1.04400510	,2284980									12.91897017	Ŭ,	277.0845633
T _{B3}	0	19.6090684	2,27050223	0.5316707	11,57715	13,095583	2.220065	,440178									5.2469037	28, 363929658	2,52970071
R _{B3}	0	2.27850273	0.0395783	0.23274569	1.6440830	7,2290 55	0.35510238	0.23656205						Í			0,41266406	2,256,9575	0.19806405
N _{B3}	0	0.5310707	0,23274560	0.35251577	1.2284986	445 28	0.2365620	0,15759290									0.134242930	2.244373572	0,06477472
×ca	9.5705229	11.57715	1,64400340	1.7284986	9,5766229	[].57715	1.04400310	.2264066											
T _{C3}	11,5775	1.995565	2.229385	485 28	11.57715	12.2824313	1.5108042	15133567											
R _{CI}	1.84408316	2.2203(65	0.35510238	0,23656208	1.844093/6	1.5108042	0.0750720	0.0759 552										•	
N _{G3}	1.2254986	1.485128	0.73656206	0. 15759200	1.2284066	0.5133567	0.0760582	0, 1499024											

TABLE 4 .- OPERATIONS TABLE FOR CYLINDER 35 WITH 90° CUTOUT - Concluded

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QUADRANT B

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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X ₈₄	1070.0009674	0	0	Q	594, 1570575	Q	3.00010032	0	23,9415572	Q	0	0	9,5760729	11,57713	.04408310	. 2284900	18. 12420149	0	360,97564828
T 84	0	53 7299068	٥	6.5657433Z	0	27,991 166	0	2.970226	0	9.0000004	2.27050 223	0.5316707	11,577)5	13,995583	2,2293185	.465 26	12.99907275	37.7(7589328	0.2655064
R	0	0	2. 434 93255	0	3.680,6032	Ð	0.7/020470	D	Û	2,27020223	1,0395763	0,73274-00	1, 84408310	2.2293 85	1,35510230	0.2305820	2.0601000	8	0.99096020
N _{B4}	0	8.58574332	0	1,77337326	۵	2.970256	0	15 8 8	00	05316707	1,23274500	1.35251577	1.2286965	1,485128	0,23050204	0, 15759290	1,37005073	4,002305972	0,66465865
X _{C4}	594, 1570675	Q	3,666,6637	Q	(859) OSA 1887	0	3.0000002	0	9.5756229	11,57715	1.0440936	1,7264906	9,5786229	1 577 5	14409310	2284966			
Tc4	0	77,991(66	0	2,970255	8	3.4300076	0 *	1,76791436	11.57715	3,005583	2,2293405	40128	11.57715	12.2824313	5100012	0.13357			
R _{C4}	3.000607	Ū	0.7102047 8	ġ	3,68618632	0	1,33503374	0	1.64(000)6	2,2293(85	0.35510238	0,23050200	1.8440036	1.5108042	0.07097288	0.0760-662			
N _{G4}	Q	2.970755	0	0,3151858	0	4,7579,438	0	2,1091925	1,2204066	1,485(28	0,23555205	0,1975029	1.7784966	0,5133907	0.0769-582	D. (490924			
X BS	23,9415577	0	0	ð	9.5766229	1.5775	1, 6440(3)10	.224966	094.0005246	0	0	0	324.50044 4 6	1, 57715	5,532779	2254900	6,67000000	0	153,24805 (32
Tas	0	9.8596664	2,7750223	9,53(6707	11,57715	B.995563	2.27.93165	405/28	0	73.4294752	2,27050225	0.3691825	11.57715	41,900749	2,2293165	(.435364	31.37288093	37.717580320	15 1202754
R	0	2.27050273	0.0995763	0. 23274500	1.84400316	2,2293185	0.35510230	0, 23650200	Q	2.2760225	2,47451086	0,2327450	3.5322794	2,9293,65	005307/4	0,2305020	0.874030	0	0,4/330/7/3
N ₈₅	0	0.5316707	0.23274569	0.3575 577	1.2254905	1.456128	0.23656700	0, 1575929	0	9.3691825	0,23274569	3.9200074	1.2204800	4.455304	0.23656200	0,477,7707	3,32010330	4,002305072	1.005110772
X _{C0}	0,5706273	11.57715	, 84400910	1,2764956	9.5766229	11.57715	1.04409310	7784988	504,5004446	II. <u>577</u> 15	5 53727948	.7764966	100,000,000	11,87715	1,537779	2264006			
T _{CS}	11.5/715	3,99555	7, 2293185	1.45 28	11,57715	7.224313	1.510004Z	1,5133567	11.57715	41.995749	7,7793185	45534	11.577.6	13.7125200	50007	5.30127100			
R _{CS}	1. 844093 [6	2.2293185	0.551028	1.23656200	1,8449336	1.5/08072	Q. 076972 88	1.07604562	5.13227948	2,2203180	1,00630714	,733326	5,51227948	1.5106042	A 4000	0,07090502			
N _{C5}	1.2284986	1.405128	0.23656206	0, 15759290	1.2284965	0.5133567	0.07694582	L 1409624	1,2284986	4.455384	8.73656206	0.477/m	- 1.2254990	5.302700	0.07604582	Z. C09700Z			
Y_/2	ID. 2429 450	2.000/775	7,000,000	1.37695973					6,5/750022	3, 3720003	1,55740,386	3 320 033				_	45.5057/005	9	70,20051454
(Q_ /2)/	r o	37.7(758)38	۵	1.00735377					0	7.7)7.602	0	1,00736507Z					0	301.94259760	٥

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TABLE 5 .- DEFLECTIONS AND ROTATIONS FOR

CYLINDER WITH 45° CUTOUT

 $\begin{bmatrix} M = 5075.45 & \text{in.-lb}; & \eta = 0.934679; \\ \theta r = -0.182954; & \text{unit for values} \\ \text{is } 1 \times 10^{-3} & \text{in. or radian} \end{bmatrix}$

		Ring A	Ring B	Ring C
Stringer 1*	5 u V W	-0.382683 .680577 .357683 018295	-0.211436 .000999 .000110 013137	45° cutout
Stringer 1	u ▼ ¥	.382683 .680577 357683 018295	.211436 .000999 000110 013137	0.070479 145643 050187 012965
Stringer 2	§ 11 7 7	.923880 .174729 863531 018295	.462027 086238 232744 028647	.154009 176519 024713 013301
Stringer 3	5 u ₩	.923880 540637 863531 018295	.461874 269938 185258 010892	.153958 183646 .002972 016637
Stringer 4	5 U V W	.382683 -1.046485 357683 018295	.191394 376640 086306 020508	.063798 179948 .003054 018817
Stringer 4'	\$ u v w	382683 -1.046485 .357683 018295	191394 376640 .086306 020508	063798 179948 003054 018817

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TABLE 6 .- DEFLECTIONS AND ROTATIONS FOR

CYLINDER WITH 90° CUTOUT

[[]M = 7845.90 in.-lb; η = 0.877023; θr = 0.128525; unit for values is l × 10⁻³ in. or radian

		Ring A	Ring B	Ring C
Stringer 2ª	ti 12 ₩	-0.707107 .748674 .620149 .012853	-0.443778 .316729 139502 081652	
Stringer 1	\$ u ₩	0 1.005548 0 .012853	0 .133452 0 .123108	90 ⁰ cutout
Stringer 2	§ ע ₩	.707107 .748674 620149 .012853	.443778 .316729 .139502 081652	0.147921 .396281 614729 .095219
Stringer 3	5 U V V	.923880 .464147 810264 .012853	.462609 .275678 327575 055475	.154210 .203256 356365 .093722
Stringer 4	5 น ▼	.923880 207097 810264 .012853	.461645 .034594 088412 .057352	.153875 .128796 .092635 .032331
Stringer 5	t u ¥	.382683 681739 335622 .012853	.191577 003785 088206 .000093	.063867 .189788 .020932 .006447
Stringer 5	5 u ⊽ ₩	382683 681439 .335622 .012853	191577 003785 .088206 .000093	063867 .189788 020932 .006447

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TABLE 7 .- DEFLECTIONS AND ROTATIONS FOR

CYLINDER WITH 135° CUTOUT

 $\begin{bmatrix} M = 4511.04 \text{ in.-lb; } \eta = 0.780683; \\ \theta r = -0.02370; \text{ unit for values} \\ \text{is } 1 \times 10^{-3} \text{ in. or radian} \end{bmatrix}$

		Ring A	Ring B	Ring C
Stringer 2*	5 u ₩	-0.923880 .275052 .721257 002370	-0.511401 .142873 .276732 093973	•
Stringer 1¶	\$ U W	382683 . 697557 . 298752 002370	381188 095065 652765 .045670	135 ⁰ cutout
Stringer 1	दू 11 17 17	.382683 .697557 298752 002370	.381188 095065 .652765 .045670	
Stringer 2	5 U ₩ ₩	.923880 .275052 721257 002370	.511401 .142873 276732 093973	0.170466 .057603 099144 .025017
Stringer 3	5 u ₩	.923880 322452 721257 002370	.461519 075011 035912 .054762	.153841 .043337 .061874 .022328
Stringer 4	ई ਪ ₩	.382683 744957 298752 002370	.191637 067597 049547 015939	.063876 .120387 .088380 003614
Stringer 4*	5 U V W	382683 744957 .298752 002370	191637 067597 .049547 015939	063876 .120387 088380 003614

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TABLE 8.- AXIAL DEFLECTIONS FOR APPROXIMATE SOLUTIONS

[Unit for values is 1×10^{-3} in]

Angle of cutout	Stringer	Ring A	Ring B	Ring C	Average moment (in1b)
	l	0.382683	0.206436	0.071479	
	2	.923880	.432027	.0142009	
45	3	.923880	.431874	.140958	
	4	.382683	.179394	.058798	
M(in1b)		5392	4788	4696	4959
	1	0	0	0	
	2	.707107	.426278	.143121	
	3	•923880	.450609	.149910	
900	4	.923880	.443144	.146275	
	5	.382683	.183577	.060567	
M(in1b)	J	8155	7586	7533	7758
	1	.382683	.341188		
0	2	.923880	.484401	.160466	
135	3	.923880	.433019	.142341	
	4	.382683	.179637	.059176	
M(in1b)	<u> </u>	4875	4272	4206	4451

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Figure 1.- Actual monocoque cylinders. (Described in reference 8.)





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Figure 3.- Effect of unit axial displacement of F. Forces and moments acting on constraints, $\Gamma = \frac{Gt}{Z}; \quad \alpha = \frac{Gta}{4L}.$







Figure 5.- Effect of unit radial displacement of F. Forces and moments acting on constraints. $\Gamma = \frac{Gt}{2}$; $\Lambda = \frac{GtL}{2}$



Figure 6.- Effect of unit rotation of F. Forces and moments acting on constraints. $r = \frac{Gt}{2}$, $h = \frac{GtL}{2}$.





 $r = \frac{Gt}{2}$; $\Lambda = \frac{GtL}{a}$. (Curvature opposite that in figs. 3 to 6.)

 $\mathsf{R}_{p}^{=}\left(\alpha_{r}\alpha_{t}\wedge\right)_{\underline{\mathbf{I}}}^{-}\left(\alpha_{r}\alpha_{t}\wedge\right)_{\underline{\mathbf{II}}}$

 $\overline{\mathbf{x}}$



Figure 10.- Effect of unit rotation of F. Forces and moments acting on constraints. $r = \frac{Gt}{2}$; $\Lambda = \frac{GtL}{2}$. (Curvature opposite that in figs. 3 to 6.)



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Figure 11.- Deflected shape of full rings in their own planes.





Figure 14.- Deflected shape of cut ring in its own plane.

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ORIGINAL SHAPE-





Figure 16.- Comparison of variation of normal strain. Full section, 16 stringers, 90° cutout, M = 20,000 in-1b.

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Figure 18.- Comparison of variation of normal strain. Cutout section, 8 stringers, 45° cutout, M=20,000 in-lb.





Figure 20.- Comparison of variation of normal strain. Cutout section, 8 stringers, 135^0 cutout, M = 20,000 in-1b.

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