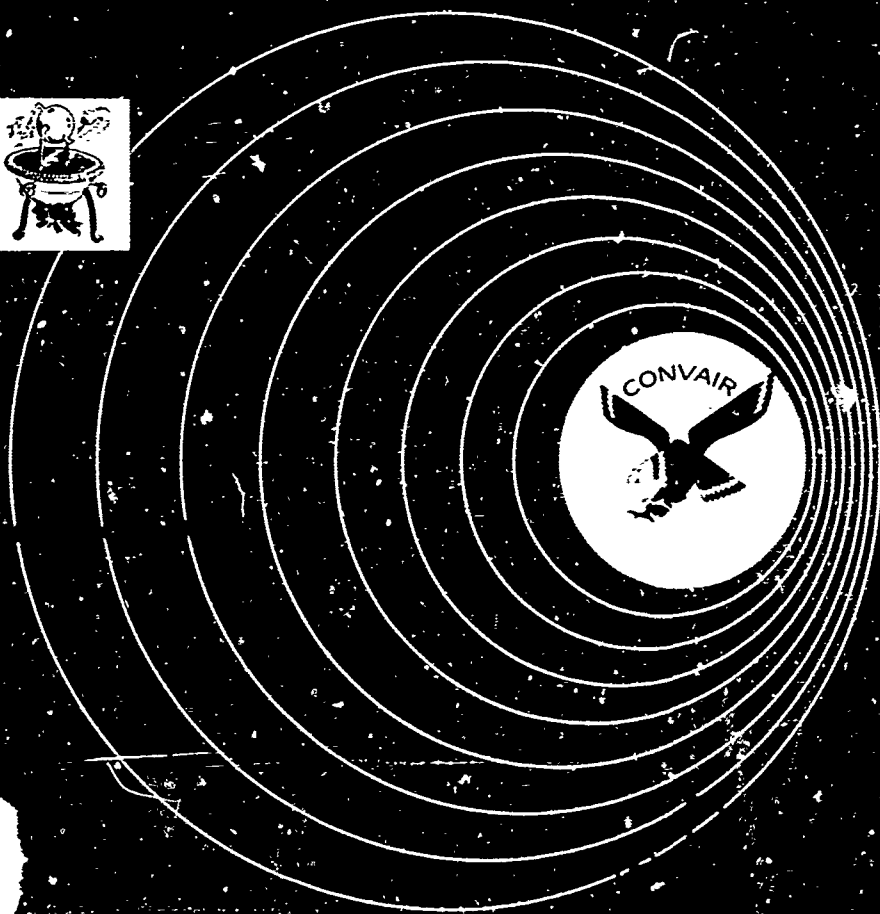
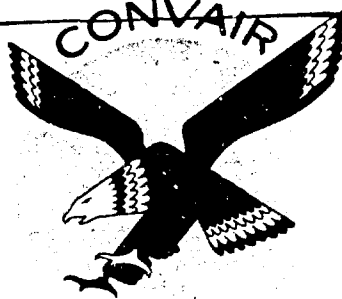


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ORDNANCE AEROPHYSICS LABORATORY
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OAL MEMORANDUM 85

CALCULATION OF THE FLOW FIELDS AROUND A SERIES
OF BI-CONIC BODIES OF REVOLUTION USING THE METHOD OF
CHARACTERISTICS AS APPLIED TO SUPERSONIC ROTATIONAL FLOW

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**CALCULATION OF THE FLOW FIELDS AROUND A SERIES
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CHARACTERISTICS AS APPLIED TO SUPERSONIC ROTATIONAL FLOW**

SUMMARY

The flow fields around a series of bi-conic bodies of revolution placed in a supersonic air stream were analyzed using the Method of Characteristics as applied to rotational flow. Calculations were carried out for three different cone combinations ($25^\circ - 40^\circ$, $20^\circ - 40^\circ$, $25^\circ - 35^\circ$) associated with various free stream Mach numbers. The results were used in designing a diffuser inlet.

A study was made of the overall effects produced by rounding-off errors, varying the size of the mesh, and disregarding the entropy term. Some interesting tables and graphs are included.

It is thought that these results will be of interest to engineers engaged in aerodynamic research and development.

INTRODUCTION

Recently the Applied Mathematics section of the Ordnance Aerophysics Laboratory calculated the flow fields about a series of twelve bi-conic bodies of revolution (hereafter referred to as "double-cones") placed in a supersonic air stream. The necessity for such computations arose in connection with the axisymmetric supersonic inlet design effort at the Applied Physics Laboratory, The Johns Hopkins University. This memorandum presents the results of the

above calculations, along with a few comments and observations.

The problem was first programmed for the IBM Card Program Calculator and later put on the powerful 650, on which machine the twelve flow fields were determined. All calculations were carried out on an eight place floating decimal board and the tabulated results are thought to be free of calculational errors. Use was made of various polynomial approximations in one and two variables.

All information concerning conical flow was obtained from reference (1), where the specific heat ratio was taken as 1.405. In all other calculations $\gamma = 1.4$ was used. This discrepancy affects M_o but slightly. Such unusual values of the free stream Mach numbers as 2.3604, etc., were chosen in order to be able to use the tables of reference (1).

The purpose of this publication is twofold: (1) to outline a method for calculating the flow fields around double-cones using ordinary IBM equipment and (2) to present and discuss some of the results obtained.

NOMENCLATURE

a	local velocity of sound
d	length of a side of a mesh
g	acceleration due to gravity: 32.174 ft/sec ²
M	Mach number back of the curved shock (region III)
M_o	Mach number in the conical flow field (region II)
M_o'	Mach number in the free stream (region I)
M^*	defined by equation (7)
P	end-point of shock front

R	universal gas constant: 53.345 ft/°F.
r	distance from mid-point of a runner to cone axis
S	entropy
S^*	$\Delta S/\gamma Rg$
u	radial velocity component in region II.
v	tangential velocity component in region II.
x,y	rectangular coordinates
α	Mach angle = arc sin (1/M)
β_1, β_2	generating angle of first, second cone
γ	specific heat ratio
δ	associated wedge angle; deflection angle
θ	inclination of flow back of curved shock (region III)
θ_w	shock wave angle associated with curved shock
λ	ray angle in the conical flow field (region II)
ϕ	inclination of flow in the conical field (region II)

SUBSCRIPTS

R	designates right-running characteristic line
L	designates left-running characteristic line
s	refers to surface solution
3	refers to the point to be calculated
n	refers to normal component, as M_n

SUPERSCRIPTS

* on a number refers to an interpolated point

THE PROBLEM

Figure 1 shows a cross-section of the upper half of a $25^\circ - 40^\circ$ double cone placed in a supersonic air stream at zero angle of attack. The flow in region I (free stream region) is supersonic and irrotational. Immediately back of the conical shock (which is a straight line) the flow is still supersonic and irrotational (isentropic). When this supersonic stream strikes the second cone a curved shock front OP is produced, back of which the flow is rotational (non-isentropic). This second shock is curved due to the fact that the Mach number is not constant in region II. This causes an entropy gradient between streamlines in region III, which means that the flow is rotational there. The dotted line lying in the plane of the paper is a typical streamline.

The problem is to analyze the flow field in region III using the Method of Characteristics. In particular, we wish to find the Mach number and flow direction at a series of grid points covering that region.

The twelve flow fields analyzed are listed below:

Group	A ($25^\circ - 40^\circ$)	B ($20^\circ - 40^\circ$)	C ($25^\circ - 35^\circ$)
Mach Number	2.3604	2.4431	2.0665
	2.7296	2.8387	2.3604
M'_0	3.2188	3.3694	2.7296
	3.9260	4.1538	3.2188

For the sake of brevity these combinations will be referred to as A(2.7296), B(4.1538), etc., meaning the second Mach number in group A, the fourth in group B, etc.

MATHEMATICAL ANALYSIS AND FORMULAS

A. REGION II.

In reference 1 the conical flow parameters, λ , a^2 , u , and v are tabulated at equal intervals of the ray angle for various combinations of the cone angle and free stream Mach number. Using these values the Mach number and flow inclination at any point in the conical regime may be obtained from

$$(1) \quad M_0^2 = (u^2 + v^2)/a^2$$

$$(2) \quad \phi = \lambda + \arctan (v/u)$$

In using these tables care should be taken to avoid the numerous errors therein.

Accurate fifth degree Gram-Tshebysheff polynomial approximations were obtained for M_0 and ϕ in terms of λ . These are listed under the various combinations. The method used in developing these polynomial approximations is illustrated in Table VI, where M_0 is found in terms of a fifth-degree polynomial in λ . The eleven values of M_0 listed under $\phi(x)$ were taken from reference 1.

It should be recalled that in conical flow all parameters are constant along a ray emanating from the cone apex. The streamlines are curved and approach the cone surface asymptotically on an infinite cone. In all cases the radius of the base of the first cone was taken as 10.

B. REGION III.

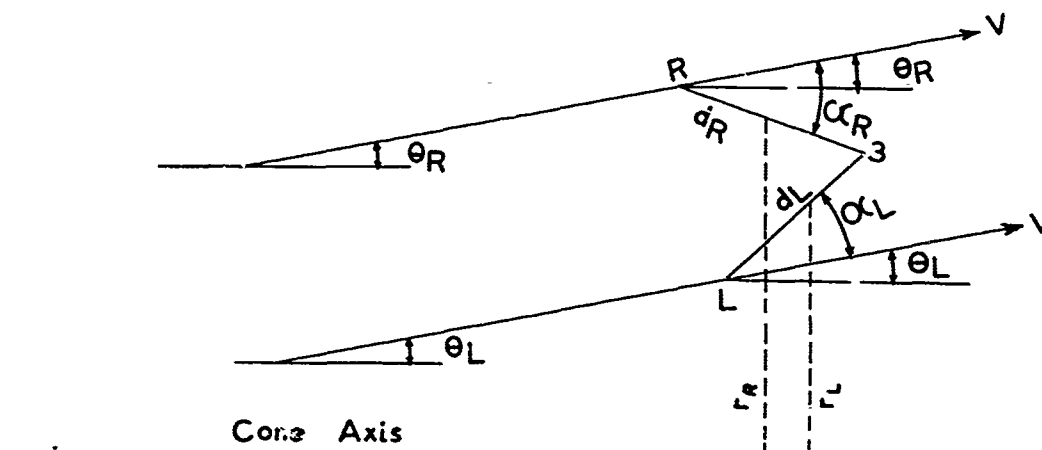
The flow parameters in this region are described by a set of complicated transcendental equations which cannot be solved in closed form, but which can be approximated stepwise by the Method of Characteristics. Since the method itself is well known only a brief outline of the steps involved will be given. It is assumed that the reader is familiar with the general terminology employed. The computational work divides itself into three distinct types: (1) Network, (2) Surface, and (3) Shock Solutions.

I. Network Solution

The sketch below illustrates the parameters involved in a general network solution. The points R and L represent two diagonal points of the network at which all parameters are known. The point 3 is determined by the intersection of the right-running characteristic line through R (R3) and the left-running characteristic through L (L3). The slopes of these two lines are given, respectively, by

$$(3) \quad m_R = \tan (\theta_R - \alpha_R)$$

$$(4) \quad m_L = \tan (\theta_L + \alpha_L)$$



From reference (2), p. 279, it may be shown that the equation of the right and left runners are given by

$$(5) \quad \theta_R - \theta_3 = \left[\frac{M_3^*}{M_R^*} - 1 \right] \cot \alpha_R - (\sin \theta \sin \alpha d/r)_R$$

$$- \frac{(S_R - S_L)}{\gamma Rg} \cdot \frac{(\sin^2 \alpha \cos \alpha d)_R}{d_L \sin \alpha_L + d_R \sin \alpha_R} \quad \text{and}$$

$$(6) \quad \theta_3 - \theta_L = \left[\frac{M_3^*}{M_L^*} - 1 \right] \cot \alpha_L - (\sin \theta \sin \alpha d/r)_L$$

$$+ \frac{(S_R - S_L)}{\gamma Rg} \cdot \frac{(\sin^2 \alpha \cos \alpha d)_L}{d_L \sin \alpha_L + d_R \sin \alpha_R}$$

respectively, where

$$(7) \quad M^{*2} = \frac{\frac{\gamma + 1}{2} M^2}{1 + \frac{\gamma - 1}{2} M^2} \quad \text{and } \theta \text{ is in radians.}$$

The simultaneous solution of (5) and (6) yields

$$(8) \quad M_3^* = \left[\theta_R - \theta_L + \cot \alpha_L + \cot \alpha_R + (\sin \alpha \sin \theta d/r)_L + (\sin \alpha \sin \theta d/r)_R \right.$$

$$\left. - \frac{(S_R - S_L)}{\gamma Rg} \cdot \frac{(\sin^2 \alpha \cos \alpha d)_L - (\sin^2 \alpha \cos \alpha d)_R}{d_L \sin \alpha_L + d_R \sin \alpha_R} \right] \left[\left(\frac{\cot \alpha}{M^*} \right)_L + \left(\frac{\cot \alpha}{M^*} \right)_R \right]^{-1}$$

The above value of M_3^* is substituted in (6) and (7), thereby yielding the Mach number and flow inclination at the point 3.

The parameters at interpolated points (starred points) are obtained by straight-line interpolation and need no further explanation.

Figure 3 further illustrates the situation at a net point.

II. Surface Solutions.

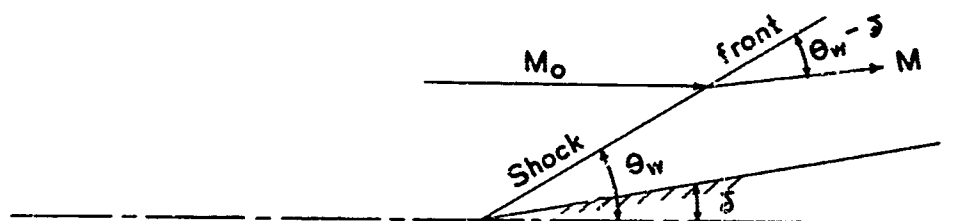
If point 3 is on the cone surface then θ_3 is known, being equal to the generating angle of the second cone. Hence from (5) it follows that

$$(9) \quad M_{3s}^* = M_R^* + M_R^* \tan \alpha_R \left[\theta_R - \theta_{3s} + (\sin \alpha \sin \theta \, d/r)_R + \frac{(S_R - S_L)}{\gamma R g} (\sin \alpha_R \cos \alpha_R) \right]$$

where S_L has the value of entropy in the surface streamline. See p. 280 of reference (2).

III. Shock Solutions

The flow parameters immediately back of the curved shock may be found by solving simultaneously the oblique shock equations of wedge flow and the left-running characteristic equation. This means that the flow inclination, shock wave angle, and the Mach number behind the shock must agree with the flow angle and Mach number given by equation (6). The sketch below illustrates wedge flow.



From reference (2) the oblique shock equations are

$$(10) \quad \cot \delta = \left[\frac{\gamma + 1}{2} \cdot \frac{M_0^2}{M_0^2 \sin^2 \theta_w - 1} - 1 \right] \tan \theta_w \quad \text{and}$$

$$(11) \quad \left[M_0^2 \sin^2 \theta_w - (\gamma - 1)/2\gamma \right] \left[M^2 \sin^2 (\theta_w - \delta) - (\gamma - 1)/2\gamma \right] = \left(\frac{\gamma + 1}{2\gamma} \right)^2$$

The left-runner may be written in the form

$$(12) \quad \theta_3 = \left[\frac{\cot \alpha_L}{M_L^*} \right] M_3^* - \cot \alpha_L + \theta_L - (\sin \alpha \sin \theta d/r)_L + \frac{(S_3 - S_L)}{\gamma Rg} \sin \alpha_L \cos \alpha_L.$$

Note that this last equation is linear in θ_3 and M_3^* . The next step is to solve simultaneously (10), (11), (12), and (7). This generally involves a good deal of computational work.

To illustrate the method of finding a shock solution let us refer to

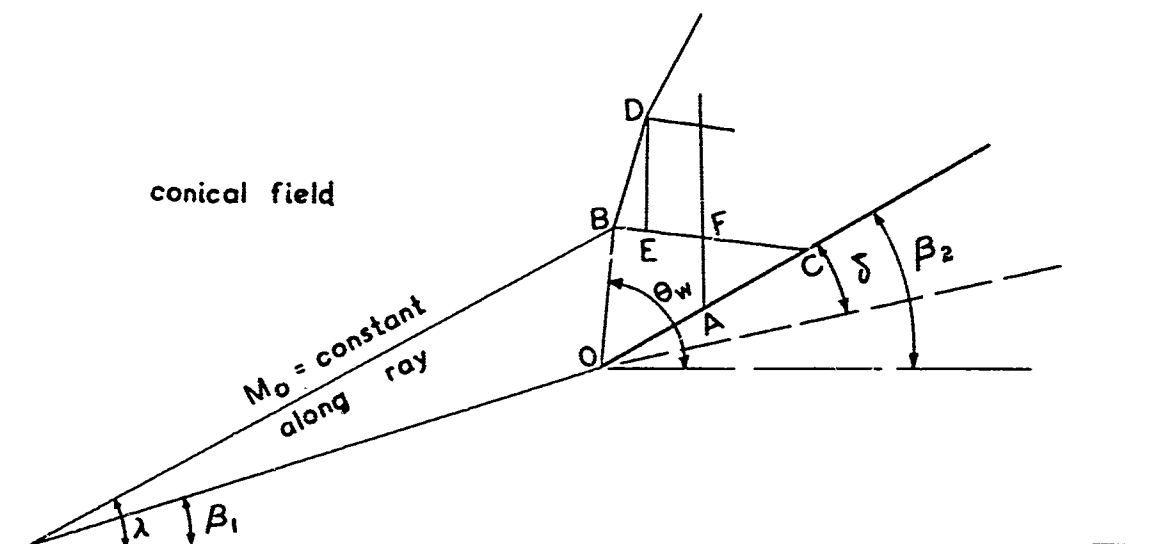
Figure 4. Assume all parameters known at the shock point 8 and at the interpolated point 8*. To find the solution at 9 proceed as follows:

- a. Assume θ_w and $\Delta S/Rg$ at the point 9 to be equal to the values at the preceding point, 8. That is, assume $\theta_{w9} = \theta_{w8}$ as a first approximation.
- b. The equation of the line (7-8) and the equation of the left-runner at 8* are solved simultaneously, obtaining a point 9' which is the first approximation to 9.
- c. Now knowing the coordinates of 9' the ray angle, $\lambda_{9'}$, is obtained. This value of λ substituted in the fifth-degree polynomial approximation yields M_0 and ϕ .
- d. Next eliminate M_3^* between (12) and the two-way approximation for M_3^* , noting that $\delta + \phi = \theta$. This results in a quadratic equation in δ which is readily solved.
- e. Then knowing M and δ the first iterated value of $\Delta S/Rg$ [say, $(\Delta S/Rg)_{9*}$] is obtained from the two-way approximation. Follow procedure a-d to get δ_{9*} , the first iterated value of δ , from which another value of $\Delta S/Rg$ is obtained.
- f. $\theta_w - \phi$ is now calculated from the approximating polynomial. This gives the first iterated value of θ_w , say θ_{w9*} .
- g. Now repeat the entire procedure, going through three more iterations. In this manner the parameters at the shock point 9 are obtained. Fortunately, the iterative process converges rapidly in all cases.

IV. Starting Solution

A point A is chosen on the surface of the second cone fairly close to O. Knowing λ on the first cone surface the Mach number M_0 is found from the

fifth-degree approximation and the parameters at A are obtained assuming wedge flow. The entropy term $\Delta S/Rg$ is found from the approximation. Since θ_L is known and α_L readily found, the left-runner from A is drawn in roughly.



Knowing M_0 on the cone surface and the deflection angle δ , θ_w is found from reference (3) or (4) and a line is drawn through O with an inclination of θ_w . A preliminary point B is taken on this line and, keeping the distance OB constant, θ_w and $\Delta S/Rg$ are obtained from the approximation formulas by iteration. The initial value of entropy at E is taken equal to that at A.

PRELIMINARY WORK

In our case quite a good deal of preliminary work was necessary before the problem could be put on the machine. The parameters at A and B (points 101 and 2 of Figure 2) were obtained by desk calculator and given to the IBM-650

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machine which performed all other calculations. A little judgment plus a couple of trials should enable one to obtain a rough value of the coordinates of the starting points graphically. Iteration is then applied at point B in order to get the parameters accurately.

Point E (the starred point, 2° of Figure 2) is chosen by eye so that the left-runner through it will locate roughly a point D on the shock such that the distance BD is of the desired length. Knowing OB, BD, and $\lambda_{\max}$ it is possible to estimate the number of points on the curved shock front. This gives a measure of the accuracy of the process. The ratio BE/BF, estimated graphically, was given to the machine which then calculated the length BE and made all other base distances (distance from a shock point to the associated starred point) that same length. If the starred point happened to fall close to a mesh-point then the left-runner through the latter was used and the starred point disregarded. This means that sometimes a left-runner starting from the cone surface went all the way to the shock front and sometimes it didn't. The machine was given a criterion for deciding whether or not to establish a starred point. Also, knowing $\lambda_{\max}$ it was able to stop after locating one shock point above this ray. After obtaining the coordinates of the last shock point the machine found the distance from each remaining net point to the perpendicular from the last shock point to the second cone surface, using the distance formula of analytic geometry. At the same time it tested this number for sign. When the sign changed along any given left-runner the machine stopped calculations on that characteristic line and went back to the surface and started up another left-runner. After giving the 650 machine the necessary initial instructions and constants it required no further attention until the problem was finished and ready to list.

In this connection it was necessary to construct an oblique shock table giving $\theta_w - \phi$, M_{no} , M , and M^* in terms of M_o and δ (reference 4). The table was constructed on the 650 and covers a range of $1.00 \leq M_o (.01) \leq 3.60$; $0.000 \leq \delta (.005) \leq \delta_{max}$. (δ in radians)

DISCUSSION OF THE APPROXIMATION FORMULAS

The approximations used in obtaining M_o and ϕ have already been discussed in some detail. These were relatively easy to get, since most of the computations were carried out on the IBM machine. The formulas are as accurate as the original data.

Much more difficult to develop were the two-way quadratic approximations for $\theta_w - \phi$, $\Delta S/Rg$, and M^* in terms of M_o and δ . These required the use of the oblique shock table mentioned above. Using numerical differentiation and Taylor's Theorem for two variables the quadratic approximations were obtained. The entropy values were taken from reference (5). These approximations give satisfactory results, since, in each case, the independent variables range over only a limited region. The numerical differentiation was carried out on a desk calculator. See reference (6).

A list of approximation formulas for A(2.3604) is given below. The formulas for the other eleven cases are not included, but are available at this facility.

The equations for the terminal point P (Table V) were developed by desk calculator using Lagrange's Formula for unequal intervals. See reference (6).

The twelve shock fronts were approximated by third degree Gram-Tshebysheff polynomials and are shown in Table IV. Using these approximations, curves of

A_1 , A_2 , and A_3 vs M_0^i were plotted (Figures 8, 9, and 10). The coefficients of a third degree approximation for any value of M_0^i within the range of interest may be read directly from these graphs. Thus for a $25^\circ - 40^\circ$ double-cone with $M_0^i = 3.5$ the shock front equation is readily found to be

$$(14) \quad x = -.00016 + .489 y + .01618 y^2 - .000421 y^3.$$

This equation gives better results than can be obtained by interpolating linearly between the curves of Figure 5.

LIST OF APPROXIMATION FORMULAS FOR A(2.3604)

$$M_0 = 1.66666 + .00149 x + .12579 x^2 - .04247 x^3 - .01486 x^4 + .03167 x^5$$

$$\phi = .43633 - .23574 x + .12085 x^2 - .10296 x^3 + .06772 x^4 - .02909 x^5$$

$$\text{where } x = 4.24570 \lambda - 1.85254 \quad (\lambda \text{ in radians})$$

$$\theta_w - \phi = .95394 - .89574 (M - 1.72) + 2.18448 (\delta - .260) + 2.1535 (M - 1.72)^2 - 8.6645 (M - 1.72) (\delta - .260) + 10.94 (\delta - .260)^2 \quad (\delta \text{ in radians})$$

$$M^* = 1.12383 + .99265 (M - 1.72) - 2.35532 (\delta - .260) - 1.754 (M - 1.72)^2 + 8.1335 (M - 1.72) (\delta - .260) - 11.326 (\delta - .260)^2 \quad (\delta \text{ in radians})$$

$$\begin{aligned}\Delta S/Rg = & .04349 - .0195 (M - 1.72) + .571 (\delta - .260) + .35 (M - 1.72)^2 \\ & + 1.35 (M - 1.72) (\delta - .260) + 4.2 (\delta - .260)^2\end{aligned}$$

DISCUSSION OF RESULTS

Values of x , y , M , and θ are tabulated for each grid point. At each shock point M_0 and ϕ are also listed. These and many other parameters such as $\mathcal{C}_w$, α , δ , M^* , and S^* were calculated to eight significant figures and listed for reference, but are not included in this memorandum.

Some useful information was obtained by varying certain parameters or by changing the process. In order to study the effect of entropy several combinations were run assuming irrotational flow in region III. Table III indicates that entropy consideration has little effect on the results -- at least, not for the combinations studied. This is an important piece of information, since it takes about twice as long to calculate a rotational flow field as an irrotational one. Figure 11 shows that the entropy term becomes more important as M_0' increases. However, the rate of increase of the entropy effect becomes less; that is, the error curve flattens out as the Mach number increases. This leads one to speculate on the existence of a maximum error for some large value of M_0' .

Figure 12 illustrates a somewhat surprising fact: namely, the flow deflection (δ) across the second shock front is nearly constant for all cone combinations considered. For small free-stream Mach numbers δ decreases and then increases reaching (approximately) the initial deflection, $\beta_2 - \beta_1$, at the end-point P. For large values of M_0' it seems that δ increases more or less monotonically with x , reaching a maximum at P. The reason for the little

hump near the origin is not known to the writer.

Table II reveals something that was entirely unsuspected -- namely, that rounding off to 5 significant figures (usually 4 decimals) at each step does not cause any appreciable loss of accuracy in the final results. It was also found that certain types of small errors introduced near the beginning (e.g., an error of 1° in the left-runner at 102) have little effect on the parameters at the end-point P. In some cases such errors made at an early stage tend to correct themselves in an asymptotic sort of way as the network expands.

Some statistics on the problem might be of interest. To calculate the parameters at 200 points in a flow field on a CPC machine required 15 hours of machine time. On the 650 machine only an hour and a half was needed. More specifically, it took 1.7 minutes to get a shock point going through 4 iterations, 12 seconds for a net point, 8 for a surface point, and 2 seconds for an interpolated point. To calculate such a flow field by desk calculator would be a formidable task.

It might be pointed out that it is dangerous to attempt to draw general conclusion from a single case. For example, in the case of A(2.3604) Mach number increases as the point moves up the second cone surface while for combination A(3.9260) it decreases.

COMMENTS

Assuming the method itself to be valid the main sources of error in the results are probably due to: (1) different values of γ used in regions II and III (2) relatively large values of mesh lengths and the assumption of linearity and (3) lack of accuracy of the approximation formulas.

It would be difficult to estimate accurately the effect of item (1). From reference (1) it appears that a variation of .005 in γ produces a change of about .01 to .02 in M_0 . Fortunately this error in M_0 on the shock front is not magnified farther out in the field. So it would seem that this source of error is comparatively unimportant.

Table II shows that the effect of the mesh size is unimportant within limits. Thus a grid of 15 shock points is nearly as good as one of 28 such points for the combination A(3.9260). This is a worthwhile piece of information.

It is believed that the approximations used give good results throughout the field. The formulas for M_0 and ϕ are as accurate as the data warrant. Since δ and M_0 range over very restricted values it is safe to assume that the two-way approximations are entirely satisfactory.

A detailed worksheet for the problem is not included since anyone interested in carrying out such computations would doubtless prefer to set up his own worksheet.

ACKNOWLEDGMENTS

The IBM programming and computations were done by D. W. Sonheim, C. E. Lake, and D. J. Glover. The preliminary work and checking was done by J. Tajen and M. B. Martin. The latter did the drafting.

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TABLE I
NUMBER OF POINTS IN FLOW FIELDS AND VALUES
OF THE PARAMETERS AT END-POINTS

Combination	Number of Points in the Flow Fields				Parameters at End-Point P			
	Shock	Surface	Network	Total	x	y	M	θ°
A(2.3504)	19	14	75	108	2.779	9.265	1.203	29.84
A(2.7296)	21	14	97	132	3.429	7.988	1.408	31.92
A(3.2188)	22	14	109	145	3.485	6.595	1.634	33.63
A(3.9260)	28	18	196	242	3.228	5.261	1.895	35.12
B(2.4431)	21	16	90	127	4.246	10.635	1.234	30.33
B(2.8387)	25	18	143	186	4.546	8.813	1.442	32.51
B(3.3694)	25	17	155	197	4.271	7.008	1.677	34.30
B(4.1538)	21	14	96	131	3.693	5.336	1.956	35.84
C(2.0665)	14	11	44	69	4.193	12.798	1.215	23.13
C(2.3604)	19	13	90	122	5.181	11.175	1.402	25.14
C(2.7296)	16	10	62	88	5.370	9.392	1.607	26.90
C(3.2188)	15	10	52	77	5.097	7.669	1.842	28.49

TABLE II
COMPARISON OF RESULTS AT END-POINT P FOR VARIOUS RUNS
($25^\circ - 40^\circ$ DOUBLE-CONE, $M_0' = 3.9260$)

Run	Description of Run	x	y	M	θ°	Error in M	Error in θ
1	Rotational. 28 shock points. 8 significant figures carried throughout the calculations.	3.2285	5.2607	1.8953	35.117		
2	Same as (1) except only 15 shock points.	3.2450	5.2709	1.8945	35.136	.0008	-.019
3	Same as (1) except 5 significant figures carried throughout the calculations.	3.2286	5.2608	1.8951	35.122	.0002	-.005

TABLE III

COMPARISON OF RESULTS AT VARIOUS POINTS FOR DIFFERENT
TYPES OF FLOW AROUND A 25° - 40° DOUBLE-CONE

End-Point								
Point	Flow	M_0	x	y	M	θ°	$M_r - M_i$	$\theta_r - \theta_i$
End Point P	Irrotational	2.3604	2.7737	9.2610	1.2050	29.791		
	Rotational	"	2.7789	9.2652	1.2027	29.839	-.0023	.048
	Irrotational	3.2188	3.4988	6.6047	1.6386	33.518		
	Rotational	"	3.4850	6.5955	1.6336	33.633	-.0050	.115
	Irrotational	3.9260	3.2411	5.2685	1.9017	34.975		
	Rotational	"	3.2285	5.2607	1.8953	35.117	-.0064	.142
Surface Points								
303	Irrotational	2.3604	1.3280	1.1143	1.1072	40.000		
	Rotational	"	"	"	1.1051	40.000	-.0021	0
1313	Irrotational	"	5.5643	4.6690	1.1500	40.000		
	Rotational	"	"	"	1.1449	40.000	-.0051	0
303	Irrotational	3.9260	.9358	.852	1.8854	40.000		
	Rotational	"	"	"	1.8870	40.000	.0016	0
1616	Irrotational	"	4.0380	3.3883	1.8780	40.000		
	Rotational	"	"	"	1.8832	40.000	.0052	0
Net Points								
305	Irrotational	2.3604	1.0779	2.1493	1.1188	37.236		
	Rotational	"	"	"	1.1181	37.220	-.0007	-.016
1115	Irrotational	"	4.1697	6.4690	1.1542	34.998		
	Rotational	"	"	"	1.1631	35.014	-.0011	.016
305	Irrotational	3.9260	1.0551	1.1496	1.8856	39.326		
	Rotational	"	"	"	1.8862	39.322	.0006	-.004
1320	Irrotational	"	3.7609	4.0467	1.8811	38.150		
	Rotational	"	"	"	1.8836	38.201	.0025	.041

TABLE IV
EQUATIONS OF THE TWELVE SHOCK FRONTS

A(2.3604):	$x = .00051 + .14089 y + .021571 y^2 - .0004826 y^3$
A(2.7296):	$x = -.00045 + .21503 y + .017628 y^2 - .0004089 y^3$
A(3.2188):	$x = -.00019 + .43879 y + .016428 y^2 - .0004080 y^3$
A(3.9260):	$x = -.00012 + .54276 y + .016086 y^2 - .0004468 y^3$
B(2.4431):	$x = -.00134 + .24045 y + .019465 y^2 - .0004315 y^3$
B(2.8387):	$x = -.00046 + .40333 y + .016134 y^2 - .0003658 y^3$
B(3.3694):	$x = -.00005 + .52581 y + .014625 y^2 - .0003360 y^3$
B(4.1538):	$x = -.00007 + .62818 y + .014956 y^2 - .0004476 y^3$
C(2.0665):	$x = .00025 + .13050 y + .019890 y^2 - .0003524 y^3$
C(2.3604):	$x = -.00086 + .31332 y + .016952 y^2 - .0003122 y^3$
C(2.7296):	$x = -.00077 + .44802 y + .016448 y^2 - .0003467 y^3$
C(3.2188):	$x = -.00039 + .56032 y + .016834 y^2 - .0004147 y^3$

TABLE V
EQUATIONS OF CURVES THROUGH END-POINTS

Group A:	$x = 5.78203 - 1.84042 y + .38190 y^2 - .02358 y^3$
Group B:	$x = 1.88961 + .09620 y + .08065 y^2 - .00649 y^3$
Group C:	$x = 10.10739 - 2.35313 y + .33239 y^2 - .01443 y^3$

TABLE VI.
11-POINT GRAM-TSHEBYSHEFF POLYNOMIAL WORKSHEET

Step 1. Divide the interval of the argument into 10 equal parts and find the corresponding values of the function. These values are listed as $\phi(X)$. The transformed interval is $0.5 \leq X \leq 1$.

X	X ²	X ³	X ⁴	X ⁵
.00000	.00000	.00000	.00000	.00000
.10000	.01000	.00100	.00010	.00001
.20000	.04000	.00800	.00160	.00032
.30000	.09000	.02700	.00810	.00243
.40000	.16000	.06400	.02560	.01024
.50000	.25000	.12500	.06250	.03125
.60000	.36000	.21600	.12960	.07776
.70000	.49000	.34300	.24010	.16807
.80000	.64000	.51200	.40960	.32768
.90000	.81000	.72900	.65610	.59049
1.00000	1.00000	1.00000	1.00000	1.00000

X	N ₀ (X)	N ₁ (X)	N ₂ (X)	N ₃ (X)	N ₄ (X)	N ₅ (X)	N ₆ (X)	N ₇ (X)	N ₈ (X)	N ₉ (X)	N ₁₀ (X)	$\phi(X)$	$\phi^2(X)$
.0	1	5	75	30	-6	-18	3	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667
.1	1	4	30	-6	-18	-6	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.2	1	3	-5	-22	-18	-1	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.3	1	2	-30	-23	-3	4	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.4	1	1	-45	-14	12	4	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.5	1	0	-50	0	18	0	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.6	1	-1	-45	14	-12	-4	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.7	1	-2	-30	23	-3	-4	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.8	1	-3	-5	22	-18	1	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
.9	1	-4	30	6	-18	6	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
1.0	1	-5	75	-30	18	-3	1.66666	1.66667	1.66667	1.66667	1.66667	1.66667	1.66667
D ₁	11	22	286	143	143	52							

Step 3. $\phi^2(X) = b_0 + b_1 X + \dots + b_5 X^5$

j	0	1	2	3	4	5
a ₀	1.702683					
a ₁	-0.50158					
a ₂	0.14318					
a ₃	-0.000612					
a ₄	0.000463					
a ₅	-0.000038					
b ₀	1.66666	0.0149	1.2579	-0.4247	-0.1486	0.0167

$$M_0 = 1.66666 + 0.0149X + 1.2579X^2 - 0.4247X^3 - 0.1486X^4 + 0.0167X^5$$

$$\lambda = 4.24570\lambda - 1.85254 \quad (\lambda \text{ in radians})$$

Step 2. $Q_1 = \frac{1}{D_1} \sum N_1(X) \phi(X)$

$$Q_2 = \frac{\sum N_2(X) \phi(X)}{D_2}$$

$$b_2 = \frac{120Q_2 + 750Q_3 + \dots + 11625Q_5}{18}$$

Argument: $2.5^\circ \leq \lambda \leq 38.495^\circ$
Function: M_0
Identification: 2.5° Conc. $M'_0 = 2.3604$

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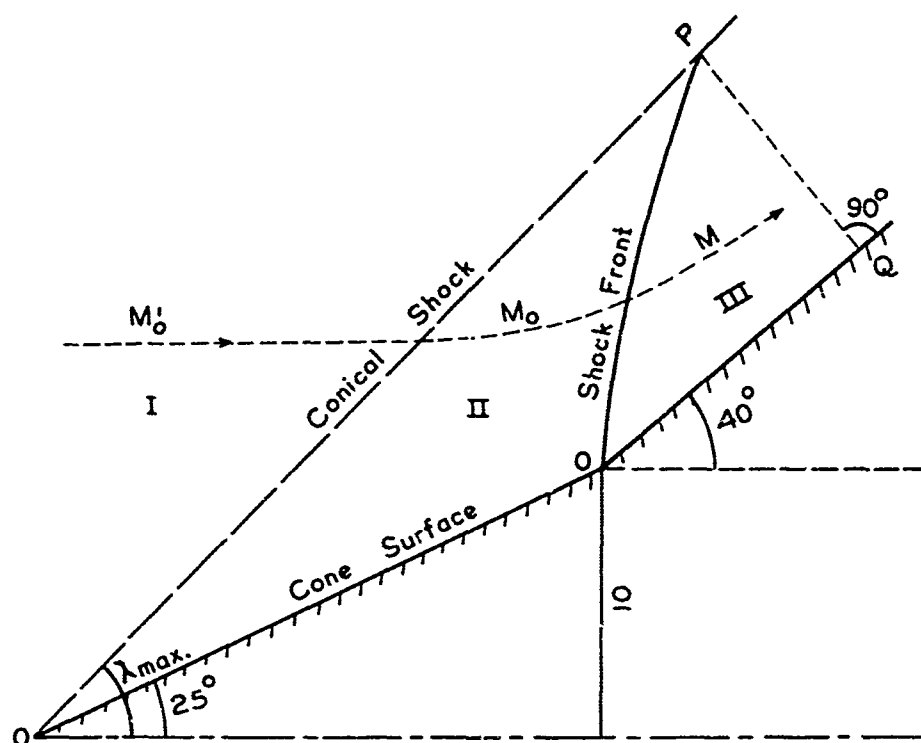


Fig. 1.
SCHEMATIC DIAGRAM OF SYSTEM

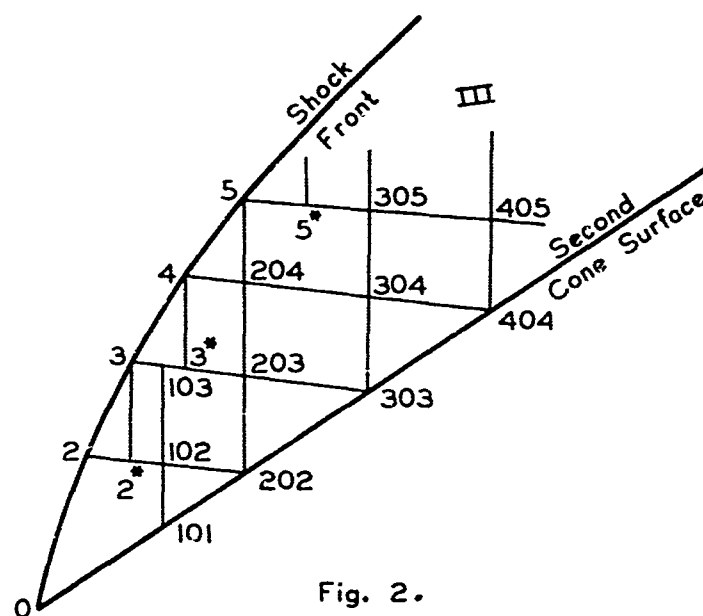
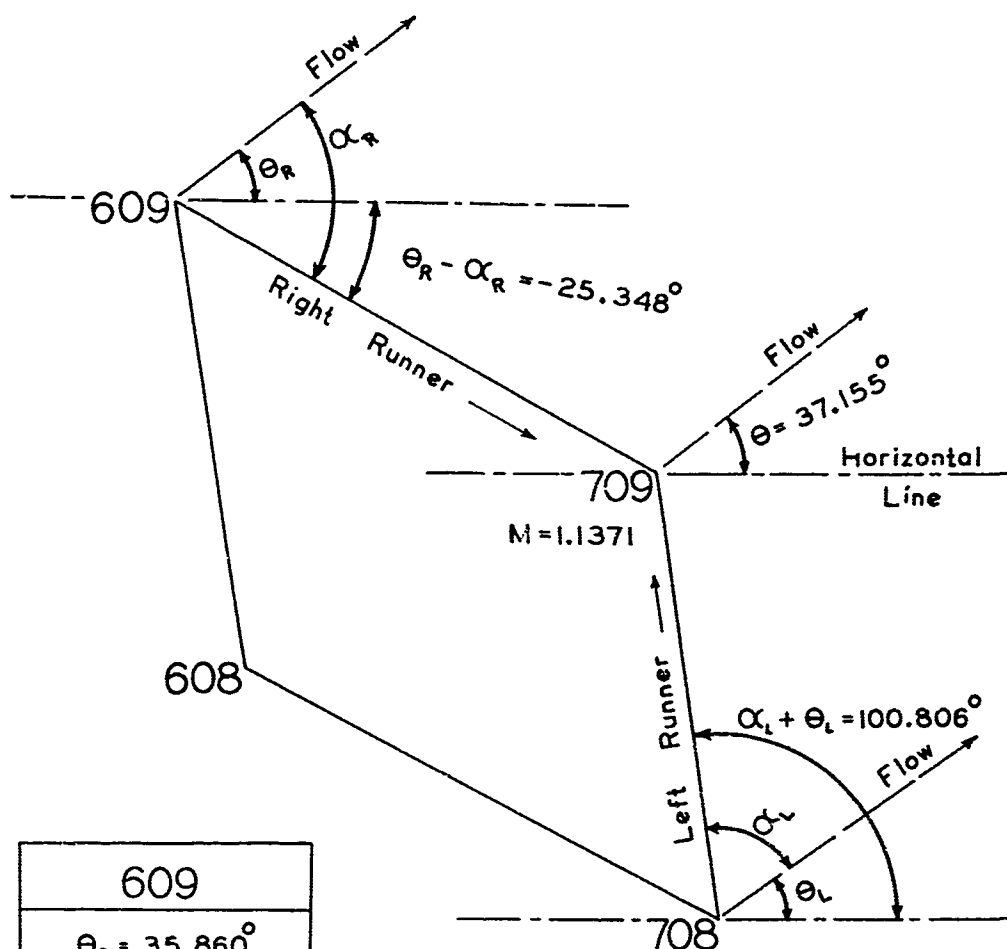


Fig. 2.
DIAGRAM SHOWING METHOD OF NUMBERING POINTS

Fig. 3.

DIAGRAM AT A NET POINT
(25°-40° Double Cone, $M_0^1 = 2.3604$)



609
$\theta_R = 35.860^\circ$
$\alpha_R = 61.208^\circ$
$M = 1.1411$

708
$\theta_L = 38.561^\circ$
$\alpha_L = 62.245^\circ$
$M = 1.1300$

θ = Direction of Flow
 α = Arc Sin(1/M) = Mach Angle
 $\theta_R - \alpha_R$ = Inclination of Right Runner
 $\theta_L + \alpha_L$ = Inclination of Left Runner

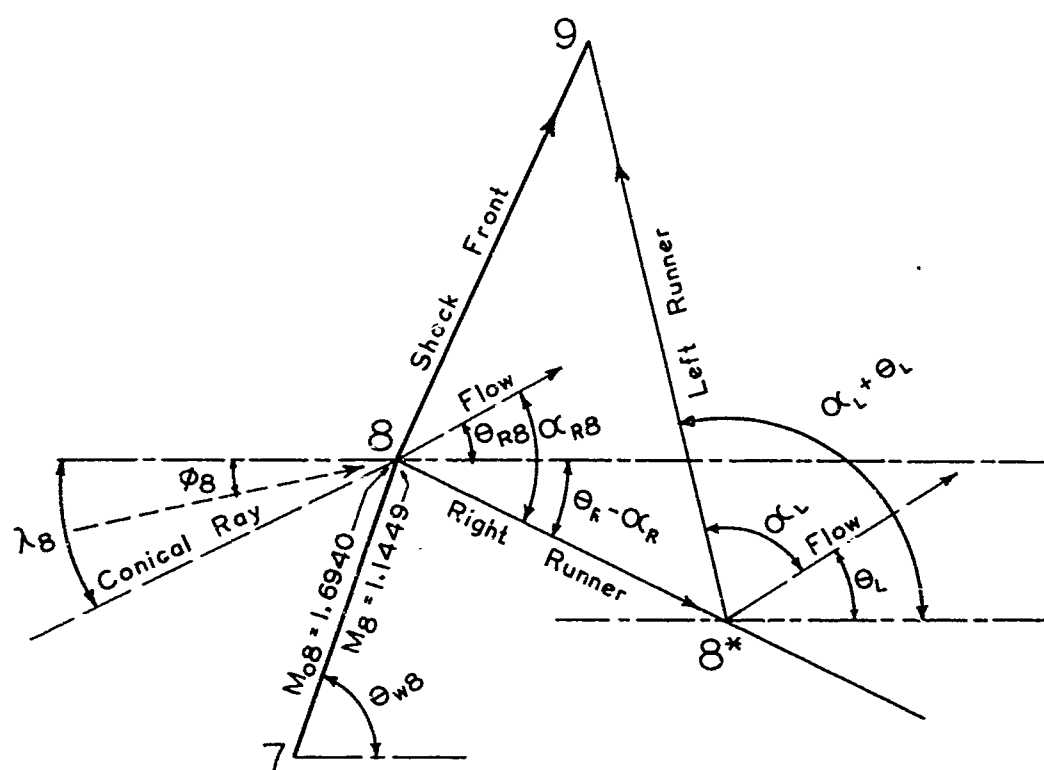
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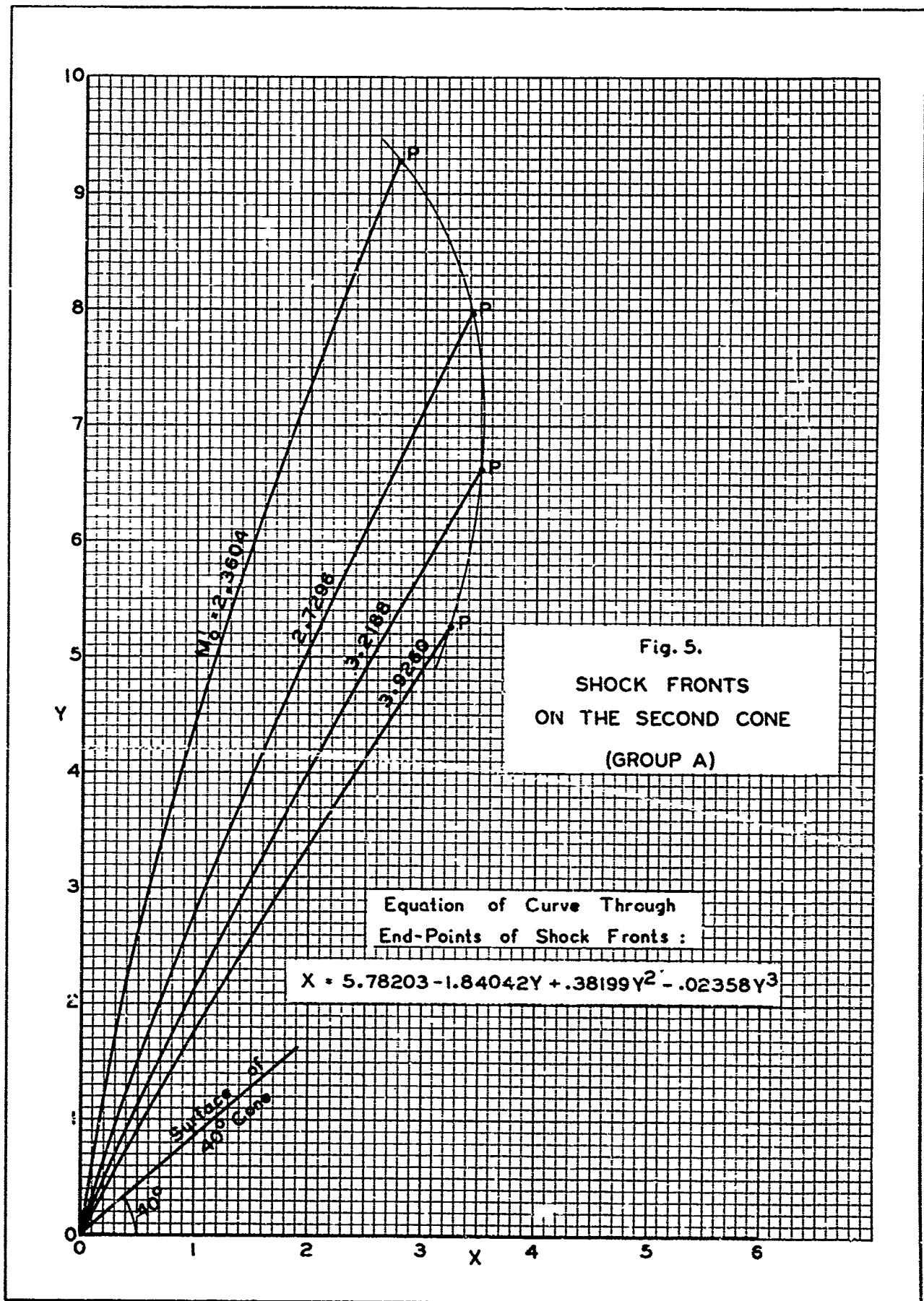
Fig. 4.
DIAGRAM AT A SHOCK POINT
(25°-40° Double Cone, $M_0^1 = 2.3604$)



Not to Scale

At Point 8	
λ_8	$= 31.801^\circ$
ϕ_8	$= 19.393^\circ$
τ_8	$= 14.445^\circ$ (Wedge Angle)
θ_{w8}	$= 74.418^\circ$
θ_{R8}	$= 33.838^\circ$
α_{R8}	$= 60.859^\circ$

θ_{w8} , the inclination of the line 7-8, is the shock wave angle associated with the parameters at pt. 8.



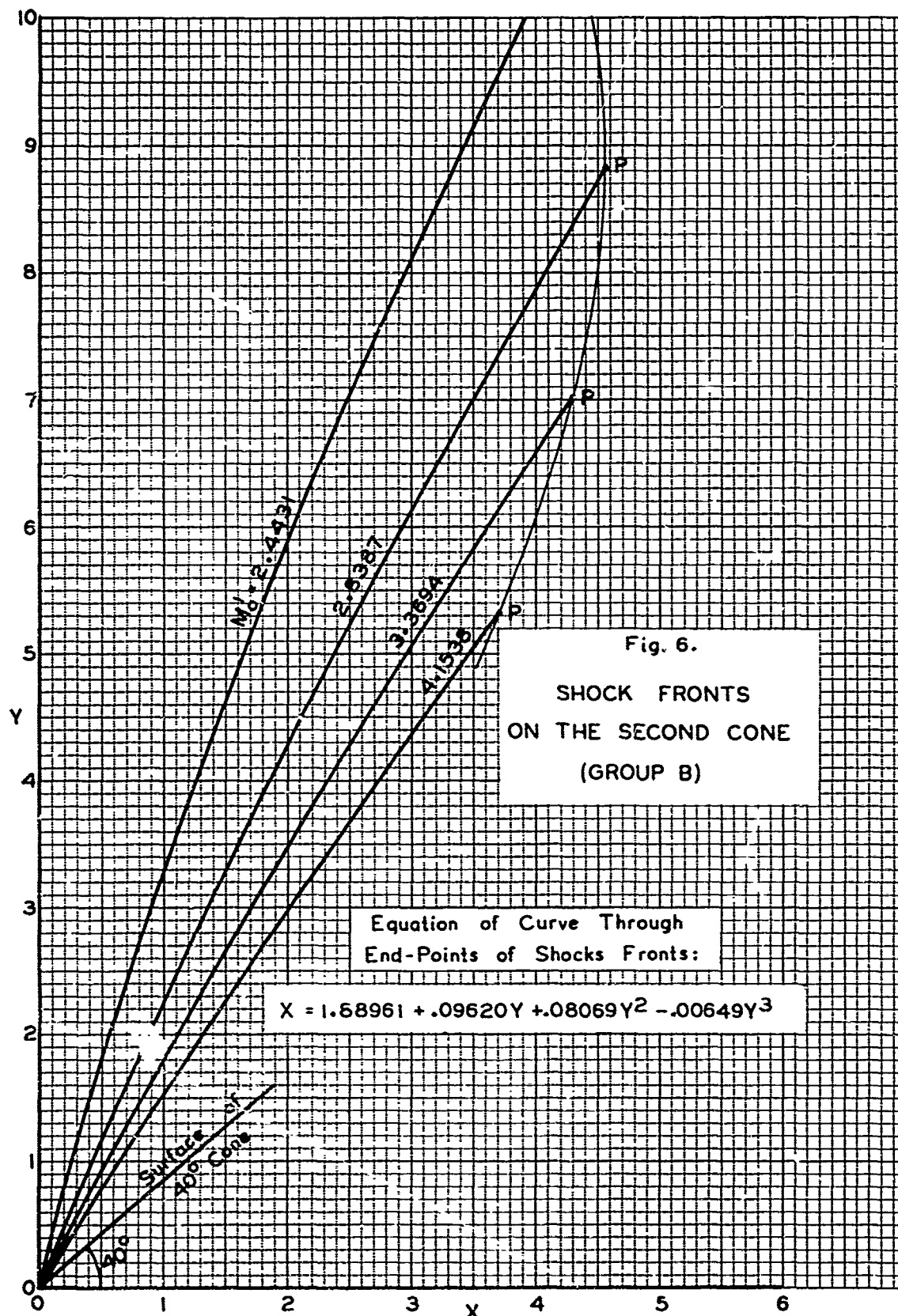
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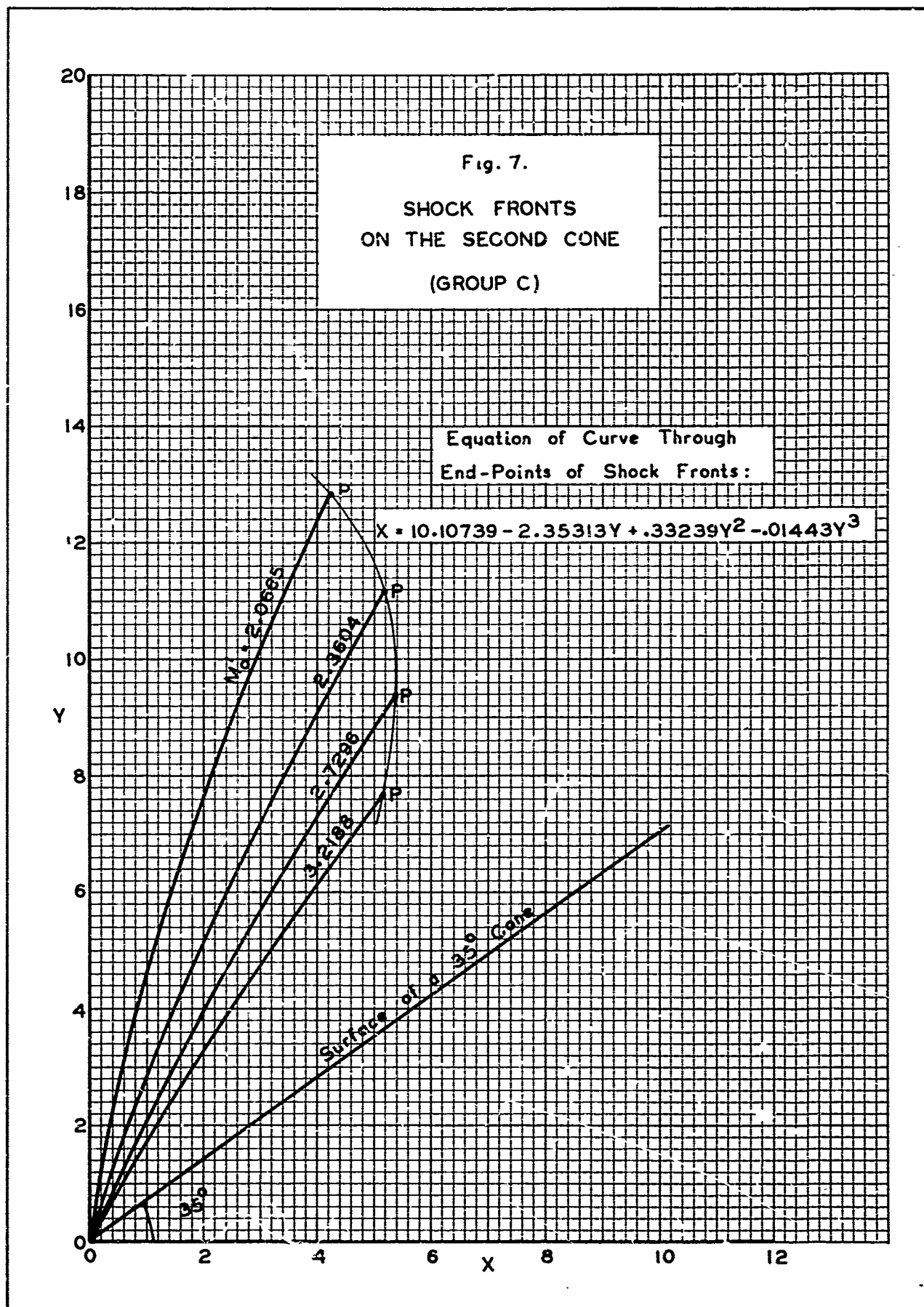
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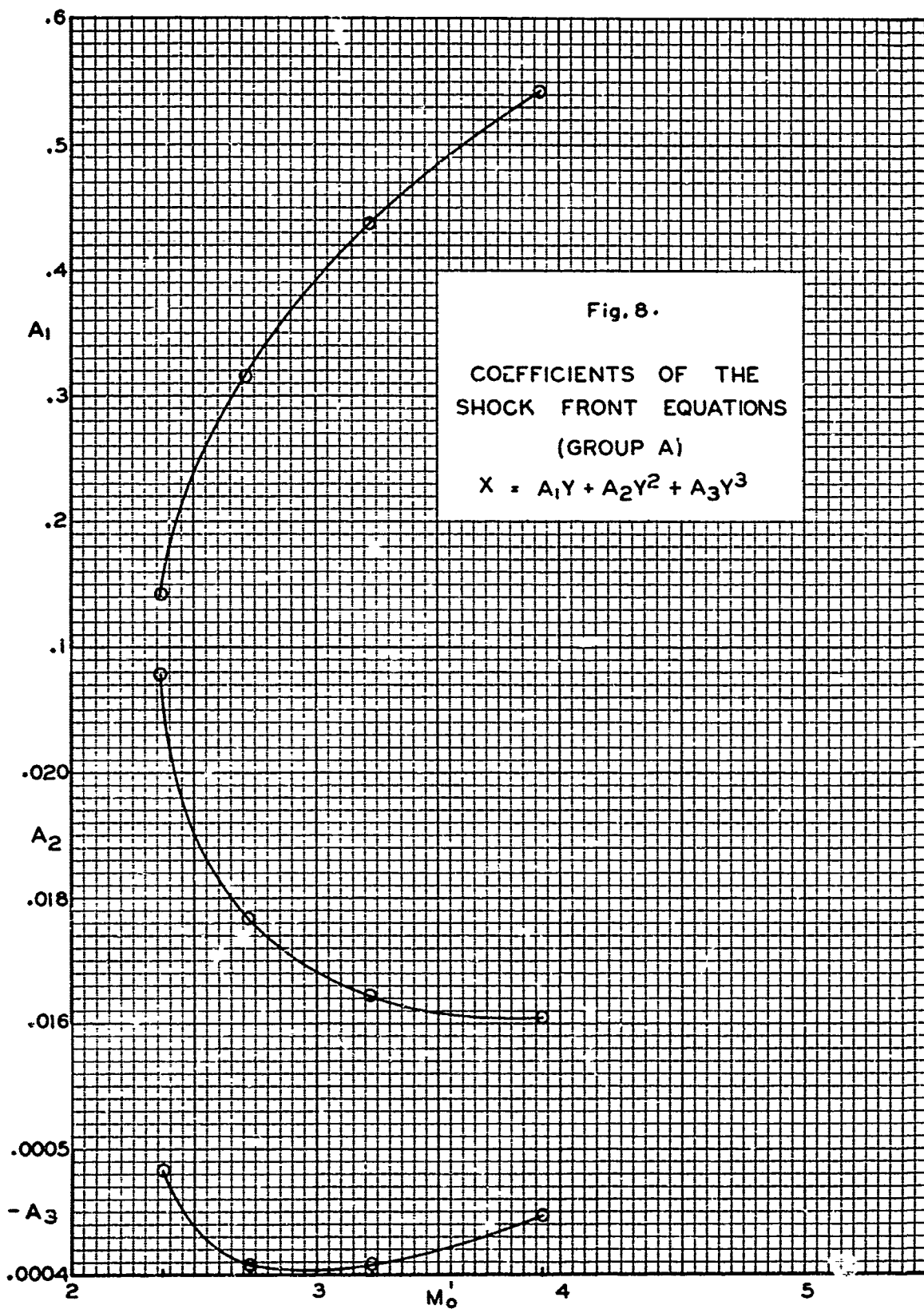
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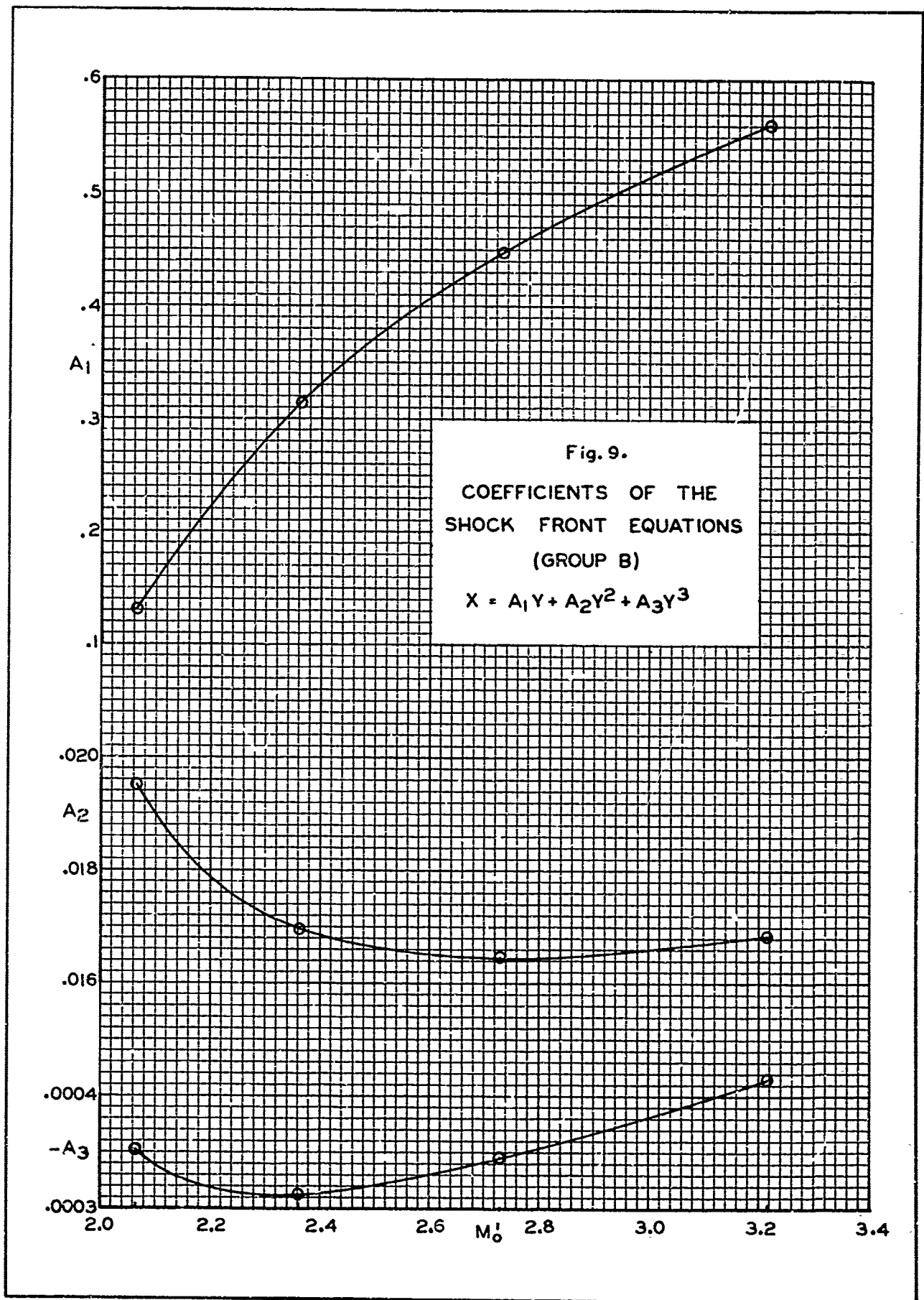
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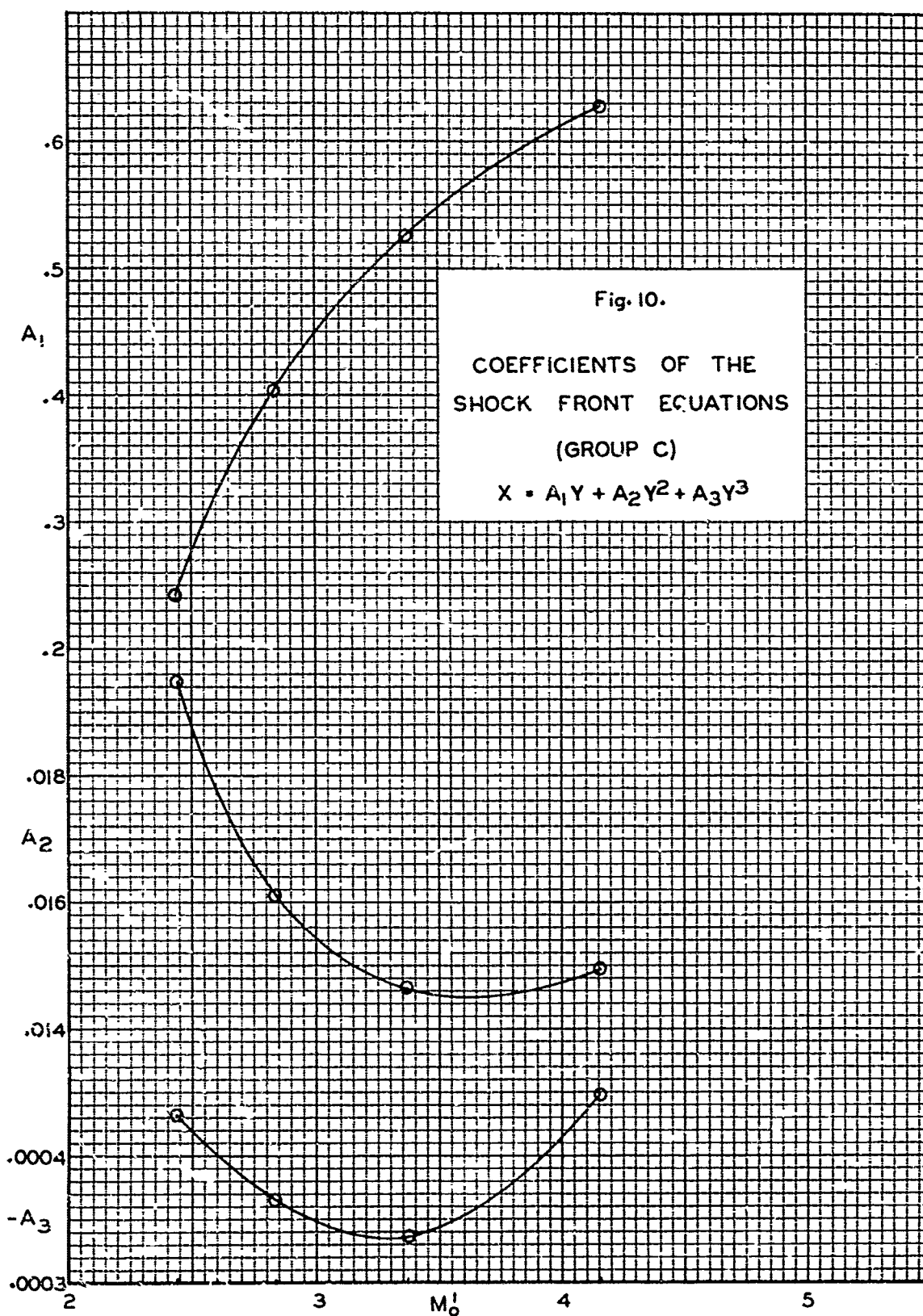


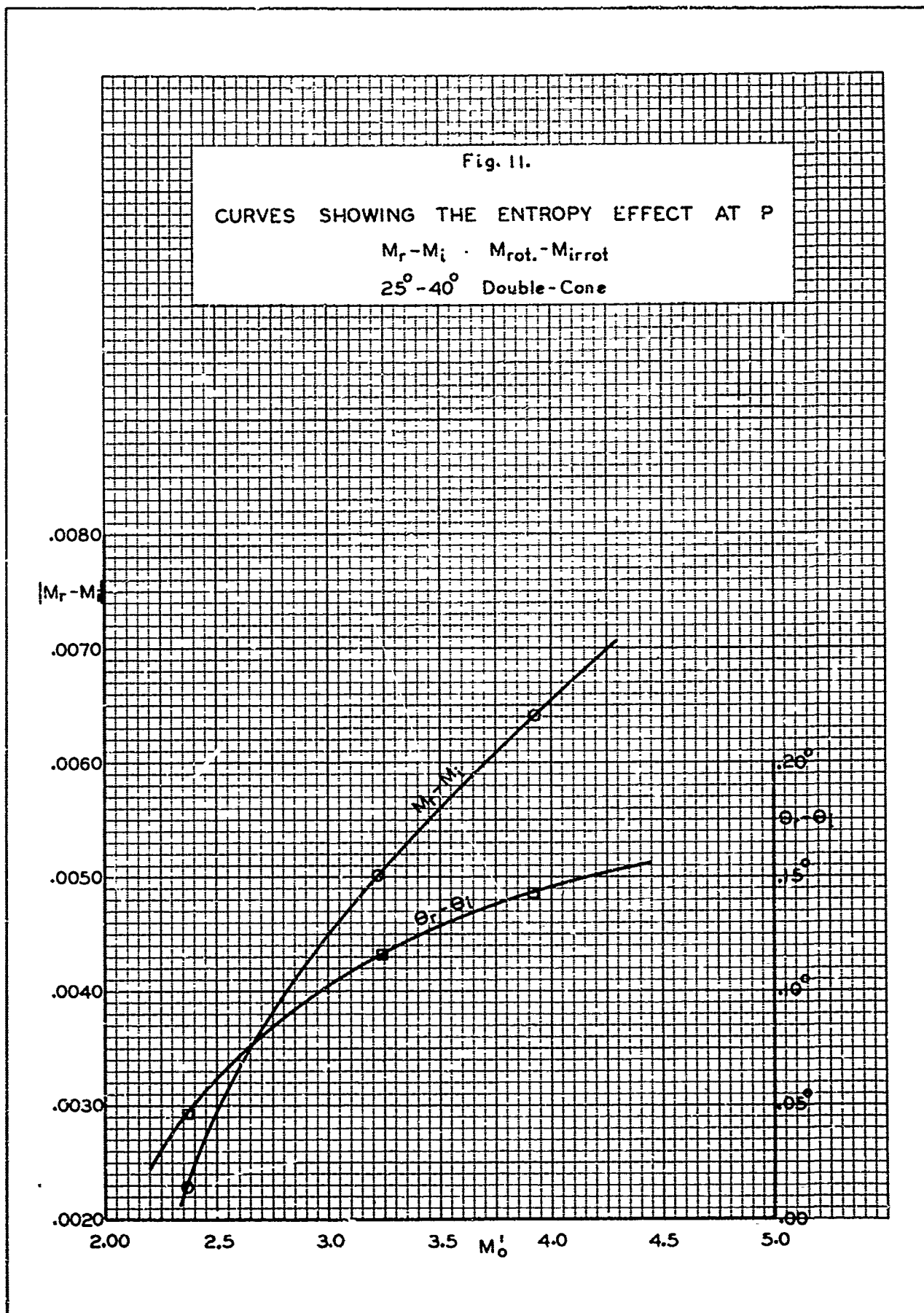
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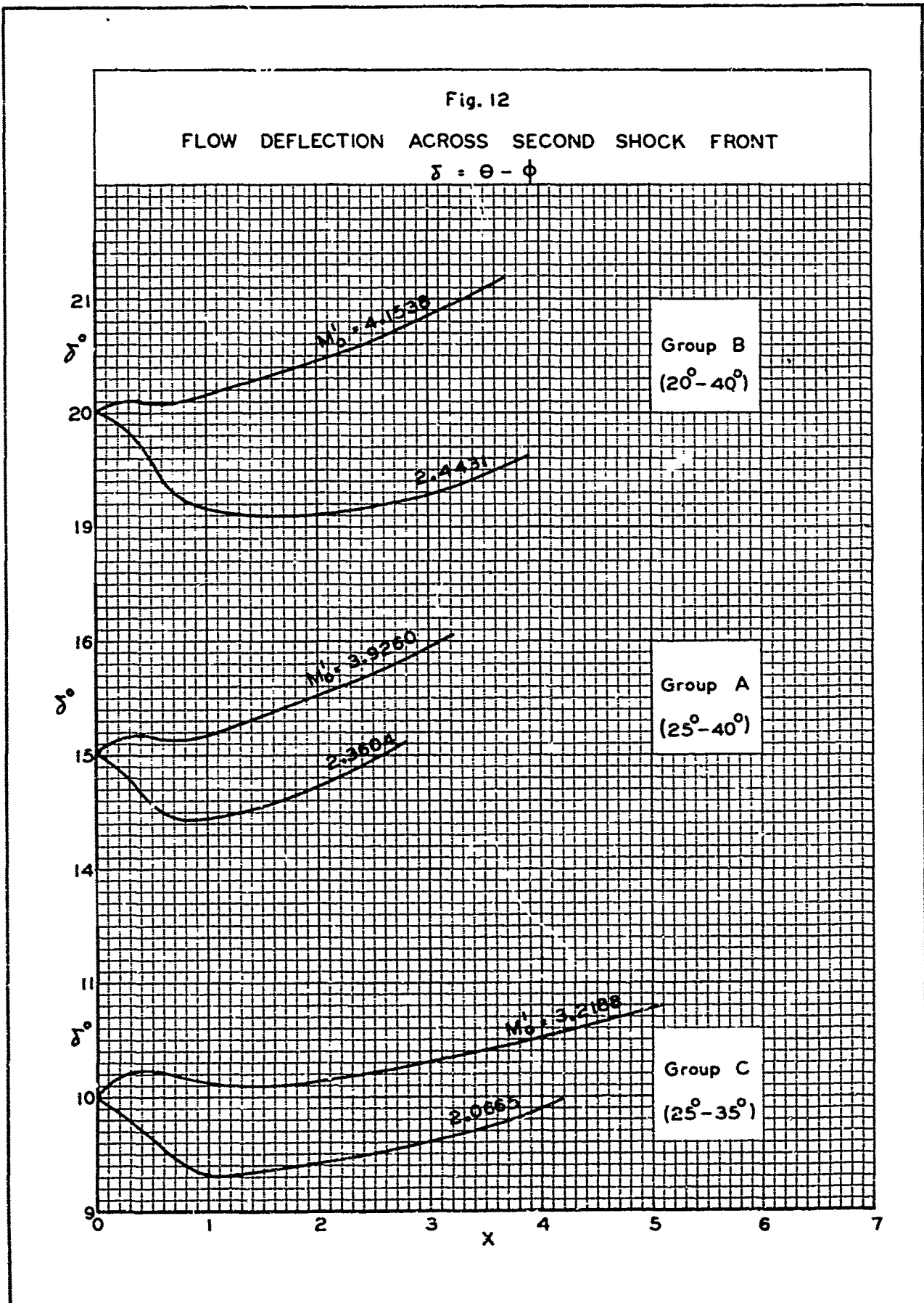


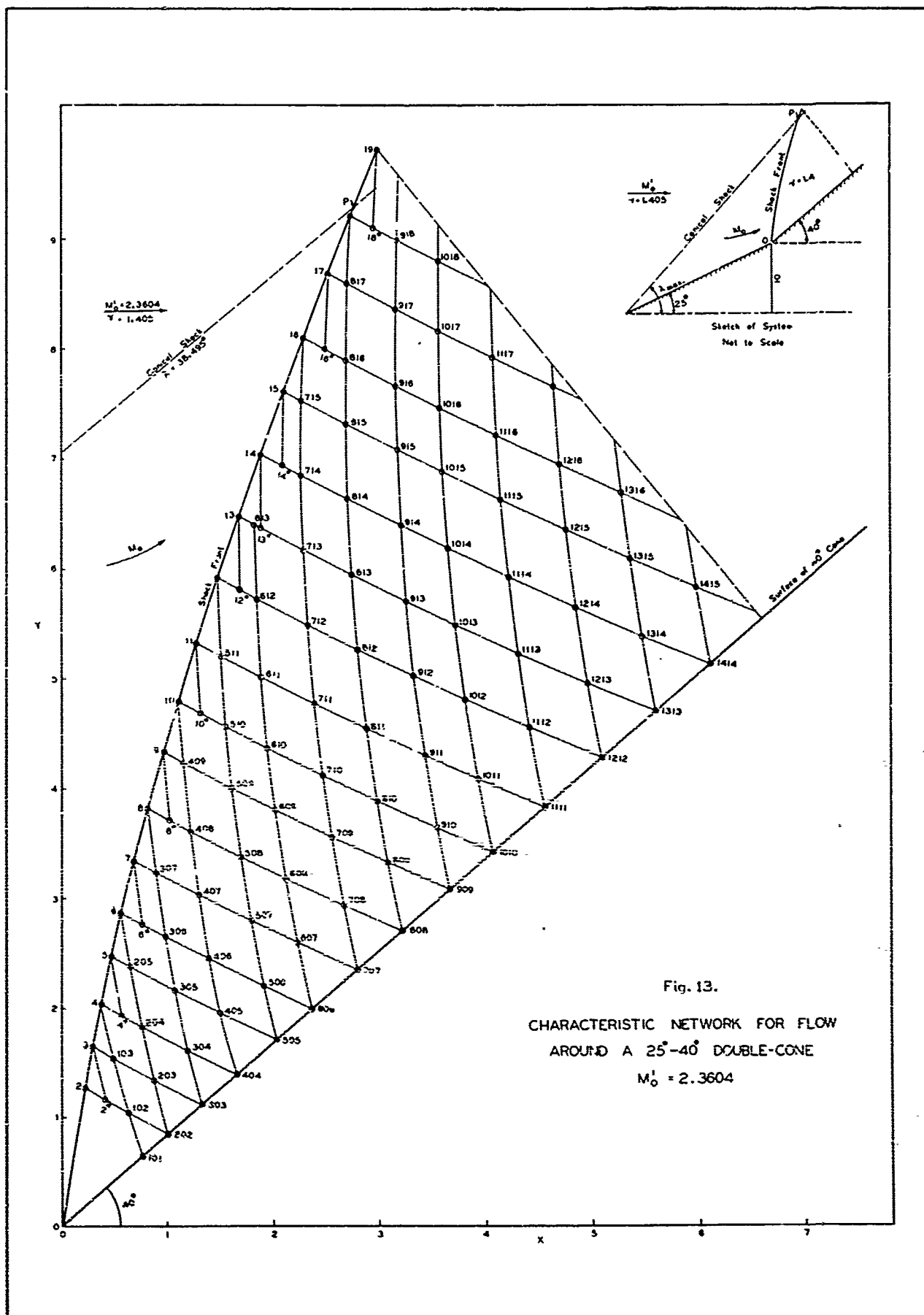
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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0^1 = 2.3604$

$25^\circ - 40^\circ$

$M_0^1 = 2.7296$

P	X	Y	M	θ°	P	X	Y	M	θ°
101	.766	0.643	1.073	40.000	101	.400	0.336	1.350	40.000
2	.222	1.281	1.087	37.595	2	.185	0.571	1.347	39.093
2			1.671	22.699	2			1.902	23.992
2*	.424	1.167	1.088	38.241	2*	.296	0.554	1.349	39.313
102	.626	1.054	1.089	38.886	102	.408	0.536	1.352	39.534
202	1.013	0.850	1.099	40.000	202	.605	0.508	1.354	40.000
3	.293	1.654	1.096	36.929	3	.316	0.960	1.352	38.375
3			1.673	22.122	3			1.903	23.368
103	.489	1.546	1.097	37.516	103	.427	0.942	1.355	38.585
203	.878	1.337	1.105	38.569	203	.622	0.911	1.356	39.031
303	1.329	1.115	1.105	40.000	303	1.015	0.852	1.356	40.000
4	.373	2.037	1.105	36.294	4	.455	1.350	1.358	37.710
4			1.676	21.567	4			1.906	22.787
4*	.576	1.927	1.109	36.810	4*	.566	1.331	1.359	37.957
204	.762	1.826	1.112	37.281	204	.646	1.317	1.359	38.136
304	1.199	1.605	1.110	38.599	304	1.033	1.254	1.358	39.063
404	1.653	1.387	1.110	40.000	404	1.426	1.196	1.358	40.000
5	.470	2.463	1.118	35.581	5	.599	1.744	1.363	37.129
5			1.680	20.392	5			1.909	22.238
205	.654	2.365	1.121	36.013	5*	.711	1.724	1.363	37.369
305	1.075	2.150	1.118	37.212	205	.679	1.730	1.363	37.300
405	1.514	1.933	1.116	38.494	305	1.058	1.664	1.361	38.187
505	2.021	1.696	1.115	40.000	405	1.444	1.602	1.360	39.084
					505	1.840	1.544	1.360	40.000
6	.572	2.875	1.130	34.942	6	.750	2.140	1.367	36.590
6			1.684	20.470	6			1.912	21.721
6*	.778	2.769	1.128	35.499	6*	.861	2.120	1.366	36.845
306	.978	2.665	1.126	36.041	306	1.090	2.077	1.364	37.372
406	1.403	2.453	1.123	37.217	406	1.470	2.012	1.362	38.232
506	1.893	2.217	1.121	38.604	506	1.859	1.950	1.362	39.110
606	2.378	1.995	1.120	40.000	606	2.257	1.894	1.362	40.000
7	.697	3.349	1.138	34.359	7	.906	2.537	1.370	36.110
7			1.689	19.906	7			1.916	21.232
307	.889	3.251	1.136	34.853	7*	1.017	2.516	1.369	36.359
407	1.297	3.045	1.132	35.921	307	1.131	2.494	1.368	36.615
507	1.769	2.813	1.128	37.183	407	1.502	2.426	1.366	37.439
607	2.237	2.592	1.126	38.458	507	1.885	2.361	1.364	38.281
707	2.792	2.343	1.125	40.000	607	2.276	2.300	1.363	39.135
					707	2.674	2.244	1.363	40.000
8	.825	3.808	1.145	33.838	8	1.066	2.934	1.373	35.664
8			1.694	19.393	8			1.920	20.769
8*	1.032	3.703	1.143	34.353	308	1.178	2.913	1.372	35.910
408	1.218	3.608	1.140	34.816	408	1.542	2.842	1.369	36.700
508	1.673	3.382	1.136	35.973	508	1.918	2.775	1.367	37.508
608	2.125	3.164	1.133	37.143	608	2.303	2.711	1.366	38.328
708	2.663	2.916	1.130	38.561	708	2.694	2.650	1.365	39.159
808	3.196	2.682	1.129	40.000	808	3.092	2.595	1.365	40.000
9	.974	4.313	1.152	33.314					

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 2.3604$ $25^\circ - 40^\circ$ $M_0 = 2.7296$

P	X	Y	M	θ°	P	X	Y	M	θ°
9			1.700	18.863	9	1.232	3.335	1.377	35.246
409	1.152	4.222	1.150	33.739	9			1.924	20.325
509	1.590	4.003	1.145	34.793	9*	1.343	3.333	1.376	35.481
609	2.025	3.790	1.141	35.860	409	1.590	3.213	1.373	36.004
709	2.542	3.545	1.137	37.155	509	1.959	3.194	1.371	36.780
809	3.058	3.311	1.134	38.473	609	2.336	3.127	1.369	37.568
909	3.644	3.058	1.133	40.000	709	2.721	3.063	1.367	38.367
10	1.113	4.765	1.158	32.878	809	3.113	3.003	1.366	39.176
10			1.705	18.412	909	3.513	2.948	1.366	40.000
10*	1.320	4.660	1.156	33.356	10	1.401	3.733	1.380	34.855
510	1.536	4.551	1.153	33.855	10			1.929	19.906
610	1.956	4.344	1.149	34.841	10*	1.511	3.711	1.379	35.085
710	2.457	4.103	1.144	36.039	410	1.643	3.684	1.377	35.359
810	2.956	3.871	1.140	37.258	510	2.005	3.612	1.374	36.105
910	3.525	3.617	1.137	38.676	610	2.376	3.543	1.372	36.863
1010	4.048	3.397	1.136	40.000	710	2.755	3.476	1.370	37.631
11	1.284	5.294	1.165	32.407	810	3.140	3.414	1.269	38.410
11			1.712	17.913	910	3.534	3.354	1.368	39.204
511	1.491	5.190	1.162	32.867	1010	3.933	3.300	1.368	40.000
611	1.895	4.988	1.158	33.772	11	1.574	4.132	1.383	34.491
711	2.377	4.754	1.152	34.868	11			1.934	19.506
811	2.858	4.526	1.148	35.983	411	1.703	4.104	1.382	34.755
911	3.406	4.275	1.144	37.281	511	2.058	4.031	1.378	35.472
1011	3.912	4.053	1.141	38.499	611	2.422	3.960	1.375	36.201
1111	4.524	3.796	1.139	40.000	711	2.795	3.892	1.373	36.942
12	1.466	5.837	1.172	31.962	811	3.174	3.826	1.371	37.692
12			1.719	17.426	911	3.562	3.764	1.370	38.457
12*	1.673	5.733	1.169	32.405	1011	3.954	3.706	1.369	39.225
612	1.855	5.642	1.167	32.794	1111	4.352	3.652	1.369	40.000
712	2.319	5.413	1.161	33.801	12	1.779	4.593	1.387	34.099
812	2.781	5.191	1.156	34.824	12			1.940	19.062
912	3.309	4.944	1.151	36.014	12*	1.890	4.570	1.385	34.317
1012	3.797	4.723	1.147	37.132	512	2.127	4.519	1.383	34.785
1112	4.390	4.466	1.144	38.514	612	2.483	4.446	1.379	35.484
1212	5.015	4.208	1.142	40.000	712	2.848	4.376	1.377	36.192
13	1.659	6.388	1.178	31.545	812	3.220	4.307	1.374	36.911
13			1.726	16.954	912	3.601	4.242	1.372	37.645
613	1.834	6.300	1.176	31.906	1012	3.986	4.180	1.371	38.382
713	2.280	6.079	1.170	32.834	1112	4.377	4.122	1.370	39.127
813	2.725	5.863	1.164	33.776	1212	4.838	4.059	1.370	40.000
913	3.234	5.621	1.159	34.869	13	1.960	4.991	1.390	33.781
1013	3.704	5.404	1.154	35.896	13			1.945	18.695
1113	4.276	5.148	1.150	37.167	13*	2.071	4.967	1.388	33.995
1213	4.881	4.888	1.147	38.537	513	2.193	4.941	1.387	34.233
1313	5.517	4.629	1.145	40.000	613	2.543	4.867	1.383	34.907
14	1.833	6.866	1.183	31.209	713	2.901	4.795	1.380	35.590
14			1.732	16.560	813	3.266	4.725	1.377	36.284
14*	2.040	6.762	1.180	31.626	913	3.641	4.657	1.375	36.992
714	2.265	6.650	1.177	32.078	1013	4.021	4.592	1.373	37.703
					1113	4.406	4.531	1.372	38.422

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 2.3604$ $25^\circ - 40^\circ$ $M_0 = 2.7296$

P	X	Y	M	θ°	P	X	Y	M	θ°
814	2.695	6.439	1.171	32.958	1213	4.860	4.464	1.371	39.267
914	3.188	6.203	1.166	33.978	1313	5.257	4.412	1.371	40.000
1014	3.644	5.989	1.161	34.936					
1114	4.198	5.736	1.156	36.120	14	2.144	5.388	1.393	33.483
1214	4.785	5.477	1.151	37.398	14			1.950	18.342
1314	5.404	5.216	1.148	38.766	514	2.264	5.362	1.391	33.713
1414	5.954	4.996	1.147	40.000	614	2.608	5.287	1.387	34.364
					714	2.960	5.214	1.384	35.023
15	2.045	7.432	1.188	30.841	814	3.319	5.142	1.381	35.693
15			1.740	16.109	914	3.687	5.073	1.378	36.376
715	2.262	7.325	1.185	31.263	1014	4.061	5.006	1.376	37.064
815	2.677	7.120	1.180	32.078	1114	4.441	4.942	1.374	37.759
915	3.151	6.889	1.174	33.022	1214	4.888	4.872	1.373	38.575
1015	3.590	6.681	1.169	33.906	1314	5.280	4.815	1.372	39.285
1115	4.124	6.432	1.163	34.997	1414	5.677	4.763	1.372	40.000
1215	4.690	6.177	1.156	36.175					
1315	5.289	5.916	1.154	37.439	15	2.348	5.818	1.396	33.182
1415	5.822	5.693	1.151	38.581	15			1.956	17.971
1515	6.475	5.433	1.149	40.000	15*	2.458	5.794	1.394	33.387
					615	2.684	5.743	1.391	33.809
16	2.277	8.029	1.194	30.484	715	3.030	5.669	1.388	34.444
16			1.749	15.649	815	3.382	5.596	1.384	35.089
16*	2.484	7.926	1.191	30.877	915	3.744	5.525	1.381	35.748
816	2.676	7.831	1.188	31.241	1015	4.111	5.456	1.379	36.411
916	3.133	7.607	1.182	32.114	1115	4.484	5.390	1.377	37.081
1016	3.555	7.404	1.177	32.931	1215	4.924	5.316	1.375	37.869
1116	4.070	7.161	1.171	33.938	1315	5.310	5.256	1.374	38.554
1216	4.615	6.910	1.165	35.024	1415	5.701	5.200	1.373	39.245
1316	5.191	6.652	1.160	36.187	1515	6.130	5.144	1.373	40.000
1416	5.707	6.429	1.156	37.241					
1516	6.339	6.166	1.153	38.553	16	2.538	6.214	1.398	32.920
1616	7.025	5.894	1.151	40.000	16			1.962	17.640
					16*	2.648	6.189	1.397	33.122
17	2.508	8.608	1.198	30.167	616	2.760	6.164	1.395	33.328
17			1.758	15.215	716	3.099	6.089	1.391	33.943
817	2.693	8.516	1.196	30.508	816	3.446	6.015	1.388	34.567
917	3.134	8.298	1.189	31.323	916	3.801	5.943	1.385	35.204
1017	3.542	8.100	1.184	32.083	1016	4.163	5.872	1.382	35.845
1117	4.038	7.863	1.178	33.019	1116	4.530	5.804	1.379	36.494
1217	4.563	7.617	1.172	34.025	1216	4.963	5.728	1.377	37.256
1317	5.120	7.363	1.167	35.102	1316	5.344	5.665	1.376	37.920
1417	5.618	7.142	1.162	36.076	1416	5.730	5.606	1.375	38.589
1617	7.028	5.879	1.151	39.970	1516	6.153	5.546	1.374	39.322
18	2.722	9.131	1.202	29.902	17	2.731	6.609	1.401	32.674
18			1.766	14.829	17			1.968	17.318
18*	2.930	9.028	1.199	30.275	617	2.841	6.583	1.399	32.874
918	3.150	8.919	1.196	30.670	717	3.174	6.503	1.395	33.470
1018	3.545	8.726	1.190	31.385	817	3.514	6.434	1.391	34.074
1118	4.025	8.494	1.184	32.264	917	3.864	6.360	1.388	34.691
1218	4.534	8.253	1.178	33.207	1017	4.220	6.288	1.385	35.311
					1117	4.581	6.219	1.382	35.939
19	2.968	9.715	1.206	29.628	1217	5.008	6.140	1.379	36.678
19			1.776	14.404	1317	5.383	6.075	1.378	37.321

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 2.3604$ $25^\circ - 40^\circ$ $M_0^1 = 2.7296$

P	X	y	M	θ°	P	X	y	M	θ°
1019	3.563	9.420	1.197	30.670	18	2.926	7.002	1.403	32.444
					18			1.974	17.003
					18*	3.036	6.977	1.402	32.638
					718	3.253	6.926	1.399	33.021
					818	3.588	6.852	1.395	33.606
					918	3.932	6.777	1.391	34.204
					1018	4.282	6.704	1.388	34.805
					1118	4.638	6.633	1.385	35.414
					1218	5.058	6.553	1.382	36.130
					19	3.124	7.394	1.405	32.224
					19			1.981	16.694
					19*	3.234	7.368	1.404	32.416
					719	3.337	7.344	1.402	32.597
					819	3.666	7.269	1.398	33.165
					919	4.004	7.194	1.394	33.745
					1019	4.348	7.120	1.391	34.328
					1119	4.698	7.048	1.388	34.918
					20	3.323	7.784	1.407	32.018
					20			1.987	16.392
					720	3.425	7.760	1.406	32.194
					820	3.748	7.685	1.401	32.746
					920	4.081	7.609	1.397	33.309
					1020	4.419	7.535	1.394	33.875
					21	3.510	8.145	1.409	31.839
					21			1.993	16.115
					821	3.828	8.069	1.404	32.376

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 3.2188$ $25^\circ - 40^\circ$ $M_0 = 3.9260$

P	X	Y	M	θ	P	X	Y	M	θ
101	.345	0.289	1.606	40.000	101	.400	0.336	1.889	40.000
2	.245	0.548	1.600	39.257	2	.290	0.525	1.881	39.400
2			2.179	24.097	2			2.521	24.186
2*	.321	0.549	1.603	39.346	2*	.335	0.531	1.882	39.440
102	.398	0.549	1.606	39.435	102	.469	0.543	1.888	39.561
202	.660	0.554	1.607	40.000	202	.688	0.577	1.887	40.000
3	.387	0.858	1.605	38.713	3	.397	0.716	1.883	39.097
3			2.181	23.626	3			2.522	23.909
103	.464	0.859	1.607	38.798	3*	.441	0.722	1.884	39.136
203	.722	0.860	1.607	39.348	103	.531	0.733	1.887	39.214
303	1.030	0.865	1.607	40.000	203	.748	0.760	1.887	39.648
4	.534	1.169	1.609	38.201	303	.936	0.786	1.887	40.000
4			2.183	23.182	4	.505	0.907	1.885	38.803
4*	.610	1.169	1.609	38.361	4			2.523	23.643
204	.788	1.169	1.608	38.735	4*	.549	0.913	1.886	38.842
304	1.093	1.169	1.607	39.369	104	.594	0.918	1.888	38.880
404	1.399	1.174	1.607	40.000	204	.808	0.944	1.886	39.307
5	.683	1.480	1.610	37.793	304	.995	0.968	1.886	39.654
5			2.185	22.760	404	1.183	0.993	1.886	40.000
5*	.760	1.479	1.610	37.952	5	.614	1.098	1.887	38.520
205	.859	1.478	1.609	38.157	5			2.524	23.385
305	1.159	1.477	1.608	38.775	105	.658	1.103	1.888	38.553
405	1.461	1.479	1.607	39.389	205	.870	1.127	1.887	38.979
505	1.768	1.484	1.607	40.000	305	1.056	1.150	1.886	39.322
6	.835	1.790	1.612	37.413	405	1.242	1.174	1.886	39.563
6			2.188	22.361	505	1.429	1.199	1.886	40.000
206	.933	1.789	1.611	37.614	6	.722	1.285	1.889	38.253
306	1.229	1.785	1.610	38.215	6			2.526	23.141
406	1.527	1.784	1.608	38.813	6*	.767	1.290	1.889	38.341
506	1.830	1.786	1.608	39.408	206	.933	1.308	1.887	38.668
606	2.134	1.791	1.608	40.000	306	1.117	1.330	1.886	39.006
7	1.032	2.183	1.614	36.968	406	1.301	1.353	1.886	39.343
7			2.191	21.882	506	1.487	1.376	1.886	39.676
7*	1.108	2.181	1.613	37.121	606	1.670	1.401	1.886	40.000
307	1.322	2.176	1.612	37.549	7	.834	1.475	1.889	38.041
407	1.615	2.172	1.610	38.128	7			2.528	22.900
507	1.912	2.171	1.609	38.705	7*	.879	1.480	1.889	38.130
607	2.212	2.172	1.608	39.278	207	.998	1.493	1.888	38.364
707	2.595	2.178	1.608	40.000	307	1.180	1.513	1.887	38.697
8	1.189	2.492	1.616	36.640	407	1.363	1.535	1.886	39.029
8			2.195	21.523	507	1.546	1.557	1.885	39.358
8*	1.265	2.489	1.615	36.791	607	1.728	1.581	1.885	39.678
308	1.399	2.486	1.614	37.058	707	1.913	1.606	1.885	40.000
408	1.689	2.479	1.612	37.622	8	.946	1.665	1.890	37.840
508	1.982	2.476	1.610	38.184	8			2.530	22.667
608	2.278	2.475	1.609	38.744	8*	.991	1.670	1.889	37.928
708	2.656	2.477	1.608	39.449	208	1.063	1.677	1.888	38.071

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 3.2188$ $25^\circ - 40^\circ$ $M_0 = 3.9260$

P	X	y	M	θ°	P	X	y	M	θ°
808	2.958	2.482	1.608	40.000	308	1.244	1.696	1.887	38.400
9	1.348	2.799	1.617	36.332	408	1.425	1.717	1.886	38.727
9			2.198	21.180	508	1.607	1.738	1.886	39.052
9*	1.424	2.797	1.616	36.482	608	1.787	1.760	1.885	39.368
309	1.480	2.795	1.616	36.592	708	1.971	1.784	1.885	39.686
409	1.765	2.787	1.613	37.143	808	2.156	1.809	1.885	40.000
509	2.055	2.781	1.612	37.692	9	1.058	1.854	1.890	37.648
609	2.347	2.778	1.610	38.238	9			2.532	22.441
709	2.721	2.777	1.609	38.926	9*	1.103	1.858	1.889	37.736
809	3.019	2.779	1.609	39.465	209	1.130	1.861	1.889	37.759
909	3.319	2.785	1.609	40.000	309	1.309	1.879	1.888	38.113
10	1.509	3.106	1.619	36.044	409	1.489	1.899	1.887	38.436
10			2.202	20.851	509	1.669	1.919	1.886	38.757
10*	1.585	3.103	1.618	36.192	609	1.848	1.940	1.885	39.069
310	1.564	3.104	1.618	36.151	709	2.030	1.963	1.885	39.382
410	1.845	3.094	1.615	36.689	809	2.213	1.986	1.885	39.693
510	2.131	3.086	1.613	37.224	909	2.396	2.011	1.885	40.000
610	2.419	3.081	1.612	37.757	10	1.171	2.042	1.890	37.464
710	2.788	3.077	1.610	38.430	10			2.534	22.221
810	3.083	3.077	1.609	38.956	10*	1.216	2.047	1.889	37.552
910	3.379	3.080	1.609	39.480	210	1.198	2.045	1.889	37.516
1010	3.677	3.086	1.609	40.000	310	1.375	2.062	1.888	37.836
11	1.672	3.412	1.620	35.772	410	1.553	2.080	1.887	38.156
11			2.206	20.534	510	1.732	2.100	1.886	38.472
11*	1.748	3.409	1.619	35.917	610	1.909	2.120	1.885	38.780
411	1.928	3.401	1.618	36.257	710	2.090	2.141	1.885	39.090
511	2.216	3.392	1.615	36.781	810	2.272	2.164	1.884	39.396
611	2.494	3.385	1.613	37.301	910	2.453	2.187	1.884	39.700
711	2.859	3.378	1.611	37.959	1010	2.636	2.211	1.884	40.000
811	3.150	3.376	1.610	38.473	11	1.285	2.230	1.890	37.288
911	3.442	3.377	1.610	38.985	11			2.536	22.008
1011	3.738	3.380	1.609	39.494	11*	1.330	2.234	1.890	37.369
1111	4.034	3.385	1.609	40.000	311	1.442	2.245	1.889	37.570
12	1.836	3.717	1.622	35.514	411	1.619	2.262	1.888	37.885
12			2.210	20.229	511	1.796	2.280	1.886	38.197
12*	1.912	3.713	1.621	35.657	611	1.972	2.299	1.886	38.501
412	2.013	3.709	1.620	35.847	711	2.151	2.320	1.885	38.807
512	2.291	3.698	1.617	36.359	811	2.331	2.341	1.884	39.110
612	2.572	3.689	1.615	36.868	911	2.512	2.364	1.884	39.410
712	2.932	3.680	1.613	37.511	1011	2.692	2.387	1.884	39.707
812	3.219	3.676	1.611	38.014	1111	2.874	2.411	1.884	40.000
912	3.509	3.674	1.610	38.514	12	1.289	2.417	1.890	37.113
1012	3.801	3.675	1.610	39.013	12			2.539	21.801
1112	4.094	3.678	1.610	39.508	12*	1.444	2.421	1.890	37.193
1212	4.390	3.684	1.610	40.000	312	1.510	2.427	1.890	37.312
13	2.002	4.020	1.623	35.271	412	1.685	2.444	1.888	37.623
13			2.214	19.934	512	1.861	2.461	1.887	37.931
413	2.102	4.016	1.622	35.457	612	2.035	2.479	1.886	38.232
513	2.376	4.003	1.619	35.957	712	2.213	2.499	1.885	38.534
					812	2.392	2.519	1.885	38.834

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 3.2188$ $25^\circ - 40^\circ$ $M_0 = 3.9260$

P	X	y	M	θ°	P	X	y	M	θ°
613	2.653	3.993	1.617	36.455	912	2.571	2.540	1.884	39.130
713	3.008	3.982	1.614	37.084	1012	2.750	2.562	1.884	39.423
813	3.292	3.976	1.613	37.576	1112	2.930	2.586	1.884	39.713
913	3.578	3.972	1.611	38.066	1212	3.110	2.610	1.884	40.000
1013	3.867	3.971	1.611	38.553					
1113	4.157	3.971	1.610	39.038	13	1.513	2.604	1.891	36.945
1213	4.450	3.975	1.610	39.521	13			2.541	21.599
1313	4.744	3.980	1.610	40.000	13*	1.558	2.608	1.890	37.025
					313	1.579	2.610	1.890	37.062
14	2.219	4.412	1.625	34.977	413	1.753	2.625	1.889	37.370
14			2.220	19.566	513	1.927	2.642	1.887	37.675
14*	2.295	4.408	1.624	35.115	613	2.100	2.659	1.886	37.972
514	2.488	4.398	1.622	35.464	713	2.276	2.677	1.885	38.270
614	2.761	4.385	1.619	35.948	813	2.453	2.697	1.885	38.566
714	3.110	4.372	1.616	36.559	913	2.631	2.717	1.884	38.859
814	3.390	4.364	1.614	37.038	1013	2.809	2.738	1.884	39.149
914	3.672	4.358	1.613	37.515	1113	2.988	2.760	1.884	39.435
1014	3.956	4.354	1.612	37.990	1213	3.167	2.784	1.884	39.719
1114	4.242	4.352	1.611	38.462	1313	3.346	2.808	1.884	40.000
1214	4.530	4.352	1.610	38.931					
1314	4.821	4.355	1.610	39.398	14	1.628	2.790	1.891	36.785
1414	5.198	4.362	1.610	40.000	14			2.544	21.402
					14*	1.673	2.794	1.891	36.864
15	2.388	4.713	1.626	34.761	314	1.649	2.792	1.891	36.821
15			2.225	19.291	414	1.821	2.806	1.889	37.125
15*	2.464	4.708	1.626	34.898	514	1.994	2.822	1.888	37.426
515	2.578	4.702	1.624	35.103	614	2.165	2.838	1.887	37.720
615	2.847	4.688	1.621	35.577	714	2.340	2.856	1.886	38.015
715	3.192	4.673	1.618	36.176	814	2.516	2.874	1.885	38.307
815	3.468	4.664	1.616	36.645	914	2.692	2.894	1.884	38.597
915	3.747	4.656	1.614	37.112	1014	2.869	2.914	1.884	38.883
1015	4.028	4.650	1.613	37.577	1114	3.046	2.935	1.883	39.167
1115	4.311	4.647	1.612	38.040	1214	3.224	2.957	1.883	39.447
1215	4.596	4.645	1.611	38.500	1314	3.402	2.980	1.883	39.725
1315	4.883	4.646	1.611	38.958	1414	3.580	3.004	1.883	40.000
1415	5.257	4.650	1.610	39.548					
1515	5.548	4.655	1.611	40.000	15	1.747	2.975	1.892	36.631
					15			2.546	21.210
16	2.558	5.012	1.628	34.558	15*	1.789	2.979	1.891	36.710
16			2.229	19.023	415	1.890	2.987	1.890	36.889
16*	2.634	5.008	1.627	34.634	515	2.062	3.002	1.889	37.186
516	2.670	5.006	1.626	34.759	615	2.231	3.018	1.887	37.476
616	2.936	4.991	1.623	35.224	715	2.405	3.034	1.886	37.768
716	3.276	4.974	1.620	35.810	815	2.579	3.052	1.885	38.057
816	3.549	4.963	1.618	36.270	915	2.754	3.070	1.885	38.343
916	3.825	4.954	1.616	36.728	1015	2.930	3.090	1.884	38.626
1016	4.102	4.947	1.614	37.183	1115	3.105	3.110	1.884	38.906
1116	4.382	4.941	1.613	37.637	1215	3.282	3.131	1.883	39.184
1216	4.665	4.938	1.612	38.088	1315	3.459	3.153	1.883	39.459
1316	4.949	4.937	1.611	38.537	1415	3.636	3.176	1.883	39.731
1416	5.319	4.938	1.611	39.116	1515	3.814	3.200	1.883	40.000
1516	5.607	4.942	1.611	39.559					
					16	1.860	3.160	1.892	36.483
17	2.729	5.310	1.629	34.366	16			2.549	21.022

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 3.2188$ $25^\circ - 40^\circ$ $M_0^1 = 3.9260$

P	X	y	M	θ°	P	X	y	M	θ°
17			2.234	18.762	16*	1.905	3.164	1.892	36.562
17*	2.805	5.306	1.628	34.501	416	1.960	3.168	1.891	36.660
517	2.765	5.308	1.629	34.429	516	2.130	3.182	1.889	36.954
617	3.027	5.292	1.625	34.885	616	2.299	3.197	1.868	37.241
717	3.363	5.274	1.622	35.460	716	2.471	3.213	1.887	37.529
817	3.632	5.262	1.619	35.911	816	2.644	3.229	1.886	37.815
917	3.904	5.251	1.617	36.360	916	2.817	3.247	1.885	38.098
1017	4.179	5.243	1.616	36.806	1016	2.991	3.265	1.884	38.378
1117	4.456	5.236	1.614	37.251	1116	3.166	3.285	1.884	38.655
1217	4.735	5.231	1.613	37.694	1216	3.341	3.305	1.883	38.929
1317	5.017	5.228	1.612	38.134	1316	3.517	3.326	1.883	39.201
					1416	3.693	3.348	1.883	39.470
18	2.901	5.607	1.630	34.184	1516	3.869	3.371	1.883	39.736
18			2.239	18.507	1616	4.046	3.395	1.883	40.000
18*	2.977	5.602	1.629	34.315					
618	3.119	5.593	1.627	34.561	17	1.976	3.344	1.893	36.342
718	3.451	5.574	1.624	35.125	17			2.552	20.838
818	3.718	5.560	1.621	35.567	417	2.031	3.348	1.892	36.438
918	3.987	5.549	1.619	36.007	517	2.200	3.362	1.890	36.729
1018	4.258	5.538	1.617	36.446	617	2.366	3.376	1.889	37.012
1118	4.532	5.530	1.615	36.882	717	2.537	3.391	1.887	37.297
1218	4.808	5.523	1.614	37.316	817	2.709	3.407	1.886	37.580
					917	2.881	3.424	1.885	37.860
19	3.073	5.903	1.631	34.009	1017	3.054	3.441	1.885	38.137
19			2.244	18.258	1117	3.227	3.460	1.884	38.411
19*	3.150	5.898	1.630	34.140	1217	3.401	3.479	1.883	38.682
619	3.214	5.893	1.629	34.251	1317	3.575	3.499	1.883	38.951
719	3.542	5.873	1.626	34.805	1417	3.750	3.520	1.883	39.217
819	3.805	5.858	1.623	35.238	1517	3.925	3.542	1.883	39.481
919	4.071	5.845	1.621	35.670	1617	4.101	3.565	1.883	39.742
1019	4.339	5.834	1.618	36.100	1717	4.277	3.589	1.883	40.000
1119	4.610	5.824	1.617	36.529					
					18	2.118	3.566	1.893	36.178
20	3.247	6.197	1.632	33.844	18			2.556	20.621
20			2.249	18.013	18*	2.163	3.570	1.892	36.256
620	3.311	6.192	1.631	33.953	518	2.284	3.579	1.891	36.465
720	3.634	6.170	1.627	34.497	618	2.450	3.592	1.890	36.745
820	3.894	6.155	1.625	34.923	718	2.619	3.606	1.888	37.026
920	4.157	6.141	1.622	35.347	818	2.789	3.621	1.887	37.305
					918	2.959	3.637	1.886	37.581
21	3.393	6.442	1.633	33.712	1018	3.130	3.654	1.885	37.854
21			2.254	17.810	1118	3.302	3.671	1.884	38.125
21*	3.469	6.437	1.632	33.840	1218	3.474	3.689	1.884	38.393
721	3.713	6.420	1.629	34.248	1318	3.647	3.709	1.883	38.658
821	3.970	6.403	1.626	34.668	1418	3.820	3.729	1.883	38.921
					1518	3.994	3.749	1.883	39.181
22	3.568	6.733	1.634	33.562	1618	4.169	3.771	1.883	39.439
22			2.259	17.573	1718	4.343	3.794	1.883	39.694
					1818	4.555	3.822	1.883	40.000
					19	2.235	3.749	1.893	36.048
					19			2.559	20.445
					19*	2.280	3.752	1.893	36.125
					519	2.355	3.758	1.892	36.255

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0 = 3.2188$

$25^\circ - 40^\circ$

$M_0 = 3.9260$

P	X	y	M	θ°	P	X	y	M	θ°
					619	2.519	3.770	1.890	36.532
					719	2.687	3.784	1.889	36.810
					819	2.855	3.798	1.888	37.086
					919	3.025	3.813	1.886	37.359
					1019	3.194	3.829	1.885	37.629
					1119	3.365	3.846	1.885	37.897
					1219	3.536	3.863	1.884	38.162
					1319	3.708	3.882	1.883	38.425
					1419	3.880	3.901	1.883	38.685
					1519	4.052	3.921	1.883	38.942
					1619	4.226	3.942	1.882	39.197
					1719	4.399	3.963	1.882	39.450
					1819	4.609	3.980	1.883	39.753
					1919	4.784	4.014	1.883	40.000
					20	2.352	3.931	1.894	35.922
					20			2.562	20.272
					20*	2.397	3.934	1.893	36.000
					520	2.427	3.936	1.893	36.051
					620	2.589	3.948	1.891	36.325
					720	2.756	3.961	1.890	36.600
					820	2.923	3.975	1.888	36.873
					920	3.091	3.989	1.887	37.143
					1020	3.259	4.004	1.886	37.411
					1120	3.428	4.020	1.885	37.673
					1220	3.598	4.037	1.884	37.938
					1320	3.769	4.054	1.884	38.198
					1420	3.940	4.073	1.883	38.455
					1520	4.111	4.092	1.883	38.710
					1620	4.283	4.112	1.882	38.962
					1720	4.456	4.133	1.882	39.213
					1920	4.783	4.013	1.883	39.998
					21	2.469	4.112	1.894	35.802
					21			2.565	20.122
					21*	2.514	4.116	1.893	35.879
					521	2.499	4.115	1.894	35.853
					621	2.660	4.126	1.892	36.124
					721	2.825	4.138	1.890	36.396
					821	2.991	4.151	1.889	36.666
					921	3.158	4.165	1.888	36.934
					1021	3.325	4.179	1.886	37.199
					1121	3.493	4.194	1.885	37.461
					1221	3.662	4.210	1.885	37.720
					1321	3.831	4.227	1.884	37.977
					1421	4.000	4.245	1.883	38.232
					1521	4.171	4.263	1.883	38.485
					1621	4.342	4.282	1.883	38.734
					22	2.587	4.293	1.894	35.686
					22			2.568	19.935
					22*	2.632	4.296	1.894	35.762
					622	2.732	4.303	1.893	35.928
					722	2.895	4.314	1.891	36.198

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 3.2188$ $25^\circ - 40^\circ$ $M_0^1 = 3.9260$

P	X	y	M	θ°	P	X	y	M	θ°
					822	3.060	4.327	1.889	36.465
					922	3.225	4.340	1.888	36.730
					1022	3.391	4.354	1.887	36.992
					1122	3.558	4.368	1.886	37.252
					1222	3.725	4.383	1.885	37.509
					1322	3.893	4.399	1.884	37.763
					1422	4.062	4.416	1.884	38.016
					1522	4.231	4.434	1.883	38.265
					23	2.705	4.473	1.895	35.573
					23			2.572	19.771
					23*	2.750	4.476	1.894	35.649
					623	2.804	4.480	1.893	35.738
					723	2.966	4.491	1.892	36.005
					823	3.129	4.502	1.890	36.270
					923	3.293	4.515	1.889	36.532
					1023	3.458	4.528	1.887	36.792
					1123	3.624	4.542	1.886	37.048
					1223	3.790	4.556	1.885	37.303
					1323	3.957	4.572	1.885	37.555
					1423	4.124	4.588	1.884	37.805
					24	2.823	4.653	1.895	35.464
					24			2.575	19.609
					624	2.876	4.656	1.894	35.553
					724	3.037	4.666	1.892	35.818
					824	3.199	4.677	1.891	36.080
					924	3.362	4.689	1.889	36.339
					1024	3.526	4.702	1.888	36.596
					1124	3.690	4.715	1.887	36.851
					1224	3.855	4.729	1.886	37.103
					1324	4.021	4.744	1.885	37.352
					25	2.962	4.862	1.895	35.342
					25			2.579	19.422
					25*	3.007	4.864	1.894	35.416
					725	3.121	4.871	1.893	35.604
					825	3.282	4.882	1.891	35.863
					925	3.443	4.893	1.890	36.119
					1025	3.605	4.905	1.889	36.374
					1125	3.768	4.917	1.887	36.625
					1225	3.932	4.931	1.886	36.874
					26	3.080	5.039	1.895	35.240
					26			2.583	19.264
					26*	3.125	5.042	1.895	35.314
					726	3.194	5.046	1.894	35.426
					826	3.353	5.056	1.892	35.683
					926	3.513	5.067	1.891	35.937
					1026	3.674	5.076	1.889	36.189
					27	3.199	5.217	1.895	35.141
					27			2.586	19.109
					27*	3.244	5.219	1.895	35.215

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 3.2188$ $25^\circ - 40^\circ$ $M_0^1 = 3.9260$

P	X	y	M	θ°		P	X	y	M	θ°
						727	3.267	5.221	1.894	35.252
						827	3.425	5.230	1.893	35.507
						927	3.584	5.240	1.891	35.758
						28	3.317	5.393	1.895	35.046
						28			2.590	18.955
						828	3.497	5.403	1.893	35.334

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 2.4431$ $20^\circ - 40^\circ$ $M_0^1 = 2.8387$

P	X	y	M	θ°	P	X	y	M	θ°
101	.800	0.671	1.086	40.000	101	.700	0.587	1.384	40.000
2	.317	1.209	1.103	38.016	2	.347	0.831	1.382	38.893
2			1.904	18.196	2			2.180	18.799
2*	.543	1.094	1.104	38.712	2*	.467	0.815	1.384	39.135
102	.694	1.017	1.105	39.177	102	.713	0.783	1.388	39.627
202	1.024	0.859	1.117	40.000	202	.906	0.761	1.392	40.000
3	.423	1.589	1.115	37.411	3	.497	1.180	1.387	38.352
3			1.906	17.706	3			2.182	18.348
3*	.651	1.476	1.115	38.067	3*	.617	1.163	1.389	38.587
103	.569	1.516	1.115	37.832	103	.740	1.146	1.390	38.825
203	.904	1.354	1.126	38.612	203	.932	1.122	1.394	39.184
303	1.367	1.147	1.125	40.000	303	1.288	1.081	1.395	40.000
4	.543	1.991	1.126	36.804	4	.652	1.530	1.393	37.846
4			1.909	17.219	4			2.184	17.920
204	.802	1.866	1.135	37.321	104	.773	1.513	1.394	38.074
304	1.251	1.662	1.133	38.591	204	.964	1.487	1.397	38.419
404	1.733	1.454	1.131	40.000	304	1.314	1.442	1.397	39.205
404					404	1.670	1.402	1.397	40.000
5	.703	2.484	1.150	35.942	5	.813	1.885	1.399	37.367
5			1.913	16.667	5			2.187	17.512
5*	.934	2.379	1.148	36.552	5*	.934	1.867	1.400	37.579
305	1.134	2.288	1.146	37.079	205	1.002	1.857	1.401	37.699
405	1.597	2.085	1.142	38.343	305	1.347	1.810	1.400	38.455
505	2.189	1.837	1.138	40.000	405	1.698	1.766	1.399	39.221
505					505	2.056	1.726	1.400	40.000
6	.863	2.951	1.159	35.386	6	.978	2.239	1.405	36.911
6			1.917	16.179	6			2.190	17.126
306	1.054	2.865	1.157	35.867	6*	1.099	2.221	1.406	37.116
406	1.500	2.667	1.153	37.014	206	1.046	2.229	1.405	37.026
506	2.069	2.424	1.147	38.517	306	1.385	2.179	1.403	37.754
606	2.621	2.199	1.144	40.000	406	1.731	2.132	1.402	38.492
606					506	2.084	2.089	1.402	39.243
7	1.006	3.356	1.167	34.939	606	2.443	2.050	1.402	40.000
7			1.920	15.780	7	1.148	2.595	1.410	36.480
7*	1.238	3.253	1.164	35.508	7			2.193	16.757
407	1.438	3.153	1.162	36.000	7*	1.269	2.577	1.409	36.743
507	1.989	2.925	1.156	37.389	307	1.430	2.552	1.408	37.094
607	2.524	2.703	1.152	38.761	407	1.770	2.503	1.406	37.805
707	2.999	2.516	1.149	40.000	507	2.118	2.457	1.405	38.530
707					607	2.471	2.415	1.404	39.260
8	1.188	3.850	1.174	34.443	707	2.831	2.376	1.404	40.000
8			1.925	15.319	8	1.322	2.952	1.413	36.135
408	1.381	3.765	1.172	34.895	8			2.196	16.405
508	1.911	3.533	1.166	36.162	308	1.480	2.927	1.412	36.475
608	2.427	3.315	1.161	37.413	408	1.815	2.876	1.409	37.160
708	2.885	3.130	1.158	38.545	508	2.158	2.828	1.408	37.859
808	3.463	2.906	1.155	40.000	608	2.506	2.782	1.407	38.565
808									
9	1.350	4.276	1.181	34.046					
9			1.929	14.944					
9*	1.582	4.173	1.178	34.579					

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 2.4431$ $20^\circ - 40^\circ$ $M_0^1 = 2.8387$

P	X	Y	M	θ°	P	X	Y	M	θ°
509	1.864	4.049	1.175	35.225	708	2.860	2.740	1.406	39.279
609	2.365	3.835	1.169	35.387	808	3.220	2.702	1.406	40.000
709	2.809	3.652	1.165	37.438					
809	3.371	3.429	1.161	38.790	9	1.553	3.415	1.416	35.722
909	3.864	3.242	1.158	40.000	9			2.201	15.969
					9*	1.673	3.396	1.415	35.962
10	1.553	4.791	1.188	33.605	409	1.880	3.362	1.414	36.376
10			1.935	14.513	509	2.216	3.311	1.412	37.044
510	1.825	4.672	1.184	34.203	609	2.557	3.263	1.410	37.719
610	2.308	4.463	1.179	35.270	709	2.905	3.218	1.409	38.402
710	2.737	4.283	1.17	35.234	809	3.259	3.175	1.408	39.093
810	3.279	4.063	1.17	37.473	909	3.725	3.125	1.408	40.000
910	3.756	3.877	1.166	38.584					
1010	4.355	3.554	1.163	40.000	10	1.733	3.772	1.419	35.415
					10			2.205	15.649
11	1.802	5.400	1.195	33.126	10*	1.853	3.752	1.418	35.651
11			1.941	14.031	410	1.937	3.738	1.418	35.816
11*	2.034	5.298	1.192	33.613	510	2.268	3.686	1.415	36.461
611	2.266	5.197	1.190	34.099	610	2.604	3.636	1.413	37.113
711	2.678	5.021	1.185	34.976	710	2.947	3.588	1.412	37.774
811	3.198	4.805	1.180	36.101	810	3.296	3.543	1.411	38.442
911	3.656	4.622	1.176	37.109	910	3.755	3.489	1.410	39.321
1011	4.233	4.398	1.171	38.396	1010	4.114	3.452	1.410	40.000
1111	4.934	4.140	1.167	40.000					
					11	1.916	4.129	1.422	35.126
12	2.028	5.935	1.201	32.736	11			2.209	15.342
12			1.947	13.630	11*	2.037	4.109	1.421	35.359
612	2.252	5.838	1.199	33.189	411	1.999	4.115	1.421	35.286
712	2.650	5.666	1.194	34.001	511	2.324	4.061	1.419	35.911
812	3.152	5.454	1.189	35.040	611	2.655	4.009	1.417	36.541
912	3.595	5.273	1.184	35.970	711	2.993	3.959	1.415	37.181
1012	4.152	5.052	1.179	37.157	811	3.337	3.912	1.413	37.828
1112	4.830	4.794	1.174	38.636	911	3.790	3.855	1.412	38.679
1212	5.448	4.572	1.170	40.000	1011	4.145	3.815	1.411	39.337
					1111	4.504	3.779	1.411	40.000
13	2.255	6.460	1.207	32.382					
13			1.954	13.252	12	2.102	4.486	1.424	34.856
13*	2.487	6.358	1.204	32.839	12			2.213	15.044
713	2.640	6.292	1.203	33.140	12*	2.223	4.465	1.423	35.082
813	3.127	6.084	1.197	34.107	512	2.386	4.437	1.422	35.390
913	3.556	5.906	1.192	34.971	612	2.712	4.384	1.420	36.001
1013	4.095	5.688	1.187	36.072	712	3.045	4.332	1.418	36.621
1113	4.751	5.432	1.181	37.442	812	3.383	4.283	1.416	37.247
1213	5.351	5.208	1.176	38.708	912	3.830	4.223	1.414	38.072
1313	5.952	4.995	1.173	40.000	1012	4.180	4.180	1.413	38.710
					1112	4.534	4.141	1.413	39.353
14	2.499	7.009	1.212	32.040	1212	4.893	4.105	1.413	40.000
14			1.960	12.871					
14*	2.731	6.908	1.210	32.482	13	2.791	4.842	1.427	34.599
714	2.647	6.945	1.211	32.322	13			2.218	14.757
814	3.118	6.741	1.205	33.223	13*	2.411	4.821	1.426	34.822
914	3.533	6.567	1.201	34.027	513	2.452	4.814	1.425	34.897
1014	4.054	6.352	1.195	35.048	613	2.773	4.759	1.423	35.490
1114	4.689	6.099	1.188	36.318	713	3.101	4.706	1.421	36.090

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 2.4431$ $20^\circ - 40^\circ$ $M_0 = 2.8387$

P	X	Y	M	θ°	P	X	Y	M	θ°
1214	5.269	5.876	1.183	37.491	813	3.435	4.656	1.419	36.698
1314	5.853	5.661	1.179	38.689	913	3.875	4.593	1.417	37.497
1414	6.483	5.440	1.176	40.000	1012	4.221	4.548	1.415	38.116
					1113	4.570	4.506	1.415	38.741
15	2.752	7.565	1.217	31.719	1213	4.924	4.467	1.414	39.369
15			1.967	12.499	1313	5.282	4.432	1.414	40.000
15*	2.984	7.463	1.214	32.150					
815	3.126	7.402	1.213	32.413	14	2.482	5.198	1.429	34.357
915	3.528	7.230	1.208	33.164	14			2.223	14.478
1015	4.033	7.019	1.203	34.116	14*	2.602	5.177	1.428	34.577
1115	4.646	6.769	1.196	35.296	514	2.522	5.191	1.429	34.430
1215	5.208	6.549	1.190	36.386	614	2.838	5.135	1.426	35.005
1315	5.774	6.334	1.186	37.499	714	3.161	5.081	1.424	35.588
1415	6.386	6.111	1.181	38.718	814	3.490	5.029	1.422	36.177
1515	7.021	5.891	1.178	40.000	914	3.925	4.963	1.419	36.953
					1014	4.265	4.916	1.418	37.554
16	3.012	8.124	1.221	31.422	1114	4.610	4.872	1.417	38.160
16			1.975	12.133	1214	4.960	4.831	1.415	38.770
16*	3.245	8.023	1.219	31.840	1314	5.313	4.793	1.415	39.383
816	3.150	8.064	1.220	31.669	1414	5.670	4.758	1.415	40.000
916	3.539	7.896	1.215	32.373					
1016	4.029	7.688	1.210	33.264	15	2.675	5.553	1.431	34.130
1116	4.622	7.443	1.203	34.366	15			2.227	14.207
1216	5.167	7.224	1.198	35.381	15*	2.795	5.532	1.430	34.344
1316	5.715	7.012	1.193	36.417	615	2.908	5.512	1.429	34.545
1416	6.308	6.789	1.188	37.552	715	3.226	5.456	1.427	35.111
1516	6.925	6.567	1.183	38.747	815	3.550	5.402	1.424	35.683
1616	7.565	6.347	1.180	40.000	915	3.978	5.335	1.422	36.436
					1015	4.315	5.287	1.420	37.020
17	3.280	8.687	1.225	31.144	1115	4.655	5.240	1.419	37.609
17			1.982	11.771	1215	5.000	5.197	1.418	38.202
917	3.566	8.563	1.222	31.645	1315	5.349	5.156	1.417	38.798
1017	4.040	8.359	1.217	32.482	1415	5.702	5.118	1.417	39.398
1117	4.616	8.117	1.210	33.515	1515	6.059	5.084	1.417	40.000
1217	5.143	7.901	1.205	34.465					
1317	5.674	7.690	1.199	35.433	16	2.870	5.908	1.433	33.912
1417	6.250	7.469	1.194	36.491	16			2.232	13.943
1517	6.849	7.246	1.189	37.607	616	2.981	5.888	1.432	34.108
1617	7.471	7.025	1.185	38.777	716	3.295	5.832	1.429	34.658
1717	8.112	6.807	1.182	40.000	816	3.614	5.777	1.427	35.214
					916	4.037	5.708	1.424	35.946
18	3.614	9.375	1.229	30.832	1016	4.368	5.657	1.422	36.514
18			1.992	11.336	1116	4.704	5.609	1.421	37.086
18*	3.847	9.273	1.227	31.228	1216	5.045	5.564	1.420	37.662
1018	4.072	9.175	1.224	31.611	1316	5.390	5.520	1.419	38.242
1118	4.626	8.938	1.218	32.571	1416	5.738	5.480	1.418	38.826
1218	5.135	8.725	1.212	33.451	1516	6.091	5.443	1.418	39.412
1318	5.647	8.517	1.207	34.345	1616	6.446	5.409	1.418	40.000
1418	6.201	8.298	1.202	35.323					
1518	6.779	8.076	1.197	36.351	17	3.053	6.237	1.435	33.722
1618	7.379	7.854	1.192	37.430	17			2.237	13.703
1718	8.000	7.633	1.188	38.559	17*	3.172	6.215	1.434	33.930
					717	3.362	6.180	1.432	34.258
19	3.895	9.942	1.232	30.595	817	3.678	6.124	1.430	34.800

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 2.4431$ $20^\circ - 40^\circ$ $M_0^1 = 2.8387$

P	X	Y	M	θ°	F	X	Y	M	θ°
19			2.001	10.978	917	4.094	6.053	1.427	35.514
1019	4.114	9.846	1.229	30.959	1017	4.422	6.001	1.425	36.067
1119	4.652	9.612	1.223	31.866	1117	4.754	5.952	1.423	36.624
1219	5.146	9.403	1.218	32.696	1217	5.090	5.904	1.422	37.186
1319	5.643	9.197	1.213	33.538	1317	5.431	5.859	1.420	37.751
1419	6.182	8.980	1.208	34.457	1417	5.776	5.817	1.419	38.320
1519	6.743	8.760	1.203	35.422	1517	6.124	5.777	1.419	38.892
					1617	6.476	5.741	1.419	39.466
20	4.165	10.478	1.234	30.386	1717	6.805	5.710	1.419	40.000
20			2.010	10.638					
20*	4.398	10.375	1.231	30.768	18	3.251	6.590	1.436	33.527
1120	4.689	10.247	1.228	31.248	18			2.242	13.450
1220	5.170	10.040	1.223	32.037	18*	3.371	6.568	1.435	33.732
1320	5.654	9.827	1.218	32.835	718	3.438	6.555	1.435	33.847
1420	6.178	9.621	1.213	33.705	818	3.749	6.498	1.432	34.375
					918	4.160	6.427	1.429	35.069
21	4.455	11.043	1.215	30.184	1018	4.483	6.373	1.427	35.607
21			2.019	10.277	1118	4.810	6.322	1.425	36.150
1221	5.207	10.711	1.227	31.389	1218	5.142	6.273	1.424	36.697
					1318	5.479	6.226	1.422	37.247
					1418	5.820	6.182	1.421	37.801
					1518	6.164	6.140	1.420	38.358
					1618	6.512	6.101	1.420	38.917
					1718	6.837	6.068	1.420	39.438
					1818	7.192	6.035	1.420	40.000
					19	3.451	6.943	1.438	33.343
					19			2.247	13.200
					19*	3.571	6.920	1.437	33.546
					719	3.518	6.930	1.437	33.455
					819	3.824	6.872	1.434	33.969
					919	4.229	6.799	1.431	34.646
					1019	4.548	6.745	1.429	35.170
					1119	4.871	6.693	1.427	35.698
					1219	5.199	6.642	1.426	36.231
					1319	5.531	6.593	1.424	36.767
					1419	5.868	6.547	1.423	37.307
					1519	6.208	6.503	1.422	37.849
					1619	6.552	6.462	1.421	38.394
					1719	6.874	6.426	1.421	38.902
					1819	7.224	6.390	1.420	39.450
					1919	7.577	6.358	1.421	40.000
					20	3.653	7.294	1.439	33.170
					20			2.253	12.954
					20*	3.773	7.271	1.438	33.368
					820	3.902	7.246	1.437	33.583
					920	4.302	7.172	1.433	34.242
					1020	4.616	7.117	1.431	34.753
					1120	4.935	7.063	1.429	35.268
					1220	5.259	7.011	1.428	35.787
					1320	5.587	6.961	1.426	36.310
					1420	5.919	6.913	1.425	36.836
					1520	6.256	6.867	1.424	37.365

TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0^1 = 2.4431$

$20^\circ - 40^\circ$

$M_0^1 = 2.8357$

P	X	Y	M	θ°	P	X	Y	M	θ°
					1620	6.596	6.824	1.423	37.896
					1720	6.914	6.786	1.422	38.391
					1920	7.577	6.354	1.421	39.994
					21	3.856	7.644	1.440	33.004
					21			2.259	12.710
					821	3.984	7.620	1.439	33.214
					921	4.378	7.544	1.436	33.857
					1021	4.688	7.488	1.433	34.356
					1121	5.003	7.433	1.431	34.858
					1221	5.322	7.380	1.430	35.364
					1321	5.646	7.229	1.428	35.874
					1421	5.975	7.279	1.427	36.387
					1521	6.307	7.232	1.425	36.903
					1621	6.643	7.186	1.424	37.422
					22	4.074	8.017	1.441	32.838
					22			2.265	12.453
					22*	4.193	7.994	1.440	33.031
					922	4.462	7.941	1.438	33.465
					1022	4.768	7.884	1.435	33.951
					1122	5.078	7.828	1.433	34.441
					1222	5.393	7.773	1.431	34.934
					1322	5.713	7.720	1.430	35.431
					1422	6.037	7.669	1.428	35.931
					1522	6.365	7.620	1.427	36.434
					23	4.279	8.365	1.442	32.691
					23			2.271	12.213
					23*	4.399	8.341	1.441	32.883
					923	4.544	8.312	1.439	33.115
					1023	4.846	8.254	1.437	33.590
					1123	5.152	8.197	1.435	34.068
					1223	5.463	8.142	1.433	34.550
					1323	5.779	8.088	1.432	35.036
					24	4.485	8.711	1.442	32.553
					24			2.278	11.974
					924	4.628	8.682	1.441	32.781
					1024	4.926	8.623	1.439	33.245
					1124	5.229	8.566	1.437	33.713
					1224	5.536	8.509	1.435	34.184
					25	4.732	9.122	1.442	32.399
					25			2.286	11.688
					1025	5.025	9.062	1.440	32.851

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0 = 3.3694$

$20^\circ - 40^\circ$

$M_0 = 4.1538$

P	X	y	M	θ°	P	X	y	M	θ°
101	.600	0.503	1.661	40.000	101	.383	0.321	1.970	40.000
2	.474	0.880	1.652	39.017	2	.267	0.422	1.962	39.584
2			2.522	18.799	2			2.964	19.425
2*	.560	0.883	1.655	39.105	2*	.348	0.435	1.965	39.665
102	.688	0.887	1.660	39.236	102	.428	0.448	1.968	39.747
202	1.075	0.902	1.663	40.000	202	.559	0.469	1.969	40.000
3	.627	1.158	1.658	38.589	3	.439	0.689	1.965	39.200
3			2.524	18.457	3			2.965	19.086
3*	.713	1.160	1.660	38.674	103	.518	0.701	1.968	39.279
103	.755	1.162	1.662	38.717	203	.648	0.721	1.968	39.527
203	1.137	1.173	1.663	39.462	303	.908	0.762	1.968	40.000
303	1.412	1.185	1.664	40.000					
4	.783	1.436	1.663	38.183	4	.611	0.953	1.969	38.838
4			2.526	18.131	4			2.967	18.765
4*	.869	1.438	1.665	38.265	4*	.692	0.965	1.968	38.992
104	.826	1.437	1.664	38.223	204	.739	0.972	1.968	39.082
204	1.203	1.446	1.664	38.952	304	.996	1.011	1.967	39.546
304	1.475	1.455	1.664	39.477	404	1.253	1.051	1.968	40.000
404	1.749	1.467	1.664	40.000					
5	.942	1.715	1.668	37.795	5	.786	1.219	1.968	38.570
5			2.529	17.819	5			2.969	18.457
5*	1.028	1.716	1.668	37.969	5*	.867	1.230	1.968	38.723
205	1.272	1.720	1.665	38.466	205	.833	1.225	1.968	38.659
305	1.541	1.728	1.665	38.980	305	1.087	1.261	1.967	39.115
405	1.811	1.737	1.665	39.491	405	1.341	1.300	1.967	39.561
505	2.085	1.750	1.665	40.000	505	1.597	1.340	1.967	40.000
6	1.103	1.993	1.669	37.519	6	.962	1.483	1.967	38.321
6			2.531	17.519	6			2.972	18.162
6*	1.188	1.994	1.668	37.691	6*	1.043	1.494	1.967	38.463
206	1.344	1.996	1.667	38.005	306	1.180	1.513	1.967	38.706
306	1.609	2.001	1.666	38.507	406	1.431	1.549	1.966	39.144
406	1.877	2.009	1.665	39.007	506	1.684	1.587	1.966	39.576
506	2.148	2.019	1.665	39.505	606	1.940	1.627	1.967	40.000
606	2.421	2.031	1.666	40.000					
7	1.265	2.271	1.670	37.259	7	1.140	1.747	1.967	38.079
7			2.534	17.231	7			2.975	17.879
7*	1.350	2.271	1.669	37.430	7*	1.220	1.757	1.967	38.220
207	1.419	2.272	1.669	37.567	307	1.275	1.765	1.967	38.317
307	1.681	2.275	1.667	38.058	407	1.523	1.798	1.966	38.748
407	1.945	2.281	1.667	38.547	507	1.774	1.835	1.966	39.172
507	2.213	2.289	1.666	39.035	607	2.026	1.873	1.966	39.590
607	2.483	2.299	1.666	39.519	707	2.280	1.913	1.967	40.000
707	2.755	2.311	1.666	40.000					
8	1.428	2.548	1.671	37.015	8	1.318	2.010	1.967	37.852
8			2.537	16.955	8			2.978	17.607
8*	1.514	2.548	1.670	37.185	8*	1.398	2.020	1.966	37.993
208	1.496	2.548	1.670	37.149	308	1.372	2.017	1.967	37.947
					408	1.617	2.048	1.966	38.371
					508	1.865	2.082	1.965	38.788
					608	2.115	2.118	1.965	39.199
					708	2.366	2.156	1.966	39.603

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 3.3694$ $20^\circ - 40^\circ$ $M_0 = 4.1538$

P	X	Y	M	θ	P	X	Y	M	θ
308	1.755	2.550	1.669	37.630	808	2.617	2.196	1.967	40.000
408	2.016	2.553	1.668	38.109	9	1.497	2.271	1.966	37.640
508	2.281	2.559	1.667	38.586	9			2.982	17.344
608	2.548	2.567	1.667	39.060	9*	1.578	2.281	1.966	37.778
708	2.817	2.578	1.667	39.532	409	1.713	2.298	1.966	38.011
808	3.087	2.590	1.667	40.000	309	1.959	2.330	1.965	38.422
9	1.593	2.824	1.671	36.786	609	2.205	2.364	1.965	38.826
9			2.540	16.688	709	2.453	2.400	1.965	39.223
9*	1.679	2.824	1.671	36.943	809	2.703	2.438	1.966	39.615
309	1.831	2.824	1.670	37.222	909	2.953	2.478	1.967	40.000
409	2.089	2.826	1.669	37.691	10	1.677	2.532	1.966	37.438
509	2.351	2.830	1.668	38.158	10			2.985	17.090
609	2.615	2.836	1.668	38.623	10*	1.758	2.542	1.966	37.576
709	2.881	2.844	1.667	39.085	410	1.812	2.549	1.966	37.668
809	3.149	2.855	1.667	39.544	510	2.054	2.579	1.965	38.073
909	3.417	2.867	1.668	40.000	610	2.298	2.611	1.965	38.470
10	1.759	3.099	1.672	36.559	710	2.543	2.645	1.965	38.862
10			2.544	16.430	810	2.790	2.680	1.965	39.247
10*	1.845	3.099	1.672	36.714	910	3.038	2.718	1.966	39.626
310	1.910	3.099	1.671	36.832	1010	3.287	2.758	1.967	40.000
410	2.165	3.099	1.670	37.292	11	1.858	2.792	1.966	37.250
510	2.424	3.102	1.669	37.750	11			2.989	16.843
610	2.685	3.106	1.668	38.206	11*	1.939	2.802	1.965	37.387
710	2.948	3.112	1.668	38.659	411	1.911	2.799	1.965	37.340
810	3.213	3.121	1.668	39.109	511	2.151	2.827	1.965	37.739
910	3.479	3.131	1.668	39.556	611	2.392	2.857	1.964	38.130
1010	3.747	3.144	1.668	40.000	711	2.635	2.889	1.964	38.516
11	1.927	3.374	1.673	36.344	811	2.879	2.923	1.964	38.895
11			2.547	16.180	911	3.124	2.959	1.965	39.269
11*	2.012	3.373	1.673	36.499	1011	3.371	2.997	1.965	39.637
311	1.991	3.374	1.673	36.460	1111	3.618	3.036	1.967	40.000
411	2.243	3.373	1.671	36.911	12	2.040	3.052	1.965	37.073
511	2.499	3.373	1.670	37.360	12			2.994	16.603
611	2.758	3.376	1.669	37.807	12*	2.121	3.061	1.965	37.206
711	3.018	3.380	1.669	38.251	512	2.250	3.075	1.964	37.419
811	3.280	3.387	1.668	38.692	612	2.488	3.104	1.964	37.805
911	3.543	3.396	1.668	39.131	712	2.728	3.134	1.964	38.185
1011	3.808	3.406	1.668	39.567	812	2.970	3.166	1.964	38.559
1111	4.075	3.419	1.669	40.000	912	3.213	3.200	1.964	38.927
12	2.095	3.648	1.674	36.142	1012	3.457	3.236	1.965	39.290
12			2.551	15.938	1112	3.702	3.273	1.965	39.648
12*	2.181	3.647	1.674	36.293	1212	3.948	3.313	1.967	40.000
412	2.323	3.646	1.673	36.546	13	2.222	3.310	1.964	36.903
512	2.576	3.645	1.671	36.987	13			2.998	16.370
612	2.832	3.646	1.670	37.425	13*	2.303	3.319	1.964	37.035
712	3.089	3.649	1.670	37.861	513	2.350	3.324	1.964	37.113
812	3.348	3.654	1.669	38.294	613	2.586	3.351	1.963	37.493
912	3.609	3.661	1.669	38.724	713	2.824	3.379	1.963	37.868
1012	3.872	3.669	1.669	39.152	813	3.063	3.410	1.963	38.236
1112	4.136	3.680	1.669	39.578					

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 3.3694$ $20^\circ - 40^\circ$ $M_0 = 4.1538$

P	X	Y	M	θ°	P	X	Y	M	θ°
1212	4.401	3.693	1.669	40.000	913	3.303	3.442	1.963	38.600
13	2.264	3.921	1.675	35.949	1013	3.545	3.476	1.964	38.957
13			2.555	15.702	1113	3.787	3.511	1.965	39.310
13*	2.350	3.920	1.674	36.099	1213	4.031	3.549	1.965	39.658
413	2.406	3.919	1.674	36.197	1313	4.276	3.588	1.967	40.000
513	2.656	3.917	1.673	36.629	14	2.405	3.567	1.964	36.743
613	2.909	3.917	1.671	37.059	14			3.003	16.142
713	3.163	3.918	1.671	37.487	14*	2.486	3.575	1.964	36.875
813	3.420	3.921	1.670	37.912	514	2.451	3.572	1.964	36.819
913	3.678	3.926	1.669	38.335	614	2.685	3.597	1.963	37.194
1013	3.938	3.933	1.669	38.755	714	2.920	3.624	1.963	37.564
1113	4.199	3.942	1.669	39.173	814	3.157	3.653	1.963	37.927
1213	4.462	3.953	1.669	39.588	914	3.395	3.683	1.963	38.286
1313	4.727	3.966	1.670	40.000	1014	3.634	3.716	1.963	38.638
14	2.435	4.193	1.676	35.766	1114	3.875	3.749	1.964	38.986
14			2.559	15.472	1214	4.116	3.785	1.964	39.329
14*	2.520	4.192	1.675	35.915	1314	4.358	3.822	1.966	39.667
414	2.490	4.193	1.675	35.862	1414	4.601	3.861	1.967	40.000
514	2.737	4.189	1.674	36.287	15	2.588	3.823	1.963	36.593
614	2.987	4.187	1.673	36.709	15			3.008	15.918
714	3.239	4.187	1.672	37.129	15*	2.669	3.831	1.963	36.722
814	3.493	4.189	1.671	37.547	615	2.785	3.843	1.963	36.908
914	3.748	4.193	1.670	37.962	715	3.018	3.869	1.962	37.272
1014	4.006	4.198	1.670	38.374	815	3.252	3.896	1.962	37.631
1114	4.265	4.205	1.670	38.785	915	3.488	3.925	1.962	37.984
1214	4.525	4.214	1.670	39.193	1015	3.725	3.956	1.962	38.332
1314	4.787	4.225	1.670	39.598	1115	3.963	3.988	1.963	38.675
1414	5.051	4.238	1.671	40.000	1215	4.202	4.022	1.964	39.014
15	2.606	4.465	1.676	35.593	1315	4.443	4.057	1.965	39.347
15			2.563	15.248	1415	4.684	4.094	1.966	39.676
15*	2.691	4.463	1.676	35.739	1515	4.926	4.133	1.967	40.000
515	2.820	4.461	1.675	35.958	16	2.772	4.078	1.962	36.448
615	3.068	4.458	1.674	36.373	16			3.013	15.698
715	3.317	4.457	1.672	36.786	16*	2.852	4.086	1.962	36.577
815	3.568	4.457	1.672	37.196	616	2.887	4.090	1.962	36.632
915	3.821	4.459	1.671	37.604	716	3.117	4.114	1.962	36.992
1015	4.076	4.463	1.670	38.009	816	3.349	4.140	1.961	37.346
1115	4.333	4.468	1.670	38.412	916	3.582	4.167	1.961	37.694
1215	4.591	4.475	1.670	38.813	1016	3.817	4.196	1.962	38.038
1315	4.850	4.485	1.670	39.212	1116	4.053	4.227	1.962	38.377
1415	5.111	4.496	1.671	39.607	1216	4.290	4.259	1.963	38.711
1515	5.373	4.509	1.671	40.000	1316	4.529	4.293	1.964	39.040
16	2.778	4.735	1.677	35.427	1416	4.768	4.328	1.965	39.365
16			2.567	15.029	1516	5.007	4.365	1.966	39.685
16*	2.863	4.734	1.676	35.572	17	2.956	4.332	1.961	36.313
516	2.905	4.733	1.676	35.643	17			3.019	15.482
616	3.150	4.729	1.675	36.051	17*	3.036	4.340	1.961	36.441
716	3.397	4.726	1.673	36.456	617	2.990	4.335	1.961	36.367
816	3.645	4.725	1.672	36.859	717	3.218	4.358	1.961	36.722
916	3.896	4.725	1.672	37.260	817	3.447	4.383	1.961	37.072

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 3.3694$ $20^\circ - 40^\circ$ $M_0 = 4.1538$

P	X	y	M	θ°	P	X	y	M	θ°
1016	4.148	4.728	1.671	37.659	917	3.678	4.408	1.961	37.416
1116	4.402	4.732	1.671	38.055	1017	3.911	4.436	1.961	37.755
1216	4.658	4.737	1.670	38.449	1117	4.145	4.465	1.961	38.090
1316	4.915	4.745	1.670	38.841	1217	4.380	4.496	1.962	38.419
1416	5.174	4.754	1.671	39.230	1317	4.615	4.528	1.963	38.744
1516	5.434	4.765	1.671	39.616					
1616	5.695	4.778	1.672	40.000	18	3.140	4.585	1.960	36.185
					18			3.024	15.269
17	2.951	5.005	1.677	35.270	18*	3.221	4.593	1.960	36.310
17			2.572	14.813	718	3.320	4.602	1.960	36.462
17*	3.036	5.003	1.677	35.414	818	3.547	4.625	1.960	36.808
517	2.992	5.004	1.677	35.340	918	3.775	4.650	1.960	37.148
617	3.234	4.999	1.675	35.741	1018	4.006	4.676	1.960	37.483
717	3.478	4.995	1.674	36.139	1118	4.238	4.704	1.960	37.813
817	3.724	4.993	1.673	36.536	1218	4.471	4.733	1.961	38.139
917	3.972	4.992	1.672	36.930					
1017	4.222	4.993	1.672	37.322	19	3.324	4.837	1.959	36.061
1117	4.474	4.995	1.671	37.712	19			3.030	15.057
1217	4.727	5.000	1.671	38.099	719	3.422	4.846	1.959	36.212
1317	4.982	5.005	1.671	38.484	819	3.647	4.868	1.959	36.554
1417	5.238	5.013	1.671	38.867	919	3.874	4.891	1.959	36.890
1517	5.496	5.023	1.671	39.247	1019	4.102	4.915	1.959	37.221
1617	5.755	5.034	1.672	39.625	1119	4.332	4.942	1.959	37.547
1717	6.015	5.047	1.672	40.000					
					20	3.548	5.140	1.957	35.922
18	3.124	5.274	1.677	35.122	20			3.038	14.804
18			2.577	14.602	20*	3.628	5.147	1.957	36.044
18*	3.210	5.272	1.677	35.262	820	3.770	5.160	1.957	36.258
618	3.320	5.269	1.676	35.443	920	3.994	5.182	1.957	36.590
718	3.561	5.264	1.675	35.835	1020	4.219	5.205	1.958	36.916
818	3.805	5.260	1.674	36.225					
918	4.050	5.258	1.673	36.613	21	3.732	5.389	1.956	35.812
1018	4.298	5.258	1.672	36.998	21			3.044	14.595
1118	4.547	5.259	1.672	37.382					
1218	4.798	5.262	1.671	37.763					
1318	5.051	5.266	1.671	38.142					
1418	5.305	5.272	1.671	38.519					
1518	5.560	5.280	1.671	38.893					
1618	5.817	5.290	1.672	39.264					
1718	6.075	5.301	1.672	39.634					
1818	6.333	5.314	1.673	40.000					
19	3.298	5.541	1.678	34.978					
19			2.581	14.393					
619	3.407	5.538	1.677	35.156					
719	3.646	5.532	1.676	35.542					
819	3.887	5.528	1.675	35.926					
919	4.130	5.525	1.674	36.307					
1019	4.375	5.523	1.673	36.687					
1119	4.622	5.523	1.672	37.064					
1219	4.871	5.524	1.672	37.439					
1319	5.121	5.527	1.672	37.812					
1419	5.373	5.532	1.671	38.183					
1519	5.626	5.538	1.671	38.551					

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MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0^1 = 3.3694$ $20^\circ - 40^\circ$ $M_0^1 = 4.1538$

P	X	y	M	θ°	P	X	y	M	θ°
1619	5.681	5.546	1.672	38.917					
1819	6.333	5.313	1.673	39.997					
20	5.520	5.880	1.678	34.807					
20			2.588	14.133					
20*	3.605	5.877	1.677	34.944					
720	3.755	5.873	1.677	35.185					
820	3.993	5.867	1.675	35.561					
920	4.233	5.862	1.674	35.936					
1020	4.475	5.859	1.674	36.307					
1120	4.719	5.857	1.673	36.677					
1220	4.965	5.857	1.672	37.045					
1320	5.213	5.859	1.672	37.411					
1420	5.462	5.862	1.672	37.775					
1520	5.712	5.866	1.672	38.136					
21	3.695	6.145	1.678	34.678					
21			2.593	13.930					
21*	3.780	6.142	1.677	34.815					
721	3.843	6.140	1.677	34.916					
821	4.079	6.133	1.676	35.287					
921	4.316	6.128	1.675	35.655					
1021	4.556	6.124	1.674	36.021					
1121	4.798	6.121	1.673	36.386					
1221	5.041	6.120	1.673	36.748					
1321	5.287	6.120	1.672	37.108					
1421	5.534	6.121	1.672	37.466					
22	3.870	6.410	1.678	34.557					
22			2.598	13.728					
22*	3.956	6.407	1.677	34.693					
722	3.933	6.407	1.677	34.656					
822	4.166	6.400	1.676	35.021					
922	4.401	6.393	1.675	35.384					
1122	4.878	6.384	1.674	36.104					
1222	5.119	6.381	1.673	36.461					
1322	5.362	6.380	1.673	36.816					
23	4.046	6.673	1.678	34.441					
23			2.603	13.528					
23*	4.131	6.670	1.677	34.574					
823	4.254	6.665	1.676	34.765					
923	4.487	6.658	1.675	35.123					
1023	4.722	6.651	1.675	35.479					
1123	4.959	6.646	1.674	35.833					
24	4.222	6.935	1.677	34.329					
24			2.609	13.329					
24*	4.307	6.932	1.677	34.462					
824	4.343	6.930	1.677	34.517					
924	4.574	6.922	1.676	34.870					
1024	4.807	6.915	1.675	35.221					
25	4.398	7.196	1.677	34.223					

P	x	y	M	θ°
25			2.615	13.130
925	4.662	7.185	1.675	34.626

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TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0 = 2.0665$

$25^\circ - 35^\circ$

$M_0 = 2.3604$

P	X	Y	M	θ°	P	X	Y	M	θ°
101	.900	0.630	1.059	35.000	101	.600	0.420	1.313	35.000
2	.277	1.677	1.079	31.895	2	.311	0.950	1.310	33.515
2			1.469	22.077	2			1.669	23.383
2*	.566	1.467	1.079	32.749	2*	.443	0.912	1.313	33.745
102	.689	1.377	1.080	33.115	102	.641	0.854	1.317	34.089
202	1.331	0.932	1.087	35.000	202	1.057	0.740	1.320	35.000
3	.404	2.327	1.093	30.855	3	.516	1.534	1.318	32.530
3			1.473	21.159	3			1.672	22.525
3*	.695	2.121	1.093	31.623	3*	.647	1.495	1.321	32.744
103	.521	2.244	1.093	31.164	103	.712	1.475	1.322	32.849
203	1.147	1.806	1.097	32.794	203	1.119	1.356	1.323	33.694
303	1.891	1.324	1.094	35.000	303	1.705	1.194	1.323	35.000
4	.567	3.054	1.108	29.813	4	.737	2.130	1.327	31.630
4			1.479	20.243	4			1.675	21.738
4*	.861	2.851	1.109	30.485	4*	.868	2.089	1.329	31.829
204	1.006	2.750	1.110	30.817	104	.801	2.110	1.328	31.727
304	1.703	2.290	1.105	32.672	204	1.199	1.987	1.328	32.512
404	2.528	1.770	1.101	35.000	304	1.770	1.819	1.326	33.726
					404	2.366	1.657	1.325	35.000
5	.775	3.864	1.124	28.769	5	.975	2.736	1.335	30.804
5			1.486	19.338	5			1.680	21.012
5*	1.071	3.664	1.126	29.367	5*	1.106	2.694	1.335	31.062
205	.915	3.769	1.125	29.053	205	1.297	2.633	1.334	31.438
305	1.565	3.336	1.118	30.606	305	1.852	2.462	1.330	32.567
405	2.334	2.840	1.112	32.548	405	2.433	2.293	1.328	33.754
505	3.251	2.277	1.107	35.000	505	3.041	2.129	1.328	35.000
6	1.032	4.756	1.141	27.761	6	1.226	3.349	1.341	30.117
6			1.494	18.455	6			1.685	20.342
6*	1.330	4.560	1.136	28.439	6*	1.356	3.306	1.340	30.364
306	1.486	4.456	1.134	28.795	206	1.412	3.288	1.340	30.469
406	2.200	3.991	1.126	30.411	306	1.952	3.114	1.336	31.520
506	3.051	3.453	1.118	32.442	406	2.517	2.942	1.332	32.626
606	4.063	2.845	1.112	35.000	506	3.110	2.772	1.330	33.790
					606	3.725	2.608	1.330	35.000
7	1.328	5.701	1.152	26.957	7	1.489	3.966	1.347	29.491
7			1.503	17.621	7			1.691	19.722
7*	1.626	5.505	1.147	27.586	7*	1.620	3.923	1.346	29.728
307	1.472	5.606	1.149	27.261	207	1.543	3.948	1.347	29.589
407	2.136	5.171	1.141	28.623	307	2.068	3.774	1.342	30.571
507	2.926	4.665	1.132	30.319	407	2.618	3.600	1.338	31.604
607	3.866	4.083	1.123	32.444	507	3.196	3.425	1.334	32.691
707	4.934	3.455	1.118	35.000	607	3.795	3.255	1.333	33.824
					707	4.415	3.091	1.332	35.000
8	1.661	6.688	1.162	26.224	8	1.765	4.588	1.353	28.918
8			1.513	16.839	8			1.697	19.146
8*	1.960	6.493	1.158	26.780	8*	1.895	4.544	1.352	29.154
408	2.139	6.376	1.156	27.112	308	2.201	4.441	1.348	29.709
508	2.874	5.903	1.146	28.548					
608	3.747	5.353	1.136	30.328					
708	4.741	4.749	1.128	32.461					

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 2.0365$ $25^\circ - 35^\circ$ $M_0 = 2.3604$

P	X	Y	M	θ°	P	X	Y	M	θ°
808	5.860	4.103	1.122	35.000	408	2.736	4.265	1.343	30.676
9	2.036	7.720	1.174	25.523	508	3.298	4.089	1.339	31.692
9			1.523	16.102	608	3.883	3.914	1.336	32.754
9*	2.335	7.526	1.170	26.039	708	4.488	3.744	1.334	33.856
409	2.204	7.611	1.171	25.812	808	5.113	3.580	1.334	35.000
509	2.890	7.169	1.161	27.043	9	2.051	5.214	1.359	28.401
609	3.703	6.653	1.151	28.554	9			1.703	18.608
709	4.627	6.080	1.141	30.347	9*	2.181	5.169	1.357	28.630
809	5.669	5.456	1.132	32.473	309	2.348	5.112	1.355	28.924
909	6.842	4.791	1.126	35.000	409	2.869	4.936	1.350	29.831
10	2.451	8.793	1.185	24.881	509	3.416	4.759	1.345	30.785
10			1.534	15.403	609	3.986	4.532	1.341	31.780
10*	2.751	8.600	1.130	25.386	709	4.576	4.407	1.338	32.815
510	2.969	8.460	1.176	25.753	809	5.187	4.237	1.336	33.889
610	3.728	7.977	1.165	27.353	909	5.818	4.073	1.336	35.000
710	4.589	7.438	1.154	28.578	10	2.348	5.842	1.364	27.928
810	5.559	6.845	1.144	30.371	10			1.709	18.104
910	6.653	6.199	1.135	32.496	310	2.510	5.785	1.362	28.206
1010	7.876	5.515	1.129	35.000	410	3.017	5.610	1.356	29.059
11	2.902	9.899	1.194	24.318	510	3.549	5.433	1.351	29.957
11			1.546	14.740	610	4.104	5.254	1.346	30.891
11*	3.203	9.707	1.189	24.795	710	4.680	5.077	1.342	31.864
511	3.107	9.768	1.191	24.642	810	5.277	4.903	1.339	32.875
611	3.618	9.316	1.180	25.775	910	5.893	4.733	1.338	33.921
711	4.622	8.810	1.169	27.092	1010	6.526	4.570	1.337	35.000
811	5.527	8.250	1.157	28.624	11	2.726	6.615	1.371	27.400
911	6.547	7.634	1.147	30.424	11			1.717	17.527
1011	7.689	6.967	1.138	32.540	11*	2.856	6.570	1.369	27.611
1111	8.952	6.268	1.132	35.000	411	3.215	6.443	1.364	28.196
12	3.389	11.031	1.203	23.810	511	3.731	6.266	1.358	29.030
12			1.558	14.108	611	4.268	6.087	1.353	29.899
12*	3.690	10.839	1.198	24.262	711	4.826	5.908	1.348	30.803
612	3.966	10.664	1.194	24.676	811	5.405	5.730	1.344	31.742
712	4.720	10.188	1.182	25.828	911	6.004	5.555	1.341	32.714
812	5.567	9.661	1.171	27.156	1011	6.620	5.384	1.340	33.719
912	6.519	9.077	1.159	28.701	1111	7.400	5.182	1.338	35.000
1012	7.585	8.439	1.149	30.503	12	3.043	7.246	1.376	27.005
1112	8.768	7.756	1.140	32.594	12			1.724	17.085
1212	.064	7.047	1.134	35.000	12*	3.172	7.200	1.374	27.210
13	3.906	12.183	1.211	23.350	412	3.393	7.121	1.371	27.560
13			1.571	13.501	512	3.895	6.946	1.364	28.349
613	4.166	12.018	1.207	23.722	612	4.418	6.768	1.359	29.170
713	4.876	11.571	1.196	24.744	712	4.962	6.589	1.353	30.024
813	5.670	11.074	1.184	25.910	812	5.527	6.409	1.349	30.910
913	6.562	10.523	1.172	27.255	912	6.112	6.231	1.345	31.828
1013	7.559	9.917	1.161	28.808	1012	6.715	6.056	1.343	32.777
1213	.069	7.005	1.133	34.910	1112	7.478	5.847	1.340	33.988
14	4.383	13.205	1.218	22.986	1212	8.117	5.684	1.340	35.000
					13	3.368	7.877	1.381	26.641

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0 = 2.0665$

$25^\circ - 35^\circ$

$M_0 = 2.3604$

P	X	Y	M	θ°	P	X	Y	M	θ°
14			1.582	12.987	13			1.731	16.665
714	5.056	12.780	1.206	23.914	13*	3.497	7.831	1.379	26.841
814	5.810	12.308	1.195	24.957	413	3.582	7.800	1.377	26.974
					513	4.071	7.626	1.371	27.722
					613	4.581	7.449	1.365	28.500
					713	5.111	7.271	1.359	29.308
					813	5.663	7.091	1.354	30.146
					913	6.234	6.911	1.350	31.014
					1013	6.823	6.733	1.346	31.912
					1113	7.569	6.519	1.343	33.057
					1213	8.196	6.350	1.341	34.016
					1313	8.837	6.188	1.341	35.000
					14	3.700	8.503	1.385	26.306
					14			1.738	16.265
					14*	3.829	8.461	1.383	26.502
					414	3.783	8.478	1.384	26.432
					514	4.259	8.306	1.377	27.144
					614	4.756	8.131	1.371	27.882
					714	5.273	7.953	1.365	28.649
					814	5.811	7.773	1.359	29.443
					914	6.369	7.593	1.354	30.266
					1014	6.944	7.413	1.350	31.117
					1114	7.674	7.195	1.346	32.202
					1214	8.288	7.022	1.344	33.111
					1314	8.916	6.853	1.342	34.045
					1414	9.557	6.692	1.342	35.000
					15	4.038	9.138	1.390	25.997
					15			1.745	15.882
					15*	4.167	9.091	1.388	26.185
					515	4.457	8.985	1.383	26.609
					615	4.941	8.812	1.376	27.312
					715	5.446	8.635	1.370	28.041
					815	5.971	8.456	1.364	28.796
					915	6.516	8.276	1.359	29.577
					1015	7.078	8.095	1.355	30.385
					1115	7.791	7.875	1.350	31.415
					1215	8.392	7.698	1.347	32.278
					1415	9.556	6.682	1.342	34.982
					16	4.383	9.766	1.394	25.708
					16			1.752	15.514
					16*	4.512	9.718	1.392	25.893
					516	4.665	9.662	1.389	26.114
					616	5.138	9.491	1.382	26.784
					716	5.629	9.316	1.376	27.479
					816	6.142	9.138	1.370	28.199
					916	6.674	8.958	1.364	28.942
					1016	7.223	8.778	1.359	29.710
					1116	7.921	8.556	1.354	30.689
					17	4.733	10.292	1.398	25.442
					17			1.759	15.160

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_o^1 = 2.0665$ $25^\circ - 35^\circ$ $M_o^1 = 2.3604$

P	X	Y	M	θ°	P	X	Y	M	θ°
					517	4.882	10.336	1.395	25.653
					617	5.343	10.168	1.388	26.295
					717	5.823	9.995	1.382	26.959
					817	6.323	9.819	1.375	27.645
					917	6.843	9.640	1.369	28.354
					1017	7.380	9.459	1.364	29.086
					18	5.141	11.107	1.402	25.161
					18			1.767	14.768
					18*	5.270	11.059	1.400	25.337
					618	5.589	10.941	1.395	25.773
					718	6.055	10.771	1.388	26.404
					818	6.542	10.597	1.381	27.057
					918	7.048	10.419	1.375	27.730
					19	5.501	11.726	1.406	24.934
					19			1.775	14.438
					719	6.267	11.441	1.393	25.957

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0^1 = 2.7296$ $25^\circ - 35^\circ$ $M_0^1 = 3.2188$

P	X	Y	M	θ°	P	X	Y	M	θ°
101	.600	0.420	1.547	35.000	101	.600	0.420	1.803	35.000
2	.419	0.908	1.541	33.731	2	.396	0.695	1.795	34.199
2			1.903	23.562	2			2.180	23.951
2*	.539	0.894	1.544	33.926	2*	.499	0.696	1.798	34.299
102	.719	0.873	1.549	34.130	102	.708	0.697	1.803	34.500
202	1.177	0.824	1.550	35.000	202	1.001	0.701	1.803	35.000
3	.715	1.522	1.548	32.835	3	.719	1.241	1.800	33.402
3			1.906	22.723	3			2.182	23.221
3*	.835	1.506	1.551	32.961	3*	.822	1.241	1.802	33.496
103	.894	1.499	1.552	33.023	103	.926	1.240	1.805	33.591
203	1.341	1.443	1.552	33.840	203	1.212	1.240	1.804	34.067
303	1.963	1.375	1.551	35.000	303	1.777	1.244	1.803	35.000
4	1.028	2.142	1.556	31.971	4	1.053	1.790	1.806	32.680
4			1.910	21.961	4			2.186	22.556
4*	1.148	2.125	1.558	32.089	104	1.156	1.789	1.808	32.769
104	1.087	2.134	1.557	32.029	204	1.435	1.785	1.806	33.224
204	1.522	2.073	1.555	32.797	304	1.986	1.781	1.804	34.114
304	2.128	1.996	1.552	33.889	404	2.549	1.785	1.803	35.000
404	2.754	1.928	1.552	35.000					
5	1.357	2.768	1.564	31.186	5	1.398	2.342	1.812	32.020
5			1.916	21.265	5			2.191	21.946
5*	1.477	2.750	1.563	31.406	5*	1.501	2.339	1.811	32.185
205	1.720	2.714	1.560	31.854	205	1.670	2.335	1.810	32.455
305	2.310	2.631	1.556	32.883	305	2.200	2.325	1.806	33.307
405	2.920	2.554	1.553	33.932	405	2.759	2.321	1.804	34.155
505	3.551	2.487	1.553	35.000	505	3.322	2.326	1.803	35.000
6	1.696	3.395	1.568	30.580	6	1.750	2.891	1.815	31.499
6			1.921	20.627	6			2.196	21.385
6*	1.816	3.376	1.567	30.795	6*	1.853	2.888	1.814	31.660
206	1.932	3.357	1.565	31.005	206	1.915	2.885	1.813	31.758
306	2.507	3.269	1.560	31.978	306	2.440	2.870	1.809	32.575
406	3.102	3.187	1.556	32.970	406	2.978	2.861	1.805	33.388
506	3.717	3.111	1.554	33.280	506	3.530	2.858	1.803	34.198
506	4.348	3.044	1.554	35.000	606	4.089	2.863	1.803	35.000
7	2.045	4.021	1.573	30.037	7	2.108	3.438	1.812	31.027
7			1.927	20.041	7			2.202	20.866
7*	2.211	3.434	1.575	29.762	7*	2.211	3.434	1.817	31.186
207	2.158	4.002	1.571	30.236	207	2.169	3.436	1.818	31.122
307	2.717	3.910	1.565	31.159	307	2.682	3.415	1.812	31.906
407	3.297	3.823	1.560	32.099	407	3.207	3.401	1.808	32.687
507	3.898	3.741	1.557	33.057	507	3.747	3.392	1.805	33.466
607	4.514	3.667	1.555	34.024	607	4.295	3.391	1.803	34.236
707	5.142	3.601	1.554	35.000	707	4.850	3.396	1.803	35.000
8	2.384	4.616	1.577	29.569	8	2.472	3.983	1.822	30.600
8			1.934	19.523	8			2.208	20.383
8*	2.503	4.595	1.575	29.762	8*	2.574	3.978	1.820	30.755
308	2.929	4.521	1.570	30.448	308	2.931	3.961	1.816	31.294
408	3.495	4.431	1.565	31.343	408	3.445	3.942	1.811	32.045

TABLE VII
MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES
 $M_0 = 2.7296$ $25^\circ - 35^\circ$ $M_0 = 3.2188$

P	X	y	M	θ°	P	X	y	M	θ°
508	4.082	4.344	1.560	32.256	508	3.973	3.928	1.807	32.794
608	4.684	4.264	1.557	33.178	608	4.510	3.921	1.805	33.536
708	5.300	4.191	1.556	34.108	708	5.055	3.920	1.803	34.271
808	5.897	4.129	1.555	35.000	808	5.606	3.926	1.803	35.000
9	2.748	5.238	1.581	29.112	9	2.840	4.524	1.825	30.210
9			1.940	19.016	9			2.214	19.930
9*	2.867	5.217	1.580	29.300	9*	2.943	4.519	1.824	30.364
309	3.163	5.164	1.576	29.767	309	3.189	4.506	1.820	30.730
409	3.714	5.071	1.569	30.620	409	3.691	4.483	1.815	31.455
509	4.287	4.980	1.564	31.488	509	4.208	4.465	1.810	32.177
609	4.876	4.895	1.561	32.366	609	4.734	4.453	1.807	32.892
709	5.478	4.816	1.558	33.252	709	5.268	4.446	1.805	33.601
809	6.062	4.748	1.556	34.102	809	5.809	4.446	1.803	34.304
909	6.588	4.683	1.556	35.000	909	6.358	4.452	1.803	35.000
10	3.119	5.859	1.585	28.696	10	3.212	5.062	1.828	29.855
10			1.947	18.542	10			2.221	19.505
10*	3.238	5.837	1.584	28.881	10*	3.315	5.056	1.827	30.007
310	3.407	5.806	1.581	29.143	310	3.453	5.048	1.825	30.210
410	3.944	5.710	1.575	29.957	410	3.944	5.022	1.819	30.909
510	4.504	5.617	1.569	30.786	510	4.450	5.001	1.814	31.607
610	5.079	5.528	1.564	31.623	610	4.965	4.984	1.810	32.297
710	5.668	5.444	1.561	32.468	710	5.489	4.973	1.807	32.982
810	6.240	5.370	1.558	33.280	810	6.020	4.967	1.805	33.661
910	6.853	5.299	1.557	34.137	910	6.559	4.967	1.803	34.333
1010	7.477	5.235	1.557	35.000	1010	7.102	4.973	1.803	35.000
11	3.496	6.477	1.590	28.318	11	3.588	5.597	1.831	29.531
11			1.954	18.096	11			2.228	19.102
11*	3.615	6.454	1.588	28.500	311	3.723	5.588	1.829	29.728
311	3.660	6.446	1.587	28.570	411	4.203	5.560	1.823	30.405
411	4.185	6.349	1.580	29.348	511	4.698	5.535	1.817	31.080
511	4.731	6.253	1.574	30.141	611	5.203	5.514	1.813	31.747
611	5.293	6.161	1.569	30.941	711	5.716	5.499	1.809	32.409
711	5.868	6.073	1.564	31.749	811	6.238	5.488	1.806	33.065
811	6.429	5.995	1.561	32.525	911	6.767	5.483	1.804	33.716
911	7.030	5.918	1.559	33.345	1011	7.302	5.484	1.803	34.361
1011	7.641	5.847	1.558	34.170	1111	7.841	5.490	1.803	35.000
1111	8.261	5.785	1.557	35.000					
12	3.878	7.091	1.594	27.974	12	4.076	6.279	1.835	29.156
12			1.962	17.674	12			2.237	18.614
12*	3.997	7.068	1.592	26.153	12*	4.179	6.272	1.833	29.299
312	3.923	7.083	1.593	28.041	412	4.543	6.247	1.828	29.806
412	4.434	6.985	1.585	28.788	512	5.024	6.219	1.822	30.454
512	4.967	6.888	1.579	29.548	612	5.516	6.194	1.817	31.095
612	5.516	6.793	1.573	30.314	712	6.017	6.174	1.812	31.730
712	6.079	6.703	1.568	31.088	812	6.527	6.159	1.809	32.360
812	6.627	6.620	1.564	31.830	912	7.044	6.148	1.807	32.984
912	7.216	6.539	1.561	32.616	1112	7.539	5.484	1.803	34.990
1012	7.816	6.463	1.559	33.407					
1112	8.425	6.393	1.558	34.202	13	4.458	6.803	1.838	28.887
					13			2.244	18.254
13	4.265	7.702	1.597	27.660	13*	4.560	6.796	1.836	29.029

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

DAINGERFIELD, TEXAS

OFFICE

AEROPHYSICS

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TABLE VII

MACH NUMBER AND FLOW DIRECTION IN THE FIELDS AROUND DOUBLE-CONES

$M_0^I = 2.7296$

$25^\circ - 35^\circ$

$M_0^I = 3.2188$

P	X	y	M	θ°	P	X	y	M	θ°
13			1.969	17.272	413	4.814	6.778	1.832	29.380
13*	4.384	7.679	1.595	27.830	513	5.285	6.747	1.826	30.008
413	4.691	7.618	1.591	28.271	613	5.767	6.720	1.820	30.630
513	5.211	7.520	1.584	29.001	713	6.259	6.697	1.815	31.246
613	5.748	7.424	1.578	29.736					
713	6.299	7.331	1.572	30.478	14	4.840	7.324	1.840	28.640
813	6.836	7.246	1.568	31.191	14			2.252	17.908
913	7.413	7.160	1.564	31.944	14*	4.943	7.316	1.839	28.781
					414	5.089	7.305	1.836	28.981
14	4.656	8.309	1.601	27.367	514	5.550	7.273	1.830	29.592
14			1.977	16.889	614	6.023	7.243	1.824	30.196
14*	4.774	8.285	1.599	27.535					
414	4.956	8.249	1.596	27.792	15	5.224	7.839	1.843	28.413
514	5.464	8.150	1.589	28.494	15			2.259	17.572
614	5.988	8.053	1.582	29.202	515	5.818	7.793	1.833	29.202
714	6.527	7.958	1.577	29.915					
814	7.053	7.870	1.572	30.600					
15	5.050	8.911	1.604	27.098					
15			1.984	16.520					
15*	5.168	8.887	1.602	27.265					
415	5.227	8.875	1.601	27.347					
515	5.723	8.776	1.594	28.024					
615	6.236	8.678	1.587	28.706					
715	6.763	8.581	1.581	29.393					
16	5.446	9.508	1.608	26.853					
16			1.992	16.166					
516	5.988	9.397	1.599	27.586					

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