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REACTION OF THE FRENCH POPULATION TO THE SUPERSONIC BANG

Dr. J. Bremond

Translation of "Reaction des populations françaises au bang supersonique", Revue de Médecine Aéronautique et Spatiale, No. 51, 1974, presented at the S.F.P.M.A.C. meeting on June 21, 1974

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16. Abstract

This survey is a continuation of the first survey conducted in 1965 in the regions which are the most exposed to the supersonic bang. It was carried out in November 1970 with the purpose of answering the following questions: -How does the bang rank in today's pollution? -What type of annoyance is caused by the bang? Does this annoyance depend on socio-logical and psychological variables? -Is the perception of the bang objective? -Is the number of bangs heard over- or under-estimated? -Does the frequency of exposure to the bang have an influence on attitudes? -Does the sensitivity to or annoyance from the bang have a linear increase with the frequency?

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REACTION OF THE FRENCH POPULATION TO THE SUPERSONIC BANG

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ATTITUDES AND REACTIONS OF THE FRENCH POPULATION TOWARD THE SUPERSONIC BANG

Over the past decade, extensive research has been conducted to /208* evaluate the effects of the supersonic bang on man. Data collected up to the present tend to demonstrate that the bangs produced by military or commercial aircraft are not likely to have a harmful influence on man's anatomy or physiology.

It is an area, however, where a certain number of facts have been brought to light on psychological and psychosociological reactions, attitudes and opinions. Two surveys, important in their scope and results, have been conducted in France at five-year intervals by the Centre d'Etudes et de Recherches Psychologiques Air. This report is concerned with the second investigation conducted in November 1970.

Continuing the first survey carried out in 1965 in two regions of France, the South-West and North-East, which were the most exposed, a second investigation after an interval of several years was necessary, since several elements had modified the situation:

-military authorities had adopted measures to decrease the intensity of the bangs on the ground: flights over certain zones became strictly prohibited, the minimum altitude of flights was increased to 10,000 meters, implementation of radar control;

-a new geographical area became exposed to Concorde bangs during its experimental flights. The construction of this aircraft and its flights over France gave rise to a wide information campaign. A certain number of complaints for damage has already been lodged;

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*Numbers in the margin indicate pagination in the foreign text.

-when supersonic airplanes were put into service, new regions in France were exposed to the bangs of these civilian aircraft, whether or not they had already been exposed to bangs from military aircraft;

-it became possible to learn the itinerary and average frequency of supersonic flights in different zones, which was not the case in 1965.

1 - OBJECTIVES OF THE SURVEY

In addition to allowing for a comparison with the results obtained in 1965, the purpose of the survey was to answer the following questions:

-What position does the bang have in today's pollution?

-What type of annoyance is caused by the bang? Does this annoyance depend on sociological and psychological variables?

-Is the perception of the bang objective? Is the number of bangs heard over- or underestimated?

-Does the frequency of exposure to the bang have an influence on attitudes? Does the sensitivity to or annoyance from the bang have a linear increase with the frequency?

2 - ORGANIZATION OF THE SURVEY

Recordings of supersonic flights provided by authorities relating to the air regions over a period of three years, have made it possible to compute the average exposure per month per region and to distinguish five zones of exposure frequency from 0 to 10, from 11 to 30, from 31 to 60, from 61 to 90, over 90 bangs (in practice from 90 to 140).

The sampling of individuals to be interviewed was carried out by l'Institut d'Opinion Publique (IFOP-ETMAR) according to the quota technique, by controlling the variables of sex, age and professional category in order to obtaine a representative sampling of the French population, both on the general level and for the zones corresponding to the different frequencies of exposure.

The survey took place from November 11 to 16 on individuals 20 years of age and older living in the provinces, since flights over the Paris area are prohibited. Conducted by interviewers from the IFOP, the interviews lasted from 30 to 45 minutes and were generally well received. From a total of 3,992 interviews, 283 were conducted on individuals who had lodged a complaint for damage (out of 570) during the first nine months of 1970.

The questionnaire contained about 150 questions. In order to /209 avoid opinionated answers on the bang problem, and to gather valid opinions by interviewing only those who are directly concerned about the bang, the apparent theme of the survey was to gather information on environmental problems and ambient noise. The whole questionnaire with the section on the bang was given only to those individuals who actually hear the bang and identify it as such; the sorting was accomplished by three filter questions. Accordingly, a sampling of 2848 entirely processable interviews was conducted, to which we may add the 283 interviews of those who had lodged the formal complaints mentioned above.

3 - PERCEPTION OF THE BANG

3.1. Overall Impact of the Bang

Answers to the three filter questions make it possible to paint a general picture of the situation.

In addition to the 27% of people who spontaneously list the bang among the noises they hear, 15% also list it spontaneously when they are asked which noises from airplanes they hear. Furthermore, 35% say they hear the bangs when answering a direct question about the subject. Finally, 23% admit they never hear the bangs.

The French population theoretically concerned about the bangs is therefore not equally affected by them. If a quarter of the population mentions it spontaneously as a noise, another fourth of the population is completely unaware of it. Even though the other half hears the bang, it doesn't seem to be sensitive enough to spontaneously list it as a noise.

The answer breakdown to these three filter questions by bands of exposure frequency to supersonic flights shows that the overall impact varies with the frequency. The increasing percentage of answers to the first filter question, which corresponds to mentioning the bangs spontaneously, is particularly revealing in this respect, as is shown in the following table:

TABLE I

	Freq band 1 0-10	Freq band 2 11-30	Freq band 3 31-60	Freq band 4 61-90	Freq band 5 " 90	All bands
Spontaneously list the bang as an ambient noise	13 %	27 %	33 %	54 %	53 %	27 %
Total identifying the bang	58%	85 %	88 %	97 %	92 %	77 %

3.2. Rank of the Bang Among the Pollutions of Modern Life

We asked to show on a list of ten items which appeared to be the most pressing problems to solve. The ten items suggested were grouped into four levels of importance:

1. Cancer
2. Highway accidents
3. Air pollution
   Bangs from supersonic aircraft
   Throwing out wastes in nature
   Sea and river pollution
4. Noise
   Decline in open spaces
   Invasion by advertising
   Invasion of countryside and seaside by secondary homes.

The same classification is found among the protesters who lodged complaints, except for the item "throwing out wastes in nature", of which the shift from the third to the fourth level of importance may be explained by the special characteristics of this population.

The bang is therefore placed in third position, equal to air pollution after cancer and road accidents.

Let us point out that the first levels of importance are for pollutions, which are likely to directly affect health or life, whereas the bang belongs to a group having indirect and long-term effects.

4 - INVESTIGATION OF ATTITUDES FROM THE GENERAL POPULATION (exluding protesters)

A certain number of themes have been presented, each by a group of questions as different as possible within a semantic homogeneity:

-General satisfaction
-Annoyance from noise
-Sensitivity to noise
-Annoyance from the bang
-Sensitivity to the bang
-Acceptance of bangs from supersonic commercial aircraft
-Acceptance of bangs made by supersonic military aircraft

Each theme leads to the construction of an attitude scale. The technique used brings out the existence of a relevant attitude dimension by the consistency in the answers and the population distribution into favorable and unfavorable attitudes (intensity curve). Only the most salient results are given here.

4.1. Annoyance From the Bang - Sensitivity to the Bang

Two identical questions have been asked in order to evaluate the annoyance from noise and annoyance from the bang. The dimensions brought out by the attitude scales are very different in their contents.

Whereas the annoyance due to noise concerns numerous aspects of daily routine: work, sleep, conversation, radio or TV listening, etc., the annoyance due to the bang takes on another dimension: fear, irritation, startling. It is more a psychological or nervous reaction

than actual annoyance extending in time. The two effects, noise and the bang, do not produce the same stress, but they are relatively related in the attitudes they create (correlation at .23 between annoyance from noise and annoyance from the bang). /210

In order to compare these results with those of 1965, a wider dimension, including annoyance from the bang, has been defined by a bang sensitivity scale. It is virtually impossible to distinguish annoyance from the bang and sensitivity to the bang by two quite different scales, which is a good indication of how these aspects are intricately interrelated and how the psychological elements in the perception of the effect are predominant. It should be pointed out that this is not the case for noise, which has two distinct scales* (even though correlated at .36), the first one in terms of behavior, the second one in psychological terms.

For sensitivity to the bang, the shape of the intensity curve brings to light, compared to 1965, a more consistent attitude. Extreme opinions are expressed more strongly (49%). On the whole, half of the population declared it was relatively sensitive and the other half (51%) stated it was moderately sensitive or insensitive to the bang.

With respect to annoyance from the bang, the attitude intensity curve described in terms of behavior shows that 29% stated they were annoyed, whereas 71% stated they were not annoyed and were more firm in their opinions than the preceding ones.

The type of individuals who were the most annoyed (or the most sensitive) are the following: farmers, property owners, women, inhabitants of an agglomeration with a population of less than 20,000, people with income levels below 1,250 F per month, people older than 50 years.

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*The noise annoyance scale may even be considered as an ambient noise index, the objectivity of which is proven by British and French research showing an almost linear relationship between the declared annoyance and the actual ambient noise level.

If we compare these statements with the fact that political leaning, general environmental satisfaction and educational level do not play a role in this attitude and that the people interviewed did not overestimate, but rather tended to underestimate the number of bangs, we may conclude contrary to what was observed in 1965 that prejudices played only a small role in the opinion which the French currently exposed to the bang express about this problem.

4.2. Variation of Attitudes with Frequency of Exposure to the Bangs

The various attitudes have been examined according to the exposure frequency bands determined during the sampling.

4.2.1. It may be observed on figures 1 through 4 showing the sensitivity to noise, a coinciding increase in annoyance and exposure frequency (statistically significant differences). In other words, it appears that we are more annoyed by the bangs (or sensitive to the bangs) as they are more numerous. It is interesting to note, however, that annoyance does not deem to increase after a certain frequency, which is estimated at about 30 bangs per month. In fact, the largest significant statistical differences are found between the frequency band of 0 to 10 bangs per month and the others, which means we can talk about habit and familiarity, at least in the range of the 1 to 4 bangs per day which occur today in France.

With repsect to attitudes toward civilian or military supersonic aviation, we may note a favorable opinion trend, which coincides with the frequency of exposure. This result may be considered as another argument in favor of habit and familiarity.

4.22. Based on the attitude intensity curves, it is possible to calculate the percentage of individuals identifying the bang who say they are annoyed, then to relate it to the total French population sampling. We may in fact combine the people who identify the bang and say they are annoyed with those who identify the bang and those who do not hear it and do not identify it. We may thus establish the following table: (table 2).

TABLE 2

Monthly Exposure Frequency / Attitudes	0-10	11-30	31-60	61-90	+ 90
Annoy. From Bang (%)	13	25	36	30	23
Sensit. To Bang (%)	23	36	47	49	44

Accordingly, less than one person in seven from the French population is annoyed by the bangs in low exposure density regions, whereas this annoyance rises to one out of three in other regions.

4.3. Correlative Attitude Analysis

Computation of the correlations between different attitudes (table 3) makes it possible to make a few general remarks, analyze the overall structure (factors analysis), including sociological variables to allow for a more general interpretation.

First, it appears that the various attitudes evaluated are all independent from the general satisfaction of the environment. As in 1965, we may note a relatively positive relationship between the annoyance from noise and the sensitivity to noise on the one hand and the annoyance due to the bang and sensitivity to the bang on the other hand. This means that those who are the most annoyed by noise (and more sensitive) tend to be the most annoyed by the bang (or the most sensitive to the bang). There is, however, practically no relationship between these four attitudes and those expressed toward supersonic aviation, whether it is civilian or military.

Furthermore, attitudes toward commercial supersonic aviation and military supersonic aviation are highly related, since the people interviewed did not distinguish them with respect to the bangs produced and the limitations they were subjected to. Here again, it appears that the prejudices noted in 1965 are gone.

VARIATION OF ATTITUDES WITH FREQUENCY
OF EXPOSURE TO SUPERSONIC FLIGHTS

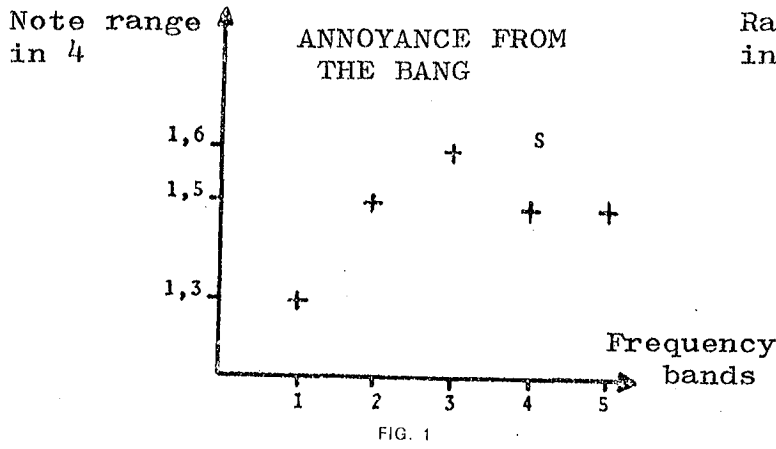


FIG. 1

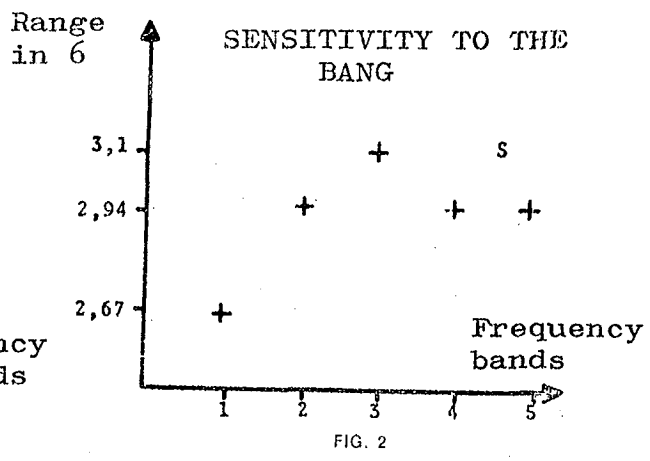


FIG. 2

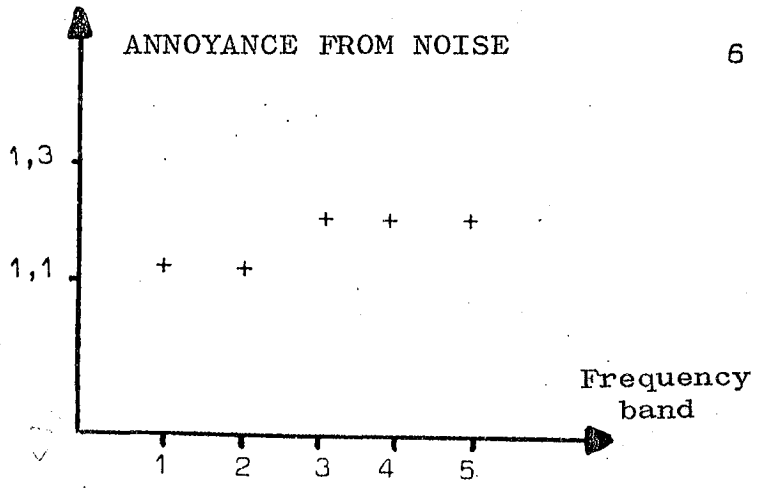


FIG. 3

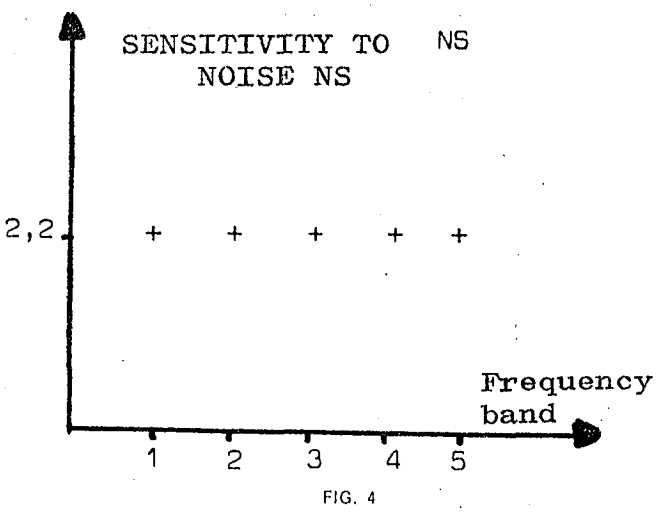


FIG. 4

4.4. Factors Analysis

Analysis of the correlations between the 16 most important variables has been performed by the centroid method. It brought to light a structure of three orthogonal factors.

FACTOR I: Annoyance and sensitivity to the bang. This is the most significant one. It alone accounts for 46% of the total variation; the strongest saturations correspond to reactions to the bang and to a smaller degree toward noise.

FACTOR II: Acceptance of bangs produced by supersonic aviation. This second factor accounts for 30% of the total variance. It

illustrates the acceptance of supersonic aviation development and to a certain degree its expansion into new areas; hence, acceptance of the bangs.

FACTOR III: Socio-ecologic factor. This third factor explains 24% of the total variance. It groups most of the objective variables introduced into this analysis, together with information on the bang and attitudes toward commercial supersonic aviation concerning its advantages in comparison with current aviation.

This analysis confirms the importance played by psychological factors in terms of sensitivity and annoyance in attitudes toward the bang. It also shows that the bang is considered as an actual noise.

The frequency of exposure to the bangs has no weight in the three factors determined, not more than environmental satisfaction.

Compared to the analysis performed in 1965 - in which the socio- /212
cultural factor hold first place and the ecological factor second position - the present analysis also confirms that the attitudes are not influenced by prejudices: the expression of an annoyance felt may therefore be accepted as a relatively objective value.

5 - THE PROTESTERS

The sociological characteristics of protesters is somewhat different from those of the population hearing the bang. Protesters have a higher educational level than the average of the general population interviewed; they are most often men (72%) over 45 years old (77%) or even more than 65 years old (31%), home owners (82%), living in rural communities (56%). They work as farm managers or small businessmen (40%) or no longer work (34%). They state they have a monthly income often exceeding 1,250 francs (45%) and vote for the government majority: UDR (23%); Independent Republicans (15%); (34% did not say how they vote).

TABLE 3

	Annoyance from Noise	Sensitivity to Noise	Annoyance from the Bang	Sensitivity to the Bang	Acceptance of Bangs Produced by Commercial Aviation	Acceptance of Bangs Produced by Military Aircraft
General Satisfaction with Environm.	.03	—.01	—.04	—.04	—.01	—.03
Annoyance from Noise	—.03	—.06	.26	.23	.36	
Noise Sensitivity	—.09	—.11	.29	.26		
Annoyance from Bangs	—.13	—.16	.91			
Sensitivity to Bangs	—.17	—.19				
Acceptance of Bangs Produced by Comm. Aircraft	.87					

Significant values: .19 at threshold of .05; .25 at threshold of .01

The damages declared during the investigation correspond to the statistics obtained elsewhere:

-broken glass 35%

-rattlings, cracks, splits (walls or ceilings): 30%

-collapses (roof, walls..) 23%

-various damages (falls of chandeliers, various objects) 10%

To submit a formel complaint, the protesters went to the gendarmery (54%), the town hall (15%), their insurance agent (11%), the airforce (8%) or other military organizations (4%). The steps to be followed seem rather simple or very simple to 67% of the protesters.

At the time of the survey, 39% of the complaints submitted still had not been decided upon by the administration, 31% had been rejected and 29% had been granted full or partial compensation, only 6% of the protesters said they were planning to file their complaint with the justice department.

A comparison of the attitudes of the protesters with those of the general population leads to the following observations: /213

The protesters do not have a different attitude toward satisfaction with the environment, their sensitivity to noise and supersonic aircraft.

On the other hand, their sensitivity to the bang is greater, the annoyance felt is stronger and probably because of this they do not accept as easily the bangs produced by military or commercial aircraft.

These overall facts seem coherent if we assume that the damages incurred have been felt as enough stimulus to create a particular attitude toward the bang. It should be pointed out that the survey conducted in 1965 emphasized the opposition between the protesters and the general population with respect to the type of annoyance felt based on material damages for the protesters and the effect of surprise for those who do not protest.

CONCLUSIONS

The opinion survey conducted in France in November 1970 seems to be the first one to have checked out as objectively as possible a factor considered important a priori - the frequency of exposure to

supersonic bangs - while the populations interviewed remain in the environment of their daily routine.

The results obtained appear to be particularly interesting by their consistency and may be summarized as follows.

Among the pollutions of modern life, the bang is considered as a problem of third importance after cancer and highway accidents, at the same level as air pollution and before noise pollution. Hence, it does not belong to the class of pollutions which are hazardous to life, but rather to those which have a long term risk, by a hypothetical type accumulative effect.

The semantics analysis of attitudes toward the bang by an appropriate technique (hierarchical analysis), has made it possible to provide an operative definition of the concept of annoyance based on the consistency of opinions gathered. Accordingly, the bang must be considered as different from noise with respect to the type of reactions it creates: its effects are mainly startling and irritating, even frightening and they do not interfere with daily activities. If the bang is considered as a noise, the annoyance it creates cannot be disassociated from its psychological repercussions, which is the opposite for noise, which results in quite different behavioral and sensitivity characteristics.

Control of the frequency of exposure to supersonic flights has made it possible to bring to light an increase in the declared annoyance with this frequency. This annoyance seems to reach a plateau quite fast, which ranges in the vicinity of 30 bangs per month. These results, however, are to be considered within a scope of observations which do not currently exceed 4 to 5 bangs per day. No conclusion may therefore be formulated for the highest exposure frequency moment. Taking these reservations into account, the percentage of people who stated they are more or less annoyed by the bang varies by 13% for the lowest exposure frequencies to 33% for the currently highest frequencies.

Finally, when the results of the 1970 survey are compared with those of 1965, a certain number of results are confirmed. A major difference appears, however, regarding the relative importance of socio-cultural variables in the attitudes toward the bang: ranked in first place in 1965, these variables now are placed third and represent only one fourth of all influences. Accordingly, it appears that preconceived ideas and prejudices toward the bang are distinctly declining, if not diappearing: in particular, attitudes are no longer tied to political leanings or environmental satisfaction and are less influenced by cultural or educational levels.

Regarding the essential problem of information, conclusions of the 1965 survey emphasize the necessity of gearing propaganda toward the cultural level "this is more necessary as the level is lower". It seems that on this point the public opinion of 1970 tends to become homogeneous because of radio and TV. If a distinguishing action no longer seems necessary, the results obtained until now by objective information is a stimulation to continue this effort: the situation seems more clear, attitudes toward the bang tend to take on their own dimension without interfering with those toward supersonic aviation.

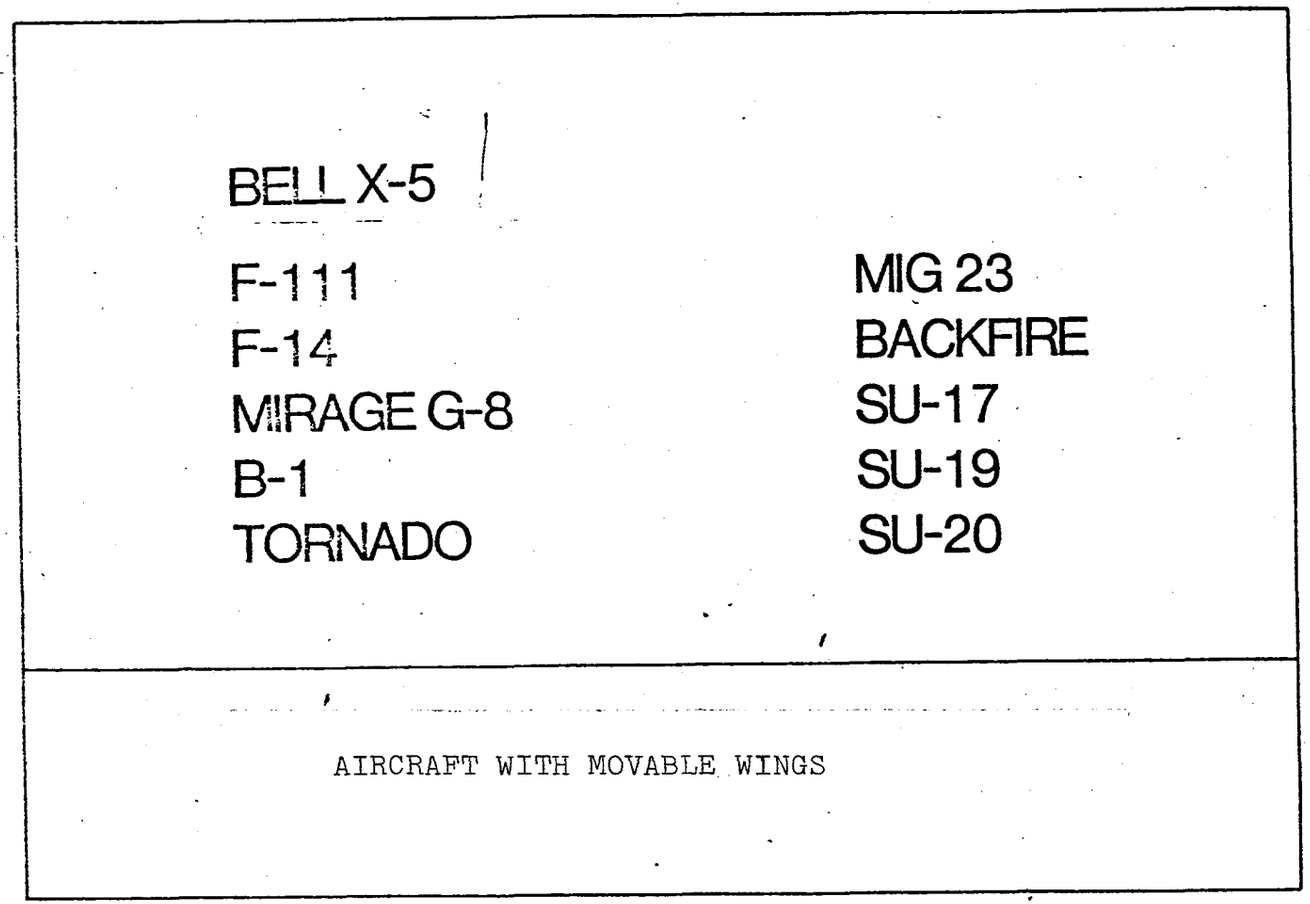

BELL X-5
F-111
F-14
MIRAGE G-8
B-1
TORNADO
MIG 23
BACKFIRE
SU-17
SU-19
SU-20
AIRCRAFT WITH MOVABLE WINGS

Fig. 1

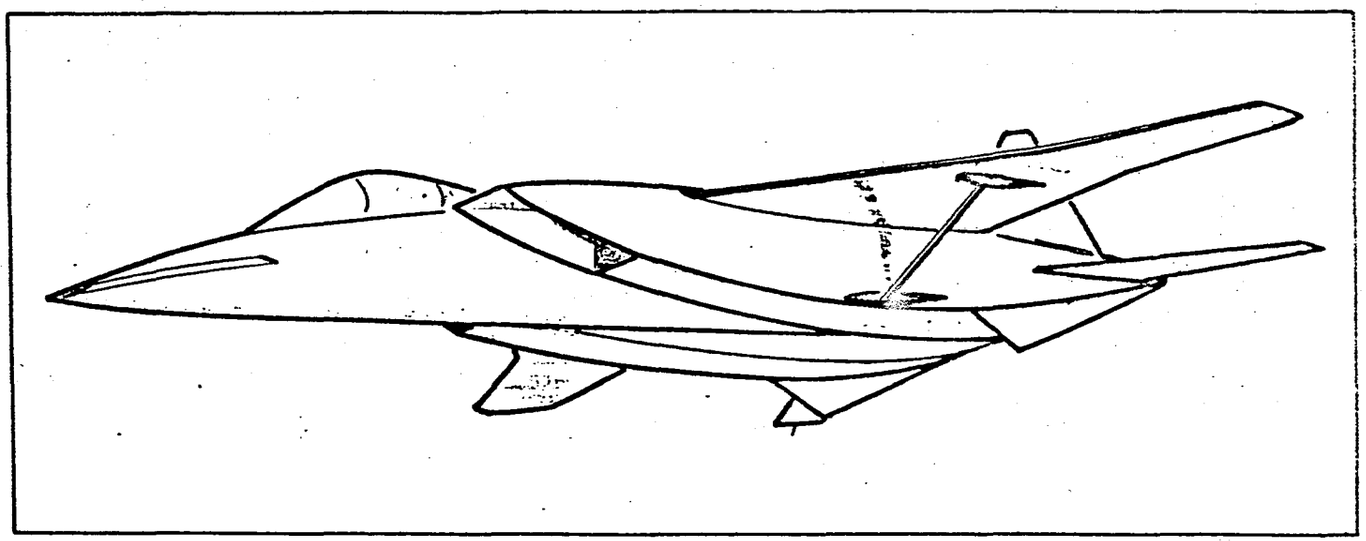
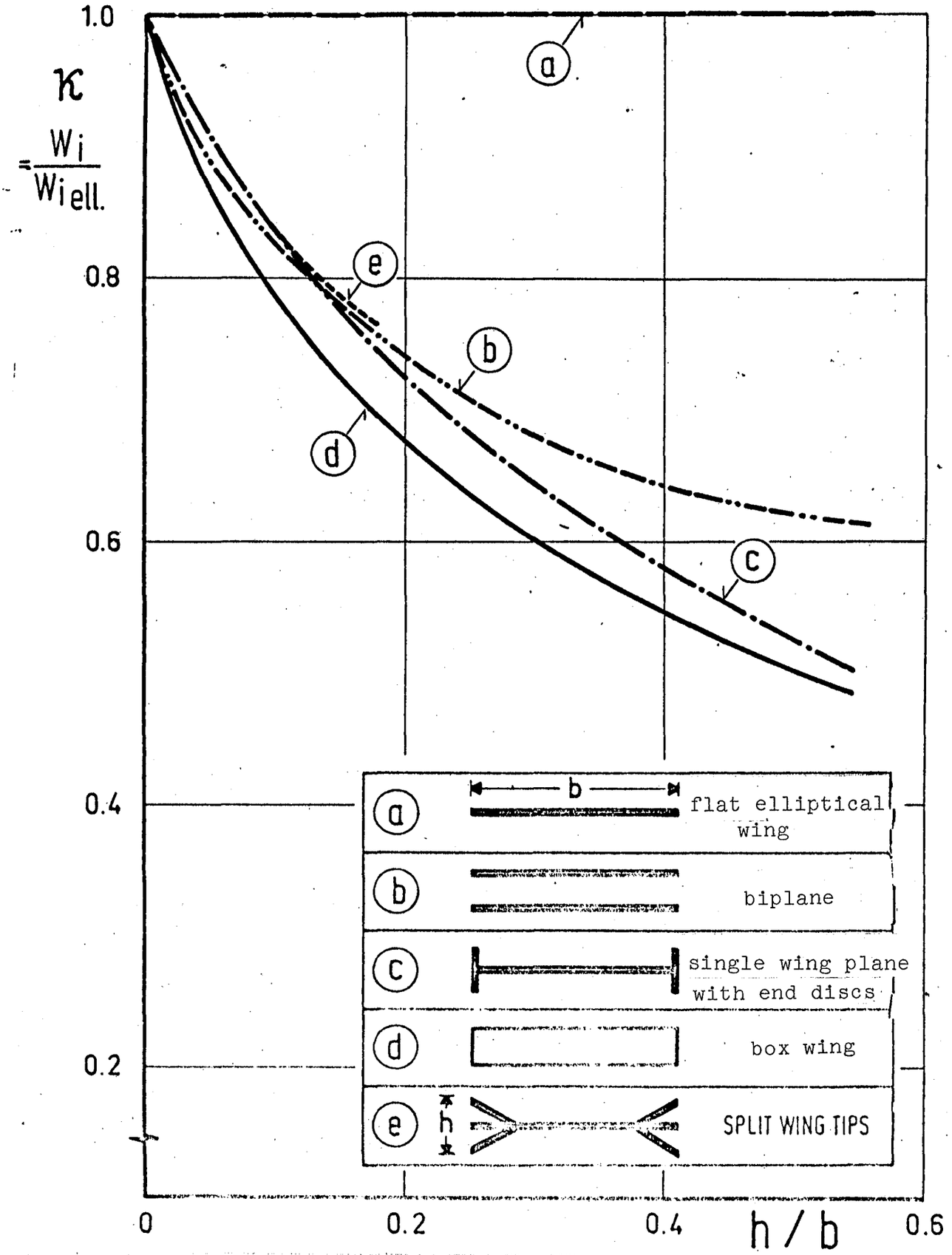


Fig. 2

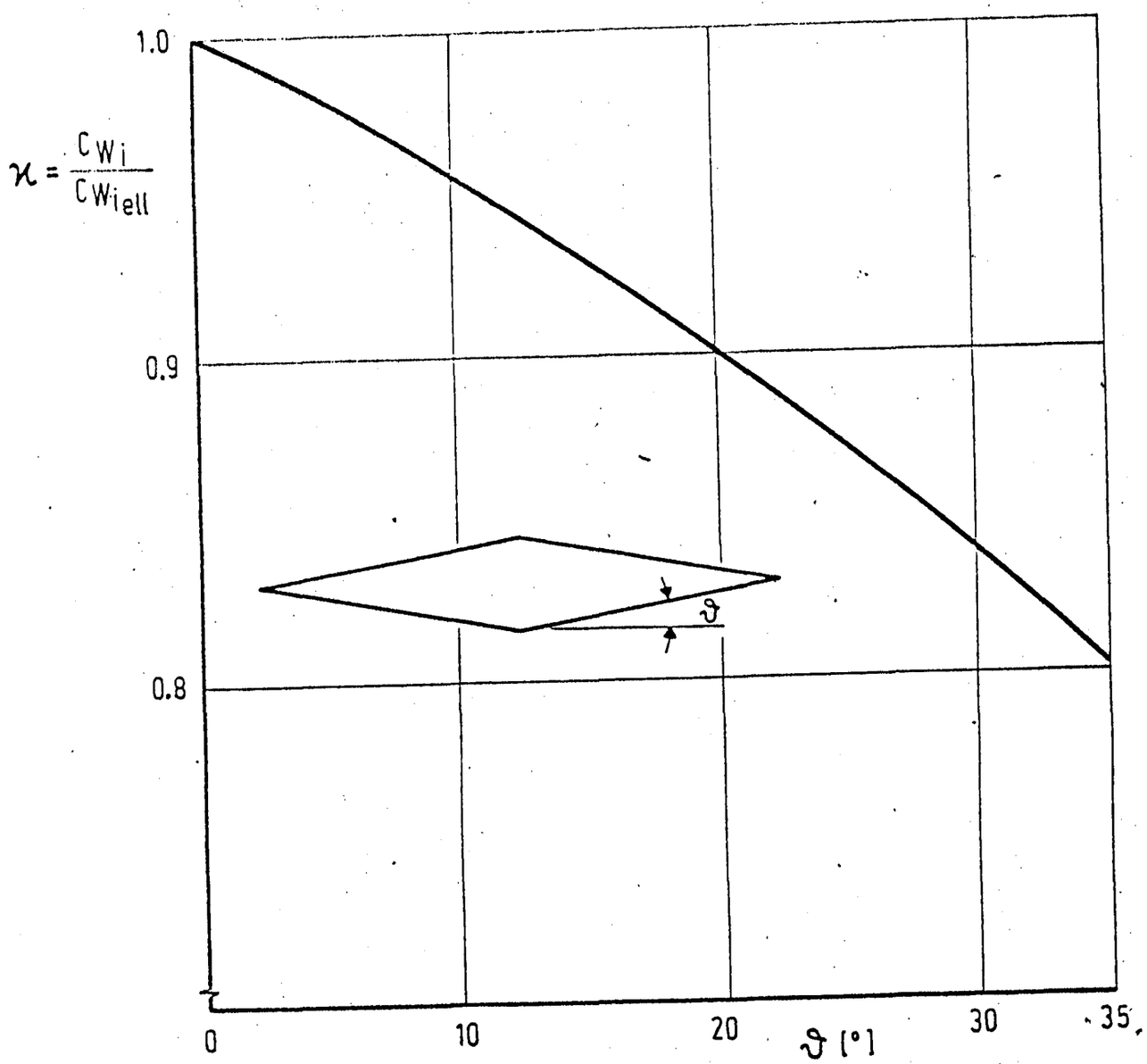
LFAX-WIND TUNNEL MODEL WITH STRUT WING (ACCORDING TO [7])

Fig. 3



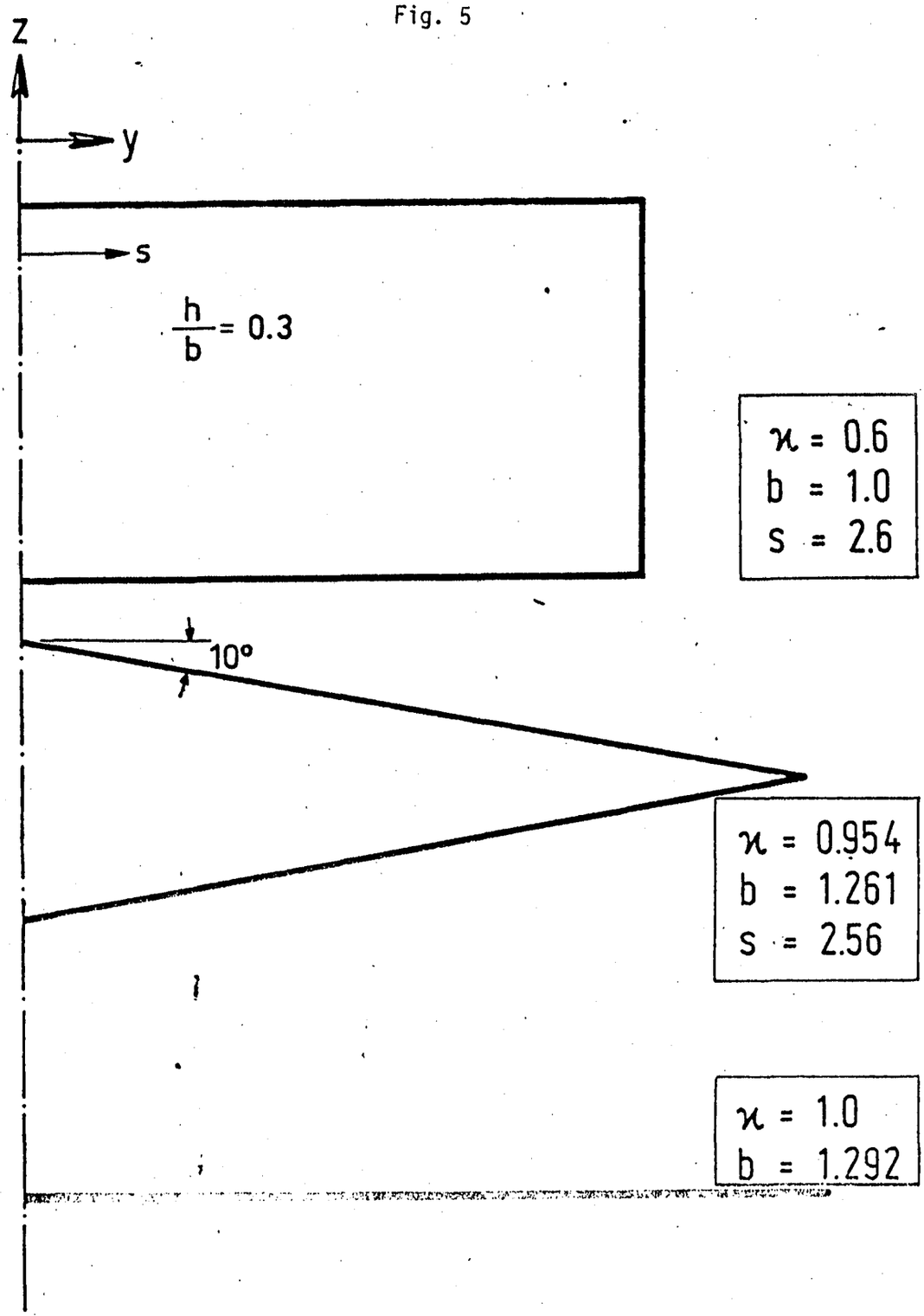
RATIO OF INDUCED DRAG FOR VARIOUS CONFIGURATIONS WITH THE SAME LIFT AND SAME SPAN

Fig. 4



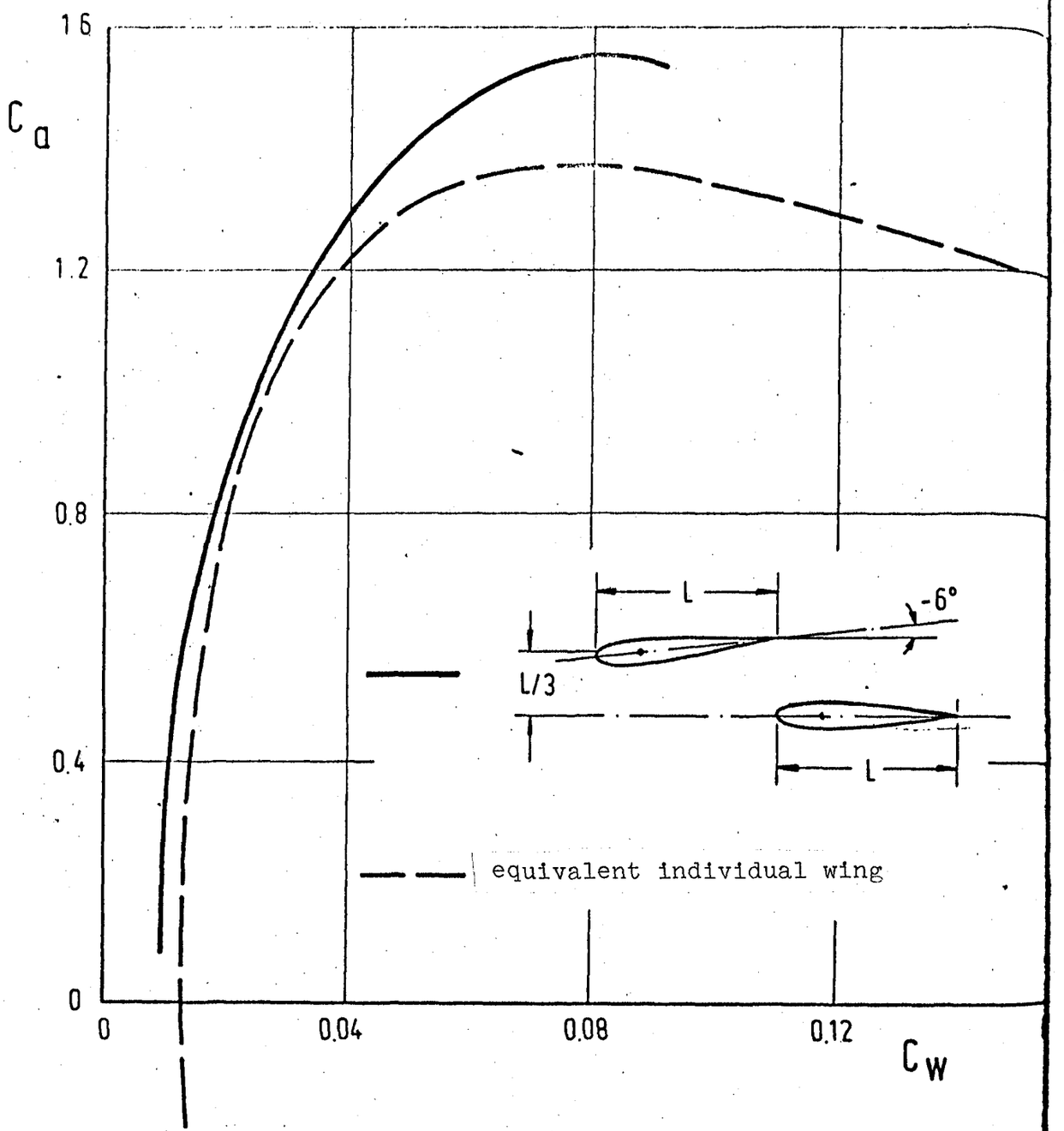
RELATIVE INDUCED DRAG OF A DIAMOND BIPLANE

Fig. 5



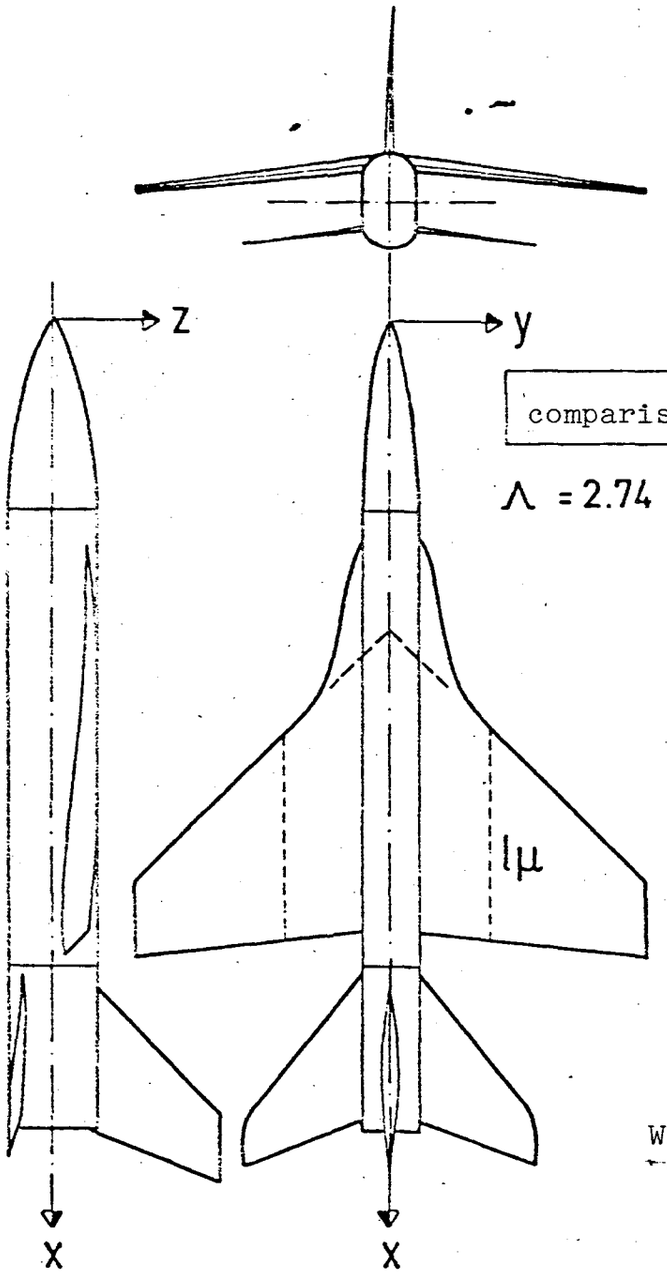
WING OF EQUAL LIFT AND SAME INDUCED DRAG

Fig. 6



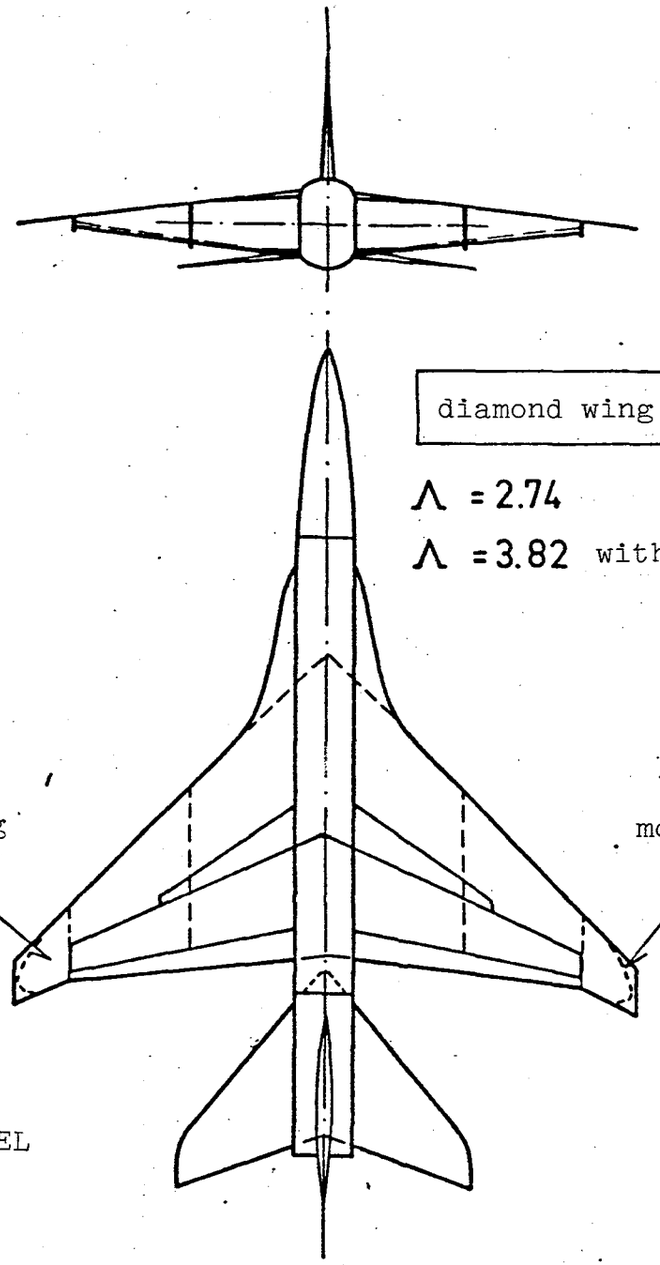
Joukowski profiles, 12% symmetric

OPTIMUM BIPLANE 2-D
MEASUREMENTS ACCORDING TO [8]



comparison wing

$\Lambda = 2.74$



diamond wing

$\Lambda = 2.74$

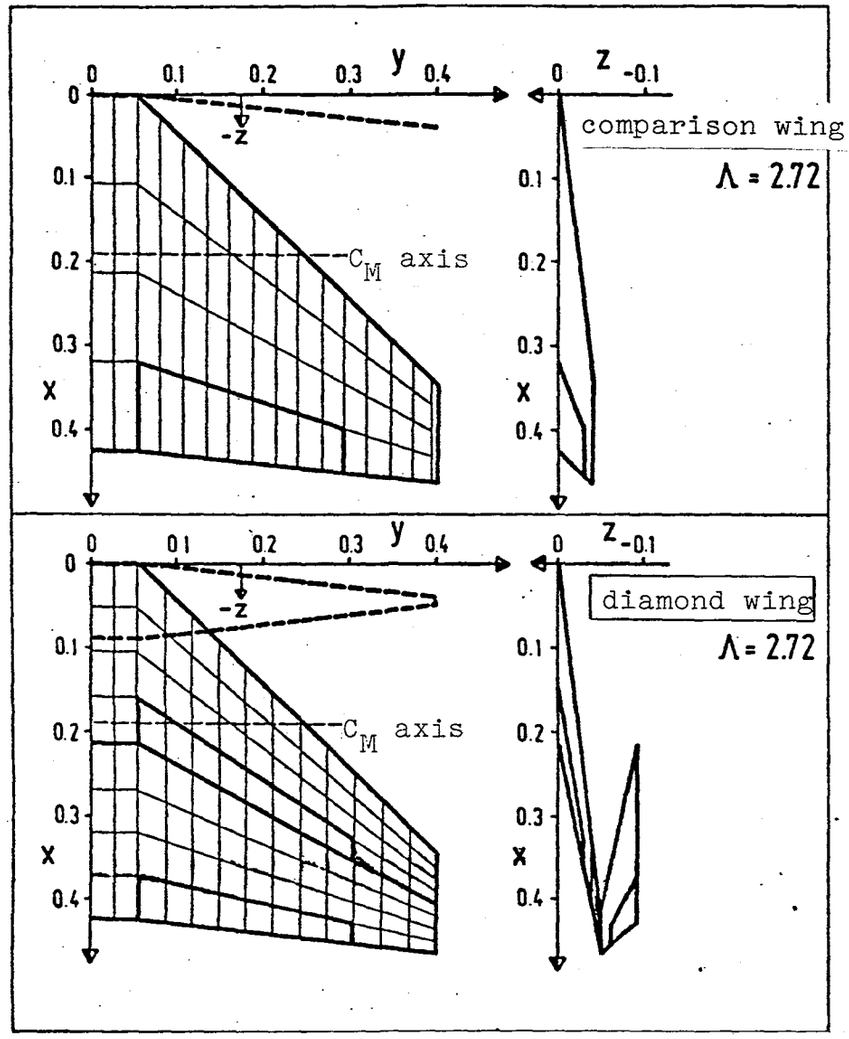
$\Lambda = 3.82$ with A.F.

outer wing removable

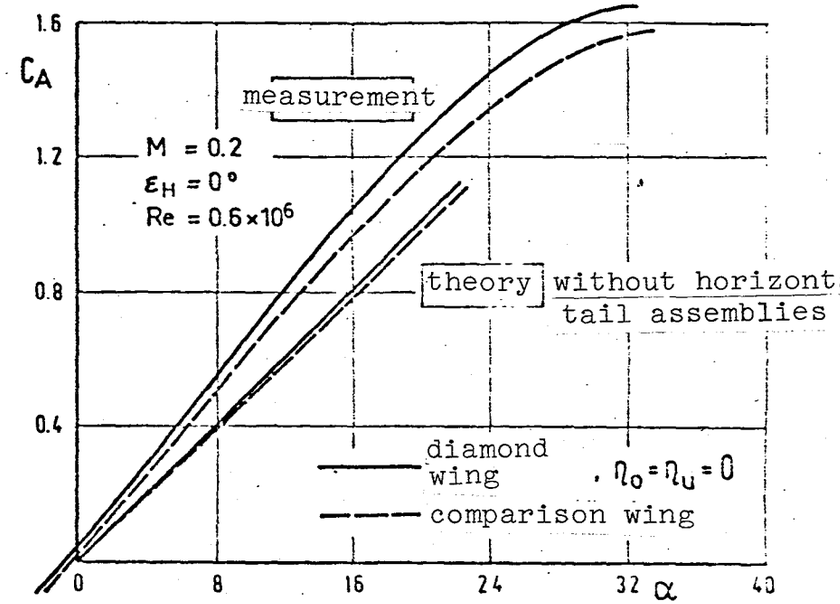
modified model

WIND TUNNEL MODEL

Fig. 7



COMPARISON OF DIAMOND WING AND INDIVIDUAL WINGS



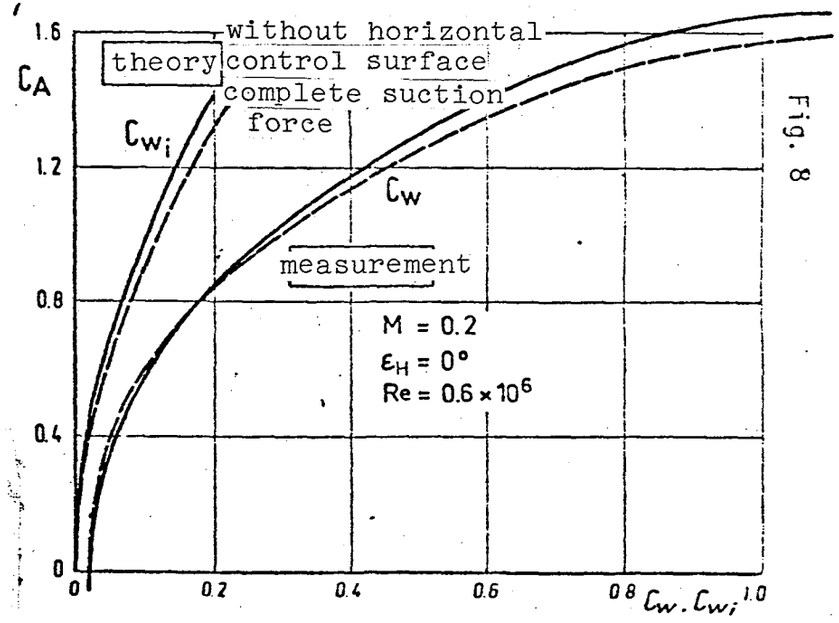


Fig. 8

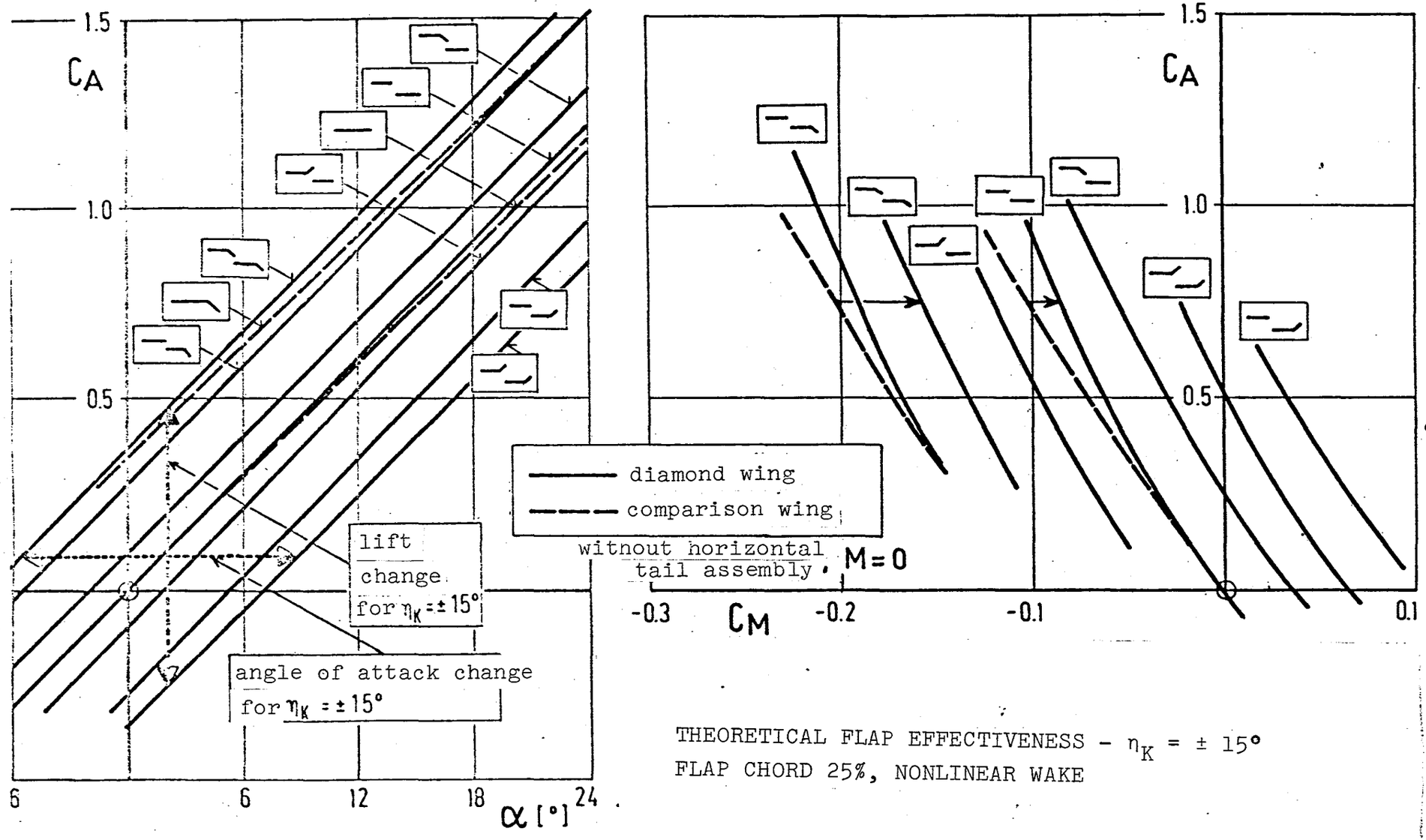


Fig. 9

THEORETICAL FLAP EFFECTIVENESS - $\eta_K = \pm 15°$
FLAP CHORD 25%, NONLINEAR WAKE

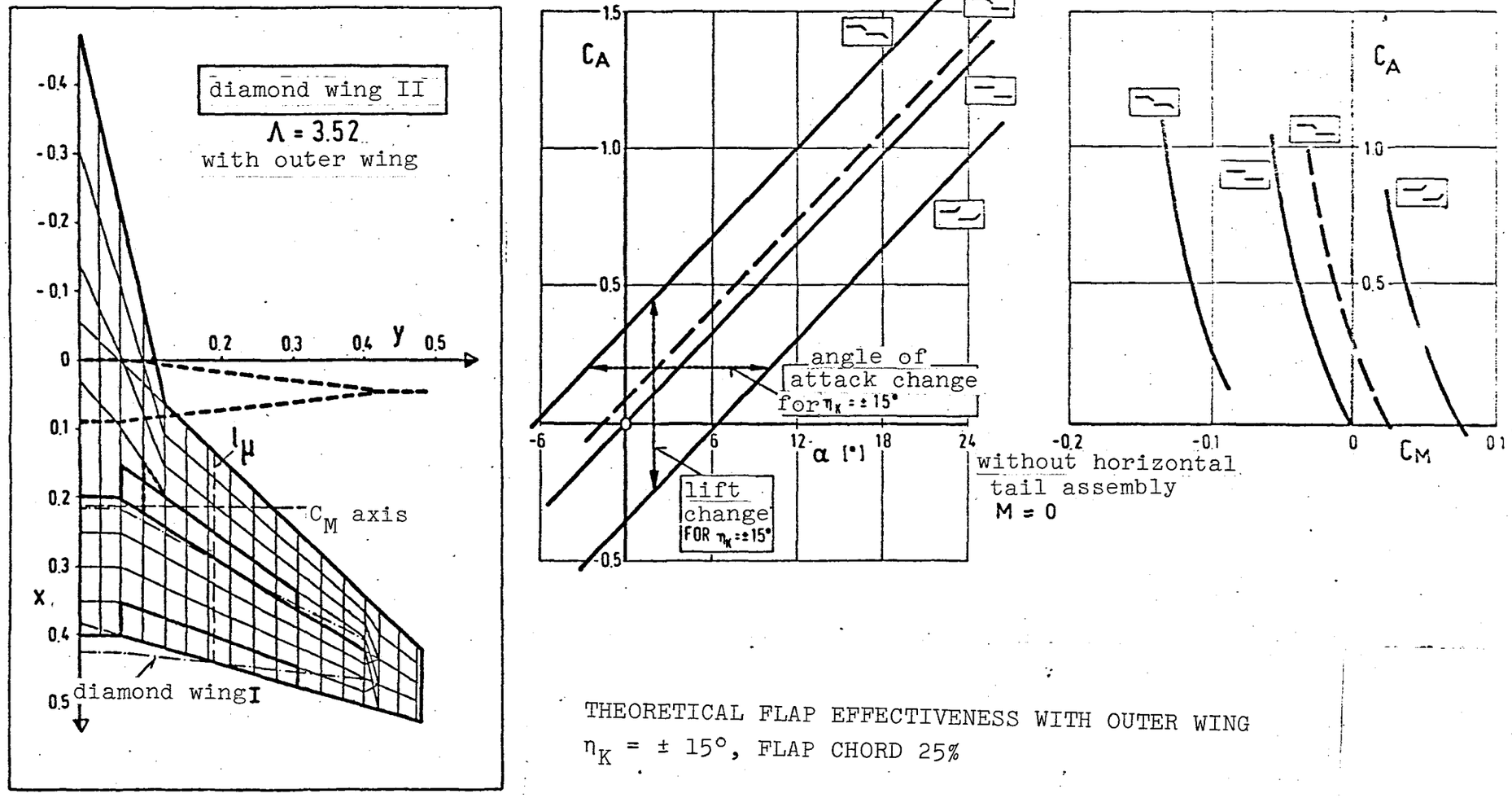
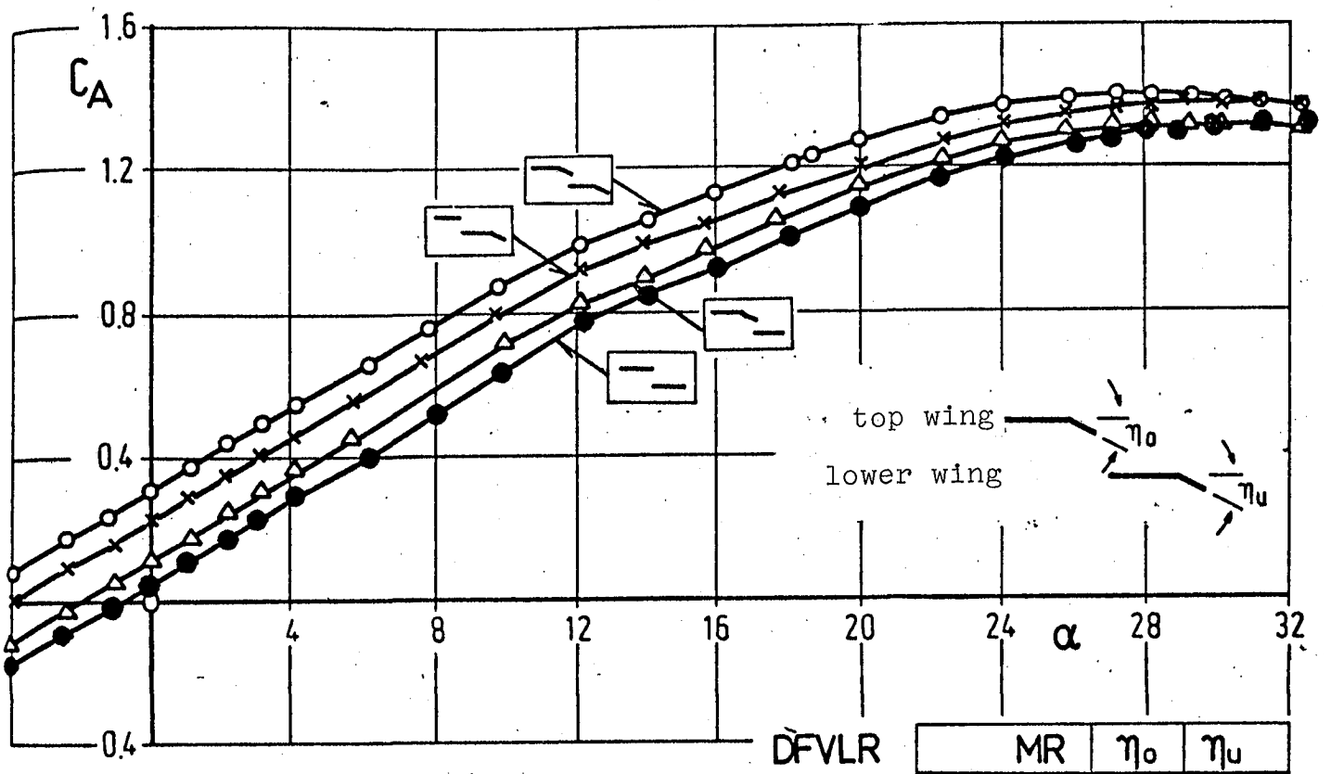


Fig. 10

THEORETICAL FLAP EFFECTIVENESS WITH OUTER WING
$\eta_K = \pm 15°$, FLAP CHORD 25%

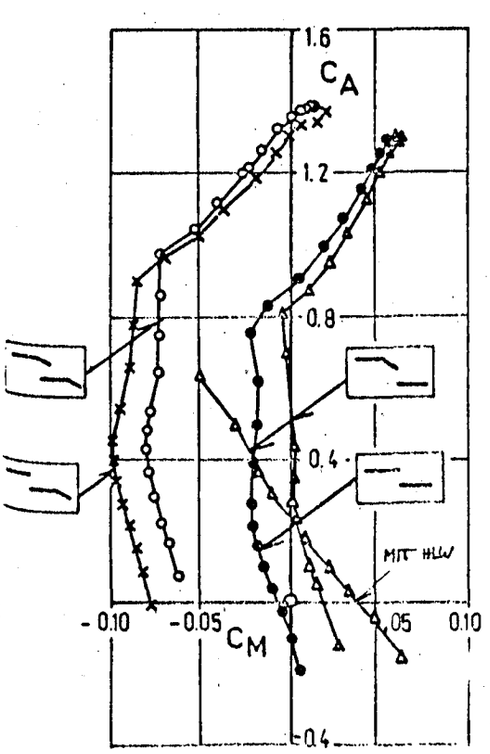
Fig. 11

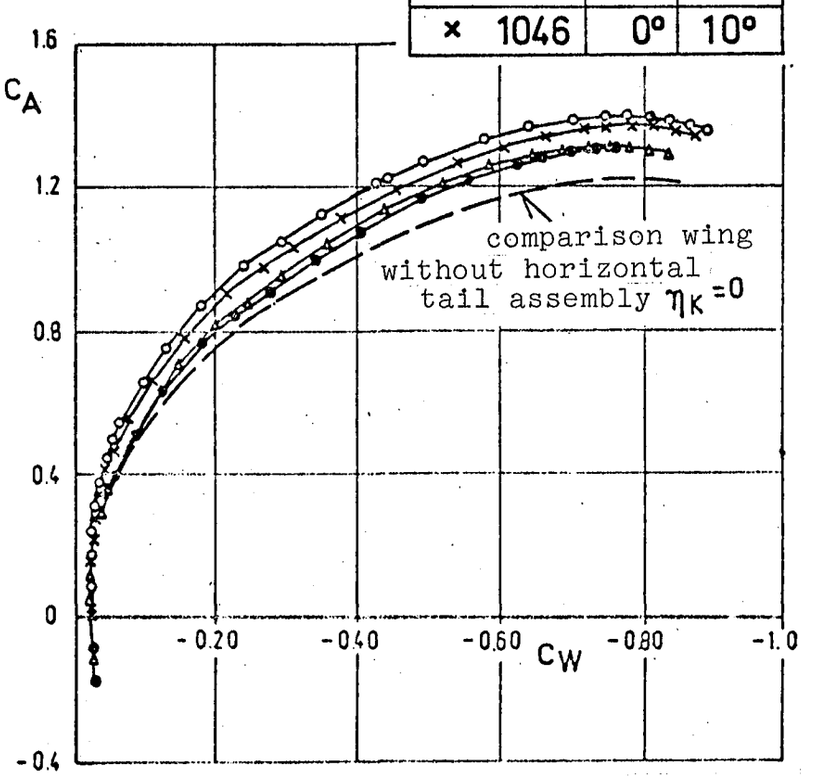


MR	η_o	η_u
○ 1015	10°	10°
△ 1019	10°	0°
● 1041	0°	0°
× 1046	0°	10°

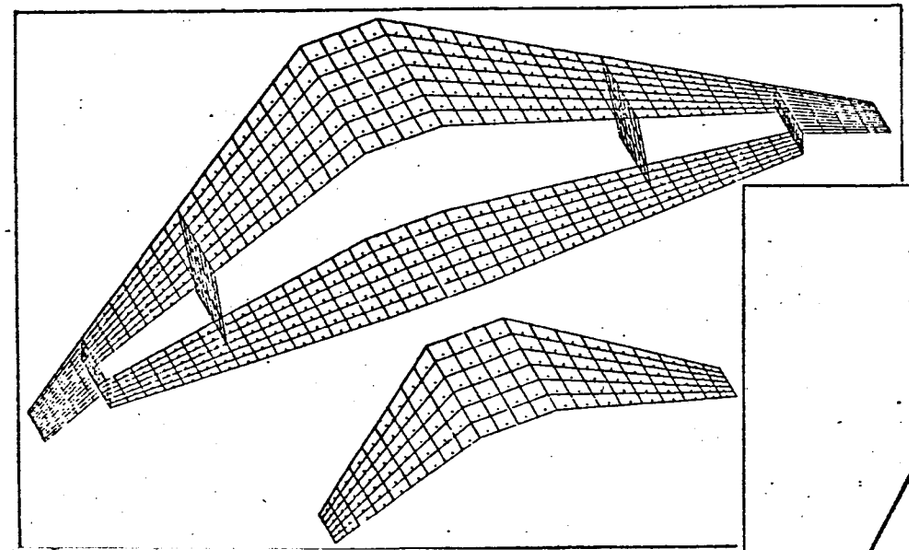
diamond wing
without horizontal
tail assembly
with A.F.

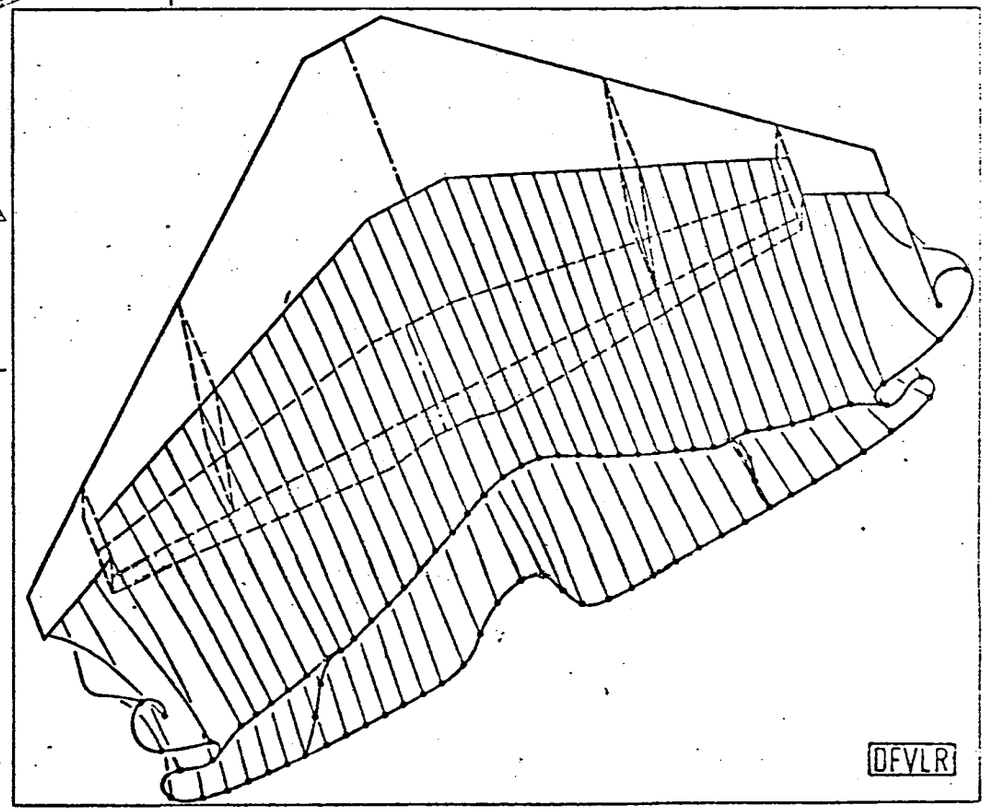
$Re = 0.6 \times 10^6$
$M = 0.2$





MEASURED FLAP EFFECTIVENESS WITH OUTER WING



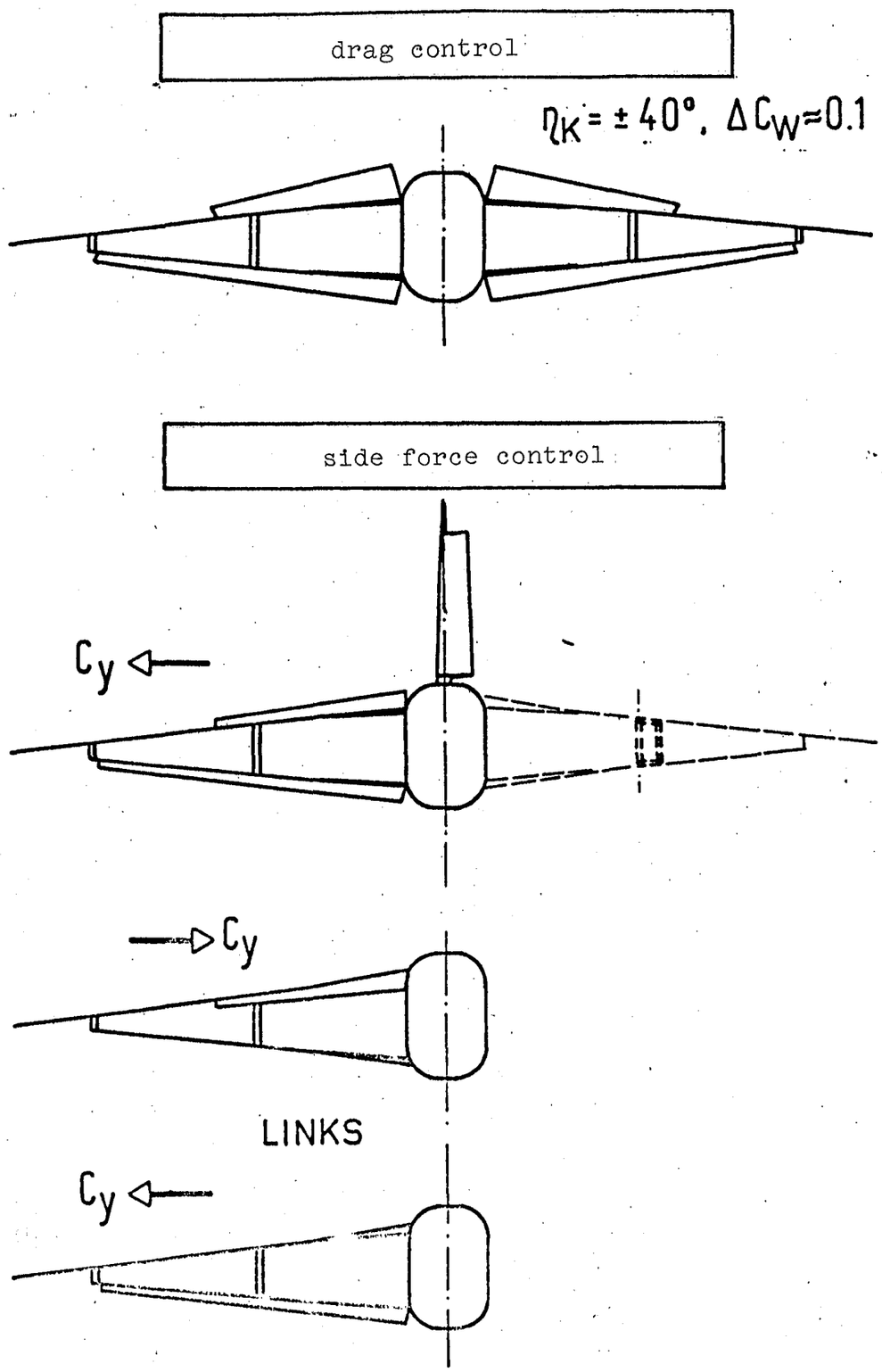


VORTEX TRAIN BEHIND DIAMOND WING WITH FLAP DEFLECTION WITHOUT HORIZONTAL CONTROL SURFACE

$\alpha = 10°$; $\eta_{ko} = 0°$; $\eta_{ku} = 10°$

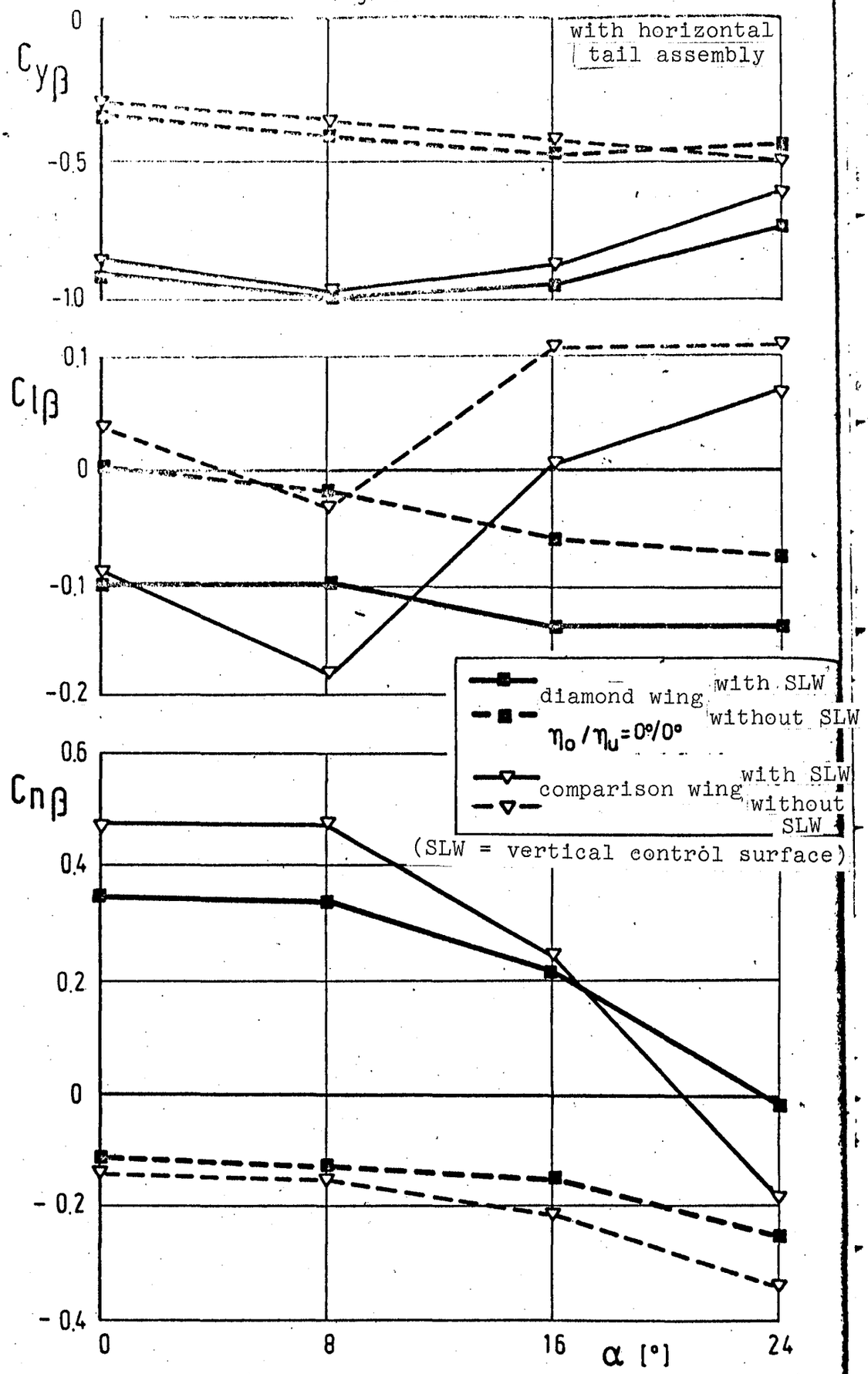
Fig. 12

Fig. 13



DIRECT FORCE CONTROL

Fig. 14



STATIC SIDEWAYS MOTION DERIVATIVES M = 0.2

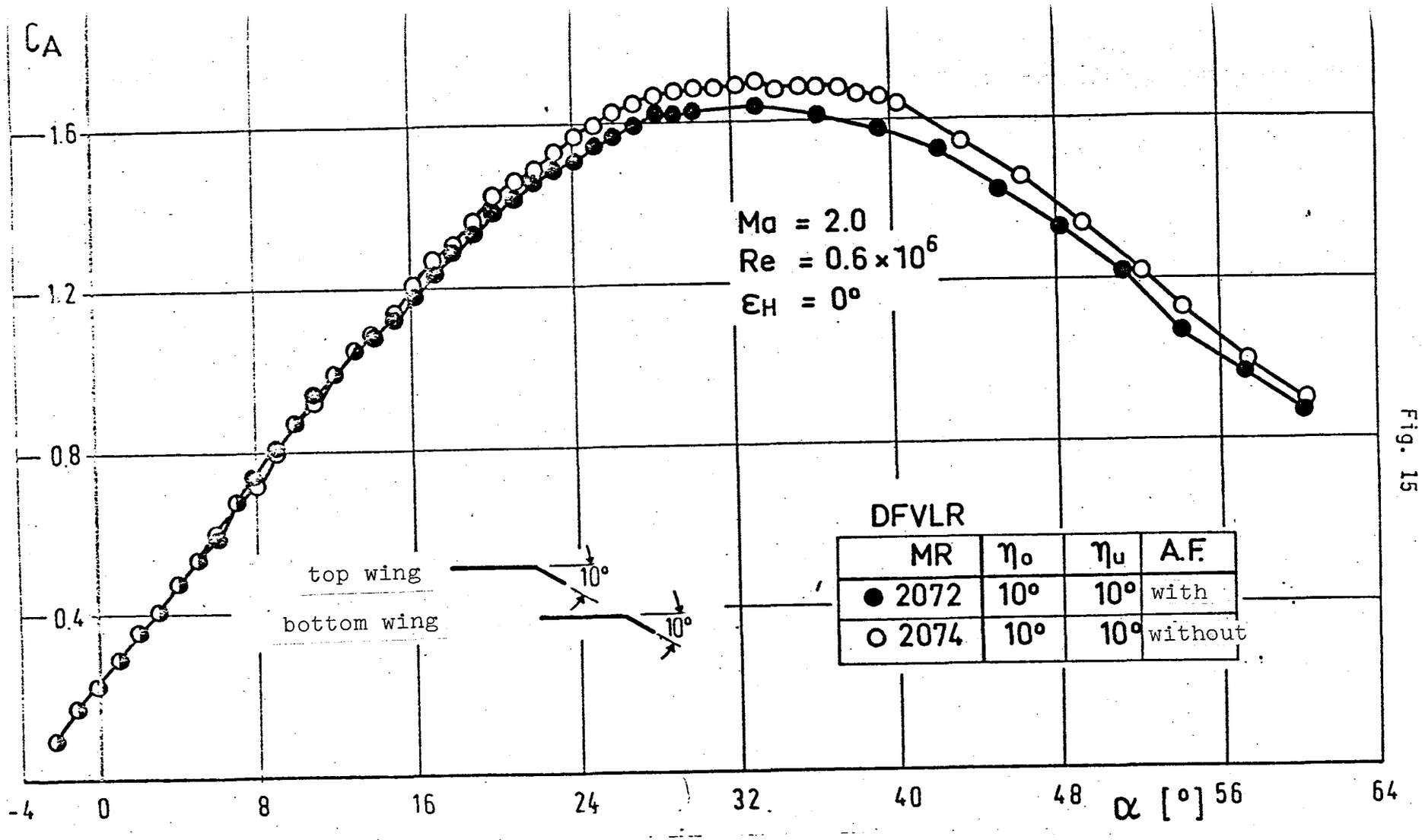


Fig. 15

LIFT UP TO HIGH ANGLES OF ATTACK (MODIFIED MODEL, WITH AND WITHOUT OUTER WING)

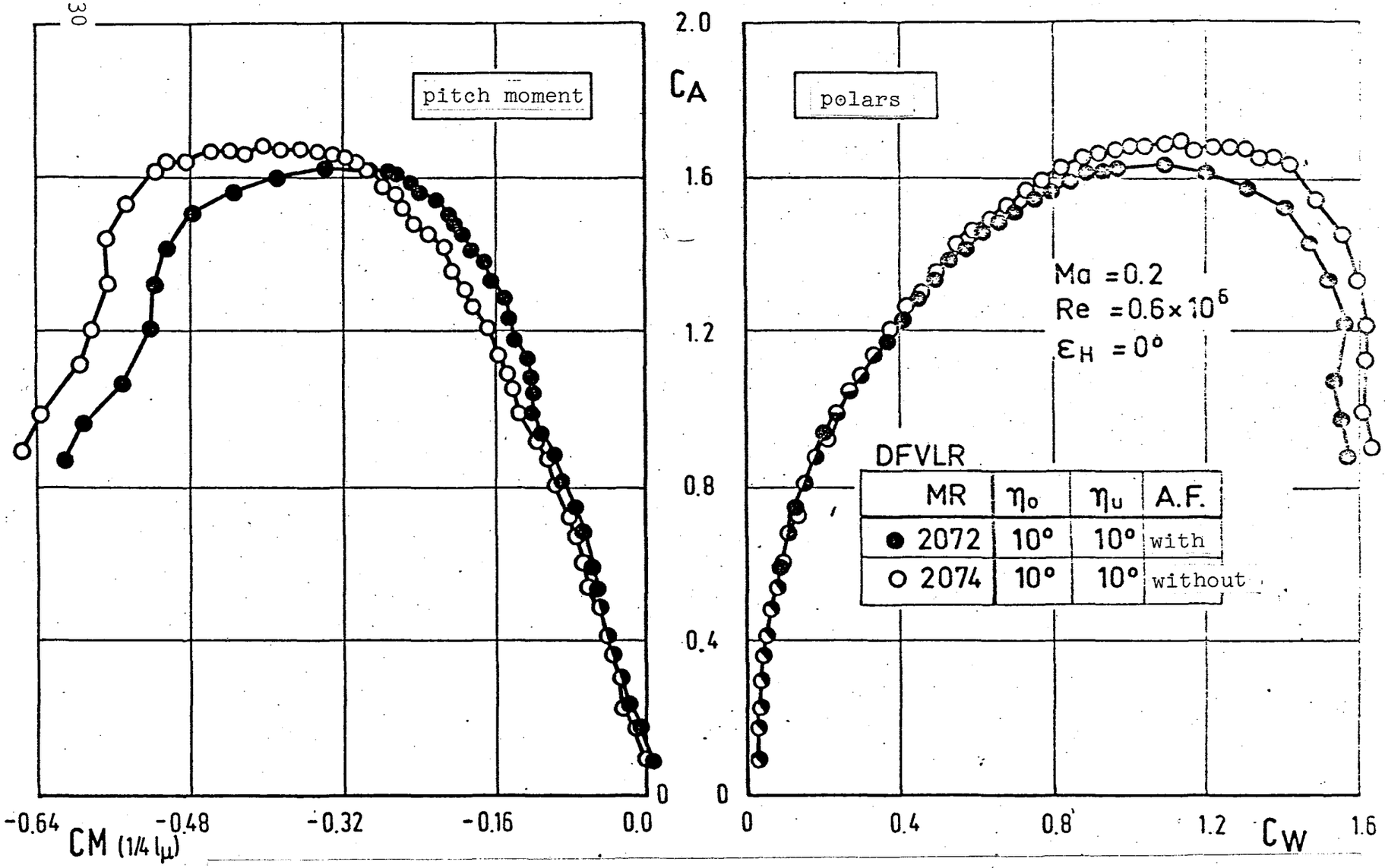
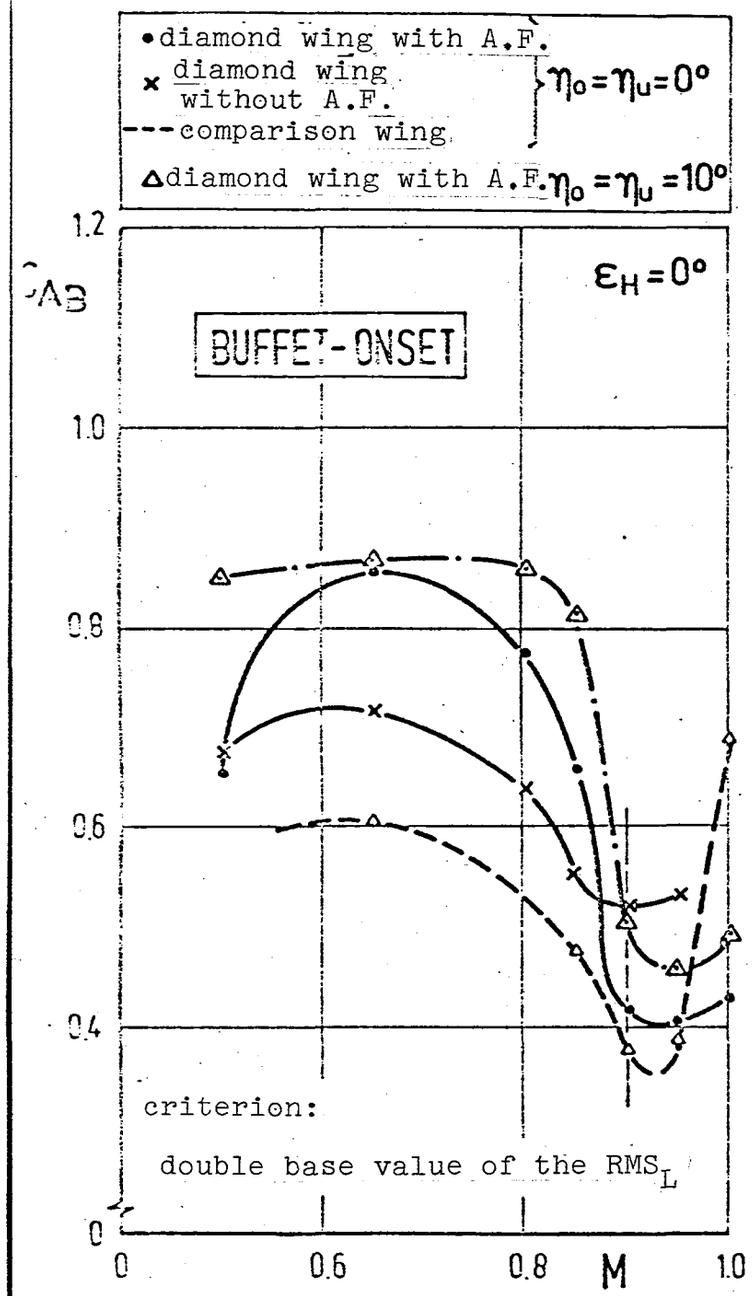


Fig. 16

PITCH MOMENT AND POLARS UP TO HIGH ANGLES OF ATTACK
(MODIFIED MODEL WITH AND WITHOUT OUTER WING)



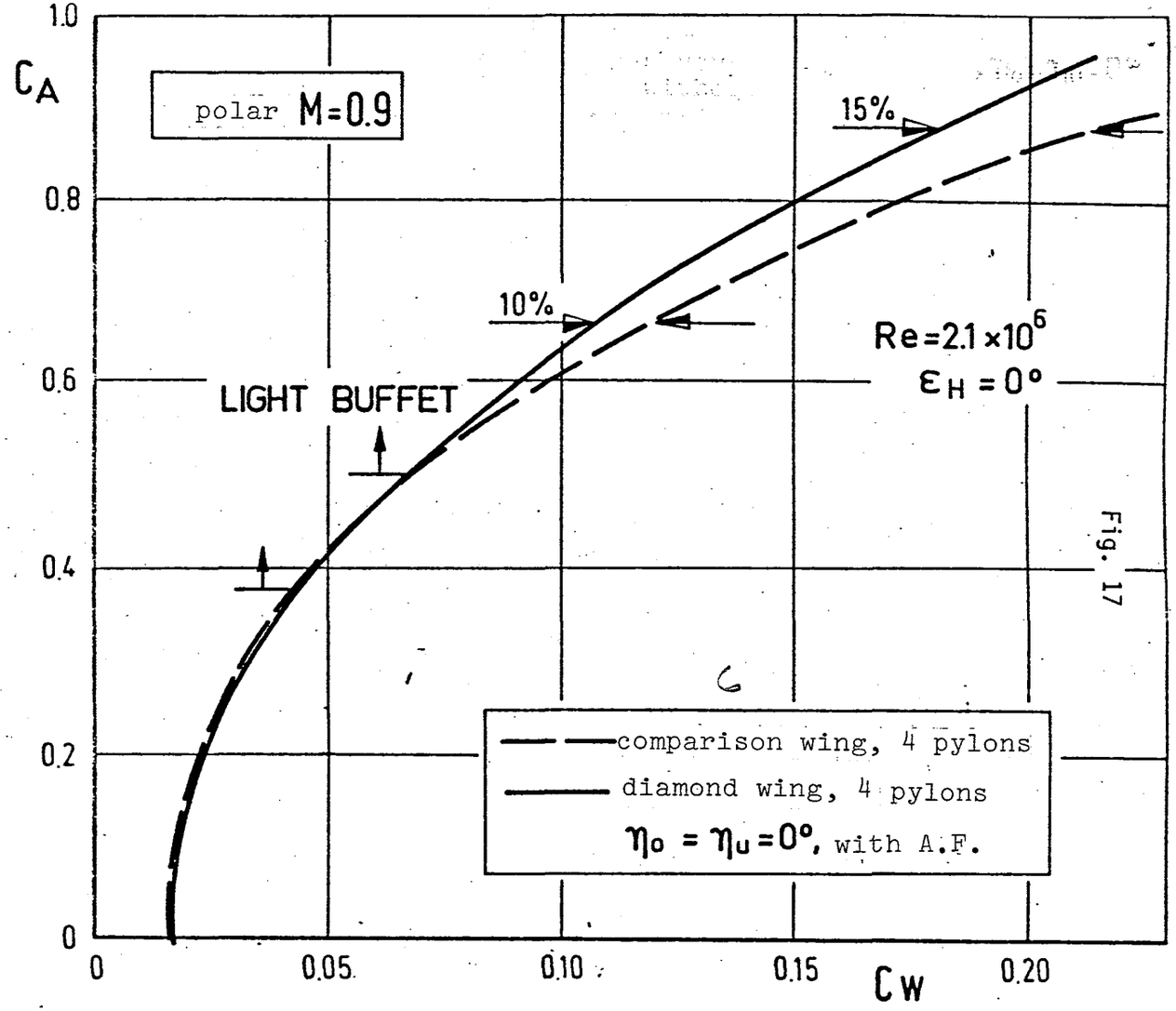


Fig. 17

HIGH LIFT BEHAVIOR WITH TRANSONIC FLOW

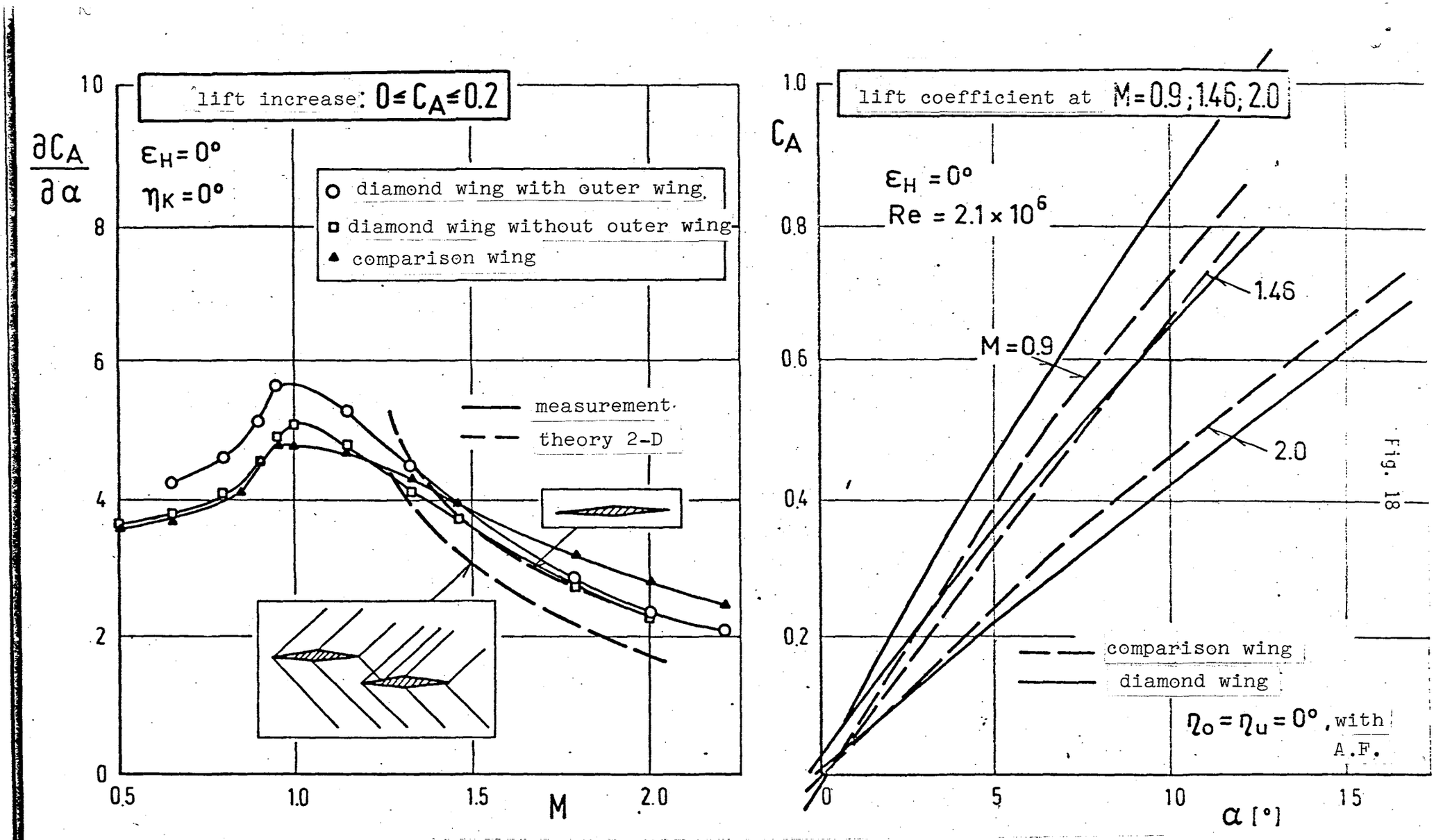
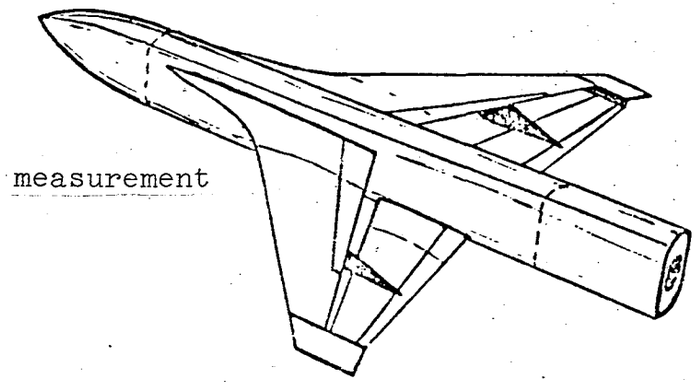
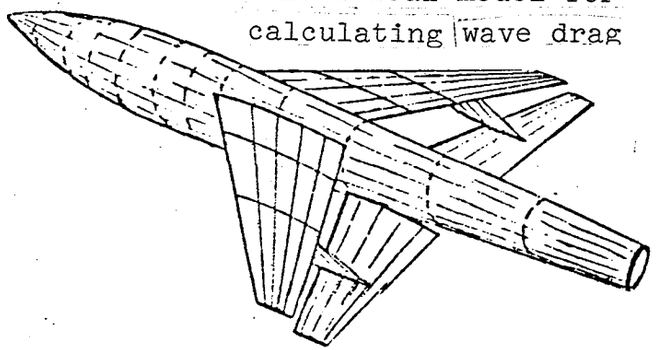


Fig. 18

LIFT IN THE HIGH SPEED RANGE





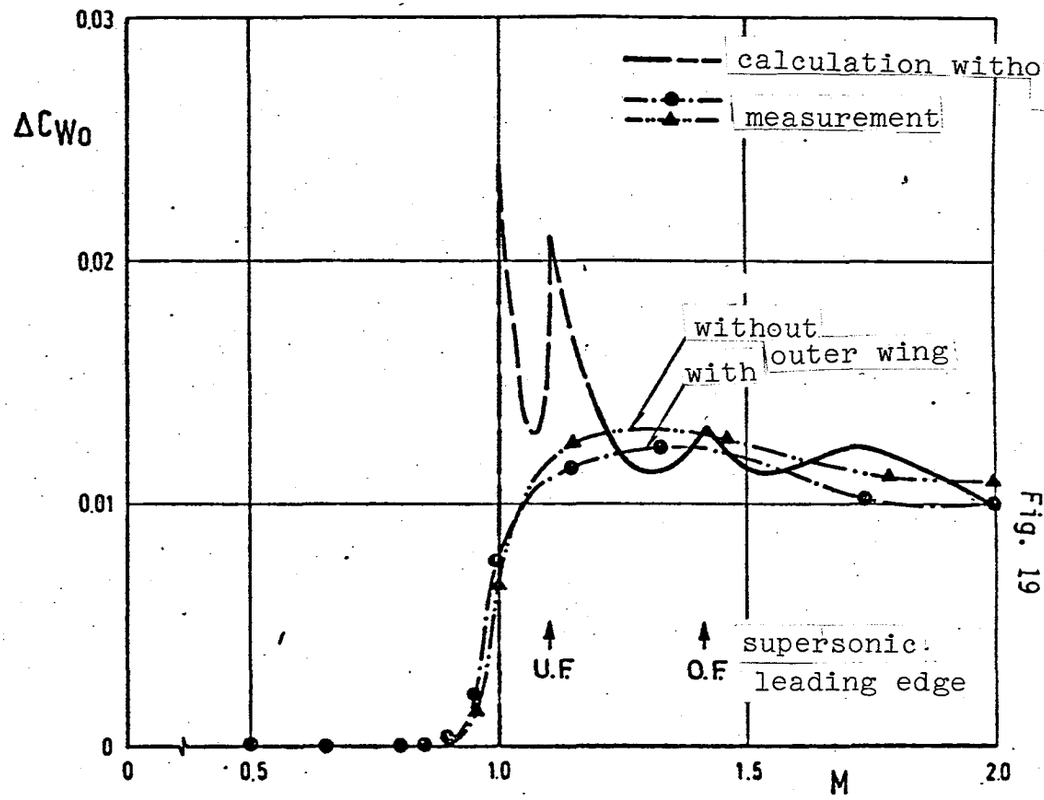
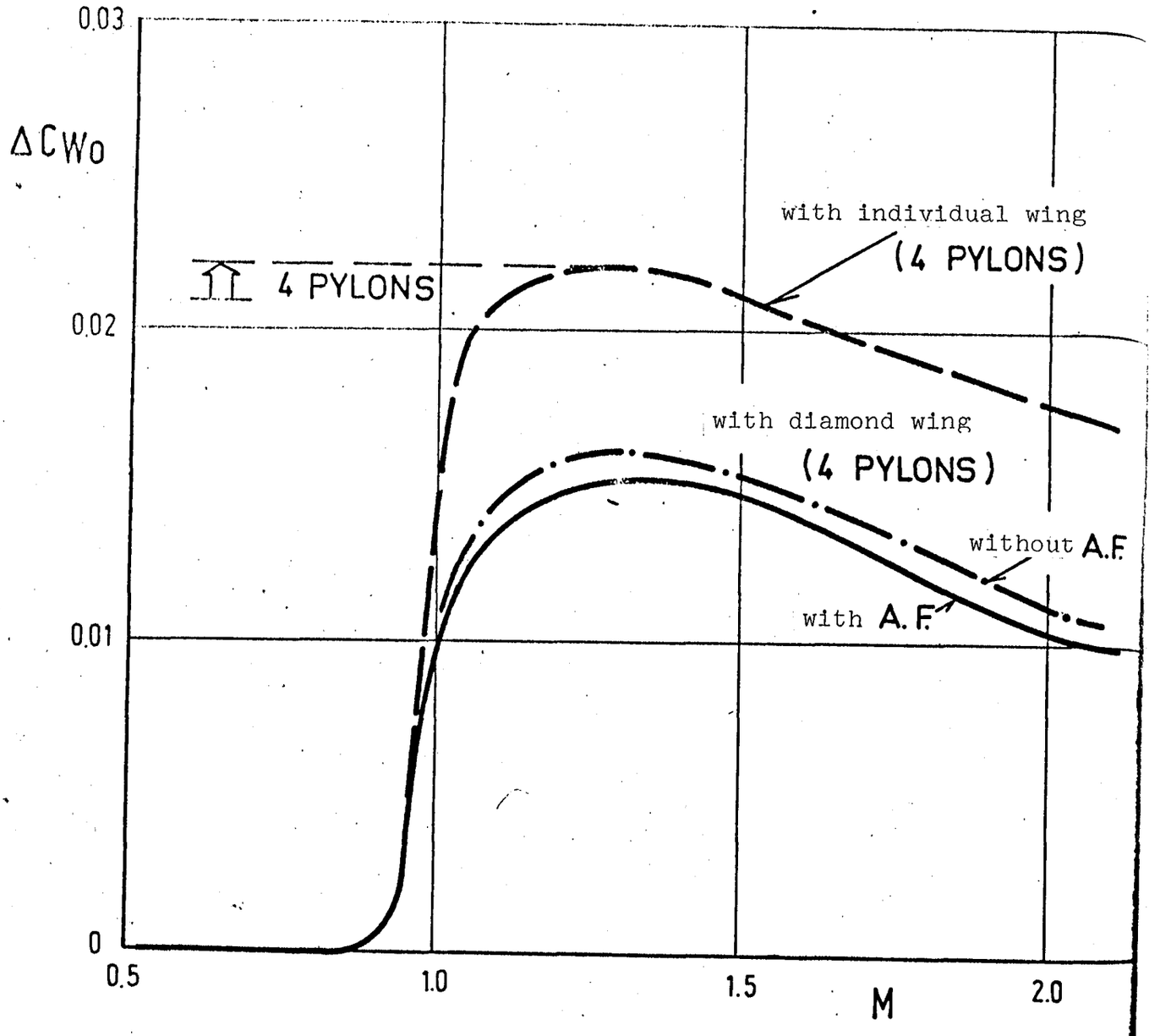


Fig. 19

Fig. 19

WAVE DRAG OF DIAMOND WING CONFIGURATION WITHOUT TAIL ASSEMBLY

Fig. 20



WAVE DRAG OF THE DORNIER VARIATION MODEL

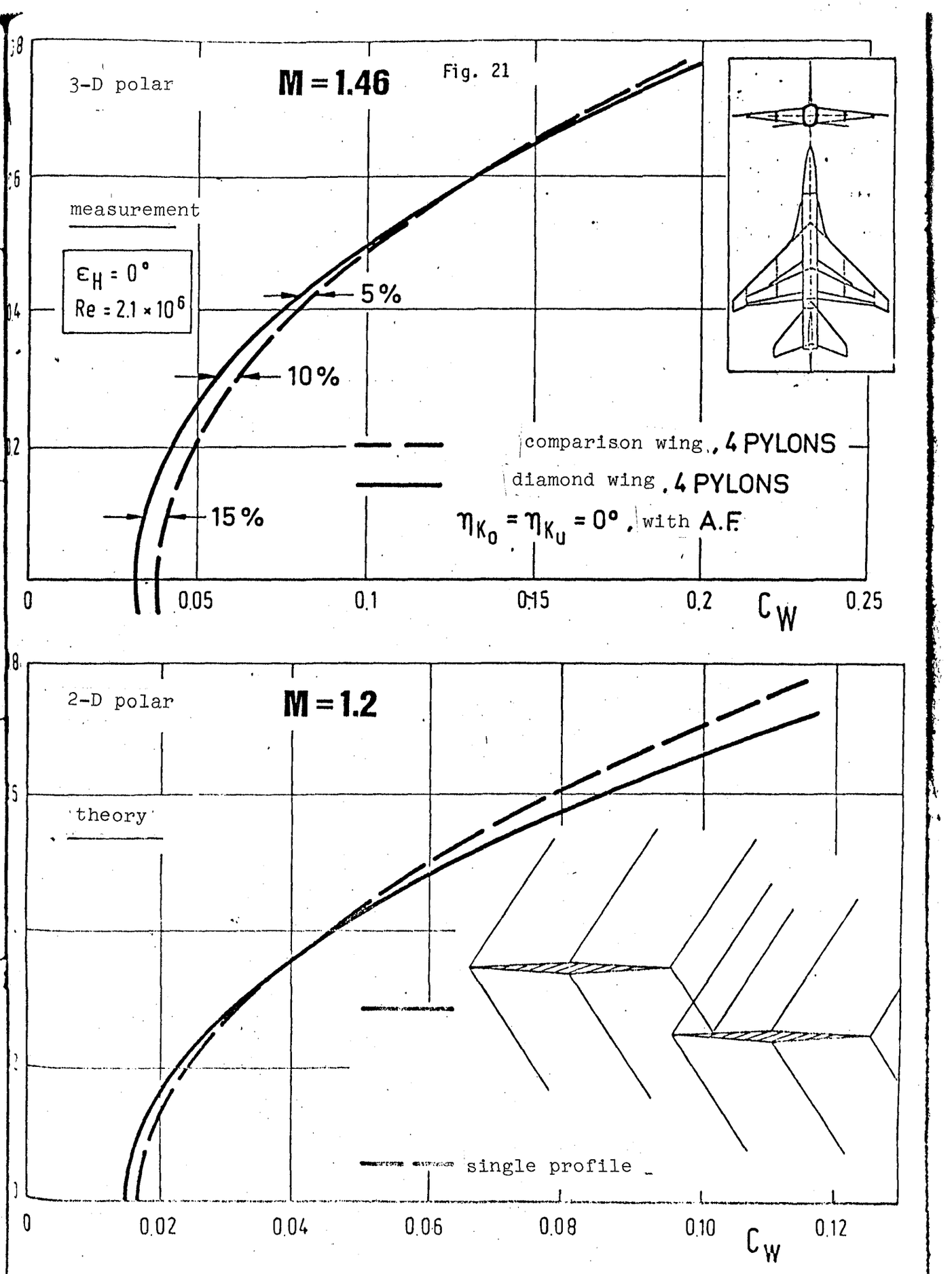
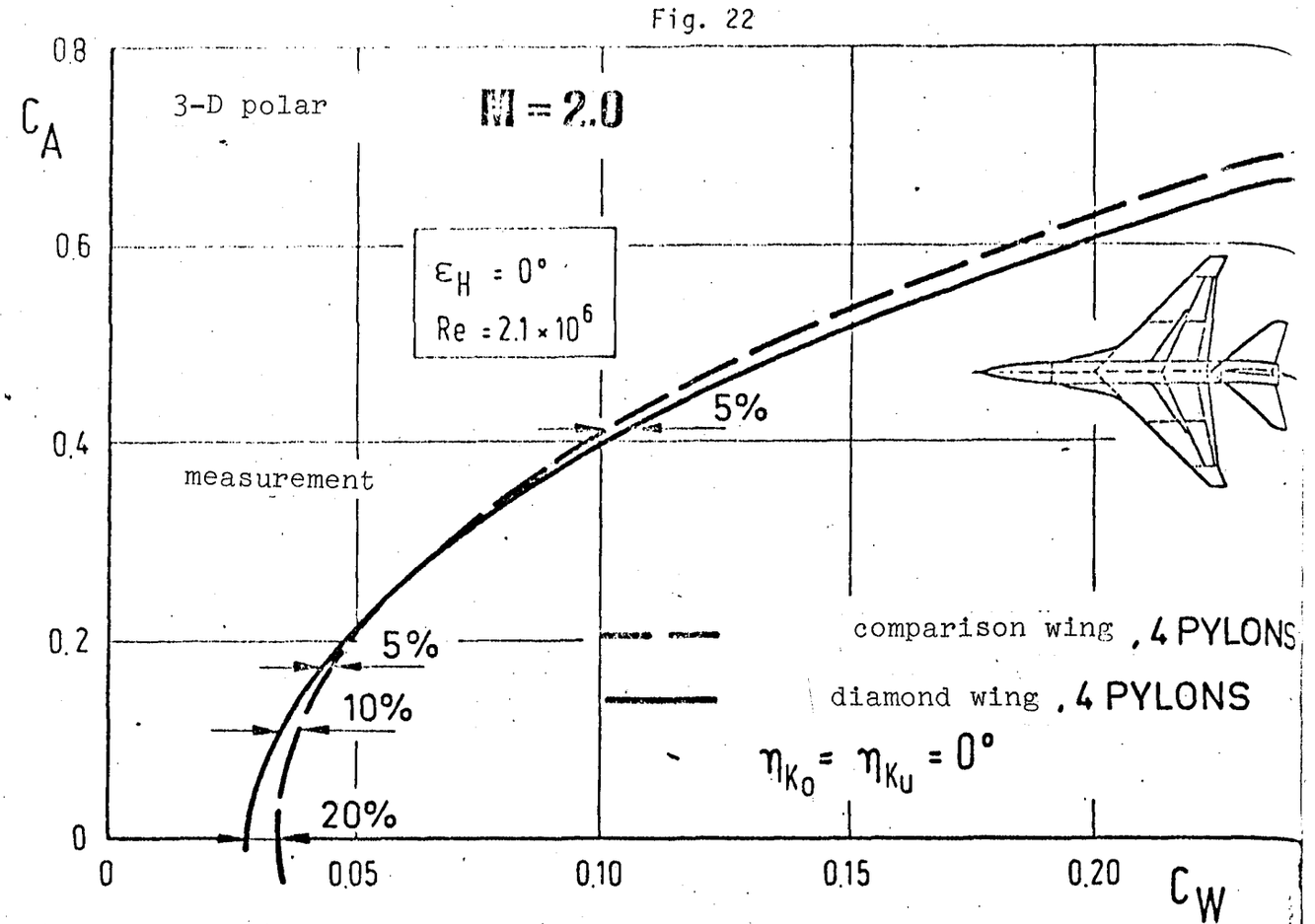

3-D polar
M = 1.46
Fig. 21
measurement
$\varepsilon_H = 0°$
$Re = 2.1 \times 10^6$
5 %
10 %
15 %
comparison wing, 4 PYLONS
diamond wing, 4 PYLONS
$\eta_{K_O} = \eta_{K_U} = 0°$, with A.F.
0
0.05
0.1
0.15
0.2
C_W
0.25
2-D polar
M = 1.2
theory
single profile
0
0.02
0.04
0.06
0.08
0.10
C_W
0.12

Fig. 22


3-D polar
M = 2.0
C_A
$\varepsilon_H = 0°$
$Re = 2.1 \times 10^6$
5%
measurement
5%
10%
20%
comparison wing , 4 PYLONS
diamond wing , 4 PYLONS
$\eta_{K_o} = \eta_{K_u} = 0°$
0.8
0.6
0.4
0.2
0
0.05
0.10
0.15
0.20
C_W

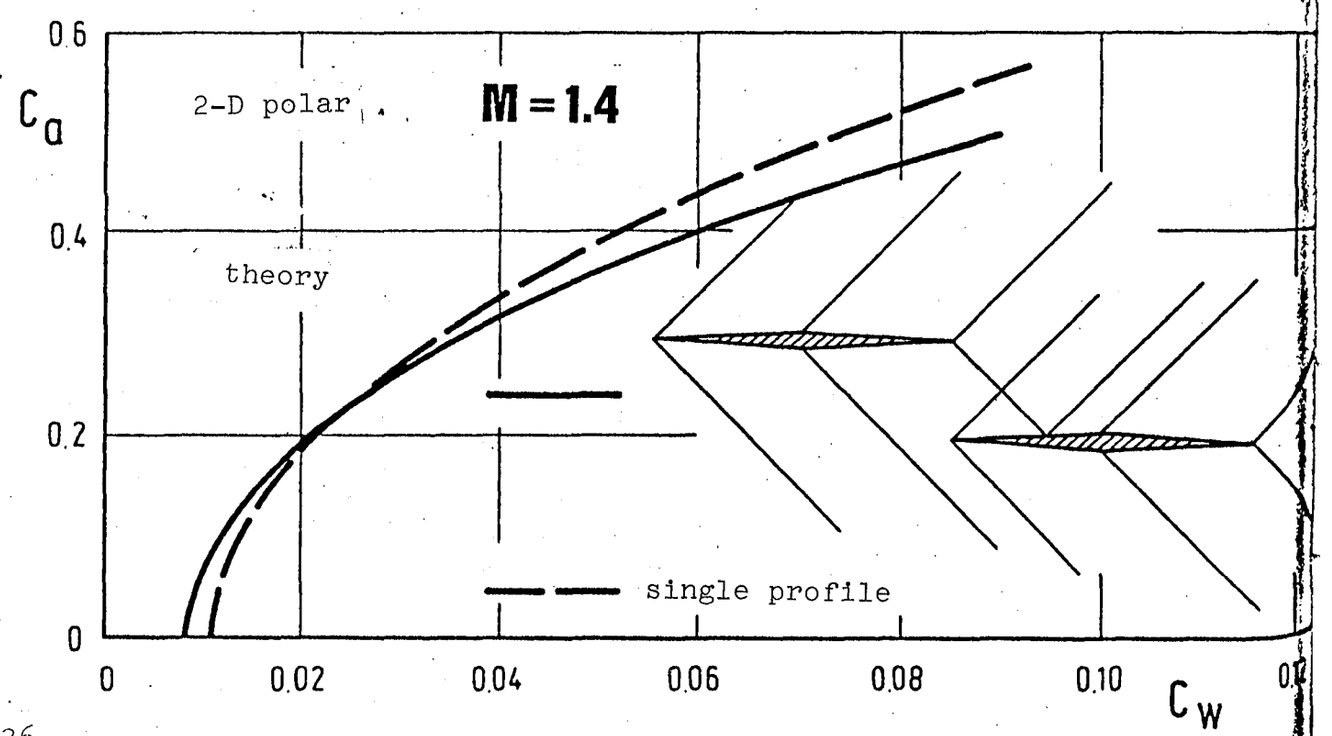
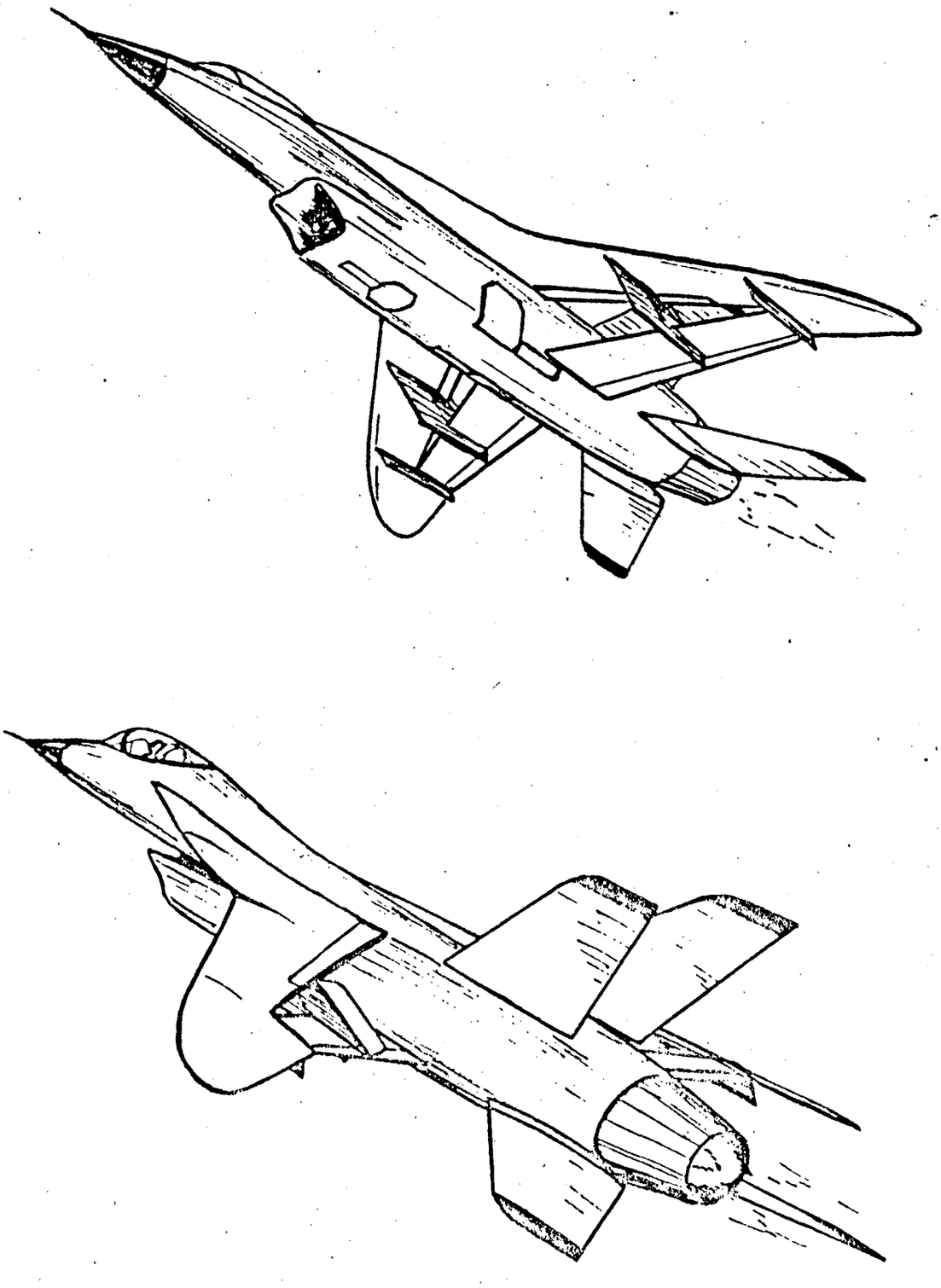
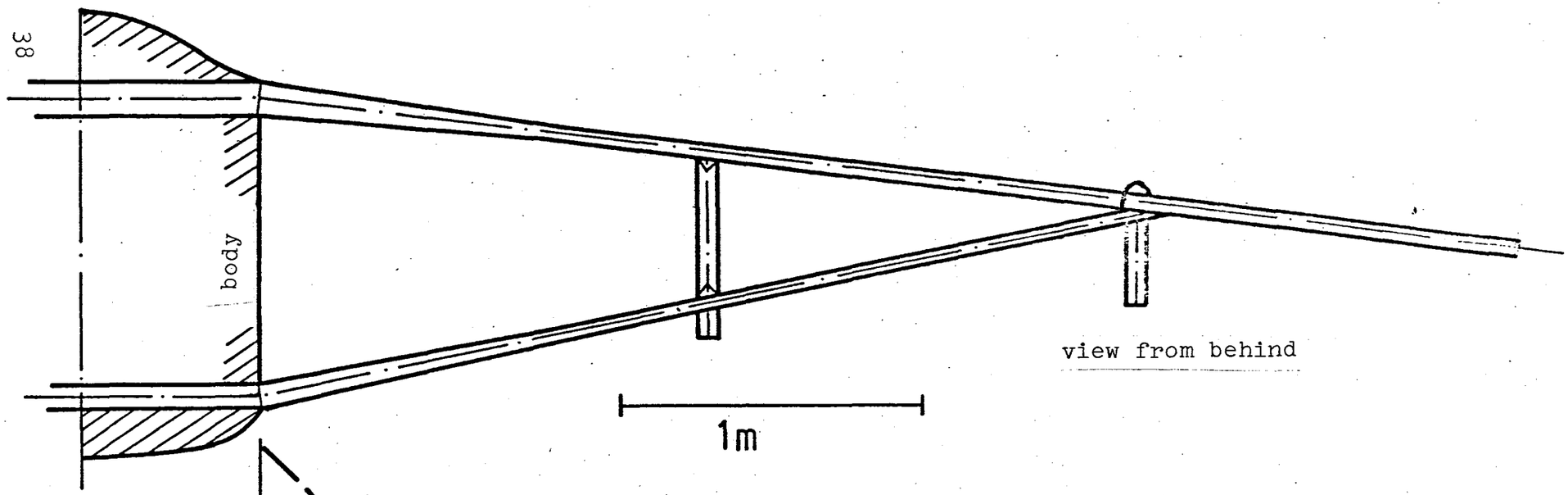

2-D polar
M = 1.4
C_a
theory
single profile
0.6
0.4
0.2
0
0.02
0.04
0.06
0.08
0.10
C_w

Fig. 23



SUPERSONIC AIRCRAFT WITH DIAMOND WING



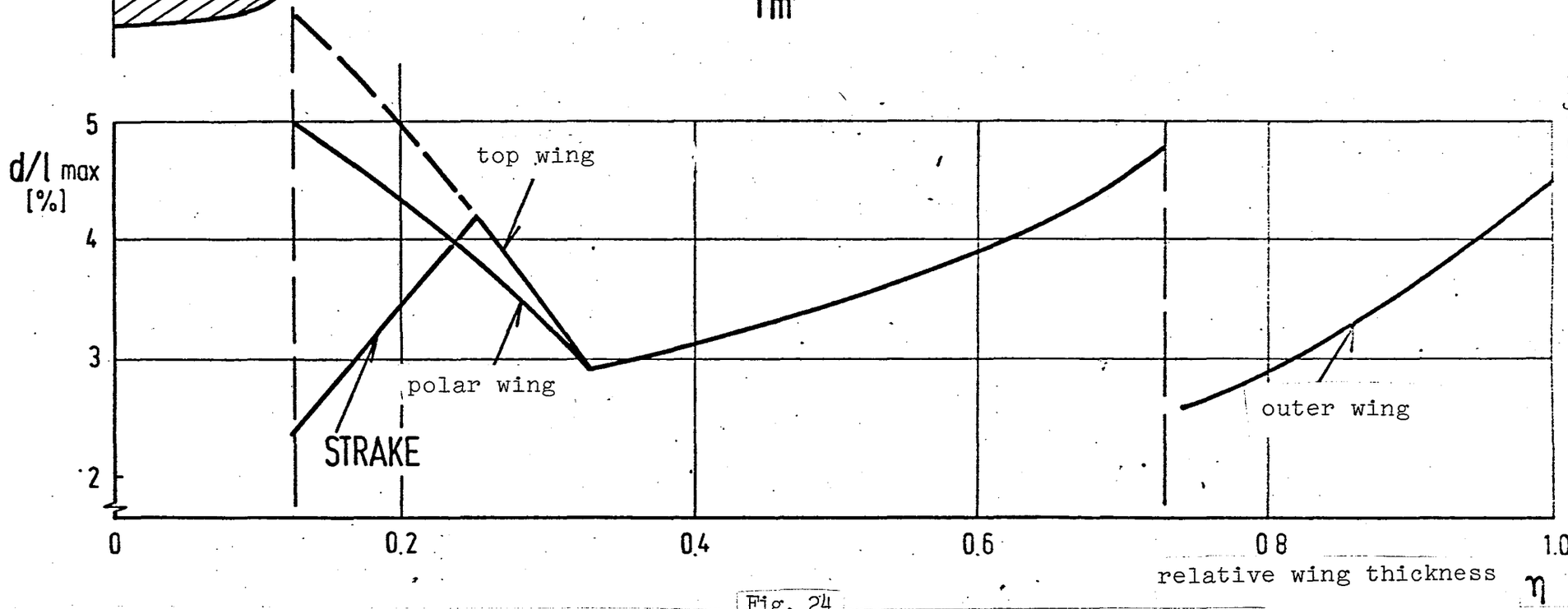
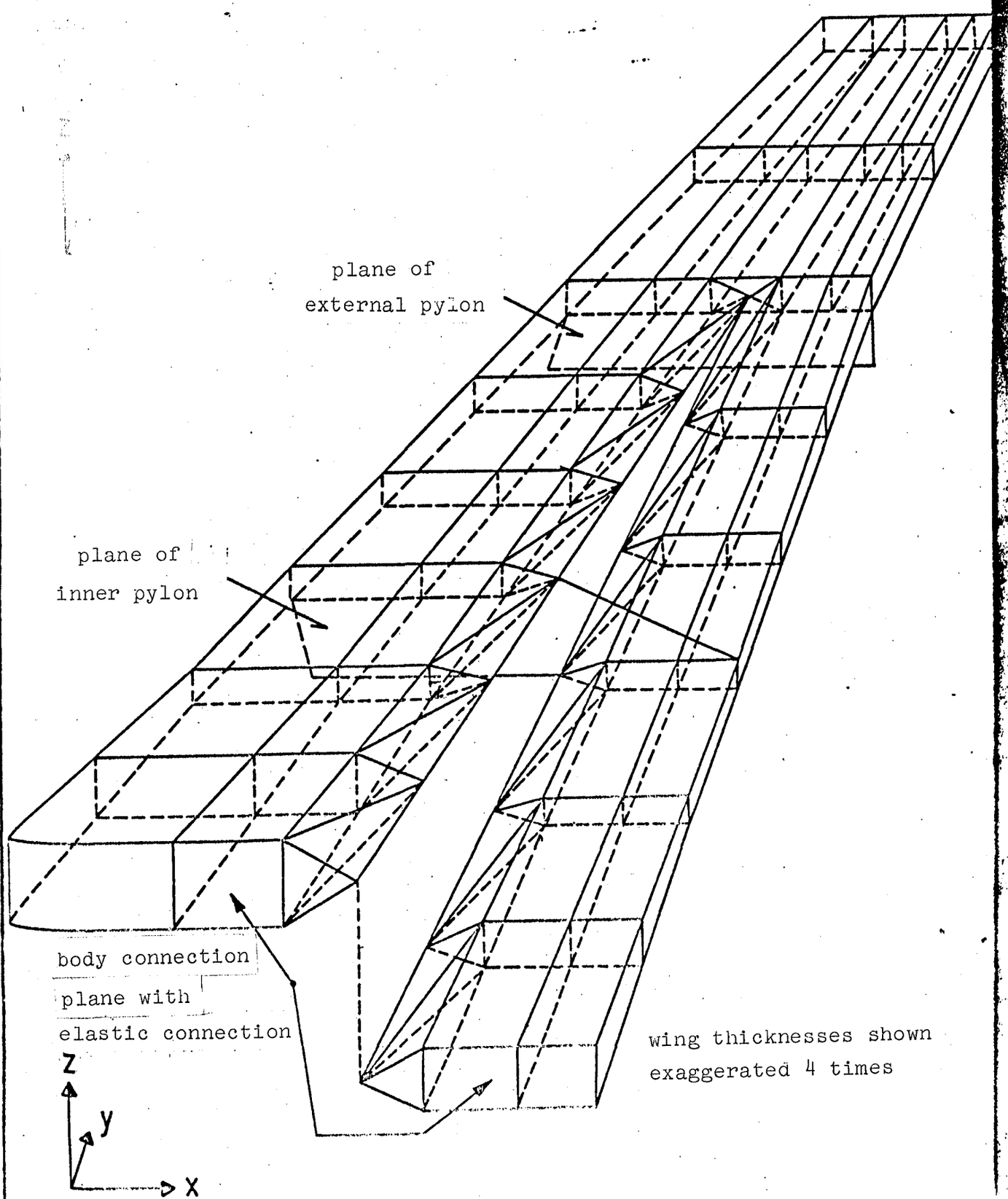


Fig. 24

Fig. 24

GEOMETRY OF WING ASSEMBLY FOR STRUCTURAL CALCULATIONS

Fig. 25



IDEALIZATION OF STRUCTURE