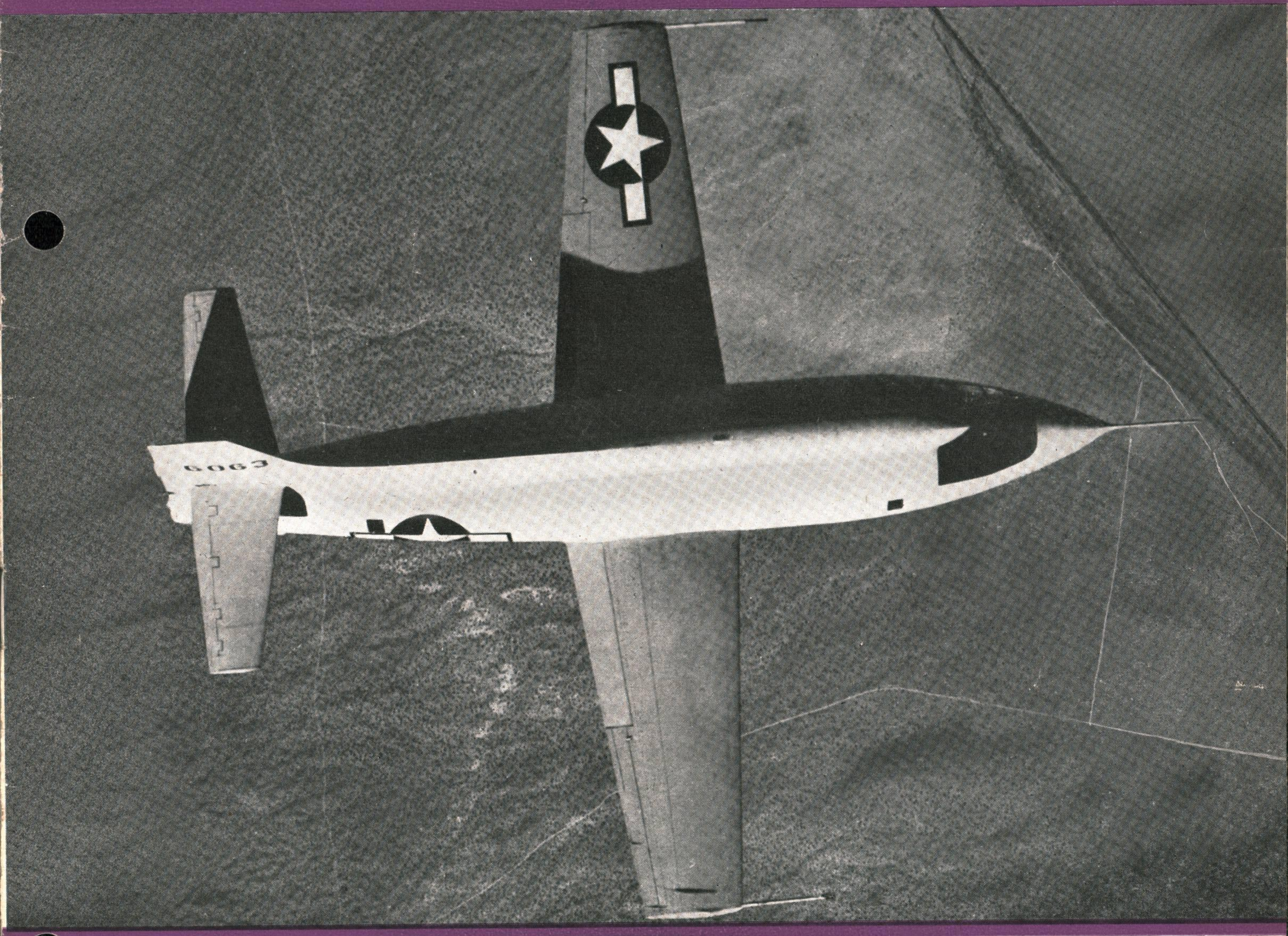
THE INTER SERVICES

AIRCRAFT RECOGNITION *Journal*



New Series

APRIL 1948

Volume 2. No. 9

Aircraft in the News

The "New Look" Military Types

1 The **Boeing XB-47** Bomber (six TG-180 Turbojets) is reported to be in the 500 m.p.h. class. The aircraft is at present undergoing tests and will probably improve on that figure.

2 The **North American XP-86** Fighter (one TG-180 Turbojet) is said to be in the 650 m.p.h. class. It too is undergoing tests ; it is also in production.

3 The **Northrop YB-49** (eight TG-180 Turbojets) is an aerodynamic and, possibly, tactical experiment in flying wing types. Reports speak of it as having good range, as jet bombers go.

All these aircraft are in the high-speed subsonic class. Note the wide differences in appearance even between the two "fuselage" models.

1

2

3

APRIL 1948 Vol. 2. No. 9

THE INTER SERVICES



AIRCRAFT RECOGNITION JOURNAL

(NEW SERIES)

De Havilland D.H. 108

Towards Easier Recognition?

AT this time of great aeronautical experimental activity, when the shape of some aeroplanes borders on the fantastic, it is as well to consider some of the reasons for this transformation. So this issue of the *Journal* is devoted almost entirely to the experimental types of aeroplane now being built, and to a simplified study of the aerodynamic problems of supersonic flight. It will be only too obvious, from the following pages, that America is making intensive efforts to lead the world on all counts.

The main reason for the violence of the changes in aircraft shapes is, of course, the introduction of jet and rocket engines. This has opened up a great new world for designers and scientists to explore, and is opening up another one for commerce to exploit. The aim at present, briefly, is to go from A to B at an ever increasing rate of knots, and to continue to arrive in one piece.

In the high-speed flight scale there are, in theory, two broad divisions, the subsonic and the supersonic regions. The two regions meet at the point of sonic speed. But, embracing both the top end of the subsonic scale and the bottom end of the supersonic scale, there is a narrow band called the trans-sonic region. There are no clear divisions between the three regions, but a gradual overlapping.

Aircraft can be divided, broadly, into three classes corresponding with these three regions, according to their speed performance. The De Havilland D.H.108 for example, belongs to the subsonic class. The Douglas D-558-2 Skyrocket is a trans-sonic type and the Bell XS-1 a supersonic type. It will be obvious that all trans-sonic and supersonic aircraft must also be subsonic.

Much high-speed flying is, at present, focused on the subsonic region, close to sonic speed, on the very edge of the trans-sonic region. There are many aeroplanes which can touch the trans-sonic region, including current jet-fighters, such as the Meteor, the Vampire, the P-80 and P-84. However, only one aeroplane is so far reported to have flown through, and to have achieved supersonic flight. This is the Bell XS-1 experimental aeroplane. It was designed to do just that. No facts and figures have yet been quoted, and no official confirmation that it has flown faster than the speed of sound has been forthcoming. Incidentally, there are, in America, a Bell XS-2, a Douglas XS-3, and a Northrop XS-4. All are supersonic types. All are enshrouded in secrecy.

British experiments in supersonic flight are, at present, being conducted with small rocket-powered model aircraft launched from Mosquitoes over the Atlantic Ocean. These models are equipped with radio which automatically transmits local flight conditions to ground stations. The models are tracked by radar and, from information thus gained, and from the models' own transmissions, details of speeds and other data are computed. In this way, it is hoped, many flights into the supersonic regions will be made at the cost only of models and without endangering the lives of valuable test pilots. When some progress has been made piloted aeroplanes will take over the work. It may come about that work will be resumed upon the Miles M-52 1,000 m.p.h., supersonic project, abandoned two years ago on grounds of economy.

Alongside the trans-sonic and supersonic speed experiments going on in various countries, investigations are being made into the efficiency of all-wing aircraft in the subsonic speed-range. Between these two lines of action there is apt to be some confusion of thought, for, although supersonic flight and flying wings do eventually appear to tie up together, many current experimental designs of flying-wing and tailless aircraft are a long way from supersonic flight, and are designed simply for research into their behaviour at moderate to high subsonic speeds. The Armstrong-Whitworth A.W.52 flying-wing is one such all-wing type from which will be gathered data concerning its efficiency up to about 500 m.p.h. It is not directly connected with trans-sonic and supersonic flight research.

In a slightly different class is the De Havilland D.H.108 tailless aircraft of which there are two models flying at present. One of them is engaged in low-speed control and stability tests. The other is doing research into high-speed flight close up to the speed of sound. It is not, however, within the supersonic class.

In America Northrops and the U.S.A.F. are developing the YB-49 bomber, among other types of all-wing machines. But they are within the subsonic class.

A survey of the world-wide experimental field leads us to suppose that the conventional aircraft of wings/fuselage/tail configuration will be in service for some time. In the fighter and bomber classes, the faster airscrew designs will probably linger for some years to come. Jet designs will probably change, perhaps only temporarily, to swept flying surfaces. There may also be a sprinkling of flying wings and tailless military types in regular service within eight to ten years.

Configurations of transport aeroplanes will probably remain fairly static. There will be an increase in speed as prop-jets, or pure jets, replace piston engines in certain classes of transport. Training aeroplanes will probably retain their present forms, with minor changes reflecting the increase of power and speed in the front-line operational types.

But what is more important to us is the fact that the extravagant shapes and proportions of future aircraft, clues to which are to be seen in current experimental designs of all classes, indicate that differences between individual types may be more marked. Recognition may therefore become easier, at least for a period. And anything towards that end is always a Good Thing.

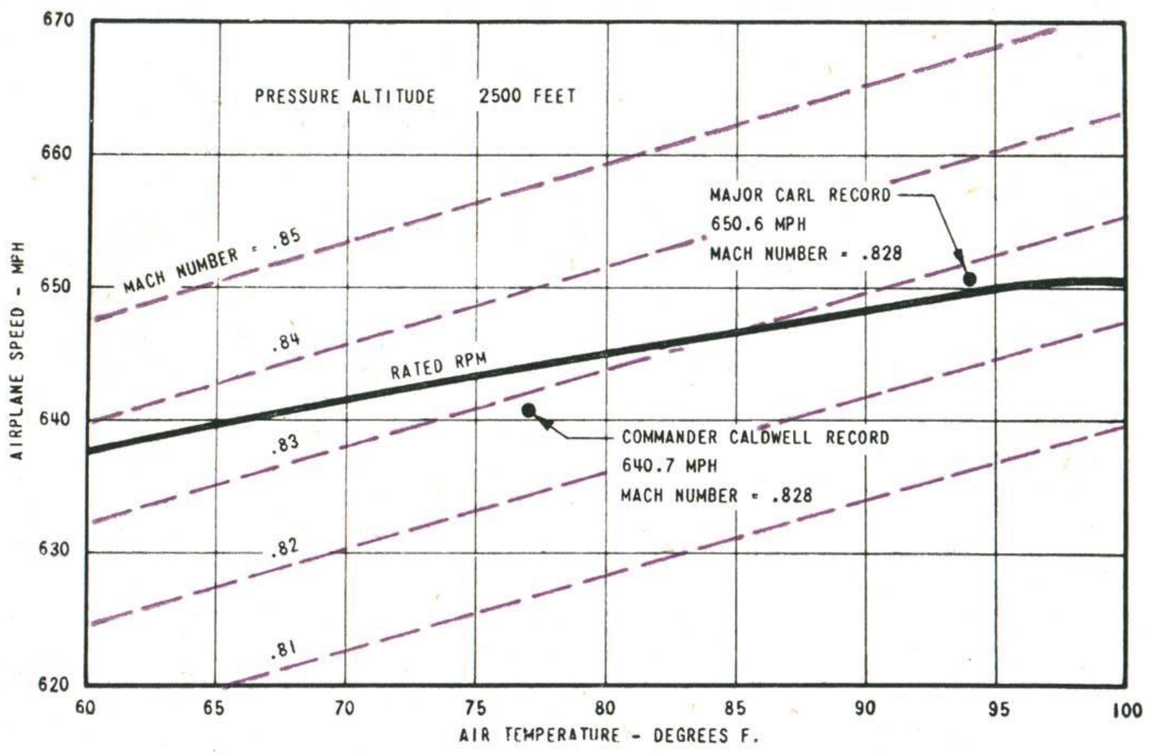
SIMPLIFIED SUPERSONICS

There are very many problems connected with high-speed subsonic, trans-sonic, and supersonic flight. This article attempts to touch upon only the broader aspects of the aerodynamic problems with a brief mention, towards the end, of some of the other problems involved. The main idea is to help readers to understand why aeroplanes are changing their shapes so radically. We are indebted to Flight Lieutenants R. W. W. Buckley, A.R.Ae.S. and J. F. Hall, of Air Ministry, for their assistance in checking the facts and for agreeing to reduce the technicalities to something approaching absurdity.

ON THE 20th August, 1947, around midday, Commander T. F. Caldwell, U.S.N., flew the Douglas D-558-1 Skystreak at 640.7 m.p.h. This was 82.8 per cent of the speed of sound, or, as it is technically termed, mach number 0.828. The speed of sound on this occasion was about 773 m.p.h. (*See Chart below*).

On the 25th August, 1947, also around midday, Major Marion E. Carl, U.S.M.C., flying the same machine, pushed the world's air speed record to 650.606 m.p.h. This also represented 82.8 per cent of the speed of sound, which was, on this occasion, about 785 m.p.h.

Why was the speed of sound different on these two occasions ? How did it affect the speed of the Skystreak ? The answer to the first question is that the air temperatures were different. On the first occasion it was 77 degrees Fahrenheit, and on the second 94 degrees Fahrenheit. The answer to the second question is that sound travels faster through warm air—one reason for flying at midday. In warm air, aeroplanes can reach a higher speed before encountering compressibility. The reasons for this we shall see later. Meanwhile let us consult Dr. Mach



Dr. Mach

The speed of sound is called mach one because a certain Dr. Mach, a German scientist, used his name as a standard by which to compare the speeds of projectiles. This was in the good old days before the thoughts of inventors, and others, had strayed to ideas of travelling at supersonic speeds. The term " mach number ", as applied to high-speed aeroplanes, means simply the relationship of the speed of the aeroplane to the speed of sound.

An instrument called a machmeter, fitted in the cockpit of most high-speed aeroplanes, shows the relationship of the *true* airspeed to the local true speed of sound ; that is, the speed of sound in the vicinity of the aeroplane.

Critical Mach Number

Aircraft in the subsonic speed range do, by virtue of their shapes, induce a speeding up of the airflow over certain parts of their structure. When travelling, say, at between 400 and 500 m.p.h., air may be flowing over some portions of the aircraft at sonic-speed, Fig. 1. That portion of the aeroplane is then subjected to compressibility effects. When this happens, the aircraft is said to have reached its critical mach number, which is marked on the machmeter. The mach number of 0.828, mentioned earlier, may be the critical mach number of the Skystreak.

In general, it can be said that aeroplanes in their present form (excluding experimental types) can fly at subsonic speeds which go up to a mach number of only about 0.85. From mach number 0.85 to 1.15 is the so-called trans-sonic region. Speeds beyond mach number 1.15 are truly supersonic speeds. The trans-sonic region and the supersonic region are mainly unexplored at present.

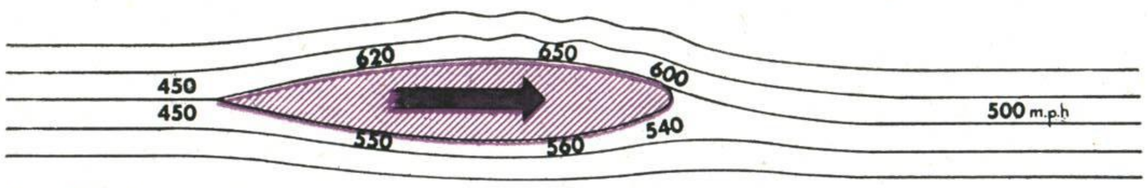


Fig. 1. A subsonic wing section reaching its critical mach number

Thick and Thin

We mentioned variation in the speed of sound. There are 440 million million million molecules of air per cubic inch at a pressure of a standard atmosphere at 59 degrees Fahrenheit. This can be regarded as the normal density of air. At an altitude of 500,000 feet—roughly 95 miles up—there are, in theory, just over four million million molecules per cubic inch, which is a very rare atmosphere indeed. We should be extremely pushed to collect enough air to breathe, let alone fly any aeroplane of present-day design. This is a picture of the extremes of atmospheric density. We can define the density of air as the number of molecules in a given space.

At normal temperatures molecules of air dart about at speeds often around 1,000 m.p.h. The speed at which they travel is directly governed by their temperature. If they are warm they move fast. If they are cold they get sluggish. We shall define this activity as " domestic speed " to distinguish it from the other types of air movement, such as winds, airstreams, and other meteorological phenomena, which are in fact mass movements of molecules in a definite pattern or stream.

The Frozen Limit

The coldest cold that it is possible to achieve, at least in theory, is about minus 459 degrees Fahrenheit. At this extreme temperature nothing moves—absolutely nothing—not even molecules. Being nothing if not human, we can appreciate their indifference. At temperatures above this frozen limit the molecules of air are always on the move. Theory has it that, as they dart about they frequently collide with one another, and with various objects which happen to lie in their paths, like chairs and tables and bottles of beer From these objects, and from each other, they rebound.

To make the picture quite clear, when thinking of airflow, picture a stream of grains of sand, or salt, all travelling along in one direction but each individual grain darting about and hitting its neighbour and whatever else it meets. Even in still air molecules keep up their darting.

In the Can

To demonstrate just how active molecules of air can become under the influence of heat, all you have to do is to seal up a can, heat it up, and stand clear. If enough heat is applied the can will burst. What happens is that the molecules of air get very " het-up " and double, and redouble their speeds if they get hot enough. This means that the number of collisions increases, and so does the force with which they collide with each other and the sides of the can. The sum total of the force which they individually apply to the can is what we call pressure.

The Speed of Sound

The speed at which the molecules dart about directly influences the speed of sound through air. Since at the frozen limit there is no movement of molecules, there is no such thing as sound. This fact led one very bright pilot to remark that it seemed to be simply a matter of reducing atmospheric temperature to the absolute limit and he could then pass the sonic-barrier while taxying out. But to continue . . .

Train Watching

If you have ever watched goods trains shunting, as we have, you will have been fascinated by the way in which the locomotive knocks the trucks about. When it gives the first truck a shove, this is transmitted all down the line of trucks to the last one, Fig. 2(*a*). When the engine pulls the first truck, the pull is transmitted from truck to truck all the way down to the end. The point to notice is that it takes a certain amount of time for the pulls and pushes of the locomotive to be felt at the other end of the train.

Now that is a pretty rough analogy of what happens to masses of air molecules when sound travels through air. The masses of molecules are alternately pushed and pulled. The best way to see this is to look at Figs. 2(*b*) and (*c*).

Here the shunting locomotive has been replaced by a tuning-fork prong, and the air has been theoretically split into layers. The vibration of the right-hand prong of the tuning-fork is simply a rapid movement from left to right and back again ; so fast that we can, normally, see only a blur. If we could slow up this vibration and if we could see air molecules, we should see that the movement of the prong to the right pushes or hits the nearest molecules, which, remember, are continually bouncing off it rather like a million cricket balls flying off a swinging bat.

Message from the Midland Area Commandant, R.O.C.

To:- All Ranks of the Midland Area Royal Observer Corps.

A little over a year has elapsed since the re-organisation of the Royal Observer Corps on a Post-War basis. During that time many difficulties have been overcome and very satisfactory results achieved. Many difficulties remain, but I feel confident that the continued enthusiasm and loyalty displayed by all Ranks in the Midland Area during the past year will surmount these difficulties and lead to further achievements during the coming year.

I take this opportunity of wishing all Ranks of the Midland Area Royal Observer Corps a very Happy Xmas and a Prosperous New Year.

(signed) W.G.HANSON.
Midland Area Commandant.

MESSAGE TO THE CORPS FROM THE COMMANDANT AND DEPUTY COMMANDANT.

It has now almost reached the first anniversary of the peace-time Royal Observer Corps Organisation, and it is opportune to say that on reviewing the activities of the past year, we can justifiably say that a satisfactory position has been reached.

This happy state is in no small measure due to your enthusiasm and loyalty to the Corps, for which we offer our sincere thanks with the knowledge that the good work done will be continued.

In conclusion we take the opportunity of wishing you a very Happy Christmas and Good Luck for the coming year.

(signed) Air Commodore the Earl of Bandon,
Obs/Capt. Cooke.

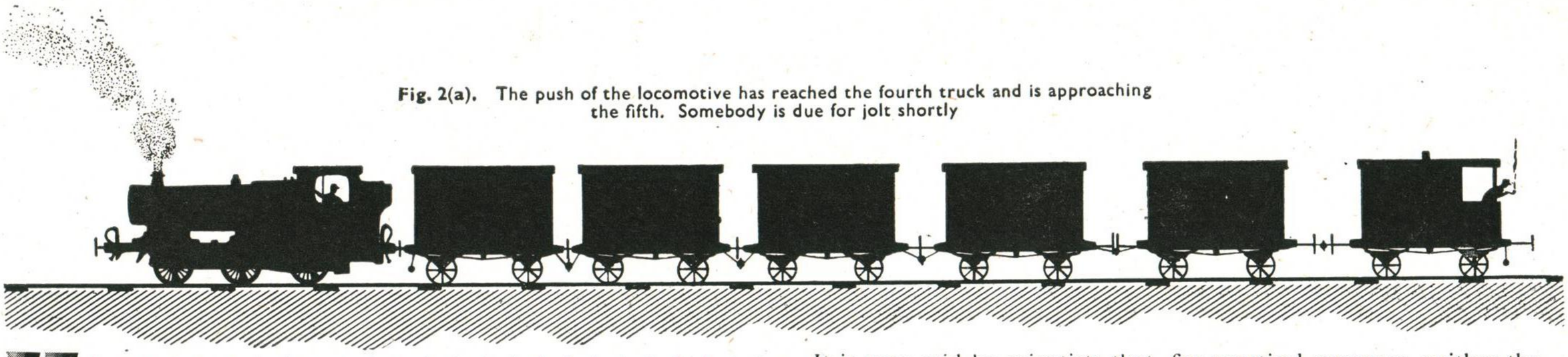


Fig. 2(a). The push of the locomotive has reached the fourth truck and is approaching the fifth. Somebody is due for jolt shortly

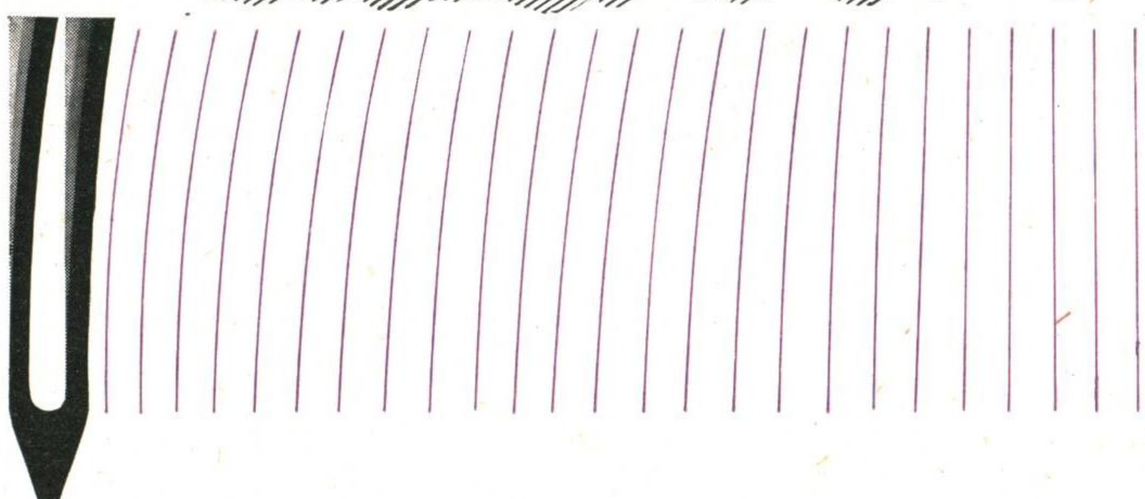


Fig. 2(b)

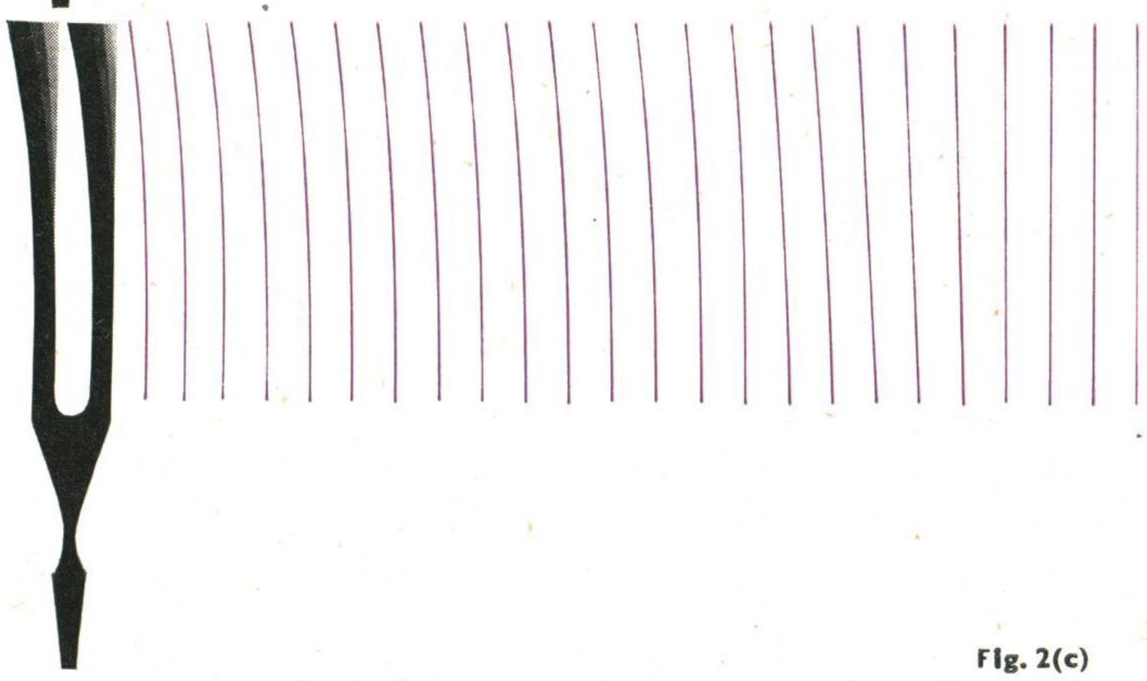


Fig. 2(c)

Knocking 'em for Six

The molecules are thus batted away at a higher speed than they are bowled. Fig. 2(*d*). These higher-speed molecules collide with others which in their turn pass on the blow, in this way propagating the original movement in the form of a pressure wave, which finally peters out some distance away. Conversely, when the prong swings to the left (analogous to the pull of the shunting engine) the rebound speed of the molecules is diminished because the prong is receding from them. Fig. 2(*e*). This diminished speed is also transmitted over a distance. There will thus be alternate waves of high and low pressure.



Fig. 2(d)
Rebound speed increased



Fig. 2(e)
Rebound speed reduced

These are the facts to note

(*a*) A replica of the tuning-fork vibration is sent over a distance, and, incidentally, if your eardrum is in the way it will vibrate in harmony and you will hear the sound.

(*b*) The speed at which these pressure waves pass is governed by the domestic speed of the molecules.

(*c*) A molecule's domestic speed is governed by its temperature, and therefore the speed of sound is governed by temperature.

The speed of sound through the atmosphere at a normal temperature at sea-level is about 760 m.p.h.

It is now said by scientists that, for practical purposes, neither the density, nor the atmospheric pressure can influence the speed of sound, except through an alteration of temperature. A decrease in the speed of sound as higher altitude is reached is simply due to a drop in temperature.

It's False !

If we now replace the tuning-fork by a wing section, and move it through the air well below sonic speed, we shall produce an area of pressure ahead of it. But since the wing, unlike the tuning-fork, is moving continuously in one direction—that is, it is not vibrating—it will produce only continuous pressure, which the molecules of air pass on to each other until the pressure area peters out some distance ahead of the wing.

This pressure area can be likened to a false leading edge to the wing, because it parts the airstream ahead of the real leading-edge, permitting a smooth passage to the wing, Fig. 3(*a*).

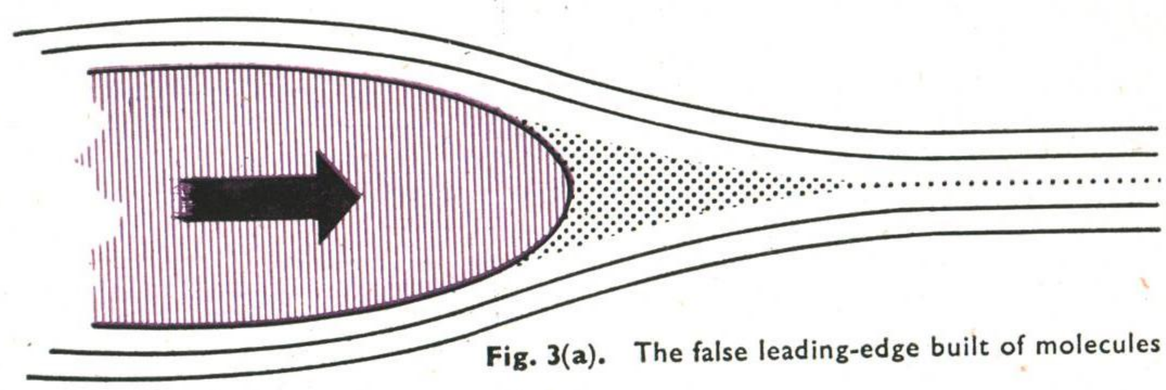


Fig. 3(a). The false leading-edge built of molecules

Try Salt on it!

This false leading-edge idea will be better appreciated if we up-end a wing, stand it on its trailing-edge, and gently pour salt in a steady stream on the leading-edge. Consider the salt grains to be air molecules, (although the analogy does not take into account the molecules' domestic speed). Some of them appear to form a mound on the leading-edge equivalent to a false leading-edge, which divides the flow of grains and makes the rest pass more smoothly round the wing. Fig. 3 (*b*). The same grains do not form the mound all the time ; they are continually being replaced by others.

Air behaves very much like that at subsonic speeds. If the wing is of good shape and form, the air closes in neatly behind it leaving no turbulence. Air likes to be induced to do things rather than be subjected to force—(who doesn't ?) —and the more gradually air is made to deviate from its normal position the less notice it takes of the fact that it is being directed.



Fig. 3(b). The false leading-edge built of salt or sand grains

The Crux

We now come to the meat of the problem of supersonic flight—the so-called sonic barrier.

As long as the airflow around a wing is below sonic speed it will remain reasonably smooth. As the speed of the wing is increased the false leading-edge diminishes until at the speed of sound it is worn right away.

With no leading-edge to help them to divide, some of the molecules strike the wing at terrific speed—a speed which can be roughly the sum total of the speed of the airflow and their own domestic speed. This means that they are batted off the wing at a speed far above their domestic speeds—their " designed " speeds if you like. They can't take it, so they cut up rough—very rough indeed. They not only refuse to play, that is to flow ; they may, by turbulence, break up the aeroplane unless it is very strongly built. This turbulence is called " compressibility effect ". This, however, is not the whole story, but we must leave it there at present.

Compressibility

" Compressibility " roughly means that the aircraft is attempting to push the air mass before it. There are two main reasons for this condition, the first being the loss or diminution of the false leading-edge, and the second the destruction of the natural pattern of the air forming the flow. The two phenomena are inter-related.

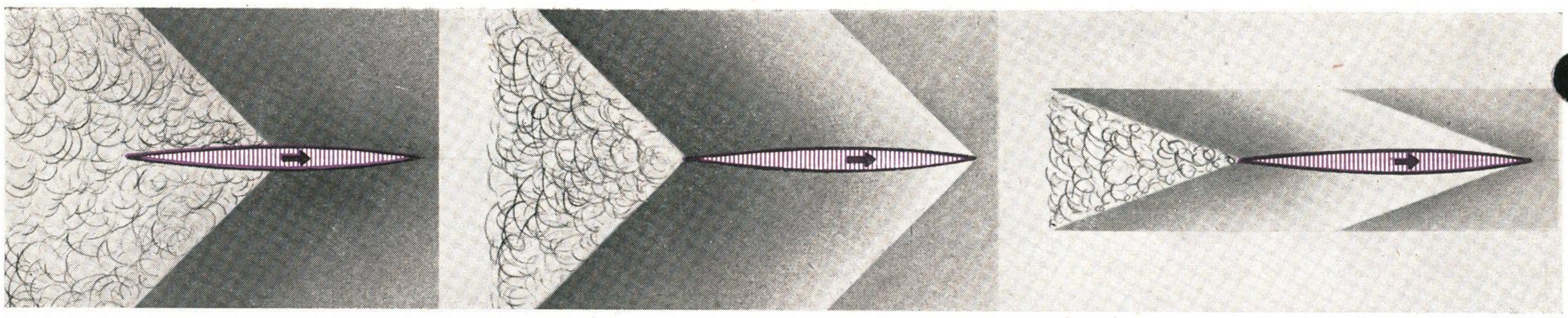


Fig. 4. Reading from left to right : the shock wave forms as transonic speed is reached ; stage two shows what happens as supersonic speed is reached ; stage three shows what happens as speed goes still higher, the angles of the shock waves reduce themselves.

Shock Wave and Shock Stall

We said earlier that a wing sends pressure waves ahead of it. Consider a point—just a point—vibrating, thus sending out waves like ripples on a pond, Fig. 5(*a*). The point moves, still vibrating, and, as it moves, produces a set of eccentric ripples, Fig. 5(*b*). When it moves as fast as sound the ripples are as seen in Fig. 5(*c*), that is, there are no sound waves ahead of its direction of travel. The point is thus meeting and compressing air. Air immediately in front of the point thus becomes more dense—the molecules are packed together more tightly. This is, in fact, the birth of the shock wave.

When the vibrating point travels faster than the speed of sound the ripples are strung out still further, Fig. 5(*d*). There are many more ripples than we can show. We have joined the edges with a line—a tangent. On this line is the region of greatest density because here the expanding ripples meet the oncoming air. This is the shock wave. It is a region—a very thin one—of very dense air. The faster the point travels the more strung-out are the ripples, and the more acute becomes the angle of the shock wave, Fig. 5(*e*).

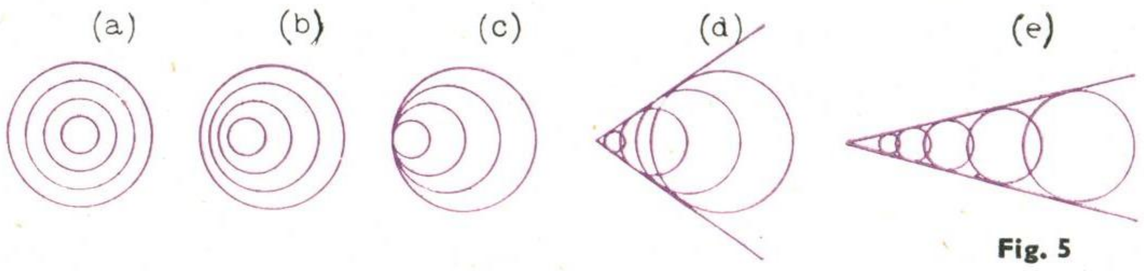


Fig. 5

Replacing the point by a wing approaching supersonic speed, the oncoming air cannot flow smoothly through its shock wave and turbulence occurs behind the shock wave. This increases drag, affects lift, and interferes with stability and control.

Incidentally, a shock stall is a stall induced by the breakdown of airflow over the wing and a breakdown of the air structure, or pattern, as well. This distinguishes it from a wing stall at subsonic speed, where only the airflow breaks down.

Pity the poor Designer

The designer's problem is to make a wing—indeed a whole aeroplane —which will slip through these turbulent conditions, causing the absolute minimum of disturbance, and remain intact and under control. Some disturbance there must be, since wings have either a camber or angle of attack to produce the differential pressures which constitute lift. If an aeroplane can be flown safely through the barrier in one piece, there is good reason to believe that, apart from the problems of power, drag, strength, and refrigeration, an aeroplane of subsonic design, such as the Meteor, would fly quite well.

The cunning of some designers in meeting their problems is shown by some of the following examples.

Swept Wings

A swept-back wing will delay the onset of compressibility. The main effect of sweepback is to slow up the relative airflow over the leading-edge of the wing, Fig. 6. In this diagram the molecules are enlarged to show they take relatively longer to cross the swept wing. Higher speeds can therefore be attained before compressibility sets in.

Usually, however, when a wing is swept back it is necessary to " droop it ", that is, to put an anhedral or "negative dihedral" angle. (American term—" cathedral ".) Look closely at the wings of the Boeing XB-47, and the De Havilland DH 108. Both have " droop ".

Droop Wings

The stabilizing influence of a dihedral angle in a swept wing would be too strong, because, if the aircraft dropped a wing, the down-going wing would get too much extra lift while the up-going one could be completely stalled, Fig. 7. To balance the distribution of lift it is necessary to build in some anhedral angle.

The swept wing idea was thought, at one time, to show promise of aiding the passage through the sonic barrier. Experience has shown, however, that a swept wing merely delays compressibility. It does not

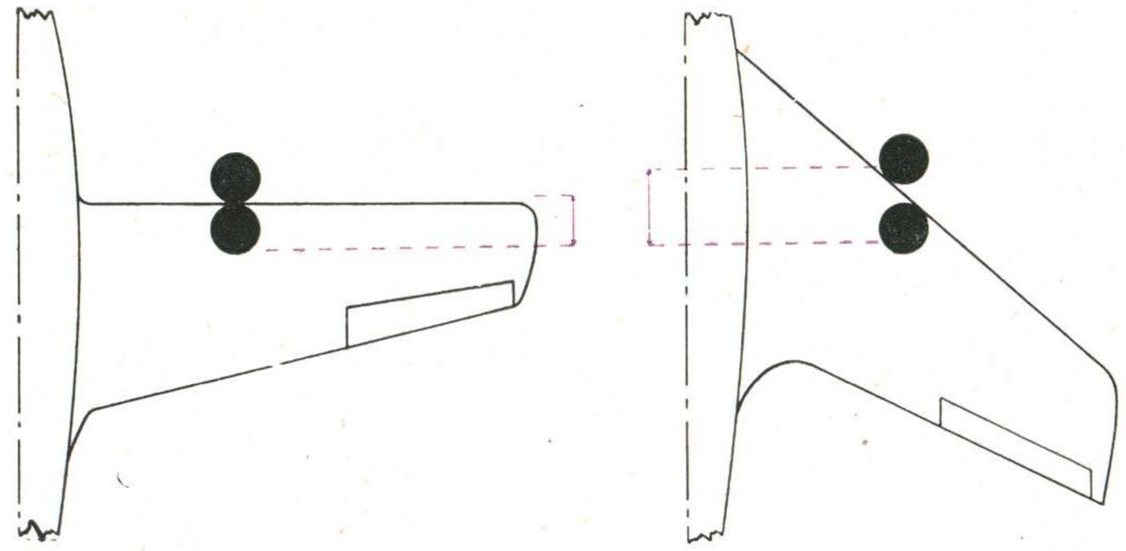
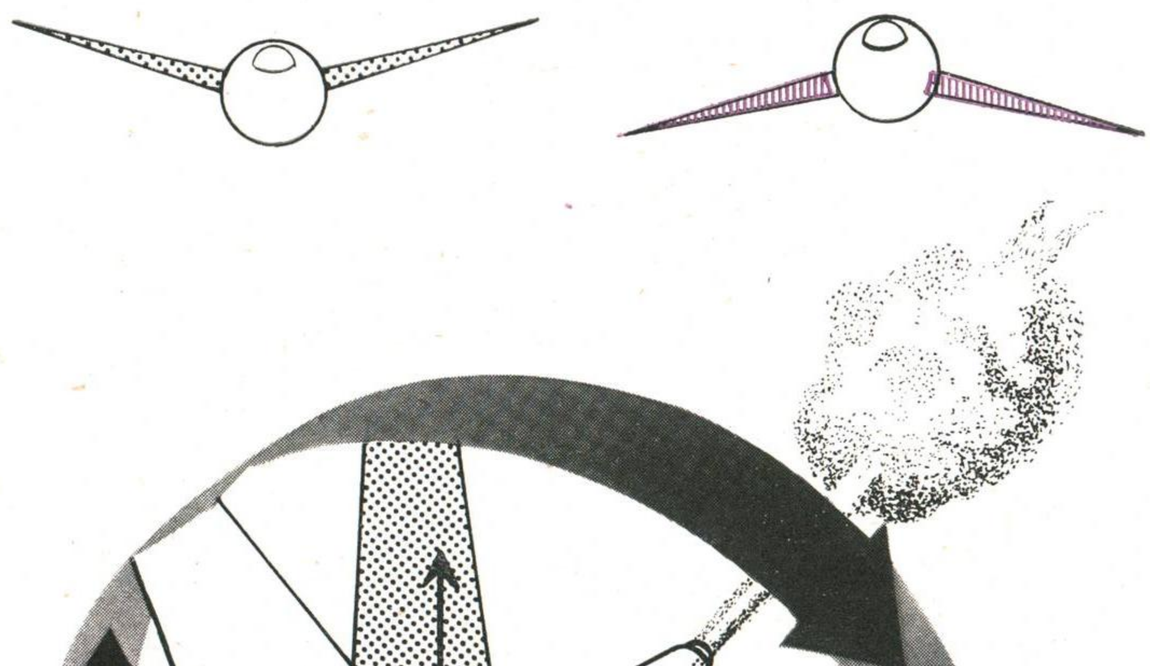


Fig. 6. The speed of the aircraft is assumed to be the same for both straight and swept wings, but the molecule of air takes longer crossing the edge of the swept wing. There is thus a relatively slower airflow over the swept wing

do away with the necessity of passing the sonic barrier, and once through, is in no way superior to a straight wing. It certainly helps in attaining a higher subsonic speed, and may help even at sonic speed.

Fig. 7. This theoretical aircraft has three sets of wings. The top set has a dihedral angle ; the centre set is neutral ; the lower (coloured) set has an anhedral angle. In the diagram we assume the aircraft drops its port wing. The thin arrows indicate the consequent relative airflow across the sets of wings. In the top set there is very much more lift on the downgoing wing than upon the upgoing one : result—over-stabilization. The difference in lift on the centre set is less marked. On the lower set (coloured) the difference of lift is even smaller : result—normal stabilization



The Inevitability of Gradualness

Bearing in mind the need to part the air as gradually as possible, and also that, at sonic speeds, the " ghost " leading-edge has gone, many wing designs have very sharp leading-edges. They must also be very thin as well as strong. Flattened diamond-section, and knife-section wings are typical examples, Fig. 8. The keynote is sharpness of entry, and thinness in proportion to the chord. This is technically described as of " high fineness ratio ".

As a result of these extreme proportions, strength problems crop up. Thus, some wings are made with solid leading-edges. Skins are very thick : as much as half an inch at the root portions of the Bell XS-1 and the Boeing XB-47 wings.

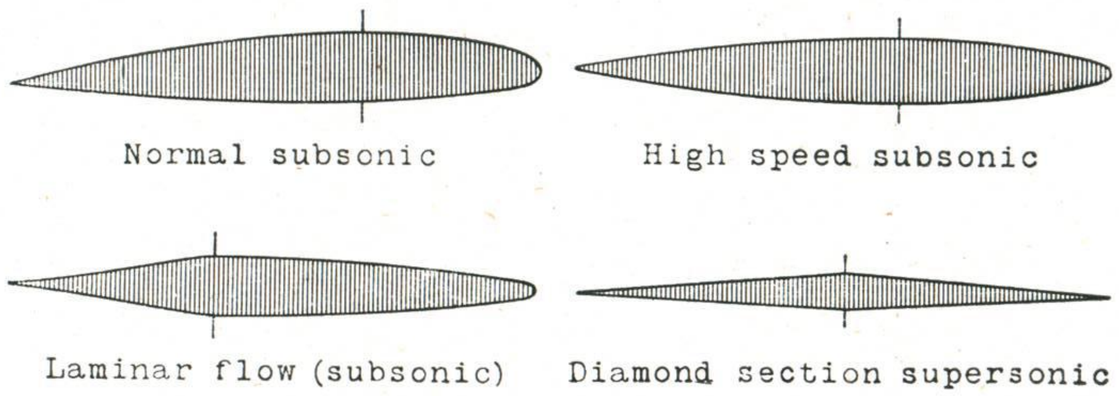


Fig. 8. Typical wing sections



The Flying Wing

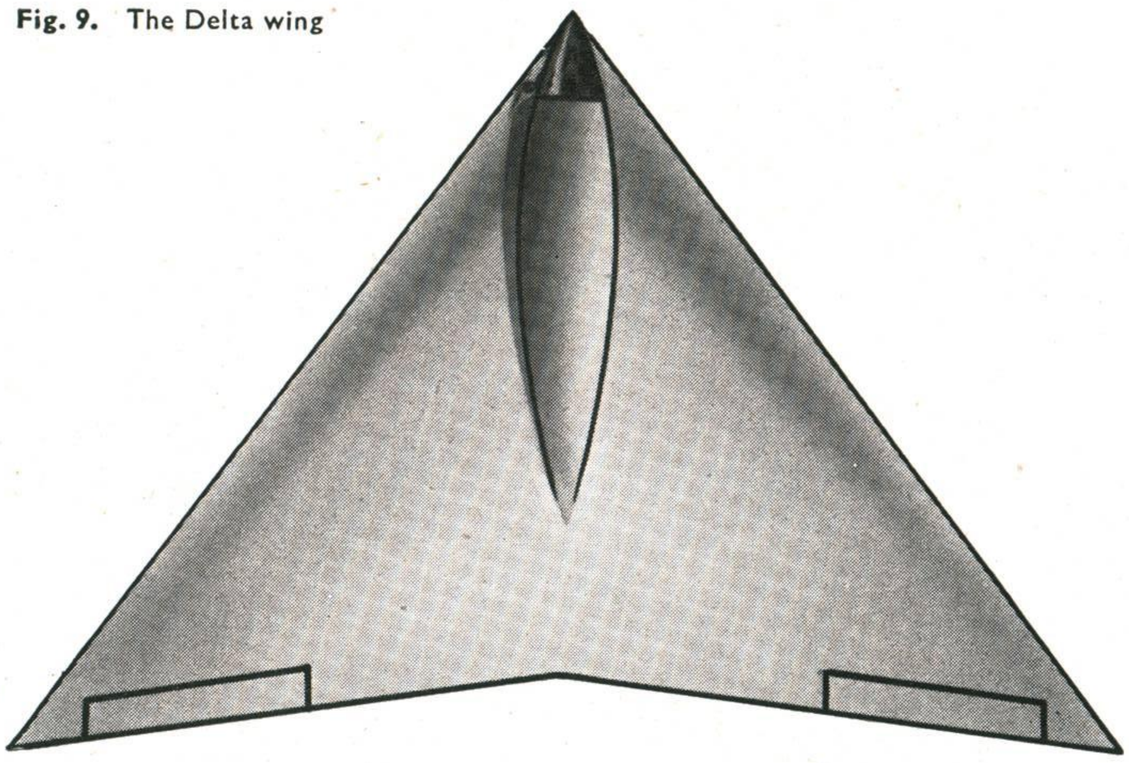
Some designers think that the delta wing, Fig. 9, is the ideal, because the aeroplane starts off at nothing, or at just a pin-point, and develops into a swept back flying-wing, which, if made long enough in chord, would permit all machinery and passengers to be put inside. It would then slip through the air with the greatest of ease—fooling the air, in other words. There may be something in this. If so, all aircraft may eventually take on this form, and instead of " flying saucers " we shall have " eternal triangles ".

Needle-nosed fuselages, as in the Bell XS-1 and the Douglas D 558-2 Skyrocket, are also designed to part the air—to warn it, if you like—of the coming of a fuselage, gradually smoothing a passage for it.

Many other startling shapes and design features are likely to appear in the near future, and because swept wings delay the onset of compressibility, we may expect to see a family of subsonic swept-wing fighters and bombers as interim models in the world's air forces ; though eventually we may go back to the straight wing jobs for the supersonic fighters and bombers of the future. At present it is impossible to say.



Fig. 9. The Delta wing



To Recapitulate

The main problem, then, is not to disturb the air too much whilst pushing aeroplanes through it at sonic and supersonic speeds, because if you do, air reacts with dire and drastic results. You can, as it were, " get round " the air by introducing special shapes and forms. These special shapes and forms are the features with which we, as spotters, must be familiar.

But besides the aerodynamic ones there are many other problems connected with supersonic flight which have to be solved, but as they do not affect appearances very much we shall discuss them in less detail.

The Power Problem

At the altitudes at which a supersonic airframe may be expected to work most efficiently, that is, in rarified atmospheric conditions, a turbojet would be starved of air and therefore useless. For this reason, though turbojets may be installed for purposes of take-off, relatively low altitude flight, and landing, as in the Douglas D 558-2 Skyrocket, rocket motors appear to be the only solution for really fast supersonic flight

One problem of rocket motor design is the extremely high fuel consumption, with attendant fuel stowage problems. For example, the Bell XS-1 burns about one and a half tons of rocket fuel in two minutes. This extremely high rate of consumption calls for very careful design of the fuel system so that the balance (flying trim) of the aircraft is not upset as the fuel is burned.

Another problem is control of thrust ; for rocket motors, in their present state of development, cannot be satisfactorily throttled as can turbojets. To try to overcome this difficulty, the Bell XS-1 and Douglas Skyrocket employ four separate rocket motors which may be selected individually or collectively by the pilot, according to the thrust required.

A burning question is the selection of refractory materials capable of withstanding the extremely high temperatures attained in a rocket motor's combustion chamber. Rocket thrust and combustion temperatures are closely related—to obtain a higher thrust one must burn a greater quantity of fuel at a higher temperature. Also, many rocket fuels are extemely " touchy ", and will ignite at the slightest provocation. This necessitates special precautions in handling and storing.

The key to supersonic flight may well be in the hands of the rocket designers, for the power curves on the graphs of the experts start to skyrocket as soon as sonic speeds are reached, and for trans-sonic and supersonic flight will probably go still higher unless, of course, very high altitudes are attained. It now appears possible that the necessary power may only be attained by means of rocket motors. This, in turn, implies that the range of supersonic aircraft will be very limited during the early stages of their development.

The Heat Problem

At supersonic speeds an aeroplane can get very hot. Just as a bicycle pump generates heat as it is used, a supersonic aircraft does so by compressing the air in front of it. There is also skin friction, a big factor at high speeds, as well as the sun's radiated heat and heat from the turbojet or rocket engine. In the Skystreak, a cockpit temperature of 170 degrees Fahrenheit was reached on a test run without the refrigeration gear operating. To combat the adiabatic heat (the heat from compressibility) obviously a clean design will help. White paint reflects radiated heat, so some high-speed aircraft are painted white or silver, and all are extremely highly polished to reduce skin friction. Various types of refrigerating methods are adopted for cooling the turbojet and pilot's cabin.

The Human Factor

The problem of safety of crews and potential passengers in supersonic aircraft increases with speed. A means of escape is a necessity in all military aircraft in case of damage in battle. This produces yet another problem, that of baling out. From the civil point of view the problem takes on a new form. Jettisonable pressurized cabins and such-like things are not attractive, so the machine will have to be one hundred per cent reliable. That is a tall order. It means too that it will probably take longer to develop than a military supersonic aircraft and, as far as can be seen at present, cost much more.

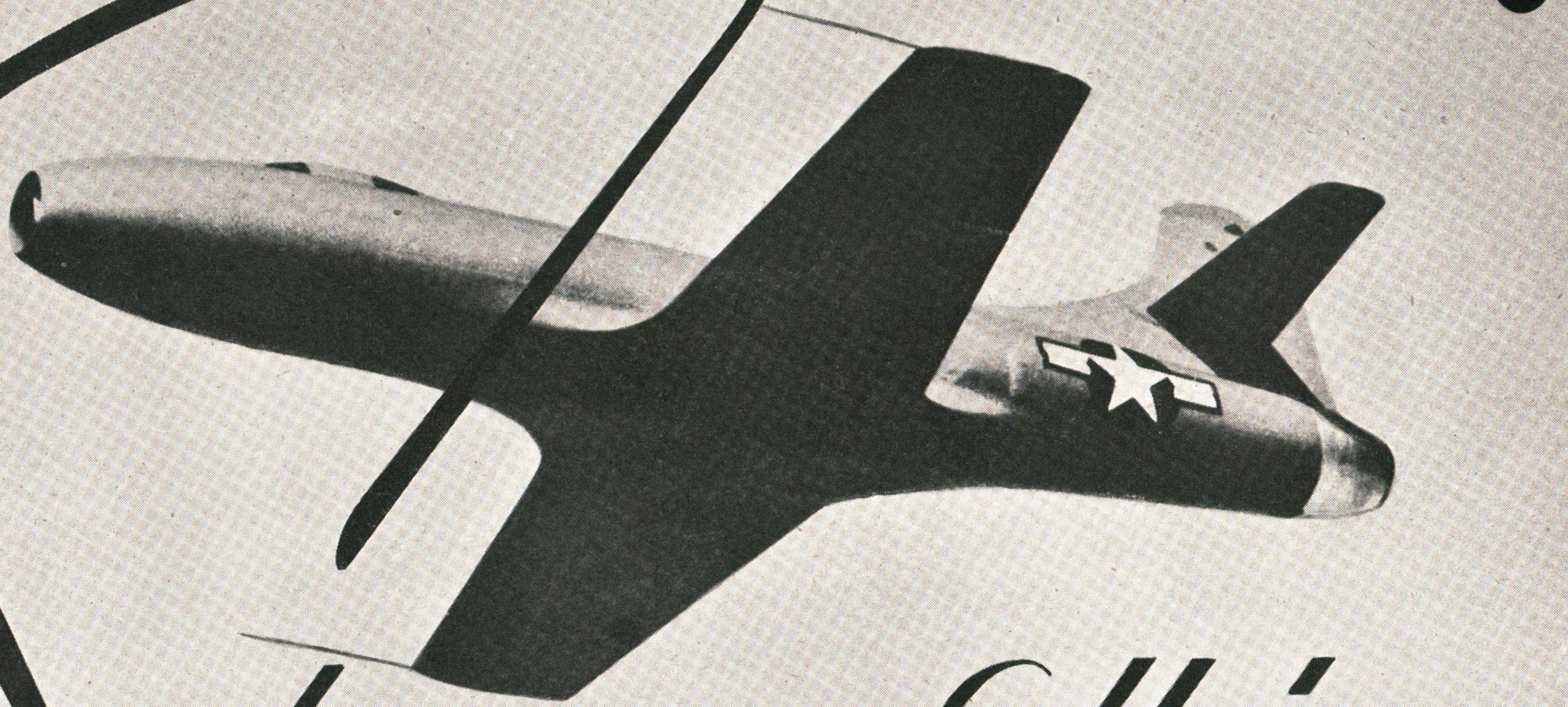
What it takes

The present type of experimental supersonic aircraft is nothing but a very expensive and somewhat dangerous flying laboratory into which a pilot has to be shoe-horned. To be rigidly harnessed and then sealed inside a tiny, pressurized cockpit ; sweating in an anti-G suit ; surrounded by rows of fluorescent dials—the only indication of what is happening outside ; amid miles of cable and piping ; a view of a small piece of sky and still less of Mother Earth; and then, with the aid of thirty, forty, or fifty thousand fiery horses, at white heat, to hurtle out into space, is not everyone's idea of a pleasant journey. Still less pleasant is the knowledge that if something goes wrong and it becomes a question of parting company with the machine, it is a matter of blowing it to pieces and of staying with one piece until atmosphere and speed conditions are such that it is safe to rebale out. That is a picture which confronts those who attempt supersonic flight today.

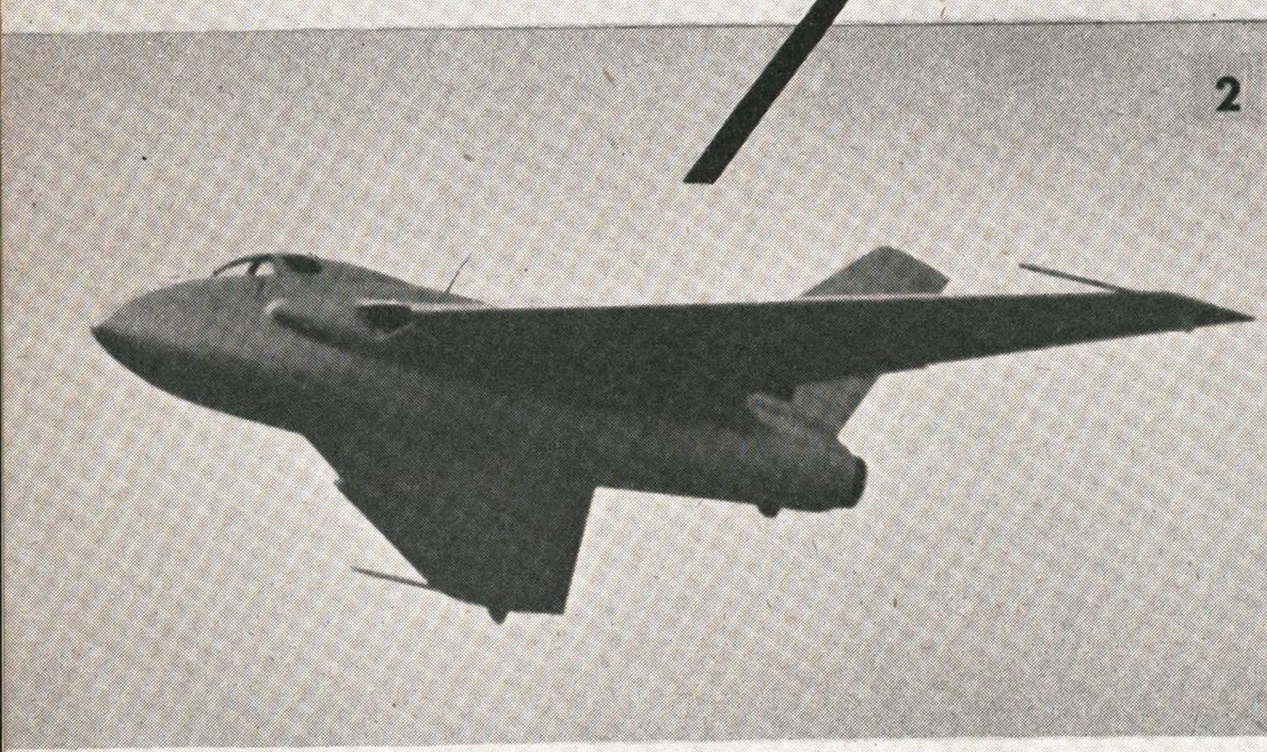
Conclusion

Men and machines are ready and on the point of making such flights —ready to probe the unknown. If the Bell XS-1 has already flown through the barrier—there is no confirmation of this—there is still further probing to be done. The surface of the job is only very lightly scratched. That supersonic flight will one day be a regular thing there seems no doubt, but the time it will take for our efforts to bear fruit is another question, in which money too, or the lack of it, will play a big part.—C.E.S.

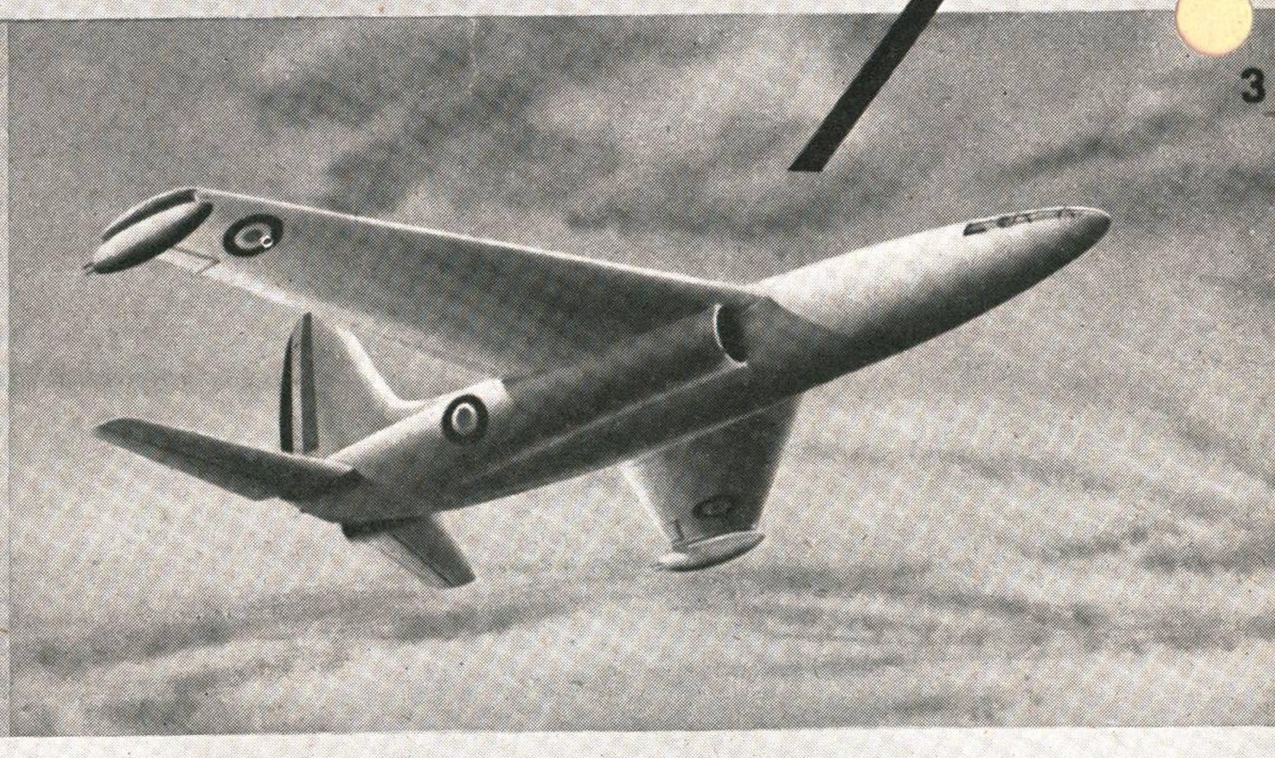
The Shape of things



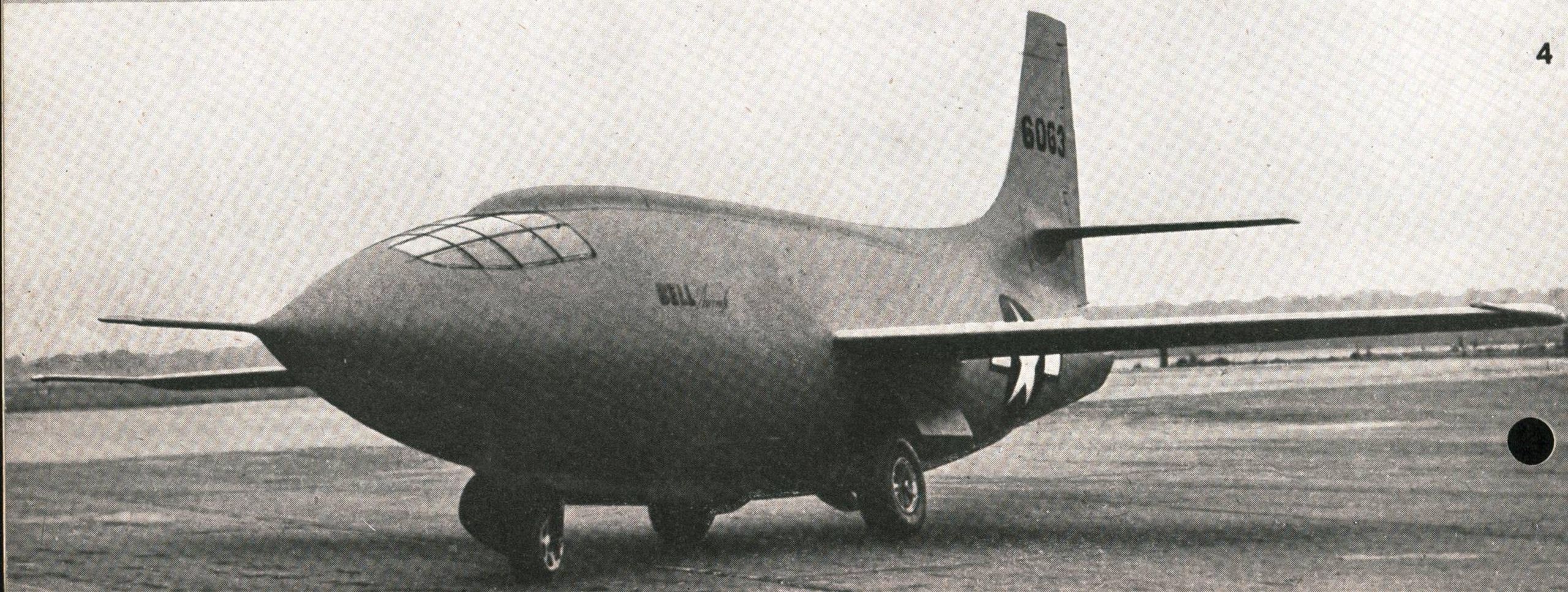
2



3



4



5

WITH the exception of the Aero-Sudouest S.O. 4000 (No. 3), which is a French bomber design, the aircraft illustrated on these two pages were designed and built purely for experiment and research flying. They represent the latest thought and constructive ingenuity of their designers that is publishable, and they cover the speed range from high subsonic to well into the supersonic region.

The Douglas Skystreak (No. 1), seen here breaking the speed record, was designed to obtain data on certain aspects of high-speed subsonic flight which could no longer be obtained in wind tunnel experiments. It is packed with instruments which will record the results of a very comprehensive flight test programme which is expected to last for at least another year. Its power-plant is the TG-180 turbojet, which, Douglas claim, was strictly from " stock ", on the occasion of its record flight. This flight was a good beginning to its career.

The De Havilland D.H.108 (No. 2), which has a D.H. Goblin II turbojet, also has a very comprehensive test programme under way, both in low-speed control and high-speed high mach number flying. Some of the data will undoubtedly be useful in the design of the D.H.106 (Brabazon IV) project.

The Aero Sudouest S.O. 4000 prototype (No. 3) is still on the stocks. It is a bomber, and preliminary data mentions a speed of 560 m.p.h. at 32,500 feet. Twin turbojets (Hispano built Rolls-Royce Nenes) are mounted inside the fuselage. The wing tip " tanks " house two heavy calibre machine guns (.59 ins.). The machine is not yet in production. A scale model is now being flown and upon the results of its flight trials production of the S.O. 4000 will depend.

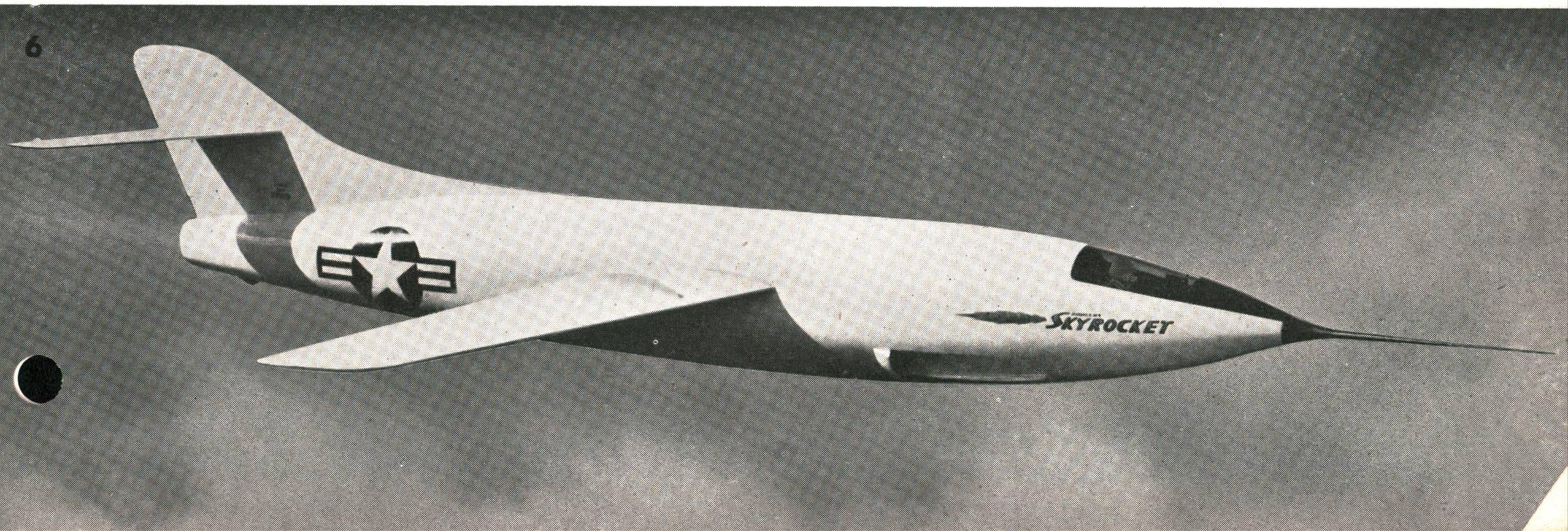
The Bell XS-1 (No. 4) is alleged to have flown faster than sound. This has not been confirmed to date. It is designed for 1,700 m.p.h. It cannot take off under its own power and is flown off beneath a B-29 which releases it at a fairly high altitude, from which it shoots to 80,000 feet—at a rate of 45,000 feet per minute. At that height it should reach its designed speed of 1,700 m.p.h. It can be best described as an extremely tough airframe fitted with powerful rocket motors. (Rockets by Reaction Motors Inc.)

The Bell XS-2 (No. 5) may be described as an even tougher airframe with more powerful rocket motors and back-swept flying surfaces. It is a development of the XS-1 and is intended to probe deeper still into the supersonic regions. Details of designed performance are not yet available.

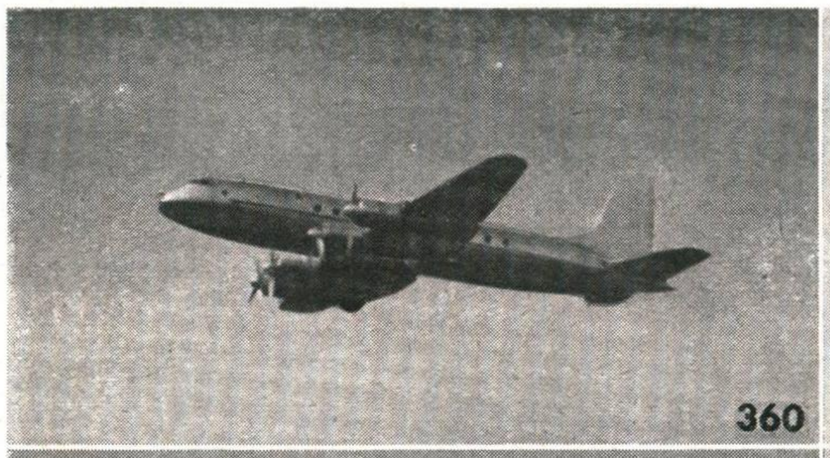
The Douglas D 558-2 Skyrocket (No. 6), a logical development of the Skystreak, is designed for investigating flight up to the speed of sound (mach one). It is therefore in the trans-sonic class. It has both rocket motors and a turbojet ; the turbojet for take-off, slow flying, and landing ; the rockets for speed bursts.

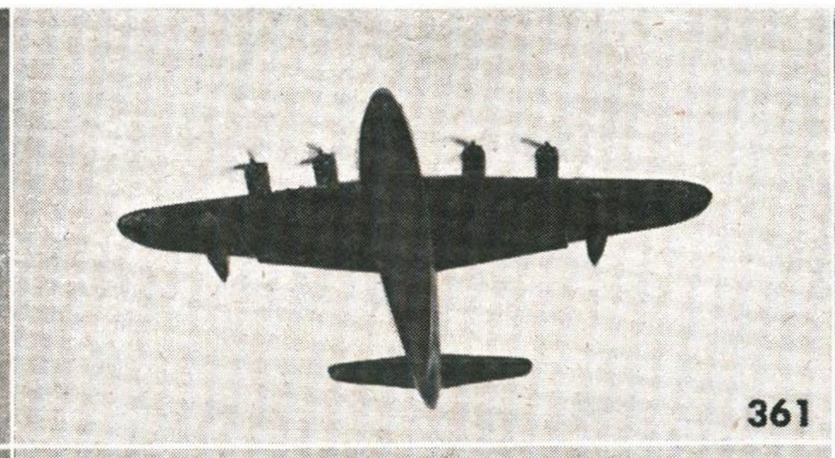
The turbojet which runs on petrol, not paraffin, is a J-34 or 24C Westinghouse. The rockets for this one too are by Reaction Motors Inc.

6

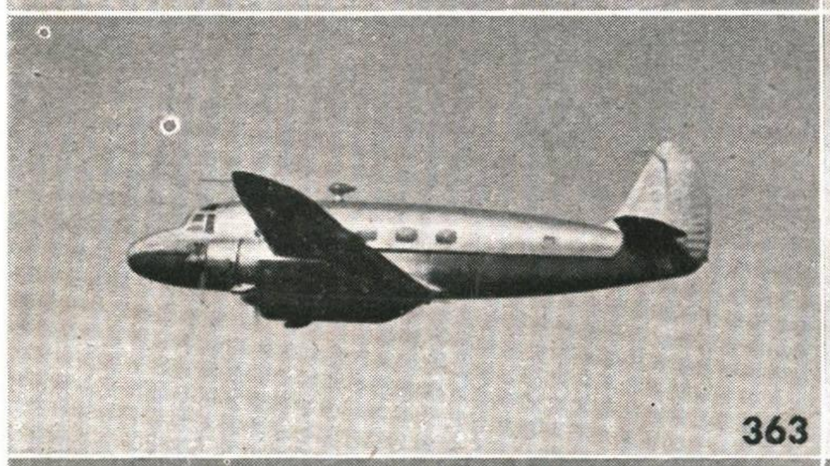


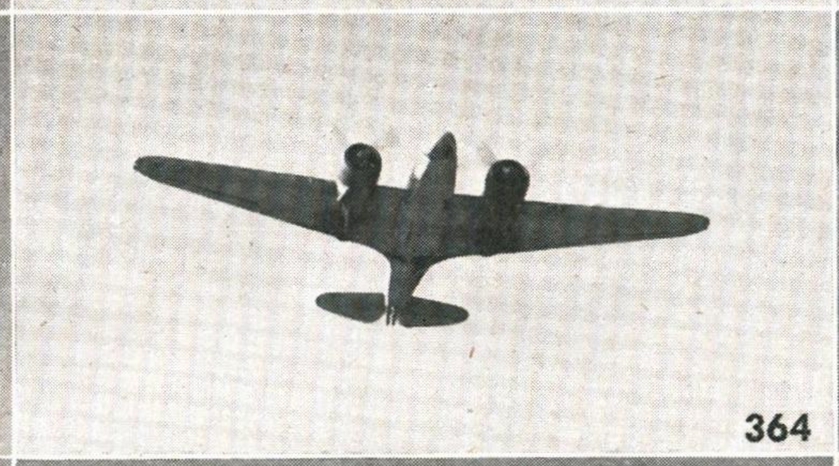
ELEMENTARY SPOTTING


360


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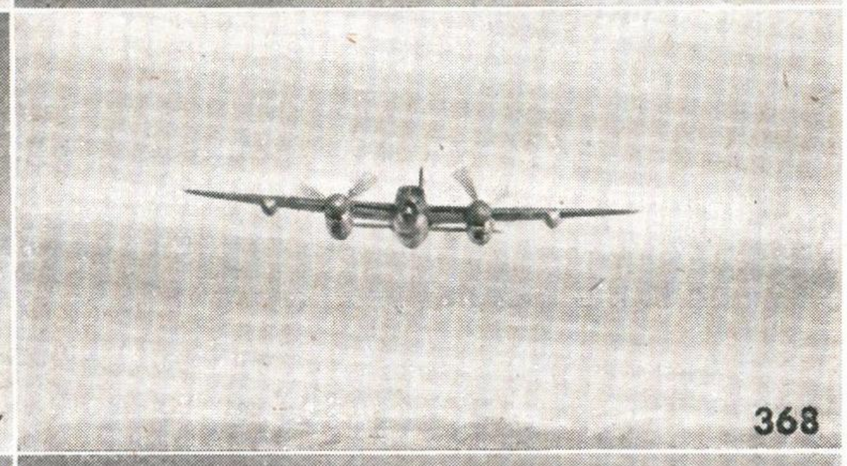

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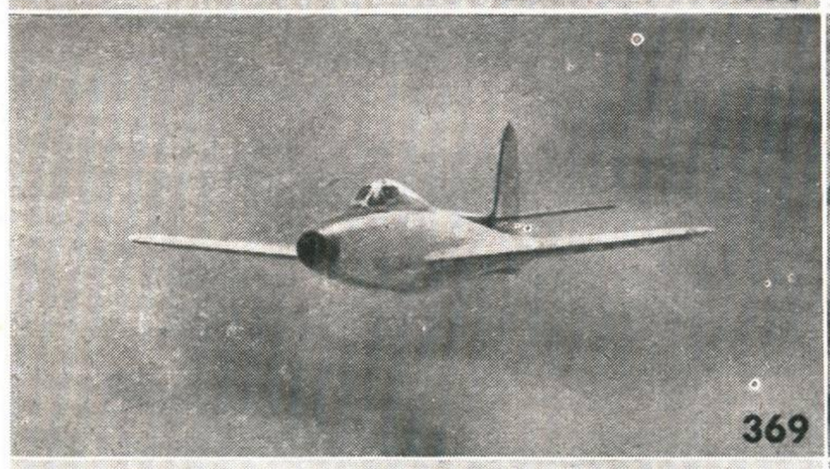

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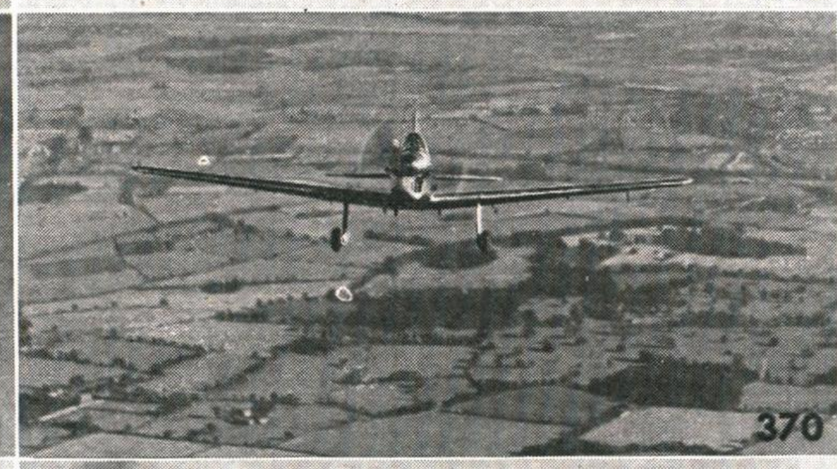

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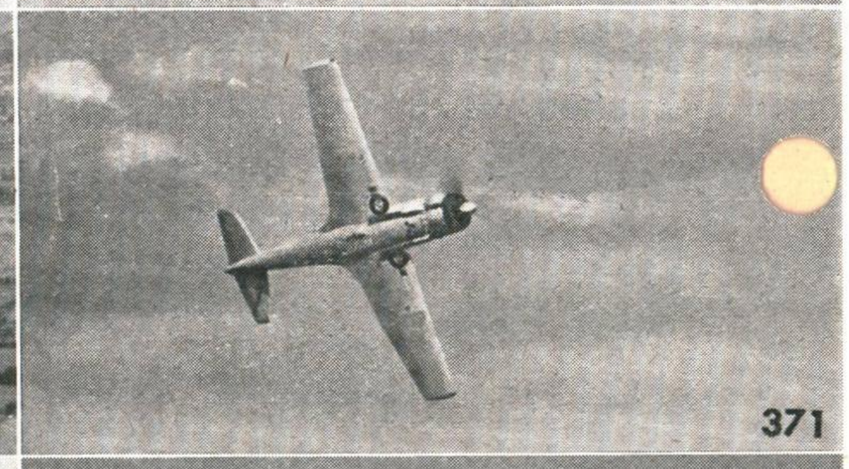

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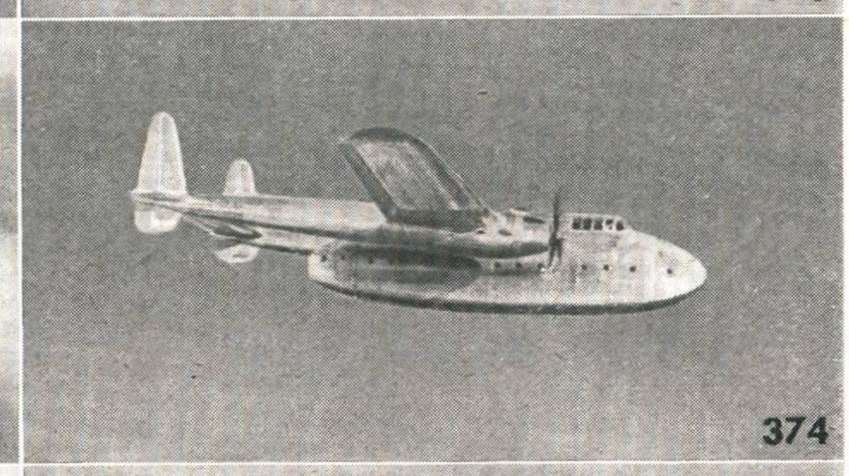

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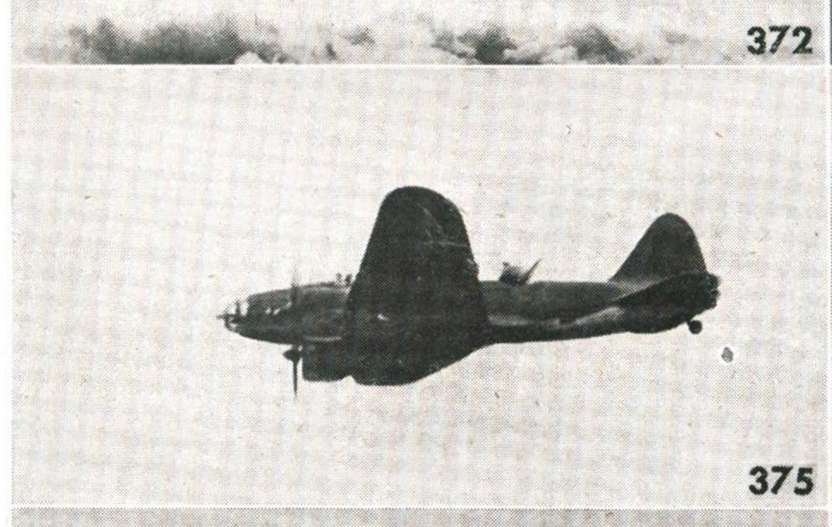

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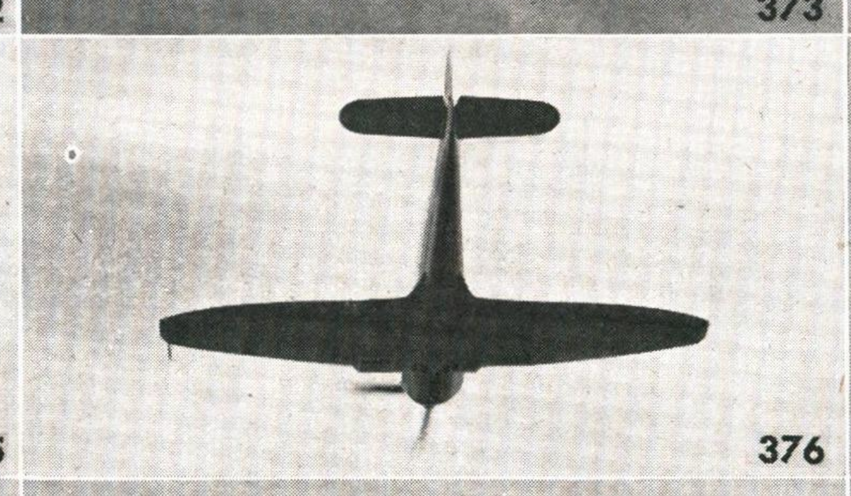

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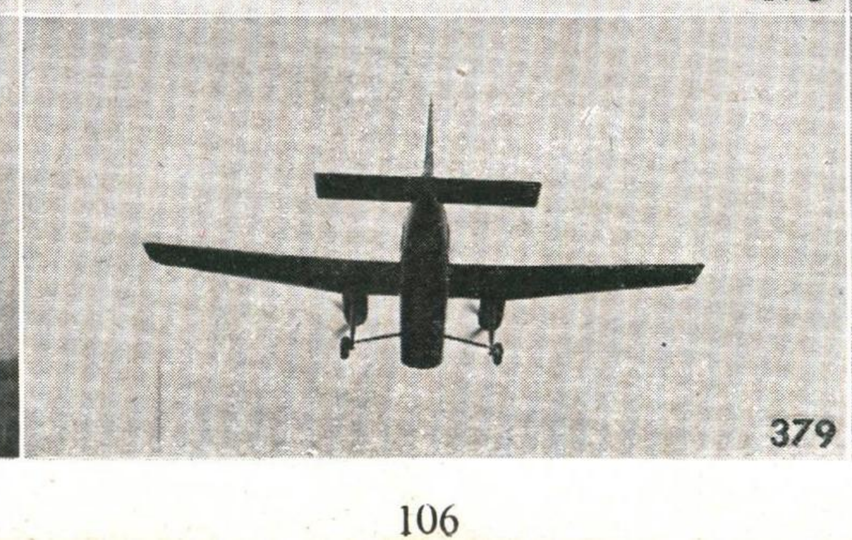

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ADVANCED SPOTTING

Recognition Test No. 62



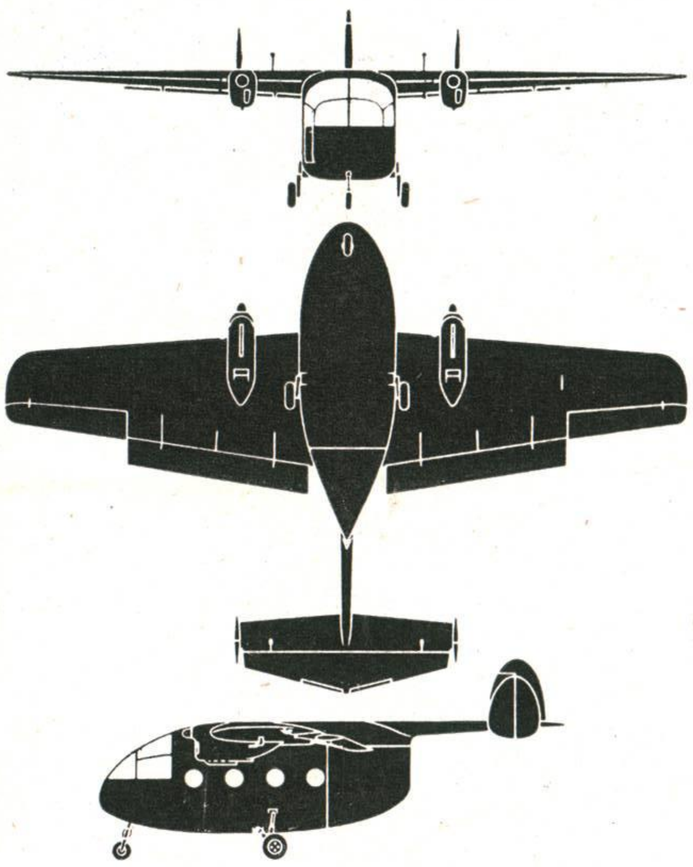
SILLOGRAPHS

Recognition Test No. 63



NEW and REVISED SILHOUETTES

MILES AEROVAN IV

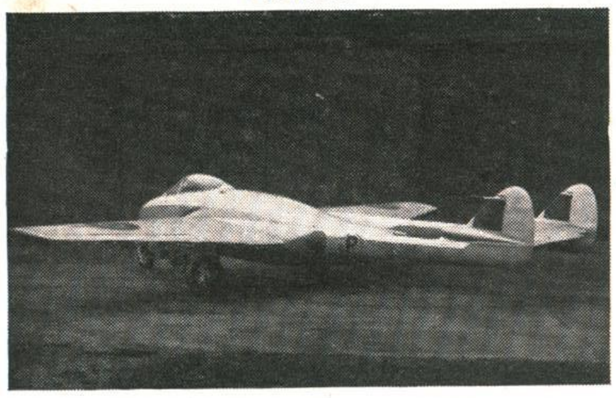


British Transport
2 Cirrus Major. Span : 50 ft.
New Silhouette

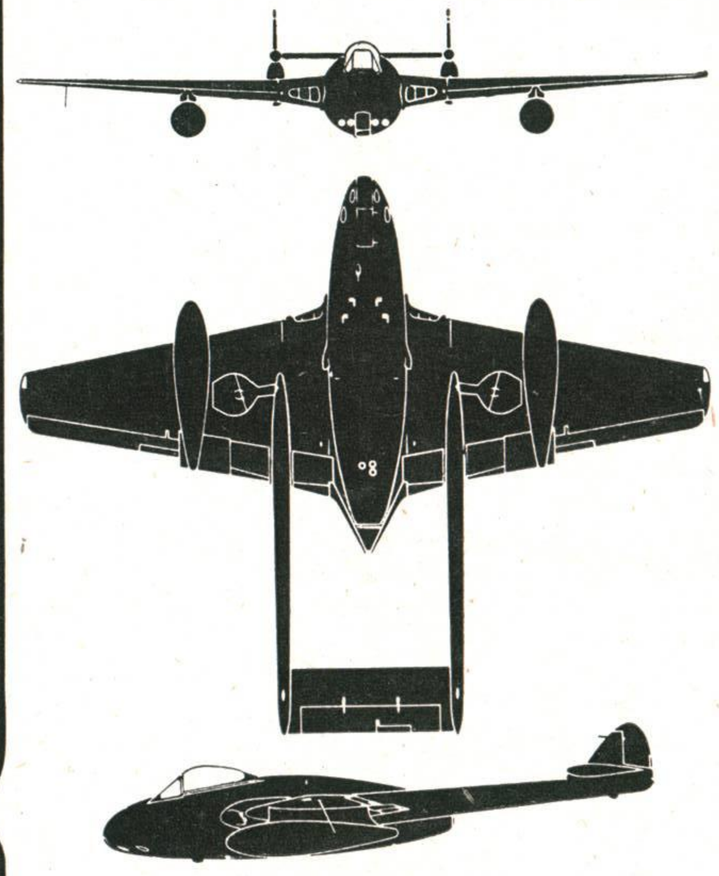


AEROVAN EARMARKS : Tadpole body form —high, stubby wing, protruding flaps—twin underslung motors—large tailplane on end of slender boom—triple fins and rudders.

VAMPIRE FEATURES : Long-egg body form—diamond wing with clipped tips, long-range "torpedo" tank on each half-wing—twin booms—rectangular tailplane—acorn fins and rudders.



DE HAVILLAND SEA VAMPIRE XX



British Naval Fighter
1 Goblin II Turbojet. Span : 38 ft. 4 ins.
New Silhouette

SOLUTIONS TO RECOGNITION TESTS IN THIS ISSUE :

FRONT COVER : *Bell XS-1 (after being dropped from B-29)*

No. 61 (ELEMENTARY)

360. Hermes II
361. Solent
362. Valetta
363. Concordia
364. Oxford II
365. Firefly IV
366. Avro York
367. Seafire 47
368. Mosquito B.16
369. P-84A Thunderjet
370. Chipmunk
371. P.108
372. Tudor VII
373. Anson XIX
374. C-82 Packet
375. IL-4
376. Fury
377. Shetland
378. AW 52
379. Wayfarer
380. Spitfire 21

No. 62 (ADVANCED)

495. Lancaster VII
496. Harvard II
497. Meteor IV
498. LA-7
499. Tudor II
500. Attacker
501. Dove
502. Brigand
503. Anson XIX
504. Sea Fury X
505. AW 52
506. Mig Jet
507. P.108
508. Lancaster
509. Meteor III
510. Miles M68
511. Seafire 47
512. Lancaster VII
513. Ambassador
514. Mig Jet
515. Lancaster II
516. Meteor IV
517. SHCHE-2
518. Tudor II
519. Prentice

No. 63 (SILLOGRAPHS)

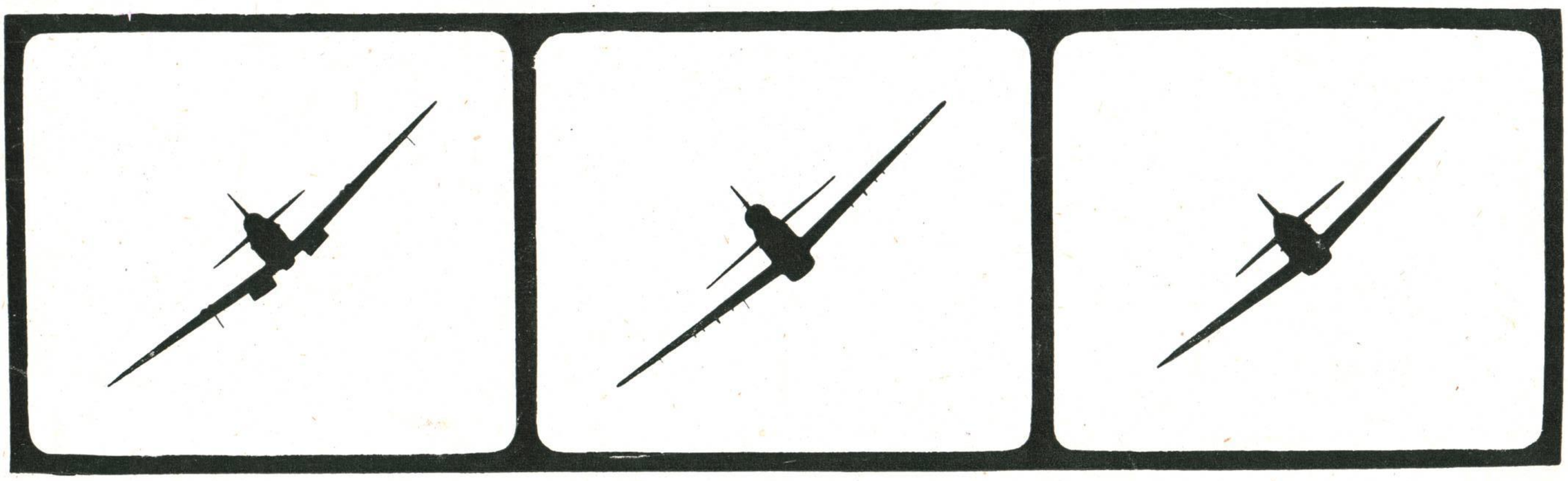
372. Kirby Kadet
373. Pioneer (Prestwick)
374. Concordia
375. Sea Otter
376. Lancaster VII
377. Seafire 47
378. Vampire I
379. Lincoln II
380. Tiger Moth
381. Mustang P.51H
382. Lancastrian
383. Sunderland V
384. Meteor IV
385. Hastings
386. Prentice
387. Wayfarer
388. Firebrand IV
389. Spiteful
390. Wyvern
391. Mosquito P.R.34
392. Tempest II
393. Valetta
394. P.80 Shooting Star
395. Tempest V or VI
396. Thunderjet P-84

ACKNOWLEDGEMENT

Photos Nos. 495 and 512 in the Advanced Test are based on originals by Charles E. Brown.

THREE OF A KIND : (Left to right)
Spitfire 22, P-51H Mustang, Yak-3.

THREE OF A KIND : Three well-known aircraft—at least, they ought to be—in the single-engine single-seater class, which show considerable difference in small detail. What are their names ? Answers above.



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