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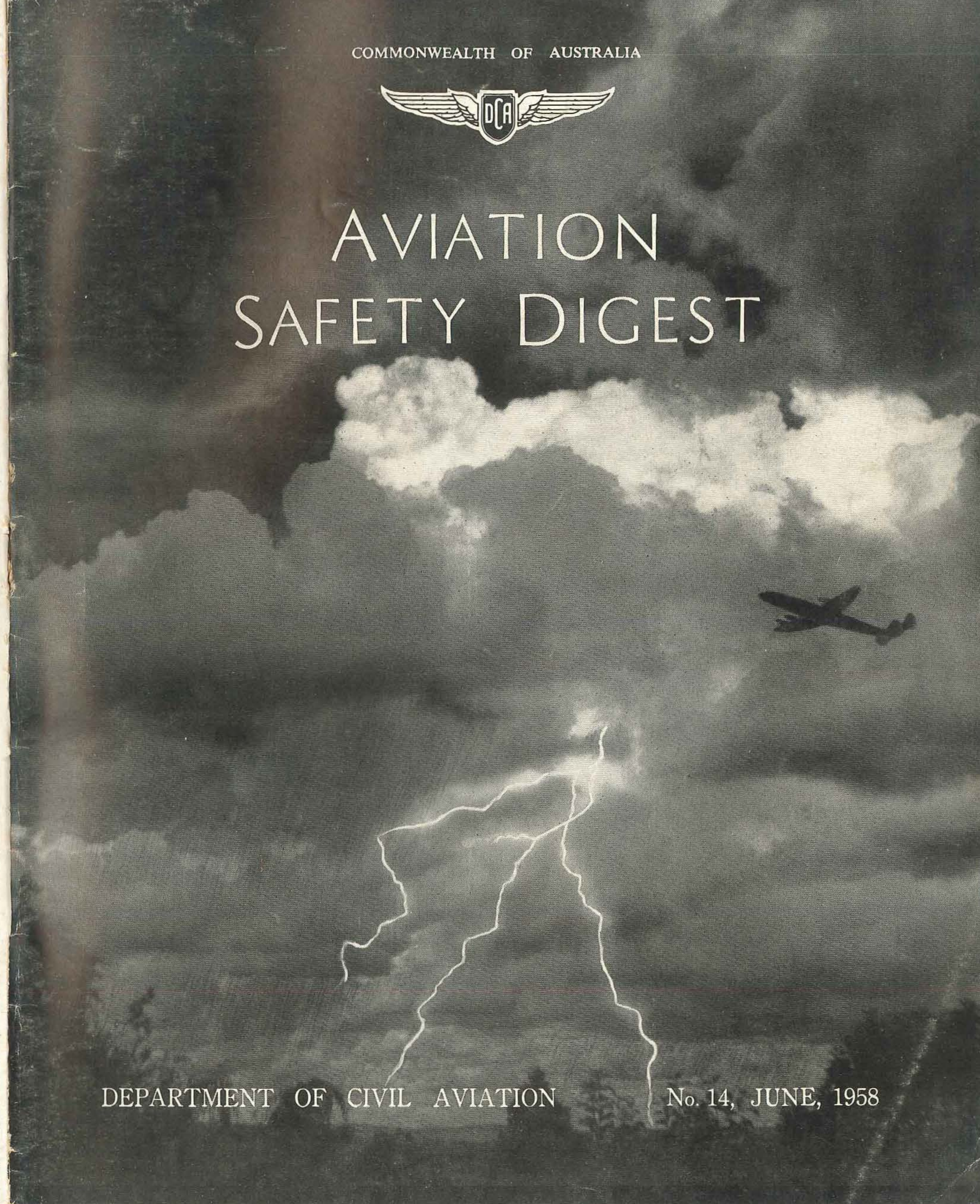
COMMONWEALTH OF AUSTRALIA

AVIATION SAFETY DIGEST



DEPARTMENT OF CIVIL AVIATION

No. 14, JUNE, 1958

Aviation Safety Digest

No. 14 — June, 1958

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(Prepared by Division of Accident Investigation and Analysis. Published by authority of Director-General.)

News and Views

On the Surface

W. B. McVEIGH
DOUGLAS AIRCRAFT COMPANY

(Reproduced from Pilots' Safety Exchange Bulletin 57-109 issued by the Flight Safety Foundation, New York, U.S.A.)

Don't be fooled into thinking ice or snow on the surfaces of your aircraft will melt or blow off. Don't settle for less than a clean, ice-free wing.

Winter weather is demanding, both on our manpower and our flying machines. If you're the member of a crew who has neglected the common sense precautions and procedures for dealing with ice and snow, it's nine chances out of ten you'll be in the midst of a real action-packed drama before very long.

An airplane covered with snow is a booby trap. Don't be fooled into thinking the stuff will be blown off before the monster becomes airborne. Facts taken from case histories of many winter accidents disprove such wishful thinking. Ice is where you find it, and in all probability you will find it on the surface under that nice white blanket if you're smart enough to look.

Prevention

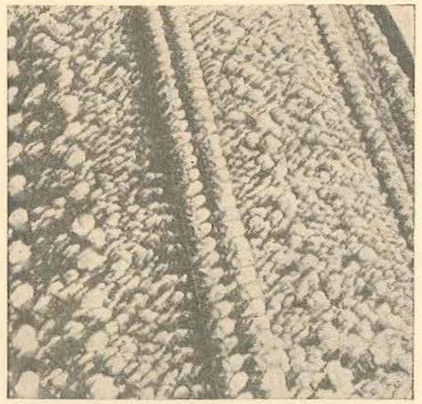
The old adage "An ounce of prevention is worth a pound of cure" most certainly applies to frost, ice or snow, where aircraft are concerned. A preventive measure to be taken in lieu of inside storage, is the use of fabric covers or some other suitable protective covering on the aircraft surfaces. A little time spent in covering the surfaces in the face of adverse weather will be repaid a hundred fold when the airplane is readied for flight.

The effect of snow or ice in all forms is very difficult to predict and too many variable factors are involved which would make any such prediction unreliable. As we all should have learned, the airplane is dependant upon smooth, uninterrupted airflow over all of its surfaces for safe, efficient flight. Then, and only then, is the human element in complete control of the aircraft.

The main effects of ice or snow on an airfoil are to disturb the normal airflow over its surface and alter the distribution of weight. This can result in increased drag, loss of lift, decreased control, flutter of the surface or all of these factors combined in varying degrees. The vital factor is the distribution of the ice or snow formation on the surfaces rather than the additional overall weight increase to the aircraft. The formation of ice or snow creates changes in airfoil contour, control and servo-tab surface mass unbalance which may lead to separation of airflow and in some extreme cases, dynamic instability of the surface.

If the ice formation is unsymmetrical, then large differential loads between two lifting surfaces may develop to a point that the aircraft may no longer be controlled. Ice formation on the leading edge of a control surface or servo-tab also creates a potential buffeting condition. This is particularly true at surface deflections where the iced portion of the control surface leading edge protrudes above or below the trailing edge of the primary surface.

Control surface buffeting caused by an unbalanced condition should be readily and easily distinguished from buffeting of the surfaces caused by the approach to a stall. If the condition is eliminated by decrease of airspeed, it is indicative of structural shake which may be attributed to control surface unbalance (inertia effects) rather than aerodynamic disturbance (stalling) of an airfoil section. Stall buffet is generally eliminated by increasing rather than decreasing the airspeed.



In addition to the many other adverse effects of ice accumulation on control surfaces, it is evident that the resultant tail heaviness and subsequent loss in flutter stability deserves special attention.

Let us consider a recent incident involving a C-124 Globemaster. Indications are that the difficulty occurred as a result of elevator ice accumulation prior to take off from Misawa to Tachikawa, Japan.

The gross weight of the aircraft was 156,656 pounds. It had been on the ground at Misawa for approximately two hours in blowing snow, at an outside temperature of 33°F. The right wing heater did not operate on the ground and no action was taken to remove the snow and/or ice which had accumulated on the aircraft. The pilot indicated he did not believe sufficient accumulation existed on the surfaces to warrant removal.

Take-off

The take-off speed appeared normal and as the aircraft climb approached 500 feet altitude, with gear and flaps retracted, engine power reduced to METO and to approximately 150 knots IAS, a light to moderate "shake" was felt and described by the pilot as being in the horizontal rather than the vertical plane. Immediately, five degrees of flap was extended and the "shake" ceased. After a change of flight altitude was granted at 8,000 ft. because of icing, the climb was continued to 10,000 ft. At 8,000 ft., the right wing heater came into operation and all heaters were then operating normally. Shortly after levelling off at 10,000 ft. cruising altitude with cruise power and 175 knots IAS, a violent "shake" in the horizontal plane was experienced. Power and airspeed were reduced immediately to 165 knots IAS and flaps were again extended to five degrees, after which the "shake" ceased, and the flight continued to Tachikawa without further incident.

Upon inspection of the aircraft immediately after the flight, shearing of the right elevator torque tube bolts was revealed, and severe major structural damage to the fuselage shell was in evidence in the empennage area.

The conclusion drawn after a thorough investigation of all the facts surrounding this accident, was that the most probable cause was icing of the horizontal tail surfaces which resulted in surface mass unbalance and dynamic instability of the surfaces. A further analysis of the stabilizer-elevator system including the effects of ice accumulation, discloses the following highly probable sequence of events responsible for this incident:

- Prior to take-off, approximately 0.15 inches of ice accumulated on the elevator surfaces. This caused the centre of gravity of the surface to shift seven inches to the rear of the elevator hinge line.

- At the reported 150 knots IAS, elevator flutter was experienced. This occurred as a result of a coupling between the tail-heavy, anti-symmetric vibration mode of the elevator at four cycles per second, and the anti-symmetric fuselage torsion-horizontal tail bending mode at three cycles per second. (Anti-symmetric refers to the port surface moving opposite to the direction of motion of the starboard surface.) The resultant flutter was primarily reflected in large amplitude oscillations of the elevators, leading to the failure of the torque tube between the surfaces reported subsequent to the incident.

- Upon failure of the torque tube bolts, the loss in restraint between the two surfaces dropped the frequency of the anti-symmetric elevator mode below the frequency of the fuselage torsion mode and resulted in momentary stability.

- As the speed was increased to the reported 175 knots IAS, flutter was encountered once again at a somewhat lower frequency on the fuselage torsion mode. The resulting large amplitude bending oscillations of the horizontal tail and associated torsional loads imposed on the aft fuselage caused the structural failures reported in that area of the aircraft. The fact that the flutter did not lead to the destruction of the tail and stopped abruptly, must be attributed to the ice breaking free of the elevator surfaces, thereby stabilizing the system.

Flutter

In an attempt to explain the forces at work in the mechanism of stabilizer-elevator flutter, let us consider a cross section of the horizontal tail surfaces with a weight placed at the trailing edge of the elevator as shown in Figure 1.

When the stabilizer translates (bends) up and down, the trailing edge of the elevator tends to remain fixed, due to the presence of this weight as shown in the series of movements in Figure 2. The relative motion of the elevator to the stabilizer is observed to be "out of phase", i.e.. when the stabilizer bends upward, the elevator effectively rotates trailing edge downward and vice versa.

This "out of phase" motion of the elevator produces an aerodynamic lift force on the stabilizer which tends to drive the stabilizer in the same direction that it is moving. The phase relationship between the aerodynamic force and the motion of the stabilizer causes a net amount of energy to be fed into each cycle of oscillation. As a result, the amplitude of the stabilizer deflection increases with each cycle and may lead to the total destruction of the surface.

When the elevator is "mass balanced", the centre of gravity of the elevator weight is made to act through the hinge axis, thus preventing the "out of phase" elevator to stabilizer motion responsible for this type of "tail wagging the dog" flutter. The control surface mass balancing "fix" has been standard aircraft design practice since the problem was first encountered on the World War I vintage aircraft.

The importance of clean airfoil surfaces cannot be emphasized too strongly. As previously stated, it is practically impossible to predict the effect of foreign substances on aircraft surfaces, even water. To illustrate this point let us turn to the accident reports and take the case of the C-47 pilot who, upon preflight inspection, observed the airplane to be covered with a thin layer of water. Discounting the danger of water, he loaded 21 passengers aboard and took off. When approximately 15 feet in the air, the plane lost altitude and started to turn to the left; the pilot applied right aileron and pushed the throttles forward. The left wing came up, but the right wing immediately dropped. The airplane then made contact with the ground about 200 feet beyond the end of the runway with the gear still extended, and crashed into a snowbank. The water on the surfaces of the aircraft had frozen when it had entered a colder layer of air above the runway, spoiling the ability of the wings to produce lift. Another case of ice wresting control of the aircraft from the pilot. If a thin layer of ice would have such a disastrous effect on control of the aircraft, it can readily be seen what hazardous proportions any appreciable building-up might have.

Complete Removal

There are many conditions which enter the problem of prevention or removal of ice, snow or frost deposits. It is not the intent of this article to elaborate further on these conditions, except to say that appropriate and systematic plans should be promulgated and followed which will insure safe, uninterrupted flight operations during any adverse weather conditions. Personnel who must cope with the problem should be thoroughly familiar with all aspects which are entailed to aid them in making the proper decision.

The removal of foreign deposits from critical surfaces should be complete. Broken or irregular pieces of ice remaining may create a greater disturbance than the original formation. The best policy is to remove all deposits from both top and bottom of the wing and tail surfaces and from the fuselage as well. Dry snow should not be left to blow off during the take-off run.

Experience shows that dry snow tends to cling to airfoil surfaces and usually will prevent a successful take-off. So far as controls are concerned, snow can sift into the smallest openings and either freeze the controls in one position or become packed so that movement may be restricted later. It also might be well to remember that even though the aircraft is outwardly clear of ice and snow and take-off is attempted on a slushy runway, it is good practice to actuate the landing gear through at least one complete cycle after climb has been established. Otherwise, slush thrown into the wheel wells may freeze and prevent extension of the gear for the next landing.

It cannot be emphasized too strongly that, in addition to the regular preflight inspection, a thorough examination for ice and snow deposits be made of the entire aircraft just prior to flight. Be sure that —

- All skin surfaces are clean and entirely free of frost, ice or snow.

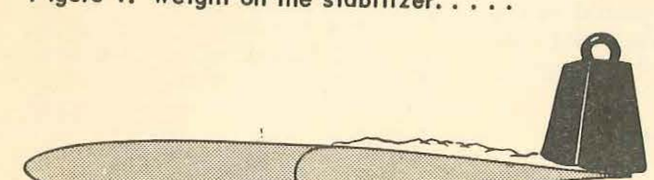
- Propeller blades and hubs are inspected and any frost, ice or snow are removed.

- All control hinge points and control surface openings are checked for freedom from ice and snow.

- All antennas and antenna fittings are free of snow and ice deposits.

- Nose and main landing gear assemblies, including drag linkage,

Figure 1. Weight on the stabilizer. . . .



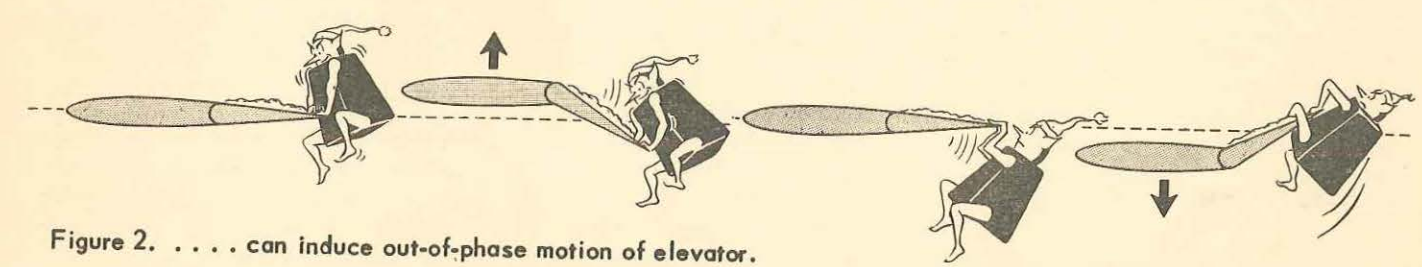


Figure 2. . . . . can induce out-of-phase motion of elevator.

uplatches and door operating linkages, are clear of ice and snow.

- All heater and supercharger air intake duct openings are clear of snow and ice deposits.
- Engines are warmed up in an area free of slush and moisture, lest the propellers pick it up and throw it back over the wings, tail surfaces and fuselage.
- After engine warm-up, all flight controls are checked through their full arc of travel to make certain that they are not restricted by packed ice or snow in areas where visual inspection is difficult.

Design for Damage

(Reproduced from Business Pilots' Safety Bulletin 57-209 issued by the Flight Safety Foundation, New York, U.S.A.)

At the recent Annual Conference of the Aero-Medical Association, at Denver, Colorado, Dr. Frank P. Gatling, Head, Human Factors Division, U.S. Naval Aviation Safety Centre, presented an interesting paper which offered some answers to the following questions: (1) Are some planes more prone to wheels-up landings than others? (2) What are your chances of injury in a wheels-up? (3) Which manoeuvre most often precedes a wheels-up? and (4) Do you telescope and transfer?

With the permission of "Approach", the Naval Aviation Safety Review, FSF is reprinting the following article, a psychological analysis of wheels-up landings, based on Dr. Gatling's paper.

Wheels-up Landings

As a result of 56 special interviews conducted by Naval flight surgeons with pilots who made unintentional wheels-up landings, some answers to the above questions were learned.

This type of accident is more damaging to the budget than lethal, despite its lethal potentiality. Of the 56 accidents investigated, none was fatal, two persons received serious injuries, four minor, and 73 received no injury at all. However, these mishaps cost the Navy the tidy sum of over three and a half million dollars in equipment alone.

An examination of pilots' training involved in wheels-up landings was made in terms of experience in the model in which the accident occurred, and in terms of total flying experience. The data is striking. Seventy-eight percent of the pilots who made wheels-up landings had less than 300 hours experience in the model at the time of the accident, and, further, 51 percent had less than 100 hours in the model. The total flying time indicates the same trend. The wheels-up landings tend to occur with greater frequency among pilots with fewer hours.

What do the pilots do when they realize, at long last, that the gear is still securely stored in the fuselage, and the plane's belly is scraping the concrete? The investigation shows that 10 added power and attempted a wave-off, but all of these 10 realized that they were not going to make it, and cut the power. Four tried to lower the gear, none succeeded. Eighteen went through the procedure to secure the engine. The other 24 did nothing. These figures are rather revealing in that they indicate that in only 32 percent of the cases were the pilots psychologically prepared to carry out the emergency procedures.

Touch-and-Go

Wave-offs have long been suspect as a preliminary manoeuvre that makes a pilot especially susceptible to a wheels-up landing. The interviews disclosed another manoeuvre that has much greater potential for a wheels-up landing than a wave-off. This manoeuvre is the touch-and go landing. Twenty-seven of the 56 wheels-up landing accidents reviewed occurred following a series of touch-and-go landings.

There are probably two psychological factors operating here. One is what educational psychologists call "telescoping". It is the nearly universal tendency to omit responses as the learning sequence is repeated, the pilot unconsciously abbreviates the landing task by leaving out a step. This step is often the wheels-down response with its easily observed result.

The other factor is a "transfer" effect. The pilot has put his wheels down in a series of previous landings containing exactly the same stimuli as the present one. As the stimuli are the same in the two situations, the pilot has a strong tendency to believe, through the medium of transfer effect, that he has made the motions normally connected with these stimuli, i.e., he thinks he had put the wheels down during this landing situation, but actually he did it in the previous landing sequence.

These two factors will help explain the large number of wheels-up landings in which the pilot is "certain" that he activated the wheels-down mechanism. Of the 56 pilots interviewed only three admitted that they "just forgot to lower the wheels". The other 53 were fully convinced that they had lowered the gear. Some of the pilots may have been protecting themselves, but the flight surgeons were convinced that most were telling the truth.

Omissions

Wheels-up landing accidents are the rather spectacular results of an error of omission, rather than commission, and are of importance in themselves, but perhaps, of greater importance is the fact that they are the objective evidence of other errors of omission. That is, a sizeable number of pilots are failing to lower their landing gear despite the elaborate warning systems in use—and many who fail are warned in time to prevent the actual landing.

How many other errors of omission are being committed in the landing pattern—or during take-off and in flight—of which we are unaware? Errors that are resulting in much more serious accidents than wheels-up ones.

The psychological point is that an error of omission is not too difficult to make in spite of the fact that the pilot is surrounded by warning devices of sounds, lights,and flares, etc., and is convinced completely that he has performed the task omitted. This is a most insidious type of error.

Not Pilot "Goof-Off"

Should the question be asked "are all involuntary wheels-up landings purely psychological?" the answer must be yes. But a further investigation of the data strongly suggests that there is more than just a pilot "goof-off" involved.

Let us compare some wheels-up landing rates. First, a comparison of jet rates with prop plane rates indicates a large difference. The jets have almost $2\frac{1}{2}$ times as many wheels-up incidents per 10,000 landings as do prop planes.

When we compare single-place jets with single-place props, a large difference still exists. The single-place jet rate is twice that of the single-place prop rate.

And when we compare airplane models in their own category we find wide differences too, for example—the wheels-up rate for one jet fighter is nearly three times that of another model jet fighter!

Design for Damage

These large differences in the rate at which pilots have wheels-up landings in jets *vs* props and in specific model *vs* specific model cast strong suspicion on the idea that the pilot alone is the culprit in these accidents. It appears that in some aircraft, situations exist in which the pilot is far more susceptible to psychological error than in others. These are situations that have been designed by others and in which the pilot is an unwilling victim.

This is further illustrated by the difference in rates for multiple-seat planes as contrasted with single-seaters. The multiple-seat jet rate is .12; the single-seat jet rate at .31, is $2\frac{1}{2}$ times as high. Multiple-seat props have a rate of .08 which is doubled by the single-seat prop rate of .16.

There is one psychological variable that is undoubtedly involved in these rate differences, and that is the very strong tendency for humans, when in the presence of other humans, to adhere more strictly to socially established regulations, such as landing check-off procedures.

Distractions

These were reported during the landing sequence by a little less than half of the wheels-up pilots. This includes 10 of the pilots who failed to lower their landing gear following touch-and-go landings. Of course, the real question is "when is a distraction distracting?" for many distracted pilots avoid a wheels-up landing. This question can not be answered completely, but an analysis indicates that a disturbance that forces the pilot to postpone lowering his wheels beyond the point at which he usually lowers them is the most damaging kind of distraction.

SUMMARY

The analysis of the 56 wheels-up interviews indicates:

(a) that they occur as a complete surprise to the pilot
(b) that touch-and-go landings make a pilot particularly likely to commit an error of omission and make a wheels-up landing
(c) that many other errors of omissions must be occurring
(d) that design factors are strongly involved in causing the pilot to commit errors of omission.

COMMENT

The article shows that the possibility of overlooking vital actions such as the lowering of the undercarriage, is increased during operations where distractions are inadvertently or deliberately introduced, or where repetition of a particular manoeuvre leads to "telescoping".

2. It is noteworthy that the accident rate for multi-crew aircraft was much lower than for single pilot aircraft. No doubt one reason for this is the greater emphasis laid on use of check lists for these aircraft, coupled with the greater certainty of the items being completed when the person calling the checks is in a position to monitor their completion.

3. Pilots can minimise the possibility of overlooking a vital action firstly by recognising that the possibility exists and then developing a mental attitude to guard against it. This applies particularly where interruptions are experienced during the carrying out of check list items. Too frequently in this country incidents are reported of vital actions being missed even when check lists are used.

4. *Ensure that in your aircraft the items are clearly called, positively and consciously carried out, and correct responses clearly made. In single pilot aircraft develop the habit of calling the items aloud whilst carrying out the cockpit checks.*

That Sudden Stop

(Reproduced from "Flying Safety", March, 1958)

Approach and landing accidents are still tops in the "cause factor" department. Proper supervision can help reduce them.

"To be or not to be, that is the question."

You've all heard that famous quote from Shakespeare's Hamlet but how many of you know what comes next? Well here is some of it:

"Whether 'tis nobler in the mind to suffer the slings and arrows of outrageous fortune or to take arms against a sea of troubles and by opposing end them."

Shakespeare had a good point. If we translate it into modern English it would read, "If you have a problem, are you going to sit back and suffer with it, or are you going to do something about it?"

Well, we have a problem: Landing our modern, high performance aircraft. If you're not aware of this problem, let's look at some statistics which will give you an idea of what we're up against.

- More major accidents happen during the approach and landing than in any other phase of flight.
- Approach and landing accidents account for almost half of all USAF aircraft accidents.
- About one out of every four pilot fatalities results from a landing accident.
- About 55 per cent of all accidents are the result of human error (most often on the part of the pilot).

Bearing these facts in mind, I think that you will admit that landings are a problem. So, let's take Mr. Shakespeare's advice and see what we can do about it.

Two of the most common types of landing accidents are hard landings and short landings. Both of these result from the same causes: Improper control of either the rate-of-descent or the airspeed, or both.

So it seems that rate-of-descent and airspeed are the factors on which we should concentrate our efforts in order to greatly reduce landing accidents.

Of course, rate-of-descent and airspeed are inter-related in that both have to be right to assure a proper landing and the pilot must control them both at the same time. But for the purposes of discussion, I will deal with them separately.

Airspeed Control

First, an aerodynamic fact: In unaccelerated (1G) flight, at any one angle of attack, there is only one equivalent airspeed at which an aircraft can fly. (Fig. 1). This is true whether the aircraft is climbing, descending or in straight-and-level flight. It is also true whether you are at full power, low power or power off. Also, the airspeed varies inversly with the angle of attack. The higher the angle of attack, the lower the airspeed and vice versa. From this we can see that angle of attack is the primary factor in the control of airspeed.

In landing, a good, steady airspeed on the approach is highly desirable. This speed will vary for different types of aircraft, but each one has its best speed based on its stall speed, aspect ratio and other aerodynamic characteristics. So it must follow that if each aircraft has one best angle of attack for flight on final approach, and if you—as the pilot—place the aircraft in that angle of attack, you will automatically realise the proper airspeed. It should be noted that for our modern high performance fighters which have a very low aspect ratio, it requires a high angle of attack to maintain low speed flight.

Rate of Descent

Another aerodynamic fact: For a given angle of attack-airspeed combination, there is only one quantity of thrust or power which will produce a particular rate of descent. (Fig. 2.) Also, the rate of descent will vary inversely as the thrust.

In other words, the throttle is the primary control for rate of descent. High power settings produce low rates of descent and low power settings produce high rates of descent. However, rate of descent and power are not completely independent of angle of attack. If the angle of attack is changed, the power required to maintain the particular rate of descent must also change. (Higher angle of attack, higher power required, and vice versa.)

Here again, we find that different aircraft have their own best rate of descent for consistently good landings. The best rate of descent for a given type of aircraft is determined by its aerodynamic characteristics. Some of the most important factors are aspect ratio, wing loading, best approach speed and sink rate. Aircraft with high wing loading experience extremely high rates of descent at low power settings.

Flareout

If you were to try to land out of a Mach One dive, you'd have to start your flareout at some point well above 15,000 feet, not because of your high airspeed but because of your high rate of descent.

Proper determination of the point to start the flare is very critical to a good landing and in this case would be beyond the capabilities of the pilot to judge.

From this extreme example, we can draw the conclusion that it is more difficult to judge the point of flare when you are in a high rate of descent than in a low rate of descent. This is because at a high rate of descent, the amount of flare or degrees of rotation required is greater; the vertical distance required to perform the flare is greater, and the pilot's judgment must be accurate from a greater distance.

Although, in normal traffic patterns you won't encounter any Mach One rates of descent, it is very easy to slip into a rate of descent so high that you can't cope with it within the altitude remaining.

Let's review the major points covered so far, so that we can start putting these disjointed facts together to create a good landing.

- First, airspeed is controlled primarily by the angle of attack.
- Second, rate of descent is controlled primarily by power, and the power required is directly affected by the angle of attack.
- Third, the point at which flareout should begin is a function of the rate of descent.

These facts may seem pretty basic to you and you are probably wondering why I am presenting them to experienced pilots. I should point out that those accident statistics which I quoted earlier were not statistics on inexperienced people. They include all of us.

Unfortunately, there are many pilots who know basic principles of flying but don't operate according to them. There are many "old heads" who still try to decrease their rate of descent by coming back on the stick. This actually increases the rate of descent if they don't have sufficient power or airspeed. It is the old story of stretching a glide.

And then there are those who try to reduce their speed on the final by chopping all the power. They end up with a rate of descent that is excessive, so back on goes the power and back comes the stick. From there on in, the final approach resembles a roller coaster!

Figure 1. Typical Angle of Attack vs. Air Speed Curve for flight under unaccelerated (1G) conditions.

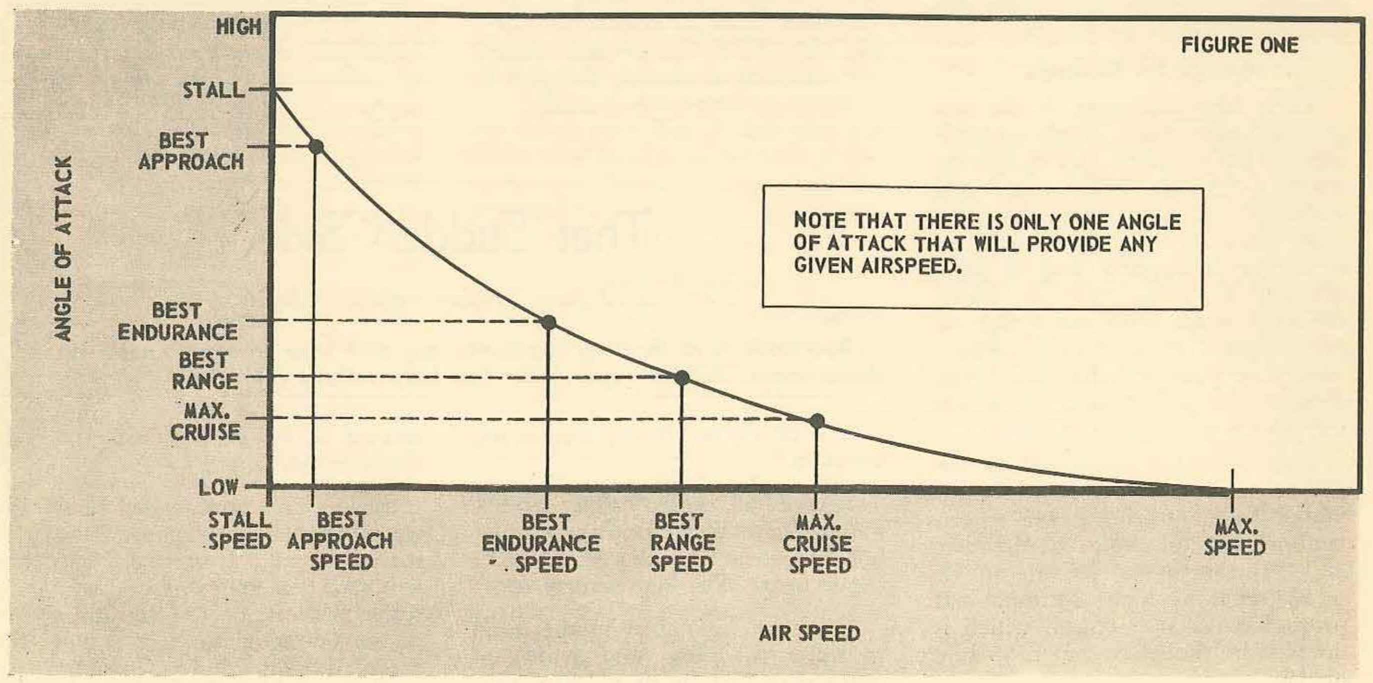
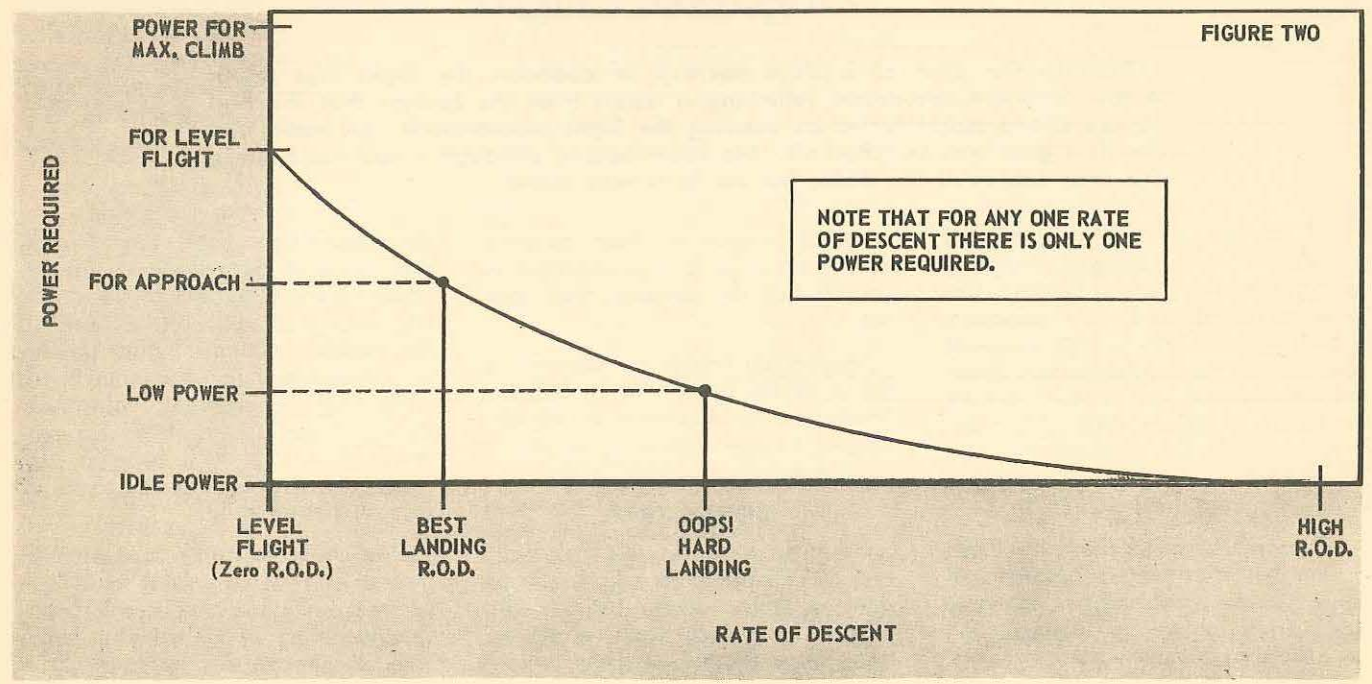


Figure 2. Typical Power Required vs. Rate of Descent Curve for constant Angle of Attack and Air Speed.



Final Approach

The importance of a constant angle of attack or attitude on the final approach can best be emphasized with this reminder. When you're on final approach in most aircraft you'll be flying on the back side of the power curve. If you let your airspeed (angle of attack) wander, particularly to the low side, you can easily end up in a situation where the only way to regain your airspeed is to sacrifice altitude. And on the final approach you don't have much to play with.

Well, how should you fly the final approach? Here is my recommended procedure.

- Put your base leg far enough out to ensure a long, straight relatively shallow, power-on approach.
- On the approach, try to nail the proper attitude and airspeed with the stick and then trim the aircraft for "hands-off" flight.
- Find the constant power setting that will nail the proper rate of descent.
- Cross-check airspeed indicator and vertical speed.
- Make any adjustments in rate of descent with the throttle.
- Make adjustments in airspeed with the stick, but remember that changes in angle of attack require power changes to maintain the desired rate of descent.
- Flareout. If you are on a shallow power-on approach, the flareout should be no problem. You have very little rotation to accomplish and your rate of descent is low. It should be easy for you to judge your flareout point.
- Touchdown. Proper level-off and touchdown are mostly a matter of your technique and judgment with respect to the type aircraft you're flying. However, a good approach will make a good touchdown much more easy to accomplish even if your techniques and judgment have taken the day off.
- If you louse up your approach, go around! There are fewer accidents during go-arounds than in any other phase of flight. Conversely, many accidents are caused by failure to go around.

One final word. The next time you fly, go to altitude and practice some power-on descents — using throttle to control rate of descent and stick to control airspeed. Check your instruments regularly and see how easy it is to nail airspeed and rate of descent with this method.

If this procedure seems foreign or awkward to you, you've probably been doing it wrong for too many years. You won't be alone though. There must be many of us or I wouldn't have been able to quote the accident statistics that I did.

So, take Shakespeare's advice. Don't sit back and suffer with your problem. Do something about it! And remember, it takes more practice to learn to do something right—after you've been doing it wrong—than it took to learn it originally.

Dangerous Cargo

Recently the pilot of a DC.4 decided to abandon the flight and return to the departure aerodrome following a report from the hostess that she had noticed strong petrol fumes on entering the flight compartment. All radio and electrical gear was switched off. The cabin heater, although it had not been in use, was inspected for leaks, but no fault was found.

The fumes appeared to be isolated to the port upper baggage compartment, therefore, after landing this was unloaded and two suitcases, which appeared to be the cause of the trouble, were subsequently opened and found to contain bottles and cans of lighter fluid. After discussions with the passengers it was discovered that at least six other cases also contained lighter fluid.

Over recent years there has been a number of reported instances of fuel leaking from cargo, in some cases from passengers' luggage, and in others from poorly packed cargo. Fortunately none of these incidents has resulted in fire or damage to aircraft but the potential was present.

Maybe you believe the element of risk is small. Possibly it is, but the results can be disastrous as demonstrated by the following summary of an article in the MATS Flyer.

BOOBY TRAP

Recently a duffle bag belonging to a MATS passenger who had been removed from a flight for a higher priority passenger was transferred from the outbound baggage dolly to the checked baggage bin. During the course of the transfer, a foreign made cigarette lighter in the duffle bag was activated, setting fire to the clothing contents. Other passengers manifested for the same flight, witnessing the incident, voluntarily informed the passenger service representatives that their baggage also contained similar lighters as well as cans of lighter fluid.

There are cases on record wherein aircraft have disappeared with little or no trace. Each time this happens the possibility of an inflight explosion is considered. We know it is

possible but hard to prove. Consider the following case.

Bound for an island airbase, a U.S.A.F. aircraft failed to arrive on schedule although a position report was received from it one hour out. An extensive air and sea search was launched immediately but several days elapsed before any wreckage was found. Then the nosewheel from the missing plane was recovered. The tyre was burned and partially melted, indicating that severe heat had been present in the area of the wheel well.

In view of the fact that no emergency transmission had been received, investigators assumed that an explosion or fire of extreme intensity had developed. Further, they reasoned that the catastrophe must have occurred with such suddenness as to render the crew incapable of sending a distress message.

Admittedly this was conjecture. However, it can be considered very logical. No other wreckage was found. The mute testimony of the burned tyre was, in reality, almost a complete story.

How can such an accident happen? There are several possibilities.

Having flown for several hours it is quite improbable that leaking fuel cells caused an explosion. Certainly it must be assumed that the crew or passengers would have detected fumes.

Another factor that would tend to eliminate the possibility of a fuel fire centres around the burned nosewheel tyre. Fuel tanks were considerably aft of that area. And, carrying the thought further, the aircraft would not have burned following a ditching, at least, not for long.

This then leaves the possibility of an explosion or flammable agent being present in one of the lower cargo compartments or topside. The former location is much more logical and this brings us to one point of this article.

It is possible for a flammable liquid, freed from its containers, to saturate a compartment with a concentration of combustible fumes.

Okay, so you say that even such a concentration of fumes should not cause an explosion unless a spark or flame was present. Well, we cannot argue that point. But how many times have you encountered chafed wirings on an airplane? Several, we'll venture. Junction boxes, switches, relays, or radios can and do cause sparks under certain conditions. Begin to get the picture?

Again we state that the analysis of this particular accident was of a speculative nature but it was speculation based on sound principles. A ruptured can of lighter fluid or a broken bottle of after-shave lotion could have been the responsible agent. The cause factor in this particular accident could not be proved conclusively for obvious reasons, so let's examine one that we can pin down.

A few months ago, while loading baggage in a C.54, the flight attendant placed several paper-wrapped parcels and some B-4 bags in the forward compartment. More bags were placed aft and finally a small surplus went topside. Passengers were loaded and the aircraft commander ordered the engines started.

During the taxying, the plane encountered several ridges of snow and ice and did considerable bucking and bouncing. It took approximately five minutes to reach a satisfactory run-up area and while the engines were being checked, the flight crew detected an odor not unlike burning rubber.

Immediately an assistant flight engineer jumped back a couple of paces and opened the internal hatch cover leading to the lower baggage compartment. The reflection of flames could be seen and some smoke was visible.

The airman grabbed a portable CO2 extinguisher and discharged it into the hold. Almost at the same time, the aircraft commander actuated the internal extinguishing system but most of the effectiveness was lost as much of the agent was forced upward through the open hatch, momentarily blinding the airman.

When it was apparent that the fire could not be controlled, the engines were shut down and crew and passengers evacuated the aircraft without incident. In due time the blaze was extinguished but not before the fuselage was thoroughly gutted.

It was no problem for the accident investigators to determine where the fire started, but how was another matter. Fire damage coupled with a near total collapse of everything topside, made it extremely difficult to get at the suspected area.

One point that puzzled the experts was a patch of external skin, just to the right of the APU, that showed signs of extreme heat. This spot, about two feet in length and breadth, looked as though it had been cooked with a blow torch from within.

It was finally determined that an oxygen line had burned through and as the system was charged with about 250 pounds, the jet of flame from the rupture really did act much like a blow torch.

It took a lot of digging to find out how the fire had started initially. But, by piecing the puzzle together the investigators found that in the process of taxying, the rough terrain had caused several paper wrapped boxes to shift forward, followed by a couple of B-4 bags and the whole mess had landed on the APU exhaust shroud. The puttputt was running.

Now most of you know, normally the exhaust pipes of APUs are insulated with a metal shroud. Usually there is ample air space between the pipe and this outer cover to ensure proper dissipation of the heat. However, in areas where a shroud cannot be routed, the pipe is then covered with strips of asbestos.

In this case, the wrapping paper coming in contact with the asbestos-covered pipe, soon burst into flame. Later experiments proved this to be possible in as little as two minutes. Now the fire was started.

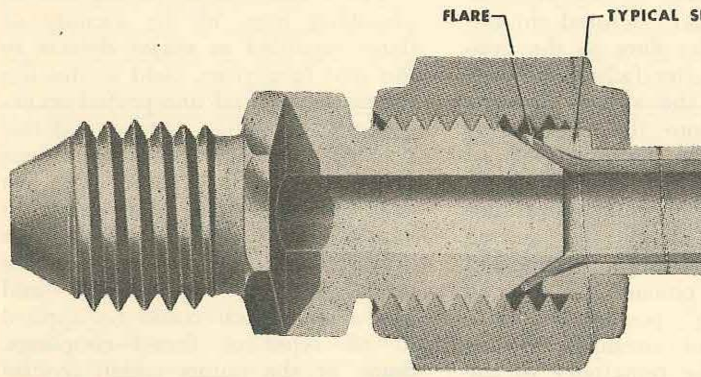
In all probability, had the original fire been confined to burning paper, it would have been extinguished quickly. But this wasn't the case.

(j) Careful uncoupling of the fitting and examination of the flare, in cases where weeping or leakage is evident, before tightening.

(k) Providing adequate support of plumbing lines to guard against excessive vibration and loading.

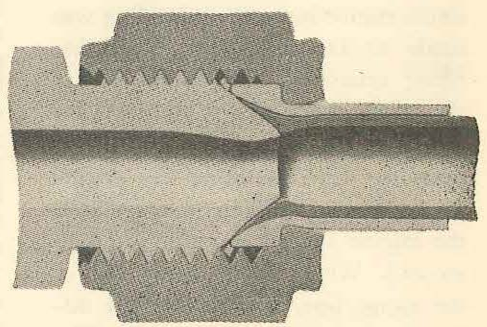
The illustrations on this page are of a triple type sleeved coupling similar to that which failed in the accident previously described. Figure 1 illustrates the proper fitting of the flare and sleeve and the correct tightening. Figure 2 illustrates the effect of over-tightening and you will notice, not only the pinching-off of the flare, but also the general pattern of distortion in the coupling area.

Failure of flared couplings in the functional systems of aircraft can introduce fire and/or personal injury hazards to say nothing of the effects of losing the usefulness of the system itself. The accident referred to earlier in this article is a good example of the dangers of personal injury and functional loss which can result from bad flare-forming techniques and bad maintenance practices and is a good reason why every care and precaution should be taken to prevent further failures.



CORRECT TIGHTENING OF NUT

Fig. 1



TUBING FLARE SHEARED BY OVERTIGHTENED NUT

Fig. 2

Uncontrollable Stick Forces

(Extract from Business Pilots' Safety Bulletin 58-201, dated February 25, 1957 issued by the Flight Safety Foundation, New York, U.S.A.)

The CAB recently investigated a fatal accident involving a Lodestar that crashed following take-off. As part of its investigative findings, the Board disclosed significant information regarding control forces that resulted from improper elevator trim tab setting. The following was included in this release (Flight Operations and Airworthiness Release No. 419):

"Most pilots are aware of the high force that can be exerted on the controls by an improperly adjusted trim tab, but not all know that on some aircraft this force can become greater than the pilot's strength to overcome it.

"High control forces can exist in the aircraft's take-off configuration if the elevator trim tab is permitted to remain as adjusted for landing. Moreover, the build-up control column or stick pressure during take-off may suddenly increase soon after the aircraft becomes airborne. This sudden increase in backward force occurs as a surprise and may produce a steep nose-up attitude leading to a stall before correction can be made.

"Undesirable control forces caused by improper trim tab settings are not confined to Lodestars. They can occur with other aircraft as well."

Overseas Accidents

Argonaut Crashes Shortly After Take-Off

(Summary based on report compiled by Ministry of Transport and Civil Aviation, London.)

Aviation Safety Digest No. 11, September, 1957, contained an article entitled "The Effect of Thunderstorms on Aircraft Operations". The hazards of thunderstorm conditions are again emphasised in the following report of an accident to a Canadian C-4 aircraft—sometimes referred to as an Argonaut.

On the evening of 24th June, 1956, an Argonaut aircraft crashed 2½ miles from Kano Airport, Nigeria, shortly after taking-off in moderate rain. The climb was normal to a height of 250 feet but the aircraft then began to lose height rapidly and despite the efforts of the crew the descent could not be checked. The aircraft struck a tree and crashed 2,500 yards from the end of the runway. Fire broke out; three of the seven crew members and 29 of the 38 passengers lost their lives. The two pilots, although injured, survived.

THE FLIGHT

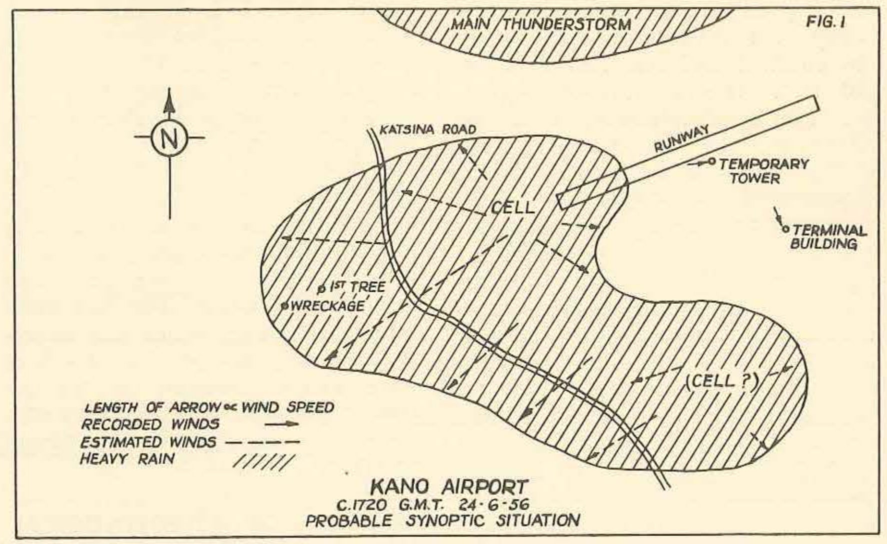
At the time of engine start-up (1715 hours, eight minutes before the accident), the wind was 300°/15 knots, there was no rain over the airport or to the west. Whilst taxying to the threshold of Runway 25 heavy rain began to fall but the visibility remained good and there was no sign of wind gusting or roll type cloud. However, it was apparent that there was a storm very near to the north-east.

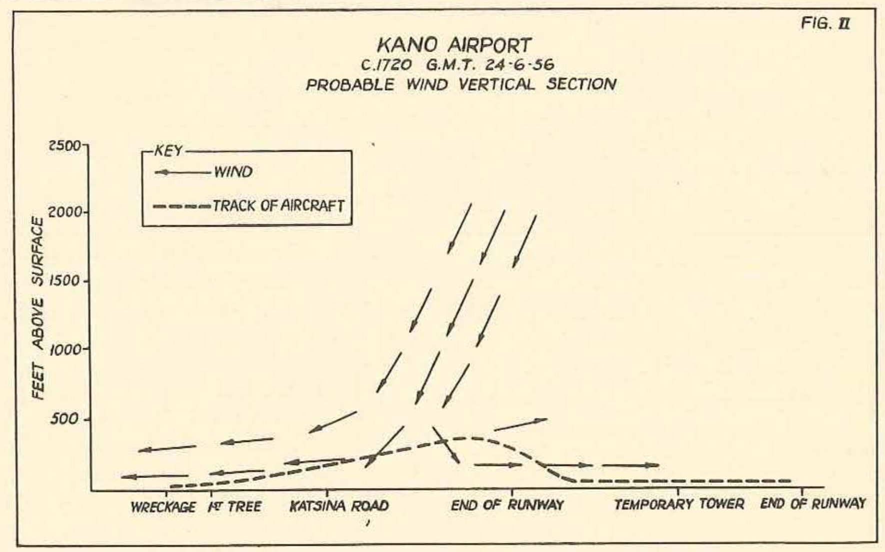
By the time the pre-take-off checks had been completed, wing flaps being set at 10° and trims central, it was raining heavily and the sky was completely overcast. The pilot estimated the visibility to be two miles and the wind still 300°/15 knots.

Take-off was normal the aircraft becoming airborne after a run of approximately 2,000 yards, but, owing to the heavy rain on the windscreen the pilot found it necessary to fly on instruments immediately the aircraft became airborne. At no time before or during the take-off did the pilot consider abandoning the take-off due to the weather conditions. He had previously taken-off on several occasions in weather conditions that had appeared to be of a similar nature.

After taking-off the undercarriage was retracted and the aircraft passed over the end of the runway at about 100 feet with an airspeed

Note: All heights in this report are actual heights above the official Reference Point of the airport, which is the highest point on Runway 25 (1,575 feet, a.m.s.l.). Both pilots in their evidence gave QNH heights and the heights given in the report are the differences between their altimeter readings and 1,575 feet.





of 125 knots. Shortly afterwards the first power reduction to 2,850 r.p.m. and 54″ manifold pressure was made. Before reducing power the pilot had assessed the flight conditions as quite reasonable with a maximum airspeed fluctuation of five knots.

A normal climb was made to approximately 240 feet where the flaps were retracted. At this time the airspeed was fluctuating between 125 and 130 knots with a rate of climb of 300 feet per minute. The rain was still heavy and there appeared to be more ahead. (At this stage of the take-off the aircraft disappeared from the sight of ground observers into heavy rain.)

When the flaps were retracted no sink was noticed by the pilots, but the airspeed dropped and remained steady at 123 knots. The altimeter was checked and noted to be 260-270 feet. The aircraft was quite level and steady. The situation remained static for a short time, then as the indicated airspeed dropped steadily and quickly full power was called for. By this time the airspeed was down to 103 knots. (The stalling speed of this type of aircraft, having regard to the all-up-weight and load distribution, has been calculated at 97 knots.) The co-pilot immediately opened the throttles fully with the r.p.m. set at 2,850. He did not have time to increase the r.p.m. to 3,000 because the master r.p.m. lever was unserviceable (a fault previously known by the crew) which necessitated the manual adjustment of each engine. The application of this power did not increase the airspeed nor was there any unusual reaction to the handling characteristics of the aircraft when it was applied.

During this emergency the pilot did not adjust the trim of the aircraft and he did not recall experiencing any turbulence or sinking of the aircraft. The aircraft lost height very rapidly and by the time the first officer had fully opened the throttles, the aircraft was nearly down to tree-top height in an almost level attitude. The pilot looked out and saw that the aircraft was flying level about 15-20 feet above the ground with a tree directly in its path approximately 200 yards ahead, he attempted to turn the aircraft but was unable to prevent it striking the tree. The aircraft crashed and fire broke out before it came to rest.

Note: Tower observations during the take-off run were W/V 275°/20 knots, visibility 1,500 yards.

WRECKAGE EXAMINATION

Inspection at the scene of the accident site showed that the first point of impact was with a tree 35 feet in height, approximately 2,500 yards from the end of Runway 25, and approximately 100 yards north of the extended line of the runway. The aircraft had struck the tree about 17 feet from the ground, with the left wing and the underside of the nose section. The left wing fuel tanks became ruptured and caused fire to break out immediately.

Examination of the wreckage did not reveal any pre-crash defect or malfunctioning which could have contributed to the accident. The main undercarriage and nose wheel were in the fully retracted and locked UP position. The flap operating mechanism, which was severely damaged, showed that the flaps were almost certainly in the retracted position. The captain's altimeter was found set at the correct QNH.

ANALYSIS OF METEOROLOGICAL CONDITIONS

At 1600 hours there were two thunderstorms in the vicinity of Kano, one about 10 miles to the north-east of the airport and the other about six miles to the south-west. Both were moving slowly towards the south-west and by 1700 hours the former lay a mile or two to the north-east with an associated cloud overhang extending over the airport itself. Moderate rain from this overhang started to fall at the terminal building at 1714 hours and ended at 1722 hours, i.e., time of engine start-up until commencement of take-off. The main centre of the thunderstorm passed a little to the north of the airport but a new cell appears to have developed in the overhang which gave heavy rain and squalls over the western half of the airport at about 1720 hours and moved westwards.

The evidence of witnesses in the area south and west of the end of Runway 25 establishes beyond reasonable doubt that a strong easterly squall with associated heavy rain was experienced there, although instrumental evidence is lacking.

It would appear that the strong wind and heavy rain from the new cell reached the ground as the aircraft was taking-off. The surface wind from this cell would fan out from the centre, but the easterly winds in the western sector would be considerably stronger than the westerly winds in the eastern sector because of the momentum brought down from the easterly air current prevailing above, about 10,000 feet. This is the normal experience in squalls in this region at this season of the year.

Initially, the aircraft would experience a moderately enhanced headwind which to some extent is confirmed by the evidence. This would rapidly change to a strong tailwind with possibly an element of downdraught, though it is improbable that any significant downdraught was experienced near the surface.

There would probably have been a pressure rise of the order of 2-3 mbs. within the cell which would have caused the altimeter of the aircraft to indicate a height 50 - 100 feet lower than the true height, that is, the aircraft would have actually been 50 - 100 feet higher than was registered on its altimeter.

The relatively sudden change of wind from a moderate headwind to a strong tailwind experienced in the cell would cause a corresponding decrease in the airspeed of the aircraft.

OBSERVATIONS

A Board of Enquiry gave close consideration to the question as to whether the pilot in command was justified in commencing the flight in the weather conditions prevailing at the time of the take-off. The pilot had taken care to ascertain the nature of the approaching storm from the Meteorological Forecaster. He was mainly concerned as to whether the thunderstorm approaching from the north-west was associated with a line squall and how fast and in what direction it was moving. He was assured by the forecaster that the thunderstorm had no association with any line squall and it was a slow moving local thunderstorm. The pilot formed the opinion that it would probably pass 8 - 10 miles north of the airport. The moderate rain which fell at the time of take-off did not cause the pilot any concern as the conditions were considerably above the company's minima and, as he had taken-off in similar conditions on several previous occasions, he did not consider it necessary to abandon the take-off. Neither he nor the forecaster could have been aware that a thunderstorm cell was forming close to the west of the airport along the take-off path from Runway 25 because the associated vertical cloud development was obscured by lower cloud.

Kano Airport was equipped with storm warning radar capable of identifying storms some distance away, but incapable of detecting the formation of a thunderstorm cell at close range.

CONCLUSIONS

From the available evidence it was concluded that after a normal take-off and climb on instruments the aircraft encountered a sudden reversal of wind direction of considerable magnitude, heavy rain and a possible down draught.

When these conditions were encountered the airspeed of the aircraft fell quickly to near stalling speed and it lost height rapidly to almost ground level with the engines operating near full power throughout.

The cause of the accident was assessed as loss of height and airspeed caused by the aircraft encountering at a low altitude an unpredictable thunderstorm cell which gave rise to a sudden reversal of wind direction, heavy rain and a possible downdraught.

Wing Failure During Landing

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)

A Martin 404 was substantially damaged whilst landing at Louisville, Kentucky, on March 10, 1957. One of the 31 passengers was seriously injured and five received minor injuries. None of the three crew members was injured.

THE FLIGHT

The aircraft was on a flight from Chicago, Illinois to Miami, Florida, with several scheduled intermediate stops. The flight had been routine until at 1135 it reported over Louisville and requested clearance to land on runway 11.

The first officer, who was flying this leg of the flight from Indianapolis, descended from 5,000 feet to 2,000 feet and then reduced both rate of descent and power. An airspeed of 165 knots was established, the landing gear lowered, and the flaps were placed in take-off position. The first officer then started a turn for final approach, and the flaps were placed in approach position. The captain saw that the aircraft was too high and reduced power still further; the first officer lowered the flaps to full down. The prelanding checklist had been accomplished.

At this point (the altitude was then 1,000 to 1,500 feet higher than the runway) the captain took over control. He nosed down sharply, holding as closely as possible to an airspeed of 100 knots. The landing gear remained down, flaps remained fully down, and throttles were pulled fully back. Neither pilot read the rate-of-climb (descent) indicator during the approach.

When approximately over the threshold of the runway and while about 100 feet above it, the captain pulled back on the yoke to flare out. No power was used. The aircraft's attitude was observed to change from nose-down to nose-up but its rate of descent did not seem to lessen markedly. The aircraft struck the runway on its main landing gear, the left wing separated inboard of the left engine nacelle, and the remainder of the aircraft half rolled to an inverted position. It slid along in that attitude, turning and coming to rest headed nearly opposite its direction at touchdown.

INVESTIGATION

Weather was excellent and was not a factor in this accident.

As mentioned, the flight from Indianapolis was at 5,000 feet altitude in clear weather. During this segment, of which the total elapsed time was only 33 minutes, the stewardess served luncheon to, and removed trays from the 31 passengers. The captain realising that this would be a rather hurried operation allowed the first officer to maintain cruising altitude of 5,000 feet somewhat longer than he normally would. The captain testified that there was a haze line with some choppiness at 4,500 feet and the descent through it was delayed slightly to give the stewardess more time in smooth air. This might account, according to the captain, for arrival in the Louisville area while somewhat higher than usual.

Examination of the entire wreckage revealed no evidence of failure or impairment of any component in flight. It also disclosed that all components of the aircraft were present in the wreckage.

The captain estimated that when

he took the controls to complete the approach his altitude was 1,000 to 1,500 feet above the runway. The horizontal distance from the approach end of the runway has not been determined with any degree of reliability, although the pilots thought it might be a mile or a mile and a half. The captain believed that his position was not enough out of the ordinary to warrant going around. He did not use power prior to starting the flareout because he thought it unnecessary to do so. He testified that when he pulled the control wheel back to flare out the response was not as expected.

A number of persons on the ground observed the approach and/or landing of this flight. Five controllers in the tower saw the approach and the runway contact. Their attention had been called to the unusually steep approach by the controller at the local control position. In all ten witnesses agreed that the approach was steep, some describing it as extremely steep. Those who could see the runway contact agreed that the attempted flare out for landing did not significantly check the downward speed, but that the aircraft struck the runway forcibly.

ANALYSIS

All evidence indicates clearly that the wing failure was the result of and not the cause of this accident. The wing structure was intact throughout the flight and the landing approach and did not separate until the aircraft had contacted the runway. Failure of the wing structure prior to and/or without a failure of the main landing gear was a clear indication that high vertical loads, such as would accompany a hard landing, had been imposed on the structure.

In exploring why the aircraft had contacted the runway as hard as it did, the Board gave careful consideration to the captain's statement that the aircraft's response was not as expected when he pulled back on the yoke in an attempt to flare out. The various components of the elevator and movable stabiliser control system were thoroughly examined for failures or malfunctioning evidence but none was found. Furthermore, no other complaints against the subject control systems had been received. Moreover, the elevators did function properly throughout this landing, as indicated by the fact that the captain's displacement of the elevators caused the aircraft's nose-down descent angle to change to a nose-up angle at touch-down. However, the change in attitude was too late to check the high rate of descent sufficiently, and the aircraft contacted the runway extremely hard. If the flare out had been started sooner, or if sufficient power had been applied just prior to and during the flare out the excessive rate of descent might have been controlled and the hard landing with its resulting damage avoided.

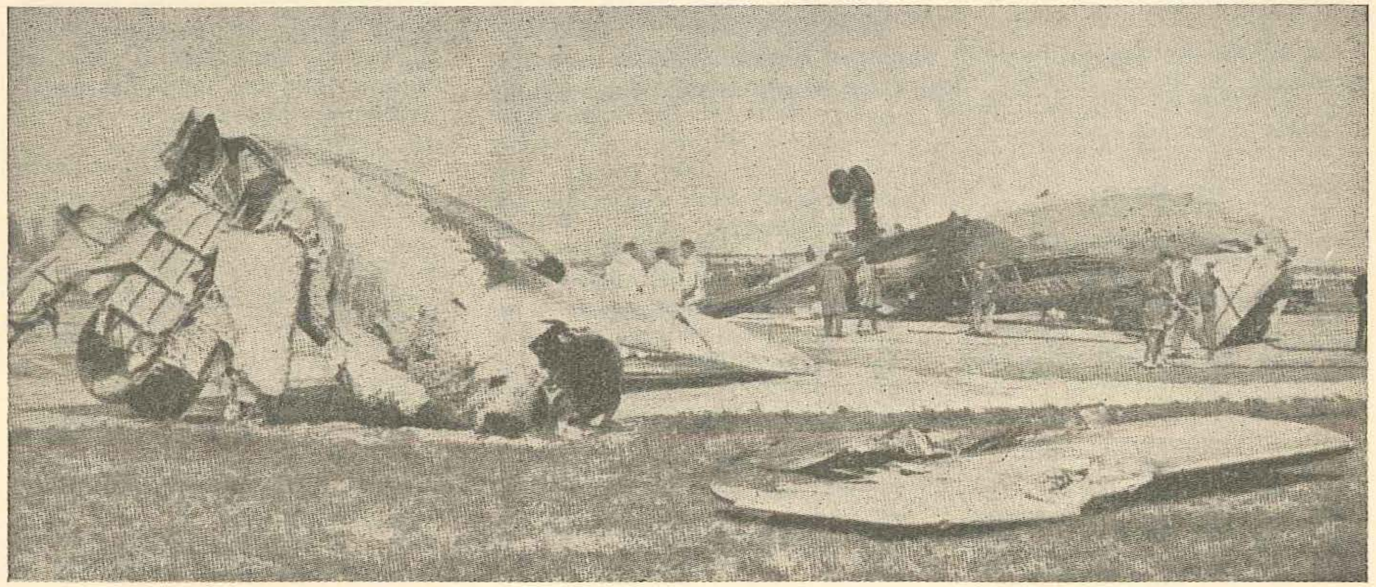
Normally, the first officer, who flew the Indianapolis-Louisville segment, would have made the approach and landing. In this case the captain erroneously allowed the first officer to bring the aircraft to a position much too close in, considering the altitude, for the planned landing on runway 11. At that position relative to the runway, the captain should have taken control and circled the airport to establish a normal approach, or instructed the first officer to do so.

But the captain did not do this. Instead, he elected to dive steeply with full flaps and no power. The precise angle of descent is not known but the preponderance of testimony is that it was exceedingly steep. This testimony is largely by well-qualified witnesses. Such an approach would require, in order safely to check an abnormally high rate of descent, a much earlier starting of the flare out with the use of such power as might be needed to maintain a safe margin of speed.

There was no urgency whatever, because of other traffic, weather, lateness in arrival, or any other compulsive factor, in pressing this approach and landing. Further, this flight crew was to have been relieved at Louisville. This type of approach is in conflict with general and long established airline training and practice. Because no other factors were involved in this accident and no alleviating circumstances stand forth, the Board can only conclude that the pilot erred in executing this type of approach and touchdown. Specifically, the approach was too steep, the flare out was ineffective because of the low airspeed, and consequently the landing was destructively hard.

PROBABLE CAUSE

The Board determined that the probable cause of this accident was the captain's faulty landing approach technique, resulting in an excessively high rate of sink at the instant of touchdown imposing a load beyond the design strength of the wing structure.



DC6 Forced Landing in Jamaica Bay

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)

Following loss of power on all engines, a Douglas DC.6A made a forced landing on a sandbar in Jamaica Bay two miles southwest of its take-off from New York International Airport. The five flight crew members were uninjured, two of the four company employee-passengers incurred minor injuries. The aircraft received substantial damage from the wheels-up landing and salt water immersion.

THE FLIGHT

On June 21, 1957, the DC.6A was engaged on a ferry flight from New York to Dover, Delaware. From there it was intended to transport MATS (Military Air Transport Service) freight to Chateau Roux, France. An IFR clearance to Dover had been given by A.R.T.C. as follows: To the Woolf intersection via the 150 degrees radial of Idlewild VOR and Victor Airway 16, maintain 3,000 feet.

The take-off from New York International Airport (Idlewild) was commenced at approximately 1048. While climbing at an indicated airspeed of 135 knots, gear up and flaps at the 20 degree take-off position, approximately over the northwest end of runway 31R, a substantial power loss on No. 3 engine occurred followed immediately by a similar loss on Nos. 1, 2 and 4 engines. Idlewild local control was advised that the aircraft was making an emergency landing. The aircraft was observed to make a descending left turn and to land wheels up on a sandbar in Jamaica Bay southwest of the airport. It came to rest on the fuselage bottom, level laterally and longitudinally.

The gross weight of the aircraft at the time of take-off was 74,977 pounds, which is under the allowable gross weight of 100,000 pounds (autofeathering inoperative). The load was distributed in compliance with c.g. limits.

The 1051 Idlewild weather was high, thin scattered clouds; visibility more than 15 miles; temperature 74; dewpoint 48; wind north-northeast 6 knots; altimeter 30.06.

INVESTIGATION

After the power loss occurred the flight was cleared by Idlewild tower to land on any runway. The aircraft passed near the approach end of runway 13R but its altitude was so low that a further left turn to the runway could not be made. According to the testimony of the captain it was necessary to go straight ahead with the small amount of power remaining and he was unable to maintain altitude at an airspeed of 105 knots. The landing, with gear up and flaps fully extended, was made on a heading of approximately 200 degrees magnetic off the east shore of an island in Jamaica Bay.

Statements of the flight crew indicated that a normal engine run up had been made at 30 inches of manifold pressure and all pressures and temperatures were normal. In accordance with the company operations manual, a wet take-off was made using 2,800 r.p.m., 59.5 inches of manifold pressure and 240 BMEP. After breaking ground and reaching an altitude of about 140 feet over the end of runway 31R, the BMEP of No. 3 engine dropped to 105, followed by a similar drop on the other three engines. A reduction of manifold pressure to 50 inches did not correct the difficulty and it was returned to 59½ inches. The continuing loss of power, drop of airspeed to 105 knots, and low altitude precipitated the forced landing.

Because of the nearly simultaneous loss of power on all four engines, initial investigation was directed to the aircraft's fuel supply. Board investigators immediately obtained samples of gasoline and ADI (anti-detonant injection) fluid from the aircraft. Samples were also obtained at the operator's supply source. The samples of gasoline were analysed and found to be the correct octane rating (108-135) and uncontaminated. Laboratory analysis of the samples taken from the ADI tanks of the aircraft revealed 55 percent of 50/50 methanol-water contaminated with 45 percent of ethylene glycol. The 50/50 methanol-water is the correct ADI fluid while ethylene glycol is a fluid used to eliminate ice accretion on the exterior surfaces of aircraft.

Investigation disclosed that the aircraft had arrived from an overseas trip the evening of June 20 and that the aircraft was serviced the morning of June 21. Fuel was added to the four main tanks only. The aircraft's four ADI tanks were filled by a mechanic using a portable cart holding a 55 gallon drum marked "ADI". Samples taken from this cart disclosed the fluid to be entirely ethylene glycol.

Investigation further disclosed that the ADI servicing cart had been replenished during the late afternoon of June 19, from a fenced drum storage area outside the company hangar on New York International Airport. It was found that there were drums containing various liquids intermingled in this storage area. Among these liquids were both ADI fluid and ethylene glycol. All of the drums were marked on one end as to the contents. However, the method of filling the portable cart was to insert a hand pump at a side bung in the drum where there was no markings. A deposition taken from the uncertificated mechanic who had serviced the cart on June 19 indicates that he had mistakenly filled the cart from a drum of ethylene glycol. This mechanic also indicated to Board investigators the drum used to fill the ADI cart. The stencilling on the end of this drum, while dirty and blurred, was distinguishable as indicating the contents to be ethylene glycol. The mechanic stated that he had previously serviced the ADI cart but he had never had occasion to draw other fluids at the out-door source of supply.

An examination of all engines at the sandbar disclosed no evidence of structural failure or malfunction.

ANALYSIS

Based on the evidence disclosed during the investigation of the accident, the Board conclusively proved that the engine power loss was the result of contaminated ADI fluid in the engines. Tests duplicating the situation showed that the continuing and increasing power loss experienced during the flight precluded continued flight. In this regard, the Board believes the pilots met the serious situation ably and did all that was possible under the conditions. In fact, the pilots are to be commended for their action in avoiding populated areas and making the landing on an isolated sandbar.

Had the engines been run up on the pre-take-off check to approximately 40 inches of manifold pressure, ADI fluid would have started to flow and its effect would probably have been detected by the crew. However, it is normal procedure to check magnetos at atmospheric pressure (approx. 30 inches) and complete the run up at about this manifold pressure to preclude a rise in cylinder head temperature.

The Board is of the opinion that the mechanic mistakenly filled the ADI cart with ethylene glycol. The mechanic should have been able to read the markings on the drum and, before filling the ADI cart, he should have made certain as to the contents of the drum used.

It is apparent that a serious lack of managerial supervision was also involved. The drums should have had additional markings indicating the contents placed at the side bung by company maintenance. It is further evident that a separation of the drums in a more orderly manner would have assisted in preventing the mistake that occurred. Finally, it is the Board's opinion that there was a definite lack of instruction for the mechanics servicing the ADI cart.

Subsequent to this accident the supplier took steps to stencil the initials "ADI" above the side bung on drums that are equipped with a side bung. In addition, the operator has revised its maintenance manual instructing its personnel to segregate ADI fluids from other fluids and to discharge a slight amount of fluid over their hand before servicing an aircraft to determine if the fluid is contaminated.

PROBABLE CAUSE

The Board determined that the probable cause of this accident was the loss of power on all engines immediately after a wet take-off due to (a) contamination of ADI fluid resulting from (b) mechanic's mistake in replenishing ADI supply cart with ethylene glycol (de-icing fluid), and (c) inadequate supervision of storage facilities.

Convair Crashes During Instrument Approach

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)

At 0001 on 6th January, 1957, a Convair 240 carrying a crew of three and seven passengers, crashed during an instrument approach to Tulsa Airport, Oklahoma. The accident resulted in fatal injuries to one of the ten occupants, serious injuries to six and minor injuries to one.

THE FLIGHT

The aircraft was engaged on a scheduled flight from Providence, Rhode Island, to Tulsa, Oklahoma, with intermediate stops including Chicago, Illinois, and Joplin, Missouri. The flight to Chicago was normal where a routine crew change was made. On the last take-off from Joplin the aircraft weighed 35,940 pounds which was well below the allowable gross weight and nothing untoward had occurred up to this point.

At 2347 the flight reported crossing the south leg of Chanute low frequency range and was immediately cleared by approach control direct to Owasso, to descend to and maintain 3,500 feet, and to report when over Owasso. The 2328 Tulsa weather was given the flight as: measured ceiling 600 feet, overcast, visibility $2\frac{1}{2}$ miles, very light drizzle and fog, wind calm.

When the flight reported $1\frac{1}{2}$ minutes from Owasso, approach control advised the pilot that the visibility was then $1\frac{3}{4}$ miles, that the U.S. Weather Bureau was checking the ceiling, and asked if an Owasso approach straight in to Runway 17 was to be made or if an ILS approach was preferred. The flight advised it would make the Owasso approach and at 2357 was cleared accordingly.

At 2400 the pilot reported over Owasso, inbound, and was cleared to land on Runway 17L. Two minutes later a special 2355 weather observation was transmitted to the flight as: measured 200, overcast, visibility $1\frac{1}{4}$, very light drizzle and fog. This transmission was not acknowledged and nothing further was heard from the flight. Repeated efforts by approach control and other facilities to contact the flight were unsuccessful.

INVESTIGATION

The scene of the accident was on rolling ground 3.6 miles north of the approach end of Runway 17L of the Tulsa Municipal Airport, at an elevation of 613 feet above sea level. It was determined that the aircraft first struck the top of a tree, breaking branches, and then hit the ground in an almost laterally level attitude 225 feet farther on, while on a heading of approximately 174 degrees. First ground contact was made by the main landing gear and nose wheel, which, it was determined, were down and locked at impact. A few feet beyond, along the ground path, were marks made by the blades of both propellers. The aircraft slid along the ground to the top of an upslope and then jumped a deep and wide ditch, finally coming to rest approximately 540 feet from the point of initial touchdown. Fire did not occur and all components were accounted for in the main wreckage area.

Both wings were severely damaged and substantial damage to the fuselage occurred including buckling of the fuselage structure in the cabin area, which caused internal distortion of cabin flooring, seats, and overhead racks. Cabin seats were found in varying degrees of failure and collapse. No seat belts were torn or broken. The nose section of the fuselage was crushed inward and the belly was badly damaged. In the cockpit both pilot seats were torn from their sliding tracks and the left seat was damaged.

Both engines were found near the main wreckage, detached from the aircraft and damaged by impact forces. Disassembly and examination of these engines revealed nothing that would have affected power output or engine response during the flight.

All aircraft navigational instruments were bench checked. Both ADF and omni indicators were found to function within allowed tolerances. The two airspeed and rate-of-climb indicators and the captain's artificial horizon also functioned properly. The first officer's artificial horizon was damaged by impact and was not operable.

Altimeter settings were: captain's 29.41 (475 feet above sea level), first officer's 30.12. Both altimeters when tested functioned within normal tolerances below 6,000 feet. No evidence of internal failure, leaks, dust, foreign material or moisture was found in either instrument. Static lines to the altimeters were damaged and broken, and portions were not found. All recovered portions of these lines were examined; nothing was found which could have affected adversely the functioning of the instruments.

The captain testified that the flight was routine until approaching Tulsa. Throughout the flight from Chicago to Tulsa he and the first officer flew the aircraft on alternate legs. From Joplin to Tulsa the first officer was at the controls. The captain said that a short time after reaching cruising altitude (4,000 feet) they went on instruments because of weather and remained on instruments until shortly before striking the tree.

The captain said he decided on an ADF straight-in approach to Runway 17, thereby using the back course of the ILS and the Owasso facility as reference for proper alignment. Accordingly, having been cleared, the flight crossed the Owasso facility initially at 3,500 feet m.s.l. and began the usual 2-minute standard holding pattern while awaiting approach clearance. Both captain and first officer said they had their ADF approach plates in readiness. While flying outbound on a heading of 354 degrees for $1\frac{1}{2}$ minutes the flight was cleared to land. The captain said he told the first officer that he could descend to 700 feet, but he did not remember telling him 700 feet on the *field level altimeter*. (The Company's landing minima for a straight-in approach to Runway 17L for Convair aircraft are 400 feet and 1 mile.) The captain said he then told the first officer to establish a rate of descent of 1,000 feet per minute. Thirty seconds later a descending standard right turn to a heading of 174 degrees was begun, the landing gear was lowered, and the flaps were extended 21 degrees. The captain stated that with the checklist completed they crossed the facility at an altitude of approximately 1,200-1,300 feet, according to his altimeter. The distance from the facility to the approach end of Runway 17L is 5.6 miles.

In this operator's aircraft both captain and first officer have an altimeter in front of them on the instrument panel. According to the company's procedure when a landing is to be made the captain's altimeter is set to field level pressure so that it would read in actual feet above the airport and zero when on the ground. The first officer's altimeter is set to mean sea level barometric pressure and thus would read, in this instance, 674 feet, the elevation of the field, when on the ground.

Throughout the approach the captain performed the duties of first officer. The captain said he did remember looking at his altimeter from time to time during final descent and that he last observed it when it read 700 feet. He fully expected they would be visually contact at 600 feet. He said the rate of descent remained about 1,000 feet per minute throughout the entire descent with the airspeed between 120 and 130 knots. He turned on the landing lights during the final portion of the descent but the reflection from the cloud was so great he immediately turned them off. He next remembered glancing out his window and seeing lights to his left.

Suddenly realising he should check the descent, he started to apply additional power but as he did he "felt something grab the airplane or hit it". He immediately pulled all power off.

The first officer testified that he did not remember anything after the start of the approach except that at one point during the descent he noted a reading of 1,500 feet on his altimeter.

ANALYSIS

As indicated previously the possibility of a failure or malfunctioning of one or both altimeters was thoroughly explored during the investigation. However, the fact that these altimeters, when bench tested, operated correctly at altitudes below 6,000 feet, coupled with the evaluation of the significance of the altimeter settings found after impact, indicates clearly that these instruments could not have of themselves produced erroneous readings which could have contributed to this accident.

The probability of an error in altitude being introduced by accumulation of water in the static system was also considered. In this connection, it must be realised that the static system is common to both the airspeed and rate-of-climb instruments, as well as to the altimeters. Any effect on the altimeter would be accompanied by a similar effect on the airspeed indicator. Furthermore, the captain's and first officer's pressure instruments are served by separate and independent static systems.

It was established that it would be necessary to have a considerable amount of water accumulation in the static system to produce an error in altitude indication of a magnitude necessary to have caused this accident. Moreover, this relatively large quantity of water would have caused airspeed indications much higher than actual. It is possible that the pilot would not have properly diagnosed these errors during the approach; however, he should have been alerted to the fact that something was wrong. Since he testified that the airspeed indications were normal throughout the approach and descent, it is apparent that an altimeter error of any sizeable magnitude could not have been present. In any event, because of the duplication of static systems, it is extremely unlikely that an error in one system would occur at the same time and with the same magnitude in the other system. According to the operator, the static system drain manifolds are drained at each periodic check, scheduled at periods not greater than 125 hours. The static drain manifolds on this aircraft were drained seven days prior to the accident.

It is worthy to note that this was the first trip the captain and first officer had flown together and that it was also the first officer's first instrument approach into Tulsa. This is not meant to imply that the first officer was a novice in instrument flying but rather that his degree of proficiency was unknown to the captain and therefore this approach, being made under rapidly deteriorating weather conditions, should have been monitored with the utmost care.

Another factor that must be carefully considered is the weather and what possible effect it may have had on the captain's judgment. The company meteorologist at Chicago briefed the crew prior to departure on the probable en-route and terminal weather conditions and the expected deterioration of the weather at Tulsa after 2100. When the flight reported crossing the south leg of the Chanute low frequency range, Tulsa approach control gave the 2328 Tulsa weather as: measured ceiling 600 feet, overcast, visibility $2\frac{1}{2}$ miles, very light drizzle and fog, wind calm. A short time after the flight was advised that the visibility was then $1\frac{3}{4}$ miles and that the visibility was lowering, and that he did not have the latest ceiling checks. The captain continued the approach, apparently assuming that the last ceiling report of 600 feet would hold.

Whether the captain, because of this last ceiling report, had a feeling of false security is not known. It is true, however, that with his knowledge that the visibility had actually lowered three-quarters of a mile in a few minutes, coupled with his knowledge of the company terminal forecast, he should have expected the ceiling then to be less than that previously reported. This is of primary importance since it was obligatory that the captain not permit the aircraft to descend below the approved minimum altitude.

As has been stated, it is company policy to set the captain's altimeter to field pressure and the first officer's to mean sea level pressure prior to an approach. The captain testified that the altimeters were cross checked twice prior to the approach to Tulsa and that the readings were found to have the correct relationship to each other.

The captain further testified that the descent to Tulsa began at an altitude of 3,500 feet and that he told the first officer he could descend to an altitude of 700 feet. In giving these instructions to the first officer he made no reference to which altimeter should be used. Since the first officer's altimeter was set to mean sea level, a descent to a reading of 700 feet on his altimeter would have placed the aircraft at or near ground level.

The descent from an altitude of 3,500 feet was begun at 2357 and the accident occurred at 0001; therefore, approximately four minutes elapsed from the start of the descent to striking the ground. Since the elevation of the terrain at the scene of the accident was 613 feet m.s.l., the aircraft descended 2,887 feet at an average rate of 721 feet per minute. This is slightly lower than the constant rate of descent of 1,000 feet per minute which the captain, in his testimony, said occurred. However, considering such variables as initial lag in establishing the descent and the decrease in rate of descent when a last-minute attempt was made to slow the aircraft down, it is probable that when observed the captain's rate-of-climb indicator did register as he stated.

This average rate of descent strongly suggests that the captain observed a reading of 1,200-1,300 feet on the first officer's altimeter instead of his own when crossing the facility inbound. This is a logical assumption since at the time the first officer's altimeter should have registered 1,200-1,300 feet and that of the captain approximately 700 feet; it is further supported by the fact that the accident occurred about one minute after the facility was crossed. The thought that the reading was made on his own altimeter may have led the captain to believe he had some 800-900 feet to descend before reaching his minimum altitude, and this may have prompted him to permit the descent to continue without realising the close proximity to the ground. Also, the first officer, in interpreting the captain's instructions to descend to 700 feet, may have planned the approach so as to descend over the station to a 700 foot indication on his own altimeter. Clearly, there was misunderstanding and lack of alertness on the part of both the captain and first officer throughout the entire approach.

PROBABLE CAUSE

The Board determined that the probable cause of this accident was the captain's lack of alertness in allowing the first officer to continue an instrument descent to an altitude too low to permit terrain clearance.

COMMENT

The practice adopted in this country of setting both altimeters to a common datum (QNH) for the approach and landing should prevent confusion of the nature suspected in this case.

C47 Fails to Recover from Spin

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)

On June 22, 1957, a C.47 on a training flight was totally destroyed when it crashed near Clarksburg, Maryland. The instructor and two pilot trainees, the only occupants, were killed in the crash.

THE FLIGHT

At 0625 the aircraft departed for the company's local practice area for the purpose of training flights. There was no further radio contact with the flight and at approximately 0745 the aircraft was observed in the vicinity of Clarksburg by many people who saw it during several minutes of flight and in its plunge to the ground.

INVESTIGATION

In its final descent the aircraft passed almost straight down through a group of trees landing on top of an automobile. The fuselage forward of the cargo door was demolished when the aircraft struck in a nose-down near-vertical attitude.

An examination of the wreckage revealed no evidence of malfunctioning of the aircraft engines or control systems.

Due to the fairly rigid sequence of manoeuvres taught by the instructor, it could be estimated which manoeuvre his pupil would be executing at a given time after take-off. It was considered that as the flight had been airborne approximately $1\frac{1}{4}$ to $1\frac{1}{2}$ hours, that it would have progressed through the sequence of manoeuvres to the "canyon approach".

The "canyon approach" simulates letting down to an airport surrounded by obstructions, followed by an emergency pull-up, and it combines most of the airwork taught each student. Proper execution requires exact control of airspeed, altitude, headings, power settings and cockpit procedures, all of which must be accomplished under the "hood".

Specifically, for the "canyon approach" the student simulates an approach making a rectangular pattern. He then performs an "in range" cockpit check and lowers one-half flap. When airspeed slows to 95 knots he calls for extension of the gear and full flap. With power off, he descends 1,000 feet holding 95 knots. At 200 feet above the simulated airport elevation (generally selected as 3,000 feet m.s.l.) he levels off applies full power, orders gear and flaps "up" and begins a maximum performance climb at 85 knots. At this point the instructor may, in his discretion, "cut" an engine. If an engine is "cut" the student must complete the emergency procedure and continue climbing at 85 knots for 300 feet. He then increases speed to 95 knots and makes a 180-degree standard rate turn.

ANALYSIS

From the evidence of several persons who saw the aircraft in flight and the company personnel familiar with the training programme, the Board believes that the accident took place while the pilot was executing the abandon-approach phase of a "canyon approach" manoeuvre.

The "canyon approach" has long been taught by many airlines and is considered a standard exercise. In this manoeuvre the pilot must fly his aircraft with extreme precision at low airspeeds to obtain maximum performance. The Board also recognises that during some of these manoeuvres the aircraft will be flown so as to exceed the limits normally expected in airline flying (although not beyond the placarded limits of the aircraft).

Eyewitnesses stated that the aircraft pulled up and started a slight turn to the right, indicating the "abandon-approach" phase of the manoeuvre. At this point the pilot is simulating an emergency pull-up, i.e., maximum rate of climb at an airspeed of 85 knots, which permits adequate control of the aircraft. As previously stated, this manoeuvre must be executed with precision because over-controlling or rough handling of the controls could result in a stall and/or spin.

A spin at this point could also be induced as a result of some mechanical or structural failure or deformation. Further corroboration of the fact that no mechanical or structural failure existed is that recovery from the spin had been started and rotation had stopped when impact occurred. Because of the absence of any such evidence it must be concluded that the pilot inadvertently allowed the aircraft to exceed its capabilities, stall, and enter a spin.

Spin characteristics of the DC.3 (C.47) have been described in several NACA reports. There are also available several reports from pilots who have spun the DC.3 both intentionally and unintentionally. These reports show that in the unintentional or inadvertent spin considerably more altitude is lost than in an intentional spin before recovery can be effected. Presumably, this is due to the element of surprise. Altitude loss, as much as 3,000 feet, has been reported by experienced pilots, in an inadvertent spin of only one turn.

Tests show that altitude loss per turn in a steady spin is about 600 feet. Further, that after the rudder is reversed rotation will stop in approximately one turn and that the loss of altitude for this final turn will be approximately 1,000 feet. When rotation is stopped the aircraft will be vertical. It will then require an additional 2,000-2,500 feet of altitude to return to level flight.

In this instance, spin rotation had stopped before the aircraft struck the ground in a near vertical attitude. Most witnesses said they saw several turns in the spin. Using the data above, it is evident that the aircraft entered the spin from an altitude of at least 2,500 feet above the ground. This determination, significantly, is in agreement with the altitudes of the aircraft as estimated by eyewitnesses. It is also significant that this altitude is approximately the altitude at which the aircraft would normally be expected to be during the abandon-approach phase of the "canyon approach". The usual procedure was to use 3,000 feet above sea level as the simulated elevation for the "canyon approach". Therefore, because the average elevation of the terrain in the vicinity of Clarksburg is 500 feet above sea level, the aircraft would be approximately 2,500 feet above the ground.

PROBABLE CAUSE

The Board determined that the probable cause of this accident was loss of airspeed while executing manoeuvres during a training flight, resulting in a stall followed immediately by a spin from an altitude too low to effect recovery.

CORRECTION

Under the heading "Instrument Filters in Agricultural Operations" in the last issue of the *Digest* we stated that a turn and bank indicator is not a mandatory instrument for operations under the visual flight rules. At that time it accurately described the Department's published requirements but we now draw your attention to Issue No. 2 of Air Navigation Order 20.18 and particularly to Section 1 of its Appendix which became effective on 1st July, 1958. The new requirement is that, in addition to an airspeed indicator, altimeter, magnetic compass and a clock, aircraft engaged in charter or aerial work operations and operating under the visual flight rules shall have a gyroscopic turn and bank indicator installed in the aircraft.

Australian Accidents

Fatal DH.82 Accident in New Guinea

On the morning of 1st June, 1957, the manager of an airline company, who held a private pilot licence, made preparations for a flight in a DH.82 from the company's headquarters at Goroka in the Central Highlands of New Guinea to Lae. He submitted a flight plan estimating a time interval of 90 minutes to Lae with a fuel endurance of 165 minutes. The forecast issued for the flight indicated that the weather would be mainly fine with 25 miles visibility on the ranges reduced to five miles in showers. The aircraft was not fitted with radio and departed Goroka at 0947 hours E.S.T., with one passenger, a company employee, aboard.

At approximately 1210 hours (i.e., 2 hours 23 minutes after departure) the aircraft was seen by a surveyor who was working on the Arona airstrip, 35 miles from Goroka. He saw the aircraft heading towards the Arona Gap, one of the frequently used exits from the Central Highlands to the Markham Valley. The aircraft was not seen again until almost 24 hours later when it was found, by a native, wrecked in thick timber on the south-eastern slopes of the Gap. The pilot and the passenger had been killed in the impact. The accident site is about 2,750 feet above mean sea level, and $1\frac{1}{2}$ miles on the Markham side of the highest point of the gap.

The aircraft had disintegrated but all major components were accounted for in an area 120 feet by 60 feet. It had crashed on a heading of 130°M which is at right angles to the general line of the Arona Gap. It is estimated that it had struck the trees at an angle of 60° below the horizontal, and a wristlet watch recovered from the wreckage indicated that the accident had occurred at 1215 hours (i.e., five minutes after it had been seen by the surveyor). There was abundant evidence that fuel had sprayed and ignited in the area of impact. Both propeller blades had been sheared from the hub; thus suggesting that the engine was still operating and probably delivering substantial power at the time of impact. There was no evidence of structural failure and, so far as an examination of the fire damaged engine revealed, no evidence of any defect.

The evidence concerning weather conditions along the route, Goroka to Lae, on this day came from both ground observers and from the pilots of other aircraft operating in the area. It indicates that conditions, particularly along the peaks bordering the Markham, were substantially worse than forecast. There was a south-easterly blowing which had filled the Markham with low cloud and was driving cloud transversely across the gaps used by light aircraft to break out of the highlands into the lower terrain of the Markham Valley. In these conditions, it can be expected that there would be moderate to severe turbulence in negotiating these gaps and they would be opening and closing rapidly. The surveyor at Arona reported that there had been a slight improvement in both ceiling and visibility during the morning and, at the time he saw the aircraft approach the Arona Gap, the entrance was clear. From his position on the ground, however, it was obvious that there was substantial cloud in the Markham Valley and at the lower end of the Gap.

Most searching enquiries failed to discover any report of this aircraft landing at any of the landing strips in the Central Highlands between the time of departure Goroka and the time of being seen at Arona. There were some reports of ground observers having seen the aircraft in flight and it seems that the pilot had spent the $2\frac{1}{2}$ hours after departure Goroka searching for a visual break into the Markham Valley. It is probable that when the aircraft was last seen, the pilot was having a close look at the Arona Gap knowing that, if it could be successfully negotiated, he could refuel and report position at Kaiapit five minutes flying time beyond the gap, and if not, he could return to Arona airstrip which was clear and over which he had just passed.

The pilot of the aircraft had a total of 358 hours aeronautical experience almost all of which had been gained in New Guinea on DH.82 aircraft. Although not an experienced pilot he was recognised in the Territory as a cautious pilot and one who was well aware of local conditions and of the special precautions which are needed to cope with them.

The surveyor at Arona estimated that the height of the cloud base was 4,600 feet above mean sea level at the time of the accident, i.e., 350 feet above the highest part of the gap. Having had aircrew experience in the R.A.A.F., his statement that the aircraft appeared to be functioning normally is regarded as being reliable. Had the engine not been functioning normally it seems almost certain the pilot would have landed at the Arona airstrip, which he knew well, and which he must have seen as he passed over it.

It is apparent that the aircraft was deliberately committed to negotiating the gap, but in the absence of eyewitnesses or survivor evidence, the events that occurred during the attempted passage can only be surmised. It seems most likely that the aircraft would have encountered either severe turbulence or cloud but it is difficult to imagine that this pilot would attempt to continue through cloud unless there was absolutely no alternative. His training and experience would prejudice him strongly against such action, particularly since he had no experience of instrument flight. It is far more likely that the pilot would abandon the attempt to negotiate the gap and would try to turn back.

At the height the aircraft was flying, the Arona Gap is very narrow and it would require considerable skill to turn safely, even in ideal conditions. The fact that the final flight path was at right angles to the line of the gap and that the impact occurred on the slope to the south east suggests that the pilot attempted to turn to starboard and, either had insufficient room to complete the turn, or was forced into the trees by turbulence or subsidence. Even if the aircraft had been clear of cloud in the airspace available during the turn it is probable that there would have been no natural horizon and loss of control could easily have followed in these circumstances. Whatever may have happened to the aircraft once it had entered the gap, the evidence strongly suggests that the real cause of the accident lay in the pilot's decision to fly into its narrow confines when he could not have been certain that visual flight could be maintained into the Markham Valley.

Hydraulic Line Failure in a DC.3

During the afternoon of 8th July, 1957, a DC.3 aircraft, engaged on a regular public transport service between Innisfail and Cairns in northern Queensland, returned to Innisfail soon after departure having experienced an hydraulic pressure failure. The port undercarriage folded during the landing roll and the aircraft skidded to a halt resting on the port wing and starboard undercarriage. None of the 19 occupants was injured.

The aircraft departed Innisfail at about 1530 hours bound for Cairns, 40 miles to the north. There was a low cloud base along the coast and visibility was reduced in rain showers. The coast was crossed east of Innisfail aerodrome and the pilot in command turned north with the intention of maintaining visual contact beneath the cloud base to Cairns. He soon found, however, that he would not be able to continue VFR and turned to seaward to climb on a track 120°M with the intention of proceeding IFR at or above the minimum en route altitude of 7,000 feet. This diversion had hardly been commenced when the failure of an hydraulic line caused a strong jet of hot hydraulic oil to be directed into the captain's face. To appreciate his surprise and discomfort needs little imagination and the danger to the aircraft at this stage lay in the fact that the cockpit instruments quickly became obscured by oil as did the front windscreens. The flow did not cease until the whole of the main reservoir quantity had been pumped into the cockpit by which time it was literally enshrouded in a spray of oil. The aircraft was turned back towards the coast and height maintained just below the cloud base.

Weather conditions at Innisfail had deteriorated quite sharply and the crew also discovered that the undercarriage had extended as system pressure dissipated. To make matters worse they could not obtain the gear down and locked indication from the undercarriage lights. In view of the probability of an emergency landing the captain considered going to Townsville or Cairns but the former could not now be reached with the undercarriage down and the latter involved an IFR flight which was not an attractive proposition in the circumstances. The emergency services at the Innisfail aerodrome had been alerted and the captain decided to land there as soon as possible. The aircraft crossed the coast in light rain showers, being forced down to a height of 500 feet to remain in visual contact.

In the best circumstances lack of a positive gear down indication calls for some careful trouble-shooting and a reasonable length of time in which to do it. On this occasion, however, with the weather conditions steadily worsening and with the crew and cockpit drenched in oil, the problem assumed formidable proportions. The captain tried all the standard methods for emergency gear extension but the use of the emergency hand pump only served to pump more oil into the cockpit and the application of "g" forces was necessarily limited and unsuccessful in the airspace available beneath the cloud base. In all the circumstances the captain decided that he could not delay the landing at Innisfail any longer and he expected that the initial impact on landing would serve to lock the port wheel in the down position.

All precautions were taken in the cabin to safeguard passengers and to secure moveable objects and the landing was made into the southwest on a grass surface strip. The captain's visibility during the approach and landing was severely restricted by oil on the interior of the windscreen, by rain and by lack of serviceable windscreen wipers to say nothing of the effects of hydraulic oil in his eyes. Nevertheless a smooth landing was made within 600 feet of the threshold and the aircraft ran for almost 1,200 feet before the port undercarriage began to retract and the aircraft slowly sank onto the port wing-tip and propeller. The ground being grassed and wet, the aircraft slid sideways for a considerable distance without doing much additional damage and came to rest just outside the confines of the strip. Fire precautions were immediately taken and the passengers and crew left the aircraft quickly and without injury.

An examination of the aircraft revealed that the hydraulic line to a windscreen wiper had broken circumferentially around the flare of the inlet to the control valve, leaving the open line directed at the captain. Since the break had occurred between the pressure manifold and the control valve and was not readily accessible, there was no practicable way of stemming the oil flow. The failure had apparently occurred because in the fitting of the line a tube of insufficient length was used, such that it had to be "sprung" to seat properly at either end and then the union nut had been tightened to such an extent that the flare had not only been pinched but had shortened by being pulled back into the union sleeve. (See the article on "flaring" in the News and Views of this issue.) As a result of this

accident all DC.3 aircraft were examined for damaged or aged hydraulic lines and engineers were reminded of the importance of proper flaring methods and careful maintenance procedures in dealing with hydraulic leaks. There was more than a suggestion that oil had previously been reported leaking from this union and that the remedial action employed was simply to tighten the union nut. This, of course, does nothing to ascertain the cause of the leak and is an unsatisfactory maintenance procedure.

It is obvious that the captain of this aircraft was presented with a most unusual situation and one where any lack of clear thinking could have resulted in disaster. It is considered that he took all possible precautions in the circumstances to avoid an accident and the relatively slight damage to the aircraft was largely due to the high standard of skill he displayed. It is also interesting to note that the undercarriage on this aircraft extended when the hydraulic pressure had dissipated because it was the operator's practice to fly with the undercarriage selector in the up position. Following this accident the practice has been revised and the selector is now left in the neutral position during flight in order to avoid a situation where it would be impossible to raise the undercarriage if it extended because of a broken line.

Vickers Viscount Landing with Nosewheel Retracted

On the night of 30th April, 1957, a Vickers Viscount was landed at Townsville, Queensland, with the nosewheel in the retracted position. It came to rest on the runway on its mainwheels and the nose. None of its occupants was injured.

The aircraft, a 720 series Viscount, was operating a scheduled service from Brisbane to Townsville and Cairns. It carried 43 passengers and a flight crew of four. The flight was routine until arrival in the traffic pattern at Townsville, when the pilot found during preparations to land, that the undercarriage position indicator lights showed that the nosewheel had not extended; indications were that the mainwheel struts had extended properly.

The undercarriage system was cycled a number of times and manoeuvres carried out which would impose a "g" loading and possibly free the nosewheel strut, but without success. The aircraft was then flown past the control tower for external inspection and this confirmed that, while the mainwheels were extended, the nosewheel strut was still stowed behind the closed doors of its compartment. Faced with a landing with only the mainwheels extended the pilot decided to remain aloft until he had burned off surplus fuel.

While circling over Townsville the flight crew prepared the aircraft, and its passengers, for the emergency landing. The passengers were informed of the situation and of the nature of the landing which would be carried out. The location and method of operating the emergency exits was carefully explained to them and they were instructed that, if possible, the forward loading door would be used to leave the aircraft. The seating of passengers was rearranged, the heaviest persons being seated at the rear, so that the centre of gravity of the aircraft was as far aft as possible, thereby assisting the pilot to hold the nose off the runway for the longest period during the landing.

Meanwhile, preparations were also being made on the ground. The aerodrome at Townsville is a Royal Australian Air Force station and this unit's medical centre and ambulance facilities were alerted. The station fire fighting services were reinforced by the local civil fire brigade and the Townsville General Hospital was also alerted. The passenger terminal on the aerodrome was set up as a casualty clearing station under the direction of a medical officer. All of these preparations were completed by 2030 hours local time and at 2052 hours the captain of the aircraft advised he was commencing his landing approach. The aircraft had been holding over Townsville for 1 hour 15 minutes.

Touchdown was made in a tail down attitude and the aircraft ran a distance of 855 feet before the nose contacted the runway, sending up a shower of sparks that illuminated the scene. The aircraft ran straight down the runway centre line on the mainwheels and nose for 970 feet and then veered slightly left and ran a further 480 feet before coming to rest still on the runway and 35 feet to the left of the centre line. The passengers and crew left the aircraft by the front loading door without difficulty.

All blades of the four propellers were bent by contact with the runway and there was slight damage to one engine mount. Apart from these items damage was confined to the steering jacks on the nosewheel strut, the nosewheel compartment doors and a surprisingly small area of the skin and some formers of the underside of the nose. It was found that the actuating jack had become disconnected from the nosewheel strut through failure of the trunnion block. This failure was subsequently determined to be due to fatigue. As the up latch is withdrawn by the action of the jack there was no means by which the nosewheel strut could have been released and extended in flight.

Immediately the nature of the defect was apparent the remaining 12 Viscounts on the Australian Register were inspected and in nine cases the trunnion block was found to be in the early stages of failure. The aircraft's manufacturer produced a redesigned trunnion block but until these were available an inspection was introduced which involved the removal of the trunnion blocks in use at frequent intervals for crack detection examination.

Improperly Loaded DH.84 Crashes Out of Control

At a height of about 70-80 feet on the take-off climb a DH.84 was seen to bank to the right and then spiral to the ground. It caught fire on impact and was destroyed. Witnesses of the take-off and subsequent descent reached the burning wreckage within a few minutes of the impact and were able to extricate the injured pilot but he died some hours later. There were no other persons on board the aircraft.

All eyewitnesses, including two commercial pilots, agreed that the sound of the engines indicated they were functioning normally throughout the flight. The strip used for the take-off was 4,321 feet long and had a hard, level surface. Weather conditions were fine with a temperature of 70°F and a wind of 5 - 7 knots across the take-off path from the right. The take-off was commenced from the end of the strip and, as it progressed, one of the pilot onlookers remarked on the abnormally long distance the aircraft had run with the tail wheel on the ground. It became airborne in a pronounced tail down attitude after a run of 2,500 feet and climbed away, still in this unusual attitude.

All the witnesses agreed that the aircraft climbed slowly and with apparent difficulty, and that the climb continued straight ahead in this manner until the aircraft was about 30 feet above scattered 45-foot high trees off the end of the strip. At this point it apparently ceased to gain height and then in a matter of seconds the right wing went down and the aircraft descended out of sight among the trees.

The point of impact was 2,800 feet from the near end of the strip and the distance covered by the aircraft from the unstick point confirmed the witnesses' observations that the rate of climb was slow. The disposition of surrounding trees and the fact that the aircraft did not contact them during its descent indicated that the final part of its flight path was very steep. The nature of impact damage to the starboard wings, evident in spite of the effects of fire, and marks on the ground showed that the aircraft had first struck with the starboard wings and then cartwheeled to its final position coming to rest right side up and heading back towards the strip.

The pilot held a commercial licence and had flown approximately 3,350 hours. The full extent of his experience on the DH.84 is not known but it was established that in the three months prior to the accident he had flown this particular DH.84 for 210 hours. Most of this time was gained on operations from the aerodrome at which the accident occurred.

Calculations based on performance data for the DH.84 show that, under the atmospheric and strip conditions existing at the time and assuming it was loaded to the maximum permissible all-up-weight of 4,500 lbs., the aircraft should have been airborne after a run of 1,600 feet. Further, at a point 2,800 feet beyond the strip end it should have attained a height of 200 feet. In this case, therefore, the aircraft had taken a run approximately 50% longer than normal and the height gained was less than half of that expected.

Although Air Navigation Orders require that a load sheet shall be compiled for the DH.84 this was not done for this flight, therefore, the disposition of the load is not known with certainty. It was ascertained, however, that at least 1,563 lbs. of freight was loaded into the aircraft. This resulted in an all-up-weight at least 313 lbs. in excess of the maximum permissible for the type. This overload represented 7% of the permissible gross weight. Because the disposition of the load is not known in detail it was not possible to calculate the position of the centre of gravity. Nevertheless, from the evidence of persons who helped to load the aircraft, it appeared that the centre of gravity could have been well outside the aft limit thus seriously affecting the controllability of the aircraft.

It was apparent from the length of the take-off run that the cause of the ultimate loss of control was present from the commencement of the take-off. Had the poor performance been caused by loss of engine power it is believed that this fact would have been obvious to such an experienced pilot, and that he would have abandoned the take-off in such circumstances. It is considered that the pilot would only have persisted with the take-off believing that he knew the reason for the long run and that this reason was the heavy load.

It was concluded that the probable cause of this accident was the excessive load and its improper distribution which made it impossible for the pilot to maintain flying speed. The fact that the aircraft was airborne for about three-fourths of a mile and gained some height was attributed to the improvement in performance of an aircraft when it is flying close to the ground and, therefore, subject to the influence of ground effect.

Low Flying Auster Strikes Tree with Fatal Results

The aircraft was wrecked and two of its three occupants lost their lives when an Auster aircraft struck a tree and dived into the ground while making an unauthorised message dropping pass over a homestead near Injune, Queensland, at 1415 hours E.S.T. on 2nd June, 1957. The third occupant was seriously injured.

One of the passengers had hired the aircraft and it was on his property that the accident occurred. This passenger was killed instantly and the pilot died shortly afterwards from extensive injuries.

An eyewitness saw the aircraft descend to a low height in the vicinity of the homestead, which was located in a small clearing in timber covered undulating country. It passed over the homestead and flew away to the north over rising ground covered with trees of varying height. It soon reappeared and passed over the house again at a low height and in the same direction as previously. On this run the pilot dropped a tin containing a message out of the left window. The aircraft then continued without deviation and struck the top branches of a tree, which stood taller than its neighbours, 334 feet from the house, on the edge of the clearing. The message fell midway between the house and this tree and, as it was dropped from a low height its position indicated that the pilot was occupied with the dropping action until about two seconds or less before the aircraft struck the tree. The rising tree-covered ground beyond the point of first impact provided a background against which the detection of the tree would depend on close attention to the flight path.

Examination of the wreckage revealed no evidence of malfunctioning or failure in the power plant or the aircraft. From this and the other evidence it was concluded that this accident occurred because the pilot did not pay adequate attention to his flight path while flying close to obstructions.

Do You Still Know?

1. How to determine P.N.R. on a flight

2. There is a requirement to check VAR equipment for interference before descending.

3. The standard phraseology for sending out a distress message and the communication frequencies to use.

4. Why indicated airspeed on approach needs no adjustment for altitude and outside air temperature.

5. There is a requirement to check the DME equipment before commencing an arrivals procedure.

6. The fixed fuel reserves and variable fuel reserves applicable to operation of the aircraft you now fly.

7. What percentage of the runway length required for landing is the stopping distance on a hard dry runway.

8. What percentage of the runway length required for landing is the stopping distance on a wet runway.

INCIDENTS

Design Features

The following two incidents serve to demonstrate once again that until such time as manufacturers design their equipment to "go, no-go" specifications, considerable care must be exercised when installing equipment which will permit incorrect fitment.

Whilst flying through strong cold frontal activity with light to heavy icing and moderate to severe turbulence, the weather radar became unserviceable at a time when pronounced storm cells were evident and it was being used for storm avoidance.

A check of the relevant fuses revealed that No. 1 fuse had failed, the fuse installed being only 3 amp instead of the required 5 amp. (The circuit load being 4 amps.) The radar volt fuse was 10 amps instead of $\frac{1}{2}$ amp. The other aircraft fuses were then checked and the autopilot control phase fuse was found to be 5 amps instead of 3 amps.

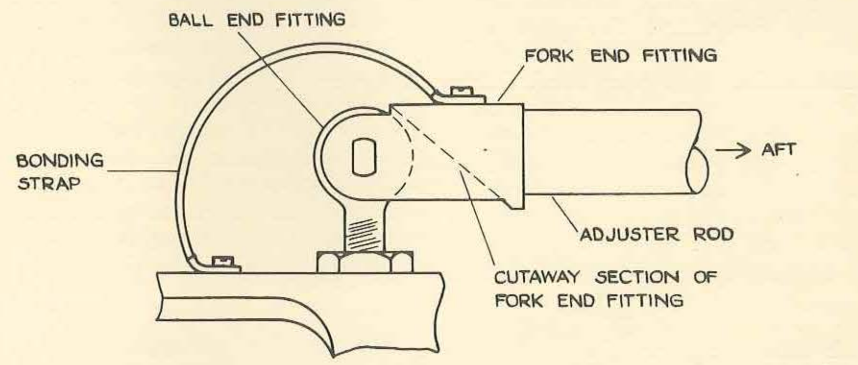
Examination of instructions indicated that there was no drawing or design error associated with the fusing system. Investigation did not reveal who was responsible for the fitting of the incorrect fuses which were all of similar design but marked as being of differing capacities, nor was it possible to determine the sequence of events leading to their fitment.

• • •

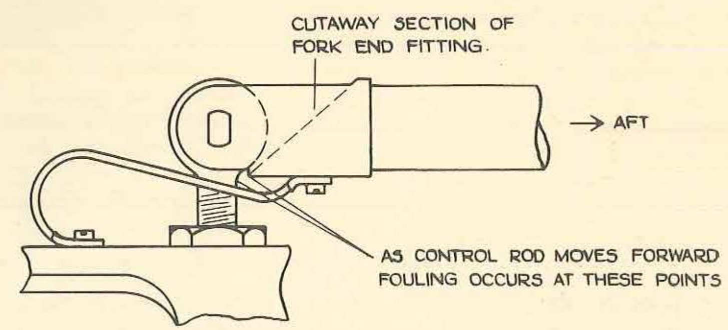
During a pre-flight check on the 6th January, 1958, the pilot of a Viscount noticed that the up travel of the elevators was restricted. Investigation revealed that the front fork end fitting on the elevator adjuster rod located in the rear fuselage was installed upside down.

The last known inspection of this aircraft when the fork end could have been installed incorrectly was on the 23rd August, 1957, when a check of the elevator rigging had been carried out—nearly five months before the error was discovered. Arising from this incident, a fleet check was made and a similar error was discovered on one other aircraft; this aircraft had undergone an elevator rigging check on the 6th December, 1957. No defects were found in the rudder control system which is of similar design.

There are no identification marks to indicate the top or bottom of the fork end, the only indication being the angle of cut-out. By referring to the sketches which show the correct and incorrect method of fitment, it will be seen that when the control rod is fitted incorrectly (upside down), the portion of the fork end not cut away and the neck of the ball-end fitting will foul as the control rod is moved forward and towards the end of its travel.



CORRECT FITMENT



INCORRECT FITMENT

L.A.M.Es PLEASE NOTE

Do you know of any other part that can be installed incorrectly? If so, what effect would it have on the safety of the aircraft? If it could be dangerous inform your supervisor. If you are not certain, be doubly sure to tell him, then any doubt can be eliminated.

If you don't know of any vital parts that can be incorrectly installed we suggest you look for them during maintenance and overhaul. If you find any, perhaps you can suggest a way which will ensure that the part cannot be improperly installed.

Controlled Airspace

Recently an incident occurred which involved the infringement of controlled airspace by a Cessna aircraft undergoing flight tests following the installation of radio equipment.

The two technicians who were performing the radio installation wished to carry out airborne tests of the equipment at various altitudes. One technician proceeded to the control tower whilst the other remained in the aircraft to operate the equipment. Once airborne the technician requested the pilot to climb to a level which placed the aircraft within the control area. The pilot complied with this request and assumed that the technician on the ground had acquainted air traffic control with the nature and height of the manoeuvres being carried out. Unfortunately, this was not the case and the Cessna, whilst in the control area, passed about 400 yards in front of a Convair on a regular public transport flight.

Quite obviously the need for a specific clearance to enter the controlled airspace was not appreciated by the Cessna pilot. All pilots are reminded that if they wish to enter a controlled airspace they must specifically request and receive approval to do so; the consequences of a failure in this respect could be extremely grave.

Minor Incidents

A pilot regularly engaged on the Adelaide-Darwin route suggested, as a safety measure, that Tennant Creek Aeradio should remain open until the aircraft had passed the mid-point en-route to the next aerodrome. The procedure at the time was for Tennant Creek to close as soon as the aircraft left its area of responsibility.

Arrangements were made for Tennant Creek to remain open as suggested by the pilot.

• • •

Action was taken to have the tarmac flood lights at Hobart re-angled as a result of a report from a pilot stating that the lights were dazzling when the aircraft was on final approach for landing.

• • •

Whilst landing at Darwin Airport the pilot of a Canberra noticed a person walking across the runway about 100 yards in front of the aircraft. The pilot braked and the person reached the edge of the bitumen as the aircraft passed. The pilot of a Dove landing at the same aerodrome reported a vehicle crossing the runway. The vehicle passed a few yards in front of the aircraft after severe braking by the pilot.

Due to the extensive works programme at Darwin there is considerable traffic crossing the runway. Procedures were evolved for the control of this traffic but, as demonstrated, they proved to be ineffective. Action has now been taken to install traffic lights for the positive control of ground vehicles and pedestrians.

• • •

The practice of acknowledging aircraft position reports and transmissions with the acknowledging station call-sign only was considered by a pilot to be confusing and dangerous.

Instructions have now been issued requiring the ground station, when confusion might arise, to acknowledge by repeating the aircraft identification as well as the ground station identification and the word "Roger".

• • •

Weaknesses in the methods being used for determining departure separation were revealed following an investigation of a pilot's report that separation between a DC.6 and a Viscount fell below the minima shortly after departure from Perth.

Action was taken to clarify the instructions relating to departure separation, and standards revised to ensure positive separation.

• • •

A number of pilots reported incorrect ADF bearings when using Port Moresby NDB which operates on a frequency of 300 kcs.

These reports indicated the possibility of "mountain effect" and tests were conducted with a view to determining the area affected and means of overcoming the defect.

With the area defined, a temporary locator was installed in the Bootless Inlet area on a frequency of 1650 kcs. Further tests were then carried out in the area in question and bearings observed on both transmissions sumultaneously. Large fluctuations were observed on the 300 kcs. transmission while the 1650 kcs. transmission provided steady bearings.

As a result action is in hand to provide a permanent locator in Bootless Inlet on approximately 1450 kcs. As it is probable that such a high frequency installation will be seriously affected by night effect at medium and long ranges it is intended to retain the 300 kcs. NDB which is expected to provide the better service by night and over a long range.

• • •

Following reports that a NDB was unserviceable although the monitoring device indicated that it was operating correctly, investigation revealed that it was under repair and was operating on a temporary aerial.

Circumstances of the incident were circulated to all technicians who were advised of precautions necessary when using temporary aerials.

• • •

During a period when visibility was below one mile at a controlled aerodrome no assessment was made of the runway visual range as required by instructions. All air traffic control staff were fully occupied on other duties.

Fire crews have now been trained in this duty.

• • •

Pilot reports indicated that the high intensity approach lighting systems were not always set at the optimum intensity during approaches under marginal conditions. This indicated a lack of appreciation of the optimum settings by some controllers, and as a result more detailed instructions for the guidance of controllers were prepared and issued.

Faulty Servicing

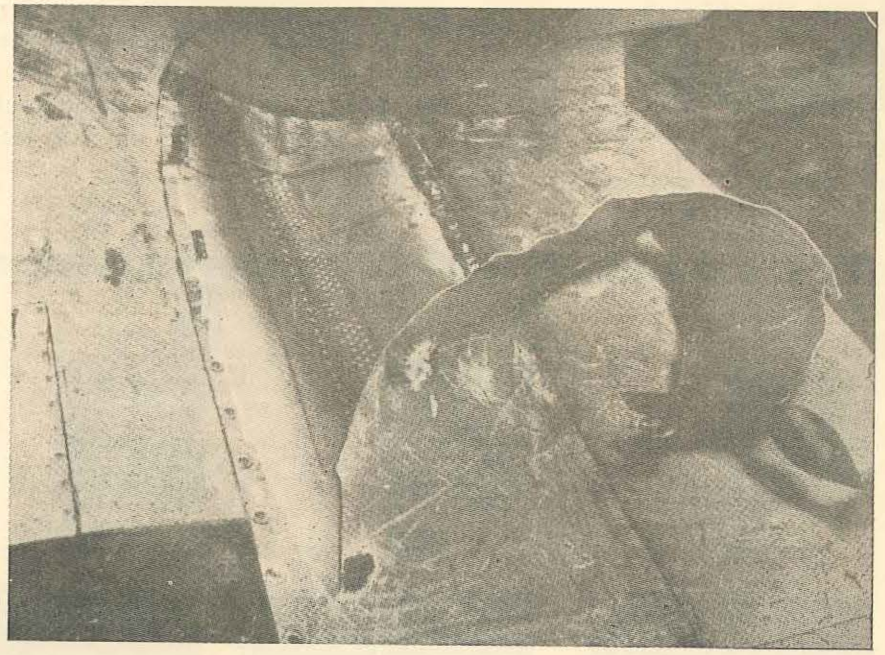
Whilst en-route from Melbourne to Wynyard the captain of a Convair aircraft reported feathering the propeller when the port engine backfired several times. The aircraft returned to Melbourne and inspection revealed that No. 17 cylinder exhaust rocker and valve springs had broken. Further investigation showed that an inlet instead of an exhaust valve spring upper washer had been fitted, resulting in the outer spring coils slipping over the periphery of the washer, after which the top coil of the spring had worn and weakened the inner side of the rocker arm. The two top coils of the spring then formed a solid pivot point each time the valve was depressed, finally causing failure of the rocker arm. New valve springs and rocker were fitted; compression check conducted, sump plug and filter checked and spark plugs changed. Engine then ground-run satisfactorily. Company personnel have been alerted to guard against this type of defect.

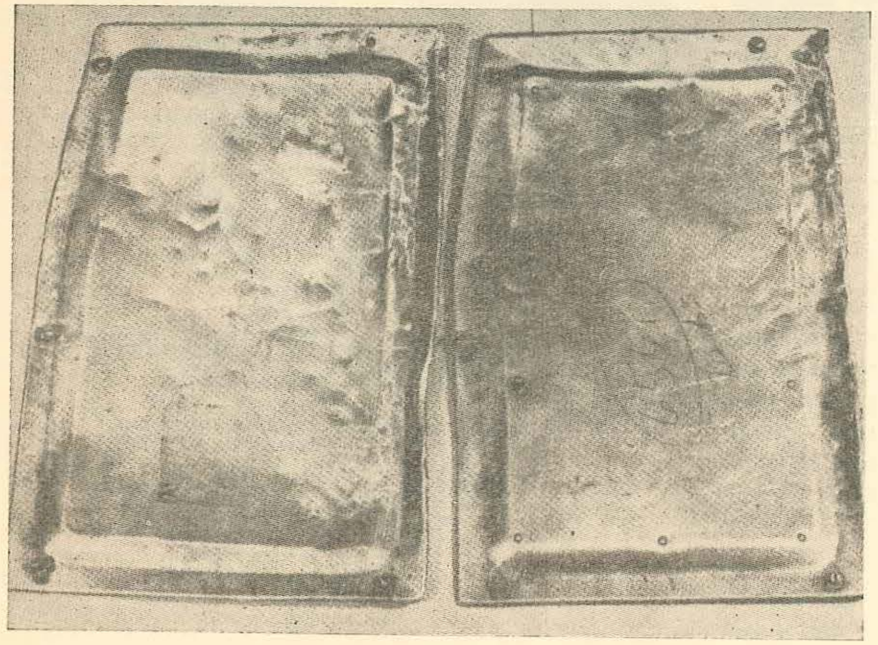
REMINDERS

(Extract from the Aviation Mechanics Bulletin, January-February, 1958, issued by the Flight Safety Foundation, New York, U.S.A.)

CAUSE OF THIS DAMAGE . . . .

The forward edge of the fillet was installed on top of the front piece instead of being secured under it.





These battle-scarred relics are junction box covers removed from the No. 4 Nacelles of a DC.6B and a DC.7. They offer mute but conclusive evidence that someone on the maintenance crew is either indifferent to or uninformed about equipment damage and the serious hazards involved.

One of these covers was caved in so far that only the paper placard on the inside of the cover prevented a short across the terminals. A mechanic's responsibility extends to the prevention of dangerous damage as well as to its correction.

ELECTRICAL SYSTEM

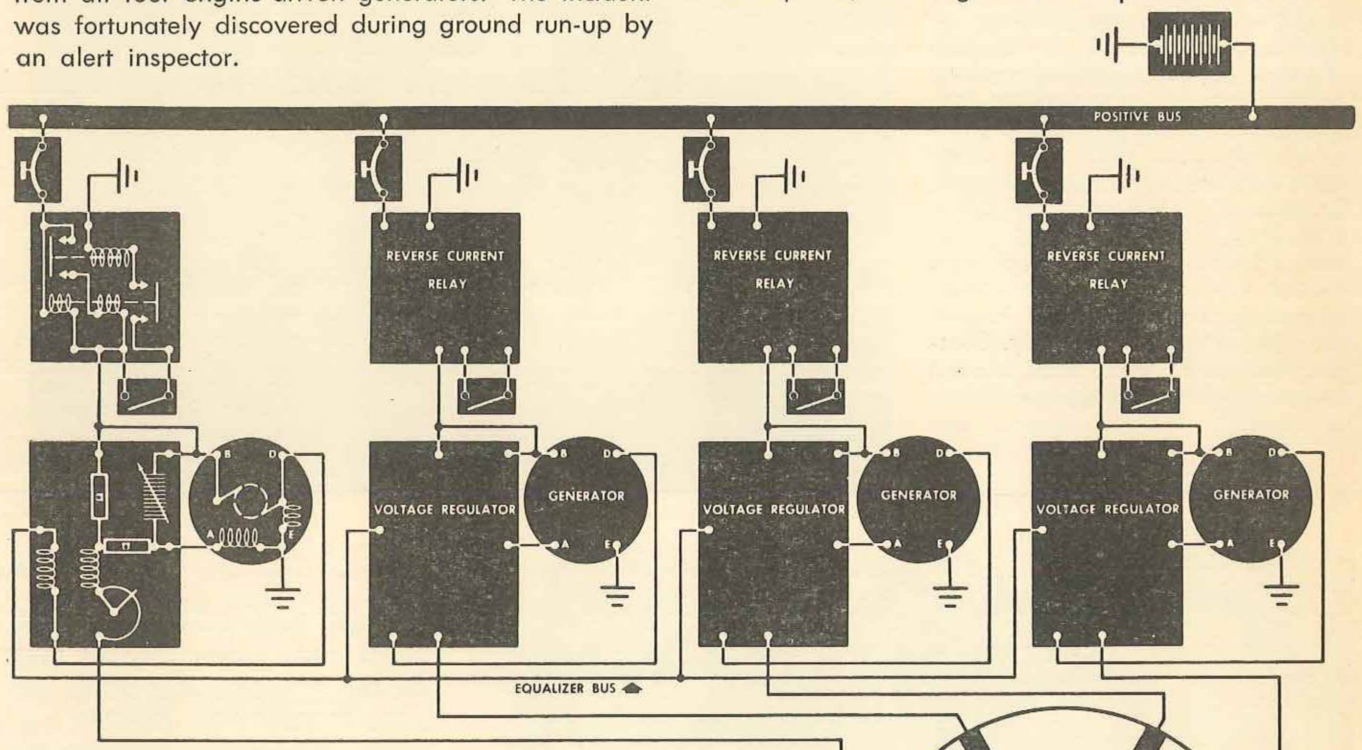
Generator Voltage Control

Loose Ground Connection Caused Electrical Power Failure

the Situation

POWER LOSS occurred when the common ground connection to the aircraft structure loosened and caused the voltage regulators to operate in cutting out electrical power from all four engine-driven generators. The incident was fortunately discovered during ground run-up by an alert inspector.

Accidental discontinuity of the connection leading from the voltage regulator to ground causes the generator to go into overvoltage condition. The equalizer action would be insufficient to counteract this effect. The overvoltage relay of the fault detecting panel would cause the generator circuit breaker to trip out, resulting in a total power failure.

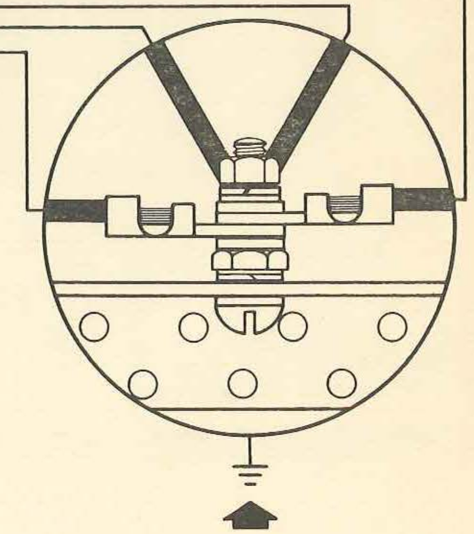


the Hazard

Since all four voltage regulator ground cables terminated on a single stud bolted to the structure, loosening of the stud affected the entire power generating system adversely to the extent that all four generators were rendered inoperative.

the Fix

Separate ground connections were provided by the airline operator for each voltage regulator. Should loosening of a ground occur again, one only, and not the entire bank of generators would be affected.



Four circuits grounded on a single stud.

(By Courtesy Flight Safety Foundation, Inc.)