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AVIATION SAFETY DIGEST

DEPARTMENT OF CIVIL AVIATION AUSTRALIA

No. 44 DECEMBER, 1965.

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Contents

A nostalgic moment for Sir Hudson Fysh, Chairman of Qantas, as he taxies a restored Avro 504K on to the tarmac during a brief ceremony at Kingsford-Smith Airport, Sydney, to mark the airline's 45th anniversary this month. Sir Hudson inaugurated the first Qantas services with an identical Avro biplane in 1920. The Qantas Boeing 707 "Winton" seen in the background of the picture is named after one of the original Qantas bases in Queensland.

The replica Avro on permanent loan from the Australian War Museum in Canberra, has been faithfully restored by Qantas maintenance personnel and is to become the central exhibit of Qantas' aviation museum in Sydney.

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GOOD NEWS FOR STUDENT PILOTS

The question of issuing student pilots with their own copies of Aviation Safety Digest has long been a bone of contention. Many students have justifiably pointed out that they, of all people, should be the ones to get the Digest so that they have ready access to a fund of "ready made" experience to help them develop a proper appreciation of the elements of good airmanship in the formative stages of their flying careers.

The Department, on the other hand, has been mindful of the fact that there is a very large percentage of student pilots who do not complete their flying training, many who "give it away" before reaching first solo stage, and some who don't even begin their flying training at all. The Department has no practicable way of assessing which students fall into these categories over the years, and although it has been sympathetic to the student's problems, it has also been conscious of its stewardship of public money and understandably reluctant to commit a large number of copies of each issue to what virtually amounts to the waste paper basket!

The degree of wastage that would be involved can be appreciated from a few figures. In all, some 16,000 copies of the Digest are now being distributed free of charge each quarter. There are at present more than 7,000 student pilot licences current, and they are increasing by about 20 per cent. each year, so that a decision to issue the Digest to all student pilot licence holders would increase the present distribution by nearly half as much again. But because as few as about 50 per cent. of student pilot licence holders ultimately qualify for a higher grade of licence, a very substantial proportion of this increase in distribution would be to no effect.

This argument of course is of little consolation to those keen students who would make good use of their own copies of the Digest, but up to now the problem has been met to a degree by providing aero clubs and flying schools with library copies of the Digest which were intended to be available to students for study. Circumstantially, the Department has also issued the Digest to all persons taking out Flight Radio Operator Licences. This has meant that all students who did their training at controlled airports and were required to obtain radio operator licences before they could be sent solo, were automatically placed on the Digest distribution list as soon as their radio licence was issued.

Whilst this arrangement was probably satisfactory as far as the majority of student pilots were concerned, it did not in any way provide for the conscientious student training at a non-controlled aerorome, who did not require a Flight Radio Operator Licence.

It also contributed nothing to reducing wastage, as many of the student pilots who get as far as taking out Flight Radio Operator Licences, do not continue their flying training beyond the early stages.

To overcome these anomalies and yet still avoid the high wastage rate that would be involved in distributing the Digest to all student pilot licence holders, the Department has now decided to make a selective distribution to student pilots who have reached solo stage, who have logged not less than 15 hours flying and who are receiving regular flying instruction. The problem of determining which students are eligible, will be met by making the distribution through the training organizations and by delegating to them the responsibility for ensuring that copies of the Digest are issued individually to those students that meet the entitlement qualifications. At the same time the Department will discontinue issuing the Digest through the post to students who hold Flight Radio Operator Licences. Recipients of the Digest, other than student pilots, will not be affected by this new arrangement and will continue to receive their indvidual copies through the post as before.

The Department has already written to all training organizations to ascertain the number of copies each will require to achieve this distribution, and it is intended that the change in policy will take effect with the issue of Aviation Safety Digest No. 45, in March, 1966.

After Thirty Years—

One minute after taking off from Warrnambool, Victoria, a Douglas DC.3 force-landed in a field with one engine feathered. The aircraft was superficially damaged as it careered through three fences and slid to a stop, wheels up, but none of the 20 passengers or the crew of three was injured.

The DC.3 was departing on the second stage of a regular public transport flight from Hamilton to Melbourne via Warrnambool. It had flown to Hamilton the day before and had remained there overnight. In the morning, the crew completed all their pre-flight requirements, nine passengers boarded the aircraft, and it took off from Hamilton at 0736 E.S.T. Twenty minutes later the aircraft arrived at Warrnambool where eleven passengers joined it and freight was loaded. A load statement prepared by the first officer and signed by the captain, showed the aircraft's centre of gravity was within safe limits and the take-off weight was 23,778 lb. Maximum permissible take-off weight is 26,200 lb.

Engines were started and at 0811 E.S.T. the aircraft reported to Melbourne "Taxiing Warrnambool for Melbourne." Weather conditions were fine with a temperature of 56 degrees F and a light westerly wind. After all pre-take-off checks had been satisfactorily completed, the aircraft lined up on Runway 31.

The captain made the take-off from the left hand seat, with the first officer monitoring the engine instruments and the airspeed indicator. The take-off up to and including the point of lift-off was completely normal, but almost immediately afterwards the captain sensed that an engine had failed and ordered the first officer to retract the undercarriage. Believing that the port engine was at fault, the captain eased back the port throttle and called on the first officer for a check identification of the defective engine. Seeing the port throttle retarded and the captain holding on starboard rudder, the first officer called "Port Engine !" The captain then feathered the port propeller and, at a height of about 200 feet, began a gentle left turn to return to the aerodrome.

As he looked at the manifold pressure gauge to throttle "the good engine" back to METO power, the captain saw the starboard needle was indicating only 40 inches instead of the take-off power setting of 45½ inches. The first officer checked the starboard throttle and pitch levers, but they were both fully forward. Already the airspeed was below 80 knots and the aircraft was beginning to lose height, and the captain saw there would be no hope of getting back to the aerodrome. Seeing a gap in the trees ahead of the aircraft and a clear run beyond, the captain headed the aircraft in that direction, holding the nose up as much as possible to try and reach the clear area. A stall warning buffet forced him to lower the nose again and he flew the aircraft on to the ground with wheels and flaps retracted. The aircraft touched lightly before reaching the first line of trees, sliced through two fences and skidded through the gap in the trees. The aircraft hit the third fence obliquely, and finally came to rest facing back towards the aerodrome. The captain ordered evacuation and, with the first officer, quickly completed the post-impact and fire drills while the hostess helped the passengers out through the cabin door. No fire broke out and four minutes later the captain turned on the battery switch again and reported the outcome of the forced landing to Melbourne Communications Centre.

INVESTIGATION

The aerodrome at Warrnambool lies six miles north-east of the town in open farming country 250 feet above sea level. Runway 31 has an effective operational length of 4,500 feet with an obstructional clear gradient of 1 : 40. The site of the accident was one mile west of the north-western end of the runway where the terrain is level and cleared of timber except for trees and hedges forming wind breaks on the boundaries of some paddocks.

The investigation began at the site on the afternoon of the accident. The aircraft was intact but had suffered damage to both wings and nacelles and to the fuselage, mostly from impact with fence posts. All control surfaces and systems were intact and capable of normal operation. The wing flaps and undercarriage were retracted. The aircraft had touched down in a substantially level fore and aft attitude on a heading of 256 degrees, with the port wing slightly above the horizontal and the undercarriage retracted. The first ground contact had been made by the rotating starboard propeller, over a distance of about 75 feet. The port propeller had then contacted the ground intermittently for a further distance of 590 feet in the course of which the aircraft passed through two post and wire fences before the wheels made contact. The aircraft then slid for

—It's Still Happening!

nearly 400 feet before the port wing struck a line of fence posts nearly parallel to the aircraft's landing path. This caused the aircraft to swing sharply to port and brought it to rest on a heading of 108 degrees, some 1,350 feet beyond the initial touchdown point.

It was evident from ground markings that the starboard propeller was rotating and the blades were at relatively fine pitch when they first struck the ground, while it was equally evident that the blades of the port propeller were in the feathered position and were not rotating.

Impact damage to the engines was confined mainly to the propellers. All three blades of the starboard propeller were bent back evenly, but only two blades of the port propeller had come into contact with the ground. The engine cowls were dented in several places and some cylinder cooling fins had been broken. The oil cooler supports and scoops were damaged and the engine mounts were distorted. The rocker hats on the two bottom cylinders were also damaged. The starboard engine was found to have sustained a structural failure in No. 7 cylinder. A large portion of the head had separated entirely from the cylinder and had been retained in the nacelle only by the engine cowling and baffle.

There was no evidence of any pre-impact defect or malfunctioning in the aircraft structure or the associated control and hydraulic systems, and it was found that the electrical and instrument systems had been operating normally. The fuel system was fully serviceable and there was no sign of contamination. The aircraft was carrying 170 gallons in the main tanks and 70 gallons in the auxiliary tank. No unserviceabilities had been reported by the crew at Hamilton and there was no evidence of any having developed during the flight to Warrnambool. The operators had maintained the aircraft properly and had complied with all mandatory modifications and inspections required for DC.3s.

Two days later the dismantled aircraft was brought back under quarantine to Melbourne Airport by road where further detailed examination and testing was carried out by Departmental engineers in the operators' workshops.

A detailed examination of the starboard propeller established that at the time of the major impact it was rotating with the blades on the fine pitch stops. Further inspection of the failed starboard engine established that the No. 7 cylinder inlet valve stem had fractured across the valve retaining collet groove, allowing the valve to drop into the cylinder, where it was hammered by the piston until the cylinder head failed. A laboratory examination established that the valve stem fracture was caused by fatigue cracking. The valve had been in service for a considerable period and the fatigue failure was attributed to normal operating stresses over an extensive service life. No defects were found in the engine other than the structural damage to the No. 7 cylinder assembly. It was evident that the valve stem had failed during or immediately after take-off and that the engine had continued to run until the aircraft flew into the ground. In this condition, the engine would have been capable of delivering about 800 shaft horsepower, 67 per cent. of the power normally available for take-off.

An examination of the port propeller confirmed that the blades were in the feathered position at impact. The port engine was checked for mechanical integrity without disturbing any vital components and as this did not reveal evidence of any defect, the engine was installed on a test stand for ground testing. It ran normally and developed full rated power. A further detailed inspection of its fuel and ignition systems showed no sign of any malfunction.

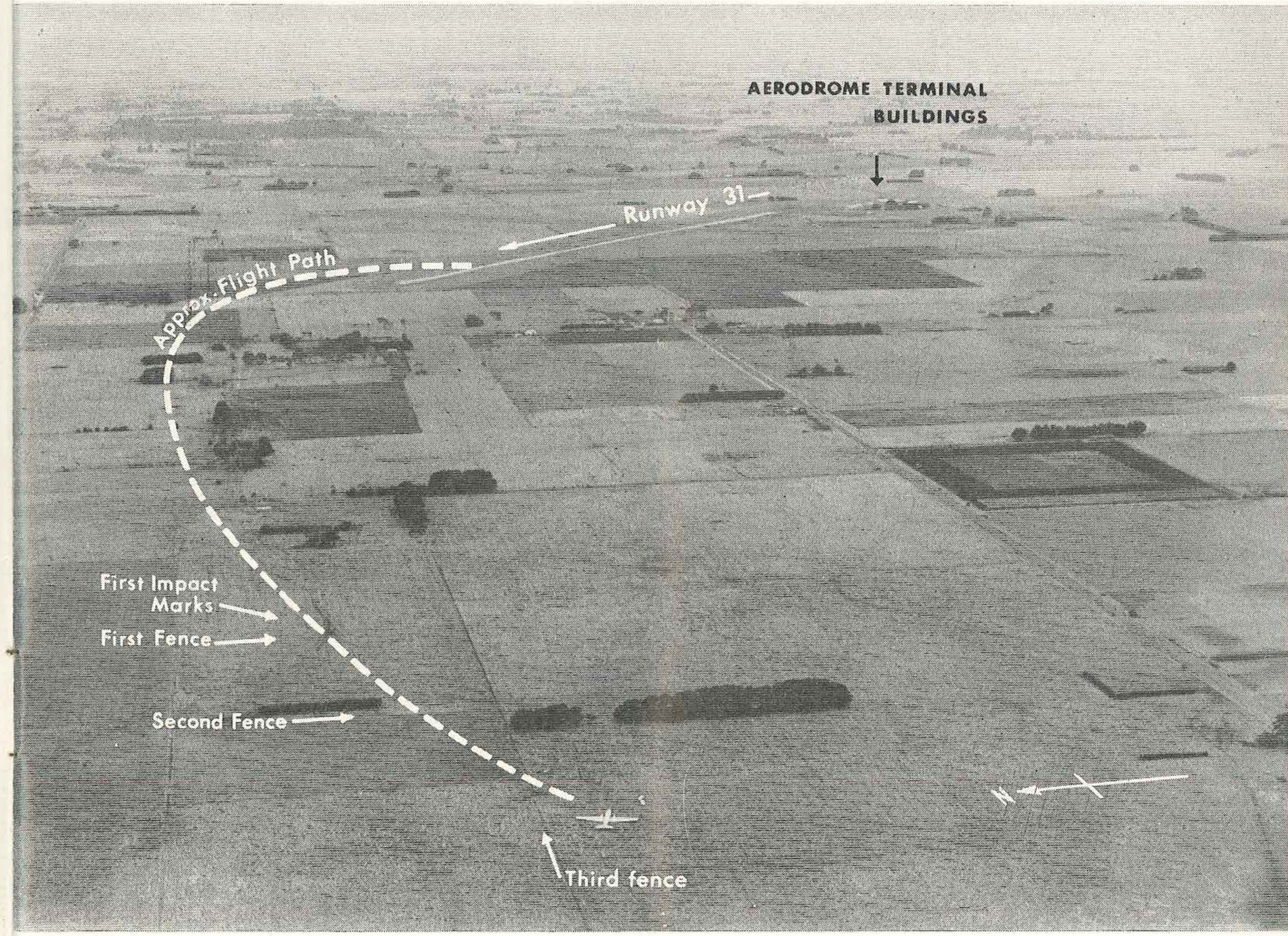
Giving evidence during the investigation, the captain said that on the flight from Melbourne to Hamilton the day before the accident, the first officer thought he could hear "some sort of back-firing." The captain had listened but the engines only seemed to be a little out of synchronization. On the sector from Hamilton to Warrnambool on the morning of the accident, he noticed that the port engine did not seem quite the same as usual and he told the first officer he knew now what he meant—the engine did have "a bit of a burble". The engines were on cruise setting at the time and all indications were normal.

The run up before taking off from Warrnambool was also normal, the captain said. He heard the engine "go" just after lifting off at V2, and described it as much the same as a simulated engine failure on a training flight. He said he had instinctively held the aeroplane straight with firm rudder and aileron before realizing that it was starboard rudder and aileron that he had applied. He thought "dead foot dead engine" and wound on rudder trim. He started to ease back the port throttle intending to feather when he called out "Identify", to the first officer. The first officer called the feathering drill and he feathered the port engine when the aircraft was about over the aerodrome boundary. The captain could not recall the boost and R.P.M. reading at the time of the engine failure or immediately before feathering action was taken. He thought the aircraft was at about 200 feet when he realized it was losing height.

The first officer said he monitored the instruments during take off, all of which appeared normal, and called V2 at 82 knots. As the captain lifted the aircraft off, he dropped his hand ready to retract the undercarriage. At this time he thought he saw a slight drop in one of the manifold pressure needles, but could not remember which one. At this instant the captain called for "gear up." He felt the aircraft's acceleration decreasing while the undercarriage was retracting, but could not remember feeling any swing. When the captain called out that they had lost an engine he looked up and saw one of the boost gauge needles reading lower than normal. He could not remember what the reading was.

When the captain asked for his "identification," the first officer looked at the throttles noting that the port one was retarded, and saw that the starboard rudder pedal was well forward, before identifying the port engine. He then called the feathering drill and the captain feathered the port engine. By this time the aircraft was low and the ASI was showing about 75 knots. They passed very low over a clump of trees at 62 knots, and the aircraft begun to shudder. He called Melbourne to report they were force landing when the captain said he was going to put it down through the gap in the trees. The touchdown itself was quite gentle.

Statements obtained from witnesses on the ground and from some of the passengers confirmed that the take-off was normal until the aircraft became airborne. A decrease in power was heard just afterwards, but no engine malfunctioning was apparent. The power decrease was described as being "rather like a reduction from full throttle to ¾ throttle on one engine". Passengers in the aircraft were not conscious of any yaw and the evidence of ground witnesses indicated that the aircraft maintained the runway heading until it began a gentle turn to the left beyond the aerodrome boundary at a height of about 150 feet. It continued turning through about 50



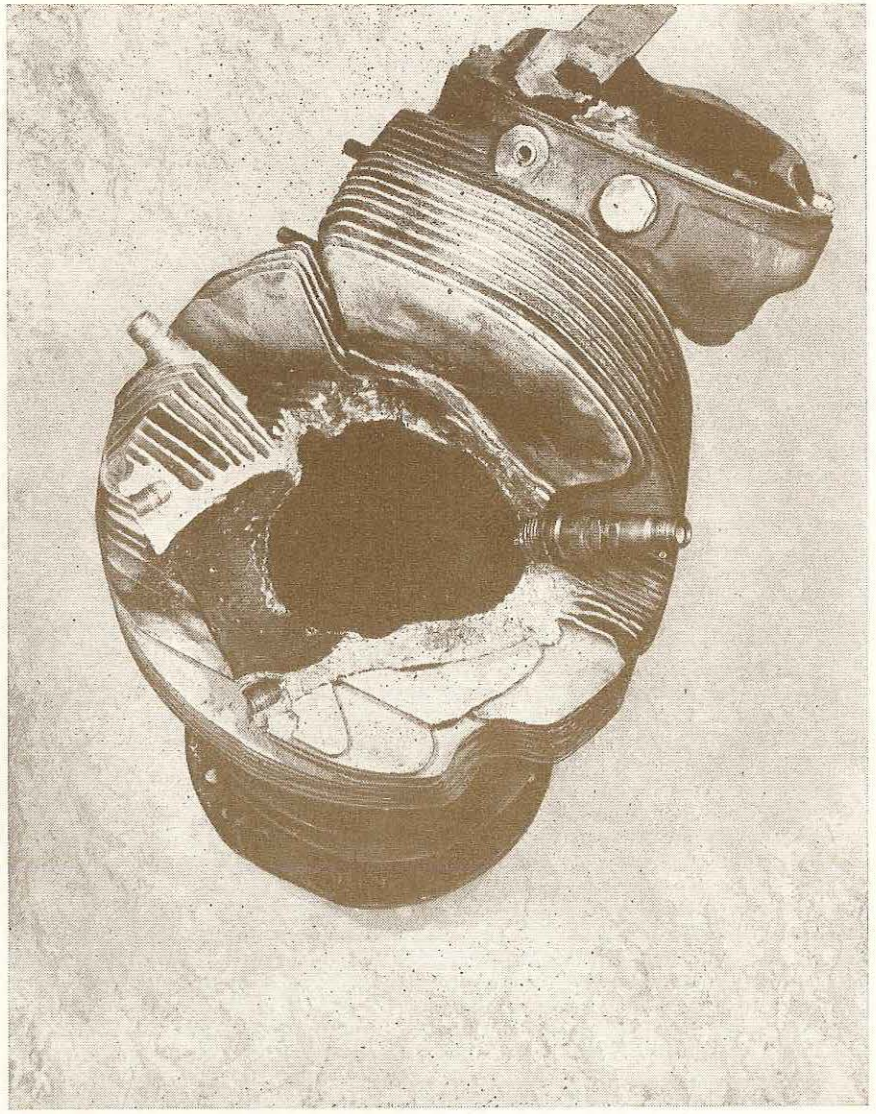
degrees before making a shallow descent to the ground on a westerly heading.

The captain had joined the operating company in 1957 after training in the R.A.A.F. and gaining civil flying experience on several types of light aircraft. He had served as first officer on DC.3's, Bristol 170's and Viscounts, after which he was transferred to first officer duties on Electra aircraft. In the middle of 1964 he underwent a flight check for requalification as a first officer on DC.3 aircraft and flew 46 hours in this capacity, preparatory to command training for DC.3's. At the end of August he began command training and flew a total of 164 hours as pilot in command under the supervision of a training captain. In December he underwent a route check with the company's DC.3 Flight Captain, who recommended the pilot for promotion to DC.3 command. A few days later he was given 6 hours 50 minutes flying training during which the sequences for a first class endorsement and a first class instrument rating were completed. On the following day he was re-examined in some sequences including engine failure on take-off and, on completing them to the satisfaction of the Flight Captain, he was certified as competent to be issued with a first-class airline transport pilot licence and a first class instrument rating.

The newly promoted captain then began normal route flying in command of DC.3 aircraft and continued in this capacity up to the time of the accident, when his total flying experience amounted to 6,172 hours. On DC.3 aircraft, his experience was 174 hours in command, 213 hours under instruction or supervision, and 1739 hours as co-pilot.

ANALYSIS

The investigation established that the aircraft lost power on one engine just after it had taken off. The captain's statement that he shut down and feathered the port engine was confirmed by the finding that the port propeller was in the feathered position at impact.



The failed No. 7 cylinder head removed from the starboard engine

After feathering the port engine, the captain became aware that full power was not being developed by the starboard engine, and with the consequent loss of aircraft performance, he saw he would not be able to return to the aerodrome and manoeuvred the aircraft towards open ground. The investigation left no doubt that it was the starboard engine and not the port engine that had suffered a partial failure shortly after the aircraft attained V2 speed. Despite this, it remained capable of delivering about 800 shaft horsepower. Performance data for the DC.3 aircraft indicates that with this power, the aircraft at the relevant gross weight would be theoretically capable of climbing at 40 feet per minute, but in this case the aircraft was in a turn and its airspeed was less than that required for optimum single-engined performance. The potential climb performance would thus have been negated by these factors. Other factors to be considered include the actual performance capability of this particular aircraft as compared with the theoretical capability of the type, and the fact that the figure of 800 shaft horsepower is an estimate carrying some degree of tolerance. A figure of 750 shaft horsepower, for instance, would be within this tolerance area but, with only this power, the aircraft would be incapable of maintaining height even at the optimum airspeed. Thus, in the circumstances to which the aircraft was committed by the feathering action, the captain's decision to make a forced landing cannot be questioned, and the evidence suggests he executed the forced landing in a very creditable manner.

There was no evidence however to support the captain's deduction that it was the port engine that had failed. Examination and test running of the port engine showed conclusively that this engine was capable of running normally during the flight. Had the captain shut down the starboard engine and utilized the power that would have been available from the port engine, the aircraft could have been flown back to the aerodrome and landed. Alternatively, if for any other circumstance it became desirable to utilize more power than would have been available from the port engine alone, the starboard engine could have been left operating, despite its defect, at least until the aircraft had been established in safe flight with reasonable clearance from obstacles.

In circumstances such as these, the decision to feather should only be made after considering the operational requirements in relation to the risk of fire and the possibility of further structural damage if the defective engine is left running. In this particular case, there is little doubt that the aircraft could have performed satisfactorily with one propeller feathered, and the decision to feather the defective engine was the correct one, but there was no operational need for haste.

The sequence of events described by the captain and first officer in their statements shows that the captain retarded the port throttle and began the actions that led to the feathering of the port propeller **almost immediately the loss of power was felt.** No reference to engine instruments was made at this time. If the port engine had in fact lost power completely as the pilot believed, retarding the port throttle would have had no effect on the rudder "feel" already produced by the engine failure, and so no advantage for identification purposes could arise from this action. On the other hand, in the actual situation that arose on this occasion of a partial power failure in the starboard engine, retarding the port throttle would have masked the aircraft's tendency to yaw to starboard and, as the throttle was closed further, a tendency to swing to port would be felt. Thus no advantage was to be gained from retarding the throttle prior to positive identification of the defective engine, but rather a high risk of disguising the identity of the defective engine was introduced.

The captain described the loss of power as similar to a simulated engine failure on a training flight, but it is significant that the first officer was not conscious of any yaw and that the other witnesses described only a change in power rather than a complete loss of power. If the port engine had failed suddenly and completely, there would have been a marked yawing moment to port and, with the change in engine noise that would have resulted from the failure it is very probable that it would have been noticed by the first officer. None of the passengers commented on any sensation such as a swing or a sudden reduction in engine noise.

It is possible that in making his decision the captain was influenced by the "burble" he had heard in the port engine on the previous stage of the flight, and that when he sensed the engine failure, he was consciously or subconsciously predisposed to associate it with this condition. In immediately retarding the port throttle, the captain produced a situation which disguised the power asymmetry caused by the defect in the starboard engine. It is not surprising then that because he found he was holding on starboard rudder, he deduced that the port engine had failed and took action accordingly.

The identification of an engine failure in a DC.3 is a process in which confusion can easily arise, and great care must be exercised. The company operations manual lays down the procedures to be followed. The primary method of identification is by analysis of foot pressures, employing the axiom "dead foot, dead engine" but the first officer's verification is required before **any** feathering procedures are begun. The closing of the throttle as the first item of the feathering procedure then serves as a further check that the faulty engine has been correctly identified. Identification by rudder pressure is best suited to the case of a complete engine failure, where the yaw is immediate and substantial. Identification in the case of a partial failure is more difficult because the yaw and the consequent rudder pressure is correspondingly less, and in these circumstances engine instrument readings become more important.

In this case when the failure occurred with the throttle set for take-off power, the loss of power would not have been very apparent from the tachometer because the propeller governor would have reduced the blade angle to maintain the RPM setting, but the manifold pressure gauge would have shown a significantly lower reading. It was this lower manifold pressure reading that the crew finally noticed and thus realized that a partial failure had occurred in the starboard engine.

It is evident that the captain, believing he had applied starboard rudder, followed the identification procedures only to the extent that he used the axiom "dead foot, dead engine" to deduce that the port engine had failed, and that he retarded the port throttle almost immediately he felt the loss of power and before he requested the first officer to verify. In so doing he did not follow the prescribed procedures and his decision to feather the port engine was based on evidence that was insufficient for correct identification.

Although it could be said that the first officer likewise had not followed the prescribed procedures in failing to make use of the engine instrument readings to check the identification, the captain's action in retarding the port throttle before requesting identification foiled the proper performance of this duty. It seems probable that when the first officer was requested to identify the failed engine, he saw the port throttle was already closed and concentrated on relating the rest of the feathering actions to the engine that the captain had selected.

The evidence suggests that the identification and feathering were carried out in haste and that the captain feathered the engine about the time the aircraft crossed the aerodrome boundary. The circumstances in which the engine failure occurred however, were not unusually difficult. The engine had failed after the aircraft had reached its take-off safety speed but before the undercarriage was selected up. The flight was being conducted in visual meteorological conditions and the weather was good, and at the aircraft's gross weight for this take-off, it would have been capable of climbing on one engine even with the faulty engine windmilling. It is understandable that the captain would have been anxious to shut down the defective engine as soon as possible to reduce the risk of fire or structural damage, but no other circumstance in this take-off warranted feathering so hurriedly and there was no valid reason why the captain should not have followed the prescribed engine failure procedures to which he had been trained.

COMMENT

Why is it that an accident can result from a relatively simple emergency such as this one? Even while this issue of the Digest was being prepared, a similar engine failure in a DC.3 at a training aerodrome in New South Wales produced the same response. Fortunately this aircraft was within gliding distance of the airport and there was no accident, but this does not mitigate the error. And this time the pilot in command was an airline training captain!

The DC.3 has now been with us for 30 years, but throughout its history defective engines have been wrongly identified and accidents have occurred simply because pilots did not take sufficient time to properly assess the emergency and follow their engine failure procedures positively and unhurriedly. Why the panic? Undue haste is so often a trap, and in neither of these latest cases was there any justification for feathering in such a hurry. Procedures do have a purpose and, if a pilot "pushes the wrong button," his error can usually be traced to his failure to follow the procedures that are designed to preclude such a happening. One of the essential qualities of an emergency procedure for any aircraft, is that it shall be capable of being carried out in an unhurried manner within the time likely to be available to the crew, assuming the emergency occurs in the most unfavourable circumstances. Thus there is no need to cut corners in carrying out any emergency procedure because it aleady has an inbuilt safe-time factor. Indeed, it is dangerous to do so, for it is vital that proper attention be given to each item in its own right.

It seems that the established emergency procedures most frequently break down with partial or intermittent engine failures because they are so much more difficult to identify than complete failures. It is difficult to simulate partial engine failures and so all a pilot's training in engine-out procedures is geared to the handling of complete failures. In emergencies like these, therefore, the emphasis must be placed on correctly following the identification procedures laid down and not on the hasty pushing of a feathering button which should be seen only as a final action in the emergency drill. In both the Warrnambool and the New South Wales cases, the purpose of this drill was defeated by unwarranted haste in altering the throttle settings, thereby destroying what evidence there was for positively determining which engine was defective.

HUMAN BALLOON

In checking the flow of high pressure helium from a small orifice, a mechanic placed a finger over the opening. In a matter of a split second the gas pierced the skin and penetrated the flesh as far as the armpit. His finger was swollen and pale and gas pressure could be felt through the skin along the arm. Immediate medical treatment relieved some of the pressure and restored circulation but it took four days for the gas to be completely absorbed.

In this incident the pressure was 6000 pounds per square inch and the orifice, which was only 0.007 in. in diameter, produced a needle-like stream of helium travelling at a sonic velocity of about 2800 feet per second. It was estimated that the helium expanding in the arm tissue increased in volume at a ratio of 200:1.

Exposure to such extreme pressures is rare, but the accident does serve to remind us that compressed gas streams, whether at 6000 or 60 pounds per square inch can be dangerous. Never allow compressed gases to come into contact with the body.

United States Navy "Safety Review"

Abandoned Take-off

As a DC-3 accelerated through 70 knots while taking off from Rockhampton, Queensland, the port engine oil pressure dropped suddenly from 80 to 50 pounds per square inch. The take-off was abandoned and the aircraft returned to the tarmac. The oil tanks were dipped and it was found that the quantity in the port tank was only 13 Imperial gallons instead of the desired 17 gallons.

Experience obtained over the years by a number of operators has shown that loss of oil pressure can occur in DC-3s during take-off with oil tank quantities at 15 gallons or less. The fall in pressure is caused by the oil surging to the rear of the tank as the aircraft accelerates, temporarily uncovering the engine off-take. Indeed, as long ago as May, 1957, the Department wrote to all Australian DC-3 operators informing them of the problem and stipulating that for any take-off, the minimum permissible quantity in a standard 24 gallon DC-3 oil tank would henceforth be 17 Imperial gallons.

In this latest incident, the aircraft involved had undergone overnight maintenance at Rockhampton and had been refuelled when the work was completed. No oil was added at the time, the refuelling attendant advising the certifying engineer that the oil levels were adequate. The aircraft was accordingly cleared for flight.

It was later found that neither the engineers responsible for the work, nor the crew, had checked the quantities in the tanks or even inspected the fuel and oil caps before the aircraft departed. It was also found that, in dipping the oil tanks, the refuelling attendant had used a dip stick calibrated in both United States gallons and Imperial gallons. Although the two sets of calibrations were engraved on opposite sides of the dipstick, the markings had become obscure, and it was possible that the attendant had read the quantity in U.S. gallons and accepted it as Imperial gallons.

There have been several occasions in the past where misunderstandings have arisen over quantities of fuel and oil to be added to aircraft. This is hardly surprising when it is considered that almost every operator orders its requirements differently. Even within the one organisation, the method of ordering may vary with different types of aircraft. Because of the confusion that these differences can obviously engender, it is extremely important that orders for fuel and oil be stated clearly and concisely and that operators satisfy themselves that refuelling attendants understand exactly what quantities are to be pumped into their aircraft.

In this particular case it is clear that the refuelling was left solely to the oil company attendant and was not subsequently checked by the engineers who were in attendance or by the crew. Some crews in fact, seem to have fallen into the habit of leaving this responsibility entirely to oil company attendants, particularly at country airports, and it may be a tribute to the efficiency of these employees that there are not more occurrences of this sort. However, responsibility for correct fuel and oil contents undeniably rests with the crew of an aircraft and the incident suggests room for improvement in this aspect of pre-flight checking.

(With apologies to Otto Lilienthal)

— *and know your Recovery Techniques*

A study of a number of reports of accidents that have occurred in recent months in Australia and overseas, leads us to believe that many of us would do well to take a fresh look at what can happen to stalling speeds under different conditions of flight and at the recovery techniques that should be employed to obtain optimum control response if a loss of control is precipitated.

The number of light aircraft accidents that have occurred in recent months as a result of incorrectly executed turns, suggests that some pilots are inclined to take too many liberties with their aircraft and that they may have forgotten some of the factors that can cause an aeroplane to stall during a turn. The seriousness of the situation is demonstrated by the following summaries of some typical accidents in the United Kingdom and in Australia.

STALLING ACCIDENTS IN THE UNITED KINGDOM

Aircraft Type	Height	Attitude of Aircraft
1. Dart Kitten	50′	Stalled in 80° banked turn.
2. PA-23	200′-300′	Stalled in turn at slow speed during approach to land.
3. Jackaroo	500′	Stalled in turn at 50 knots.
4. DH-82	500′	Stalled in 60° banked turn.
5. Miles Gemini	100′	Stalled when turning with one engine out.
6. Auster	100′	Swung on take-off and stalled in subsequent turn.

Our own aircraft have fared no better:—

STALLING ACCIDENTS IN AUSTRALIA

Aircraft Type	Height	Attitude of Aircraft
1. DH-82	400′	Stalled after baulked approach.
2. Victa	200′	Stalled during unauthorized low flying.
3. C-172	30′	Stalled after overshoot during attempted precautionary landing.
4. DHC-1	80′	Pilot attempted very steep turn with full flap and half power to align aircraft for landing.
5. PA-25	50′	Stalled during turn at low speed after take-off.
6. Auster	100′	Instructor failed to prevent student from stalling aircraft during approach to land.

We can gain a better appreciation of the reasons for accidents of this type, by looking briefly again at the aerodynamic principles involved in turning an aeroplane.

To make an aeroplane turn, a force must be applied towards the centre of the turn required. To impose this force on an aeroplane, the total air reaction must be inclined from the vertical towards the centre of the desired turn so that its horizontal component provides just enough force to make the aeroplane turn and keep it turning. This force is known as the "centripetal force."

In a correctly balanced turn, the inclination of the reaction is produced by banking the aeroplane as shown in Fig. 1. OW represents the weight of the aeroplane, and OL the lift it develops. The lift component is of course vertical in straight and level flight, but now is inclined to the vertical at the angle of bank. The vertical component OA of OL, balances the weight of the aeroplane, while the horizontal component OC of OL provides the necessary centripetal force.

As the bank is increased, so must the total lift produced by the wings be increased to maintain height, and this increase in lift will also cause an increase in the stalling speed. So one of the essential facts of flight that should always be in the front of the pilot's mind is THE STALLING SPEED INCREASES IN A TURN.

But by how much does it increase ? The answer is a simple mathematical one; it increases as the **square root** of the load factor, the factor by which

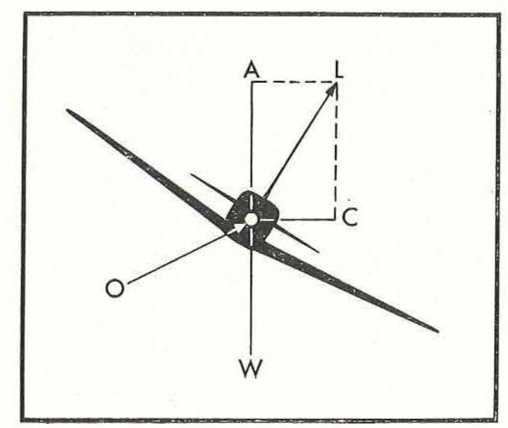
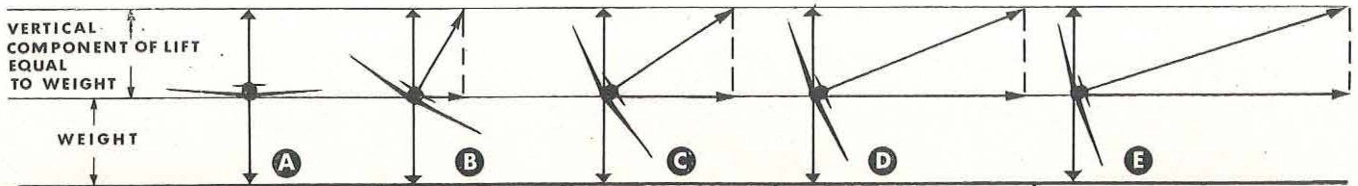


FIG. 1.

the lift increases in a turn compared to the lift required for straight and level flight. This is clearly illustrated in Fig. 2. In (C) with 60 degrees of bank the wings are producing **twice** as much lift as they were at (A) in straight and level flight. The



BANK	0°	30°	60°	70°	75°
LOAD FACTOR	1·0	1·15	2	2·9	3·86
STALLING SPEED	60knots	64knots	85knots	102knots	118 knots

FIG. 2.

stalling speed in straight and level flight is **60 knots**, so with 60 degrees of bank, the stalling speed will be

$$60 \times \sqrt{2}$$
$$= 60 \times 1.414$$
$$= 85 \text{ knots.}$$

Notice that in (E) of Fig. 2, with a load factor of 3.86, i.e., with the wings producing nearly **four times** as much lift as in straight and level flight, the stalling speed is nearly double its basic value, and as the angle of bank steepens further, the rate at which the stalling speed increases in a balanced turn rises very rapidly. At 80 degrees of bank it would be 144 knots, at 81 degrees, 150 knots, and at 82 degrees it would have risen to 162 knots ! The accident to the Dart Kitten already mentioned is a particularly interesting example of this effect. The Dart Kitten is an ultra-light aeroplane and cruises at 66 knots. Its normal stalling speed is only about 28 knots, yet it was stalled during a steep turn because the stalling speed had become equal to the speed at which the aircraft was flying. It will be obvious from all this that **an aircraft flying at low speed can tolerate only a relatively small angle of bank before the onset of the stall.**

The danger of losing control is increased if the aircraft should drop a wing while flying close to the stall with the wings at a large angle of attack, as represented by the point X on the lift curve in Fig. 3. As the wing drops, the angle of attack of the down-going wing is increased, while that of the up-going wing is decreased, as shown in Fig. 4. The result is that the aerodynamic condition of the up-going wing has come back to the point Z on the lift curve, while that of the down-going wing has moved past the stall to the point Y. Note that the up-going wing is now producing more lift than the down-going wing. The loss of lift on the downgoing wing, together with its increased drag, provide the elements necessary for auto-rotation and either a spin or a steep spiral dive may develop.

An additional hazard is always present during a steep turn if the pilot's attention is distracted. Because of the inherent directional stability of the majority of light aircraft, the nose will aways tend to drop towards the lowered wing. If this happens without being checked, the aircraft will enter a spiral dive, with an ensuing loss of height.

The recovery action to be taken if control is lost such as during a poorly executed steep turn, depends on whether the aircraft has been permitted to approach the stall or whether it has entered a spiral dive. If the onset of a stall is detected, for example from the stall warning horn or light, from a sloppy feel in the controls, or from airframe buffetting, the control column should be moved forward,

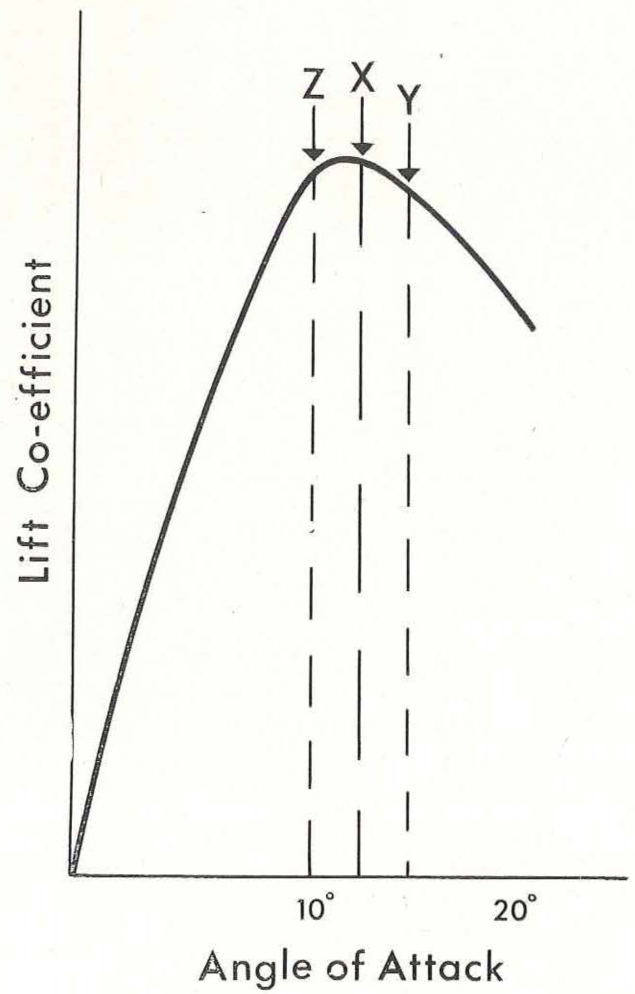


FIG. 3.

full power applied, and the wings levelled. Because the recovery from a normal correctly executed steep turn requires the use of considerable top rudder, it follows that, if the aircraft is in a steep turn when a stall becomes imminent, levelling the wings will require co-ordinated use of rudder as well as ailerons. The application of power assists the recovery action by increasing the airflow over the wing and tail surfaces, thus decreasing the stalling speed and increasing the response of both rudder and elevator control. The use of power also has the beneficial effect of helping to accelerate the aircraft to a higher

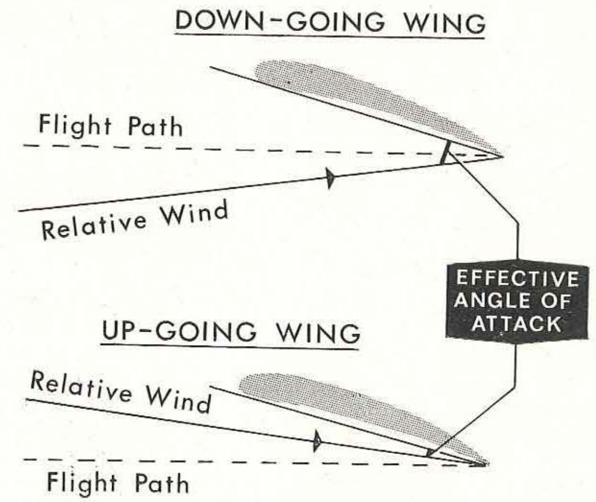


FIG. 4.

speed away from the stall, so decreasing the angle of attack of the wings.

The correct recovery action to be taken when the aircraft has been allowed to enter a spiral dive near the ground is a little different. Initially, power should be reduced to prevent the spiral "tightening", the wings should be levelled, again with co-ordinated rudder and aileron, and the aircraft then eased out of the dive. At this point, especially if the airspeed is low, re-application of full power can aid the recovery, as with the recovery from the stall, by improving control response and by enabling the aircraft to climb immediately.

All too frequently, throughout the history of aviation, pilots have found themselves in trouble when their attention has been divided between flying their aircraft and looking at something on the ground, or when they have been possessed by an irresistible, spur of the moment, urge to demonstrate their flying ability to lesser mortals watching from below.

The modern light aeroplane is usually very docile to handle in normal flight, even at the stall, but, like its ancestors, it can still become a killer if control is lost during a turn at low altitude when the steep attitudes attained may make recovery impossible in the height available.

The best possible insurance against this risk is the ability to recognize the conditions that bring about this change in character, coupled with a sound knowledge of the principles involved in executing correct turns. As a further safeguard, pilots should have a thorough understanding of the recovery techniques to use if control *is* lost.

WATCH THOSE TURNS AND LIVE!

CORRECTION

In the September issue of the Digest we told the story of an accident in which a Cessna 175 struck the water whilst engaged on a shark spotting patrol. In the last column on page 9 we said that "Persistence of the aircraft's slip stream long enough for it to have entered its own slip stream was thought very unlikely." This statement is hardly consistent with earlier references in the article to the possible consequences of a slip stream encounter, and one of our readers has been kind enough to draw our attention to the fact that in the light of the reported weather conditions it is inconsistent with his own experience and with that of other pilots.

We agree entirely that the statement published is inaccurate, and we apologise for any confusion it may have caused. Quite clearly, in the conditions prevailing, the possibility of an aircraft encountering its own slip stream, in carrying out a steep turn of 360 degrees or more, cannot be neglected. Such a possibility was given due weight in our analysis of the accident and the fact that this statement crept into the published article in no way reflects any error in the earlier investigation.

Mountain Slopes Claim a 180

Working as a team from an agricultural airstrip in the Liverpool Ranges, north of Merriwa, New South Wales, two Cessna 180's were spreading gypsum on mountain slopes forming part of an adjoining grazing property. The strip, aligned east-west, lies in a valley 2000 feet above sea level, surrounded by mountain ridges rising in places to well over 3000 feet. The slopes being treated, actually part of the northern wall of the valley, were one and a half miles due north of the airstrip, and to reach them the aircraft had to climb 800 feet from the strip.

The day was fine and mild with a light south-easterly breeze, and the aircraft were taking off into the east and turning within the confines of the valley, as they climbed back towards the treatment area. Because the valley narrows sharply two and a half miles to the east of the strip, the point at which it was necessary for the aircraft to begin their turns was critical. Carrying 8 cwt. loads, both the aircraft began operations at 1130 hours, and by early afternoon each had completed about 20 loads. At 1330 hours, one aircraft came in to refuel. The loader driver topped up its tanks to 25 gallons, loaded its hopper with another 8 cwt. of gypsum and the pilot took off again. The aircraft was back for another load soon afterwards and once again the pilot took off into the east. Five minutes later it crashed and burnt on the valley side two and a half miles north-west of the strip, killing the pilot instantly.

Examination of the wreckage at the site of the accident showed that the port wing had first struck a large tree well below the top of the ridge. The aircraft had then nose-dived into the ground, burst into flames and rolled 150 feet before coming to rest upside down. No evidence was found of any defect or malfunction which could have contributed to the accident. The pilot held a Commercial Licence with a Class 1 Agricultural Rating and a B1 Flying Instructor's Rating and his total experience was almost 3000 hours. One third of this time was agricultural experience on Cessna 180 aircraft.

The pilot of the other Cessna was the only person who actually saw the crash. After spreading a load, he was holding on the western side of the treatment area before returning to the strip, and watched the ill-fated aircraft as it made its climbing turn in the valley. It then banked sharply to port, a stream of gypsum issued from its hopper, and it plunged into the valley side. The owner of the property on which the strip was located, was working in the valley midway between the airstrip and the accident site at the time and noticed that on its final run the aircraft flew further up the valley than previously before beginning its climbing turn. Less than a minute later he looked up to see the aircraft banking steeply, high up on the northern wall of the valley. He lost sight of it, heard the impact and saw a column of black smoke rising from where it had disappeared.

Because the aircraft had been refuelled shortly before the accident, it was being flown at a somewhat higher weight than during the previous hour and a half, apart from the one flight completed since refuelling. The temperature would also have increased as the day wore on, and as a result of these factors, the aircraft's rate of climb would have been lower than it was earlier in the day. It was found that on all his earlier flights, the pilot had climbed into the east along the southern wall of the valley and had begun his climbing turn back to the spreading area at a point where the valley was approximately a mile wide. He had followed this procedure for approximately $2\frac{1}{4}$ hours and a number of times the aircraft was sighted completing its turn between 50 and 100 feet above the trees on the northern side of the valley. On the flight on which the accident occurred, however, the pilot did not follow the same route as previously and before commencing to turn, flew some 400 yards further up the valley where it narrowed sharply to a width of about 800 yards. At this point the aircraft would have been only 300 yards from the "blind" eastern wall of the valley.

It was calculated that in the air-space available for the final turn, a 180 degree turn would require 75 degrees of bank, and this would raise the indicated stalling speed to about 80 knots. Although in fact the aircraft had only to turn through 160 degrees to avoid the northern wall of the valley, this was sufficient to commit it to a rate of turn requiring more than 60 degrees of bank.

Apparently the pilot had not realized that such a steep turn would be required, for he had begun it at a rate similar to the turns he had made further down the valley on previous runs. As the nose of the aircraft came around, he had obviously seen that the turn was carrying him into the wall of the valley, and had steepened it sharply in an attempt to clear the trees. This action would have increased the aircraft's stalling speed substantially and although it could not be definitely established that the aircraft had stalled before it hit the tree, it is highly probable that it was at least "semi-stalled" and slipping in.

The weather conditions would have been conducive to a minor subsidence in the valley on the leeward side of the hills and by flying a further 400 yards up the valley, the aircraft would have come under the influence of subsidence from the eastern wall at the valley's blind end. In the restricted manoeuvring area available to the aircraft near the end of the valley however, it is doubtful if the turn could have been completed successfully even in still-air conditions and the subsidence along the eastern valley wall, while adversely affecting the aircraft's climb capability probably made little difference to the final result.

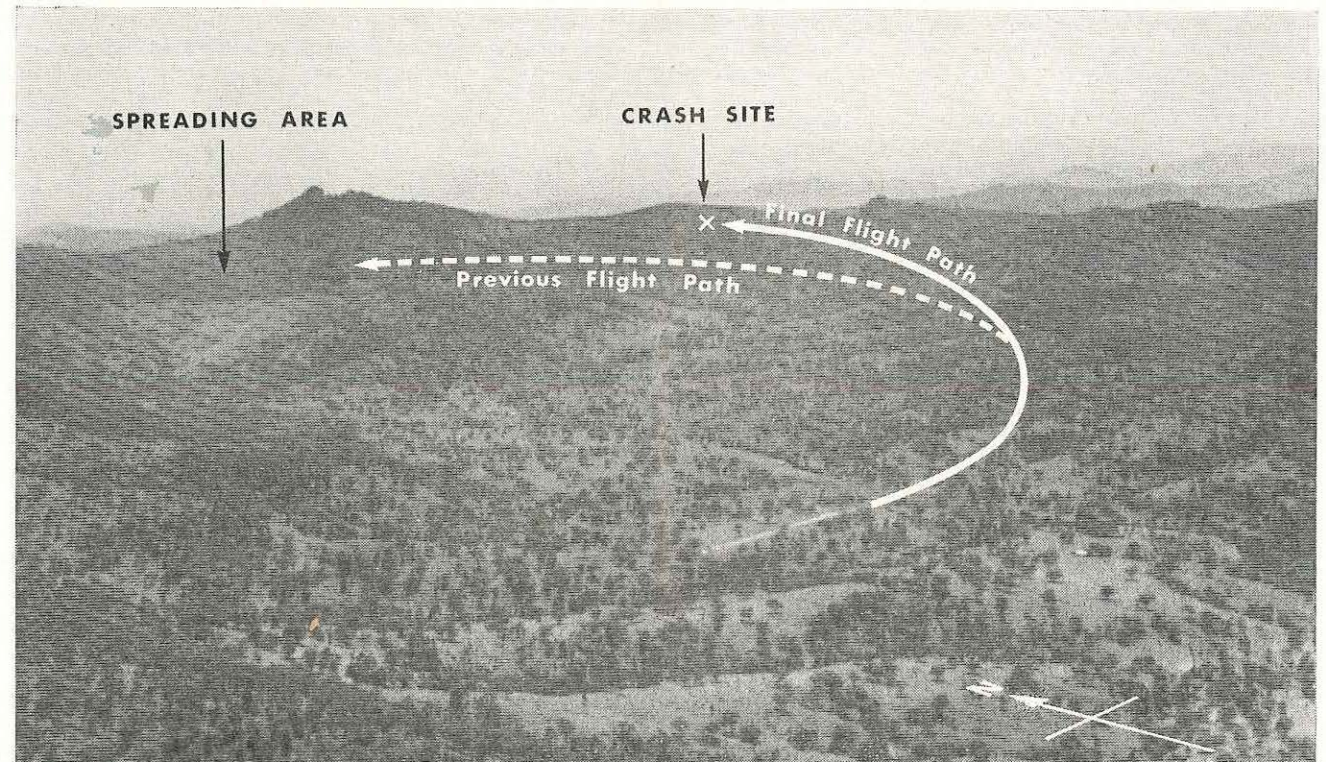
The aircraft was trapped and the accident virtually inevitable once the pilot had flown too far up the narrowing, steep-sided blind valley. In climbing further up the valley before beginning the turn, he may have been influenced by the reduced rate of climb demonstrated by the aircraft on the first run after refuelling, apparently not realizing the valley narrowed so abruptly. Even so, because the aircraft's clearance on earlier runs was only 50 to 100 feet above the trees after completing the climbing turn in a much wider part of the valley, the danger of flying into an even slightly narrower section should have been clear.

COMMENT

This accident need not have happened. Its theme is the same as that of many other accidents in which pilots have allowed their aircraft to become trapped amid terrain that they could neither outclimb nor out-manoeuvre. A number of these accidents have been reported from time to time in the Digest as a warning to pilots who are sometimes obliged to operate in blind valleys.

Don't ignore the safety messages embodied in these accidents. If you must fly in a blind valley, make sure you leave yourself room to turn back, and that you do not fly into a position where you have to make a violent manoeuvre to avoid surrounding terrain.

There is one other point to watch, which, though evidently not a factor in this particular accident, has been responsible for others: Be careful that you do not become spatially disoriented from the effect of a sloping valley floor. This phenomenon can lead pilots into the error of believing the horizon to be well above the true horizon line, to the detriment of the aircraft's performance just at a time when optimum performance is vital to safety.



From the INCIDENT FILES

Too much of a Good Thing

After taking off from Port Lincoln, S.A., on a regular public transport flight, the crew of a DC.3 found that they were unable to unlock the undercarriage down-latch in order to retract the gear. The aircraft returned and landed at Port Lincoln and it was then found that the down-latch spade on the starboard undercarriage was jammed in the locked position by a small stone which had become wedged between the spade and a nut on the latch housing. The latch operated normally after the stone had been removed. The latch spade on a DC.3 is greased regularly and it is possible that the stone was thrown up by the wheels during the take-off, and became lodged in excess grease adhering to the fitting around the grease nipple.

In another recent incident, a Beechcraft 18 taking off from Moorabbin Airport, Vic., developed a tail-heavy condition immediately it left the ground. The undercarriage was raised, the engines were throttled back to below climb power, and the aircraft returned and landed on the departure runway. The pilot said that after he had advised the tower that he was returning, he had attempted to correct the out-of-trim condition by winding the elevator trim forward as far as it would go. Even so, a pronounced tail-heaviness remained, requiring a lot of forward pressure on the control column. Later when the aircraft was inspected by an engineer it was found that a stone had become lodged in the trim tab drive sprocket in the tailplane.

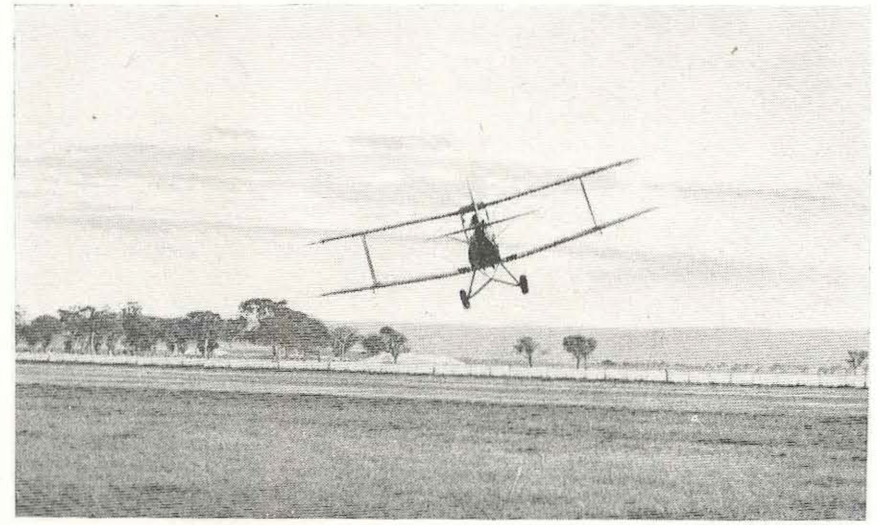
Unlikely though it seems, the two incidents show that matter flung up by the landing wheels can become a source of trouble especially if it can stick to something. Applying excessive amounts of grease to lubrication points achieves nothing except to allow dust and grit to collect on and around moving parts. In the case of control linkage greasing points in control surfaces, it is conceivable that a sufficiently large accumulation of grease and dirt could eventally affect the static balance of the control surface itself. Keeping lubricated parts wiped free of surplus grease and dirt should help to prevent problems of this sort developing.

BUSH FLYING HAZARD

Landing at a station airstrip in the Northern Territory after a brief flight to locate livestock, the pilot of a Piper Cub saw a kangaroo leap from a patch of scrub beside the strip and cross in front of the aircraft just as he touched down. He braked hard to avoid a collision but the aircraft struck the animal with the starboard landing wheel. The force of the impact, on top of the harsh braking effect, nosed the aircraft over enough for the propeller to strike the ground, bending the blades. Only the slow landing speed of the aircraft prevented it going right over on to its back.

The pilot, who was the manager of a Northern Territory pastoral company, would have been no stranger to the menace that kangaroos pose in the outback to any sort of fast moving vehicle. He was caught simply because the kangaroo bounded on to the airstrip right in front of his aeroplane. No doubt other bush pilots are equally wary, but now that many city-based aircraft operate into the outback, there may be some pilots who are not familiar with this unusual but nevertheless real hazard.

Blind Flying—The Hard Way



A flying instructor was giving a student pilot dual instruction in a DH.82. Seated in the front cockpit and dressed in a flying suit with a triangular nylon scarf tucked into the neck, the instructor began the first take-off. As the aircraft left the ground the scarf was blown upwards over his face, obscuring his vision. Wind currents in the cockpit made it difficult for him to pull the scarf down again and he had to lean out into the slip-stream before he could clear the scarf from his eyes and see where he was going. The wind blew the scarf free, and the instructor was able to climb away safely. Because it was the student's first period of flying instruction, he was of no help in controlling the aircraft during the emergency.

The instructor afterwards re-enacted the take-off with an experienced pilot in the student's seat, and found that as soon as the aircraft became airborne the scarf again blew over his face in the same way. Reporting the incident, the instructor said that although he had given over 1,000 hours instruction in DH.82s, he had never heard of this happening before.

In days gone by, when most flying training was carried out in open cockpit aircraft, it was an instructor's responsibility to warn student pilots against happenings of this sort. Today, however, when most training takes place in cabin aircraft, it is easy to see that potential hazards like these may not always be recognized. Pilots who still fly open cockpit aircraft would do well to profit by this flying instructor's unnerving experience.

NO CHARGE

A Beech Bonanza was departing from Sydney Airport for Bankstown. The aircraft was cleared to the runway holding point and, after running up, the pilot reported "Ready". The tower instructed the aircraft to line up but no acknowledgement was received and the aircraft failed to answer further calls. At this point the tower controller sought the assistance of a following Electra to instruct the Bonanza to return to the tarmac and when this also failed, he directed a series of green signal lamp flashes at the aircraft, intending that it should taxi clear of the runway. The pilot, seeing the green light, accepted it as a clearance and took off. Immediately he did so, communication between the aircraft and the tower returned to normal. As it happened, the aircraft's unauthorized take-off did not conflict with other traffic.

This incident points two useful lessons. The first is that the communication difficulty was caused entirely by the low state of the aircraft's battery. While the engine was idling at the holding point no generator power was available and the charge in the battery was insufficient to enable the radio to operate properly. Had the pilot recognised this, communication could have been maintained at the holding point by increasing the engine power until the generator cut in.

The second lesson from the incident is one for both pilots and air traffic controllers: The pilot was expecting to take-off and when he saw the flashing green light he assumed it was his take-off clearance. With a more adequate knowledge of light signals, however, he would have realised that it was a signal only to taxi. The tower controller, on the other hand, should have foreseen that a signal to taxi at that stage could cause confusion, because the pilot was already on the end of the runway expecting a clearance to take-off. In this case therefore either white flashes (return to starting point on the aerodrome) or red flashes (taxi clear of landing area in use) would have been a more appropriate signal.

Boeing damaged by Volcanic Ash

Approaching the island of Bali while en route from Brisbane to Singapore, the crew of a Boeing 707 saw a large cumulo-nimbus cloud situated over the north-east part of the island in the vicinity of the Agung volcano and rising to about 50,000 feet. While still flying in clear air, a few minutes before reaching the coast, the aircraft suddenly ran into a patch of slate-like hail which lasted for about 25 seconds. As the aircraft emerged into the clear again the crew saw that the cockpit windscreen had the appearance of having been sand-blasted. The flight continued and as the aircraft passed abeam of the cumulo-nimbus cloud, the crew saw that the volcano was erupting into the base of the cloud. When the aircraft was inspected after landing at Singapore, sand-blast type erosion and pitting were found on the nose and on all flight station windows. Four windows were replaced. The leading edges of the wings and tail also showed similar but lighter damage, and slight damage was found on the engine cowlings and landing lights.

Another Boeing aircraft which had been flying from Singapore to Brisbane at the same time had diverted 130 miles off course to try to avoid the effects of the eruption but was, nevertheless, in the dust bearing cloud for about 13 minutes. After the encounter the crew found the engine pressure ratio indicators for Nos. 1 and 2 engines were sluggish in operation and suspected that they had been contaminated by volcanic ash. An inspection after the aircraft arrived at Brisbane revealed slight abrasions to the cockpit windows and landing lights. Two of the windows were changed. The affected engine pressure ratio lines were also blown through and the indicators afterwards operated satisfactorily.

NEW GUINEA READERS

Although this incident is of interest mainly to airlines that operate high speed jet aircraft, and the majority of our readers may well ask what it has to do with them, it also has a message in it for the small piston engine aircraft operator. It is not unusual for light aircraft to undertake rescue operations, photographic flights for newspapers, or even sight-seeing flights into the vicinity of erupting volcanoes. A few minutes of flight in ash-polluted air such as the Boeings encountered, could cause rapid wear in the engine and reduce its overhaul life by as much as 80 per cent. Remember this if you should happen to be flying anywhere near an erupting volcano !

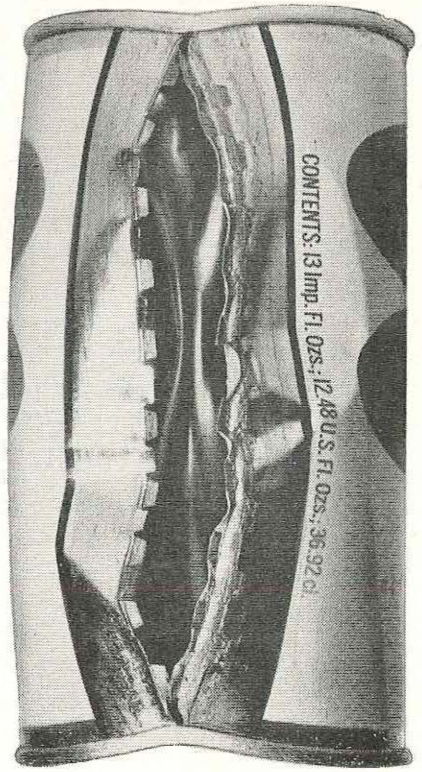
SOFT DRINK CAN EXPLODES IN AIRCRAFT CABIN

Returning to his aircraft after it had been parked in the summer sun for two days at Perth Airport, the owner found that a tin of soft drink he had left in the cabin, had exploded. Apart from spattering lemonade over the upholstery, the explosion caused no damage but it illustrates that cabin temperatures can become surprisingly high inside aircraft parked in the sun.

The can manufacturers said that, at temperatures of the order of 140°F, the internal pressure in a soft drink container will rise to about 100-110 pounds per square inch. The cans are designed to withstand considerably higher pressures and are, in fact, sample tested to above 160 p.s.i. during manufacture. Testing at this pressure will cause the ends to bulge but has not been known to produce an eruption of the side seam, as occurred in the aircraft. This type of failure has, however, been produced in laboratory tests by subjecting a filled can to temperatures of the order of 140°F for several days, thus producing a creep-fatigue type of failure. This is believed the most likely explanation of the can failure in the aircraft.

COMMENT:

If you carry drink cans in your aircraft we suggest you remove them when the aircraft is to be left in the open for a length of time. It is also a good idea to keep them away from the immediate vicinity of the windscreen and instrument panel. A face-full of lolly water, or even your favourite brand of ale, could be most disconcerting during take-off !



AGRICULTURAL FLYING AND COMMON LAW

In recent months, the Department has received a number of complaints from people objecting to agricultural aircraft flying low over their properties. Some of the complaints have come from householders who have merely registered annoyance; others, more serious, have been made by poultry farmers whose birds have panicked and smothered one another when aircraft flew over the hatcheries and pens. The incidents raise the question of the liability of pilots and operators for damage caused to property in the course of agricultural operations.

A brief look at the legal requirements for operating an aircraft in agricultural work will help us to see the implications more clearly.

We start with the proposition that if a person is appropriately licensed and the aeroplane is registered and has a Certificate of Airworthiness and so on, then that person may fly the aeroplane, provided he complies with Air Navigation Regulations and Air Navigation Orders. For our immediate purposes the relevant ones are A.N.R. 133 and A.N.O. 20.21:

The material part of A.N.R. 133 reads as follows:—

"133(2) .... an aircraft shall not fly over—
(a) any city, town or populous area at a lower height than 1,500 feet; or
(b) any other area at a lower height than 500 feet.
(3) The provisions of sub-regulation (2) of this regulation shall not apply if—
(b) the aircraft is engaged upon aerial work of a nature which necessitates low flying and the owner or operator of the aircraft has received from the Director-General either a general permit for all flights or a specific permit for a single flight to be made at a lower height while engaged upon such aerial work."

As related specifically to the aerial agricultural industry, is therefore an offence to fly at a height lower than 500 feet unless—

(1) engaged in agricultural operations; and
(2) permission has been given by the Director-General.

This brings us to A.N.O. 20.21 which provides—

"3.1—Pursuant to Air Navigation Regulation 133(3)(b), permission is hereby granted for aircraft to operate at lower heights than that prescribed in Regulation 133(2)(b) of the Air Navigation Regulations while engaged on agricultural operations and inspection flights relating thereto for which an appropriate aerial work licence is held or which are classified as private operations under the provisions of Air Navigation Regulation 191(1)(iii).

3.2—Notwithstanding the permission granted in paragraph 3.1, aircraft engaged on agricultural operations and inspection flights relating thereto shall not be flown below a height of 500 feet above the terrain within 2,000 feet horizontally of a building occupied by persons except with the permission of the occupier."

So we see that, because the Director-General has given authority to agricultural operators to fly under 500 feet, no offence is committed while such flights are performed beyond a range of 2,000 feet from an occupied building. But if a pilot wishes to fly nearer than that to a house or building in which people are living he must get permission from the occupier. If he flies within that range without such permission he can be prosecuted and fined for a breach of the law.

Here we should note the distinction between civil and criminal law. A criminal offence is one for which a penalty is provided, in this case by the Air Navigation Regulations. The charge is laid by the Commonwealth, and any penalty imposed by the court on the pilot or operator is for a breach of the law only and is quite irrespective of any litigation by persons who feel they have a rightful claim for damages to property as a result of the same act by the pilot or operator.

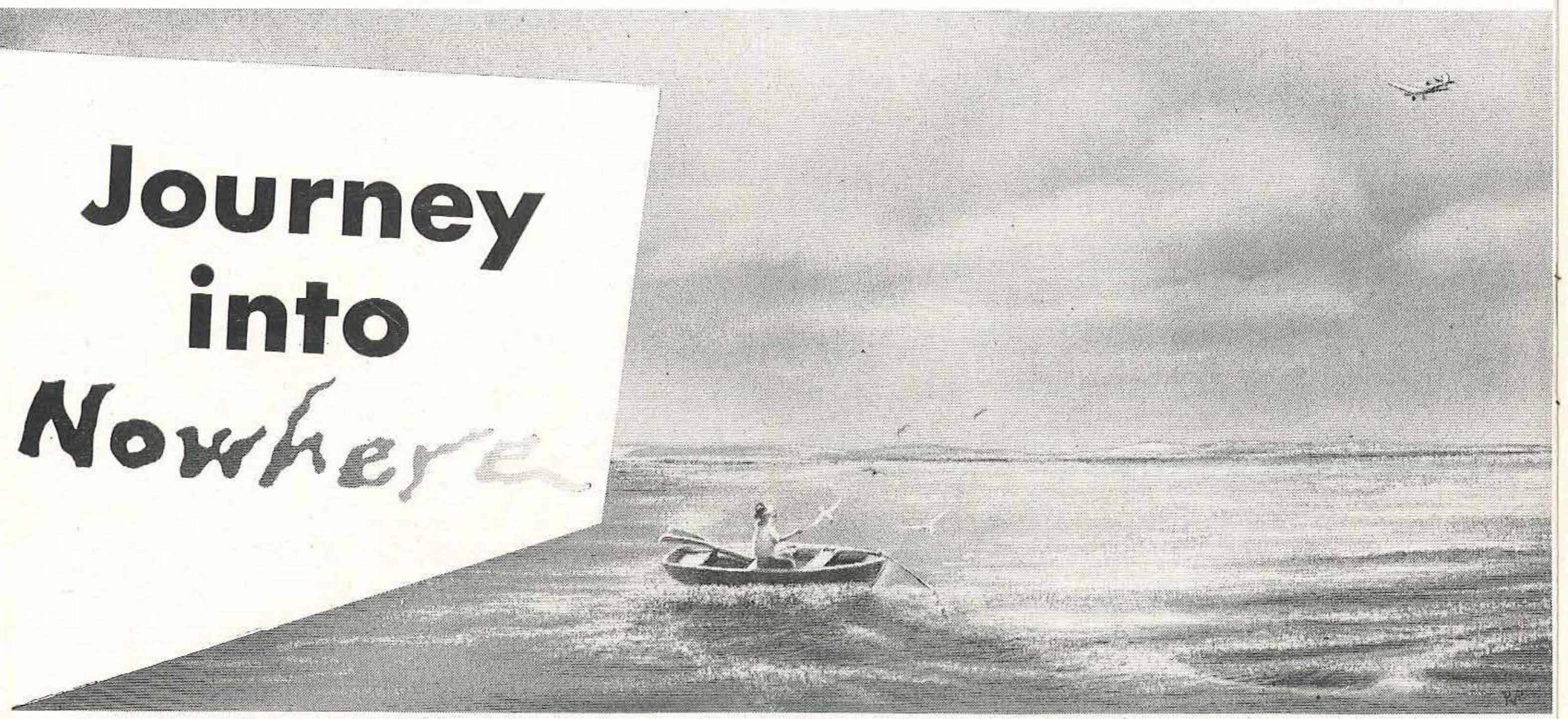
On the other hand, a civil or common law action is one in which a person has suffered loss (e.g., the poultry farmer whose birds died when frightened by the low flying aircraft), and takes legal action (through a private solicitor) for recompense for the damage he has suffered. The fact that an aircraft may not have been flown "within 2,000 feet horizontally of a building occupied by persons," is not, in itself, necessarily germane to an action of this sort and the liability aspects are clearly indicated in the note which follows paragraph 3.2 of A.N.O. 20.21:—

"Attention is directed to the fact that the permission granted in this paragraph 3 does not confer on an operator any rights, as against the owner of any land over which the operations may be conducted, or prejudice in any way the rights and remedies which any person may have in common law in respect of any injury to persons or damage to property caused directly or indirectly by the operator."

Although the responsibility of initiating proceedings of this sort lies solely with the person concerned, an action to recover loss may be taken against a pilot or operator **regardless** of whether or not a breach of the regulations has been proved in a criminal case.

It is intended in the near future to make some amendments to A.N.R. 133 and to A.N.O. 20.21 to more clearly define the circumstances in which operations may be conducted at less than the normal minimum altitudes. The proposed changes will not, however, affect the principles outlined in this dissertation.

Journey into Nowhere



At Ceduna, on the Great Australian Bight, an aerodrome groundsman was spending his Sunday fishing a mile off-shore. The day was fine and clear and the light south-easterly breeze rippled the surface of the bay, making it sparkle in the noon-day sun. From the aerodrome came a distant high pitched whine of an aircraft taking off, and a single engined low wing aeroplane climbed out over the town and set course to the west. The fisherman watched it with detached interest. It seemed to be on about the right heading for Cook or Forrest, though more to the north than usual. Must be following the east-west highway, he thought, and went back to his fishing.

A few minutes later the aircraft droned over the aboriginal mission at Koonibba, twenty miles north-east of Ceduna. *More than three years were to elapse before it was seen again.*

★ ★ ★

Jim Knight had learned to fly in Western Australia, gaining his private licence, and had since logged several hundred hours on a number of different single-engine types. For two years he had been working in Melbourne and with his annual leave due in January, planned a holiday trip to his home State, flying himself across the continent in his newly acquired ex-R.A.A.F. Wackett CA.6. His wife was to join him in Perth, flying from Melbourne by airline the day after he set off.

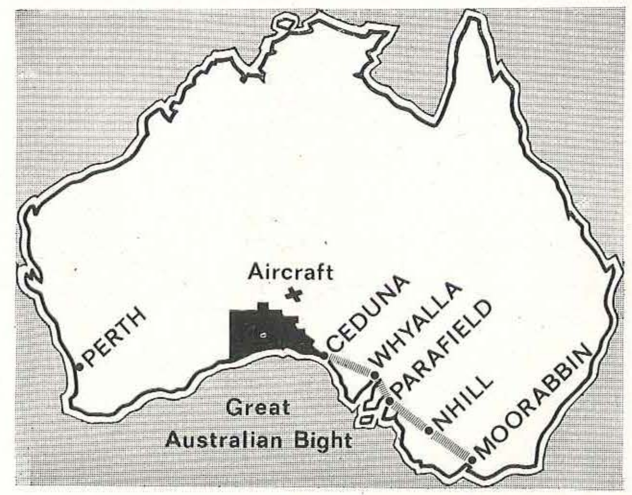
On Saturday morning 13th January, 1962, Knight drove to Moorabbin Airport. It was already later than he intended, but he had been up late the night before and had slept in. His aircraft, smart in a fresh coat of paint, and with only a thousand hours in its log book, had already been pushed from its hangar and was waiting for him on the tarmac. Knight made a pre-flight inspection, stowed his luggage securely in the rear cockpit, and went to submit his Flight Details. This done, he returned to his aircraft and strapped himself in. The 7-cylinder Super Scarab turned over noisily on the starter, caught and roared into life. Knight called the tower on VHF and taxied out. He was on his way at last.

The flight over the ranges to Nhill, where he refuelled, then across the sparsely settled Mallee country to the irrigated Murray farmland and the lush Adelaide Hills was uneventful. Letting down ten minutes out of Parafield, Knight called the tower on 118.7 Mc. There was no reply. He tried again, then again without success. Continuing his approach, he got a 'green' from the tower, landed and taxied in.

Five minutes later Knight climbed the stairs to the tower to cancel his S.A.R. His V.H.F. receiver had been intermittent during the flight from Moorabbin, he explained, and he would flight plan as 'no radio' for his next leg. Sitting down, he filled in details to Whyalla. He didn't use a computer and declined an offer of a route forecast to Whyalla—he'd been given one to Parafield and Whyalla before he left Nhill, he said. He stood up when he had finished and handed in the form. "What can you tell me about the country between Ceduna and Cook ?" he asked.

The duty controller, an ex-pilot with a wealth of experience in South Australia, went over the route with him, suggesting he should aim to intercept the transcontinental railway about 15 miles east of Cook and follow it in. Knight nodded his agreement; thanked him and picked up his papers. The controller watched him as he turned to go. He seemed airmanlike and capable, but very tired.

On the tarmac, Knight boarded his aircraft and started the engine again. Receiving the tower successfully this time, he copied take-off instructions and departed via the St. Kilda light aircraft corridor to follow the eastern coast of St. Vincent's Gulf. "The set's brand new again," he told the tower as he set course.



Route followed by aircraft and Search Area.

Landing at Whyalla, late in the afternoon Knight took a taxi into town and booked into a hotel. He put a trunk line call through to his wife in Melbourne to report progress, and went to bed.

He was up early next day and rang the aerodrome refuelling service. It was Sunday morning and the number was not answering. He waited a while then tried again but it was no use. He went to the aerodrome and checked his tanks again. There should be just enough fuel to make Ceduna. He decided to press on.

It was a typical fine mid-summer's day and he didn't wait to phone his Flight Details through to Adelaide. Flying conditions were hot and turbulent, but apart from a few misgivings about his fuel reserves, the flight across the rolling plains of Eyre Peninsula passed without incident and he touched down at Ceduna just before 10 a.m.

Knight turned his aircraft off the runway and followed the paved taxiway back towards the apron. The engine, which had been bellowing healthily since he'd started it at Whyalla, suddenly coughed once or twice and died. The reason was obvious. He let the aircraft roll to a stop, undid his harness and walked the remaining 100 yards to the flight information office. The Meteorological Officer on duty greeted him, Knight explaining that the small amount of fuel he had left had run to the rear of the tanks when the tail came down.

"Could you get hold of the fuel agent for me ?" he asked. The Met. man phoned the agent for him. "Get him to bring out a few oranges, too, if he can," Knight added. While he waited, he leant against the table and discussed the turbulence. "Do you think it would be any better along the coast ?"

"Well, there's always a sea breeze along this part of the coast in the afternoon, and conditions would be smoother."

Knight nodded. "I'll probably stick to the coast as far as Fowler's Bay then turn inland. The sea breeze should be some help." Twenty minutes passed and a vehicle went past the office. It pulled up by the fuel depot and Knight went out to meet the driver. Together they refuelled the aircraft from a 44 gallon drum. It took 31 gallons.

"Must have had three gallons left when I landed," Knight remarked. "I'm going to refuel again at Cook, so I shouldn't have any worries this time. I'm going direct to Cook. I did think of going via the coast, but I'll probably be better off sticking to the direct route." He dipped the oil tank and the agent added four pints.

"She looks to be in good condition," the agent observed. "Better than one a chap used to have around here".

"She's going like a charm," said Knight. "I'd like a modern aircraft of course. But they're too pricey for me just yet. These Wacketts do a good job but they're like an old car — you have to drive them all the way. It's a long way on your own too — I don't think I'll do it again".

They checked both tanks for water, Knight signed for the fuel and collected his bag of oranges, thanked the agent then walked back to the Met. Office. He asked for details of the upper winds and for cloud heights, then went through into the adjoining Communications Office. He filled in a Flight Details form showing his time intervals to Forrest via Cook at 5000 feet together with a SARTIME of 0830 G.M.T. and he handed it to the Com. Officer.

"Could I use your phone before I go ?" he asked.

The Com. Officer passed him the phone. He consulted the directory and rang the chief pilot of the Ceduna Flying Medical Service and asked if there was any 80 octane fuel at Cook. Knight explained he had ordered fuel to be sent from Kalgoorlie. But in case it hadn't arrived he wondered if there was fuel available that he could use. His reserves were not enough to fly non-stop to Forrest.

The chief pilot gave him permission and they talked for a few minutes, Knight mentioning he had previously flown to Perth in a Proctor that was formerly owned by the Flying Medical Service at Ceduna. Finally, he asked a few details about the aerodrome at Cook and hung up. Knight closed the door and walked down the steps to where his aircraft was parked on the apron. He climbed in, fastened his harness, started the engine and taxied out. Five minutes later the Wackett lifted off Runway 23 and set course towards the west.

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Three hundred and fifty miles away at Forrest, beyond the Head of the Bight and across the flat and featureless Nullarbor Plain, the duty Com. Officer looked at the clock again. It was six hours since the Wackett had left Ceduna and still there was no sign of it. He logged the Uncertainty Phase in the station journal, typed out the Urgent SAR Message, and transmitted it. Minutes later Ceduna Com. came on the air to pass a report from the Flying Medical Service Network that the aircraft had not reached Cook.

Back in Adelaide, the Senior Operations Officer at Adelaide Airport declared the Distress Phase, and the Search and Rescue Organization swung into action. Police stations, outpost radio transceivers and telephone subscribers west of Ceduna were checked first for hearing or sighting reports, and the train controller at Port Augusta was asked to contact railway sidings along the line from 100 miles east of Cook to as far as Forrest. A D.C.A. Aero Commander at Adelaide was readied for a night flight to Ceduna with additional Com. and A.T.C. staff and two storepedoes, and an airline DC.3 was requisitioned at Adelaide Airport to be at Ceduna in time to refuel and begin searching at first light. Meanwhile, three airline aircraft flying between Perth and Adelaide were diverted via Forrest, Cook and Ceduna calling and listening on the Wackett's V.H.F. frequencies. Ceduna reported that the F.M.S. Cessna 210 would be ready to begin searching there at first light, and from Melbourne the D.C.A. Flying Unit advised that their Fokker Friendship would be leaving in the morning. During the night several hearing reports came in from a native camp at Tallowan Hut 120 miles west of Ceduna. The only sighting report was the one from Koonibba. The Rescue Co-ordination Centre at Adelaide Airport assessed an area of probability around and beyond the Ceduna-Cook track, and plans were made to search it first using all available aircraft working to a visibility distance of two miles.

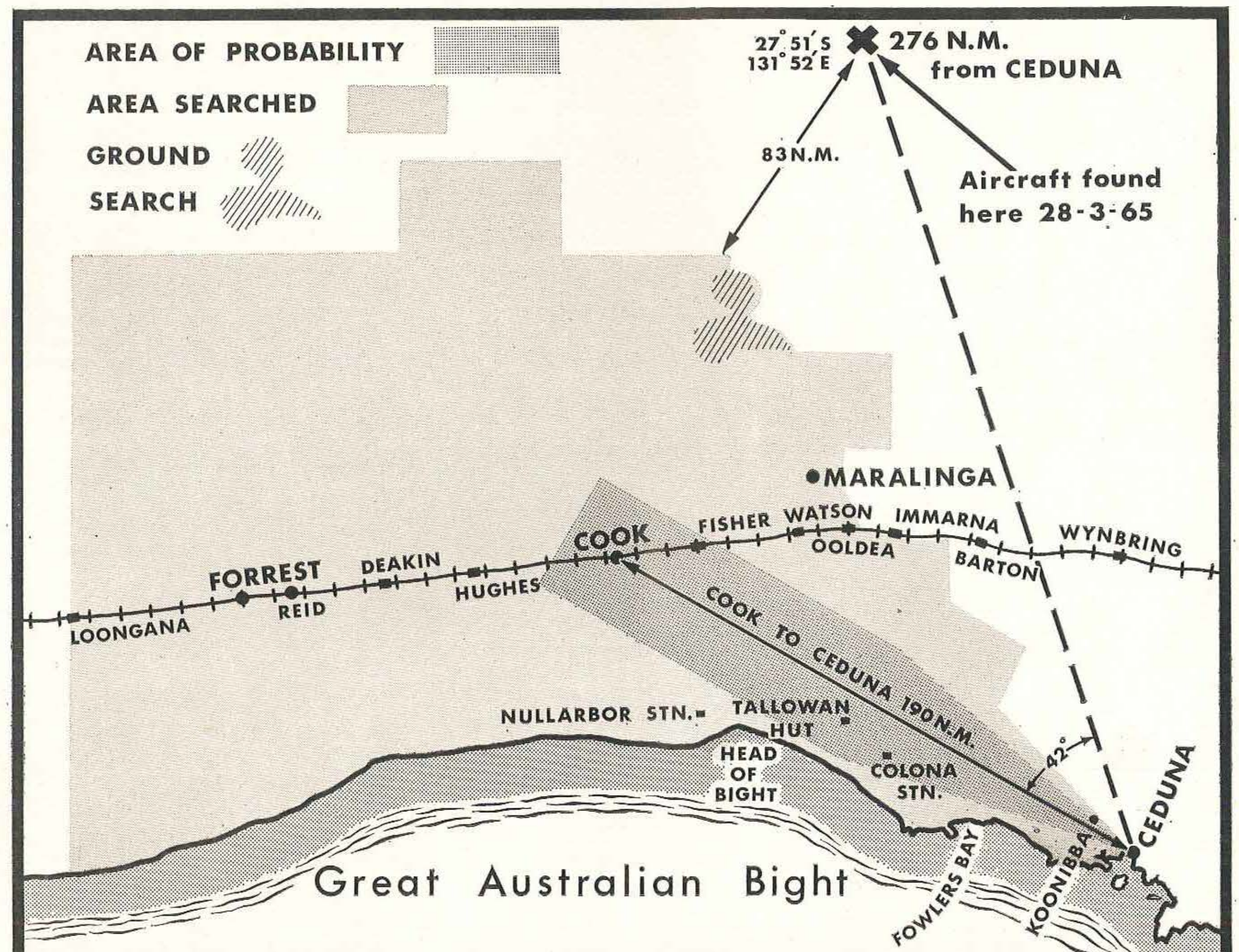
The first day's searching on Monday 15th January covered the entire probability area and investigated two fire sightings. That night the crew of the F.27 carried out a night search over the Wackett's probable tracks, watching for fires and signal lights. On Tuesday, the search force, reinforced by a second DC. 3, a R.A.A.F. Otter, an F.D.S. Cessna 182 from Kalgoorlie, a private Auster and a PA.22, completely saturated the probability area, working on a one mile visibility basis, and making sweeps at 90 degrees to the previous day's search patterns. The search area was extended along the coast as far as the Head of the Bight and the Nullarbor Plain and the probability area was widened. Two Doves operating courier flights from Adelaide to Maralinga searched along their tracks from Ceduna to Watson, and on their return flights covered the area south of the railway line between Fisher and Immarna. The Cessna from Kalgoorlie landed twice at Nullarbor Homestead to investigate hearing reports and the other light aircraft checked a further five reports of smoke. Many of the hearing reports that had come in suggested the Wackett had been following the coast and so the coastal route from Ceduna to the Head of the Bight was flown three times.

So far, the search planning had been based on the assumption that the Wackett would not have crossed the transcontinental railway, but now it seemed possible that the pilot might have overshot the railway. The railway line had become overgrown in many places since the introduction of diesel locomotives, making it more difficult to distinguish than when steam trains were running, and some pilots who knew the area believed it would be easy to miss, especially while flying high and looking into the sun over a radial engine. Had the aircraft flown beyond the line, it was thought that the pilot would maintain his heading until ten to 15 minutes after his E.T.A. Cook, then turn north for a further ten or 15 minutes. If he had still not sighted the line by this time it was likely that he would turn on to a reciprocal heading, descend to a lower altitude and fly south again until he sighted the railway, the east-west road or the coast. By this time the aircraft would be nearing the end of its endurance and the pilot would presumably land as near as possible to one of these geographical features. The fact that the railway at Cook is only 60 miles north of the coast, and the presence of a distinct line of timber at the northern extremity of the Nullarbor Plain, 40 miles north of Cook made it difficult to imagine the pilot flying very far to the north. The search on the third day was based on this theory, using 12 aircraft.

That day, a report came in that two fettlers at Hughes, 55 miles west of Cook, had seen a single engined aircraft pass over Hughes on the Sunday afternoon, flying from south-east to north-west. The time of sighting was consistent with the distance the aircraft could have covered since leaving Ceduna. The men were flown to Ceduna for interrogation and their description tallied with that of the missing Wackett. A Dove carried out a night sweep over a presumed track plotted from the Hughes sighting ,and a search plan for the following day was drawn up. The area north of the railway and east of the 128 deg. meridian seemed the most promising.

Because of the difficulties being experienced in navigating accurately in this remote and virtually featureless desert country, the Rescue Co-ordination Centre decided that the search patterns would need to be flown by large aircraft well equipped with radio. A DC.4 flew from Adelaide to supplement the six other multi-engined aircraft in the search area while three light aircraft scoured tracks and areas of scrub immediately to the north-west of Hughes. By Sunday, 21st January, a week after the Wackett had disappeared, all areas of probability and reasonable possibility had been searched. Nevertheless, it was decided to once again cover both the primary probability area and the second area of probability based on the Hughes sighting. The primary probability area was extended to the north-west of Cook, and tied in with the area previously searched to the north-west of Hughes.

All reasonable areas had now been searched at least once and the primary probability area and other probable areas had been covered by up to four searches using a visibility distance of one mile. So far the intense effort had failed to add one single fact to the knowledge that the Wackett had left Ceduna on the 14th and had set course in the right direction. Beyond that nothing definite was known but the reported sighting at Hughes seemed a significant piece of evidence and could be justified



MAP SHOWING AREA SEARCHED, AND ACTUAL SITE OF MISSING AIRCRAFT

from considerations of endurance, ground speed and heading. The search area comprised huge expanses of uninhabited plain and sandhill country and it was possible that the Wackett could have been missed, despite the coverage already given. The plausibility of the Hughes report warranted yet another search of the whole area using four D.C.A. aircraft and a chartered Dove.

On Thursday 25th, hopes were raised when the crew of one of the Aero Commanders sighted fires north of Maralinga which appeared to be of human origin, and a ground party carrying a portable V.H.F. transceiver, set out by Landrover from Maralinga to investigate. The patrol did not expect to reach the site for at least two days and the aerial search continued throughout Friday, Saturday and Sunday. Finally on Monday 29th, the ground party radioed that they had investigated all the fires and found that they had been lit by natives. There was now no prospect that the missing pilot could still be alive and on Tuesday 30th, 19 days after the Wackett had disappeared, the search, after covering 26,000 miles involving 760 flying hours in eighteen different aircraft, was abandoned.

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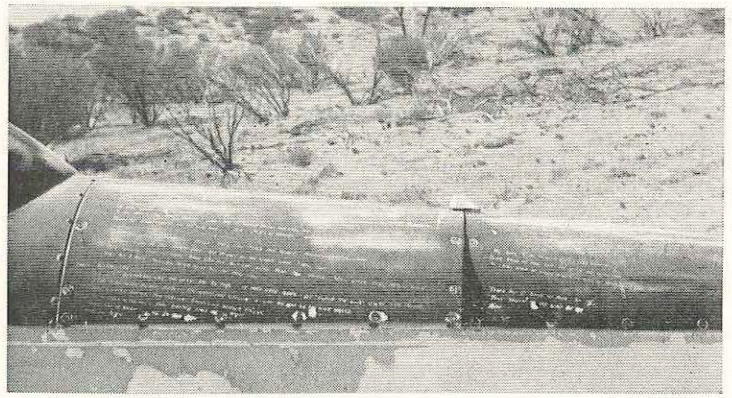
Three years later, a Lockheed Hudson based at Oodnadatta was carrying out an aerial survey of desert country well to the north of Maralinga. It had been working in the area for several weeks when on 28th March, 1965, its crew reported sighting an abandoned single-engined service aircraft lying between sand ridges 135 miles due north of Maralinga. At the Department's request the Hudson crew photographed the aircraft and there was no longer any doubt of its identity. The lost Wackett was 180 miles north-north-east of its destination, more than 40 degress off the Ceduna-Cook track, and 83 miles from the nearest part of the search area.

An investigation team led by the Department's Senior Inspector of Air Safety from Adelaide, supported by Commonwealth Police from Maralinga, set out over the sandhills for the site on Saturday 3rd April. In the stifling heat and heavy sand, the going was extremely difficult and the first vehicle gave in with a broken axle after 22 miles. A replacement was despatched from Maralinga but it was 24 hours before the party could go on and only another 26 miles could be covered before nightfall on the Sunday. On the morning of Monday, 5th, the party broke camp at dawn and before the day was out achieved a position only 12 miles to the south of the Wackett. Progress throughout was painfully slow, deviations to find passable gaps in the ridges, overheating engines, frequent tyre repairs and the ever-present swarm of black flies all adding to the party's tribulations, and it was after midday on Tuesday, 6th, before the expedition finally reached its goal.

They found the Wackett resting normally on its wheels in the red sand at one end of the clearing between two parallel ridges. At first glance it appeared intact, and it was only after a closer look that impact damage was evident. The pilot had obviously made a powered approach from the west into the 300-yard clearing and had ground-looped to starboard as the aircraft had run into thickening scrub and spinnifex at the eastern end. The flaps were still fully down, the starboard one damaged from having ridden over a small mulga tree, and the scrub had torn the fabric in places as the aircraft jolted to its final resting place. The three years of exposure to the scorching sun and the wind had also taken its toll; the paintwork was blistered, in places the wind-driven sand had eroded the finish down to bare metal and the rudder hinges had succumbed to their many months of flapping in the winds. Four scattered seat cushions, a piece of blanket, the remains of a signal pegged out on the ground, and a day to day diary scratched on the fuselage panels behind the rear cockpit, poignantly told the story of the pilot's agonizing wait for the rescue aircraft that never arrived, but apart



from a note suggesting that the front cockpit compass could have been 30 degrees out, they offered no explanation for his gross navigational error. Both compasses had been dismantled.

It was not hard to reconstruct the events of those few days more than three years earlier. Nearly four hours after he had set course from Ceduna on that fateful Sunday afternoon and only seven minutes before his fuel would have been exhausted, the pilot had picked out the most likely looking patch in the waste of sand ridges and had made a precautionary landing. It was 1610 Central Standard Time as he switched off. He wouldn't be overdue at Forrest for another two hours yet and it would be well and truly dark before anyone really started looking for him. He had two gallons of water and with nothing more to do but bide his time, he made himself as comfortable as he could and waited for the lonely night to pass.

Daylight came at last. Now, he knew, the search for him would be well under way and there was no reason why they shouldn't find him soon. Eagerly, he pegged out a ground to air signal in front of the aircraft and set about getting a scrub fire going. Having no matches, he held a piece of rag under one of the fuel tank drains to soak it with petrol, then climbing up on the wing to open the engine cowling, ignited the cloth with a spark from the battery and threw it into a patch of scrub.

Slowly the hours passed as he looked and listened for signs of aircraft searching for him. He tried to work out where he could be, reconstructing his flight to see where his navigation had gone wrong; he had been shaken to find there was a difference of 30 degrees between the compass indications in the front and rear cockpits. At 1610 that afternoon he wrote, "24 hours on ground. Sighted no aircraft."

He ate his last remaining orange as he watched the desert dawn break for the second time. With his earlier optimism daunted now, he rationed his drinking to eke out the dwindling supply of precious water. Already the day was hot and even at this hour the myriads of black flies swarmed around him with maddening persistance. He rigged a makeshift shelter by nailing a blanket to the wooden leading edge of the wing and took what refuge it afforded beneath the aircraft. It was little enough, but at least it offered shade from the harsh, withering sun throughout the day. Still no aircraft came. When the sun went down he came out from his shelter and lay on top of the wing. After the scorching heat, the coolness of the night was like a tonic.

Wednesday came and went, another day of fierce heat with not a cloud in the sky and still no sign or sound of searching aircraft. On Thursday morning his spirits rose a little again when he found a box of matches amongst his luggage and he lit a fire in the clumps of spinnifex on the edge of the clearing. "Hope someone sees it," he scratched on the side of the fuselage. But still no one came. Now he was getting desperate—today he'd have to try and do something, even if it meant leaving the aircraft.

At dawn next morning he was back with his aircraft and resignedly wrote his final entry. "Decided to make a dash on foot north to the—but was too weak in the legs. When taking the front compass out I found both front retaining bolts were missing and the rear one loose enough to let the whole thing swing about 15 degrees . . . I used the alcohol out of the compass to rub over my face and body to make it cool for a while. D.C.A. may not have been looking for me. I put in Flight Details at Ceduna at 12 saying I was going to Cook and then to Forrest. My Sartime at Forrest was 6 p.m. Central Time so they should have started an alert on Sunday night . . . Someone could have forgot. At noon today it will be one week since I had a meal . . . I'll run out of water today . . ." The diary ended with personal messages for his wife.

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Why did this tragedy happen ? What was it that made this experienced pilot fly so far off course that one of the greatest aerial searches in Australia's history failed to find him, and left him to perish in one of the most inhospitable parts of the continent ?

Dozens of theories and counter questions spring to mind. Did the pilot go to sleep at the controls and let his aircraft fly on unguided ? Highly unlikely in a Wackett and in the turbulence of the hot afternoon. Did his watch stop and he lose track of the time and distance he had flown ? No, he had recorded the time he landed. Why then did he allow himself to cross the transcontinental railway ? Why did he go on flying over the sandhills when his map showed that he should be over the Nullarbor Plain? Even on the direct Ceduna-Cook track, Fowler's Bay and the Head of the Bight are clearly visible from as low as 3000 feet—why then did he go on without sighting these landmarks ? At Cook, the railway is only 60 miles north of the coast—why didn't he turn around and fly south when he hadn't sighted it after a reasonable time ? And why did he *still* think he was south of the line when he landed, as his final diary entry suggests ?

Difficult as these questions are, they become even more puzzling when set beside the pilot's claim to have flown the route to the west before. If the pilot's compass was out 30 degrees as he later believed, how did he navigate accurately from Whyalla across Eyre Peninsula to Ceduna, as he must have done to reach Ceduna with such slender fuel reserves ? Was the compass upset while the aircraft was on the ground at Ceduna ? If so how ? And if we do assume the compass was out 30 degrees how do we explain the aircraft being 42 degrees off track ? What route *did* it follow to the landing site ?

These questions can never be answered with certainty, but if we accept the pilot's compass was 30 degrees out when he left Ceduna it becomes possible to surmise what might has happened. To do so emphasises yet again that with navigation nothing can ever be taken for granted. The pilot was tired and in a hurry to be on his way. He rejected the easier coastal route in favour of the shorter direct track, gave only the briefest thought to his flight planning, and was in the air again as soon as he could be. After his turbulent flight that morning he might well have decided to climb into the calm air above the three eighths of strato-cumulus at 8000 feet. Above the cloud layer, his view of the more distant landmarks such as Fowler's Bay and the Head of the Bight would have been obscured.

As well as being tired, he was hungry. According to his diary he hadn't eaten a proper meal since lunch time two days before and certainly he'd had little, if anything, since leaving Whyalla early that morning. He ate some of his oranges as he flew, possibly not giving much attention to navigating, apart from maintaining his compass heading. Meanwhile, the aircraft would have actually been tracking about 330°T and would have crossed the railway between Barton and Immarna nearly an hour before his ETA Cook.

The pilot would no doubt have descended some minutes before he expected to sight the railway and was probably surprised to find himself over sandhill country. The upper winds he'd been given at Ceduna had indicated a northerly airstream at altitude. If it had strengthened, he may have thought it could have blown him south of track. From his previous flight to the west some years before, he may have remembered that there were sandhills south of Colona, and at this stage it is possible that he altered his heading a few degrees to the north. At any rate, it seems he flew on in the same general direction until some 35 minutes after his ETA Cook, expecting to intercept the railway. Apparently believing he could not have missed the line, and with his fuel position becoming critical, he then turned north to find it as quickly as possible.

Unknowingly tracking about 030°T now, he flew on, expecting the line to come into view at any moment. Another 30 minutes dragged on and still there was no sign of it. Now with only 40 minutes fuel left he realized his situation was serious. If he flew south again he'd only be backtracking to an unknown position and would be faced with a forced landing in the sandhills; Surely he *must* sight the railway soon . . . Thirty minutes later he bowed to the inevitable and landed while he still had power for a precautionary approach.

Whatever the actual sequence of events during the flight, they could hardly have been very different. And in any case, although they were the means by which the pilot went astray, they were not the root cause. The real reasons could probably be listed under three headings: Physical Fitness, Flight Preparation, Airmanship, with the first one leading to the other two. Fatigue in the human element of flight, caused by lack of rest and inadequate meals over an extended period, can have consequences as dire in their own way, as fatigue in some vital part of an aircraft structure. Surely the real lesson is that pilots need to be as concerned for every facet of their own fitness for flight as they are for those of the aircraft they fly !

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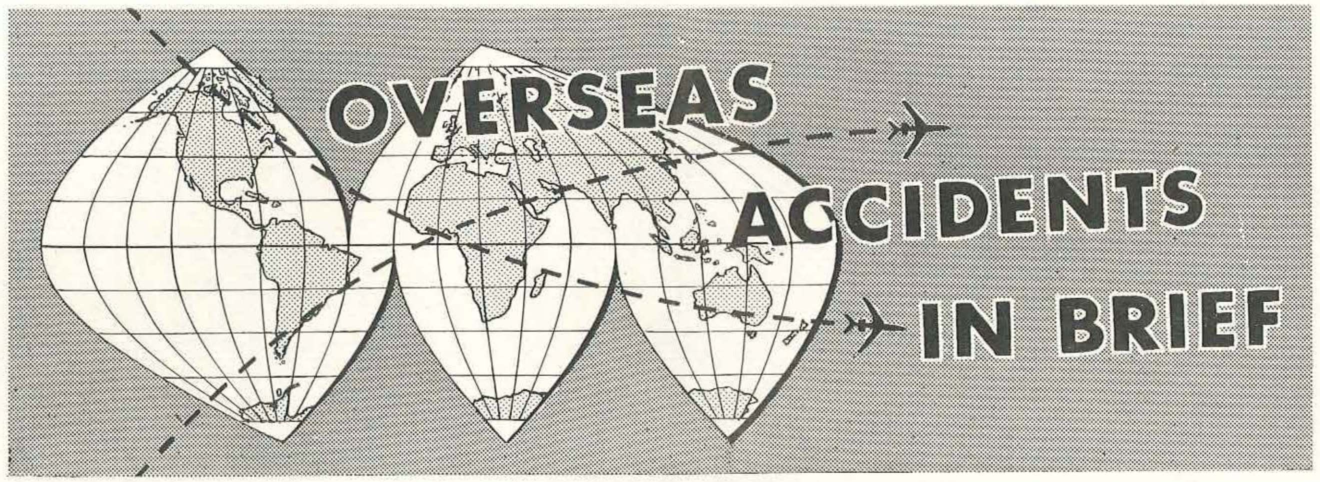
This then is the story of the Wackett and of the tragic end of its pilot so far as we will ever know it. It helps us to understand why one of the biggest aerial searches ever mounted in Australia was unsuccessful. We cannot truly explain how or why the aircraft finished so far from its destination but we have put forward our best guess. You may have another theory. Whatever really happened to the Wackett after it left Ceduna, we do know from other experiences that there is no substitute for care in preparation for a flight, nor for alertness and sound judgement in its conduct. Perhaps you now feel, as we do, this is the message Jim Knight would have wanted to pass on.



Power lost when Throttle cable fails

A single-engined light aircraft with a student pilot at the controls was engaged in circuits and landings. While climbing away after the fifth take-off, the engine started to lose power at 400 feet. The pilot advised the tower of his emergency, then closed and re-opened the throttle but to no effect.

The pilot, who was engaged in only his second period of solo flying, had not received any forced landing training, and the aircraft crash-landed in a building construction yard, striking several concrete beams. The aircraft was destroyed and the pilot seriously injured.

Examination of the engine controls showed that although the throttle control knob was in the full throttle position, the carburettor throttle lever was only 10 degrees from the closed position. The swaged flexible outer casing of the throttle cable had failed and was detached from the forward end of the rigid casing ahead of the instrument panel.

Department of Transport, Canada

COMMENT: Failure of throttle control linkages has been responsible over the years for a large number of incidents to light aircraft in Australia. The December, 1963, issue of the Digest (No. 36) contained an article, "The Insurance Value of Good Maintenance," which dealt with the problem in some detail and emphasised the importance of adequate maintenance.

In past years, particularly in aircraft fitted with Gipsy series engines, throttle control linkages were readily accessible and could be fairly thoroughly inspected in the course of the daily inspection schedule. With the tightly cowled, horizontally opposed engines in widespread use today, however, it is almost impossible to examine the throttle cables in any detail without resorting to the often tedious work of removing the engine cowls completely.

This, of course, places a greater responsibility on the shoulders of maintenance engineers, who perform 100-hourly inspections on these aircraft. Engine control linkages must be carefully examined at these inspections and certifying engineers must assure themselves there is no danger of the linkages failing in service.

Engine Fire in Flight

Entering the circuit area of his destination airport, the pilot of a PA-23 completed his pre-landing checks which included switching on the electric fuel booster pumps. He then noticed fuel leaking from the port engine nacelle and closed the port throttle, but the engine caught fire as he did so.

The pilot, who was the sole occupant of the aircraft, switched off the booster pump and, with smoke filling the cabin, made an emergency landing on the nearest runway and abandoned the aircraft as soon as he could bring it to a stop. He then returned to the cabin to remove the log books and some personal effects, and unsuccessfully used the aircraft's fire extinguisher on the burning engine. The airport staff also tried to control the fire with dry chemical extinguishers but without success, and the aircraft burned to destruction.

Examination of the port engine fuel system showed that the fuel pump outlet elbow had fractured through the threaded section inside the fuel pump body, and that the pump itself had been vibrating on its mounting bolts, despite the fact that these were lock-wired. The vibration of the pump had probably induced stresses in the elbow fitting, which was being restrained by the rigid steel fuel pipe, and eventually culminated in the failure of the fitting. The fracture had allowed fuel to spray out and be ignited by the engine exhaust.

Department of Transport, Canada

Controls jammed by Unrestrained Cargo

While approaching to land at a private airstrip, a Piper Cub was seen to suddenly assume a nose-up attitude, stall and spin. The aircraft struck the ground in a steep nose-down attitude, killing the pilot, who was the sole occupant.

It was found that two cardboard cartons of groceries and a chain saw, together weighing 180 lb., had been loaded on to the rear seat, and had been secured by the seat belt and a piece of rope.

During the flight the fastened seat belt had apparently slipped off one of the cartons and, as the aircraft was approaching to land, the carton had slid forward until its forward top edge was resting against the front seat, with the near lower edge of the box still on the forward part of the rear seat. The rear seat control column stub and torque tube had forced a hole in the base of the carton and had been jammed in a "nose-up" position. Compressive buckling of the forward edge of the hole in the carton showed how the pilot had tried to force the control column back into the forward position when he found himself in difficulties.

Department of Transport, Canada

Comet Damaged during Ground Handling

A Comet arriving at London Airport taxied to its assigned stand on the tarmac, but over-ran the position slightly. It later became necessary to reposition it rearwards and in preparation the towing crew pushed the front and rear passenger steps away from the aircraft doors. One of the crew boarded the aircraft to operate the brakes while a second stood by the ground power unit to pay out the power lead which was still connected to the aircraft.

The nosewheel of the aircraft was resting in a drainage gully and the tug had to use considerable power to start the aircraft moving. When the resistance was overcome, the aircraft rolled back suddenly and the port aileron collided with the passenger steps, which had been moved away from the rear door of the aircraft. About three inches of the aileron trailing edge was damaged.

The towing crew had acted contrary to instructions in failing to move the steps and the ground power unit clear of the aircraft and in not positioning a wing tip lookout.

Airline Bulletin

Vortex Turbulence

In instructor was giving a student pilot circuits and landings in a PA-22 at Tucson Airport, Arizona, U.S.A., using the 4,200-foot 12R runway. At the same time, a Boeing 707 was carrying out circuits and landings on the 12,000-foot 12L runway. The two runways are parallel and 800 feet apart.

The Boeing had taken off and was turning cross-wind as the PA-22 was making its third approach to land. At 50 feet, the nose of the PA-22 suddenly pitched up and the port wing dropped violently. The aircraft failed to respond to control corrections, veered to port and crashed into the ground. Both occupants were injured, one seriously.

The surface wind at the time was a steady 080/10 and the loss of control was attributed to the Boeing's wingtip vortices being carried down-wind into the light aircraft's approach path.

C.A.B., United States

COMMENT: The problem of vortex turbulence generated at the wingtips of heavy aircraft is a serious one in the United States, where large numbers of light aeroplanes share primary airports with heavy jet transport aircraft, and it has been the subject of studies by the National Aeronautics and Space Administration. Although warnings on vortex turbulence have appeared in the Digest on at least two previous occasions, we would be well advised to heed the lesson of this latest accident and refresh our minds on the hazards associated with the phenomenon.

Like all clear air turbulence, vortex turbulence is invisible, but if the vortices could be seen, they would appear as a pair of narrow horizontal whirlwinds rotating in opposite directions and streaming rearwards from each wingtip of an aircraft. The energy of the turbulence at its source is directly proportional to the wingspan loading of the aircraft and inversely proportional to the airspeed. Thus, the most violent vortex turbulence is likely to be found in the wake of large swept-wing jet aircraft during an approach to land or immediately after take-off — the very phases of flight in which another aircraft is most likely to fly into its wake. In rough air, the whirling funnels can be expected to break up and weaken in less than a minute but in calm air, vortices of large magnitude can remain dangerous for **several miles** behind the generating aircraft.

A following light aircraft encountering the wake of a large jet, such as during an approach to land, could be subjected to extremely high upsetting forces. For example, the downwash of air between the vortices could well exceed the climb performance of a small aircraft, while the rolling rates induced in the core of the vortices could be greater than those achieved with full aileron. A light aircraft crossing behind a heavy aircraft and encountering its trail of vortex turbulence, would be subjected to four sudden near-vertical gusts,—UP, DOWN, DOWN, UP, in rapid succession as the peripheries of each of the two vortices were encountered in turn. Because there would be sufficient time between each pair of blows for the pilot to react with elevator control, this could compound the effect of the second pair of gusts and could result in the structural strength of the airframe being exceeded. For this reason, pilots encountering such severe turbulence should try to suppress their normal reaction and allow their aircraft to "ride with" the turbulence-induced loads.

One slightly encouraging aspect of this rather dismal overall picture is that, for the destructive potential to persist, the vortex turbulence must remain in the compact cylinders of between 15 and 20 feet diameter in which it was generated. The chances of flying into such a narrow band of airspace are thus relatively small, particularly away from the immediate vicinity of aerodromes. Nevertheless, with more and more small aeroplanes mixing it with "heavies" at our primary airports in Australia, the potential for vortex turbulence accidents is increasing. As in the accident quoted, the area of greatest danger is downwind from the path of a heavy aircraft landing or taking off. A few instances of encounters have already been reported in Australia, but there have been no serious consequences so far. Let's keep it that way. Keeping your distance from large aircraft is the only sure way to avoid the danger!

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