No. 71 NOVEMBER 1970

AVIATION SAFETY DIGEST

DEPARTMENT OF CIVIL AVIATION AUSTRALIA

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Contents

COVER: Last month saw the introduction of regular 747 services across the Pacific to Australia. In our cover picture, the Pan American World Airways 747 "Ocean Rover" taxies to the Overseas Terminal at Sydney (Kingsford-Smith) Airport. By comparison, the two 707's parked in the background seem almost dwarfed by this newcomer to the Australian aviation scene.

— S. J. CHERZ PHOTOGRAPH

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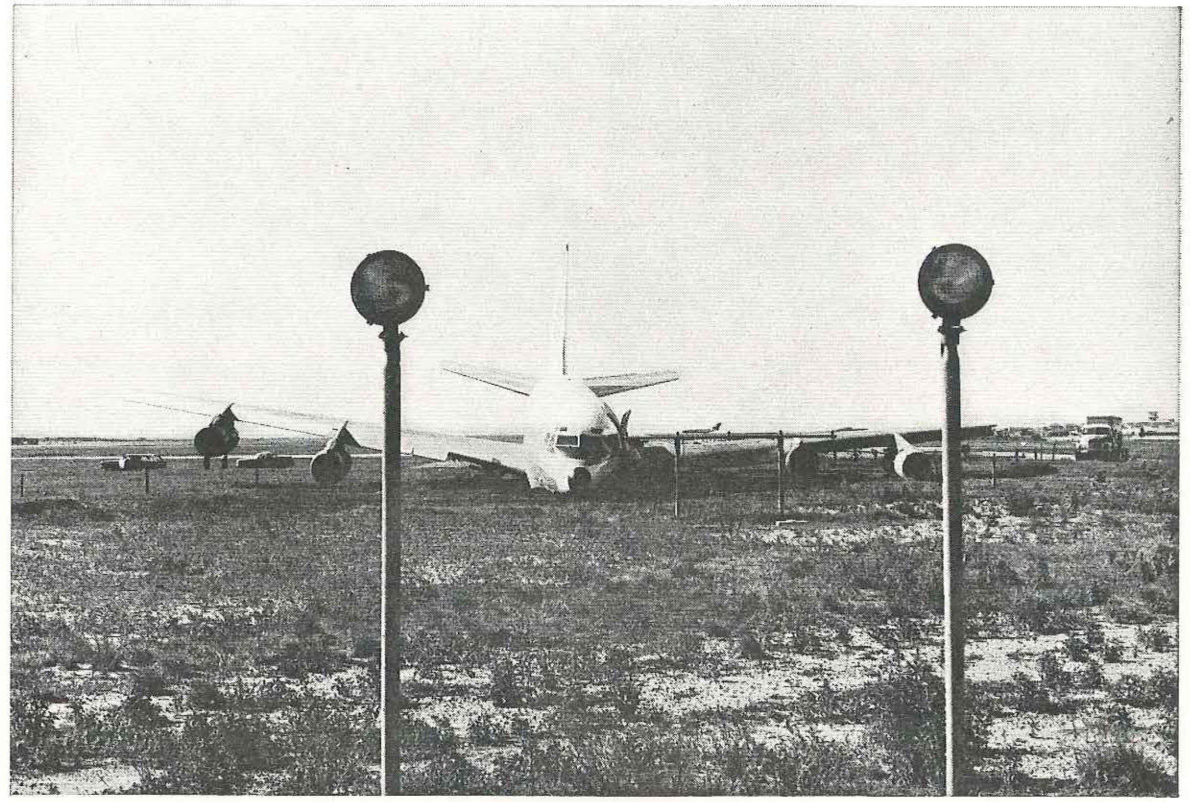


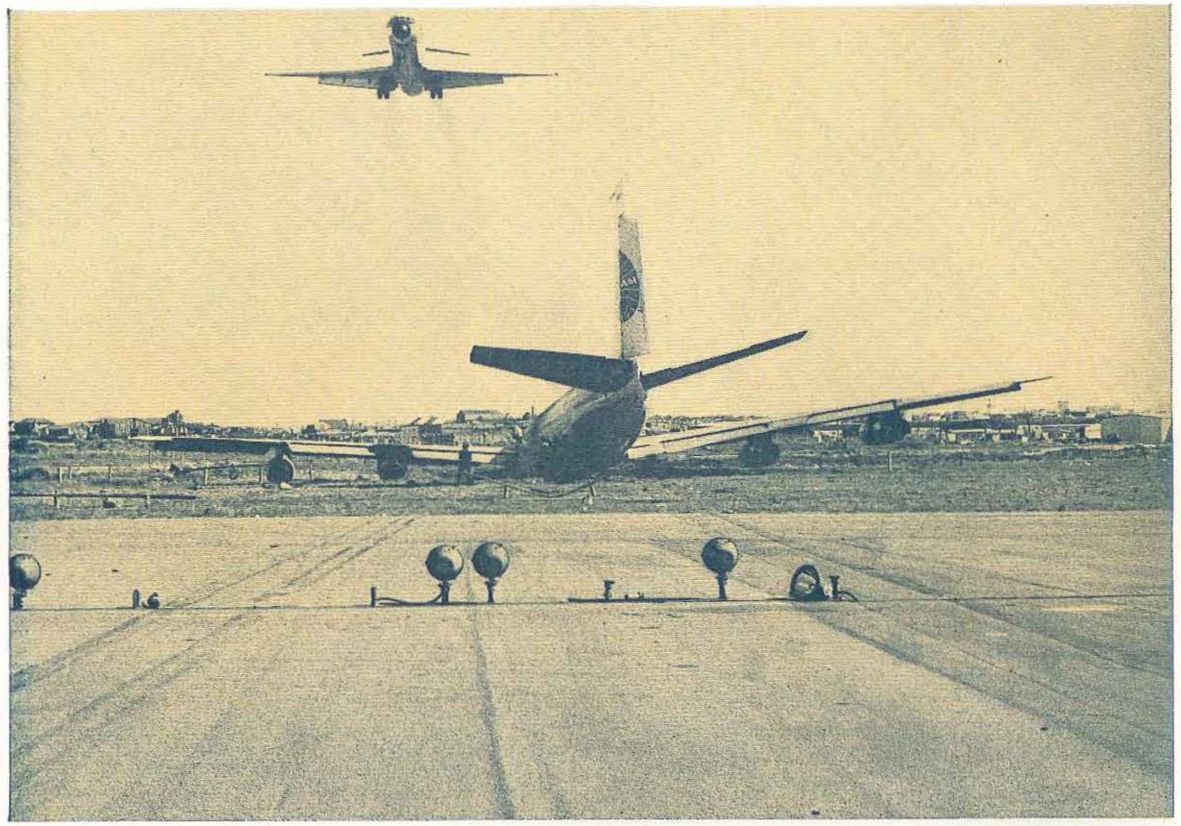
Boeing over-runs runway

when take-off discontinued

While taking off from Runway 34 at Sydney (Kingsford Smith) Airport for a flight to Honolulu U.S.A., a Boeing 707 struck a flock of seagulls, the number two engine lost power and the captain abandoned the take-off. Before the aircraft could be brought to a stop, it over-ran the end of the runway, struck a section of the approach lighting installation and came to rest with its nose in muddy ground, nearly 600 feet beyond the runway end. None of the 136 persons on board was injured and they quickly evacuated the damaged aircraft.

The aircraft, a Boeing 707-321B, was scheduled to depart at 1745 hours local time and while taxi-ing to the threshold of the runway the crew completed the taxi-ing check list and were passed an airways clearance. The aircraft was subsequently cleared for take-off, the pre-take-off checks were completed as it was turned on to the runway and the take-off was commenced from a rolling start.

The take-off was being carried out by the first officer from the right hand seat. As the aircraft accelerated, the captain called airspeed indications of 80 knots and 100 knots, and then "V_1", but just after the V_1 call the aircraft struck a flock of seagulls and there were two sharp reports from outside the aircraft. The captain, who was scanning the engine instruments, saw the No. 2 engine



The aircraft as it came to rest beyond the over-run of Runway 34. The damaged first bar of the precision approach lighting installation is in the foreground.

pressure ratio (EPR) indication drop from 1.85 to about 1.55 and at about the same time, the flight engineer called that there was a power loss. The captain immediately took control of the aircraft and abandoned the take-off.

As it decelerated, the aircraft over-ran the end of the runway and crossed an area of low strength pavement. It passed through the first bar of the runway's approach lights, sustaining tyre damage, then continued into soft ground where the nose leg struck the concrete base of an approach lighting bar-ette. The nose leg was torn off and, as the aircraft skidded on the muddy ground, the port undercarriage struck the base of another approach light mounting in the next row of bar-ettes and was partially detached. Numbers 1 and 2 engines then came into contact with the ground and the aircraft swung slightly to the left and came to rest.

Immediately after the aircraft came to a stop the captain ordered the evacuation of the aircraft. Stewardesses who had been seated adjacent to the four main exit doors during the take-off opened the doors and rigged the escape slides. The evacuation of the aircraft was completed in less than 2 minutes.

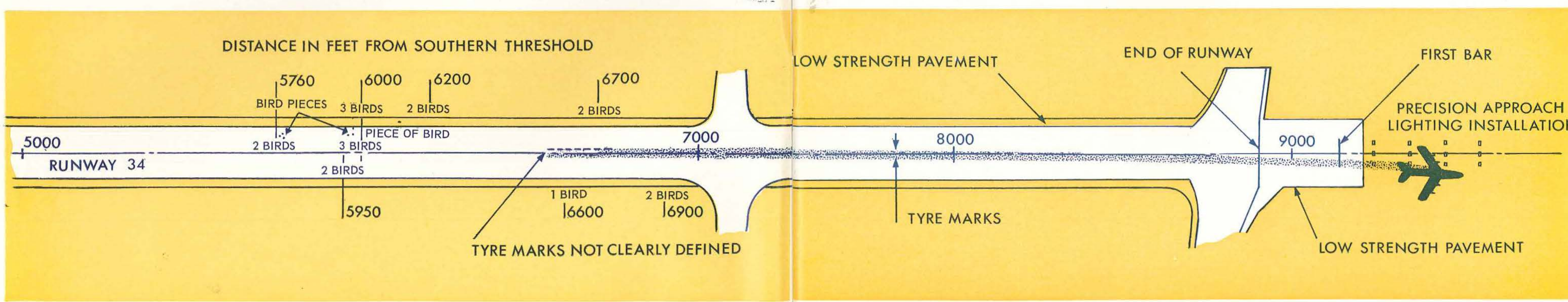
The abandoned take-off had been observed from the airport control tower, and when it became obvious that the aircraft was not going to stop within the confines of the runway, the Senior Tower Controller sounded the crash alarm. The airport fire service responded promptly and five fire fighting vehicles were at the scene of the accident within 2½ minutes. There was no fire and their activities were confined to cooling the smoking wheel brake assemblies. Other emergency services also responded promptly.

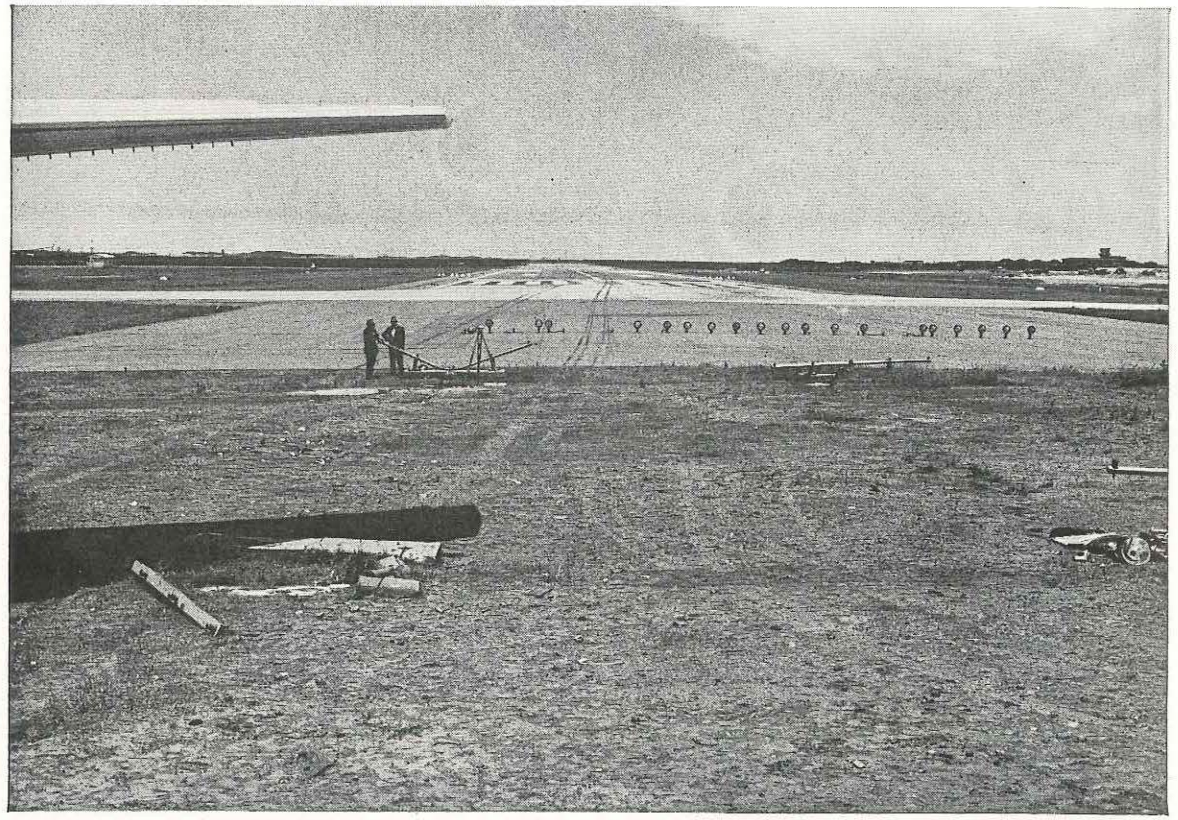
Runway 34, on which the aircraft was taking off at the time of the accident, is 8,900 feet in length and 150 feet wide. Beyond the northern end of the runway is an area of sealed low strength pavement 300 feet in length in which the lights forming the first bar of the precision approach lighting system are located.

The aircraft had come to rest with its nose in soft mud 260 feet beyond the end of the low strength pavement. A number of bird strikes had been sustained on the leading edges of the wings and the engine cowls of Nos. 1, 2 and 3 engines. The strikes were more numerous on the port wing and there was evidence of at least 11 separate bird strikes. Carcasses of some 17 seagulls were found on and adjacent to the runway between 5,760 feet and 6,900 feet from its southern threshold. Wheel marks of the aircraft could be discerned on the runway, commencing 6,570 feet from the threshold. The marks extended to the point where the aircraft came to rest.

The captain's recollection of the sequence of events was that the power loss occurred shortly after the aircraft attained 100 knots and before V_1 speed and this recollection was shared by other crew members. The captain said that when he abandoned the take-off he had applied considerable braking simultaneously with the selection of

Below: Diagram of northern end of Runway 34 showing location of bird carcasses, markings made by aircraft's tyres, and position in which aircraft finally came to rest.





View looking back along runway from where aircraft came to rest, showing tyre marks indicative of heavy braking.

speed brake and reverse thrust, and full wheel braking almost immediately afterwards.

The forecast for the proposed flight indicated that the weather at Sydney Airport at the time of take-off would be fine with no significant cloud and a visibility of 15 miles. The surface wind was forecast to be from 010 degrees true at 15 knots, the temperature 27 degrees C, and the QNH would be 999 millibars. At 1800 hours, about a minute after the accident had occurred, an aerodrome weather report produced by the meteorological office indicated that the wind was from 050 degrees true at 15 knots and that the temperature and QNH setting were unchanged. Examination of the trace recorded by the airport anemometer showed that, at the time of the accident, the wind was fluctuating between 040 degrees and 060 degrees true and its speed was varying between 6 knots and 13 knots. Thus, the actual headwind component could have varied between 2 knots and 9 knots at the time of the accident.

The maximum permissible take-off gross weight of this type of aircraft is 333,100 pounds but at Sydney Airport, the length of the runway imposes a weight restriction. For Runway 34 in the forecast weather conditions, the maximum permissible take-off gross weight was computed to be 303,100 pounds. The load summary and weight and balance sheet prepared for the flight showed that the aircraft's take-off gross weight on this occasion was to be 302,748 pounds.

When the loading of the aircraft was being planned, the fuel required for the flight was calculated to be 131,000 pounds, including an allowance of 1000 pounds for taxi-ing. Before refuelling, the density of the fuel in the refuelling tanker was measured as 6.28 pounds per U.S. gallon, and it was calculated that 15,840 gallons was required to bring the fuel load up to the planned figure of 131,000 pounds. The aircraft was then refuelled accordingly.

During the investigation of the accident however, it was established that the operator's metal hydrometer, used to measure the fuel density, was defective. The upper end of the graduated stem was split circumferentially at its junction with the end plate, allowing fuel to enter the instrument. This caused it to float lower in the fuel sample and to indicate a lower than actual fuel density. Investigation showed that the actual density of the fuel added to the aircraft before its departure was between 6.58 and 6.59 pounds per U.S. gallon. On this basis, the weight of usable fuel on board the aircraft before it commenced to taxi was 137,271 pounds. The weight carried in the aircraft's four holds, and that of the passengers' luggage, were also checked and as a result, the gross weight of the aircraft at the commencement of take-off was finally assessed as 309,560 pounds.

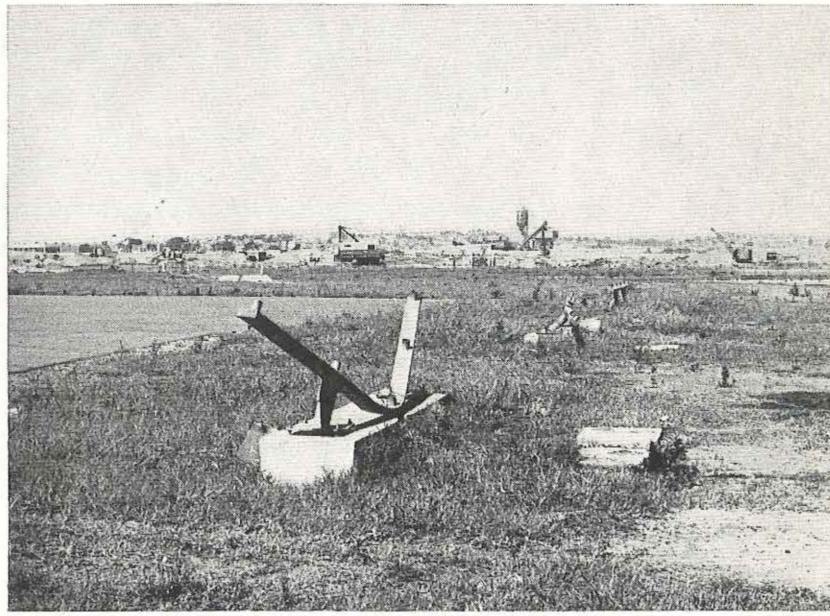
Examination of the aircraft provided no evidence of any deficiencies or malfunctioning which could have affected its performance during the acceleration or deceleration phases of the abandoned take-off. Examination and testing of the braking system indicated that full braking capability was available, and wheel marks on the runway supported the view that full braking was achieved. All four engines were operating in the reverse thrust configuration when the aircraft came to rest. The post-accident testing of numbers 1, 3 and 4 engines indicated that they were capable of normal operation and the component testing of No. 2 engine indicated that it would have been capable of normal or near-normal operation after the bird strike. There was some foreign object damage in the fan stages of all four engines, but in Nos. 3 and 4 engines this was only minor and was evidently caused by the ingestion of stones and dirt after the aircraft had left the sealed surfaces. Although there was evidence that birds had been ingested by Nos. 1, 2 and 3 engines, there were no indications that this had resulted in any damage to Nos. 1 and 3 engines.

Staining and bird remains on the inside of the intake cowl, the fan dome, and the inlet guide vanes indicated that at least one bird had entered the No. 2 engine intake, and one blade in the first stage of the compressor had been severely deformed. The ingestion of one or more birds and the observed damage to the No. 2 engine compressor blade would probably have been sufficient to cause engine surge and the observed fluctuation in power.

The aircraft was equipped with both a flight data recorder and a flight deck audio recorder, both of which were recovered from the aircraft in an undamaged condition and were available for detailed analysis. The analysis of the audio record involved firstly, a transcription of the voice record and readily identifiable individual sounds and secondly, a sound spectrum analysis of background noises. This latter analysis was carried out by the National Transportation Safety Board in the United States.

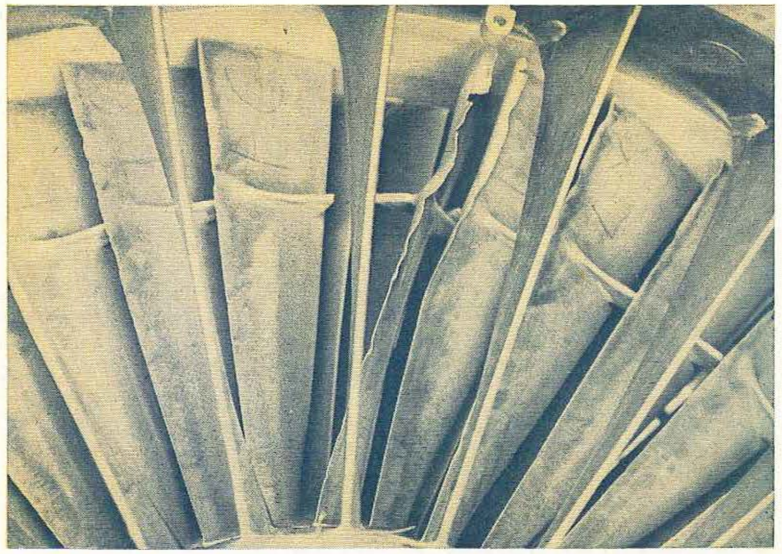
The combined results of these analyses were of great significance to the investigation of the accident. The essential elements of the audio record are shown in the table on page 7, the time in seconds being related to a "0" datum at the compass check in the pre-take-off check list as this point permitted precise correlation between the audio record and the flight data record.

This analysis showed that, taking as a datum the time at which the aircraft passed through 010 degrees while turning on to the runway heading, thrust had been applied progressively and 13.7 seconds had elapsed before take-off thrust was achieved by all four engines. Once full power was established during the take-off roll, it did not vary until the compressor stall occurred. The analysis also established that an engine speed of 110%N_1 was achieved and maintained by all four engines during the deceleration phase. This confirmed the flight engineer's observation that the EPR readings of all four engines were "well up" at this time.

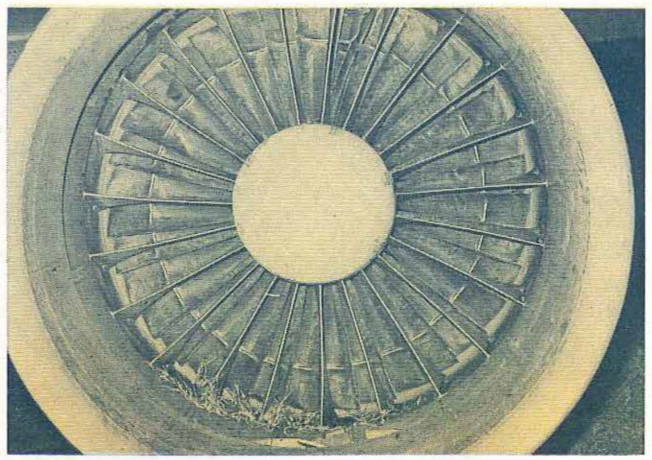


Damage sustained by the first row of approach lighting bar-ettes, which the aircraft struck after over-running the end of the low strength pavement on the left of the picture.

An analysis of the aircraft's performance was conducted using the data obtained from both the flight deck recorder and the flight data recorder, in conjunction with performance data provided by the aircraft manufacturer. The performance information provided by the manufacturer showed that in the planned circumstances of this take-off,



Left and Below: Blade damage sustained by the fan stage of the No. 2 engine.



but at the aircraft's actual gross weight, the distance that would be travelled in an accelerate/stop manoeuvre with engine failure recognition at the nominated V_1 of 138 knots was 7,830 feet. Using reverse thrust the distance would be reduced to 7,310 feet. The distance actually covered in the abandoned take-off, however, was 9,460 feet, despite the fact that reverse thrust was applied until the aircraft came to rest. The investigation was therefore directed to determining what effect the known circumstances of the occurrence would have had on the distance travelled by the aircraft during the phases of acceleration, transition, and deceleration.

* * *

The gross weight of the aircraft at the time of the accident was assessed as 6,800 lbs. in excess of the flight planned weight, and performance calculations indicated that this excess weight would have contributed 200 feet to the total distance actually travelled by the aircraft. Since the flight crew were not aware of the aircraft's true gross weight, the V-speeds were selected for the flight planned weight and consequently were lower than those appropriate for the actual weight of the aircraft. This aspect had no effect on the development of the accident, and it was concluded that the overloading had not in itself resulted in the aircraft overrunning the runway.

The aircraft's rolling start from the side entry to the runway and the crew's technique of progressively applying thrust during the take-off, had also contributed to the distance travelled by the aircraft. These factors had resulted in the effective point of the commencement of take-off being displaced 320 feet from the runway threshold. This effectively reduced the take-off distance available by this amount, as runway length requirements are based on measurement from the runway threshold and do not make allowance for manoeuvring an aircraft for either a standing start or for a rolling start from a side entry.

The point at which the decision was made to discontinue the take-off was next considered. For this take-off, the V_1 speed had been computed as 138 knots, but the engine compressor stall occurred 1.3 seconds **after** the captain had called V_1.

The F.A.A. approved flight manual for the aircraft type states that "when an engine failure occurs. the take-off is normally refused when the failure is recognised prior to V_1, and is normally continued when it is recognised after V_1. At V_1, the take off may be either continued or refused". Also, the operator's manual states that "in actual operations, a specified value of V_1 speed for any particular take-off condition should not be considered as inerrant. Manual data for acceleration stopping distances are based on ideal runway conditions, and corrections for wind and gradient are empirical and arbitrary. Therefore a decision to continue or stop in the event of an engine failure . . . must be a matter of pilot judgement".

Although the captain said his decision to abandon the take-off was based on his observation of a loss of power on only one engine, he also said that he was aware that the aircraft was being struck by a number of birds at the time he made the decision. It was impossible to establish the thought processes which resulted in the captain abandoning the take-off after passing V_1, but the possibility of a multiple engine failure may well have influenced him consciously or subconsciously. It was fruitless pursuing this aspect further in the investigation as the captain's recollection of the sequence of events was that he abandoned the take-off following a loss of engine power occurring shortly after the aircraft had reached 100 knots. Having regard to the circumstances of the occurrence, and to the guidance material provided in the operating manuals, the pilot's action in abandoning the take-off appears reasonable and the speed of the aircraft at the time the take-off was discontinued did not in itself result in the aircraft over-running the runway. The decision to abandon the take-off after passing V_1 must however, remain as the primary factor in the circumstances leading to the accident.

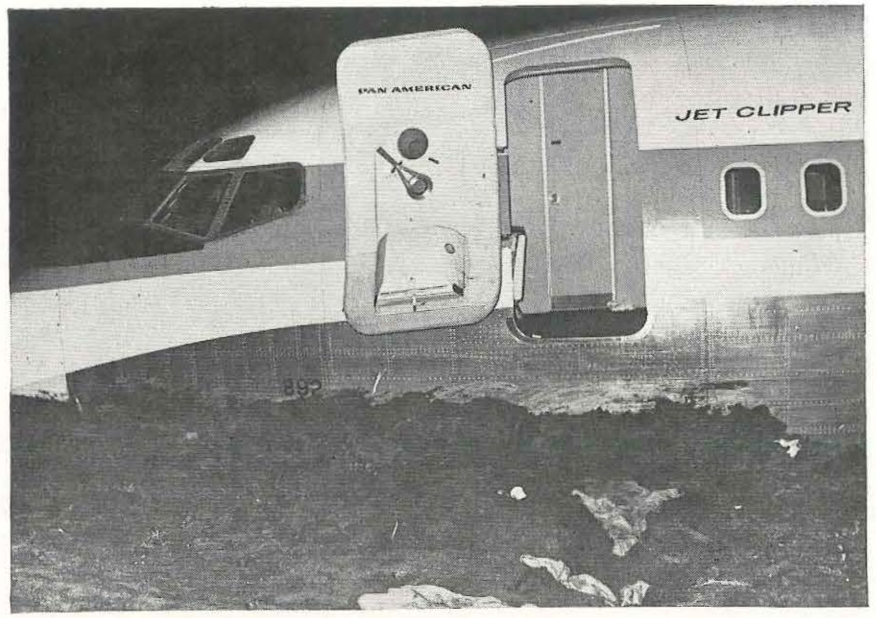
The flight deck audio recorder, which indicated that the engines remained at 110% N_1 until the compressor stall occurred 1.3 seconds after the V_1 call, also provided some information on the actions of the pilot during the transition to the deceleration phase. The time taken by the pilot to cut the throttles when the compressor stall occurred was only 1.6 seconds and this compared very favourably with the aircraft's certification transition delay time 1.76 seconds. The use of reverse thrust is not included in the certification testing of the aircraft, but information provided by the manufacturer specified a time lapse of 6.86 seconds for the implementation of full reverse thrust from the moment of engine failure. In this case, the flight deck recording indicated that reverse thrust was achieved 8.25 seconds after the engine failed, but it is noteworthy that the time taken to achieve full reverse thrust is governed not only by the pilot's actions but by the time taken to release the throttle interlock which is controlled by the speed of operation of the mechanical components of the reversers of each engine.

A factor which could have a significant effect on the accelerate/stop distance of the aircraft was the actual wind velocity at the time. As already indicated, a headwind component of 10 knots was allowed for in the pre-take-off computations, but because of the variation in wind that could have occurred at the time of the attempted take-off, the performance study considered the effect of a 10 knot headwind component, compared with that of a zero head wind component. It was calculated that with a zero headwind component, the accel-

TIME	TRANSCRIPT DATA	SOUND SPECTRUM ANALYSIS DATA
−30·7	Traffic and take-off clearances given	
−22·7	Traffic and take-off clearances acknowledged	
−15·7	Pre-take-off check commences	
0	Compass check (Heading 010)	Two engines at idle and two at 82·5% N_1
1·7		Two engines commenced to advance towards take-off thrust
5·0		The other two engines commenced to advance towards take-off thrust
8·3	Call for take-off thrust	
13·7	Peak power noted	Take-off thrust achieved by all four engines.
		Power stabilised at 110% N_1
28·2	80 kt. call	
34·7	100 kt. call	
49·0	V_1 call	
50·3	Sound of compressor stall	Identification as compressor stall confirmed
50·9	Secondary compressor stall?	Variation of power down to 93·9% N_1 during this period
51·0	Sound of engine(s) running down	
51·2	Loss of power call	
51·9	Sound of power levers hitting stops	
54·9	Sound of reverse thrust begins	The lowest value of N_1 occurred and then N_1 increased in reverse thrust
58·55		Maximum N_1 was achieved by all engines
		Thrust stabilised at 110% N_1—no variations of power during deceleration phase nor any evidence of additional compressor stalling
65·9	Sound of impact noises	
74·4	Impact noises cease	
74·5	Evacuation instructions issued	
89·4	End of recording	

Above: Table showing sequence of events against time in seconds, as derived from flight deck audio recorder and sound spectrum analysis.

Below: Impact marks left by the aircraft as the nose leg was torn off after colliding with the approach lighting bar-ette in the foreground. Nos. 1 and 2 engines also came in contact with the ground before the aircraft came to a stop.



The nose of the aircraft as it came to rest in the muddy ground. The fact that the main cabin door was close to ground level facilitated the evacuation of the passengers from the aircraft.

erate/stop distance would be 990 feet greater than for the 10 knot headwind situation.

The accelerate/stop performance analysis based on the 10 knot headwind component showed that the compressor stall would have occurred well before the aircraft reached the position in which the bird carcasses were found on the runway, and also posed an unreasonably long delay between the time the decision to abandon the take-off was made, and the commencement of the wheel marks on the runway. As well as this, the total calculated stopping distance was much less than that indicated by the wheel marks, and the aircraft should have been able to stop within the confines of the runway. In the zero wind case on the other hand, the compressor stall would have occurred just after the position of the first bird carcasses, the wheel marks commenced 620 feet after the assumed point of engine failure recognition, and the aircraft would have come to rest 200 feet beyond the end of the runway. The total accelerate/stop distance required in this case was 9,055 feet, measured from the threshold of the runway. By comparison, the actual position of the aircraft was 9,460 feet from the threshold of the runway. The theoretical zero wind case thus more closely approximated the evidence found and indicated that the headwind component at the time of the accident was considerably less than forecast.

* * *

Performance calculations made so far during the investigation had been based on the assumption that the captain had called V_1 at precisely 138 knots. The engine failure recognition speed was then established from the time relationship of that call and the subsequent events recorded on the flight deck audio recorder. But the total accelerate/stop distance would be affected very significantly by any variation in the recognition speed. Had the V_1 call been made at 140 knots for instance, the total distance travelled by the aircraft would have been increased by 290 feet.

It was not possible to determine precisely when the wheel brakes were applied, but the possibility that there was some delay in their application was supported by the fact that the wheel marks commenced 620 feet from the assumed engine failure recognition point. In the zero headwind case of the performance study this would represent a delay of about two seconds. The certification transit delay times established for the aircraft type provide for brake application to be made 0.39 seconds from the time of engine failure recognition. The need for immediate brake application is obviously vital in the case of an abandoned take-off, but the technique of applying brakes as a first step, even before the throttles are cut, is one which is contrary to normal practice. In a landing roll, which is of course the deceleration phase most usually experienced by pilots, the normal technique is to close the throttles, actuate the speed brakes and then, when reverse thrust has been selected, to apply the wheel brakes. Whether or not a pilot, in the split second decision of an abandoned take-off, can be expected to make the conscious effort to

The softness of the ground in which the aircraft came to rest is clearly evident from this photograph of the bogged starboard undercarriage.

act with his feet in advance of acting with his hands, must remain a matter for conjecture.

The investigation of this accident thus showed that the aircraft had overrun the runway as the result of a combination of a number of factors. In the first place, there was the pilot's decision to discontinue the take-off after the aircraft had reached V_1. Secondly, there was the loss of effective runway length brought about by the use of a rolling start and the progressive application of thrust. Thirdly, there was the possibility of a delay in the calling of the V_1 speed. The fourth factor was the reaction time taken to apply full braking as evidenced by the wheel markings on the runway. The fifth factor was the overloading of the aircraft resulting from the defect in the hydrometer, and finally, there was the effect that a reduction in headwind component could have had in increasing the overall distance travelled by the aircraft. No one of these factors in itself would have caused the accident but, with the decision to abandon the take-off after V_1, and the reduction in effective runway length brought about by the rolling start and the progressive application of thrust, it only required an adverse combination of the remaining factors to result in the aircraft failing to stop within the confines of the runway.

Cause

The probable cause of the accident was that in the circumstances of an abandoned take-off, the aircraft could not be brought to a stop within the nominally adequate runway length because of an error in the calculation of load, a reduction in wind velocity from that forecast, and the use of a rolling start and braking techniques which would not ensure the most effective use of the available runway length.

Comment

It is a fact of life that there is very little margin built in to the accelerate/stop criteria and the rationality of the criteria is questioned by many. On the other hand it can be properly argued that there is a low probability of the combined circumstance of a need to abandon a take-off at V_1 in a situation of the runway being accelerate/stop critical. This is a matter which is under continuing review by the authorities of all leading aviation countries.

Since this accident arose in the circumstance of a decision to abandon take-off after V_1, it cannot really be tied to a criteria which accepts the concept of V_1. Nevertheless the accident clearly indicates the need to be conscious that every take-off has the potential for an emergency in critical circumstances and that there is therefore a need to ensure that the maximum practicable use is made of each foot of runway. There is too often expressed a belief that a little bit here and a little bit there doesn't matter very much but pilots who have this belief should make a conscious study of the effect, in terms of runway use, that individual departures from standards can involve. Many will be surprised at the magnitude of the erosions that can occur.

FATAL ATTEMPT TO OUT-CLIMB RIDGE

Soon after departing from Gurney in eastern Papua, on a charter flight to Esa'ala on Normanby Island, a Piper Aztec failed to out-climb a saddle in a mountain ridge that lay across its path and crashed on the mountain slopes in dense jungle. The pilot and the eight passengers on board were killed and the aircraft was destroyed.

At 0831 hours on the day of the accident, the aircraft, a PA23-250, reported to Port Moresby Flight Service Centre that it was taxi-ing at Gurney for a flight to Esa'ala, which is on the northern coast of Normanby Island and 46 miles north-east of Gurney. No further communications were heard from the aircraft and it subsequently failed to reach its destination. Distress procedures were introduced and an air and ground search was begun for the missing aircraft.

The search quickly developed into an extensive operation, using up to ten aircraft, including four helicopters, while a number of army and police patrols scoured the rugged terrain north of Gurney, on foot. The entire search operation was continuously hampered by bad weather and it was not until ten days later that the burnt-out wreckage of the aircraft was sighted from the air slightly less than 4 miles north of Gurney Airstrip. The wreckage was lying in dense rain forest on high ground that could not be searched previously because of poor weather.

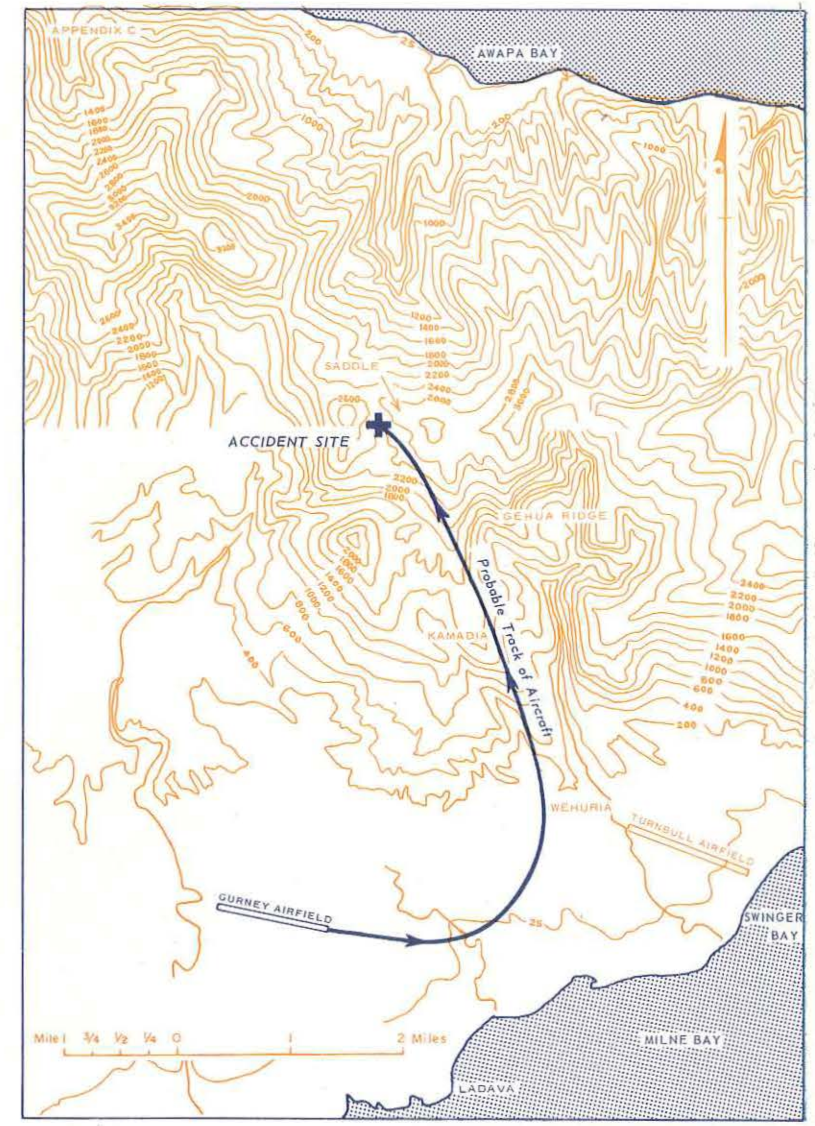
The saddle in the mountain ridge through which the pilot was attempting to climb. Gurney airstrip, from which the aircraft took off, is in the foreground of the picture.

By mid-afternoon of the same day, a ground party had been dropped by helicopter within a mile and a half of the crash site. The party was to proceed to the crash site and cut a helipad in the jungle as near as practicable to the wreckage. But because of the very rugged nature of the terrain and the continued bad weather, access to the accident site proved extremely difficult and a further three days elapsed before the party which had been reinforced by an army patrol, was able to reach the wreckage.

The site of the crash was on the southern side of a mountain ridge about 250 feet below the lowest point of a saddle, 2,450 feet above sea level, which lies between two peaks rising to some 2,650 feet. Aircraft travelling between Gurney and Esa'ala usually cross the ridge at this point. Examination of the accident site showed that the aircraft had broken through the dense rain forest at a shallow angle and struck the ground on a heading of about 290 degrees. It was evident that when the aircraft entered the trees, some of which were up to 150 feet high, it was banked almost vertically to the left and was still rolling in that direction. The aircraft passed through a number of trees as it descended, severing some of them and, when 20 feet above the ground and almost inverted, collided heavily with the trunk of a large tree. The wreckage then fell to the ground and with the exception of the starboard wing and engine and the rear section of the fuselage, was consumed by fire.

It was evident that when the aircraft struck the tops of the trees, it had already begun a turn to the left and that this turn had progressed through some 90 degrees.

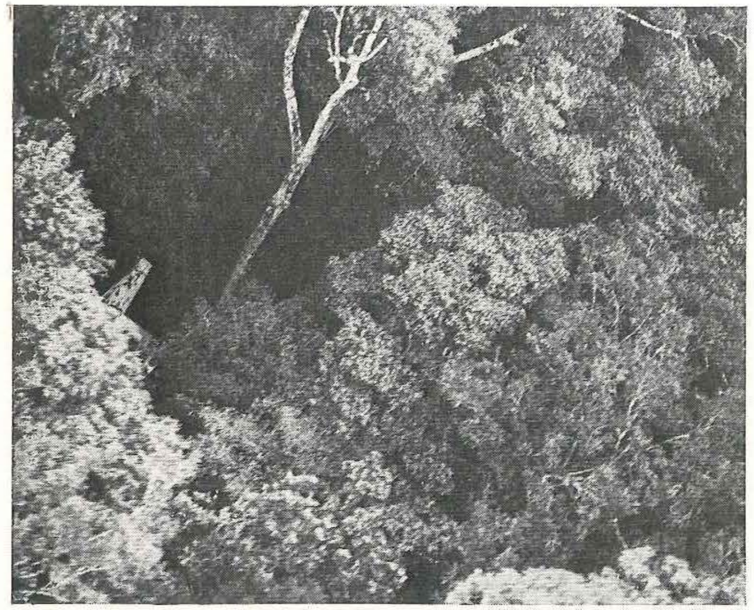
The destruction of the forward fuselage and the port wing was so complete, that no useful information could be gained from these sections of the wreckage, but it was clear that all structural failures had been induced by impact forces and there was no evidence of any malfunction or failure of the primary structure or of the flight control systems before the aircraft struck the trees. At the time of impact the rudder trim was neutral, the stabilator trim was in the full nose-down position, and the undercarriage was retracted. It was not possible to determine the position of the flaps. The section of the fuel system within the unburnt starboard wing was virtually free of contamination and the filter element was clear. The engine and propellers were recovered from the wreckage and carried to the helipad where they were air-lifted from the site, and were later air-freighted to Melbourne for strip examination and laboratory testing.



Contour map showing approximate flight path of aircraft and site of crash.

The pilot in command of the aircraft held a commercial pilot licence and had accumulated 1,272 hours aeronautical experience. Of this 19 hours had been gained on PA23-250 aircraft. This endorsement, which he had gained a month after commencing flying duties in New Guinea, was his first on a multi-engine aircraft.

Because of the mountainous terrain, tropical weather and the special features of many aero-



The wreckage on the heavily timbered mountainside, as it was first sighted from the air, ten days after the aircraft had disappeared.

dromes in Papua/New Guinea, pilots engaged in commercial operations in the Territory are required to undergo route and aerodrome familiarisation training before being authorised to fly in-command on any particular route. The requirements for this training specify that a pilot should carry out a minimum of five flights under supervision in each direction over each route. In this case, it was found that the pilot had flown over the route between Gurney and Esa'ala on only one previous occasion in only one direction, and that this flight had not been supervised.

There is no meteorological office or observing facility at Gurney but for this flight, which was to be conducted VFR, the pilot was not required to obtain a forecast. An eye witness who watched the aircraft depart said there was cloud on the high ground to the north-east of the aerodrome but the gap in the ranges to the north seemed clear, though there seemed to be some cloud beyond it.

For the flight on which the accident occurred, the aircraft's passenger manifest had not been completed, only three of the eight passengers on board being listed. Two of the passengers were infants who could properly be carried in the arms of adult passengers, but there was evidence that while two adults were seated in the two middle-row seats, a third adult occupied the space between them, sitting partly on each of the two seats, and this person was not provided with a seat belt. The maximum permissible gross weight for the PA23-250 aircraft in New Guinea operations is 4,950 lbs., but the gross weight of this aircraft at the time of take-off was calculated to have been 5,228 lbs. When the accident occurred the gross weight would have been approximately 5,200 lbs. There was no record of the distribution of mail, freight or luggage carried in the aircraft, but calculations based on witness evidence and the location of articles found in the wreckage indicated that the centre of gravity at the time of take-off was about 0.3 inches behind the aft limit. It was unlikely however, that this would have affected the handling characteristics of the aircraft to any significant extent.

It was learned that on flights that the pilot had made in the aircraft during the week preceding the accident, he had encountered difficulty in starting the starboard engine and that, on several occasions after the engine had reached normal operating temperatures, it had stopped abruptly when running on the ground at about 1,500 rpm. Witnesses, who had watched the aircraft's departure from Gurney on this occasion, said that the pilot at first had difficulty in starting the starboard engine and that once started, it had initially run roughly. After the pilot had taxied out for take-off, the aircraft spent a short period at the western end of the Gurney strip, presumably while the pre-take-off checks were carried out, then commenced to take-off into the east. Shortly afterwards however, the take-off was abandoned and the aircraft was brought to a stop some 600 feet from the western end of the strip. The witnesses then saw that the starboard propeller was stationary. Three attempts were then made to re-start the engine. The third attempt was successful, and the take-off was immediately continued straight ahead from the point where the aircraft had stopped. This take-off seemed uneventful and the aircraft climbed for a short distance before turning left on to a northerly heading towards the saddle in the mountain range on the direct route to Esa'ala. To the witnesses watching the departure from the strip, the low point in the saddle was obscured from view by an intervening ridge which the aircraft crossed and, when last seen, it was approaching the saddle, close to the point at which the wreckage was subsequently found.

* * *

The detailed examination of the engines and propellers later carried out in Melbourne showed that they were in very poor condition considering the number of operating hours that they had logged since the last overhaul, but no defects were found which could have caused a complete loss of power before impact. It was concluded that the fault which caused the engine to stop during the pilot's first attempt to take off from Gurney probably involved a fuel system or electrical system component that could not be examined because of fire damage.

Examination of the port propeller showed that at the time of impact with the large tree, the blade angle was 24 degrees. The type of failure sustained by the crankshaft flange, together with the damage to the blades themselves, left no doubt that the propeller was rotating at high speed when it was abruptly stopped by impact. The starboard propeller's blade angle was found to be 23 degrees and, as well as being still attached to the starboard engine, it had sustained considerably less damage than had the port propeller. The main impact of the starboard propeller had been against soft moist earth, in a relatively flat attitude, and the difference in mode of impact evidently accounted for the disparity in the damage sustained by each propeller. The blade angles found could have resulted from any one of a large number of combinations of aircraft speed, engine rpm and engine power. One

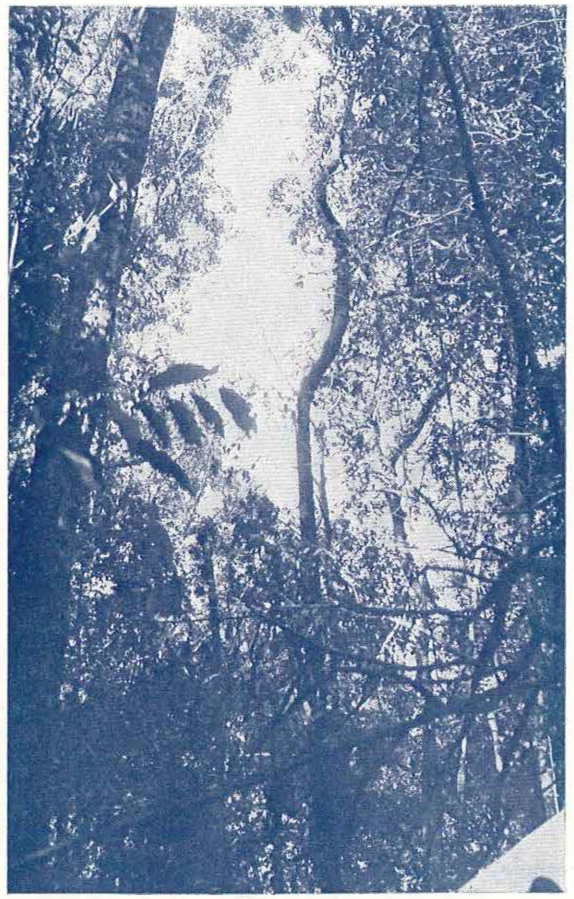
The burnt-out wreckage of the Aztec, as found by the investigation team. The starboard wing and engine nacelle is on the right hand side of the picture, separated from the main wreckage by the large tree.

such combination would be 85 knots, 2,700 rpm and full power. At the other end of the scale, a speed of 160 kts, 2700 rpm, and idling-power could produce the same blade angle. The wreckage examination did not indicate that the impact had occurred at high speed however, and a power and speed combination close to the first mentioned case seemed the more likely.

The eye witness evidence indicated that, after taking off, the aircraft turned and flew directly towards the saddle in the mountain range 2,450 feet above sea level, and a performance assessment was made of the aircraft type's ability to clear this saddle when flying this path. The calculations were made using the type certification flight test data and applying the air temperature and wind conditions that existed at Gurney at the time. Using the normal climbing power and speed prescribed by the manufacturer, the test data indicated that the aircraft should have been able to clear the saddle by 477 feet. The test data however is derived from performance tests carried out on a new aircraft under ideal conditions and flown by a competent test pilot. Any degradation of aircraft or pilot performance, or any adverse effect from turbulence or local winds, could very quickly have reduced this marginal terrain clearance to the point where the aircraft would be unable to clear the saddle without first circling to gain sufficient height.

* * *

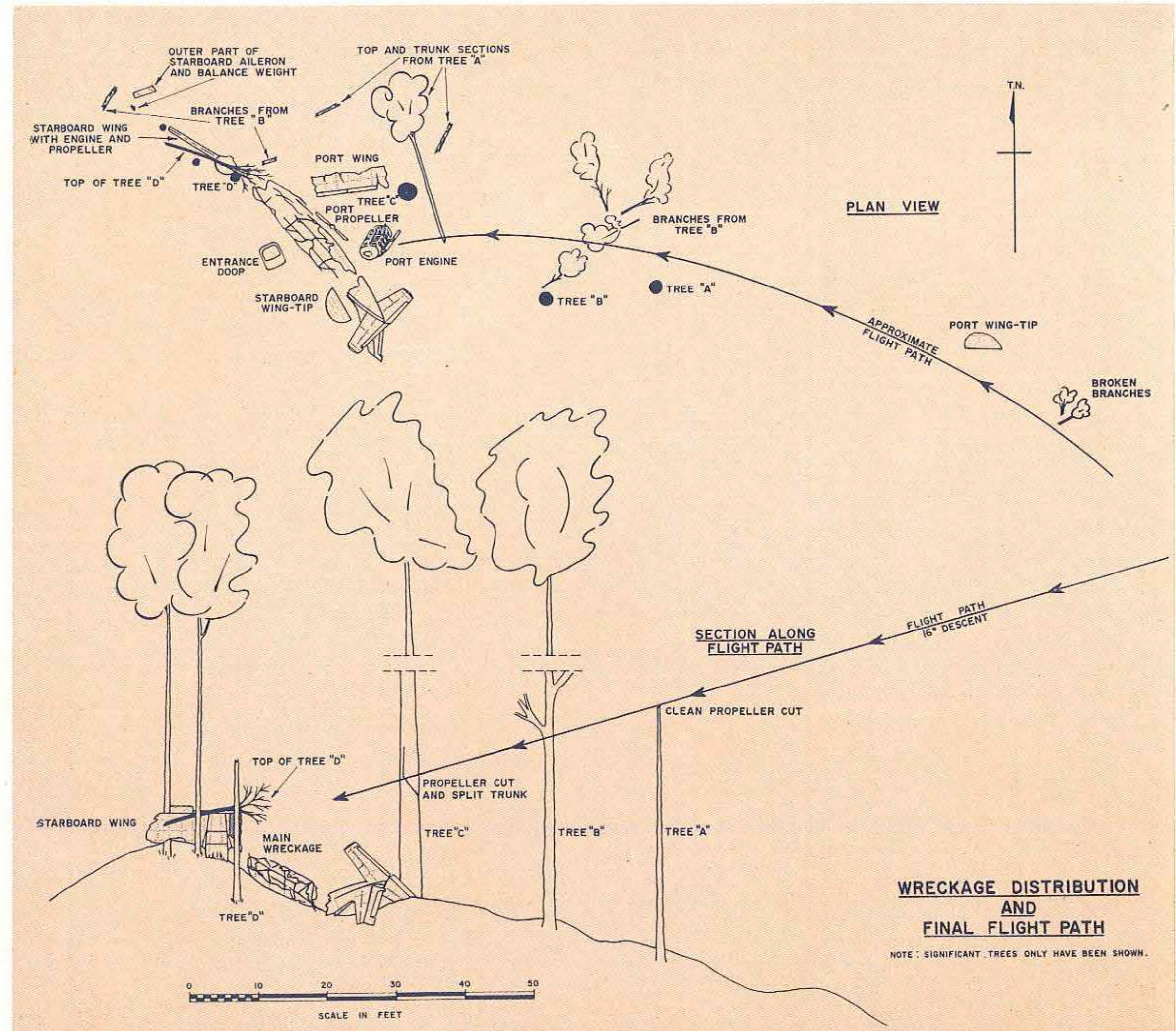
Below: Clearing the site for the helipad near the scene of the accident, ready for air-lifting out the engines and propellers of the crashed aircraft.



Above: View from the wreckage site, looking back in the direction of impact. The gap that the descending aircraft tore in the forest canopy, is clearly evident.

The investigation showed that under optimum conditions, a marginal clearance above the terrain was available along the path being flown by the aircraft. The examination of the aircraft's engines however, showed that they were in poor condition, and it was evident that, before taking off for the flight, the starboard engine had developed a condition which could have affected its power output. As well as this, the pilot's ability to obtain the best performance from the aircraft would have been restricted by his limited experience on the type. In these combined circumstances it is probable that the climb performance of the aircraft was insufficient to clear the rising terrain that lay ahead.

It seems likely that, as he approached the saddle in the mountain ridge, the pilot did not realize the aircraft would be unable to clear the terrain, until too late. When he finally attempted to turn away, either the aircraft was too close to the tops of the



trees, or the turn had to be made so steeply that a loss of height was inevitable. The result was that the port wing tip struck the tree-tops, control was lost, and the aircraft, rolling to the left, crashed through the trees to the ground.

The accident and its tragic outcome testifies too clearly to the pilot's lack of experience on the aircraft type and to his inadequate knowledge of operating conditions in Papua and New Guinea. But despite this lack of experience, the pilot had been permitted to operate the aircraft from Gurney without direct operational supervision, and was expected to exercise his own operational control over flight planning and loading. The pilot's decision to operate the aircraft in an overloaded condition with one passenger improperly seated, his decision to proceed immediately with a second take-off after experiencing an engine failure during his first attempt, and his selection of a flight path that provided only a marginal clearance over the terrain, not only reflect his own deficiencies; they also demonstrate the inadequacy of the operational supervision being exercised by the pilot's employer.

Cause

The probable cause of the accident was that the pilot who was inexperienced in the operational circumstances which pertained, did not make a timely decision to turn away from rising terrain when it should have been apparent that the aircraft could not clear it.

EDITORIAL

Experience counts—if it's recent

AMONGST the variety of Australian accidents reviewed in this issue of the Digest, are the accounts of two which arose from that unenviable, but fortunately rare, event that lurks in the minds of all who fly single engined aeroplanes — sudden and complete engine failure over unfavourable terrain.

Of the forced landings that ensued in each case, one would almost certainly have been successful, despite the adverse geographical and meteorological conditions in which it was conducted, but for the intervention of what can only be called "bad luck". The other, carried out in an area and in weather which offered far better possibilities of success, resulted in a fatality.

The particular circumstances that led to these two forced landings need not concern us here. These matters have been fully discussed in the relevant articles on pages 17 and 22 respectively. What is of concern at this point is the relationship of the pilots' total experience on the one hand, and, on the other hand, their ability as evidenced by the outcome of the forced landings. The pilot who made the near-successful landing in adverse terrain had been flying for only a little over three years and had a total of 600 hours experience. By contrast, the pilot involved in the fatal accident had over 4,000 hours and had held a licence for many years. In these past years he had accumulated very extensive flying experience, much of it as a war time service pilot. It is thus doubly tragic that it required a fatal accident to make manifest the extent to which his aeronautical knowledge, airmanship and manipulative ability had diminished with the passage of time.

Certainly the flying school with which this pilot had done most of his flying in recent years had not recognised the situation. Despite the fact that the school's manual required pilots to undergo a dual check for in-command flying on any aircraft type they had not flown in the preceding 90 days, this pilot had not been subjected to such a check for nearly three years. During these three years, he had flown the aircraft type on only three occasions, each separated by long periods of time, including the flight on which the accident occurred. The flying school obviously believed the pilot to be a person of unquestioned competence and, in deference to his reputation, had apparently been reluctant to press their requirement. It is evident that the flying school overlooked the fact that a pilot's ability is not solely a function of the number of years he has held a licence, or indeed, of the total number of hours he has logged. Recent flying experience, and familiarity with the aircraft type being flown is obviously of equal importance if such a broad background of experience is to be of value to any given operation.

The privilege of holding a pilot's licence carries with it a high degree of responsibility. In professional flying, these responsibilities and the measures to ensure they are properly discharged, are covered in detail by legislation and various types of documentation governing training and checking procedures. But with non-professional pilots, though the legislation is there, it is obviously not possible to exercise the same degree of control and supervision to ensure that standards are maintained. For private pilots therefore, the responsibilities implicit in holding a licence must be largely self-imposed ones. One such responsibility is surely to ensure that one's recent experience, knowledge of procedures, manipulative ability and familiarity with the aircraft type to be flown, are adequate for the operation being undertaken. If they are not, then they should be brought up to standard with revision training before the contemplated operation is attempted.

Responsible private pilots, whether they hire the aeroplanes they fly, or own them outright, will appreciate that such measures are no reflection on their overall competence, and are no more than the counterpart of what is done every day in professional aviation.

FUEL EXHAUSTION

leads to fatal forced landing

While making a local private flight from Bankstown, New South Wales, the engine of a Piper Comanche failed shortly after the pilot had altered the position of the fuel selector. The pilot was unable to restore power and attempted a forced landing. During the final stages of the approach, the aircraft struck trees and crashed. One passenger was killled, and the pilot and the other two passengers were seriously injured.

The aircraft belonged to a Bankstown flying school and the flight was intended as a local pleasure and sight-seeing trip to Katoomba and return. The flight had been authorised by an instructor of the flying school and was being conducted on a NOSAR basis.

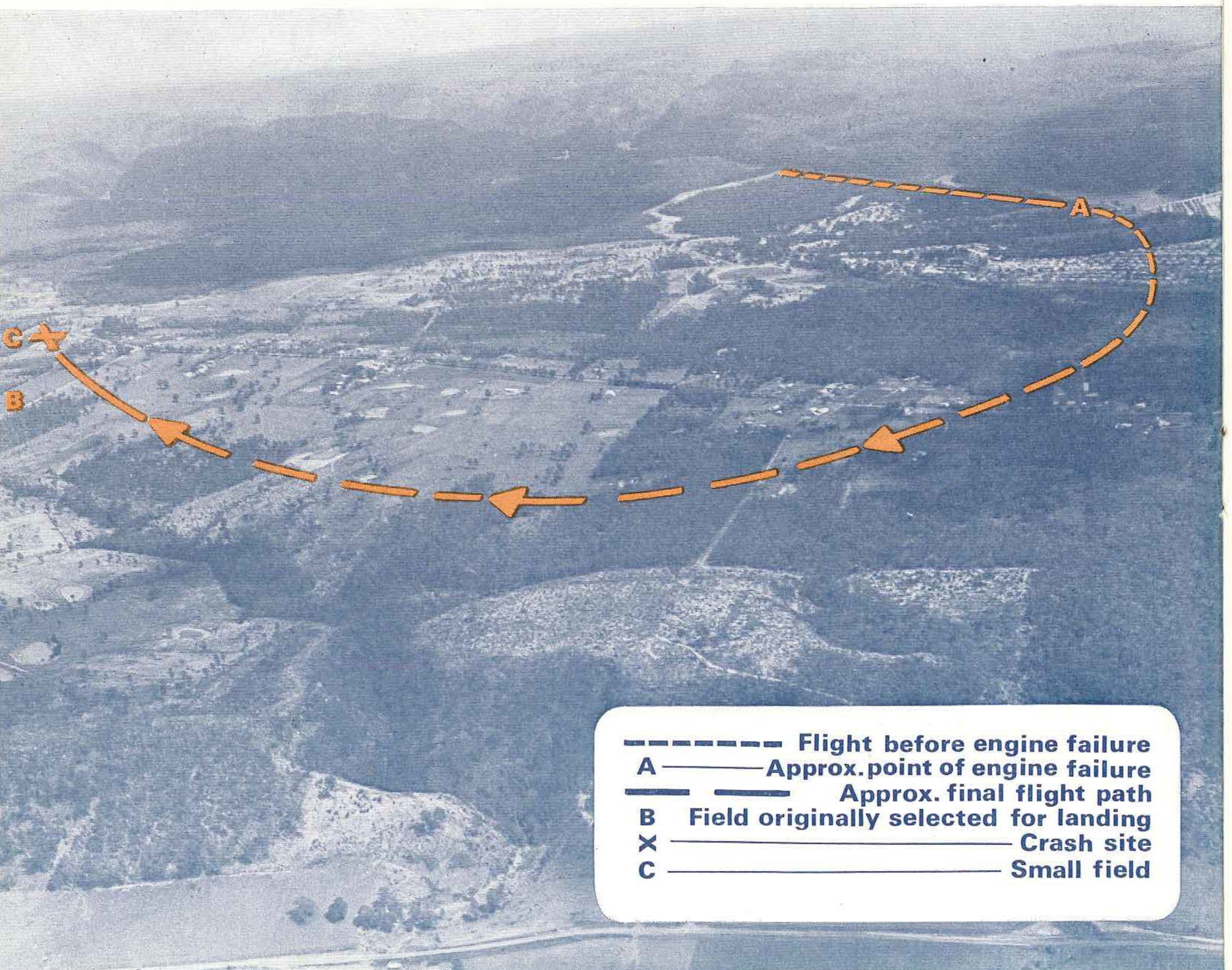
When preparing for the flight, the pilot briefed himself on the meteorological situation and the current flying procedures within the training area and, before boarding the aircraft, carried out a pre-flight inspection which included an examination of the fuel tank contents. The weather at the time was fine and warm and there was a light westerly wind blowing.

After taking off from Bankstown, the pilot climbed to 1,500 feet and flew via Hoxton Park and Wallacia to the Warragamba Dam. Approaching the wall of the dam, where the foothills of the Great Dividing Range rise steeply from the coastal plain to some 2,000 feet above sea level, the pilot climbed to 4,000 feet, then followed the north-western arm of the lake towards Katoomba. Shortly before reaching Katoomba, the pilot decided to turn back and retraced the aircraft's flight path along the same arm of the lake. A little later, flying a north-easterly heading parallel to and just south of the southern shore of the lake, while approaching the position of the dam itself, the pilot noticed that the fuel gauge for the starboard tank, on which the aircraft had been operating throughout the flight, was reading less than he expected. Turning on the booster pump, he then selected the port tank.

A few seconds later, the engine lost all power. The pilot manipulated the throttle, mixture control and pitch control, and applied carburettor heat, but to no effect. He then changed the position of the fuel tank selector several times in an attempt to re-select the starboard fuel tank but, apart from a brief surge from the engine, was unable to restore power.

During his attempts to restore power to the engine, the pilot had been looking for a suitable forced landing site. The terrain over which the aircraft was flying was rugged and heavily timbered, but some distance away to the south-east, on the starboard side of the aircraft, the pilot sighted a field aligned east-west. Placing the aircraft in a shallow turn to the right in an attempt to position it for a landing into wind, the pilot lowered the first notch of flap and trimmed the aircraft so that it was nose heavy. Still doubtful of being able to reach the field, he then flew directly towards it and, with the airspeed close to the stall and the

Aerial view of the area in which engine failure occurred, showing approximate flight path and accident site.



stall warning sounding intermittently, the pilot concentrated on keeping the aircraft in a level attitude.

By the time it reached the field, the height and position of the aircraft were such as to make a landing impossible. Forced to over-fly the area, the pilot continued straight on towards a second, smaller, irregularly shaped field that now offered the only possibility of a safe forced landing, but the aircraft passed over the first half of this field, heading towards some trees. The starboard wing then hit the top of a small tree and the aircraft descended steeply in a flat attitude. As it struck the ground, the aircraft collided violently with a clump of trees and came to rest close to a group of out-buildings, at the rear of a house.

The final stages of the aircraft's descent and the impact were heard or seen by a number of witnesses, several of whom arrived on the scene of the accident within 30 seconds of the crash, and rendered the survivors assistance until an ambulance arrived from the township of Warragamba.

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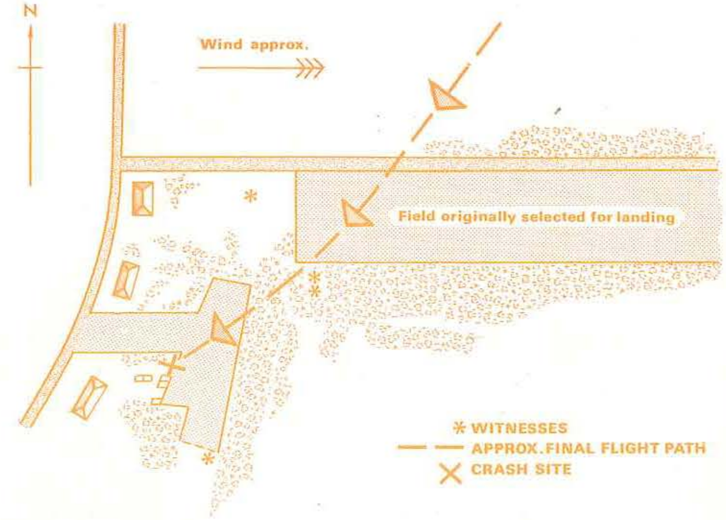


Diagram showing final flight path, accident site and position of eye-witnesses.

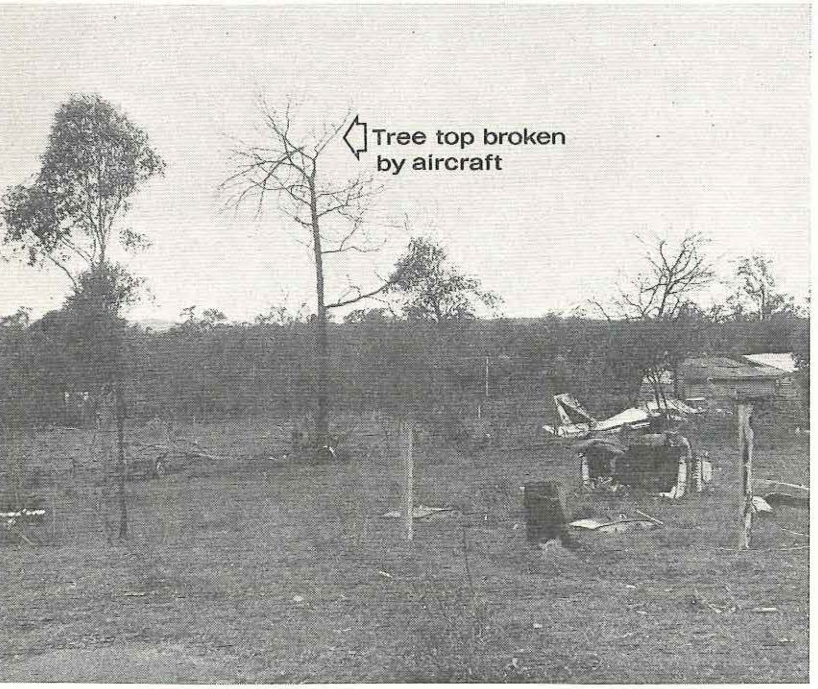
The badly damaged aircraft had come to rest in an upright attitude. The port wing had been sheared off approximately two feet from the fuselage and was attached to the main structure only by the control cables. The starboard wing, though still attached to the fuselage, had been dislodged by impact forces. The rear section of the fuselage and the tail unit, though intact in itself, had been wrenched from the main structure by the force of impact. The aircraft's cabin was still basically intact but on the port side had been severely damaged by impact with a tree. The undercarriage was found to be fully retracted and the undercarriage selector switch was in the neutral position.

The position in which the fuel tank selector handle was found during the on-site examination of the aircraft wreckage was just beyond what is normally the port auxiliary tank position. This is shown on Page 21. Because this particular aircraft was not fitted with auxiliary tanks, no fuel could have been available to the engine with this selection. A small aluminium stop plate was fitted to the face of the fuel selector in this aircraft to prevent the selector handle from being moved into the port or starboard auxiliary tank position. One side of the stop plate was found bent flat, as though the selector handle had been forced over it from the starboard side.

Two alternative fuel systems can be fitted to this model Piper Comanche aircraft. One fuel system incorporates two main tanks only and the other, two main tanks and two auxiliary tanks. The fuel cock and selector handle design is common to both systems, with the "OFF" position forward or at 12 o'clock, where the fuel selector engages in a small detent. To select fuel from the port main tank, the selector lever is moved to the left until it engages in a detent at almost the nine o'clock position. Conversely, to select fuel from the starboard main tank, the lever is moved to the right until it reaches a detent at about the three o'clock position. If the auxiliary fuel system is installed, the selector lever is moved to the half past seven and half past four positions to select fuel from the port and starboard auxiliary tanks, respectively. In an aircraft that is not fitted with auxiliary tanks, such as the one involved in this accident, the auxiliary fuel selector ports are not used.

The instruments associated with the aircraft's fuel system were found to be serviceable and indicating correctly, and the aircraft's electrical and ignition systems were tested and found to be in a satisfactory condition. The engine itself was then removed from the aircraft and mounted in an engine test rig, which incorporated all fuel and electrical components previously removed for individual bench testing. With fuel being supplied through the aircraft's fuel tank selector valve, the engine was then run and found to perform normally. The selector valve operated normally and supplied fuel to the engine in both the port and starboard "ON" positions, but when the selector was placed in any other position, the engine ceased to deliver power. The symptons of the loss of power when the selector was moved from either the port or starboard "ON" positions were consistent with those described by the pilot and passengers when the engine lost power in flight.

The pilot said after the accident that, at the time he changed the position of the fuel selector, shortly before the engine failed, the operation of



The steepness of the aircraft's final descent is evident from this picture. The top of the tree has been broken off only a short distance from where the aircraft finally came to rest.

the selector seemed devoid of "feel" and he had gained the impression that the selector movement was not effective. He was "feeling for a notch" in the fuel selector movement but could not find one. Examination of the fuel selector cock however, showed that the selector movement from one position to the next was very smooth and that a very positive indication was felt when it reached either detent position. But to move the selector from the starboard tank position to the position in which it was found after the accident, it was necessary to force it over the bent aluminium tab. This required a significantly greater effort than was required to move the selector from the "OFF" position to either one of the "ON" positions.

It was learned that the pilot had not flown this type of aircraft for some seven months and his previous flight in the type prior to that occasion had taken place a further four months earlier. In the intervening period the pilot had flown two other types of aircraft, the more recent flight being in a Piper Cherokee. The fuel selector movement in a Piper Cherokee normally requires a heavier force than the Comanche's and, in switching from the starboard tank to the port tank in the Cherokee, the selector is moved anti-clockwise through an arc of 90 degrees. In this case, because the Comanche's engine began to lose power almost immediately after the pilot attempted to select the port tank, it seems possible that he could have made a "Cherokee-type" selection by moving the selector anti-clockwise through 90 degrees. Had he done this in the Comanche, the fuel cock would have been turned off.

From the investigation there was no doubt that the pilot had moved the fuel selector to a position that deprived the engine of fuel. He did not remedy the situation in the time available possibly because of his lack of familiarity with the aircraft's fuel system, and was thus committed to a forced landing.

* * *

The pilot said that immediately after the engine failed, he looked around for somewhere to land and he sighted a "green patch" some distance away to the south of the aircraft's position. Believing that there was no other suitable area available, he placed the aircraft in a gentle turn to the right in an attempt to approach the field for a landing into wind. Because the pilot was doubtful whether the field was within gliding range, he extended the first position of flap in an attempt to extend the glide. In actual fact, of course, this would have increased the aerodynamic drag of the aircraft and therefore could only reduce its gliding range. The pilot also deliberately chose not to trim the aircraft to the correct gliding speed and intentionally flew it throughout the descent with heavy nose-down trim. Questioned about this afterwards, the pilot explained that he wanted the aircraft "to tell him what it was doing". Clearly such a practice is undesirable and in this case it was evident that the aircraft was on the verge of a stall throughout the last 500 feet of its descent. Whether it was for this reason or not, the pilot then chose to keep the aircraft in a laterally level attitude during the final stages of the approach, and made no attempt to position the aircraft into the most suitable area still left to him. Having overshot the field he had originally selected, the pilot had no alternative but to continue towards the smaller field beyond it. On reaching this field however, it is possible that a gentle turn either to the right or the left of the aircraft's flight path would have provided a much less-obstructed area in which to make a wheels-up landing.

After considering all the evidence, the investigation could only conclude that the pilot had grossly misjudged his forced landing approach, an outcome to which the several factors already mentioned undoubtedly contributed, and the aircraft descended into an area which was completely unsuitable for any sort of forced landing. A heavy impact with the ground and trees was the inevitable result.

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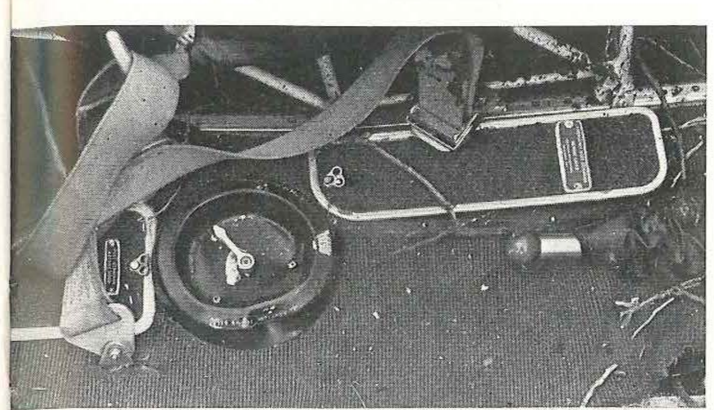
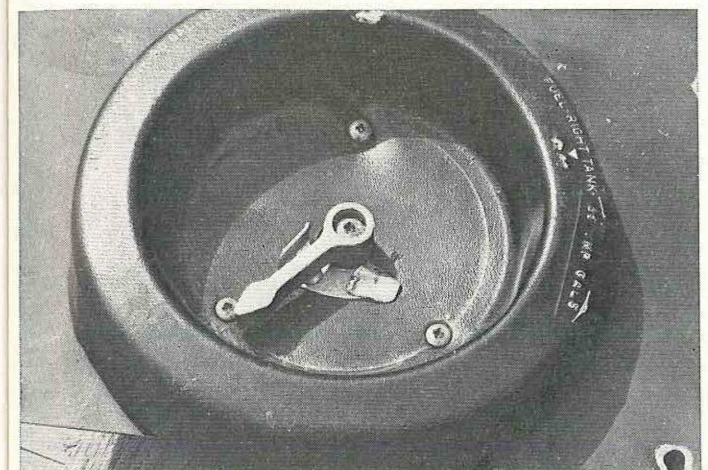




The position in which the fuel selector was found after the accident. The enlarged picture shows one tab of the aluminium stop plate bent flat, as though the selector lever had been forced over it from the starboard side.

Two important object lessons emerge from this tragedy. The first, relating to the factors that led to the mismanagement of the forced landing, is discussed in the editorial comment on page 16. The second is one that will have a familiar ring to many readers of the Digest but which obviously needs to be spelt out again.

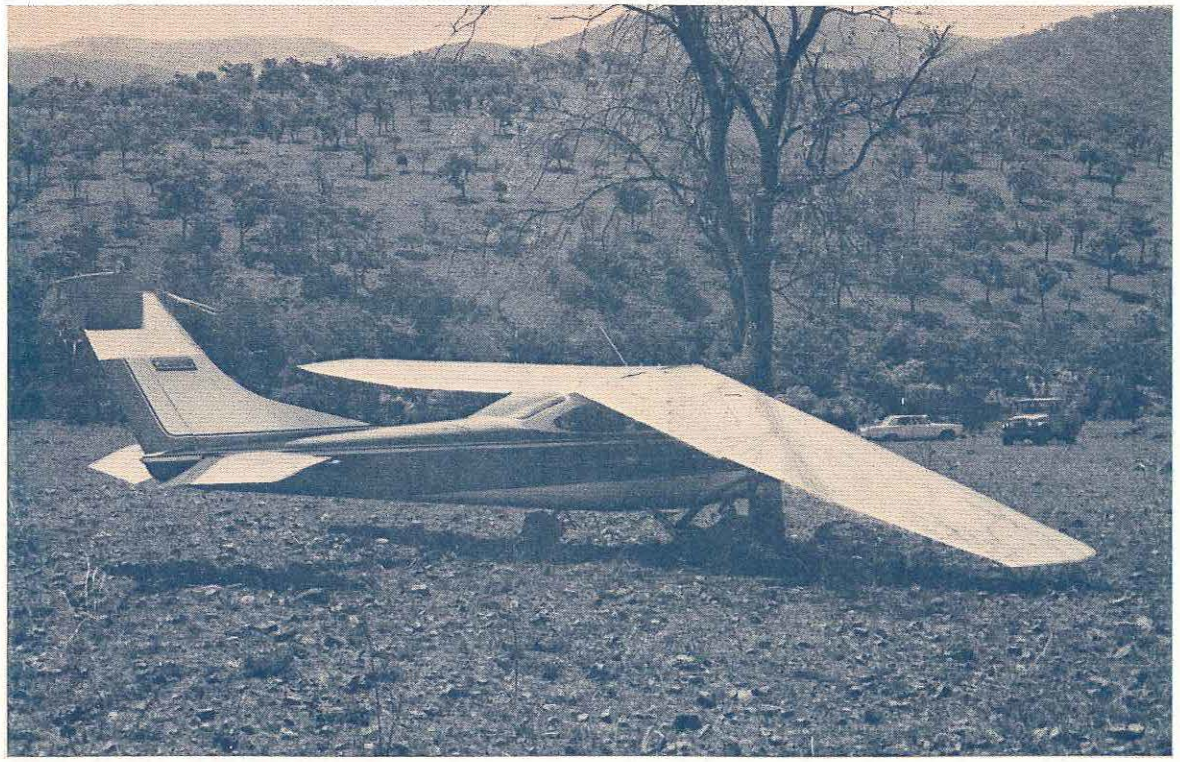
This is the old problem of different types of fuel selectors in different types of aircraft (and even in different models of the same type) that has been responsible for a number of accidents and incidents over the years. The danger of confusion is greatest when a pilot transfers from one aircraft type or model to another, without first making himself thoroughly familiar with the differences in the aircraft's fuel systems. Even while this report was being prepared for publication yet another incident report came to hand in which a pilot, who had done most of his flying on Cessnas, was preparing for a flight in a Beech Musketeer. Having completed his pre-take-off checks, the pilot lined up on the runway and was cleared for take-off. He opened the throttle but as the aircraft accelerated, the engine suddenly lost power, and the pilot was forced to brake the aircraft to a stop. It was then found that the pilot, more familiar with the Cessna's fuel selector, had positioned the handle of the Musketeer's fuel selector to the required tank, rather than the small pointer on the opposite side of the selector spindle. This in effect, had turned the fuel off.

A similar lack of familiarity, this time with the Comanche's fuel system, was the seed from which this fatal accident grew.

Cause

The cause of the accident was that following an engine power failure the pilot misjudged the forced landing approach. The engine power failure was the result of the pilot making an incorrect fuel tank selection.

The relationship of the impact point to the shape of the field in which the accident occurred is evident from this picture. A gentle turn either to the right or the left during the final stages of the descent might have resulted in consequences a good deal less severe.



CREDIT WHERE IT'S DUE

TAKING off on a private flight to Rockhampton, Queensland, from a homestead property some 70 miles to the west, the pilot of a Cessna 182 set heading and climbed to a cruising height of 1,400 feet on the area QNH altimeter setting. Although the weather forecast obtained by the pilot earlier in the day indicated that the flight could be conducted in Visual Meteorological Conditions, the weather in the area was generally poor, with showers and isolated thunderstorms, and a cloud base between about 1,700 and 2,000 feet. The pilot, who was flying alone, had calculated a time interval of 41 minutes for the flight.

About 13 minutes after take-off, the aircraft approached the Boomer Range, a line of low mountains to the west of Rockhampton crossing the aircraft's track almost at right angles, and the pilot increased power and climbed to approximately 1,800 feet, to maintain as much clearance as possible above the rising ground. Although the visibility in the direction of Rockhampton was about 20 miles, the sky was now completely overcast with a general cloud base of 2,000 feet.

The flight had been uneventful to this stage and the pilot was able to pin-point his position on track shortly before reaching the lower slopes of the Boomer Range. Just after passing the first peak of the range however, when the aircraft was over rugged and hilly terrain, the engine, without warning, lost all power. Immediately, the pilot applied carburettor heat, moving the control in and out but the engine failed to respond. Leaving the control in the fully hot position, he then manipulated the mixture control and although the engine "coughed" once as he pushed the mixture control to full rich, the engine would not restart. The pilot also moved the fuel selector from "BOTH ON" to the port tank, but when he saw that this was having no effect, he returned it to its original position. After all his efforts to restart the engine had proved in vain, the pilot left the engine controls in the "start" positions and concentrated on planning a forced landing approach.

The pilot called the Rockhampton Flight Service Centre and transmitted details of the emergency, including his approximate position and his intention to make a forced landing. While he had been attempting to restart the engine, the pilot had been heading towards a small, clear area on a hillside that he believed offered the best chance of a safe forced landing and now, resigned to the fact that the engine was not going to start, he turned off the fuel, and the magneto and master switches.

Realising early in his approach that he would only barely reach the clearing he had chosen, the pilot elected not to lower any flap. Approaching his selected touch-down point, the stall warning horn began to blow as he endeavoured to hold the aircraft in a nose-high attitude for an uphill landing on the steeply sloping rock-strewn ground. As the pilot pulled the control wheel hard back, the aircraft touched down on the rocky, undulating surface, bounced for a short distance, then rolled straight ahead up the slope. The pilot tried to apply the brakes but found that they were ineffective. At this point, the starboard tyre blew out and, as the aircraft veered to the right off the intended landing path, the pilot was unable to prevent the starboard wing colliding heavily with a tree. The wing and lift strut were dislodged by the impact and the aircraft pivoted around the tree before finally coming to rest facing back down the slope.

Evacuating the aircraft quickly, the pilot stood clear until he was sure there was no danger of fire breaking out. When satisfied that it was safe to do so, he returned to the aircraft, carried out temporary repairs to the HF aerial and contacted Rockhampton once again to advise the location of the aircraft and that he had not been injured in the accident.

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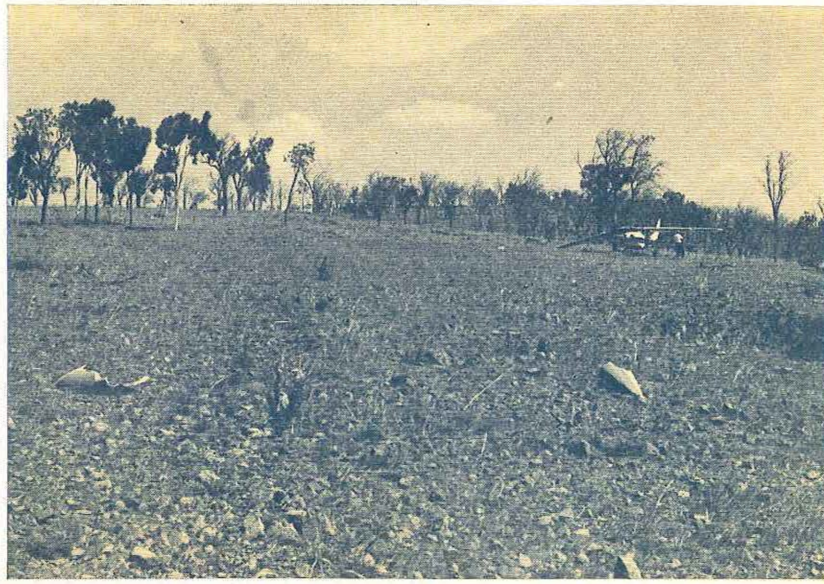
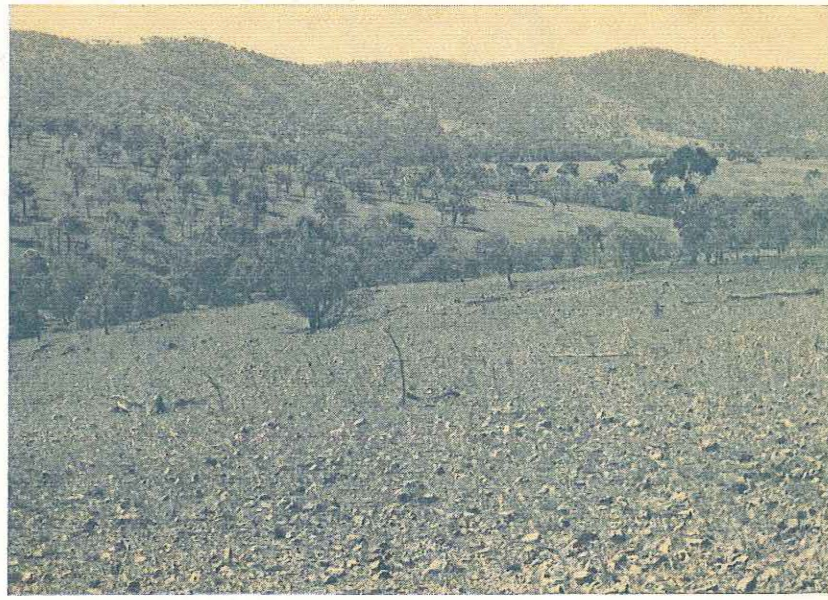


Above: The forced landing site, looking up-hill in the direction of touch-down. The aircraft has pivoted to the right about the tree and come to rest facing in the opposite direction. Note the rock-strewn surface and the broken wheel spat.

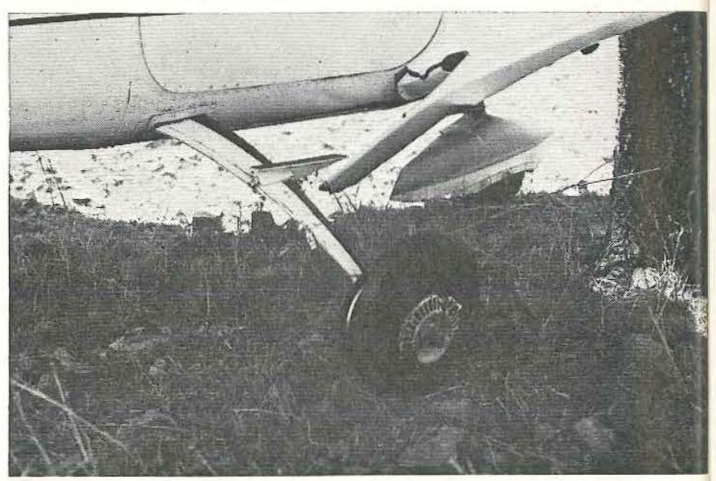
Below: This picture, looking down-hill, and back in the direction from which the forced landing approach was made, conveys some idea of the unenviable situation in which the pilot was placed when his engine lost power at comparatively low altitude.



Preliminary investigation at the accident site disclosed no obvious reason for the engine failure. When tested, the engine started immediately and could not be faulted during the ground run although, because of damage sustained by the propeller, this had to be limited to 1500 rpm. It was found that the hydraulic brake line for the port landing wheel had been fractured, evidently by impact with a stone during the landing roll.

In the absence of any apparent mechanical defect and after a check of the fuel remaining in the tanks had revealed no evidence of contamination, the possibility that carburettor icing had led to the power failure was considered. Extensive rain showers and thunderstorm activity had saturated the lower air levels and the general weather contions at the time of the accident were conducive to the formation of carburettor ice. The pilot said however, that during the short time he had been in the air he had twice checked for the presence of carburettor ice, applying full heat each time, and there had been no indication of icing on either occasion. As he had made the second of these checks only a few minutes before the engine failed, it seemed most unlikely that ice could have built up to any appreciable degree in such a brief period. Furthermore, the symptoms of the sudden power loss were not indicative of a failure of this type.

On completion of this initial inspection, arrangements were made to have the aircraft recovered from the accident site and the engine transported by road to Brisbane for a further, more detailed workshop examination. When this examination was being carried out some three weeks later, a maintenance engineer placed his hand upwards into the throat of the carburettor and felt an obstruction there. As he withdrew his hand, a piece of soft rubber strip, measuring approximately 10 inches by five-eighths of an inch, fell to the bottom of the carburettor hot air box. The length of rubber proved to be one side of the gasket normally glued to the rear face of the carburettor air intake flexible expander assembly, which is in turn attached to the intake duct forming part of the lower engine cowling. The complete gasket comprises four separate strips of rubber but, when the cowling of the aircraft was located and examined, the seal from the lower side of the rectangular face was found to be missing. It was thus clear that the rubber strip had become detached from its mounting during the flight and was sucked up into



Right: These three photographs show the comparatively small extent of the damage sustained by the aircraft in the circumstances. Had a brake line not been fractured by a stone during the landing roll, there is every possibility that the forced landing would have been far more successful.

the throat of the carburettor, affecting the fuel/air mixture to the extent that the engine suffered sudden and complete failure at cruising power settings. The restriction had apparently not blocked the carburettor throat completely and enough clearance apparently remained for the engine to be started and run at low power.

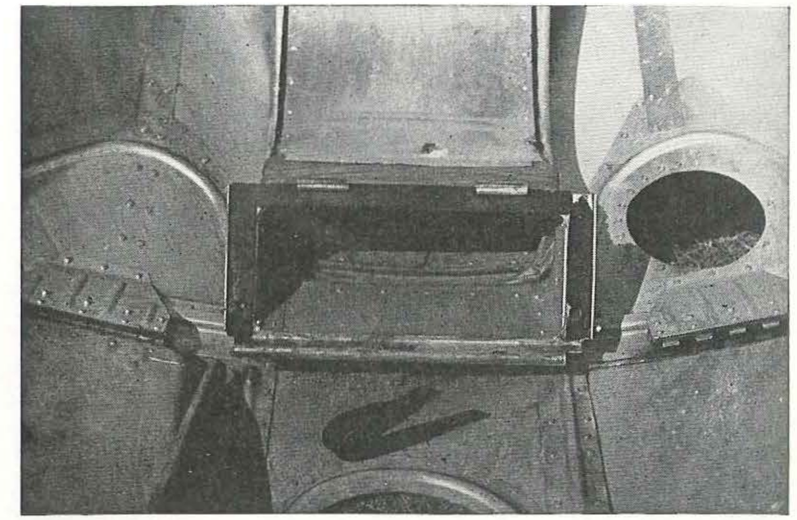
As a result of this accident, the engine cowlings in a number of other aircraft of the same type were inspected. In some of these, the rubber sealing strips were found to lack adhesion and could quite easily have come away with the possibility of causing further engine failures of the same type. The Department has since taken action to correct this situation. *

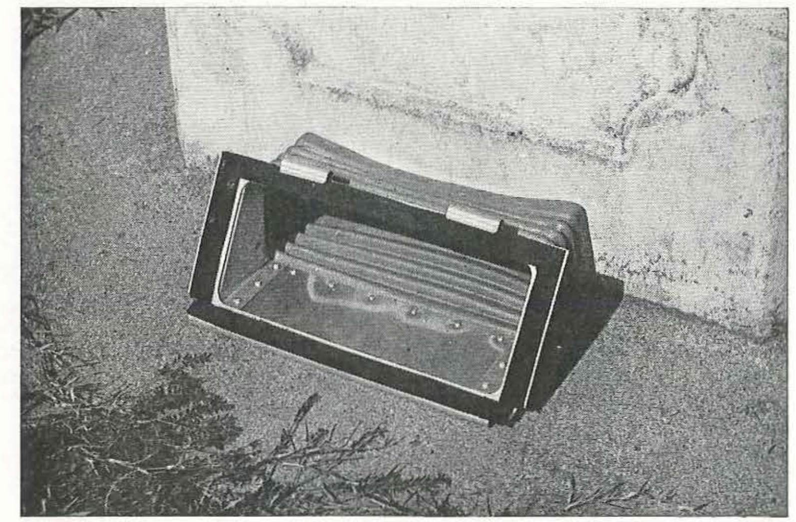
* * *

The circumstances of the engine failure and the nature of the terrain over which the aircraft was flying at the time, placed the pilot in a most unenviable situation. Although the weather was suitable for the flight undertaken, the low cloud base dictated the maximum height at which the pilot was able to operate and afforded him little time or space in which to manoeuvre when the loss of engine power occurred. In any event, the aircraft was over a particularly inhospitable region, both rough and timber covered, which offered a very limited choice of areas suitable for a forced landing.

In these circumstances, the pilot's handling of the difficult situation was most commendable. His cockpit drills after the engine failed were conducted promptly and methodically, and despite the very short time he had in which to plan and carry out his approach, he managed to transmit details of the emergency and his position to the nearest Flight Service Centre, thus initiating Search and Rescue action at this early stage. His subsequent actions in repairing the radio aerial and notifying his actual position in relation to nearby landmarks displayed a high degree of initiative and greatly facilitated his early rescue.

Although the pilot had commenced his flying training only a little over three years prior to the accident, he had in this time amassed a total of some 600 flying hours, about 400 of which had been flown in the Cessna 182 type. Clearly the experience he had gained, and the degree of competence he had developed in this comparatively short time contributed in no small way to the capable manner in which he handled the situation. It is quite likely that the forced landing would have been successful in every respect had not rocks on the rough ground fractured a brake line and punctured the starboard tyre, depriving him of both braking ability and directional control at a critical stage after touch down.



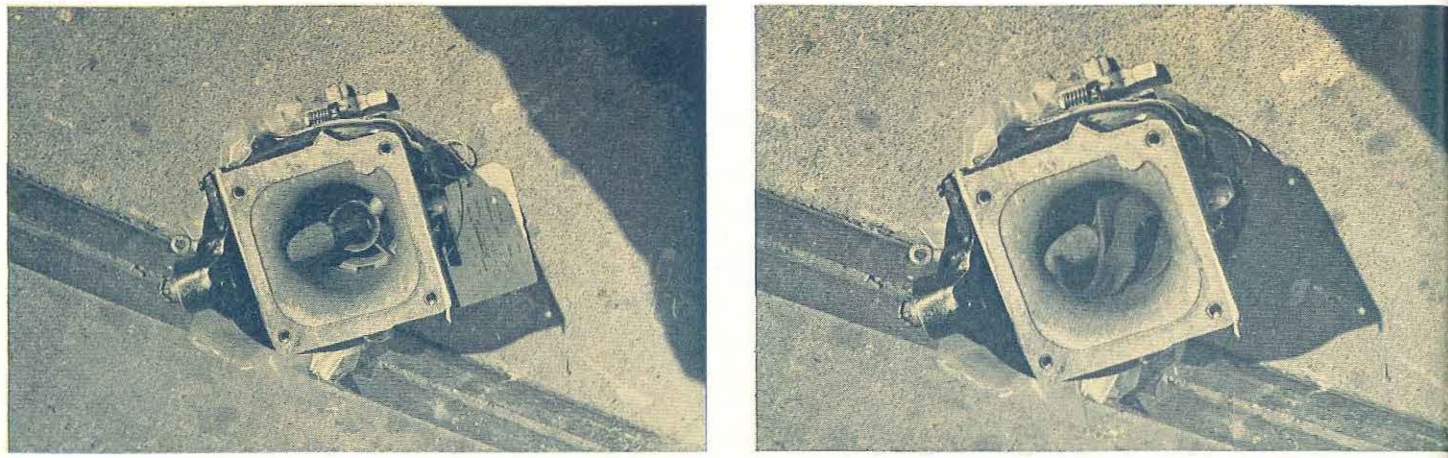


The carburettor air intake flexible expander assembly, in the lower engine cowling. The rubber strip which formed the lower section of the gasket on the rear face of the duct was detached and drawn into the carburettor throat. The lower picture shows a new fitting with a complete gasket.

* * *

Quite apart from the obvious lessons which can be drawn from this accident, the investigation disclosed one aspect of the emergency procedures which could have had serious consequences had the other factors involved been less favourable. The pilot, in his first radio transmission, said that he was "three to five miles" from a known position, but up until the time he made his second call, the

* Airworthiness Advisory Circular No. 29 Refers.



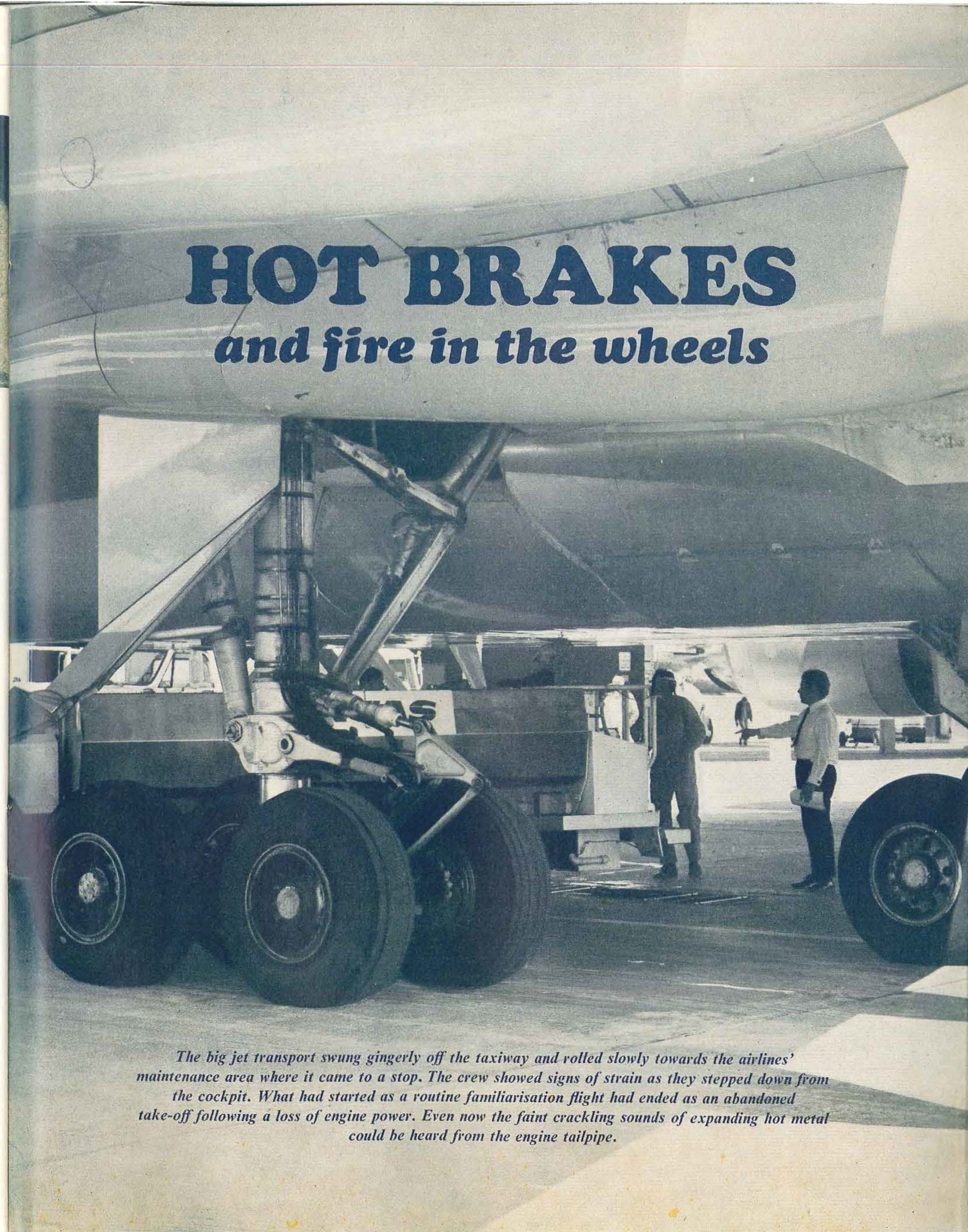
The type of carburettor fitted to the aircraft, showing the way in which the rubber strip probably lodged in the throat, upsetting the fuel-air ratio and causing a complete loss of power at cruising settings.

aircraft's location for SAR purposes was being plotted as "thirty-five miles" from the reference point.

Although the pilot in this particular accident could hardly have foreseen that his position report would have been transposed in this way, the fact that an error did occur shows how easy it is for confusion to arise where it is least expected. In the circumstances of an impending forced landing in difficult conditions, it is certainly unreasonable to expect a pilot to reflect on the possible interpretation of every detail of the information he transmits. Pilots should nevertheless bear in mind that radio propagation conditions are frequently poor and emergency transmissions should be as clear and concise as the occasion permits. In this regard, distances are better expressed as a single figure, even if this is only an approximation such as "about four miles", rather than in terms of a variety of figures which could easily be misunderstood.

In this accident, had the pilot been unable to transmit after his forced landing, the erroneous position information could have caused a substantial delay in his rescue. In the case of an accident in a remote area or involving serious injury to the aircraft's occupants, such a delay could only too easily prove fatal.

—With acknowledgement to Flight Safety Bulletin, U.K.



HOT BRAKES
and fire in the wheels

The big jet transport swung gingerly off the taxiway and rolled slowly towards the airlines' maintenance area where it came to a stop. The crew showed signs of strain as they stepped down from the cockpit. What had started as a routine familiarisation flight had ended as an abandoned take-off following a loss of engine power. Even now the faint crackling sounds of expanding hot metal could be heard from the engine tailpipe.

Twenty minutes later the usual airport noises were punctuated by a loud explosion, accompanied by the clatter of chunks of metal striking the side of a hangar and several ramp vehicles.

A wheel on the jet transport had exploded, and now thick black smoke was beginning to envelop the whole landing gear assembly, as the brake hydraulic fluid ignited. Before the fire was out, the landing gear assembly, hydraulic lines, electrical lines and junction boxes, and flap and wing areas were severely damaged.

* * *

The accident should have surprised no one familiar with the operation of heavy aircraft.

Brake fires and wheel and tyre explosions are always possible after high speed braking situations, when care is not taken directly afterwards to prevent rapid heat transfer from the brakes to the wheels. They can occur after a number of braked stops during crew training or when a take-off must be cut short by a maximum effort stop. Wheel and brake assemblies can also overheat to the danger point during or after a long taxi roll with dragging or seized brakes.

Friction heat in brakes is the product of the aircraft's weight and speed at the time the brakes are applied. Kinetic energy absorbed by the brakes is converted into heat.

Most of the heat is dissipated to the surrounding air: some of it moves from the brakes to the wheel, and from the wheel to the tyre. To prevent tyre explosions caused by overheating, turbine aircraft wheels have thermal fuse plugs in the inner wheel half which releases air pressure in the tyres when wheel temperature exceeds 300°F.

In addition, on some aircraft, heat shields attached to the wheel inner half, retard the transfer of heat from the brake and wheel rim to slow down overheating of the bead seat of the tyre.

Many brake assemblies incorporate hydraulic shut-off valves which cut off the flow from lines severed by wheel or tyre explosions. Since no hydraulic fluid is entirely resistant to fire, there is always the possibility of fire resulting from the fluid dripping on excessively heated brake surfaces. The hydraulic shut-offs limit this possibility.

When it is suspected that the brakes of an aircraft have been subjected to dangerously high temperatures it should be segregated from other aircraft, vehicles and personnel, and left with the parking brakes 'off'. With parking brakes 'set', the heat dissipates less rapidly; the elevated temperatures could cause sealer rings and gaskets to soften, allowing hydraulic fluid to spray hot brake assembly parts, inviting the possibility of fire.

The cooling of overheated brakes can be safely speeded up by fans or blowers. Since the maximum heat within the wheel or tyre develops 15 or more minutes **after** heavy or repeated braking, there is always the danger of a tyre or wheel explosion. It is standard practice in the military air services, for example, to enclose wheel assembles with a heavy gauge wire cage as a protective device for personnel and material whenever excessively 'hot brakes' are suspected.

Some wheel explosions have been violent enough to hurl parts of the wheel rim up to 500 feet. The flying shards of metal can cause fatal injuries and heavy property damage.

Overheated brakes should not be cooled rapidly by application of water, CO_2, or foam since these agents chill the wheel unevenly, causing internal stresses which change the strength values of the metal in the wheels.

All wheel assemblies, but especially those which are overheated or those actually on fire, should always be approached from fore or aft, never from the side. Firemen, fire trucks and rescue equipment should be positioned out of the lateral 'line of fire' to minimize injury or damage to equipment from flying debris in the event of an explosion.

Once a brake fire starts it can quickly develop into a blaze that could threaten the entire aircraft. The tyres could ignite, creating a fire with temperatures exceeding 500°F. Wheel fractures under these high temperatures could rupture fuel tanks or lines, adding to the intensity of the fire.

The most effective agents for fighting wheel and brake fires are the various dry chemicals—potassium-chloride base, potassium-bicarbonate base, and mono-ammonium-phosphate base. The powder soaks up the heat and blankets out air, stifling the fire without chilling the metal. After the fire has been extinguished and the area cooled down to prevailing ground temperature, the chemical residue can be hosed away by air or water without trouble.

In an emergency when no other agent is available, brake and wheel fires may be attacked by a fine spray of water, or by a high pressure fog, applied from behind a protective barrier. The greatest danger from wheel explosions is the hidden 'time bomb' of heat accumulation which can go off without warning after the danger has apparently passed.

(With acknowledgement to "Aviation Mechanics Bulletin," and the Federal Aviation Agency, U.S.A.)