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AVIATION SAFETY DIGEST

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Department of Civil Aviation · · · Australia

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Contents

Cover: *The active volcano "Matupi" forms an unusual backdrop for a Departmental Fokker Friendship as it is serviced at Rabaul, New Britain, in the course of a regular survey flight to check the operation of radio navigational aids and airways facilities.*

The volcano lies directly in line with Rabaul's single runway, only a mile from its south-eastern end.

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LOSS OF CONTROL IN HUDSON

At the conclusion of a survey flight in the Northern Territory, a Lockheed Hudson called the Tennant Creek Flight Service Unit and reported that it was in the circuit area. The aircraft did not land as expected and no further communications were received from it. A search was subsequently carried out, and the wreckage of the aircraft was found two miles west of the aerodrome. All six occupants had been killed and the aircraft destroyed.

The Flight

The aircraft was owned and operated by an aerial survey company and at the time of the accident, was returning from a magnetometer survey flight in an area about 120 miles south-east of Tennant Creek. The aircraft had been carrying out survey flights from Tennant Creek for several weeks.

Before departing on the morning of the accident, the captain of the aircraft submitted a flight plan which showed that the aircraft would be operating in the survey area for 200 minutes. The flight was to be carried out below 5,000 feet and the aircraft's endurance was 400 minutes. The flight plan nominated a SARTIME of 0300 hours G.M.T., 1230 hours local time.

For survey flights of this nature, the usual complement of the aircraft was pilot-in-command, survey navigator and magnetometer operator, but on this particular flight, three additional persons were being carried. A second pilot, who had recently been endorsed on the aircraft, was observing the operation to gain experience in survey work, a Doppler equipment technician was travelling on the aircraft to check the operation of the equipment in the air, and an eleven year old boy was being carried as a passenger at the invitation of the pilot-in-command.

After a daily inspection had been completed, the aircraft departed from Tennant Creek at 0630 hours local time and reached the survey area an hour later. The aircraft commenced survey operations, but at 0750 hours the Doppler equipment became unserviceable, and at 0800 hours, after light rain had been encountered the survey work had to be abandoned. Ten minutes later, the aircraft advised Tennant Creek that it was returning and that its estimated time of arrival was 0910 hours.

At 0907 hours, the aircraft reported 10 miles south of Tennant Creek and the aerodrome weather was passed to the aircraft. At 0914 hours, the aircraft reported that it was in the circuit area and requested the present wind velocity. The Flight Service Officer advised the aircraft that the wind was 070 degrees at 14 knots, and the aircraft acknowledged the transmission.

The aircraft did not call again and although the Flight Service Officer knew it had not landed, he also knew that on several previous occasions when the aircraft had returned with unserviceable equipment, the crew had carried out lengthy equipment checks before landing. At 0952 hours however, the aerodrome refuelling agent walked into the Flight Service Office and asked what had become of the Hudson, mentioning that he had seen it in the circuit more than half an hour before with the undercarriage down. The refuelling agent said the aircraft had been to the north of the airport, heading west with the undercarriage lowered, as though on a downwind leg for a landing on runway 07.

The aircraft's SARTIME was not due to expire for more than two and a half hours, but the Flight Service Officer, disturbed at the refuelling agent's information, immediately began calling the aircraft and when it failed to reply, declared the Uncertainty Phase. Further attempts were then made to contact the aircraft from both Tennant Creek and adjacent Flight Service Units, but without success. At 1014 hours, the Alert Phase was declared, and attempts were made to obtain aircraft sighting reports from the surrounding area. The airport area was checked from the ground and the pilot of a Cessna aircraft based at Tennant Creek, was requested to carry out an aerial search of the surrounding area. At 1043 hours, the Distress Phase was introduced. Some ten minutes later, the pilot of the Cessna sighted the wreckage of the Hudson two miles west of the threshold of runway 07.

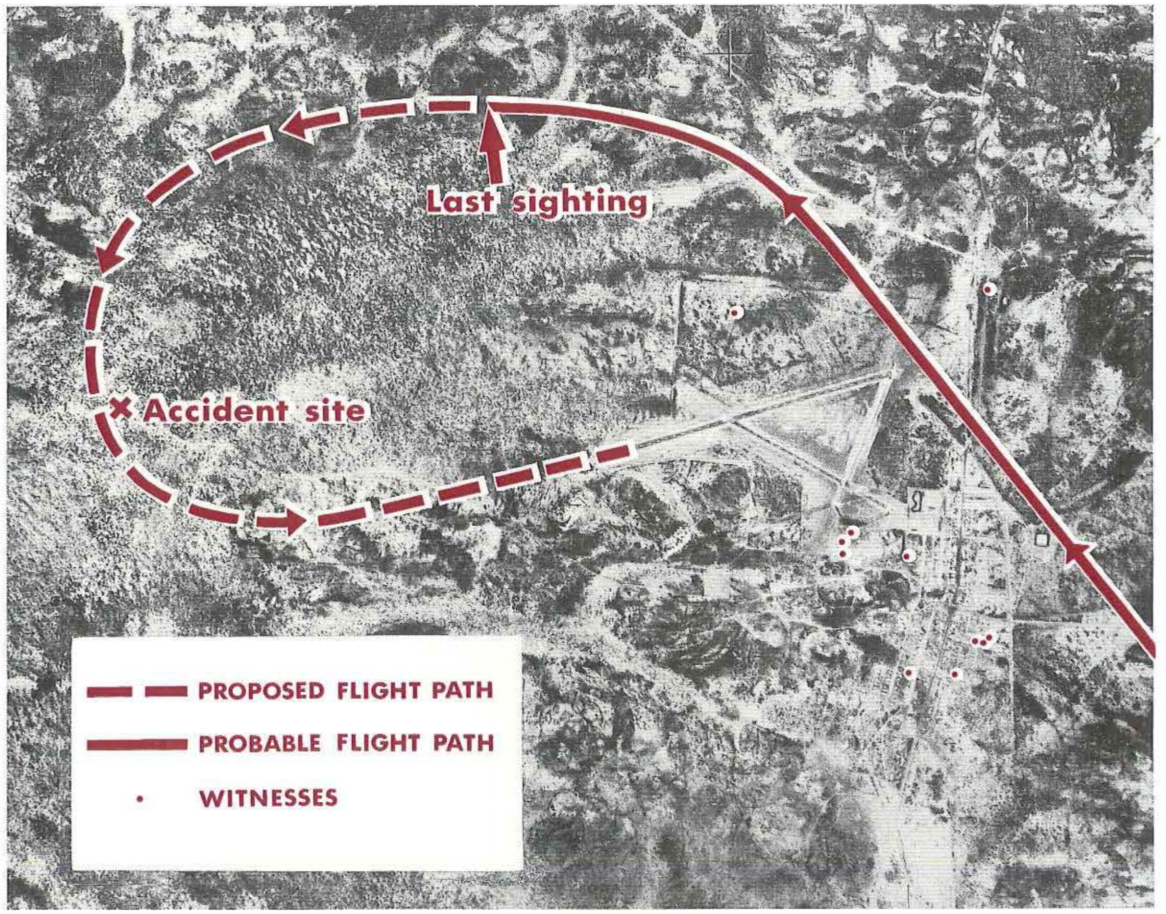
Investigation

The area in which the crash occurred is relatively flat, lightly timbered country, but the crash site itself is screened from the town by low hills. The weather conditions at the time of the accident were fine and warm with a visibility of 20 miles, the wind was 080 degrees at 10 knots, and there was 1/8th of cloud at 10,000 feet.

The aircraft appeared to have struck the ground at low forward speed and all major components of the aircraft were found in the area of impact. There was no evidence of any structural failure, fire or explosion which could have affected the structural integrity of the aircraft in flight. It was established that the undercarriage was lowered and the flaps were retracted at the time of impact. The possibility of an asymmetric flap condition was investigated very thoroughly, but rejected. Both propellers had been rotating at impact, but neither engine appeared to have been delivering significant power. Examination of the engines themselves showed that they had been capable of normal operation up to the time of impact. All four fuel tanks had burst open at impact and their contents spilt, but examination of the fuel system revealed nothing to suggest that fuel would not have been available to the engines. The engine magneto switches were on, selected to the "Both" position. Although the master ignition push-pull switch was on, it was not possible to determine if the switch was in fact in this position at impact. Because of the extensive damage and possible movement at impact, the positions of the throttle mixture and pitch controls could not be established, but the firewall shut-off lever for the starboard engine was in the closed position, and it was evident that it had been moved to this position before impact. This indicated that although the engines were capable of normal operation, some action might have been taken to shut them down immediately before impact.

Because on survey flights, it was necessary for the crew to have access to the nose compartment of the aircraft, neither the co-pilot's seat nor the co-pilot's rudder pedals were installed, and the second pilot was on board the aircraft primarily to observe the operation. The co-pilot's control column was installed however, and some limited control of the aircraft with aileron and elevator, would have been possible by standing or squatting in the co-pilot position.

The most significant finding to emerge from the examination of the wreckage was that one of the duplicated aileron control chains in the pilot's control column was broken in the region of the control wheel sprocket. The breakage had occurred when a link pin of the chain had failed, and there was evidence that the broken link pin could have subsequently jammed the assembly as the control wheel was being rotated. Following further extensive examination and laboratory testing, it was concluded that the failure of the chain and the associated damage to the control column assembly, were not consistent with impact damage, but the investigation could not positively establish



Aerial photograph of Tennant Creek area, showing township, aerodrome, final flight path and accident site.

when the failure had occurred, or what was the sequence of events which led to the separation of the chain. Measurements of the possible control restriction which could have resulted from the failure of the chain showed that fouling could have occurred in two positions, at 17 and 12 degrees from neutral, as the control wheel was being returned from a port-wing-down movement. A flight test in another Hudson was arranged to check the effect that jamming of the controls in these positions would have produced, but it was found that control of the aircraft could be maintained comparatively easily with rudder and elevator.

A load sheet had been completed and signed by the pilot-in-command before the commencement of the flight. Although this sheet contained a number of errors and the aircraft was overloaded to some extent at the time of take-off, the position of the centre of gravity was well within its limits of allowable travel, and it was clear that the load condition of the aircraft had had no bearing on the accident.

There were no witnesses to the accident itself, nor could any be located who had seen or heard the aircraft flying other than normally. A number of witnesses saw the aircraft shortly before the accident and it was evident that, after approaching Tennant Creek from the south-east, the aircraft had passed over the eastern side of the aerodrome at 1,500 feet, lowered the undercarriage, and made a descending turn to the north of the aerodrome to enter a downwind leg for a normal left hand circuit and landing on runway 07. The crash site was consistent with a position on base leg, shortly before the aircraft would have turned on to final approach. From evidence obtained from various sources, it was concluded that the aircraft had crashed at 0918 hours local time.

Inquiries into the medical history of the pilot-in-command, showed that he had been intermittently in poor health throughout the nine months preceding the accident, and that on several flights some four or five months before the accident, he had suffered symptoms which included restriction of vision and vertigo. Following these occurrences, he had undergone a medical investigation but no diagnosis was reached and he was regarded by the medical specialist who examined him as fit to fly.

Further inquiries revealed that on one occassion six years previously, while the pilot was carrying out a survey flight from Mackay, Queensland, he had told his crew that he was feeling ill and was going to return to Mackay. The navigator had hurried to the cockpit to find the pilot looking very pale and slumped in his seat, and although not a pilot himself, he had taken over control of the aircraft for several minutes until the pilot recovered sufficiently to descend and land. It is believed that the pilot subsequently consulted a doctor in Mackay, and that his complaint was diagnosed as malaria, but this information could not be positively confirmed. Details of this occurrence were not reported to the Department as an air safety incident, nor did the pilot disclose the episode at his next medical examination for the renewal of his licence.

It was found also that, during the month preceding the accident at Tennant Creek, the pilot had experienced headaches, shivering and vomiting and had said that he thought it was a recurrence of the malaria. The pilot had twice consulted a doctor locally but no definite diagnosis had been made, and he had continued to fly in command of the aircraft. The pilot appeared to be in normal health before departing on the flight which ended in the accident.

Analysis

The investigation established that the aircraft had entered the traffic pattern at Tennant Creek for a normal landing in good weather conditions, that the undercarriage had been extended, and that a loss of control then occurred because of something that happened between the time the aircraft entered the downwind leg and when it would have turned on to final approach. The aircraft had subsequently struck the ground in a stalled condition. The normal pre-landing checks were being carried out at the time control was lost and there was evidence that the procedures were interrupted at a point immediately before the first flap extension was made.

Aerial view of the wreckage. The initial point of impact is at the extreme left of the picture.

The pilot was experienced both in general flying and on Hudson aircraft and with him in the aircraft was another pilot who had recently been endorsed on the type and who, it would be reasonable to assume, would be taking a critical interest in the handling of the aircraft.

Although the investigation failed to bring to light any one item which, in itself, suggests a reason for the loss of control, it nevertheless revealed two independent, anomalous situations, which must be considered as possible factors in the sequence of events that led to the loss of control.

Firstly, it was found that one of the duplicated aileron control chains in the pilot's control column assembly had broken and there was evidence that it had temporarily jammed. The damage was believed to be inconsistent with impact damage and consideration was therefore given to the effect of such a situation occurring in flight. Flight and ground tests conducted to simulate such sudden jamming, showed that although the pilot would be temporarily deprived of aileron control, the aircraft could still be controlled to maintain level flight with the elevator and rudder controls alone. The tests could not however, simulate the element of surprise. Similarly, it was not possible to test the reaction of a pilot to circumstances in which he would not only be required to control the aircraft, while it was turning to the left, probably at low airspeed, but would also be required to try and overcome the restriction by exerting considerable force on the control wheel. It was found that the physical force required to free the aileron controls in such a situation, would be well within the capacity of one person. While it could not be conclusively established what overall effect the total situation would have on the control of the aircraft, the test results showed that the very least effect would be a gross distraction of the pilot from his task.

Secondly, the investigation established that the pilot had been intermittently in poor health during the nine months preceding the accident, and that although he had undergone a medical investigation some three months before the accident, no diagnosis was reached. The investigation also established that periods during which the pilot had been ill, could be linked with occurrences in which he had suffered restriction of vision and vertigo in flight. In view of this association, and the fact that the pilot had again been ill in the month before the accident, it was possible that he had suffered a similar experience during the flight that had ended in the accident. On this flight however, such an event in itself should not necessarily have led to an accident, for the other pilot on board the aircraft should have been able to change places with the captain, unless the onset of his symptoms was very rapid and accompanied by a severe deterioration in ability. But even if the pilot-in-command had become incapacitated very suddenly in the control seat, the other pilot should have been able to maintain control of the aircraft despite the limited co-pilot controls, and to discontinue the landing approach, unless this had reached a very critical stage. The position of the wreckage in relation to the duty runway, and the fact that the flaps had not been extended, suggests that the approach had not reached a very critical stage, and that there should have been more than adequate height available to allow the second pilot to safely take over control.

If it had so happened however, that the aileron controls had jammed in the manner discussed after the aircraft entered the traffic pattern of the aerodrome and the captain had become partly or fully incapacitated at about the same time, it is most unlikely that safe control of the aircraft could have been maintained from the co-pilot position. Indeed, in such an unfortunate and unusual combination of circumstances, a complete loss of control could easily have resulted. In the circumstances of this accident, remote though the chances may seem, the possibility that such a coincidence of the two factors did occur, is one which cannot be disregarded.

Cause

The cause of this accident was a loss of control of the aircraft, and although the evidence available does not permit the reason for the loss of control to be determined, the possibility cannot be eliminated that the pilot suffered an impairment of ability and, coincidentally, was deprived temporarily of aileron control.

DIFFICULTY IN FEATHERING

A DC-3 was making a night flight from Launceston to Melbourne carrying freight. The aircraft was cruising at 9,000 feet in clear air and the outside air temperature was minus 20 degrees C. Thirty minutes after reaching the top of climb, the crew felt a slight thump in the cockpit. There was no indication of any malfunction and the engine instruments continued to indicate normally, but a short time later a smell of burning came from the heating system. The first officer then saw a shower of sparks coming from the lower section of the starboard engine and the captain immediately began the shut down procedure for that engine. The shower of sparks ceased when the captain closed the throttle, but when he pressed the propeller feathering button, the engine RPM only decreased to about 500. At this speed the feathering button popped out and the RPM increased again to about 1,200. The captain tried several times more to feather the propeller, but on each occasion the result was the same.

By this time the aircraft was entering an area of built-up cloud with tops at about 10,500 feet. The captain adjusted the power on the port engine to 35 inches of manifold pressure and 2,250 RPM, with 15 degrees of carburettor heat, and reduced the airspeed to about 100 knots. Losing height at about 200 feet per minute, the aircraft then entered cloud and encountered icing and turbulence almost immediately. Melbourne air traffic control was kept advised of the situation and the aircraft was cleared for a slow descent to 6,000 feet. During the next 30 minutes, the captain tried a number of times to feather the engine, but each time the RPM would only decrease to approximately 500 before the button would pop out again, and the RPM would return to approximately 1,200. Because the fire in the engine appeared to be out, the captain decided not to close the firewall shut off valve, thus permitting the oil system to continue lubricating the windmilling engine.

The aircraft's rate of descent fluctuated while it was descending in cloud, increasing at times to as much as 500 feet per minute because of turbulence. The crew requested a further descent to 3,000 feet and the aircraft finally broke out of cloud at 3,500 feet. Once in the clear, the aircraft began to shed the ice that it had accumulated, and at about 3,000 feet the captain again tried to feather the starboard propeller. This time the propeller feathered normally. With the starboard propeller feathered, the crew experienced no further trouble in maintaining 3,000 feet for the remainder of the flight to Melbourne, and the aircraft made an uneventful landing.

The captain said later that before taking off, the aircraft had been on the ground at Launceston about one hour only. During the pre-take-off check, the engines had been run up to 2,400 RPM for a magneto check, but the propellers had not been exercised. It was the Company's practice to make a full engine run-up on the initial start for the day but, at the captain's discretion, only magneto checks were made at intermediate stops during the day's flying. At Launceston on this occasion, the captain said the oil temperature had risen quickly to 40 degrees C while the aircraft was taxi-ing out, and he had not considered a full run-up necessary. The starboard engine oil temperature was indicating 70 degrees C just before the engine trouble developed.

Giving an account of what happened after the engine trouble developed, the captain said he had closed the throttle, pressed the feathering button and moved the pitch control lever to coarse and the mixture lever to idle cut-off. At this stage, he noticed that the engine RPM was increasing again to 1,200. He continued with the engine shut-down procedure, turning off the ignition and the fuel, then again pressed the feathering button. The button stayed in until the RPM dropped to between 500 to 600, then it popped out and the RPM increased again. It was about this time that the aircraft entered cloud and the cockpit windows iced up almost immediately. Turbulence and a hail storm followed, and for a short period the captain was wholly occupied in controlling the aircraft. After this he pressed the feathering button again and held it in for about 10 seconds, but when he removed his finger it popped out once more. Before removing his finger, the captain said, he felt the pressure from the button, but he was able to hold it in quite easily. The RPM was indicating between 500 and 600 when he first felt the button exerting pressure on his finger, and during the next two to three seconds while he was still holding the button in, the RPM began to increase again. He had repeated this procedure about three times with the same result but he had not held the button in for any longer than 10 seconds. He had not changed the mixture, ignition or pitch control settings from the time the engine was first closed down. During the descent, he experimented on one occasion by opening the throttle and then pressing the feathering button, but the result was exactly the same as before. When he had opened the throttle, the manifold pressure indication increased from about 10 inches to 30 inches. The air speed was about 100 to 105 knots at this time. When the aircraft had broken out of cloud at 3,500 feet, the captain said, he had allowed the descent to continue to 3,000 feet and the ice the aircraft had accumulated started to melt. Just before reaching 3,000 feet, he had pressed the feathering button once more and this time the propeller had feathered. He had not moved any of the engine or propeller controls before doing so and he had pushed the button for only a short period.

Asked why he had only set 2,250 RPM on the port engine after the starboard engine was shut down, the captain explained that he had not used a higher power setting at this stage, because the icing conditions they were encountering obviously made a descent necessary. The all-up weight of the aircraft at the time was 22,000 lbs., considerably below the maximum all up weight, and the power he had set was sufficient to meet these requirements.

* * *

When the starboard engine was inspected after the aircraft had arrived at Melbourne, the No. 7 cylinder was found to be cracked in the vicinity of the cylinder shrinkage band. The indications of fire seen by the crew had evidently been caused by combustion gases escaping through the crack and "torching". There was no evidence of any sustained fire having developed in flight. It was apparent that age and fatigue had contributed to the cylinder failure.

Because of the difficulty the crew had experienced in feathering, a detailed examination of the propeller and its associated components was carried out. For this purpose the propeller dome assembly and distributor valve were removed from the aircraft, inspected and placed on a test bench rig. The inspections and tests failed to reveal any fault which could have prevented normal feathering action taking place, and the operation of all components was found to be satisfactory.

A further study of technical data on the operation of the propeller was then undertaken and a reference to feathering difficulties at low temperatures was found in the Hamilton Standard Propeller Service Manual which appeared to be very relevant to the situation experienced during the flight. The particular reference reads:

> (*e*) Due to viscous oil in the propeller system at low temperatures, difficulty may be encountered with the pressure at the cut-out switch reaching the operating pressure of the switch before the propeller reaches the fully feathered position. This causes the feathering switch to release prematurely. If this condition is encountered, the feathering switch should be depressed each time it releases. The switch should not be held in continuously as the pressure may then build up sufficiently to shift the distributor valve and cause the propeller to start to unfeather before reaching the feathered position.

As a result of further study and consultation with the oil company responsible for servicing the aircraft, it was considered likely that, at the very low temperatures the aircraft had encountered in cruising flight, which were below the "pour point" of the engine oil, the circulation of the oil in the propeller dome would not have been sufficient to prevent wax forming in the forward portion of the dome. It was thought that waxing of the oil in the dome might well have been the cause of the difficulty in feathering.

The validity of this theory was checked during a later test flight in the aircraft. At 10,000 feet, with an outside temperature of minus 15 degrees C., an attempt was made to feather the port engine. The throttle was closed, the mixture moved to the idle cut off position and, with the pitch control lever left in the cruising range, the feathering button was pressed. The RPM indication dropped to about 800, then the button popped out and the RPM increased again. It was found that neither holding the button in nor pressing it each time it popped out, had any effect in reducing the RPM below 800. The feathering button was then released, and the RPM was permitted to return to the cruising range. After a few moments, the feathering button was pressed again and this time the engine feathered perfectly. The same procedure was tried on the starboard engine with similar results.

The test thus supported the belief that the difficulty in feathering the starboard propeller when the engine trouble was encountered, was caused by oil wax which had formed in the propeller dome, and that when the feathering cam reached the feathering range, the feathering pump was unable to cope with the load. Exactly the same situation existed during the low temperature feathering tests, but because the propeller was allowed to return to the constant speed range in between the attempts to feather, a considerable amount of hot oil would have been circulated through the propeller dome and would have melted the wax. This permitted the propeller to feather normally the next time the feathering button was pressed.

At the time of the incident however, the operator's feathering procedure used by the pilot, which provides for the pitch control to be moved to the full coarse position before the propeller is feathered, would have prevented the propeller returning to the constant speed range when the button popped out. This in turn, would have prevented hot oil being flushed through the propeller dome in any large quantities. Had the pilot involved in the incident cycled the pitch control, instead of operating the throttle when he encountered difficulty in feathering, he would undoubtedly have achieved feathering action much sooner. As in the test flight, the cycling of the pitch control would have broken down any wax in the propeller dome by pumping in warmer oil and the less viscous oil in the dome would have permitted normal feathering action to take place when the pilot again pressed the feathering button.

It was nevertheless agreed, that feathering difficulties caused by oil waxing in propeller domes at low temperatures, should not present a significant hazard to aircraft operating in Australia because such temperatures are not encountered at low altitudes in Australian conditions. At altitudes high enough for these temperatures there should normally be ample time to exercise the propeller before feathering. Even if for some reason, the propeller cannot be exercised, the increase in outside air temperature as altitude is lost, would usually be sufficient to melt any wax in the dome and so enable feathering to be accomplished normally, as occurred in this particular incident.

The real lesson of the incident is that it is good practice for crews to cycle the propeller pitch controls during pre-take-off checks, after even short stop-over periods at intermediate ports, whenever low outside air temperature conditions are to be expected in flight.

Theory becomes Fact . . . Helicopter Wrecked

"Overpitching — a condition resulting from an extreme angle of attack on the main rotor blades (induced by excessive collective pitch or violent manoeuvres) which has created a drag so great that the engine power being utilized is insufficient to maintain normal RPM."

While making a climbing turn in translational flight, shortly after taking off from a paddock in the Konnongorring district of Western Australia, a Bell 47-G2 suddenly began to lose height. The pilot saw that both engine and main rotor RPM were decreasing, but despite some attempt at remedial action, he was unable to prevent the helicopter striking the ground heavily. The helicopter was extensively damaged, although both pilot and passenger escaped without injury.

At the time of the accident, the helicopter was being ferried from Perth to Mt. Newman, via Meekatharra. A licensed aircraft maintenance engineer, employed by the operating company, was accompanying the pilot in the helicopter, which had just undergone a 100 hourly inspection at Perth. The inspection, which had been completed the previous day, was followed by a satisfactory test flight.

Before its departure from Perth on the first stage of the ferry flight, the helicopter was refuelled to capacity and an additional 32 gallons of fuel contained in eight jerricans was loaded aboard the aircraft. The helicopter took off from Perth soon after 0700 local time and two hours later the pilot landed in a paddock near Konnongorring so that he and the engineer could top up the fuel tanks from the fuel reserve carried in the jerricans. After the refuelling was completed, during which a funnel and chamois filter were used, the tanks were checked for water. Shortly before 1000 hours, the pilot started the engine and, after a normal pre-take-off engine and control check, the helicopter took off on the second leg of the ferry flight.

The take-off itself, which was made into a light north-easterly wind, proceeded normally and the pilot made a turn to the left to take up a northerly heading, at the same time climbing the helicopter steeply to clear a telephone line which borders the northern boundary of the paddock. As the helicopter passed over the wires, the engine and rotor RPM began to decay and the aircraft lost height. The respective RPM needles remained synchronised on the instrument, indicating that there was no clutch slippage, and with the throttle fully open, the pilot decreased collective pitch to try and regain engine and rotor speed. The engine did not seem to respond however, and the aircraft lost height more rapidly. Seeing that a forced landing was inevitable, the pilot then closed the throttle and increased collective pitch again. At the reduced RPM to which the rotor speed had decayed, the change in collective pitch had little effect in cushioning the helicopter's descent and it struck the ground tail first with little forward speed. The force of the impact caused the retreating main rotor blade to strike the tail boom, severing both these components. The helicopter then slewed violently to the left, collapsing the starboard skid and splitting open the perspex cockpit bubble.

A detailed examination of the damaged helicopter revealed no evidence of any malfunction which could have contributed to the accident. The engine had run only a little over 200 hours since overhaul and was found to be in good condition. Calculations revealed however, that because of the additional fuel being carried, the aircraft would have been 264 lbs. above its maximum permissible weight at the time of its take-off from Perth, and that even after the refuelling had been carried out at Konnongorring, it was still 63 lbs. in excess of its maximum permissible weight of 2,450 lbs. There was no evidence that the aircraft's loaded weight had been calculated before departing from Perth, and both the pilot and engineer admitted that they knew that the helicopter was overloaded to some extent.

The weather at the time of the accident was overcast and showery with eight eighths of cumulus and strato-cumulus cloud at 2,500 feet. Visibility was reduced to 2-5 miles in drizzle, and the surface temperature was 18 degrees C. In view of these conditions, consideration was given to the possibility that carburettor ice had affected the power output of the engine at the time of take-off, but after obtaining statements from both the pilot and the engineer, who said that the engine indications, up to the time of the reduction in RPM, were normal at 3,000 RPM with 24 inches of manifold pressure, the possibility was rejected.

In the absence or any other reason for the loss of engine and rotor RPM, it was considered probable that this condition had been brought about through overpitching of the main rotor blades while the helicopter was turning and climbing above the telephone line. This in turn had slowed the main rotor and engine causing the helicopter to lose height, and making a forced landing inevitable.

The pilot's action in closing the throttle during the final stages of the descent undoubtedly contributed to the heaviness of the touch-down, as any engine assistance in this situation would have been preferable to none. Furthermore, his selection of 3,000 engine RPM in the first place, instead of the 3,100 RPM recommended for this type of helicopter, coupled with the aircraft's excessive gross weight, probably contributed to the onset of the overpitching condition. The 100 engine RPM which the pilot "gave away", meant a rotor speed loss of 17 RPM or five per cent of that available.

As this accident demonstrates all too well, overpitching is a potentially hazardous condition and pilots should be particularly alert to its dangers when operating under any of the following conditions:

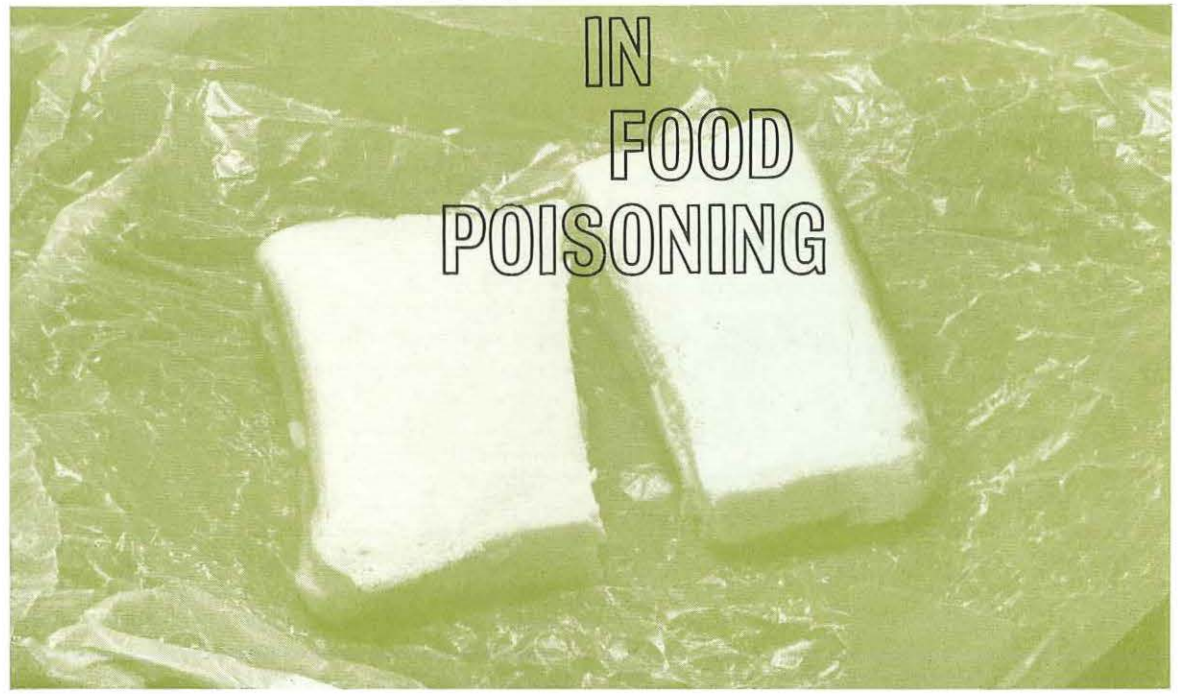
- **High gross weight**
- **High density altitude**
- **Low airspeed and RPM with high power utilisation**
- **High "G" loading manoeuvres**

If the situation is to be saved when overpitching occurs, it is most important that remedial action be taken at its very first indication. The procedure to be followed to restore engine and rotor RPM will of course, vary with the situation in which the helicopter is placed. If there are no immediate obstacles in the flight path, collective pitch should be judiciously reduced ("milked", as this action is known) simultaneously with the throttle being opened to maximum power, taking care of course, that the engine manifold pressure limitations are not exceeded. At the same time if the airspeed is sufficient, the helicopter should be flared slightly to maintain altitude and to assist in increasing rotor RPM.

On the other hand, if the helicopter is being flown in a situation where there are obstacles immediately ahead, such as in agricultural spraying operations or a take-off or landing over obstructions, the maximum flare permitted by the flight conditions should be adopted immediately, full power applied and the collective pitch should be "milked" momentarily. If this action fails to restore the engine and rotor RPM, there is no alternative but to abandon the flight and make the best landing possible in the circumstances— and overpitching will have claimed another victim!

No doubt most helicopter pilots already know something about the dangers of overpitching — most likely from what they learned during their early training. But how many are competent to deal with the situation when theory becomes fact?

THERE'S DANGER IN FOOD POISONING



THE crew of a DC-4 freighter were making a night flight, Melbourne-Hobart-Launceston-Melbourne in the small hours of the morning.

Departing from Essendon at 0230 hours, the first leg of the flight proceeded uneventfully and the aircraft touched down at Hobart at 0450. While the freighter was being unloaded, the captain and the first officer made themselves comfortable in the operations room, and proceeded to toast some sandwiches they had brought with them from Melbourne. The sandwiches each consisted of three slices of bread and contained meat and cheese. The first-officer had a whole sandwich but the captain ate only half of one of the sandwiches.

An hour later, when the aircraft was ready for departure again, neither pilot was feeling very well, but they continued with their flight schedule and took off from Hobart for Launceston at 0615 hours. Not long after they arrived at Launceston at 0640 hours however, the first-officer suddenly became very ill with acute diarrhoea and vomiting and was near a state of collapse. He recovered slightly a little later, but was quite unfit to resume duty, so arrangements were made for him to be taken as a passenger on an aircraft which was returning to Melbourne via Hobart. The first-officer's condition deteriorated again during the flight and he was so ill by the time the aircraft reached Hobart that it was necessary to admit him to hospital where he was detained for the next two days. On being discharged from hospital he was able to return home to Melbourne, but was not fit to resume duty for another five days. Investigation of the reason for the first-officer's sudden illness disclosed that the sandwich he had eaten at Hobart, had been prepared in Melbourne some 12 hours before. Bacteriological analysis of the remnants of the sandwich meat revealed the presence of staphylococcus microbes.

Food poisoning of this type is not only very unpleasant, but when it occurs to a member of the crew of an aircraft in flight, it can obviously pose a threat to the safety of the aircraft and its occupants.

Two points of significance emerge from this incident:—

- The food had been prepared 12 hours before being eaten and had been kept at an unsuitable temperature.
- The crew of the aircraft were unwise to continue the flight when they were not feeling well. Had both members of the crew become ill before they reached Launceston (as could easily have happened since they both ate the same food), the safety of the aircraft would certainly have been in jeopardy. It was fortuitous that the leg being flown on this occasion was a very short one and that the crew were on the ground again before the symptoms had fully developed.

As well as this, quite apart from the food poisoning aspect of the incident, it may well be asked if a stale sandwich toasted in the operations room, constitutes a suitable breakfast for the crew of an aircraft engaged on a scheduled night flight!

From the point of view of flying safety, the staphylococcal poisoning which the first-officer experienced in this incident, is probably the most serious type of food contamination. The reason for this is that staphylococcal poisoning can develop so rapidly, and although its full effects do not usually last long, they can be absolutely incapacitating. Symptoms of staphylococcal food poisoning may begin to appear an hour or two after contaminated food has been eaten and can occur in various combinations of nausea, faintness, vomiting, headache, abdominal cramps and diarrhoea. The victim may suffer severe collapse and prostration, but recovery when it begins, is usually quite rapid. There are other types of food poisoning caused by different bacteria, but the onset of their symptoms is usually much slower and less precipitate.

The staphylococcus microbe abounds in nature. It is present in the air and can be found in the nasal passages of one in two healthy people. It can be grown from the nasal and throat discharges of persons suffering from colds, it is present on the hands, and is often the cause of cuts, abrasions and burns becoming infected. It is also the cause of infectious skin diseases such as impetigo. The staphylococcus bacteria produce a toxin or poisonous substance and it is this toxin which can be the cause of food poisoning. In food that is contaminated with staphylococci from a human source, and then kept at room temperature for several hours, the bacteria will multiply and produce the toxin. At temperatures under 65 degrees F however, the production of toxin is almost negligible.

The production of the toxin is thus dependent on staphylococcal contamination of a suitable food medium, and the food then being kept for a period at a temperature conducive to the breeding of the bacteria. The toxin is extremely resistant and can withstand boiling for as long as 1½ hours and freezing at zero degrees F for as long as nine months.

The staphylococcus bacteria and its toxin does not alter the appearance, odour or taste of food. Foods most likely to support a prolific bacterial growth of staphylococci are pies, brawn, meats, (especially ham and beef), sausages, poultry, milk, cream, cheeses and custards. Because of the high resistance of the staphylococcus microbe and its toxin to cold, deep frozen foods are no guarantee against staphylococcal food poisoning. Unless the temperature of deep frozen food is brought up to about room temperature before being cooked, the normal cooking time may not be enough to raise the temperature in the centre of the food sufficiently to cook the food adequately, or to kill bacteria that may have been introduced while the food was being prepared. The effect can be quite the contrary, the temperature rise being just what is needed to stimulate the growth of the bacteria and the production of the toxin!

A case occurred recently where passengers on two different aircraft of the same airline suffered from food poisoning on the same day. The two flights had a common menu and the food had been prepared in the same kitchen. Investigation revealed that some samples of roast turkey which had been served on the flights, contained a profuse growth of staphylococcus. The turkey, which was a very large bird, had been supplied to the kitchen deep frozen. It is likely that the toxin

was formed before the turkey was deep frozen, and that because of its size, the turkey had not completely thawed out before cooking. The cooking time and temperature were thus insufficient to destroy the toxin in the deeper layers of the meat.

To reduce the risk of food poisoning, food must be cooked thoroughly and as close to the time of consumption as feasible. Heat penetrates slowly into foods such as joints and pies, and adequate cooking times should be allowed for the central portions to reach and exceed boiling point. For example, a large pie weighing between 5 and 7 lbs., needs to be cooked for 2 to 3 hours at 350 to 400 degrees F for the centre to reach 212 degrees. To be really safe, a "meat thermometer" should be used to ensure that the temperature in the centre of the food rises sufficiently.

Roasting temperatures are generally high enough to ensure that well roasted joints are sterile when they leave the oven, but the chance of contamination after cooking still remains. Indeed in most cases, where food poisoning has resulted from eating cold meat, it has been found that the contamination has occurred while the meat was being kept under unsuitable conditions after cooking. If it is not possible to cook meat on the day it is to be eaten, it should be thoroughly cooked, cooled rapidly and refrigerated overnight. The thorough cooking should destroy any staphylococcus bacteria present before any toxin can be formed. Stewed or boiled meats, as well as milk foods, should always be freshly prepared unless they can be refrigerated. Where foods are to be kept hot for serving after being cooked, a temperature high enough to inhibit the growth of the bacteria should be maintained. For this reason such foods should be kept at a temperature of at least 130 degrees F until they are served.

Pilots operating away from home, obviously have little control over hygiene in the kitchens in which the food supplied to them is prepared, or in the methods of food preparation employed at places where they buy it over the counter. It is nevertheless important for pilots to be conversant with the causes of food poisoning, the symptoms it produces and the hazard that it poses to safety in the air.

Previously, when this problem was discussed in the Digest (see "Pilots and Food Poisoning", Aviation Safety Digest No. 40, December, 1964) the danger seemed to be greatest where, to quote the words of our earlier article, "aircraft are operating from country or outback aerodromes and pilots have had to obtain an improvised meal away from reliable restaurants or other recognised catering establishments". Since that time it has been encouraging to find that there have been very few cases of food poisoning in remote areas. In more recent incidents however, city or airport catering organizations appear to have been the source of food poisoning, and in the light of these experiences, pilots who feel the onset of any of the symptoms of food poisoning, would be well advised to avoid exposing themselves to an attack in flight.

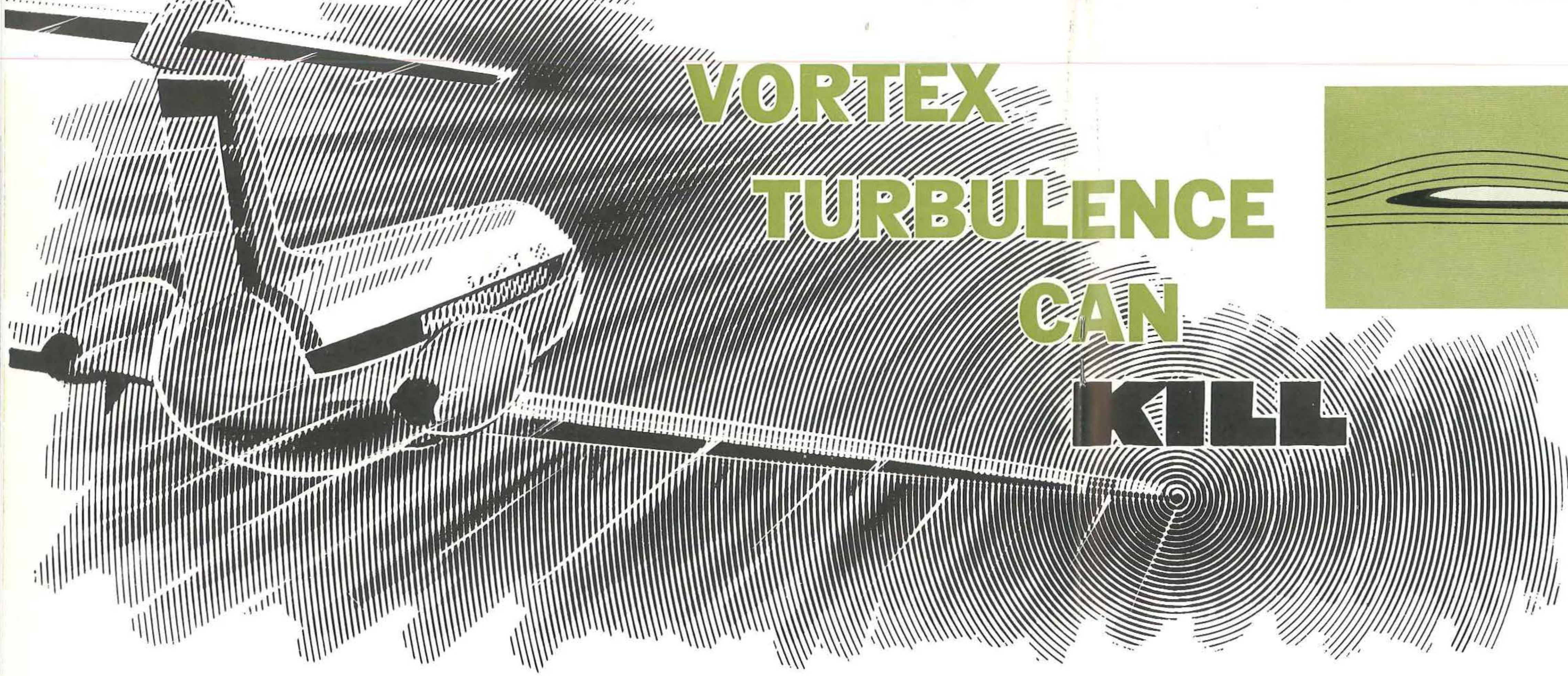
Exhaust Pipe Failure

Landing at Esperance, Western Australia, the pilot of a Cessna 182 reported there was an unusual exhaust noise and smell of exhaust gases in the cockpit.

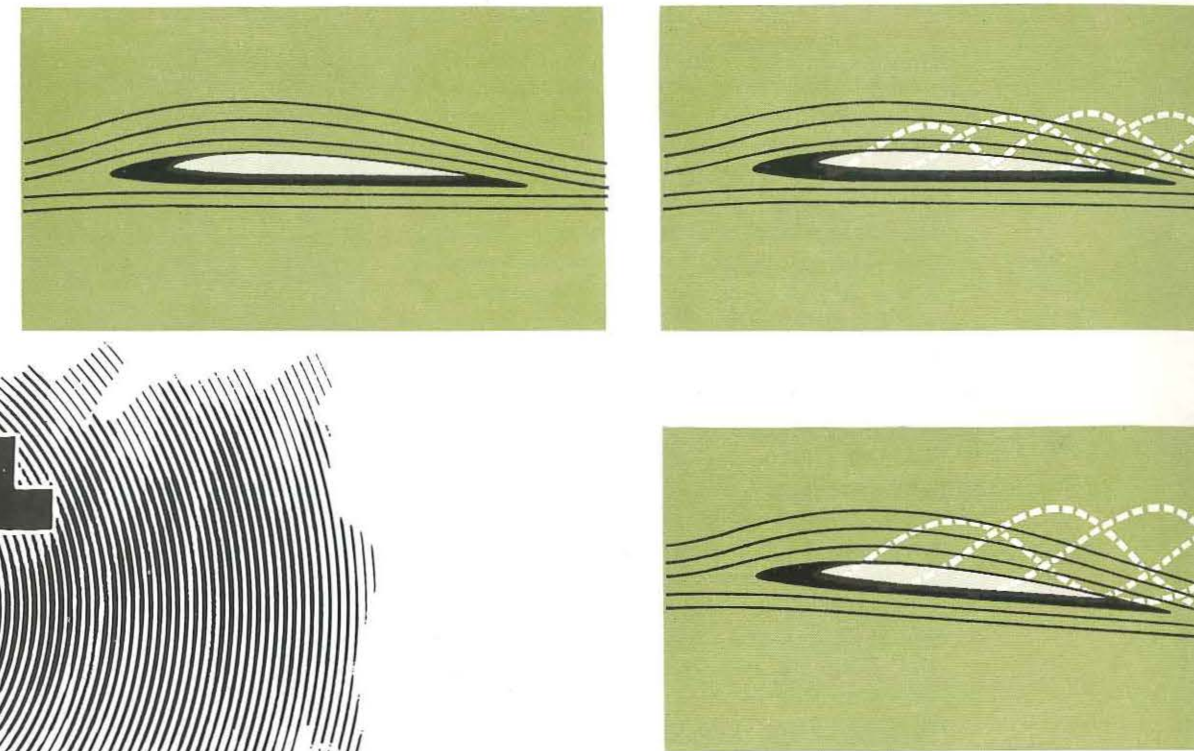
Inspection of the aircraft showed that the exhaust manifold had broken away at the inlet to the exhaust muffler, and that the metal of the exhaust pipe had been almost paper thin before the failure occurred. The defect was considered to have resulted from erosion of the exhaust pipe over a long period of service.

Another carbon monoxide poisoning accident going somewhere to happen?

(See "Cabin Heaters and Carbon Monoxide", Aviation Safety Digest No. 45, March, 1966.)



VORTEX TURBULENCE CAN KILL



IN our flying training days, perhaps especially for those of us who learnt to fly in Tiger Moths, one of the measures of a skilfully executed steep turn was the ability to strike one's own "slip stream" at the completion of a full 360 degree turn. In light training aeroplanes the effect of this encounter was little more than a sudden jolt which, though it might momentarily throw the aeroplane about, could be easily corrected with the controls. Inconsequential though its effects were, the sharpness of this "slip stream" and the suddenness with which it was met and passed, left no possible doubt of its identity — it was in fact quite unlike any other form of turbulence which we had experienced at that stage of our flying careers. As our flying training progressed, we probably experienced slip stream encounters in other phases of flight — at the completion of a loop while practicing aerobatics, or at odd times while learning to fly in formation.

Until comparatively recent years, these "slip stream" effects were generally attributed to the wash of the aircraft's propeller. With the advent of large multi-engined aircraft with high wing loadings however, it was found that by far the larger proportion of an aircraft's wake is produced by vortex turbulence, generated at the wing tips of the aircraft, as a side effect to the lift which the aircraft's wings are producing. These vortices are formed in flight, by air in the region of high pressure beneath the wings, spilling around the wing tips, into the region of low pressure which the aerofoil shape is producing above the surface of the wings. (See diagrams in title illustration). This motion, coupled with the forward movement of the aircraft through the air, creates a horizontal whirlwind-like movement of air funnelling back from each wing tip. The twin vortices induced in this way spin in opposite directions, (See figure 1) and are of relatively narrow diameter. They normally reach their greatest intensity at a distance behind the aircraft between two and four times its wing span, but remain very compact for very considerable distances behind. In calm conditions, the vortices can persist for up to three minutes after the aircraft has passed. As a result of their own motion, the vortices tend to settle below and behind the generating aircraft, but if the aircraft is close to the ground as in an approach to land, the vortices will reach the ground and tend to fan out laterally behind the aircraft. (See figure 3.)

Vortices generated behind the wing tips of large aircraft can be very powerful, especially when high lift devices are being employed. Their magnitude is in fact inversely proportional to the speed of the aircraft and directly proportional to the wing span loading. Thus the most powerful vortices will be generated by large heavily laden swept wing aircraft flying at low speed with all high lift devices extended, such as during an approach to land. This is the very situation in which a light aircraft is most likely to encounter the wake of a large aircraft.

The hazard which the wing tip vortices of large aircraft can obviously pose to light aircraft taking off or landing behind them, has not so far been a problem in Australia, but it is likely to become one now that numbers of light aircraft are using the primary airports of our capital cities. Indeed, if overseas experience is any guide, a great deal of caution will need to be exercised by pilots of these light aircraft if some of them are not to become victims of vortex turbulence. The following three accidents, all of which occurred in Canada in recent months, give some indication of the hazards for which we must be prepared:

- **On final approach to land at Vancouver, Canada, shortly after a large aircraft had landed, a Cessna 175 encountered an area of extreme turbulence and the pilot was unable to recover control. The aircraft's starboard wing struck a telephone line and the aircraft crashed to the ground. The pilot and passengers were seriously injured and the aircraft was substantially damaged.**

The Cessna had joined the downwind

leg of the circuit at about the same time as the larger aircraft was on final approach. The larger aircraft touched down while the Cessna was on base leg, and the Cessna then turned on to final three quarters of a mile out from the runway threshold. Evidently at fairly low altitude, the Cessna encountered the turbulence about half a mile out from the runway a minute and a half after the large aircraft had passed.

- A Cessna 172, being flown by a highly experienced pilot, was making an approach to land at Vancouver at the conclusion of a cross-country flight. While on base leg for a landing on Runway 08, the Cessna pilot heard a DC-6 requesting a clearance to take-off from the same runway. The Cessna pilot advised the Tower he would do a 360 degree turn to allow time for the DC-6 to depart, and on completing the turn, continued his approach towards the right hand side of the runway. When about twenty feet above the runway, during the final stages of its approach, the Cessna suddenly assumed a nose-high attitude and rolled more than 90 degrees to starboard. The pilot attempted to recover, but the aircraft struck the ground with the starboard wing, skidded about seventy feet and came to rest badly damaged. The occupants received minor injuries.

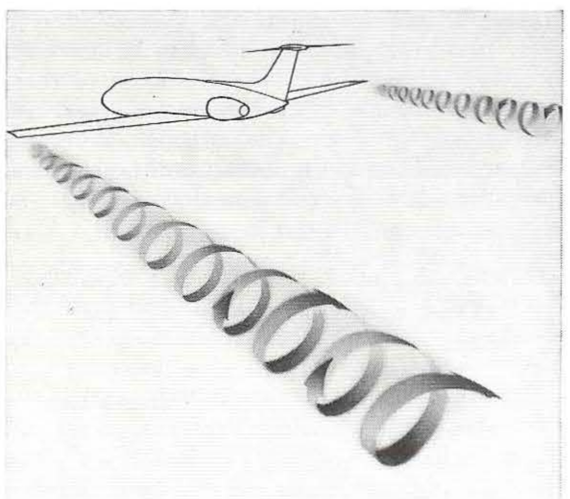


Fig. 1. Diagram showing direction of rotation of wing tip vortices generated behind an aircraft in flight.

The weather at the time was cool and cloudy and the wind was 090 degrees at eight knots. The pilot said later, that he was aware of possible turbulence caused by the departing DC-6, and had planned his approach to try and place his aircraft in the best possible position in the circumstances. As he was leveling out at about twenty feet above the runway, his aircraft suddenly assumed the steep nose up attitude and banked violently. He had immediately applied full power with forward stick and opposite aileron and rudder but this was insufficient to prevent the aircraft striking the ground.

- A Piper PA 15 was taking off from Runway 16 at Calgary Airport, Alberta, two minutes after a Viscount had departed from the same runway. A few seconds after the Piper became airborne, it banked very sharply to the left, the nose dropped and the aircraft struck the ground. The pilot was seriously injured and the aircraft substantially damaged.

The weather at the time was fine and the wind was from the south-south east at four to eight knots. Runway 16 is 12,000 feet long, but the Piper had commenced its take-off from a runway intersection 3,000 feet from the southern end of Runway 16. The point where the Piper had crashed was 1,500 feet from the beginning of its take-off run. The pilot said that before taking off, he had taxied his aircraft to the runway intersection to await his take-off clearance. He watched the Viscount taking off and it passed the runway intersection at a height of between 200 and 300 feet. He was then cleared for take-off and taxied his aircraft to the centre line of the runway and took off smoothly. At about 60 knots, when the aircraft was at about 50 feet, it rolled almost instantaneously to the left more than 90 degrees, and despite his attempts to regain control, struck the ground.

The tower controller who was watching the take-off, said that when the Piper was about 50 feet off the ground, it suddenly yawed to the left, the starboard wing lifted, and the aircraft turned through approximately two hundred degrees before striking the ground. At the time he had issued the take-off clearance to the Piper, the Viscount was nearly three miles beyond the far end of the runway. A further half minute would have elapsed before the Piper became airborne.

(Courtesy United States Forest Service)

Fig. 2. This photograph of an aircraft dusting trees with insecticide clearly shows the edges of the dust sheet being rolled into the wing tip vortices. Note how compactly the vortices persist behind the aircraft, before beginning to dissipate.

These three cases, with others that have occurred overseas from time to time, clearly demonstrate that the forces which can be encountered in the wake of a large, heavily laden aircraft, considerably exceed the control capability of light aircraft. Studies actually show that the core of a wing tip vortex rotates at a rate of about 80 degrees per second. This is about double the rate of roll that can be achieved by many light aircraft even with full aileron deflection. Similarly, the downdraught which a light aircraft would encounter if it entered the area between the centres of the twin vortex cores of a large jet aircraft, would exceed the light aircraft's climbing performance by several hundred feet per minute. But apart from any possibility of being able to counteract the effects of vortex turbulence, the sudden, violent aerodynamic loads, which such an encounter can impose on a light aircraft, coupled with the pilot's attempts to apply corrective control, can easily exceed the design strength of the airframe and result in structural failure. This has actually happened on several occasions in the United States, with fatal results to the occupants.

What then is the answer to this problem, to ensure complete safety for light aircraft sharing major airports with large airline aircraft? Clearly the only answer that can guarantee immunity from the danger, is for light aircraft to stay away from these airports altogether! Quite obviously however, this is not a practical solution, and some commonsense approach to the problem must be found which will reduce the risk of an encounter to an acceptable level.

Because of the large number of variables involved, it is not possible to set out inflexible rules, but when something of the behaviour and likely movement of wing tip vortices near the ground is known, it is possible to adopt precautions to suit a particular situation. As a general rule, because the vortices tend to settle towards the ground, a light aircraft which is obliged to operate behind a heavy aircraft, should try to remain above the flight path of the heavy aircraft, whether landing or taking off. The measures recommended in the following situations should serve as examples of the type of precautions which can be taken.

Taking Off:

Pilots of light aircraft taking off on a runway from which a large aircraft has just departed, should start their take-off run from the end of the runway so as to be airborne before reaching the point where the heavy aircraft lifted off. With a normal take-off and climb, this should place the light aircraft above the settling vortices of the heavy aircraft. Discretion should be exercised if there is a light crosswind component on the runway, or if the light aircraft is taking off from the grass parallel to the runway. In these conditions, the lateral movement of the settling vortices could place one of them in the path of the light aircraft. A light crosswind of the right order can in fact, cause a vortex to linger directly over the runway from which the generating aircraft took-off. (See Fig. 4). In the accident at Calgary, for instance, it is evident that just such a combination of circumstances existed at the time the Piper departed.

The pilot of a light aircraft, taking off in a direction which intersects a runway from which a heavy aircraft has just taken off, should ensure that his flight path is above the flight path of the larger aircraft. If the take-off is being made after a heavy aircraft has just landed however, the pilot should plan to become airborne *beyond* the point where the heavy aircraft touched down. A little thought will show that this is necessary to enable the light aircraft to clear the vortices generated by the landing aircraft.

Circuit Area Flying:

Pilots of light aircraft should avoid flying below and behind large aircraft in the circuit area. If possible, light aircraft should stay laterally separated from heavy aircraft by at least several hundred feet. On final approach, as already mentioned, light aircraft should assume an "above and behind" position to remain clear of the turbulence being generated by the preceding aircraft.

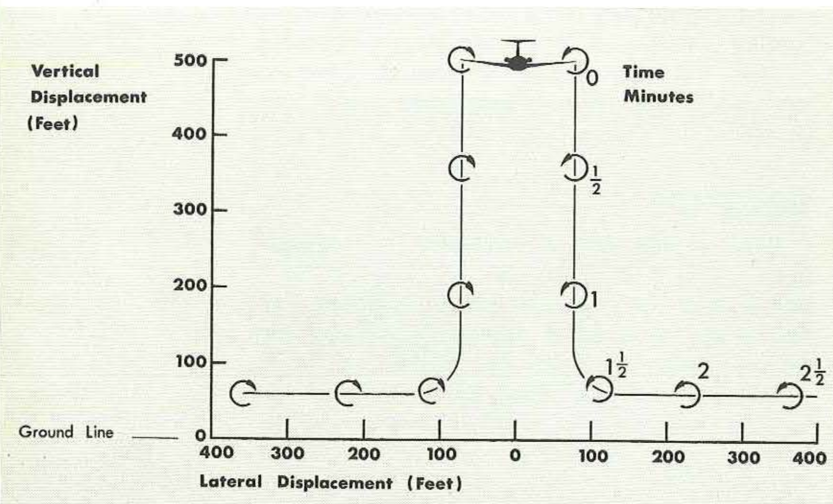


Fig. 3. Wing tip vortices tend to settle behind the generating aircraft, and to spread out laterally on reaching the ground. The graph shows the rate of sink and lateral movement which can be expected in calm conditions.

Landing:

Maintaining the same the "above and behind" position during final approach, should place the pilot of a light aircraft in a good position to touch down beyond the point where a preceding large aircraft has already landed. When a light aircraft is landing after a large aircraft has departed, the light aircraft pilot should aim to touch down well to the rear of the point where the larger aircraft has lifted off. This usually involves the light aircraft landing as near to the threshold of the runway as possible. In the case of the Cessna landing at Vancouver that encountered vortex turbulence just after the DC-6 had departed, marks on the runway indicated that the Cessna struck the runway no less than 4,000 feet in from the threshold.

Although vortex turbulence in the wake of large aircraft is without doubt the greater hazard, this is not to suggest that vortex turbulence generated by other light aircraft can be disregarded altogether. An accident occurred recently in the United States while two Piper Cubs were engaged in spraying a crop of wheat in clear, calm conditions. The pilot of the first aircraft had just completed swath runs to the north-east and south-west when the second aircraft took off to join in the operation. Towards the end of another run into the south-east, the pilot of the first aircraft saw the second aircraft to the left and ahead of him, slightly above his own. As he climbed off the crop to make a turn back on to a reciprocal flight path, the pilot saw the second aircraft suddenly roll sharply to the left then back to the right, and nose dive steeply into a pond. The pilot was very seriously injured and the aircraft was destroyed. The pilot had little recollection of what happened but said he thought he had encountered turbulence from the first aircraft. He had been able to correct the sudden roll to the left but not the roll to the right. The accident investigation attributed the pilot's loss of control to the aircraft flying into vortex turbulence.

Another case of what was obviously a vortex turbulence encounter in the wake of a light aircraft occurred in Australia only a few weeks ago. A private pilot was carrying out some solo night flying training at Moorabbin airport in a Piper Cherokee and was on the final leg of a powered approach at 70 knots, with full flap extended. Approaching the runway threshold, the

pilot closed the throttle as the first row of runway light disappeared beneath the nose, and eased back the control column. The airspeed was decreasing normally to 60 knots when suddenly the starboard wing dropped. The pilot immediately attempted to correct, and progressively applied almost full opposite aileron, but the bank continued to increase and the aircraft slipped to starboard, veering off the approach path. The roll was only checked when the pilot opened the throttle to full power. The aircraft then slowly returned to level flight and the pilot recovered normal control. Because the aircraft was by this time very close to the ground and flying parallel and to the right of the runway, the pilot carried out an overshoot and made another circuit.

The weather at the time of this incident was fine and the wind almost negligible. The pilot said that he had made several other landings during the same training period, but had not encountered any turbulence. There were a number of other aircraft in the circuit at the time and another Cherokee had landed and a light twin had departed while the pilot was on final approach. At the point where the wing dropped, the pilot said, he was not conscious of any definite bump, rather, it seemed to be more of a sudden rotation of the aircraft around its rolling axis.

The chances of an encounter such as this pilot experienced, are always present whenever a number of aircraft are carrying out circuits and landing sharing the same runway. In the case of light aircraft however, the effects should not be serious if pilots are prepared for them and act accordingly, as this pilot did in discontinuing his approach without delay. As we have seen, it is the possibility of an encounter with the wake of a large aircraft that is the real problem. As already discussed, the best way of avoiding the hazard is to know where the vortices are most likely to be found and to plan an approach or take-off so as to keep well clear of them. Vortices are not formed until lift is being produced, so they will not be generated by an aircraft until just before it lifts off. Similarly, vortices cease to be generated once an aircraft has landed and its wings are no longer producing lift. Pilots should remember however, that in calm conditions, a large aircraft could have taken off and be out of sight, or have landed and taxied to the terminal, and yet the dangerous vortices it has created could still exist in the vicinity of the duty runway.

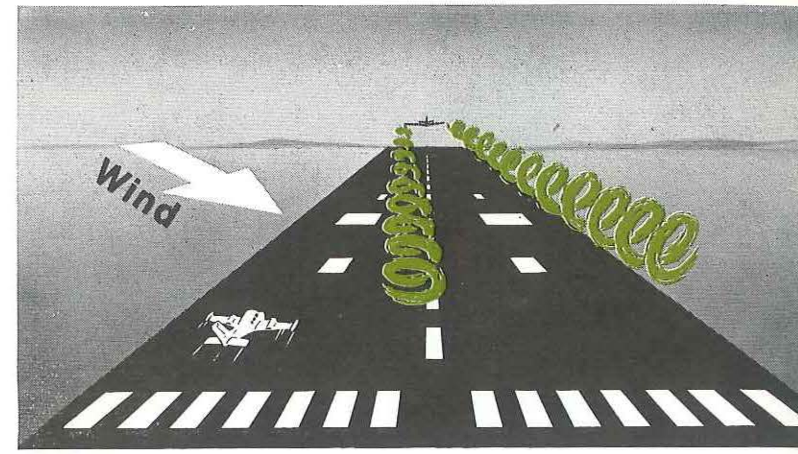


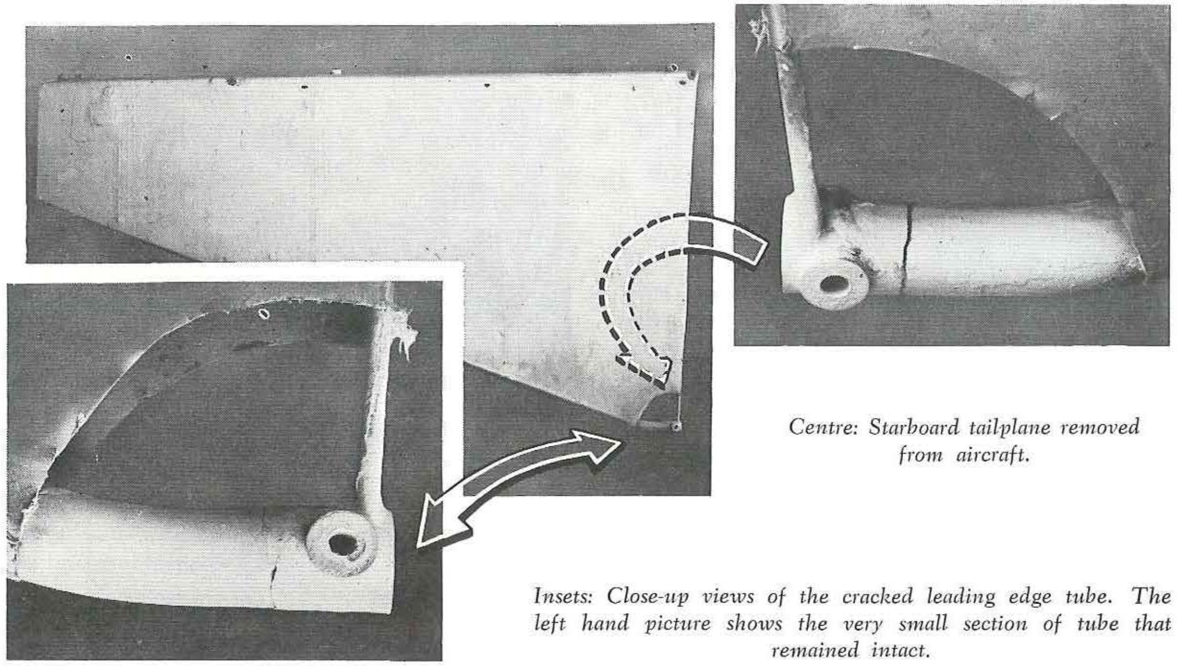
Fig. 4. A typical example of planning to avoid vortex turbulence. The light aircraft is landing as near to the threshold as possible, using the up-wind side of the runway, to keep clear of the vortices generated by the large departing aircraft. In such a case, the direction and rate of movement of the "up-wind" vortex would depend on the strength of the cross-wind and would need to be assessed in the light of the information shown in Fig. 3.

Air Traffic Control

Procedures

At controlled aerodromes, the phrase "Caution — Wake Turbulence" is used to warn pilots when tower controllers consider that vortex turbulence generated by a preceding aircraft could be of significance. Pilots receiving this advice should analyse the situation. They may request further information, or they may ask the controller for an alternative clearance if they consider another course of action preferable, e.g. when taking off after a large aircraft and there is a cross-wind on the runway, a pilot may request to diverge to the windward side of the runway, or to diverge from the runway heading as soon as possible after becoming airborne, to keep clear of the vortices left by the preceding aircraft.

The primary task of Air Traffic Controllers is of course to prevent collisions between aircraft. Within the limitations imposed by regulating air traffic for this purpose however, Air Traffic Controllers will assist pilots in any way they can to avoid the hazards of vortex turbulence.



Centre: Starboard tailplane removed from aircraft.

Insets: Close-up views of the cracked leading edge tube. The left hand picture shows the very small section of tube that remained intact.

AUSTER TAILPLANE near Failure

During a 100 hourly maintenance inspection being carried out on an Auster J5F, the tube which forms the main structural member and leading edge of the starboard tailplane, was found badly cracked. The crack was one inch outboard of the attachment bolt hole and had propagated almost completely around the tube, leaving only a very small section of the tube holding the tailplane in place.

Investigation established that, according to the airframe log book, the aircraft had flown a total time of 1,354 hours. It had flown only 57 hours since being inspected for the renewal of the aircraft's Certificate of Airworthiness four months before, and only 46 hours between that inspection and the previous Certificate of Airworthiness renewal.

The nature of the crack was such that it had obviously developed over a very extended period, and it was quite evident that the standard of inspection at the last Certificate of Airworthiness renewal, left a great deal to be desired.

The Chief Engineer of the authorised workshop which discovered the crack, estimated that the tailplane would probably have failed in flight some time during the next 10 flying hours if the crack had not been detected. If the failure had occurred a little earlier than this, the fatal accident that would almost surely have followed would have resulted because the licensed engineers to whom the earlier inspections were entrusted, had failed to measure up to their responsibilities.

WHEELS-UP LANDING IN HS-125

While making what was intended to be a "touch and go" flapless landing at Avalon, Victoria, a Department of Civil Aviation HS-125 landed with the undercarriage retracted. The aircraft caught fire, and was substantially damaged, but the two pilots escaped without injury.

The aircraft was on a training exercise and had been carrying out a series of circuits and "touch and go" landings during which normal and emergency procedures were being practised. Both pilots had the status of check captains on the HS-125 and the pilot in the left-hand seat flew the aircraft while the other pilot performed the functions of co-pilot and check pilot. After a training sequence covering six "touch and go" landings the pilots exchanged seats, and their respective roles. The training sequence was then being repeated.

As the HS-125 was approaching for its eleventh landing, an R.A.A.F. Mirage was taxi-ing for take-off and, to allow the Mirage to turn left after taking off, the tower instructed the HS-125 to make a right turn after the "touch and go" landing and report west of the airport. The HS-125 made the "touch and go" and turned right as instructed and it was then decided that the next landing would be made in the unflapped configuration. The two pilots discussed the target threshold speed required for the approach and commenced the pre-landing checks.

By this time the Mirage had lined up for take-off. The tower instructed the HS-125 to report approaching a right base and advised that it might be necessary for them to fly one holding pattern to the north-west of the field. The HS-125 acknowledged this transmission as the Mirage commenced its take-off run. The HS-125 was then instructed to continue on to a right base and to report on final.

After the HS-125 had turned on to base leg, the pilot in the right hand seat noticed that the flag warnings for the localiser and the glide slope indications were showing on the instruments, indicating that the runway ILS was inoperative. He called the tower to query this, and was informed that the ILS had been switched off so that crash barriers at the end of the runway could be erected while the Mirage took off.

The HS-125 continued the approach, and, at about 200 feet on late final, the pilot flying the aircraft closed the throttles fully to reduce the airspeed to the target threshold speed of 115 knots. With the undercarriage still retracted, the aircraft crossed the threshold at 30 to 40 feet and touched down smoothly on the fuselage keel skid. It was only as the aircraft was skidding along the runway, that the crew realised that the undercarriage was not extended, and they immediately closed the high pressure and low pressure fuel cocks. As the aircraft came to rest, the tower advised the crew that the rear section of the aircraft was on fire. The crew turned off the master battery switch, and evacuated the aircraft through the main cabin door. Units of the airport fire service quickly reached the aircraft and extinguished the fire with foam.

* * *

When the aircraft was inspected, all three undercarriage legs were found in their fully retracted positions and the nose wheel doors were closed. The flaps were also fully retracted. Marks on the runway showed that the aircraft had slid for 2,400 feet before coming to rest. The fuselage keel skid had worn away completely, during the ground slide, exposing the fuselage skin to the friction of the runway. The runway friction had ruptured the centre section integral fuel tank, allowing fuel to escape, and had provided a source of ignition. When the aircraft came to rest, fuel continued to leak from the damaged tank, feeding the already established fire.

Inspection of the cockpit showed that, although all components of the undercarriage were in the retracted position, the undercarriage selector lever was in the "down" position. The flap lever was in the "up" position and both high and low pressure fuel cocks were off.

After the initial inspection had been completed, the aircraft was lifted and removed from the runway on trolleys. It was then raised on jacks and subjected to further examination to test the operation of the undercarriage mechanism and its associated warning systems. Particular care was taken, while the aircraft was being raised, not to interfere with the hydraulic or electrical systems.

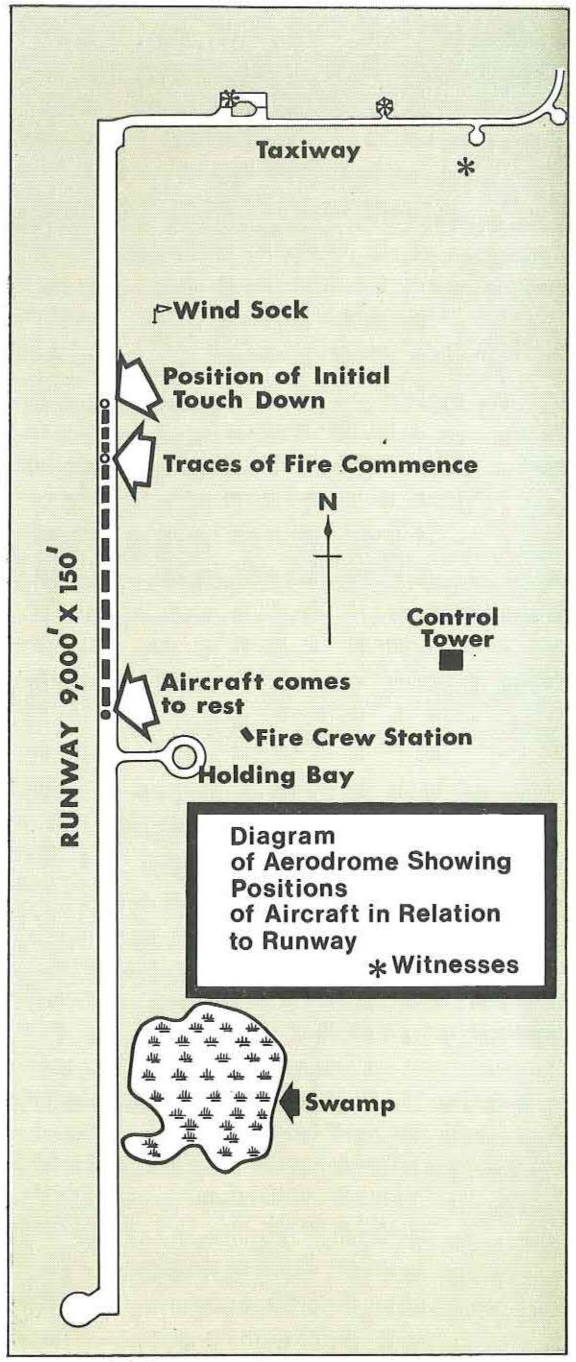
The undercarriage of the HS-125 is operated hydraulically. The electrically operated warning system comprises three red lamps which illuminate when the undercarriage is in transit, either up or down, three green lamps which illuminate when the undercarriage is down and locked, and a warning horn. The warning horn sounds when the undercarriage is not locked down and either throttle lever is retarded below about the 60 per cent thrust position, or if approach or landing flap is selected while the undercarriage is not locked down. There are also mechanically operated position indicators for each of the three undercarriage legs. The mechanical indicator for the nose leg is mounted on the central control pedestal in the cockpit and the main leg indicators are located on the upper surface of each wing immediately above their respective undercarriage legs. The mechanical indicators for the main legs are not visible from the cockpit.

The electrically operated undercarriage warning system makes provision for the warning horn to be silenced, if required, when it is actuated by retarding either one of the throttle levers. The warning horn circuit is automatically re-armed immediately either throttle lever is re-advanced beyond the warning horn activating position. There is no provision for silencing the warning horn when it is activated by extending the flaps.

Inspection of the aircraft's hydraulic and electrical systems showed that, although components and wiring in the rear equipment bay had been subjected to excessive heat, the systems remained capable of operation for testing purposes, and there was no external evidence of any failure having occurred before the aircraft landed. Power was applied to the electrical system and, with the undercarriage selector lever still in the down position, the main hydraulic system was pressurized by operating the hydraulic hand pump located in the rear equipment bay. As pressure built up in the system, each undercarriage leg extended and moved into the locked down position. At the same time, the electrical and mechanical warning devices all operated normally. The undercarriage was then retracted and extended again by the same means, and again the warning devices operated normally.

The aircraft was then lowered on to its wheels, and towed to a hangar for further examination.

Diagram of Avalon Aerodrome.



Here it was again jacked up, and an external source of hydraulic pressure was connected to the aircraft's system through leads to the engine driven hydraulic pumps. A further number of undercarriage retractions and extensions were then carried out and on every occasion, the hydraulic system, the position indicating lights, and the warning horn all operated normally. The engine driven hydraulic pumps were removed from the aircraft and bench tested and both pumps were found to be capable of normal operation. Finally, the system was examined as far as practicable for evidence of contamination of fluid or other possible source of intermittent failure, but no such evidence was found.

Throughout the whole programme of testing, nothing came to light to indicate that the aircraft's undercarriage had been other than completely serviceable, or that the undercarriage actuating system and its associated warning systems had malfunctioned in any way.

The Air Traffic Controller on duty at the time of the accident said that although he had seen the HS-125 turning on to final about the time he cleared it for a "touch and go", he did not see it actually landing. He had been occupied in co-ordinating the Mirage's departure with the R.A.A.F., and when he next saw the HS-125, it had almost come to rest on the runway and was on fire. The aircraft's final approach and touch-down was seen, however, by a number of other reliable witnesses on the aerodrome, all of whom were positive that the undercarriage remained retracted throughout the final approach.

Both pilots said after the accident that they were certain they had not moved the undercarriage selector after the aircraft made contact with the runway. Neither pilot could positively recall moving the undercarriage selector to the down position, seeing the red "undercarriage in transit" lights or checking the green "down" lights and the mechanical nose leg indicator, but each believed they had followed the normal pre-landing procedures during the circuit, subject to the interruptions caused by the tower's instruction to vary their circuit pattern to allow the Mirage to depart, and the apparent failure of the runway ILS. Both pilots said that the undercarriage warning horn had not sounded when the throttles were retarded fully on final approach. However, the pilot who was flying the aircraft recalled that, early on the downwind leg, he had reduced engine power to the point where the warning horn had sounded and he had muted the horn at that time. It was evident that, throughout the remainder of the circuit, the throttles were not opened again far enough to re-arm the warning horn circuit. This, together with the fact that the flaps were not lowered, was undoubtedly why the warning horn did not sound during the final stages of the approach to land.

* * *

It is quite clear from the investigation that the crew failed to make use of the means available to them to ensure that the undercarriage was extended and safe for landing. It is this question of why the crew omitted to follow the prescribed pre-landing checks that is of primary significance for there is no doubt that the cockpit indicators, had they been checked by the crew at the proper time, would have shown that the undercarriage was still retracted.

As a result of the accident, disciplinary action has been taken against the pilots concerned. The training sequences to be followed in Departmental aircraft have also been reviewed, together with the manner in which responsibilities are to be divided, when similarly qualified pilots are flying together in an aircraft for the purpose of maintaining proficiency.

The fact that an accident of this type can occur to an aircraft being crewed by two senior, highly experienced, professional pilots, is some indication of the degree of care necessary for the conduct of concentrated training exercises in modern complex aircraft. As cockpit sequences are repeated, circuit after circuit, it is unfortunately all too easy to gloss over, and perhaps to gradually disregard, the methodical implementation of the prescribed cockpit checking procedures so essential to safe operation. There can be little doubt that the insidious nature of the type of hazard inherent in such concentrated training exercises, is the most significant lesson to be derived from the HS-125 accident.

from the INCIDENT FILES

OBSTRUCTION IN CARBURETTOR

Preparing for a charter flight from Launceston to Flinders Island, the pilot of a Cessna 175 had the aircraft refuelled, and carried out a daily inspection.

This completed, the passengers boarded the aircraft, the pilot started the engine and they taxied out for take-off. At the holding point, the pilot ran the engine up to 1,700 RPM, checked the magneto switches and the carburettor heat control, and completed his pre-take-off checks.

Lining up on the runway, the pilot applied full throttle but as the aircraft accelerated, he found that the engine RPM would not increase above 2,400 and at this speed the engine began to run roughly. The pilot immediately discontinued the take-off and taxied back to the tarmac.

Here, further engine running showed that the engine was lacking in power above 2,000 RPM, and a subsequent inspection of the engine found a small piece of cellophane paper lodged in the main venturi of the carburettor. This would have impeded the flow of air through the carburettor at high power settings, and created turbulence in the airflow within the venturi at the main jet position, upsetting the metering of the fuel.

It was apparent that the paper had been drawn into the carburettor through the unscreened hot air duct while the pilot was checking the operation of the carburettor heat control before commencing the take-off.

Comment

Hot air ducts and alternative air inlets are normally unscreened because they are designed to remain functional if the main air intake should become blocked—as could occur, for example, in heavy airframe icing conditions. Fitting these alternative sources of air with screens would largely nullify their usefulness, as such screens could also become blocked in severe icing conditions.

Notwithstanding this incident, the likelihood of similar occurrences is remote, and checking the carburettor heat control during run-up must be considered a necessary pre-take-off item. This not only ensures that the control is working correctly, but should remove any carburettor ice that may have accumulated during taxi-ing, or while the engine was idling.

Wind Gust Damage

During a scheduled maintenance inspection being carried out on a Piper Pawnee, the centre hinge bracket of the starboard aileron was found fractured. The bracket had failed through its channel section in line with the forward end of the aileron stop fitting. The bracket, which had been badly kinked before it fractured, had obviously been damaged by violent movement of the ailerons.

It was evident that the aircraft had been left parked in the open with the control surfaces unlocked and the damage had been caused by wind gusts.

Airlock in Fuel System

Flying a Cessna 337 from Mount Isa to Darwin, the pilot ran the auxiliary tanks out completely, then changed the fuel selectors to the main tanks. Soon afterwards, as the aircraft was approaching Katherine, it encountered a patch of severe turbulence. Fuel pressure for the front engine dropped, the engine stopped and very shortly afterwards the rear engine stopped also. The pilot reported that the aircraft's fuel was exhausted and stated that he would make an emergency landing at Katherine which was by now within gliding distance. The Distress Phase was declared and emergency services were alerted at Katherine. Thirty seconds after the rear engine had stopped, however, it recovered fuel pressure and restarted. The pilot then found that by using the fuel booster pump in the low prime position he was also able to restart the front engine. The fuel pressure on the front engine could only be maintained however if the fuel booster pump was left running in the low prime position, so the pilot held the aircraft in a position for a forced landing at Katherine if this became necessary.

After ten minutes he tried the engine again without the booster pump. This time it continued to run quite normally. Acting on advice from Darwin Operations, the pilot nevertheless made a landing at Katherine to ensure that the aircraft was serviceable to continue the flight. The Distress Phase was cancelled when the aircraft landed.

The fuel flow to both engines could not be faulted after the aircraft had landed, and there were 42 gallons of fuel still in the main tanks. It was evident that an airlock had been caused in the fuel systems of both engines by leaving the auxiliary tanks selected until they ran out completely and then encountering severe turbulence. The pilot had used the fuel booster pump only in the low prime position in his efforts to restore power on the front engine, and this had apparently been responsible for the delay in clearing the airlock. The use of the fuel booster pump in the prime or purge positions would undoubtedly have been more effective in clearing the airlock quickly.

PILOT'S SEAT ADRIFT

At Perth, Western Australia, a pilot was to be flight checked for the renewal of his Instrument Rating in a Cessna 411. The pilot occupied the left hand seat and the Examiner of Airmen who was conducting the test, was in the right hand seat. Settling himself in his seat before the engines were started, the examiner pressed his feet against the rudder pedals to test the security of the seat. As he did so, the seat tore away from its mountings and toppled over backwards. The examiner was not injured but the flight had to be abandoned.

When the damaged seat was inspected, it was found that its mountings had been secured to the floor by only four attaching screws instead of the ten for which screw holes were provided. It was learned that for a series of earlier aerial photographic operations, the pilots flying the aircraft had removed the seat on a number of occasions to make room for photographic equipment to be carried in that position. Some of the seat mounting screw positions were not readily accessible, and because of the difficulty and time that was involved in replacing all the screws each time the seat was removed, the pilots had secured it with the minimum number of screws necessary. Movement of the seat, had then gradually worn and enlarged the holes in the seat attachments to the point where the screw heads pulled through the metal. The L.A.M.E. responsible for the maintenance of the aircraft said that he had previously warned the pilots on the need to re-install the seat correctly after it had been removed.

It had been the operator's intention to incorporate a modification to the second pilot's seat mounting, to permit the seat to be removed and replaced easily, but this had been deferred a number of times because of pressure of work. The modification was carried out without further delay immediately after the incident occurred.

Irrespective of the pressure under which the pilots were working and the need for the seat to be modified to adequately cope with the type of work the aircraft was undertaking, the fact remains that, for the time being, the pilots involved had been content to operate the aircraft with the second pilot's seat in an unsafe condition.

(Condensed from Official Accident Reports as Acknowledged.)

FROST ON WINGS

A single engine Stinson was departing from an aerodrome in British Columbia, Canada, with the pilot and two passengers on board. The aircraft made an unusually long take-off run before becoming airborne, after which the pilot was unable to maintain height, and the aircraft struck the ground. The pilot and passengers were not injured but the aircraft was badly damaged.

The aircraft was airworthy at the time of the accident and no evidence could be found of any fault existing in the engine, airframe or controls, before the accident occurred. The weather at the time was fine and calm with a surface temperature of minus two degrees C. Fog was lying over a nearby river.

The pilot said that on the morning of the flight, the wings of the aircraft were covered with frost. Because of this, he delayed his departure and positioned his aircraft to allow the sun to melt the frost. Later, when he started the engine for departure, the pilot said he used carburettor heat until he was ready to begin the take-off run. Before beginning the take-off however, a patch of fog had swept over the aircraft and momentarily misted the windows. The pilot proceeded with the take-off and after the aircraft finally became airborne, the engine appeared to lose power. The aircraft did not respond when placed in a climbing attitude. After flying for approximately 900 feet, the aircraft seemed to stall and struck the ground in a clearing beyond the end of the runway. The maximum height the aircraft had attained was about 10 feet.

Threads of ice and frost were found on the wings after the accident. The accident was attributed to the frost on the wings causing a loss of lift and impairing the performance of the aircraft.

Department of Transport, Canada.

Helicopter Upset by Passenger

A Hughes helicopter was being flown on a local flight in clear, calm conditions with one passenger on board. Because the passenger was heavier than the pilot by about 100 lbs., the load in the cabin was uneven. After lifting the helicopter off the ground, the pilot hovered the aircraft while he adjusted the tension on the cyclic control friction nut to compensate for the uneven load.

In the meantime, the passenger had noticed that the cockpit door on the starboard side was open and he leant across to the right to close it. Before the pilot could apply corrective control, the suddenly increased unevenness in the load, tilted the helicopter to the right and the main rotor struck the ground. The helicopter then rolled on to its side and was badly damaged. The occupants were not injured.

Department of Transport, Canada.

TWO COUNTS OF CARBURETTOR ICE

BEECH TRAVEL AIR

Preparing for an IFR flight from Lancaster to Port Erie, Pennsylvania, U.S.A., the pilot of a Beech B95 obtained a weather briefing which forecast deteriorating conditions associated with a cold front over the area of the aircraft's destination, with instrument conditions expected in blowing snow. The aircraft departed normally at 0927 hours local time.

Approaching his destination an hour and a half later, the pilot was advised that the sky was partly obscured with a cloud base of approximately 1,800 feet, and that visibility was varying between three quarters of a mile and one and a half miles, in light blowing snow.

After the aircraft had been cleared for an ILS approach, the weather deteriorated below the airport landing minima and the aircraft was accordingly cleared to discontinue its approach and proceed to the Erie VOR at 3,000 feet. The pilot subsequently reported normally over the beacon, but three minutes afterwards, advised he was having trouble with the engines. Another minute later, the pilot reported he was unable to keep the engines going. He was then at 1,800 feet and losing height.

About this same time, a witness on the ground heard the sound of a misfiring engine and saw the aircraft descend in a gliding turn. He then heard the aircraft crash. The pilot was killed and the aircraft destroyed.

The aircraft had come to rest in a creek. Impact forces had been high, but damage to the aircraft showed that it had not been out of control. At the time of impact, the undercarriage was down and the flaps retracted. Both engines had separated from the aircraft.

Both carburettors had broken away from their respective engines and had been thrown into the creek below the frozen surface. One carburettor, which was still relatively intact, had a two inch deposit of crystalline ice on the venturi tubes. The carburettor hot air doors were found jammed by impact in the "cold" position, but apart from these findings there was no evidence of any malfunction in the aircraft.

In view of the state in which the carburettor was found, and the existing weather conditions, which were highly conducive to the formation of carburettor ice, it was concluded that the simultaneous loss of power on both engines had been caused by a build-up of carburettor ice. The probable cause of the accident was the pilot's failure to use carburettor heat to prevent the accumulation of carburettor ice.

CHEROKEE SIX

Approaching Dallas, Texas, after a cross country flight, the pilot of a PA32 commenced descent from 3,500 feet. He maintained 22½ inches of manifold pressure until the aircraft reached 2,400 feet, then reduced power to 15 inches, applied partial carburettor heat, and turned on to a long base leg for the airport. A little more than a quarter of a mile from the runway, at about 300 feet, the engine stopped without warning. After checking the fuel, mixture control and magnetos, the pilot tried pumping the throttle to restart the engine. The engine failed to start, so the pilot reported his emergency to the tower, turned off the master and ignition switches and carried out a forced landing in a street. The aircraft collided with trees and a car before it could be brought to a stop, injuring the pilot and one passenger and damaging the aircraft extensively, but it did not catch fire.

Examination of the engine and fuel system disclosed no evidence of any mechanical malfunction which could have contributed to the engine failure. The carburettor heat control was in the "off" position.

The weather conditions at the time were highly conducive to the formation of carburettor ice. The Owners Manual for the aircraft type contains a warning on the use of only partial carburettor heat in aircraft not fitted with a carburettor air temperature gauge. In certain air temperature conditions, the manual explains, suspended moisture in crystal form that would otherwise pass through the induction system, can be raised in temperature by partial carburettor heat to the point where the crystals melt. The liquidified moisture can then form carburettor ice as a result of the drop in temperature that occurs in the neck of the carburettor venturi. In aircraft not fitted with carburettor air temperature gauges, it is therefore advisable to fly with the carburettor heat control in either the full hot or full cold positions, as conditions dictate.

The aircraft involved in this accident was not fitted with a carburettor air temperature gauge, and the engine failure was attributed to carburettor icing which formed as a result of the pilot's incorrect use of the carburettor heat control.

Comment:

This accident occurred in winter conditions considerably more severe than those normally encountered in Australia. Conditions in which suspended moisture would be present in the air in frozen crystal form, are rarely, if ever, encountered in Australia, and the advice which this accident report gives on the use of carburettor heat, requires some qualification for Australian operations.

In Australia's milder winter temperatures, it is seldom necessary to operate a light aircraft with full carburettor heat applied continuously. Rather, it is preferable to use the full heat position only for long enough to clear the induction system of ice, and then to be alert for any further symptoms of icing. This whole subject was discussed in the article "Be Alert for Carburettor Ice", in our March, 1966 issue. As stated in our last issue (See footnote to "Caught Out by Carburettor Ice", Aviation Safety Digest No. 50, May, 1967) the Department is making reprints of this article available to pilots and flying schools on request. Applications for reprints should be forwarded to the Editor at the address shown on the inside front cover.

C.A.B. United States.

GLIDER CABLE RELEASE FAILS

Before taking-off for an aero-tow launch behind a Tiger Moth at Wattisham Aerodrome, Suffolk, U.K., the pilot of a Ka-7 glider was briefed by the tug pilot to release the tow rope when he reached a point near the end of the base leg of the aerodrome circuit and to land on the grass to the right of the duty runway. The tug pilot intended to turn left after the glider had cast off, and to land on the runway itself.

The aero-tow proceeded normally and, approaching the proposed release point, the pilot of the Tiger Moth reduced speed to allow the glider to cast off. As the tow rope went slack, the glider pilot operated the cable release mechanism twice. Both pilots having assumed that the tow rope had released normally, the Tiger Moth then turned left to land on the runway, while the glider continued on an extended base leg to land on the right of the runway as instructed. The rope had not released however, and when the glider was abeam the end of the runway, the tow rope suddenly stretched taut, pulling the glider violently through 90 degrees to port and jerking the tail of the Tiger Moth upwards and to starboard. The glider pilot immediately operated the cable release again. This time, the tow rope fell away at once and he was able to check the glider's yaw and land straight ahead. The pilot of the Tiger Moth however, was unable to recover from the resulting spiral dive, and the aircraft crashed close to the runway threshold. The pilot was seriously injured and the aircraft destroyed.

Board of Trade, United Kingdom.

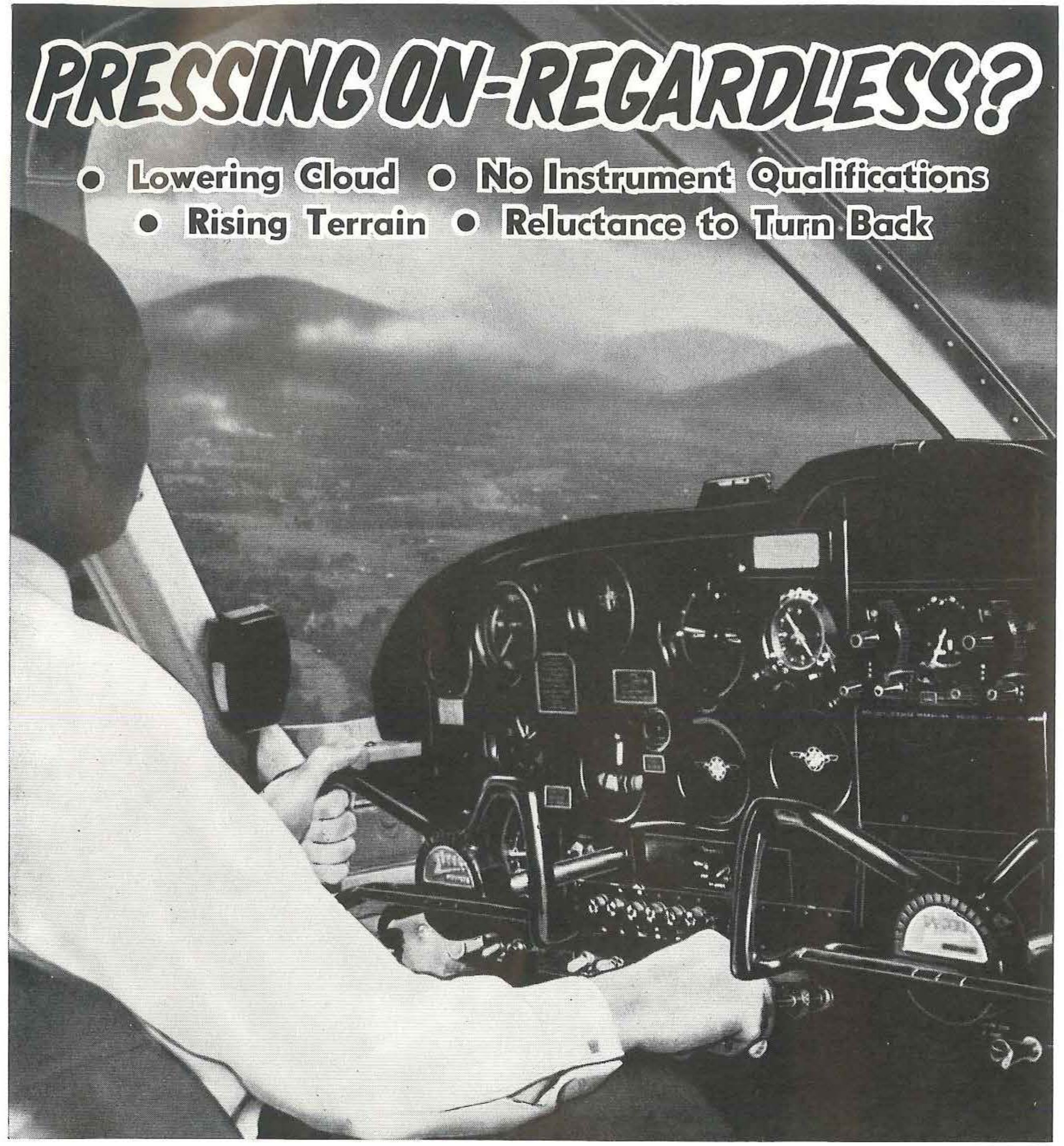
TAKE-OFF COMMENCED WITH CONTROLS LOCKED

An HS-125 executive jet with a crew of two and four passengers was taking-off from Des Moines, Iowa, U.S.A.

After take-off power had been applied and the aircraft was accelerating, the co-pilot noticed that the elevator and aileron gust lock had not been disengaged from the pilot's control column. He called out to warn the pilot, who then attempted to remove the lock while the aircraft continued to accelerate. When the pilot finally realized he could not release the control lock in time to lift the aircraft off the ground, he discontinued the take-off. The aircraft overran the end of the runway, struck a ditch and came to rest in a ploughed field, nearly 800 feet beyond the runway. The aircraft was badly damaged and both pilots sustained serious injuries, but the passengers were unhurt.

The control column gust lock which should have been clearly visible to the pilot from his seat, was found still in place after the accident. The rudder control lock had been removed and stowed properly before the aircraft departed.

C.A.B. United States.



In these conditions, visual reference can be lost very suddenly. Disorientation is then almost inevitable.

THE RESULT IS USUALLY FINAL.