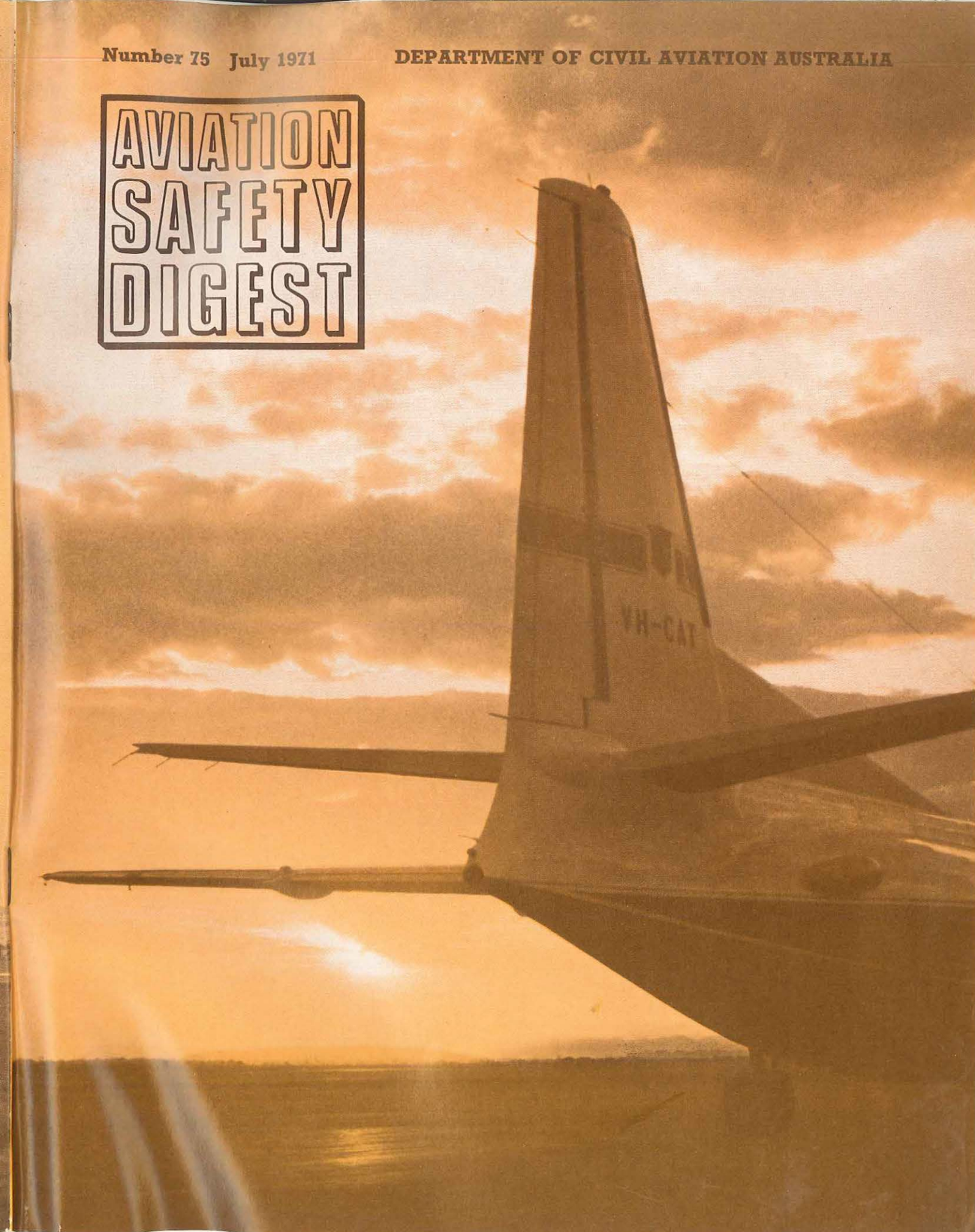
Number 75 July 1971

DEPARTMENT OF CIVIL AVIATION AUSTRALIA

AVIATION SAFETY DIGEST



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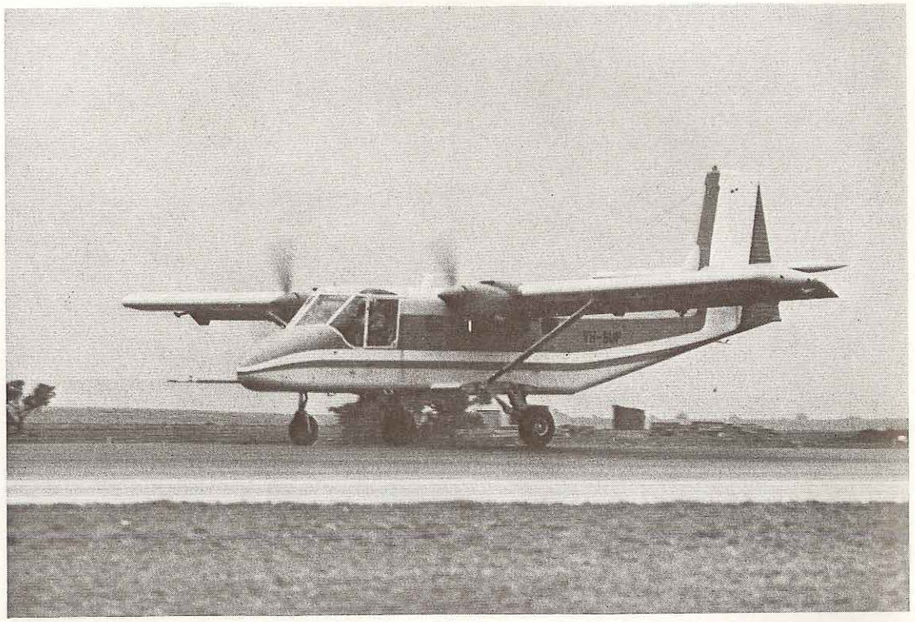

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—D.C.A. Photographs by J. Montgomery

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AUSTRALIA

Editorial

A Time For Re-assessment

Four months ago, in Aviation Safety Digest No. 73, a great deal of emphasis was given to the dangers of pressing on in "below VMC" weather and five fatal accidents were cited to manifest the need for much greater care when attempting to continue a flight visually in marginal conditions.

It seems ironical that even while that issue was being prepared, no fewer than six more accidents, resulting from this same basic cause, claimed the lives of 14 people. At least two further accidents in this same category have occurred since. One of these is reviewed in this issue and is unique in that all the occupants of the aircraft miraculously survived the impact and were able to describe their experience.

In retrospect it could perhaps be said that it is a pity the contents of Digest No. 73 were not available earlier, as they might have been instrumental in preventing some, or even all, of these accidents. But is this a realistic comment? For surely it is not merely ignorance of the dangers that lead the pilots concerned into these situations. This type of accident is by no means new. Similar "press on" disasters have been reported in the Digest, as well as in other aviation publications, on many occasions in the past. It is also relevant that the six accidents were each given prominent coverage in the daily press at the time and it is hard to believe that some of the pilots concerned had not heard or read of the circumstances in which the earlier of these occurred.

No — the overall problem cannot fairly be attributed to ignorance of the hazards involved. Rather, the underlying common factor seems to be one of disregard — disregard of the legislation that exists to protect pilots from such dangers, and disregard of the wealth of hard-earned experience that brought about this legislation. In a few cases, this disregard is regrettably deliberate, but in others, especially those involving the less experienced, it probably results to some degree from the pilot's failure to properly assess an operational situation which is beyond his ability and which, in theory, he would not contemplate.

Two other factors no doubt also play their part in the circumstances leading to some of these accidents. One is the deep-seated belief, present in all of us to a greater or lesser degree, that "it won't happen to me". The other is "I've got away with it before — I can do it again". Both these attitudes, powerful though their influence may be, are entirely irrational. There is no room for such notions in aviation and pilots must be alert and responsible enough to anticipate a situation that will exceed their ability and experience, as well as sufficiently self-disciplined to do something about it while time is still on their side.

Overall, it is clear that some general aviation pilots need to do a lot of re-thinking about their attitudes to flying in general, and where the limit of their ability lies in particular. As pointed out elsewhere in this issue of the Digest, the air is an alien environment for man, and only by coming to terms with its hazards can he remain master of the situation. These terms have all been learnt the hard way over the years and are reflected in the Air Navigation Regulations and Orders. The whole philosophy of our A.N.R.'s and A.N.O.'s is to provide for a margin of safety, a way of escape or an alternative plan that allows for the unexpected and unforeseen. If this philosophy is ignored and the unforeseen occurs, there can obviously be only one result.

Airmanship, in the best sense of the word, is that quality which, by observing a "margin of safety" philosophy at all times, applies the accumulated wisdom of the years to ensure that each and every flight is conducted as safely as is humanly possible.

'I Had No Fears About Flying In Cloud'

AT Wollongong, New South Wales, a private pilot and a friend had arranged to entertain two other friends from northern New South Wales for the weekend, during which it was intended that the party would make a flight over the Snowy Mountains in a Cessna 172. This was the second time the trip had been arranged, the first occasion three or four weeks previously, having been cancelled for personal reasons. The pilot was therefore particularly anxious that the trip should be a success.

The pilot had ordered a route forecast, including a terminal forecast for Cooma, but early on the morning of the flight when he telephoned the Briefing Office at Sydney Airport, the weather details read to him over the telephone were unfavourable. In fact from the expected en route cloud, and the possibility of fog at Cooma, it seemed likely that the flight would have to be cancelled once more. However, as the pilot had already arranged to meet his passengers at the aerodrome at about 0800 hours, he decided not to cancel the flight until he had reached the aerodrome and had telephoned Sydney again to obtain the latest area forecast. The pilot reasoned that, as the information on which the route forecast had been prepared was already several hours old, it was possible that a later area forecast would indicate better conditions.

Arriving at the aerodrome at about 0730 hours, the pilot rang the Bankstown briefing office and requested the current area forecast. This forecast indicated that on the coast, there would be three eighths of cumulus cloud at 2,500 feet and three eighths of strato-cumulus at 3,000 feet, while inland there would be five eighths of strato-cumulus at 4,000 to 5,000 feet. Fog was also forecast on the ranges, but was expected to lift between 1000 and 1200 hours. On the basis of this forecast, the pilot decided that if he waited an hour or so, the flight would be possible, so he submitted a flight plan for Cooma via Braidwood with an estimated time of departure from Wollongong at 0900 hours. When the passengers arrived at the aerodrome a little later, the pilot explained that because of the fog on the ranges, their departure would have to be delayed until 0900 hours.

The weather in the area of the aerodrome as the time of departure approached was almost completely overcast with a cloud base of between 3,000 and 4,000 feet, but just to the west of Wollongong itself there was a large hole in the cloud cover through which blue sky was visible. While he was waiting, the pilot discussed his proposed flight with a flying instructor, who suggested that on departure, the pilot should climb up through the hole in the cloud to have a look at conditions along the route. If he didn't like the look of the conditions he found, he should return to Wollongong. The flying instructor also asked the pilot if he knew how to use the ADF fitted to the aircraft, and the pilot told him that he did.

After the pilot had carried out a thorough daily inspection and checked that the fuel tanks were full, the passengers boarded the aircraft, the pilot started the engine and they taxied out. The aircraft then took off and headed towards the hole in the cloud cover immediately to the west of Wollongong.

At 0903 hours the pilot reported his departure to Sydney Flight Service and that the aircraft was climbing to 4,000 feet over Wollongong. Ten minutes later at 0913 hours, the aircraft called again to report that it was over Wollongong, at 6,000 feet, setting course for Cooma and climbing to 8,000 feet over eight eighths of cloud. The pilot added that if he couldn't obtain a fix within 30 minutes he would be returning to Wollongong and that he would report again at 0945.

At 0926 hours, Sydney called the aircraft to advise that another light aircraft, bound from Canberra to Moruya, had reported eight eighths of cloud with a base of 5,500 feet. The pilot acknowledged this call and then reported that he was "Descending 5,000 VMC". He was then requested to call Cooma Flight Service. A few minutes later however, the pilot called Sydney again to advise that he was returning and was now estimating Wollongong at 1015. On being asked his present position, the pilot replied that he was still over cloud but that his estimated position was "60 miles on track Cooma". Sydney then requested the aircraft's altitude and the pilot replied "4,000", adding that he was climbing to 8,000 feet over cloud.

The aircraft did not call again and although Sydney Flight Service called the aircraft several times at about the time it should have been landing at Wollongong, there was no reply.

* * *

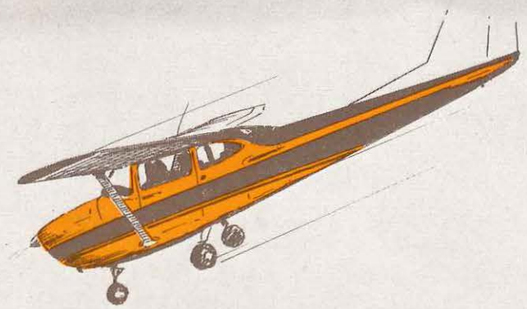
At 1120 hours, when the aircraft's SARTIME had expired, communication checks were begun and the phases of search and rescue action were progressively introduced. When these checks produced no result and police at Mittagong reported that the aircraft was not on the airstrips at Bowral, Mittagong or Berrima, the Distress Phase was declared and arrangements were made to commence an air search as soon as possible. Weather reports in the vicinity of the aircraft's track to the south-west of Wollongong indicated that there was extensive low cloud and heavy rain showers, but throughout the rest of the day, as this weather permitted, five light twin-engined aircraft searched the mountainous terrain to the south-west of Wollongong. Meanwhile a sixth aircraft, a Cessna 150 from Canberra, checked all the agricultural strips in the area at which it was thought the missing Cessna could possibly have landed. But by nightfall there was still no trace of the overdue 172.

When the search was resumed at first light the following morning, the weather had improved to some extent. To supplement the fixed-wing aircraft engaged in the search, the Royal Australian Naval Air Station at Nowra had made available two helicopters equipped with winches and stretchers, and with crews which included medical staff. The helicopters were standing by for immediate departure should the missing aircraft be sighted.

Shortly after 1000 hours, a Cessna 172, which had been attracted to the site by a column of smoke, reported that it had found wreckage in a steep sided, heavily timbered valley, approximately 10 miles south-east of Moss Vale. Immediately the news was received, the two helicopters took off from Nowra and a police ground party also set out from Moss Vale. Meanwhile, except for a Departmental Cessna 310 which remained over the accident site to co-ordinate the search and act as a link between the Navy helicopters and the Rescue Co-ordination Centre in Sydney, all other search aircraft were recalled to base.

While waiting for the helicopters to arrive, the Cessna 310 reported that winching gear would be required, as the wreckage, lying on its side with both wings torn off, was located close to the base of a 200 foot cliff amongst trees 60 to 70 feet high. There was fire near the wreckage but there appeared to be at least one person in its vicinity, although this sighting was uncertain. Shortly after 1100 hours, the two Navy helicopters arrived over the wreckage site and a medical officer was winched to the ground. On reaching the ground, he was astonished to find that the persons who had been seen from the air were not bush walkers that had stumbled across the wreckage as he had first supposed, but rather the four occupants of the aircraft itself, all of whom had escaped serious injury! They had lit a fire while awaiting rescue. The survivors were winched aboard the helicopters and flown back to the Nowra Naval Air Station where they were treated for minor cuts and abrasions.

The inaccessibility of the crash site rendered a detailed examination of the wreckage extremely difficult, but it was evident that the aircraft had first struck the tree-tops at comparatively low speed in a level attitude. The impact had banked the aircraft sharply to the right,



The wreckage of the Cessna, lying on its starboard side, as first sighted from the air. The surrounding trees at the accident site are up to 70 feet high.

after which it had struck other trees with the wings and fuselage whilst still some 40 feet above the ground. It had then slid down sideways through the trees until the starboard wing-tip struck the ground. The impact with the trees and ground had torn off both wings and severely buckled the fuselage, but the cabin area remained relatively intact. Examination of the wreckage itself produced no evidence that the aircraft would not have been capable of normal operation before the accident occurred.

* * *

If the outcome of this accident had been what would normally be expected in such a situation, the circumstances that led to it would have remained largely a matter of conjecture. There would have been little or nothing to explain what had happened to the aeroplane and its hapless occupants between the time the pilot reported that he was returning to Sydney above cloud, and the aircraft's obviously controlled descent into a heavily-timbered steep-sided valley amongst the precipitous escarpments of this part of the Great Dividing Range. The mystery would have only deepened when an examination of the engine showed no sign of any defect or malfunction having developed before the crash, and in all probability, the cause of the accident would have remained undetermined.

As it turned out however, the immediate results of the accident were anything but "normal". For not only did the pilot and his passengers achieve the seeming impossible by living through this nominally "fatal" accident, but they did so almost unscathed and were able to give a detailed account of all that happened. It thus becomes possible to reconstruct the whole history of this accident in some detail and to fill in the "gaps" in the narrative already related. When pieced together in this way the chain of events that led up to the accident seem almost as unbelievable as the fact that we are able to relate the story at all! The pilot's own account speaks for itself:

"We took off within a minute or two of our planned time and climbed to 6,000 feet over Wollongong, where I levelled off in the hole in the cloud cover and then set course on 202 degrees. As I was quite close to the top of the cloud, I decided to climb to 8,000 feet. I called Sydney to let them know that I was going to fly for 30 minutes and if I couldn't establish my position I was going to return to Wollongong.

I checked that we were on track by taking a backbearing on the ADF from Wollongong. After about 29 minutes, I was about to tell Sydney I was returning, when Sydney called to inform me that the pilot of another aircraft, flying from Canberra to Moruya, had reported that he was flying VFR and the cloud was three eighths* at 5,500 feet.

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* The pilot had misunderstood this transmission. The cloud cover was actually eight eighths. (See page 3).

With this information and knowing that my lowest safe altitude was 4,200 feet I decided to descend below the cloud. At 5,500 feet I was still in cloud but I continued descending to my lowest safe altitude. At 4,200 feet I levelled out, checked that I was still on track by the ADF, and readjusted the power.

I was still in cloud and, realising that I wouldn't be able to carry on under these conditions, I worked out a return track to Wollongong and then began a rate one turn to the right. Having turned back on to a reciprocal heading, I set full power and began to climb at 70 knots. Then I called Sydney and told them what I was doing.

I think I had climbed about 1,200 feet and was looking at the Visual En-route Chart, when things began to go wrong. First I noticed that the vertical speed indicator was showing a descent of 300 feet a minute. This was rather odd because I had been climbing at 70 knots and everything else seemed right. However, when I saw this rate of descent I put on just a little back pressure, just a gentle stick movement but the VSI stayed the same. The airspeed indicator didn't move either. It stayed at 70 knots, so I pulled back just a little more. The VSI still didn't move and then I looked across to the left to check the ASI again. As I was looking at it, something caught my eye over to the right of the instrument panel. I looked and it was the VSI. I think it was showing maximum down but whichever way it was, the needle had gone right around to the stop. Then I felt in my kidneys that we were going up, so I pushed hard on the control column but there was no reaction. The aircraft seemed to be standing as if in a stall — the controls became sloppy and everything went quiet. I pulled back on the column and the elevators took effect — it felt as if we were going over in a loop. As we came out of the "loop", the instruments were all fluctuating jerkily with the VSI moving more than the rest. The airspeed indicator was off the scale — I think the needle was up against the stop. I took off a bit of power and put on some carburettor heat. The gyros had toppled but I got the aircraft level again, more by sensation than by instruments because they had all gone haywire. Things seemed to settle down for a short while and I turned to my passenger in the right hand seat and told her that whatever she did she was to watch the VSI and let me know what it was doing.

After a little while the turn and bank showed that everything was all right — the needle was back in the middle and the ball was in the middle. So I put on full power, turned the carburettor heat off, and began to climb again at 70 knots.

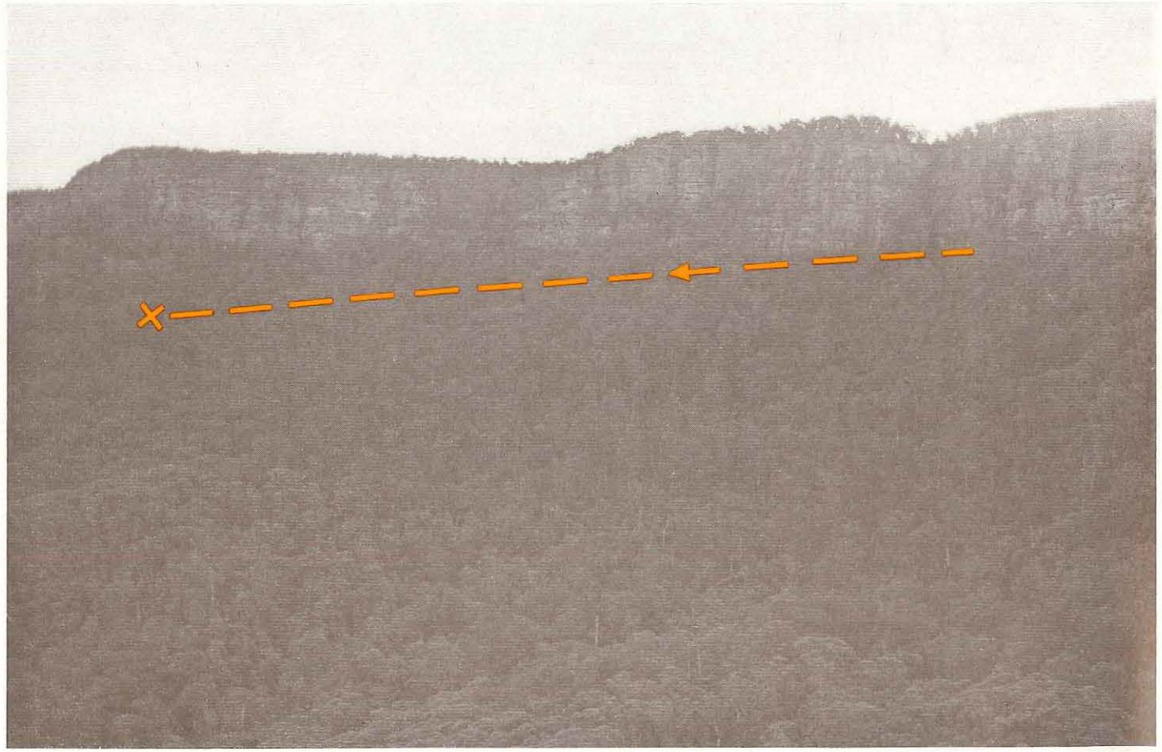
Then I got this vertical climb sensation again. The airspeed fell off and we seemed to go into a loop again. Everything was all over the cabin — I felt it was hopeless. I pulled the control column back and as we came out the bottom of the "loop", I saw trees through the mist directly ahead of us. We skimmed over the trees as the aircraft pulled out of the dive and I levelled out. Then the ground disappeared as we crossed the edge of a valley. Then I began to climb once more — it was the only thing to do — and I tried using the airspeed indicator. We must have gone into yet another loop and we dived out

Close-up of aircraft, showing cabin area and dislodged port wing lying across the top of the fuselage. Fuel from the port tank drenched the occupants before they could extricate themselves from the wreckage.

of the cloud again steeply nose-down, and levelled out this time only 20 feet above the trees. I then decided to try and fly visually but the cloud was almost on the trees. Suddenly a low hill materialised out of the cloud directly in front of us — I had to jerk the control column hard back, but even so the propeller just caught a tree as we began to climb. Branches and leaves went everywhere — the windscreen seemed full of flying greenery.

I pushed the control column fully forward again and managed to regain sight of the trees but it was drizzling and extremely difficult to see which way we were going at all. I throttled back a little and slowed down, put down 10 degrees of flap and tried to fly at 60 knots. At this stage I remember the back window had been broken — it had been caused by the picketing stakes being thrown about and crashing through the window. I was sweating with apprehension now, so I turned the cold air vent full on and tried to settle down a bit. Thinking about the tree we had just hit, I realised that to continue like this was absolute madness — it would happen again. So I applied full power, raised the flaps and began to climb once more at between 60 and 80 knots.

I got the aircraft settled into quite a reasonable climb and we must have been climbing for, I think, somewhere in the region of four minutes. In fact I was just about able to see the sun shining through the clouds. The wings were level on the turn and bank indicator, though the airspeed indicator was fluctuating a little bit. During the climb there had been some gentle turbulence but now I noticed the VSI jumping madly. The altimeter was still showing a climb but its movements were irregular. It would move about 100 feet and then pause for quite some time, then it would move another 100 feet and pause again. The next thing I remember we seemed to be in a spiral dive and then I saw the ground — it was rocky and heavily timbered and very close. Then we went up into cloud again briefly and as we came out I saw the ground again.



The valley in which the accident occurred, showing the aircraft's approximate final flight path and the accident site close to the base of the cliff.

Rear view of the extensively damaged aircraft. The heavy timber and the dense undergrowth are clearly evident in this picture.

This time we were over a tableland and over to the right I could see something like a cliff edge with the cloud falling over it. I decided I just had to put the aircraft down somehow or else we would all be killed.

I thought if I went left, we might be turning into higher ground because I couldn't see in that direction very well — the visibility was very, very poor. I decided that if I went right and turned 180 degrees and started letting down we'd probably be all right. So I reset the directional gyro and began a fairly gentle turn. I think it steepened to about 60 degrees of bank at one stage, then I levelled out and began to slow the aircraft down. I took off power and put it in a gentle descent — the VSI was coming down gradually but still fluctuating. We were in cloud or mist for about a minute but I continued to slow the aircraft down and when the trees became visible again I turned everything off -- master switch, ignition and fuel. Then I looked ahead across the tree-tops and just kept pulling the control column back and back and back as though I were "feeling" the aircraft on to the ground. I knew it was clutching at a straw but it was our last hope. The aircraft was very nose-up. I think the tail hit first, I looked down at the ground then, and I thought it was the end. I don't really remember much after that. When I came to, I realised that I must have banged my eye, probably on the control column. We were drenched with fuel from the severed port wing. Everybody else had remained conscious and we got out — I told the passengers we must stay with the aircraft."

Comment

If there were ever any doubts as to the veracity of the old saying that "truth is stranger than fiction", this pilot's story should put an end to them for all time. The spontaneous understatement of his description, which gives his account such an unmistakeable note of authenticity, also brings out the stark terror of the incredible series of events that befell the occupants of the aircraft before their flight came to such an equally improbable end.

Questioned after the accident, the pilot said that although he understood the limitations of VFR flight, he had descended into cloud "because the success of the flight depended on me getting there". Some time before the flight he had undergone one hour's dual instruction in instrument flying and he had also "studied it" himself. On this occasion, he "just wanted to do everything possible to make the flight a success" and "had no fears about flying in cloud".

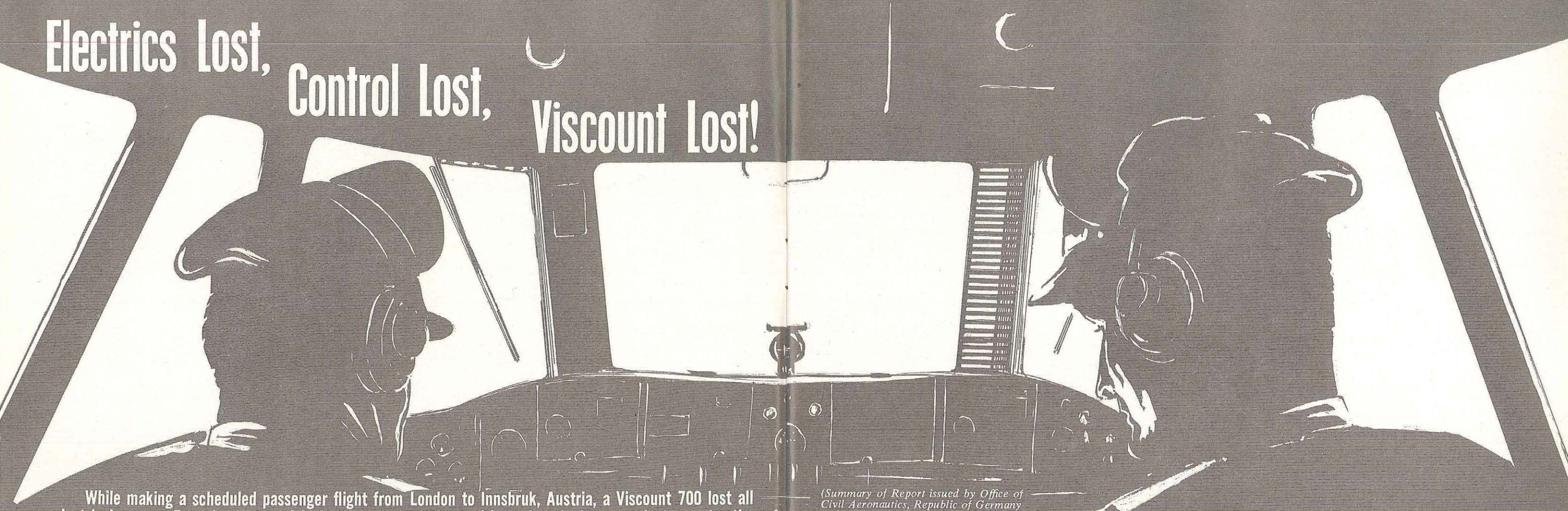
It is all too evident from the subsequent events that quite apart from this pilot's almost incomprehensible disregard for Air Navigation Regulations, and the safety of his passengers and other airspace users he had no real idea or experience of instrument flight technique. The frightening results of his several attempts to control his aircraft in cloud provide indeed, a most effective demonstration of the physiological processes described in the accompanying article "Sensory Illusions in non-visual Flight", on page 18. The pilot's unforgettable experiences also vindicate in a most dramatic way the point that the Digest has been attempting to make to some of its readers for a long time — that, to continue into non-visual conditions when not qualified for instrument flight, is to invite disaster.

It is not less than tragic that so many pilots, now no longer with us, have failed to heed these past warnings and object lessons.

The pilot concerned in this latest accident now realizes how utterly wrong he was in believing he could fly in Instrument Meteorological Conditions. He also appreciates that his is a rare privilege in being able to recount the results of his attempts to do so. He is anxious that other pilots, similarly disposed to try it for themselves, should have the benefit of his unique experience before they too, fall victim to the same insidious snare. We acknowledge his co-operation and complete frankness, in sharing his experience through the pages of the Digest.

It is to be hoped that this necessarily rare first-hand account of what happens when a non-instrument pilot is deprived of all visual reference, will now prove a more timely and effective deterrent to others who may still feel tempted to enter cloud in an ill-advised effort to complete their flight as planned.

Electrics Lost, Control Lost, Viscount Lost!



While making a scheduled passenger flight from London to Innsbruk, Austria, a Viscount 700 lost all electrical power. Forced to descend in instrument conditions without functioning gyro instruments, the crew lost control of the aircraft. Both wings subsequently failed outboard of the two outer engines and the aircraft crashed on to an autobahn near the village of Langenbruck, Bavaria. All 48 occupants were killed.

(Summary of Report issued by Office of Civil Aeronautics, Republic of Germany and published by Department of Trade and Industry, United Kingdom.)

The aircraft had departed London Airport at 1037 hours GMT with an estimated time of arrival at Innsbruk of 1317 hours. The aircraft's endurance was five hours.

The weather over the latter portion of the aircraft's route was expected to be fine but overcast with four to six eighths of alto-stratus and alto-cumulus cloud between 7,000 and 16,000 feet. Actual weather conditions in the area of the accident were however, considerably worse than forecast. There was a stationary front lying across the route and the sky was completely overcast by cloud with a base of between 700 and 1,000 feet and tops extending to about 16,000 feet.

The flight apparently proceeded normally, until after the aircraft passed Allersberg at 1252 hours (see map), during which it maintained communications successively with Air Traffic Service units at London, Brussels, Frankfurt and Munich. At this stage of the flight, the aircraft was still in contact with Munich ATS, and advised that its ETA at the next reporting point, the NDB "Mike", 31 miles to the south-east of Allersberg, was 1302 hours. The aircraft was being observed on radar at Munich and, at 1302 hours, Munich Radar informed the aircraft that it was now passing the "Mike" NDB and that it was cleared to descend to Flight Level 120. This clearance was in accordance with a previous request from the aircraft for a descent from the "Mike" NDB, preparatory to an approach to Innsbruk. There was no reply to this transmission, nor to further calls made to the aircraft, but Munich continued to observe the aircraft on radar until it was about another 13 miles to the south of the "Mike" NDB. From this point on, the aircraft target was no longer visible on the radar screen.

Nothing more was heard or seen of the aircraft until 27 minutes later at 1329 hours, when witnesses on the ground near Langenbruck, seven miles north of the "Mike" NDB, heard a loud report in the overlying cloud. They then saw the aircraft emerge from the cloud base at a high rate of descent, and plunge into the ground immediately to one side of the embankment of the Munich-Nurnberg autobahn. The wreckage was thrown against the embankment, scattering burning fuel and components on to the autobahn itself. A by-stander was injured by the flying debris and one motor vehicle was damaged.

* * *

The aircraft had struck the ground on a northerly heading and, at the initial point of impact, marks of the four engines and an impression of the underside of the fuselage were clearly recognisable. From these impact marks, together with the height and position of a power line which crossed the aircraft's final descent path a short distance away, it was evident that it had struck the ground at an angle of at least 12.5 degrees. Some 6,000 feet back along the final flight path, both outer wing sections of the aircraft were found, together with a number of smaller pieces of wreckage. Part of the port elevator and elevator anti-balance tab were also found some 1,200 and 1,500 feet respectively from the main impact point (see diagram). It was obvious that all these components had been shed in flight.

Examination of the demolished and burnt-out wreckage showed that both wings had fractured symmetrically immediately outboard of the two outer engines. It was evident that the wing failures had occurred simultaneously as a result of overstressing in the direction of positive lift, and probably at an airspeed in excess of 310 knots. No sign of fatigue was found in any of the fractures of the wings or elevators, and there was no evidence of any malfunction of the aileron controls before the failure of the wings, or of the elevator or rudder controls before impact. At the time of the crash, the undercarriage and the flaps were in the retracted position.

An examination of the engines showed that all four were operating normally up to the moment of impact. It was not possible to determine with any certainty how much power the engines were developing at the time, but there was some evidence to indicate that their power outputs were probably in or a little above, the idling range.

The aircraft was fitted with a flight data recorder and despite the considerable damage this had sustained in the crash, it was determined that the aircraft's DC supply to the inverters had failed within a short period of time while the aircraft was cruising at Flight Level 210 on headings corresponding to the route segment from the Allersberg reporting point to Munich, via the "Mike" NDB.

A complete examination of the aircraft's electrical supply system was not possible because of the extensive damage sustained in the crash and the ensuing fire, but no indication of any electrical fault or overload was found in the many components examined. Although the aircraft's four DC generators were running at the time of impact, both AC inverters, which are energised by the aircraft's batteries, were stationary. Similarly, none of the aircraft's radio communications equipment, radio navigational aids or electrically-powered flight instruments were being energised, and the gyros of each of the aircraft's two artificial horizons, gyro compasses, and turn and bank indicators, were stationary at the time of impact.

The aircraft's certificate of maintenance was valid and all mandatory airworthiness requirements current at the time had been complied with. However, a modification of the means of reconnecting the generators in flight, involving the addition of an auxilliary reset switch, which had been recommended by the manufacturer nearly 10 years before, had not been incorporated in this aircraft.

The hours logged by the engines, propellers and auxiliary equipment were all within specified limits at the time of the accident, but a total of twelve electrical faults had been recorded in the aircraft's technical log during the preceding five months, the last one three days before the accident. It was also found that the aircraft's four DC generators had tripped out on a number of occasions, sometimes without their corresponding warning lights illuminating.

As it seemed possible that such an occurrence could have initiated the chain of events that led to this accident, ground tests were carried out on another Viscount aircraft of the same type, to establish how long this would take to affect the voltage of the electrical system with normal in-flight electrical loads. With power being supplied only by the aircraft batteries, it was found that the DC voltage dropped below 20 volts after 31 minutes. The VHF transmitter failed after 33 minutes, and the inverter warning light illuminated after 39 minutes. After 43 minutes, the DC voltage had dropped below nine volts. Other tests carried out on a single battery of the type fitted to the aircraft, produced equivalent results. According to information supplied by the aircraft manufacturer, a minimum of 16 volts would have been required to reconnect the generators in this aircraft as it was not fitted with the auxiliary reset switch previously recommended.

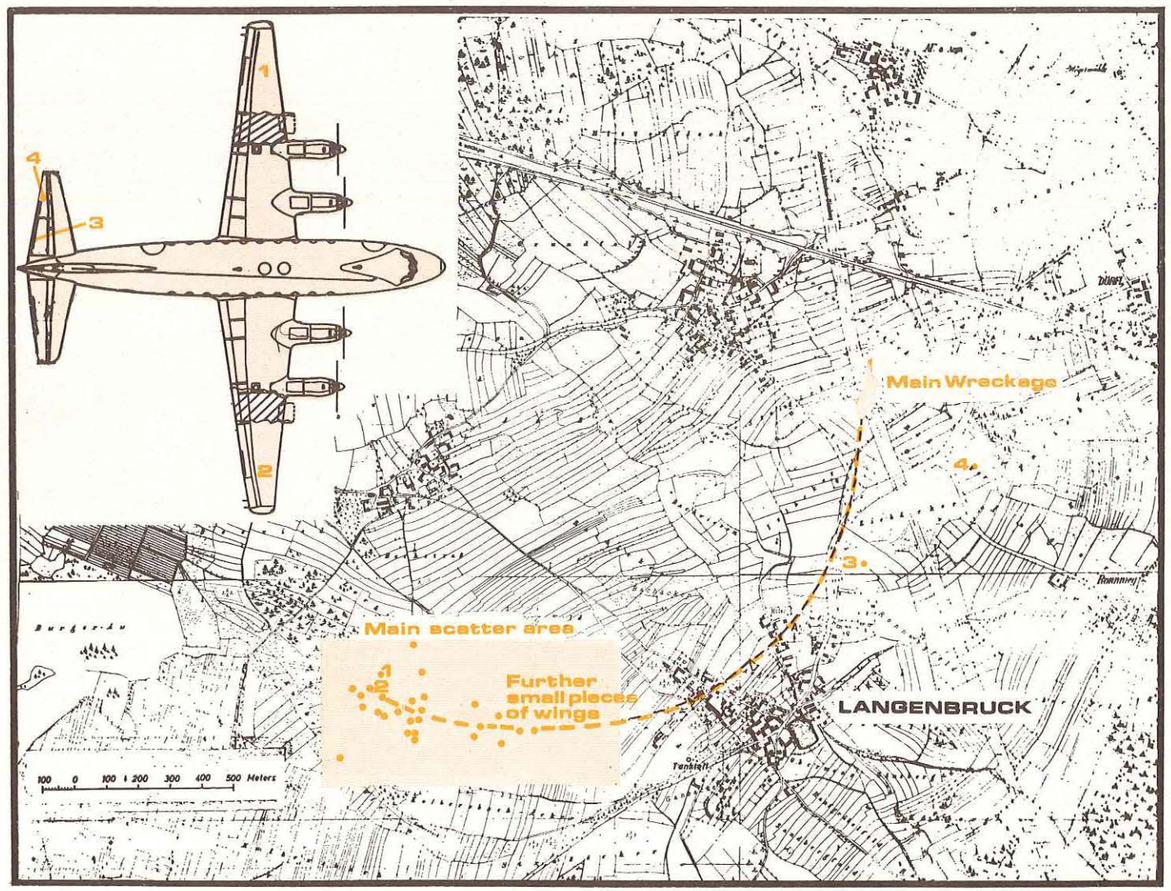
Tests were also carried out to determine how long the artificial horizons and turn and bank indicators would have remained operative after the electrical supply failed. It was found that from the time the power was disconnected, the artificial horizons continued to show the bank attitude for five minutes with not more than a two degree error. Some 10 minutes after the loss of power, the error increased to about 10 degrees, after which the readings became progressively less reliable. The pitch indication remained normal for about 13 minutes after the power was disconnected, and the gyros stopped completely after about 15 minutes. In this type of aircraft, the artificial horizons are energised from the AC inverters and further tests showed that normal readings of the artificial horizons could be obtained with the inverter input voltage as low as 9.6 volts. Below this, the power supply "off" indication appeared on the instrument, and when the input voltage dropped below 5.5 volts, unstable readings were obtained.

The test of the turn and bank indicators showed that the accuracy of the turn needle remained within permissible limits until the DC voltage was reduced to 17 volts. Indications in the correct sense continued to be obtained down to a minimum voltage of 3.5 volts, when the gyro stopped rotating altogether. It was also found that, from the time normal power was disconnected from the instrument, it took about 34 seconds for the gyro to come to a standstill.

* * *

From the evidence of the investigation, it may be concluded that, some time between when the aircraft passed over the Allersberg reporting point and it reached

Map of area in which accident occurred, showing final flight path and general distribution of wreckage.



the "Mike" NDB reporting point, the VHF transmitter failed. It is also evident, from the fact the aircraft's transponder was selected to the code prescribed for communication failure, that this failure was noticed by the crew.

As there was no evidence of any fault in the equipment itself, it must be assumed that this radio failure was the result of the loss of electrical power. The flight data record shows that there was a rapid fall in the DC voltage being supplied to the AC inverters which could only have resulted from the inverters being powered from the batteries alone. As the generators were still being driven by the engines when the aircraft crashed, and there were no indications of electrical failure in the busbar terminals, it can only be concluded that the generators were disconnected from the main busbar. As a number of faults in the aircraft's electrical system had been recorded during the preceding five months and as the generators had tripped out unexpectedly on other occasions as well, it seems quite possible that when these previous faults were remedied, their true cause was not established.

With the generators thus disconnected from the main busbar, the aircraft's entire electrical system was being supplied only by the batteries, and as a result of this heavy current drain, the battery voltage dropped continuously until it failed completely.

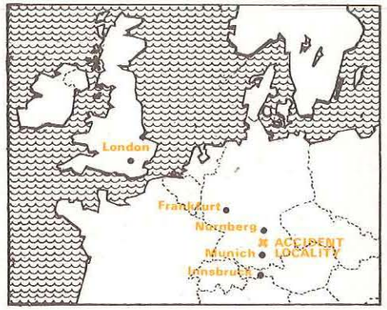
It is not known to what extent the crew realised the aircraft's electrical system was failing when their VHF transmitter radio ceased to operate. As it is very unlikely that the four generator warning lights on the instrument panel would have gone unnoticed, it seems doubtful that the generator failure was indicated by these warning lights. The fact that the DC generators had become disconnected could also have been determined from the aircraft's four ammeters, but as these are located on the starboard side of the cockpit behind the pilots' seats, the crew would hardly have been keeping these instruments under constant observation, particularly as the generator warning lights are so much more readily observable. A further means of checking the electrical system is on the overhead instrument panel where, by selecting a switch, it is possible to measure the voltage of the batteries and the voltage being produced by the generators.

There can be no doubt however, that if the DC supply failure had been recognised by the crew at the time, they would have immediately switched off all unessential equipment, some of which would have been consuming very heavy current. Had this been done, there would have been sufficient power available from the batteries to supply the navigation and radio equipment, essential for a descent and landing at the nearest airport. It is clear from the flight data record that the crew did not take this action.

The other action which the crew would have undoubtedly taken, had they recognised the failure in time, would have been to try and reconnect the generators. However, because this aircraft had not been modified as recommended by the manufacturer, there was only one way in which this could be achieved and this system would not have been able to function once the DC voltage had dropped below 16 volts. The system would also have been inoperative with an unremedied defect in the voltage control circuit and it therefore seems doubtful whether any such attempt could have been successful. In any case, from the fact that a minimum of 20 volts is required to operate the VHF transmitter, it would probably have been too late to reconnect the generators only a minute after the aircraft had passed the "Mike" NDB, for the simple reason that the battery voltage was already too low.

It seems possible that when the radio failure occurred the crew, in accordance with the regulations, continued the flight to the terminal airport at Flight Level 210. They probably did not abandon this intention until they realised that their radio navigation equipment had also failed and that a descent in visual meteorological conditions was not possible at Innsbruk. From the weather information previously supplied to them, they would have known that they had insufficient range to reach any other airport where a descent in visual meteorological conditions would have been possible, and, after turning back from the mountainous terrain around and to the south of Innsbruk, it seems probable that they decided to descend while they could still make an approximation of their position. Unknown to the crew however, the weather in the area of their descent was considerably worse than forecast with cloud tops at 14,000 to 16,000 feet and a base between 700 and 1,000 feet above ground level.

From the flight data record and other evidence, the aircraft's battery voltage would have dropped below the minimum required for reliable indications of the artificial horizons and turn and bank indicators within ten minutes of the aircraft passing the "Mike" NDB. The only



Locality map showing reporting points and accident site.

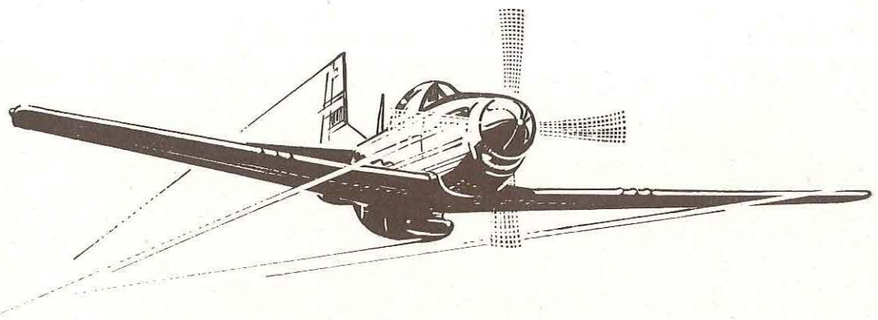
instruments still available to the crew would thus have been the slip indicators, the emergency compass, the altimeters, the vertical speed indicators and the airspeed indicators, provided these had not been affected by pitot icing after the electrically powered pitot heaters had ceased to operate. As a result, the crew would have been without any means of determining the attitude of the aircraft during their attempt to descend in cloud. This inevitably resulted in uncontrolled flight attitudes, producing severe structural loadings which finally exceeded the ultimate strength of the airframe. From a reconstruction of the final flight path, and the cloud base in the vicinity of the accident, there is no doubt that the outer wing sections failed and broke off while the aircraft was still in cloud. The loud report heard by witnesses on the ground, shortly before the aircraft was seen to plunge from the base of the overlying cloud, was probably the sound of the wings fracturing. There was no possibility of controlling the aircraft from this point onwards.

Cause

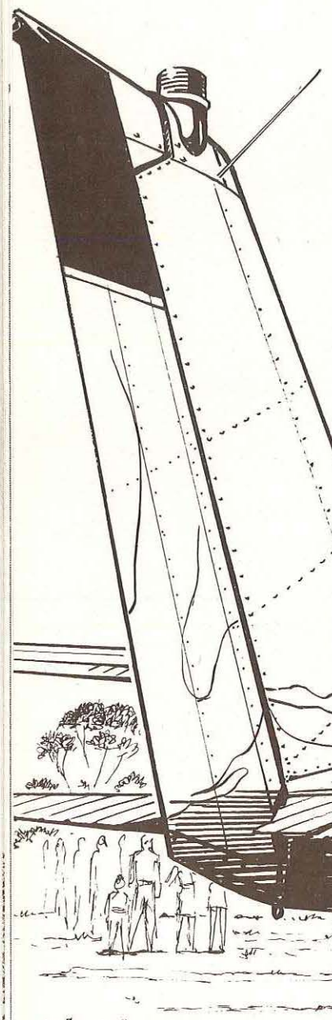
The accident is attributable to the fact that the aircraft's electrical power supply failed in cruising flight, possibly without the generator warning lights illuminating. During the subsequent descent, which had to be carried out on instruments because of the weather, the vital instruments for indicating the flight attitude showed increasingly incorrect readings and failed completely after the gyros had stopped rotating.

Under these conditions, uncontrolled flight attitudes were unavoidable, during which the aircraft was subjected to severe loading. These loads exceeded the ultimate load and led to structural failure.

It has not been possible to determine with certainty the cause of failure of the electrical system.



'One More To Make Three'



As part of the programme at an air pageant to mark the opening of a new aerodrome at Bendigo, Victoria, arrangements had been made for a privately-owned Mustang aircraft to fly a series of "passes" over the aerodrome to coincide with the official opening ceremony.

As neither of the aerodrome's two gravel strips were long enough for Mustang operations, the aircraft was to fly to Bendigo from its base at Moorabbin, make one, or two, low runs not below 500 feet and then return to Moorabbin. The day before the pageant, the owner-pilot of the Mustang was briefed over the telephone on the timetable to be followed and general conduct of operations, and at 1424 hours on the day of the opening ceremony he took off from Moorabbin as planned and set out for Bendigo under an overcast sky.

* * *

The weather in the Bendigo area was fine and cloudless with a 10 to 15 knot wind blowing from the south-west. At about 1450 hours, the controller on duty in the temporary control tower at Bendigo aerodrome received a call from the Mustang advising that it was 10 miles out. As other aircraft were engaged at the time in display flying, the Mustang was requested to hold for the time being over the city. Five minutes later, as the official party had not yet arrived for the scheduled opening, the pilot was advised that there would be a delay in the programme of approximately 20 minutes.

After the official party had arrived and the opening ceremony had commenced, the pilot of the Mustang, now operating at 3,000 feet in the circuit area, was cleared to position his aircraft to the north-east of the aerodrome in preparation for a low run to the south-west over one of the two strips. Shortly after 1515 hours, an organising official signalled to the controller that the aerodrome was about to be declared officially open, and the Mustang was cleared to commence its fly-past. Rolling into a turn, the pilot lowered the nose of the Mustang and descended with increasing speed towards the threshold of the strip.

Crossing the aerodrome boundary at a height between 200 and 300 feet, the aircraft continued to descend until it was only about 150 feet above the strip. At a speed estimated by expert witnesses to be about 250 knots, the pilot held the aircraft down until it reached the far threshold of the strip, then raised the nose to about 30 degrees and climbed away straight ahead. The pilot allowed the speed to decay during the climb and, at about 1,500 feet, without lowering the nose he initiated a slow, moderately banked turn to the left to reposition the aircraft for a second run in the reciprocal direction along the same strip.

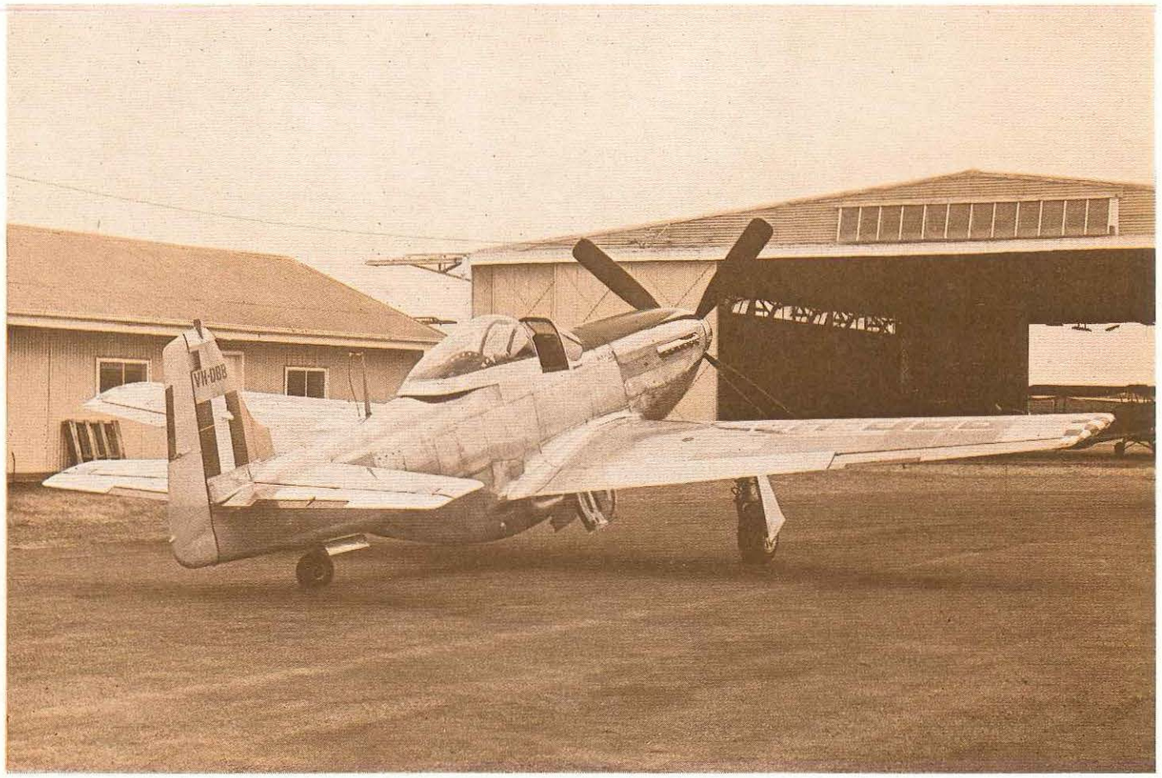
Approaching the aerodrome again, the aircraft appeared to be descending lower than on its first pass but, on being warned by the tower controller that there were power lines close to the strip threshold, the pilot abruptly checked the descent. Maintaining about 270 knots, the pilot again held the aircraft down almost to the end of the strip before climbing away once more at about 30 degrees. Meanwhile the pageant organisers had asked the controller to arrange for the Mustang to make one more run. The controller therefore called the aircraft at this stage and requested "One more to make three", and the pilot acknowledged the call.

The aircraft continued its steep climb to about 1,500 feet as the speed decayed and, again at low airspeed without any apparent lowering of the nose, the aircraft banked steeply into a tight, almost vertical turn to starboard. Almost immediately, the nose dropped and the Mustang flicked into a roll to the right which continued for two and a half turns as the aircraft descended at an angle of about 30 degrees. Between 1,000 and 800 feet, the aircraft appeared to hesitate momentarily on its back with the nose down about 45 degrees, then fell away in a tight, descending spiral to the right, making about four more turns before disappearing behind trees beyond the north-eastern boundary of the aerodrome. A few seconds later, black smoke rose in clouds from where the aircraft had gone down.

Immediately, the pilot of a Beech Musketeer who had been waiting to depart was cleared for take-off and, shortly after becoming airborne, reported sighting the wreckage of the Mustang in an area of forest two miles north-east of the aerodrome and approximately in line with the strip. The wreckage was burning fiercely and the fire had spread to the surrounding timber. Ground parties arriving on the scene a short time later found that the aircraft had been almost completely destroyed and that the pilot had been killed.

* * *

The extreme force with which the aircraft had struck the ground had almost completely demolished its structure and much of what remained was reduced to ashes by the intense fire that followed. Although damage to the surrounding trees confirmed that the aircraft was descending almost vertically immediately before the impact, it was evident from the disposition of the wreckage that the aircraft had struck the ground in a relatively flat attitude. Little conclusive evidence could be obtained from an examination of the wreckage, but there



The ill-fated Mustang being prepared for flight at Moorabbin Airport shortly before taking off for Bendigo on the day of the accident.

—D. L. Prossor photograph

General view of accident site, looking in approximate direction of impact. The aircraft's near vertical descent is evident from the broken upper branches of the tree on the right of the picture.

was nothing to suggest any malfunction which might have contributed to the accident. The aircraft had been issued with its initial certificate of airworthiness only seven weeks before the accident and its conversion to civil airworthiness standards and subsequent routine maintenance had been carried out to a high standard virtually without regard to cost. Damage sustained by the engine and propeller, both of which were unaffected by the fire, clearly indicated that the engine had been operating at high power at the moment of impact. This fact was supported by the evidence of many witnesses, two of whom were experienced Mustang pilots who had watched and heard the aircraft operating normally and at high power during the display, and as it climbed away from the aerodrome for the last time.

The pilot held an unrestricted private licence endorsed for Mustang aircraft and had accumulated a total of 440 flying hours. His flight time in the Mustang however, amounted to only 25 hours, the remainder of his experience having been gained in light training and touring aircraft. The pilot had obtained his Mustang endorsement after a little over two hours training in the aircraft. The conversion was conducted by an experienced Mustang pilot who held a Senior Commercial Licence and had a wide background as a service and civil flying instructor. During numerous briefings before his first flight in the Mustang, the pilot was given extensive instruction on the aircraft's handling characteristics, systems and emergency procedures. He was especially warned against mishandling of the controls and the tendency of the aircraft to "flick" when stalled in a steep turn.

Three days after obtaining his endorsement the pilot made another flight of three hours duration to gain further experience on the type. This total of five hours was the only flying the pilot was known to have spent on training and familiarisation. Of the remaining 20 hours, 16 were accumulated on travel flights, and the pilot's log book did not disclose the nature of the flying he had carried out during the other four hours he had logged in the Mustang.

The pilot had also owned a Chipmunk and had been given some aerobatic training in this aircraft. The training consisted of just over four hours total time spread over five separate flying periods. All the basic manoeuvres had been covered but there was no record of the pilot having performed aerobatics at any time when flying solo, nor was his log book endorsed for solo aerobatic flight.

Because the evidence of a number of reliable witnesses clearly indicated that the turn at the end of the aircraft's second run was quite tight, consideration was given to the possibility of the pilot having lost control as a result of blacking out under high flight loads, or having become incapacitated in some other way. However, as he appeared to lose control early in the intended 180 degree turn, it was considered most unlikely that he would have been affected by "g" forces to any appreciable degree by that stage. Furthermore, the onset of a black-out is progressive and the condition can be relieved promptly by easing the back pressure on the elevator controls, so reducing the load factor. Neither the pilot's medical history nor the pathological examination conducted after the accident, revealed any condition which could have caused a sudden physical incapacitation. The evidence that the aircraft was checked momentarily before it entered the tight, vertical spiral, suggests that the pilot might have effected some degree of control recovery, an action not consistent with his being incapacitated.

The aircraft was fitted with the standard Mustang rear fuselage fuel tank which has a capacity of 70 Imperial gallons. The quantity of fuel in this tank has a significant effect on the stability of the Mustang about its pitching axis and the pilot's notes for the aircraft type state that, unless manoeuvres are confined to very gentle turns when the contents of the fuselage tank exceed 30 gallons, a

marked tendency for the aircraft to tighten in a turn will be experienced. The investigation therefore considered the possibility that the fuel load in this tank might have precipitated the loss of control.

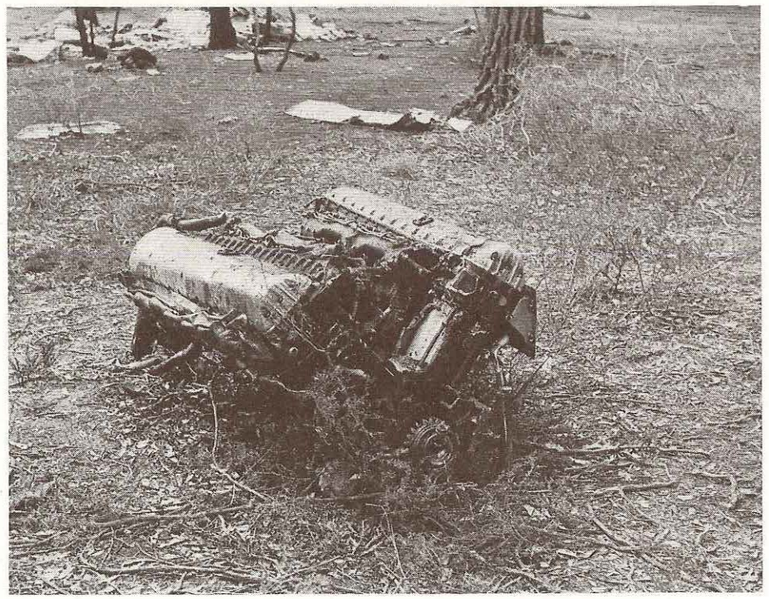
The aircraft had been refuelled at Moorabbin before departing on the day of the accident. The wing tanks were filled to capacity and 20 gallons were added to the fuselage tank. The refuelling agent said later that this did not fill the fuselage tank, and he did not know how much the tank contained before the 20 gallons were added.

The aircraft's certificate of airworthiness stipulated that engine starting, run-up, take-off and climb to operating height were to be made using the port main fuel tank, after which fuel was to be drawn from the fuselage tank. It was also stipulated that five gallons were to be retained in the fuselage tank for landing. The owner-pilot of the Mustang had a reputation for being thorough and precise in operating his aircraft, and there is little doubt that he would have observed these requirements during his previous flight in the aircraft. It is probable therefore, that before this last refuelling, the tank contained between five and ten gallons and that the additional quantity brought the total contents to about thirty gallons.

Calculations taking into account the aircraft's probable fuel consumption during the flight from Moorabbin, the likely sequence of fuel tank usage, and the remaining endurance reported by the pilot while he was holding over Bendigo, indicate that the fuselage tank probably contained ten gallons or less at the time of the accident. Examination of the fuel cock revealed that it was selected to draw fuel from the starboard wing tank. This fact also suggests that the contents of the fuselage tank had already been reduced to ten gallons or below. Further examination of the wreckage showed that although the fuselage had been consumed by an intense fuel fire, this had been fed not by the fuselage tank but by the contents of the port wing tank which had burst across the fuselage when the impact tore off the wing. On the basis of this information, it was concluded that the fuel load in the fuselage tank had no bearing on the accident.

* * *

It is quite clear from the available witness evidence that, at the end of his second run, the pilot climbed very steeply before initiating a tight, almost vertically banked turn to starboard in a nose high attitude. This, combined with the low airspeed and the Mustang's high wing loading, placed the aircraft in a critical situation where a stall and flick was almost certain to result.



In view of his earlier briefings on the Mustang's possible behaviour in a steep turn, it is most unlikely that the pilot would have deliberately placed the aircraft in this situation at such a low height. Clearly, however, he was inexperienced and therefore unfamiliar in handling an aircraft in any way similar in character to the Mustang. Although the pilot had practised normal stalls during his conversion to the Mustang, there was no evidence that he had attempted stalls off steep turns, or spins of any type, in this aircraft.

In the opinion of one of the eye-witnesses who had extensive Mustang flying and instructional experience, a pilot familiar with the type could have comfortably recovered from the flick rolls within one rotation and indeed, even prevented them by anticipation and immediate reaction. In this case, however, the pilot's total aerobatic experience was very limited and confined to Chipmunk aircraft, and it is evident that he did not recognise the impending stall. Although the pilot apparently achieved some degree of recovery at one stage, there can be little doubt that he would have been disorientated by the sudden onset of such a rapid manoeuvre, and therefore had little hope of recovering fully in the very limited height available.

Notwithstanding the pilot's lack of experience on the aircraft type, there had been no suggestion at any time that he was expected to include in his display any manoeuvre he was not capable of performing. The pilot's decision to descend below the authorised minimum of 500 feet appears to have been made on the spur of the moment and was undoubtedly intended to make his runs appear more spectacular. Whether it was this same motivation that prompted the pilot to initiate such a tight turn at comparatively low height, or whether he simply over-banked during the turn to re-position the aircraft for his final pass will never be known.

Whatever the pilot's intentions were however, it seems clear that he unknowingly placed his aircraft in a situation which was beyond his ability to control, and the aircraft stalled and flicked into a descending spiral at a height too low for the pilot to have any hope of effecting a recovery.

Opposite page—

Top: The burnt-out wreckage of the aircraft, looking in the direction of impact. The starboard wing tip can be seen in the foreground.

Bottom: The engine as it was found at the accident site some 60 feet ahead of the main wreckage.

This page—

Wreckage of the central fuselage and cockpit area, with the remains of the rear fuselage in the background. The aircraft struck the ground in a flat attitude and, apart from cuts made by the propeller, left no ground marks of significance.

Cause

The probable cause of the accident was that the pilot, who was inexperienced on the aircraft type, attempted a manoeuvre in which his capacity to control the aircraft was exceeded.

Comment

The tragic outcome of this accident emphasizes the importance of a cautious and responsible attitude in operating an aircraft of this type, and the need for a pilot to be able to recognise the limits of his ability, as well as those of his aircraft.

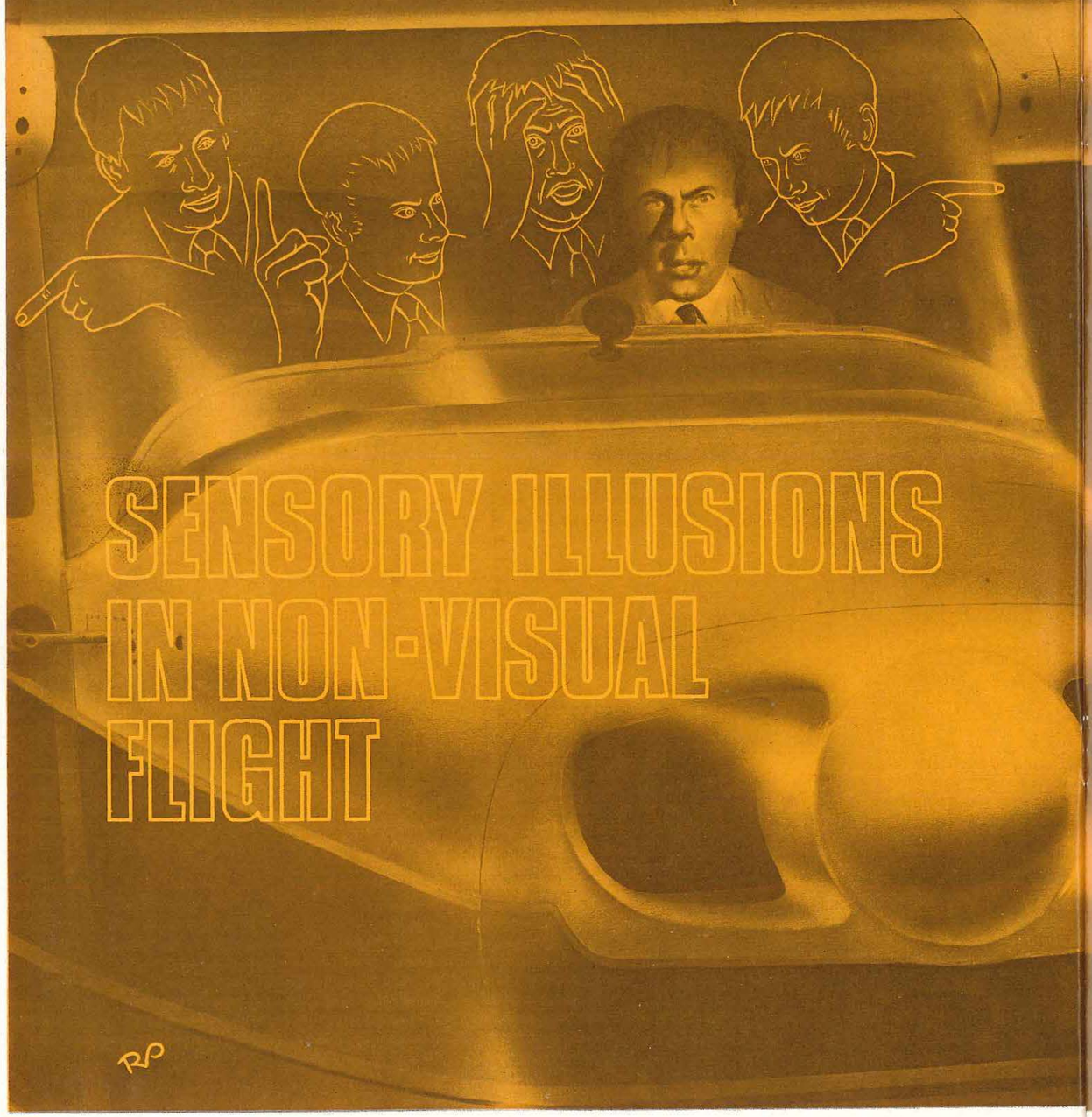
Modern light aircraft, especially those used for flying training, are designed to be easily controllable and forgiving in nature. Such characteristics are of course, highly desirable but they hardly prepare a pilot to cope with aircraft of the power, speed and wing loading of the Mustang. Service pilots who progress to advanced aircraft, do so in well-planned stages by gaining experience on intermediate types of increasing complexity. Such a procedure may not always be practicable for the holder of a civil licence and, in the case of a relatively inexperienced pilot who has not flown any similar type before, a great demand is made on his natural ability and general flying background. Procedures and operating techniques learned and practised in aircraft having the built-in safety margins of modern training types can compound a dangerous situation or even contribute to an accident in a high performance service-type aircraft where no such margin for error exists.

It is also significant that this accident occurred during a display and on an unplanned run. Experience over the years both in Australia and overseas has shown that it is during just such unrehearsed manoeuvres that accidents most often occur at air displays.

The deceptively heavy demands which display flying makes on a pilot's skill and concentration, especially when operating at high speed and low height, afford him little opportunity to assess the likely hazards of making an unplanned change in sequence. Pilots involved in display flying at low height should plan and rehearse the sequence of manoeuvres they intend to carry out. Factors such as the direction of flight, height, airspeed, location of spectactors and the possible demands of the weather, require particular attention during the planning stage and of course largely determine the form that the display finally takes. In this accident, the pilot's "plan" probably consisted of no more than a basic intention to make "one or probably two runs" over the aerodrome. Although the manoeuvres involved were comparatively straightforward, this could hardly be considered an adequate preparation in view of the aircraft's high performance and the pilot's inexperience.

A carefully prepared plan of operation is essential if the risks involved in hasty or ill-considered decisions are to be avoided.

'The pilot, who was not qualified for instrument flight, proceeded into weather conditions in which visual flight could not be maintained.'



SENSORY ILLUSIONS IN NON-VISUAL FLIGHT

RP

THESE stark words are the epitaph of many a private pilot and their theme has been repeated time and again in the Aviation Safety Digest over the years. Yet despite all this, there seems little doubt that similar tragedies will continue to occur in the future. In some cases they will go on happening because pilots will not recognise soon enough that they are compromising the margin of safety provided for in the visual flight rules to the point where it is simply not possible to turn back without entering cloud. In others, as in the case reported in detail on pages 2 to 7, accidents will continue to occur because the pilots involved have a completely false confidence in their ability to fly an aircraft entirely by reference to instruments. They believe that because they have never had the slightest difficulty in interpreting the instruments when flying visual, there is no reason why they should not be able to continue to do so, just because the view through the windscreen happens to be obscured by cloud!

Taken to its logical conclusion, this type of thinking would imply that the long, expensive, and arduous training undergone and maintained by professional instrument rated pilots is quite unnecessary; that any pilot can fly in marginal weather, in cloud or at night, provided his basic manipulative ability is sound and of a high enough standard. There is an old saying that "a little learning is a dangerous thing" and any such premise is obviously very much in this category, because it takes no account whatever of that most important occupational hazard of flying without visual reference — physiological illusions.

These illusions are false sensations or perceptions, derived from the various sensory mechanisms of the body, especially the organ of balance. They are a natural physiological phenomena in instrument flight and are common to all pilots. The difference with instrument rated pilots is that they are trained to disregard them, and to interpret only the indications of the aircraft's instruments! It is the difficulty of learning to disregard these illusions, just as much as the actual task of learning to control an aeroplane on instrument indications alone, that makes instrument training so absolutely vital to any sort of flying without full visual reference.

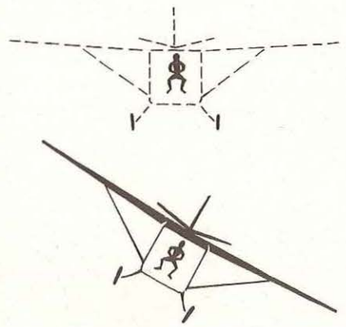
Flight is not a natural environment for man and it is not one for which the human sensory mechanisms are well suited. But because the most powerful stimuli received by the brain are those of vision, a pilot in visual flight learns to use his eyes to counteract most of the false sensations from the other sensory organs. For example, all pilots will remember something of the confused feelings or sensations experienced during their first flight; but very soon with further experience, these strange sensations ceased to be apparent — the aeroplane no longer seemed to be "standing still" in the air, the horizon no longer "tipped" when the aeroplane banked, and so on. In other words, a student pilot learns to overcome the false sensations produced in the brain by the movements of an aircraft in flight, and learns to see these movements as they really are.

All remains well while a pilot continues to receive such visual information from outside the aircraft — as we say while he can "maintain visual reference". It is important to note here that there is no such thing as "partial visual reference". Either the pilot has visual stimuli outside the aircraft or he has not. It follows, as most pilots will know from their own experience, that very little outside stimuli, for example the sight of just a small patch of ground through a hole in the cloud, can be sufficient to maintain the visual "input" that the pilot's brain continually needs to overcome the false sensations inherent in flight.

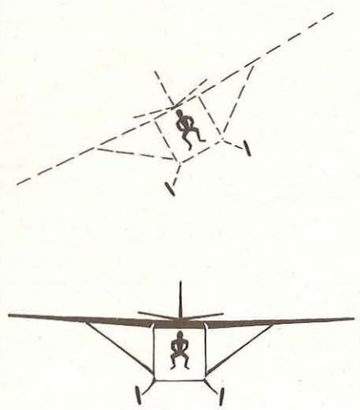
But once this outside visual reference is removed altogether, as can happen very quickly indeed when the remaining view of the ground is already small, the counteracting influence of vision on the brain is suddenly removed and the false sensations from the other sensory organs suddenly become paramount. Illusions of movement or attitude are then inevitable and, unless a pilot has learned by experience, in the form of instrument training, to ignore these illusions by concentrating his whole attention on instrument indications in a systematic way and reacting accordingly, their effect is overpowering. As a result a pilot can become absolutely convinced that his aircraft is turning, or that its attitude has changed, when in fact, it has not. Conversely, he can be led to believe that the aircraft is flying straight and level, when in fact it is "winding up" into a spiral dive. This, of course, is the natural aerodynamic result of any uncorrected banking or turning movement applied to an aircraft, as is demonstrated to all student pilots at a very early stage of their training.

Powerful illusions of this sort are the most common form of disorientation in flight and the loss of control that almost inevitably follows has been responsible for many fatal accidents in "below VMC" weather. They are also the explanation for the phenomenon experi-

INITIAL STRAIGHT AND LEVEL FLIGHT.



GENTLE BANK, PILOT FEELS AIRCRAFT IS STILL STRAIGHT AND LEVEL.



WHEN BANK IS CORRECTED ON INSTRUMENTS, PILOT FEELS HE IS BANKING IN OPPOSITE DIRECTION.

FIG.1

enced by nearly all who become disorientated in cloud — the belief that the aircraft's instruments have suddenly gone "wild", or "haywire", as one pilot has so succinctly put it elsewhere in this issue of the Digest! Pilots may be assured that it is very rarely the aircraft's instruments that suddenly lose their sense of order in these circumstances.

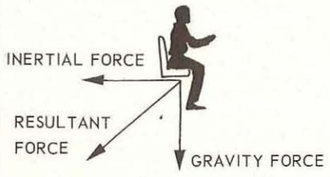
Accidents resulting from disorientation and loss of control in cloud follow a distinct pattern of development: The aircraft enters cloud, intentionally or unintentionally, in a straight and level attitude. As it does so, the world outside the aircraft changes almost instantaneously from one of familiar normality, to one remote and detached, where there is no "up" or "down" as we usually understand it, nothing but a bewildering wet grey void where time and distance seem to have lost their meaning. Inside the aircraft nothing seems to have changed yet and perhaps all is well so far, but the pilot cannot help being awed by this strange and unreal environment into which he has suddenly plunged. He is unable to resist frequent glances outside, as he sub-consciously seeks some glimpse of the familiar world which can so quickly restore normality and confidence.

But there is none; it is up to him to fly the aeroplane on instruments alone, those same instruments which in the past have been so helpful in making nicely balanced turns in the training area, and accurate rates of descent at the end of a cross-country flight but which suddenly have become such utterly inadequate substitutes for the sight of real earth and sky.

The pilot tenses a little and takes a firmer grip of the control wheel. For a few moments more all remains calm. Perhaps the aircraft feels as though it is descending a little, but the altimeter shows that it is not so there is no need for concern — undoubtedly this is one of the "believe your instruments" sensations he has read about! Perhaps this instrument flying isn't so hard after all — there, the bat and ball is still well and truly in the middle!

But soon the aircraft encounters some slight turbulence — perhaps only the sort of turbulence that will be found in the most innocuous patch of cloud. The aircraft bumps a little, the "bat and ball" oscillates gently and settles down again. But now the aircraft feels as though it is flying one wing low — why doesn't it settle down again too? Without thinking the pilot applies a little opposite bank

NORMAL SENSATION OF GRAVITY WHILE AT REST OR IN STRAIGHT AND LEVEL FLIGHT AT CONSTANT SPEED.



DURING ACCELERATION, INERTIAL FORCE ACTING AT RIGHT ANGLES TO GRAVITATIONAL FORCE, PRODUCES RESULTANT FORCE.

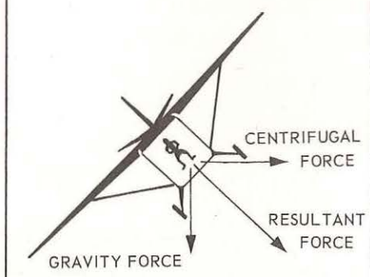
PILOT MISINTERPRETS RESULTANT FORCE AS THAT OF GRAVITY, OBTAINING SENSATION OF PITCH UP.

FIG.2

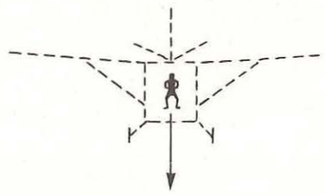
to correct the feeling. He watches the wing tips to try and see when they are level again. Ah! that's better — or is it? No, the aircraft still feels a bit one wing low. He adds a little more opposite bank. If only he could **see** where the wings really were in relation to the horizon! But that certainly feels right now.

He glances back at the instrument panel to confirm that the wings are really level. But now the artificial horizon shows a steep bank the other way! That can't be right — the aircraft still feels straight and level. But wait — which way **is** the artificial horizon showing — it's always a bit hard to interpret, especially when you can't see outside. He glances at the turn and bank indicator again. The ball isn't in the middle any more. And the turn needle is well over to one side too! But before he can think which way he should correct, his glance falls on the airspeed indicator — it is registering well above the aircraft's cruising speed! Very tense now, the pilot tries to correct in the most obvious way he knows, by easing back the control wheel. The speed begins to drop a little, but at the same time the vertical speed indicator, already showing more than a 500 feet per minute descent, dips frighteningly towards the 1,000 mark and beyond. And now the airspeed is increasing again, this time alarmingly, and with it the engine begins to overspeed, its note rising increasingly into an ear-splitting scream. As the spiral dive tightens the artificial horizon topples and gives up the struggle, the directional gyro spins furiously and the needle of the vertical speed indicator plummets to full deflection down. Panic stricken, the pilot realises too late that the situation is utterly beyond his ability. His training and experience have stopped far short of such demands.

If the base of the cloud is not too low when this sort of situation develops, there is a possibility that he may have room to recover from the resulting "graveyard spiral" before the aircraft plunges into the ground. But there is also an excellent chance of structural failure occurring during the recovery, as a result of the aerodynamic forces that this inevitably applies to the airframe. Even the few pilots who have been lucky enough to succeed in recovering control after emerging from the base of a cloud, have in most cases caused severe structural damage to their aircraft. Usually however, when a non-instrument pilot loses control in such a situation, the cloud base is already low,



DURING A TURN, CENTRIFUGAL FORCE, ACTING AT RIGHT ANGLES TO THAT OF GRAVITY, PRODUCES RESULTANT FORCE



BECAUSE RESULTANT FORCE ACTS IN SAME DIRECTION AS GRAVITY IN STRAIGHT AND LEVEL FLIGHT, PILOT FEELS AIRCRAFT IS STILL IN THIS ATTITUDE

FIG.3

if not actually lying on the higher terrain, and a catastrophic ending to the flight can be the only result.

The illusions which bring about disorientation and loss of control in cloud, though very "real" to the person experiencing them, are simple in character and can be traced to the vestibular apparatus of the inner ear which maintains the sense of balance. This organ achieves its purpose by conveying sensations of orientation to the brain. The vestibular apparatus consists of a sac and three semi-circular canals at right angles to each other. The sac contains a membrane which senses the direction of gravitational force, so controlling the balance of the body when it is stationary. The canals contain fluid and small sensory hairs connected to the nervous system. The fluid reacts to rotational movements of the head, stimulating the hairs so that a nerve impulse conveying an appropriate impression of movement is transmitted to the brain, thus controlling the sense of balance while the body is in motion.

The balance mechanism of this inner ear apparatus works well enough while we remain on our natural habitat — the ground. Here, even with our eyes closed, we can maintain our balance. But maintaining our equilibrium in the air is a very different matter. In the first place, in the three dimensional motion of flight, centrifugal force often distorts the effects of gravity and when this happens our balance and orientating mechanisms receive a misleading stimulus. For instance, in a properly co-ordinated turn, "down" is always felt to be the floor of the aeroplane, regardless of the angle of bank. Secondly, while our balance mechanism is well able to sense the comparatively small angular accelerations involved in normal body movements in relation to the ground, it can be completely deceived by the large scale angular accelerations imposed upon the body by an aircraft in flight. In very gentle turns, the rate of change of direction may be insufficient to cause any movement of the fluid in the semi-circular canals of the inner ear, so there will be no feeling of turning. In prolonged turns, even though a turn may have been sensed when it began, the fluid in the canal "catches up" with the motion of the aircraft. The turn is then no longer sensed and so we feel that the turn has stopped. Similarly, if a recovery from a turn is made suddenly, the inertia of the fluid in our inner ear canals causes it to flow for a brief period, which can give us the completely false impression that we are turning in the opposite direction.

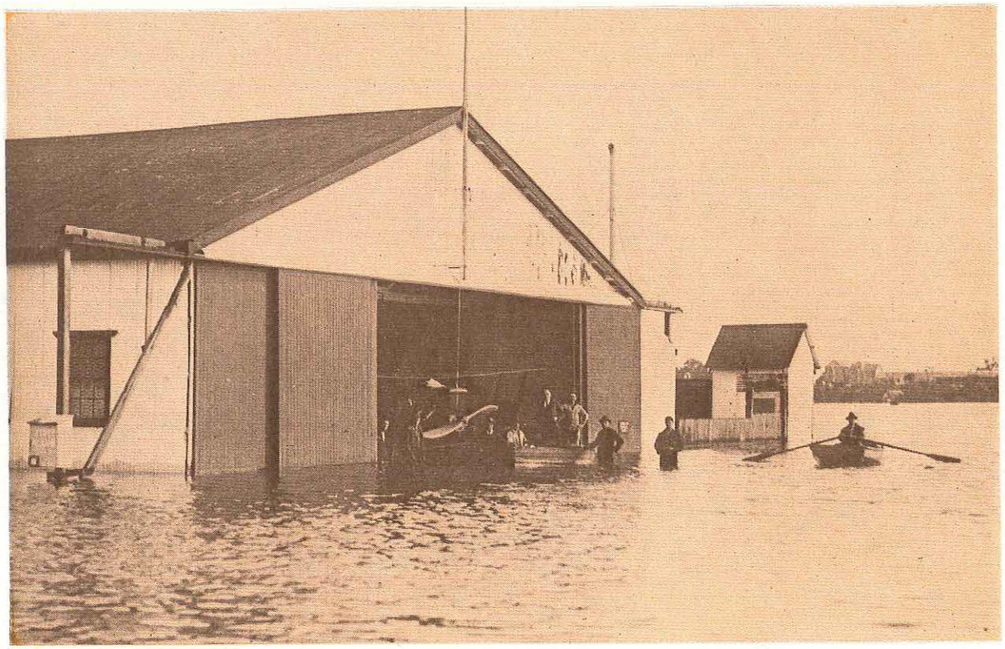
It should not be hard to see now why the effect of these reactions is to produce illusions and disorientation when an untrained pilot attempts to fly in Instrument Meteorological Conditions. For example, a gradual entry into a turn or spiral can go undetected until a dangerous degree of rotation has been reached. Another common illusion, sometimes experienced even by qualified instrument pilots, is "the leans". Should the aircraft recover slowly from a movement in the rolling plane, the pilot may feel that it is still banked. Conversely, if the aircraft makes a sudden recovery from a banked attitude, he might feel that it is banked in the opposite direction. Sensations of turning during straight and level flight, and sensations of climbing whilst banking are particularly convincing in Instrument Meteorological Conditions. Again, a rotary movement suddenly dis-

continued, can give a strong sensation of rotation in the opposite direction. This situation can occur during recovery from a spin when there is no satisfactory ground reference, and the sensation produced may be so strong that the pilot attempts to correct it and goes into a spin in the opposite direction. Another very powerful illusion which has been responsible over the years for a large number of accidents is the sensation of climbing during a rapid forward acceleration. During take-offs on dark nights with no visual reference once the flare path was left behind, this illusion has deceived even highly experienced instrument-rated pilots. As a result their aircraft have been unwittingly flown into the ground.

As already explained, the only way these illusions can be overcome is by using the sense of vision to counteract them. If there is no visual reference outside the aircraft, the pilot's vision must be transferred immediately to the indications of the aircraft's instruments. But, as pointed out at the beginning, for a pilot to gain sufficient visual stimulus from these instruments to enable him to overcome the illusions from his other senses, his responses must be conditioned by long and thorough instrument flying training.

There is simply no short cut to this stage — either a pilot has been properly trained to fly on instruments or he must face the inescapable fact that he will not be able to do so. If this is the case he must, at all costs, avoid placing himself in situations where he is likely to be deprived of outside visual reference. The accident discussed on pages 2 to 7 of this issue, as well as the numerous fatal accidents in this same category that have been reviewed in past issues of the Digest, provide eloquent testimony to the fact that the pilot who has not been instrument trained is not sufficiently equipped, mentally, physically or physiologically to fly safely by reference to instruments. The tragic overseas accident, involving an airline Viscount, described on page 8, also convincingly demonstrates the inadequancy of man's faculties to cope with "seat of the pants" flight in non-visual conditions. As well, it exposes the utter folly of the type of thinking exemplified by one private pilot who, at a certain well-known pilots' rendezvous, was recently heard to claim that he could fly in any cloud and keep level "provided he could see his wingtips"!

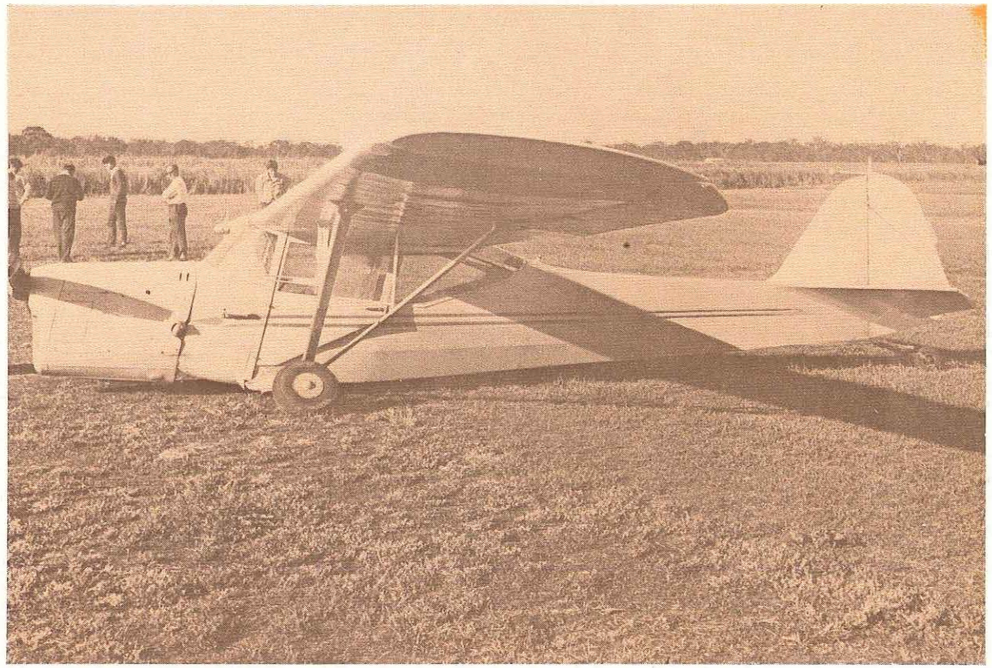
AIR SAFETY ADVICE-ILLUSTRATED



"... landing on a rain-swept or flooded runway is an exercise calling for a high degree of caution."
(Aviation Safety Digest No. 53)

—Maylands Aerodrome, W.A. in early 1920's

In Brief . . .



• OUT OF TOUCH

At a country aerodrome in central Victoria, the owner-pilot of an Auster J5 was taking a friend for a local sightseeing flight. Immediately after take-off the pilot noticed that the altimeter seemed to be indicating sluggishly and it was not until they had climbed to 200 feet that the needle started to move at all. Nevertheless, everything else seemed normal, so the pilot continued the flight and after 20 minutes, returned to the aerodrome to land. The aircraft rejoined the circuit on base leg and shortly afterwards turned on to final approach at about 500 feet.

Although the pilot was relatively inexperienced, he had adopted the practice of lowering all three stages of flap at once. As Auster pilots well know, this can be quite a gymnastic feat, especially if the pilot is not thoroughly familiar with the correct physical action entailed! Raising the nose of the aircraft until the speed had decayed to 40 knots, the pilot pulled the flap lever down to the third notch and, as he returned his concentration to the approach, he saw that the aircraft was under-shooting. He advanced the throttle to reduce the rate of descent, and the airspeed indication increased slightly to about 45 knots, but as the aircraft descended to about 20 feet, it began to sink rapidly.

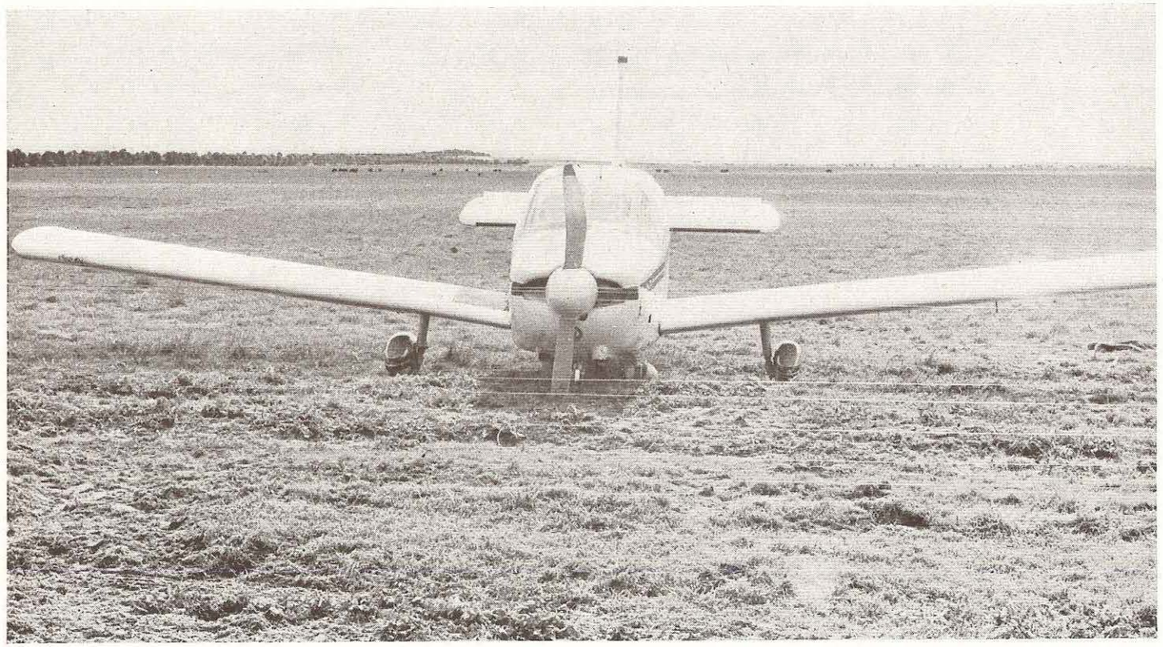
By this stage, the chief flying instructor of the local flying school, who was watching the approach from his office window, had become anxious about the aircraft's decidedly nose-up attitude and it was clearly evident to him that the airspeed was very low. Describing his feelings later he said, "At about 50 feet in my estimation, if something wasn't done about it, the aircraft would cease to fly. At about 20 feet, this is exactly what happened."

The aircraft struck the ground heavily on its wheels in a flat attiutde 48 feet short of the threshold markers of the strip. The undercarriage collapsed and the aircraft slewed to the right and skidded to a halt 70 feet from the initial impact point, with the propeller broken.

During the subsequent investigation some evidence was found to show that the pitot system may have been temporarily blocked at the time of the accident, though when it was examined by a licensed aircraft maintenance engineer some time later, no irregularity could be found. A temporary blockage in the pitot-static system, caused either by insects or moisture, could certainly have produced abnormal lags in the aircraft's airspeed indications. It was evident that the pilot, who had only 55 flying hours, was not sufficiently experienced to detect any such abnormality from the attitude of the aircraft or the feel of the controls. Another point providing food for thought, was the fact that in the 90 days before the accident, the pilot had flown only 1 hour 25 minutes, and was undoubtedly out of touch with the feel of the aircraft.

In Brief . . .

• The Elusive Strip



● THE ELUSIVE STRIP

The pilot of this Cherokee had planned a flight to a country property, allowing himself a margin of about 30 minutes before last light. The day was fine but overcast, and there had been some rain in the area.

The aircraft duly arrived over the property after an uneventful flight but the pilot found great difficulty in identifying the landing strip because of cloud shadows and water lying on the ground, as well as development work on the property itself and changes in the vegetation since his last visit some months before. After about 15 minutes of unsuccessful searching, the light was beginning to fade and the pilot decided to land on a strip at an adjacent property which he knew he could find without delay. Reaching this strip a few minutes later, he found a large number of cattle grazing on it and realised that a landing there was out of the question.

As it was now almost dark, the pilot was becoming increasingly concerned and after circling the property he selected what he believed was a suitable alternative paddock which appeared to be about 2,000 feet square. There was a light wind blowing from the south and, after making an inspection run across the field, the pilot flew a normal circuit and lined up for a landing into the south, and deliberately touched down about 700 feet in from the northern boundary fence to avoid more cattle grazing in this area of the paddock. After touching down, the pilot braked heavily but because the grass surface was wet, he was unable to bring the aircraft to a complete stop in the length remaining and it ran into an earth embankment immediately inside the southern boundary fence. The impact dislodged the aircraft's nosewheel and, as the nose of the aircraft dropped, the propeller dug into the soft ground. The pilot had turned off the ignition and master switches as the aircraft slid to a stop and, after turning off the fuel, he climbed out and went to a nearby farmhouse to report the accident.

The pilot said later that during his approach to land his speed had initially been 80 knots but he had reduced this to about 70 knots as he flared for the touchdown. Even so, this is still about 10 knots above the landing chart requirement for the conditions existing at the time. The chart shows that at the weight at which the aircraft was operating, it would have required approximately 1,700 feet, on a short dry grass surface, to land and bring the aircraft to a full stop, using maximum braking, from a height of 50 feet. After allowing for the position of the grazing cattle, it is apparent that the pilot had an effective strip length of about this distance, but the 10 knots excess speed on touch-down, together with the ineffective braking which resulted from the wet grass, prevented the aircraft stopping in this distance. Although the speed was relatively low when it struck the embankment, the impact was still sufficient to cause damage.

It was found that the pilot was totally unfamiliar with the approach and take-off safety speeds specified in the landing and take-off performance charts contained in the aircraft's flight manual. The landing area he selected was quite satisfactory providing minimum approach speeds were used, and had the pilot adopted a proper precautionary-type approach at reduced speed, there is little doubt that the accident would have been avoided.

This accident is by no means an isolated case. Rather, it is but one of many that have occurred in recent years. It is surely a wise precaution when landing in paddocks, particularly those in which the surface conditions are not well known to the pilot, to touch down and stop in as short a distance as can safely be achieved. In this way the chances in hitting some unseen obstacle or over-running the selected landing area are obviously reduced to a minimum.

• Touch And No Go

● TOUCH AND NO GO

The Cherokee 140 shown in the picture was departing from Orange for a flight to Urana, New South Wales. The wind at the time was blowing from the south-west at 15-20 knots and the pilot, who was well experienced both generally and on the aircraft type, elected to use the 22 grass strip. This strip is almost 3,000 feet long and although the surface was firm at the time, it was covered in dense grass and lucerne up to eight inches high. The surface of the strip is level for the first third of its length, after which there is a shallow depression over the next third, and the final third of the strip rises progressively until the end is about 25 feet higher than the threshold.

After the pilot had taxied out and completed the normal pre-flight checks, he began the take-off using the full available length of the strip. The acceleration initially was slow but the aircraft became airborne after covering about two-thirds of the strip. The pilot then held the aircraft close to the ground while it accelerated to a higher speed but, when about 350 feet from the far end of the strip, the aircraft's wheels contacted the gently rising strip surface. The aircraft did not become airborne again and over-ran the end of the strip. After encountering a dense growth of grass beyond the prepared surface, the aircraft ran through the boundary fence, continued across a ploughed area, and finally came to rest at right angles to the take-off path nearly 600 feet from the end of the strip.

Examination of the aircraft and engine did not reveal any defect which could have contributed to its failure to become airborne. Although the aircraft's performance charts indicated that the dimensions of the strip were somewhat marginal in the existing conditions, the take-off should have been within the capacity of the aircraft. The accident was attributed to the fact that the pilot did not establish a positive rate of climb after the aircraft became airborne.

In Brief . . .

• An Expensive Try

• AN EXPENSIVE TRY

Before departing Moorabbin Airport, Victoria, for a private business flight to Hobart, Launceston and George Town, Tasmania, the pilot of this Cessna 172, who was a comparative newcomer to Australia, obtained information which led him to believe that there was an airstrip at George Town. (It was later found that because of a misunderstanding, the persons from whom the pilot sought the information thought that he was enquiring about George Town, Queensland, where there is a serviceable airstrip in regular use.)

The flight to Hobart and back to Launceston was without incident, and after arriving in Launceston the pilot made enquiries about the supposed strip at George Town. When he could obtain no further information about it, the pilot off-loaded two of the three passengers who were accompanying him on the flight and took-off to fly to George Town to look for the strip himself. Arriving over George Town, he could find no strip, but sighted a field which appeared to be suitable for landing. As there was no other suitable field in the area, he decided that this must be the field in regular use. After an uneventful landing the pilot and his passenger went to the town to conduct their business.

On his way back to the aircraft, the pilot called on the owner of the property on which they had landed, to ascertain the size of the field and the owner estimated it as 2,000 feet square.

The wind was blowing from the west at 15 knots, but because there were several houses on the western boundary of the field, the pilot decided to make a cross-wind take-off into the south to avoid them. The pilot did not consult the take-off performance charts in the aircraft's flight manual and, after taxi-ing into position on the northern side of the field, he held the aircraft on its brakes until he had opened the throttle to full power. At first the aircraft appeared to accelerate normally but soon afterwards it was retarded by dense patches of clover growing in the centre of the field. By this stage the pilot believed he would not be able to bring the aircraft to a stop in the length remaining, so he continued his attempt to take-off. Approaching the trees on the far boundary of the paddock, he pulled the nose up sharply, but the tail plane and port wing struck the tree-tops. Control immediately became extremely difficult and the pilot was forced to try and land downwind in a small paddock which lay to port of his flight path. After touching down in this paddock, the aircraft ran through the fence at its far end and came to rest in a mound of earth by the side of a road. The aircraft was substantially damaged but the pilot and his passenger escaped injury.

During the investigation of the accident, it was found that the effective operational length of the take-off path the pilot used was in fact only 1,100 feet and the direction and strength of the wind at the time was such that he had probably attempted the take-off with a tail wind component of between 5 and 12 knots. Even a cursory examination of the aircraft's take-off performance chart would have shown that a take-off in these circumstances was out of the question. Other take-off paths were available to the pilot which would have taken advantage of the wind velocity and at the same time afforded an adequate effective operational length. Had the pilot selected one of these alternatives there is no reason why the take-off should not have been successful.

• Unsuccessful Precautionary Landing

• UNSUCCESSFUL PRECAUTIONARY LANDING

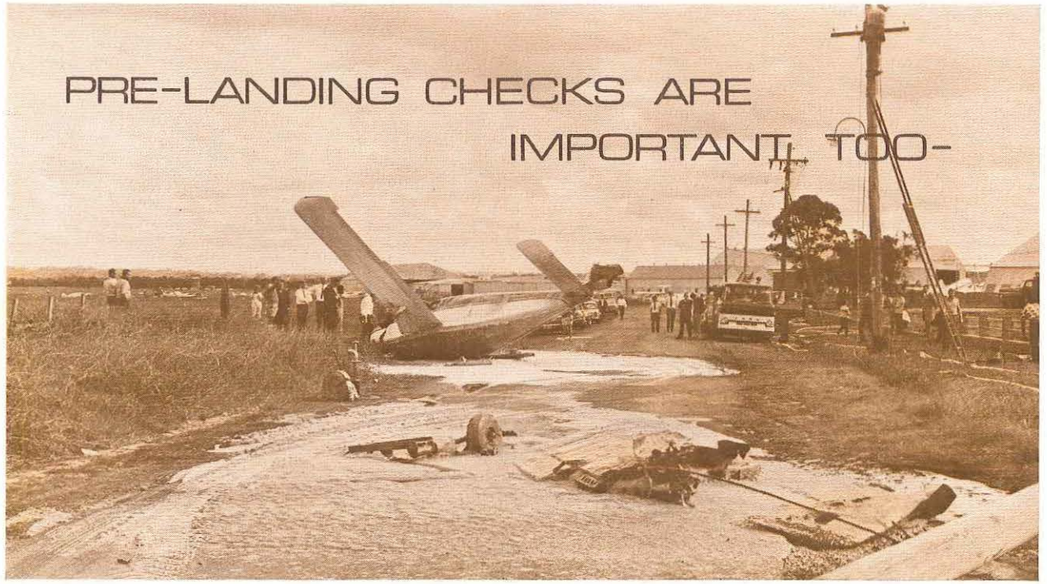
At a country airport in northern New South Wales, a pilot had planned a flight in his Bonanza 33 aircraft to his property in southern Queensland. The weather on the morning of departure however, was extremely poor with widespread low cloud and rain and, after telephoning the property and finding that similar weather conditions existed there, the pilot decided to postpone the trip.

During the morning conditions improved and, by about mid-day, the pilot thought the flight might now be possible. He again telephoned his destination and this confirmed that there was a general improvement. As the area forecast also indicated that some improvement could be expected, the pilot decided he would depart and assess the weather from the air and, if it was satisfactory, he would continue.

Thirty minutes after taking-off, having climbed through breaks in the overlying cloud to 8,500 feet, the pilot encountered cloud development rising well above his cruising level and he altered course towards the west, believing that the weather was clearing in this direction. When breaks appeared in the cloud below him, the pilot descended into an area where visual meteorological conditions still existed, but which seemed to be surrounded on all sides by deteriorating weather. The pilot was now doubtful that he would be able to return to his aerodrome of departure in these conditions and, rather than attempt to climb back above the cloud and risk being caught in instrument meteorological conditions, he decided his best course of action was to land.

Selecting what appeared to be a suitable paddock, the pilot made two runs over it to check the wind direction and surface, then made a precautionary type approach into wind. Immediately the aircraft touched down the pilot applied heavy braking but because the surface was wet the aircraft did not decelerate as the pilot expected. Approaching the upwind fence he was forced to initiate a ground loop to the right and the aircraft skidded sideways into the fence, sustaining substantial damage.

The pilot, once he was in this unenviable position, obviously took the logical and correct action in deciding to land rather than risk continuing into deteriorating weather. Had he been prudent enough to turn back earlier however, it is very likely that he would not have been placed in the position of having to land in such unfavourable conditions on an unknown surface.



Fuel starvation on final approach can be even more embarrassing than at cruising height!

Pilot Contribution

The Proof Of The Pudding!

In the article "Dual in the Sun", in our last issue, a reader gave a first hand account of two near-misses he experienced during one afternoon's cross-country flying. The article also offered some comment from two of our overseas contemporaries, on measures that can be taken to avoid mid-air collisions.

The further comment and first hand experience that follows, has been contributed by a pilot who is also an experienced yachtsman, and presents a most convincing case for the collision avoidance principle expounded in our last issue.

AS a Private Pilot who has had one near miss and who has been a yachtsman from away back, may I comment on "Dual in the Sun" in Issue 74 of the Aviation Safety Digest, and in particular commend what the former fighter pilot had to say in "Airline Pilot".

His assertion "that you can't hit anything which has moved out of a spot from which it was first observed" is written on most yachtsmen's hearts to the extent that application of the rule is absolutely instinctive. Though only concerned with two dimensions whereas a pilot is concerned with three, the rule holds good on the water.

Two fundamental International Yacht Racing Union Rules, 36 and 37, determine which yacht has right of way when racing but there needs to be a ready method of deciding whether, when two yachts converge, they are on a collision course. Both skippers having made the decision are bound to act in accordance with Rules 36 and 37.

Quite automatically skippers and crews of converging yachts look for a change in the relative bearing of each other. If the bearing is changing you will miss, if it is changing only slightly you may increase the rate of change by altering course. If it is not changing you will collide and the yacht that doesn't have right of way must bear away, luff up, gyb or go about.

In crowded sailing waters, such as Melville Water in Perth or Sydney Harbour on Saturdays, you can see this decision-making process in action continuously and with outstanding success.

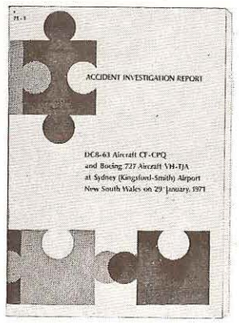
Being trained in it, I instinctively used the rule to get out of trouble one day in central Australia. Departing Narwietooma for Darwin at about 9 a.m. on a beautiful July morning I tracked initially for Aileron. I had just finished settling the Cessna 337 down in the cruise phase after completing a climb to 5,000 feet and I looked around the horizon slowly, left to right, with the aim of identifying the aircraft's position. As my eyes moved due east I was appalled to find myself gazing into the nose, cockpit and two engines of a Queen Air on a dead collision course at right angles.

Quite automatically I went up — very, very quickly. The decision was instantaneous in that going up was the only way to produce a rapid change in the relative bearing. The panic set in some seconds later and persisted for most of the rest of the day!

To the best of my knowledge the other aircraft didn't see us. I called Alice Springs, who confirmed there was another aircraft due to cross our track at that time but flight planned below 5,000 feet, whereas I had flight planned at 5,000 feet. I haven't flown at 5,000 feet since.

The fighter pilot's rule works, and it is vital particularly when coupled with the second rule, "keep the other bloke in sight!"

ACCIDENT REPORT NOW AVAILABLE



The Department's report on the collision between a Boeing 727 and a DC8-63 at Sydney Airport on the night of 29th January this year, has now been released by the Minister for Civil Aviation.

Aviation Safety Digest expects to publish a summary of the report shortly, but copies of the full report are now available, price 75 cents each, from the Australian Government Publishing Service, P.O. Box 84, Canberra A.C.T. 2601, or from A.G.P.S. Book Centres in each capital city.