

No. 54

JANUARY 1968

AVIATION SAFETY DIGEST

DEPARTMENT OF CIVIL AVIATION AUSTRALIA

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COVER: Cloud seeding aircraft, under charter to the Victorian Government, wait at Moorabbin Airport for favourable operating conditions, during the southern state's long dry spell.



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A MESSAGE FROM THE DIRECTOR-GENERAL

ACCIDENT PREVENTION CONCERNS US ALL

Having read the circumstances surrounding the fatal accidents to Australian aircraft reported in this issue of the Aviation Safety Digest, I am once again struck by the fact that each one of them could so easily have been avoided, and the needless personal tragedies that followed in their wake averted.

These accidents, together with many others investigated by my Department, bear silent testimony to the truth that such disasters don't "just happen"—nearly always they are the culmination of a chain of untimely or unfavourable events, any one of which, in isolation, would probably have been nothing more than an air safety "incident".

Close analysis of the circumstances of almost any aircraft accident will in fact show that it is as these incidents occur or combine in a certain order that the stage is set for an accident. From this point on, only one more, perhaps quite minor, occurrence is usually necessary to precipitate the further chain of events that constitutes the accident itself. The key to accident prevention lies in the knowledge and understanding of this process of what might be termed "accident evolution". The task of preventing accidents, which is the whole purpose of air safety investigation, can be tackled realistically only by accumulating a fund of experience of the many factors that can play a part in the accident process, and then applying this knowledge to the best possible advantage in future operations.

Obviously however, the fund of experience that is so necessary for accident prevention, must come first hand from the people in the industry who are acquiring this knowledge. It cannot be acquired by my Department from the investigation of accidents alone. For every accident that happens, there are many more that might have been, had the circumstances been a little more adverse, and such accidents in the making frequently contain lessons in every way as significant for accident prevention, as those with less happy endings. It is vital that the wealth of experience acquired in the course of these occurrences, and from the investigation of their circumstances, be applied to the promotion of air safety as a whole. It is for the acquisition and application of this knowledge that my Department's air safety incident reporting system exists.

Several years ago, through the medium of the Aviation Safety Digest, I expressed my policy of granting an indemnity to the originator of an incident report, against any resulting disciplinary action, except in certain special cases. I am concerned, however, that a large number of more recently trained pilots do not appear to be aware of this policy, and that as a result, significant air safety information may not be reaching the Department as it should.

I am therefore taking this opportunity to re-affirm that the primary objective of air safety investigation in my Department is still the promotion of safety—not the establishment of blame and that I will not impose any disciplinary or punitive measure on the originator of an incident report for any of his actions in an incident which are brought to notice by his submission of such a report. I make only one exception to this policy. If the investigation of an incident shows beyond doubt that persons or property have been exposed to danger because of a deliberate and contemptuous disregard of the law or published instructions, or because of a dereliction of duty which amounts to gross negligence, then and only then, will my Department deal with the offender by whatever means are appropriate.

It should be evident that everyone in the industry has it within his power to promote the cause of air safety, and in this cause it is incumbent upon all to exercise this power to the utmost. There should be no place for the thought that accidents are inevitable. Accidents can be prevented and an accident rate of zero should remain our ultimate objective. If individually, every one of you who reads these words will resolve to attain this standard within your own sphere of operations, supporting your efforts and those of your fellows by full and frank reporting of every situation in which safety is compromised, you will be contributing in a very real way to further progression towards this ultimate goal.

D. I. Anderson

INTERFERENCE WITH CONTROLS

Passengers' unintentional interference with controls responsible for two fatal accidents

(1) DH-82

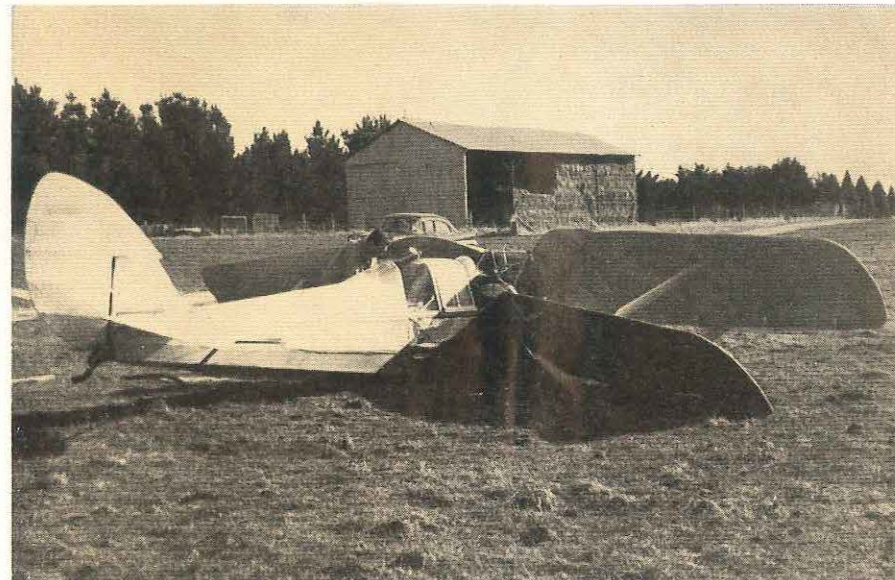
The aircraft, which was normally used by a country gliding club as a glider tug, had just undergone a major engine overhaul and was being flown by a private pilot locally from the private airstrip at which it was based, to run in a new set of piston rings that had been fitted during the overhaul.

On the first flight of the day, which lasted about 20 minutes, a photographer travelled in the front seat of the aircraft and the pilot flew him around the adjacent town and nearby river to enable him to take some aerial photographs.

After landing from this flight, the photographer disembarked from the front cockpit taking his photographic equipment with him, then assisted another man and a four year old child, who the pilot had agreed to take for a flight, to settle themselves in the aircraft. The man climbed into the front seat, and fastened the safety harness with the assistance of the photographer. The boy

was then lifted into the cockpit to sit on the passenger's knee. The cockpit canopy was slid shut and the aircraft then took off to make a local flight of similar character and duration to the previous one.

Returning towards the strip about 20 minutes later, the aircraft passed close to the home of the boy and the pilot decided to make a turn around the house before joining the circuit pattern of the aerodrome. As the aircraft passed the house, the pilot applied aileron to begin the turn, but then as he tried to move the control column towards the centre again to hold off bank and stabilize the turn, he found the column was jamming about three inches from the full aileron position. The angle of bank continued to increase, and the aircraft rolled on to its back. Realising a crash was inevitable, the pilot closed the throttle. Continuing to roll, the aircraft lost height and struck the ground heavily in a level attitude. The adult passenger was killed, the boy and the pilot



Left: The wrecked DH-82 as it came to rest.

Right: The child passenger's boot re-positioned in the control column aperture. Note how the distortion of the sole matches the shape of the control column socket.

were seriously injured and the aircraft was severely damaged.

A study of the wreckage at the scene of the accident and a subsequent detailed examination of all flying control assemblies and cable runs, particularly those associated with the aileron controls, disclosed no fault which could have contributed to the control restriction. All available evidence obtained from the wreckage examination in fact indicated that there was no mechanical impediment to normal operation of the aircraft up to the moment of impact with the ground. There was evidence, however, that the dual control installation in the front cockpit had been unintentionally obstructed during the flight by one of the passengers occupying the front seat.

For dual control flying in the DH-82, provision is made for a control column to be fitted in the front cockpit and this is inserted through a six inch square opening in the top of a box on the floor of the cockpit, housing the dual control mechanism. A metal cover plate is hinged to the forward end of the opening and is intended to swing back and down to cover the control column socket, when the front control column is not fitted, and thus prevent interference or restriction to the movement of the controls while a passenger is being carried in the front cockpit.

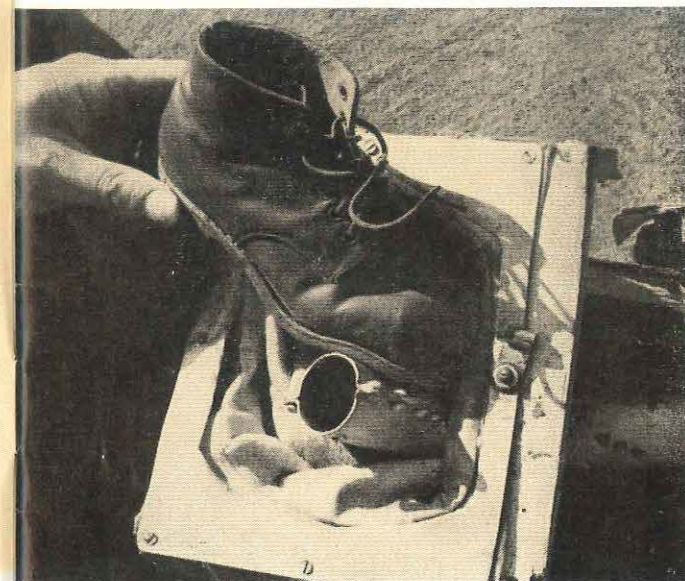
During the examination of the wreckage, this cover plate was found open and buckling of the

plate and marks on its undersurface indicated that it was open at the time of impact. It was also found that scratch marks on one of the leather boots which the boy-passenger was wearing, and the way in which the leather sole of his boot was distorted, could be accounted for if the boot were placed in the control box aperture and compressed by sideways movement of the control column. Subsequent laboratory examination of dried mud and other matter adhering to the boy's boots, and scraped on to the structure surrounding the control column aperture, showed that at least one of the boy's boots had been in the aperture at some stage of the flight.

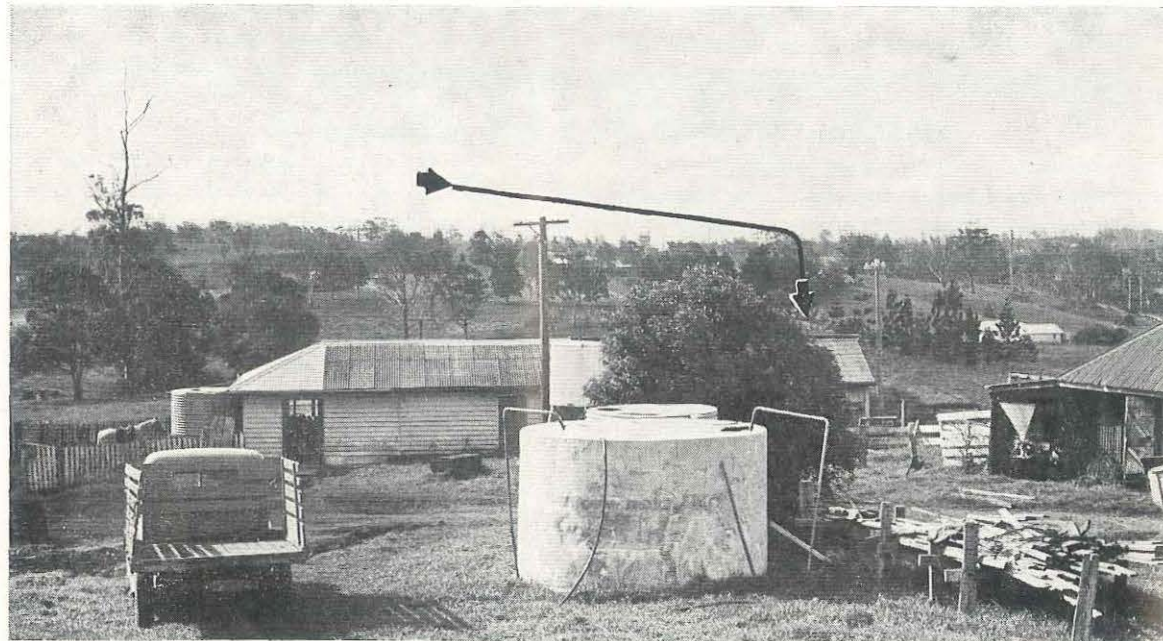
The pilot said that during the flight, the boy was sitting on the adult passenger's knee, firstly on the left and then on the right side of the cockpit. As they approached the house towards the end of the flight, and just before the aileron controls became obstructed, the boy appeared to stand up, apparently to get a better view of his home. The pilot also said that when the obstruction occurred, the resistance to movement, though impossible to overcome, was slightly spongy and was only in the direction of movement towards the centre.

While the boy was sitting on the man's lap, his feet would have rested naturally on the forward end of the control box between the elder man's knees. It is evident that when the boy stood up as the aircraft approached the house, he actually stood on the control column socket, and when the pilot applied aileron, causing the front seat control column socket to move sideways, the boy's right boot slid down into the opening in the control box and became wedged between the socket and the control box structure, thus preventing the column being returned to the central position. It is also evident, that the deformation of the sole of the boy's boot, was caused by the pilot's efforts to move the control column towards the centre again to counteract the increasing angle of bank.

From the investigation it is obvious that the cover plate provided to protect the front control column socket from interference, had not been closed before the flight began. It is equally obvious that if the cover had been properly secured, the control restriction could not have occurred and the accident would not have happened.



INTERFERENCE WITH CONTROLS (continued)



Final flight path of aircraft as seen by eyewitness 300 yards south of accident site.

(2) Cessna 150

The aircraft, carrying a pilot and photographer, was being used to obtain aerial photographs of farming properties at Mt. Mee, Queensland, a rural district 55 miles north of Brisbane.

As part of his professional photography business, the photographer who was also the owner of the aircraft, had over the preceding months, built up a line of business by photographing farms from the air and then offering the photographs for sale to the farmers concerned, during a "follow up" call made by car. The photographer had bought the aircraft for this work and employed a commercial pilot to fly it.

On the day of the accident, the aircraft departed from Brisbane Airport at 0730 hours local time and reached the Mt. Mee area about half an hour later. For the next 45 minutes the aircraft flew around the area photographing properties from various heights, some from as low as 200 feet above the ground.

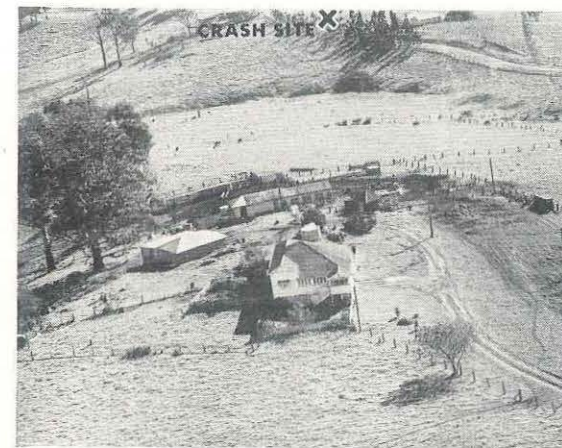
The flight attracted considerable attention from local residents. The starboard window was seen to be open during this time and it was evident that the photographs were being taken through this window. At times the engine would be throttled back, probably to reduce vibration while

the photographs were taken, and on some occasions, the aircraft would be yawed to the left, evidently to position the object being photographed, between the starboard lift strut and the nose of the aircraft.

At about 0845, after photographing a farm from low level, the aircraft headed north, made one or two wide orbits, then took up a southeasterly heading and commenced a straight shallow descent with power on. When it had descended to between 150 and 200 feet, the aircraft suddenly and abruptly nosed over into a steep dive and with engine power unchecked, dived straight into the ground at an angle of about 60 degrees. Both occupants were killed and the aircraft destroyed.

* * *

The extent to which the aircraft was demolished in the crash, indicated that it struck the ground at considerable speed in a steep nose-down, wings level attitude. The damage sustained by the propeller showed that the engine was developing power at impact, and the throttle control was bent at a position consistent with a cruising power setting. A detailed inspection of the engine and the flying control systems did not disclose evidence of any pre-impact defect and it



The last photograph taken during the ill-fated flight. The camera was recovered from the aircraft wreckage. The low level from which the picture was taken is especially evident when compared with the photograph on the opposite page.

was evident that the aircraft was capable of normal operation at the time of the accident.

The accident was seen by a considerable number of witnesses from various angles and as a result it was possible to reconstruct the aircraft's final flight path quite accurately. Before the final dive the aircraft did not nose-up, climb, bank, or yaw, nor was the dive preceded by any squashing descent or hesitancy which might have indicated that the aircraft had stalled. The speed at which the aircraft dived into the ground was in any case obviously well above that to be expected if the aircraft had stalled, and it is well known that this type of aircraft cannot be abruptly stalled from a laterally level descent under power, without a very pronounced change of attitude.

The possibility that the aircraft collided with a bird incapacitating the pilot was considered, but no evidence could be found to support this theory and the post-mortem examinations of the occupants disclosed no evidence of any sudden incapacitation for any other reason.

The question of interference with the flying control system was considered next and in some detail, particularly in relation to the fact that the dual control wheel and rudder pedals for the right hand seat were not fitted to the aircraft at the time of the accident. The aircraft had in fact, been bought with only the one set of controls, to allow the passenger-photographer more room for his work in the small cockpit.

From a study of the Cessna 150 cockpit and other available information, it was evident that the most likely area in which control interference could have occurred, was the central control yoke beneath the instrument panel (See photo page 6). Ironically, this central control yoke becomes more accessible to interference from the passenger's seat in the Cessna 150 when the rudder pedals are not fitted. If a foot is placed against the yoke or against the attached aileron control cables, a small movement of the foot can push the control wheel sharply into the fully forward position.

Evidence was obtained from another pilot who, flying a Cessna 150 on a charter photographic flight three years before, had experienced control interference of this sort in flight. This pilot said that while he was positioning the aircraft for a photograph, the photographer in the right hand seat turned sideways to sight his camera. As he did so, the pilot felt a sudden forward load on the control column and the aircraft pitched nose down about 30 degrees. Both occupants were subjected to negative G forces and were forced off their seats until restrained by their seat belts. The aircraft lost almost 250 feet before the pilot succeeded in regaining level flight. Subsequent investigation revealed that as the photographer braced himself with his left foot to turn sideways in his seat, he had unintentionally pushed against the control yoke beneath the instrument panel.

During the investigation of the accident a series of flight tests were made in another Cessna 150 and confirmed that from level flight, the aircraft can be abruptly placed in a steep dive by firm foot pressure on the central control yoke. In the tests, the aircraft lost height at about 50 feet per second and it was obvious that there would be little chance of recovery if this manoeuvre commenced from a low altitude.

The photographer killed in the accident was wearing rubber soled shoes at the time and it was found that the left shoe had a series of distinct marks imprinted diagonally across the sole. These marks matched the shape of the aileron cable attached to the lower right hand section of the control yoke assembly and it was evident that the shoe had been in this position at the moment of impact. This was confirmed by subsequent laboratory examination of the shoe and control yoke assembly, which established that matter adhering to the aileron cable on the lower right hand side of the yoke, had come from the sole of the shoe. With the shoe in this position the

toe would have been pushing against the central column of the control yoke (See photograph below).

It was this photographer's practice during photographic flights to keep his camera accessories and spare film in a box which he carried in the luggage space of the aircraft behind the two seats, usually on the port side, where it was more accessible to the photographer sitting in the right hand seat. For a person seated in this position, it would be a natural reaction, when turning either to the right towards the window to take a photograph, or to the left to reach behind the seats for the accessories box, to extend his feet forward. In a Cessna 150 not fitted with rudder pedals for the right hand seat, a normal sized person making such a movement, could easily reach the bulkhead beneath the instrument panel with his legs and then only a small movement of the body would be necessary to bring the left foot over on to the control yoke assembly. If this occurred and, at the same time the person braced his feet as he reached back into the luggage compartment, the control yoke assembly would suddenly be pushed fully forward. The flight tests showed that in this situation, it would be almost impossible for the pilot to effect a recovery while the passenger's foot continued to apply a positive pressure to the control yoke.

It was concluded that such a chain of events was the probable explanation of the aircraft's sudden steep dive into the ground. At the low altitude at which the aircraft was flying, it is doubtful if there would have been time even for

the passenger to realise what he had done and remove his left foot from the control yoke, let alone for the pilot to effect a recovery, before the aircraft struck the ground.

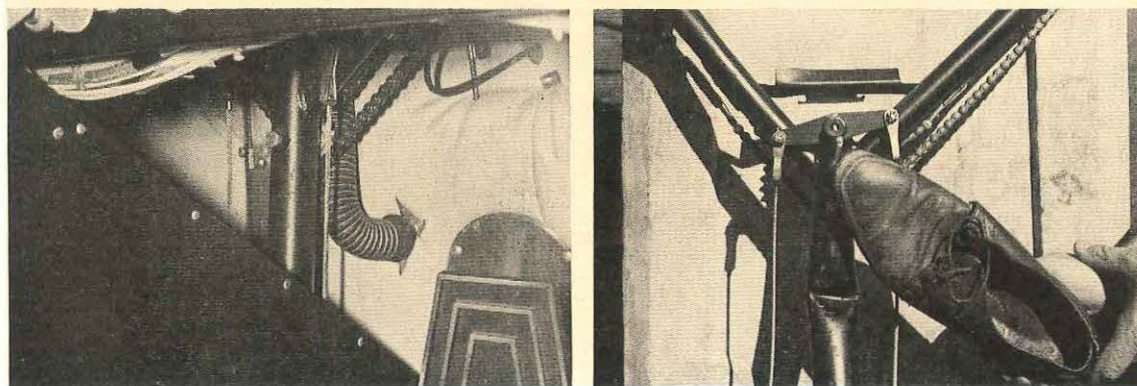
Comment

The lesson to be learnt from these accidents quite apart from the old story of unauthorised low flying, is a twofold one. In the first place, it is obviously good airmanship, and indeed a pilot's responsibility, to use all the measures provided in the design of the aircraft to protect the control installations from interference by unknowledgeable passengers. This applies especially to tandem cockpit aircraft where the pilot cannot supervise a passenger's movements and behaviour once they are both seated.

Secondly, it is clear that merely removing the dual controls from an aircraft will by no means guarantee immunity from interference with the controls, particularly in modern light side by side dual control aeroplanes where the control linkage mechanism is usually located under the instrument panel. Generally speaking, the smaller the aircraft and the more restricted the cabin space, the greater the care that is necessary.

Pilots who carry passengers in the control seats of any dual control aircraft should make themselves thoroughly familiar with the layout of the dual control system and any particular parts which appear vulnerable to passenger interference. Armed with this knowledge, a pilot is then in a position to properly brief his passengers on the potential interference hazards of the system.

Below left: The central control column yoke beneath the instrument panel of a Cessna 150. This photograph was taken from the starboard side. Dual rudder pedals are installed in this particular aircraft. Below right: Position occupied by passenger's shoe against control yoke of crashed aircraft, when marks on the sole were re-aligned with aileron cable.



FATAL AGRICULTURAL FERRY FLIGHT

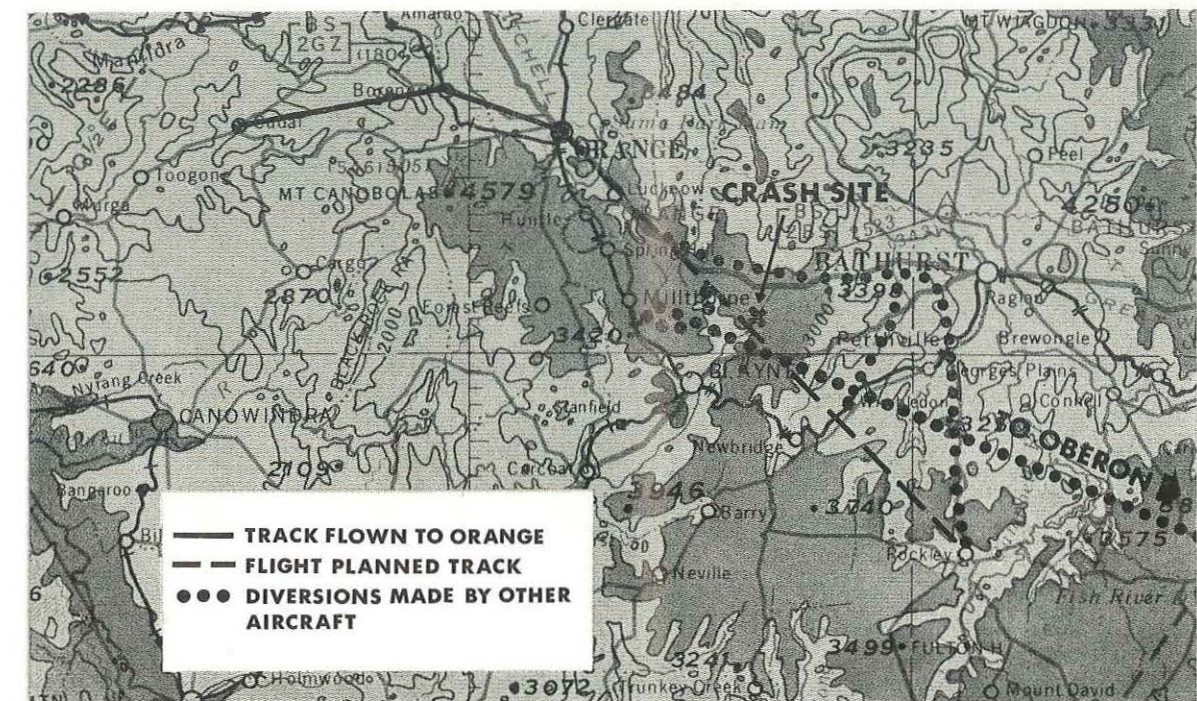
AT 0630 hours on a mid-November morning, two agricultural Cessna 180's, each carrying a pilot and a loader driver, took off from their base at Cudal N.S.W., to fly to Rockley, 35 miles to the south-east of Orange, where they were to spend the day engaged in aerial top dressing operations. The morning was cool and although it was fine generally, there were extensive areas of low stratiform cloud lying on the higher terrain to the south-east of Orange.

The two aircraft flew in company until they passed over the city of Orange but then separated. Seeing that a bank of low cloud was covering the higher ridges which lie between Orange and Blayney, the pilot of the second Cessna diverted to the east from the flight planned track, and followed the Orange-Bathurst Highway towards lower terrain on the western side of Bathurst. The first aircraft continued on a south-easterly heading and was last seen flying in the direction of the ridges covered by the low cloud. Soon afterwards, as the pilot of the second aircraft was passing abeam and to the east of these ridges, he saw that the cloud cover was 200 to 300 feet thick and that the tops of some of the ridges were actually in cloud.

When he reached the area of lower terrain to the east of the ridges, this pilot found no difficulty in resuming a southerly heading beneath the cloud layer, which at that point was becoming broken. The cloud continued to break up as he flew further south towards his destination, and by the time he reached the agricultural strip near Rockley, the sky was almost clear.

After landing at the agricultural strip, the pilot and his loader driver waited for the other aircraft to arrive. When it did not do so within a reasonable time, they became anxious and, after checking that the missing aircraft was not at another agricultural strip near Rockley, they telephoned their base at Cudal. After learning that their base had no news of the missing aircraft, the pilot took off to begin an aerial search of the flight planned track, back towards Orange. Two hours later he sighted the wreckage of the missing aircraft on high ground just to the north of the Blayney-Bathurst Highway. An ambulance and its crew were in attendance at the crash site.

The aircraft had been sighted at 0650 hours that morning, flying over the township of Kings Plains, less than two miles south-west of the



accident site. The weather at the time was dull and the sky was completely overcast by very low cloud. The aircraft was flying straight and level at about "twice treetop height" and appeared to be following the Blayney-Bathurst Highway eastwards in the direction of Bathurst. The witness who saw the aircraft, watched it until it disappeared from view over a small rise immediately to the north-east of the township.

Shortly afterwards the aircraft was seen again by the driver of a bulk-milk lorry en-route to Bathurst which, travelling from Blayney, had just passed through the township of Kings Plains. Flying an easterly heading above the highway at treetop height, the aircraft passed over the vehicle as it was descending a hill about quarter of a mile east of Kings Plains. The aircraft followed the road for a further half mile ahead of the vehicle, to a point where the highway climbs to cross the summit of the main ridge of high ground, the top of which was in cloud. It then turned left from the highway and followed a shallow valley in a north-easterly direction towards the crest of the main ridge. The valley itself was clear of cloud, but the ridge at its head and the high ground to the north and south of the road were partly obscured by the unbroken layer of low cloud. As the aircraft approached the head of the valley, still heading towards the ridge, it became lost to the lorry driver's view in the cloud which at this point, was down to treetop height with occasional patches at ground level.

At 1000 hours that morning, a farmer mustering sheep at his property on the northern side of the Blayney-Orange road a mile to the east of Kings Plains, came upon the wreckage of the Cessna close to the crest of the ridge. Both occupants had been killed.

* * *

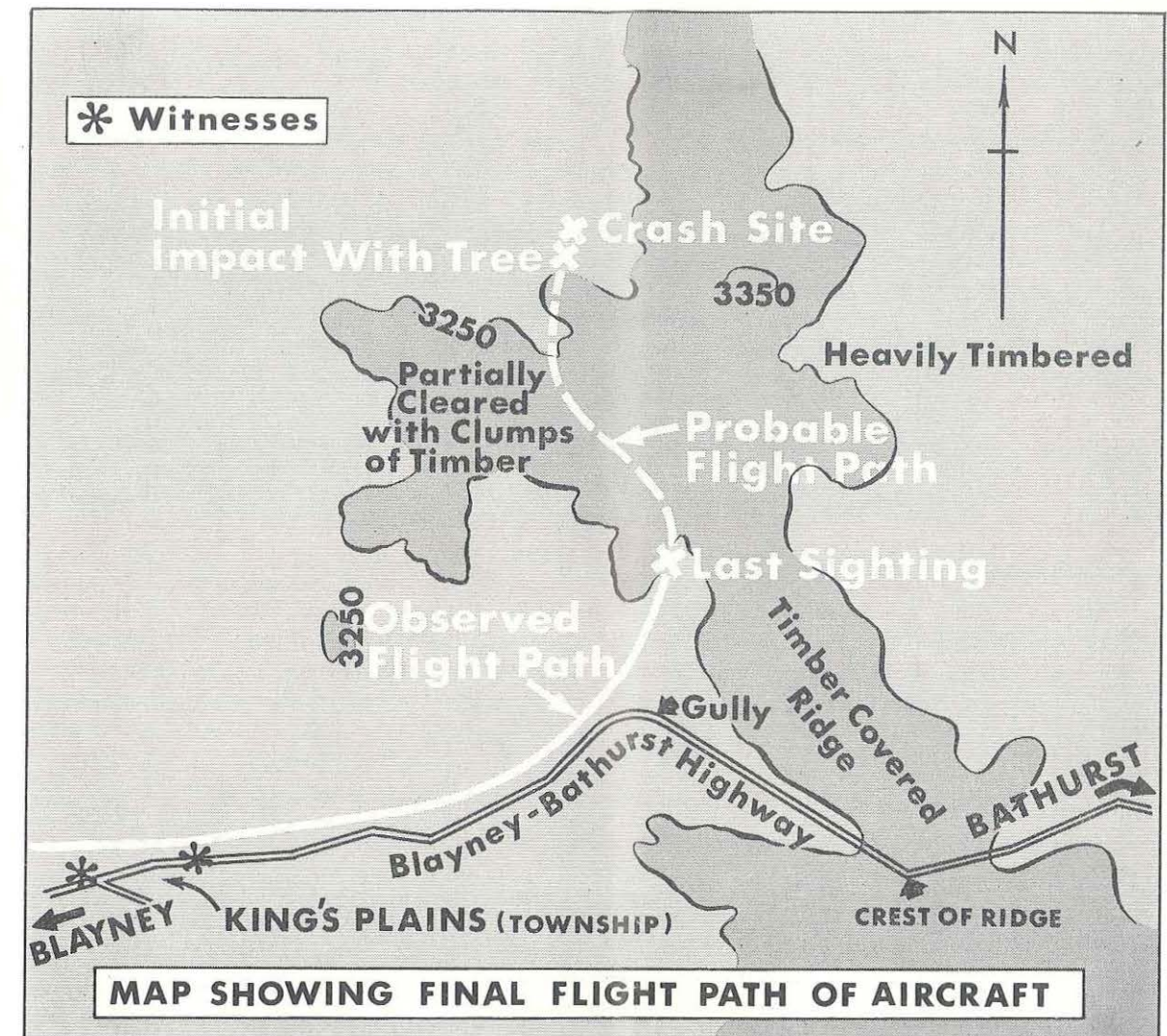
Examination of the wreckage and the site of the crash, showed that the aircraft had flown into a clump of trees just beyond the top of the ridge only half a mile from where it was last seen in flight. The starboard wing was torn off and the aircraft dived into the ground and broke up as it slid inverted for almost 200 feet. A detailed examination of the wreckage indicated that the aircraft had been operating normally up to the moment of impact and there was nothing to suggest that any malfunction had contributed to the accident. The aircraft was not equipped for

instrument flight, having only basic flying instruments, nor was the pilot qualified to fly in Instrument Meteorological Conditions.

In addition to the statement made by the pilot of the aircraft that left Cudal in company with the ill-fated Cessna, evidence was obtained from the pilots of two other Cessna 180's which took off from Cudal seven minutes after the first two aircraft. This second pair of Cessna 180's was bound for Wimbledon, in the same general direction as Rockley, but eleven miles closer to Orange. These two pilots had also intended to track over the higher ridges between Orange and Blayney, but, after passing over Orange, they could see the area was covered by low cloud. Knowing that the terrain falls away to the west of the main ridge however, they continued towards Kings Plains by flying at 500 feet. But when they reached a point two miles to the north of Kings Plains, they were forced to divert to the north of the high terrain, and then they also joined the Orange-Bathurst Highway, which they followed east, towards Bathurst, until they had passed the higher ridges. Both these pilots said they could see the cloud was at ground level on the main ridge and almost 200 feet thick. These pilots were also able to resume their southerly heading once they had passed abeam the ridges and reached the valley to the south-west of Bathurst.

Thirty minutes later, a fifth Cessna 180 departed from Orange for Oberon, 45 miles to the south-west of Orange. Again the pilot's intended track was similar to that of the previous four aircraft, but when he was confronted with the low cloud on the ridges, he turned back towards Milthorpe, to the north-west of Blayney. Shortly before reaching Milthorpe, he found he was able to climb visually above broken cloud and then resume track to Oberon "on top". As he passed over the main ridge on top of the cloud, the pilot noticed the cloud layer was unbroken, but that further to the east towards Bathurst, it was breaking up. As he flew further south, the cloud rapidly dispersed and at his destination the sky was clear.

From all the evidence it is apparent that, after flying very low beneath the cloud base over Kings Plains, following the highway in the direction of Bathurst, the pilot involved in the accident was confronted by even lower cloud on the ridges ahead of his aircraft. No doubt in an effort to



maintain visual reference, he turned left from the highway to follow a shallow valley. The ridge at the head of the valley was also in cloud however, and there was insufficient airspace in the valley below the cloud base for the aircraft to turn back. The pilot apparently attempted to cross the ridge in cloud but losing visual reference, collided with the trees just beyond the top of the ridge.

Comment

The disastrous finale to this agricultural ferry flight provides yet another grim reminder that familiarity can breed contempt and that the "it

can't happen to me" philosophy is completely fallacious.

Of all professional pilots, probably none are more exposed to these sorts of temptations than agricultural pilots. Flying as they do for the greater part of their time in an almost intimate relationship with the ground, often in close proximity to rugged terrain and from precariously located airstrips that would horrify more sedate members of the flying fraternity, agricultural pilots are peculiarly liable to develop a mental detachment from the hazards of their environment.

Seen against this background, it is perhaps

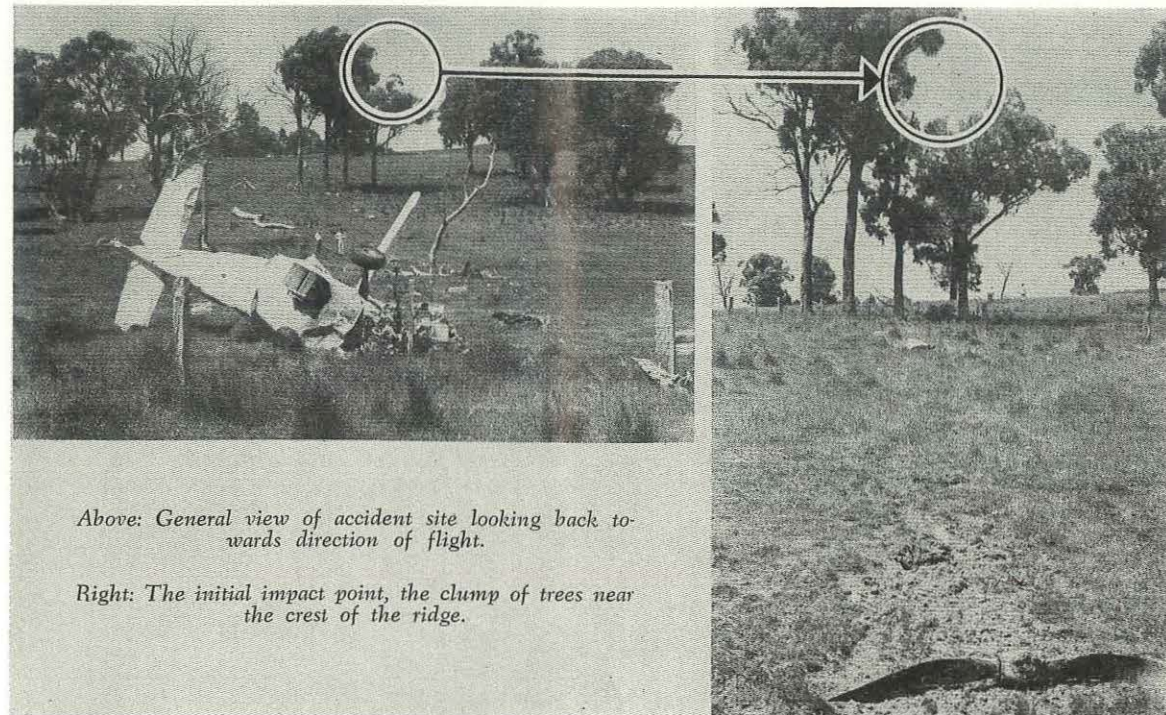
understandable if an operation as simple as a short agricultural ferry flight over familiar country should be undertaken without much forethought. And, if in the course of this flight, weather conditions compel an agricultural pilot to fly low and manoeuvre at low level around and over hilly terrain in his path, it could be said he is only doing what he normally does in the course of his daily occupation. And even when he is obliged to fly just beneath a lowering cloud base, he is still "on familiar ground", and his training and experience as an agricultural pilot will stand him in good stead.

But if while doing so he is forced to actually enter the cloud and his familiar relationship with the ground is suddenly obliterated, he is plunged into an utterly changed set of circumstances. Now, no matter how skilful he is in manoeuvring his aeroplane close to obstructions, it will do him no good. For now he is in Instrument Meteorological Conditions, safe flight in which requires a quite different, but equally specialized type of skill. For this, the agricultural pilot usually has neither the aircraft equipment, the qualifications nor the experience and constant practice necessary

to maintain that particular skill to the high standards that safe flight in I.M.C. demands. By its very nature too, safe instrument flight demands a very different set of operating standards—much more generous allowances for obstruction clearance, to cater for the lateral and vertical distance errors inevitable in instrument conditions.

So the agricultural pilot in this situation is caught-out on two counts simultaneously. With little or no warning he is suddenly transported into an almost totally alien flight regime, and his aircraft is placed in a position in relation to terrain or other obstructions which would be fraught with danger even for an expert.

It is this insidious, double-barrelled snare for which the agricultural pilot must be especially on his guard when he sets out for a destination in weather that is at all marginal for flight under Visual Flight Rules. As this tragic accident so clearly shows, what begins as one of the most innocuous of tasks for a pilot with highly developed manipulative skills can, in these circumstances, be transformed into the most hazardous of flight situations, the outcome of which is almost a foregone conclusion.



Above: General view of accident site looking back towards direction of flight.

Right: The initial impact point, the clump of trees near the crest of the ridge.

GLIDER PILOT FAILS TO RECOVER

FROM SPIN



Investigation uncovers startling lack of knowledge on Spin Recovery Techniques

AT a country centre in South Australia, a gliding club was conducting operations with its two gliders, a Kookaburra ES 52 and a Grunau Baby, utilizing the club winch for launching. The day was fine and cool with a light wind blowing from the south at between five and ten knots. Flying was commenced soon after 1000 hours, and throughout the morning and early afternoon, 29 launches were carried out in the Kookaburra and six in the Grunau.

With the exception of one, all these flights were made in the vicinity of the aerodrome and included one in which a normal left hand spin and recovery were practised in the Kookaburra. The exception was a soaring flight of 17 minutes duration which one club pilot made in the Grunau shortly after 1400 hours. Half an hour later, this pilot made a second solo flight, a normal circuit in the Kookaburra then followed this later with another circuit in the Grunau.

Later in the afternoon, the same pilot prepared to make a further solo flight in the Kookaburra and a junior member of the club who was acting as despatcher at the launching point, assisted the pilot into the front seat of the glider. The pilot strapped himself in and the despatcher secured the harness in the empty rear seat. The despatcher also checked that the ballast weights were in position and were properly secured. As he was discussing the proposed flight with the despatcher during

the pre-launching drill, the pilot said he thought he would "do a couple of spiral dives" during the flight. The despatcher replied that this could be dangerous as the speed builds up too rapidly. The pilot made a non-committal reply and the two continued with the pre-launch drill.

The despatcher functionally checked the glider's cable release fitting then re-connected the launching cable. He then went to the lowered port wing tip and picked it up to level the glider, checked that the pilot was ready and gave the take up slack signal to the control vehicle. When the slack had been taken up in the launching cable, the despatcher signalled for the launch to commence and the glider began its take off run.

The glider maintained a straight heading along the strip without any significant drift, and climbed to 1200 ft. before the pilot released the cable. The glider then continued in level flight until it reached the position almost over the winch and turned left on to an easterly heading. Shortly afterwards the glider made a sloppy, but apparently deliberately induced entry into a left hand spin or spiral dive, and club members watching from the ground assumed that the pilot was going to practice a spin recovery.

After the aircraft had lost about 200 feet, the rate of rotation slowed, the angle of bank decreased, and the nose rose slightly as though the pilot was affecting a recovery. Instead of con-

tinuing to recover however, the glider's rate of rotation to the left then increased again, the nose dropped to about 45 degrees below the horizon, and the aircraft appeared to become stabilised in a normal left hand spin with the nose down about 50 degrees. Without any further indication that recovery action was being taken, the glider continued to spin until it struck the ground, nose first. The nose and cockpit section of the glider were completely demolished and the pilot received fatal injuries.

* * *

Investigation of the wreckage of the glider revealed no evidence of any pre-impact failure or any malfunction which could have contributed to the accident. There was no evidence to suggest that the pilot had become incapacitated during the flight, and it was established that before taking off he was in good spirits. The glider itself had been spun earlier the same day and had responded to normal recovery action after one and a half to two turns of the spin. The required balance weights were correctly positioned and secured in the glider, and it was loaded within the specified centre of gravity limits.

Witnesses at the aerodrome who watched the glider spin to the ground were unanimous in stating that it remained in a fully developed spin from approximately 1000 feet, without any apparent change of nose attitude or rate of rotation, indicating that the pilot did not take normal recovery action. The investigation was therefore concentrated on determining possible reasons for the pilot's failure to take the correct action to recover from the spin.

The pilot had completed 175 winch launched flights, comprising some 19 hours flying experience, and had accumulated sufficient experience for the issue of the F.A.I. "C" certificate, though he had not applied for the issue of this certificate. He had been cleared for solo flight eight months before the accident. Most of the pilot's dual instruction had been carried out by the chief flying instructor of the club, who said he had given the pilot five or six spins, both incipient and fully developed, before he cleared him for solo flight. The pilot had also undergone a further dual period of spinning only one month before the accident. The chief flying instructor said that he encouraged club pilots to practice spinning about once a month. He added however, that most club members would practice incipient, rather than fully developed spin recoveries.

On the day of the accident, it had been arranged for the pilot to be checked in spinning and recovery by another club instructor, during the last flight of the day. In view of this, and the evidence of the despatcher concerning the pilot's stated intention to carry out "a couple of spiral dives" during the flight on which the accident occurred, it is probable the manoeuvres he intended to carry out, were in fact practice spin recoveries in preparation for his later flight with the club instructor. The evidence of witnesses that the initial entry, though poorly executed, was into a deliberate spin, rather than a spiral dive, seems to confirm this.

The subsequent partial recovery of the glider from the spin as observed by the witnesses, occurred after a number of turns and at a height at which it could be expected that recovery action would be initiated. The entry of the glider into the further spin which followed, before full recovery was achieved from the first spin, suggests that the second entry was unintentional. It is apparent that the initial recovery action taken by the pilot, resulted in a higher than normal nose attitude for a spin recovery, which then led to the fully developed spin.

Tests were carried out in another Kookaburra glider to attempt to simulate the manoeuvres described by witnesses to the accident, and to determine what control combinations would achieve manoeuvres closely resembling those observed by the witnesses. These showed that the spin was probably entered by the application of full back stick with left rudder, and that the rudder was centralised after half a turn. After one full turn the stick was probably moved from fully back to the right rear position. It is likely that as right aileron was applied, there was a slowing of rotation and a slight pitch up of the nose. Within another quarter of the turn from this position however, the test glider returned to the previous nose-down spinning attitude and the rate of rotation then remained steady. Recovery was effected in the test aircraft after a total of four turns, by the application of full right rudder and the stick being moved to the central position. Altogether 1200 feet was lost during these manoeuvres.

A subsequent general investigation of glider club training practices, indicated that the training being given in spin recovery techniques was inadequate in some clubs, most of the emphasis during training apparently being given

to recovery from incipient spins, rather than fully developed spins. Several months before the accident, the Gliding Federation of Australia had forwarded a training memorandum to all affiliated clubs, drawing attention to this aspect of training. The training memorandum indicated that recent spin checks of all pilots by several clubs had revealed that many pilots in some clubs (including pilots of considerable experience) were not capable of carrying out spin recovery action, the most notable tendency being to use full back stick. It was also found that one of the glider pilot witnesses to the accident, who had recently soloed in the glider concerned, had it firmly fixed in his mind that the correct recovery action from any spin was opposite rudder and full back stick. The Department's Technical Liaison Officer with the Gliding Federation, also noted during gliding instructor training at Kingaroy, Queensland, that one member of a Queensland gliding club attempted to employ this same incorrect recovery technique on a number of occasions during training. This particular pilot was loath to move the stick forward at all while attempting to recover from a spin and required no less than five flights to overcome his "back stick fixation", notwithstanding the fact that he had some 40 hours gliding experience, most of which was on Kookaburra gliders. The Liaison Officer gained the impression that this pilot had not previously understood that in recoveries from fully developed spins, forward stick movement is required to unstall the glider. Had this pilot allowed a full spin to develop from the incipient stage, another accident could well have resulted.

In the accident under investigation, the witness evidence that there was no apparent change in the attitude of the aircraft from the time it entered the fully developed spin until it struck the ground, indicates that any further recovery action taken by the pilot only resulted in maintaining the spin and probably indicates that he continued to apply back stick. Even so, the application of full right rudder should have at least resulted in some slowing of the rotation and the only likely reason that can be suggested for the pilot's apparent failure to apply the required rudder correction is that he became confused or disoriented when the glider entered the second manoeuvre.

Altogether, the evidence of the investigation strongly suggests that the spin recovery training of the pilot involved in the accident was, like

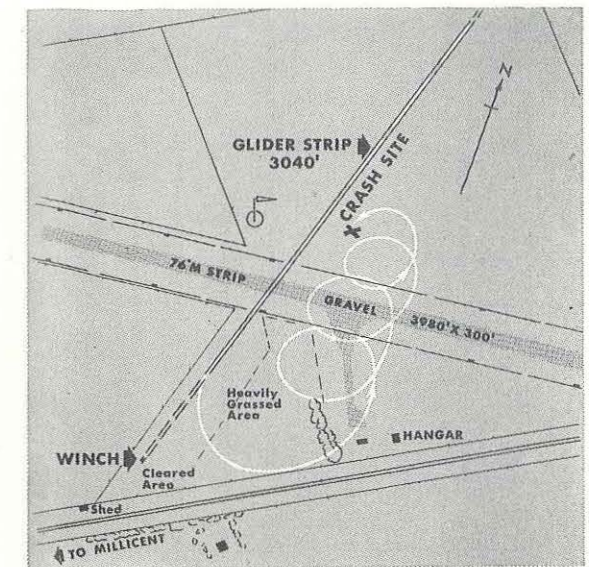


Diagram showing take-off direction and final flight path of glider.

many others from gliding clubs without aero-tow facilities, concentrated on incipient rather than fully developed spins. It appears quite possible that before he entered the spin which culminated in the accident, he had not carried out recovery action from a spin beyond the incipient stage since very early in his training. As a result, he was not fully aware of the need for a positive forward stick movement to recover from a fully developed spin.

Cause

The cause of the accident was that the pilot, probably due to inadequate training and experience in spinning manoeuvres, did not take effective recovery action.

Comment

This accident has brought to light serious inadequacies in spin training which exist in some gliding clubs that have only winch launching facilities available for their aircraft. Clearly, 1,200 feet, the maximum height usually attained during a winch launch, is too low to practise sustained spinning exercises and some means of overcoming this difficulty must be found. As a result of this accident the Gliding Federation have again taken up the matter of spin training with all affiliated gliding clubs to ensure that any deficiencies in this aspect of training are corrected, and that member pilots in future receive adequate instruction in recoveries from fully developed spins.

SKILL AVERTS A DISASTER

IN the Moorabbin flying training area, Victoria, a commercial pilot undergoing a flying instructors course was receiving dual instruction from a senior flying instructor in a Chipmunk.

After climbing to 4,500 feet in the training area, the senior pilot took over control to instruct the trainee in spinning and recovery sequences. The aircraft was stalled with power off and placed in a spin to the right. After three complete turns, full opposite rudder was applied and the control column was steadily moved forward to effect recovery. As the pilot did so, while the aircraft was still rotating to the right, there was a dull thump in the aircraft. The rate of rotation increased but then, as the pilot moved the control column further forward, the spin slowed and the aircraft entered a steep spiral dive. Application of full left rudder had no effect in stopping the turn to the right, so after sufficient speed had been gained for the ailerons to be effective, the rotation was slowed further with ailerons. The pilot finally managed to recover from the spiral into a straight diving attitude at an altitude of 1,800 feet.

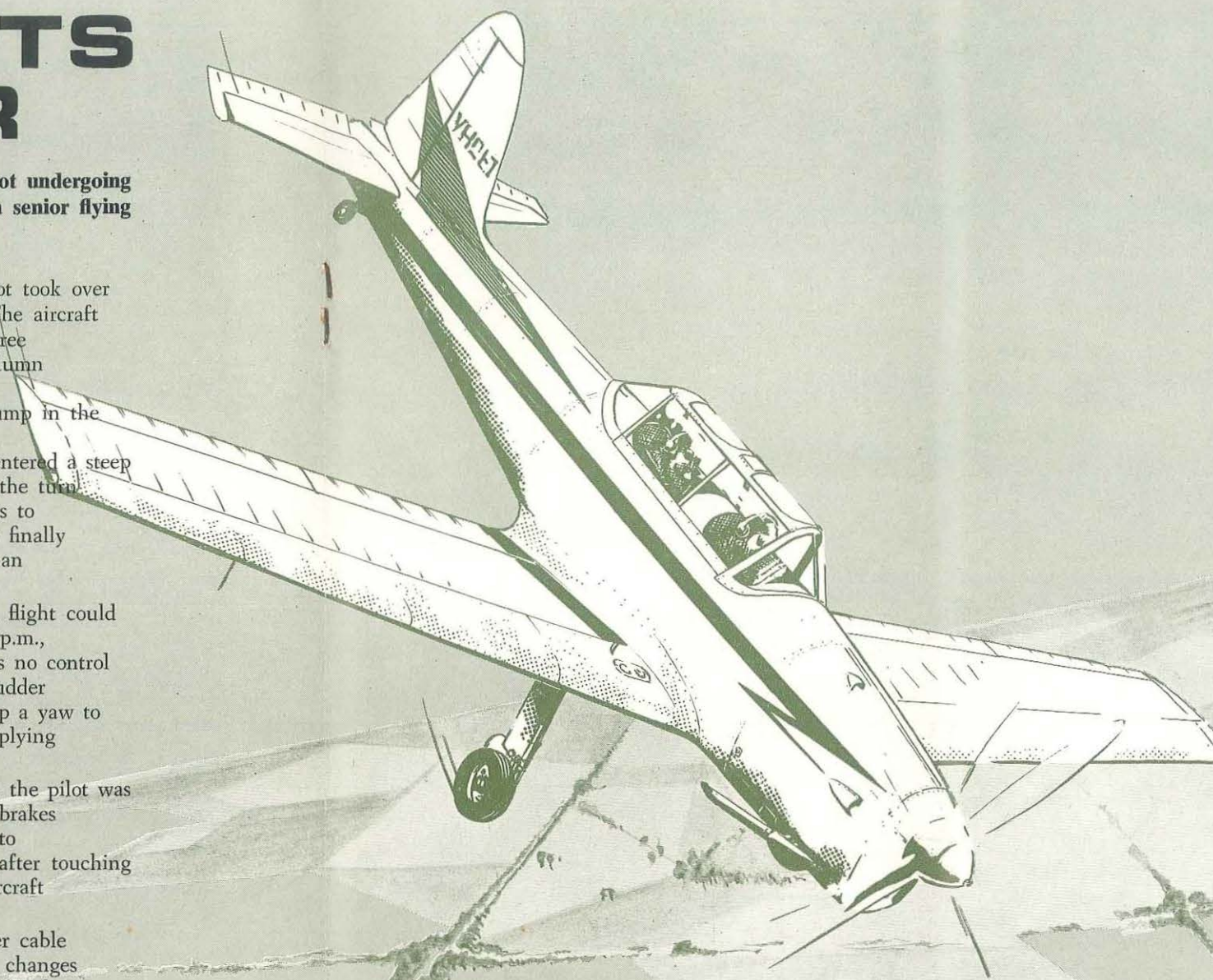
After regaining level flight, it was found that straight and level flight could only be maintained with a power setting between 1,800 and 1,900 r.p.m., any higher power causing the aircraft to yaw to the right. There was no control "feel" at all on the left rudder pedal, but the loading on the right rudder pedal seemed normal and any pressure applied to it immediately set up a yaw to the right. This could only be countered by decreasing power and applying left aileron.

By using a combination of power and aileron control in this way, the pilot was able to gain a measure of directional control and after checking the brakes and finding their "feel" normal on both wheels, the pilot returned to Moorabbin Airport and made a landing without flaps. Immediately after touching down, rudder control was lost but the pilot was able to keep the aircraft straight with differential braking.

Inspection of the aircraft after it landed, showed the port rudder cable had broken where it passes over a pulley $2\frac{1}{4}$ inches in diameter, and changes direction by ten degrees. The cable had been in service for about 8,500 hours. The corresponding starboard rudder cable was found to be similarly worn and contained a number of broken strands.

Further examination of both rudder cables at the Aeronautical Research Laboratories showed that their strength had been reduced by internal as well as external wear.

The external wear consisted of a reduction in the overall diameter of the cable, and was easily discernible to the naked eye, showing up as flats on the external surfaces of the cable strands. On this appearance alone the condition of the cable was such that it should have been replaced some considerable time before the failure occurred. The standards by which the serviceability of cables should be determined during inspections are set out in Air Navigation Order 108.2.19., and in this case both the failed cable and the corresponding starboard cable were worn to dimensions considerably below the limits specified.



The internal wear and loss of strength in the failed cable consisted of wear on the inner surfaces of the cable strands produced by relative motion of the strands against each other over a long period. This had reached the stage where some of the wire strands had been cut through completely. Most of the others had been reduced to only about 20 per cent of their original diameter. Wear of this sort is not easy to see unless the strands of the cable are forcibly separated and for this reason it is necessary to accept external signs of wear on a cable as a means of monitoring the wear taking place within the cable. It was to achieve this purpose that the limits set down in Air Navigation Order 108.2.19. were devised.

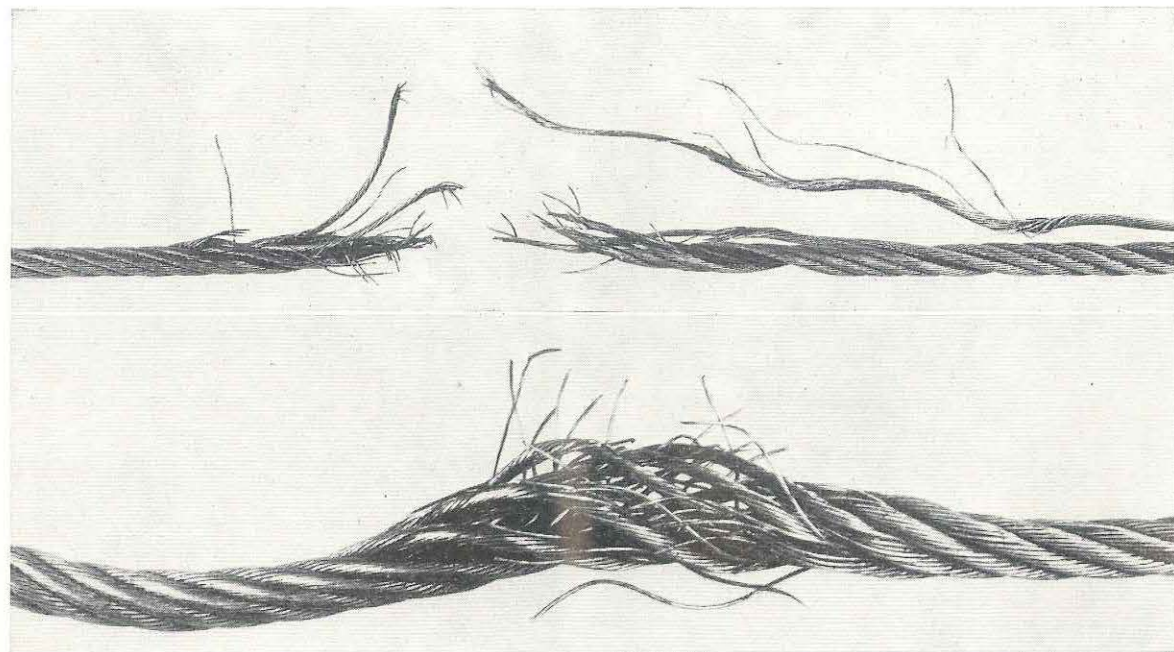
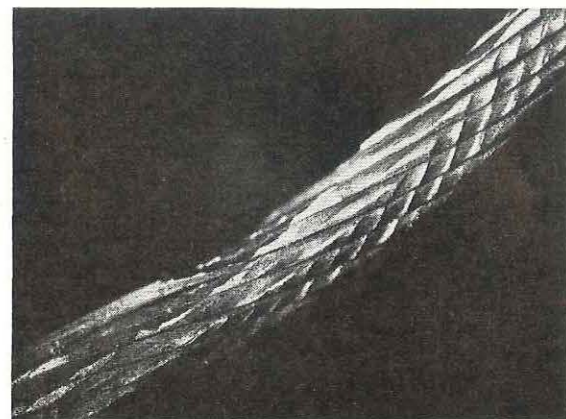


Fig. 1: (Top) The failure in the port rudder cable. Tapering of the wires towards the fracture area has been caused by wear.

Fig. 2: (Lower) Portion of the starboard rudder cable. The cable has been opened by manipulation with pliers, allowing previously broken wires to protrude. Patches of external wear can also be seen on the surface of the cable.

Fig. 3: (Below) A section of the port cable magnified ten times. All the wires are seriously reduced in thickness.

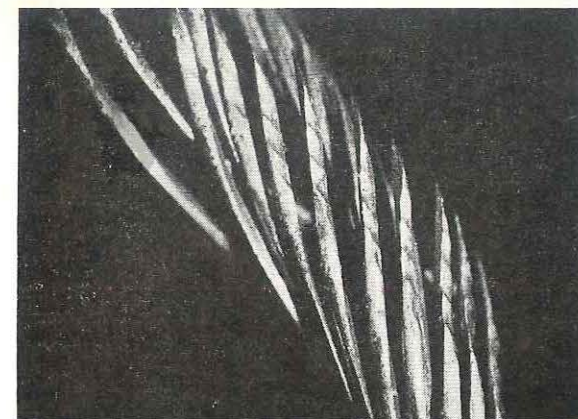


When a new cable is installed in an aircraft control system, the area of contact between the cable and a pulley is small, because each wire strand of the cable is perfectly round. But as the cable becomes even slightly worn, the strands develop flat surfaces, increasing the area of contact with a pulley or fairlead, and the rate of external wear is thus reduced. It is not generally realised however that while wear is taking place on the exterior surface of a cable, exactly the same process is taking place inside the cable, particularly in those sections of the cable which pass over pulleys. Experience has shown that the rate of internal wear can, in fact, be greater than that taking place on the surface. (See figures 1, 2, 3 and 4). Internal fretting of the strands can also take place even in a "straight run" portion of a cable that does not touch pulleys or fairleads. This wear results from the movement of the strands relative to one another, caused by differences in the loads imposed in operation, and the tension to which the cable was initially rigged. Wear of this type can be reduced considerably by maintaining recommended rigging tensions on control cables. An example of this type of wear in the cable concerned in this incident is shown at Figure 5. In this case, however, the wear in the straight run sections of the cable had developed over some 8,500 hours of service and at that rate of progress was not likely to become serious.

Thus for the maintenance engineer it is the wear and the damage that takes place in the vicinity of pulleys and fairleads, that is of greatest concern, together with the problem of detecting this wear. As we have already seen, the internal condition of control cables cannot readily be determined in service by acceptable inspection methods and maintenance engineers are thus compelled to rely on external indications of wear as a means of determining their airworthiness. Because of the many different factors involved in aircraft control systems such as pulley diameter, cable size, angle of deflection around pulleys, loads on the cable and the frequency of application of those loads, initial tension and standards of cleanliness, it is impractical, except in special circumstances, to specify a period in operating hours at which cables should be renewed.

The evidence of this and other control cable failure investigations shows that although the rate of wear differs for internal and external strands, the wear ratio is such that, providing the degree of external wear does not exceed the limits specified in Air Navigation Order 108.2.19., a safe working condition will usually be maintained. At this stage it may be appropriate to remind maintenance engineers concerned with the inspection of control cables, that the cable inspections specified in 100 hourly inspection schedules mean exactly what they say — obviously it is not much use checking cable attachments if the cable itself is worn beyond acceptable limits.

Fig. 4: Another section of the port cable seen under magnification. Wear has progressed to the point of cutting right through several wires.



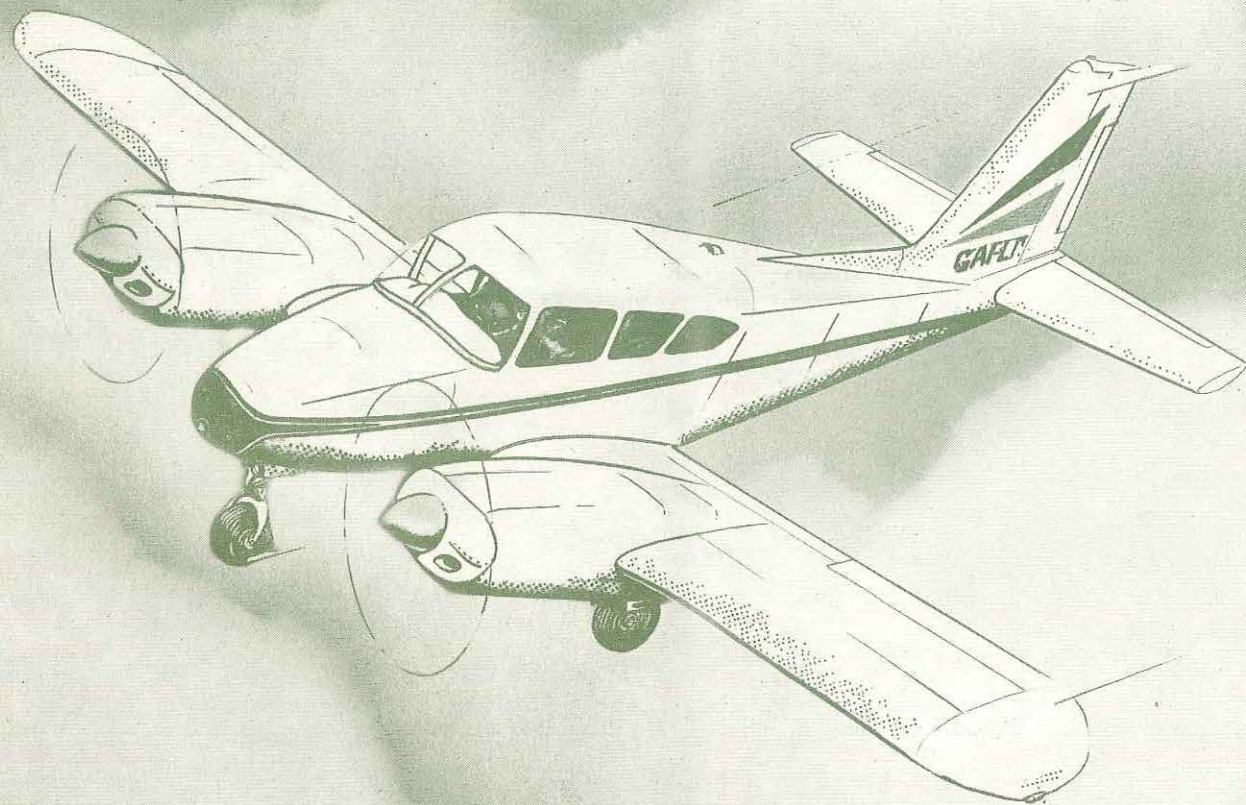
To sum up then, the problem of maintaining control cable systems in an airworthy condition can be met only by conscientious attention to the following points:

- Ensuring that cable runs are clear of obstructions between pulleys and fairleads.
- Maintaining their rigging tension to the specified figure.
- Examining cables critically at all pulley and fairlead contact points paying particular attention to the mid-travel positions, and using the limits specified in A.N.O. 108.2.19. as the standard of serviceability.
- Reporting to the Department any instances in which cable wear appears to be unusually rapid. It is probable that a minor modification will eliminate the hazard, and save repeated early cable replacements.

It should hardly be necessary to stress that the undoubted integrity of flying control systems is absolutely vital to safety in the air. In the case reviewed in this article however, inadequate maintenance could easily have resulted in a fatal accident, but for the skill and judgment demonstrated by the pilot-in-command of the aircraft. Licenced maintenance engineers, and indeed all who play any part in the maintenance of aircraft would do well to heed the object lesson of this incident.

Fig. 5: Photograph of a cross section of the port cable, away from the failure area, magnified 20 times. Although wear on the surface is negligible, severe damage has already taken place within the cable.





LIGHT TWIN STRIKES HILL

(Based on Accident Report issued by Board of Trade, United Kingdom)

WHILE making a single-pilot instrument approach to land at Dalcross Aerodrome, Inverness, Scotland, at the conclusion of a charter flight from Edinburgh, a PA.23-250 struck a hill 10 miles south-west of the aerodrome. The pilot was seriously injured, the sole passenger was killed, and the aircraft was destroyed by impact forces and the fire which followed.

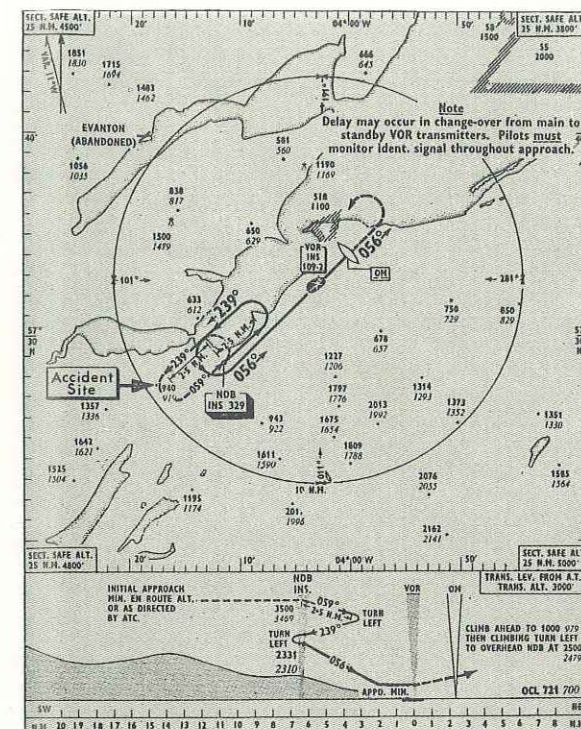
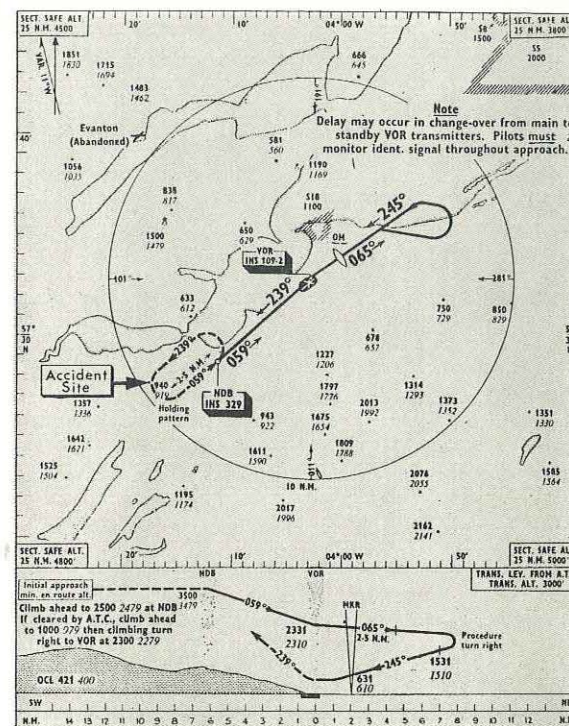
The flight departed Edinburgh at 0945 and proceeded normally at Flight Level 85. At 1018 hours, the pilot established contact with Dalcross and was cleared to descend to Flight Level 65. The aerodrome weather was passed to the pilot and as the surface wind was calm he was offered the choice of runways 24 or 06. The pilot acknowledged the call and nominated runway 24.

At 1022 hours, the pilot reported he was going to maintain Flight Level 70 on top of cloud, and at 1026 hours he reported over "the beacon" and turning on to the holding pattern. A minute later, the pilot was cleared to descend at his discretion and requested to report when visual. At 1032 hours, in reply to a call from the tower, the pilot advised he was just turning inbound on the holding pattern and passing through 2,700 feet in cloud. Two minutes later, the aircraft struck trees and crashed in a pine plantation on a hill 900 feet high, 10 miles south-west of the aerodrome and almost directly beneath the inbound turning point of the holding pattern.

Examination of the wreckage revealed no evidence of any pre-impact defect or malfunction. The swathe which the aircraft cut through the pine plantation, showed that at the time of impact the aircraft was descending, laterally level, on a heading of 080 degrees magnetic. The undercarriage was lowered and the flaps were one third extended. The directional gyro was uncaged and indicated a heading of 076 degrees.

The weather at the time was misty with a surface visibility of two miles and no wind. There

Dalcross VOR/Marker Instrument Approach Chart for runway 24.



Dalcross NDB/VOR Instrument Approach Chart for runway 06.

was two-eighths of cloud at 500 feet, five-eighths at 1,000 feet and the sky was completely overcast at 3,500 feet.

The pilot held an airline transport pilot's licence and was widely experienced, having served in the R.A.F. for 30 years, and had flown well over 4,000 hours. He had accumulated 255 hours in command of PA.23 aircraft and had landed at Dalcross on a number of occasions previously, though he had not before been obliged to make an instrument approach to land there.

The instrument approach aids at Dalcross consist of a VOR located on the aerodrome, an NDB situated 5.8 nautical miles to the south-west, and a fan marker on the approach to runway 24, 1.72 miles from the threshold. All these aids were functioning properly at the time of the accident.

Current approach procedure charts for Dalcross were found in the wreckage of the aircraft. The profile section for the runway 24 procedure, shows an altitude of 3,500 feet over the NDB and a subsequent descent to an altitude of 2,331 feet at the VOR; i.e., when the aircraft is to the south-west of the NDB, it should not descend below 3,500 feet.

The profile section of the chart for the runway 06 approach, shows an initial altitude of 3,500 feet over the NDB, followed by an intermediate procedure in which the aircraft is required to pass abeam the NDB at 2,331 feet heading north-east on a VOR radial of 056 degrees. Using this procedure, the aircraft should not at any time be below 2,331 feet while to the south-west of the NDB.

Because of his injuries, the pilot was not able to remember all that happened immediately before the accident. He did recall however, that just after he had reported over the NDB and was turning on to the holding pattern, he had caught sight of the aerodrome through broken cloud, and he had considered whether to make a visual approach through the gap before deciding to continue with an instrument approach. During the subsequent descent on instruments the pilot said, the directional gyro began to spin on two separate occasions and had to be re-set. At about this time, the pilot had considered applying propeller de-icing and believes he selected carburettor heat at the same time.

During a single-pilot instrument approach such as this one, the pilot, as well as flying the aircraft solely by reference to instruments is required to operate the radio, including making position reports at appropriate times, calculate ETA's, maintain specified terrain clearances, and conform to the established approach procedure, while at the same time conforming to air traffic control instructions to maintain separation from other traffic. He must also carry out the correct cockpit checks and change the configuration of the aircraft at the appropriate times. Lastly, while doing all these things, he must remain alert for any

failure of the aircraft's systems and radio facilities.

In this case, it is clear that the pilot had to contend with most of these factors, but in addition to this high mental workload, had to give his attention for some of the time to resetting the gyro. The evidence from the wreckage examination indicates that he reset it correctly, but whether or not this was achieved at the expense of paying insufficient attention to the instrument approach procedure, cannot be determined.

Although the reason for the pilot's failure to adhere to one of the two established instrument approach procedures remains obscure, it becomes possible to explain the error if it is assumed that, after sighting the aerodrome through the gap in the clouds, the pilot mentally transposed the positions of the VOR and the NDB. The fact that site and elevation of the crash site relative to the NDB transmitter, bears a close resemblance to a position on the final approach path for runway 06, which has a similar relationship to the VOR installation, is consistent with this theory.

In the absence of evidence of any failure or defect which might have caused the aircraft to descend while to the south-west of the NDB, it was considered that the descent was a manoeuvre within the control of the pilot. The accident was a result of the pilot's failure to adhere to the instrument approach procedure, for reasons that have not been determined.

Comment

In Australia the volume of general aviation instrument flying is increasing rapidly. This accident provides a timely warning to all engaged in single pilot instrument operations, of the degree of concentration and care that needs to be exercised for the safe conduct of these flights.

THAT FLAPPING NOISE AGAIN

Levelling out after climbing to cruising altitude from Cambridge, Tasmania, the pilot of a Cessna 172 was alarmed to hear a banging noise coming from somewhere outside the cabin. Suspecting engine trouble, the pilot transmitted the emergency call "PAN, PAN, PAN" and advised Hobart tower that he was returning to Cambridge. The aircraft made a normal landing and after taxi-ing in, it was found that the noise had been caused

by a loose seat belt protruding from beneath the starboard door of the aircraft.

"Frights" arising from this source have been reported in the Digest on a number of occasions in the past. This one is included in the hope that it might remind some of the newer generation of pilots to always ensure that unused seat belts are correctly stowed before take-off.

Over enthusiasm doesn't always pay . . .

AS he was touching down at Bridgetown, Western Australia, at the conclusion of a positioning flight, the pilot of an agricultural Cessna 180 heard a loud bang from the rear of the aircraft and at the same time the tail of the aircraft sank abruptly. The pilot immediately applied power to raise the tail, thus committing himself to going around again.

As he climbed away, the pilot found that control of the aircraft in the air was unaffected, and from the aircraft's shadow on the ground, he saw that the tail wheel was hanging from the aircraft at an abnormal angle. Suspecting that the tail wheel spring had broken and, rather than land the aircraft in this condition at Bridgetown, the pilot decided to fly direct to Jandakot Airport, 130 miles away, where full repair facilities were available.

As the aircraft accelerated to cruising speed however, the broken tail wheel assembly, still restrained from falling away by the tail wheel steering cables, began banging against the fuselage, and the pilot could feel the tugging on the rudder controls as the tail wheel assembly flailed in the slip-stream. To counter this, the pilot reduced speed, lowered 10 degrees of flap, and with a power setting of 15 inches of manifold pressure and 2,000 r.p.m., maintained an airspeed of 80 knots.

Shortly after passing Bunbury, 50 miles further on, the Cessna 180 was joined by another aircraft, the pilot of which confirmed that the tail wheel spring was broken and that the tail wheel assembly was thrashing about in the slip-stream and appeared to be causing damage to the underside of the tail plane.

The two aircraft flew on in company towards Jandakot. The tail wheel assembly flailing at the end of the steering cables gradually twisted the cables together until the pilot had only about two inches of rudder pedal movement left, but eventually, half an hour from the destination, the steering cables broke and the tail wheel assembly fell into open country near Pinjarra. Immediately the rudder controls returned to normal and the



This photograph, taken after the tail plane was removed from the aircraft for repair, shows the extensive skin damage inflicted by the flailing tail wheel assembly.

pilot found he again had full rudder pedal movement.

After the aircraft had landed at Jandakot it was found that the underside of the tailplane was badly holed in a number of places between the front and rear spars, and that two of the punctures had penetrated through the upper surface of the tail plane. Both elevators were distorted at the trailing edge and the underside of the rear fuselage was dented in several places. The tail wheel spring itself had fractured six inches forward of the tail wheel attachment point. The total cost of repairing the aircraft was estimated at \$1,400.

No doubt the pilot's motive in deciding to return the aircraft to Jandakot instead of landing at Bridgetown was to save time, money and inconvenience. But the degree of secondary damage which resulted from his decision considerably outweighed any advantage he could have hoped to gain. His standard of airmanship in continuing the flight, knowing that the aircraft was sustaining damage, leaves a great deal to be desired and little imagination is required to envisage the far more serious consequences that could easily have developed in this situation.

MORE WRONG FLUIDS

THE article "The Wrong Fluid", published in the Digest in May last year, has attracted a good deal of interest, particularly from companies and persons directly concerned with the refuelling of aircraft. As a result of this article, the Department has since been advised of two instances overseas, in which the wrong type of fuel was supplied to light aircraft. These latest incidents provide further reminders of the degree of vigilance necessary by all concerned with refuelling operations (and this includes pilots who sign for fuel, delivered to their aircraft) if, potentially dangerous situations of this sort are to be avoided.

In the first incident, aviation turbine kerosine was delivered to a Bell 47G-4a helicopter instead of avgas 100/130, and the refuelling was completed without the attendant noticing that the helicopter's fuel tank caps were clearly marked with the correct type and grade of fuel. The aircraft took off, but very soon afterwards, a rising cylinder head temperature reading made a forced landing necessary. Fortunately, the helicopter was not damaged.

The refuelling operator had previously received a telephoned order for fuel for the helicopter, which he mistakenly believed to be for turbine kerosine. Accordingly, he took with him a small turbine kerosine refuelling unit which he had been using to refuel Alouette helicopters belonging to another operator. The fuel was delivered to the Bell helicopter from this unit, and the pilot signed the delivery docket which clearly showed that the product supplied was turbine kerosine.

Although the pilot must share some of the blame, in blindly accepting the fuel without checking to see that the document was correct,

the incident would undoubtedly have been avoided if the refuelling operator had taken sufficient care beforehand to clearly establish the type and grade of fuel the aircraft required.

The other incident occurred when a Cessna 401 was similarly refuelled with turbine kerosine, instead of avgas 100/130, principally because the refuelling attendant saw the words "TURBO SYSTEM", painted prominently on the aircraft's engine nacelles! Another factor contributing to this error was that the refuelling operation had to be carried out in difficult conditions in continuous heavy rain, and as a result, the rather obscure fuel grade markings painted on the fuel tank filler caps, were not noticed. Once again, at the completion of the refuelling, the pilot signed the delivery docket, which clearly showed the delivery as turbine kerosine, without noticing what he was signing for.

The aircraft subsequently took off and it was only minutes before overheating engines forced him to turn back. The pilot was fortunate that the engines did not fail before he was able to return and make a successful landing at the aerodrome of departure.

Both the Department and the oil industry, view these incidents with grave concern. Although they occurred overseas they could just as easily have taken place in Australia and, in both cases quoted, the errors could have had consequences far more serious than those that actually followed. It is of the greatest importance that all who are involved with the business of refuelling aircraft continually emphasize to their staff how vital it is to *check and re-check* the grade of fuel required by any aircraft with which they are not familiar.



ENGINE CONTROL MAINTENANCE

Although there are many different types of engine controls, some better than others, they all share the common feature of having working parts subjected to an environment of severe vibration. It is not surprising, therefore, to find that most controls are subject to characteristic kinds of wear which, unless detected and rectified in time, can very easily lead to loss of control through disconnection or jamming in flight.

A typical example occurred late last year while the pilot of a Maule aircraft was making a local flight over Hervey Bay, two miles north of Pialba, Queensland. Reducing power to lose height, the pilot descended to 500 feet, then advanced the throttle again, but there was no response from the engine. The throttle control was obviously inoperative and the engine merely continued to run at about 1,000 r.p.m.

The pilot immediately turned towards the shore to attempt to carry out a forced landing on the beach, but the aircraft's gliding distance was insufficient and the pilot had no alternative but to make a landing in shallow water off the beach. The propeller was bent and the nose cowl and starboard undercarriage were damaged during the landing and the aircraft suffered further extensive corrosive damage as a result of its immersion in salt water.

Examination of the engine showed that the throttle linkage had become disconnected where the throttle push-pull rod pivots on the arm attached to the throttle butterfly spindle. The rod had fallen off the pivot bolt on the arm after the securing nut had worked loose and come off. At the time of the accident, the aircraft had flown only 610 hours since new, and was operating under a valid maintenance release.

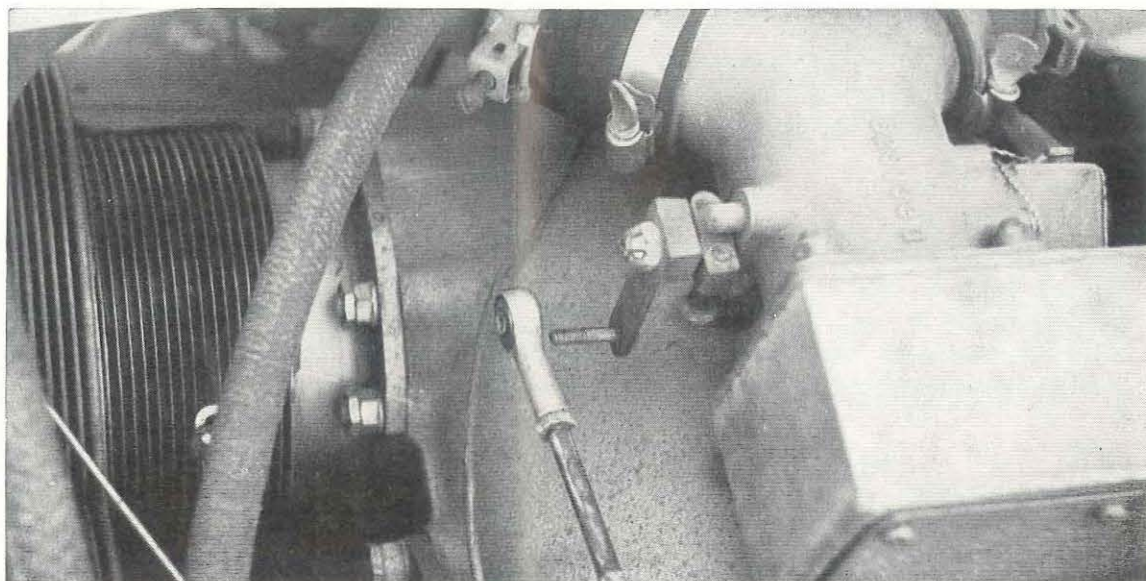
In another recent case, the throttle control of a Cessna 182 aircraft was found to be so badly worn that the throttle could not be closed beyond the cruise position. Inspection showed that the brass rod which protrudes from the steel tube casing at the engine end of the control had a step worn into it which eventually caught against the

edge of the tube and prevented further movement toward the "closed" position. Fortunately in this instance, the fault was found before flight because the pilot carried out the control freedom check before he started the engine.

The basic cause of the trouble was that the control system was out of alignment, with the result that as the throttle control lever on the engine travelled in its arc from the "open" to the "closed" position a very heavy bending load was imposed on the brass rod. The normal vibration of the engine coupled with the heavy pressure between the rod and the casing caused the rod to wear down between the "cruise" and "closed" positions until a step 1/16" deep was formed on the rod. If the control had been properly aligned in the first place, there would have been virtually no side load on the rod at the cruise position and a very much reduced pressure in the "open" and "closed" positions.

The aircraft had flown 207 hours since new, and only 10 hours since its last 100 hourly maintenance release inspection. If it is assumed that the control was improperly aligned at assembly of the aircraft, the amount of wear visible at the first 100 hourly inspection would have given a trained maintenance engineer a clear indication of the trouble. The fact that the fault in its obviously advanced stage of development was allowed to pass unrectified at the last 100 hourly inspection is inexcusable, and reflects very strongly and unfavourably on the ability and attention given to detail in certain workshops.

The standard of a 100 hourly inspection must be such that the aircraft will be in a fit condition to operate until the next scheduled inspection,



The disconnected throttle linkage found on the Maule after the forced landing.

under normal conditions of operation. On this basis, it is most disturbing to have defects of the kind discussed occurring, as in one of these two instances, within 10 per cent of the period between inspections.

The only real remedy to these problems is good maintenance, involving careful examination and functional testing of controls at each scheduled aircraft inspection. This inspection should include verification of correct rigging, thorough checks for security of parts, and freedom of movement *over the full range of travel of control*. Remember that engine controls usually spend most of their

operating life in a cruise position. It is while they are in this position, therefore, that most of the wear can be expected to take place. Depending on the design of the particular control system, such wear may not always be shown up by checks made when the control is at either end of its travel.

Despite the publicity given to this subject in other publications, the forced landings and accidents which have resulted from faulty engine controls show that there are still some maintenance personnel who have either failed to get the message or have forgotten it—hence this reminder.

HELP YOURSELF!

The types of weather least loved by pilots are unfortunately those most difficult to forecast—turbulence, hail, mountain wave effects and other extremely uncomfortable and potentially hazardous varieties. It is surprising how often pilots, who encounter unforecast weather phenomena in this category, and later enthusiastically compile a graphically worded incident report describing their experience, simply forget to pass a SPECIAL AIREP, which could have informed

weather forecasters of the need for promptly issuing a SIGMET and perhaps of the necessity to other following aircraft.

The AIREP system of reporting weather is an invaluable one if it is used properly by pilots and it can play a most important part in providing speedy advice of hazardous weather, especially in areas where ground observations are few and widely scattered.

VORTEX TURBULENCE THE CULPRIT AGAIN?

THE article "Vortex Turbulence Can Kill", (Aviation Safety Digest No. 51, July 1967) discussed the dangers to light aircraft that can exist in the wake of large aircraft, particularly in the vicinity of airports, while approaching to land, or just after take-off. The article also cautioned pilots that even the wake of other small aircraft could sometimes cause control difficulties when a number of aircraft are carrying out circuits and landings, sharing the same runway. It went on to cite an example of this, which occurred during night flying at Moorabbin Airport a short time before.

An accident report received recently from the Department of Transport, Canada, shows that the hazard of vortex turbulence is by no means confined to instances where light aircraft are operating behind very large aircraft.

At a controlled airport in Ontario, Canada, a PA-22 flown by a student pilot, was preparing to land. The weather was fine and warm and there was a light wind blowing from 170 degrees at eight knots, and the airport's runway 12 was in use.

After the student pilot had received landing information, the tower cleared an R.C.A.F. jet

training aircraft for a military type "break" landing on the runway ahead of the PA-22. This type of approach involves a low run over the runway, followed by an abrupt, steep climbing turn, during which the undercarriage and the flaps are lowered, and making a tight circuit to land on the runway. The jet aircraft completed its landing, and the tower then advised the student pilot, now on final approach, that he was cleared for a touch and go landing.

Almost immediately afterwards, the port wing of the PA-22 dropped suddenly and the aircraft began turning. The pilot was unable to regain control and the aircraft spiralled into the ground. Just before it struck the ground the pilot raised the nose as far as possible and shut off the engine, but the aircraft was substantially damaged and the pilot received serious injuries. The pilot said afterwards that the airspeed was indicating 70 knots immediately before he lost control.

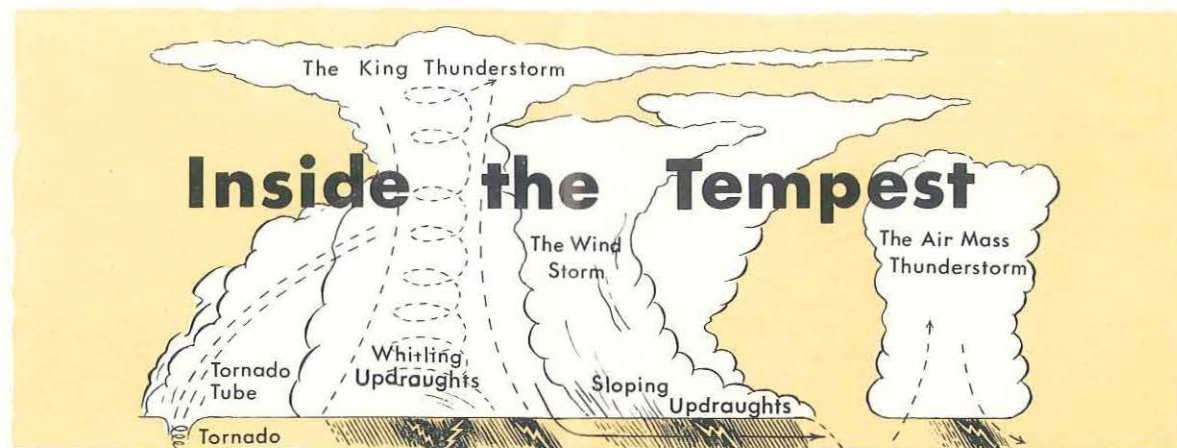
The circumstances of this accident are consistent with the PA-22 having encountered the wake of the jet aircraft during the final approach, and the investigation concluded that this vortex turbulence was the probable cause of the accident.

Actions Speak Louder Than Words:

Recently, while a Cessna 180 was undergoing an inspection for the renewal of its Certificate of Airworthiness, the inboard flap track bracket on the port side was found to be cracked. When the bracket was removed from the wing, cracks were also found in the web of the port wing spar, where the flap track bracket is rivetted to the spar rib.

The aircraft had previously been used in agricultural operations, and the damage to the wing structure had probably resulted from lowering the flaps while flying at more than the maximum recommended flap lowering speed.

This is not the first time that damage of this type has been found in the wing structures of aircraft used in agricultural operations. The possible consequences of exceeding placarded operating limitations, and the moral of this story, should be obvious.



By Ferdinand C. Bates, Associate Professor, University of St. Louis

In Australia until recently, the possible hazards to aviation posed by tornadoes have not been regarded as very significant. Earlier this year, however, a tornado caused a lot of damage to buildings in the Sydney suburb of Mosman, and this has aroused a great deal of interest in the cause of such phenomena. The following article has been condensed from a paper originally published in the St. Louis University Magazine in the United States, and describes some of the findings of recent research into the formation of tornadoes.

Of particular significance to pilots is the fact that the Sydney tornado was not visible on the radar screens of the JACMAS storm warning system at Sydney Airport, because it contained no precipitation. The article contains a theory which explains how these "dry" tornadoes may be formed.

The thunderstorm is a machine. This fact is not really new, but one is apt to think of machines as things of metal with well-formed and precisely-functioning parts. The thunderstorm is a machine which converts heat released by condensing water vapour partly into the kinetic energy of the updraughts and downdraughts, the eddies of turbulence, the whirl of the tornado, the gusting surface wind and the modified wind fields in the environment of the storm. Another part of that energy is converted into electrical energy, a tiny part of which goes into thunder. Still another part goes into supporting and retarding the descent of precipitation which forms within its updraughts. Again, all of this is not really new. The new thing is the realization that in the genus, "thunderstorm", there are sub-species, each a different kind of machine.

It might be interesting to note here the power of the machines we are discussing. The available horsepower ranges from about one hundred and forty million horsepower for a benign thunder-

storm, to fifty-thousand million horsepower for a king-sized severe thunderstorm.

The realization that thunderstorms differ, not only in intensity, but in their parts and processes, has led us to ask why two thunderstorms, each with about the same "fuel in its tank", manifest the difference between a prolific rain-making but otherwise benign thunderstorm, and one with damaging hail, tornadoes and aircraft-crippling turbulence associated. Bearing in mind that much of what follows yet remains theory and must be tested, let's shop through "King Thunderstorm's Showroom" for some of the machines he plans to unleash on his human subjects this year.

The first model is a "good guy"—the air-mass thunderstorm. This is the most popular model, accounting for more than 90 per cent of all thunderstorms. That's probably the reason why meteorologists understood this type of thunderstorm first. It starts out as a cumulus cloud with small water droplets and an updraught increasing in intensity and depth with time. It grows into a towering cumulus with the size and number of

water droplets increasing with time. Then, somewhere up in the cloud, the weight of the water becomes so great that it overcomes the buoyant force of the updraught, which can be thought of as a chimney of air warmed from heat released by condensing water vapour. A downdraught begins. It's about this time that the towering cumulus graduates into a thunderstorm. Charge separation has attended the breaking apart, freezing and relative motions of droplets, and the huge voltage differences between cloud regions and the earth break down in lightning discharges, with thunder crashing forth as shock waves from the superheated air columns through which the lightning passes.

This "good guy" thunderstorm dies by literally "choking" on the water in its updraught. In usually less than a hour after its birth this storm has collapsed into a cloud with downdraughts and decreasing precipitation. In its lifetime it will have produced lots of rain, moderate lightning and thunder, surface winds gusting to no more than fifty miles per hour, and perhaps a little hail. In flying through it, an experienced pilot with a good aircraft might have a few busy minutes, but he really wouldn't be in dire peril.

In regions where there are large changes in wind speed and direction with height, and especially over rough terrain, the first set of "nasty-actor" thunderstorms are encountered. They get that way because their updraughts slope, allowing water products to fall partly out the sides of the updraughts. Thus, with the same "fuel in the tank" as one of the "good guy" thunderstorms, these members of—let's call them "The Wild Bunch", since they come in different models—can be several times as intense in their updraught speeds. They can also live much longer, because they will have less water to choke on. Some of

the nasty things they do relate more directly to their sloping updraughts than their greater intensity.

One member of the Wild Bunch is the continuously-gusting windstorm. In this model the updraught slopes backwards into the wind that blows around the storm in the lower fifteen to twenty thousand feet. The air from this blocked flow, which is rather dry, shears in under the updraught, is cooled by the evaporation of rain falling through it, accelerates downwards by becoming cooled and by precipitation drag, and bursts on the surface as a wind with speeds up to 125 miles per hour.

Another member of the Wild Bunch is the hailmaker. The key to understanding this prolific ice-making machine lies in finding a path that hailstones may follow that will keep them in the ice-making machine long enough to grow to great size and that will cause them to have concentric laminations of ice of different types. That path is a bobbing ascent along the upper flank of the updraught which slopes away from the wind blowing around the storm and, of course, in the portion of the updraught which is below freezing. In general, therefore, hail can be expected to form between fifteen and forty thousand feet.

Thus, we can expect hail from thunderstorms in the Wild Bunch—often almost continuous hail, with stones ranging up to baseball size; strong, gusting surface winds, and turbulence aloft that will give the best pilot and aircraft lots of trouble. With these storms we can also expect vigorous lightning and thunder.

The Rex Tyrannosaurus of all thunderstorms is the one with an erect, rotating updraught. The key to understanding this fellow is that if a thunderstorm (which may originally be one of



the Wild Bunch) can live long enough over smooth enough terrain, its updraught will develop a vigorous whirl. This won't show much on the outside of the cloud. The updraught can stand essentially erect without the storm choking on its water because the larger droplets are being thrown out by centrifuge action. These storms are huge. They stand to more than fifty thousand feet quite often. The base of their steady updraught may often be fifteen to twenty miles in diameter. Their anvils can stream a hundred miles from their tops and can cover a thousand square miles.

These king thunderstorms are often seen as the principal storm members of squall lines. They can live for hours and dominate twenty to thirty miles of such lines. Aside from extreme turbulence aloft, these king thunderstorms don't contain the nasty phenomena of the Wild Bunch. Sporadic large hail, surface wind gusts and the tornadoes occur, however, in parasitic cloud structures on this thunderstorm's flank—and these parasitic clouds are there because the king storm helped them to develop.

The reader may have watched the sky during severe thunderstorms and seen puffball cumulus develop, try to stand erect, fail and shear away in defeat. On the flank of the king thunderstorm, which stands erect and blocks the wind almost as effectively as a mountain, there is a region where puffball cumuli can succeed in growing. Here, by favourable aerodynamic-drag interference such a cloud can develop and grow into a thunderstorm itself. As one such cloud grows immediately on the flank of the king, another often grows on its flank, another on the flank of that one, and so on—so that a line of such growing clouds will exist, extending usually to the south or south-west from the king thunderstorm. Thus, these lines of clouds are not developing on a cold front, but are simply in a position which is determined by the king thunderstorm and the relative wind.

The foregoing is not simply theoretical conjecture. The writer has, on two occasions, flown under and in the vicinity of such flanking cloud lines and observed and photographed tornadoes over their life cycles. The question, "How do you account for tornadoes occurring in and under these flanking clouds?" has taken four years to answer—but we are confident, short of one experiment to probe the interior of the flanking cloud line, that we have the answer.

When the growing clouds in the flanking lines have great slope towards the king thunderstorm, one or more of these may have the tops of their updraughts actually come in contact with the intense updraught of the king thunderstorm. They may then become physically connected with that updraught, usually above twenty thousand feet and probably below forty thousand feet. When that happens, because of great pressure reduction at their tops, the central region of their updraughts will draw down into violently rotating tubes. This happens because they will always have some slight rotation of their updraughts in the first place, and a process called "conservation of moment of momentum in a central force field" comes into being. This effect is propagated down the updraught in the flanking cumuli and the tornado, as identified by the visible cloud funnel, comes into being below the base of the cumulus cloud involved.

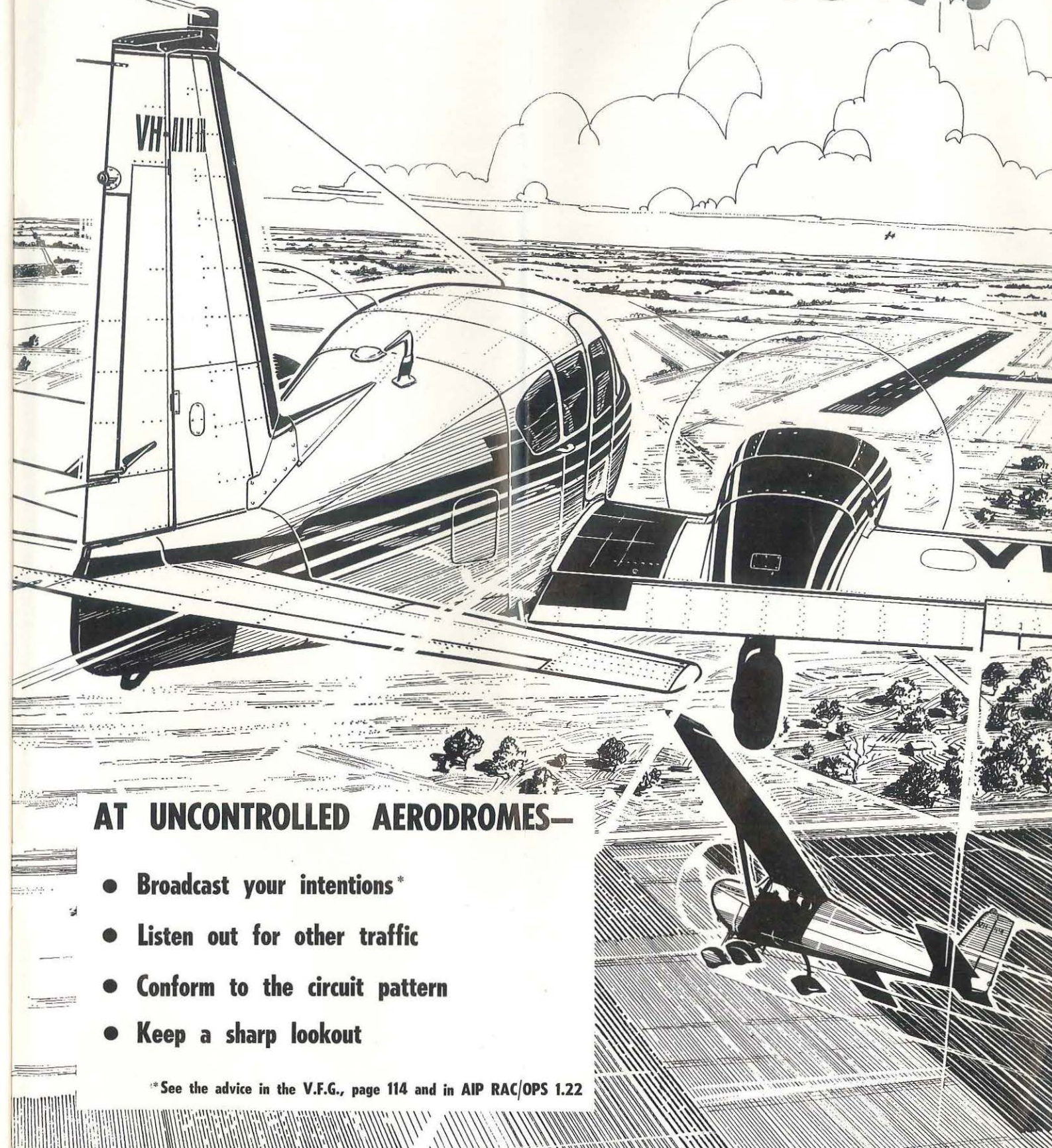
Actually, the visible funnel appears after an intense vortex has been established to the surface. The point below the flanking cloud where the tornado develops may be as much as twenty miles from the heavy precipitation and lightning of the king thunderstorm! This is beyond the range of audibility of thunder from that storm. Note also that more than one tornado may develop, and that many vortices may be present which never become visible.

Aside from the scientific value of the observation of this tornado mechanism and the validity or non-validity of the mechanics we have just described, the observation of these tornadic vortices on the flank of the king thunderstorm has identified one of the greatest hazards to aviation that can exist in the atmosphere. Beginning with a briefing of meteorologists shortly after interpreting this observation, the writer has attempted to reach as many pilots as possible through popular and technical aviation publications and personal briefings, to let them know about these claws of the Rex Tyrannosaurus storm.

All the possibilities that can happen in such storms have occurred to jet transports in the past six years. It is absolutely essential that word of this danger reach all airline pilots and that safe flight procedures be adopted to avoid these structures. The safe flight procedure is simple: NEVER FLY WITHIN TWENTY MILES OF AN INTENSE THUNDERSTORM.

AVIATION SAFETY DIGEST

FINAL APPROACH?



AT UNCONTROLLED AERODROMES—

- Broadcast your intentions*
- Listen out for other traffic
- Conform to the circuit pattern
- Keep a sharp lookout

* See the advice in the V.F.G., page 114 and in AIP RAC/OPS 1.22