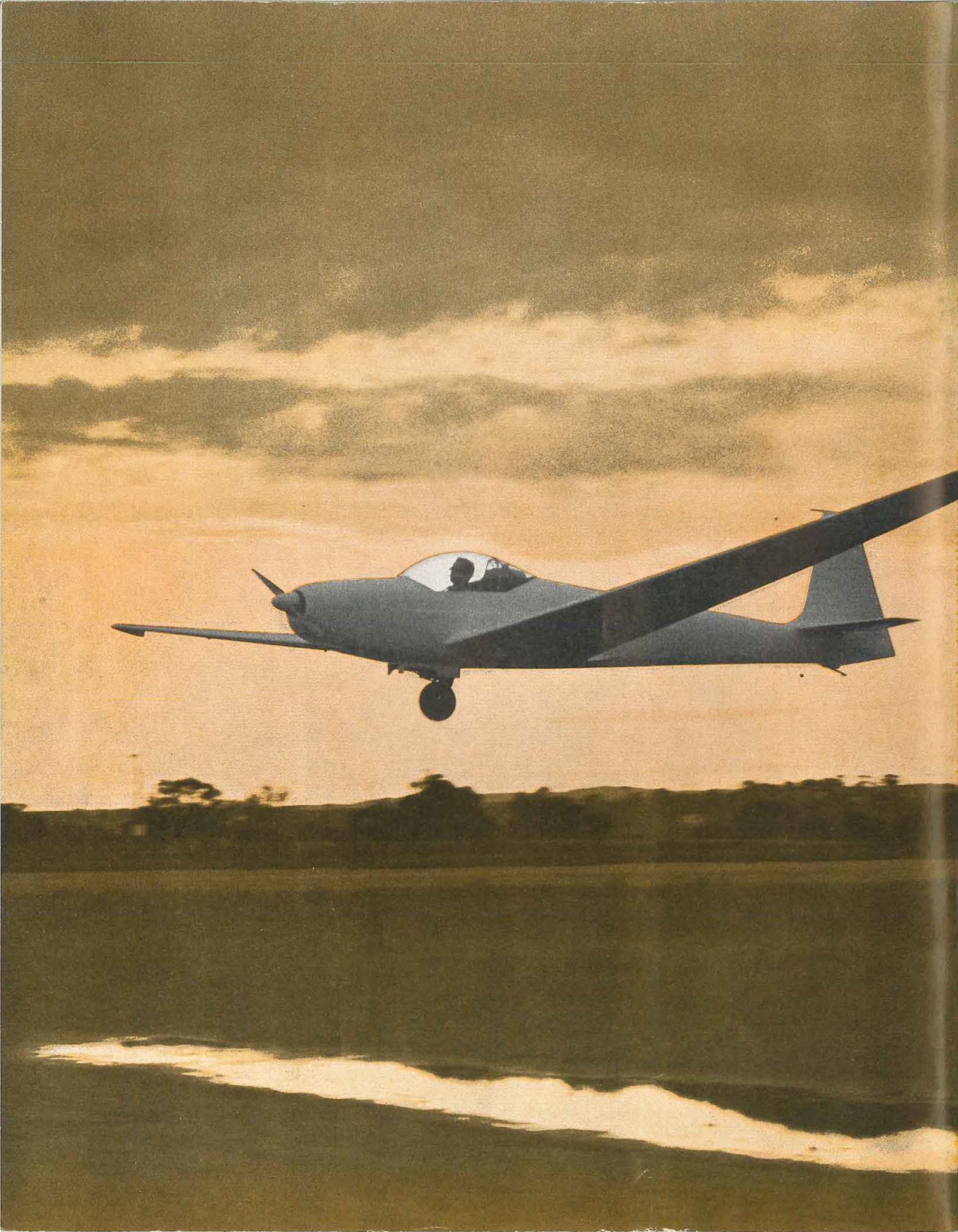
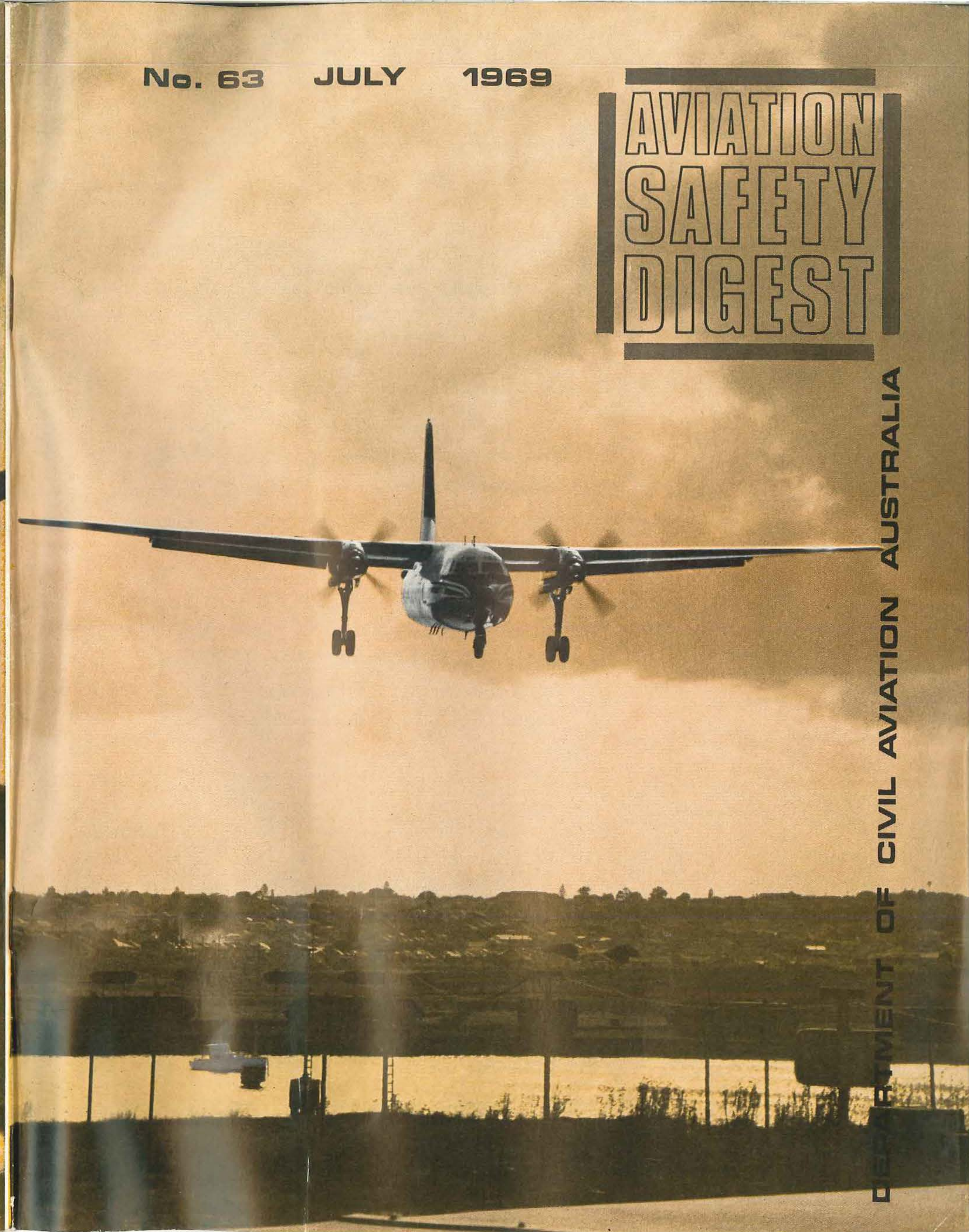


No. 63 JULY 1969

AVIATION SAFETY DIGEST



DEPARTMENT OF CIVIL AVIATION AUSTRALIA

AVIATION SAFETY DIGEST

No. 63 JULY, 1969

DEPARTMENT OF CIVIL AVIATION, AUSTRALIA

Contents

FRONT COVER: An East-West Airlines Fokker Friendship crosses Cook's River on short final approach for Runway 07 at Sydney's Kingsford-Smith Airport. Part of the runway's high intensity approach lighting system can be seen in the foreground.

—S. J. CHERZ PHOTOGRAPH

BACK COVER: With propeller feathered and single landing wheel extended, the first Schleicher ASK-14 motor glider to be imported to Australia comes in to land at Gawler, South Australia, during type certification flights for the issue of an Australian Certificate of Airworthiness.

AUSTRALIA

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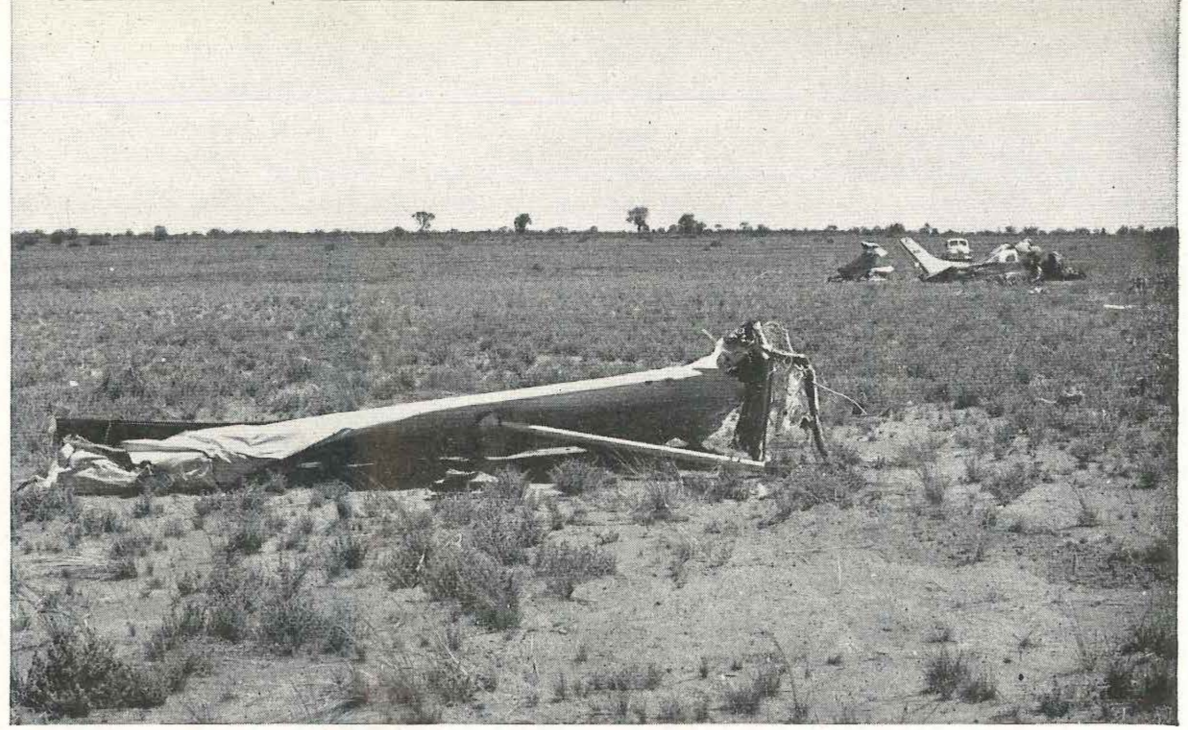


THE PRICE OF IRRESPONSIBILITY

Late in the afternoon, at an aerodrome in the far west of New South Wales, a Cessna 210 departed to return to a station homestead. After taking-off, the aircraft made a low level circuit of the aerodrome, then commenced a "beat-up" of the nearby town. After turning steeply over the town several times, at a low height, the aircraft turned back past the aerodrome in a shallow descent. At a point about a mile north-east of the aerodrome it began another steep turn to port, towards the aerodrome, and passed from sight behind a low rise. The aircraft did not re-appear and almost immediately a large cloud of dust rose up from behind the hillock. Eye witnesses watching from the aerodrome rushed to the scene to find the wreckage of the aircraft scattered and all four occupants dead.

The aircraft, with four persons on board, had arrived at the aerodrome soon after 0900 hours on the day of the accident, after a private flight from a station property some 80 miles away. The purpose of the flight was for one member of the party to visit the town in which he had previously lived and to meet old acquaintances. He was accompanied by the owner-pilot of the aircraft, his brother and a boy who had come for the flight in the aircraft. The owner of the aircraft held a private licence endorsed for the Cessna 210 and occupied the left hand seat. The brother of the man for whom the visit was arranged also held a private licence though it was not endorsed for the Cessna 210 and, from subsequent remarks and conversation, it was evident that on the flight that morning he had flown the aircraft from the right hand seat.

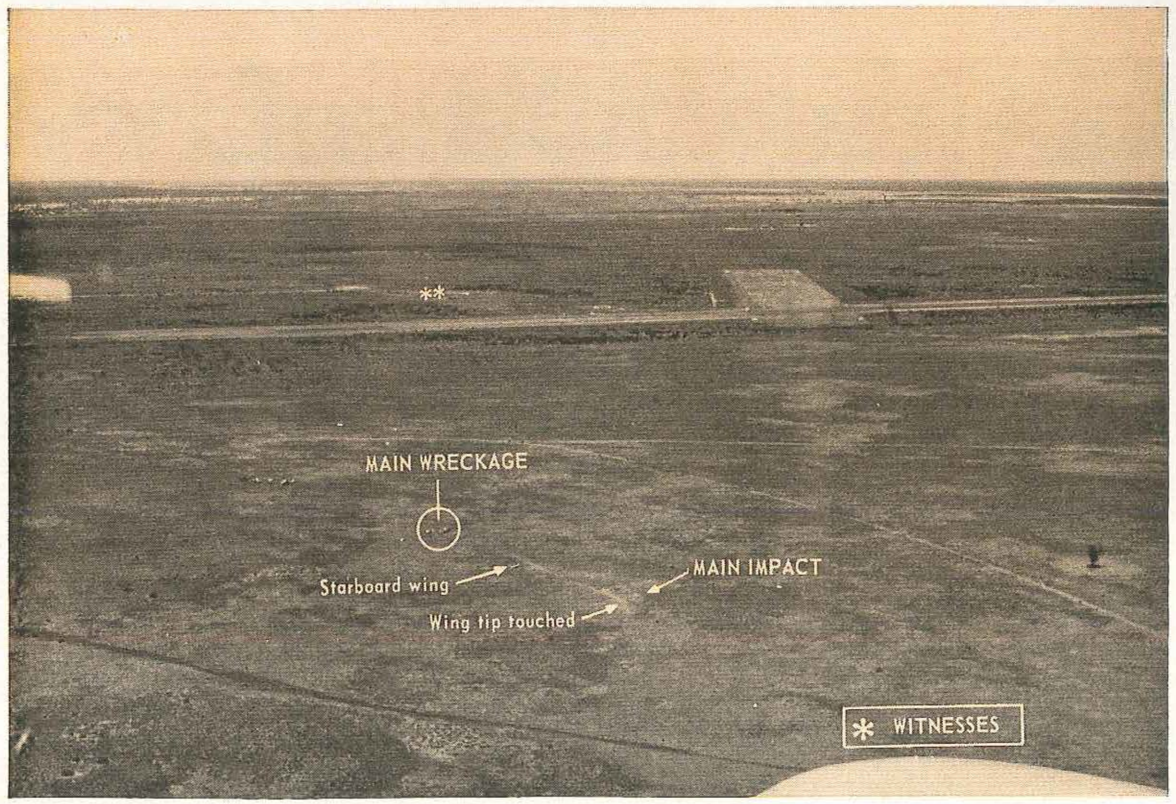
After they had called at an oil company agency in the town to arrange for the aeroplane to be refuelled later in the day, the three adult members of the party went to a hotel, where they stayed drinking from about 1130 until 1430 hours. During this time the two pilots drank at least nine glasses of beer each. The men were in an exuberant mood and engaged in a good deal of horseplay with other drinkers in the bar. From here, evidently after having something to eat, they went on to another hotel in the town at 1450 hours, where they were each seen to drink a further quantity of beer before leaving the premises at 1545 hours.

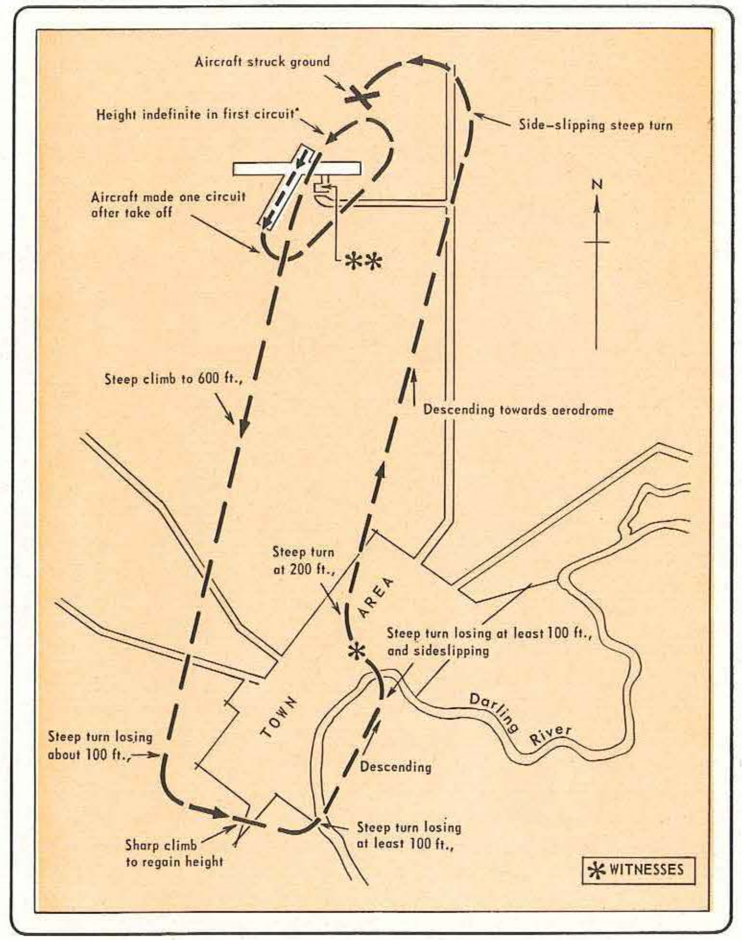
An hour later, the three men returned to the oil company agency to pay for the fuel they had ordered and have the aircraft refuelled. The two pilots appeared to be affected by the alcohol they had consumed. Their speech was slurred and the owner of the aircraft was inclined to be aggressive. They had been there only a short time when an argument developed with the man who was attending to them, and they were finally told they could not have any aviation fuel because they were "not in a fit state to fly the plane".

The men then went to another oil company agency, where they spoke to an attendant who had been left in charge during the manager's temporary absence from the depot. This employee also concluded that the party had been drinking but allowed the two pilots to prevail upon him to take some fuel out to the aircraft for them. The pilots helped him roll a drum of fuel into a utility vehicle and then, leaving the third member of the party in the town, accompanied the attendant to the aerodrome where they refuelled the aircraft with a hand pump. Before leaving the depot yard, the attendant had remarked to the pilots that he "would not like to fly with you fellows" and now that the refuelling was complete, the pilots suggested he should go "for a flip over the town" with them. Despite their persuasion, the attendant refused, excusing himself on the grounds that he had to get back to the yard, and saying he would go with them "next time they were down".

The attendant drove the pilots back to the depot where the fuel was invoiced and signed for. At the pilots' request he then drove them to the home of an acquaintance in the town where their two passengers were waiting for them. This acquaintance and his wife had previously arranged

Aerial view of aerodrome area showing crash site and position of eye-witnesses.





Map showing approximate flight path of aircraft from take-off to accident site.

to take the party back to the aerodrome and see them off. After arriving at the house at about 1830 hours, the men had another two small glasses of beer each, while their friend's wife and the lad who was accompanying them again on the homeward flight each had a soft drink. Shortly before 1900 hours they all drove to the aerodrome.

After showing their friends over the aircraft, the pilots and passengers settled themselves aboard. The owner occupied the left hand seat, the other pilot the right hand seat, and the two passengers were in the rear seats. The engine was started and the aircraft taxied to the north-eastern end of the aerodrome's 03-21 strip, where it was heard to run up in the normal way. The aircraft then took off into the south-west, turned left and made a tight low level circuit of the aerodrome before heading south towards the town. Just before reaching the town, the aircraft climbed steeply to a height of about 600 feet, then began another left hand circuit over the town itself, turning very steeply on to each "leg" and progressively losing height with each turn. Finally, the aircraft made a steep turn to the right at about 200 feet over the town and headed back in the general direction of the aerodrome, in a gradual descent. Reaching a position just to the north-east of the aerodrome, the aircraft began another steep turn to the left, during which height was lost. The turn, if continued on to a reciprocal heading, would have brought the aircraft back over where the party's friends were still watching from the aerodrome apron. When the aircraft had almost turned through 180 degrees however, the steeply depressed port wing made contact with the ground. It scraped along for about 30 feet, then the aircraft cartwheeled, breaking up and shedding components as it went until the main wreckage finally came to rest more than 500 feet beyond the point of impact.

* * *

The site of the crash was on flat open terrain about three quarters of a mile to the north of the aerodrome. From the first scrape mark made by the port wing tip, the wreckage trail extended for a distance of 645 feet. No fire broke out after the impact. Examination of the wreckage showed that the aircraft was functioning normally up to the moment of impact, and the engine was under considerable power when the crash occurred. Both the undercarriage and the flaps were in the retracted position. The speed of the aircraft at impact was estimated to be about 105 knots. The weather, which at the time was clear and warm, with a light south-westerly wind, in no way contributed to the accident.

Post mortem examination of the occupants confirmed that both pilots had consumed considerable amounts of alcohol before the flight. The alcohol level present in their bodies was such that their judgment and capacity to cope with the tasks involved in flying would have been substantially impaired. Apart from their indulgence in alcohol, there was no medical factor which could have contributed to the accident, and both pilots had been assessed as fit to hold private pilot licences at their last medical examinations.

The investigation found that there was adequate witness evidence of the pilots' whereabouts, behaviour and movements throughout the day of the accident. The party's visit to the town was purely a social one, at least four hours of which was spent drinking in hotels in the town. There was also ample evidence attesting to the physical effects of this intake of alcohol on the two pilots—the horseplay witnessed at the hotels, the belligerent attitude of the aircraft owner when he had difficulty in obtaining fuel, and the impression formed by a number of witnesses that both pilots were moderately under the influence of alcohol during the latter part of the day. There is no doubt that at the time of the accident, the aircraft was being flown in circumstances in which errors of judgment were inevitable. It is apparent that the port wing's fatal brush with the ground during the final low level turn was the climax to a series of such errors which began when the flight was commenced by pilots with impaired capability.

The flight over and around the town itself was seen by a person of authority who had held a private pilot licence several years before.

This witness's description of the aircraft's flight path and manoeuvres was supported by statements from a number of other witnesses located to the north of the town and on the aerodrome, as well as in the town itself.

The fact and the circumstances of the "beat-up" of the town together with the behaviour of the aircraft in flight, clearly indicate that the skill and judgment of the pilot were grossly deficient. The aircraft's final manoeuvre in the vicinity of the aerodrome was badly executed, the angle of bank was steep and the aircraft was descending and probably side-slipping. The descent was not checked and the port wing struck the ground with the disastrous results already described. Undoubtedly the reason for the final turn was the fact that the people who had seen the party off were still standing on the aerodrome apron. The position in which the aircraft crashed and the direction of the wreckage trail indicate that it was the pilot's intention to make another pass over them before departing.

It was not possible to determine conclusively which of the two pilots was flying the aircraft, but the evidence obtained during the investigation indicates that it was probably the pilot in the right hand seat. He had evidently flown the aircraft that morning and, shortly before departing for the aerodrome for the homeward flight, the owner of the aircraft was heard to remark that the other pilot was "captain for the day". This pilot was not endorsed for Cessna 210, but as he had flown some 600 hours in lighter Cessna types, he would not have experienced difficulty in manipulating the controls. The flight over the town, exhibiting considerably more exuberance than skill, would seem to support this view. Accurately flown steep turns require a good deal of judgment and co-ordination and, even allowing for the somewhat intoxicated state of both pilots, it seems likely that the less experienced pilot in the right hand seat would have flown less accurately than would the pilot who owned the aircraft.

Notwithstanding this contention, it is the owner-pilot who occupied the left hand seat who must be regarded as having been the pilot in command of the flight. He was the only pilot properly qualified to fly the aircraft and was seated in what is normally the "command" position. There is no reason to suspect that he relinquished control in any circumstances other than by his probable willingness to hand control of the aircraft to the other pilot nor is there any reason why he should not have assumed control if he so desired. In this situation, it is evident that the aircraft, flying at very low altitude, was finally committed to a manoeuvre which was beyond the ability of either pilot to accurately control.

Cause

The cause of the accident was that the pilot-in-command, whose judgment and ability to act in this capacity were impaired by the consumption of alcohol, permitted the aircraft to be operated at an unsafe height by a person whose judgment and capacity were also impaired by the consumption of alcohol. ●

LOSS OF CONTROL ON TAKE-OFF

(Condensed from report published by Board of Trade, United Kingdom)

At Southend Municipal Airport, Essex, U.K., a Viscount 812 which had recently been delivered from the United States was to be test flown for the re-issue of a United Kingdom Certificate of Airworthiness. An inspection of the aircraft had been carried out, and it had been prepared for flight in accordance with the Certificate of Airworthiness Renewal flight test schedule. The flight test crew consisted of the captain, another experienced Viscount captain, who was to act as co-pilot, and a Viscount-qualified first officer, who was to act as observer during the test flight.

Before the flight began the co-pilot conducted a pre-flight inspection, and the captain briefed the other two members of the crew of the flight test procedure, showing them the flight test schedule that they were to take with them in the aircraft. The co-pilot was to fly the aircraft from the left hand seat and, after he had made a normal take-off, the captain, occupying the right hand seat, would feather No. 4 propeller while the co-pilot continued the climb on three engines. The third member of the crew was to occupy a seat in the passenger cabin for the take-off, then go forward to the cockpit to record instrument readings when a safe height had been attained.

After the crew had boarded the aircraft the co-pilot's right hand began to bleed, and the captain decided that the co-pilot would carry out the first officer's duties and the feathering procedure from the right hand seat.

The captain extracted the appropriate speeds for V_1 (95 knots), V_R (105 knots) and V_2 (109 knots) from the operations manual and the figures were tabulated and displayed in the cockpit where they could be seen by both pilots. After being cleared by A.T.C., the aircraft was back tracked along the runway for a take-off from the threshold of Runway 24. During this time taxi checks were carried out and the flaps were set for take-off. The pre-take-off checks were completed at the runway threshold and the aircraft was cleared for take-off.

The aircraft accelerated normally until at about V_1, the co-pilot took action to feather No. 4 propeller. Shortly afterwards the captain rotated the aircraft. Almost immediately it became airborne the aircraft began to roll and turn uncontrollably to the right. At a height of no more than 40 or 50 feet the aircraft was seen to make a partial recovery, then the starboard wing dropped again and the bank and turn increased until the wing tip began to scrape the ground. After following a curving path in this attitude for a distance of more than 700 feet the aircraft collided with a light crane parked by the aerodrome perimeter track, continued across the perimeter track and crashed into a fenced-off storage compound where three men were working. An intense fire broke out, but the crew escaped from the aircraft through the emergency exit on the starboard side. The three men working in the compound were killed, and the aircraft was virtually destroyed.

* * *

Examination of the wreckage showed that at the time of the crash the undercarriage was down and the flaps were set to the take-off position of 20 degrees. Part of the outer portion of the starboard wing and No. 4 propeller lay on the perimeter track, having broken off before the aircraft came to a stop.

Examination of the runway revealed tyre scuff marks made by the starboard undercarriage wheels. The scuff marks were suggestive of the aircraft becoming airborne and then contacting the runway again, starboard wing down. The wheel marks continued across the runway to the right on to the grass, where a break in the marks occurred, indicative of the starboard wing being lifted and the aircraft becoming airborne again. Other marks further on showed the starboard wing had touched the ground 123 feet to the right of the runway and some 2,300 feet from the commencement of take-off. Altogether the marks indicated that the aircraft had progressed in a wide arc to the right when banked steeply at a height of less than half the wing span. The wing tip had dug into the ground with increasing force over a distance of 303 feet until about eight feet of the outer wing broke away. There was a break in the marks for 48 feet, then gouge marks showed that the inboard part of the broken wing had contacted the ground heavily for 186 feet. A series of propeller cuts approximately half-way along this second set of marks were made by No. 4 propeller which broke off shortly afterwards. From the nature of the propeller cuts it was clear that the No. 4 propeller was not in the feathered position. Furthermore, from the progressive increase in pitch between successive slash marks, it was apparent that the propeller was windmilling a dead engine.

After being examined at the site the aircraft wreckage was moved to a hangar for detailed examination. This examination produced no evidence of any pre-crash failure or malfunctioning of the airframe or the power units. The No. 4 engine was subjected to a strip examination, but no evidence of any pre-impact failure was revealed. The propeller oil control system was examined, but nothing was found to suggest any failure or condition which might have prevented the propeller from feathering.

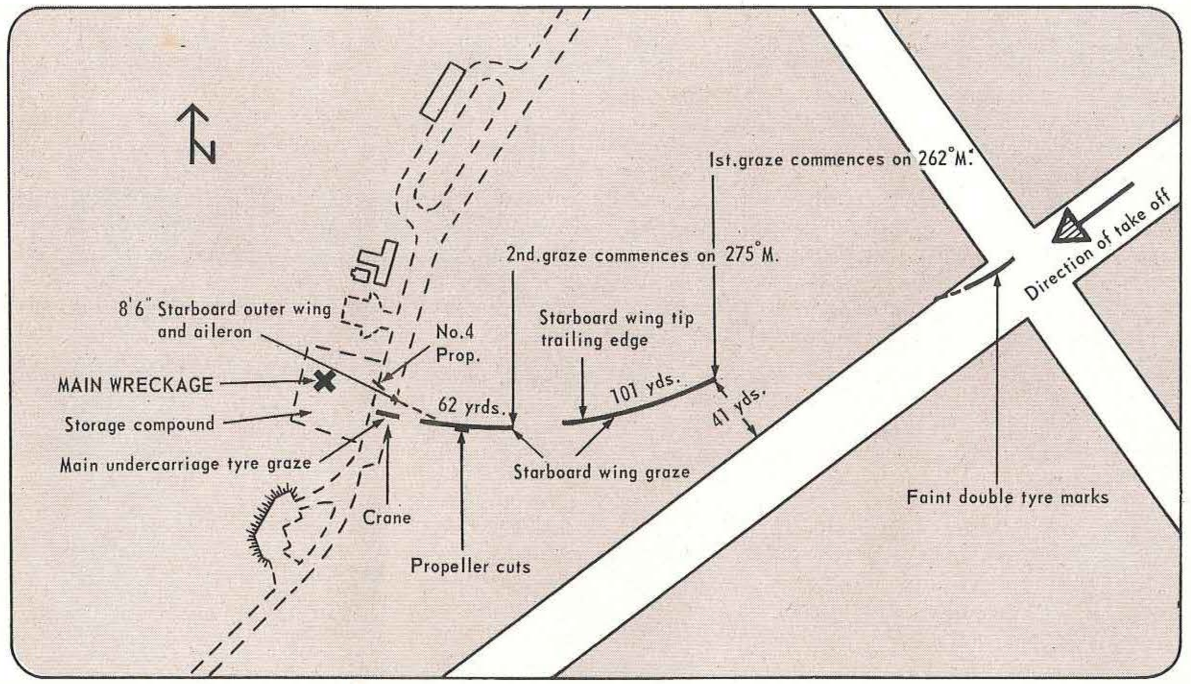
The airport's Runway 24 from which the aircraft was taking off has a tarmac surface 5,265 feet long and 120 feet wide. At the time of the accident its surface was dry and braking action was good. The storage compound into which the aircraft crashed is situated on the outside of the perimeter track approximately 640 feet to the right of the centreline of Runway 24. It is 390 feet outside the landing strip and well below the transitional slope of the licensing criteria. The light crane which the aircraft struck was parked on the inside edge of the perimeter track. It had its jib lowered parallel to the ground and was also below the transitional slope. The weather at the time of the accident was fine and cool and the wind was blowing from 230 degrees at 18 knots.

A flight data recorder was installed in the aircraft, and was recovered from the crash site in a slightly damaged condition. Information extracted from the recorder indicated that the maximum speed attained during the take-off was 82 knots. At the point where the airspeed began to register, the aircraft's heading was 240°. This had changed to 264°M by the time the airspeed had built up to its maximum value and, at the point where the recorder trace ended, the heading was 324°M. At the point where the maximum airspeed was achieved, accelerations of plus 2.2g and minus 0.9g were recorded, which coincided with the wing tip's impact with the ground.

The captain said that among other matters in his pre-flight briefing, he had instructed the co-pilot to fly the aircraft from the left hand seat and carry out a normal take-off. When they were airborne, he, the captain, would feather No. 4 propeller from the right hand seat. After the co-pilot's hand had began bleeding and it was decided that the co-pilot would perform the first officer's duties and the feathering from the right hand seat, the captain had rebriefed the co-pilot, saying that the previous briefing still applied except that, during the take-off, the co-pilot was to call out the speeds and, on reaching V_2, the captain would call for the feathering of No. 4 propeller.

The captain said that during the take-off run, when the co-pilot called "V_1", he glanced at his airspeed indicator and it was reading nearer to 100 knots. Soon afterwards the co-pilot called "V_R" but he did not notice the speed because he was about to rotate the aircraft. The co-pilot then called "No. 4 going into feather" and he saw him reach for No. 4 HP cock lever. He told the co-pilot it was too early but by this time feathering action had been taken and the co-pilot simply called "V_2". Up to this point the captain said he had held the nosewheel firmly on the ground and at the call "V_2" his airspeed indicator was reading 110 knots, so he rotated normally. As the nosewheel left the ground there was considerable drag to starboard. Corrective action was taken but when the main wheels came off the ground the aircraft yawed about 20 degrees to the right and there was considerable starboard wing drop. The captain thought he felt the starboard wheels skimming the ground and took maximum corrective action by applying full port aileron and rudder. The starboard wing came up again and he felt he had regained control. He continued with the take-off because the speed was above V_1 and because of the aircraft's heading and attitude. He said the nose of the aircraft was not lifted too high and at no time did the stick-shaker operate. The next thing he remembered was seeing the co-pilot reach for the feathering button a second time and then the starboard wing flicked down. Simultaneously, the heading of the aircraft altered further to the right. He called to the co-pilot "I can't hold it, cut everything" and the co-pilot immediately closed the throttles.

The evidence of the co-pilot differed from that of the captain in some important details, particularly in relation to the pre-flight briefing. The co-pilot confirmed it was originally intended that he should fly the aircraft and that the incident to his hand had caused the change of duties. He agreed that he had been briefed on the test schedule and had been shown it, but he was adamant that the captain had instructed him to feather No. 4 propeller after reaching V_1. The



Plan of portion of airport showing runway from which aircraft was taking-off, scrape marks made by wing, and main wreckage site.

observer also understood from the briefing that the feathering of the propeller was to be carried out after reaching V_1. The co-pilot said when the aircraft was lined up at the runway threshold, in a position to give the maximum take-off run, he had opened the throttles to the power check position and then to full power. He then called that all engine instrument readings were normal and the captain commenced the take-off. At 60 knots, the co-pilot called that both airspeed indicators were reading the same, then continued to call the speeds at intervals of 10 knots. At 95 knots he called "V_1, feathering No. 4"; the co-pilot estimated that three seconds elapsed between his calling V_1 and initiating feathering action. He then moved No. 4 HP cock lever into the feathering gate and pressed No. 4 feathering button. The red warning light in the feathering button illuminated, indicating that the feathering motor was running, and the engine rpm began to decrease. He glanced at the airspeed indicator in readiness to call V_R and V_2 speeds, but at that moment the captain said he could not control the aircraft. The co-pilot did not know if the aircraft was airborne at this stage, nor could he remember calling V_R or V_2. He gained the impression the aircraft was banked about 30 degrees to the right but he could not say if any part of it was touching the ground. He pressed the feathering button again and moved No. 4 HP cock lever forward and back to ensure it was in the feathering gate. At this stage he believed the aircraft was airborne and it became obvious to him a crash was inevitable. He closed the throttles and braced for the impact.

The flight test schedule being used specified that a normal take off was to be carried out and any unusual handling or functional characteristics recorded. After take off for which a take off safety speed (V_2) appropriate to the aircraft's weight was to be selected, the aircraft was to climb from "a low safe altitude" for five minutes with the undercarriage up, the flaps set to 20 degrees, the No. 4 engine stopped and feathered, and the other engines operating at maximum take-off power.

A normal take-off is defined by the Air Registration Board as one made with all engines operating throughout and the aircraft flown to the schedule speed of V_2 in accordance with the appropriate section of the flight manual. The point in the flight path at which the take-off is completed is not defined in the Air Navigation Order or British Civil Airworthiness Requirements, but in the case of aircraft such as the Viscount, it is thought reasonable to interpret it as being the earliest point at which the aircraft settles into a steady climb having achieved take-off safety speed, the gear having been retracted, all inertia resulting from the flare-up and unstick having dissipated, and the flaps and power remaining at the take-off setting. The initiation of feathering procedure shortly after V_1 and V_2 speeds have been reached cannot be considered to be a normal take-off.

A "low safe altitude" for commencing the five minute climb after take-off is also not defined. The captain held the view that it was at about 300 feet after the undercarriage had retracted and locked up. The chief pilot and the chief training captain of the company which owned the aircraft were of the opinion that 1,000 feet above the terrain would be a safe altitude to feather an engine after take-off, subject to weather and traffic considerations. The Air Registration Board also considers 1,000 feet to be the prudent minimum altitude for this test.

* * *

The evidence of the crew and that relating to the flight path of the aircraft shows clearly that loss of control occurred immediately after "unstick". If the feathering of No. 4 propeller had proceeded normally, loss of control should not have occurred, provided the correct take-off technique was used and "unstick" was made at the appropriate take-off safety speed; reference to the graphs in the flight manual and the operations manual shows that the values of V_1, V_R and V_2 had been correctly extracted for the flight, as 95 knots, 105 knots and 109 knots respectively. The graphs are based on the automatic feathering device being operative and a minimum control speed in the air (V_{mca}) of 98.5 knots at sea level. The manual states that normal action following a power unit failure after V_1 would be to continue the take-off run, making use of the nosewheel to ensure directional control until just before unstick, which should be made at V_2. If an outer power unit has failed, a large amount of aileron will be required immediately after unstick to hold the wings level.

In this case, the captain stated that he rotated the aircraft when the airspeed indicator was reading 110 knots and that he applied full aileron and rudder in the appropriate sense. If this was so, since there was no technical fault with the aircraft nor evidence of fault with the feathering system, he should have been able to maintain control of the aircraft. He also said that on rotation, when the wheels left the ground, the aircraft swung to the right with a considerable starboard wing drop and that he thought he felt the starboard wheels skimming the ground. It is believed that the tyre scuff marks found on the runway were in fact made by the starboard wheels shortly after unstick. Assuming the take-off was commenced from a position not exceeding twice the length of the fuselage from the beginning of the runway, the wheel scuff marks began at a distance of 1,720 feet from the start of the take-off roll. The manufacturer's performance calculations show that three seconds after V_1, the aircraft would attain a speed of approximately 106 knots IAS with all engines operating. The distance travelled to reach this speed with a 10 knot and a 20 knot headwind component would be 2,020 feet and 1,650 feet respectively. Since these distances bracket the tyre scuff marks made by the starboard wheels, it seems reasonable to assume that, shortly after rotation, the aircraft banked and the starboard wheels touched the ground again, probably at a speed not exceeding 106 knots IAS. If this was the case, the aircraft could not have been rotated at a speed of 110 knots IAS, but more likely was rotated before reaching the scheduled V_R speed of 105 knots IAS. The fact that the co-pilot was unable to remember calling "V_R" tends to confirm this.

From the results of flight tests made during the investigation, it was calculated that, in the conditions prevailing at the time of the accident, with 10 and 20 knot headwind components, the speed of the aircraft at the position of the scuff marks on the runway would have been 97 knots and 104 knots respectively. This is a further indication of an early rotation when the speed was close to the V_{mca}. The actual rotation speed was possibly still above V_{mca} and, providing the captain was not distracted and was prepared for the full use of the controls, particularly aileron control, it should still have been possible to control the aircraft. It seems likely however, that some distraction may have occurred when feathering action was taken before the captain expected it. Shortly afterwards, when there was perhaps partial control, the actions of the co-pilot in trying to ensure that feathering had taken place, probably interrupted the feathering cycle and resulted in the propeller windmilling in flight fine pitch. With power on the other three engines, control of the aircraft was not achieved because of the extra drag and the attitude of the aircraft.

It appears that the pre-flight briefing given by the captain was imprecise since he expected No. 4 propeller to be feathered after V_2 whereas the co-pilot and the observer understood it was to be feathered after reaching V_1. The misunderstanding arising from this briefing and the last-minute change of seats, with the re-allocation of pilots' duties, created a potential accident situation. In these circumstances, premature rotation of the aircraft and the interruption of the feathering cycle, resulting in the propeller windmilling in flight fine pitch, precipitated a loss of control.

Cause

The accident was caused by loss of control during take-off, after feathering of No. 4 propeller had been initiated. ●

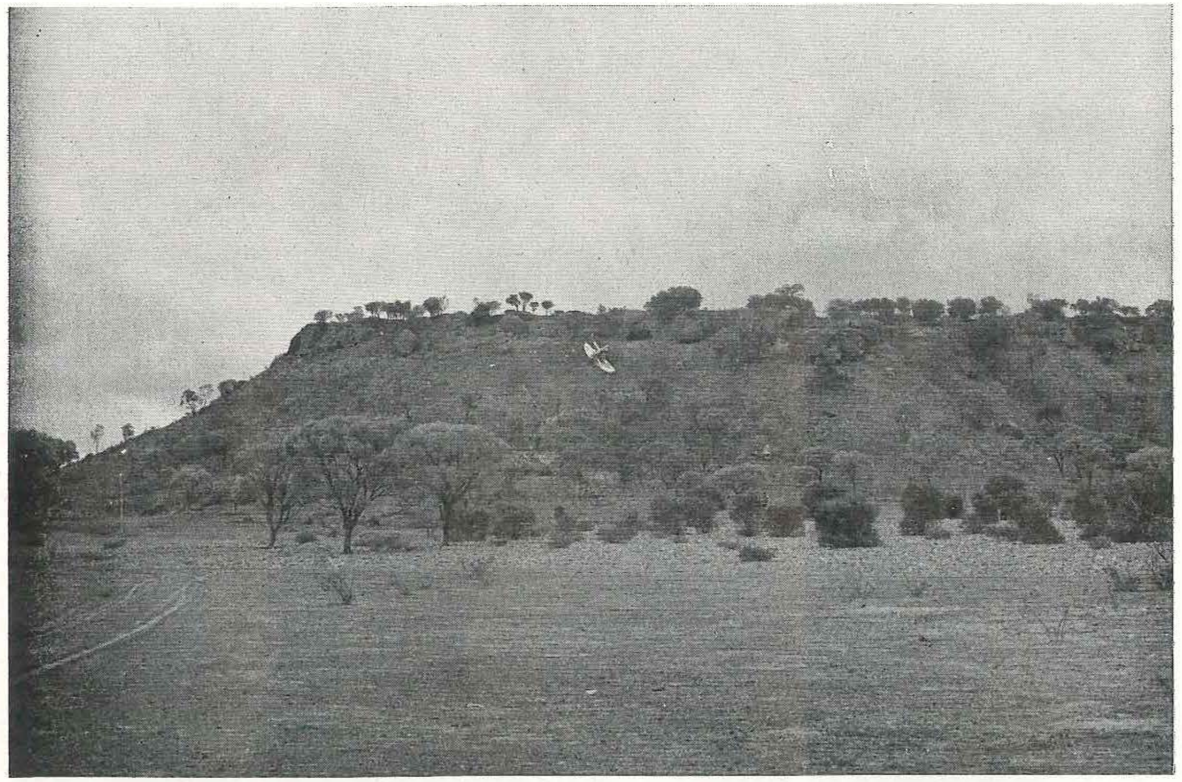
INEXPLICABLE COLLISION WITH HILL

IN western Queensland a grazier took off from his station property in his Cessna 172. Rain had fallen the day before, and it was his usual custom after rain to make an aerial inspection of the property and the surrounding district to assess the effect of the rain on the different areas of the countryside.

Not long after the aircraft departed the overseer of the station, who had left the property only a short time before to drive into the nearby town, saw the aircraft in level flight some distance ahead of his vehicle. The aircraft was flying at about 300 feet, but appeared to be operating normally in all respects. As the overseer watched it the aircraft turned back in the direction of the station homestead, on to a heading which lay across a range of low but steep-sided hills.

Soon after completing the turn, the aircraft began a shallow descent which continued until it was below the height of the terrain ahead of it. Levelling out, the aircraft continued in flight towards a steep ridge and, without any apparent change in attitude or power setting, flew straight into the side of the escarpment. A cloud of dust arose, but the wreckage did not catch fire.

Unable to climb the ridge himself to render assistance because of a previous leg injury, the overseer hurried to a neighbouring property, where



Crash site on hillside. Note prominence of escarpment above surrounding level terrain.

he alerted several station hands to the accident and telephoned the local police. Taking a vehicle, the station hands drove at once to the site of the crash and climbed the hill to reach the wreckage. They found the aircraft had been almost completely demolished by the impact and that the pilot had obviously been killed instantly.

* * *

Examination of the wreckage produced no indication of any pre-impact defect having developed in the aircraft which could have contributed to the accident. There was evidence that the engine was developing substantial power when the crash occurred. The disposition of the wreckage and the severity of the damage it sustained indicated that the aircraft was travelling at considerable speed when it collided with the hillside. At impact the aircraft was in a near-level attitude, with 20 degrees of flap lowered.

The weather at the time of the accident was fine, with only high level cloud, and the visibility was excellent.

The pilot, who was also the owner of the aircraft, was 40 years of age and held a private pilot licence. He had flown a total of 600 hours, nearly all of it on Cessna 172 aircraft. He was regarded as a sensible and competent pilot, who appeared to be very safety conscious. Although it was his habit to fly his aerial inspections of the property at heights between 200 and 300 feet, he always did so at reduced speed with some flap selected. He had not been known to fly lower than 200 feet at any time during these inspections, and if ever he found it necessary to turn steeply in these circumstances he would always do so to the left. The pilot did not, however, have any permit to engage in low flying during operations over his property.

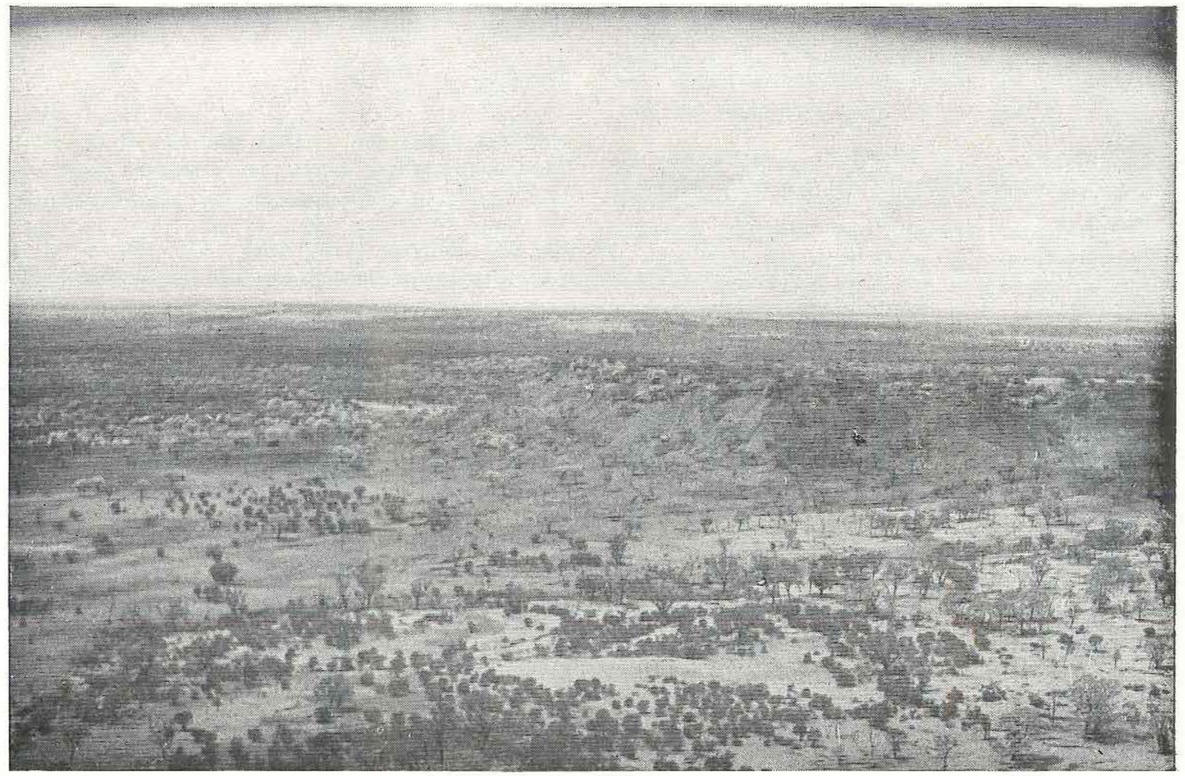
Before departing for the flight on which the accident occurred the pilot seemed to be in normal health and spirits. He had said nothing to indicate that the flight was other than a normal inspection of the property, an operation that he often carried out, particularly after rain had fallen. It was the pilot's habit to tell his wife if he intended landing anywhere away from the homestead and, on this occasion, he had said nothing to suggest he would be doing so.

The hill into which the aircraft crashed is 120 feet above the surrounding level terrain and is located about half a mile west of the main road which runs north from the nearby town and is less than a mile south of the turn-off to the station property. The location of the whole range of low hills, of which the accident site is but a part, is such that when travelling into the town by road the hills are to the south of the road for the first part of the journey, and then, after the main road has been joined, lie to the west of the road. In contrast, to the north and east of the road the country is completely flat. The pilot, who had lived in the area for some 15 years, and had travelled the country between his property and the town hundreds of times both by road and air, would have been completely familiar with the fact that the terrain rises abruptly to the south and west of the road. Thus, when flying southwards above the main road, as he was seen to be doing shortly before turning towards the hills just before the crash, he would have known there were hills to his right, even if he had not looked in that direction.

The witness who saw the aircraft in flight before it crashed indicated that the aircraft's turn towards the hill from its southerly heading was completed fairly rapidly and was not a gradual turn from the southerly direction of the road towards the hill. The hill would therefore have been directly ahead of the aircraft for about half a mile before impact, or for approximately 23 seconds, assuming an airspeed of about 80 knots, the speed at which the pilot customarily flew with flap lowered during his property inspections. It is difficult to understand how the pilot, who was in any case aware of the hill's position, could have been distracted by some factor either inside or outside the cockpit to the extent of failing to observe the hill during this period in sufficient time to take avoiding action.

The aircraft's heading at impact was close to that of the direct track from the point at which the aircraft was seen to turn, and the homestead at the pilot's property. It was evident, too, that when the aircraft turned it was flying at a height which would have taken it over the range of hills, well clear of the terrain. From other witness evidence, it was learned that the pilot, when making aerial inspections of this area, normally flew past one side of the hills on his outward leg and then flew back on the other side. But, if for

Aerial view of hill and crash site, taken from approximate position at which aircraft turned.



some reason on this occasion, such as if he were not feeling well, the pilot had decided to return home as quickly as possible, there was nothing to stop him turning straight back towards his homestead and flying home without any change in height. It seems possible therefore that at the time the aircraft turned the pilot may have decided to return home by the most direct route, but at this stage, for some undetermined reason, the aircraft descended below the level of the terrain ahead.

The possibility of a human factor having contributed to the accident became evident when it was learned in the course of the investigation that the pilot had a medical history of anxiety neurosis extending back over a number of years.

Unknown to the Department's Aviation Medicine Branch, the pilot's anxiety condition had worsened during the two years preceding the accident, and during this period he had been under constant medical treatment, taking prescribed courses of tranquillizing and sedative, sleep-inducing drugs. One of the drugs that the pilot was taking regularly at the time of the accident was a tranquillizer prescribed for anxiety state, tension and stress. This drug intensifies the action of the sedative, sleep-inducing type of drugs that had been prescribed for the pilot to take at night. It also can have the effect of lowering the subject's tolerance to alcohol and reducing his competence to drive or to operate machinery. The manufacturers of the drug stipulate that patients should be advised not to drive until it is clear that their competence has not been affected. Side effects produced by the drug are drowsiness when the treatment is begun, headache, faintness and undue elation.

The pilot had been warned that the drugs he was taking could slow his reaction time and his assessment of critical flight situations, and that for these reasons they should be taken with care. As the pilot did most of his flying in the morning the daily dosage of the tranquillizer drug was accordingly concentrated in the afternoon and evening, and the prescription for taking the tablets reflected this intention.

Although it could not be positively determined that the pilot had taken the prescribed sedative and tranquillizer drugs the night before the accident and the tranquillizer again on the morning before the flight, circumstantial evidence indicated a high probability of his having done so. If in fact, the pilot had done so, it is possible that the combined effects could have asserted themselves later and resulted in the pilot being partially sedated. The flight path of the aircraft immediately before impact does not preclude the possibility that the pilot might have been in a drowsy, inattentive state as a result of the drugs he had taken.

It was not possible to positively establish whether the pilot's illness or the treatment he was receiving had contributed to the accident. One factor which certainly contributed to the accident, however, was the height at which the aircraft was being operated. Whatever took place in the cockpit during the brief period between the time the aircraft was seen to turn and its collision with the hillside there is no doubt that there would have been a better chance of averting an accident if the aircraft were being flown at a height greater than 500 feet above the surrounding terrain.

Cause

The cause of the accident was that, while operating at an unsafe height, the pilot, for reasons that have not been determined, failed to detect an obvious obstruction to his intended flight path. ●

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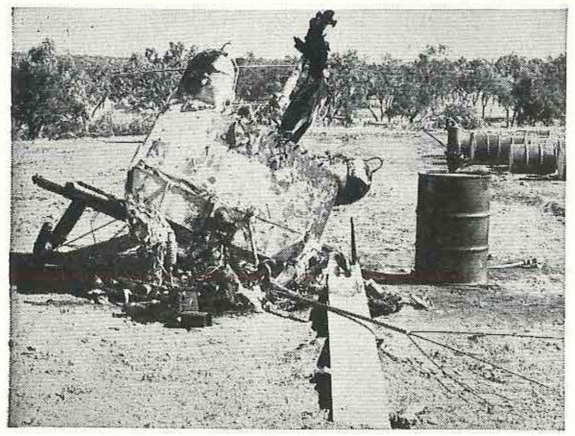


be bonded or earthed. There is little doubt that one or a combination of the unsatisfactory aspects of the operation was responsible for the fire.

Apart from the fire danger aspects, the refuelling was also unsatisfactory in that no funnel and chamois or other approved type of filter was used and no proper test for water was made before the refuelling began. The only "precaution" evidently taken was to pump several strokes of fuel on to the ground from the drum when it was first opened, ostensibly to remove any water or sediment in the base of the drum. Such a procedure hardly suggests that a great deal of care was being taken with the operation, and would do nothing to mitigate the effects of a fire, once it had started. ●

WHOOMF GOES ANOTHER !!

FROM time to time the Digest has attempted to convey to pilots and ground engineers some idea of the extreme care that is necessary when refuelling aircraft, and the ease with which a fire can start if the correct procedures are not followed. In some cases the Digest has done this by citing instances in which aircraft have been completely destroyed by refuelling fires. Two examples that readers may remember are the Debonair near Port Hedland (Digest No. 45) and the Pawnee in northern Queensland (Digest No. 55).

The circumstances in which the Pawnee was burnt out were so seemingly innocent that some readers found the story hard to credit. Nevertheless it **did** happen and now another occurrence of this type shows again that refuelling fires can and do occur in apparently harmless situations if proper care is not taken.

The photographs of the burnt-out Bell 47 tell most of the story. Operating in Western Australia on mineral survey work, the helicopter had been parked at the end of the day's flying, for maintenance and refuelling. Some 40 minutes after the engine had been shut down, by which time it was dark, the pilot and a ground engineer began to refuel the helicopter by torchlight. Using a quart stroke pump, they filled both tanks from 44 gallon drums, passing the hose between the rear of the perspex cockpit bubble and the fuel tanks. Some fuel overflowed into the fuel tank scuppers, and ran down the drain tubes to the ground.

The refuelling had just been completed and the engineer, standing on the port side pannier rack, was passing the hose back to the pilot who was standing alongside the helicopter, when the area around the helicopter's undercarriage burst into flames. The flames leapt up waist high and both men had to run through the fire to get clear. Both suffered burns and were admitted to hospital. Neither was able to explain later how the fire started, other than to suggest the possibility of a static discharge from the perspex cockpit bubble or the delivery hose. There was some suggestion that the hose might have been dropped against the structure of the helicopter immediately before the fire started, but the pilot and engineer were not able to remember clearly.

The actual mechanics of how the fire started is not certain. What is certain is that none of the recommended refuelling procedures were followed. Neither the helicopter nor the refuelling equipment were bonded to earth or even to each other, and the hose was evidently of a type that cannot

(Continued on opposite page)

ANOTHER VICTIM OF WAKE TURBULENCE ?

ON a number of occasions in recent years, the Digest has reported accidents that have occurred overseas as a result of light aircraft being upset when they flew into the wake of a large aircraft, either just after take-off or during an approach to land. The very serious hazard posed by wake turbulence (or vortex turbulence as it is sometimes known) at major airports was also the subject of a special article in Aviation Safety Digest No. 51, published in July, 1967.

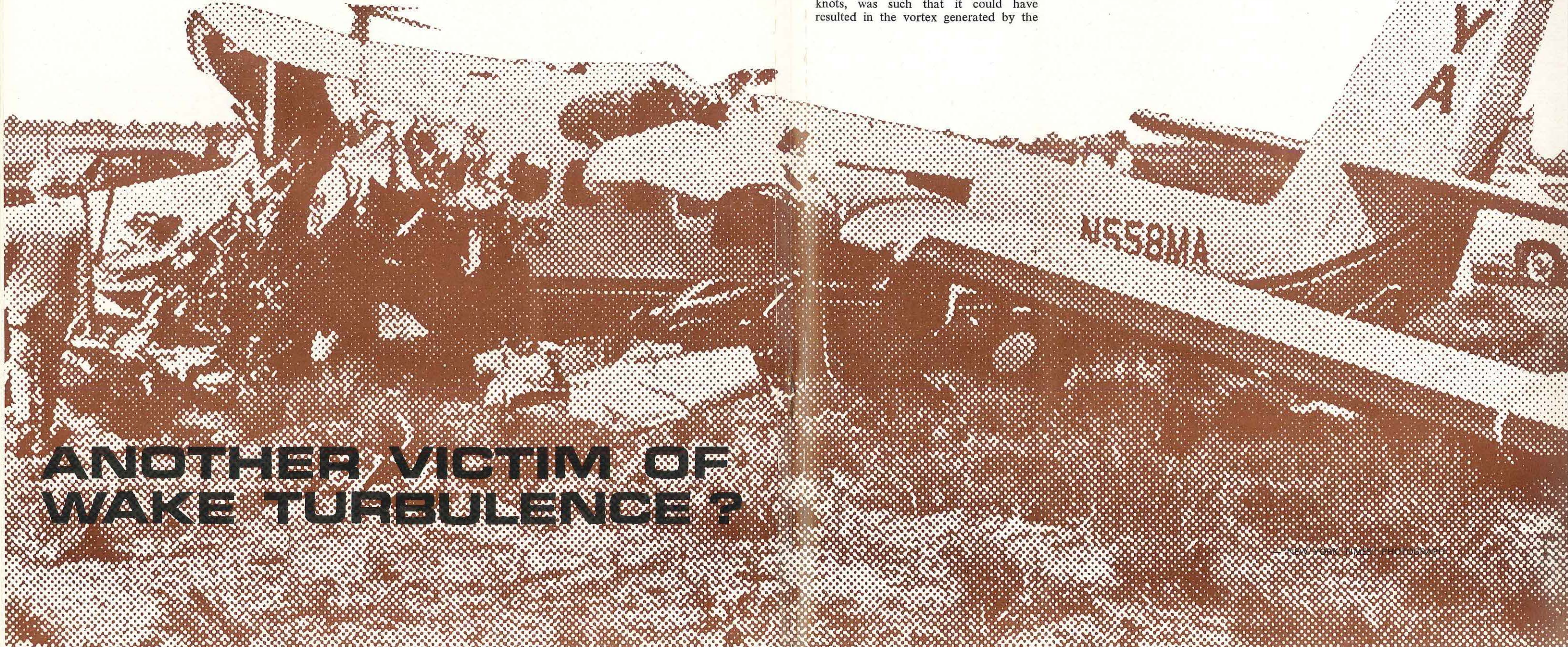
A fatal accident at the J. F. Kennedy International Airport in the United States, involving a Twin Otter aircraft that was taking off shortly after a heavily laden Boeing 707 had departed from the same runway for a trans-Atlantic flight, has again focused attention on this ever-present danger to smaller aircraft using busy major airports. The investigation of the accident to the Twin Otter has not yet been completed, but, because of the need for urgency in taking whatever steps are required to minimise the chances of further similar accidents, the National Transportation Safety Board in the United States has already issued a statement on what their investigation has revealed to date. The information the Board has released is of vital interest to all pilots, whether private or professional, who operate small aircraft into airports served by large aeroplanes.

The Board's statement first describes the circumstances which led to the accident. At 0754:41 local time on 15th July a Boeing 707-320 bound for Madrid began its take-off from the airport's 14,572 foot Runway 31L. The pre-computed figures for the Boeing's take-off run and the time to lift-off were 7,400 feet and 52 seconds respectively. Just over a minute later, at 0755:46, the Twin Otter, with a crew of two and eleven passengers on board, was cleared for an intersection take-off on the same runway. The taxiway intersection at which the Twin Otter entered the runway is 9,000 feet north-west of the runway threshold. The Twin Otter's take-off was normal until it had reached an altitude of between 50 and 100 feet. According to eye witnesses, the port wing then dropped violently, the aircraft turned sharply to the left and crashed to the ground, coming to rest facing a direction 160 degrees from that of the take-off path. The two members of the crew and one passenger were killed and the other occupants were injured.

The Board's investigation has disclosed no evidence of any failure or malfunction in the Twin Otter which could have contributed to the accident.

A study of the ground and flight paths of the two aircraft indicates that the wing tip vortices generated by the departing Boeing would have still been in the area where the Twin Otter was making its take-off. The surface wind at the time, blowing from 040 degrees at six knots, was such that it could have resulted in the vortex generated by the Boeing's starboard wing remaining in position over the runway where it could have been encountered by the Twin Otter as it climbed after lifting off. It is clear that the controller who cleared the Twin Otter for take-off was aware of the possibility of wake turbulence because his clearance included the warning "caution, wake turbulence." Whether or not the crew of the Twin Otter understood this transmission, however, or were in a position to evaluate the seriousness of the hazard, has not yet been determined. As a result of this accident the Board has recommended that additional emphasis be given to the task of disseminating information on the important problem of wake turbulence, to both pilots and controllers.

Fortunately, in Australia we have so far been spared any serious accidents resulting from encounters with wake tur-



NEW YORK TIMES PHOTOGRAPH

bulence. But there have been instances from time to time which should be sufficient to remind us that the danger of wake turbulence is not to be treated lightly. These should stimulate us all to be very much on our guard whenever we find ourselves in a situation where we could foreseeably become another victim of a wake turbulence encounter. One such instance occurred recently at Canberra, while a Twin Comanche was in the final stages of an approach to land, some two minutes after a BAC 111 had departed from the same runway.

The Twin Comanche, which was approaching Canberra from the south at the conclusion of a flight from Moorabbin, had been cleared to descend from 7,000 feet about the time the BAC 111 requested a taxi clearance. The BAC 111 was subsequently cleared for take-off shortly after the Twin Comanche had begun a long final straight-in approach to Runway 35 from 4,000 feet.

The Twin Comanche's approach was uneventful until the pilot flared the aircraft for landing. At this point, just as the aircraft seemed to be settling normally, it suddenly yawed quite violently to starboard and began to roll in the same direction. Despite what appears to have been severe turbulence, the pilot managed to regain a level attitude, but he could not re-align the aircraft with the runway, and it touched down tracking about 40 degrees to the right of the runway heading. The aircraft ran off the runway, groundlooped to the right, striking and demolishing a runway gable marker, then came to rest facing west, 130 feet from the edge of the runway. Fortunately, none of the occupants were injured and damage to the aircraft was confined to a bent undercarriage door.

The weather at the time was fine with a very light wind, the very conditions in which the vortices generated at the wing tips of an aircraft are likely to persist for some minutes before dissipating. After taking all the evidence into consideration, it was concluded that the most probable reason for the pilot's sudden loss of control was that, when about to touch down, his aircraft flew into the wake turbulence created by the departing BAC 111, which had apparently drifted down-wind towards the point where the Twin Comanche pilot was intending to touch down.

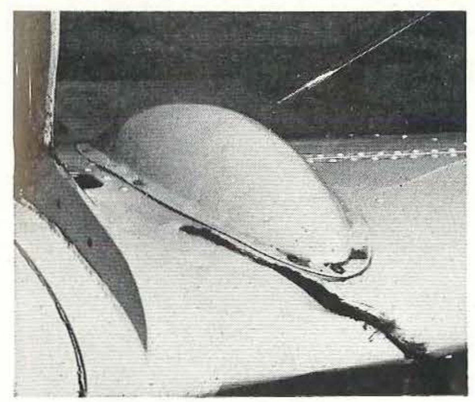
There can be little doubt that the occupants of the Twin Comanche were fortunate indeed to emerge unscathed from an encounter with the wake turbulence of a large jet. Possibly the fact that the Twin Comanche was almost on the ground before it flew into portion of the large aircraft's wake contributed to the happy outcome of a potentially dangerous situation.

Amongst the earlier overseas accidents referred to in the first paragraph have been several cases where the pilot of a light aircraft approaching to land behind a large aeroplane has been completely deprived of control in flight and the aircraft has dived into the ground with fatal results to the occupants. One light aircraft which flew into the wake of a Douglas Globemaster actually broke up in flight as a result of the excessive aerodynamic loads which the wing tip vortices of the Globemaster imposed on its airframe structure.

Statistically the chances of accidents of this sort occurring in Australia can only increase now that more and more general aviation aircraft are making use of our major airports. The possibility of an accident can thus be countered only by an increased awareness of the hazard by the pilots of these aircraft, resulting in increased vigilance in selecting flight paths which offer the best opportunities for avoiding likely areas of wake turbulence. The previously mentioned Digest article on the subject in issue No. 51 set out in some detail the factors to be considered in planning to avoid wake turbulence and the best procedures to follow for take-off, circuit area flying and landing when large aircraft are using the same airport. The problem is of such vital importance that it is now proposed to re-issue the information published in this earlier Digest article as a special pamphlet on the subject, which will be available on application to the Editor, as well as in Departmental Briefing Offices. In this way all pilots should have the opportunity to become familiar with the characteristics of wake turbulence, and so be mindful of its hazards whenever they are operating in a situation where there is the possibility of encountering the wake of a large aircraft.

One final point for pilots of twin engined aircraft in the Aero Commander-Beech Queenair-Cessna 411 bracket, who may feel inclined to regard references to "light aircraft" as applying only to single engine types. Don't imagine that the wake turbulence of a large aircraft makes any such distinctions. The situation depicted on the inside back cover of this issue is no exaggeration—the accident to the Twin Otter should be proof enough of that! ●

PLAN-AND RE-PLAN!



THE Grumman Agcat shown in the picture was engaged in spraying a crop of bananas on a property in hilly country on the north coast of New South Wales. The highly experienced pilot flying the aircraft had treated the same area some weeks before, but had found some difficulty in spraying it downhill. After making one spraying run downhill on this occasion, he decided it would be better to complete the spraying of the area by flying a pattern which followed the contours of the slope.

Approaching for the first contour run, almost at right angles to his previous flight path, the aircraft collided with a pair of steel cables which formed part of a "flying fox" system used to transport bananas from an adjoining field. The wires flattened about a foot of the leading edge of the port upper wing and tore deep, jagged gashes in the leading edge of the starboard lower wing before breaking free, leaving the aircraft trailing two long pieces of wire. The pilot immediately applied full power and despite the retarding effect of the trailing wires which were snagging in the crop, he kept the aircraft under control and lifted it clear.

Assessing the situation, the pilot decided against landing back on the agricultural strip, because of the length of wire the aircraft was trailing. Instead he called the tower at Coolangatta Airport, 28 miles away, explained his plight, and requested a clearance to land on the longest runway. The tower controller alerted the Airport Fire Service and a few minutes later the pilot made a steep approach and landed well down the runway to reduce the possibility of the trailing wires tangling in power lines or fences.

The pilot said after the accident that the owner of the property had given him a pre-flight briefing on the obstructions to be avoided and had supplied him with a map of the area. The pilot also made a personal inspection of the area from the ground before beginning the treatment. The wires that the aircraft struck however, were not on the property being treated, but on an adjoining one. The client had not drawn them to the pilot's attention and they were not immediately apparent from the ground.

Taking all the circumstances into account, it was clear that the stage had been set for the accident when the pilot made a last minute change of plan after he had begun to spray the area. The pilot had apparently not appreciated the significance of the fact that his changed spraying pattern required an approach along a flight path that he had not previously inspected for obstructions.

* * *

The fact that this particular accident had a happy ending should in no way be allowed to blunt the important object lesson it contains. The circumstances which led to this aircraft striking the flying fox wires are in fact typical of a large number of accidents, many of them fatal, that have plagued the industry from the time that agricultural flying was introduced to Australia, as the result of unplanned, spur-of-the-moment decisions taken in flight to depart from pre-planned spraying or spreading patterns.

Although the situation was slightly different in this case, this type of accident usually manifests itself during "finishing" or "cleaning up" runs made more or less at right angles to the planned treatment pattern. The problem was first aired in the Digest as long ago as September 1958, and it has been the subject of a number of other articles from time to time. As well there is a more permanent warning of this insidious hazard in OPS 6.6 of the Agricultural Pilot Manual.

Despite all such efforts to make pilots aware of the risks involved in hasty or ill-considered departures from planned agricultural flying patterns, it is apparent that some pilots have still not "got the message". An examination of the Department's records of recent accidents to agricultural aircraft involving collisions with wires, shows that by far the greatest proportion are still occurring during the "cleaning up", or "finishing" phase of operations.

The situation in which a pilot, finding he has a small amount of chemical left in the hopper at the completion of a series of normal runs, decides while still in flight to use it to "clean up" a section of the area being treated, seems to invite this type of accident.

There is obviously no simple solution to this recurring problem that has been the downfall of so many experienced and capable agricultural pilots. The danger can be counteracted only by the individual effort and determination of every agricultural pilot, to adhere strictly to sound operational practices despite whatever demands expediency may make. The advice contained in the final paragraph of an early Digest article on the same subject is as relevant as ever:

> "Plan the whole operation, including the finishing runs, in relation to all obstructions which are observed at this time. Further, if you decide to change your plan of operation, it is essential that you consider if your new plan takes into account previously insignificant obstructions." ●

MEDICATION *and the* Pilot

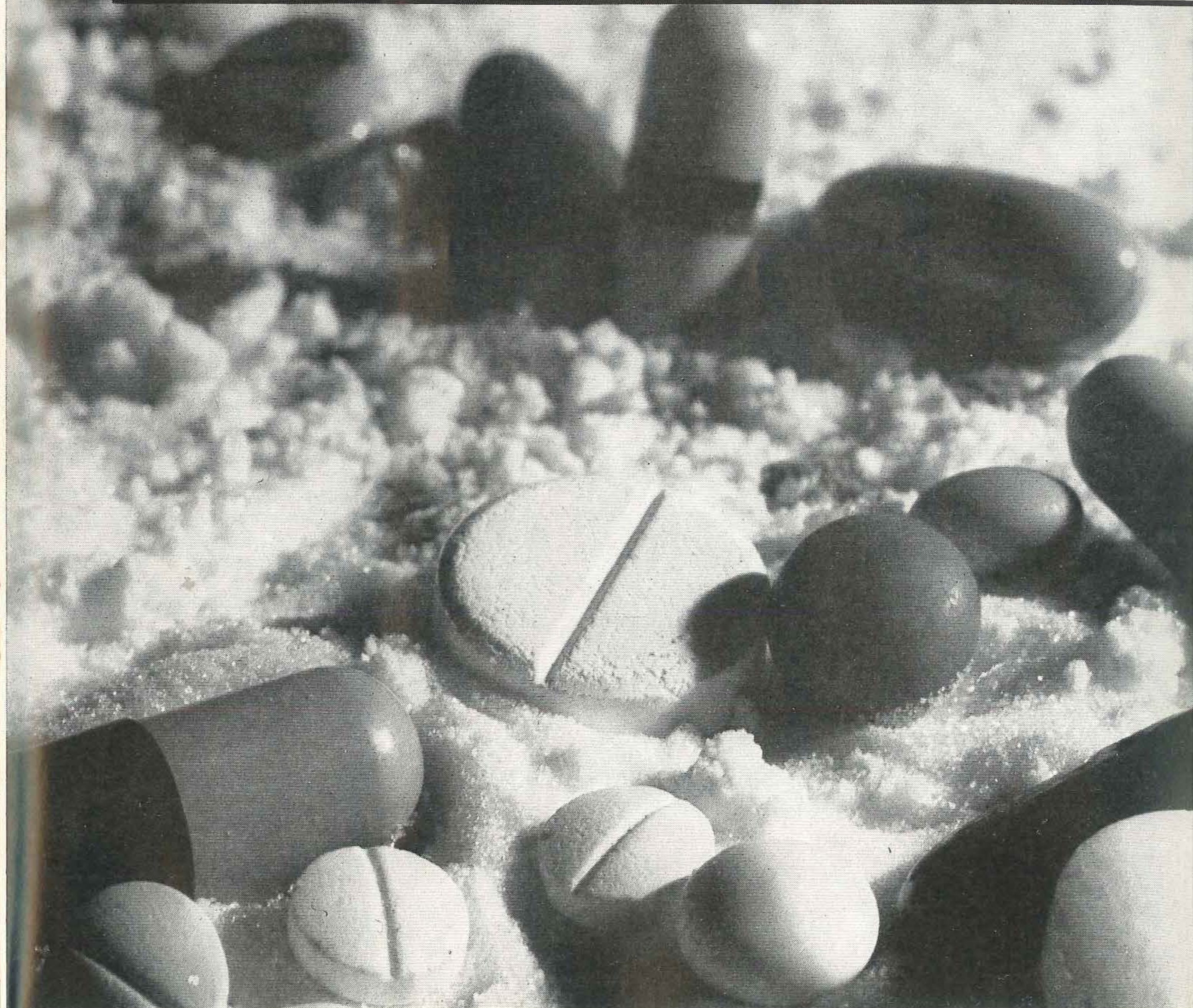
A.N.R. 247 (2): "A person acting as a member of the operating crew of an aircraft, or carried in the aircraft for the purpose of so acting, shall not while so acting or carried, be in a state in which, by reason of his having taken or used any sedative, alchoholic or spirituous liquor, narcotic or stimulant drug or preparation, his capacity so to act is impaired".

LIKE any other person, a pilot can become ill and need to take a medicine or drug in a normal and prescribed dose. But medicines and drugs are substances that alter the functions of the body and they may have a deleterious effect on flying skills.

It would be easier for everyone concerned if there were a simple set of rules on whether pilots should or should not fly when certain drugs are being taken. Unfortunately there can be no such rules for the following reasons:

- **There are very many different types of drugs.**
- **Individuals vary in their reaction to a particular drug; a pilot may or may not suffer from side effects which might impair his performance.**
- **The illness for which the drug is prescribed may itself make flying inadvisable.**

What then should a pilot do in such a situation?



If he is consulting a doctor for his complaint, he should ask if the illness itself or the drugs that the doctor has prescribed will prevent him flying. If they will, the next question to resolve is, after what interval of time it will be safe for him to resume flying. For example, if sleeping drugs are prescribed, will he be fit to fly on the following morning?

There are also many drugs that can be bought over the counter without a doctor's prescription. Some of these, too, can have an adverse effect on pilot performance. In this case a pilot should always obtain advice from the pharmacist in charge of the chemist's shop where he is buying the drugs. If in doubt, a pilot can telephone his doctor — or, if he has no regular doctor, his aviation medical examiner.

The following discussion on the characteristics of some of the more commonly used drugs will give some impression of the way in which pilot performance may be affected. The side effects described will not **always** occur, but they are by no means unlikely.

Barbiturates

These are sleep producing drugs. They are used in small doses for daytime sedation and in large doses to induce sleep. They can disturb thought processes, impair judgment and co-ordination. They can induce sleep at inappropriate times, such as while flying. In high dosages they can disturb the sense of time and space — an effect not likely to benefit flying skills. Although many barbiturates are said to be "short acting" sleeping drugs a measurable effect may persist after awakening.

Some barbiturates commonly prescribed, either alone or combined with other drugs, are: Amylobarbitone, Amytal, Butobarbitone, Carbrital, Gardenal, Luminal, Nembutal, Pentobarbitone, Phenobarbitone, Seconal, Soneryl and Tuinal. "Sleeping tablets" such as Doriden, Noludar and Relaxatabs are not barbiturates, but have a similar sedative action and side effects.

Amphetamines

The amphetamine group of drugs is used either alone or in combination with other drugs. They are sometimes prescribed with a weight reducing diet because they decrease hunger. But they are also stimulants, relieving feelings of tiredness and depression and giving a temporary feeling of energy and vitality. In larger doses they can cause elation, truculence, aggressiveness and excitability.

Other weight reducing drugs are Appetrol, Durophet, Endoz, Steladex, and may produce side effects similar to those of the amphetamine group.

Antibiotics

This large group of drugs is used to combat infections of many kinds. The pilot being treated by an antibiotic will probably not be fit to fly because of his illness itself, but some antibiotics also produce side effects such as headache, upset stomach, slight depression and sometimes a sedative action. Penicillin rarely produces side effects, but some pilots may be allergic to it.

Examples of commonly used antibiotics are: Achromycin, Achrostatin, Aureomycin, Austramycin, Chloromycetin, Eromycin, Erythrocin, Griseofulvin, Ledermycin, Mysteclin V, Panmycin, Rondomycin, Streptomycin, Terramycin, Tetracyn.

Antihistamines

Antihistamines are used to cure or relieve allergies such as hay fever, urticaria (or "hives") and some skin diseases. They are often the basis of "cold cures." They are also a constituent of some cough medicines and travel-sickness preventions. Some antihistamines, especially common-cold cures, can be bought without a prescription and, unless he makes enquiries, the pilot may have no indication of their nature. Antihistamines can cause side effects such as drowsiness. Some are long acting, the effects lasting over twelve hours.

Examples of antihistamines are: Actidil, Allergex, Ancolan, Antistine, Avil, Benadryl, Clistin, Fabahistin, Histryl, Nilergex, Perazil, Periactin, Phenergan, Piriton, Polaramine, Pro-Actidil, Thephorin, Vallergan and "cold cures" such as Contac-500.

Drugs to Lower Blood Pressure

In recent years many drugs of this group have proven beneficial to sufferers of high blood pressure. However, side effects such as headache, depression and dizziness may occur. Drugs in this group include: Aldomet, Apresoline, Ismelin, Raudixin, Rauwiloid and Serpasil.

Tranquillisers

These drugs are used to treat anxiety, stress, tension, neurosis and emotional states as well as the more serious mental illnesses. All these drugs are likely to cause drowsiness and slowing of reaction. Nearly all of them intensify the action of sedative drugs and alcohol. The taking of tranquillisers has been found to be associated with some recent fatal accidents to light aircraft.

Commonly used tranquillisers are: Adumbran, Anatensol, Atarax, Equanil, Largactil, Librium, Melleril, Mepbromate, Miltown, Prozine, Serenace, Sparine, Stelazine, Stemetil and Valium.

Analgesic Drugs

Such drugs as aspirin, A.P.C., Bex, Vincents, Veganin, Codeine, Panadol and others can usually be taken in ordinary doses without immediate side effects. Pilots can fly after taking these drugs provided the illness itself does not affect flying performance.

In the case of more powerful analgesic drugs such as Butazolidin, Butazone, B.T.Z. and Indocid, however, medical advice should be obtained on the likelihood of possible side effects on pilot performance.

Alcohol

It must be remembered that alcohol, too, is a drug, and, in addition to its own characteristic effects, it may intensify the actions of tranquillisers and sedatives. The effects of alcohol on flying performance will be the subject of a separate article to be published in a future issue of the Aviation Safety Digest. ●

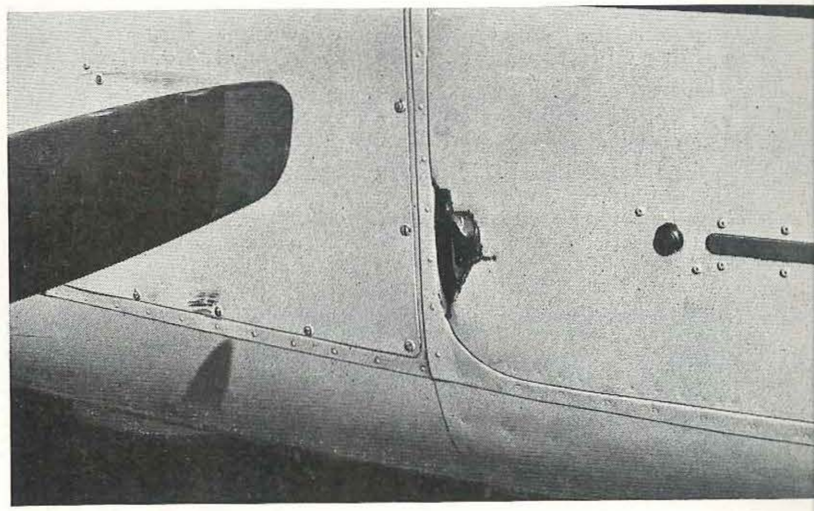
Make sure it's properly closed !

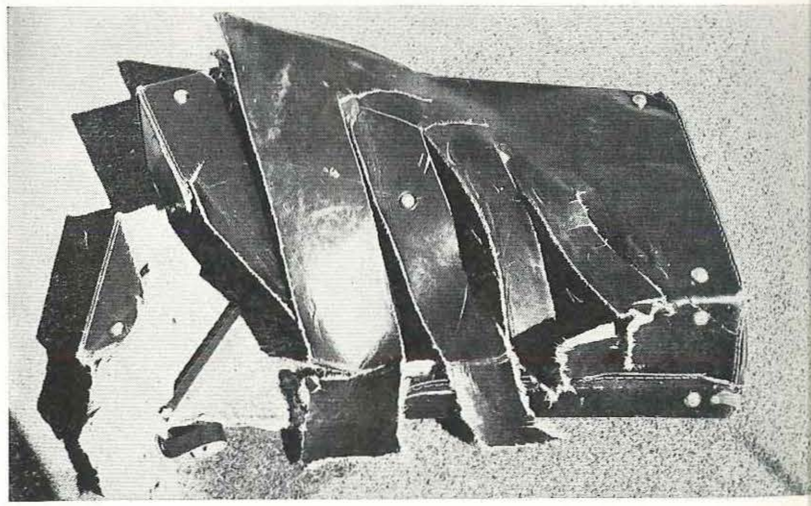
TAKING off from Perth for a flight to Meekatharra, Western Australia, the pilot of a Piper Aztec had just retracted the undercarriage when there was a loud thump on the starboard side of the nose and he caught a glimpse of an object as it flashed past the cabin windows.

Thinking the aircraft had struck a bird, the pilot obtained a clearance to land again, then noticed that the nose locker door warning lamp was illuminated. Neither the pilot nor the front seat passenger could see whether the door was in fact open, but just before they landed the tower advised that a badly damaged suitcase had been recovered from the runway. After landing, the aircraft's spring-loaded nose locker door swung into the fully open position.

Damage to the aircraft was found to be confined to a small section of the nose locker door, and minor abrasions to the starboard propeller.

It is apparent that the pilot did not return the door handle to the fully flush position (see photograph) when locking the compartment. As a result, the handle was not restrained by the locking lug, thus allowing vibration to unlatch the door during the take-off. ●



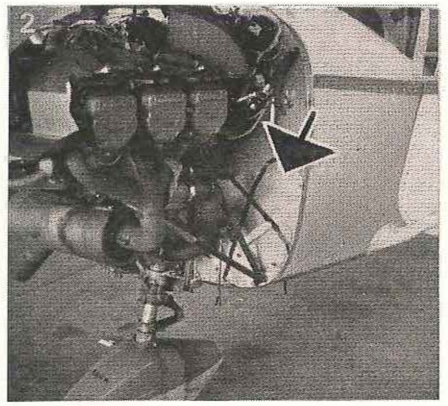


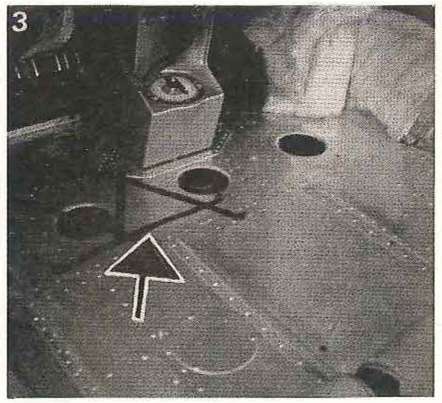
Above: View of damaged "trailing edge" of nose locker door and scuffed starboard propeller. The door handle is in the fully closed position, flush with the surface of the door.

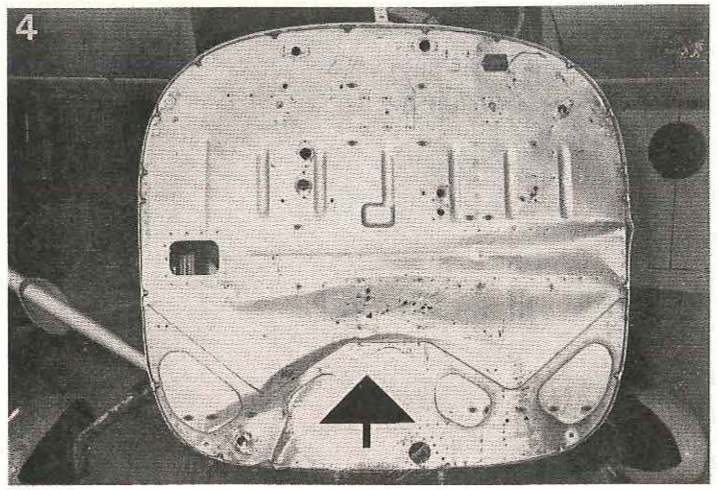
Right: The real "victim" of the mishap. What was left of the suitcase that fell from the locker into the propeller arc, just after take-off.

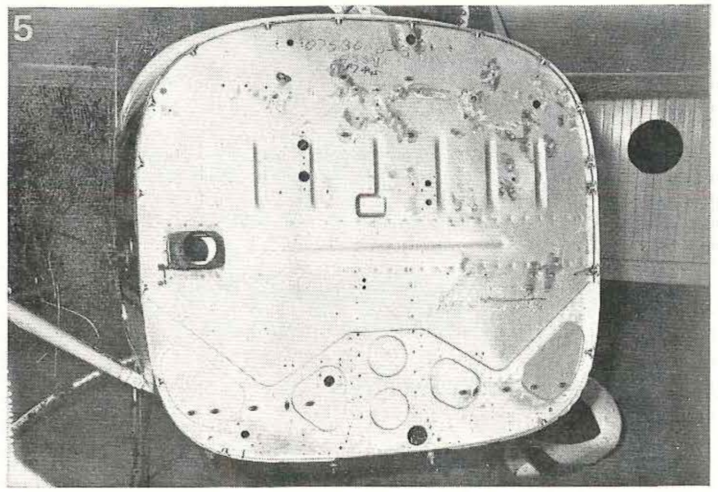
DID YOU REPORT THAT HEAVY LANDING ?

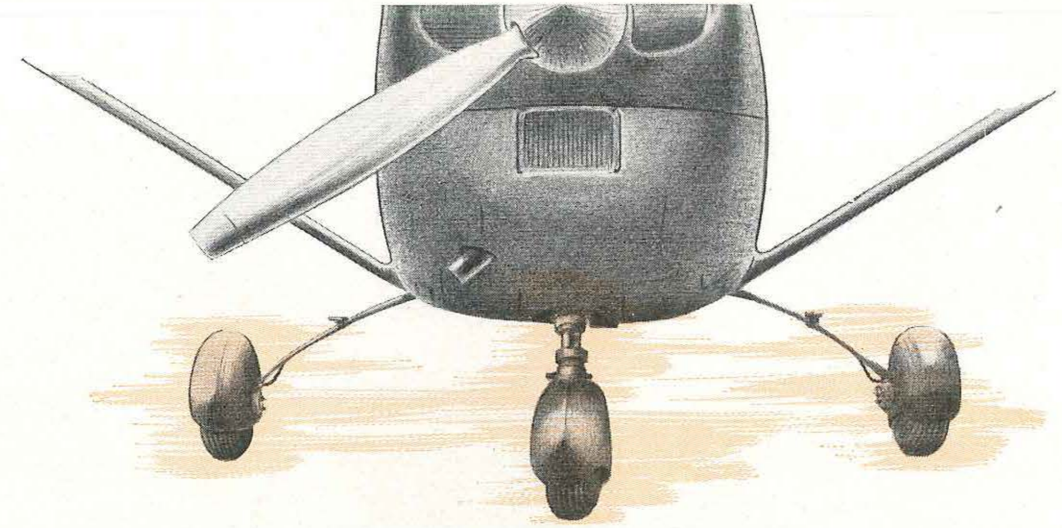
1. Damage to aircraft may not be in evidence at all until engine cowlings have been removed and structure in vicinity of nose leg attachments can be inspected. 2. Tell-tale buckles in firewall bulkhead confirm the worst. Bulkhead is a major structural member of fuselage and buckling represents serious loss of strength and rigidity. Bulkhead must therefore be replaced. Areas of damage in picture are marked by black adhesive tape applied to affected parts of fuselage structure. 3. Structural damage (again represented by buckling and distortion) may also extend to lower fuselage skin and cockpit floor. 4. Full extent of damage to firewall bulkhead is visible to camera only after engine, accessories, engine mounting structure, nosewheel strut attachments and electrical wiring have been stripped from fuselage. Note severe buckling in lower centre of bulkhead where nose strut attaches. 5. Comparison with condition of replacement firewall emphasizes degree of distortion sustained in heavy landing. 6. Actual replacement of firewall involves major structural work. First damaged bulkhead is removed from fuselage by drilling out rivets. Next, damaged panels on underside of fuselage, and on cockpit floor are drilled out and new panels rivetted into place. New firewall bulkhead is then rivetted into place. Finally engine and nose leg assemblies are refitted and repair is at last complete.

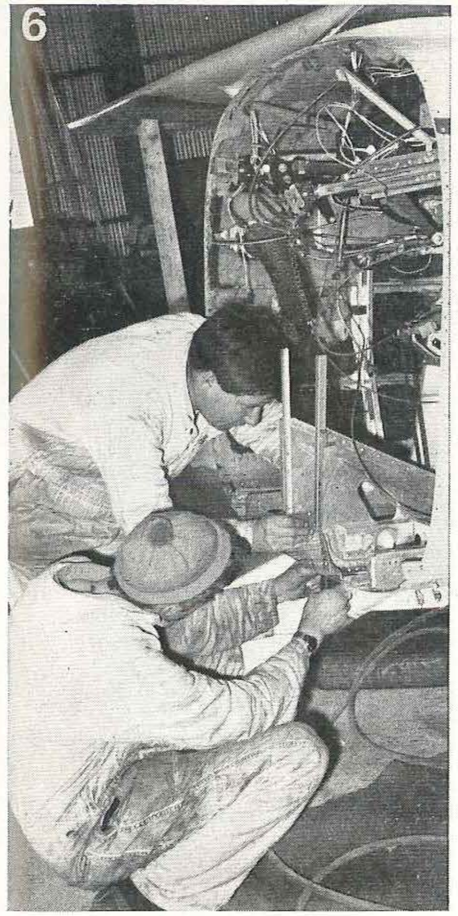












There was nothing to indicate that the club aircraft had been damaged until it went in to the workshop for a 100 hourly inspection. Only then was it found that the firewall had been buckled and the adjacent lower fuselage skin had been distorted. Immediately, the maintenance engineers who discovered the damage checked the maintenance release, but there was no mention of any occurrence that could explain the damage. Next they checked with the operations staff but they also had no knowledge of the damage or of how it might have been caused. All the pilots who had flown the aircraft since its previous major inspection were then interviewed.

NO ONE had made a heavy landing!

Strange to say however, all maintenance engineers who inspected the damage and who were familiar with the aircraft type, agreed unanimously that the damage had been caused by a heavy landing. The mystery remained unsolved.

* * * *

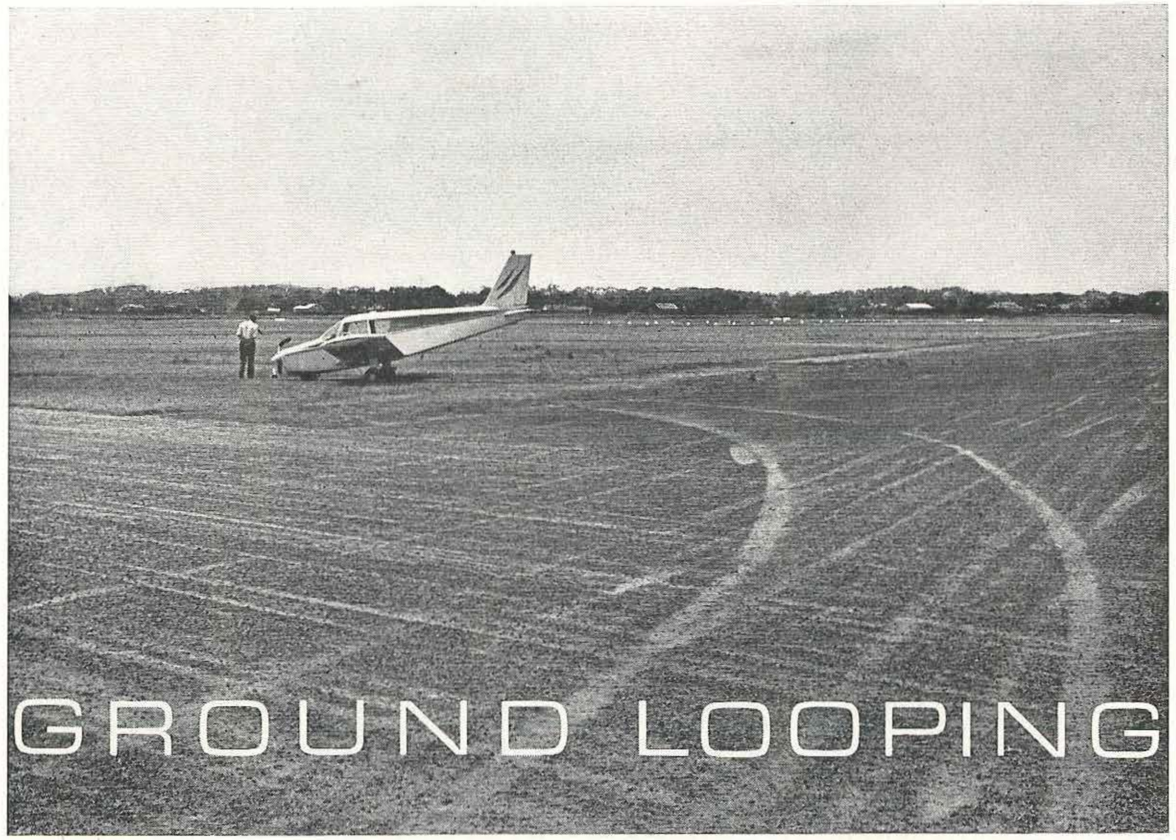
This little story depicts a situation that has become far too typical in the light aircraft industry today. It is quite obvious that a large number of pilots do not appreciate the potential dangers of failing to report heavy landings.

Generally, the immediate consequences of a heavy landing in a light aircraft are not very spectacular. In fact they might not ever be evident to an untrained eye, particularly while the engine cowlings remain in place. But this fact does not lessen the potential danger inherent in the damage that might have been caused, and it makes it all the more important that the aircraft be inspected by a qualified person before it is cleared for further flight.

Very often, although the damage incurred in a heavy landing, may **appear** quite slight, it is very serious indeed, and major repairs are necessary before the aircraft is safe to fly again. The sequence of pictures opposite explains what we mean better than any words.

It should be obvious from these photographs that the consequences of not reporting a heavy landing could be quite catastrophic if an aircraft continues to be flown in such a seriously damaged condition. There have been a number of cases where, after a seemingly normal landing, an aircraft's nose strut has collapsed, causing further major damage to the aircraft. In other cases, heavy landings in some types of aircraft have led to control problems in the air. One example of this was graphically illustrated by the accident described in the article "And All Because of a Heavy Landing" in Digest No. 60, January 1969, in which the aircraft became a total loss.

For your own protection as well as for that of your fellow pilots, it is vital that you report a heavy landing. The next pilot flying a damaged aircraft could well be you!



GROUND LOOPING IN NOSE-WHEEL AIRCRAFT

IN the days when most light aircraft had tail-wheel undercarriages, ground loops were regarded as very much of an occupational hazard. Despite the advent of the tricycle undercarriage, however, the ground loop is still one of the most common of all accidents. This article describes the general background to the problem and draws attention to those areas of nosewheel aircraft operation requiring special care if the continued occurrence of these accidents is to be prevented.

* * *

A number of significant improvements in ground handling accompanied the widespread appearance of the tricycle undercarriage on general aviation aircraft some years ago. Better manoeuvrability of the nose-wheel types on the ground combined with better visibility "over the nose" were among the many notable features inherent in these aircraft, not normally characteristic of their tail-wheel counterparts. In the light of these welcome benefits, it would not have been unreasonable to expect at the time that the ground loop would rapidly become a thing of the past. Unfortunately, this has proved not to be the case, and ground loops have continued to occur all too often in the supposedly easy-to-handle nose-wheel aircraft. The following examples are typical of many such accidents on record and illustrate the development of ground loops in three common situations:—

- **A student pilot, who was also the owner of a Beech Musketeer, had been receiving dual instruction in his own aircraft and, after successfully undergoing a flight check with his instructor, was authorised to carry out a period of solo circuit and landing practice. A number of touch-and-go landings were then conducted without incident, during which time the runway direction was changed twice owing to wind fluctuations. A further successful landing was carried out in gusty wind conditions, following which the pilot re-applied power for take-off and, at the same time, eased the control wheel forward. As speed increased, the aircraft swung off the runway, crossed the flight strip and, after turning through almost 180 degrees, came to rest badly damaged in a storm water drain.**

- **A Piper Cherokee was being flown by a student on solo circuit and landing practice. Following a normal take-off on one of these circuits, the duty runway was changed because of variable wind conditions and the aircraft then made an approach for a full-stop landing in the new direction. Although there was a significant cross-wind component on the new runway, the approach and touch-down appeared quite normal to the pilot and, after the aircraft had run forward a short distance, he started to raise the flaps. Simultaneously, the aircraft veered to port and the pilot was unable to correct the rapid swing which followed. As the aircraft commenced to slide sideways, the nosewheel strut folded to the left, and the propeller and the starboard wing tip struck the ground.**

* * *

- **Another Cherokee pilot had planned to carry out a series of cross-wind take-offs and landings in conditions in which the cross-wind component on the runway to be used was fluctuating about the maximum value authorised for the type. Before opening the throttle on the first take-off, the pilot applied aileron in the direction from which the wind was blowing and at the same time forward pressure on the control wheel. Shortly after the take-off roll commenced, a swing to port developed and, as speed increased, the port main wheel lifted clear of the ground. Despite attempts by the pilot to correct the aircraft's heading, the swing continued and the aircraft left the runway several hundred feet from the point of commencement of the take-off run. By this time, the turn had progressed through approximately 110 degrees and, as the aircraft slid sideways, the nosewheel strut collapsed, permitting the propeller to strike the ground.**

* * *

Ground loop accidents can occur under a wide variety of conditions and circumstances. Most such accidents, however, apart from those originating in some form of mechanical failure, are basically the result of either:—

- loss of directional control during the take-off or landing roll, or
- the pilot allowing the aircraft to contact the runway in a crabbed attitude during, for example, a cross wind landing.

Accident records show that, taken on a broad average, the chances of a ground loop occurring in a nose-wheel aircraft are much less than in a tail-wheel type. Nevertheless, certain tricycle undercarriage aircraft have ground-loop accident histories which are significantly worse than those of some tail-wheel aircraft. In the following paragraphs we will review both the basic causes of the ground loop and appropriate corrective action in a potential accident situation, with particular emphasis on the nose-wheel aircraft. In looking at the mechanics of the ground loop itself, however, and in order to gain a more complete appreciation of the overall problem, we will use as a starting point for our discussion the classic sequence of events as applicable to the tail-wheel undercarriage type.

GROUND LOOPS IN TAIL-WHEEL AIRCRAFT

Tail-wheel aircraft are in general more prone to ground-loop accidents than nose-wheel types primarily because of the location of the centre of gravity aft of the main wheels. Figure 1 depicts the forces which would take effect as a result of either a swing developing during a ground roll or the aircraft touching down in a crabbed attitude through the use of incorrect cross-wind technique. In this situation, the sideways motion of the aircraft is opposed by another sideways-acting force at the main wheels which is generated by friction between the tyres and the runway surface. In the tail-wheel aircraft, this force acts ahead of the centre of gravity and gives rise to a yawing moment which, if not corrected swiftly, will cause the swing to develop further and the aircraft to veer towards the edge of the runway.

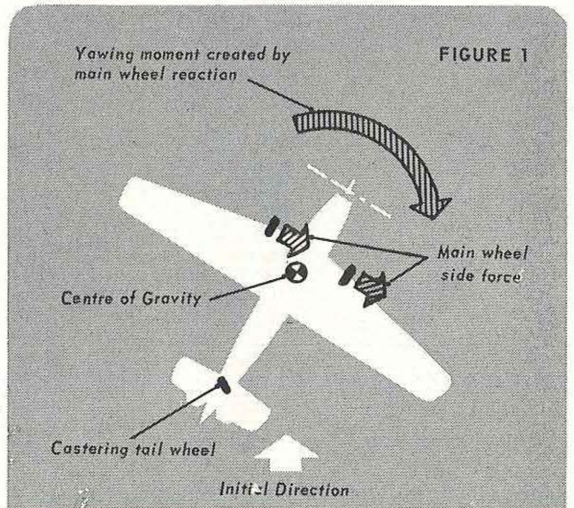
With the distribution of forces shown in the diagram, an unstable situation exists, for the tighter the turn, the more powerful the yawing moment which causes the turn becomes. Similarly, as the distance between the main wheels and the centre of gravity increases, the effect of this adverse yawing moment will also increase, further adding to the severity of the swing in some aircraft. If the runway surface is slippery, the tyres will rapidly lose their grip and the aircraft may slide backwards; if it is dry, then the spiral will continue to develop until a situation is eventually reached where the inside main wheel may lift and the outer wing tip may contact the ground.

THE NOSEWHEEL CASE

Turning now to the tricycle-undercarriage aircraft shown in Figure 2, we have a set of circumstances and distribution of forces which are quite different to those just described for the tail-wheel aircraft. In the tricycle-undercarriage case, the centre of gravity lies ahead of the main wheels and if the aircraft contacts the ground in a crabbed attitude during, for example, a landing in crosswind conditions, the main wheel tyres will be subjected to an opposing side force which acts on this occasion behind the centre of gravity. The yawing moment thus created tends to re-align the aircraft with the runway and it can be seen that in these circumstances a basically stable situation exists. In addition, the further forward the centre of gravity is located with respect to the main undercarriage, the greater this restoring force and, consequently, the ground roll stability becomes. Where, then does the problem lie?

EFFECT OF NOSEWHEEL CASTER

Looking again at Figure 2, the situation depicted is, in fact, valid only where the aircraft's nose wheel is clear of the ground or where the nose gear is of a type which is free to caster or swivel. If the latter case applies and the aircraft touches-down in a crabbed attitude, the nosewheel will caster as it contacts the ground, permitting the aircraft to straighten-up and continue travelling in the runway direction.

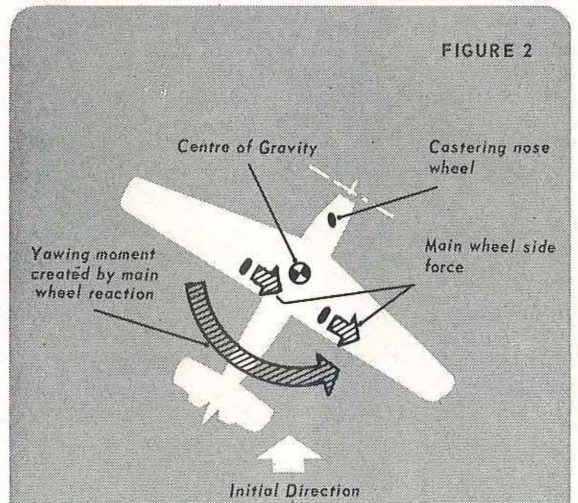


INITIATION OF A GROUND LOOP IN A TAIL WHEEL AIRCRAFT. THE MAIN WHEEL SIDE FORCE ACTING AHEAD OF THE CENTRE OF GRAVITY CAUSES THE AIRCRAFT TO ROTATE TO THE RIGHT.

In practice, however, the nosewheels of most general aviation aircraft are not completely free to caster, but are limited by virtue of their steering characteristics, shimmy and other design considerations. The extent of any swing developing either during the ground roll or as a result of an excessive crab angle at touch-down, may be sufficiently large to preclude any effective castering action and the nose-wheel will be subjected to a side force arising from the reaction between the tyre and the runway surface. The yawing moment created by this force may be powerful enough to overcome the inherent ground stability of the tricycle undercarriage configuration leading, in turn, to the characteristic initial swing of the ground loop. This is the case illustrated in Figure 3.

FACTORS LEADING TO LOSS OF CONTROL

The extent and severity of the initial swing during the ground roll depends to a very large degree on the distribution of the aircraft's weight between the three wheels and in particular the percentage of this weight supported by the nose gear. Consider, for example, the case where a pilot has used an airspeed considerably higher than the recommended value on an approach to land and the aircraft touches down at this high speed with little or no flare. To prevent the aircraft from becoming airborne again after initial ground contact, the pilot then attempts to hold it on the runway with a firm forward pressure on the control wheel. With the aircraft still travelling at high speed and with partial or full flap selected, the wings will continue to produce considerable lift although the wheels may be in contact with the ground. This effect, combined with down-elevator or "stabilator" control, will tend to lighten the load on the main wheels and, if the speed is high enough, may even raise them clear of the ground. A similar situation can also arise during the take-off run through the use of excessive forward pressure on the control wheel to hold the aircraft on the ground after take-off speed has been reached.



GROUND ROLL STABILITY OF THE TRICYCLE UNDERCARRIAGE. CASTERING NOSE WHEEL PERMITS AIRCRAFT TO TURN BACK INTO RUNWAY DIRECTION UNDER THE EFFECT OF MAIN WHEEL SIDE FORCE REACTION WHICH ACTS, IN THIS CASE, AFT OF THE CENTRE OF GRAVITY.

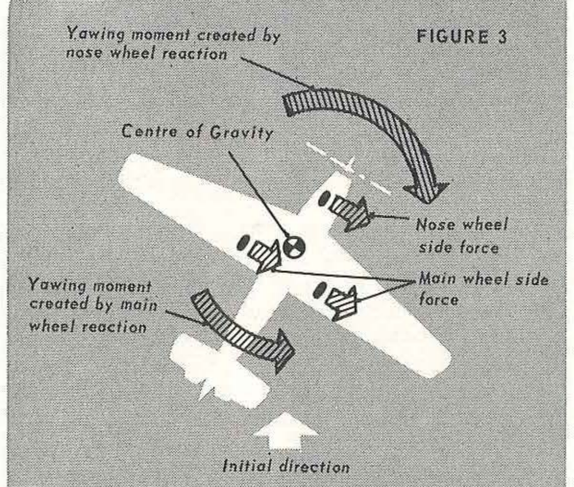
Directional control of the aircraft on the ground is achieved through the use, either separately or in combination, of nosewheel steering and differential braking. In the circumstances just described it is obvious that both the braking and steering capabilities of the aircraft will be severely diminished. Consequently, in strong or gusty crosswind conditions, or where the nose wheel fails to caster following a crabbed touch-down, the aircraft will tend to pivot rapidly about the nose wheel in a manoeuvre which is very similar to the ground loop described earlier for the tail wheel case. Provided the main wheels are in contact with the ground and able to contribute even a small restoring moment, the turn on this occasion will not tend to tighten of its own accord but damage to the aircraft, often in the form of nose gear failure, may occur as a result of excessive sideways loading.

RECOMMENDED HANDLING TECHNIQUES

As most ground loops are in the first instance basically the result of loss of directional control on the ground, it is obvious that the primary means of avoiding such accidents must lie in the use of correct aircraft handling techniques during the take-off and landing ground rolls, especially in cross-wind conditions.

It has been explained that forward pressure on the control wheel, combined with excessive speed during the ground roll, may result in a considerable percentage of the aircraft's weight being transferred to the nose wheel with a correspondingly marked decrease in steering and braking effects. If the situation is then further aggravated by cross-wind

FIGURE 3



EFFECT OF REDUCED NOSE WHEEL CASTER CAPABILITY. SIDE FORCE REACTION AT MAIN WHEELS IS, ON THIS OCCASION, INSUFFICIENT TO OVERCOME YAWING MOVEMENT CREATED BY NOSE WHEEL REACTION AND AIRCRAFT ROTATES TO THE RIGHT.

conditions or lack of nose-wheel caster effect, the stage is set for a ground loop accident. If, on the other hand, the main wheels are firmly in contact with the runway and the nose wheel is lightly loaded (or even held clear), any adverse yawing moment which may be created as the result of a side force at the nose wheel will be insufficient to overcome the relatively large restoring force at the main wheels. The ground roll stability of the tricycle undercarriage configuration will then tend to re-align the aircraft with the runway direction.

The majority of ground loops in nose-wheel aircraft are initiated during the ground roll just after touch-down or in the latter stages of take-off. It follows that, in order to obtain maximum benefit from the restoring forces provided by the main-wheel reaction, and also differential braking if this is available, the aircraft weight should be predominantly on the main wheels during these critical phases of take-off and landing. On take-off, the use of excessive forward control wheel pressure to hold the aircraft on the ground at speeds above the normal take-off speed should, therefore, be avoided. During landing, the aircraft should be flown so as to touch-down on the main wheels first and the nose wheel allowed to contact the runway only after speed has diminished. In the case of a short-field landing, heavy braking will tend to throw a high proportion of the aircraft's weight on to the nose wheel and to avoid loss of control in these circumstances, as well as gain maximum braking effect, it may be necessary to hold full up-elevator control while the brakes are being applied.

Recommended aircraft handling procedures are normally published in owner's handbooks and manuals issued by the various manufacturers. A check of a representative number of manuals for tricycle undercarriage types has shown that the landing techniques just described are invariably called up as recommended practices and it cannot be stressed too highly that strict observance of these techniques is essential if loss of directional control on the ground, followed by the inevitable ground loop, are to be avoided.

RECOVERING DIRECTIONAL CONTROL

It will be appreciated that once a swing has commenced during the take-off or landing ground roll, it may progress very quickly to the point beyond which recovery is not possible. The pilot should therefore be constantly alert for signs of a swing starting or indications that the aircraft's weight is shifting to the nose wheel. In either of these circumstances, he should immediately initiate one of the following courses of action, depending on the extent to which the situation has developed:

- Close the throttle and relax forward control wheel pressure to aft of the neutral position to lighten the load on the nose gear and return steering and braking to normal.
- If the aircraft is not pivoting, adequate performance and runway length are available, and obstructions are not a factor, carry out a "go-around".

The pilot should also be prepared to initiate a "go-around" unless he is satisfied that, in strong or gusty cross-wind conditions, a touch-down can be achieved with little or no drift resulting from the cross-wind effect.

A good landing, particularly in cross-wind conditions, depends to a large extent for its success on a well planned and executed final approach. This in turn depends on proper compensation being made for drift, and the use of the recommended approach speed and touch-down technique for the prevailing conditions. Careful monitoring of all these factors, together with a close watch for signs of loss of directional control during the take-off or landing ground rolls, will contribute towards a significant reduction in the occurrence of further accidents of the ground-loop type. ●