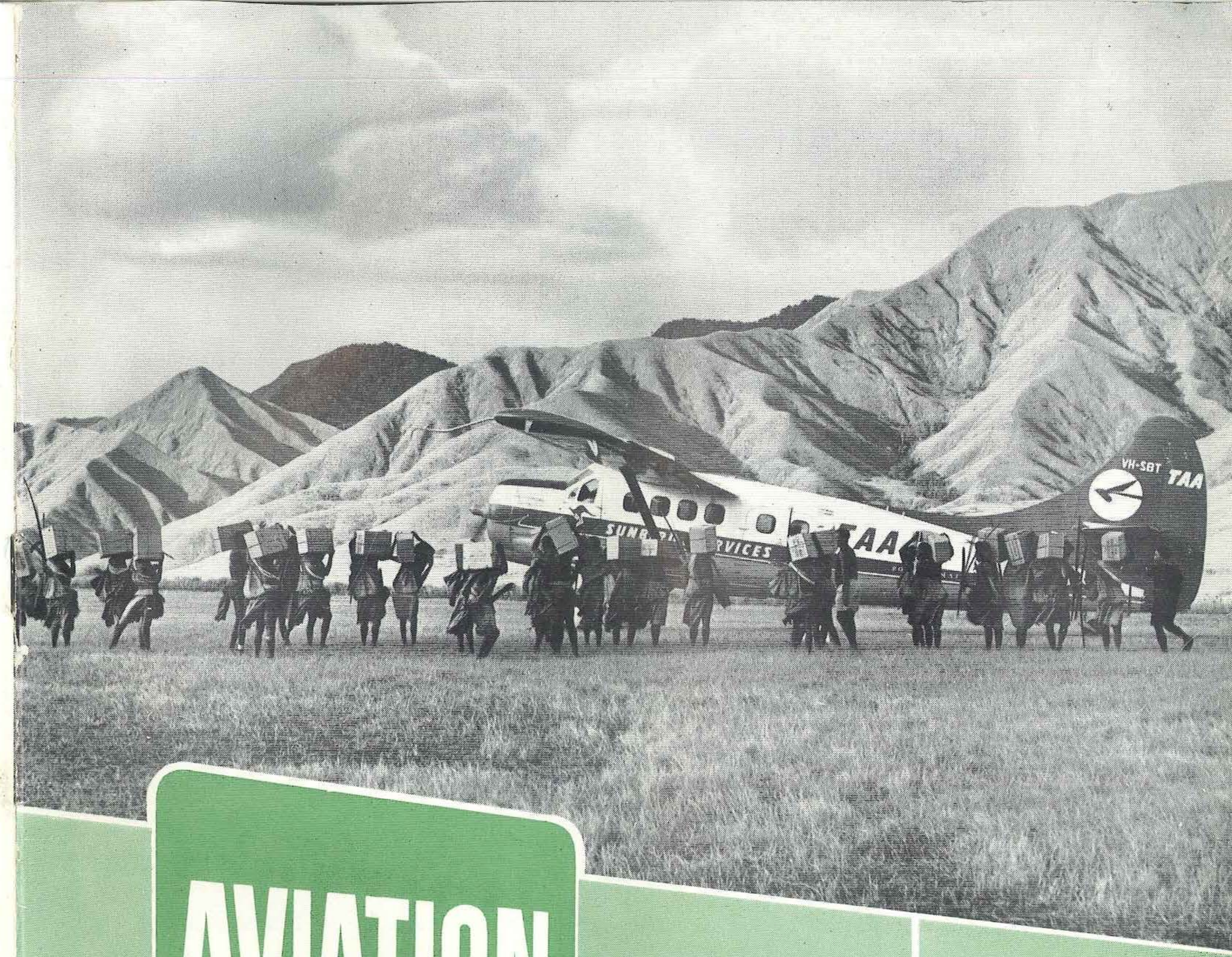
Printed by The Dominion Press, 62 Carrington Road, Box Hill, Victoria.



AVIATION SAFETY DIGEST

No. 35, SEP., 1963

DEPARTMENT OF CIVIL AVIATION

AVIATION SAFETY DIGEST

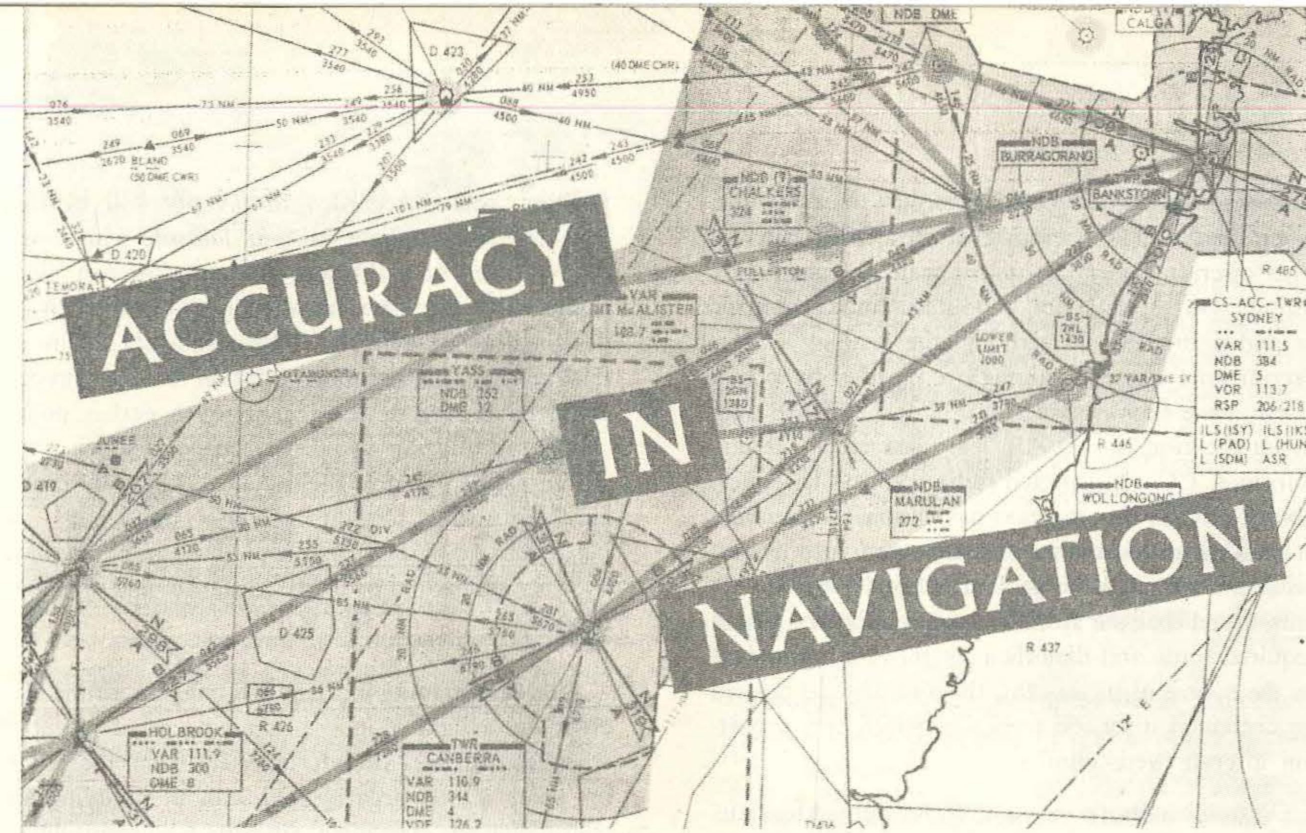
No. 35 **SEPTEMBER, 1963**

Prepared in the Division of Air Safety Investigation,
Department of Civil Aviation.

Contents

Native (Kuku-kuku) porters unload a T.A.A. Otter at Menyamya in the New Guinea Highlands.

Commonwealth of Australia



ACCURACY IN NAVIGATION ..... its Importance to Aircraft Separation

The proportion of airspace over the Australian continent which is controlled for the purpose of preventing collisions between aircraft is quite small in the quantitative sense. The vast areas of non-controlled airspace seem to coincide with the areas where our best flying conditions are enjoyed and accordingly, the navigation of an aircraft in this country is quite often a straightforward exercise in map-reading with a little dead-reckoning thrown in as a back-up or to tide us over some of the featurless areas. So long as the destination aerodrome is reached within the limits of fuel and daylight, we tend to discount the off-track wanderings which may have occurred en route. Even if we are equipped and fly under instrument meteorological conditions outside controlled airspace, we can still enjoy a certain latitude in track-keeping subject to the position reporting requirements, because lateral or track separation is not a device which is used in these areas for collision avoidance.

In controlled airspace, however, the picture is very different because navigation errors, which result in an aircraft being positioned outside the area of navigation tolerance for the route, probably mean that the aircraft is in an area being used by other aircraft. Unless the pilot is aware of this situation and informs A.T.C., his aircraft will be operating without the benefit of the anti-collision service normally provided in controlled airspace. Although in Australia we have not experienced a collision between two aircraft arising from inaccurate navigation, some of the incidents reported to the Department show that we should not be complacent about this state of affairs.

In one such incident, an airline aircraft inadvertently landed at a military airport situated some five miles distance from the destination airport. The approach was made under visual meteorological conditions at night, but the runways at both airports are identically aligned. The crew failed to positively establish the position of the aircraft at the time the approach was commenced and landed at the military airport, despite the fact that navigation aids and visual references which would have enabled them to properly identify their destination were available. In addition the terminal charts relative to the destination airport contained a special warning notice which advised pilots to exercise extreme caution because of the relative positions of the two airports.

Some time ago, another aircraft proceeding from

Canberra to Sydney deviated from track to the extent that it was operating in close proximity to other aircraft, under instrument meteorological conditions. On the basis of a doubtful radio-compass fix and a brief visual sighting, the heading of the aircraft was altered, although a positive fix could shortly have been obtained by the use of DME and an interception of a VAR leg. The crew did not inform A.T.C. of suspected radio compass unserviceability, nor did they mention navigational uncertainty at the time of requesting a descent clearance. When visual reference to the ground became possible, the crew found that the aircraft was 20 miles west of the required route and they then sought radar guidance. In the course of its descent, the aircraft had crossed an outbound diversion track, on which two departing aircraft were climbing.

On another more recent occasion, an airline aircraft approaching a capital city airport was found by radar to be fifteen miles off the prescribed route and in the vicinity of another aircraft proceeding in the opposite direction on an adjacent route. These two routes are so designed that adequate lateral separation normally exists between arriving and departing aircraft, provided they remain within the boundaries of the respective navigation tolerance areas. When the offending aircraft was detected by radar, it was 35 miles from its destination and had just left an altitude of 11,000 feet, descending to its assigned altitude of 8,000 feet head on with the outbound aircraft which had been cleared to climb to flight level 90, 28 miles from the airport and on its assigned route. The descending aircraft was immediately instructed to maintain 10,000 feet and was vectored clear of the outbound track by radar before a further descent was approved.

The airborne radio-navigation equipment carried by this aircraft and the relevant ground equipment were checked and found to have been serviceable at the time of the incident. It was not possible to positively reconstruct the track followed by the aircraft up to the point where the deviation was detected by radar, but it seems likely that a track change of 14 degrees at a positive fix point was not provided for, and a subsequent bearing from an NDB, which gave the first indication of an off-track position, was disregarded in favour of a bearing obtained from a more distant locator, which was then situated at a distance from the aircraft more than twice the maximum range at which it is designed to be reliable. The significant point of this incident is that the deviation of the aircraft could have been detected at a much earlier point, simply by utilizing two DME beacons which were within range or, at a slightly later stage, by cross-checking against a group of offset radio aids. A positive fix from this group could have been obtained by a combination of DME distance and a VAR transit.

A close proximity incident involving an airline aircraft and a light training aircraft occurred recently, when the airline aircraft diverted from the route on which it had been cleared without notifying air traffic control. The light aircraft was operating in a training area, in accordance with an air traffic clearance which specified an upper limit of 5,000 feet. The airline aircraft was approaching a capital city airport, and had been cleared to commence descent to 3,000 feet upon reaching DME 22 with instructions to reach that altitude by DME 5. The light aircraft was operating at an altitude just below 5,000 feet, at a position six miles off the route along which the airline aircraft had been cleared. The training area in use is 3½ miles from this route at its nearest point, and because this is also only seven miles from a 1,000 watt NDB at the major airport, the radio navigation coverage is regarded as adequate to provide lateral separation between aircraft flying the route and those operating in the training area. The pilot in command of the light aircraft reported that the airline aircraft passed overhead with a vertical separation estimated as 200 feet, apparently descending with undercarriage and some flap extended. The captain of the larger aircraft stated that, on reaching a point 10-12 miles north of his destination airport, he diverted from track to avoid heavy cumulus cloud. He did not see any other aircraft in this area and, since he anticipated that the diversion required would not exceed two miles, he did not notify air traffic control of his action. When he later considered the substantial change in heading required to regain track, he realised that the diversion could have been greater than was intended. The diversion to avoid cloud could quite easily have been carried out on the other side of the track, and undoubtedly this is what A.T.C. would have cleared the aircraft to do if the crew's wishes had been made known to them.

In the incidents we have referred to, the aircraft crews found themselves ultimately in unpremeditated positions either because they did not properly use the network of radio-navigation aids available to them, or because they did not appreciate the dimensions of the tolerance area applicable to their flight. In most cases, however, it is noteworthy that the crews either knew of their off-track position or had good grounds to suspect such a possibility, and yet they did not advise A.T.C. of their actions or suspicions.

All tracks and lowest safe altitudes specified in the Aeronautical Information Publications have been determined after a careful assessment of the guidance available to pilots from all the radio navigation aids serving each route. Wherever possible, these routes have been laterally separated to reduce en route congestion, including climb and descent delays between arriving and departing aircraft and to avoid danger areas, restricted areas, light aircraft training areas and military control zones. In determining the areas within which aircraft are expected to operate, whilst attempting to follow a particular route, consideration must be given to expected levels of pilot skill and to the limitations of the airborne and ground based radio navigation equipment. The following are the **total** tolerances applied:

Tracking by VAR-visual leg: 10 or 11 degrees either side of the nominal on-course bearing depending on the on-course signal width of the particular installation.

Tracking by VAR-aural leg: 8 degrees either side of the nominal on-course bearing.

Tracking by Localiser: 4 degrees either side of the nominal on-course bearing.

Tracking by ADF: 12 degrees either side of the rhumb line track.

Tracking by DR: Where no change of track is involved and, following initial track guidance by one of the radio aids, 12 degrees either side of track, otherwise 15 degrees either side of track.

These tolerance angles extend to a maximum width of 50 miles either side of track, whilst the minimum width of the tolerance area is one mile either side of track at the point of overflying a radio aid. Where more than one radio navigational aid is available, the tolerance applicable to the secondary aid is the one used for lateral separation purposes.

The total tolerance referred to above includes a "pilot ability" factor which assumes that a pilot is able to maintain track at least within the following limits:

Tracking by VAR or VOR-visual indication: within 2 dots either side of centre on the aircraft cross-pointer indicator.

Tracking by VAR-aural indication: within the limits of the twilight zones.

En route tracking by Localiser indication: within 3 dots either side of centre on the aircraft cross-pointer indicator.

Tracking by ADF using an NDB or Locator: within 5 degrees either side of the specified rhumb line track as indicated by the radio compass.

If for any reason the aircraft is not being or cannot be navigated within the appropriate "pilot ability" factor, air traffic control should be notified immediately.

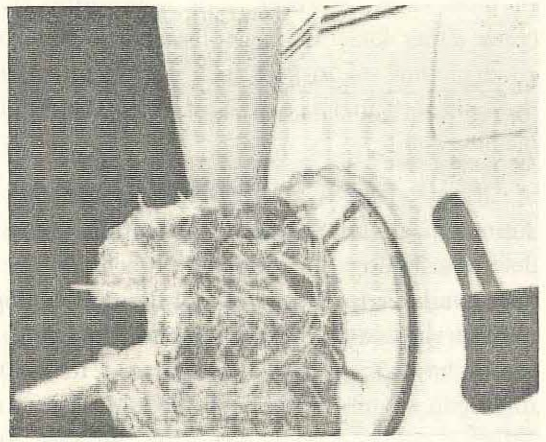
The procedures for lateral separation of aircraft are founded upon these navigation tolerance standards. It is assumed that a localiser, VAR or VOR will be used at all points within its useable coverage area, that an NDB will be used only within 75 miles of the transmitter and a locator or transistorized NDB only within 30 miles of the transmitter. Since the tolerance area diverges when back-tracking and converges when you are flying towards an aid, the transfer to the aid ahead of the aircraft should be made at a point which has proper regard for the useable range of each of the particular aids involved. If the lateral boundaries of the tolerance areas determined for adjacent routes are separated by a minimum "buffer" area of 1 n.m., it is accepted that aircraft operating on adjacent routes are safely separated. This same principle is applied to determine the existence of lateral separation between en-route aircraft and aircraft operating locally such as within a training area. Thus pilots engaged on local flying exercises also have a responsibility to ensure, by means of visual reference, that they remain within their allotted airspace. Where the tolerance areas of adjacent routes overlap or the minimum "buffer" area is non-existent, air traffic control is required to apply vertical or longitudinal separation.

The effectiveness of the lateral separation standards is dependent upon pilots adhering to the "pilot ability" factor referred to earlier, making optimum use of the available en route radio navigation aids including off-set track aids and being satisfied that their radio navigation equipment is fully serviceable. When there is a need to deviate from track in excess of the "pilot ability" factor applicable to the radio aid being used, take immediate steps to notify air traffic control and then rejoin track as soon as possible or proceed as directed by air traffic control. Remember that the published "lowest safe altitudes" are also determined by the use of the same navigation tolerance formulae although, in this case, a buffer of 5 miles is applied.

The accuracy of pilot navigation, particularly in controlled airspace, is therefore a keystone in the procedures which have been developed for the prevention of collisions with other aircraft or with terrain. If for any reason you have some doubts about your ability to maintain track accurately, or if you know or suspect you are off-track at any point in the flight, the position can be quickly made safe if you communicate your doubts to A.T.C. They can immediately assess the potential hazard to other traffic and adopt a safer form of separation until your position is firmly established. The responsible pilot is the one who speaks up when he is not satisfied with the information he has as to the position of his aircraft. This pilot has a right to retain the professional pride which he might momentarily have put in his pocket, but there is no room in the system for the pilot who is off track through carelessness or who fails to speak up when he suddenly finds himself where he should not be.

Remember the Birds

Every year, about this time, we receive incident reports which deal with the effect of birds' nests which have been built in vital areas of aircraft and engines. To remind pilots and engineers to carefully check all likely nesting spots before take-off if an aircraft is left unattended for even a few hours during the nesting season, we reprint an article which appeared in Aviation Safety Digest No. 24, entitled "Watch the Birdie".



The bird's nest in the picture was discovered during pre-flight inspection of a Beechcraft Bonanza. The aircraft had not been flown for six days. Had the bird used shorter raw material so that none protruded from the blade cutouts in the propeller spinner, the nest might have gone unnoticed.

It takes a chicken 21 days to hatch an egg, and a turkey 28 days. Thus it would seem the harder the mother hen sits (or sets) on the egg the longer it takes to hatch. From this we wonder how long it would take to hatch the bird egg at the loads encountered in the spinner at the cruising r.p.m.

Remember that an extensive bird nest construction programme has been placed in effect by the local bird population. The rapidity of construction from raw materials to finished product is amazing. Pilots and maintenance personnel must be particularly meticulous in conducting inspections.

(Beech Aircraft Corporation "Safety Suggestions").

Fatal Overload in New Guinea

At approximately 1050 hours on the morning of 27th October, 1962, a Cessna 185 took off from Mount Hagen Aerodrome, New Guinea, at the commencement of a charter flight. Shortly after the take-off the aircraft crashed in an area covered by a dense undergrowth of native cane interspersed with trees. The aircraft and its contents were substantially damaged and the pilot, who was the only occupant, was killed.

Mount Hagen aerodrome is located in the western highlands of New Guinea at an elevation of 5,500 feet above mean sea level. It comprises a single airstrip, 4,000 feet in length and 250 feet wide. Although two-way operations are permissible the surrounding terrain in all directions rises above the level of the aerodrome.

The operator of this aircraft used a very small building at the aerodrome as an office for its traffic officer and as a cargo store. On the day prior to the accident the traffic officer accepted a quantity of mixed freight, with a manifested total weight of 1,188 lb., for transport to various aerodromes in the southern highlands area and this freight was placed in the operator's building on the aerodrome. Later, on the same day, a further quantity of freight with a manifested weight of 937 lb. was also placed in the same building, without the knowledge of the traffic officer, for transport to the same group of aerodromes.

On the morning of the accident the traffic officer, believing that all the freight in the building comprised the load of 1,188 lb. previously accepted, arranged for it to be placed near the aircraft parking area in groups according to the destination of each item. During loading operations, under the supervision of the pilot and the traffic officer, it was found that the volumetric capacity of the aircraft was insufficient to accommodate all the freight and an amount totalling 432 lb. was not loaded. The pilot, believing that the loaded weight of the aircraft was below the maximum permissible all-up-weight by at least 432 lb., arranged for the fuel tanks to be filled to capacity and 29 gallons of fuel was added.

At 1041 hours the pilot reported by radio that he was taxiing prior to take-off at Mount Hagen and this was the last transmission heard from the aircraft. The surface wind was from the north at two knots and the aircraft was seen to take-off in a north-easterly direction. When it passed over the end of the airstrip, it was observed to be unusually low. The aircraft was in a tail-down attitude and it appeared to be flying at a low speed without any appreciable rate of climb. It then made a turn to the left and continued flight in a northerly direction without there being any change in attitude or increase in height above the terrain apparent to the eye-witnesses on the ground.

The impact was not observed but it was heard by witnesses who located the wreckage of the aircraft shortly after the accident at a position 1¼ miles north of Mount Hagen Aerodrome. The elevation of the accident site was approximately 150 feet above that of the aerodrome.

The pilot held a current commercial pilot licence endorsed for Cessna 185 type aircraft in which he had flown some 100 hours. His total aeronautical experience amounted to 4,290 hours of which some 2,500 hours had been flown on charter operations in New Guinea during the four years immediately preceding the date of the accident.

A detailed examination of the wreckage of the aircraft failed to reveal evidence of any defect or pre-impact failure which may have contributed to the accident. The manner in which the propeller blades were damaged indicated that the engine had not been delivering power but, as there was no evidence to suggest that the engine was not capable of normal operation, it is believed that the pilot reduced power immediately prior to impact.

The investigation revealed that, at the time of the last take-off, the all-up-weight of the aircraft was at least 604 lb., and possibly as much as 810 lb. in excess of the maximum permissible all-up-weight of 3,200 lb. and the centre of gravity was outside the aft limit. In these circumstances the climb performance of the aircraft was insufficient for it to outclimb the rising terrain surrounding Mount Hagen.

It was concluded that the cause of the accident was that the aircraft was overloaded to such an extent that the climb performance required to clear rising terrain after take-off could not be obtained. The aircraft was overloaded because the operator's facilities and procedures for load control were not adequate to ensure that a proper level of safety was achieved.

Spatial Disorientation — Loss of Control

WEST WANAKA, OTAGO

(Summary of the report of the Air Department, N.Z.)

At 1030 hours on 27th April, 1963, a Fox Moth dived out of control into a shingle bank in the Minaret Creek, West Wanaka, Otago. The pilot suffered burns and shock and the passenger was fatally injured.

FLIGHT

The pilot took off at 0950 hours from Cattle Flat to carry out some flying over the West Wanaka country with the object of pinpointing areas favourable for deer shooting. Flying along the western shore line of Lake Wanaka, the pilot had achieved an altitude of 4,500 feet when he turned into the comparatively narrow valley through which Minaret Creek flows. The aircraft flew between six and eight miles up the valley before turning on a reciprocal heading. While flying at a height estimated by the pilot to have been some 1,500 feet above the valley floor, the pilot thought that the aircraft was behaving strangely. From this point onward the aircraft, under cruising power and sometimes under full power, continuously and rapidly lost height until it dived at a moderate angle and with wings approximately level into a shingle bank close to Minaret Creek. Fire immediately broke out.

INVESTIGATION

The pilot, aged 27, was the holder of a private pilot licence and his total flying experience amounted to 128 hours, of which 77 hours had been flown in Fox Moth aircraft.

Examination of the wreckage revealed nothing which might even remotely account for the behaviour of the aircraft as described by the pilot. It was considered that no defect, malfunction, or failure in the aircraft or its controls precipitated the accident.

The pilot was interviewed shortly after the accident and again six weeks later after he had recovered from the effects of shock. He was clearly unable to recall the sequence of events preceding the accident with complete accuracy, but a number of points of which he had a clear recollection provided sufficient information to establish the cause of the accident.

Of primary significance is the pilot's statement that, during a previous flight in a narrow valley surrounded by high country, he found his airspeed inexplicably decreasing despite the fact that he believed the aircraft was flying straight and level. On leaving the confines of the valley and emerging into more open country the air speed in straight and level flight returned to normal.

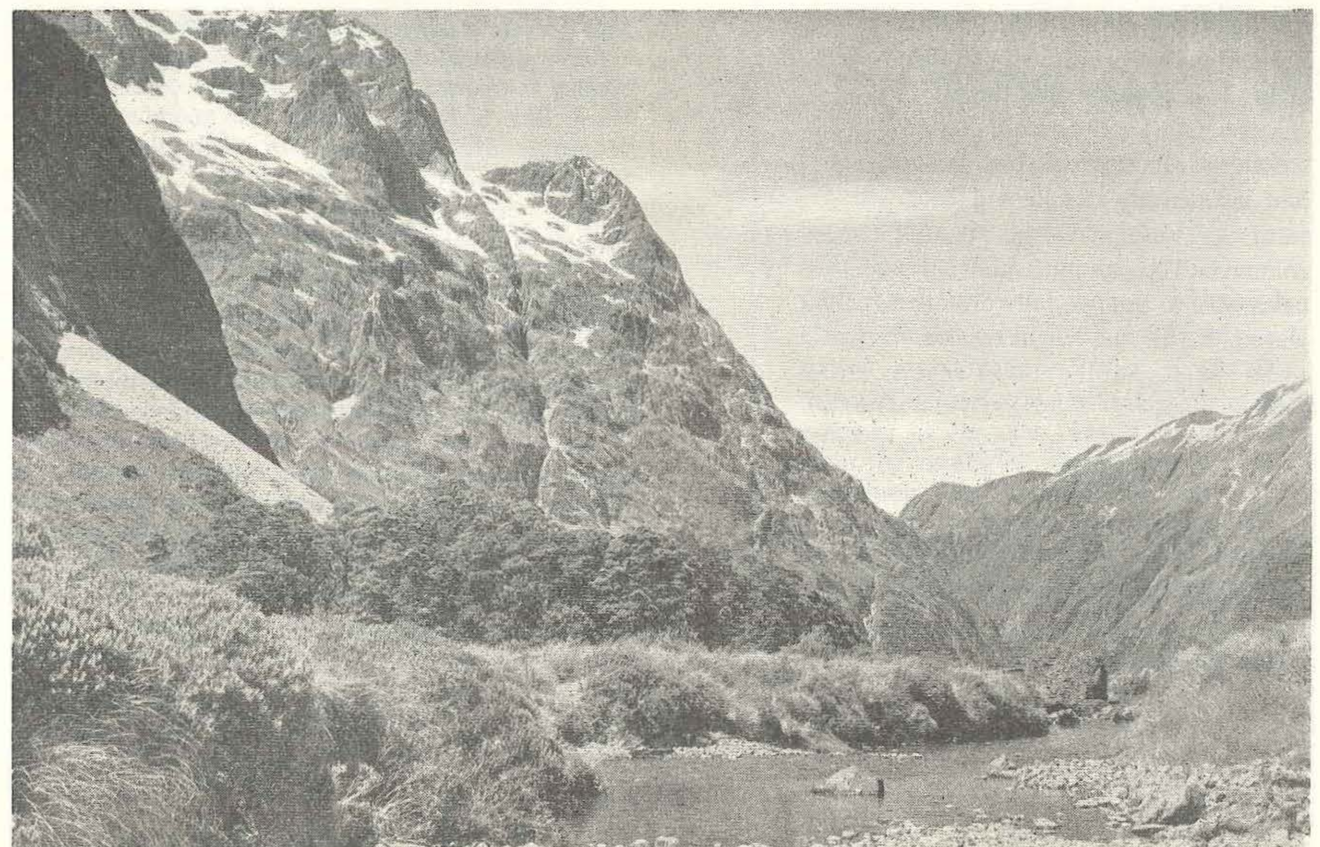
Of further significance are other statements made by the pilot in respect of events immediately preceding the crash. Minaret Creek flows through a valley whose two sides are relatively close together and which soar steeply upward to very considerable heights. The aircraft was flying some 1,500 ft. above the river bed when the pilot first became aware of what, to him, was its unusual behaviour. Whilst watching for signs of deer and endeavouring to follow indications of their presence pointed out by his passenger, he described what might be termed a weaving flight through the valley. He was well aware of the aircraft skidding, for he noted, for a considerable part of the last stages of the flight, that the slipstream from the propeller was buffeting the left-hand side of his face. In laterally level flight he observed the turn needle of his turn and bank indicator to be pointing hard to the left. The aircraft was continuously and rapidly losing height despite the use of normal cruising power. The application of rudder from side to side did not have its usual effect and the elevator control felt mushy and ineffective. The aircraft appeared to respond to forward movements of the control column but not to backward ones. The nose dropped and on one occasion the aircraft appeared to the pilot to be diving very steeply. He noted at one stage that the airspeed indicator was reading 70 m.p.h. in a dive but also thought that his speed was greatly in excess of that figure though he apparently did not observe the instrument in an effort to confirm that impression. The pilot applied full throttle for a period he was unable to recollect but the aircraft continued to descend and the controls to remain soggy rather than crisply responsive. There was a tendency, the pilot thought, for the aircraft to turn involuntarily to the right.

The aircraft apparently did not maintain a constant angle of dive during its descent towards the river bed, for at one stage the dive was steep and at others much shallower. When questioned, the pilot was unable to affirm with certainty whether or not his aircraft was stalled.

There can be little doubt that the pilot's experience of a decrease of air speed when flying in a narrow valley some time prior to the accident is indicative of a phenomenon well known to experienced pilots. This was a case of simple spatial disorientation induced by the lack of the kind of horizon pilots are used to when flying in open country. With no true horizon to act as a plane of reference for positioning the nose correctly for straight and level flight, for climbing, gliding, or making any turn, the pilot is obliged, in cases where he is narrowly encompassed by high country, to estimate the position of the horizon for himself and even the most experienced may easily be led into error. Such estimated horizon may well be considerably above the line of the true horizon, in which case what may both appear and feel to be straight and level flight is, in fact, climbing flight and what may appear and feel to be turns without loss or gain of height may, in fact, be climbing turns. A seemingly inexplicable reduction in air speed occurs. These symptoms are perfectly typical of spatial disorientation which may be defined as a false or incorrect impression on one's position or attitude in space with respect to the surface of the earth.

It is clear from the pilot's description of the behaviour of the aircraft shortly before the accident occurred that he was spatially dis-

This scene does not depict the accident site but as it is taken in the area, it will convey to the reader an idea of the terrain in the vicinity of the accident.



oriented. Furthermore, it is apparent that he was even incapable of maintaining straight flight, either when flying laterally level or climbing or diving, for his turn and bank indicator (an instrument he had not been trained to use) recorded a marked skidding outward to the right, and he felt the slipstream of the propeller continuously on the left-hand side of his face. The behaviour of the nose of the aircraft — pointing downward at varying angles from shallow to steep despite cruising power and, for one indeterminable period, full power—together with the mushy feel of both rudder and elevators (the latter responsive virtually to forward movements of the control column only) all point conclusively towards a stalled condition. The stall was, obviously, not fully developed for had it so been the aircraft would inevitably have spun. The evidence points to a comparatively well developed stall in which the nose at one stage dropped steeply and then rose again but never to the position it would normally occupy in straight flight. It is apparent that the pilot's concern with his uncontrollable descent towards the river bed caused him instinctively to retain a backward pressure on the control column. The aircraft thus was never able to become fully unstalled with the result that height continued to be lost despite the use of engine power.

CAUSE

The accident was caused by the inability of an inexperienced pilot to regain control lost through spatial disorientation, before his aircraft struck the ground.

MORE ABOUT STUCK MIKE BUTTONS

In Aviation Safety Digest No. 31 we reprinted a short item from a Flight Safety Foundation Bulletin, under the title of "Stuck Mike Button", drawing attention to a case where radio communication reception was lost because a microphone button had stuck down. As incident reports relative to this subject continue to be received it seems that not all pilots were tuned in to that particular "Digest" message. Perhaps the circumstances of the following incident, and a brief outline of the effects that can be produced, will help pilots to recognise the fault and take corrective action.

In the course of a routine flight, a crew experienced what appeared to be a complete loss of air-ground communication. After some time it was established that VHF reception was possible provided the microphone selector switch was positioned to HF. Conversely, HF reception was available if the microphone was selected to VHF.

Subsequent maintenance checks disclosed that the defect was caused by a faulty microphone PTT (Press-to-talk) button, which stuck in the ON position. Under these circumstances, the fault could have been cleared in the air if the pilots had removed the offending microphone.

The PTT switch on most microphones has two sets of contacts, one of which simply interrupts the microphone audio output when the PTT button is not depressed. The other set of contacts is used to operate a relay in the selected transmitter, to put the equipment in the "Transmit" condition. This relay is frequently used to perform other functions, one of which is switching the antenna from the receiver to the transmitter or, alternatively, grounding the receiver antenna input. It also transfers the headphones from the receiver to the transmitter modulator side-tone output for monitoring purposes.

The effect of a sticking microphone button may be seen if we assume that the PTT button becomes stuck in the ON position when the microphone selector is in the VHF position, the complementary VHF audio selector switch is ON, and the headsets are used for audio reproduction. Under these circumstances the transmitter will radiate continuously, the antenna will not be connected to the VHF receiver and the headphones will, in most aircraft systems, be connected to the transmitter side-tone circuit instead of the receiver output. While this situation exists the pilot will not hear incoming signals from this receiver and it would be reasonable for him to conclude that the receiver is inoperative. He would have no positive indication of the condition of his transmitting equipment. Where an aircraft is equipped with more than one audio selector, the symptoms would be similar at all crew stations. However, except for that particular receiver, all other selected audio signals would normally still be available at the headset.

In the alternative condition, with HF selected, a similar situation would exist, except that some receiver noise may be evident because, unlike VHF, most HF receivers are not muted in the absence of incoming signals.

Apart from causing irregular operation of the communication equipment in the aircraft concerned, a stuck PTT button produces interference into the airways communication network. Because a continuous signal is being radiated by the transmitter, use of the particular frequency to which the aircraft transmitter is selected may be seriously affected or even completely denied to ground stations or other aircraft. When this happens to be a VHF frequency, the range of the jamming signal could be in excess of 50 nautical miles radius from the aircraft, depending upon aircraft altitude. In congested airspace the loss of a busy VHF communication channel can significantly increase the workload on the air traffic control service as well as cause annoying inconvenience to other aircraft.

A similar continuous signal radiated on HF can disrupt communications over a wide area. Such a situation occurred in one incident where a regular public transport aircraft experienced a fault in the PTT button wiring. The fault produced a continuous transmission whenever the HF power switch was in the ON position and the aircraft caused severe interference over a large section of eastern Australia. The interference persisted for two or three days, during which the PMG Department in two States used direction finding equipment to locate the origin of the interfering signal. Eventually it was traced to the offending aircraft, the fault rectified and the HF communication system was able to resume normal operation.

Where an aircraft is fitted with a cockpit speaker, additional problems can be introduced by a sticking PTT button. The speaker is connected, through its amplifier, to the same audio selector output source as a headset and will be muted in the same way as the headset during transmission. The muting achieved in this manner affects only the receiving equipment complementary to the selected transmitter. To prevent acoustic feedback in the cockpit, it is necessary to silence the speaker on both HF and VHF frequencies during any transmissions and when intercom is being used. This further muting is achieved by an additional relay which silences the speaker at all times when the PTT button is depressed. The net result is that all audio output from the speaker, including that from the navigation aids, is lost when the PTT button becomes stuck.

It is worth noting that when two cockpit speakers are installed, these may be connected in parallel to the output of an audio source or, alternatively, they may be connected to separate audio selectors. The extent of speaker silencing will therefore depend upon the manner in which the two speakers are connected.

In summary, therefore, the following symptoms should be recognised as suggestive of a possible stuck microphone PTT button or a PTT wiring fault:

- Apparent simultaneous failure of all communications.
- Apparent failure of a receiver only when the complementary transmitter is selected on the microphone selector switch.
- Complete loss of audio from one or more speakers. (Alone, this is not a reliable symptom).

In view of the facilities which can be rendered inoperative by a simple PTT fault, it is worthwhile to apply the following simple tests which will usually enable identification of the faulty microphone or audio selector.

1. Select "Phones" on all audio selector panels.
2. Withdraw the microphone plugs, one at a time, until the defective microphone is located.
3. Check each control column microphone PTT button for sticking — free it if possible.
4. Select "Intercomm" on all microphone selector switches except one. Check communications from that position. Repeat for each position in turn until the faulty selector box is isolated.

Most PTT circuit faults can be isolated by these tests. If the procedure is followed, normal communication — with perhaps some minor inconvenience — can generally be restored.

THE BREATH OF LIFE

The importance of regular breathing to human beings is well known. Perhaps a fact not so well known is that breathing is no less vital for the proper functioning of aircraft fuel tanks. Since accident and incident reports show that fuel system "respiratory" troubles are not uncommon, some of the more important points about fuel tank venting are reviewed below.

The Menace of Blocked Vents

The very simplest type of aircraft fuel system consists of a single tank equipped with filler opening and vent, with an off-take line leading to an on-off cock, filter, pump (if required) and carburettor. Note the inclusion of a vent, for without it the system would be quite unworkable. If the tank was sealed, fuel drawn off and used by the engine would create an ever-increasing vacuum until such time as the reduction in pressure resulted in starvation of fuel to the engine despite the best efforts of any fuel pump included in the system. Furthermore, there would be a very great risk of the tank collapsing due to lack of resistance to the external air pressure.

Although this idea is very elementary, it can only be neglected at the peril of the aircraft occupants. A blocked vent opening that is not detected on the ground is certain to lead to trouble, and possibly very serious trouble, in the air.

Uneven Feeding Between Tanks

A problem that is not quite so elementary is commonly met when two or more tanks are selected simultaneously to an engine. In this case it is almost the rule, rather than the exception, to find that one tank loses fuel more rapidly than the other. In a bad case, one tank may even empty completely and allow air to be drawn into the engine supply line while the other tank still contains an appreciable quantity of fuel. Why?

Assuming that the respective fuel lines are clear of obstruction and that any interconnecting valves are fully open, the answer can only lie in a difference in pressure between the air spaces in the respective tanks, i.e. in a difference in the vent pressures. In fact, it is not difficult to see how this comes about. Even with a completely symmetrical fuel system, airflow patterns, velocities and corresponding pressures across opposite wings may not be identical, due to propeller slipstream effect. It is important to be aware that the difference in pressure picked up by the respective tank vent outlets need only be very small to account for a substantial out-of-balance in tank contents, especially with a gravity feed system. For instance, a pressure difference of only 1/20th of a pound per square inch is equivalent to a two inch head of fuel, which would represent a comparatively large gallonage in a flat, shallow tank.

Of course, one solution to this problem is obvious. Design or modify the fuel system so that tanks must be selected individually and the difficulty vanishes. Alternatively, where it is desired to retain a BOTH ON position, arrange for the pilot to be able to switch to individual tanks in the event that signs of uneven consumption are noted. In fact, most light aircraft fuel systems comply with one or other of these conditions, although there are exceptions.

In systems where tank outlets are permanently interconnected (i.e. Tee'd together upstream of the fuel cock), it is a normal design requirement that the airspaces should also be interconnected with the idea of ensuring that the tank vent pressures are automatically balanced under all conditions. Unfortunately, this arrangement does not always work ideally in practice unless the interconnecting vent line is of reasonably large diameter. Even then the pressure balance can be seriously upset by unserviceability in the system, such as a badly sealed tank filler cap.

Loss of Fuel in Flight

We have records of a number of incidents of fuel loss and fuel starvation resulting from defective filler caps, so this point deserves special emphasis.

Most aircraft fuel tanks are vented either through a forward facing pick-up above the wing or through a vent line whose opening is located underneath the wing. In either case the result is very much the same. Due to the dynamic (ram) effect of the airflow, the pressure transmitted to the surface of the fuel in the tanks is in excess of the free-stream air pressure in flight, creating an effect that assists the flow of fuel to the engine. On the other hand, tank filler caps are almost inevitably located at the highest point in the system, i.e. on top of the wing, where the static air pressure in flight is always less than the free-stream air pressure (remember that "suck" above the wing is the main force supporting an aeroplane in flight). An improperly sealed tank cap in effect creates an additional vent open to a low pressure region, thereby causing a substantial reduction in air pressure in the tank and a corresponding reduction in the effective "head" of fuel available at the pump inlet or, in a pure gravity feed system, at the carburettor. With interconnected fuel tanks, however, the outcome can be much worse. In such cases the resulting unbalance in the respective tank vent pressure may not only lead to uneven feeding between two tanks, but to actual transfer of fuel from one tank to another. In a number of reported cases an effect of this nature has resulted in substantial quantities of fuel being ejected overboard through the defective filler cap before the situation became obvious to the pilot. Somewhat paradoxically, it is the "good" tank which empties first under these circumstances, as illustrated in Figure 1.

The aircraft in question was a popular single-engined type having a twin bag tank fuel system. The locking mechanism of the starboard fuel tank cap was damaged while the aircraft was being refuelled for a cross-country trip. In the absence of an immediately available spare part the defective cap was secured, in good faith, with two strips of sticking plaster and the flight commenced with the starboard tank selected to the engine, no doubt with the idea of lowering the level of fuel in that tank as soon as possible to reduce the possibility of loss of fuel through the suspect filler cap.

Long before this tank was expected to have emptied the engine lost power, the pilot noting that the starboard tank gauge still indicated "full" and that the port tank gauge showed "$\frac{3}{4}$ full". Power was quickly regained on switching the selector cock to the port tank, but shortly afterwards the engine failed once more and the pilot was fortunate in being able to make a forced landing without power at a nearby aerodrome far short of his original destination. At this stage he observed that the starboard tank still showed "$\frac{3}{4}$ full" and the port tank "$\frac{1}{2}$ full". On landing, both tanks were found to be virtually empty, with the flexible bottoms drawn up within finger depth of the caps. The starboard side of the aeroplane (a high wing type) was noted to be heavily fuel stained. Obviously the pilot's confidence in the patched-up tank cap had been misplaced and he had lost overboard most of the fuel from both tanks. How did it happen?

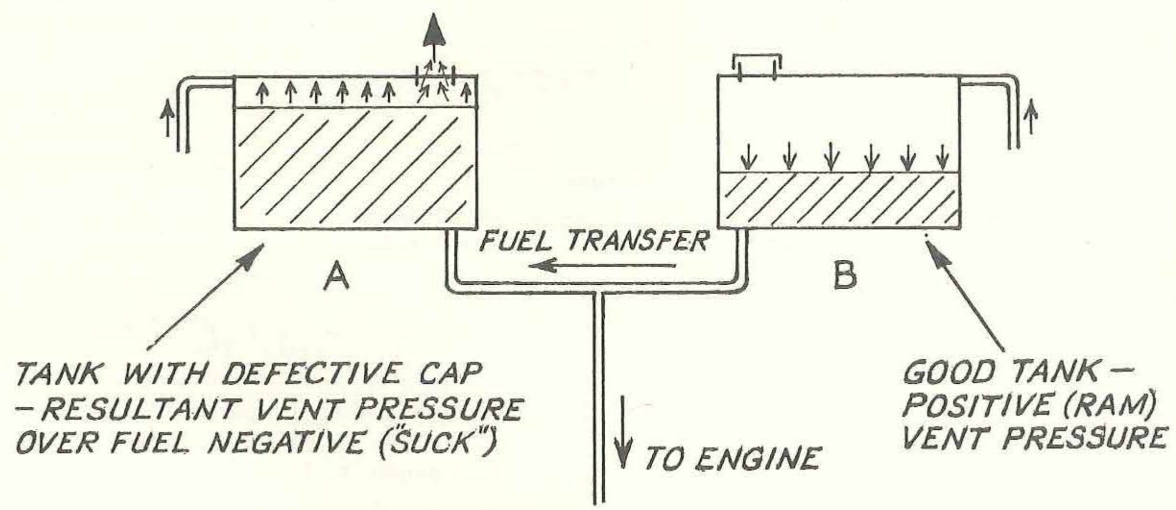


FIGURE 1

ILLUSTRATING EXTREME CASE OF UNBALANCED VENT PRESSURES TANK "A" REMAINS VIRTUALLY FULL AND LOSES FUEL OVERBOARD WHILE THE LEVEL IN TANK "B" FALLS. WHEN TANK "B" EMPTIES AIR WILL BE DRAWN INTO THE ENGINE SUPPLY LINE.

Squeeze Effect on Flexible Tanks

Where an aircraft is fitted with flexible bag-type fuel cells the effect of applying a negative vent pressure is particularly insidious, since a "squeeze" effect can come into force as a result of the pressure in the tank bay being in excess of the pressure inside the tank. This possibility is graphically illustrated by a recent incident reported in Australia, the story being as follows:—

The only reasonable explanation is as follows. Firstly, the starboard tank cap must have been sealing so badly that substantial suction was applied to both fuel tanks (there is an interconnecting vent line) despite inflow of air through the pressure vent line fitted to the port tank. This would result in both tank cells collapsing from the bottom upwards, since they are buttoned to the supporting wing structure on the upper surface. At this stage another diagram may help — see Figure 2.

should not be neglected. With simple open vent lines this is no problem at all, for air can pass with equal freedom in both directions.

In some of the more modern aircraft fuel systems, however, the primary tank vent outlets are fitted with check valves, either float-operated or lightly spring-loaded to the closed position, designed to minimise loss of fuel through the tank vents as a result of surging of fuel in full tanks. Where such devices

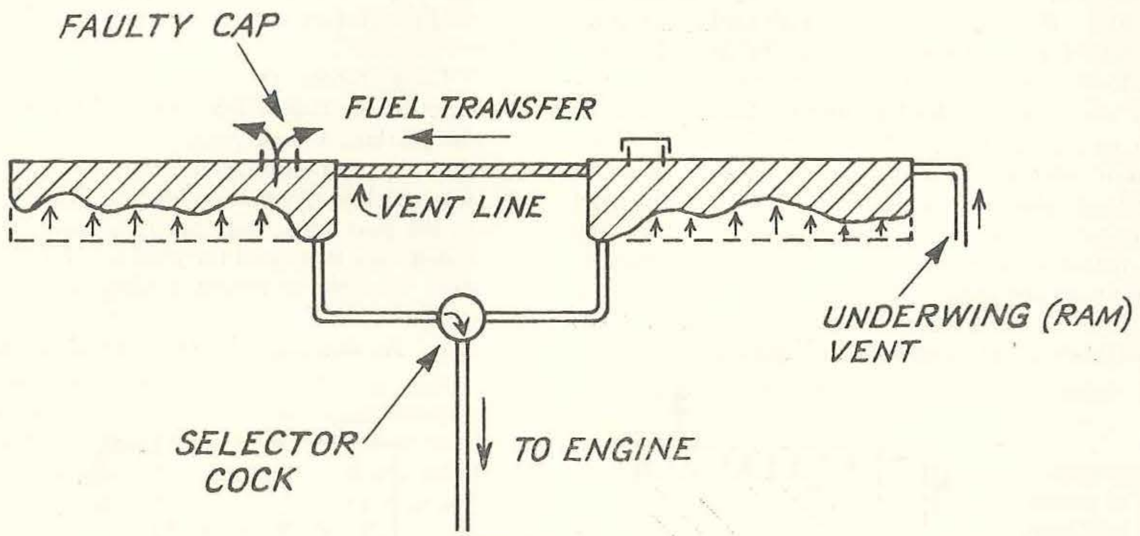


FIGURE 2
ILLUSTRATING SQUEEZE EFFECT ON BAG TANKS DUE TO FAULTY FILLER CAP — FUEL FROM BOTH TANKS LOST OVERBOARD.

It will be seen that the starboard tank would have been gaining fuel from the port tank through the vent interconnection at the same time that it was losing fuel, at an even greater rate, through its own filler cap, not to mention the amount being drawn off to the engine. The inevitable depletion of this tank no doubt corresponded with the first reported power cut. It is obvious that the port tank must also have lost most of its fuel by this stage as the second engine failure followed quite shortly after selection of that tank.

Note that the fuel tank gauges were no help at all. Fundamentally, all aircraft tank gauges are sensitive merely to fluid **level** in the tank and record contents on the assumption that the tank "geometry" remains unchanged. In the case of collapsed tanks, gauge indications are therefore quite misleading.

Allowing for Pressure Relief

We have so far been considering the more usual situation of inward venting, but the need for fuel tanks to be able to "exhale" as well as "inhale"

are fitted it is quite vital that separate means be provided for relieving any internal pressures that may be built up in the tanks. This is done, for instance, by drilling a small hole through the plate of the vent valve, by providing a separate passage for outward venting, or by fitting special pressure relief valves as is common in the case of the larger transport aeroplanes equipped for underwing pressure refuelling.

Whatever the means provided for outward venting it is important that they be serviceable at all times, as pressurisation of fuel tanks can have most unfortunate results.

Pressurisation on the Ground

By way of illustration, let us now look at the details of a local incident recently reported to the Department.

The aircraft involved was a modern single-engined type having two bag-type fuel tanks in the wings. It had been refuelled and then left standing in the

sun for some time, the shade temperature being about 100°F. On returning to the aircraft the pilot noted that the leading edge and top and bottom surfaces of the wing in the region of the port tank were obviously distorted. When he removed the tank cap air rushed out and the disturbed wing structure returned to more or less its normal shape. After an on-the-spot inspection, the aircraft was ferried back to base without passengers, presumably with the port tank selected to the engine for the initial stage of the flight. Subsequent examination showed that the port tank vent line, which is fitted with a spring-loaded vent flap valve, had worked into a position where a small auxiliary vent hole in the side of the tube had been covered by the rubber fitting in the wall of the tank, thus sealing the tank air space against the relief of internal pressure.

The main interest of this incident lies not so much in what actually happened as in what else might easily have taken place under slightly different circumstances, especially had the pilot not quickly noticed the trouble and taken appropriate action. It may therefore pay to look at the possibilities of the situation in a little more detail.

Firstly, how does it come about that sufficient pressure can be built up in a sealed fuel tank to cause noticeable structural deformation while an aircraft is at rest on the ground? The answer lies in the rise in vapour pressure caused by an increase in fuel temperature. We do not know the exact temperature involved in this case, but let us assume that the temperature of the fuel in the tank just after refuelling was 75°F and that, as a result of warming by the sun, the temperature subsequently increased to 100°F. For aviation gasoline the increase in vapour pressure under these circumstances would be about 2 p.s.i. That is to say, the tank would now have an internal pressure of this amount in relation to the outside atmosphere. In the case of a flexible fuel cell, any such pressure will be transmitted directly to the tank supporting structure.

It has been found by practical test that an internal tank pressure of 1.5 p.s.i. can initiate permanent deformation of wing structure in an aircraft of the type involved in this incident. It will thus be seen that a comparatively modest rise in fuel temperature in a sealed tank is quite sufficient by itself, to cause structural damage. In the case reported, the aircraft apparently escaped serious trouble, but it is not difficult to see what might have happened had the actual increase in fuel temperature been greater or the pressurised condition of the tank not been detected and relieved before take-off.

Pressurisation in Flight

A flexible tank which has lost its means of outward venting can also be a danger in flight even apart from the fuel vapour pressure effect discussed above. For instance, consider the case of an inadvertently sealed tank in which the air space pressure is equalised with ambient air pressure on the ground prior to take-off (the normal situation). Suppose that the aircraft takes off and climbs rapidly to 5,000 feet above aerodrome altitude with a different tank selected to the engine. Allowing for a small relieving effect due to slow cooling of the tank contents in flight, the sealed tank will now be trying to expand under an internal pressure nearly equivalent to an altitude difference of 5,000 feet — something over 2 p.s.i. The structural stresses resulting from this, superimposed on the stresses due to flight loads, could create a potentially dangerous situation. If the aircraft were subjected to heavy turbulence and/or high manoeuvering loads at this time the possibility of an in-flight failure of the wing would become very strong indeed.

Whilst the figures chosen to illustrate this discussion are to some extent arbitrary, they are not unreasonable. The point worth underlining is that even a small pressure (force per unit area) acting over a sufficiently large area, such as a fuel tank surface, can give rise to very large forces. For instance, a pressure of $1\frac{1}{2}$ p.s.i. will produce a distributed load of nearly one ton on both the top and bottom surfaces of a tank bay measuring 4′0″ by 2′6″.

In this article we have tried to demonstrate that correct venting of fuel tanks is of critical importance and that any unserviceability, whether in connection with the vent systems themselves or with the sealing of fuel tank caps, should not be tolerated for a moment.

In your own interest, make sure that you fully understand the fuel system of any aircraft you are called upon to fly and be alert to possible symptoms of uneven feeding or other vent system troubles, so that remedial action can be taken before it is too late.

You have possibly noticed that modifications and inspections relating to fuel tank venting systems often feature in the mandatory requirements for different types of aircraft. It should now be clear that such instructions have a serious purpose even though in some cases the actual work involved might seem, to the uninitiated, to be almost trivial.

Pilot Responsibility in Refuelling

Periodically we receive reports from light aircraft pilots in which they draw attention to inadequate or dirty refuelling equipment, or complain of being supplied with contaminated fuel. In almost every case investigation has disclosed that the fuel supplier involved was not an accredited agent of one of the major fuel supplying companies. For instance, a pilot recently reported that he landed at a country town where he had previously arranged for fuel to be made available. The local fuel supplier had left on the aerodrome what he considered to be necessary equipment and took no personal interest in the refuelling proceedings. The pilot checked the filter on the pump and found that it contained approximately one and a half pints of muddy water. No water detecting material was available, nor was there suitable equipment to bond together the drum, pump and aircraft.

Naturally, the pilot was incensed and reported the circumstances to the Department. No corrective action could be taken in respect of the supplier because he was a retailer who had purchased drums of aviation gasolene from one of the fuel supplying companies so that he could resell it to aircraft operators. Under such circumstances the pilot has the full responsibility for all aspects of refuelling.

Although the organization of the fuel supplying companies for distributing aviation fuels and lubricants is known to most aircraft operators, it appears that there are some owners and pilots who are unaware of the distinction between an accredited fuel company agent and other types of retail suppliers. Furthermore it is apparent that the division of responsibility between the pilot and the fuel supplier in each case needs some clarification.

Basically, the pilot in command is responsible for refuelling of his aircraft on all occasions. The extent of the detailed checking that he must carry out, however, is dependent upon the circumstances under which the aircraft is being refuelled.

At airports where refuelling is carried out by personnel employed by the major fuel suppliers, the Company accepts responsibility for the quality of the fuel or oil that is delivered to the aircraft and for the pre-delivery contamination checks. The pilot should inform himself of the results of these checks and ascertain that the aircraft tanks contain the required quantity. He is also responsible for ensuring that appropriate water contamination checks have been carried out on the aircraft tanks, and that fuel and oil tank caps are secure prior to commencing his flight.

The major fuel suppliers also operate a network of accredited agents throughout Australia. These agents are trained in refuelling practices and are delegated to act on behalf of the fuel company under its quality control system. They are supplied with proper equipment and are responsible for ensuring that this equipment is maintained in good condition. Where the refuelling is carried out by these agents the fuel company accepts responsibility for the quality of the fuel or lubricant delivered into the aircraft, in the same way as it does when the work is carried out by its own employees.

In selecting these accredited agents throughout Australia, it has been necessary for the fuel companies to utilize a wide range of local organizations or persons. In large towns and in areas where there is a continuous demand for aviation fuel, the accredited agent is often a small business organisation, but the principals have a responsibility under the fuel company's quality control system only when work is supervised by that particular person. Should this accredited person not be available for refuelling the responsibility reverts to the pilot, who must ensure that the necessary pre-fuelling checks are carried out, that the fuel or oil is of the correct grade and is not contaminated.

Apart from providing direct refuelling services at the main airports and supplying fuel and lubricants through their network of accredited agents, the fuel supplier also sells in bulk direct to operators and retailers. In these cases the fuel company's quality control responsibility ends when the bulk stock is delivered, and the responsibility for ascertaining whether or not adequate precautions have been taken to guard against contamination during storage and subsequent distribution rests entirely with the user.

Aircraft operators purchasing fuel in bulk are responsible for ensuring that the equipment used is adequate and correctly maintained. In commercial aircraft operations the responsibilities of employees during refuelling are defined in the operations and maintenance manuals. The owner/pilot engaged in private operations who purchases fuel in bulk carries the whole responsibility for quality control.

When bulk fuel is sold to a supplier other than an accredited agent, the fuel company accepts responsibility for it being free of contamination at the time it is delivered. Obviously the fuel company cannot exercise control over the storage or distribution of its product beyond this point. There are some unaccredited suppliers who take every possible precaution to guard against contamination, provide proper refuelling equipment and give good service to aircraft operators. Experience has shown, however, that there are also some who are either unaware of or choose to ignore the responsibilities involved in the distribution of aviation fuels and lubricants. For this reason pilots obtaining fuel from these sources must ensure that all of the requirements relative to refuelling, which are detailed in A.N.O. 20.9.2, are observed.

One way of easing the burden of responsibility is to plan your flight in such a way that your fuel supplies will be obtained from accredited agents who are aware of their responsibility under an approved quality control system.

The systems of control used by the fuel companies are approved by the Department and are designed to ensure that only clean products, of proper quality, are supplied to aircraft. Any occasion in which there is the slightest suspicion that contaminated fuel or lubricant has been supplied by one of their branches or accredited agents is thoroughly investigated by the company and by the Department. It is claimed that the network of agencies is so comprehensive that it will meet the requirements of most, if not all, of the travel flights undertaken by light aircraft.

State branch offices of the fuel companies and their airport depots hold lists of their accredited agencies at places throughout Australia, and can inform pilots if it is necessary to obtain the services of a particular person at any agency. This source of information is available to all pilots and forearmed with this knowledge it should not be difficult to exercise the degree of supervision which is necessary to ensure that your flight is completed safely and without incident.

Insecure Door — Explosive Decompression — Hostess Fatality

(Summary of a Report released by the Civil Aeronautics Board, U.S.A.)

BRADLEY FIELD, CONN., U.S.A.

In October, 1962, the rear service door of a Convair 340/440 became disengaged at its lower latch points whilst the aircraft was descending for landing. A hostess working in the doorway area was ejected by the forces of explosive decompression.

INVESTIGATION

The aircraft was engaged on a scheduled flight, carrying 48 passengers and a crew of four—two pilots and two hostesses. After the right-hand engine had been started, the crew noticed that the warning lights associated with both the passenger door and the rear service door were indicating that the doors were not properly locked. The first officer assisted one of the hostesses to close the passenger door and the rear service door was closed by the ramp agent, whereupon the warning lights went off.

The aircraft took-off in darkness, with the pressurisation controls set to maintain sea level cabin pressure at the flight planned cruising level of 5,500 feet. Some five minutes after take-off, the first hostess informed the captain that a high pitched sound was emanating from the rear service door. In describing the action taken to check the door the first-officer explained — "I immediately checked the door handle; it was in the locked position. I then moved over to the door and checked the overhead door latches; they were in the locked position. I knelt down by the door, placing my left arm around a stanchion in the galley compartment and pushed forward on the door handle with my right hand. It was in the full forward or locked position. The bottom latches not being visible, I put my hand down at the bottom of the door and felt at the bottom latches; they felt to be locked. I took some paper from the beverage glass box and dropped it around the door to see if I could find a leak around the door. I could not find any." The first-officer informed the captain of what he had done and was instructed to attempt to stop the noise. This was achieved by placing several dampened pillow cases on the rear side of the door where the rubber seal was visible.

The flight proceeded with the cabin pressure maintained at sea level and a gradual descent was made into the destination airport. Just after passing through the 4,000 feet level, explosive decompression occurred, and the service door warning light illuminated. The dividing door between the flight compartment and cabin was torn off and blown some eight feet down the cabin aisle, whilst the lavatory door was ripped from its hinges. The first hostess, who was in the buffet area, was ejected through the rear-service door and fell to her death.

Subsequent examination revealed that the lower edge of the rear service door had twisted rearward and was one foot away from the lower lock pins. The upper latching hooks were over the upper lock pins but the hooks were twisted and bent outward. The door handle was in the "open" position. The parallelogram hinge structure had separated at the horizontal and diagonal tubular cross members. The vertical portion of the hinge remained attached to the fuselage and the horizontal portion had separated at the attachment to the interior of the door.

The door warning system, which is activated by two micro switches operated by the upper and lower **forward** latching hooks, was found to operate normally. The distorted upper latching hooks were replaced and attempts were made to duplicate the unsafe door condition which caused the accident. When the door was closed normally all four hooks engaged and the warning light went off. The door was re-opened and **slammed** shut, whereupon the two upper hooks and the lower forward hook engaged and the light went off. The lower aft hook did not fully engage.

The door was then partially closed, sufficient to trigger the lower latching hooks actuating plunger, quickly opened, then slammed and locked. Although the warning light went off and the door appeared to be locked, the lower aft hook was again insecurely positioned over the lock pin.

With the door latched in this manner and with No. 2 engine running to provide pressurisation, the cabin pressure was raised to a differential of 2.1 p.s.i. — the equivalent of an altitude of 4,200 feet based on standard day conditions. Under pressurisation and the influence of vibration, the door handle slowly progressed 1.5 inches towards the "open" position and could not be moved manually towards the "locked" position. As the cabin was allowed to depressurise normally the door handle progressed further toward the "open" position and, at a differential pressure of 0.5 p.s.i., the door popped outward at the bottom, hinging about the two upper hooks which remained engaged.

It was computed that the cabin pressure at the moment of the accident would be approximately 1.7 p.s.i. under standard day conditions.

ANALYSIS

As a result of the tests conducted, it was concluded that the procedure adopted to close the rear service door prior to flight resulted in an insecure engagement of the aft lower latching hook over its lock pin, and that such a slight displacement from the locked position could easily be overlooked in a visual inspection. It is believed that the hook remained in this condition during climb and cruise. On descent the decrease in pressure differential lessened the tension on the partially latched hook and allowed the lower portion of the door to be distorted by pressure which, assisted by vibration, caused the door handle to move toward the "open" position. When the hook finally became disengaged, the door distortion increased and the handle moved further towards the "open" position, thereby disengaging the forward lower hook and permitting explosive decompression. Assuming a pressure differential of 1.7 p.s.i., the total force exerted on the door at the moment prior to decompression would have been in excess of 3,000 lb. It is obvious, therefore, that a person adjacent to the door would be ejected by the decompression forces.

Although the crew took reasonable precautions to determine that the service door was secure, the Board noted that they should have exercised the precaution of depressurising the aircraft and warning the hostesses and passengers to avoid the rear service door area. They also noted that only some of the improvements to the door latching and warning system, recommended in Convair Service Bulletins, had been incorporated in the aircraft. As a result of the accident, the improvements contained in these bulletins became mandatory.

CAUSE

The Board concluded that the probable cause of the accident was an undetected insecure latching of the rear service door resulting in an inflight explosive decompression which ejected a hostess from the aircraft. Inadequate emergency pressurisation instructions and the continuance of pressurised flight after discovery of the pressurisation leak were considered contributory causes.

Glue Deterioration results in Loss of Control

Reference to the safety of glued aircraft structures was made in an article in the Aviation Safety Digest, No. 19, and in the December, 1962, issue, Digest No. 32, a pilot report was featured concerning glue failure in a Miles Messenger aircraft which resulted in almost complete loss of aileron control. The following is a summary of a fatal accident which resulted from glue deterioration in a wooden aircraft.

FLIGHT

On 25th August, 1962, a Percival Proctor V, which was being used for spotting isolated flocks of sheep on the pilot's property and directing a radio controlled ground party, dived steeply to the ground following the loss of a considerable portion of the covering of the outer section of the starboard wing. The aircraft was destroyed by impact forces and subsequent fire. The owner/pilot, who was the only occupant of the aircraft, was killed.

At approximately 1245 hours on 25th August, shortly after taking off for the second flight of the day, the aircraft flew what was described as "a fairly wide circle" at an estimated height of 300 feet above the ground in the vicinity of the mustering party. The aircraft was observed to "straighten up" and, shortly afterwards, the observer heard "what appeared to be the engine change note as though it had been throttled down." At this time he saw what he described as "several fairly large pieces of the aircraft falling down" and then noticed the aircraft disappearing behind trees. Immediately following this he heard the noise of impact and saw smoke and flames some 400 yards from his position. He proceeded immediately to the aircraft and found that it was burning fiercely and that the pilot had been killed. There were no other witnesses of the accident.

INVESTIGATION

The accident occurred on terrain some 1,200 feet above mean sea level, generally flat and covered with mulga and other light trees to 20 feet in height.

The weather was cloudless with good visibility and a light south-easterly breeze. The temperature has been estimated as between 80° and 85°F and it is probable that there was slight to moderate turbulence at the aircraft's operating height.

The maximum permissible all-up-weight of the aircraft was 3,500 lb. and the all-up-weight at the time of the accident is estimated to have been 3,100 lb., with the centre of gravity within permissible limits.

It was apparent from markings on surrounding trees and the general pattern of the wreckage that the aircraft struck the ground initially in a 30 to 40 degree nose down attitude whilst banked vertically to starboard. The flight path of the aircraft prior to the initial impact was probably at an angle of 60 to 70 degrees below the horizontal. Following the first impact with the ground the aircraft bounced 70 feet, still in a nose down attitude, and came to rest with the main wreckage in an inverted position. Fire, which had started at the first impact, continued at the main wreckage site and consumed the majority of the airframe structure.

It was possible to determine that the port wing and tail section had been relatively intact before the fire destruction. The starboard wing and the starboard side of the fuselage had absorbed the initial impact and small pieces of these sections of the structure were scattered about the accident site.

Parts of the starboard wing, comprising portions of the plywood leading edge from the landing light bay to the wing tip, most of the upper surface fabric corresponding to this section and one section of undersurface fabric were found all within a few yards of each other at a point 285 yards from the main wreckage. Scattered around these detached wing pieces, but over a much larger area, were lighter sections comprising nose ribs, sections of inter spar ribs and the complete leading edge member. These were all positively identified as originating from the starboard wing and specifically from the landing light bay outboard towards the wing tip.

The finding of various metal fittings and other evidence amongst the wreckage proved beyond doubt that the starboard wing, although minus a large portion of the plywood leading edge and fabric covering, was basically intact and attached to the aircraft at the time of initial impact. Examination of the remaining pieces of the starboard wing structure revealed a marked deterioration in the glued joints and (in many cases) virtually no adhesion between glue and wood. There was a remarkable lack of pronounced degree of wood failure at the glue lines and any wood fibre present on the glue faces was only in the form of a light "sheen" of microscopic fibres. The detached plywood leading edge was completely separated from the underlying ribs which in turn had almost all failed within themselves and the internal leading edge member was also completely separated from the skin. Failures had tended to occur mostly on the solid-wood sides of the glue layers, although in many cases it was possible by hand pressures alone to separate the remaining glue layer from the plywood face.

The pilot held a current private pilot licence endorsed for Percival Proctor aircraft in which he had flown some 632 hours and he had accumulated a total of 2,556 hours flying experience since he first commenced flying in 1935. Apart from a minor taxiing accident, he had not previously been involved in an accident and was known to be a particularly cautions and sound pilot.

The pilot purchased the aircraft new from the manufacturers and, after it was assembled in Western Australia, a certificate of airworthiness was first issued on 3rd July, 1946. The aircraft was owned and flown solely by the pilot throughout its life. It was regularly maintained in accordance with the schedules supplied by the manufacturer and in conformity with Departmental requirements. It was always carefully hangared when not in use.

During the first two years of it's life the aircraft was flown for some 266 hours and, during the following 14 years, a total of 366 hours.

ANALYSIS

It is apparent that the plywood nose covering of the wing became detached in flight but it has not been possible to positively determine the point of origin of the leading edge failure. A close study of the structure of the leading edge failed to disclose any evidence of external damage such as a bird strike or other impact which might have initiated the failures. The general direction of failure of the leading edge structure appeared to have been in an upward and a rearward direction, except for the outboard portion, where it appeared to have failed substantially rearwards with part of the nose skin passing above the wing and part beneath the wing. The evidence strongly indicates that the initial failure was in the vicinity of the landing light bay and that this resulted from an upward collapse of the leading edge structure under a positive manoeuvering load.

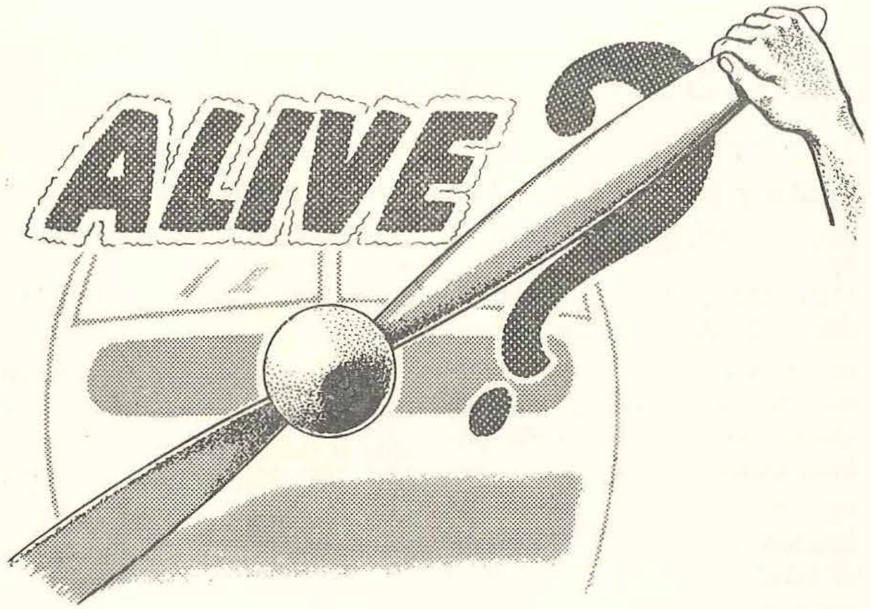
Consideration of the evidence leaves no doubt that the aircraft became uncontrollable immediately following the separation of the leading edge together with much of the covering from the outer starboard wing. The change in engine noise as reported by a witness probably resulted from the pilot closing the throttle after the wing failure.

It has been concluded that glue used in assembling the starboard wing had deteriorated to such a degree as to render the wing considerably under design strength and that, under normal operating conditions, collapse of the wing could have originated from a number of points at any time. The deterioration was of a nature such that it could not have been expected to be found during normal maintenance inspections.

CAUSE

The cause of the accident was that the aircraft became uncontrollable in flight as a result of detachment of substantial portions of the starboard wing covering, arising from undetached deterioration in the adhesive properties of the glue used in its construction.

Is it ALIVE?



In all walks of life accidents are brought about by a brief relaxation of mental vigilance in situations of known danger. Just how close one of our readers came to being a victim of this casual approach is clearly illustrated in his own description of a narrow escape.

"With several years spent flying a DH84 for the Flying Medical Services in South Australia and later operating the same type with a small N.S.W. Charter organisation, I had, I suppose, become fairly casual in my attitude to propeller swinging. Indeed, without so much as a second thought, I had sometimes handstarted the Pratt & Whitney R985's fitted to the Lockheed 12 which replaced the old Dragon in South Australia.

However, I can now assure you that my attitude to this potential game of Russian Roulette will not be quite so cavalier in the future!

Lately I have been operating a little Continental powered Champion 7EC, which, despite its mere 95 h.p., I have found to be a surprisingly pleasant little aeroplane. A few days prior to the incident in question, the starter cable had become disconnected. Being busy with other matters and with not long to run before the machine went back to the workshop for a 100 hourly inspection, I had stuffed the cable into the luggage locker and had been content to revert temporarily to my hand starting procedures of former years — a deceptively simple matter in the case of the Champion, particularly with a start from cold when the engine would consistently fire after a couple of strokes on the primer and a pull through.

But on this occasion I was restarting after refuelling and the engine was still warm. I did not prime it of course but straight away set the throttle, put the magneto switch to "Both" and swung the propeller. The engine coughed once then refused to do anything else. Obviously it was too rich. I switched off, opened the throttle wide and set about pulling it through several compressions to blow out the rich mixture.

I wound the propeller affectionately, as one might a ship's helm, standing much too close in front. After all — I'd done this hundreds, perhaps thousands of times before and had long since ceased to regard the old Air Force admonition on propellers as anything more than advice to "erks" who didn't know any better!

Three more pulls and the nonchalance built of years was shattered in an instant. The engine suddenly fired, caught as the fully opened throttle took effect, then as suddenly died. I stood transfixed in front of the aircraft — the propeller had actually brushed my tie as it spun, I had felt the breath of its passage on my face and its tip had lightly flicked the fingernails of my right hand.

It was a moment before I fully realised from what I had been delivered and I blanched at the thought of what might have happened if the engine had kept going with its throttle wide open!

A subsequent check showed that although the magneto switch was functioning correctly in the "L" and "R" and "Both" positions, it was no longer earthing properly in the "Off" position and the engine was fully capable of running with the switch in this position.

So Mr. Editor, in the future not only will I be affording propellers the respect due to them, but as well there will be more diligence shown in the checking of magneto switches during daily inspections!

COMMENT

We are grateful to this pilot for his contribution and agree that "what might have happened" warrants serious thought. Our records contain reference to other similar occurrences where experienced pilots and engineers have suffered injury because they temporarily forgot that propellers should be treated as though they were "alive" at all times.

This occurrence prompts us to remind light aircraft operators that particular care should be paid to ignition switch leads at periodic maintenance inspections. A damaged lead can have disastrous consequences either in flight or on the ground. Faulty insulation can result in loss of ignition from that particular magneto or, on the other hand, a break in the wire or a faulty connection can leave the magneto alive at all times. As most light aircraft have impulse starters on one magneto even a slight movement of the propeller may trip the impulse mechanism thus causing the engine to fire.

A Classical Case of THROTTLE ICING

Whilst practising stalls at 5,000 feet the pilot of an aero club Cessna 172 noticed that the engine did not seem to respond normally when the throttle was advanced during the recovery sequence. On the fifth such manoeuvre the throttle jammed.

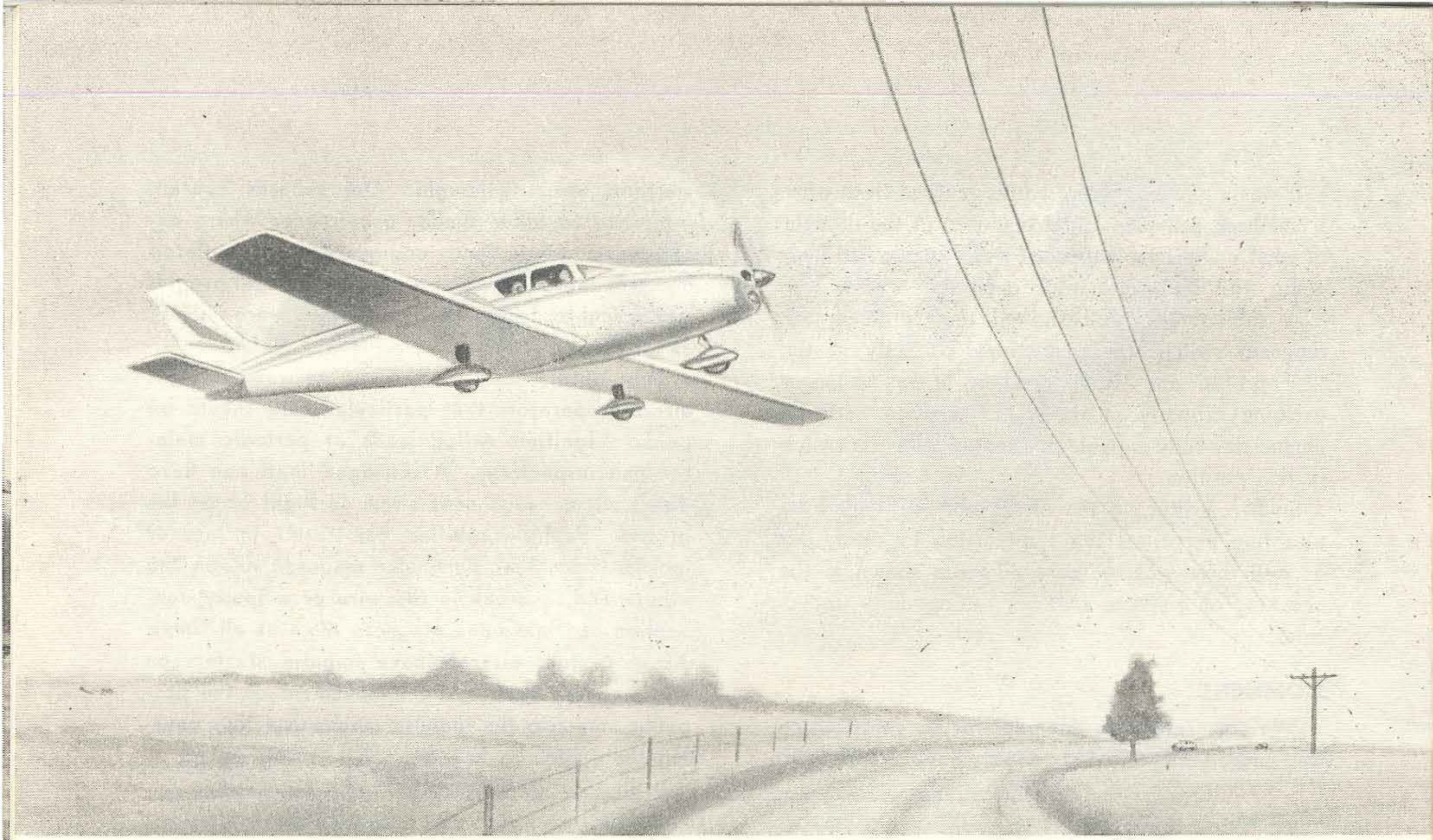
After recovering from the stall the pilot managed to free the throttle mechanism and restore engine power, whereupon he immediately returned to the aerodrome.

Ground power tests and physical checks failed to reveal any fault in the engine, which performed normally during a subsequent test flight. In view of the absence of any mechanical defect and as the pilot confirmed that carburettor heat was not applied at the time, it was concluded that the throttle had been jammed by ice.

Fine weather conditions prevailed in the area in which the flight was conducted, with only a trace of high cloud but there was a noticeable haze. Meteorological records show that the ground level temperature a short time prior to the incident was 42°F and the relative humidiy was 74 per cent.

The incident provides a classical example of throttle icing and prompts us to remind light aircraft pilots of our previous article dealing with the types of icing that affect carburettors, under the title of "Be Ice Conscious", in "Aviation Safety Digest" No. 25, March, 1961. Particularly pertinent to the incident is our statement in the 1961 article, which reads — "If the throttle movement is sticky or abnormal, or it fails to increase the power, it is a sure sign that ice has formed and the application of hot air has already been delayed longer than is healthy but it is still not too late to apply it".

We are pleased to note that there has been a decline in the number of incident reports that relate to loss of power from carburettor icing since the publication of our earlier article. At the same time, it is obvious that some light aircraft pilots have still not learned to recognise the meteorological conditions conducive to icing, or the symptoms which should warn them of an imminent loss of engine power. Perhaps a few minutes reflection on these conditions and symptoms, whilst on the ground, will obviate the anxious minutes that it takes to force-land an aircraft that has suffered complete loss of engine power due to carburettor ice.



Power Lines struck by Piper Cherokee

At about 10 minutes past 10 on the morning of 1st February, 1963, a Piper PA28-160 "Cherokee" struck the ground and burnt after colliding with an electric power line some 19 miles south-west of Coonabarabran in New South Wales. All four persons in the aircraft were killed in the accident and the aircraft was destroyed.

THE FLIGHT

The aircraft was being operated privately for the purpose of transporting various officials connected with a motor car tour from point to point along the route being followed by the competing cars. During the three days prior to the accident the aircraft was flown for this purpose from Sydney via various points to Orange.

At approximately 0850 hours on the day of the accident, the aircraft departed Orange for Tooraweenah, Moree and Armidale. There were three passengers on board the aircraft, two of whom were tour officials and the other a representative of a motoring magazine. At approximately 1000 hours, the aircraft circled the aerodrome at

Tooraweenah but did not land and a number of observers saw it flying shortly afterwards, in the vicinity of the Oxley Highway between Tooraweenah and Coonabrabran, along which the competing cars were travelling. Just prior to the accident, some eyewitnesses observed the aircraft flying at or near tree top level and, almost immediately after it passed out of view, smoke and flames were observed in the direction it was last seen. It was found that the aircraft had collided with an electric power transmission line and, after striking the ground in a steep, nose-down attitude, it had burst into flames.

INVESTIGATION

The accident occurred in lightly timbered undulating terrain with low hills on either side of a relatively flat valley some 1,400 feet above sea level. The sky was overcast with a cloud base between 2,000 and 3,000 feet. There was a light wind from the south and the visibility was unrestricted.

A high tension electric power transmission line comprising three steel cables passes along the southern side of the Oxley Highway from the direction of Coonabarabran, and crosses the Highway at an oblique angle in the immediate vicinity of the accident.

The evidence indicated that the aircraft, whilst flying towards the southwest, struck and broke the first of the three cables some 22 feet above the roadway at approximately the mid-point of the cable span. The aircraft then struck the ground some 400 feet beyond the power line in a steep nose down attitude, bounced and finally came to rest in an inverted position approximately 60 feet from the point of first impact with the ground. The impact forces were severe and there was an intense fire which consumed the cockpit and cabin areas together with the major portion of the centre section of the aircraft and the wing covering. Fire damage to the carburettor and air filter, which became detached at the initial impact indicated that the fire commenced when the first impact with the ground occurred. The majority of the instruments were destroyed and it was not possible to determine the position of the engine and flight controls. It was possible to establish that the ignition switch was in the "on" position and that the starboard main fuel tank was selected.

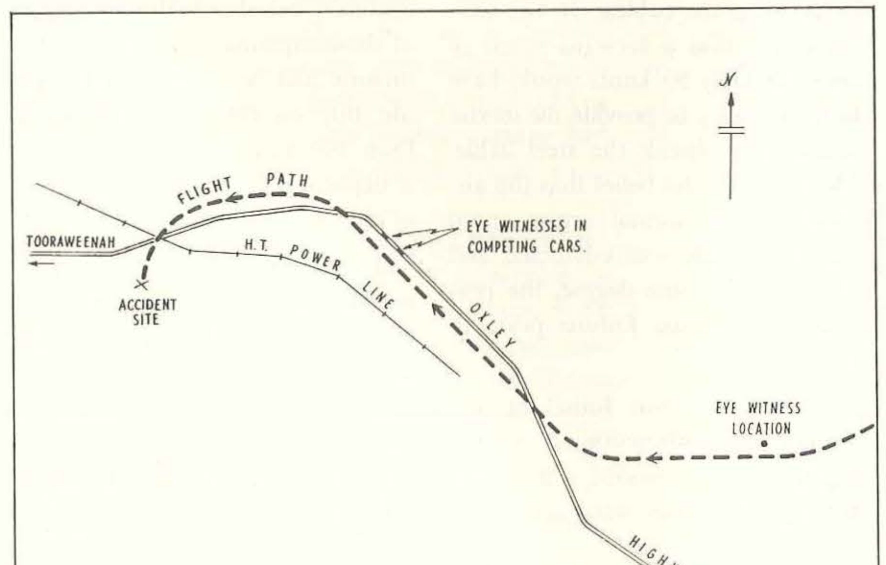


DIAGRAM SHOWING FINAL FLIGHT PATH AND ITS RELATIONSHIP TO WITNESSES LOCATIONS.

There was no evidence of pre-impact failures of the aircraft structure or of any defect in the flight controls. The engine was removed and subjected to careful examination, but no evidence was found of any defect or malfunctioning which might have contributed to the accident. The damage to the propeller indicated that it was rotating at low speed when it struck the ground.

During the morning, a number of witnesses observed the aircraft flying at various heights along sections of the Oxley Highway between Tooraweenah and Coonabarabran. Immediately prior to the accident, the aircraft was observed by one witness flying towards Tooraweenah near the tops of trees bordering the Highway (see the locality diagram).

It was in full view of the observer until it turned to the right at a point approximately 600 yards from the observer's position. The aircraft was then occasionally obscured by trees until a short time later when it climbed slightly to just above tree top height and commenced a turn to the left. After turning through some 90 degrees, the aircraft was then obscured by a slight rise in the terrain and, almost immediately, smoke and flames were observed in this direction.

Approximately 30 seconds before the accident, the drivers of two of the leading tour cars saw the aircraft flying at low altitude along the Highway towards them. A few seconds after it had passed them, the navigator of the leading car looked back to assess the position of the second car and saw a column of smoke rising from a position near the road.

Photographic films extracted from cameras, which were recovered from the aircraft wreckage, included a number of aerial shots of the competing cars which were estimated to have been taken at heights ranging from 1,500 feet to as low as 30 feet above ground level.

The pilot held a valid commercial pilot licence endorsed for Piper PA-28 type aircraft. No entries had been made in his flying log book since July, 1962, and his total flying experience was estimated as 647 hours of which 34 hours were gained on this type of aircraft.

ANALYSIS

The aircraft contacted one electrical supply cable only. This cable was one of three lying in the same horizontal plane and was the leading cable relative to the aircraft's flight path. This impact occurred when the aircraft was either in a substantially nose-up or nose-down attitude as any other attitude would have resulted in more than one cable being contacted. A nose-up attitude is considered more probable since the relatively high fin showed no cable marks which might have been expected from the other two cables if the aircraft had passed beneath them. It seems probable that the pilot initiated a pull-up which was too late to be effective in avoiding the cables. It has been calculated that a forward speed of approximately 93 knots would have been necessary to provide the inertia necessary to break the steel cable. This supports the belief that the aircraft was at normal cruise speed when the cable was contacted and discounts, to some degree, the possibility of engine failure prior to the accident.

No evidence was found of any pre-impact malfunctioning in the engine or its accessories. Clearly defined ground cuts were typical of propeller rotation and although the propeller damage suggests a low power condition at impact this is probably attributable to the fact that the pilot closed the throttle following impact with the cable.

Witness evidence clearly indicates that a low level flight pattern was being flown. The possibility that the pilot was seeking a favourable forced landing field has been discounted as the aircraft flew over and past several particularly suitable landing areas in the last few minutes of flight. In addition, observers expressed the opinion that the aircraft appeared to be operating normally.

It was apparent from the investigation that the original intention to use the aircraft as a medium for fast transport of tour officials was extended to include visual supervision of the car tour from low altitudes, together with photography of the competing cars. Since no permission had been obtained to operate this aircraft at lower heights than 500 feet this action involved a departure from the requirements of the Air Navigation Regulations.

The evidence indicates that the accident arose from the pilot's decision to operate the aircraft at an unsafe height and in a manner such as to preclude the sighting of electric power transmission cables in time to allow successful avoiding action.

HIDDEN HAZARDS

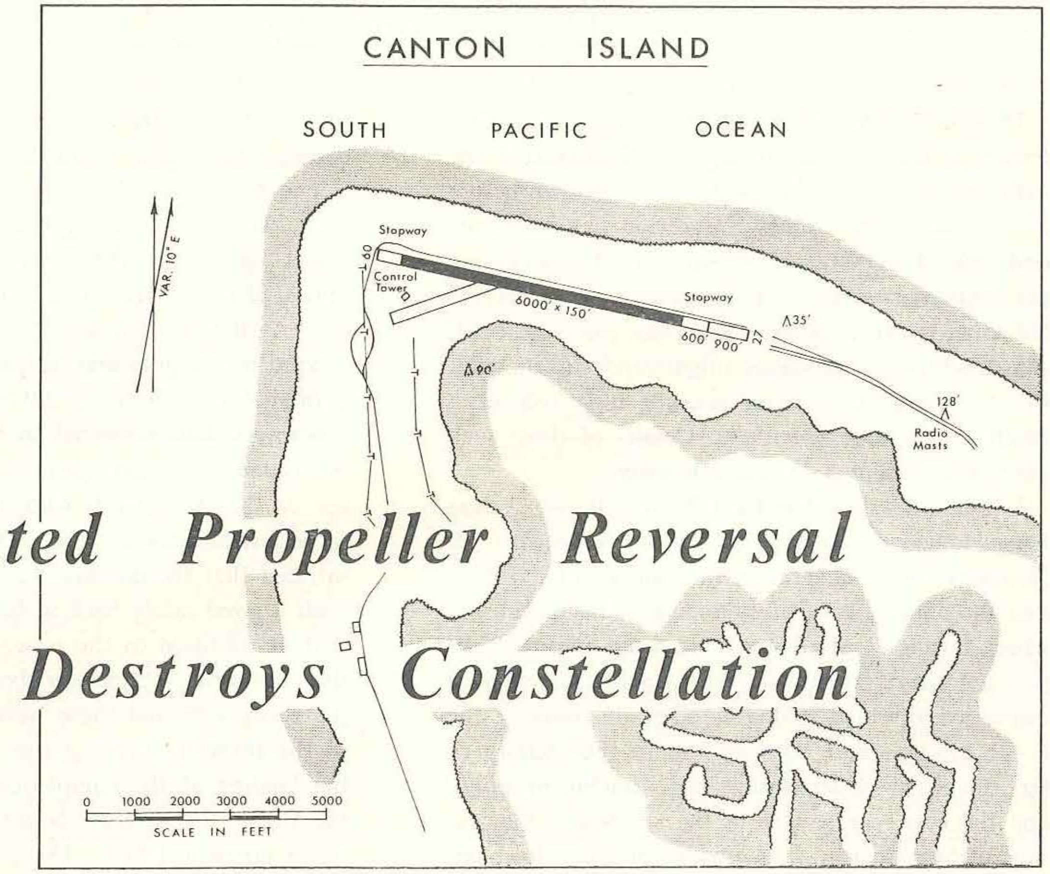
In recent months there has been a disturbing increase in the number of reports of aircraft being damaged in an accident and then being flown before an adequate airworthiness inspection has been carried out. In several cases subsequent engineering examination revealed that the aircraft had sustained far more serious damage than the pilot believed; consequently the subsequent flights undertaken, prior to proper repair, incurred a very high risk of a much more serious accident. Details of three such cases are presented in the following.

Early this year a Cessna 175 aircraft, which was being taxied in long grass on an aerodrome in Northern Queensland, struck a number of ant beds and the pilot assessed the damage as being cracked wheel fairings. After they had been removed, he flew the aircraft to Cairns where a further external inspection revealed that a number of rivets in the lower fuselage had been sprung in the vicinity of the starboard undercarriage leg attachment point, and that the rear section of the starboard door sill was slightly buckled. A subsequent strip down inspection showed that considerable damage had occurred to the fuselage centre section between the undercarriage attachment points, with some buckling of the engine bulkhead. This hidden damage had reduced the strength of the undercarriage to a marked degree.

During April of this year a Piper Cherokee aircraft, which was being taxied on a racecourse in Western Australia, struck the top of a metal stake with the port mainplane. The leading edges and undersides of both the mainplane and the aileron were dented but the skin was not pierced. The pilot carried out a test flight in the aircraft and, as the aircraft handling characteristics appeared to be unchanged, he flew the aircraft to Perth for repair. Inspection of the aircraft at Perth confirmed that, to the untrained eye, the damage appeared superficial but a closer examination revealed that the aileron spar was buckled and required replacement of the aileron. The wing panels were so indented as to also require replacement, and there was some distortion of the nose ribs and the mainplane stringers in the affected area, indicating the possibility that damage may have occurred to the mainplane spar.

The pilot of an Aero Club Victa Air Tourer aircraft, which was on the second stage of a private travel flight, noted that the movement of the rudder appeared to be stiff, both in flight and during taxiing. At the next landing place the aircraft was inspected by the pilot and the passenger, who also held a private pilot licence, and it was found that the nosewheel strut appeared to be slightly bent. This was immediately conveyed by telephone to the manager of the Aero Club who authorised the aircraft to be ferried back to base, subject to the pilot being satisfied that the damage was only minor. The aircraft arrived safely back at base where it was found that, in addition to the nosewheel strut being bent, the top strut attachment bracket had torn from the shear web and there were a number of cracks in the firewall. Investigation revealed, that during the landing at the completion of the first stage of the flight, the aircraft bounced and then touched down nosewheel first. The pilot and the passenger did not believe that this landing was sufficiently heavy to cause structural damage to the aircraft, but there is no doubt that the damage occurred at this time.

In each of these cases there was more to the damage than met the eye and, although each aircraft was subsequently flown without further incident, the aircraft structures had been weakened to such a degree that the damage could have progressed in normal flight to a stage likely to have catastrophic results. The important structural members are usually not seen in a superficial examination, and it is vital that the possibility of damage to these items be eliminated if the aircraft is to operate safely. The need to call upon the services of a licenced maintenance engineer whenever damage occurs to an aircraft is surely apparent from these instances, and it follows that the licenced maintenance engineer should be given a clear and factual account of any incident known or suspected to have caused the damage, to facilitate his assessment of primary and secondary effects.



Undetected Propeller Reversal Destroys Constellation

(Summary based on the report of the Civil Aeronautics Board, U.S.A.)
(All times are local)

A Lockheed Constellation L749A operated by the Federal Aviation Agency crashed following a local training flight at Topham Field, Canton Island, on 26th April, 1962.

There was only one survivor out of the four crew members and two passengers. The survivor was a passenger who was a Federal Aeronautics physician. The aircraft was destroyed.

The purpose of the flight was to train the co-pilot prior to being tested for an Airline Transport Pilot rating, and to train a flight maintenance technician as a flight engineer.

INVESTIGATION

After run-up, the aircraft took off at 0914 hours and made several approaches and landings with various flap configurations. Some of the landings included propeller reversing after touchdown. On the first flight a go-around procedure was commenced some 300 feet over the threshold from which position the aircraft flew over the runway with flaps down before leaving the traffic pattern and climbing to altitude for the purpose of conducting emergency procedures training.

The emergency procedures included the feathering and simulated feathering of propellers and the simulation of hydraulic and electrical systems failures. During this period the crew contacted Canton International Flight Service Station several times. At 1142 hours the aircraft reported 4 miles out, requested traffic information and advised an intention of making a pass over the airport. Shortly thereafter the aircraft passed over the airport from north to south at an altitude of about 500 feet and then continued out over the water where it circled several times. The aircraft was then climbed to traffic pattern altitude, entered a left downwing leg and was given the current altimeter setting. Acknowledgement of the altimeter setting was the last radio contact with the aircraft. None of the previous radio contacts had included any mention of mechanical difficulty.

The aircraft was observed to make an approach for landing and after touchdown rolled 239 feet on the right main landing gear with the right wing continuing to drop. It then lifted off in a nose-high and right wing-down attitude and the right wing tip struck the ground at the right hand edge of the runway. This contact crushed the tip as well as the outboard portion of the wing and the right aileron. The angle of bank increased and the turn continued with the right wing scraping the coral. An 18 inch high coral ridge was struck causing further breakup of the wing. The angle of bank continued to steepen and the aircraft cartwheeled coming to rest 220 feet off shore in water about three feet deep. There was no fire either before or after impact.

The weather at the time of the accident was: scattered clouds at 2,000 feet; visibility more than 15 miles; temperature 86 degrees F; dewpoint 73 degrees F; wind east-north-east 6 knots altimeter 29.86.

The runway is 6,000 feet long and 150 feet wide and the first identifiable tyre marks were 650 feet past the threshold of runway 09. The touchdown was 20 feet to the right of the centreline on the two right main wheels only, which left a solid mark for 17 feet, then very light and intermittent markings for the next 95 feet. At this point a solid mark made by the outboard tyre of the right landing gear started 29 feet to the right of the runway centreline and ended 127 feet down the runway 38 feet from the centreline, where the aircraft became airborne again leaving a trail of fragmented parts and debris to the edge of the water. The main wreckage consisted of a large portion of the fuselage and sizable portions of both wings.

Much of the forward portion of the aircraft was literally ground away by sharp coral. An examination of the airframe proper, its control systems, other aircraft systems, the instrumentation, the engines and the propellers revealed no evidence of failure occurring immediately prior to the accident. Readings of instruments, engine controls, and tab settings which could be obtained, yielded nothing that could be directly related to the accident. The flap selector was in the "up" position. The flap control mechanism indicated that the flaps were in transit upwards at approximately 60 per cent at the time of impact. The aileron and rudder boost control levers as well as their related control valves were found in the "off" position.

Examination of the four propellers indicated that the blade angles at the time of impact were 15 degrees positive, for Nos. 1 and 2, 23 degrees positive for No. 3 and 20 degrees negative for No. 4. The low pitch stop is at 15 degrees positive and the reverse pitch stop is at 20 degrees negative. Functional tests and disassembly of the pitch changing mechanism of the four propellers did not reveal any irregularities. Functional tests of the four governors were satisfactory. The only discrepancy found during examination following disassembly was scoring and pitting of the low pressure relief valve on the No. 4 propeller governor.

The extent of the scoring and pitting was excessive, considering the relatively low operational time of 352 hours since the last overhaul, and the reason for this could not be established.

The sequence of events prior to and during the accident was established largely through details provided by the survivor. Initially he was able to recall only the general details and voluntarily submitted to being questioned while under the influence of sodium amytal, a drug which is used to prompt memory recall. During this interview under narcosynthesis the survivor recalled the words shouted by the Captain as the aircraft veered to the right on landing: "Controls frozen" and "Ailerons frozen". He also remembered that at approximately the same time the Captain reached for the aileron and rudder boost control levers and pulled them to the "off" position. This was the first use of the narcosynthesis interview technique by the Board in connection with the investigation of an aircraft accident.

ANALYSIS

Investigation of the airframe, systems, and powerplants revealed the following three items which cannot be accepted as normal:

1. No. 4 propeller in reverse pitch (–20 degrees).
2. No. 4 propeller governor low pitch relief valve pitted and scored.
3. Aileron and rudder boost off.

The initial touchdown on the right main landing gear and the subsequent attitude and path of travel of the aircraft cannot be divorced from considerations of the No. 4 propeller which was found in full reverse pitch. The propeller operating with an ineffective low pitch stop during approach constitutes a logical cause for the landing events as described. In the event of an ineffective low pitch stop, the decrease in blade angle as power and airspeed is reduced would continue, at least initially, to maintain the r.p.m. selected. This situation would be most evident by an r.p.m. decrease on three tachometers and one, No. 4, would remain as selected. As airspeed and/or power was further reduced, energy input to the propeller would decrease to a point where the selected r.p.m. would not be maintained and the propeller blade angle would move into the reverse pitch regime and continue to full reverse. The reverse pitch indicating light on the pilot's panel would come on about 5 degrees before full reverse pitch was reached. An abrupt and very substantial increase in drag and some reduction of right wing lift would follow. It is concluded that this is what occurred as it is compatible with the touchdown attitude and the physical evidence as well.

After contact with the runway by the right landing gear for 239 feet, during which an application of power was heard, the aircraft lifted off and, while turning to the right, the right wing tip contacted the ground. The right turn continued with the right wing dragging. Indications that the wing flaps were in transit toward the retracted position, in conjunction with the application of power, leads to the conclusion that a go-around was being attempted.

There are several possibilities for an ineffective low pitch stop. A false electrical reversing signal is considered to be a most unlikely possibility as the special precautions taken to protect the reversing solenoid circuit from false signals have been very effective. Either a governor low pressure relief valve seized in the closed position or a low pitch stop lever assembly servo valve stuck in the open position would render the low pitch stop levers ineffective. A propeller feathering and unfeathering in flight would provide the positioning for either of these valves which, in the event of sticking, would precipitate the events which are believed to have culminated in this accident. The physical condition of the low pressure relief valve, as found, makes it the most likely cause of the unselected reversal. That the fault was not revealed by functional tests is not a compelling reason for eliminating these two possibilities. It is not unusual for a hydraulic component malfunction to fail to recur when checked on a test facility because, if the initial trouble had been caused by contamination in the oil, the original contaminant may be displaced immediately.

It is obvious by the Captain's action in pulling the aileron and rudder boost control "off" and shouting "Controls frozen, ailerons frozen", that his reaction to the directional and attitude control difficulty following touchdown was to correct a control malfunction — not a propeller reversal problem. This action further compounded the control difficulties. A jammed aileron because of damage from contact of the right wing with the ground logically accounts for the Captain's erroneous diagnosis.

CAUSE

The Board found that the probable cause of the accident was loss of control during an attempted go-around following initial touchdown, as the result of an undetected reversal of No. 4 propeller.