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AVIATION SAFETY DIGEST

DEPARTMENT OF CIVIL AVIATION AUSTRALIA

No. 43 SEPTEMBER, 1965

AVIATION
SAFETY DIGEST

Department of Civil Aviation · · · Australia

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Contents

A new development in Australian airfreighting: Ansett - A.N.A.'s recently acquired Carvair loads at the freight terminal at Melbourne Airport.

Aviation Safety Digest is prepared in the Air Safety Investigation Branch and published quarterly. Enquiries and contributions should be addressed to The Editor, Aviation Safety Digest, Department of Civil Aviation, Box 1839Q, P.O., Elizabeth Street, MELBOURNE, C.1.

Cessna 205 Destroyed in New Guinea Highlands

While making a charter flight from Madang to Goroka, New Guinea, a Cessna 205 crashed into a cloud-enshrouded mountainside and was destroyed. Both occupants were killed instantly.

The aircraft, which was owned by a New Guinea charter company, had been engaged to fly a load of trade goods destined for a highlands mission station, to Goroka. The flight was under the command of a commercial pilot who had joined the company two months before and who was comparatively inexperienced in New Guinea operations. He had, however, been given the required familiarisation for the route and on this occasion was accompanied by another more experienced company pilot who was based at Goroka. This latter pilot had ferried an aircraft to Madang and was returning to his base as a passenger on the charter flight.

Before departing, both pilots had discussed the weather en route to Goroka with a senior company pilot. Goroka, 58 nautical miles south-west of Madang, is situated 5,140 feet above sea level in a valley in the Eastern Highlands of New Guinea. A wall of mountains, rising in places to more than 11,000 feet, lies immediately to the north of the town, separating the valley from the 40 miles of comparatively low-lying country between the highlands and the coast. An aircraft flying from Madang to Goroka, may enter the valley through one of four gaps in the range. The usual and most direct route is via the Bena Gap, 12 miles north-east of the town, which in good conditions, can be negotiated as low as 6,500 feet, although 7,500 feet is the normal minimum altitude flown. The other gaps require minimum altitudes of between 8,000 and 9,000 feet. Reports this day indicated that although there was considerable cloud in the Bena Gap, other aircraft had been able to fly through at 9,000 feet. After reviewing the reports, the pilot in command submitted a flight plan for Goroka via the Bena Gap and the aircraft departed from Madang at 1212 local time.

At 1238, the pilot reported that he was in the Bena area at Flight Level 70 and was attempting to enter the gap below the cloud because the tops looked too high. In reply to a transmission from Madang enquiring if the Bena Gap was still open, the pilot asked Madang to stand by, then two minutes later advised that he was abandoning the attempt to fly through the Bena Gap and instead would try the Dirty Water Gap, which he was now estimating at 1245. The Dirty Water Gap, actually no more than a saddle in the main ridge, is approximately eight miles east south-east of the Bena Gap and in visual conditions can be safely negotiated at 8,000 feet. Three minutes later at 1243, Madang again called the aircraft to pass advice of conflicting traffic operating out of Goroka. The pilot acknowledged this call but a few minutes later failed to answer another call from Madang Air Traffic Control. Repeated calls from Madang and also from a DC-3, which had just left Goroka, brought no response and at 1301 the Uncertainty Phase was introduced.

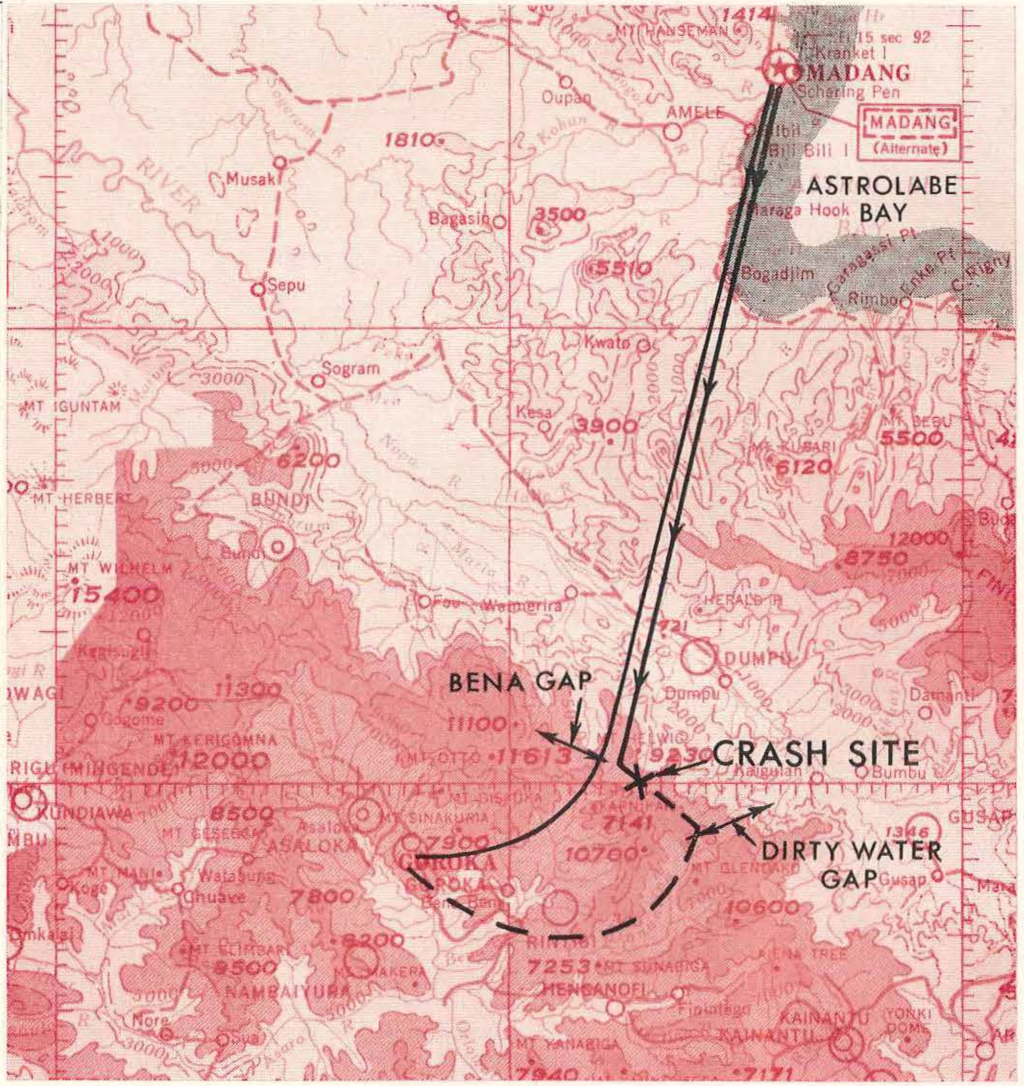
The assistance of the DC-3 crew was obtained to check if the Cessna had diverted to Dumpu, some ten miles north of the Gap. After seeing that there was no aircraft on the ground at Dumpu, the DC-3 returned to Goroka to check whether the Cessna had landed there in the meantime, and at 1314 reported to Madang that the aircraft had not landed at either Dumpu or Goroka. This gave rise to serious doubts for the safety of the aircraft and the Distress Phase was introduced at 1319.

Action was immediately taken at Madang to organise a search for the missing aircraft and to check a number of airstrips in the area where it was thought the aircraft might have landed, if the pilot had experienced engine trouble. A Piaggio 166 en route to Goroka from Baimuru was diverted to assist in this investigation and a DC-3 making a charter flight to Goroka from Madang was instructed to make a track crawl search en route to Goroka. Immediately afterwards a Cessna 185 from Madang, and a Beech Baron and a Cessna 182 from Goroka, took off to take part in the search. These aircraft were joined later by four DC-3s, three more Cessna 185's and a Bell helicopter. During the late afternoon, however, deteriorating weather forced the search aircraft to restrict their operations to areas in the vicinity of Goroka and Madang respectively, and finally made it necessary to recall all aircraft. The cloud cover during the afternoon had, in any case, made it impossible to search the mountain ridges above 7,000 feet.

Later that evening a report came in from a primitive native village that an aircraft answering the description of the missing Cessna, had been sighted flying low over a ridge in the Dirty Water Gap area some time between noon and 1400 hours that day. Plans were made to resume the search at first light deploying a total of twelve aircraft from Madang, Goroka and

Lae, with the helicopter standing by for rescue operations.

Three Cessnas from Madang were the first to rejoin the search in the morning, followed shortly afterwards by three DC-3s. The day was fine and cloudless with unlimited visibility on the mountains, but fog lying in the highland valleys prevented the Goroka based aircraft from taking off early. At 0624, one of the Cessnas reported sighting wreckage on a ridge near Mount Helwig which rises in the centre of the Bena Gap. The site was just north-west of the saddle in the ridge which forms the so-called Dirty Water Gap. Within minutes, the pilot confirmed that it was the missing aircraft. There was no sign of survivors. Action was then taken to recall all aircraft engaged in the search and to commence recovery operations.



MADANG - GOROKA AREA

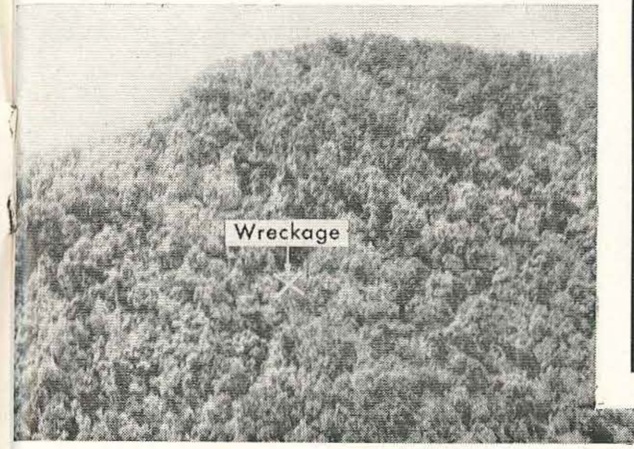
SHOWING ACTUAL AND PROPOSED FLIGHT PATHS

——— .. .. .. Flight Plan Route
——➤—— .. .. .. Actual Flight Path
— — — .. .. .. Proposed .. ..

The helicopter, carrying two doctors from Goroka, and a DC-3 with a ground rescue party from Madang were both despatched to Dumpu. The helicopter was used initially to land a doctor and a patrol officer as near to the accident site as possible, then to run a shuttle service from Dumpu to fly in more members of the ground party to assist in the recovery action. The heavily timbered, extremely rugged and mountainous country offered no suitable landing pad for the helicopter close to the crash site and it was necessary to land the ground party more than three hours' walk from the wreckage. The going subsequently proved extremely difficult for the ground party, not only in making their way towards the site but also in locating the wreckage itself. The Beech Baron and later the helicopter were despatched again from Goroka to contact the party through the portable VHF transceiver which they were carrying, to assist in guiding them in. Even this proved most difficult as the heavily wooded slopes made it virtually impossible to sight the ground party from the air. As a result the party were not able to reach the site of the accident until 1530 hours and finally determine that there were no survivors.

The aircraft had crashed on the northern side of a ridge of the main range at an altitude of 8,350 feet, 400 feet below the crest of the ridge. Both occupants had been killed on impact. The site was heavily timbered with slope of at least 65 degrees and the aircraft was lying nearly longitudinally and laterally level with the engine almost completely buried in the mountainside. One propeller blade had been torn from its hub and was lying badly damaged, 20 feet

These photographs convey some impression of the extremely rugged nature of the slopes on which the aircraft crashed.



Above: The wreckage as sighted by the search aircraft.

away. The trees were sheared off in an almost horizontal line from the aircraft's point of first impact to the position in which the engine was lying. Both wings were torn off and the port one had been virtually destroyed. The fuselage as far back as the rear door pillar was severely damaged and the engine firewall had been pushed back against the instrument panel. Both master and ignition switches were in the "ON" position. The control wheels in the cockpit, one of which was undamaged, were in a neutral position. No evidence was found of any malfunction which might have contributed to the accident; indeed all the evidence at the site of the crash indicated that the aircraft had flown into the ridge at about cruising speed in a straight and level attitude with the engine developing at least cruising power.

Although there were no witnesses, other than the native villagers, who saw the aircraft during the flight and up to the time of the accident, it is reasonable to assume that the aircraft had proceeded normally along its flight planned route from Madang to as far as Mount Helwig, which is at the entrance to the Bena Gap.

Reports from other pilots who were flying in the area of the accident about the time it happened, show that there were large build-ups of cloud in both the Bena and Dirty Water gaps and that the mountain ridges in the vicinity of the Dirty Water Gap were almost completely obscured by cloud up to heights of more than 8,000 feet. It is difficult, in view of this, to understand why the pilot had attempted to penetrate the gaps at such a comparatively low altitude. He had ascertained the actual weather conditions from the area forecast and knew that other aircraft were flying into Goroka at 9,000 feet. Together, these reports should have indicated that there would be cloud build-ups in the gaps and on the ridges, particularly at that time of the day. At times, it is possible to fly through the gaps into the Goroka Valley under the cloudbase, but only experienced pilots are able to sum up the chances of getting through in such conditions. The pilot in this case was not experienced in New Guinea operations.

Pilots flying the Madang-Goroka route sometimes use the Dirty Water Gap as an alternative route into the Goroka Valley when all other gaps are closed. In this case, because cloud conditions prevented his entry to the Bena Gap, the pilot had evidently followed this practice and turned towards the Dirty Water Gap, which, in this type of aircraft, is a flight of less than five minutes. No Mayday calls were received from the aircraft before the crash and its final flight path indicated that it had flown into the mountainside in level flight with normal engine power settings. It is therefore reasonable to assume that the accident was not caused by a loss of control while in cloud. Rather, it is probable that the accident occurred when the pilot intentionally flew into cloud believing that he was approaching, or had arrived at the Dirty Water Gap and that visual conditions would be encountered in the Dirty Water Valley.

This pilot fell into the same error that, over the years, has proved the undoing of many other pilots — flying in poor visibility below the tops of nearby high ground. The dangers associated with instrument flight by inappropriately qualified pilots in inadequately equipped aircraft have been featured in recent issues of the Digest. Although in this case, the pilot was evidently capable of flying on instruments and did not lose control of his aircraft, the sort of instrument operation in which he was engaged is every bit as lethal — flight into clouds with rocks inside them !

FUEL MISMANAGEMENT – FORCED LANDING

The last issue of the Digest contained a report of a forced landing by a PA24, brought about by fuel mismanagement. This, in turn, had resulted from inadequacies in the cockpit check procedures followed by the pilot in command. (See Cockpit Checks Have a Purpose, Digest, No. 42, June, 1965.)

Two more forced landings have since been made by light aircraft as a result of fuel mismanagement arising, surprisingly enough, not from sloppy cockpit drills, but from sheer ignorance of the particular aircraft's fuel system. Happily, in both instances, the forced landings were entirely successful and the aircraft were not damaged, but this does not lessen the impact of the story.

The first case involved a private pilot who was making a cross-country flight in a Beechcraft B23 Musketeer. The aircraft had departed from Bankstown early in the day and had flown to Canberra and Cooma, then back to Canberra. Ten minutes after taking off again from Canberra for the return flight to Bankstown, the engine power suddenly fell from the cruising setting of 2300 rpm to 1200 rpm, and the fuel pressure indication to the bottom of the green arc. The pilot selected the booster pump and carburettor heat on, checked the ignition switches, and quickly rotated the fuel selector to all four positions in turn, but was not able to restore power to the engine. He then picked out an open paddock near the southern tip of Lake George and landed safely.

Both the aircraft's fuel tanks had been full on departure from Bankstown. Usable fuel in each tank in the Musketeer is 24.5 imperial gallons. The flight time up to the point of engine failure was three hours 45 minutes, which, at the 65 per cent. power fuel consumption rate of 6.5 gallons per hour, would require 24.4 gallons. The pilot had conducted the flight with the fuel selector positioned to what he believed was "Both" tanks. Examination of the aircraft after the forced landing showed, in fact, that the selector was in the starboard tank position with the starboard tank empty and the port tank still full.

The pilot said later that during the day's flying he had noticed the aircraft was using more fuel from the starboard tank than from the port, and, before taking off from Canberra for the homeward flight, he had physically checked both tanks. Despite the fact that he knew the starboard tank to be almost empty and the port full, he again selected what he thought was "Both" tanks for take-off and left the selector in that position until the engine failed.

It was found that the pilot's experience on Musketeer aircraft was limited to conversion training of 1 hour 50 minutes, consisting of two periods with a different instructor on each occasion, and three subsequent local flights of less than an hour each. It is the operator's practice not to turn the fuel selector "Off" in this type of aircraft, and it was therefore doubtful if the pilot had ever been required to manipulate the fuel selector himself before undertaking the cross-country flight.

The pilot had been trained and had done most of his previous flying in Cessna 150 and 172 aircraft and was familiar with the four-position fuel selector, installed in these Cessna types (see Figure 1). The four-position selector in the Beechcraft Musketeer at first glance appears to be similar in operation to the Cessna fitting, but in fact functions in the reverse sense. It also differs in having no "Both" position, two of the four positions being "Off" positions (see Figure 2). In the Cessna, the "tail" of the selector level is placed over the tank selector position required. In the Musketeer the selector lever has a similar "tail," but the pivot point is extruded slightly in the opposite direction to form a small pointer. Tank selection is achieved by directing the small pointer to the desired position.

In this case the pilot, for an unknown reason, believed that the port side "Off" position (see Figure 2 (a) was a "Both" tanks position. Altogether, it was obvious that his knowledge of the aircraft's fuel system was totally inadequate, and there seems little doubt that this aspect of the pilot's conversion training was inadequately covered by his flying instructors.

In the second instance, a private pilot was making a local flight in an aero club's Piper Colt. Before departing, he had carried out a preflight check, but, because the Chief Flying Instructor had told him that the port fuel tank was full and the starboard tank empty, he did not physically check the fuel contents. In the Piper Colt, the port tank is the main tank and must be used for take-off and landing. The starboard tank is an auxiliary tank and may be used for level flight only.

Selecting what he believed was the port tank, the pilot started the engine, taxied out and, after completing his pre-take off checks, took off. The flight was uneventful until some 20 minutes later, when, without warning, the engine suddenly lost power. The pilot immediately applied carburettor heat, but, to use his own words, "after a few hopeful splutters it died again . . . so in exhausting all possibilities, the fuel cock was moved to the other tank, which I believed to be empty, and the engine sprang to life." The pilot still thought that carburettor icing might be causing the loss of power and switched back to what he thought was the full tank. Again the engine cut out and he jumped to the conclusion that a restriction had somehow developed in the fuel flow from the full tank. The fuel selector was again turned to the other tank and once more the engine power returned, but because he expected fuel exhaustion from this tank at any moment the pilot immediately carried out a precautionary landing in the paddock he had already chosen for a forced landing.

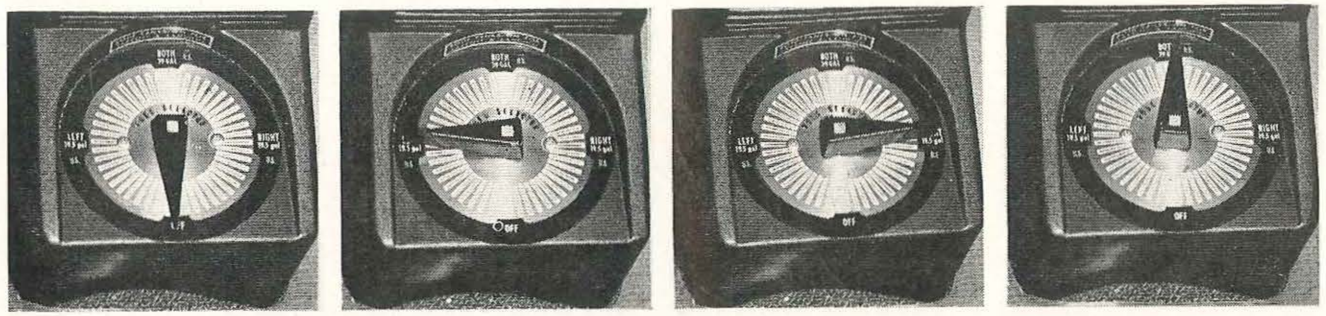


Fig. 1: Cessna fuel selector positions: (a) Fuel Off. (b) Port Tank Selected. (c) Starboard Tank Selected. (d) Both Tanks Selected.

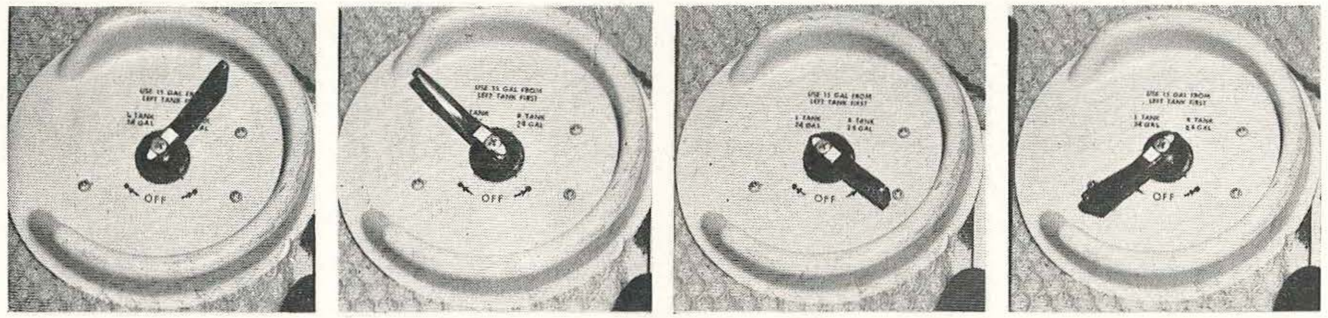


Fig. 2: Beech Musketeer Fuel Selector Positions: (a) and (b) Fuel Off. (c) Port Tank Selected. (d) Starboard Tank Selected

The pilot said afterwards that in turning on the fuel before starting, he had moved the selector to the vertical position (actually the starboard tank, see Figure 3), thinking it was the port tank. He went on to explain that the word "Right" in the placard wording didn't "register" as meaning the starboard tank. Just what it did register was not elucidated! The Club's Operations Manual for the Piper Colt lists the item "Fuel on Left Tank," in both the pre-take-off and pre-landing checks.

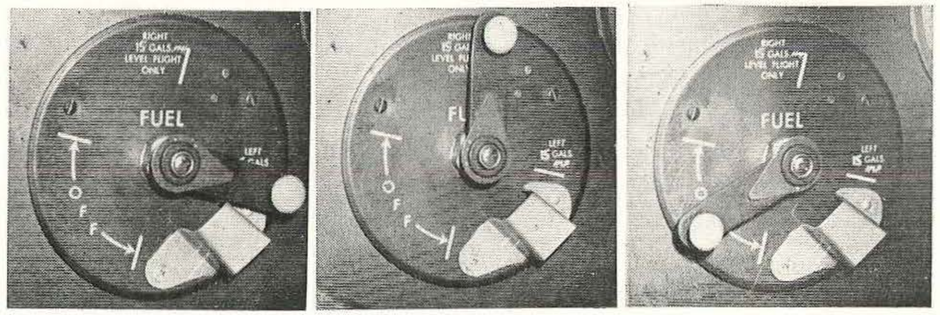
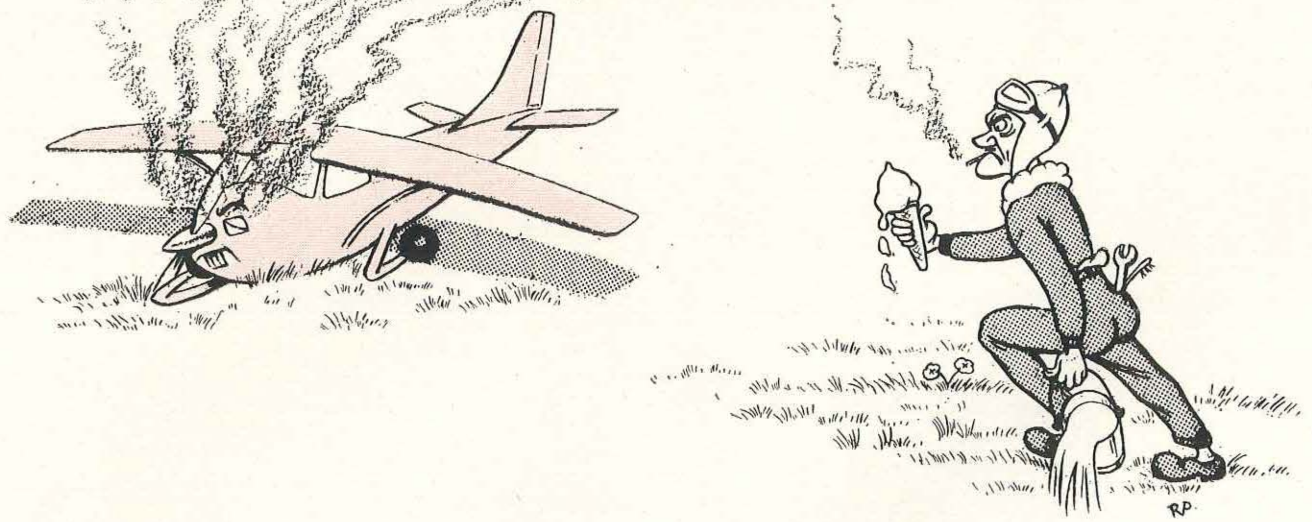


Fig. 3: Piper Colt Fuel Selector Positions: (a) Port (Main) Tank Selected. (b) Starboard (Auxiliary) Tank Selected. (c) Fuel Off.

Inquiries disclosed that although the pilot had been endorsed on the Piper Colt some 18 months before, his total experience on the type amounted to only 5 hours 20 minutes. At the time of the incident he had not flown the aircraft for nearly six months, and his last check with an instructor had taken place 10 months previously.

Both these incidents stemmed from the fact that the pilots were unfamiliar with the fuel systems of the aircraft they were flying. The lack of familiarity could certainly be attributed in the first case to lack of experience on the type and to lack of recent experience in the second, but this does not excuse the happenings. Every pilot should have a thorough understanding of the correct procedures for the aircraft he is flying — the procedures as specified in the appropriate Operations Manual or Flight Manual. Lack of experience or recent experience should only be a further incentive to study and apply these procedures with scrupulous care.

When the HEAT'S on . . .



Rough running and other engine troubles featured in a number of incident reports last summer. In warm weather, certain types of light aircraft can be troublesome to start when the engine is hot, and frequently vapour locking in the fuel system is the culprit; it has also been suspected in a few of the in-flight incidents. So with the hot days ahead again, it is worth having a look at this problem and some of its effects.

Until recently, vapour locking in fuel systems presented few operational problems for light aircraft, and there was little cause to regard it as a major factor in the design of a fuel system. Today, however, the constant demand for improved performance has led to the development of very closely cowled engines and has accentuated the difficulty of keeping engines and fuel systems properly cooled. Within the last 18 months, there have been a number of cases where engine or aircraft manufacturers have found it necessary to issue service bulletins on modifications intended to reduce the chances of vapour locks forming, and the Department has seen fit to make some of these design changes mandatory. This has made pilots more alert to the symptoms of the problem and a spate of vapour locking reports has resulted. In many of these cases, however, it was found that vapour locking could not have been the source of trouble, and it was obvious that the pilots concerned did not have a very clear idea of the causes and effects of vapour locking.

The symptoms of vapour locking in flight can actually be very similar to those associated with venturi icing in carburettor type engines but, of course, the outside air temperature, in which the latter condition is likely, is usually lower. Although this may seem an obvious statement, the surprising fact is that, in certain weather conditions, light aircraft pilots have sometimes mistaken carburettor icing effects for vapour locking in the fuel system. It should be kept in mind that while fuel injected engines are the more susceptible to vapour troubles, carburettor type engines are more likely to be affected by venturi icing.

Vapour troubles occur when bubbles of vapour form and obstruct the flow of liquid fuel to the carburettor or fuel pump, reducing the quantity of fuel available to the engine. If a combination of liquid fuel and vapour is delivered to the engine, the resulting weak fuel/air mixture may be insufficient to run the engine at full power, and in extreme cases, the mixture may become so weak that the engine fails for want of fuel. The fuel system is then said to be vapour locked. The tendency for fuels to vapourize increases with increase in temperature and decrease in air pressure but, for practical purposes with light aircraft, temperature changes are the more significant. At sea level, avgas will begin to boil at about 107°F, but as only a few bubbles form at this temperature, the effect on a fuel system is not marked. If the temperature rises to 140°F, however, vapour becomes a significant factor, and at 150°F there would be seven times as much vapour as liquid fuel in a fuel system, and the engine would not run.

Fuel vapourization sufficient to cause rough running is not very likely to develop once an aircraft is stabilized in cruising flight. At this stage, engine temperatures are usually "in the green", and cool fuel is being delivered to the engine. Pilots experiencing what appear to be vapour locking symptoms in flight should have a good look at engine temperatures before jumping to conclusions. If the oil and cylinder head temperatures are not abnormally high, vapour locking is unlikely to be the cause. It is during ground handling in hot weather, especially while standing or taxiing with the engine idling or while attempting to start with the engine hot, that vapour locking is more likely. In the case of engines with auxilliary pumps, vapour bubbles formed during ground running can sometimes cause trouble after take-off, and pilots should always ensure, during run-up, that such engines will operate satisfactorily with the auxiliary pump switch in both the "On" and "Off" positions.

Fuel injection engines are more susceptible to vapor locking troubles because their labyrinth of small diameter fuel line plumbing in close proximity to the engine can quickly become overheated whenever there is insufficient cooling in the engine bay. Taxiing at slightly higher than normal R.P.M. helps through the twofold effect of increasing the airflow around the engine while at the same time increasing the flow of cooler fuel from the tank. Confining taxiing distances to a minimum, especially downwind, and not allowing the engine to idle for long periods, will also help to prevent vapour locking. Other worthwhile precautions in hot weather are parking aircraft in shade between flights, opening engine cowlings to reduce the engine bay temperatures, and keeping drum fuel stocks out of the sun. Above all, stick to avgas—don't be tempted to "top-up" with motor spirit for the sake of expediency. Although we have laboured this point before, as well as on page 28 of this issue, we repeat that motor spirit can be a potential source of trouble for light aircraft. Because its vapour pressure is between two and seven pounds per square inch higher than avgas, motor spirit boils at a considerably lower temperature.

Difficulties in starting a fuel-injection engine when hot can often be overcome by using the booster pump to clear the fuel distribution lines of vapour and to draw fresh, cool fuel from the tank. One way in which this can be done is as follows:—

After setting the engine controls for starting, with the mixture control in full rich, select the booster pump "on," using "high" position where dual selection is available. If vapour is present in the lines, the fuel pressure gauge needle will flicker; it will steady when the vapour has been blown out and liquid fuel is flowing in the lines, and care should be taken to avoid over-priming. At this point turn off the booster pump, quickly select the mixture to idle cut-off, and press the starter. As soon as the engine fires, return the mixture control to full rich in the normal way. Starting difficulties caused by vapour locking are possible whenever cylinder head temperatures are above 150 deg. F., especially on a hot day, and under these conditions judicious use of the booster pump may well save a great deal of time and trouble.

Pilots should make a study of the layout and operation of the fuel system of their aircraft, taking particular note of features designed to prevent vapour locking, such as cooling blast tubes for fuel lines, filters and pumps, fuel line lagging, and submerged auxiliary pumps. This knowledge, intelligently applied to the ground handing procedures already recommended, should help pilots to keep vapour locking troubles to a minimum.

SUSPECTED ENGINE FIRE

After taking off from Moorabbin airport, Victoria, the pilot of a Victa reported that his engine was on fire. The Distress Phase was declared and the aircraft was cleared for an immediate landing but an inspection made as soon as the engine had been shut-down, could find no sign of fire. However, because the aircraft had just been released from a 100 hourly inspection, it was suspected that a small amount of cleaning fluid had been left trapped between the exhaust muffler and the heater muff. It was probable that exhaust heat caused the fluid to vapourise and produce smoke which the pilot saw coming from the cockpit heater ducts above and below the instrument panel.

Blowing out the exhaust muffler and heater muff systems with compressed air after cleaning the engine helps to avoid "frights" of this sort. It is also a good idea to run the engine on the ground for a few minutes with either carburettor heat or cabin heat selected on. The cockpit should be adequately ventilated when using cabin heat to clear any fumes produced. A few minutes at normal warm-up RPM is sufficient and ensures that any remaining dregs of cleaning fluid are dissipated before the aircraft is flown.

STEEP TURN, LOW ALTITUDE, INATTENTION

The Deadly Combination claims Another Victim

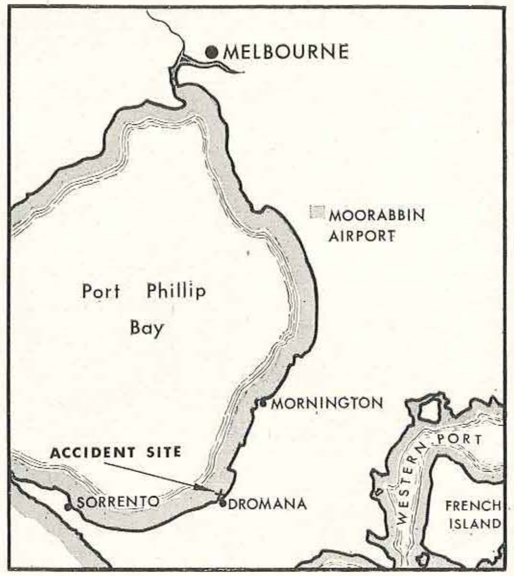
Early in the afternoon on 19th December, 1964, a Cessna 175 flying a shark patrol dived into the sea while the pilot was circling at low altitude off Dromana, Victoria. One of the four occupants died later from injuries received in the crash, the pilot was seriously injured and the other two passengers escaped with minor injuries.

The aircraft was owned by a charter company based at Moorabbin Airport, Victoria, and at the time of the accident was patrolling the eastern shore of Port Phillip Bay under charter to a Melbourne commercial broadcasting station. A friend of the pilot was sitting in the front right-hand seat, and two employees of the broadcasting station, acting as observers, were in the rear seats. The aircraft had left Moorabbin Airport at 1430 hours and had begun the patrol shortly afterwards, working southwards around the Bay towards Sorrento. Twenty-five minutes later, the aircraft was off Dromana, and from an altitude of about 600 feet the crew sighted a large shark lying in the shallows near the beach where people were swimming. The pilot lowered 20 degrees of flap and rolled into a descending steep turn to port to circle over the shark and keep it in view. The aircraft descended to below 500 feet during several progressively tightening 360 degree turns, and the angle of bank gradually increased to between 60 and 70 degrees. The nose of the aircraft was then seen to drop, and it plunged into a steeply banked spiral dive towards the water.

The pilot attempted to prevent the aircraft building up speed by closing the throttle, then applied full opposite aileron and some rudder. He managed to level the wings by the time the aircraft was down to 100 feet, but as he tried to pull out of the dive the aircraft seemed to "mush" and it hit the water violently in a slightly nose-down attitude. The aircraft sank immediately in some 10 feet of water, 400 yards off shore, but a motor boat less than 100 yards away when the aircraft crashed, was on the scene almost immediately and its crew quickly rescued the occupants from the water. Three were admitted to hospital, but the fourth did not need medical attention. The aircraft was badly damaged by the impact with the water and sustained more damage while it was being salvaged.

Salvaging the aircraft from the Bay in fact presented a good deal of difficulty. The wreckage defied the efforts of two police launches to tow it ashore, and an attempt to winch it on to the beach using a heavy military vehicle was similarly fruitless. Finally, late in the evening, the aid of a fishing vessel was enlisted to tow the aircraft, still partly submerged, nine miles to Mornington. Early next morning a wharf-mounted derrick hoisted the aircraft on to the Mornington wharf, where, after being examined, it was dismantled and transported by road back to Moorabbin Airport.

The damage to the aircraft showed that it had struck the water at a moderate to high speed while in a slightly nose down attitude with the wings almost horizontal and with some degree of skid to starboard. The virtually undamaged propeller was consistent with the pilot's evidence that he had closed the throttle before impact. A thorough examination of the aircraft indicated that it was fully serviceable at the time of the crash.



Although not a contributing factor in the accident, it was established that the aircraft had been slightly overloaded when it took off. The pilot had mentally estimated the pre-take-off weight and believed it to be within limits, but the investigation showed the combined weight of the occupants differed from that used in his mental calculation. It also showed that some items of fixed equipment which had been added to the aircraft were not included in the empty weight used by the pilot. Fuel consumption would, however, have reduced the all-up weight to within prescribed limits by the time the accident occurred.

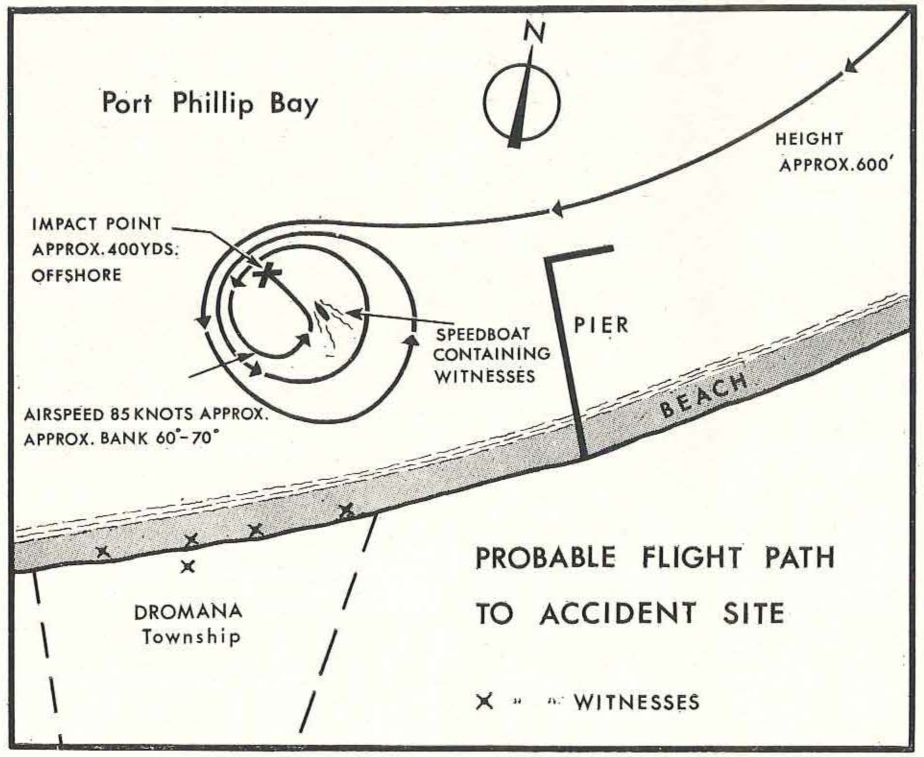
From witness statements it was established beyond all doubt that the aircraft had been in a steep turn before it dived towards the sea. From the pilot's statement, and as a result of other investigations, it was clear that the dive was unintentional. The pilot, who held a Commercial Pilot Licence endorsed for a number of aircraft types, including the Cessna 175, said later that he believed the spiral dive developed when the aircraft flew back into its own slipstream. He did not believe the aircraft had stalled. Neither the pilot, nor one of the passengers who was a reliable witness, could recall hearing the stall warning about the time the aircraft fell out of the steep turn. The passenger thought he might have heard it just before the aircraft struck the water. In a later discussion, the pilot said that during his attempt to pull the aircraft out of the dive, he was apprehensive of a high-speed stall and had eased off some "back stick" to prevent this happening. The pilot estimated that the angle of bank in the turn immediately before the spiral dive was between 60 and 70 degrees, and two witnesses on the ground also described it as very steep. If, as the pilot suggested, an encounter with the slip-stream had increased the angle of bank still further, control of the aircraft could certainly have become difficult, but not to the extent of making a steep spiral dive inevitable.

Weather conditions in the area at the time of the accident were excellent with a light wind from the SSW. Turbulence would not have been significant over the sea 400 yeards off shore, and in no way would have accounted for the aircraft's loss of altitude. Persistence of the aircraft's slip stream long enough for it to have entered its own slip stream was thought very unlikely. There was no indication that the weather conditions had in any way contributed to the accident.

Despite the views expressed by the pilot, consideration was given to the possibility that the aircraft could, in fact, have stalled. The air speed during the turns, according to the pilot, was about 85 knots, but in turns as steep as these evidently were, the stalling speed could have risen to around 77 knots. As well, some of the witnesses on the ground had commented on the aircraft's slow speed during the turns. Extensive questioning of the pilot and other witnesses nevertheless failed to shed any more light on what had actually caused the aircraft to fall out of the steep turn.

Whatever the cause of the dive, there was no doubt that the pilot had lost control of the aircraft during a steep turn. He had been circling very tightly at low altitude to watch a shark in the water directly below. Control of the aircraft in this situation would demand a precision requiring the undivided attention of the pilot if the safety of the aircraft was not to be compromised. In this case, it is evident that the pilot failed to give the required degree of concentration to flying the aircraft. Rather, it is very probable that he was giving most of his attention to the shark, the task for which he was carrying his two observers.

The combination of inattentive flying, low altitude and high rates of turn, with consequent steep angles of bank and increased stall-



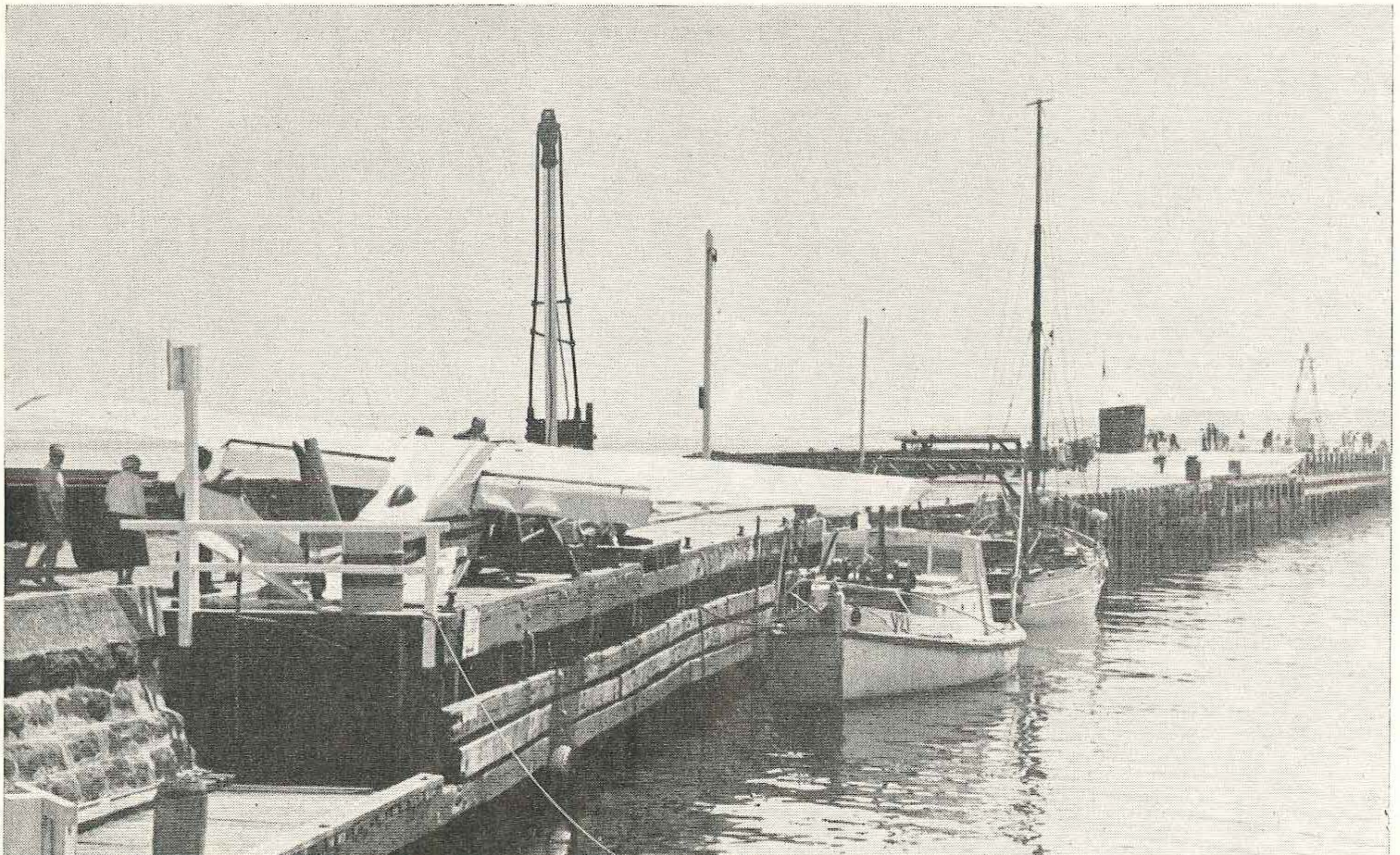
ing speeds, has been responsible for countless aircraft accidents, and again on this occasion, set the stage for a disaster. The aircraft circled lower, the angle of bank steepened, the pilot became more engrossed in watching the shark, and the accident happened. Loss of control in such circumstances could hardly be expected to produce results very different than those that followed; the slender margin of height available to the aircraft was simply insufficient for the pilot to assess what had happened, initiate recovery action and regain control, and so the aircraft struck the water. There is little doubt that the accident occurred because the pilot's attention was diverted while he was flying too low to recover from the unsafe attitude that thus developed.

Although it could not be clearly substantiated, there was some suggestion during the investigation, that even at the stage of having lost control and entered the dive at low altitude, the pilot might have had a chance of avoiding the accident if he had used the correct recovery technique. Certainly, the pilot's application of aerodynamic principles appears to have been lacking, for in closing the throttle he reduced both the amount of "back stick" the aircraft could withstand aerodynamically and its response. The aircraft was apparently on the verge of recovery from the dive when it struck the water, and it is possible that engine power could have made all the difference. Space does not permit a full discussion of control response and recovery techniques in this report, but the subject is such an important one that it is proposed to devote a separate article to it in a future issue of the Digest.

There is one other important lesson to be drawn from this accident which, though it has been spelt out many times before and may seem obvious, nevertheless bears repeating. The pilot stated that the aircraft was at a height of 450 feet just before he lost control. Some witnesses suggest he might have been even lower, but this was not established with any degree of certainty, and in any case is irrelevant to the lesson. The important point is that he was below the statutory minimum height of 500 feet, which provides little enough margin for error, particularly the sort of errors made in this accident.

Whenever aircraft are used in operations of this type, pilots seem to display an impulse to go down lower to get a better view. Experience has shown, however, that because the field of view is wider at altitude and the illusion of speed is diminished, a better view is often obtained by staying at a reasonable height. This applies particularly to underwater objects, because the ability to see into water usually improves with height. In the case of this accident it might be argued that it was necessary to descend below 500 feet to warn the swimmers of the shark, but this surely begs the question, for some other method of warning could no doubt be developed quite simply. This and other accident statistics show quite definitely that low-level spotting operations can be fraught with danger if a safe height is not maintained. WHY THEN STICK YOUR NECK OUT TO DOUBTFUL ADVANTAGE BY FLYING LOWER?

The wreckage on the wharf at Mornington after being recovered from the water.



Are You a SCUBA Diver?

Just over four years ago, in Digest No. 28, December, 1961, we re-printed an article from the United States Flight Safety Foundation entitled "Scuba Fans!", which warned pilots against the hazards of flying soon after having engaged in skin diving to depths as little as 20 to 30 feet. The original article stimulated a great deal of discussion in the United States and has since resulted in a good deal more attention being given to the dangers which can arise when a man is subjected to reduced atmospheric pressure within hours of having been diving to any depth in excess of 15 feet.

One example of what can happen, occurred to an experienced SCUBA exponent who had been diving for some two hours in depths up to 50 feet. During one dive he felt a little discomfort in his chest but this seemed to clear up when he surfaced again and he ignored it. After he had left the water, however, the feeling returned and became more intense. Five hours later the man was experiencing mild chest pains when he breathed deeply and discomfort in swallowing, so he consulted a doctor. It was then found that he had pockets of air under the tissues of the neck and in the sac around the heart, trachea and oesophagus and that if he had undertaken a flight with a cabin altitude of even a few thousand feet, the resulting expansion of the air trapped in his neck and chest would have had fatal consequences.

By far the most common malady arising from deep diving is de-compression sickness or "the bends," which is caused by the formation of nitrogen bubbles in the blood stream and body tissues when de-compression takes place too rapidly.

Gases will dissolve in fluids in direct proportion to their pressure. Similarly, when pressure is reduced, gases come out of solution in the form of bubbles. A simple example of this is seen when a bottle of soda water is opened. While the cork remains in place, the carbon dioxide stays dissolved and the soda water is clear, but as soon as the cork is withdrawn and the pressure inside the bottle is released, bubbles form and the soda water effervesces.

At sea level a man breathes air at slightly less than 15 pounds per square inch. Air consists of approximately 80 percent nitrogen and 20 percent oxygen; the oxygen content is of course used up by the body tissues and the carbon dioxide formed in the process is exhaled during respiration. However, the nitrogen absorbed into the body remains unchanged and is merely dissolved in the blood stream and body tissues at atmospheric pressure. The higher the pressure of the air breathed, the greater the quantity of nitrogen that can be absorbed by the body. At a depth of 120 feet, where a diver breathes air at 75 lb. per square inch, his body would be potentially capable of taking up to five times as much nitrogen as at sea level.

Unlike oxygen and carbon dioxide, which go in and out of solution readily and are able to be transferred rapidly to and from the blood stream through the lungs, nitrogen can only be transferred slowly. Consequently, it may effervesce anywhere in the body when pressure is suddenly reduced. This is what happens when a diver ascends too rapidly. The decreasing pressure allows his blood and tissues to become super-saturated with the excess nitrogen absorbed at the higher pressures and bubbles are released. Bubbles forming in this way in the joints and abdominal organs will cause severe pain; those forming in the heart or brain can cause death in extreme cases.

Obviously, the effects of decompression sickness will be compounded if a period of SCUBA diving is quickly followed by a flight at high altitude. Indeed, decompression sickness can be experienced from the effect of very high cabin altitude alone, but after SCUBA diving it can occur at cabin altitudes as low as 8000 or 10,000 feet. In an incident in the United States, the crew of a pressurised aircraft developed severe decompression sickness with nearly fatal consequences during a flight which followed a day of SCUBA diving to depths of only 20 and 30 feet. In this case the cabin altitude was only 8000 feet. As a result of this incident, the Aviation Medicine Group of the FAA has recommended that flights should not be undertaken either as a crew member or a passenger for at least 24 hours after SCUBA diving. The United States Flight Safety Foundation has recommended that aircrew who indulge in this pastime should make it a rule not to dive to depths greater than 50 feet at any time.

Persons who have experienced any symptoms of decompression sickness should not fly until a medical examination has shown that the separated gas has been completely re-absorbed. The re-absorption process may take several days and an X-Ray may be required to confirm that it is complete. Aircrew who find themselves affected by decompression sickness in flight are advised to descend immediately to the lowest safe altitude and to land as soon as possible. Affected areas of the body should not be moved or massaged as this could break up the nitrogen bubbles and force them into a more vital organ. Oxygen is of no assistance in either preventing or treating decompression sickness. The only immediately effective treatment is in fact re-compression of the body to force the effervescent bubbles of nitrogen back into solution. But by far the best course of action for aircrew is to carefully avoid placing themselves in a situation where they could fall victim to decompression sickness.

UNDERSHOOT

Approaching to land at Melbourne Airport in gusty conditions after a flight from Darwin, a Comet undershot the runway and touched down on a soft, grassed area 50 feet short of the threshold. Wheel ruts four inches deep were gouged out of the grass surface and clods of earth were thrown on to the runway, but the aircraft suffered no damage.

The captain said later that the first officer was making the landing from the right-hand seat, under his supervision. The wind was gusting between 25 and 40 knots and the approach was made at a speed 10 to 20 knots higher than the nominated approach speed to allow for the effect of gusts. Immediately after crossing the fence at 130 knots indicated, the aircraft encountered a down-draught and sank rapidly. The first officer checked the descent, but the aircraft touched down, skipped, then settled firmly on the runway. **The captain did not know until later that the initial touch-down had been made short of the runway.**

Following this incident, the operator issued a circular to all crews reminding them of the need to guard against undershoots. The circular pointed out that the incident had probably been caused by the crew focusing their attention on the beginning of the runway, thereby placing the aircraft in a potentially dangerous situation during the final stages of the approach. Had the crew focused on the recommended touch-down point on the runway, the sudden loss of height from the down-draught would have placed the aircraft on the runway instead of the grass. The operator's circular also contained a reminder that pilots of large jet aircraft sit a long way ahead of the main landing wheels and that allowance has to be made for this in selecting the aiming point on the runway.

Undershoots in large aircraft are a frequent source of incidents and have been responsible for a number of accidents. It is therefore worth examining, in a little more detail, some of the factors that contribute to this tendency.

Incorrect Aiming Point

As this particular incident demonstrates, an undershoot can occur when a pilot selects the threshold itself as the aiming point for his approach. Because the wheels of a heavy aircraft in the approach attitude may be as much as 25 feet below the pilot's eye level, they follow a path during the approach which is parallel to, but considerably lower than, the pilot's line of vision down to the aiming point. In such case, a pilot making a standard approach at an angle of 2½ degrees to the runway would need to select an aiming point as much as 600 feet down the runway to make sure that the approach path actually being followed by the main wheels did not intersect the ground short of the runway.

Also to be considered is the fact that the flare in a large aircraft is usually made when the main wheels are about 50 feet above the ground. In a standard 2½ degree approach aimed at the threshold, this would involve commencing the flare while the aircraft is still about 1700 feet short of the runway. The risks arising from misjudgment of the flare height or from an unexpected sink late in such an approach need no emphasis.

Excessive Air Speed

Sometimes an approach to land is made initially at a speed above that required for a normal approach. The pilot has then to dissipate the excess speed during the final approach phase by gradually raising the nose of the aircraft. As he does so, however, the apparent position of the threshold is lowered and for the pilot the impression can be one of gaining height. A premature touch-down can easily follow. This illusion is accentuated in modern swept-wing aircraft, which normally approach in a pronounced nose-up attitude.

Approach Speed Below Normal

An aircraft's normal approach speed is designed to provide an adequate margin above the stall. Where this safety margin is infringed by approaching at a lower speed, the chances of the aircraft "mushing" or stalling prematurely are greatly increased. The main causes contributing to this hazard are the rise in stalling speed which occurs with the increase in load factor or "g" during the flare, and loss of airspeed as a result of wind gradient. It should also be remembered that the correct approach speed of a heavy aircraft is derived from its stalling speed, which, in turn, is a function of its landing weight. Hence, underestimating the weight of an aircraft at the time of landing will result in a low approach speed.

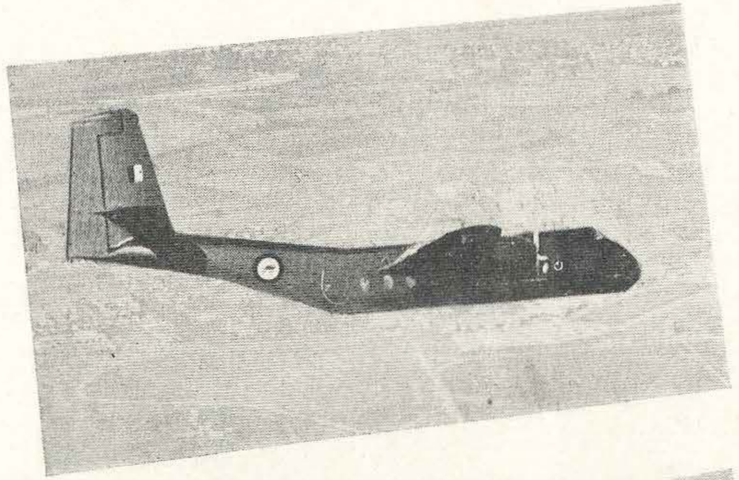
What has been said so far applies generally to visual approaches, but when the landing phase is complicated by a rapid transition from instrument to visual flight during an instrument approach, errors are much more easily made. An aircraft making an I.L.S. approach is stabilised on a flight path defined by the electronic glide slope which intersects the runway approximately 1000 feet beyond the threshold. But at the moment of breaking through to visual flight, a change both in flight reference and configuration has to be accomplished by the pilot in a short space of time. This naturally tends to unsettle the flight conditions which he has previously established by reference to instruments; after re-adjusting himself to the visual cues he now has available, the pilot has to apply landing flap and reduce the airspeed by some 20 knots before crossing the threshold. It is at this stage that the aircraft is frequently allowed to descend below the approach path provided by the electronic glide slope. Although the change in the configuration of the aircraft contributes to this tendency, the prime cause is believed to be switching from the I.L.S. "aiming point" approximately 1000 feet along the runway to a visual aiming point at the threshold itself. To eliminate the possibility of such an undershoot, a pilot becoming visual on an I.L.S. approach must select a visual aiming point which is also 1000 feet along the runway.

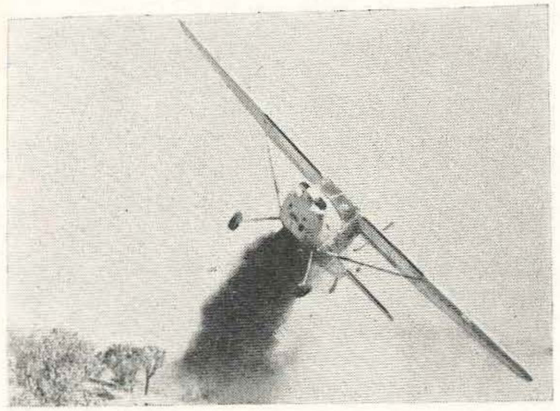
Primarily, it is up to pilots to school themselves in this technique, but because this could involve a break with long-established habits, it has been recognized that some form of external assistance is required. The Department has already taken steps to this end. Distinctive runway markings have been placed 1000 feet from runway thresholds so that pilots can concentrate on keeping this marking, instead of the threshold, at a constant angle below the horizon during their approach. Markings have also been provided at distances of 500 and 1500 feet from the threshold, so that, as well as an aiming point, the pilot is offered a positive indication of distance along the runway. This system is fully illustrated in A.I.P./AGA-3-6, and in the Light Aircraft Handbook, GEN-3-22. Overall, the markings have the effect of diminishing the prominence of the threshold, thereby assisting the pilot to avoid focusing his attention on it during an approach to land.

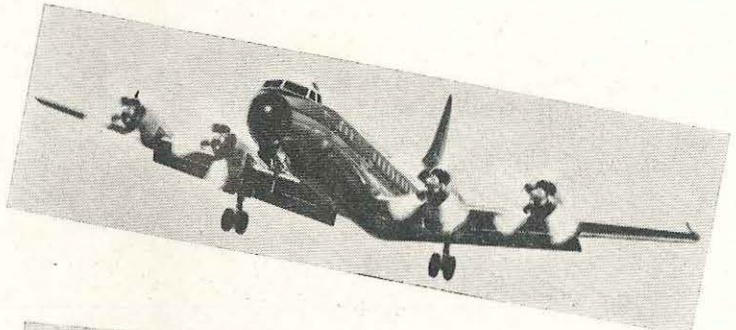
Probably the biggest step forward in the elimination of the undershoot problem has been the development of Visual Approach Slope Indicator Systems (VASIS). At present three types of VASIS are being used in Australia, the Precision Visual Glidepath (P.V.G.), the "Red-White" VASIS, and an Australian-designed VASIS known as the T.V.A. System. Operating instructions for these systems are detailed in D.C.A. Publications Nos. 37, 43 and 44, which are available on application to the Department. Visual Approach Slope Indicator Systems are at present being installed at a number of airports, initially on runways not served by electronic glide slopes and on those which have too few, or perhaps misleading visual cues, for approach judgment—e.g., approaches over sloping terrain or over water.

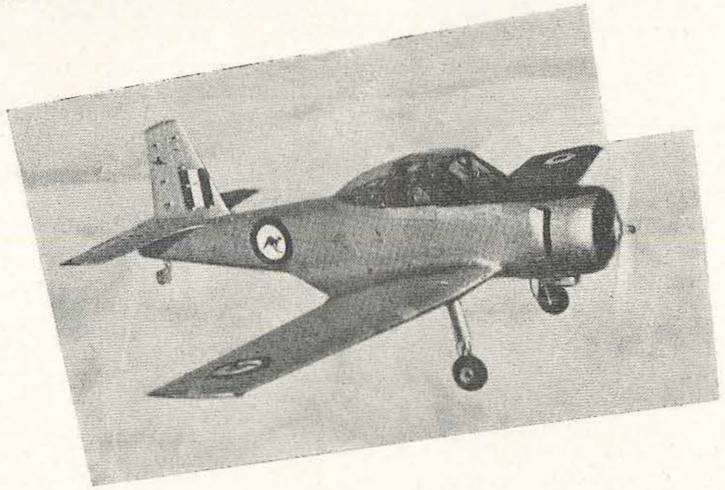
Wherever a Visual Approach Slope Indicator is installed, pilots should make use of it at every opportunity, not only for the assistance it offers during that particular approach, but also for the experience it affords in flying the correct approach path. In this way, selection of the proper aiming point should eventually become a matter of habit in all visual approaches. When this happens, then perhaps we can expect a significant reduction in the number of landing accidents which can be labelled - - - "UNDERSHOOT."

Service or Civil . . .









the lessons are the same

Recently we were privileged to read a copy of the Royal Australian Air Force's publication "Crash Critique", containing three reports of recent accidents to service aircraft. The reports in "Crash Critique" follow the same general pattern as our own accident investigation reports, consisting essentially of a description of the accident, an analysis of the evidence, and a commentary on the circumstances of the accident.

From the Department's point of view, the most striking feature of this latest issue of "Crash Critique", is the extent to which the comment sections could be applied to equivalent situations in civil flying. Although "Crash Critique" is understandably a restricted document, we believe the value of these comments merits their being given a much wider circulation. We have therefore obtained R.A.A.F. approval to reprint the three commentaries in isolation from any detailed analyses of the accidents to which they refer.

ACCIDENT:

A Caribou, operating in S.T.O.L. configuration, made a heavy landing short of the runway threshold on a 6000-foot runway.

COMMENT:

Flying to the limits in any aircraft, when there is no sound reason to do so, is almost always attempted without due pre-planning and consideration of all factors, and almost invariably places the aircraft in a dangerous situation. Then only the skill of the pilot can save it and in these circumstances, this skill is often lacking — as it was in this case. The urge to "show off" a pilot's or an aircraft's capabilities unnecessarily must be resisted by all pilots, and Squadron supervisors must ensure that this tendency is firmly discouraged.

ACCIDENT:

Two training aircraft, on solo exercises, collided while on final approach. The accident was primarily attributed to inadequate look-out by both pilots and contributory causes were listed as being breach of flying orders and an error by air traffic control.

COMMENT:

As aviators, our formative years represent the period of greatest danger. It is impossible to over-estimate the importance during training of rigidly enforcing every flying order or regulation, and every standard procedure both by example and strong discipline. Equally important in safely guiding fledglings through these dangerous times is the need for the closest attention to every detail by all personnel responsible for the control or supervision of their activities.

ACCIDENT:

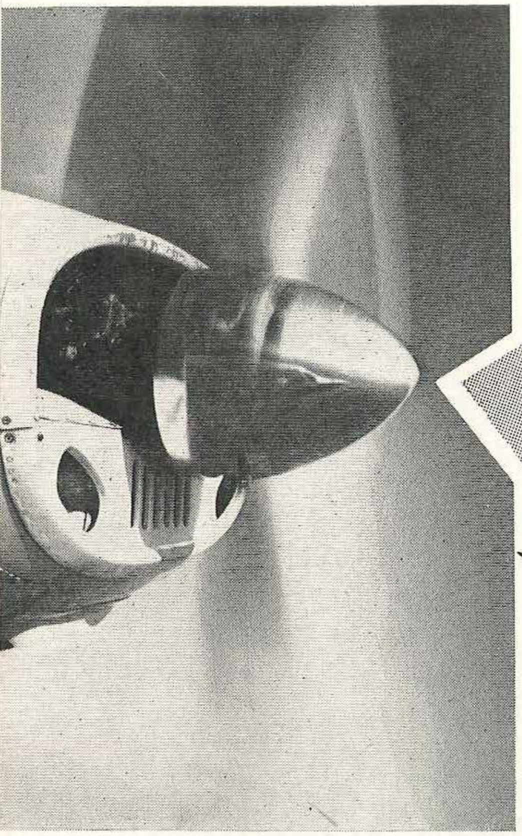
A light aircraft crashed during a flying display and following an unauthorized manoeuvre commenced at a height below the minimum approved for the operation.

COMMENT:

Why is it that an adult, experienced and apparently level-headed pilot suddenly throws caution, common sense and the rule book out of the window? The immature student pilot, who doesn't yet appreciate the dangers inherent in this sort of behaviour will occasionally behave this way. It is not to be tolerated and still less is to be tolerated from an operational pilot who presumably knows better. This accident demonstrates very well that a whim of the moment departure from a pre-briefed and practised routine, more often than not ends in disaster.

It should be obvious that these commentaries do not need the support of their particular accident reports to establish their validity. Each is, in fact, a comment that could be appropriately appended to a significant number of our own aircraft accident reports.

It would be time well spent if pilots and instructors studied them carefully and took their advice to heart.



Spare a Thought for the Spinner

Several minutes after reporting over Wardang Island, South Australia, the starboard engine of a light twin began to run roughly with slight fluctuations in R.P.M. All other instrument indications were normal. A minute or so later, a loud bang and a shower of sparks came from the vicinity of the engine. The engine was immediately feathered and Adelaide Control advised.

After landing at Adelaide, a visual inspection showed that the leading section of the starboard propeller spinner had broken off, damaging the starboard side of the aircraft's nose. The rear section of the broken spinner was still attached to the propeller hub.

In recent months there has been an increasing trend in instances of light aircraft losing their propeller spinners in flight, and in some cases serious damage has been caused to propeller blades, engine cowlings, fuselages and wing skins. Instances of rough running in engines, caused by an out of balance condition arising from an incorrectly installed spinner, have also become far too common. Before describing some of the known causes of these troubles, let us look at the spinner itself, its origin, how it is made, and why it is installed.

Spinners were originally fitted to the earlier small aircraft engines of about 1930 vintage for exactly the same purpose as the hub cap on your motor car; they provided a trim finish to an untidy assembly of nuts and bolts. This type of spinner was spun out of soft aluminium sheet and if it became dented, a few taps with the hammer soon restored it to something like its original shape. It was so small that a large degree of eccentricity could be tolerated because its weight and shape had no operational effect on the comparatively slow running engines of the day.

The spinners used on today's aircraft are a totally different proposition. They are still spun or drawn from sheet alloy, but because they are considerably larger, closer attention must be given to dimensional tolerances. The material from which they are made is also different. It is heat treated, and is therefore less ductile than the soft aluminium used in earlier products.

Present day engines are more closely cowled than those of former years, and the control of the air flow into the forward facing apertures is a matter of some importance. Where earlier spinners were used purely for decorative purposes, the modern spinner needs to combine this purpose with the function of providing an acceptable air flow into and around the nose cowl. Because it is used as a fairing over a bulky propeller hub and pitch control mechanism, the modern spinner has grown in both diameter and length to about four times that of its early counterpart. Add to this the higher R.P.M. at which the majority of the modern propellers turn, and you can readily appreciate from considerations of weight, contour, concentricity and secure attachment, that the spinner is not to be treated carelessly.

CAUSES OF FAILURE

In all piston engines there is some vibration, which is normally damped out to a large degree by flexible mountings between the engine and the airframe. There is no such provision between the spinner and the engine and any effects of an out-of balance condition, eccentric mounting or loose attachment are therefore transmitted directly into the engine. In severe cases, the effects of one or other of these conditions may cause the engine to vibrate to the limits of its flexible mountings and produce apparent rough running, with consequent accelerated wear on all rotating components within the engine. The vibration reacts back on the spinner and causes excessive loads on the spinner attachments and backplate. This is soon shown up by the cracking of the spinner around its attaching screws, cracking originating from the cut-out around the blade shanks, failure of attaching screws or failure of the back plate. Since these defects usually occur at the point of highest loading, it naturally follows that the movement permitted by the defect amplifies the original eccentricity and results in an increasing rate of failure.

Causes of spinner failure can frequently be traced back to—

- Pushing the aircraft around on the ground, using the spinner as a point of application of force.
- Eccentric mounting. When a spinner has been removed and replaced, check it for concentricity by observation during the first engine warm up.
- Operation with an unrepaired crack. Stop-drilling is not a long-term fix for cracks in spinners.
- Loose attachment. If provision is made for lock wiring the spinner attaching screws, make sure that it is in good condition. Any other form of locking device should receive the same attention.

Because of the rapidity with which defects can develop in spinners following an initiating cause, it is particularly important that spinners be carefully examined at each daily inspection and that any indication of trouble be fully investigated and rectified before flight.

Conscientious attention to this requirement, by maintenance engineers and authorized pilots generally, should effect a marked decline in the present rate of propeller spinner failure.

Over-tightening Causes Loss of Oil

After landing at a station property in New South Wales, at the end of a flight from Nyngan, the pilot of a Lockheed 60 noticed a stream of oil pouring from the engine cowling. There was a large pool of oil on the ground where the aircraft was standing, and a trail of oil led back along the taxiway towards the strip. The pilot opened the engine cowling to check the oil level and saw that the oil was coming from the disposable-type oil filter mounted on the fire wall. The dip-stick showed that the sump was empty.

An aircraft maintenance engineer inspected the aircraft the next day and found that excessive force had been exerted on the pressed steel nut spot-welded to the base of the oil filter body. This had fractured the welds and had also strained the top of the filter, allowing the element inside to be thrown about by engine vibration. The movement of the element inside the oil filter body finally failed the welds completely, letting the oil escape rapidly. The engine was removed from the aircraft for examination and was later found to have sustained severe damage as a result of oil starvation. The aircraft had flown approximately 100 hours since the filter was installed.

Departmental maintenance requirements clearly make it the responsibility of the L.A.M.E. performing or certifying maintenance to acquaint himself with the details of the aircraft and equipment on which he is working. Disposable oil filters of this type are used widely both in motor vehicles and light aircraft engines and their manufacturers specifically warn against over-tightening the nuts during installation. The failure undoubtedly arose from insufficient care on the part of the engineer or organization responsible for installing the filter.

From the INCIDENT FILES

Propeller Causes Battery Cart Fire

When difficulty was experienced in starting a Dove at Derby, W.A., a battery cart normally used for starting F.27's was obtained and connected to the external power socket on the starboard side of the aircraft's nose.

The starboard engine was still reluctant to start so the port engine was started first and set to 1200 RPM. After another attempt the starboard engine fired and was set to the same RPM. Unnoticed by the captain, whose attention was engaged in checking the engine instruments in the cockpit, the aircraft then began to creep forward. Efforts by the ground crew to move the battery cart out of the way in time proved futile and the blades of the starboard propeller struck the rear of the battery cart. Feeling the impact, the captain immediately cut all switches but not in time to prevent the propeller slashing through the electrical lead and shattering a bottle of avtur fuel drainings which had been left on the battery cart. The severed battery lead arced and ignited the fuel, touching off a fire on the battery cart. The ground crew quickly towed the cart clear where they extinguished the flames with a portable extinguisher and damage to the aircraft was confined to the propeller blade tips.

The aircraft had not been flown for some days and although the brakes were set to parking, the brake air pressure was only 70 lb. pounds per square inch. In such circumstances, the use of wheel chocks would have been advisable and would have prevented the occurrence.

SEAT BELT TROUBLES AGAIN

CESSNA 172

After taking off on a solo flight from Mildura, Victoria, the pilot of a 172 heard a loud knocking sound coming from the rear of his aircraft. Alarmed, he called "PAN PAN PAN, returning Mildura", completed the circuit and landed. After taxiing in, he found 4 in. of seat belt with the buckle attached projecting from the closed starboard side door. During flight the buckle had been banging against the side of the fuselage in the slip stream. The pilot later admitted that he had not made a seat belt check before taking off.

DC-3

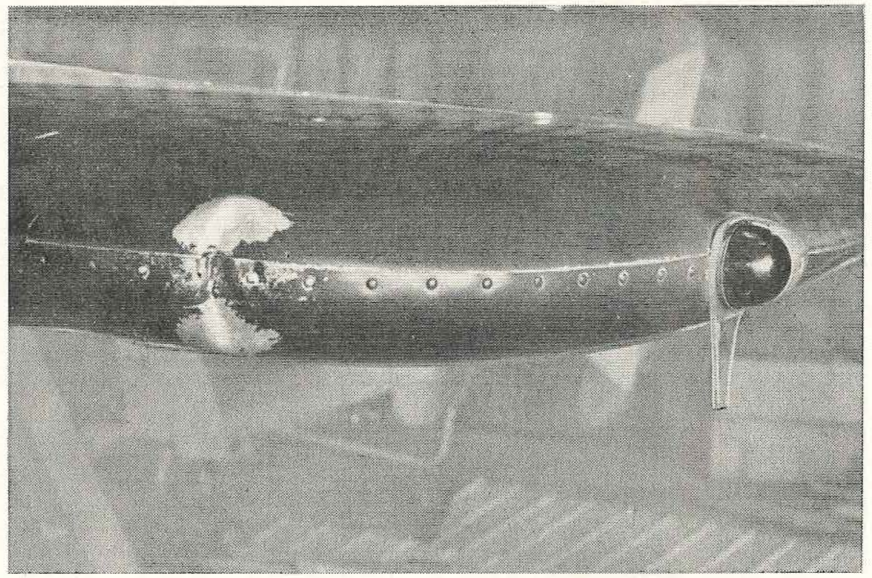
Before boarding his aircraft for a charter flight from Launceston Airport, Tasmania, the captain of the DC-3 noticed that the door of the forward freight compartment was open and that the safety belt attached to the third crew member's seat was hanging from it. When he entered the cockpit soon afterwards, however, he found that the door had been closed and the seat belt appeared to have been folded on the floor just inside and against the door.

The engines were started and the aircraft taxied out to the holding point but during run-up an impact was felt on the port propeller. The engine was shut down immediately and on opening the freight door the seat belt was found to be still protruding and severed. The aircraft was taxied back to the tarmac for further inspection; it was then found that the A.D.F. antenna system had been damaged. Pieces of the belt and buckle were later found on the runway.

COMMENT:

Flapping seat belts have been responsible for a number of incidents of this sort, but this is the first time that we have had to report one in a heavy aircraft. The two incidents again emphasize that loose belts on unoccupied seats can create a hazard if they are not safely stowed.

Hidden Damage in Rear Spar



Damage to port wing tip caused by collision with hangar post.

While making a daily inspection at Esperance, W.A., the pilot of a Cessna 172 noticed some distortion on the port wing trailing edge close to the fuselage. The pilot, a member of the aero club which was operating the aircraft, had flown 5 hours 40 minutes since picking up the aircraft from Bunbury the previous day.

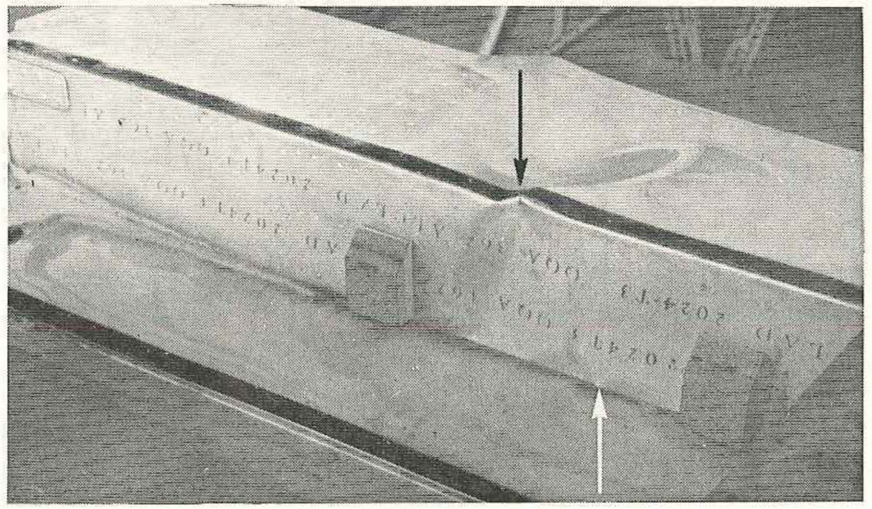
Arrangements were made for a licensed aircraft maintenance engineer to inspect the aircraft before it was flown again and he found that the rear spar and adjacent structure had been severely damaged 24 inches outboard from the fuselage attachment point. Further enquiries established that, while another pilot had the aircraft several days previously, the port wing had struck a post when the aircraft was being taxied to its hangar. The collision had dented the port wing tip. The pilot concerned, whose total aeronautical experience was 85 hours, had reported the incident to the president of the aero club and to the manager of the company that owned the aircraft. Both officers had inspected the aircraft and had agreed that, as the damage was confined to the dent at the wing tip, there was no reason why the aircraft should not be used for the private flight to Esperance the following day. They said later that they were certain the wrinkling of the wing was not apparent at the time. Although both were pilots of some experience, neither held maintenance authorizations.

Examination of the wing left no doubt that the internal damage was the result of the collision with the post. The distortion of the rear spar and the wrinkling of the surrounding structure was consistent with the direction of the force which would have been applied on striking the post.

It is quite possible that flight loads imposed on the aircraft structure during the day's flying and the final landing at Esperance in gusty conditions with full flap selected, contributed to the distortion of the wing skin and made it more evident. Nevertheless, a more thorough and competent inspection at Bunbury would have revealed the true extent of the damage and avoided the grave risk involved in continued operation.

The incident arose from ignorance of what seemingly minor damage can involve. It provides a sharp lesson for all pilots and operators of light aircraft.

Damage to rear spar and skin viewed from tank bay. The spar to fuselage attachment bracket is shown in the upper left corner of the photograph.



Control Lost in Severe Turbulence

(Summary of Accident Report issued by Civil Aeronautics Board, U.S.A.)

A few minutes after departing from Miami International Airport, Florida, U.S.A., on 12th February, 1963, a Boeing 720B disintegrated in flight and crashed in the Everglades National Park, 37 miles away. All 43 occupants were killed and the aircraft was completely destroyed.

THE FLIGHT

The aircraft was making a regular public transport flight from Miami to Portland, Oregon, with several en route stops. At departure it was fully serviceable and its loading was well within limits. The weather in the Miami area was typified by a squall line just to the north-west of the city. A few thunderstorms extending to 40,000 feet were expected and a Sigmet had forecast severe turbulence in thunderstorms with a chance of extreme turbulence.

Before taxiing out at 1325 hours, the crew asked the ground controller what departure routes were being used. They were advised that most flights were departing either on a south-westerly climb, or on a south-easterly climb, followed at altitude by a turn back over the weather. The pilot requested a south-easterly departure and the aircraft took off at 1335. Vectored by radar from Miami Departure Control, it then followed a circuitous routing to avoid areas of expected turbulence. At 1343, when some 20 miles west-south-west of the airport, the flight was cleared to climb to flight level 250 on a heading of 270 magnetic, which, the crew advised, would take them "out into the open again." The crew also reported they were encountering moderate to heavy turbulence and suggested the controller should "run the rest of them off the other way."

At 1345 the radar service was terminated and operational control of the flight was transferred to Miami Air Route Traffic Control Centre. In reply to a request for their position and altitude, the flight reported passing through 17,500 feet and asked Miami to stand by for a D.M.E. position. This transmission, at 1348, was the last communication from the aircraft.

Witnesses in the area where the aircraft crashed reported a loud explosion in the air, and several said they had felt a ground tremor shortly afterwards. One witness, who was seven miles south of the crash site, heard the explosion and saw what seemed to be a ball of flame in the edge of a cloud. The flame then streaked downwards, disappeared behind trees, and a sound of impact followed.

INVESTIGATION

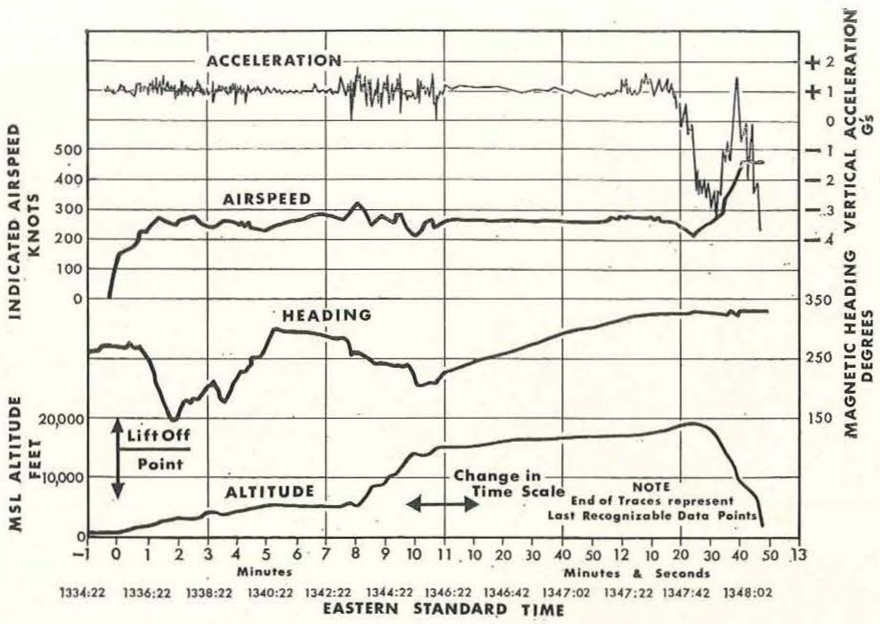
The wreckage was found in a flat, open section of the national park amid scattered clumps of trees, rocky outcrops and areas of marshland. The area was almost inaccessible and vehicles took three hours to reach the site from the nearest road 15 miles away. The distribution of the wreckage, extending over an area 15 miles long and one and a half miles wide, showed that the aircraft had broken up in flight. About 90 per cent. of the structure, including all the larger sections, was concentrated in the westernmost two miles of the wreckage trail. The main fuselage section had been gutted by fire, the wings and all the tail surfaces had separated and broken up, and there was evidence of a severe in-flight break-up of the forward fuselage. The smaller portions of wreckage, found scattered to the east of the main concentration, consisted mostly of light material which had drifted with the prevailing wind. Altogether, about 97 per cent. of the aircraft structure, including the flight data recorder, was recovered.

Early in the investigation, the extensive in-flight disintegration suggested the accident had been caused by a single catastrophic event such as an in-flight explosion, fatigue failure, control system failure, excessive gust loading, flutter, or, since the operator's records showed that the aircraft had been involved in a landing accident 12 months before, by a static type failure from the effect of heavy turbulence on a previously damaged component. With the exception of flutter and gust loading, however, these possibilities were discounted by an exacting examination of the "reconstructed" wreckage. It was found that the wings and the tailplane had failed symmetrically in downward bending, the forward section of the fuselage had broken upwards, and the fin had failed to the left. All four engines had separated upwards and outwards. The fractures in the engine mountings were examined for signs of fatigue which might have resulted from damage sustained by the aircraft in the earlier landing accident, but none were found. There was no evidence of any control system failure or malfunction apart from those associated with the in-flight disintegration and the ground impact. The tailplane trim jackscrew was found in the full nose-down position. Examination of the aircraft instruments showed that the nose-down pitch stops of both vertical gyros had been severely damaged as a result of the aircraft rotating rapidly about its pitch axis. There was no indication of arcing or burning in the aircraft's electrical system and the fuel tank vents recovered showed no sign of fire damage. Similarly, there was no evidence of internal wing tank fires having occurred before the in-flight failure. There was nothing to suggest the aircraft had been damaged by a lightning strike or by hail, and an FIB laboratory examination of several samples of wreckage failed to find any trace of explosive residues.

A read-out of the flight recorder traces indicated that after take-off at 1335.22 (1335 hours 22 seconds) a series of turns was made while climbing in light turbulence. At 1342.46, heavier turbulence was encountered, lasting until after a left turn was made on to a heading of 200 degrees, three minutes later. During this period the aircraft had continued climbing to 15,000 feet and the airspeed had fluctuated between 210 and 320 knots. The aircraft then turned on to 320 degrees while climbing to 17,250 feet. At this point the climb ceased and the altitude remained constant for about 12 seconds. At 1347.25 the aircraft started to climb again at an increasing rate, reaching 9,000 feet per minute by 1347.38. The rate of climb then fell off, dropping to zero at 1347.47, when the altitude momentarily reached a peak of 19,285 feet. In the course of this climb, the airspeed decreased from 270 to 215 knots, and as the peak altitude was reached, the vertical acceleration changed rapidly from plus 1g to minus 2g. During the next seven seconds the negative acceleration increased further with rapid fluctuations, to a mean value of minus 2.8g, while altitude was lost at an increasing rate. The descent continued with rapidly increasing airspeed and the vertical acceleration changed to plus 1.5g, at which point it reversed once again. In the last nine seconds, the altitude trace showed a continuous decrease, the airspeed rose to the limitations of the recorder, the acceleration trace showed an increase again in a negative direction, and the heading remained fairly constant at 330 degrees. From the commencement of the climb from 17,250 feet at 1347.25, the final manoeuvres occupied 45 seconds. In this short space of time, the aircraft climbed steeply, reaching a rate of climb more than three times greater than normal, then pitched nose-down and dived towards the ground at high speed.

During the investigation, the manufacturers of the aircraft supplied data from studies made to determine the capability of the aircraft to perform the manoeuvres shown on the flight recorder, what control inputs these would require, and how the aircraft would respond if the tailplane were lost. The studies gave a graphic illustration of the final manoeuvre and showed that, although the aircraft was capable of performing the manoeuvres, full nose-down deflection of both the tailplane and the elevators would be required to achieve the high negative load factors recorded. The elevators would have had to be intact and functioning to achieve the partial recovery that followed the nose-over. Loss of the tailplane before the partial recovery would have produced a much higher rate of pitch and vertical acceleration. The studies also indicated that pitch attitudes during the final manoeuvre would have varied from 22 degrees nose-up during the steep climb to beyond the vertical nose-down, in the dive.

Because of the large control inputs these studies revealed, the manufacturers set out to determine to what extent the aircraft had been affected by vertical currents. This was done by comparing the airspeed and altitude traces obtained from the flight recorder, with the known aircraft climb performance at maximum continuous power, the normal climb setting for this type of aircraft. The comparison revealed that draughts of high intensity were acting on the aircraft at the time of the steep climb and subsequent dive, but that they



Read-out obtained from Flight Recorder Traces.

were not in themselves of sufficient magnitude to cause structural damage. Nevertheless, it was thought that the aircraft's response to such draughts could have been misleading to the pilot in instrument meteorological conditions. Although the overall effect of an up-draught is an increase in altitude and nose-up attitude, an aircraft flying into an up-draught initially tends to "weathercock" nose-down into the relative wind. If the pilot had tried to counteract this initial bunt with nose-up elevator, the overall effect of the up-draught would have been amplified. The converse would occur with down-draughts. The manufacturers also studied the effect of vertical air currents by simulating flights in various gust conditions, and showed that gusts alone could not have been responsible for the vertical acceleration traces revealed by the flight recorder.

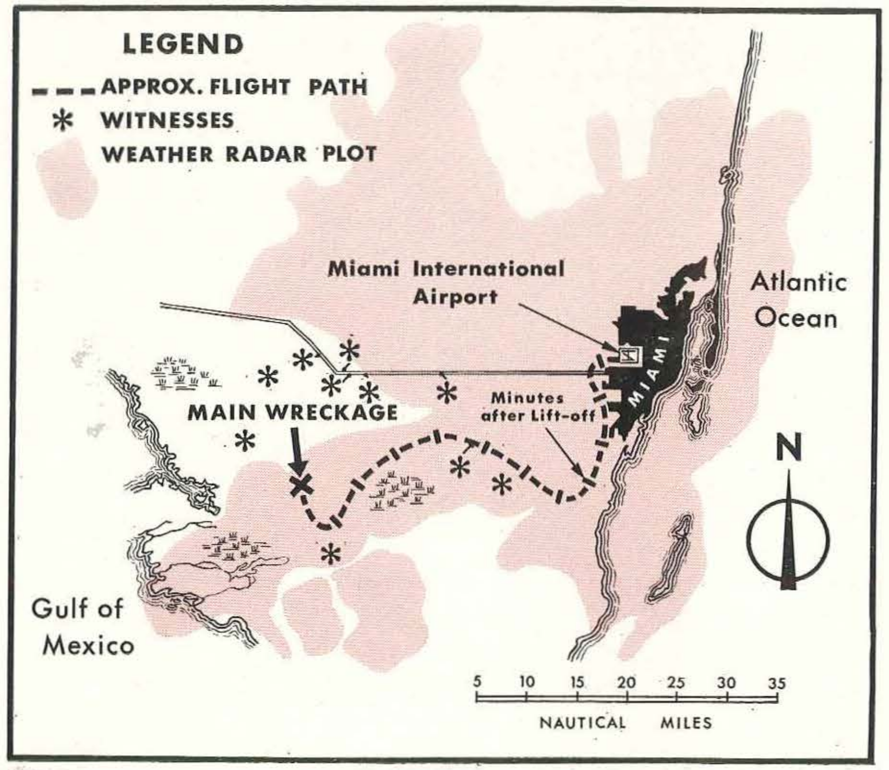
The techniques used in the design of the aircraft to provide protection against flutter and gust loadings were reviewed, and were found to be satisfactory and in accord with established design practice. An analysis of the gust intensities recorded at the time in the area of the accident demonstrated that the weather was severe but not unusual, and that, apart from the statistically remote chance of an extreme gust encounter, the maximum gusts the flight would have encountered were within the design limits of the aircraft. It was thus established that no single catastrophic event had been responsible for the accident. This finding was supported by both the flight recorder read-out and a study of the wreckage trajectories.

The wreckage trajectory study showed that the aircraft structure was intact throughout most of the final manoeuvre and that components did not begin to separate until the aircraft had dived to below 10,000 feet. Data obtained during the review of the aircraft's design strength was also in agreement with this finding. Design regulations required the structure to withstand only a minus 1g limit load, but the actual design strength was considerably in excess of this value. The tailplane was capable of withstanding the high minus 3.2g load imposed in the early part of the nose-over and should not have failed under these conditions unless the elevators were suddenly deflected upwards at a rate considerably greater than that shown by the flight recorder read-out. The manner in which the elevators and tailplane did fail nevertheless suggested that a loading of this sort had occurred later in the dive. The forward section of the fuselage was also capable of withstanding the initial high negative loading and would not have failed until the tailplane separated. The design strength of the wings would have been exceeded at each of the two high negative loadings, but the second loading at the lower altitude would have been the more critical. Perhaps the most convincing evidence that the aircraft was essentially intact down to a low altitude, however, was the finding that the final manoeuvre required full nose-down elevator trim with full down elevator, held for about eight seconds, followed by a return to the full up elevator position some nine seconds later.

Two other factors which might have had a bearing on the accident were studied during the investigation. The first was that rain might have frozen in the elevator balance bay and that icing of the balance panel seals and the hinge connecting the balance panel to the elevator could have restricted elevator movement. It was found that at least 13 previous instances of longitudinal control difficulties had occurred from this cause, usually characterized either by a stiffness in the control column with a corresponding poor response by the aircraft, or by a cycling force in the column with a porpoising aircraft motion. In some cases, additional force on the control column overcame the difficulty, but in a few instances the controls were so stiff that elevator trim had to be used to control the aircraft. Some crews had successfully overcome the problem by descending to a lower altitude, where normal control response returned. In no case had the icing caused a loss of control.

Tests were performed in climatic conditions similar to those that would have been met by the flight, and the temperatures within the elevator balance bay were measured. In all cases, the measured temperatures were equal to or higher than the ram air temperature. When the results of the tests were analysed, it was determined that the ambient temperature in the balance bay of the aircraft at the time of the accident would have been about 40 degrees F. The data from the tests was also analysed by the aircraft operators themselves in the course of preparing a comprehensive report setting out their views on the accident evidence. The operator's analysis produced different results and suggested that the balance bay temperature would have reached freezing level by the time of the accident. The operators believed that this may have led to difficulties of control by forcing the crew to make large control movements.

The remaining factor requiring study emerged from the results of calculations made by aerodynamicists during the investigation. A mathematical analysis of the aircraft's longitudinal control system indicated that control forces could lighten, or even reverse, at full-down elevator deflections, and a full-scale wind tunnel test of the tailplane and elevator was needed to resolve the question. The test was conducted using a half tailplane and elevator supplied by the aircraft manufacturers, and the data obtained was used to analyse the control forces which could have been experienced during the aircraft's final pitching manoeuvre, together with those which could be encountered with various tailplane settings in plus 1g level flight. It was found that from level flight, with various tailplane settings, the control forces varied normally with increases in elevator angles, but that during pitching manoeuvres with constant tailplane settings, the push force required for downward elevator angles reached a maximum at 10 degrees down, then decreased as the downward elevator angle increased further. Positioning the tailplane at the full nose-up or nose-down settings did not appreciably affect the control forces. It was also found that variations in the balance panel cove gap clearances, and the rigging of the tailplane actuated elevator tab, had an effect on the control forces. The control column push force required for the pitching manoeuvres was reduced 7.5 pounds for each .05 inch reduction in the cove gap, and 8 pounds for each degree the tab was mis-rigged. The aero-elastic effects of the aircraft structure itself also tended to reduce the amount of force required to perform nose-down pitching manoeuvres.



ANALYSIS

The picture that initially emerged of the final manoeuvre was that of an intact aircraft describing a path resulting from unusual longitudinal control displacements. It was inconceivable that the captain would have imposed such displacements unless prompted by the most exceptional circumstances, and it was equally difficult to imagine a control difficulty that could account for the tailplane and elevator movements the manoeuvre required. No possible control malfunction, such as a runaway tailplane trim drive or a hard-over auto-pilot, would produce the drastic results shown by the evidence. The two most likely explanations appeared to be the control restriction caused by icing in the elevator balance bay, as propounded by the operators, and the misleading effect of the aircraft's response to gusts, as suggested by the manufacturers. Each of these two possibilities were thoroughly considered in the final assessment of all the available evidence.

The temperature lapse rate data obtained from the elevator balance bay during the flight test programme clearly demonstrated that the temperatures at all times were at least as high as the corresponding ram air temperatures. The ram air temperature at the time of the accident, as determined both from radiosonde data and the flight recorder airspeed traces, was above 40°F for the entire flight. In arriving at their conclusion that immobilization of the elevators by freezing had precipitated the large control inputs, the operators relied chiefly on previously reported instances of balance bay freezing and on their own calculations of the temperature in the balance bay at the time of the accident. Their thesis presented no additional weather evidence but rather a different interpretation of the same evidence. It employed a different method of determining the temperature variation with altitude in the accident area, and assumed a 20 degree differential between the rain and ambient temperatures. However, in view of the facts demonstrated by the actual flight tests it was felt that the operator's theory could not be substantiated and that freezing of the controls was not likely to have been a factor in the accident.

The performance analysis prepared by the manufacturers in support of their explanation that the accident manoeuvre had developed from an "out of phase" relationship between the aircraft's response to the severe turbulence and the pilot's control inputs, was carefully considered together with the results of the wind tunnel tests carried out on the tailplane. The wind tunnel tests were extremely useful in establishing the validity of many of the results obtained by calculation. Although the control forces did not actually reverse in the course of the tests, it was shown that a considerable lightening of the control forces occurred at large down-elevator angles and that small variations in the cove gap clearance and the rigging of the tailplane actuated elevator tab were capable of producing a further lightening effect or even a mild control force reversal.

A further study made by the manufacturers on the possibilities of recovering from a vertical dive below 20,000 feet was also examined. It showed that an aircraft in a 95 degree dive at 320 knots with full nose-down trim was recoverable if full up elevator were used. It was most important however that the recovery be begun in time for the aircraft to be levelled out before the speed rose to 480 knots. Beyond this speed it would not be possible to achieve level flight with full nose-down tailplane trim and full up elevator. At the start of the recovery, the application of full up elevator would require a control force of 185 pounds and would impose a load factor of plus 4g on the aircraft. The load factor would decrease throughout the recovery as the elevator became less effective with the increasing speed, until the aircraft reached its maximum speed in the dive. At the same time, the force needed to maintain full up elevator would increase, reaching a maximum of 320 pounds shortly before the aircraft levelled out. While demonstrating the ability of the aircraft to recover, the study indicated the magnitude of the task which would confront a pilot in such a situation.

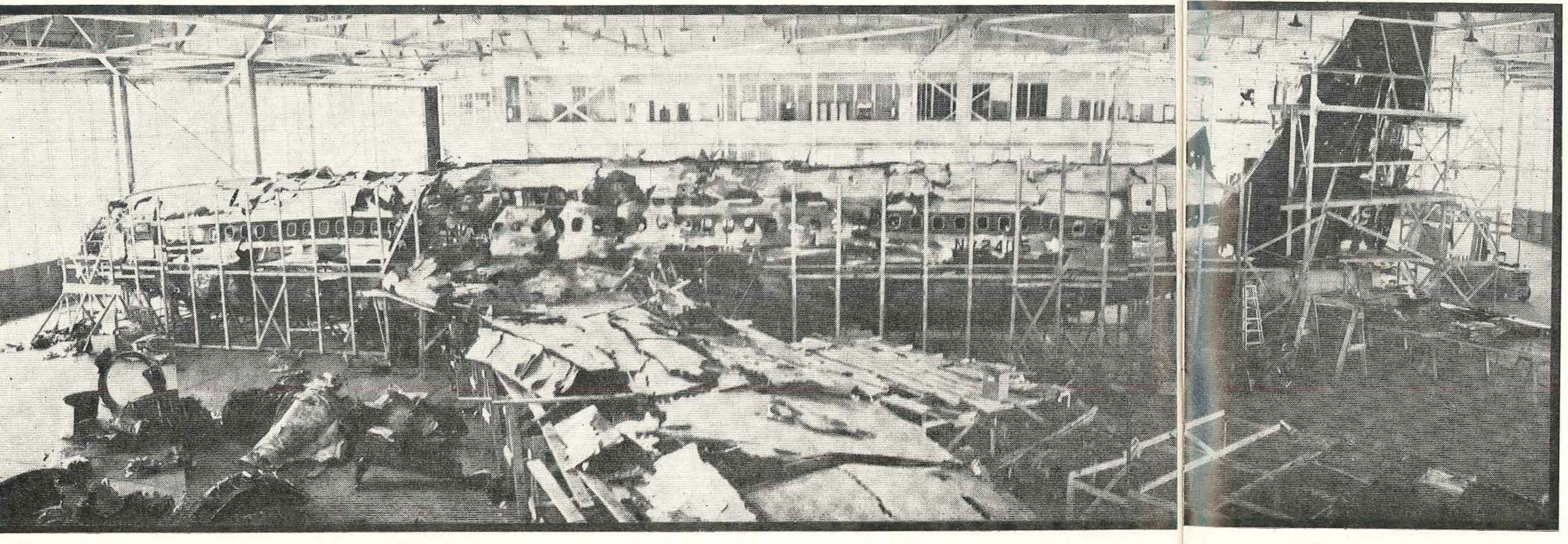
Evidence from several other accidents and incidents that had occurred under conditions bearing some similarity to this accident was also examined. In all these instances, turbulence was involved, pitch attitudes, airspeeds and altitude had varied greatly in the course of unusual manoeuvres, and the crews had found it necessary to make large displacements of both the tailplane and elevator controls. In reviewing this evidence, it was difficult to avoid the conclusion that the phasing relationship between the turbulence-induced aircraft motion and the crew's control inputs was at least a factor in each of the occurrences.

Some of the results of the rough air penetration studies being conducted at the time by the National Aeronautics and Space Administration, were also of much interest and assistance in analysing the cause of the accident, and showed that in certain circumstances the unfavourable coupling of a pilot's control inputs with aircraft motions induced by turbulence could create a hazardous situation. Of particular interest was the finding that pilot workload, cockpit acceleration forces, cockpit instrument display, aircraft characteristics and piloting technique could all become factors in precipitating an upset. It was shown in the simulator that an aircraft, without any control inputs, could fly through the most severe gusts without experiencing excessive "g" loadings or large airspeed and altitude variations. The technique involved large changes in pitch attitude, but in each case the inherent stability of the aircraft provided the restoring power to maintain the trim condition. With a pilot "flying" the simulator through a "storm", the variations in load factor, airspeed and altitude depended on how closely the pilot tried to maintain the desired pitch attitude. Some of the trials resulted in large oscillations, indicating that the pilot's control inputs were out of phase with the gust induced motions, and in a few cases the oscillations increased to the point where an upset occurred. Large oscillations also resulted when pilots were instructed to ignore the pitch attitude indicator and to concentrate on controlling the airspeed during a simulated turbulence penetration.

Other studies made since the accident on the human factors, design, and operational aspects of rough air penetration, were examined during the overall consideration of the accident evidence. Notable among these were papers prepared by Captain Paul Soderlind, which discussed the potential "miscues" that could be obtained from primary flight instruments, and sensory cues which could be misleading in certain weather conditions. The importance of using the attitude indicator as the primary reference in turbulence, and the need for further improvement in the design of attitude instruments, were other significant conclusions reached by Captain Soderlind.

While the Civil Aeronautics Board felt unable to agree in detail with all the findings obtained and presented during the investigation, it believed the available evidence was sufficient to enable a broad picture to be drawn of the events leading up to the accident. It was evident that shortly after 1347 hours, the aircraft entered an area of turbulence at 17,250 feet. The climb that began at this point could have been initiated by vertical currents or by the pilot and probably resulted from a combination of both. The way in which the rate of climb then increased, the increasing nose high attitude, and the rapidly falling airspeed, could have indicated to the pilot that a stall was imminent. Acting on this belief, probably while being subjected to severe vibrations from the turbulence, the pilot apparently used full down elevator and tailplane trim to correct. Such large control displacements would of course have arrested the high rate of climb and the decrease in speed, and would have returned the aircraft to a nearly level attitude, but they would also have developed extremely high negative "g" forces. The negative "g" forces actually revealed by the flight recorder would have caused chaos in the cockpit. As well as the distraction of warning lights and bells which would have been actuated under such conditions, the crew would have had to contend with loose articles being flung violently about the cockpit. The crew members themselves, meanwhile, would have been forced upwards against their seat belts and would probably have found it almost impossible to keep their hands and feet on the controls. It is inconceivable that the pilot would have continued to apply full down elevator under these conditions; rather it seems very likely that the control forces lightened nearly to zero in the manner shown in the wind tunnel tests and the control column thus remained in the fully forward position. Eight seconds later, it seems that the pilot was able to grasp the control column again, but by this time the aircraft was diving vertically through 16,000 feet with the airspeed building up rapidly. The flight recorder indicated that in attempting to recover, the pilot initially moved the control column back to the neutral position where it remained for a few seconds before being pulled right back into the full up elevator position. By then, the airspeed had passed 470

The wreckage being "reconstructed" at Opa Locka Airport, Miami. A helicopter was used to lift the wreckage piece by piece from the accident site.



knots, the aircraft was down almost to 10,000 feet, and the vertical acceleration was again moving in a negative direction, indicating that the excessive airspeed and air loads were preventing a successful recovery. The pilot's attempts to re-trim the tailplane into a nose-up position would also have been foiled by the tailplane trim drive motor stalling under the high nose- down elevator loads. Although it might have been theoretically possible for the aircraft to recover from the dive, the crew could hardly be blamed for not having been able to do so in view of the likely conditions in the cockpit and the extremely high control forces needed. Apart from this, it was thought possible that the rapid upward elevator displacement required in the theoretical recovery might only have caused the elevator and tailplane to fail earlier.

It was apparent that some characteristics of the aircraft itself had played an important part in contributing to the accident. The acceleration forces in the cockpit induced by bending or flexing of the fuselage in the heavy turbulence, and amplified at the pilot's head by the combined effect of his seat cushion and fastened seat belt, probably blurred the pilot's view of the instruments. In extreme cases, this unpleasant characteristic, common to all large swept wing aircraft, could have a detrimental effect on a pilot's performance during rough air penetrations, and on this occasion was no doubt highly disturbing. The lightening of the elevator control forces at large down elevator angles was another aircraft characteristic which had undoubtedly made matters more difficult for the pilot. This effect provided the only reasonable explanation for the control column remaining in the fully forward position for eight seconds and was probably one of the principal contributing factors in the accident. Another aircraft characteristic which played a part in producing the final manoeuvre was the powerful effect of the movable tailplane. A movable tailplane was of course essential to the design of the aircraft, but its operatiion should be such as to preclude serious out-of-trim situations developing. The attitude indicator installed in the aircraft was one of the newer types available and provided an adequate attitude reference for all normal pitch attitudes. At large pitch angles however, the horizon reference line disappeared from the face of the instrument, making interpretation of attitude extremely difficult. This peculiarity would certainly have been a complicating factor to the pilot during the pitch down and the subsequent attempt to recover.

Altogether it was obvious that many factors, which by themselves would not have constituted extreme hazards, had combined to cause the accident. Weather was certainly one of the factors, but the conditions were not greatly different from what might be encountered during any regular airline operation. It was clear from the evidence however, that instrument flight in heavy turbulence could become difficult if a pilot did not follow the recommended practice of using the attitude indicator as his main reference. Undue emphasis on any other instrument could lead to serious misinterpretations with dangerous results. In the same way, attempts to control attitude too accurately could be equally hazardous, because of the high load factor this induced, the dangers of over-controlling as a result of large control movements, and the possibility of inducing oscillations in the motions of the aircraft. A "loose" attitude control with moderate control inputs appeared to be the safest way of handling an aircraft in heavy turbulence.

The Civil Aeronautics Board's initial reaction in the vast mass of complex and inter-relating evidence was that, as no single factor had caused the accident, it would not be possible to ascribe a definitive probable cause. Later, when a preponderance of the evidence pointed to a general cause involving the relationship of man, machine, and environment, the Board considered that a probable cause could be established on this basis. The Board finally concluded that the accident was probably caused by an unfavourable inter-action of severe vertical air draughts with large longitudinal control displacements, resulting in a longitudinal upset from which a successful recovery was not made.

COMMENT

This accident, and the very comprehensive investigation which stemmed from it, has attracted world-wide interest.

Other accidents and incidents have pointed to the existence of some of the individual design and operational factors which were also deemed to have been significant on this occasion. Intensive research is already being conducted in these areas, by those best equipped to carry out such research, and the developments are being closely monitored by the Department. This accident has played its part in further identifying the factors and in adding impetus to the need for satisfactory solutions.

More specifically, however, the investigation establishes that, in turbulence-caused excursions, control reaction is the predominant single factor and the observations on control techniques therefore deserve earnest consideration from everyone directly concerned with the piloting aspects of jet transport aircraft.

UNWANTED PASSENGERS

Late on a summer afternoon, I landed my Auster near Penola, S.A., intending to stay overnight, and return to Parafield shortly after first light in the morning. I tied the aircraft down and left it where it stood on the north-western side of a 640-acre clover paddock which I have been using as an aerodrome for the past three years. On the far side of an adjoining paddock there is a cluster of eight bee hives. The weather at the time was calm and warm, with an occasional light easterly breeze, and it was a perfect afternoon for flying insect activity.

Early next morning I returned to the aircraft, carried out a pre-take-off check, and took off for Parafield. The weather had changed and with the wind now coming from the north at 20-25 knots, I decided to head for Keith to refuel. This track passed close to Naracoorte, a fact I was soon to appreciate.

I climbed to 4,500 feet and settled down on my heading. Half an hour later I carried out a ground speed check and swotted several bees flying around inside the cabin, assuming that they had somehow been shut in the cabin on the previous evening. I then went to check the fuel consumption, and on glancing up at the wing tank gauge I was astonished to see the dial was completely covered with bees! I then noticed the rear of the cabin was also carrying quite a large number of the unwelcome passengers and that a steady stream of newcomers was joining them from outlets in the wing root.

I wasted no time in heading for Naracoorte Aerodrome, which by now was conveniently under the nose, and, after a frantic check for other traffic in the circuit, unceremoniously plonked down on the end of the main runway and smartly vacated the cabin. Almost immediately the air around the port wing became black with very angry bees, and I saw a great blob of them hanging to the fuel tank drain cock; they would break away and reform again like a bunch of grapes.

Fortunately, I was able to obtain the help of a local apiarist, and, after much spraying with insecticide, we eventually eliminated them. Later, I asked an entomologist friend how I could find out whether the queen bee had been killed, as I had little enthusiasm for a repeat performance. At his suggestion, I landed at another farm where there were hives. I parked the Auster near them and kept close watch. As the bees ignored the aircraft completely, I was assured that the queen was dead and that my worries were over. Looking back, I am amazed that I was not attacked, for at times I had bees in my hair and on my face and arms. My early action in opening the windows and ventilators in the cabin made it very draughty and caused the air inside to become turbulent, and I think kept the bees too busy hanging on to worry about me. It certainly kept the majority of them at the rear of the cabin.

It is apparent that in the hour and a half of daylight that remained after I had parked the aircraft the previous night the breeze had carried the swarm from the hives to the drain holes on the underside of the Auster wing, where they were able to enter the space between the rear spar and the flap attachment area near the wing root. I have since learnt that it is a mistake to park an aircraft, or even a car, downwind from a group of hives; distance is not a safety factor, for bees are great travellers and when swarming will take the line of least resistance and drift with the wind. In this case the hives were TWO MILES away.

I have also learnt to look for the impossible when carrying out my daily inspections, and sincerely hope that someone else will benefit from this incident. What turned out quite an educational experience for me could just as easily have ended my flying days permanently.

COMMENT

We are grateful to our contributor for providing us with such an informative account of his unnerving experience. His comment on "looking for the impossible" during daily inspections is a timely one. On another occasion recently a Cessna 205 was tied down overnight at Condoblin, N.S.W., and in the morning was inspected in readiness for a charter flight. The aircraft was passed as fully serviceable but as it took off, the airspeed indicator rose normally at first to 45 knots, then fell back to zero. Committed to continuing the take-off, the pilot climbed away relying on attitude and power settings, then completed a circuit and landed. He obtained approval to ferry the aircraft solo to the nearest workshop at Parkes where a maintenance engineer found that a wasp had deposited mud inside the pitot tube while the aircraft was left unattended.

No pitot head cover had been fitted to the aircraft while it was parked overnight in the open.

AVGAS, PLEASE

The pilot of a light aircraft was forced by weather to divert to an aerodrome where only a limited demand existed for 80/87 avgas. Finding that none was available at the aerodrome, but that supplies were reputedly held in four gallon drums at an oil company depot in the nearby town and would be delivered on request by the local taxi proprietor, the pilot telephoned the taxi service and ordered twenty gallons of 80 octane avgas.

In due course the taxi driver arrived with five four gallon drums of fuel and, under directions from the pilot, proceeded to decant them into the aircraft tanks. In conversation while the refuelling was going on, the taxi driver casually mentioned that the fuel in the drums was standard grade motor spirit. To the astonishment of the driver, the pilot immediately stopped the refuelling and set about draining the affected tank, while the former hastened to explain that this was what they always supplied to light aircraft !

Enquiries later revealed that what the driver had said was true. For some time past he had been refuelling itinerant light aircraft with motor spirit drawn from his own taxi service pump, and did not know that motor spirit was unsuitable for use as an aircraft fuel. At some time in the past he had evidently misunderstood that a request from the aerodrome to bring out some four gallon drums of 80 octane fuel was intended to be conveyed to the oil company depot where the avgas 80/87 was held, and instead brought drums of his own fuel. Having once established this precedent of supplying aircraft from his own pump, he cheerfully carried on the practice with each subsequent refuelling operation !

It was not possible to determine how many aircraft had been refuelled with motor spirit in this way, but the quantities were probably comparatively small in most cases, and it is apparent that no harm was done. It is rather surprising that the orange colour of standard motor spirit, in contrast to the red avgas 80/87, had not betrayed itself to pilots earlier. Certainly the fact that the fuel was already in four gallon drums when it arrived at the airport, would make it less obvious, but such facts say little for the vigilance of light aircraft pilots generally.

The Department has previously issued warnings against the use of motor spirit in aircraft. There are several reasons for this, the principal ones being the variations in knock rating that may be found in automotive fuels, with consequent dangers of detonation if used in aircraft engines, and the fact that vapour pressures are considerably higher than in aviation fuels. This could lead to the formation of vapour locks in aircraft fuel systems under high ambient temperature conditions or at high altitudes. Aviation fuels on the other hand are produced to exacting specifications and a strict quality control is exercised over their handling and storage. The result is a product of uniform high quality which can be depended on to produce optimum power from aircraft engines under a very wide range of operating conditions.

There may be other country aerodromes where there are refuelling arrangements similar to those featuring in this incident. Pilots who avail themselves of these impromptu sort of facilities would do well to read again our earlier article "Pilot Responsibility in Refuelling", Digest No. 35, September, 1963, and to keep in mind the case of the enterprising taxi-driver !

Misunderstood

An airline training captain, with a reputation for being over-active with his tongue during flight, was instructing a bright young first officer in circuits and landings. During one circuit the captain was startled to hear the trainee snap, "Less talk"!

Very annoyed, the captain managed to restrain himself until they had taxied back to the tarmac, then, in no uncertain terms, proceeded to admonish the pupil for his cheek and rudeness. It was some time before the latter could get a word in but at last he managed to burst out "But, excuse me, sir, all I wanted was less T-O-R-Q-U-E."