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AVIATION SAFETY DIGEST

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DEPARTMENT OF CIVIL AVIATION

AVIATION SAFETY DIGEST

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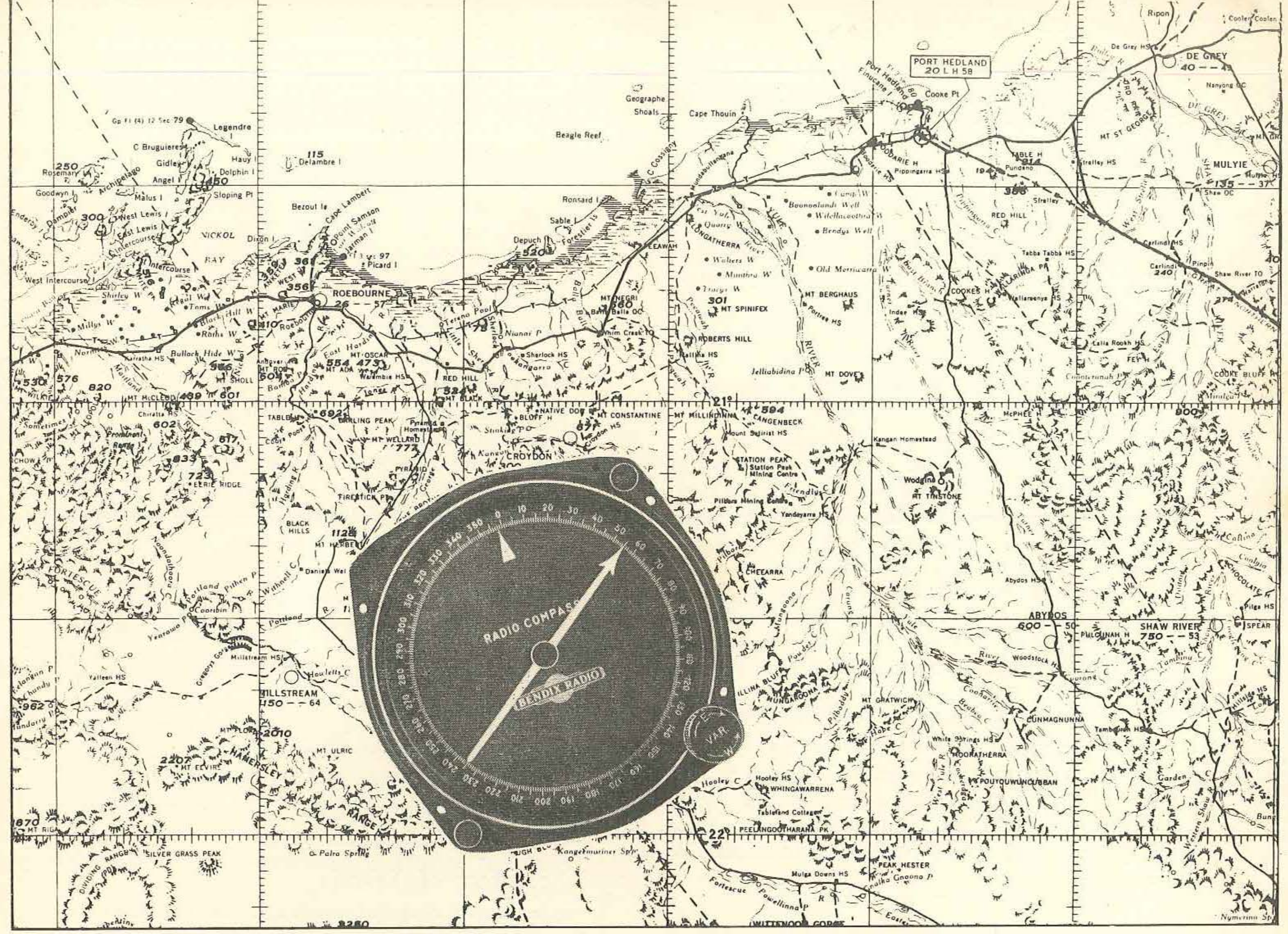
Overseas Passenger Terminal, Kingsford Smith Airport, Sydney

Commonwealth of Australia



KNOW YOUR RADIO COMPASS

Although the radio compass is one of our oldest radio navigation aids, reports are still received from time to time concerning abnormalities experienced in using this aid. As some of these reports indicate a misunderstanding of the limitations of medium frequency direction finding systems, the purpose of this article is to restate the factors which affect the performance of the radio compass and suggest how to obtain optimum performance under varying conditions.

General

At its best, the radio compass indicates the direction of arrival of the radio wave to which it is tuned. However, because the radio wave is subject to a number of outside influences which can result in a deviation of its path from the Non-Directional Beacon to the compass, the bearing indication of the latter will not always be the bearing of the N.D.B. from the aircraft. It is also possible for the wave of an N.D.B. on the same or an adjacent frequency to be received in addition to that of the station tuned. When this happens the indicated bearing could be that of either N.D.B., depending upon the strength of the signals received because the receiver tends to select the stronger of the two signals.

Night Effect

Radio waves take two paths to the radio compass receiver. The first and normal path is along the earth's surface. If only these waves were received, the compass would point directly to the N.D.B. The second path is via one or more wave refracting layers above the earth (the ionosphere) returning to earth to mix with the direct waves.

Complete changes in the nature of the wave take place on this path and produce errors in direction.

It is the ratio of the intensity of the indirect to the direct waves in the total received signal which determines the liability to error of the radio compass. As the strength of the indirect waves is greater at night, errors are then more common and of greater magnitude, and so the term "night effect" is given to this phenomenon*. It is often found that this effect is most pronounced within the hour either side of sunrise and sunset when the changes in the state of ionisation of the upper atmosphere are particularly violent.

Near the N.D.B. the ground wave will predominate but as the distance increases the ratio of indirect to direct waves will increase and bearing indications will become erratic. At night the maximum reliable range of an N.D.B. is approximately 60 miles over land and 100 miles over the sea. These ranges are virtually independent of the power of the transmitter—increasing power increases the strength of the ground and sky wave by the same amount and the ratio of indirect to direct waves would therefore remain the same. The exception to this rule is the low powered locator beacon which seldom has a range exceeding 30 miles, day or night.

It is essential to know when night effect is present and to thoroughly understand its effect upon the performance of the equipment because these errors are not only most common but impossible of correction.

Co-channel and Adjacent Channel Interference from other N.D.B.'s

As mentioned earlier, if the signal from another N.D.B. operating on the same or an adjacent frequency is received with sufficient strength, the automatic bearing determination circuits of the compass receiver will be influenced and a bearing error will result. Non-directional beacons are normally spaced geographically and by frequency allocation to minimise these effects. At night, however, when the sky wave component of an N.D.B. extends to a far greater range than that of its ground wave, it may cause interference. This effect will be aggravated by attempting to use an N.D.B. beyond the range for which it was intended; when its signal strength may be low and therefore prone to interference. This is further discussed later in the article.

Sometimes an ionospheric disturbance occurring during the day may make long distance propagation possible by means of the wave passing to the refracting layers above the earth's surface. Effects similar to those discussed earlier may be noted but these day time effects are uncommon and therefore easily recognised.

It is most important to appreciate that an unwanted N.D.B. may not be strong enough to cause any bearing errors. The fact that its identification signal is audible does not necessarily indicate that the bearing of the wanted N.D.B. is not correct, although it must be considered suspect and should be checked by other means.

* The possibility of these phenomena is not confined to the hours of night therefore the term "night effect" is a misnomer.

Mountain Effect

An effect similar to night effect is sometimes obtained in mountainous areas where the energy received from an N.D.B. consists of two or more waves, one of them direct and others by reflection from the mountains. Bearing indications are found to change rapidly until the affected area is passed.

Thunderstorms

A thunderstorm generates a tremendous amount of radio frequency energy and when the aircraft is near to a storm centre, the radio compass may indicate the direction of the storm and not that of the N.D.B. to which it is tuned. Caution should therefore be exercised when flying in the vicinity of a thunderstorm to check by other means whenever possible the accuracy of the bearing indications.

The Effect of Terrain

The useful range of an N.D.B. is influenced by the type of terrain over which the radio wave travels. It is greatest over the sea and least over sandy or mountainous country, and an N.D.B. with a daylight range of 600 miles over the sea may only have a range of little more than 100 miles over the least favourable types of soil. Therefore, when an N.D.B. is located on the coastline, its range in different directions can be expected to vary considerably.

Height Effects

The range of an N.D.B. over the sea is relatively independent of aircraft height, but over unfavourable soil increases considerably with height for each 10,000 feet increase. In extreme cases the range may be doubled by a change in height of the aircraft from 1,000 to 20,000 feet.

Tuning the Compass Receiver

It is of vital importance when using the radio compass receiver to ensure that it is correctly tuned to the frequency of the required station in accordance with the techniques specified either in the manufacturer's instruction book or the company's operations manual.

Adherence to the correct tuning procedures is of major importance with the introduction of newer types of compasses which require precise tuning to be effected by aural means instead of the previously used visual tuning meter method. It would be inappropriate to deal with the new tuning techniques in this article as the methods to be used may differ, not only from one type of receiver to another, but also in relation to a particular type of receiver because of variations in ancilliary equipment in the various installations. The 1020 cycles per second RANGE filter which usually forms part of the selector box and the mechanical or crystal filters which may be fitted within the receiver for SHARP tuning purposes are examples of this.

If a radio compass receiver is not tuned in accordance with the manufacturer's prescribed method its efficiency will be affected. Faulty tuning may result in —

(a) incorrect bearing indication (produced electrically),
(b) increased adjoining channel interference,
(c) incorrect bearings when the atmospheric interference level is high,
(d) reversed sense indications, and
(e) restricted service range.

Use the Most Appropriate N.D.B.

Frequently efforts are made to use an N.D.B. at distances far beyond its maximum range. Often this is done even when there is another and more appropriate N.D.B. available for use. An example of this is the main high-powered N.D.B. at Sydney which should be used for any considerable distance in lieu of the lower powered locators which should only be used for approach procedures. It should be remembered that these locators were never intended for other than restricted coverage, usually for instrument approach procedures and certainly not for en route purposes.

When overflying an N.D.B. make use of back-tracking procedures. The bearing indication from this N.D.B. will be far superior to that obtained by switching to a more distant N.D.B. ahead of the aircraft.

Indentification Interference

As indicated previously, the identification signal of an unwanted N.D.B. may be audible without that N.D.B. causing bearing errors — but where there is any doubt it is wise to proceed with caution.

Night Effect

Remembering that the dependable night time range of an N.D.B. is only dependable over distance equal to its ground wave transmission. Treat with caution night bearings obtained at distances greater than 60 nautical miles over land or 100 nautical miles over sea.

Ruptured Fuel Cell

600 GALLON SPILL

The events which led up to this accident started in the repair base. The aircraft had undergone a major fuel cell repair. In the final stage of this maintenance, a clear acetate tape was placed over the No. 3 main tank and cavity vents during the purging operation. After completion of the job, this tape was not removed, but the aircraft was signed off as ready for flight.

The flight crew performed the preflight inspection at night, using flash lights, and did not see the clear tape covering the vents. A ferry flight was completed without incident. Before the aircraft was returned to schedule, maintenance and preflight inspections again failed to detect the presence of the tape, as it blended into the usual discolouration on the lower wing surface.

Later fuel was transferred from the main tanks to the outboard tanks to stabilize the tip gear on the ground. Approximately, thirty minutes after this transfer started, the No. 3 main tank collapsed inward from negative pressure. The tank ruptured, spilling approximately 600 gallons of fuel on the ramp.

This accident would not have occurred

(i) had warning streamers been attached at the closed vents,

(ii) had signing off the tank repair been preceded by an adequate inspection to make certain the job was completed.

Both (i) and (ii) indicate unsatisfactory supervision.

(Extract from Aviation Mechanics Bulletin)

Super Constellation Overturns during Landing

MONTEGO BAY, JAMAICA

On 21st January, 1960, a Lockheed Super-Constellation crashed whilst landing at Montego Bay Airport, Jamaica. Two crew members and 35 passengers were killed, but five crew members and four passengers were able to escape before the aircraft was consumed in an intense fire.

(Summary based on the report of the Public Inquiry)

THE FLIGHT

The aircraft was engaged on a scheduled flight from New York to Bogota, Colombia with intermediate stops at Montego Bay and Kingston, Jamaica. The aircraft with a crew of seven and 39 passengers departed from Idlewild at 1035 hours local time. The flight proceeded normally to a point about 30 minutes beyond Wilmington, North Carolina when malfunction was detected in No. 3 engine. The captain elected to divert to Miami and the aircraft landed at 1657 hours.

The defect was rectified and the flight was airborne at 0012 hours on 21st January, and the flight to Montego Bay was uneventful. Shortly before arrival overhead, a standard instrument approach clearance was obtained and a normal instrument approach procedure was carried out. On completion of the procedure turn at 2,000 feet, the airport was sighted and the approach continued visually. The initial contact with the ground was reported to have been very hard, and almost immediately after contact, the flight crew state that they were conscious of a depression of the port wing and a flash. The aircraft fuselage came to rest in an almost inverted position. The captain ordered the flight engineer to open the door between the flight deck and the crew rest cabin, but this he was unable to do. A pilot's bad visibility window was then opened and the flight crew left the aircraft through this means of exit.

Two of the four surviving passengers, all of whom were seated in the aft cabin, were suspended inverted by their seat belts. They quickly contrived to free themselves; the other two had released their belts on initial impact. Efforts to free the port emergency exit were unsuccessful at first. The surviving steward managed to open the starboard emergency exit and escaped from the aircraft, but when the others attempted to follow they were beaten back by flames. Ultimately the port emergency exit window was opened and all four passengers together with the surviving stewardess left by this exit.

INVESTIGATION

The first indications that this accident was caused by a heavy landing were some tyre marks which were imprinted on the threshold markers of the runway. The relative positions of these marks made it possible readily to identify them as having been made by a Super Constellation and the tread pattern, which differed between the No. 1 and No. 2 tyres of the port undercarriage assembly, proved to be identical with those which would have been produced by the aircraft at the time of the accident. The starboard tyres were destroyed by the fire, but the port tyres were readily identifiable.

From this point on the threshold, the aircraft appears to have bounced into the air, and the next indications of its progress along the runway were a series of slashes which were identified as having been produced by the propellers of No. 1 and No. 2 engines, at a distance of 700 feet from the threshold.

As subsequent examination of wreckage showed the nose undercarriage strut of the aircraft to be undamaged, it therefore can be established that the propeller slash marks on the runway could only have been made if the port wing immediately prior to this, was detached from the fuselage and inclined in an abnormal leading edge downward position, which could not have been achieved if it were still attached in its correct position to the fuselage structure. In addition, as the slash marks were of equal pattern and depth the wing must have moved downwards at the tip, deflecting its centre line through $7\frac{1}{2}°$ to a position approximating the horizontal.

Marks on the runway extending from this position indicated that the major portion of the aircraft rolled to the left, and that the centre line of the fuselage was also deflected to the left, during the course of which the aircraft turned over onto its back before slithering finally to rest 1,900 feet from the threshold of the runway and 200 feet to the left of the centre line, and on a heading 130° to the runway.

From the evidence it would appear that fire occurred in the aircraft when it was in a position where the propeller slash marks commenced and increased in intensity as the aircraft proceeded to its final point of rest where it practically burnt out before the fire could be got under control.

The port wing followed a slightly different course to the main portion of the aircraft, and slid to its final point of rest behind the main wreckage in a tip first attitude, the root end being supported by the extended port undercarriage unit and No. 2 engine. This wing was also on fire and during its passage along the airport surface the No. 1 engine became detached and rolled along the runway, coming to rest immediately behind the main wreckage. It was also on fire.

During the process of the aircraft rolling over, the port outer fin and rudder with a portion of the port tail plane, became detached from the tail unit, and proceeded along the runway coming to rest a few feet from the No. 1 engine.

As the aircraft proceeded along the runway various portions became detached from the structure which included pieces of the wing and fuselage frame, wing structure from the region of station 105 and No. 2 fuel tank, and also a panel from the underside of the wing between No. 1 and No. 2 nacelles. These pieces of the structure confirmed that the port wing was detached. Subsequent examination showed that the wing had fractured at Station 80.

Photographic evidence was produced to show that at the time the wreckage came to rest both the port and starboard undercarriage units were in their correct positions for landing, in relation to the main structure to which they are attached, and subsequent investigation showed their retracting mechanisms to be correctly locked in the down position, despite the fact that the supporting structure had been almost completely melted away due to fire in each case, allowing the port undercarriage assembly to subside in a rearwards direction, and the starboard leg to fold over in a relative outwards direction, causing distortion of the undercarriage support beam and retracting mechanism. This latter movement was made possible by the members becoming ductile due to heat.

The port undercarriage unit was removed from the wreckage, dismantled, and subjected to detailed examination. This revealed the following—

(a) There was no evidence of any impact damage, and on the tread and side walls there was no evidence of rim cutting. There was some lateral scoring and cutting on the No. 1 tyre. The side walls of the tyres had been lightly burnt and both the inner tubes had burst due to heat and the weakening of the tyre due to burning.

(b) **Wheels and Brake Units.** There was no evidence of any rim or spoke cracking, and the tie bolts clamping the two halves of the wheels together were in good condition, indicating that the wheel rims had not parted. There were, however, score marks on the inner face of No. 1 wheel and the outer face of No. 2 wheel, which had been caused by contact with the top bolts positioned around the circumference of the brake assembly. This indicated that the tops of the two wheels had been displaced towards each other due to the upward deflection of the wheel axle extremities.

(c) **Oleo Strut.** Before dismantling, the pressure in the oleo strut was checked and found to be 450 p.s.i. which is 182 p.s.i. in excess of normal. Five gallons of oil were removed from the strut. On dismantling the leg, a mark on the top of the ram piston extending around 280° of the circumference, was found to coincide with a similar mark on the orifice plate of the cylinder, which indicated that the strut had been compressed to its maximum extent, and had bottomed. No other defects were found.

The starboard undercarriage unit was removed from the wreckage and on examination it was found that both wheels and tyres had burnt away, and that the oleo cylinder had split due to excessive internal pressures presumably caused by the combustion of the oil it contained due to intense heat. During this disintegration the piston and ram assembly had been forced beyond its lower limit due to the partial collapse of the stop sleeve. The nature of the collapse of the stop sleeve indicates that it failed due to extreme heat rather than fracture due to a shock impact. Further outward movement of the piston assembly was prevented by the torque links. There were no indications of strut bottoming on the piston head.

The nose landing gear had survived the fire, and was still attached to pieces of the supporting structure. It was intact and correctly locked down. The left wheel outer rim had been scored and damaged, due to contact with the runway, and the outside of the left tyre had been scrubbed, and was deflated.

The left wing of the aircraft had broken away outboard of the Station 80 wing joint, and through No. 2 fuel tank. The identifiable portions of the left wing structure which remained, included part of the top wing skin with rib No. 125, the front spar inboard of Station 80, the rear spar to Station 80 and the bottom skin. The structure outboard of Station 145 remained with the wing and had been virtually destroyed. The inner part of the wing between the fuselage and Station 80 remained attached to the main wreckage. It had survived the fire and it was possible to reconstruct the fracture by placing in position the detached portions which had been collected from the runway area. On examination, failure appeared to have originated with a relative upward movement of the rear spar, as a result of which it had broken across Station 87 at the bottom boom, and Station 70 at top boom. Remains of the bottom wing skin had a failure pattern consistent with a nose down-wing torsion, and the detachment of the wing had been completed by the failure of the front spar in a tip upwards direction. All the sections of this failure appeared to be caused by overstressing, and no evidence could be found to suggest previous damage to the wing, or fatigue failure.

The remains of the flap mechanism showed that all flap sections had been fully extended.

The control booster system operating mechanism was in the "ON" position in the case of the elevators, rudder and right aileron. The left aileron unit was beyond the normal "ON/OFF" position, apparently caused by the extension of the operating controls as the wing became detached.

The propeller hubs were dismantled and it was determined that all propellers were in the 14° fine pitch position, at the time of impact.

In evidence the Department Manager of the Lockheed Aircraft Corporation Projects Stress Group gave the following data appertaining to the structural design strength of the Super Constellation Aircraft

(1) That the aircraft structure was designed to withstand a rate of sink during landing of 10 feet per second.

(2) That the static rating of the tyres used on the aircraft was 34,500 pounds each, and that the maximum deflection load without damage was in the order of 115,000 pounds each, making a total load capacity of each pair of wheels of 230,000 pounds, which could be transmitted to each oleo leg.

(3) That the load which it would be necessary to apply to each undercarriage unit axle was 192,000 pounds in order to cause a sufficient deflection to bring the wheel hubs in contact with the brake assemblies.

(4) That the force necessary to bottom an undercarriage oleo strut which was correctly charged was 187,000 pounds.

(5) That the rate of sink necessary to bottom an oleo strut as at (4) above, at an aircraft landing weight of 110,000 pounds would be between 12 to 14 feet per second, that is 2 to 4 feet per second above the design maximum.

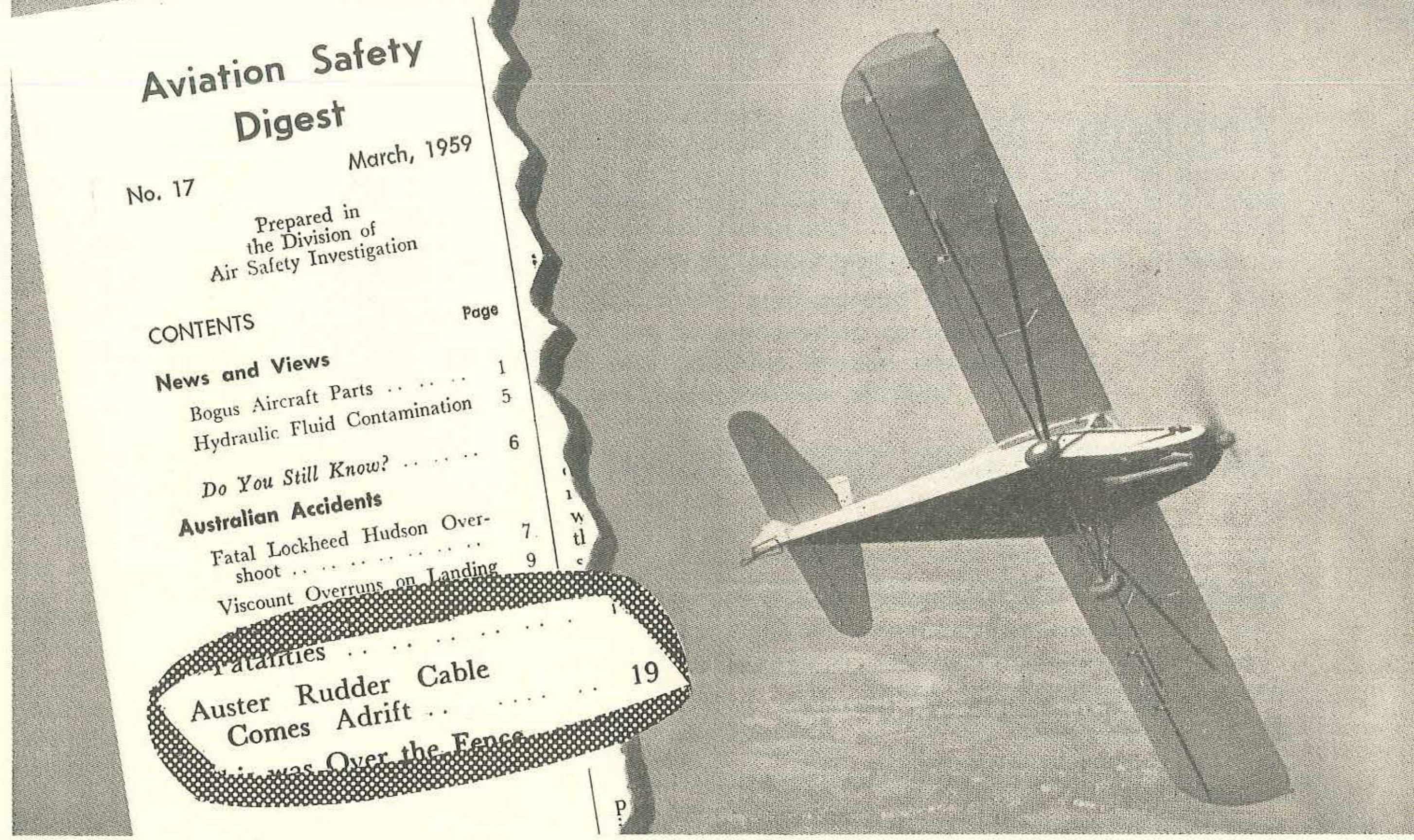
(6) That the tyre marks on the runway threshold, presuming a landing weight of 110,000 pounds with a forward speed of 115 knots, represented an aircraft sinking speed in excess of 10 feet per second.

Whilst it is impossible wholly to exclude a degree of conjecture when reconstructing the aircraft's approach, the following presents a fairly accurate picture of what in fact occurred:—

The aircraft maintained an undesirably high flight path at ranges within one nautical mile of the runway threshold. In order to make a height reduction sufficient to effect a landing, power had to be reduced, and this was done so as to produce a rate of descent that must have exceeded 1,200 feet per minute. Such a rate of descent was greatly in excess of what is considered to be normal practice, and if maintained to the point of contact with the runway must result in major structural damage of the aircraft. The pilot's efforts in the final stages of the approach arrested the rate of descent by some measure but the procedure adopted was insufficiently effective to prevent a severe impact with the runway.

CAUSE

The cause of the accident was the adoption of a final approach path resulting in a heavy landing during which a major structural failure occurred in the port wing in the immediate vicinity of the Station 80 joint caused by the transmission of stresses through the undercarriage in excess of those which would be encountered if the rate of sink of the aircraft at the time of impact had been controlled within the designed maximum of 10 feet per second.



The DIGEST to the Rescue

At 1430 hours E.S.T. on 17th September, 1959, an Auster J5 departed from an airstrip near Narromine on a private flight. The aircraft was being flown by a private pilot licence holder and was carrying two passengers. The weather was fine.

When approximately one mile from the airstrip at a height of about 500 feet above the terrain, the port rudder pedal suddenly moved forward to the bulkhead and the starboard pedal moved forward about four inches. At the same time the aircraft yawed violently to starboard.

From the movement of the rudder pedals and the behaviour of the aircraft the pilot assumed that the port rudder cable had failed. Recalling a report in an Aviation Safety Digest of an accident involving the same type of aircraft when a loss of directional control resulted from the same cause, and the advice in the report on how directional control could be regained in this situation, the pilot followed the advice given in the Digest at that time. The throttle was closed to reduce propeller torque and the starboard rudder pedal was pulled backwards by hooking the toe under the pedal. Directional control was gained in this way after a loss of approximately 100 feet of height.

The pilot then increased power and found that he could maintain straight and level flight with almost cruising power. He then made a turn to starboard by relaxing the pressure behind the starboard pedal and landed in a cleared paddock. The landing was uneventful and directional control during the landing run was achieved by the use of brakes.

The port rudder cable was found to be broken at the point where it passes around a fibre pulley attached to the cabin floor. An inspection of the starboard cable revealed that it was worn at the same point to the extent that the diameter in this area was .006 inches less than the original diameter, and one strand of the cable was broken. Both the port and starboard cables had been in service for 922 hours. Failure of Auster rudder cables at the floor pulleys is not uncommon; there have been 13 partial failures and 10 total failures reported in this country since 1953. In an endeavour to prevent these failures, different types of cables have been tried without success. Following this incident, and pending a positive fix, a letter was sent to all Auster owners drawing their attention to the possibility of such a failure and suggesting frequent inspections.

Freight Movement causes Loss of Control

GREAT BARRIER ISLAND, N.Z.

At 1335 hours on 13th January, 1960, a Piper PA.18A approaching Great Barrier Island was seen to assume an acute angle of port bank, the nose dropped and the aircraft spiralled into the ground. The pilot, who was the only occupant, received fatal injuries.

(Summary based on the report of the Accidents Investigation Branch, Air Department, New Zealand)

THE FLIGHT

The purpose of the flight was to transport urgently needed spare parts for a motor lorry from Mangere on the mainland to Great Barrier Island, N.Z. The pilot had flown to the island on several occasions previously.

The aircraft used was a Piper PA.18A equipped with a rear bench seat and tandem controls on the left side. The rear control column was removed for this flight.

The freight consisted of an Austin 5-ton truck differential weighing 140 lb., together with brake linings, paper gaskets, nuts, bolts and washers. To facilitate stowage of this equipment, the pilot obtained an upholstered 3-ply chair seat, and placed it, upholstery downwards, on the rear aircraft seat. The truck differential was then placed on the chair seat with the crown wheel vertical, teeth to starboard, and the universal joint to the rear. The assembly was secured by passing the rear seat lap strap around the front edge of the crown wheel where it emerges from the casing. Two packets of brake linings were stowed vertically within the belt, one each side of the differential. No other lashing or means of securing the freight were used.

The aircraft took off and the flight was normal until arrival over Great Barrier Island. The normal approach to the island was to cross a coastal range of hills at a point known as "the saddle" and it was well known that under southerly wind conditions, a small area of moderate to severe turbulence was invariably encountered in this area.

Five witnesses watched the aircraft approach across this range of hills, at about 800 feet above the ground. All agreed that, just after crossing the saddle, the port wing of the aircraft dropped suddenly into a vertical bank position. The nose pitched down and the aircraft rotated to the left, with engine noise progressively increasing. As the dive progressed the radius of turn became larger and the angle of dive decreased, until, just before impact, the aircraft was describing a wide left hand arc, still vertically banked.

INVESTIGATION

Investigation of the wreckage trail confirmed the witnesses' description of the crash. No fault could be found in the structure of the aircraft which could be reconciled with the vertical wing-down attitude. The pre-impact integrity of the control runs, hinges and attachments of control surfaces and flaps were confirmed. The tail plane trim indicator was at the full nose heavy setting, coinciding with the trim setting of the tail plane. The impact forces had been taken on the left side of the aircraft, leaving the right hand wing and undercarriage relatively undamaged. The differential was wedged in the space between the front and rear seats, jammed underneath the rear of the pilot's seat. The rear safety belt, still done-up, was underneath the differential casing. The chair seat upon which the differential had been resting had slipped forward and was tilted into the area between the front and rear seats. The two packets of brake linings were jammed under the front port rudder pedal.

Examination of the rear control column socket revealed that the upper edge of the steel tube was dented and had been burred over by a force delivered from the starboard rear.

The front seat supporting structure had failed in shear as a result of a forward movement of the seat. All witnesses were unanimous in their opinion that the aircraft was flying normally until it assumed a steep angle of left bank and that this angle of bank still existed when the aircraft struck the ground. It was a logical conclusion, therefore, that the cause of the sudden application of bank was also the primary cause of the accident.

Calculation of the inertia forces at the impact established that had the differential been on the seat at the time, the comparatively sharp edge of the crown-wheel would have severed the seat belt and thrown the unit into the port upper area of the cabin. However, as the belt was still intact and the impact damage inflicted on the aircraft by the differential was concentrated on the seat structure, it was clear that the unit must have been in the space between the seats before impact.

It was concluded that the differential escaped from underneath the seat belt by toppling 90 degrees to starboard before sliding forwards. Under the influence of negative G or deceleration associated with turbulence, it then fell forward, forcing the rear control column socket hard over to the left and slightly forwards.

In these circumstances the only controls available to the pilot to counteract the acute angle of bank and pitch down of the nose would be top rudder and tail trim. It is probable that the instinctive recovery action of the pilot was to apply full top rudder and wind the trim fully back in an effort to get the nose up. Realising that the effect of nose-up trim was to tighten the spiral he probably then wound it fully forward. This effect, plus top rudder and the gradually increasing speed, progressively converted the steep spiral dive into a wide left-hand slipping turn.

It was concluded that the cause of the accident was the jamming of the controls by the breaking loose of inadequately stowed freight.

The foregoing accident report conveys a very important lesson for all persons who carry freight in aircraft of a type not especially designed for the purpose with appropriate tie down points provided. It must be remembered that an aircraft is not stressed to withstand forces which can be imposed by a heavy piece of freight becoming dislodged and being thrown about, such as can easily happen in conditions of turbulence if not adequately secured.

As turbulence can be encountered without warning on any flight, it is essential to ensure at all times that freight of any kind is securely restrained against any movement from its position of stowage.

BACKWARD MECHANIC ENDANGERS FLIGHT

Ever know anyone to do the paper work before the aircraft was serviced or before the maintenance work was completed? Such a backward system may save a minute or two at despatch time, but it is not conducive to accurate records; it is contrary to all the rules, and it is a very dangerous practice, dangerous for everyone concerned.

Let's learn from an incident that happened in Europe.

About 30 minutes after a twin-engined aircraft departed on a five-hour flight, an employee of the oil company which had serviced the aircraft reported that he had reason to doubt the accuracy of the record that both engines had been serviced with 6 gallons of oil. The record in question was the duplicate page of the Technical Log. It showed that on arrival both tanks contained 17 gallons, that 6 gallons had been added to each tank, and that on departure each tank held 23 gallons.

On being questioned, the mechanic who certified the oil and fuel record admitted that at no time had he checked the oil tank contents. He had completed the paper work on servicing that was **never** started. A further check with the oil company disclosed that 6 gallons of oil had been added to both tanks of another aircraft for which no instructions had been issued, and no oil had been added to the aircraft just despatched.

Fortunately no accident resulted. The aircraft was contacted by radio and the captain advised to divert to the nearest company station. On landing it was found that the left oil tank contained 7 gallons and the right $3\frac{1}{2}$ gallons.

Thus it was that in the age of flight a "backward" mechanic learned the inadvisability of putting the cart before the horse.

(Extract from Aviation Mechanics Bulletin)

Dove in Fatal Fly Past

CARDIFF, WALES

On 6th May, 1959, a Dove DH.104 engaged in a "fly past" flew at an extremely low altitude with the starboard propeller feathered. After continuing some distance, the starboard propeller commenced rotating and a few seconds later the aircraft dived steeply to the ground. All on board were killed instantly.

THE FLIGHT

The aircraft took off at 1320 hours with three passengers on a private flight to fly over the opening ceremony of the Welsh Ideal Homes Exhibition being held in Sophia Gardens near the centre of Cardiff, Wales. The pilot flew over the exhibition at least three times at a very low altitude, the length of each run extended for some three or four miles and its altitude during the first two of these was estimated to have varied between 200 and 1,000 feet. The engines were operating normally and there was no outward sign of any malfunctioning of the aircraft.

On the final run towards the exhibition the aircraft was seen approaching from the south-east at a range of about 1½ miles and at an altitude of about 100 feet. The starboard propeller was then stationary and was later identified as being feathered. It passed over the exhibition with the propeller feathered at an extremely low altitude and, after continuing for about half a mile, rotation of the starboard propeller indicated that the pilot was attempting to restart the engine. A few seconds later the aircraft yawed from side to side and climbed slightly to clear some high trees. It then went into a steep right-hand climbing attitude from which it dived almost vertically to the ground.

INVESTIGATION

Inspection at the scene of the accident confirmed that the aircraft had dived into the ground in a near vertical attitude. With the exception of the outer sections of the mainplane the aircraft was almost entirely burnt out. The flaps and undercarriage were retracted, and the starboard fuel cock was in the "off" position. There was no evidence that the starboard engine was running under power at the time of impact.

It is probable that during the unfeathering action of the starboard propeller the pilot omitted to turn on the fuel. Consequently, the engine did not develop power and the aircraft lost airspeed due to drag from the windmilling propeller. Under the prevailing conditions the performance of the aircraft, with a propeller windmilling and with maximum power from the other engine, would permit only a very small rate of climb. The fact that the starboard propeller was not feathered and that the cockpit pitch control lever was in the feathered position indicates that the pilot had initiated refeathering action at the last moment.

The pilot was the holder of a commercial licence and had completed a total of 256 flying hours chiefly on single-engined aircraft. His experience in Dove aircraft was 28 hours of which approximately four hours only had been in command. He had failed to obtain a Group 1 type rating endorsement as he was not competent to fly the aircraft under conditions of asymmetric flight.

CAUSE

It is considered that the cause of the accident was loss of control by an inexperienced pilot during an attempt to restart an engine following asymmetric flight at a very low altitude.

AIRCRAFT SERVICING

Recently, when the cowling panels around a jet power plant were opened for a routine power plant inspection — an empty oil can dropped to the ground. Paint from the exterior of the can was found on the fuel heater — close to the fuel control unit.

One of the basic rules of aircraft maintenance is to complete a thorough "Final Inspection" for tools, loose objects or foreign articles before closing inspection panels and cowling. No circumstances should cause deviation from this rule.

(Extract from Aviation Mechanics Bulletin)

ISOLATED CASE!

Some accidents and many hairy incidents are caused by stray tools, and parts being adrift in aircraft. From the number of cases reported it appears that maintenance personnel are not aware that such misplaced hardware can lead to disaster.

The U.S. Navy provided some tragic and near tragic examples, but it should not be assumed that they happen only in the Navy. Usually labelled "Isolated Case", they occur far too frequently throughout civil aviation.

THREE NAVY CASES

A F9F-5 was just out of check and on a rocket-bombing run. Full recovery was not made from a run on its target and the aircraft struck the ground in an upright flat attitude, and then exploded.

Cause of the accident was not conclusive, due to the explosive forces which destroyed the aircraft on impact. But the unexplained presence of a screw driver handle found in the wreckage, and considerable other evidence led the Accident Investigation Board to believe that jamming of the elevator controls by the screw driver was the most probable cause.

In the next case the consequences were not as severe. The discovery of control difficulty was made during a less critical manoeuvre, and skill of a professional type brought home the aircraft as well as the evidence.

Immediately after becoming airborne, the pilot of an FJ-2 noted a definite stress in the aileron controls. The stiffness became progressively worse. During the approach to landing the pilot attempted to raise the left wing and encountered an abrupt stop in the stick movement to the right. The stick would move about one inch past centre and then stop.

The pilot levelled the wings with the rudder and what aileron control he had, then added power and climbed to 15,000 feet. He tested characteristics and decided a landing would be possible at 150 knots airspeed, with the use of the rudder and by making gentle turns. Touchdown was made 1,000 feet down the runway after a constant power-on descent.

An investigation was made immediately. The left-hand wing leading edge was dropped revealing a 1¼ inch piece of aluminium tubing jammed between the outboard fold aileron bell crank assembly and the nut on the second Phillips head screw, outboard of the wing fold which secures the forward-most stringer of the outboard section.

The report called this one an isolated case.

A Marine Air Wing reported that an FJ-4 pilot suddenly found his flaps had lowered during a turn. The flap handle was still UP and the accelerometer showed 8.4 g had been imposed.

A 5/16 inch washer had edged across the terminals of the flap control relay, completing the "flap down" circuit. The washer had not come loose from anything. It was just part of the trash that all too often is adrift in aircraft.

IT CAN HAPPEN AGAIN

The inference from these "isolated cases" is that this kind of thing can only happen once. There is no such thing as an "isolated case". If it happened once, it can happen again, and again. Perhaps the exact same circumstances may never be combined again, but you can bet your bottom buck the end results will be the same.

What can you do to help eliminate this type of accident?

The following should help:

- Remember first that an aircraft is most vulnerable after maintenance and service checks.
- Second, that trouble usually comes from where you don't look.
- Inspect thoroughly for tools, parts and other hardware which may be adrift.
- Vacuum out all residue and other foreign materials after maintenance.
- Be as meticulous as a surgeon, use a check list—inventory your tools, parts and other equipment after each job.
- Make sure the inventory is accurate. If a shortage is noted this is reason for a thorough investigation of the aircraft involved. Otherwise you may be setting the scene for a major accident.
- Learn to associate tools with the jobs on which they're used — if any are missing you are more likely to locate them.

(Extract for Aviation Mechanics Bulletin)

Convair Crashes during Instrument Approach

MIDWAY AIRPORT, CHICAGO, U.S.A.

(Summary based on the Report of the Civil Aeronautics Board, U.S.A.)

(All Times U.S.A. Central Standard)

A Convair 240 aircraft engaged on a cargo flight crashed in a railroad yard during an instrument approach to the Chicago Midway Airport on 15th March, 1959. Neither pilot was injured although the aircraft and cargo were destroyed.

At the time of the accident the company's prescribed cargo minimum ceiling of 300 feet existed; visibility was one mile in rain which was one-fourth mile more than cargo minimum. The flight missed one approach to Runway 31, was again vectored into proper position and then started another. Descent continued below 300 feet until the aircraft struck the top of a 96 foot steel tower, crashed and burned.

Investigation disclosed no functional difficulty with the ground aids, the aircraft or any of its components. Descent below the minimum approach altitude, before the runway was definitely in sight, stands as the basic reason for the accident.

INVESTIGATION

The flight originated at La Guardia Airport, New York, for Midway Airport, Chicago. The captain and first officer were the only occupants. The aircraft's gross weight was within limits as was the location of its centre-of-gravity.

The aircraft departed from La Guardia at 2145 hours and was cleared only to Detroit because of adverse weather conditions at Chicago. The flight to Detroit was uneventful and after landing, fuel was added and the captain talked by telephone with the company's despatcher at Chicago concerning the expected Midway weather at arrival time. The despatcher, after consulting with the company meteorologist, advised the captain that the weather was not expected to go below minimum, although thunderstorm activity was likely at Midway. In reference to this weather information the captain testified, "At that point, I could see no reason to say 'No', so I went. I didn't want to, but I couldn't find a good reason not to." Accordingly, the flight departed Detroit for Chicago with Cincinnati as the alternate. There is no evidence that the despatcher urged the captain to continue.

The flight proceeded to Chicago in continuous rain and was cleared to Surf intersection 12 miles east of Midway. The airport weather was reported at that time as ceiling 500 feet, visibility one mile. Runway 13, the instrument landing system runway, was then in use. Shortly thereafter, because of a change in wind direction, the active runway was changed to 31 and the flight was so advised. The I.L.S. equipment for Runway 31 differs from that for Runway 13 in that Runway 31 does not have a glide path or approach lights and the frequency of its localiser is 109.5 mcs. instead of 109.9 mcs.

Upon reaching the Surf intersection, the tower controller vectored the flight to the Kedzie fan marker, 3.3 miles from the active runway, and the final approach was started.

During the approach the pilot reported to the tower that the localiser indicator in the aircraft was not functioning correctly. The controller then advised that the localiser frequency for Runway 31 was 109.5 mcs. The captain changed from 109.9 mcs. to the proper frequency and the trouble was corrected. He explained later that he was using the wrong frequency because at that time he thought he was making a "back course" approach utilising the Runway 13 I.L.S. He said that the controller used the words "back course". This approach was discontinued at 600 feet above field elevation and the missed approach procedure was started.

The first officer flew the aircraft during a portion of the return to Kedzie while the captain studied the Runway 31 I.L.S. approach plate.

The landing gear was extended and the aircraft was trimmed for a rate of descent of 300 feet per minute. Both pilots stated that on this second attempt, according to their altimeters, they were never less than 400 feet above ground level and never more than two dots deflection from the centreline on the I.L.S. indicator. The captain testified that there was turbulence during this second approach and that he was checking power and attitude instruments as well as looking over the glareshield while making a decision to go around or continue. Directly under and ahead of the aircraft approaching Runway 31 was a large railroad yard with well-lighted areas, and a heavily travelled and brightly illuminated highway lay only a short distance to the left of course. The captain stated that he did not see this lighted area but suddenly saw a steel tower through a break in the clouds, attempted to pull up, applied power, and ordered the landing gear up.

The first officer stated that he observed ground lights as the aircraft passed intermittently in and out of cloud bases and suddenly saw a red light on top of a transmission tower. Previously he had called out "minimum altitude" when his altimeter read 1,000 feet (400 feet above airport level) and then concentrated his attention to looking for the runway. He stated that he believes he started the gear-up as ordered. Almost simultaneously the aircraft struck the tower, was substantially damaged, and nosed down sharply. Up elevator was applied and descent was lessened somewhat as the aircraft plunged into a railroad yard. It skidded across tracks, coming to rest close to a moving freight train about 2,600 feet from the tower. Both pilots got out through the captain's window just ahead of a fast growing fire which consumed the aircraft and its cargo.

The steel tower is 96 feet higher than the airport, 6,350 feet from the approach end of Runway 31, and approximately 3,000 feet to the left of the extended centreline of the runway.

Examination of the wreckage disclosed that both I.L.S. receivers were at the proper frequency. Little could be learned from the remains of the A.D.F. receivers because of fire damage, although the captain had been using both of them, apparently satisfactorily. Nothing whatever could be learned from the remains of the altimeters nor their static systems. The wing flaps were found at a setting of approximately 20 degrees, and the landing gear was down and locked.

Examination of the engines and propellers showed that they were operating in an approach condition at the time of impact. The right propeller governor was set to obtain 2,220 r.p.m. and the right propeller was at 31 degrees pitch. The left governor was set to obtain 2,310 r.p.m. and the left propeller was at 30 degrees pitch.

All ground radio navigational facilities utilised during the final approach were checked by the Federal Aviation Agency and found to be functioning normally.

The correct altimeter setting was given the flight before the approach to Midway and the crew set their altimeters accordingly. Investigation also showed that the ground altimeters from which the setting was given were indicating accurately. Both of the aircraft's altimeters functioned properly and were cross-checked during the flight from La Guardia including the landing in rain at Detroit.

Investigation disclosed that the reporting of the Midway weather to the flight was both accurate and current. Thunderstorm conditions prevailed in the general area and lightning flashes could be seen in the northwest and northeast quadrants. Nevertheless, there was no frontal passage at the time and place of the accident which could have caused wind changes of sufficient magnitude to have significant effect upon the approach path.

The captain had not been flying regularly into Chicago. His last previous landing there had been about three weeks before this accident and the preceding one had been six months earlier. He and the first officer had flown together only once, some 16 months earlier. The captain testified that he was familiar with the Chicago area but had not studied the Chicago approach plate recently nor prior to the Detroit-Midway leg of the flight.

ANALYSIS

According to the approved approach procedure for an I.L.S./A.D.F. approach to Runway 31, the Kedzie fan marker should be crossed at an altitude of 900 feet above airport level, a gradual descent begun, and the descent continued until reaching minimum altitude at or near the middle marker six-tenths of a mile from the approach end of the runway. Upon reaching the middle marker or shortly thereafter, if the pilot does not have at least ceiling and visibility minimums, and the lights identifiable with the runway are not in sight, a missed approach procedure must be started. The evidence clearly indicates that this procedure was not followed.

The captain's inability to execute the first approach properly stems from his failure to study the approach plate and his lack of knowledge of the procedure, even the frequencies involved. As he had studied the approach plate between the first and second approach, it is apparent that he must have been aware of the proper procedure during the second approach. A descent to a dangerously low altitude must have been made early in the second approach. Several facts point to this belief. The tower struck was only 96 feet high. It was located more than a mile from the approach end of the runway and it was 3,000 feet to the left of course. At impact the aircraft was in the approach configuration with respect to propeller governors and propeller blade pitch angles, and wing flaps with landing gear down and locked. It is evident that during the approach both the I.L.S. and A.D.F. pointers clearly indicated that the aircraft was off course to the left. In fact, the I.L.S. pointer must have been fully deflected quite some time before impact. The captain was a well qualified instrument pilot and would normally easily detect these discrepancies, this can only mean that he was not referring to his instruments during the final portion of the approach.

PROBABLE CAUSE

The Board determines that the probable cause of the accident was the pilot's descent below his allowable minimum altitude and his inattention to flight instruments while attempting to locate the runway visually.

Elevator Controls Disconnected

ABILENE, TEXAS, U.S.A.

(Excerpts from the Official Report of the Civil Aeronautics Board, U.S.A.)

On the afternoon of 2nd September, 1959, a C46F crashed on runway 16 at Air Force Base, Abilene, Texas. The crash occurred while the pilots were attempting to land the aircraft with the elevator controls inoperative. The captain and co-pilot, the only persons aboard, were killed and the aircraft was demolished.

Examination of the longitudinal control system of the aircraft disclosed that the aft end of the aft link assembly was disconnected from the clevis in the elevator control horn assembly.

From irrefutable physical evidence the Board concluded that the bolt which normally secures the link assembly-clevis attachment was not in place at impact. It concluded that the bolt worked out following departure from Dyess resulting in the loss of control which caused the accident. The Board further concluded that the bolt worked out because it was improperly secured, a condition which should have been detected during a No. 2 maintenance inspection completed just prior to the origination of the flight. The inspection was performed by a certificated repair station which performed under contract the maintenance work for the operator.

INVESTIGATION

At 1611 the flight departed Dyess for Carswell. At 1631 the flight contacted the Abilene, Texas, Municipal Tower. The pilot stated he was about 30 miles east of Abilene, declaring an emergency, and returning to Dyess. He reported that he had lost elevator control and was on autopilot. The Abilene controller passed this information to the Dyess Tower and requested the flight to contact Dyess. Dyess promptly alerted the Base emergency facilities.

About 1638 the flight contacted Dyess Tower. The pilot reported the flight was on emergency because of the loss of elevator control and would attempt to land at Dyess. He then requested ground - controlled approach (GCA) assistance. (Weather was no factor in this request. GCA assistance would help the pilot in his visual judgment of alignment, distance, and elevation during the approach). The tower controller advised local traffic of the GCA frequency and advised him to switch to that facility. The controller advised local traffic of the emergency and gave the flight complete latitude of action.

Radio communication was established between the flight and the GCA and, about 1645, GCA had positive radar contact.

The pilot requested a straight-in approach to runway 16, which is 13,500 feet in length.

GCA assisted with alignment, elevation, and distance information he asked for. To observers the approach seemed good although the closest observer, a qualified multi-engine pilot, noted that control of the aircraft in the pitch plane was jerky and slightly over-controlled. A short distance from the runway threshold and about 50 feet above the ground the approach was discontinued. At that time the pilot transmitted, "I'm going out north a couple miles, I'm going to try to land this thing on elevator tab instead of autopilot. I get a little better control using power and trim." The flight then proceeded several miles north of the Base.

The flight manoeuvered with GCA assistance for a long (about nine miles) final approach. Alignment was very good and when the glide path was intercepted, the GCA controller gave, as the pilot had requested, glide path information. The position of the aircraft on the glide path was good. The closest observer noted that pitch control was better but still jerky and over-controlled. A C-46 pilot suggested, through GCA, that the pilot roll in forward trim as soon as touchdown occurred. The captain responded, "Roger, we've already got that figured out".

Touchdown occurred at 1715. It was a "wheel landing" with the aircraft speed greater than normal and with considerable power. The wing flaps appeared to be extended between 10 and 20 degrees. The touchdown was considered excellent by all observers. The aircraft rolled on the main wheels for the next 500 - 1,000 feet without an audible power reduction. It then skipped about 1-2 feet above the surface and again contacted the runway on the main gear only. This contact caused the tail to rotate downward and the aircraft "porpoised", leaving the runway nose-high. It reached 4-6 feet, then descended slightly nose-down and again contacted the runway, this time with greater force on the main gear. The force amplified the downward tail rotation causing a second, more severe "porpoise". At this time power, estimated by several observing pilots as full power, was applied. The aircraft climbed in a steep nose-up attitude to 150-200 feet above the runway. There it stalled, pitched down violently and crashed on the runway in a nose-down angle in excess of 45 degrees.

The fuselage forward of the leading edge of the wing was demolished by impact. This section was torn off and moved 425 feet ahead of the remaining aircraft structure when the cargo broke loose and shifted forward with great force. Relatively, the remaining fuselage and empennage was undamaged. The left wing was sheared off at the attachments to the fuselage and the right wing remained attached only by control cables. Both engines were torn from the mounts. A fire occurred but was extinguished in seconds by the efficient and well-equipped Dyess rescue and fire-fighting team.

Because the pilot had indicated an elevator control failure, investigation was immediately directed to the longitudinal control system of the aircraft. Upon removal of the yoke assembly access panel, it was immediately noted that the aft or bearing end of the link assembly was not connected to the clevis in the elevator control tail section assembly (see Fig. 1). The bolt which normally connects the clevis and link assembly was missing.

The effect of this disconnect condition would be the loss of all longitudinal control except that obtained through use of the elevator trim tab system and that which could be obtained by manipulation of engine power. Under this condition the autopilot could not be used for pitch control; however both the manual control system and the autopilot system could be used normally to furnish lateral and directional control.

During a search of the tail area, a bolt of the same size and specification, AN5-12, as the missing bolt was found. It was found lodged on the right side of a shelf of a bracket in the tail compartment. The shelf where the bolt was found is located aft of and above the link assembly and clevis attachment and separated by a bulkhead containing 3½ inch lightening holes. The bolt did not have a washer, castellated nut, or cotter key on it and no such item which would fit the bolt was recovered.

Examination of the bolt showed it had been in recent use. The shank surface was moderately bright and there was no evidence of rust, corrosion, or grease film on the bolt. The peaks of the threads revealed minor wear and polishing. A small amount of loose residue was found in the cotter key hole. This residue appeared to be the same as residue which was accumulated in the bottom of the fuselage in the area below the link assembly-clevis attachment. Relatively, the shelf where the bolt was found was clean.

At the request of the Board, the recovered bolt, clevis, and link assembly were examined by the National Bureau of Standards.

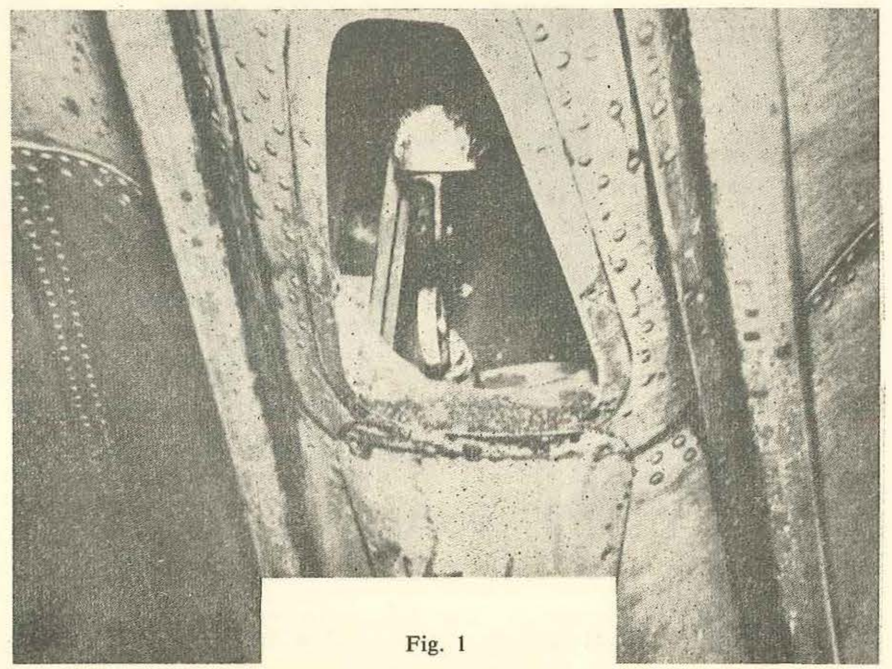


Fig. 1

From the examination it was not possible to identify the bolt with the specific link assembly and clevis from N5140B. It was possible, however, to determine from marks on the bolt that it had been installed in an assembly with the same dimensions as the clevis forks and bearing bore of the link assembly (see Fig. 2).

It is worthy of note that the AN5-12 bolt is not specified for any other attachment or assembly in the empennage section of the C-46.

In an effort to satisfy the contention that it was possible for the bolt that had connected the bearing end of the link assembly to the clevis to have been properly in place at impact, and that impact forces could have sheared the bolt and that the pieces could have fallen free and could have been lost, the longitudinal control system was re-examined in its entirety. In addition, the stress analysis data on the pertinent parts of the link assembly-clevis attachment were carefully reviewed and tests to failure were made on the attachment assembly. The tests were performed by the National Bureau of Standards at the request of the Civil Aeronautics Board.

The stress analysis data showed that the strength of the AN5-12 bolt was greater than the strength of several other components which comprise the link assembly-clevis attachment; this therefore showed other components in the assembly would fail first. As stated, all components of the attachment recovered from N5140B were undamaged.

ANALYSIS AND CONCLUSIONS

Examination of the longitudinal control system of N5140B revealed the link assembly was disconnected from the clevis and all of the components which comprise the link assembly-clevis attachment were undamaged. Stress analysis data and tests by the National Bureau of Standards conclusively proved that had an AN5-12 bolt been in place in the attachment, high impact forces could not have sheared the bolt but would have badly damaged the components. It is on this irrefutable physical evidence that the Board concluded the AN5-12 bolt which normally secures the link assembly-clevis attachment was not in place when the aircraft crashed.

In addition to the above it was the Board's opinion that the recovered bolt is not evidence that a bolt of the required specification for the attachment, one of recent use, and one with markings matching the bearing bore and clevis fords, was left in the tail during previous maintenance. On the contrary, it was the Board's opinion that this is evidence that the bolt was the one holding the attachment together immediately prior to the accident. Considering the inflight jostling, the forward forces when the aircraft struck the runway, and the aft forces when the tail toppled to the runway, it is entirely possible for the bolt to have reached the location where it was found.

In view of the aforestated analysis and conclusions, it was the judgment of the Board that the bolt worked out of the attachment, causing the loss of elevator control. It follows that the bolt could have worked out only because it was improperly secured, a condition which had to exist and should have been discovered when the No. 2 maintenance inspection was made less than two flying hours before the accident. In the opinion of the Board it also followed that, had the inspection of the attachment been performed by the inspector, the insecurity of the bolt would have been detected.

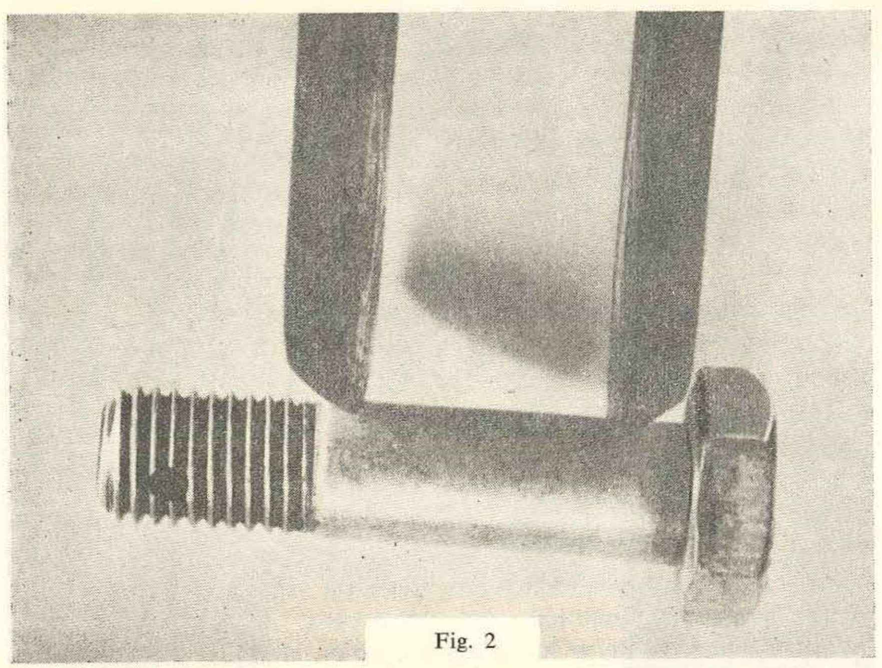


Fig. 2

PROBABLE CAUSE

The Board determined that the probable cause of this accident was loss of elevator control because of an improperly secured bolt, a condition which was undetected because of an inadequate inspection.

DESIGN FOR SAFETY

FUSIBLE WHEEL PLUGS REDUCE THREAT OF BLOWOUTS AND WHEEL FAILURES

by
VERNON A. TAYLOR
Flight Safety Foundation

Fusible wheel plugs, designed to deflate the tyres on the big birds before a heat induced explosion can occur, are making airports safer for ground personnel. Installed in all tubeless tyre and wheel assemblies on the heavy turbine transports they have significantly reduced the hazards of blow-outs and wheel failures.

The high landing speeds, reduced tyre size and new gross weights of the modern transports have increased brake energy requirements to a fantastic degree. Any expended brake energy spells heat, and the problem of dissipating this heat is compounded on the jets by the lack of cooling air from a propeller. With a lot of heat and a built-in heat transfer from brake-to-wheel-to-tyre, the result was dangerously high tyre pressures.

The threat of a blow-out or wheel failure coupled with the possibility of a brake fire made a rough situation. After extreme braking, as in the case of an aborted take-off or an exceptionally fast landing, mechanics were warned to stay clear of the aircraft for at least thirty minutes. And when there was a fire the firefighters were cautioned to approach the wheel only from the front or back, never from the side where they could be struck by the fragments of an exploding wheel.

Fusible or thermal relief wheel plugs have changed all this. Designed to melt at a pre-determined temperature they release the air pressure in the tyre before an explosion can occur. Plugs vary from a rivet or screw of fusible alloy to hollow bolts filled with a eutectic metal. One such metal is composed of 91% zinc and will melt between 390 - 400°F. This is just below the critical temperature for nylon tyres and well below the critical temperature for wheel assemblies. Three or four plugs are spaced around the wheel so there will always be one near the top where the wheel is the hottest when at rest.

Thermal relief plugs will not eliminate tyre explosions under all conditions. A skid may wear through several tyre plies and failure due to reduced tyre strength may follow. Tyre side walls may also become over heated to the point of blowout simply because of excessive taxiing at full gross weight. Fusible or thermal relief plugs however, will undoubtedly prevent a great majority of blowout incidents that would otherwise be experienced.

CESSNA BRAKES

When brakes were applied on the landing run in a Cessna 172 the starboard brake remained locked in the "on" position. Subsequent investigation into the defect established that it was caused by the cross arm of the parking brake unit partially turning over, due to incorrect rigging of the linkage of the parking brake mechanism.

The spring linkage mechanism had been misaligned to the extent that it had pushed the cross arm toward the firewall, causing the cross arm to turn over, and the loop in the centre of the cross arm to ride over the top of the looped clip on the end of the spring linkage. This misalignment had the same effect as applying the parking mechanism and resulted in tilting the cross arm, lifting the starboard lockplate to the parked position.

For satisfactory operation of the brake parking system it is essential that an angle of 90° be maintained between the vertical and horizontal arms of the spring linkage, in order to preserve an equal lift on each of the lock plates.

Though this occurred on a Cessna 172, the same defect could occur on other Cessna models, as the parking mechanism is similar. It is important that the manufacturer's instructions for rigging of the brake mechanism are strictly adhered to.

DC3 Captain's Judgment Astray

KERRVILLE, TEXAS, U.S.A.

(Summary based on the Report of the Civil Aeronautics Board, U.S.A.)

(All Times Central Standard)

A DC.3 crashed shortly before midnight near Kerrville, Texas, on 1st February, 1959. Three of the 28 occupants including the captain and reserve captain were killed, four were seriously injured and the remainder received minor injuries.

THE FLIGHT

The aircraft was engaged on a civil air movement of 25 military personnel from Boise, Idaho, to Lackland Air Force Base, San Antonio, Texas. The final segment of the flight was from Pueblo, Colorado, where the Weather Bureau station furnished weather-briefing which indicated icing conditions that were likely to continue. An I.F.R. flight specifying cruising at 9,000 feet was filed.

Departure from Pueblo was made at 1800 hours and at 1916 hours the flight requested an altitude change from 9,000 feet to 7,000 feet, reporting light icing. Approval was granted at 1945 hours and shortly thereafter, the flight again reported light icing. An involved series of radio contacts ensued as the ice accretion became worse, then critical, then incapacitating. A privately used airport at Kerrville, Texas, was staffed and lighted but after an attempt to land there had failed, the aircraft was crash-landed nearby.

INVESTIGATION

The crew of the aircraft consisted of a captain, a reserve captain and a co-pilot. After a rest period of approximately twelve hours they commenced duty in the early morning of 31st January and were on continuous duty for more than 40 hours until the time of the accident at approximately 2337 hours on 1st February.

For the flight from Boise to Pueblo to Lackland Air Force Base the load consisted of twenty-five members of the Idaho National Guard, 597 pounds of baggage, and the three-pilot crew. The flight plan filed with the F.A.A. combined station-tower facility provided for the use of Victor Airway 4 at 9,000 feet, I.F.R., to Malad City, Idaho, with the intention of refiling at Malad City without landing and indicated sufficient fuel for six hours and 30 minutes. The estimated time en route to Pueblo was given as five hours and 30 minutes, with Salt Lake City as an alternate airport.

Investigation of the actual amount of fuel on board revealed an error of 624 pounds in fuel weight and as a consequence the aircraft being approximately 517 pounds over its permissible take-off weight when departing Boise. Again after refuelling at Pueblo, Colorado, the aircraft had a total of 622 gallons and not 380 gallons as shown on the weight and balance form. Thus, the apparent discrepancy of 242 gallons amounting to 1,552 pounds, made the gross weight at take-off from Pueblo 26,322 pounds rather than the 24,870 pounds shown in the weight and balance form. The maximum allowable take-off weight from Pueblo (elevation 4,725 ft.) was 24,950 pounds. The aircraft, therefore, was overweight upon departure from the latter airport by a computed 1,372 pounds.

Either the captain or reserve captain obtained a weather briefing by telephone from the U.S. Weather Bureau Station for the Pueblo - Lackland portion of the flight. This unrecorded briefing, according to testimony of the Weather Bureau, was comprehensive in regard to the probability of widespread icing conditions. The pilot, who did not identify himself, displayed considerable interest in the expected weather and questioned the observer extensively. An I.F.R. flight plan was then filed by telephone with the F.A.A. combined station - tower facility.

The aircraft was cleared for take-off and was off at 1800 hours. Eight minutes later it reported to Pueblo as at 9,000 feet.

At 1916 hours, the flight reported over Dalhart at 9,000 feet and the pilot requested a change in altitude to 7,000 feet as he was encountering light icing. A change in altitude was not approved at this time. At 1945 hours over Amarillo, a further request for a change in altitude was approved by A.R.T.C. At 2022 hours the flight called Lubbock Radio and reported encountering light icing at 7,000 feet. Weather and terminal forecasts for Wichita Falls, Texas, and Oklahoma City, Oklahoma, were requested. The information transmitted to the flight indicated above minimum conditions at several locations.

A change to the minimum en route altitude (5,100 feet) was requested at 2031 hours. The flight was advised of icing conditions at lower altitudes, but following a further request from the flight an A.R.T.C. clearance to the minimum route altitude was granted.

The flight reported over Big Spring at 2115 hours at 5,100 feet. At that time and again at 2138 hours, the flight was asked if a higher altitude was required. It advised being in severe icing and using climb power to maintain altitude. In answer to a request, the San Angelo and Junction weather was transmitted to the flight. Both were above minima with light freezing drizzle. A.R.T.C. records indicate that the flight reported over San Angelo at 2158 hours at an altitude of 5,000 feet experiencing severe icing. The pilot reported that he did not believe he could make San Antonio owing to shortage of fuel.

At 2215 hours, San Antonio A.R.T.C. requested the operator to have its agent at Kerrville, Texas, proceed to that airport and put runway lights and radio beacon in operation in the event the aircraft landed there.

At 2219 hours, the flight advised San Angelo of ice 1½ inches thick on the aircraft's landing lights and at 2220 hours requested 4,000 feet being unable to maintain 5,000 feet. At 2229 hours it advised being at 4,000 feet and descending. At 2231 hours the pilot reported having regained 4,000 feet and Junction radio relayed the Kerrville Airport information.

At 2243 hours the pilot advised Junction that he was at 3,600 feet and at this time Kerrville weather as ceiling 700 feet, visibility one mile was relayed to the aircraft.

At 2249 hours, Junction heard the pilot report that the aircraft was stalling and that he had "less than 100".*

Communication was established between San Antonio A.R.T.C. and the flight at 2257 hours. The pilot advised that he was at 3,600 feet, unable to pick up the Kerrville beacon, and was "awfully low on gas".

In an effort to maintain continuous contact, San Antonio Centre utilised a U.S.A.F. aircraft in flight as a relay station. This aircraft reported at 2313 hours that the flight was over Kerrville attempting an approach, and that the pilot had reported intermittent stalling. At 2325 hours it was reported that the flight had missed the first approach to Kerrville and would make a second attempt. Six minutes later the aircraft was observed commencing an approach and the Kerrville 2245 hours weather observation was relayed to it. At 2339 hours the relay aircraft reported being unable to maintain radio contact.

At 2347 hours, a person living near the Kerrville Airport called the San Antonio Tower and reported that at approximately 2337 hours an aircraft passed over his house and that he then heard an explosion.

The crash site was located at an elevation of 1,535 feet m.s.l. in moderately hilly, wooded terrain 6.8 statute miles bearing 123 degrees T from the Kerrville Airport and 4.4 statute miles bearing 118 degrees T from the Kerrville radio beacon. It is in the approximate area where a procedure turn from an outbound heading to an inbound heading would normally be made for a prescribed DF approach to Kerrville Airport.

At impact the cockpit was demolished by contact with trees. The captain and reserve captain, and one passenger received multiple severe injuries, which in all probability were instantly fatal. The third pilot, in the cabin, was seriously injured and momentarily pinned in the wreckage until extricated by one of the passengers. The twenty-four surviving passengers were injured in varying degrees. They and the third pilot, with assistance, quickly got out and clear of the aircraft as fire broke out.

The co-pilot was not on pilot duty during the Pueblo-Kerrville flight. Shortly after take-off he went to sleep in the cabin. He was the only pilot to survive and his testimony is most enlightening. Portions of it are here quoted:

"I did not awaken until I heard the sound of the engines revving which was approximately forty-five minutes before the accident. This was my first indication that we had any unusual problems. The captain explained that we had been picking up ice for about an hour previous to that. The revving of the engines at this time was for the purpose of flicking ice off the propellers. When we first went forward we were holding an approximate airspeed of 120 knots with cruise power 29 inches and 2,050 r.p.m.

"In a few short minutes the airspeed slipped from 120 knots to 115, to 110 and finally 100 at which time as nearly as I can recall the pilot added power to 35 inches and 2,250 r.p.m. which brought the airspeed up to around 115 to 120 knots. The icer boots were engaged and ice on the leading edge of the wings came off which further increased the airspeed. By the time we were a few minutes short of Kerrville airport the pilot had tuned in the homer at Kerrville and found we were receiving it properly and at this point made the decision to attempt to land at Kerrville rather than continue on to San Antonio since the fuel supply was getting real critical by this time. At this point we were flying at 4,000 feet presumably to have been cleared to that altitude; we were allowed some few feet less than 4,000 feet in that section which would put us approximately 2,000 feet above the terrain. We went to the homer at that altitude and then took an outbound heading for a normal descent and approach; completed the procedure

* Airspeed in knots.

turn, returned to the homer and from there to the airport descending continuously. I don't believe anyone in the cockpit saw the airport though we must have been close. Ice was covering the front windshield entirely and the only visibility was from the side window which the pilot was able to open and could look out from; although unable to see the airport, we had at this time contact conditions and could see the ground. I remember passing over a highway and car lights being visible below. Fuel supply by this time was so low that the gauges could hardly be regarded as reliable.

"The pilot decided to make a second attempt at an approach but rather than follow recommended approach altitude maintained his contact with the ground rather than climb back into the overcast. Somewhere during the second approach attempt the pilot made his decision to bring the plane in for a wheels up belly landing rather than risk the possibility of the fuel running out during blind conditions in the overcast, the re-entry of which would be necessary if we were to go through a normal approach procedure. When he had made that decision, I went to the rear to warn the passengers to keep their seat belts tightly fastened and at the first sign of any emergency to put their heads in their laps. I returned forward and the pilot was still searching for a spot to set down. About this point one of the engines sputtered and was out of fuel. A few seconds later we were making our forced landing. I had taken a seat on the floor facing the rear just behind the bulkhead at the rear of the pilot."

It was subsequently found that at the time of first contact with the ground the aircraft was heading about 75 degrees true; left wing low by about 10 degrees and descending at approximately a 10-degree angle. These figures are readily reconciled with the co-pilot's statement and point to the aircraft being about halfway through a turn from downwind to approach and descending.

There was about a 40-minute lapse between crash and arrival of fire apparatus. As a consequence a great deal of the physical evidence was destroyed by fire, as were all records being carried. It was not possible, for example, to determine the position of the wing flaps, nor was it possible to determine why the windshield de-icers were not effective. Wing de-icers apparently were functioning and testimony of the carrier's maintenance personnel indicates that they should have been in good condition. The landing gear was up.

ANALYSIS

Three pilots had exceeded the regulatory limit of flight duty upon arrival at Boise. Even at that time a degree of pilot fatigue must have set in. Pilot fatigue, which may engender a decrease in competence and diligence, could have been a factor in an overweight take-off from Boise.

The time on the ground at Pueblo was relatively short and it may reasonably be expected that an increased level of pilot fatigue prevailed upon departing Pueblo. The reason for the overload upon departing Pueblo may have been an anticipation of added and unforseeable flight time because of the questionable weather ahead or an indifference to regulations.

Economics could have been a factor in departing Pueblo in the face of a critical weather picture rather than remaining overnight. Laying over would have obligated the carrier to furnish lodging and two additional meals to 25 persons.

The captain was highly experienced with 15,000 hours of piloting, 9,000 of it in DC.3's. This, combined with the weather briefings he obtained, should have alerted him to the fact that by decreasing altitude as he did he would be staying in clouds, with below freezing temperatures and severe icing conditions. The changing of altitude from 9,000 feet to 7,000 feet early in the flight because of icing appears to have been the start of his trouble. He could safely have gone elsewhere; landing in the panhandle section of Texas or a diversion to the east would have been an understandable and safe course of action.

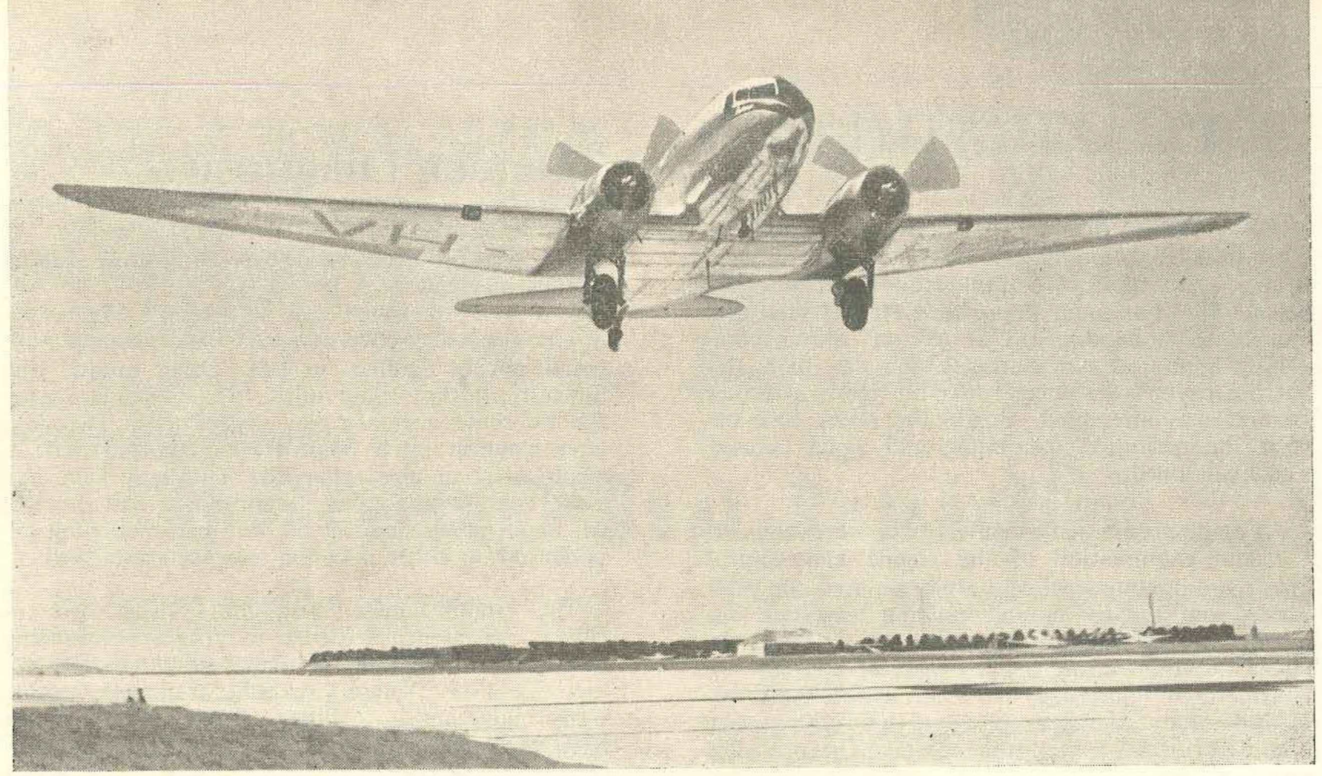
Certainly there was nothing lacking in ground help; personnel of Air Route Traffic Control went to the greatest possible lengths in helping and in getting others to help.

CONCLUSION

This accident was a considerable length of time in the making and was fully preventable. The facts show that operational supervision demanding compliance with regulations was completely lacking and that the captain demonstrated disregard for the Civil Air Regulations. The flight went to and beyond its point of safe diversion despite exemplary efforts by F.A.A. personnel to help. This captain pressed on to complete a mission long after good judgment called for discontinuing the flight.

PROBABLE CAUSE

The Board determined that the probable cause of this accident was the captain's poor judgment in continuing into known and dangerous icing conditions.



NOT TOO OLD TO BITE

When landing at an aerodrome in Northern Queensland, in the course of a regular public transport flight, a DC.3 skidded from the end of the strip and struck a boundary fence when turning at the end of the landing run.

The strip, which has a grass surface, is 4,850 feet long with a downgrade of 1 : 323 in the direction which was used. As the result of continual rain over a period of three months up to and including the day of the accident, the surface was slippery although firm.

There was a low overcast with light continuous rain, the visibility was 2 to 3 miles and the wind was light and variable.

The all-up-weight of the aircraft was 4,400 lb. less than the maximum permissible for the landing.

Following a low level circuit and a full flap approach, the aircraft touched down on the main wheels at a point 1,790 feet beyond the threshold. Moderate braking was promptly applied and the tail wheel lowered after a ground run of 1,260 feet.

When nearing the end of the strip, braking proved ineffective on the slippery surface so power was used to turn the aircraft whereupon it skidded sideways beyond the end of the strip and, unknown to the crew, the tail cone and the port elevator struck the boundary fence.

Although the captain was not aware that the tail of the aircraft had struck the fence, he was aware that it had swung through the tall dense undergrowth which surrounds it. Nevertheless, other than an inspection of the undercarriage, there was no inspection made for damage and it was not until the aircraft had flown to the next stopping point, where the captain requested a further inspection of the undercarriage, that the mechanics discovered a hole measuring 12 inches by 6 inches in the tail cone and damage to the trailing edge and several ribs in the port elevator which necessitated its replacement.

Since this particular airfield's surface is known to be slippery when wet, the captain should have ensured that the aircraft touched down within 900 feet of the threshold which is a close approximation of the distance to the touchdown point from a height of 50 feet over the threshold in the conditions prevailing. Had the height over the threshold been reduced to 25 feet, as would have suited the conditions, the aircraft should have touched down within an approximate distance of 600 feet.

By executing the approach in such a manner that the aircraft touched down 1,790 feet from the threshold, the pilot erred in his judgment of the action required in the circumstances and as a result was deprived of the use of some 1,000 feet of strip. A more careful assessment of the conditions obtaining was warranted and had it been carried out there is little doubt that the aircraft could have been safely brought to rest in the distance available, despite the fact that the surface was slippery and the landing was down the slope of the strip.

PILOT'S DILEMMA —Defect Diagnosis

On take-off from an airfield remote from technical facilities an engine of a transport aircraft oversped beyond the maximum permissible r.p.m. The pilot immediately abandoned the take-off. After completing a ground run, during which the r.p.m. did not rise beyond the normal take-off figure, a second take-off was attempted. Again the r.p.m. rose beyond the permitted maximum, and again take-off was abandoned.

As maintenance personnel were not available, and a visual examination of the engine and control linkages did not reveal any abnormalities, the pilot carried out further ground running tests but was unable to establish the reason for the malfunctioning. Operation during a third take-off was normal, and the flight continued. However, as the flight progressed, high oil temperature and low oil pressure became evident on this same engine. The propeller was feathered and the flight terminated at a suitable aerodrome.

Examination of the engine revealed failure of No. 1 piston and cylinder barrel, due to detonation. It is believed a faulty magneto which had been removed the previous day was the source of this trouble. It was also concluded that the overspeeding experienced during the attempted take-offs was due to metal particles in the oil system causing the propeller governor to stick in one position, thus preventing the governor from maintaining constant r.p.m.

In another incident involving a transport aircraft, the pilot experienced propeller malfunctioning, again at an airport where technical assistance was not available. On take-off the r.p.m. was in excess of the normal figure and did not reduce on operation of manual propeller control. Take-off was immediately abandoned. Because of the relatively short time the r.p.m. was above the prescribed take-off maximum, the pilot was uncertain whether there had been a genuine overspeed condition, or if it was a momentary surge frequently experienced on take-off. The field length had prevented him from continuing with the take-off for sufficient time to establish whether the r.p.m. would stabilise at normal. After carrying out various ground checks, he contacted his base by telephone, discussed the symptoms experienced, and obtained approval to carry out a test flight without passengers.

On this flight the r.p.m. stabilised at a figure in excess of the take-off setting, but was fully controllable by manual means. All other engine and propeller functions were normal. The scheduled flight then proceeded and was completed without further incident.

The propeller governor unit was changed, but could not be faulted on test. Other ground and air tests at that time failed to establish a reason for the above normal r.p.m. experienced. Two days later sluggish pitch control was reported and an electrical component changed. This may have had some bearing upon the circumstances first described, but a precise reason for the malfunctioning experienced on either occasion was not established.

The circumstances surrounding these two incidents are published for the purpose of introducing the problem that faces transport pilots where there are indications of unserviceability at airfields remote from maintenance facilities. These two incidents have been chosen because they illustrate two different approaches to a similar situation. It is not intended to discuss rights or wrongs, or attempt to deal with the many aspects that the pilot-in-command must consider under these circumstances. The sole purpose of this article is to invite attention to the nature of the unserviceability experienced, how it was caused, and the possible effects of continued operation. By doing so, we hope that safety considerations will be carefully weighed against the other factors which influence a pilot in his decision whether to continue with a flight or not where there are indications of mechanical malfunctioning.

Although overspeeding of a propeller may occur during the early take-off stage on almost any constant speed propeller it is a condition which cannot be mistaken by an experienced pilot and therefore not likely to be confused with the conditions associated with some mechanical defect. In the case where metal was present in the engine lubrication system, the contaminated oil could have resulted in the governor pilot valve sticking in a manner that neither feathering nor full power would be possible; as it was, the engine failed, and an unscheduled landing was necessary.

Operational experience has shown there is a definite relationship between malfunctioning of constant speed propellers and contamination of the engine lubrication system. This symptom is appreciated by experienced aircraft engineers, and has frequently led to detection of engine failure in its early stages before serious secondary damage occurred. Proper inspection by qualified persons, is essential when mechanical malfunctioning occurs.

In all cases where a defect remains undiagnosed and uncorrected, a serious hazard may exist and advice should always be sought from properly trained and qualified persons whenever a doubt exists regarding the serviceability of a vital service. Until this has been done, the pilot cannot be sure that a recurrence, or even more serious troubles, will not develop under circumstances that jeopardise the safety of the aircraft. Although aircraft accidents emanating from mechanical causes rarely occur without some prior warning, reports from aviation authorities throughout the world show that this type of accident frequently happens because the pilot has failed to appreciate the significance of an intermittent and/or apparently minor malfunctioning.

Sometimes a ferry flight has been undertaken with an undiagnosed defect. Such a flight under these circumstances has not reduced the chances of an accident, but has merely limited the exposure to the crew.

Maintenance Hazard —

Inadvertent Gear Retraction

"Disciplinary action has been taken . . . and those in charge . . . ordered to ensure . . . all supervisory personnel exercise more personal control over proceedings . . . "

This is a quote from a ground accident report concerning an inadvertent undercarriage retraction that cost $6,000 and 60 man-hours of work.

This is what had happened. A mechanic was detailed to jack the aircraft for a retraction test. Wing jacks were used to lift the main wheels clear of the floor, but contrary to established procedures the nose wheel was not jacked. When an "up" selection was made the nose wheel retracted — proving the adage, "There is never enough time to do it right; but always enough time to do it over".

How many accident reports like that have you seen? Accidents of this type have been amazingly common. They can be attributed chiefly to lack of supervision, shortcuts and carelessness. And because they follow a pattern they should not be hard to stop.

Most inadvertent gear retractions correspond closely to one or another of these three typical cases.

(i) An aircraft was given a retraction test and then parked on the flight line with the undercarriage selector in the up position. When the engine was started the nose wheel retracted. Anyone of three people—the mechanic who made the retraction test, the supervisor, or the man in the cockpit when the engine was started—could have prevented this accident.

(ii) After a retraction test an aircraft was taken off the jacks before the landing gear locking pins were installed. When the hydraulic system was pressurized the gear collapsed. The men who lowered the aircraft did not follow established procedures. The men who pressurized the system could have averted the accident by doing a cockpit check to make certain the selector was in the down position. We have no report on the supervisor's whereabouts all this time.

(iii) In the third case the crew left an aircraft on jacks while they went for lunch. While they were away someone lowered the nose jack and took the jacking pad. The crew returned and without checking they pressurized the system. The nose wheel folded. They had not noticed that the nose jacking pad had been removed and the jack lowered. And the supervisor had not noticed that the crew was shortcutting procedures. (Incidentally, the "thief" should have been strung up three times, once for tampering with another crew's work, and again for not leaving some obvious, unmistakable indication that the work had been tampered with, and finally for impersonating a mechanic.)

This is the pattern. It reveals mechanics who take short cuts and who either do not know or willfully disobey established procedures. And they also reveal supervisors who do not supervise.

The answer seems relatively simple:

(a) Supervisors to spend more time "on the floor" so the mechanics may have the benefit of the supervisor's experience and example.

(b) Better instruction. A refresher for supervisors might help, with emphasis on the fact that "paper work" is not the supervisor's main job, but only the report of how his job is being conducted.

Obviously some mechanics can use instruction too. It is particularly important that they learn the economics of shortcuts and of the avoidance of time consuming procedures. You have to save an awful lot of minutes to pay for a six thousand dollar accident.

(Extract for Aviation Mechanics Bulletin)

Error in Reading Altimeter

leads to Britannia Accident

CHRISTCHURCH, HANTS, U.K.

(Summary based on the report of the Ministry of Aviation, U.K.)

(All times G.M.T.)

On 24th December, 1958, a Britannia engaged in a test flight was cleared to descend from 12,000 to 3,000 feet. About three minutes after commencement of the descent, the aircraft struck the ground which was obscured by fog. The captain and eight occupants were killed, while the first officer and two engineer officers suffered serious injuries.

THE FLIGHT

The aircraft took off from London Airport into a cloudless sky at 1010 hours for a test flight in connection with the renewal of the Certificate of Airworthiness. The captain was at the controls in the left-hand seat and the first officer in the right-hand seat where he operated the R./T. and was responsible for the navigation.

The aircraft was climbed towards Woodley and on levelling out at 3,000 feet the first officer cross-checked the captain's altimeter with his own. At 1015 hours the aircraft left the airways, the propeller of No. 4 engine was feathered for test purposes and the aircraft was climbed to 18,000 feet. After the completion of the climb, when all four engines were running normally, a series of handling tests were commenced.

On completion of the tests, the first officer called Hurn approach, requested a clearance to descend to 3,000 feet, and sought information as to the height of the tops of the lowest cloud layer. Hurn approach replied "I haven't got an estimate here but in the Southhampton area they are VMC at 2,000 feet". At 1135 hours, the first officer replied, "We'd like permission to descend to 3,000 feet. We're VMC on top at 13,000 feet just above a cloud layer, we will come over Hurn and have clearance from there." A course was steered towards Hurn for about 18 minutes and during this flight the first officer believed they were 3,000 feet above a cloud layer. At 1153 hours, the first officer reported over Hurn at 12,000 feet VMC on top and requested descent clearance to 3,000 feet. As there was no IMC traffic in the area, the aircraft was requested to advise when descent to 3,000 feet had been completed. During the descent, which was made at an airspeed of 180 knots, the aircraft entered haze and the First Officer expected, on passing through it, to see a second layer below, but to his surprise the ground suddenly appeared. An attempt to check the aircraft's descent was too late to prevent it striking the ground. The aircraft broke up progressively and isolated fires broke out.

INVESTIGATION

The aircraft struck the ground with its starboard wing while flying approximately longitudinally level. After this, considerable break-up occurred as it traversed level ground for a distance of some 600 yards.

An inspection of the wreckage established that the flaps and undercarriage were retracted and that the fuel dump chutes were in the extended position. The engines were running under power at the time of impact. A number of flight test forms, completed during the flight, were recovered and they provided details of temperature and altitude logged during the aircraft's climb. Subsequent examination of the wreckage failed to reveal any pre-crash defects in the airframe or engines.

Comparison of the outside air temperatures logged during the climb with the upper air temperatures provided by the Meteorological Office confirmed that an altitude of approximately 18,000 feet was attained.

At 1135 hours the First Officer reported to Air Traffic Control that the height of the aircraft was 13,000 feet and at 1153 hours 12,000 feet, i.e., a descent of 1,000 feet in 18 minutes. Between these times, according to the First Officer, the aircraft flew towards Hurn approximately 3,000 feet above a cloud layer. From a consideration of the meteorological conditions, however, it would seem that the only cloud layer which existed in

the vicinity of Hurn was on or near the surface.

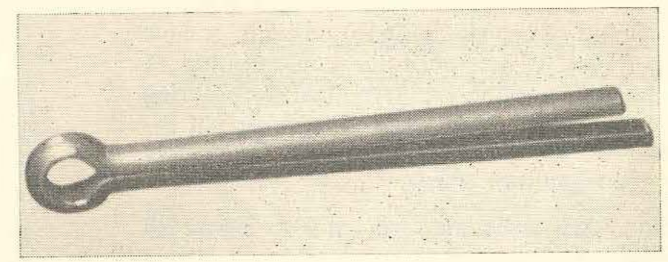
The final descent was commenced some time after 1155 hours with the inboard engines at "flight idle" power and at an airspeed of about 180 knots with the dump chutes in the extended position. Under these conditions the associated rate of descent would be about 750 feet per minute. It has been established that the aircraft struck the ground at approximately 1158 hours. It would seem therefore that at 1153 hours the aircraft was at approximately 2,000 feet and not 12,000 feet as reported and that consequently some 10,000 feet was lost prior to 1135 hours without either pilot appreciating it. It might be of some significance in this respect that when the climb to 18,000 feet was concluded the subsequent air tests were not of a kind which required the crew to focus attention on the altimeters.

CAUSE

The accident was the result of the aircraft being flown into ground obscured by fog. This was caused by a failure on the part of both the captain and first officer to establish the altitude of the aircraft before and during the final descent.

The height presentation afforded by the type of three-pointer altimeter fitted to the subject aircraft was such that a higher degree of attention was required to interpret it accurately than is desirable in so vital an instrument. This, when taken in conjunction with the nature of the flight on which the aircraft was engaged was a contributory factor.

The VITAL LINK



Seeking to establish the cause of looseness in his engine throttle controls prior to flight, the owner/pilot of a private ultra-light aircraft disconnected various joints in the throttle linkage. This involved the removal of a number of clevis pins. Eventually, he ascertained the cause of the apparent looseness, so proceeded to reassemble the control linkage. As each clevis pin was installed, he loosely inserted a retaining split pin, but did not bend out the ends to secure these pins. At this stage he was called away from the job.

Some time later he completed the work required and prepared his aircraft for flight. He then took-off to practise circuits and landings. Turning onto base leg on his first circuit the pilot reduced engine r.p.m. from the cruising setting for an engine assisted approach. On final approach, at a height of about 150 feet, he applied throttle to correct for undershooting but the engine failed to respond.

Realising he would not reach the aerodrome the pilot attempted a landing in an open field outside the aerodrome boundary. The field was being ploughed and formed into wide furrows which proved to be too much for the undercarriage and inevitably the aircraft ended up on its back. Although the pilot was not injured, his aircraft suffered major damage.

Examination of the engine a short time after the accident revealed that the throttle linkage had become disconnected, due to a clevis pin falling out. The pin was found lying in the engine cowling with no sign of it having been properly secured.

The obvious reason for this accident was that the owner/pilot overlooked securing of the split pins at the time of completing the adjustments prior to flight Although he firmly believes that he inserted and secured all split pins and thoroughly checked the linkage prior to flight, there is no doubt that this belief is in error.

It seems obvious that the owner/pilot's error arose from an unsound procedure in performing simple maintenance work. By inserting a split pin without securing it immediately, he ignored one of the basic principles of aircraft maintenance that whenever a locking device is installed, it must be secured at the time of positioning. This principle rightly supposes that if the device is not installed, its absence will be apparent during a final inspection whereas loosely positioning the item can easily conceal the fact that it has not been properly secured.

The fact that the owner's attention was distracted by being called away at a vital stage of this work was, under the circumstances, considered a factor which contributed in this error. Provided the proper procedures are employed and a thorough final inspection of all points concerned is carried out however, this type of interruption should not, in itself, result in maintenance errors.

Carbon Monoxide is Lethal

The deadliness of carbon monoxide is widely known as a result of publicity on accidental deaths and suicides involving inhalation of automobile exhaust gases. In an aircraft, death or serious injury can result from exposure to a much lower concentration of this gas as it may rapidly reduce the mental capabilities of the pilot to a state where he loses control; the resulting accident does the rest.

In the early days of closed cockpit aircraft, accidents due to carbon monoxide poisoning were not infrequent. These led to design requirements intended to ensure that the concentration of carbon monoxide reached in cockpits and cabins as a result of entry of exhaust gases would be held below a specified limit. A newly designed aircraft is now routinely tested to determine the concentration of carbon monoxide in the cabin or flight deck during the type certification flight tests. This must not exceed 0.005%, which can be tolerated indefinitely without any significant effect.

It would seem reasonable from this to expect all new aircraft to be free from dangerous carbon monoxide contamination but such is not the case. Even minor modifications, whether made in production or in service may introduce a hazard. A typical case was that of a single-engined cabin type in which a small camera installation hole had been cut through the floor in proximity to the exhaust stack. This modification had no influence on the aircraft structure or performance, but it did allow entry to the cabin of carbon monoxide in dangerous amounts. In another case, an aircraft type which had been in service for many years was modified for agricultural use. The additional equipment below the fuselage affected the flow of exhaust gases in such a way that they entered the tail-wheel aperture producing a hazardous concentration of carbon monoxide within the fuselage. The route of contamination was discovered only after extensive investigation.

These two examples will show why the Department, in addition to calling for carbon monoxide determinations prior to issue of initial Certificates of Airworthiness, requires that similar tests be made after any modification to an aircraft in service which could conceivably result in gas contamination.

Where Does It Come From?

Carbon monoxide is a colourless, odourless and tasteless gas. As its vapour density is only slightly less than that of air it diffuses slowly. Nevertheless, it does diffuse upwardly and, even if it enters an aircraft near the floor, may soon rise to pilot head level.

In aircraft, carbon monoxide derives from incomplete combustion of hydrocarbon fuels. The principal potential source of contamination is the engine exhaust, but petrol-burning cabin heaters, where used, may be an additional source.

The percentage of carbon monoxide in piston-engine exhaust fumes is related directly to the fuel-air ratio used. Rich mixtures, in which the amount of air and hence of oxygen available to support combustion is relatively inadequate, result in high carbon monoxide outputs; conversely, operation on lean mixtures reduces carbon monoxide generation. Even in cruise settings, however, where the fuel-air ratio is as near as possible to the ideal, complete combustion of fuel is not achieved, and carbon monoxide is still present in the exhaust gas.

The gas turbine engine under normal circumstances does not produce significant concentrations of carbon monoxide. This is due to a high degree of fuel combustion resulting from the relatively very large quantities of air taken in. Only in military aircraft where air for cabin pressurisation is bled off from the engine compressor itself, rather than being supplied by an accessory compressor, is there any real risk of cabin contamination.

In addition to its intrinsic carbon monoxide problem resulting from high fuel/air ratio, the fuselage-nose location of the piston engine in most contemporary light aircraft adds to the possibility of cockpit carbon monoxide contamination. It is usual to find that the amount of gas entering the aircraft will progressively increase over the period between engine overhauls, for reasons not associated with fuel combustion efficiency. These reasons include a falling-off in effectiveness of sealing throughout the exhaust system, and between the engine nacelle and the interior of the aircraft. Thus routine in-service checking of the various firewall seals for correct function is highly desirable. Changes of engine venting or cabin ventilation arrangements may, of course, drastically influence the entry of exhaust gas to the enclosed area.

The exhaust-muff type of heat exchanger, in use on many types of light aircraft, can be Pilot Enemy No. 1 in the carbon monoxide field. This system is very good — provided the muff is properly maintained. If, however, the assembly is not maintained in a sound condition, exhaust gases can feed directly into the aircraft. It was for this reason that aviation authorities throughout the world introduced strict pressure-testing requirements for exhaust-muff type cabin heaters soon after they came into general use. Local requirements are contained in Air Navigation Orders Part 105, which requires that the heat exchanger must be pressure tested at each engine change period. Defects in the system may escape a visual inspection, but they will not elude detection under a properly conducted pressure test. The fuel-burning cabin heater, also, will not provide a hazard if it is maintained as laid down by the manufacturer.

What Can It Do? — (To You)

Being colourless, odourless and tasteless, carbon monoxide is liable to be most insidious in its physiological effects; it can produce unconsciousness without any clear recognisable warning.

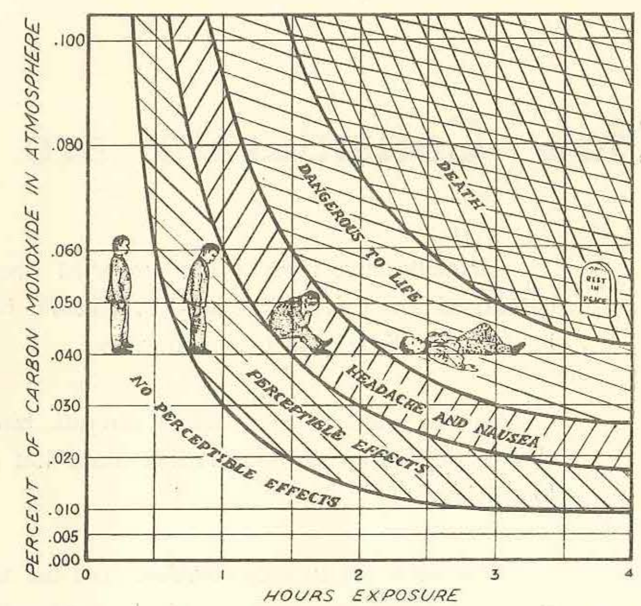
Toxic effects result chiefly from the strong affinity of haemoglobin, the oxygen-carrying component of the red cells of the blood, for carbon monoxide. This affinity is stronger than the normal affinity of haemoglobin for oxygen, so that the presence of carbon monoxide in the lungs embarasses the uptake of oxygen, and its transport to the tissues of the body. Less importantly, the presence of carbon monoxide in the red blood cells hinders the release from them to the tissues of such oxygen as has obtained transport. Thus the symptoms and signs of carbon monoxide intoxication are in fact mainly those of oxygen-lack in the body tissues, of which the brain is the most vulnerable in this regard. The entry of carbon monoxide to the bloodstream is entirely through the lungs.

The toxic effects of carbon monoxide in terms of concentration and exposure-time are shown graphically below. **This graph should however be accepted with some reserve in the high-concentration case, in which symptoms occurring before the development of serious incapacity may be transient and vague.** As has already been stated, actual loss of consciousness may occur without any real warning, if the concentration of carbon monoxide breathed is high.

It will however be seen that the healthy body can, and, in all probability, frequently does tolerate low concentrations of this gas without any significant effect. This physiological tolerance makes it possible to lay down that, allowing an operational safety factor, 0.005% carbon monoxide is permissible in an aircraft interior.

In everyday life, danger begins if exposed to 0.025% for prolonged periods, and death is likely after exposure to 0.040% for four hours. However, for the crew of an aircraft, the hazard appears at an earlier stage. Headache and nausea caused by relatively slow build-up of carbon monoxide can reduce the most competent crew member to a state of inability to fly or navigate safely. In the case of more severe contamination, useful consciousness can be lost with very little in the way of premonitory symptoms.

Data from Bureau of Standards Technical Paper 212



What Can You Do About It?

In flight, development of headache, drowsiness or mental sluggishness, or even the smell of exhaust fumes, is good enough reason to suspect the presence of carbon monoxide. The immediate action is to get rid of contaminated air by introducing fresh air. The recommended drill is:—

(1) shut off any heating system, whether it be exhaust-muff or combustion heater type;

(2) open all windows or other fresh air sources immediately;

(3) land as soon as possible, and have your aircraft carefully inspected by a qualified engineer, ensuring that he is fully advised of the circumstances and the symptoms experienced. If no cabin heater is fitted, pay particular attention to the entire exhaust and general sealing of the cabin area.

If no defect can be located, despite thorough inspection, it is not necessary to freeze during flight to make sure that you are not being poisoned by carbon monoxide. The Department has test equipment available that will soon establish whether you have a carbon monoxide problem and, if you have, its nature and extent.

This equipment, which utilises quantitative "colour-change" of silica gel crystals impregnated with potassium pallado-sulphite, is sensitive and accurate. Kits are held at various centres throughout the Departmental network, and tests can be arranged by contacting the Regional Aircraft Surveyor at your nearest Regional Office. There is no charge for this service; the only cost involved is that of the relatively short flight time required for the necessary tests.

If in doubt, have your aircraft checked. An ounce of prevention is better than a ton of cure—in fact, with this gas, **if prevention is ignored cure may not be possible.**

BEWARE OF EXHAUST FUMES

How Considerate are YOU?

Incidents have recently been reported where pilots have been flying below 500 feet in other than authorised low flying areas and, as a result, have caused considerable financial loss to poultry farmers in the outer Sydney metropolitan area.

At the sound of approaching aircraft, birds have panicked, crowded into the corners of their sheds, and suffocated. One farmer alone lost poultry valued at over £300 in three separate cases of low flying.

The witnesses to these incidents did not take steps to identify the aircraft and for this reason the Department has been unable to approach the pilots concerned. The farmers have now been advised of the need to obtain aircraft registration markings in any future case of low flying over their properties.

Clearly these incidents have been caused by a few pilots only and this article is published in the hope that those responsible will in future show more consideration for people on the ground.

Remember, low flying below 500 feet is permitted only in low flying areas designated by the Director-General under Regulation 117B. At all other times, pilots must strictly observe the height requirements of Regulation 133.

Even at 500 feet birds may be disturbed and take fright, particularly in those areas where aircraft seldom operate or pass over. As a poultry farm is usually easy to recognize every endeavour should be made to fly round the area or to climb the aircraft to a height of at least 1,000 to 1,500 feet.