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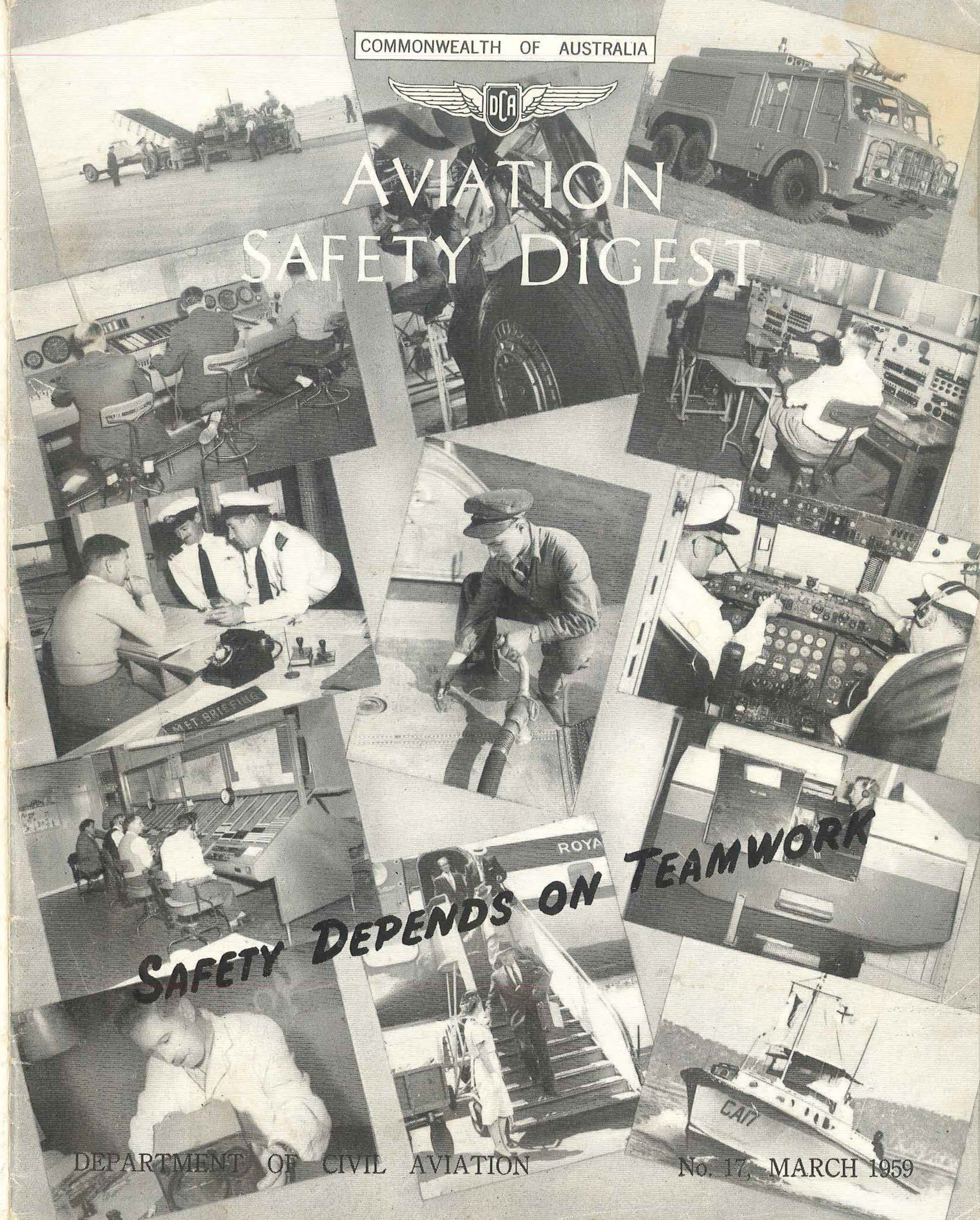
COMMONWEALTH OF AUSTRALIA

AVIATION SAFETY DIGEST



SAFETY DEPENDS ON TEAMWORK

DEPARTMENT OF CIVIL AVIATION No. 17, MARCH 1959

Aviation Safety Digest

No. 17 March, 1959

Prepared in
the Division of
Air Safety Investigation

CONTENTS

News and Views

Bogus Aircraft Parts

(The following is the substance of a report, "Bogus Parts", published by Flight Safety Foundation Inc., New York, U.S.A.)

Your attention is directed to the infiltration into the aviation industry of bogus aircraft parts which, in the main, appear to originate from overseas sources of supply.

These parts are not airworthy as their history is unknown. In many cases the parts have been fabricated from incorrect or unknown material or are at variance with the relevant approved specification, process or drawing. Some of the parts are those which were rejected by inspection as not airworthy and ultimately came into the possession of unscrupulous persons who have removed the red paint rejection markings and marketed them as genuine airworthy aircraft parts.

Bogus aircraft parts become available to the aviation industry by importation from unreliable dealers, distributors or speculators in surplus aviation goods.

The problem of bogus aircraft parts is serious, because it is almost impossible to detect some of the phonies without extensive tests which few of us are equipped to make. Many of the counterfeits are skillfully fabricated and some carry the inspection marks and part numbers of the genuine articles. Some of the parts are even packaged like the original and in many cases differ from the genuine part only in material, a difference which is often extremely difficult to discern.

You may be wondering how this plague of bogus aircraft parts came about. It had its inception shortly after the last war, when vast numbers of aircraft, aircraft engines and other units were declared surplus and manufacturers announced that they would no longer make replacement parts. No one worried over the situation for a long time as spare parts obtained by dismantling complete units seemed endless and were available from countless sources. But gradually this field of supply diminished and the problem of bogus aircraft parts was born. It was pushed into lusty childhood with the discovery by traders that many new and genuine surplus parts had lost their identity during handling, destruction of original packages and obliteration of inspection markings.

These parts could not be guaranteed as genuine and so were not acceptable to the civil aviation authorities. Consequently, they were valueless to reputable organisations in the aviation industry. This reduced the supply of useable parts, made the shortage more acute and increased the price.

Perhaps we should have expected what happened. These orphans not only found their way into the market, but helped to create a new market, a market where integrity and responsibility are not requirements for doing business and where the only questions asked have to do with payments.

With business ethics weakened or destroyed, it was but one step more to modify parts without the requisite engineering data and approval, and another step to introduce outright counterfeiting of parts.

Bogus parts can endanger flight as indicated by the following incidents which occurred in U.S.A. due to the use of such parts:—

1. A twin engine cargo aircraft crashed and burned and both pilots were killed because nonconformities in the elevator tab

controls produced pitch-down and structural failure. Nonconformities in the elevator tab controls, in this case, mean bogus parts.

2. A bogus link pin bushing failed in flight and the entire engine wound up. The fact that there was no accident was largely a matter of good fortune.

3. New bolts were being installed in the attach angles of a DC.3 aircraft. When three of the bolts broke before reaching the prescribed torque loading samples were tested and failed. The bolts proved to be bogus parts on which someone had made an illicit profit.

4. A cam reduction gear assembly was purchased as a new part on the surplus aircraft parts market and installed in an R-985 model engine undergoing overhaul. After a four hour test run the engine was dissembled. Inspection of the gear on a comparator against a factory new gear revealed that the gear teeth had been reworked which resulted in a most unacceptable tooth form and that unusual and excessive wear had taken place during the engine test run.

A thorough inspection revealed many deviations from the tolerances laid down in the approved drawing and a spectrograph analysis of the cam gear material showed that it did not meet the relevant specification requirements. None of the defects were readily apparent, but they were there, contributing to rapid and excessive wear and possible engine failure. Had this bogus part not been detected during dissembly after the test run, anything could have happened.

5. Someone found that there was a good demand for piston pins used in R1830-75, R1830-94 and R2000 model engines, so he obtained piston pins used in R1830-92 model engines cut them down in length and machined new lock ring grooves. Evidently he was not troubled by the fact that the modified piston pin would be subject to higher loads than those it was designed to withstand. The bogus piston pin was detected by the chamfer at the bore which is greater than that cut on the genuine piston pin for R1830-75, R1830-94 and R2000 model engines. It also has a heavier side wall. However, this does not compensate for the difference in metallurgical composition and the bogus part is weaker than the genuine piston pin.

6. Another piston pin which started out as a genuine surplus part ended up in a far different category. This piston pin was manufactured for fitment to an R-1830 engine but was modified for an R-985 engine. The hardness and material requirements for an R-985 engine were not met by reworking the R-1830 piston pin, too much material was removed and the inside surface was subjected to abnormal tempering. Figure 1 shows how machining of the inside diameter cut into the part number and heat code marks, leaving notches from which cracks could develop.

7. Figure 2 shows another surplus part which was converted for a purpose it was never intended to fill.

The impeller intermediate drive gear was manufactured for R-1830-43 model engine fitted to defence aircraft, it had no commercial application and should have been mutilated for disposal as scrap metal.

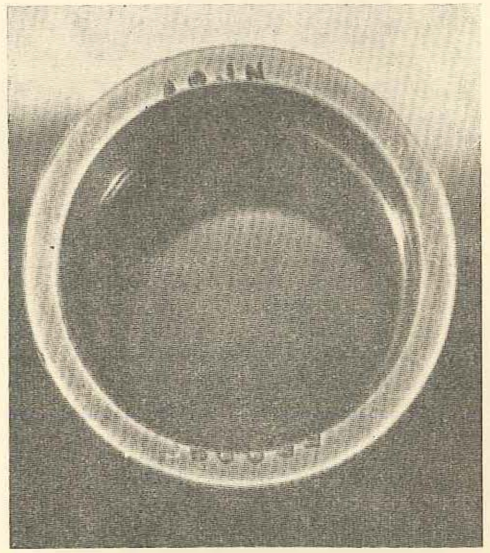


FIG. 1

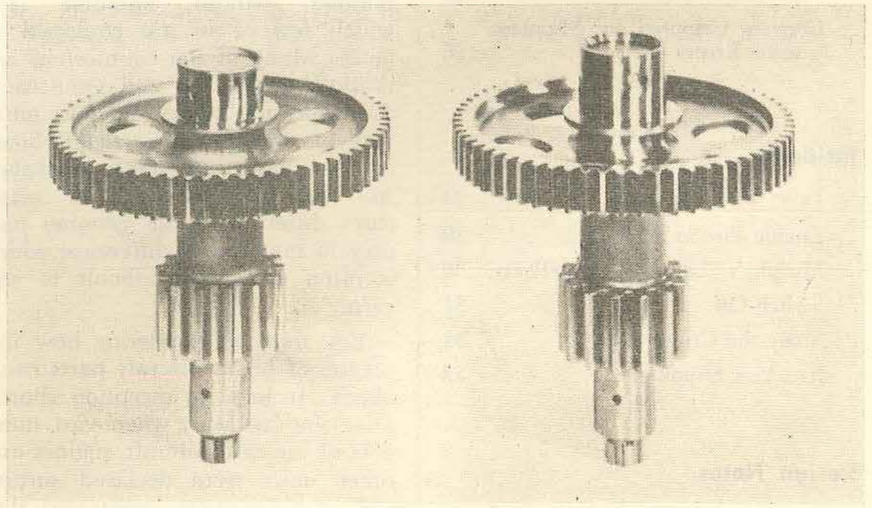


FIG. 2

However, a genuine gear for an R-1830-75, R-834-94-M2 or R-2000 engine cost approximately $220 so the scrap gear from R-1830-43 engine was modified to fit the above engines by shrinking and pinning a stud spline on the rear end of the assembly for an estimated cost of two man hours. The job was skilfully done and in some instances the pin can be detected only by magnaflux. Other discrepancies are more obvious. As can be seen in Figure 2, the front journal is $\frac{1}{4}$ inch too short, which dangerously reduces the bearing surface.

Figure 3 shows the bogus drive gear on the right, all other parts in the assembly being genuine. Note that the bogus gear does not mesh properly. This increases the unit loading of the teeth on both the intermediate and impeller gear. Failures in service causing non-operation of hydraulic and fuel pumps have been common.

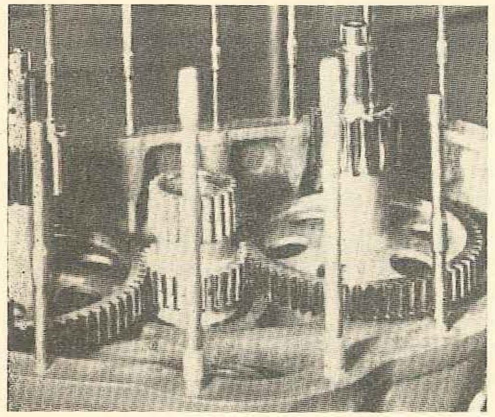


FIG. 3

8. An engine overhaul organisation found it had been sold plain unadulterated counterfeit exhaust valve guides for an R-985 engine when the flanges of the valve guides broke off when driven into the cylinders. Examination disclosed other discrepancies as the guides were reddish brown, a color which contrasts with the lighter, more brassy appearance of the genuine guides. The composition of the valve guides is "powdered metallurgy" similar in appearance to the material used in "oilite" bearings and having a greater affinity for combustion residue than the material used in genuine approved parts, it attracts and holds carbon and lead deposits. This, of course, causes valve sticking.

Another group of counterfeit value guides for the R-1830 engine, can be detected by a chamfer which is not cut on genuine valve guides. Also the flange thickness and overall length are under the minimum dimensions stated on the approved drawing. The chief hazard, however, is in the material which tends to swell in operation. Some of these phonies have failed during engine test run and others early in service.

9. Figure 4 shows a thrust nut. The absence of a trademark, lack of inspection marks, poor threads and sharp edges all indicate that the nut never passed the prescribed factory inspectional requirements and that there is no doubt the part was rejected by inspection for disposal as scrap metal.

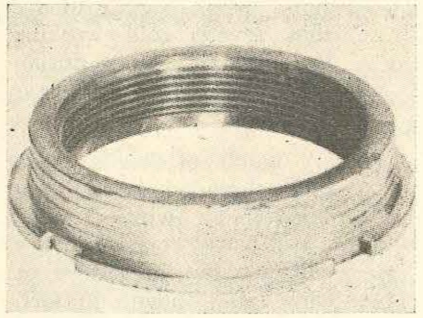


FIG. 4

10. Another case, which concerns the use of rejected parts relates to a junk merchant who collected propellers that had been bent beyond the repairable limits prescribed by the manufacturer. The junkie straightened the blades and then re-sold the propellers to repair agents as being within repairable limits.

11. To illustrate the prevalence of counterfeit parts we have listed in this paragraph a few of the incidents where such parts have been detected during engine overhaul.

(a) Figure 5 is an enlarged view of a bush removed from an R-1830 engine which had suffered internal failure. As you see, a portion of the bush is broken away and the fractured surfaces indicate cold working subsequent to the failure as well as shrinkage-porosity, apparent on the inside diameter.

In addition to faulty material, the bush was probably made to an old drawing, consequently, the dimensions are incorrect. The makers of bogus parts cannot be trusted as, not being aware of current en-

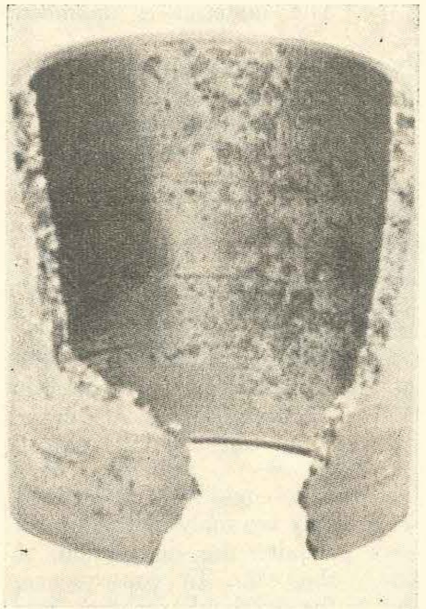


FIG. 5

gineering changes, the majority of parts they produce are incorrect either in material or dimensions.

(b) Another bush removed from the same engine showed severe shrinkage - porosity on the inside diameter surface. There was evidence of overheating and casting defects. The bush did not comply with the dimensions given on the manufacturers approved drawing in respect to length, I.D. and O.D. and was also .0011" out of round.

(c) A bogus link pin found during the overhaul of an R-2000 engine was completely devoid of manufacturer's inspection markings. The material was soft and could be easily filed and the manufacturer had omitted to drill one of the oil holes.

(d) The sharp edges on the gear and lack of part and inspection markings identify the cam shown in Figure 6 as a bogus part. The material is unknown

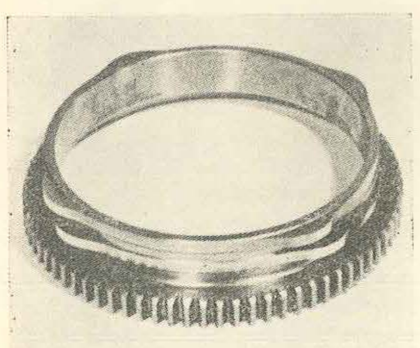


FIG. 6

and could be determined only by analysis that would require the destruction of the cam. In consequence, the overhaul workshop was unable to accept it as airworthy and the part was scrapped.

(e) Figure 7 is a bogus oil screen inlet spacer for an R-2000 engine. There are short cracks at the roots of the corrugations which appear to be tensile breaks. Micro examination of a section through the spacer revealed that the grain size of the material was up

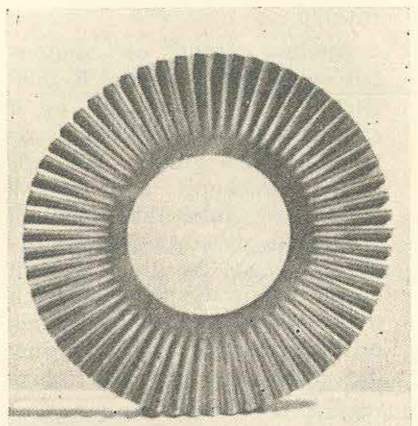


FIG. 7

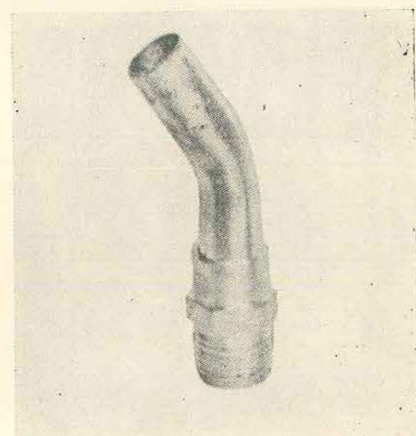
to four times as large as that prescribed by the relevant material specification. There was evidence that severe cold working had taken place during fabrication of this bogus part.

(f) A batch of bogus spark plug threaded inserts was discovered which need never cause concern. They will not fail in service or cause an accident, in fact, they can never be installed in an engine cylinder. In his eagerness for easy money the parts forger cut right hand threads on the outside diameter where left hand threads are required and to identify his work beyond mistake he cut the inside diameter threads too small.

Unfortunately all bogus parts cannot be detected as easily and few others are as safe.

(g) Figure 8 illustrates a home made intercylinder drain pipe which is kinked at the radius and the soldering not oil tight. The fabrication is so poor that even an apprentice should have questioned the use of such a part.

It is pictured merely to illustrate the point, that an overhaul organisation which is approved by a government airworthiness authority can keep such unairworthy parts out of an aircraft.



F.G. 8

12. Other bogus parts which have been detected, such as, a landing gear torque arm bolt which had been drilled so deeply that only a thin section of material was left between the bolt head and the shank, a rudder tab hinge which had been made from a casting instead of being forged in accordance with the approved drawing, tail wheel axles for DC.3 aircraft which were defective, bogus fuel pump shafts seals and defective engine valves, indicate that no one can afford to be complacent about the bogus aircraft part situation.

HOW CAN YOU PROTECT YOURSELF FROM BECOMING A VICTIM OF THE PERSONS TRADING BOGUS AIRCRAFT PARTS? THE DEPARTMENT'S ADVICE TO YOU IS:—

(i) Obtain your aircraft parts from D.C.A. approved distributors with Release Note certification.

(ii) Ensure that the overhaul of your aircraft is performed by an organisation which is holding the appropriate D.C.A. approval.

(iii) If you import aircraft parts from the U.S.A. obtain them direct from the C.A.A. approved manufacturer, the manufacturer's authorised distributor or a reputable distributor. In all cases, you should state in your order that the goods must be accompanied with the appropriate C.A.A. authorised certification document.

(iv) When importing aircraft parts from U.K., obtain them from an organisation approved by the Air Registration Board and certified on A.R.B. Authorised Release Notes.

(v) When importing aircraft parts from other countries your order should state that the consignment must be accompanied with a certificate issued with the approval of the airworthiness authority of the country concerned.

If you are in doubt concerning the integrity or reputation of an overseas organisation with which you wish to trade or require information regarding the appropriate certification document that should accompany a consignment of aircraft parts from another country, please contact this Department's nearest Regional Office which will advise you accordingly.

Hydraulic Fluid Contamination

(Extract from "Aviation Mechanics Bulletin" September-October, 1958)

Civil Aviation is moving rapidly toward high altitude flight. We can learn now about the special problems such flights present from the experience of the military services.

Flight control system discrepancies, ranging from locking of the controls and failure to change over from one system to the other, to reports of stiff controls at altitudes, have been noted by operating activities. Hydraulic fluid samples taken for contamination test after the subject discrepancies occurred proved negative. However, additional investigation has shown that the findings from the fluid samples were not conclusive, since a small quantity of water was trapped in the valves, switches, accumulators, in the flight control systems and went undetected at the time of the tests.

To illustrate the effect of water in the hydraulic fluid of the flight control hydraulic system, one instance is quoted per the pilot's statement:

"During flight at 42,000 feet, the controls stiffened up. The stick was extremely hard to move and, once displaced, would not return to neutral. Descent was made to 25,000 feet and the controls loosened up. After climbing back to 40,000 feet, they stiffened again."

The airplane was ground checked, and it was determined that the aileron trim bungee was malfunctioning. When the bungee was removed it contained water. The bungee was disassembled and lubricated, and the next flight was satisfactory.

Another discrepancy concerning stiffening of the flight controls was also reported. A summary of this report follows:—

A pilot who returned from a high altitude flight (40,000 ft.) reported that higher than normal stick breakout forces were necessary to move the stabilizer and ailerons. Fluid samples taken from the flight control system were very cloudy and contaminated with a grey substance; also, the fluid was a light pink colour instead of the normal dark red color of clean hydraulic fluid. A check of the hydraulic system servicing units was also made and a quantity of water and other foreign matter was discovered in the reservoir servicing units. The servicing units were home made and were not adequate to prevent the entrance of rain water into the reservoir of the servicing unit.

A container of the contaminated fluid from the subject airplane was laboratory tested. The results of the analysis revealed that the sediment in the fluid was fibrous material, paint and trace amounts of metal chips. The quantity of water contamination in the fluid was approximately 0.5 percent. The water droplets in the subject hydraulic fluid could not be emulsified into the hydraulic fluid and became frozen at temperatures below 30°F. It was determined that the water present would be sufficient to cause high breakout forces. Previous laboratory tests have shown that an approximate one percent water contamination doubles the flight control actuator control valve breakout force at - 65°F. Also, demonstrations have revealed that there is an increased valve operating load after breakout when water contamination is present in the hydraulic fluid.

The seriousness of water contamination in the hydraulic system fluid cannot be over-emphasized. Pilot personnel of the squadrons which reported the stiff controls later disclosed that they had noticed an increase of breakout forces in the flight control systems. Since this increase was gradual and progressive, it was not reported as a malfunction. When an actual malfunction did occur (extremely stiff controls at altitude), water contamination in the hydraulic fluid of the affected airplanes proved to be most severe. The other airplanes were found to have water contamination in varying amounts. To remove the water contaminated hydraulic fluid, the flight controls hydraulic systems were extensively flushed (i.e., lines disconnected and valves, switches, etc. removed and drained). After flushing of the hydraulic systems, the pilots reported a noticeable decrease in breakout forces to which they had become accustomed.

In an effort to aid those personnel who may encounter similar problems with the flight control systems, the following suggestions are offered:—

1. In all cases of flight control system malfunction, always take fluid samples.
2. Establish procedures to incorporate the taking of fluid samples during each preflight inspection.
3. If failure occurs, always suspect hydraulic fluid water contamination first. Thus, assurance is made that fluid samples will be taken.
4. Inspect servicing units daily for contaminated fluid prior to servicing airplanes.
5. Evaluate all flight control discrepancies carefully. Be specifically wary of reports of stiffening controls, failures to change over, decreases in pressure at altitudes and varying functional operation at different altitudes.

Do You Still Know?

1. **That there is a material difference between an Information Service and an Advisory Service.**
2. **The emergency action to be taken in the event of failure of both radio communication and navigation equipment.**
3. **When your vertical displacement should be given as an altitude, and when it should be given as a flight level.**
4. **That you should manoeuvre after take-off to establish flight on the authorised departure track as soon as possible and at no further distance from airport than five miles.**
5. **When you should obtain meteorological briefing.**
6. **The allowable error in an aircraft's estimate at a reporting point before advising A.T.C.**

(Key to questions appears on Page 32)

Australian Accidents

Fatal Lockheed Hudson Overshoot

Towards the end of June, 1957, a Lockheed Hudson crashed in the near vicinity of Horn Island during an attempted single engine go-around. All occupants consisting of the crew of three and three passengers received fatal injuries and the aircraft was totally wrecked.

The aircraft was temporarily based at the Weipa Mission aerodrome, northern Queensland, with the normal crew consisting of a pilot, a navigator and a photographic assistant. On the day before the accident the aircraft was flown on a private flight from Weipa Mission to the Horn Island aerodrome with three non-paying passengers aboard in addition to the crew. The aircraft remained overnight at Horn Island, and early on the following morning took off with the normal crew, and carried out survey work over a period of some four hours. The aircraft returned to Horn Island at about midday and was refuelled.

During the same morning another Hudson aircraft engaged on photographic survey work had arrived at the aerodrome and the two crews lunched together. Both aircraft were prepared for departure and the three passengers again boarded the Weipa Mission aircraft, which took-off first and set course at 1518 hours E.S.T. intending to climb to 7,000 feet en route for Weipa, 45 minutes flying time to the south. Five minutes after departure the pilot of this aircraft advised the communication station at Thursday Island that trouble had developed in the port engine and that he was returning to land at Horn Island. He also asked that the other Hudson aircraft be held on the ground in case some assistance was needed. At the stage that this message was relayed to the captain of the second Hudson the aircraft was lined-up for take-off but immediately vacated the strip. The captain watched the circuit and approach of the other aircraft from a position clear of, but adjacent to, the threshold of Runway 08 (see diagram on next page).

The returning aircraft was seen to cross Runway 08 and then turn downwind at a height of 1,500 - 1,700 feet and proceed with a left-hand circuit towards the threshold of that runway. As the aircraft turned on to final approach at about the normal distance from the threshold but still unusually high, the ground observers noticed that the undercarriage had not been extended. The aircraft continued to descend in this configuration and it seemed likely at this stage that a wheels-up landing would be made well down the strip. When the aircraft had reached a point approximately 600 feet from the threshold and 150 feet above ground level the undercarriage was observed to extend and it was also noticed that the port propeller was feathered. At this point there appeared to be no wing flap extended and the aircraft crossed the strip threshold at a height of more than 100 feet and at a speed estimated to be well in excess of the normal approach speed. Soon after the aircraft had passed the threshold it was seen to roll and turn to port and this motion continued until the aircraft disappeared from view at such a height and angle of bank that an accident seemed imminent. The pilot of the Hudson on the ground immediately took-off and located the wrecked aircraft on a coral mud shelf just beyond the northern shore of the island. Ground parties discovered that the aircraft had been virtually destroyed by very high impact forces and the six occupants had lost their lives.

The Horn Island aerodrome is situated on flat terrain and the runway being used on this day is 4,540 feet in length. Weather conditions at the time were fine with a visibility of 25 miles, there were 4/8ths of cumulus cloud at 2,000 feet and the wind was 5 knots from the north-east.

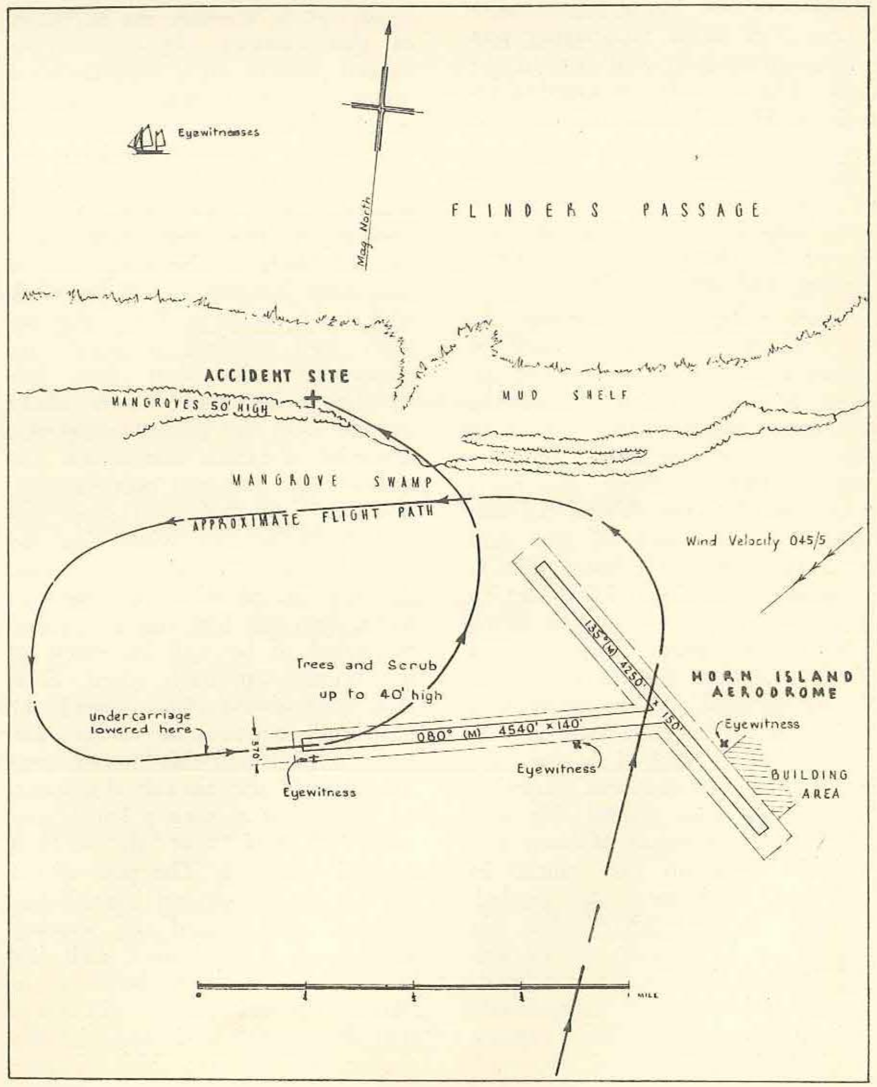
The wreckage examination revealed that the port wing tip of the aircraft had first struck the exposed mud shelf and it had then cartwheeled with the forward fuselage and starboard wing absorbing the major impact forces. The fuel tanks had ruptured but there was no outbreak of fire. The undercarriage and flaps were found to be in the retracted positions. An examination of the port engine revealed that there had been a failure of the master rod bearing which led to a seizure of that engine and the normal feathering action had been carried out. So far as could be ascertained there was no defect in the starboard engine and it was operating under power at the time of impact. There was no other defect discovered which might have contributed to this accident.

In view of the single engine configuration of the aircraft and the fact that the undercarriage was observed to be extended during the latter part of the approach, it is reasonable to conclude that the pilot was making the approach for the purpose of landing. This being so, it is of considerable significance to note that the circuit was abnormal in many respects. It was commenced at least 500 feet higher than usual and continued to be excessively high for all stages up to the threshold of the runway. The lowering of the undercarriage was left until a stage too late to allow the pilot time to check that it was down and locked if a landing had immediately followed the approach. The flap was apparently not lowered at any stage of the approach.

The extension of the undercarriage about 600 feet short of the threshold indicates that, even at this stage, the pilot hoped to make a landing. The height and speed at which the aircraft crossed the threshold, however, made it essential that a baulked approach be carried out to avoid running beyond the landing area. The observed rolling and turning of the aircraft, which commenced soon after the threshold was passed, suggests that substantial power was applied to the starboard engine at this stage as would occur at the initiation of a baulked approach procedure.

Although the eye - witness evidence indicates that the aircraft began to get out-of-hand right from the point of initiation near the threshold, there is no known reason why a successful baulked approach could not have been carried out from that position under the conditions which existed. Assuming the aircraft had been allowed to roll or turn with the application of asymmetric power it is conceivable that the pilot might have been faced with an uncontrollable flight situation from which the only means of recovery would be a power reduction; unexpectedly finding himself steeply banked and close to the ground it is understandable that he would be most reluctant to do this. It seems likely, therefore, that he was faced with a serious dilemma with little alternative but to continue in the turn, perhaps, hoping to recover to a level attitude over the sea to the north of the aerodrome.

There are several possible explanations of why control was lost during this baulked approach but it is considered that the most likely one relates to the infrequency with which this pilot had practised the manoeuvre. The operator had no established system for training or for regular competency checks of its pilots and it seems that practice in emergency situations was left largely to the individual's discretion. Although it is known that this pilot had carried out some single engine landings under conditions of both actual and simulated engine failure in the months prior to the accident, he had not, as far as is known, carried out a baulked approach on one engine for a number of years prior to the accident. Considering all the evidence it is probable that the pilot's skill was not equal to that required to successfully carry out a baulked approach in the single engine configuration due to his lack of recent training in this manoeuvre.



Viscount Overruns on Landing

A Viscount carrying a crew of five and 38 passengers overran Runway 12 at Brisbane Airport at 1621 hours on 1st April, 1958, when the propellers did not move into ground fine pitch after landing. After leaving the runway the aircraft skidded sideways until it struck a bitumen spreader parked to the right and beyond the end of the runway. The aircraft and the spreader were substantially damaged but there were no persons injured. At the time of the accident the gross weight of the aircraft was only 250 lb. below the maximum permissible landing weight.

EVENTS PRECEDING THE ACCIDENT

Because it was raining and his windscreen wiper was defective the captain advised the first officer that he might have to do the landing. Visual contact was made over the airport and the captain handed over to the first officer as the aircraft was turning final at about 130 knots with 20 degrees of flap. The first officer completed the turn and at a height of about 600 feet lowered 32 degrees of flap followed by 40 degrees. Speed was then gradually reduced and the aircraft crossed the runway threshold not above 50 feet at about 115 knots. The throttles were closed and the aircraft touched down 1,600 feet along the runway, i.e., 1,285 feet beyond the threshold.

Touchdown was firm but not heavy and the nosewheel was immediately placed firmly on the runway. The ground fine pitch warning lights did not operate and there was no noticeable retardation of the aircraft. The first officer promptly applied full hand braking without apparent effect. The captain then took over and applied full hand braking followed by full application of the foot brakes but again there was no noticeable deceleration of the aircraft. Forty-seven degrees of flap were selected at this time in an endeavour to provide more drag. About 600 feet from the end of the runway the aircraft's speed was 50-60 knots, and as there were heaps of rubble beyond the 200 feet overrun, the captain steered the aircraft off the runway to the right towards a clear area. As the aircraft left the runway it commenced to slide sideways and became uncontrollable. The nosewheel and underside of the nose section of the fuselage struck a bitumen spreader parked 320 feet to the right of the centreline and 260 feet beyond the end of the runway. The aircraft swung through some 45 degrees about the nosewheel before coming to rest with the nose section on top of the spreader. The occupants left the aircraft without further incident.

INVESTIGATION

The Weather

The conditions observed at the time of the accident were wind velocity 090°/4 knots, visibility 8 miles, continuous light rain, 4/8ths strato-cumulus cloud at 1,800 feet. The light rain had commenced to fall 30 minutes before the arrival of the aircraft, only one to two points being recorded up to this time.

The Runway

The length of the runway is 5,040 feet with a 200 feet overrun at each end, the effective operational length under both wet and dry conditions being 4,940 feet. The runway is of sealed gravel construction, the surface consisting of rounded aggregate one-eighth to three - eighths diameter. The condition of the runway surface was generally good, particularly the last 1200 feet southeast of the Runway 04-12 intersection which had recently been resealed. The surface was wet but there was no water lying on the runway.

The Aircraft

The aircraft was substantially damaged, the fuselage being torn and buckled on the port side of the nosewheel well, the nosewheel assembly was broken off, and the four blades of the No. 2 propeller were bent rearwards about one foot from the tips. The port undercarriage torque link was broken at the strut attachment lug and the assembly was toed-in slightly. A flat spot was worn on the port outer tyre and it had blown at this position.

All cockpit controls and circuit breakers were normal. The captain's windscreen wiper was unserviceable and subsequent tests indicated that air had entered the hydraulic section of the wiper system.

The Ground Fine Pitch System

The aircraft was powered by four Rolls Royce Dart 510 engines driving four bladed constant speed Rotol type propellers. The flight fine pitch angle of these propellers is 24 degrees. The ground fine pitch range, which is required for starting and idling is from 0 degrees to 24 degrees. Apart from being required for starting, the ground fine pitch setting also provides aerodynamic braking on landing. To prevent the propellers from entering this range in flight, a mechanical pitch lock is incorporated which is automatically controlled by an electrical circuit through switches operated by the throttles and the main undercarriage oleo struts. The four throttle switches are in series and arm the circuit when the throttles are below the take-off power position. The undercarriage switches— two in parallel on each main undercarriage strut — are made when the oleo struts are compressed. For the pitch lock to be withdrawn all four throttle switches and at least one switch on each strut have to be made. There is an additional switch in the circuit which, through the medium of an electro hydraulic lock, prevents the pitch setting from falling below 19 degrees in flight should an electrical fault occur in the ground fine circuit.

A preliminary examination of the aircraft revealed that Nos. 2 and 3 propellers were in ground fine pitch range, and that Nos. 1 and 4 propellers were in flight fine pitch range when the engines stopped. Following a series of functional tests in situ, which indicated normal operation, the ground fine pitch system was examined in detail. The circuit wiring was found to be serviceable, and with one exception, all connections were satisfactory. Failure of this one connection, which was loose but in fair contact, would have resulted in asymmetric withdrawal of the ground fine pitch locks. As one propeller on each side of the aircraft was found in the ground fine pitch range it is apparent that the circuit had functioned normally and it had been possible for all four propellers to enter the ground fine pitch range.

The propellers and controller units were removed from the aircraft for testing and strip examination but no defects were found which would have resulted in maloperation of the ground fine system.

The oleo strut pressures were checked before removal of the struts from the aircraft and were found to be slightly below the desired figures. On stripping, the oil quantity in both struts was also found to be less than the required quantity. No other defects were found. The only effect of these irregularities on the ground fine system would have been to "make" the undercarriage switches earlier than usual in the landing run because of the easier compression of the oleo struts.

The undercarriage switches satisfactorily passed all electrical tests and internally were in good condition. A lead to one switch was broken but as the switches on each strut are in parallel the other switch would have operated the circuit. It was established that the break was due to metal fatigue.

NOTE: Action has been taken to re-route the wiring to eliminate this type of failure.

When stripped, the throttle switches exhibited signs of severe burning of the switch contact arms and contacts. Subsequent tests reproduced severe arcing and intermittent operation of these switches. In the throttle switches the moveable arm carries two contacts (hence a split contact type) which make with two contacts on short fixed arms—the switches were installed in the aircraft with the fixed contact arms horizontal and below the moveable arm. These switches are of the micro type with a quick make and break action essential in an inductive circuit, such as the ground fine pitch circuit, in order to minimise arcing. However, when installed in this circuit in Viscounts the points were wired in series and this destroyed, to a large extent the advantage of the quick make and break action. When operated slowly one or other of the contacts will release first and so draw an arc and heat the points.

Tests on another aircraft using a new switch of the same type revealed that by careful movement of the throttle to the position where the switches were actuated it was possible to cause continuous arcing. Maintaining the throttle in this position for a few seconds resulted in damage to the contact points and severe heating of the contact arms. During the tests an arc was drawn and maintained on a new switch for two seconds. Apart from burning of the points this resulted in the fixed contact arm becoming red hot and drooping. After two such operations the extent of the droop was such that there was a marked loss of pressure between the contacts (and a loss of the contact wiper action). This resulted in the contacts being even more conducive to arcing during further operations of the switch and subsequently the fixed contact arm drooped to such an extent that when the throttle was retarded the contacts would not close until the switch was subjected to moderate vibration.

As the throttle position at which the switches are actuated is between the take-off and climb settings it is unlikely that arcing would occur in flight. However, during the engine ground run tests conducted every 50 hours, the engineer is required to record the r.p.m. at which the ground fine pitch warning lights go out, that is, as the throttle switches are opened. The natural tendency is for the engineer to inch each throttle forward towards the position where the switches operate and, as mentioned above, fairly severe arcing occurs. In this regard it is noteworthy that all the switches in the aircraft were burnt, indicating that, at some time, each had been the first to break the circuit, the four throttle switches being connected in series.

Note: In addition to the deterioration of the contact arms and points arising from excessive heat, the switches were installed in such an attitude that the fixed contacts could, when heated, droop away from the moveable arm. Following this accident, all Viscount operators were instructed to wire the contact points in parallel and to ensure that the throttles were always moved smoothly through the critical position. Checks on throttle switches since the above action have revealed negligible deterioration.

The approved life for the throttle switches is 5,100 hours and those in this aircraft had exceeded this figure by 786 hours. A fleet check revealed that in several other aircraft a number of throttle switches had exceeded the approved life, in some cases by as much as 1,500 hours. Following this accident the throttle switches from the 12 other Viscount aircraft operating in this country were examined. Four of these switches were of different manufacture to those in the aircraft involved in the accident and had rigid fixed contact points; their hours of

operation ranged from 2,100 hours to 6,600 hours and although the contacts were burned there was no evidence of severe heating. Thirty-four of the other 44 switches had contacts burned in varying degrees and the contact arms had been subjected to severe heating. There was no pattern, however, between the condition of the switches and the operating hours, some of the switches found to be burned had only been in operation for about 1,500 hours. From the above it is apparent that the excess period of life of the switches was not the prime factor affecting their condition.

The Brake System

The brake system obtains its hydraulic supply from the main system, this being fed to two independent brake accumulators to give a primary and secondary system. In the event of failure of one system the other must be selected by the crew. The brakes are either foot operated, through hydraulic actuators to the brake control unit, or hand operated through cable connections to the same unit. Additionally, the aircraft was equipped with an automatic brake control system in which the pilot operates either foot or hand brakes in the normal manner but the system meters the hydraulic pressure being applied at the brake units to ensure maximum retardation without skidding of the wheels. This automatic brake system, which is electrically operated, is integral only with the primary brake system and is armed by selection of an ON/OFF switch on the cockpit pedestal. The switch is safety-wired in the ON position; should the switch be turned OFF the primary braking system reverts to manual operation. The secondary braking system is manually operated only and is selected by means of a lever situated on the right hand wall of the cockpit pedestal.

On test, before the aircraft was moved, the brakes operated normally and subsequently no fault could be found with the hydraulic section of the brakes, or the brakes proper, which would have prevented normal operation. All the components of the automatic brake control system operated satisfactorily on test, but, on stripping, three of the four brake solenoid valves were found to contain a considerable quantity of metal swarf in the valve cage. It was determined that this metal was similar in composition to that of the valve body and valve cage, and it had apparently entered the valves in the course of manufacture during the drilling and tapping of a hole for a retaining grub screw. Tests were conducted to simulate the introduction of swarf under the high pressure valve seat but it was found that, even after it had been badly damaged by scoring, the valve continued to operate at the normal brake line pressure of 1,050 lb. p.s.i., and up to 1,450 lb., p.s.i. It is considered, therefore, that the swarf did not adversely affect the operation of the solenoid relief valves. It is worthy of note that a fleet check revealed a number of other solenoid valves in service containing a similar quantity of swarf. In no instance did these aircraft have a record of brake malfunctioning.

Note: Immediate action was taken to clear all solenoid valves in use and in stock and the supplier has revised manufacturing methods to eliminate this fault.

The runway was inspected for wheel marks immediately after the accident. The only marks visible were the scuff marks at touchdown, and the mainwheel and nosewheel marks extending back some 500 feet from where the aircraft left the runway. The mainwheel and nosewheel marks were white-ish in appearance and this was apparently caused by the washing effect of water under pressure between the tyres and the runway. The track patterns were uniform and each track (mainwheels and nosewheel) was similar in appearance. Such marks will only occur if the wheels are being braked or if the aircraft is turning. As the nosewheel cannot be braked it is evident that the nosewheel marks were solely due to turning. The tyre marks did not indicate conclusively whether or not there had been retardation, but immediately after the accident steam was observed coming from the right-hand brake assembly which was partially immersed in water and it was still hot some 20 minutes later. Tests conducted subsequent to the accident revealed that on a wet runway maximum braking using the automatic brake control system will not leave runway marks except at relative slow speeds, and even these are very faint.

The port outer tyre had a badly scrubbed area of tread and had blown at that point; examination of the blow-out established that it was a concussion fracture. Heavy scuff marks for about half the circumference of this tyre led into the scrubbed area and similar scuffing for about the same distance occurred on the starboard outer tyre. It was apparent that the scuffing had resulted from sideways movement of the wheels as would have occurred as the aircraft was being turned off the runway. The port outer tyre pattern on the runway was uniform and identical with the patterns made by the other tyres, which suggests that it was not blown before leaving the runway. The edge of the runway, where the port outer tyre left the runway, was extremely rough and it is considered that this was where and when the severe scrubbing of that tyre occurred. Immediately after the port outer tyre left the runway it ran over a drain cover made of hardwood and which was slightly raised above the ground. This probably resulted in the concussion fracture. It was concluded therefore, that the port outer tyre did not burst until after the aircraft had left the runway.

Note: It was important to establish when the tyre blew out because the circuitry of the automatic braking system was such that the two outboard and two inboard wheels *were paired electrically so that either sensing unit in a pair would operate both brake systems in the pair. A blown tyre, because of the lesser weight being carried by that wheel, would tend to retard more easily than the other wheels, therefore, the sensing unit would reduce the brake pressure being applied at that wheel and also due to the pairing, at the other wheel in the pair. This would reduce the overall braking to little more than one wheel in each bogie. The circuitry has now been modified to eliminate this feature, also, other features have been modified to provide for fail-safe operation.*

Performance

Under the existing load and atmospheric conditions, the required safe landing distance in accordance with the approved landing chart was 4,900 feet, that is, equal to the effective operational length of the runway. The stopping distance (from a height of 50 feet over the threshold) on a wet runway as given in the Flight Manual, was 3,050 feet. The safety margin (1,850 feet) included in the required landing distance of 4,900 feet did not specifically cater for ground fine pitch failure as the probability of failure was considered to be very low. During the investigation an examination of the maintenance history of this system revealed that the failure rate was relatively high. In addition to the erroneous belief that the ground fine pitch system had a very low failure rate, the performance data available prior to this accident indicated that the stopping distance on a wet runway would only be increased by some 400 feet in the event of ground fine pitch failure and consequently it was assumed that the aircraft could still be brought to rest well within the required landing distance. However, landing distance tests carried out as a result of this accident revealed that without ground fine pitch and using the automatic brake control the stopping distance on a wet runway is increased by approximately 2,500 feet. Applying the data obtained from the performance tests to the landing of this aircraft, it has been calculated that the stopping distance required was some 5,550 feet, that is, 610 feet in excess of the effective operational length of Runway 12. Following this accident a manually operated switch has been incorporated in the ground fine pitch circuit in case automatic operation fails.

ANALYSIS

As previously mentioned, Nos. 2 and 3 propellers were found in the ground fine pitch range after the aircraft came to rest. The circuitry is such that once the circuit is made all four flight fine pitch locks will be removed simultaneously, thereby permitting all four propellers to enter the ground fine pitch range. It is apparent, therefore, that at some time before the engines stopped the flight fine pitch locks were withdrawn and it had been possible for all four propellers to enter the ground fine pitch range.

Although the testimony of the crew and eyewitnesses indicates that the ground fine pitch system did not operate whilst the aircraft was on the runway, the system must have operated before impact with the spreader and this is confirmed by the evidence of an engineer on the ground who heard a distinct change of propeller noise just after the aircraft left the runway. It is quite probable that as the aircraft ran over the rough ground after leaving the runway, the defective throttle switch/es jarred and closed. This would complete the ground fine circuit, remove the flight fine pitch locks, and permit the propellers to move into the ground fine pitch range. However, as the aircraft pivoted on impact with the spreader, the port undercarriage torque link failed and the bogie rotated thus permitting the ground fine pitch undercarriage switches to open.

As the ground fine pitch circuit was then broken the electro-hydraulic circuit would move the propellers towards the 19 degrees pitch angle, i.e. the open undercarriage switches simulated the normal in-flight condition of the circuit and as the propellers were below normal in-flight fine pitch angle, the inbuilt safety device was automatically activated to return the propeller pitch to 19 degrees at which setting flight can be maintained. Also, the crew moved the high pressure cocks to the feather position as the aircraft came to rest. Therefore, as the engines ran down the propellers could continue to move back beyond 19 degrees towards the maximum coarse pitch position. The difference in blade angles as found on the aircraft was due to the difference in the rundown times of the four engines occasioned by the varying damage to each blade.

Ten days prior to this accident the ground fine pitch was reported as being slow to operate but no fault was found; corrective action consisted of tightening connections and checking the oleo strut pressures. Three days prior to the accident the ground fine pitch was again reported as not operating on landing or whilst taxying. In this instance a lead to one of the undercarriage switches was found to be broken, but as the switches are duplicated this would not have caused the incident. Again all connections were tightened and the aircraft signed out as serviceable. It is apparent that the cause of the malfunctioning on these two occasions was not established and it now seems likely that the faulty operation of the system was caused by the defective throttle switches.

No defect or evidence of malfunctioning was found in the brakes which could have been caused or contributed to a loss of efficiency. The pre-landing check indicated that brake pressure was available at the wheels and, although no noticeable deceleration was achieved during the landing run, the brake controls felt normal and the brakes were hot for some time after the aircraft came to rest.

The aircraft ran off the runway about 4,500 feet from the threshold, that is, 1,000 feet less than the distance in which subsequent tests indicated it could have been stopped with automatic brake control braking and without ground fine pitch. It has been calculated that the speed 4,500 feet from the threshold would have been approximately 60 knots. This is consistent with the speed at which the crew and eyewitnesses estimate that the aircraft left the runway. From this and from the results of the examination of the brakes and tyres, it is concluded that the maximum possible braking on a wet runway was achieved during the landing run.

CONCLUSION

The cause of the accident was that propeller aerodynamic braking was not obtained during the landing run because of a defect in the ground fine pitch circuit.

Mercy Flight

A Cessna 182 ambulance aircraft set course from Emerald for a flight 132 miles eastward to Rockhampton, in Queensland, on 7th June last year in the face of deteriorating weather conditions and darkness. By the time it reached the foothills of the Gogango Ranges, which lay across its path, the aircraft had been forced to a very low height by cloud and rain and at approximately 1815 hours* it struck trees whilst manoeuvring near Edungalba, some 40 miles south-west of Rockhampton. The aircraft disintegrated and caught fire — all four occupants being killed instantly.

EVENTS PRECEDING THE ACCIDENT

During the evening of Friday, 6th June, a patient, who was 5½ months pregnant, was successfully treated in the hospital at Alpha, Central Queensland, for an internal haemorrhage. On the following morning the local doctor consulted with the medical authority at Rockhampton by telephone and it was agreed that she should be removed to the Rockhampton Base Hospital for the remainder of her pregnancy. It was agreed that transport by air offered the best solution, considering the distance involved (i.e., 215 miles), and, since another male patient at Alpha had suddenly gone blind in one eye, it was decided to transport him also for specialist treatment in Rockhampton. The Central Queensland Aerial Ambulance Service was alerted at approximately 1130 hours and the aircraft departed Rockhampton at 1330 hours. The forecast weather conditions indicated very marginal conditions for flight under the visual flight rules along the route and the pilot was asked to declare his flight as a mercy flight from the outset. This he did and the "uncertainty" phase of S.A.R. procedures was instituted at the commencement of the flight.

Nothing is known of the outward flight to Alpha but the aircraft reached there at 1520 hours and, since this was only eight minutes after planned E.T.A., it is presumed that this section of the flight was negotiated without incident. The patients were loaded and the aircraft set course for Emerald at 1555 hours landing there in moderate rain at 1655 hours. The aircraft was refuelled and, just before departure, the airport controller at Rockhampton rang and discussed the weather conditions and reporting procedures with the pilot who indicated that he would continue the flight to Rockhampton despite the certainty that he would not arrive until after last light and would encounter unfavourable weather conditions. He was advised to follow the railway line and that sighting reports would be obtained from small towns along it. The pilot said that he had enough fuel to stand-off at Rockhampton or return to Emerald if the visibility was poor on his arrival and the aircraft then departed Emerald at 1714 hours. The distance to be flown to Rockhampton was 132 miles requiring 83 minutes. Official last light at Rockhampton on this night was 1739 hours and the E.T.A. of the aircraft was 58 minutes after this time (i.e. 1837 hours).

Two sighting reports were received from towns along the line and then the aircraft was heard and seen passing over a third town, Edungalba, at a very low altitude. Some two miles further on, a number of eyewitnesses report that it carried out an orbit in steady rain and under a cloud base of not more than 200 feet, at the foot of the Gogango Ranges. It then flew in the general direction of Rockhampton but when approaching the crest of the first ridge of the Gogango Ranges it turned sharply to starboard, struck the trees and burst into flames.

INVESTIGATION

Weather Conditions

The accident occurred in the western foothills of the Gogango Ranges 40 miles south-west of Rockhampton and at a height of approximately 420 feet above sea-level. During the preceding 30 miles of flight the aircraft had been traversing fairly level terrain, the average height of which is 300 feet above sea level, but soon after passing Edungalba it encountered the first thickly timbered ridges of the mountainous area which lies between Edungalba and Rockhampton. Terrain heights are up to 1,600 feet above sea level in this sector. The impact occurred in very dense timber and within sight of several farm houses which were situated along a subsidiary road.

* All times in this report are Eastern Standard Time.

At the time that preparations were being made for the departure for Alpha the weather conditions at Rockhampton were observed to be fine, visibility 25 miles, cloud 7/8ths stratus at 2,000 feet and the wind velocity was 140°/6 knots. Except for the rather frequent passage of rain showers bringing a lowering of the cloud base to 1000-1500 feet and a reduction of visibility to as low as one mile, the observed weather at Rockhampton did not show any substantial change during the course of this flight.

The route forecast indicated that there would be light, intermittent to steady rain with the lowest cloud 3/8ths to 5/8ths stratus with base 800-1500 feet and 4/8ths to 6/8ths strato-cumulus at 2000-2500 feet. The visibility would be 10-15 miles reduced to two miles in rain. This forecast would indicate that over substantial sections of the route the flight could be conducted in accordance with the visual flight rules but, in particular, where it crossed the Drummond and Gogango Ranges the ability to observe these rules would at least be very marginal. A number of people who were travelling on the Inland Highway near the accident site report that the cloud was very low and obscured much of the road over the Gogango Ranges at the time of the accident.

The Aircraft

This Cessna 182 was purchased in October, 1957, and had flown only 76 hours at the time of the accident. Since it was not fitted with radio-communication or radio-navigation equipment, it did not meet the Department's minimum standards for instrument flight. On the point of flight instruments however, the aircraft was reasonably well-equipped, the most notable deficiency being that it carried a standard and not a sensitive altimeter. It also lacked a pitot heating system and an outside air temperature gauge but all the other instrument and lighting requirements for I.F.R. flight were available. It is apparent that this aircraft could be operated in reasonable safety at night over settled areas in favourable weather conditions affording visual reference to the ground for navigation purposes. In the interests of saving life the Department has always waived the "VFR only" restriction provided the flights are conducted under favourable conditions.

The aircraft was apparently quite airworthy at the time the flight commenced, the pilot gave no indication during its progress of any conditions of unserviceability and the evidence of persons close to the accident site gives no indication of any malfunctioning prior to impact. It appears that the propeller first struck the leafy top of a tall tree situated on rising ground when the aircraft was steeply banked to starboard. The aircraft then crashed through trees and heavy undergrowth striking the ground heavily with the propeller and forward fuselage 102 feet beyond the first impact point. The aircraft bounced and slid forward for a further 57 feet coming to rest against the base of a substantial rosewood tree where spilt fuel ignited. It was apparent that the engine was delivering at least cruise power at impact; the aircraft had ample fuel and there was no evidence of contamination.

The Pilot

The pilot, who was 29 years of age, had flying experience of between 235 and 245 hours including 59 hours in the Cessna 182 type. His only other type endorsement was for DH82 aircraft. His experience included a small amount of night and instrument flying some of which had been gained on the Cessna 182. He did not hold an instrument rating, and in normal circumstances he would not be permitted to fly any aircraft under I.F.R. conditions. This restriction is also waived in the case of a medical emergency provided that other circumstances are favourable to the flight.

There was an event of some significance involving this pilot a week prior to the accident. On that occasion he was called to transport a patient from Blackall in Central Queensland to Brisbane. The flight was made in daylight hours but poor weather conditions grounded the aircraft at Toowoomba and the patient had to be taken on by road transport. During the evening of the same day, another VFR aircraft on a mercy flight from St. George overflew Toowoomba and landed safely at Brisbane. Although this latter flight was in the hands of a very experienced bush pilot, the pilot involved in this accident was on the receiving end of some good-natured banter both at Toowoomba and when he returned to Rockhampton because he did not get through in daylight hours, whereas the other aircraft had reached Brisbane in similar conditions and in darkness. It seems that these comments had their effect on the Rockhampton pilot whose retort at the time was that if a similar situation arose in the Rockhampton area, which he knew well, he would get through in the same way. This situation arose only six days later and it is very difficult to dismiss the possibility that he was determined to show the critics that bad weather would not ground his aircraft in territory with which he was familiar.

The Medical Emergency

The female patient had experienced an internal haemorrhage; any recurrence of this condition (which was highly probable) would necessitate an immediate blood transfusion. The transfusion could only be given by a doctor, and the recurrence of bleeding being quite unpredictable, the doctor at Alpha would have to remain within a short distance of the patient. The next nearest medical officer was at Springsure, some 40 miles away over indifferent roads. Considering the Alpha doctor's other responsibilities over a large practice, geographically, and considering the difficulties of transfusing without blood bank facilities, the necessity for removing the patient to Rockhampton became obvious. The only real consideration in carrying this out was the length of time during which the patient would be away from transfusion facilities if a haemorrhage occurred. There was little hesitation in agreeing upon the use of the aerial ambulance since alternative surface transport would be considerably slower and less comfortable.

There is every reason to believe that if the doctor at Alpha had known that a flight into darkness or unfavourable weather was involved, he would have readily concurred in any decision to delay the flight until it could have been made in safer conditions. The patient was quite comfortable in the Alpha hospital where an emergency blood donor panel existed and the doctor could have remained with the patient until flight conditions were suitable.

The medical authority at Rockhampton indicated that it was concerned to have the patient transferred to Rockhampton as soon as possible but it was not envisaged that it would be done in unsuitable weather or darkness. The aerial ambulance was alerted at about 1130 hours believing that there was plenty of time for the return flight to be completed in daylight on that day. Local weather conditions at this time had not impressed the medical people as being such as to hazard the flight but, had they been informed that beyond Emerald, a flight into unfavourable weather or darkness would be necessary to meet their request, it is clear that the need for aerial transport beyond that point would have been reconsidered. Transferring the patient to the Emerald hospital or to a road ambulance would have involved some risk with the female patient but it is quite clear that, whatever the medical risks may have been, they could not justify the assumption of such overwhelming flight risks as should have been apparent to the pilot at that stage of the flight. In alerting the aerial ambulance, the medical authority indicated that a patient had been haemorrhaging at Alpha and believed that she should be transferred to Rockhampton on that day. It is apparent that this information was passed to the pilot before his departure but at no subsequent stage did he seek or obtain further details on the patient's condition or the degree of medical urgency.

ANALYSIS

It appears that this flight was conducted with normal and adequate safety margins up to the point of landing at Emerald for fuel on the return journey. At this stage it was obvious that the flight would have to be continued in abnormal circumstances or postponed until better conditions prevailed. AIP/SAR 1-12 makes it quite clear that the pilot is solely responsible for this decision but in order to assist him it lays down certain conditions and gives particular advice. It states first of all that a mercy flight shall not be undertaken when:—

(a) alternative means of achieving the same relief are available; or

(b) the crew and other occupants of the aircraft involved will be exposed to undue hazard; or

(c) the relief or rescue can be delayed pending the availability of a more suitable aircraft or more favourable operating conditions.

There is also a list of factors which the pilot is enjoined to consider, many of which contain distinct warnings in relation to circumstances similar to those involved in the continuation of this flight beyond Emerald.

It is also quite clear that, on the one hand, the medical officers involved with this flight had no idea of the circumstances in which the latter part of it was being attempted and, on the other hand, the pilot had only a very general and probably a false conception of the patient's condition. This situation could have been overcome by a telephone call from the pilot to his employers before leaving Emerald. This would, almost certainly, have led to a re-assessment of the situation with the medical authorities becoming aware of the flight risks involved. It is considered that, at the time of the initial alerting, the medical briefing to the pilot was sufficient since the task involved only the air transport of a patient. When the aircraft reached Emerald on the return flight, however, it was obvious that a continuance of the flight involved an irregular and highly dangerous operation; it was at this point that the pilot should have informed his employers or medical authorities that the flight could not be continued and sought advice as to the disposal of the patients.

It is true that there was no doctor located at Emerald and this was probably known to the pilot but the patients could have been taken on to Rockhampton by road transport and *the Emerald ambulance met the aircraft with this possibility in mind.* Apparently the pilot felt impelled to complete the job he had set out to do and quite probably he viewed the woman patient's condition more seriously than was, in fact, the case. No doubt these factors induced him to "write down" the risks of the flight ahead but nevertheless they were so great that it can only be concluded that the pilot's lack of experience played a big part in his decision. When the aircraft left Emerald 25 minutes before last light in steady rain and under a low cloud base the chances of a successful landing anywhere were extremely remote and it is considered that the pilot's decision to continue beyond Emerald was in error and it constitutes the prime cause of this accident.

Comment

There is increasing concern not only within the Department but amongst other groups and individuals in the community with the problems and risks which mercy flights entail. It is not easy to gauge how many lives have been saved by mercy flights but certainly many lives have been lost when unnecessary and quite unreasonable risks have been undertaken. Some benefit is undoubtedly available if each person or organisation involved clearly understands their own responsibilities and appreciates the problems of others. This is the theme of an editorial published recently in the Medical Journal of Australia reproduced here because it may help to bring aircraft pilots, operators and medical practitioners closer together in their approach to mercy flights.

"MERCY FLIGHTS AND THEIR SAFETY"

From time to time reports appear in the newspapers of what are described as "Mercy Flights". They are usually undertaken to convey someone from an outlying area to a larger centre where he can obtain urgently needed special medical attention or to rescue someone in danger of his life, for example, from flood. A number of such flights have ended in disaster, perhaps with loss of the lives of all concerned, and no doubt many people have wondered what lay behind these tragedies. What is not generally realised is that the term "Mercy Flight" is not just a striking phrase coined by some imaginative newspaper reporter, but a term defined in aviation law, and that by definition it involves a degree of hazard. Since the majority of Mercy Flights intimately concern members of the medical profession, it is vital that they should understand what such flights involve and the conditions under which they may be undertaken, and that in particular they should not under-estimate their own moral responsibility in the matter. For this reason we are grateful to the Director of Aviation Medicine, Dr J. C. Lane, for drawing our attention to the subject and for supplying detailed information about it.

Reference is purposely made to the doctor's moral responsibility, for, despite the great influence that he may exert in the initiation of a Mercy Flight, he does not bear the legal responsibility for it. That rests with the pilot of the aeroplane. With humane intention our aviation law gives great freedom to a pilot in departing from the rules of safe operation on Mercy Flights, but it also lays down that he is "solely responsible for the final decision as to whether or not a Mercy Flight shall commence or continue". A Mercy Flight is defined in the regulations as an urgent medical, flood relief or evacuation flight, to save or relieve some person from grave or imminent danger, which cannot be made under the ordinary rules of safe flying. The last qualification is important. Many medical flights are made. Mostly they are safe, routine flights, whether by single-engined or multi-engined aircraft. These flights are merciful, but they are not Mercy Flights in law. The regulations say that "a Mercy Flight shall not be undertaken when . . . the relief can be delayed pending the availability of a more suitable aircraft or more favourable operating conditions". In deciding whether the flight "shall commence or continue", the pilot is required to take account of a number of factors—weather, terrain, his own experience—including the probable effect of delay on the patient's condition. The pilot is obliged to discuss this with the doctor, so as to find out whether an immediate flight is needed, and, if it is, to compare the relative risks to the patient from delay, and to the patient, pilot and attendants from the lowered standard of safety, if the flight proceeds. This point is laboured, because there is sometimes a lack of communication between doctor and pilot, so that the pilot is influenced to carry on with the flight by an impression of a degree of medical urgency which does not really exist. This, of course, cannot happen when a doctor is a regular member of the crew of the aircraft or when the doctor is also the pilot.

Taking patients to medical care or the doctor to the patient by aircraft is common in this country, and its remarkable success is well known. There is unhappily a reverse side to the picture, and for some time past those primary responsible for aviation safety have been increasingly concerned with the disastrous outcome of certain medical flights. We are so used to the regularity and safety of air transport that perhaps we tend to take these qualities for granted, but safety in flying has been won slowly. A truth that experience has taught flying people is that there are two very different conditions of flight. These are (i) visual flight, in which the pilot is able to stay well clear of cloud and is always able to see the ground, and (ii) instrument flight, in which both the above requirements cannot be met — that is, all flight which is not visual flight. Experience has further shown that an acceptable level of safety in instrument flight conditions demands an aircraft which can fly with one engine inoperative and which has certain flight instruments, radio navigation equipment, and radio for communication. The pilot must be trained in instrument flight technique and have the means of keeping in practice.

Of the aircraft regularly used in flying doctor and air ambulance work only three meet these requirements. Not many of the pilots concerned have good instrument flight experience. However, present aviation law permits these "visual flight" aircraft and pilots to undertake medical emergency flights under instrument conditions, provided the flights are declared to be Mercy Flights (this declaration alerts the Search and Rescue organisation). It follows from what has been said on such Mercy Flights there must almost always be some degree of extra risk. This risk may be small, as on a flight by clear moonlight over flat land with numerous towns en route, or very large, as when a light plane has to fly over mountains or at night through bad weather; a fatal accident is then at short odds. In making his decision the pilot needs to weigh the flying risks, which he knows, against the medical risks, which he depends on the doctor to tell him about. In discussing this with the pilot, the doctor ought to distinguish between the need for immediacy of transport and the need simply for a short journey time (so that the patient is away from medical care for as short a time as possible or to minimise the upsets of travel). In defining the degree of urgency, the doctor should also consider whether the extra skills and facilities available at the destination are likely substantially to improve the patient's chance of survival, or whether this extra help is being invoked as an act of desperation. To sum up, if all the factors, flying and medical, could be balanced fairly, Mercy Flights would present few problems. At the same time, there is a factor, not printed in the regulations, that weighs heavily against postponing a flight; that is the social pressure on the pilot — from emotion, fear of community censure, the aura of drama and, perhaps, professional pride to the point of bravado. The doctor can help by shielding the pilot, so far as possible, from the importunities of the patient's anxious relatives.

It is not the intention of this discussion to discourage in any way the use of air ambulance — on the contrary, they could probably be used more widely; but it is emphasized that, while medical emergencies can arise at any time, the aircraft mostly used in this work can be flown with normal safety only in daylight and fair weather. Most medical or ambulance flights take place under visual flight conditions and are perfectly normal operations with an excellent safety record. It is the minority which become Mercy Flights that constitute the problem. The difficulties outlined here could be reduced by an understanding on the part of the doctor of the pilot's problems, and by a readiness to discuss with the pilot the medical aspects of a flight proposed at night or in bad weather — that is, by definition, a Mercy Flight.

Instrument Flight — Four Fatalities

At about 1345 hours on 6th June, 1958, some 25 minutes after departing from Moorabbin on a local pleasure flight to be conducted within the training area, a Piper Tri-Pacer emerged from cloud at high speed in a steep dive and struck the side of a ridge near Belgrave, Victoria. All four occupants were killed and the aircraft was demolished.

The aircraft had been flown by the Chief Flying Instructor of the club immediately preceding the fatal flight. This flight was uneventful and the aircraft was not serviced or refuelled between the flights. Only six minutes elapsed between the flights and the fatal flight was commenced with an endurance of three hours.

The weather was influenced by a cold front extending from Nhill to Melbourne thence south-east over the Belgrave area. The general weather was broken cloud with overcast patches and moderate west to south-west winds, gusty at times. Throughout the time the Tri-Pacer was airborne an Avro Anson was being operated in the area east of the range and about 8-10 miles from the crash site. This pilot confirmed that these conditions existed over the ranges with localised patches of cloud at 600-700 feet above ground level with frequent rain squalls; at times large areas were cloud shrouded to ground level. He also encountered severe turbulence when near the range. The testimony of witnesses who heard and saw the aircraft during the final few seconds of flight shows that at that time the crash site was overcast with the cloud base on the tops of surrounding ridges. Light rain was falling.

The crash site was two-and-a-half miles east of Belgrave, seven miles outside the training area, in a cultivated field at an elevation of 1,200 feet on the southern slope of a 1,500 feet high ridge running approximately northwest - southeast. There is considerable urban development throughout this district and it is a popular touring area with light aircraft pilots. Mt. Dandenong (2,078 feet) can be circumnavigated at a height of about 900 feet m.s.l. and to do so necessitates penetrating the range a distance of 10-11 miles. A popular route on such a flight lies along the main road from Melbourne which passes through Belgrave. It was within a few hundred yards of this road and at a point about six miles into the range that the accident occurred.

The wreckage was strewn up the slope of the ridge, the point of initial impact being marked by a crater ten feet long, eight feet wide, and two feet six inches deep. The formation of the hole and the location of the major impact damage to the engine indicated that the aircraft hit the ground in about a 30 degree angle of dive and banked to the right. The engine was ten feet beyond the point of initial impact. Sixty feet beyond the engine was the whole of the left and right wings and most of the cabin structure above window sill level. This structure had apparently sheared from the lower section of the fuselage through inertia forces. It was rolled into a twisted mass and without close scrutiny was unrecognisable as wing or cabin material. The remaining section of the fuselage came to rest a further ten feet along the wreckage path. Only the fin and rudder bore any resemblance to former shape, the whole being a closely tangled mass.

Except for two pulleys which had disintegrated all control cable pulleys, fairleads, and cables were examined but no evidence of malfunctioning was found. Of the control surfaces, only the right aileron was detached from its hinge fittings and it was determined that this was due to impact forces.

Examination of the lift struts, fuselage, and empennage revealed that they were intact until the moment of impact. A detailed examination of the engine revealed no evidence to suggest that it was incapable of normal operation before the impact.

ANALYSIS

None of the eyewitnesses caught more than a fleeting glimpse of the aircraft before the impact. It is clear, however, that the crash site was approached in a steep descent from a height which permitted a very high speed to be attained. All of the witnesses first became aware of the aircraft through the unusual sound it made—this was of short duration, their description of its sudden onset and rapid increase in intensity describes an aircraft diving at high speed. This evidence indicated also that the engine was delivering power during this descent. The complete disintegration of the aircraft and the extent of the area over which small pieces of it were scattered amply testified to the high speed at impact.

The accident site was overcast with cloud covering the top of the ridge struck by the aircraft, that is the cloud base was about 100 feet. There is no doubt that the aircraft was in cloud until a few seconds before impact but even if it had been possible to descend between cloud banks it is most unlikely that this could have been done without the necessity to rely on instrument indications to maintain control of the aircraft.

All of the evidence shows that the aircraft descended through cloud conditions which would have required flight by instruments. Furthermore, that it did so in a steep dive at high speed and in the final stages at least, it was turning to the right. Since no pilot would deliberately place an aircraft in

such a configuration in the flight conditions that prevailed and in the certain knowledge that he was close to the ground, it is apparent that the aircraft was not under the control of the pilot at this time.

The aircraft was equipped with the basic flight instruments comprising a magnetic compass, airspeed indicator, sensitive altimeter, gyroscopic turn and bank indicator, and a vertical speed indicator. Neither the instruments nor the operating systems were duplicated and there was no provision for protecting the operating systems against icing or condensation.

Although this limited range of instruments is not acceptable for operations in instrument conditions it is sufficient to permit a pilot practised in the art to exercise control over the aircraft without exterior visual reference. However, it would have been hazardous to undertake prolonged flight in cloud because of the lack of standby instruments and operating systems, and the absence of means to prevent malfunctioning through ice formation and entry of water.

The pilot had logged some 300 hours, his total instrument flight time being only 10 hours 35 minutes, which had been flown during training to obtain a commercial pilot's licence six-and-a-half years prior to the date of the accident. As it is impossible for a pilot inexperienced in the art of instrument flying to maintain proper control of an aircraft when faced with the task of flying by instruments, it could be expected that this pilot would be in serious difficulties if he had to fly on instruments.

This flight was apparently undertaken solely for pleasure. It was to return to the departure point with no intermediate stops, therefore, there appears to have been no pressing need for it to proceed into the mountain area where it terminated. The cloud conditions existing over the range were in evidence before the aircraft entered the area and it should have been apparent to the pilot that the continuation of flight in that direction clear of cloud was uncertain. It seems that he either grossly misjudged the conditions or took a calculated risk. Although it is possible that cloud was entered deliberately in the belief that the aircraft would be in it for only a short time, the most likely explanation is that the pilot found himself in a situation in which there was no alternative to proceeding without adequate visual reference and in so doing he lost control of the aircraft because of lack of experience and recent practice in flight by instruments.

Auster Rudder Cable Comes Adrift

Between 1500 and 1600 hours E.S.T. on 30th April, 1957, an Auster aircraft struck the ground soon after taking-off from a private airstrip 30 miles east of Wilcannia, New South Wales.

It was owned and operated as a private aircraft and, at the time of the accident, was commencing a flight to Wilcannia. There were five occupants of the aircraft, the owner/pilot, his wife, a son aged four years, a son aged two years, and a daughter aged seven months. Serious injuries were sustained by four of the five occupants and the owner/pilot's wife died of her injuries, during the rescue operations. The aircraft was substantially damaged.

The pilot's aeronautical experience amounted to 320 hours, of which 281 hours had been obtained on Auster type aircraft and the remainder on the DH.82 type.

The private airstrip being used for this take-off is on the pilot's property about three-quarters of a mile from the homestead and is oriented northeast - southwest. It is some 2,000 feet long and averages 150 feet in width with a surface of hard sandy loam and is 268 feet above mean sea level. There are scattered trees up to 30 feet high surrounding the airstrip. At the time of the accident the weather was fine with unlimited visibility and there was a surface wind of about six knots from the southwest.

The owner purchased this aircraft on the day prior to the accident and flew it from Broken Hill to his property via Wilcannia during the afternoon of that day. On the next morning he flew it over a neighbour's property for about 1¼ hours whilst engaged in locating stock. It was his intention to fly to Wilcannia during the afternoon with his family and then proceed to Deniliquin on the next day to obtain medical treatment for one of the children. There were no eyewitnesses of the take-off but apparently it took place between 1500 and 1600 hours. The owner's wife occupied the right hand seat nursing the seven months old baby whilst the two boys occupied the rear seat. Suitcases were placed on the floor between the front and rear seats and in the rear luggage space. The take-off was carried out into the south-west into the wind and apparently proceeded normally until the aircraft reached a height of about 100 feet. At this point the aircraft suddenly commenced to yaw to the right and despite attempts to correct this, the aircraft got out of control and struck the ground in a steep dive. The accident was not discovered until three or four hours later when a station-hand, hearing that the aircraft had not arrived at Wilcannia, commenced a search of the airstrip and its environs. He eventually found the wreckage amongst trees on the north-west side of the strip, about 200 feet from its edge and opposite a point about 1,500 feet from where the take-off commenced. All of the occupants were either trapped in the wreckage or were too seriously injured to move without help.

There is no evidence suggesting any engine power failure and, in fact, the pilot stated that the engine performance was excellent. There is no evidence that the pilot mishandled the engine or the aircraft during the take-off in such a way as to have contributed to the accident. However, there is considerable evidence that the port side rudder cable became disconnected at the turn-buckle immediately prior to the accident and the reported behaviour of the aircraft is consistent with this proposition.

The pilot's description of the accident is that, on reaching 100 feet the aircraft suddenly yawed to the right. The application of left rudder had no effect and the use of full left aileron, similarly, did not stop the turn and the aircraft dived to the ground out of control. Accepting that the port rudder cable turn-buckle became unfastened when the aircraft had reached 100 feet in this take-off the behaviour of both pilot and aircraft were as might be expected. Since most pilots fly with some pressure on both rudder pedals the first effect of the cable failure on the port side would be to induce an inadvertent pressure on the starboard rudder pedal yawing the aircraft to the right. Even if this pressure was quickly released (and it is possible that it was not), there are other forces tending to yaw the aircraft to the right. The effect of propeller torque at engine speeds above the cruise setting is also to yaw the aircraft in this direction and it is probable that, at 100 feet, full power or at least climbing power was being delivered by the engine. With a disconnected port rudder cable this force can only be eliminated by reducing power and there is no evidence that this was done. Then again, in this aircraft, each rudder pedal is spring loaded forward to maintain cable tension. The immediate effect of a cable failure on the port side would be to allow the spring tension on the starboard rudder pedal to apply a yawing moment to starboard. Meanwhile, the port rudder pedal would be held forward by spring tension and any pressure on it would be valueless. The pilot could only eliminate this force by placing his toe behind the starboard rudder pedal, pulling out against the spring tension and allowing the rudder to streamline. Such action could only have been effective in this case if the pilot had made an immediate and correct diagnosis of the defect and had a very thorough knowledge of the rudder system. These factors all contributed to an explanation of the aircraft's diving turn to the right from 100 feet and its rotation through 300 degrees before striking the ground. They also provide an explanation of why a pilot of this experience could not be expected to quickly appreciate the situation and take proper corrective action when the failure occurred so close to the ground.

The circumstances leading to the disconnection of the turn-buckle in the port rudder cable were closely examined. Between 28th February and 8th March, 1957, this aircraft was overhauled by an aircraft engineering organisation for the renewal of its certificate of airworthiness. During the course of this overhaul the port rudder cable was removed and replaced by a brand new cable from store. The work was done by an unlicensed engineer working under supervision. It is required that the turn-buckle of such a control cable be lock-wired after it has been installed and properly tensioned. The engineers who were responsible for preparing and inspecting the work, state that the turn-buckle was lock-wired but there was no trace of locking wire found on the disconnected turn-buckle in the wreckage.

The aircraft was flown for a total of eight hours between the certificate of airworthiness renewal and the accident, being kept in a hangar at Broken Hill for six weeks. During the seven weeks between certificate of airworthiness renewal and the accident it is possible that a lock-wire could have been removed by an unknown person, but all authorised people who worked on the aircraft state emphatically that the cables were not touched and there is no known motive for any malicious interference with the aircraft.

The turn-buckle was removed from the wreckage and on examination, it was found that the wiring hole in the swaged end of the cable was blocked by some substance. The fitting was subjected to independent scientific examination for confirmation that the hole was completely blocked, for determination of the nature of the blocking substance and for an opinion as to whether a locking wire had even been passed through the hole. To assist in this examination, a new cable which had been forwarded from the manufacturer in the same batch as the cable installed in this aircraft, was made available for comparative examination. The laboratory tests revealed no evidence that a locking wire had at any time been passed through the locking wire hole in the swaged end of the rudder cable. In addition, the wiring hole of the unused cable was found to be blocked in a similar manner to the one recovered from the crashed Auster and the blocking substance in each case was "zinc yellow" carried in a paste of wool wax and oil, which is widely used as a corrosion inhibitor. Having regard to these conclusions it is considered that the port rudder cable turnbuckle was not lock-wired following installation.

During the investigation it was also noted that the work sheets contained no signatures relating to inspection of the work but, nevertheless, the licensed and responsible engineer signed the general certificate of inspection for the renewal of the certificate of airworthiness. It seems most likely that the work was done in a hurried manner and that there was a complete oversight in relation to the wiring of this turnbuckle. The unlicensed engineer who actually worked on the aircraft was a licensed pilot and he carried out the test flight on completion of the overhaul work.

The evidence indicates clearly that the cause of this accident was that the persons responsible for the performance and inspection of overhaul work on the aircraft failed to ensure that the turnbuckle was lock-wired and this resulted in a complete loss of rudder control at a critical stage in the take-off.

This was Over the Fence

A De Havilland Dove operating on a regular public transport service left Derby in Western Australia early one morning during August of last year for Halls Creek via Fitzroy Crossing.

The aircraft reached Fitzroy Crossing at about 0720 hours W.S.T. in cloudless conditions and with a surface wind of 080 degrees 10-12 knots. The landing approach was made to the 07 runway and this involved a left turn of only 41 degrees from en-route track to runway alignment. The approach was made in poor conditions of forward visibility because of glare from the sun just above the eastern horizon (it was 79 minutes after sunrise) and on touching down the pilot noticed a three strand wire fence crossing the strip immediately ahead of the aircraft. He hurriedly pulled the aircraft into the air and landed again on the other side without any apparent ill effects. An examination of the aircraft on the apron, however, revealed that it had struck the fence causing damage to the flaps, the starboard tailplane and elevator and tearing the undersurface skin adjacent to the starboard wheel well. The pilot and the two passengers were uninjured.

Fitzroy Crossing aerodrome consists of two strips and the one being used for this landing is 3,580 feet long and 300 feet wide aligned 066 degrees magnetic. The western end of the strip is black soil surrounded by a heavy growth of grass whilst the remainder lies on red gravelly soil. The dimensions of the strip are outlined by boundary markers consisting of 44 gallon drums cut longitudinally in halves and painted white. Four such markers define the corners of the threshold together with two flush markers across the threshold itself. Several months earlier some grading work was carried out at the western end of the strip with a view to increasing its length. At the time of the accident, however, this extension of some 1,200 feet had not been incorporated in the usable strip length; it was not marked by boundary or threshold markers to indicate its serviceability and, in fact, the boundary fence of the aerodrome crossed the extension diagonally at a point some 300 feet west of the marked threshold.

Flying the same approach into the sun after the accident showed that it was most difficult to pick out the threshold and boundary markers of the strip proper and it was virtually impossible to see the crossing fence until very close to it. The situation was aggravated by the fact that the sides of the graded area which were quite distinguishable in these conditions showed no break where the unserviceable extension joined the threshold of the strip.

The pilot concerned had landed at Fitzroy Crossing on many occasions but apparently had not used the western approach to this runway for some months prior to the accident. It is apparent, however, that this pilot elected to make a straight-in approach into the sun and he landed on an area which was not defined by boundary markers and which did not have any marked threshold. If the pilot had adopted the precaution of crossing the strip before making his approach he would have noted the threshold and fence positions, since they are both easily distinguishable from any angle except looking directly up-sun. He could then have made a safe approach in full appreciation of the strip condition. His decision to make a poor visibility approach without first inspecting the strip constitutes the prime cause of this accident.

Overseas Accidents

Straight-In Approach in the Libyan Desert

(Summary based on the report of the Ministry of Communications, United Kingdom of Libya, and the Department of Civil Aviation, Federation of Rhodesia and Nyasaland)

On 9th August, 1958, a Vickers Viscount 748 aircraft struck high ground 5½ miles to the south-east of Benina aerodrome near Benghazi, Libya. Fire broke out on impact. Both pilots and two other members of the crew of seven were killed together with thirty-two of the forty-seven passengers. The remaining occupants sustained varying degrees of injury.

THE FLIGHT

The flight was a scheduled service from Salisbury, Rhodesia, to London, operated by three crews with crew changes at Entebbe and Benina. The sector from Entebbe to Benina involved stops at Khartoum and Wadi Halfa for refuelling. The flight was completely uneventful and slightly ahead of schedule up to the time of the accident. At 0112* hours the aircraft was cleared into Benina control zone. At the request of the pilot, at 0114 hours, permission was given by Benina approach control to make a direct approach onto runway 330° Right, using the locator and responder beacons. Between 20 and 30 seconds after this clearance had been acknowledged by the pilot the aircraft struck the ground.

INVESTIGATION

The pilot held a valid airline transport pilot's licence. When this was last renewed his total flying experience on multi-engine aircraft was 8,603 hours by day and 555 hours by night, which included 769 hours in command of Viscount aircraft.

The take-off from Wadi Halfa was made at 2120 hours with an estimated time of arrival at Benina of 0126 hours.

After take-off the aircraft climbed to a flight level of 14,500 ft. and at 2248 hours to a flight level of 16,500 ft.; the flight continued in a completely normal manner. After passing longitude 25° east, the boundary of the Malta Flight Information Region, two-way radio communication was established with Malta Area Control Centre. At 0052 hours Malta cleared the aircraft to Benina Approach Control and to a flight level of 4,000 feet.

Subsequently the aircraft communicated with Benina and confirmed its estimated time of arrival Benghazi South East (the boundary of Benina Control Zone) as 0111 hours and on this first contact with Benina, Approach Control passed the 0100 hours weather observation "Surface wind 360° at 2 knots, visibility 6 miles. Weather cloudy with 6/8 stratus estimated base 500 ft. QNH 1012. Runway in use 33 Right." This message was acknowledged and Benina Approach Control then asked the aircraft to report reaching flight level 4,000 ft. and when at Benghazi South East, which was acknowledged. The next call from the aircraft to Benina Approach Control was at 0112 hours when it advised "At Benghazi South East this time and just coming up to flight level 4000 ft." The aircraft was then under the direct control of Benina Approach Control. The controller then cleared the aircraft to continue its descent to a height of 2,500 ft. which was acknowledged by "Roger clear down to 2,500 ft. request QFE and surface temperature." This was passed to the aircraft as 997 millibars, surface temperature 22°C, the aircraft acknowledging with "Roger 997 22°". Approximately one minute later the pilot asked if he was clear for a direct approach on responder and locator beacons. This was acknowledged by Benina Approach Control "Affirmative, I have no other traffic. You are cleared to position for a direct approach on locator beacon and responder. Advise finals". This was acknowledged, "Roger leaving two-five now". This was the last call received from the aircraft.

After this call the controller in Benina tower looked out in a south-easterly direction where he expected to see the aircraft come into sight on its final approach to runway 330° Right. Almost immediately he saw a red glow in the sky followed by a column of fire which rose up to some considerable height and illuminated the tops of the hills. The time lapse between the last call from the aircraft and the time of seeing the glow in the sky was estimated by the controller as a minimum of 20 seconds and a maximum of 30 seconds. He thought that the fire may have been connected with night exercises carried out by the army. However, on reflection, he thought it possible that the fire might be connected with the Viscount and so he called the aircraft several times on the R/T without receiving a reply.

The controller then called the following aircraft and asked if he would call the Viscount over his R/T, which was tried without success. The flight then reported to Benina that he had seen a red glow ahead and that he would descend and circle around the fire in an endeavour to establish its position. This was subsequently done and the position given as 6 miles from Benina and on a bearing of 130° from Benina.

Wreckage investigations showed that the first indications of contact with the ground were the track marks of the nose and main wheel tyres at a position surveyed as 6.058 statute miles from the Control Tower at Benina aerodrome and 539 feet above the height of the runway (964 ft. a.m.s.l.). The magnetic heading of the aircraft at the time of impact was 328°, this being clearly shown by the ground markings. The path of approach had been over a rocky plateau with some undulations, but for the most part flat country.

The twin nosewheels struck the ground first, followed at a distance of five yards by the port and starboard main wheels. The ground marks at this first point of contact clearly indicate that the aircraft was flying laterally level and probably in a slight nose down attitude. Extending the initial direction of approach, the ground rises by approximately 20 feet in the next 126 yards after initial impact, falls 30 feet in 53 yards and then remains at this general level for the next 300 yards after which it falls steeply away. Ten yards from their first point of touchdown and whilst running along the ground the port main wheels struck a clump of rocks which wrenched the undercarriage assembly from the aircraft and permitted the blades of No. 1 propeller to strike the ground, the blades of No. 2 propeller then struck the rocks remaining in the path of the port undercarriage nacelle. The aircraft continued in the same direction with engine and propeller parts from the two port assemblies scattered in the wreckage path. Heavy slide marks in the centre of the trail together with other damaged components indicate that the underside of the forward fuselage received substantial damage whilst ascending the slight slope of the ground. It is thought that the nose wheel assembly broke away from the aircraft at this stage. Reaching the crest of the hill and with the starboard undercarriage still extended, the aircraft momentarily became airborne again, finally coming to rest inverted to the left of the line of approach and 350 yards from the original point of touch down.

First signs of fire in the wreckage trail occurred at 90 yards in the path of the starboard outer engine. The ground is marked at this position with a deep trough formed in the direction of the aircraft's movement. Loss of the nose wheel assembly caused the starboard propellers to strike the rocky ground and it is evident that their respective engines commenced to tear away from the mountings at this stage. A scorched area was also discernible in the path of the port outer engine at a distance of 160 yards. The burnt area increased in the direction of break up and it is thought that this was due to rupture of the port fuel cells when the wing traversed the rocky ground prior to the aircraft becoming airborne over the hill crest. All four engines were torn out of the aircraft and came to rest 280, 330, 400 and 450 yards from the initial point of impact.

No defects were found in any of the power plant components. The substantial damage to the blades of all propellers, particularly to their leading edges is indicative that the engines were delivering some power at the time the propeller blades struck the ground.

Flying controls were almost completely destroyed by fire but those components of the system still remaining were examined and found satisfactory and free from obstruction.

The plotting chart was recovered from the wreckage. The two MF/DF receivers, type 7092D, together with the DME transmitter/receiver were recovered and frequencies to which they were tuned checked. The dial of one altimeter was found with the millibar scale set to 997; the 10,000 foot hand, the only hand remaining, was pointing to zero.

ANALYSIS

The possibility of any structural failure of the airframe or malfunctioning of the engines or propellers is dismissed in view of the complete lack of any evidence to support such a possibility. The examination of the wreckage, the survivors' statements, some of whom were expert witnesses, and the fact that the pilot was in R/T communication with Benina Approach Control 20, or at the most 30 seconds before the accident occurred all point to the conclusion that no emergency existed.

There is no reason to suspect malfunctioning of any of the navigational or radio aids. In this connection the DME responder on the aerodrome was functioning correctly at the time of the accident and the fact that the pilot had used this equipment when passing El Adem and on the approach to Benina indicates that the aircraft's equipment was also serviceable.

At Benina aerodrome the pilot had the choice of three instrument approach landing procedures. The first involves the use of the locator beacon "BNI", the second the locator beacon and DME, the third VDF. In this instance the pilot elected to approach the runway using the DME and locator beacon without first establishing himself over the aerodrome by the appropriate radio aids. This de-

*** All times in this report are Greenwich Mean Time. Rhodesia, Sudan and Libyan times are two hours ahead of G.M.T. East African Time is three hours ahead of G.M.T. Miles referred to in this report are nautical miles unless otherwise stated.**

cision had doubtless been influenced by the fact that the major part of the descent had been made in the clear and with the lights of Benghazi in sight and possibly those of the aerodrome, although the latter is considered to be unlikely. This method of approach, which in reality is the last part of the published DME locator procedure, can be regarded as acceptable if all the equipment is serviceable, and in this case the evidence indicates that it was so. However, with a cloud base of 500 ft. the margin of safety must be reduced compared with the procedure whereby the pilot first establishes his position over the aerodrome at the minimum safe altitude. Nevertheless, the controller's evidence shows that the type of approach used in this instance is often carried out by pilots when landing at Benina.

The captain's decision to make an approach using DME and locator beacon indicates that it was he and not the first officer who was flying the aircraft, since he was sitting in the left-hand seat and the DME indicator is on the lower left-hand side of the captain's instrument panel making it difficult for the second pilot to read this instrument when sitting in his seat in a normal position.

The pilot commenced his descent from flight level 16,500 ft. at 0101 hours. The descent was made in the clear until the aircraft entered the stratus cloud reported to the south-east of the aerodrome at probably 2,000 to 2,500 ft a.m.s.l.

At 0112 hours the pilot reported that he was at flight level 4,000 ft. and his position Benghazi South East (this is the entry point to the Benina Control Zone and is 14 miles from the aerodrome). The aircraft was then cleared to continue the descent to 2,500 ft., but before reaching this height the pilot asked for clearance to make a direct approach on to runway 330° Right, using the responder and locator beacons. After permission was given for this approach, the pilot announced that he was leaving 2,500 ft. which, as near as can be judged, was two to three minutes after he had called when over Benghazi South East. Twenty to 30 seconds after the call at 2,500 ft. the aircraft struck the ground 964 ft. a.m.s.l., 8½ miles from the zone boundary and 5½ miles from the aerodrome.

It is difficult to calculate with accuracy the rates of descent and ground speeds during the latter part of the flight since R/T messages were not automatically recorded. The sequence and timing of events were obtained from a report made by the controller after the accident and although he may have recorded accurate times from his clock to the nearest minute (it was an electric clock, the large hand of which moves each minute), it is possible for these times to have varied perhaps up to 59 seconds either side of the minute. However the evidence concerning the time lapse between the last call from the aircraft and the crash, as estimated by the controller and subsequently checked by a time demonstration, is sufficiently accurate to calculate that a rate of descent between 3,100 and 4,600 ft. per minute would have been necessary for the aircraft to have struck the ground at a height of 964 ft. a.m.s.l., assuming that it was actually at 2,500 ft. when the call was made. Other evidence also supports the controller's estimation of the short period of time between the last call and the crash.

Such an excessive rate of descent is unacceptable in view of the survivors' evidence on the normality of the descent, and it would have resulted in far greater initial structural damage than was evident from examination of the wreckage. Alternatively, since the distance of the crash from the aerodrome has been definitely established as 5½ miles, and accepting that the last call was made 20 to 30 seconds before impact, the aircraft would have been between 6.25 and 6.6 miles from the aerodrome at the time of the call, assuming an approach speed of 135 knots. Therefore, if a rate of descent of as much as 1,500 feet per minute was being maintained the aircraft would have been located a little more than 4 miles from the aerodrome when it reached the height of 964 ft. and at this distance would not have collided with the high ground. Although in this example a rate of descent of 1,500 ft. per minute has been used, it should have been considerably less (nearer to 500 feet per minute) if the pilot was adhering to the procedure for approaching runway 330° Right when using DME and locator aids. Therefore, on this final descent it is evident that when the pilot made the call "leaving two-five now" he could not, in fact, have been at this altitude.

The main point at issue in this accident is, therefore, the determination of why the aircraft struck the ground 539 ft. above aerodrome level and 5½ miles out from the aerodrome on final approach, when it should have been at about 1,650 ft. at this distance. If the pilot was aware of the distance from the aerodrome then he would have elected to be a great deal higher than he was, or alternatively, if he was aware of his height then he must have estimated that he was considerably nearer to the aerodrome than he actually was. In regard to his awareness of distance, the earlier paragraphs give reasons for the assumption that the DME was serviceable but the possibility of his misreading this equipment should not be overlooked. In this connection it will be remembered that the two scales 0 to 20 miles and 0 to 200 miles on the indicator are presented on the same instrument dial; however, the very big difference in the position of the needle when reading 6 miles on the 0 to 20 mile scale and the same distance on the 0 to 200 mile scale makes the possibility of inadvertent range selection remote. This equipment would almost certainly have been used to establish the aircraft's position when at Benghazi South East, 14 miles distant from the aerodrome, and the fact that it was necessary for this position to be established with accuracy supports the view that the correct lower range scale was selected then, as well as at the time of the accident.

Turning now to the error in height at the time of the crash when the aircraft was 539 ft. above aerodrome level instead of at about 1,650 ft. as given in the approach chart, three explanations are possible.

Firstly, the pilot deliberately descending to 500 ft. above the runway height in order to break cloud is considered to be extremely unlikely since there is no doubt that he was familiar with Benina aerodrome and the surrounding terrain. In support of this view, the captain had used this aerodrome on many occasions and evidence given by a pilot who had recently flown as his first officer confirms that he was well aware of the presence of the high ground to the south-east of the aerodrome.

Secondly, the incorrect setting of the altimeter millibar scale by the pilots has been considered but rejected as unlikely. The QNH and the QFE were repeated back to the controller by the pilot and the dial of one altimeter was recovered from the wreckage; the dial of this instrument had the correct QFE set upon it and the 10,000 ft. needle, the only one remaining, was found at the zero position. To minimise the possibility of incorrect settings of the millibar scale and to check the accuracy of two altimeters it is common practice for pilots to cross-check their respective QNH and QFE altimeter readings after the settings are applied, the difference in altimeter readings indicating the published height of the aerodrome, or, that one of the altimeters is unserviceable. The operator had issued an operational order to pilots requiring this to be done. In view of the foregoing it is unlikely that either of the altimeters was unserviceable or incorrectly set on the millibar scale.

Thirdly, the misinterpretation of the reading of the altimeter by the pilot is strongly supported by the evidence of the short lapse of time between the last call from the aircraft and the moment of impact. It must be taken into account that, since for the greater part of the descent the pilot had been flying in clear weather conditions with the lights of Benghazi in view, he had probably not made the same reference to his instruments as if the whole descent had been in cloud. It is possible that the initial incorrect interpretation of the instrument reading may have been made some time before entering cloud at about 2,000 feet. After entering the cloud at this height the pilot would have been commencing the direct approach and his attention would, in all probability, be more concerned with the 100ft. hand than with the 1,000 ft. hand, so that an error made before entering the cloud would have been maintained subsequently. It is pertinent to consider here that if the pilot did in fact over-read his altimeter by 1,000 ft., then the rate of descent between the time of his last call and the time of the crash would be acceptable. A contributory factor when considering the likelihood of the pilot misreading his altimeter is the instrument panel lighting. The aircraft was equipped with two lighting systems, ultra-violet and red. When the red system only is being used, the position of the lights causes a shadow to be cast over the upper part of the altimeter, thus detracting from the ease of reading. This is particularly noticeable when the 1000 ft. hand is between the dial figures 9 and 3. However, if the ultra-violet lighting is directed on to the altimeter, this difficulty is eliminated, but in any case it has not been possible to establish whether either or both systems were being used at the time.

Finally, the question of whether or not the pilots were unduly fatigued at the time of the accident should be considered. A surviving crew member stated in evidence that the crew had retired at about 1900 hours on the 7th August and the following morning had taken breakfast at 0630 hours. The same witness was not aware of any crew member sleeping between breakfast time and 1230 hours, the time they reported for duty at Entebbe aerodrome. Therefore, at the time of the accident the crew would have completed over 19 hours without sleep, of which 12 hours, 44 minutes had been spent on duty, including 9 hours, 30 minutes flight time, although from 3rd August until the commencement of this flight the crew, with the exception of the cabin staff had been relieved of all duties. During the sector between Wadi Halfa and Benina the captain had complained to a flight hostess of slight pains in his stomach, for which he was given some kaolin. The fact that the captain was slightly indisposed is not considered significant in itself. Nevertheless, this, coupled with the long period he had been without sleep, and the fact that the flight was finishing in the early hours of the morning makes it possible that his efficiency had been lowered to some extent.

A pilot's flight time limitation, as prescribed in the appropriate Air Navigation Regulations, is 12 hours in any 24 consecutive hours.

PROBABLE CAUSE

In the opinion of the Inquiry Board the cause of the accident was that when making an approach to Runway 330° Right and whilst flying in cloud, the pilot descended below the correct height thus permitting the aircraft to strike high ground. The reason why the pilot descended so low, 5½ miles from the aerodrome, cannot be established, but the most probable cause is that he misinterpreted the reading of his altimeter. The possibility that his efficiency had been reduced by fatigue and a slight indisposition cannot be excluded.

The Board further concluded that if the pilot had established his position above the aerodrome by means of the locator beacon before descending below the minimum safe altitude it is unlikely that the aircraft would have struck the ground. The relatively high proportion of survivors was attributed to the large number of emergency exits fitted to Viscount aircraft and the fact that all survivors had their safety belts fastened securely.

Convair Crippled by Maintenance Errors

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

The crew of a Convair 340 experienced severe control difficulty just after take-off from Palm Springs, California, on 13th February, 1958. An emergency gear-down landing was made four miles from the airport in boulder-strewn desert, causing substantial damage, and fire which broke out in the left wing destroyed the aircraft. There were no fatalities but five of the 24 occupants received serious injuries, the remainder sustained minor injuries.

THE FLIGHT

The aircraft was on a flight from Las Vegas, Nevada, to San Diego, California, with an intermediate stop at Palm Springs. Earlier on the same day it had been flown by the same flight crew from Los Angeles to Las Vegas. This was the first time the aircraft flew following a maintenance check performed at the operator's base at Los Angeles. Before departure from Los Angeles the pilots performed a pre-flight-walk-around inspection of the aircraft in accordance with company procedures. The flight from Las Vegas to Palm Springs was uneventful except for an altitude change on encountering mild turbulence at 10,000 feet.

The take-off at Palm Springs appeared normal and the aircraft climbed to approximately 500 feet above the ground. At this time ground witnesses saw two or more silvery pieces separate apparently from the right wing area of the aircraft. Almost simultaneously the aircraft nosed down sharply, descending at a steep angle. As it neared the ground it levelled off considerably but continued to descend. A large cloud of dust appeared as the aircraft contacted the ground before disappearing from view being higher terrain. Seconds later smoke was seen rising from the accident site.

INVESTIGATION

Weather conditions were not a factor in the accident.

Both pilots stated that except for about four degrees left aileron trim required during climb and cruise, the aircraft operated normally during the flight to Palm Springs. The amount of trim necessary was within allowable tolerance for continuation of the flight but would have been reported at San Diego.

Take-off at Palm Springs was made with the first officer flying the aircraft. At about 1000 feet (550 feet above terrain) he called for climbing power. The pilots stated the climb angle was normal and the airspeed was 155 knots. The first officer made a slight right bank to keep another aircraft in sight and then rolled out. At this instant there was a noise which impressed the pilots as being a structural failure. The first officer, who continued to fly the aircraft, said the elevator control became "sloppy" and the aircraft began "bucking" and "buffeting" in a manner "as bad or worse than a secondary stall". The nose dropped and elevator control would not raise it. The first officer doubted that he would be able to control the aircraft and told the captain he thought they had a "broken elevator". Both pilots agreed a crash landing was inevitable and the nose would have to be raised to accomplish it. The first officer pushed the nose down to a 30-40 degree angle and added nearly full power. When the airspeed increased to 240-260 knots the first officer sensed a partial regaining of elevator control. He then added full power and, when about 300 feet above the desert, began decreasing the angle of descent. When about 50 feet above the ground the landing gear was extended on the first officer's decision and somewhat more positive elevator control was noted. He was able to raise the nose of the aircraft so that ground contact occurred main gear first. The specific touch-down speed is unknown but thought to be in excess of 200 knots.

A passenger seated in the right-hand window seat of the first row stated that at the onset of the vibration he saw a large piece of the right wing break loose and "flop back and forth" for three to four seconds before separating from the wing. A mass of tubing and pipes was then exposed along the front of the wing. At least one other passenger saw a piece flash past his window at about the time the buffeting started. The nature and effect of the buffeting was described by passengers and the stewardess. There was no pattern to the buffeting and it was

equally severe up and down and from side to side.

The crew said the aircraft rolled fairly well over the rough terrain until the landing gear failed when it struck boulders and mounds of drifted sand. The aircraft then slid to a stop and fire broke out in the left wing, shortly becoming uncontrollable. The aircraft was evacuated through the front loading door and the first and second window exits on the right side. The rear emergency door was jammed. The evacuation was orderly, fairly well distributed through the three openings, and required less than a minute to accomplish.

Initial contact with the desert floor was on a heading of 320°M at a point some four miles from the end of the runway. The main wreckage, comprising the fuselage, left wing and engine, and portions of the empennage stopped upright about 1,185 feet beyond the initial contact point. Other components had separated from the aircraft along the wreckage path, the left main landing gear being thrown about 100 feet and 45 degrees to the right after being torn off by a huge boulder 500 feet beyond the touchdown point. The right main gear was found near the main wreckage. The fuselage apparently withstood the severe impacts and came to a stop in relatively good condition. It was subsequently destroyed by fire.

The major portion of the right wing leading edge was found about half-a-mile beyond the end of the runway used for take-off. Its location relative to the aircraft wreckage confirmed ground observation that this component separated in flight. It is an individual section of the leading edge 52 inches long and 25 inches deep which serves as part of the aerofoil design by forming the leading edge of the wing inboard of the right engine nacelle to the fuselage. Its construction is a series of six former ribs over which the wing skin is attached. The component is hinged on the top side with a "piano hinge" enabling it to be raised for inspection and/or repair purposes. In its down position the leading edge is secured by a series of 27, 10-32 x 11/16, stress screws installed from the bottom edge of the leading edge into an equal number of 10-32 self-locking nuts mounted on the lower spar cap of the wing. Gap straps are used to cover the small spaces on each side of the leading edge when it is in the down position. The gap straps are flexible metal strips retained by screws at the top. At the bottom ends of the straps are cross pins which connect the straps into a turnbuckle overcentre latch assembly for the purpose of adjusting and drawing up the straps. The turnbuckle overcentre latch unit is screwed to the lower spar cap. Over the gap strap length a series of 12 fasteners is incorporated to hold the strap and prevent it from "ballooning" in flight. Although the straps do hold the leading edge down to some extent they are not intended to serve this function.

The leading edge component was relatively intact when recovered, except that the skin covering, about one-half of the heater duct, and the piano hinge were missing. A major portion of the skin and the heater duct were found about 200 yards beyond the leading edge, and the hinge with the balance of leading edge skin attached was recovered still attached to the right wing. The self-locking nuts which retain the 27 stress screws are normally held in position by a "gang channel" riveted to the lower spar cap. The gang channel was recovered in the main wreckage, separated from the wing spar cap by impact forces which sheared the retaining rivets, with 21 of the 27 self-locking nuts still in place.

Examination of the self-locking nuts produced no evidence that the screws were in the nuts. In fact, the threads of each nut were found to be in good condition; none was pulled and there were no screw portions in any of the nuts. A thorough search failed to recover any of the screws normally used to secure the leading edge.

Other mechanics testified that the screws originally taken from the assembly were hanging in a rag at the leading edge opening, although the mechanic performing the work said he did not see them. An engine lead mechanic said he had seen the mechanic tighten two screws with the air-driven screw driver but did not recall whether these screws were in the gap strap or bottom leading edge. When the mechanic was asked at the public enquiry if, in view of the evidence that there were no screws installed along the bottom of the leading edge, he might have forgotten to install them, he stated, ". . . it just doesn't seem like they were in it." The enquiry found personal factors which could have contributed to such an omission.

The lead mechanic, who was responsible for ascertaining that all inspection openings were properly closed and secured, stated that he made the inspection in his usual manner, to determine that no plates were open and/or hanging down. He did not check each plate "screw by screw" but went over the aircraft looking over various areas and sighting over its exterior surfaces and then checked the cargo pit lining. He could not, from his inspection, state whether or not the leading edge screws were in place but his inspection would normally reveal any screws sticking out or plates not flush with the aircraft surface. After completing the inspection he signed for the work on the master record form and when he was relieved he reported to the incoming lead mechanic that the plates were closed.

The lead mechanic's concept of the inspection required under company maintenance procedures was at variance with the concepts of other maintenance personnel. Another lead mechanic indicated that his method of inspection was to view the plates from close proximity looking for proper placement, looseness, and/or missing or partially tightened screws, taking the time which the task required.

ANALYSIS

The pre-flight walk around inspection made by the pilots was in accordance with company procedures. This inspection is not a maintenance function nor a "screw by screw" check of the aircraft.

The sharp report and control difficulty which followed the take-off from Palm Springs was caused by in-flight separation of the right wing leading edge section, normally installed between the right engine nacelle and fuselage. The control difficulty is compatible with disruption of normal airflow over the right aerofoil after the leading edge separated. Undoubtedly normal lift was affected and a turbulent abnormal slipstream was introduced to the horizontal stabilizer and elevator control surface. The section of leading edge skin which remained attached to the hinge would blow back and forth in the slipstream, aggravating the disruption of airflow and producing a spoiler effect on the right wing, which necessitated an immediate forced landing.

Examination of the leading edge disclosed no evidence that the screws used to retain the leading edge were in place at the time of the accident. If the proper screws had been installed they would not have worked out and if shorter screws had been used it is extremely improbable that all 27 screws would work out evenly at the same time. The screw holes and the 21 self-locking nuts recovered were in good condition, free from damage which would indicate vibration or working out of the screws in flight. It was concluded that the mechanic assigned to close the leading edge opening forgot to install the screws. He did install the gap straps which held the leading edge in place for about two hours of flight time before they failed under loads which exceeded their design limits.

The method of inspection of the aircraft followed by the lead mechanic could not have assured him that screws were installed in the leading edge. His responsibility for inspecting the access panels for being "in place and secured" was clearly expressed in company material and its importance should have been evident to him. Nevertheless the inspection was treated in a cursory manner, suggestive of an inadequate appreciation of its importance.

PROBABLE CAUSE

The Board determined that the probable cause of the accident was the failure of a mechanic to secure properly the right wing leading edge section as a result of which the unit separated in flight. This improper installation was undetected because of inadequate inspection.

INCIDENTS

False Fire Warning

To a pilot there should be no such thing as a false fire warning. This is emphasised in the following incident.

The pilot of a Dove aircraft reported that immediately after take-off, the two port fire warning red lights showed (the bell did not ring). When the throttle and pitch levers were moved to the feather positions the lights went out. However, when climb power was resumed the lights came on.

As he had experienced something of a similar nature on several previous occasions which had been the result of malfunctioning of a fire detector, he reasoned that the same thing had happened again and continued the climb with the lights on. On reaching cruising level and reducing power the lights went out and stayed out. At the next stopping place he inspected the engine and everything appeared to be normal, indicating that his diagnosis was correct. Subsequently, several take-offs were made before reaching the destination and on each occasion the fire warning lights came "ON" on take-off and went out when power was reduced for cruise.

On inspection at the destination it was found that a number of components between the exhaust manifold and the fire wall were charred and that a blanking plate was missing from the exhaust pipe. On Dove aircraft the exhaust pipe branches as it leaves the exhaust manifold, one branch being for the cabin heating intensifier tube and the other for the normal exhaust outlet. On this particular aircraft the intensifier tube had been removed and a blanking plate fitted. However, on this flight the blanking plate became detached, allowing the exhaust gases to escape into the nacelle. The heat from these gases at take-off and climb power charred the components in the vicinity of the outlet and caused a legitimate fire warning. When cruise power was adopted the intensity of the gases evidently lessened to such an extent that the fire detector was not activated and the warning lights went out. From an examination of all the aspects, there is little doubt that the fire risk was high during the periods the aircraft was flown with the warning lights "on" and that a fire could have reached catastrophic proportions before being visually detected by the pilot.

The pilot has stated that one of the reasons why he believed that warning lights were giving a false indication was because the warning bell did not alarm. Inspection of the system revealed that this was due to a faulty bell relay. This defect would not show up in the pre-take-off fire warning test. The test circuit was so arranged that the push button switch operated both port and starboard warning lights and the bell relays simultaneously. That is, the bell would ring if one of the relays was unserviceable as on this occasion. Since this incident the operator has replaced the push button switch with a three position switch which enables the port and starboard circuits to be tested independently.

The pilot had previously experienced false fire warnings due to malfunctioning of the system and this, in conjunction with the symptoms, led him to believe that the same trouble was being experienced on this occasion. Another factor which apparently contributed to this belief, and to his decision to continue to operate the subject engine, was a note in the company's operations manual which stated that if a visual check, following a fire warning, reveals no fire, to suspect a short circuit in the detector system and to remove the fuse from the top of the bell. This suggests, in the absence of instructions to the contrary, that if no fire is visible the engine can be operated and the flight continued. The above note has since been deleted and the drill now requires closing down of the engine and bans a restart.

COMMENT

The test circuit on Dove aircraft at the time of this incident was similar to that on the majority of other multi-engine aircraft in this country. That is, the fire warning test will not reveal a faulty bell relay on one engine. In some aircraft, this weakness can be readily overcome by a simple modification whereas in others it would involve extensive re-work which could probably introduce other weaknesses. Because it is difficult to modify some aircraft to test each bell relay independently, it is considered that it would be illogical to require mandatory modification of only those aircraft which can be conveniently modified. Accordingly it has been suggested to the operators concerned that where practicable such modification should be incorporated and where this is not done, frequent checks to ensure that the circuits are functioning satisfactorily be carried out.

Engine Fire in a DC.3

Approximately 20 minutes before landing at Wau after flying from Goroka the port carburettor air temperature gauge was seen to decrease to zero. The pilot advised Air Traffic Control prior to landing at Wau that the instrument was unserviceable.

On landing the engines were stopped, and after leaving the aircraft, the pilot was advised by a native attendant that the port engine was on fire. The pilot released the fixed engine CO2 and extinguished the fire.

An engineer checked the installation and found fuel was leaking from beneath the domed indexing cover to the carburettor mixture control selector and had been ignited by exhaust gases from the engine assembly. This unit had been fitted immediately prior to this trip due to stiffness in the previous unit. The system was pressurized prior to departure by means of the wobble pump system and no sign of leakage was apparent.

Upon return to Lae the carburettor was inspected, together with the burned leads to the carburettor air temperature bulb, the mixture control rod and the carburettor to air scoop sealing rubber. Damage was of a minor scorching nature only.

It was decided to remove the shaft and inspect all seals as this was considered to be the only place from which it could leak. Upon examination it was found that the gland packing seal was missing although the tapered brass gland washer was in place. As there were no small pieces of packing in the assembly it was obviously not assembled correctly during overhaul. This gland packing being missing had the effect of removing end thrust from the shaft in the inwards direction due to removal of all pressure from the spring, and allowed the shaft to float in the assembly and the fuel to have a free passage between the shaft and housing.

The cause of the incident was the failure on the part of the person overhauling the unit to fit the seal in the unit during assembly.

Murphy's Law Par Excellence

The following incident is further proof, which is quite unnecessary, of Murphy's Law which states that, "If an aircraft part can be installed incorrectly, someone will install it that way".

On the night of 1st June, 1958, a DC.3 underwent an inspection at Sydney Airport. Numerous components were changed during this inspection, including the cables on the right and left fuel tank selector systems. These cables, through the tank selectors situated one on each side of the cockpit pedestal, operate two fuel tank selector valves, left and right, mounted on the forward face of the port spar in the centre section of the aircraft below the cabin floor. Each valve is connected to its respective engine and to the four fuel tanks. Movement of both selectors from the "off" position through the tank selections is from left to right, or anticlockwise when viewed from above, and the valves move in the same direction. The position of the valve is indicated by a vee notch cut in a plate attached to the valve spindle on top of the valve; the notch points to the rear when the valve is in the "off" position and as the valve is turned points to the fuel line entering the valve from the tank selected. The check for correct movement of the valve is made by noting that the notch points to the correct fuel tank line as the selector is moved to the various positions. With the floor in position, this check is made by looking upwards through a relative small inspection hole in the underside of the fuselage. Because the notch is above the valve it cannot be directly seen from below and it is necessary to use a mirror to check its position.

The replacement of the cables was carried out by licensed aircraft maintenance engineers. The work was checked by a leading hand and a maintenance inspector, both licensed aircraft maintenance engineers, and a Dual Inspection Certification form was signed certifying to the correct functioning of these systems. Subsequently, a Maintenance Release was signed and the aircraft was released for service.

At 1050 hours on the morning following the inspection, the aircraft departed on a regular public transport service to Williamtown and Coolangatta. The fuel uplift was 450 gallons comprising full main tanks (165 gallons in each) and 60 gallons in each auxiliary tank. The aircraft arrived at Williamtown at 1140 hours and departed at approximately 1155 hours. The flight from Sydney to Williamtown and the take-off from Williamtown were made with the main tanks selected to their respective engines.

The assigned cruising level, flight level 90, was reached at 1215 hours and at this time the left auxiliary tank was selected for the left engine. At 1230 hours the right engine fuel selector was changed from right main to right auxiliary. At 1315 hours, whilst flying in cloud, all power was lost on both engines. Power was restored by selecting the main tanks to their respective engines and the captain then diverted to and landed at the nearest aerodrome, Coffs Harbour.

INVESTIGATION

After landing at Coffs Harbour, the fuel tanks were dipped and it was found that no fuel had been used from the right tanks. The fuel consumed from the left tanks was consistent with the time in the air at the normal consumption rate.

An inspection of the fuel system revealed that the cable from the right hand tank selector to its selector valve was crossed with the result that when the selector was moved through the tank selections the valve moved in the opposite direction. Thus, when the right tanks, either main or auxiliary, were selected to the right engine the left tanks were in fact connected to that engine and vice versa.

Just how the engineer responsible for the assembly of the right hand fuel selector system came to install the cable incorrectly has not been conclusively established and no entirely satisfactory explanation has been found for the failure of the engineers concerned to detect the incorrect operation of this system. However, there was no doubt that the release of this aircraft in an unairworthy condition arose through a series of errors and omissions on the part of the engineers concerned in the servicing of the right hand fuel selector system.

However, if Murphy's Law had not been in operation, the fault would not have occurred.

Switch Off

Many aircraft fires have occurred while aircraft maintenance work was being carried out. The most common causes are failure to de-energise the electrical systems before working on them, and accidental contact with live circuits while doing other maintenance work, and accidental short circuits.

Recently an engineer was performing maintenance work on a fuel gauge transmitter. The aircraft power was left on and after removing the transmitter cap and commencing work a spark ignited fuel leaking from the tank through the float actuating arm. The engineer's clothing caught fire and he was taken to hospital for treatment. The aircraft fire was extinguished before any serious damage occurred.

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Whilst servicing the propeller blades on an aircraft in a hangar the propeller was turned by the engineer and the engine started. Another engineer who was in the cockpit working on other maintenance closed the throttle and turned off the ignition switch before any damage or injury was sustained. It would appear that one of the ignition switches had been inadvertently knocked on by one of the numerous persons working inside the aircraft.

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In a previous issue of this Digest (No. 12) there was a detailed account of an accident to an aircraft when an engine was inadvertently started during the synchronising of a replacement magneto. In this instance four engineers were injured and the aircraft, the hangar and two private cars were damaged.

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These are only a few of the incidents and accidents which have occurred due to failure to take all proper precautions before commencing work on an aircraft. Precautions such as de-energising electrical systems before commencing work, locking-out circuits so that they cannot be energised accidently, and many others covering all aspects of maintenance are prescribed in maintenance manuals. These precautions are based on experience — often obtained the hard way. As they are there to protect you they should not be forgotten or ignored.

Stone the Crows

Following the report in the last Digest of an accident attributed to the presence of a wasp's nest in the induction manifold of a DH.82 aircraft, further reports have been received of troubles of a like nature.

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In the first case recently reported, the captain of a DC.3 abandoned his take-off and returned to the tarmac due to low r.p.m. and manifold pressure on the port engine during the take-off run. An examination revealed that a bird's nest had been built on the carburettor intake screen. The nest was removed and engine performance was then normal. The aircraft had had a pre-flight service carried out two days prior to this occurrence and was not flown on the intervening day. During the time it was not in use it had been standing on the apron.

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There were similar symptoms in the second case and an inspection revealed a partly built bird's nest in the carburettor airscoop of the port engine. The scoop was removed and the intake screen cleaned. Subsequent operation of the engine was normal. A pre-flight service had been carried out overnight and the aircraft was delivered to the tarmac for loading at 0130 hours E.S.T. Apparently the nest was built between the delivery time of the aircraft and its departure at 1345 hours on the same day.

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There have been six reported cases of birds nesting in carburettor intakes during the past two years. Four have occurred in Melbourne and one at Cairns, all in DC.3's, while one case was reported from Port Moresby in a DC.4 aircraft. One major airline operator now requires an inspection of the air intakes of all aircraft which have been standing for four hours or more in daylight. This sounds like good safety sense.

Key to Do You Still Know?

1. AIP/GEN-0-0-11 and RAC-1-5-1
2. AIP/SAR-1-9
3. AIP/RAC/1-3-1
4. AIP/RAC/3-2-1
5. AIP/RAC/3-3-1
6. AIP/RAC/1-4-1

Are You Slipping?

Fastening the safety belt immediately after entering the aircraft, and prior to starting the engine, has become second nature to most pilots. Where applicable the adjusting of the pilot's seat and checking to ensure that the locking mechanism is secure is a function of equal importance but it is often overlooked. Failure to lock the pilot's seat has resulted in two accidents recently.

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During maintenance the forward stop pin on the seat rails was removed and the seat brought fully forward past the seat installation slots. The stop pin was not replaced and its omission was not noticed by the pilot.

During the take-off run the seat was grasped from behind by a passenger and it moved the seat aft bringing the seat attachment fittings opposite the installation slots. The seat tipped backwards, rudder control was lost and the aircraft ground-looped causing substantial damage to the aircraft.

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Immediately after applying full power for take-off the front supports of the pilot's seat came off the seat rails and the seat then moved to the full extent of the rearward travel. From this position the pilot could not reach either the rudder controls or the throttle. Because of the aircraft acceleration, the sloping floor, and having nothing readily available with which to pull himself forward it was some time before he could reduce power. The aircraft ground-looped and was extensively damaged.

Strapping yourself into an insecure seat is only asking for trouble.

MAKE THIS CHECK A HABIT

Surface Controls – Flap Control Torque Tube

Upside-Down Lever Caused Bolt to Cut Drive Shaft

the Situation

An emergency landing had to be made shortly after takeoff because the wing flaps failed to function properly. Excessive use of brakes in attempting to avoid overshooting the runway resulted in a blown tire and damaged landing gear.

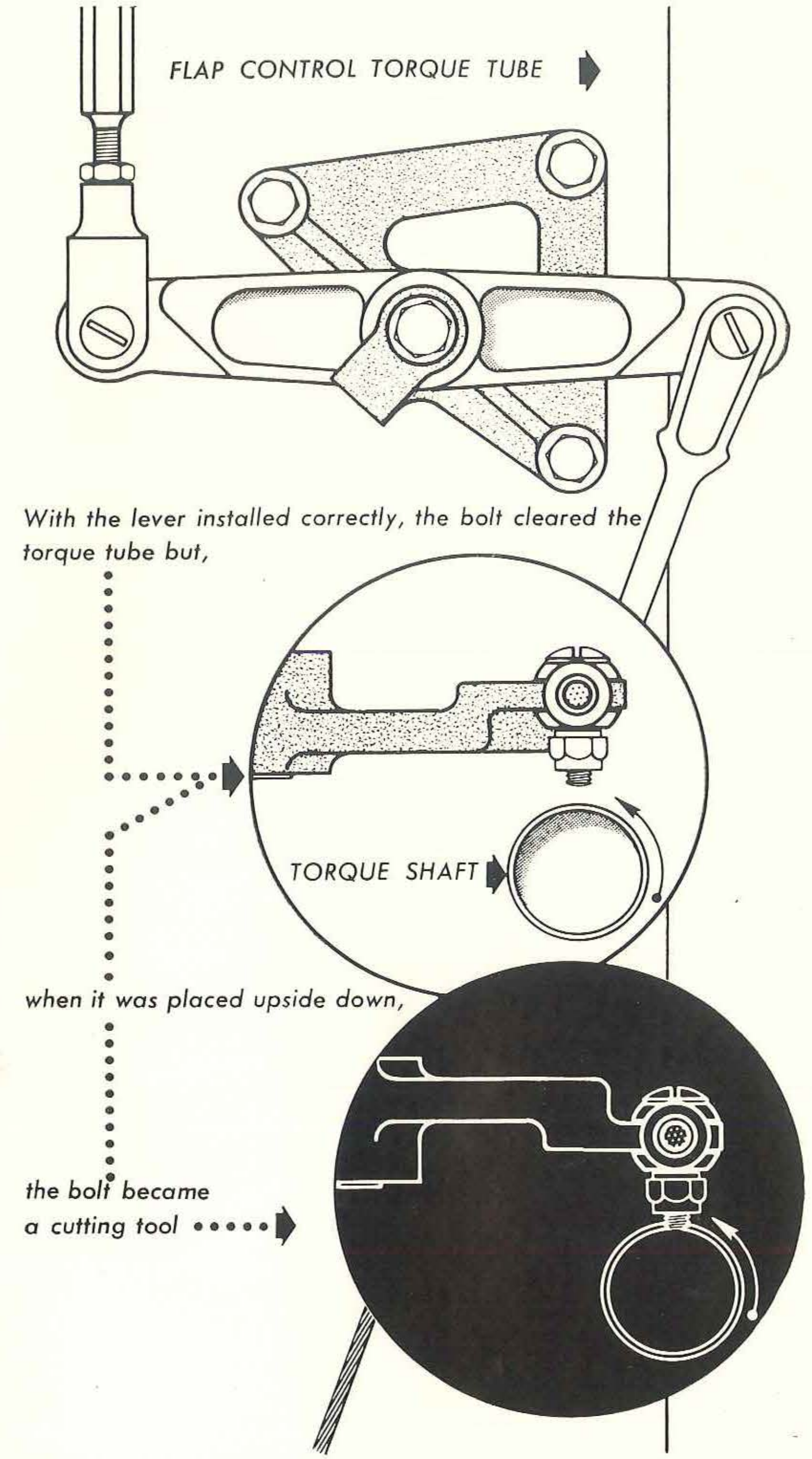
Malfunctioning of the flaps occurred when one of the drive shafts broke. A lever of another control system had been replaced during a previous overhaul. but had been installed in the reverse of its original position. When correctly installed, a cable connecting bolt in the lever would clear the adjacent torque tube but, with the lever turned upside down, the bolt came in contact with the revolving tube and cut it in two.

the Hazard

The flap control system in this aircraft was designed asymmetrically as a "fail safe" measure. Had this not been the case, the flap on one side would have stopped while the opposite flap would have continued its travel, resulting in sudden loss of control.

The lever was not noticeably unsymmetrical which made wrong installation easy to do. This possibility had been overlooked when the lever was designed. See Murphy's Law*

*** Murphy's Law: "If an aircraft part can be installed incorrectly, someone will install it that way".**



(By Courtesy Flight Safety Foundation, Inc.)