COMMONWEALTH OF AUSTRALIA

REPORT OF CHAIRMAN

OF

BOARD OF ACCIDENT INQUIRY

ON

ACCIDENT TO VISCOUNT AIRCRAFT

VH-RMI NEAR WINTON, QUEENSLAND,

ON 22ND SEPTEMBER, 1966.

MELBOURNE

COMMONWEALTH OF AUSTRALIA

AIR NAVIGATION REGULATIONS

REPORT

of

CHAIRMAN OF BOARD OF ACCIDENT INQUIRY

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ACCIDENT WHICH OCCURRED NEAR WINTON, IN THE STATE OF QUEENSLAND, ON THE 22ND OF SEPTEMBER, 1966, TO VISCOUNT AIRCRAFT VH-RMI, OPERATED BY ANSETT TRANSPORT INDUSTRIES (OPERATIONS) PTY. LTD., TRADING AS ANSETT-A.N.A.

CHAIRMAN

The Honourable Sir John SPICER

ASSESSORS

Captain R.J. RITCHIE
T.W. AIR, Esq.
Captain F.J. BALL
Captain C.S. GRIFFIN

SECRETARY

C.P. WHITMAN, Esq.

Melbourne.

To:

The Honourable the Minister of State for Civil Aviation

This Board of Accident Inquiry was appointed on the 15th day of March, 1967 to inquire into the causes of an accident to Viscount Aircraft VH-RMI operated by Ansett Transport Industries (Operations) Pty. Ltd. (trading as Ansett-A.N.A.) which occurred near Winton in the State of Queensland on 22nd September, 1966.

For the purpose of recording the composition of the Board I set out the terms of the instrument appointing the Board. It was in the following terms :

" AIR NAVIGATION ACT 1920-1966
AIR NAVIGATION REGULATIONS

I, REGINALD WILLIAM COLIN SWARTZ, Minister of State for Civil Aviation, in pursuance of the powers conferred on me by regulation 287(1) of the Air Navigation Regulations made under the Air Navigation Act 1920-1966, HEREBY APPOINT a Board of Accident Inquiry constituted by the HONOURABLE SIR JOHN ARMSTRONG SPICER, Chief Judge of the Commonwealth Industrial Court, as Chairman, and ROBERT JAMES RITCHIE, Deputy Chief Executive and Deputy General Manager of Qantas Empire Airways Ltd., THOMAS WILLIAM AIR, Technical Director of Hawker de Havilland Australia Pty. Ltd., CAPTAIN FRANK JOHN BALL, A.F.C., Manager Flying Operations of Trans-Australia Airlines, and CAPTAIN COLIN SIDNEY GRIFFIN, Airline Pilot, as Assessors, to inquire into the causes of an accident to Viscount aircraft VH-RMI operated by Ansett Transport Industries (Operations) Pty. Ltd. (trading as Ansett-A.N.A.) which occurred near Winton in the State of Queensland on the 22nd September, 1966.

DATED the Fifteenth day of March, 1967.

(R. W. Swartz)
Minister of State for Civil Aviation."

The first sitting of this Board was held in Brisbane on 26th April, 1967.

Mr. C.D. Sheahan Q.C., and Mr. A.K. McCracken (instructed by the Commonwealth Crown Solicitor) appeared to assist the Board and I granted leave to the following persons to appear before the Board:

Mr. W.B. Campbell Q.C., with him Mr. A.S. Given (instructed by Grant & Company), appeared for Ansett-A.N.A.

Mr. W.C. Crockett Q.C., with him Mr. B.W. Beach (instructed by Coltman, Wyatt & Anderson) appeared for Godfrey Engineering Products Limited and Godfrey Engineering (Australia) Pty. Limited.

Mr. A.D. Pearce, appeared for the Australian Federation of Air Pilots, the Airline Hostesses Association of Australia, and the next-of-kin of Captain J.K. Cooper and First Officer J.F. Gillam.

Mr. E.S. Williams Q.C., with him Mr. C.E.K. Hampson (instructed by the Commonwealth Crown Solicitor) appeared for the Department of Civil Aviation.

Mr. G.J. Samuels Q.C., with him Mr. R.A. Howell (instructed by Stephen, Jaques & Stephen) appeared for British Aircraft Corporation (Operating) Limited, the successor in title to the manufacturer of the aircraft VH-RMI.

Mr. C.S.C. Sheller (instructed by Remington & Company) appeared for Rolls Royce Limited.

Mr. W.A. Howell (instructed by J.J. O'Connor, Duncan & Company) appeared for the next-of-kin of one of the passengers, R.B. Boyle.

Mr. D.L. Power (Solicitor of Power, Leonard and Power) appeared for the Australian Licenced Aircraft Engineers Association.

Mr. F.R. Soden appeared for the Civil Air Operations Officers Association of Australia.

Mr. W.P. Allinson appeared for the Professional Radio Employees Institute of Australia.

With the exception of the five last named persons those who were granted leave appeared throughout the Inquiry. The five last named appeared on occasions when matters of particular concern to them were under discussion.

The hearing continued in Brisbane on the 27th and 28th April, 1967. On 2nd May the Board proceeded to Winton and on that day an inspection was made of the area in which the accident occurred. On the 3rd and 4th May evidence was taken in Winton from a number of local witnesses who had observed the aircraft in flight prior to the accident and were able to give some account of the course followed by the aircraft in the last stages of its flight.

Thereafter sittings of the Board took place in Melbourne on the 8th, 9th, 10th and 11th May. On 8th May the Board proceeded to Essendon Airport where an inspection was made of two Viscount aircraft similar to RMI. One of these was intact and the other in a condition which enabled an inspection to be undertaken of those components and sections of the aircraft which appeared to be of most relevance to the Board's Inquiry. On the same day the Board proceeded to a wool store at Footscray, Melbourne, where wreckage of the aircraft which had been recovered at Winton and transported to Melbourne was assembled. It was estimated that some 80 per cent of the aircraft was in the shed including such reconstruction of the fuselage as was possible. Particular attention was paid in the course of the inspection to those parts and components which appeared to be of most significance for the purpose of the Inquiry.

Further sittings of the Board took place in Brisbane on 16th to 19th May, 22nd to 25th May, 31st May, 1st and 2nd June, 5th to 8th June, 13th to 16th June, and in Melbourne on 19th to 23rd June, 27th, 29th and 30th June, 31st July to 4th August, and 7th August to 9th August, on which latter date the hearing of evidence was completed.

Thereafter Counsel addressed the Board on 10th to 18th August and 21st, 22nd, and 28th to 31st August, on which date the hearing concluded.

Throughout the proceedings the Board has been greatly assisted by a most comprehensive report of an investigation of the accident carried out by an investigation team under the leadership of Mr. F. E. Yeend, Director, Air Safety Investigation Branch, Department of Civil Aviation. This investigation was undertaken with commendable promptitude, members of the team reaching Winton in the early hours of the morning following the accident. The report comprises two volumes in which every aspect of the accident and its possible causes is examined in great detail and the members of the Board are satisfied that no possible clue to the cause of the accident has been overlooked. The investigation involved long hours of searching examination for which those who took part deserve the highest commendation.

THE AIRCRAFT

The Viscount 832 aircraft VH-RMI was a low wing monoplane constructed in 1958-59 by Vickers Armstrong Aircraft Limited, England, now known as The British Aircraft Corporation (Operating) Limited, Weybridge Division (hereinafter referred to as B.A.C.), for passenger and freight carrying. The type number 832 indicates that it was one of the 810 series aircraft manufactured specifically for Ansett-A.N.A.

At the time of the accident VH-RMI was fitted to accommodate 63 passengers. It was designed to be operated by a flight crew of two pilots and cabin staff. The aircraft had not been involved in any previous accident reported to the Department of Civil Aviation.

The aircraft was operating under a current Certificate of Registration issued by the Department of Civil Aviation No. 3253. The Certificate was issued on the 14th February, 1961, to remain valid until the 13th February, 1970 and there was also a current Certificate of Airworthiness for the aircraft which was last renewed on the 10th April, 1964 to remain valid until the 10th April, 1973, subject to the aircraft continuing to be operated and maintained in accordance with the Air Navigation Regulations and Orders and the approved maintenance system.

IMMEDIATE PRE-FLIGHT HISTORY OF THE AIRCRAFT

At the time of the accident the aircraft had flown a total of 18,634 hours since new, of which 6,586 hours had been flown since the last complete overhaul.

The aircraft was maintained by Ansett-A.N.A. under a maintenance system approved by the Department of Civil Aviation. The regular maintenance services required on the radio equipment were performed by Amalgamated Wireless (Australasia) Ltd. as an integral part of the approved Ansett-A.N.A. system.

Evidence was given by Captain Hugh Lister Mackey, an Ansett-A.N.A. Viscount line Captain, that he had flown this aircraft on 19th September 1966 from Sydney to Adelaide and had reported in Adelaide that maintenance attention was required for four items :

(1) The roof panel light showed white instead of red.

(2) The First Officer's heading directional indicator was unserviceable.

(3) The cockpit to cabin public address system was unserviceable.

(4) The auto-pilot height lock was hunting.

These items were all attended to before Captain Mackey again flew the aircraft from Adelaide to Canberra and Sydney on 20th September, 1966. The only unserviceability noted and reported following this flight was that the cabin public address system was rowdy.

On 21st September, 1966, Captain Mackey flew the aircraft from Sydney to Brisbane, arriving there at 0935 hours, and after this flight he reported that the generators were out of balance. Captain Mackey gave evidence that there were no unusual events or weather conditions encountered in any of these flights and that no other malfunction in the aircraft was observed by him other than those noted above.

The last intransit pre-flight check performed on VH-RMI was carried out in Brisbane at 1130 hours on 21st September, 1966, by Mr. B. A. Prescott. The defective balance of the generators was rectified and a maintenance release was issued on that day.

Prior to this last intransit pre-flight check, engines and airframe inspections had been performed at Sydney on the afternoon of 20th September 1966 and were certified to by licensed aircraft maintenance engineers Messrs. Hatton and Vardy respectively.

At 0315 hours on 21st September 1966 an engine ground test run procedure was carried out on Nos. 1 and 3 engines by licensed aircraft maintenance engineer Black, and at 0715 hours on 21st of September 1966 licensed aircraft maintenance engineer Witney carried out an intransit pre-flight check.

A regular 500 hourly inspection was carried out at Sydney on 10th September 1966 and the work was performed progressively at times when the aircraft remained overnight at appropriately equipped bases. It had undergone a 6000 hourly major inspection in Ansett-A.N.A.'s Melbourne workshop during the period 20th June, 1966 to 1st July 1966, and at the time of the accident had completed 565 hours since the completion of this 6000 hourly inspection.

A complete overhaul of the aircraft in accordance with Ansett-A.N.A.'s Maintenance Manual had been performed in February to March 1964, when the aircraft had flown 12,048 hours, and it had flown 6,586 hours since this overhaul up to the time of the accident.

An examination of the records which are relevant to the maintenance of VH-RMI shows that, with the exception of six units, all the components installed on the aircraft at the time of the accident were operating within their currently approved operating hours between complete overhauls. The items which were exceeded their operating hours were :

(1) A propeller de-icing alternator installed on No. 1 engine, which had exceeded by 319 hours its approved figure of 1600 hours between overhauls.

(2) The cabin temperature control valve position transmitter had exceeded by 586 hours its approved figure of 6000 hours between overhauls.

(3) The door seal pressure transmitter had exceeded by 574 hours its approved figure of 3000 hours between overhauls.

(4) (5), (6). Three brake pressure transmitters had also exceeded by 574 hours their approved figure of 3000 hours between overhauls.

As the requirements of the approved maintenance system detailed in the Ansett-A.N.A. Viscount Maintenance Manual were not met in respect of these six components, the aircraft had failed to conform with the requirement under the Air Navigation Regulations in respect of the replacement of components and by virtue of Regulation 34.1(a) the Certificate of Airworthiness of the aircraft was deemed to have been suspended. It is necessary to add that none of the items referred to had any relation whatever to the accident in which the aircraft was involved.

At the time when the aircraft departed from Brisbane on 21st September all known defects in the aircraft appear to have been rectified. The only matters requiring attention immediately prior to this departure had been the balancing of the generators above referred to, and the door seal pressure system was required to be recharged to its normal maximum pressure. Both these items were rectified.

There was nothing in the pre-flight history of the aircraft which suggested that it was not ready, suitable and safe for the operation on which it was engaged at the time it left Brisbane for Mt. Isa and return.

THE FLIGHT CREW

At the time of the accident the operating crew of VH-RMI were Captain John Kenneth Cooper, First Officer John Frederick Gillam, Senior Hostess Beverley Ann Heeschen and Hostess Narelle Erica Davis.

Captain Cooper was 41 years of age and commenced his flying career with the Royal Australian Air Force in 1944. He joined Ansett Airways in 1950 and, apart from a short break in 1951, he was continuously employed until the time of the accident by Ansett Airways and other organisations which have succeeded it.

Captain Cooper obtained his First Class Airline Transport Pilot's Licence in December 1954 and since that date he had flown successively in command on D. C. 3., Convair 340, Convair 440, Fokker F. 27 and Viscount 832 aircraft. During his command flying Captain Cooper held various appointments as Training Captain to Check Captain and in November, 1965 he was appointed Training Captain on Viscount 832 aircraft which position he held at the time of the accident.

He commenced flying Viscount aircraft in June, 1965 and since that time had accumulated 1025 hours in command of such aircraft. At the time of commencing the flight which culminated in the accident he had flown a total of 14,288 hours of which 10,003 hours were flown in command. Throughout his career he demonstrated a high standard of efficiency. He had not been involved in any flying accident reported to the Department of Civil Aviation during his twenty years of civil flying nor had he been involved in any reported incident reflecting adversely on his competence. There was nothing to suggest that he was other than in good health on the day of his death nor was there anything in his behaviour or demeanour on the eve or the day of the accident that would indicate that he was in any way unfit to perform the duties involved in the flight from Mt. Isa to Brisbane.

First Officer J. F. Gillam was 29 years of age and commenced his flying career with the Darling Downs Aero Club in April 1961. He joined Ansett Mandated Airlines in March, 1964 and was issued with a Second Class Airline Transport Pilot's Licence which was still current at the time of the accident. He joined Ansett-A. N. A. in January 1966 and since that time he had performed the duties of First Officer on D. C. 3 and Viscount 832 aircraft. At the commencement of the flight which culminated in this accident First Officer Gillam had flown for a total of 2803 hours most of which were as First Officer on airline aircraft, including 249 hours as First Officer on Viscount aircraft. His records indicate that he had reached a high standard of efficiency having regard to his experience and responsibilities.

He was medically examined only two days prior to his death and this examination showed that he continued to meet the medical standard for an airline transport pilot. There is nothing in his medical records or in his behaviour or demeanour on the eve or day of the accident to suggest that he was in any way unfit properly to discharge his responsibilities.

Miss B.A. Heeschen, the senior hostess on board, had over four years experience in these duties. She was amply qualified and experienced to provide proper assistance to the passengers in all, including emergency, conditions.

The other hostess, Miss N.E. Davis, had only some two months experience but she acted under the direct supervision of Miss Heeschen who was a trainer hostess and there was no reason to suggest that Miss Davis was in any way incapable of discharging her responsibilities in an efficient manner.

CREW AND PASSENGERS

The names and addresses of those on board the aircraft at the time of its loss were :

The Crew -

Captain John Kenneth Cooper, 28 Tristania Road, Kenmore, Queensland.

First Officer John Frederick Gillam, 48 John Street, Redcliffe, Queensland.

Senior Hostess Beverley Ann Heeschen, 5 Mollinson Street, West End, Queensland.

Hostess Narelle Erica Davis, "Fairview", Ringwood, via Corowa, New South Wales.

The Passengers -

Mr. Philip Edward Anderson, 251 Honour Avenue, Graceville, Queensland.

Mr. Harold Stewart Bagot, Liverpool Road, Enfield, New South Wales.

Mr. George Livingstone Bardsley, 36 Forrest Street, Everton Park, Queensland.

Miss Roberta Brook Boyle, 39 Park Avenue, Auchenflower, Queensland.

Mr. William James Caples, 19 Richmond Street, Denistone East, New South Wales.

Mr. Ronald Francis Cashell, 6 Larch Street, Mt. Isa, Queensland.

Mr. Percy Alan Doyle, 249 Mains Road, Sunnybank, Brisbane, Queensland.

Mr. Javier Fernandez-Real, 97 Garden Street, Maroubra Junction, New South Wales.

Mrs. Eileen Elaine Fisher, 7 Nettle Street, Mt. Isa, Queensland.

Mr. Robert Emmet Marquess Friend, 37 Buckley Avenue, Mt. Isa, Queensland.

Master John Paul Gamin, Ocean Street, Mermaid Beach, Southport, Queensland.

Master Thomas George Gamin, Ocean Street, Mermaid Beach, Southport, Queensland.

Mr. Charles John Gregson, 2 Twin Street, Stirling, South Australia.

Mr. Thomas James Henty, 366 Orrong Road, North Caulfield, Victoria.

Mr. Glen James Jull, 15 Bellhurst Outlook, Tarragindi, Queensland.

Mr. Noel Mervyn Killingly, 4 Dents Place, Gymea, New South Wales.

Mr. Carl Furner Lott, 20 Nagle Street, Upper Mt. Gravatt, Queensland.

Mr. Alan McDonald, 368 Macquarie Grove, Caves Beach, Swansea, New South Wales.

Mr. Samuel Lindsay McKenzie, 61 West Street, Mt. Isa, Queensland.

Mr. Alexander Munro, 61 Mary Street, St. Kilda, Victoria.

All lost their lives in the disaster.

AT MT. ISA

After its departure from Brisbane on 21st September 1966 the aircraft landed at Longreach and then at Mt. Isa.

Mr. McCue, the Manager of Ansett-A.N.A. at Mt. Isa, on arrival of the aircraft had a conversation with Captain Cooper, and no mention was made of any unusual incident on the flight from Brisbane to Mt. Isa. No maintenance requirements were requested by the Captain when he arrived at Mt. Isa. There were no Ansett-A.N.A. maintenance personnel in attendance at Mt. Isa but arrangements made between Ansett-A.N.A. and Trans Australia Airlines enables T.A.A. engineers at Mt. Isa to carry out minor rectifications on Ansett-A.N.A. aircraft when so requested by the crew. Similar arrangements exist at other ports where maintenance personnel of only one of the two airlines are in attendance.

There is evidence that Mr. Butler, an aircraft engineer employed by T.A.A. at Mt. Isa, was requested by the T.A.A. engineer to top up the door seal pressure on such Ansett-A.N.A. aircraft as may require it, and he performed this function on VH-RMI on the morning of 22nd September, 1966. Since no other request for assistance appears to have been received from the crew by T.A.A. engineers at Mt. Isa or by the Ansett-A.N.A. servicing base at Brisbane, it appears that the pilot-in-command regarded the aircraft as airworthy at the time it arrived at Mt. Isa on the 21st September, 1966 and also at the time of the subsequent departure of the aircraft from Mt. Isa on the morning of 22nd September, 1966.

On the evening prior to the departure of the aircraft from Mt. Isa both Captain Cooper and First Officer Gillam had spent some time with the Mt. Isa Manager of Ansett-A.N.A., Mr. McCue, and each appeared in all respects normal to Mr. McCue who had known them for some time.

On the morning of the 22nd September 1966 Mr. Smith, who is the Air Traffic Control Officer at Mt. Isa, spoke with Captain Cooper and found him to be normal in all respects. Mr. Smith had personally known Captain Cooper for some 16 years and he observed nothing unusual in Captain Cooper's behaviour, demeanour or speech.

On the morning of the 22nd September 1966, the Captain arrived at the Mt. Isa control tower at approximately 1100 hours, obtained the meteorological forecast for the intended route to Brisbane, and completed a Flight Plan and handed a copy of this to Mr. Smith, who was then on duty.

THE WEATHER CONDITIONS

The forecast weather conditions did not suggest any unusual or hazardous circumstances. The forecast for the flight was prepared by the duty weather officer at Cloncurry. It indicated that between Mt. Isa and Longreach VH-RMI would encounter westerly winds of about 15 knots below flight level 150 (15, 000 feet pressure altitude) with wind increasing above this level. Cumulus cloud giving a sky cover ranging from 2/8ths to 5/8ths with a base of 5, 000 to 6, 000 feet and with tops varying between 8,000 and 12,000 feet with isolated patches to 18, 000 feet was forecast with up to 4/8ths alto-cumulus cloud between 12, 000 and 15, 000 feet. The expected visibility was 20 miles reduced to 5 miles in isolated showers and reduced further to 3 miles in patches of local dust.

In the Longreach area it was expected that the surface wind would be from 120 degrees at eight knots with a visibility of 25 miles beneath 5/8ths of cumulus and strato-cumulus cloud having a base of 6000 feet. It appeared that the outside air temperature between Mt. Isa and Longreach at Flight Level 175 would be minus 4 degrees centigrade. Having regard to the forecast it would be normal to have the de-icing systems switched on.

A post flight analysis prepared by the Bureau of Meteorology suggests that the weather actually encountered was probably much the same as forecast. Between Mt. Isa and Winton the actual cloud base was probably as high as 12,000 feet and the temperature at flight level 175 was probably as low as minus 8 degrees centigrade.

At Winton at the time of the accident the weather conditions were fine with broken alto-cumulus cloud having a base of 12, 000 feet, the visibility was unlimited and the surface wind light swinging from south-west to south-east.

THE FLIGHT PLAN

The flight plan prepared by Captain Cooper and which he submitted to the Air Traffic Control Officer at Mt. Isa indicated that the flight to Longreach would be made along the direct track, bearing 116 magnetic, at cruising flight level 175 and would take 73 minutes. All calculations relative to wind and drift were correctly calculated by Captain Cooper and the other items contained in the flight plan were in order.

The flight plan was subsequently approved by the Senior Operations Officer at Townsville.

FUEL

The aircraft fuel tanks were refuelled to capacity and then rechecked for water and sediment and the quantities of water methanol mixture were also checked. None of the tanks which were refuelled went past their proper capacity and there was no overflowing.

Subsequent to the accident samples of the fuel contained in the Shell Company's storage tanks from which the aircraft obtained its fuel at Mt. Isa were forwarded to Brisbane for testing and found to be within specifications and unadulterated.

LOAD STATEMENT

Mr. Goodwin, the Ansett-A.N.A. Traffic Officer at Mt. Isa, prepared a load statement which shows the weight at departure, and anticipated landing weight at Longreach and a calculation of the position of the centre of gravity of the aircraft. This statement was inspected by Captain Cooper before he departed from Mt. Isa. He signed it and thereby certified to his satisfaction that the aircraft was properly loaded.

CARGO UPLIFT SHEET

The cargo uplift sheet indicates that no items of freight were declared as dangerous cargo by any of the consignors. A subsequent careful check of the items of freight and luggage recovered from the aircraft itself suggests that no explosive or inflammable substance outside of the normal equipment of the aircraft contributed to the accident by being placed deliberately or inadvertently on board the aircraft.

At the time of take-off at Mt. Isa and during the ensuing flight the gross weight of VH-RMI and the position of its centre of gravity were within the limits prescribed in the flight manual for the aircraft in question. At the time of this last take-off it was estimated the gross weight was 64,068 lb. which is 8,432 lb. less than the maximum permissible weight for take-off. It is also estimated that the centre of gravity position was approximately 63 per cent of the permissible travel aft of the forward limit described in the flight manual.

RADIO EQUIPMENT

Prior to obtaining clearance for take-off from Mt. Isa the aircraft radios were checked with the Mt. Isa tower and also with Cloncurry, and both radios were found to operate satisfactorily.

THE FLIGHT

The accident occurred while the aircraft was on a scheduled public transport passenger flight from Mt. Isa to Longreach, a distance of 316 nautical miles.

The aircraft departed from Mt. Isa at 1208 hours E.S.T. on 22nd September 1966 on Flight 149. It was cleared to proceed in accordance with the terms of the flight plan prepared and approved before departure from Mt. Isa which, as already appears, indicated it would take 73 minutes to fly to Longreach and would cruise at a height of approximately 17,500 feet.

Evidence obtained from the flight data recorder indicates that the aircraft reached this flight level at approximately 1240 hours and that it continued at this level with the automatic pilot engaged until 1247 hours. In normal circumstances the aircraft would have continued at its cruising flight level with the automatic pilot engaged until approximately 1305 hours when it would have been 70 miles from Longreach in a position to commence a normal descent for landing. However indications from the flight data recorder showed that the automatic pilot was disengaged prematurely at 1247 hours and this was followed shortly after by a descent which was described in a message from the aircraft to Longreach as an emergency descent. It would seem therefore that disengagement of the automatic pilot perhaps signifies the point of time when an emergency situation became apparent to the crew.

A series of messages between the aircraft and Longreach and other aircraft indicate the nature of the emergency as it became manifest to the crew. There is no recorded version of the messages but the flight service officer on duty at Longreach and pilots who were in the vicinity have given evidence of their recollections from which it is reasonable to conclude that the messages were in substance as follows :

1252	VH-RMI notified Longreach - making emergency descent - standby.
1252:40	Longreach asked VH-RMI - are you operating normally?
	VH-RMI replied - negative - standby.
1253:30	Longreach asked VH-RMI - Can I be of assistance?
	VH-RMI replied - Still on emergency descent. We have fire warnings in two engines. We have one out. Unable to feather other engine.

1254	Longreach acknowledged receipt of this message.
	VH-AEQ advised Longreach - Will you keep me posted anything I can do please?
1257-1258	VH-RMI advised - We have a visible fire in number 2 engine tracking to Winton below 5, 000 feet.
	VH-AEQ asked Longreach if he had copied the message from VH-RMI.
	Longreach advised - negative - he must be out of range.
	VH-AEQ passed details of message from VH-RMI to Longreach.
	Longreach acknowledged receipt.
1259	Longreach called VH-RMI to advise that he was maintaining a listening watch on 122.1 mc and 6540 kc. No reply was received. Longreach requested VH-AEQ to pass this message to VH-RMI and to obtain an estimate for the aircraft's arrival time at Winton.
1300	VH-AEQ called VH-RMI twice with the above message but no reply was received and Longreach was advised accordingly.
1301-1331	Longreach and other ground and aircraft stations called VH-RMI without establishing contact.

Despite repeated calls by both ground stations and aircraft in the area, and despite the maintenance of intensive listening watches by ground stations and aircraft, no further communications were heard from VH-RMI after 1257 hours. However a number of people in the Winton Shire adverted to the presence of the aircraft in the area from about 1300 hours up to about 1303 hours, and at about the latter time some of these witnesses saw a black puff of smoke in the air west of Winton followed by two rising columns of black smoke. Mr. Kum Sing, who was the then overseer at Nadjayamba Station, heard what he described as "an extreme screaming sound like a jet 'plane". He then heard an explosion. Subsequently he saw the wreckage of an aircraft on the station property.

Subsequent investigations established that the observations of these witnesses were associated with the destruction of VH-RMI, which struck the ground at about $13\frac{1}{2}$ miles from Winton Aerodrome on a bearing of 260^{o} magnetic.

FLIGHT DATA RECORDER

Reference has already been made to the flight data recorder which records altitude, indicated air speed, magnetic heading, vertical acceleration and time.

VH-RMI was equipped with such an instrument and it was recovered from the wreckage of the aircraft. Very great difficulties were encountered in analysing the tape recording contained in the instrument. Some 7000 to 8000 microscopic readings were necessary to arrive at a stage of satisfaction as to the correctness of the readings achieved.

The flight data recorder commenced to record the aircraft's flight when it began to taxi for the take-off from Mt. Isa. The air speed trace commenced during the take-off when the indicated air speed of the aircraft reached 77 knots. This was approximately 30 seconds after the take-off was commenced. When the air speed reached 120 knots the aircraft became airborne and the weight of evidence points to this having occurred at $1208\frac{1}{2}$ hours. This time was used on the flight recorder-graph as a datum for the time of all subsequent manoeuvres carried out by the aircraft.

After becoming airborne, VH-RMI continued straight ahead for about 42 seconds while the air speed increased to 163 knots and the aircraft reached an altitude of 1600 feet. It then commenced a gradual climbing turn to the left until a heading of 100^{o} magnetic and an altitude of 2200 feet was reached approximately 30 seconds later.

Between 1210 and 1216 hours the crew made adjustments to the headings of VH-RMI, finally assuming a heading of 110^{o} magnetic eight minutes after becoming airborne. During this period the crew maintained an average air speed of 180 knots and a steady rate of climb averaging 866 feet per minute, and at 1216 hours the aircraft had reached an altitude of 7400 feet.

During the next seven minutes the crew maintained the 110^{o} magnetic heading but increased the indicated air speed to 185 knots and the aircraft reached an altitude of 12, 200 feet at 1223 hours, the average rate of climb over this period being 700 feet per minute.

The headings flown by the aircraft from departure from Mt. Isa until 1223 hours indicate that the crew were compensating for the effects of winds encountered during the climb. At 1223 hours the crew altered the heading of VH-RMI by 10^{o} to 126^{o} magnetic and also reduced the indicated air speed for the remainder of the climb to within the range of 170 to 180 knots.

These alterations of heading suggest that the crew recognised, probably by visual reference to ground features, that the aircraft was slightly north-east of the track, as it appears to have been.

At 1240 hours the aircraft reached its planned cruising level. Between 1240 and 1241 hours the crew climbed the aircraft a further 100 feet and then allowed the air speed to reduce to 158 knots before they finally levelled out to cruise at 17,850 feet.

Although the altitude trace suggests that the aircraft was cruising at 350 feet above the planned flight level, the comparison of altitude traces on previous flights carried out by the same aircraft shows a similar difference between reported and recorded cruising altitudes, and the crew of VH-RMI were probably flying at an altitude of 17,500 feet, as determined by reference to the aircraft's altimeters.

Between 1241 hours and 1247 hours the altitude trace remained steady at the cruising level. A heading of 126° magnetic was maintained and the indicated air speed increased at an even rate from 175 knots to 189 knots. The traces in this period indicate that the aircraft was cruising with automatic pilot engaged.

The flight recorder graph next indicates that at approximately 1247 hours the automatic pilot was uncoupled and the crew took over the flying of the aircraft.

Between 1247 and 1250 hours descent was commenced. The heading of the aircraft gradually drifted to port until it reached 087° magnetic, which is a total variation of 39°, and the air speed gradually reduced until it stabilized at approximately 170 knots.

Since the aircraft was approximately 84 miles from the point at which the crew would normally commence descent to Longreach, it is a reasonable assumption that the commencement of descent at this stage was associated with the beginning of the emergency situation subsequently reported by the aircraft. Since the heading change was made at a rate of only 13° per minute, it seems that this was a drift in heading rather than a conscious turn and that it probably occurred while the crew's attention was diverted to the emergency situation which had arisen.

At 1250 hours a normal starboard turn back towards the flight planned heading was commenced and was maintained for twelve seconds, after which the heading again drifted back to 087° and the rate of descent increased from 425 feet per minute to 1000 feet per minute while the air speed remained in the vicinity of 170 knots. This second heading drift to 087° and the increase in the rate of descent were probably associated with the occurrence of a second emergency in the aircraft.

Shortly after 1251 hours, however, the crew again initiated a turn to starboard and regained a heading of 122° at 1253 hours, continuing the descent at a constant rate and speed. This suggests that by 1253 the crew had completed their initial emergency actions to the point that they were able to re-direct their attention to the heading of the aircraft.

The next major variation in heading occurred shortly before 1255 hours, when the aircraft had reached 11,000 feet. Meteorological evidence indicates that at this altitude the aircraft would have been below cloud and the crew in a position to navigate by visual reference to the terrain.

At 1256 hours the rate of descent increased to more than 1700 feet per minute, which rate was maintained until 1258 hours, when the aircraft had descended below 7000 feet.

An easterly heading was maintained during this period, and it is probable that the decision to divert to Winton was made at about this time.

The evidence shows that by 1258 hours the crew probably had Winton in sight and were navigating, in all probability by visual reference to the terrain.

The altitude trace indicates a reduction in the rate of descent between 1258 and 1300 hours followed by a period of level flight at approximately 5000 feet until 1301 hours, when the trace becomes unreadable. The airspeed trace showed fluctuations between 170 and 190 knots until it also became unreadable shortly after 1301 hours.

CONDUCT OF FLIGHT CREW

It appears that the flight followed the normal course until the disengagement of the auto-pilot at 1247 hours. It would seem that the No. 2 air flow warning light may have illuminated in the cockpit in some period of minutes prior to that time.

Such a warning would not have caused Captain Cooper to take any action other than to ensure, so far as he was able, that the other components driven by the accessory gearbox in the engine nacelle, were not affected. Having regard to the operating procedures in effect at that time, such a warning would not cause Captain Cooper to divert from his flight plan or to close down the engine in question. He would certainly not be expected to conceive of the possibility that the failure involved a fire hazard to the aircraft.

The evidence from the flight service officer at Longreach and from the crews of the aircraft who overheard communications from VH-RMI indicates that Captain Cooper first notified an emergency situation affecting his aircraft at 1252 hours. Approximately one and a half minutes later he said that the nature of the emergency was the occurrence of fire warnings in two engines, one of which had ceased to alarm, and that he had been unable to feather the propeller of one of the engines.

Although the communication at 1252 hours was the first advice that an emergency situation existed, the flight data recorder clearly shows that the operation of the aircraft was not normal after 1247 hours. That can be deduced from the recorded flight path of the aircraft after that time. But having regard to the events described in the communication of 1253 hours, it is probable from the evidence that in the five minutes following 1247 hours the flight crew's attention was concentrated upon coping with the two fire warnings and at least one inability to feather a propeller.

In these circumstances it is understandable that no communication with ground stations was attempted during this period and the absence of any such communication is consistent with the concentration by the crew in handling the aircraft in the emergency. The engine positions of Viscount aircraft are numbered 1 to 4 from port to starboard.

It is not clear what was the nature of the event which first confronted the Captain of the aircraft as an emergency, but it is probable that it was a fire warning received in respect of No. 1 engine. The flight crew, in face of such a warning, would take immediate action to close down this engine using the primary method, the first step of which is to move the high pressure fuel cock lever to the feather position.

No. 1 propeller was not feathered and it is possible that the primary method was unsuccessful because the control rod for No. 1 engine was severed or affected by fire where it crosses No. 2 nacelle. Since the primary method of feathering was unsuccessful, the flight crew would then in all probability resort to the secondary method of shut-down, which consists in using the low pressure fuel valve, thus depriving the engine of fuel after which the propeller should have automatically feathered.

A fire warning occurring in isolation would not necessarily have induced Captain Cooper either to descend from cruising level or divert to Winton.

Having regard to the communications received from the aircraft, it seems certain that shortly after 1247 hours the flight crew were then confronted with another fire warning and a further feathering difficulty. These events were probably sufficient to induce Captain Cooper to take emergency action which he appears to have done.

The disengagement of the automatic pilot would seem to reflect the time of the first positive indication to the Captain of an emergency situation. He commenced the descent which he subsequently described as an "emergency descent" within one minute of that time. The heading trace does not give any clear indication that at this time he had any intention other than to continue the flight to Longreach possibly at a lower altitude.

There were several changes of heading towards Winton between 1247 and 1257 hours, but there were as many in the opposite direction, and it is considered that these changes probably occurred because the crew's attention was directed to other matters more closely associated with the emergency situation.

The evidence indicates that Captain Cooper believed he had a visible fire in No. 2 engine by 1258 hours. It is reasonable to presume that by this time he had discharged both fire extinguisher bottles on the port side of the aircraft into No. 1 engine and therefore he had no measure immediately available to him to combat the fire which he believed to exist in No. 2 engine.

The flight data record indicates the aircraft made a positive alteration of heading towards Winton at 1257 hours and this would seem to be the time at which the flight crew obtained some visible evidence which they interpreted as being related to a fire in No. 2 engine. At this time the aircraft was flying below cloud and was near the junction of the Diamintina and Western Rivers. Prior to 1256 hours the aircraft had been flying over rough country in which there were no suitable areas for a forced landing. After 1256 hours the aircraft was over areas of flat open country bordering the Diamintina and Western Rivers.

A forced landing may have been possible in some of these areas, but Winton was apparently only about 12 minutes flight away and in those circumstances it is quite probable that the information available to Captain Cooper gave no indication that Winton could not be reached.

The evidence indicates that the aircraft was prepared for an emergency evacuation of the cabin. Apparently Captain Cooper was prepared for the need to quickly evacuate the aircraft after landing

and expected to do this on the Winton aerodrome. An examination of the cabin chute showed that it had been prepared for an emergency evacuation.

Having regard to all the evidence I entertain no doubt that Captain Cooper's decision to divert to Winton rather than continue to Longreach was an appropriate one, and that the Captain acted properly in following this course rather than seeking to make a forced landing.

CABIN BLOWERS

As in the course of this report considerable attention will be focussed on the part played in the catastrophe by No. 2 cabin blower, it seems desirable to provide some description of these units which perhaps are more correctly described as superchargers or compressors. As, however, the term blower has been commonly used in this Inquiry, I propose to employ that term generally in this report.

Viscount aircraft are equipped with three cabin blowers. They are designed to maintain an adequate supply of air for pressurisation and temperature control purposes within the pressure hull of the aircraft. The blowers were manufactured by Sir Geo. Godfrey and Partners Ltd., now known as Godfrey Precision Products Limited of England (hereinafter referred to as Godfrey U.K.). On the Viscount aircraft they are installed on engines 2, 3 and 4.

If any one of the blowers fails in flight it is quite practicable to maintain proper pressurisation by the use of the others.

Each blower is driven by the engine through what is called the accessory gear box, which is situated behind the engine. The rotor speed is approximately 12, 080 r.p.m. at take-off engine speed; the air for the pressurisation and conditioning system is drawn by each blower through a screen in the side of the nacelle, and supplied through fibreglass and aluminium ducting to the air conditioning equipment, which is situated in the under-floor area of the fuselage.

Two rotors fit inside what is called the rotor case. One is a driving rotor, which meshes with the gear on the other one, which is then simply a driven rotor. They rotate together, and in rotation they come exceedingly close together. The clearance between the outside edge of each rotor and the inside of the rotor case is about sixteen thousandths of an inch and there is a similar clearance between each rotor during rotation.

The rotor case is a finned oval tube of cast aluminium alloy closed at both ends by end covers. These covers house the bearings which support the rotors. The helical gears which locate one rotor with respect to the other to prevent physical contact and which supply the drive are situated in the drive end cover. At the other end the rear end cover has a mounting for the oil metering unit which allows a measured quantity of oil to flow to the four main bearings of the blower. The metering unit delivers about 6 cc's of oil to each pair of bearings each minute and is fitted by means of two long studs and three short studs. When fitted nuts are screwed on to the end of the studs, and tightened with a torque spanner.

The rotors themselves are made from die-cast aluminium alloy and each is supported by two steel stub shafts which are shrunk into them. The drive is transmitted from the shafts to the rotors by two lugs which are integral with the shaft and which have screws attaching them to the rotor. The rotors are supported at the drive end by deep grooved ball bearings which locate them with respect to the drive end cover and which absorb any end thrust on the rotors.

At the rear end the rotors are supported on roller bearings and these allow relative movement to take place between the rotors and the casing as a result of differential thermal expansion.

The ball bearings are assemblies which are mounted in bearing housings and retained by an extractor seal. The roller bearings are made up in two sections, an inner track, which has assembled on it the rollers and their retaining cage, and an outer track, which is not fixed in any way with the other components of the bearings. The inner track is fixed to the rotor stub shaft by a nut and lock washer. The outer track, which is a push fit into the bearing housing, is retained in the driving shaft housing by a cover plate.

In the driven shaft housing it is retained by the oil metering unit. Both the cover plate and the oil metering unit at the time of the accident were retained by plain nuts, spring washers and plain washers to the steel studs screwed into the end cover. The bearing housings were steel shells which are shrunk into the rear end cover and retained by the same nuts and studs as retain the bearing cover plate and the oil metering unit.

The purpose of the oil metering unit is to regulate the amount of oil which is delivered to the bearings so that the quantity of oil delivered varies with the speed of the blower. Within the blower case itself where the rotors are turning at speed, oil is intended to be excluded.

The metering unit contains a pinion driven by a tongue engaging in a slot in the end of the driven rotor shaft. The pinion in turn drives the shaft, housing a small oil transfer pin which reciprocates in a hole drilled diametrically through the shaft.

Oil supplied to the metering unit is transferred by the hole and by the transfer pin to each roller bearing in turn every time the shaft rotates through 180 degrees. Because the oil metering unit is attached to the driven rotor roller bearing housing it supplies oil directly to this bearing by the holes in the driving pinion. It also supplies oil to the driving rotor roller bearing by way of a flexible hose.

Oil is also transferred to the driving end ball bearings by way of a flexible hose running from the rear end cover to the gear end cover. There is a system of labyrinth seals which restrict air leakage from the rotor chamber into the vent chambers and scroll seals which prevent oil from entering the rotor chamber. The vent chambers prevent oil and air being mixed in either the bearing housing or the rotor casing and they prevent oil drainage past the seals into the rotor casing when the blower is stopped.

The blower itself is bolted on to the accessory gear box and driven from the blower drive group of the gear box by a short quill shaft which has splines at both ends to transmit the drive. This quill shaft is hollow and it is designed to fail at the reduced diameter called a shear neck if an excess torque is applied to it. The main purpose of this design is to protect the gear box from damage in the event of seizure or failure of the blower and allow the other driven accessories to continue to function. In other words, if there is a blower failure and that failure imposes an undue strain on the quill shaft it will shear or break and give way before the accessory gear box suffers damage. The accessory gear box has a variety of functions, only one of which is to drive the rotors. If the blower fails it is desirable that this failure should not put out of action all the functions of the accessory gear box. That is the purpose of the shear neck of the quill shaft. The quill shaft as designed originally and at the time of this particular accident was capable of transmitting up to four hundred horse power, before it failed.

NO. 2 BLOWER IN VH-RMI

No. 2 blower in VH-RMI was first installed on an aircraft in 1959. It had, on the day of the accident, been in service for 14,427 hours. It was last overhauled in January 1966.

Following that overhaul, the unit was installed on 3rd March, 1966 on No. 2 engine in the Viscount 832 aircraft VH-RMJ and it completed 38 operating hours on this aircraft before being removed on 9th March, 1966 for workshop testing following reports of the No. 2 airflow warning light remaining ON in flight. That particular defect persisted in VH-RMJ after this blower was removed and subsequently a fault in the aircraft duct system was found. The removed blower unit proved satisfactory under test and was released for further service. It was next fitted to the No. 2 position on VH-RMI on 30th April, 1966 and remained in service in that position until the accident, at which time it had completed 915 hours since the last overhaul.

The period between overhauls prescribed by the operator is 3000 hours, and 1000 hours between inspections of the oil filter. No. 2 blower was accordingly approximately 2000 hours short of its next complete overhaul and had a further 85 hours before inspection of the filter. A sectioned diagram of the Type 15 Cabin Blower and Oil Metering Unit is appended to this Report.

THE ULTIMATE CAUSE OF ACCIDENT

The searching investigation undertaken by the Air Safety Investigation Branch of the Department of Civil Aviation involved a consideration of every feature of the aircraft which could possibly have had any relation to the accident. From the reports of the various groups which undertook these investigations it can be said with certainty that the primary cause of the disaster was not related to any malfunctioning of any such components as engines, engine control, propellers, instruments, fuel systems, electrical systems or hydraulic systems. It can also be said that the aircraft in its original design was completely airworthy.

The report of Mr. Frank E. Yeend, the Investigation Director, dated 7th April, 1967 contains a number of conclusions with reference to the accident and indicates the views of the Investigation Branch as to the cause of the accident so far as it had been possible to reach conclusions in that regard. Paragraphs 18 - 25 of the conclusions set out by the Director read as follows :

> "18. The wreckage examination indicates that the nuts and studs securing the oil metering unit onto the rear end cover of the No. 2 cabin air blower loosened, probably as a result of an out-of-balance condition in the rotating elements of the blower, and the consequent separation of the oil metering unit induced both a mechanical failure of the blower and an internal fire. The fire entered the nacelle

area either by erupting through the fibreglass section of the air conditioning duct or by passing between the oil metering unit and the blower rear end cover.

19. The evidence indicates that an in-flight fire existed in the wheel bay but there is no evidence that it originated in this area. It is probable that the fire reached the wheel bay from the rear of No. 2 nacelle area and affected the electrical looms and engine control rods on the rear face of the wing leading edge member so as to induce a fire warning in respect of No. 1 engine compartment and deprive the flight crew of the facilities to feather the propeller of No. 1 engine. It is also probable that, at a later time, the fire induced a fire warning in respect of No. 2 engine compartment by heating the cables in its fire warning electrical circuits. There is no evidence that fires occurred in flight in either No. 1 or No. 2 engine compartments.

20. There is clear evidence that an in-flight fire existed in cell 2 of fuel tank No. 2 and it is probable that this fire propagated to the fuel cell bay from the adjacent port wheel bay. The pattern of airflow in flight would assist the spread of a fire in this direction and, although there are several feasible points of ingress to the fuel cell bay, it is most likely that the fire first entered the bay close to the rear face of the wing leading edge member.

21. It is probable that the airframe anti-icing system was in operation during most of the flight and this would have augmented the normal wing internal airflow which vents through louvred exits set in the upper surface of the wing. It appears that, under the influence of this airflow, the fire in cell 2 of fuel tank No. 2 was directed towards the air exit located in the top of this bay and, in so doing, impinged upon the adjacent upper boom of the wing main spar. The strength of the material in the upper boom of the spar was progressively reduced by heat until it was no longer capable of sustaining the flight loads being experienced.

22. The evidence indicates that the port wing main spar failed in upward bending at wing station 170-188 at approximately 1302½ hours when the aircraft was at a height of 3,500-4,000 feet above ground level.

23. Immediately upon failure, the upper surface of the port wing struck the cabin roof and a blade of No. 1 propeller cut through the roof structure exposing the interior of the cabin to severe air loads. From this point the cabin roof failed progressively rearward until the tail assembly, together with the rear fuselage,

separated from the aircraft in flight and fell to the ground. The remainder of the aircraft then struck the ground and a severe fire immediately ensued. The port wing section which still contained No. 1 engine, also struck the ground and was similarly involved in a severe ground fire.

24. At the time of the wing failure the aircraft had been prepared for a landing at Winton aerodrome which was in sight. It is apparent that the evidence available to the flight crew up to this time was insufficient to cause Captain Cooper to alter his earlier decision to land at Winton aerodrome.

25. It is probable that the primary cause of the wing failure in flight was that the means of securing the oil metering unit to the No. 2 cabin blower became ineffective and this led to the initiation of a fire, within the blower, which propagated to a wing fuel tank and substantially reduced the strength of the main spar upper boom. "

At a somewhat late stage in the course of the investigations Mr. Thomas Madgwick, a member of the Design Staff of B.A.C., who was in Australia assisting in the investigations, drew attention to two matters which have assumed considerable significance in the course of the Inquiry.

On the 16th February, 1967 in the course of an inspection of the accessory gear box region of a Viscount aircraft, he observed that in the case of all three blowers installed in the aircraft the vent plug, which has a hole in it, was seen to be in the uppermost position. A blank plug was fitted to the bottom position. As this differed in its location from the locations shown in a Godfrey U.K. drawing No. 139003 in Mr. Madgwick's possession, he thought it might be relevant to the investigation and drew attention to the circumstance he had observed.

On the following day Mr. Madgwick observed in particular the condition of the extractor seal shell and felt that certain markings thereon might be of significance in ascertaining the reason why there was a rotor break-up.

He returned to England and consulted with members of his own Company and also with employees of Godfrey U.K. The upshot was that on the 14th March, 1967 a message was sent to the Sydney office of B.A.C. requesting that the following message should be passed on to Mr. Yeend :

"Reference failed blower from RMI. B.A.C. and Godfreys very interested in the evidence discovered during Madgwick's visit that

outer race of ball bearing on driven rotor at front end had been spinning. Considering the elapsed time to produce the wear found on the race retaining ring we believe this to be more likely to be a first occurrence in chain of events. Could you please supply the following photographs of retaining ring housing and races, also measurements of outer race width, depth of housing and thickness of each shim. "

In the course of the Inquiry by the Board there has been no dispute as to the finding of the Investigation Branch that the nuts and studs which secured the oil metering unit to the rear end cover of No. 2 cabin blower worked loose. There has however been considerable controversy in relation to the question as to why they worked loose.

Whatever may have been the cause, it seems clear that the oil metering unit moved rearward away from the blower rear end cover and this allowed the outer bearing track of the driven rotor roller bearing to separate from the remainder of the bearing. However, the metering unit continued to be driven after separation occurred and oil continued to be supplied to that area. The driven rotor lost its rear stub shaft location and this caused metal-to-metal contacts, generating high temperature. In addition, it caused the rotor to machine through the rear end cover between the rotor chamber and the vent chamber.

In this situation the necessary ingredients for a fire in this area were all present - namely, intense high temperature, lubricating oil and air supply. As a result a fire occurred within the blower.

The blower was probably still rotating at this time and the path taken by the fire was either through the blower to the fibreglass duct which is situated down-stream of the blower outlet, or alternatively rearwards and then externally to that duct.

There has been considerable argument before the Board as to the course which the fire took. Further attention to that matter will be given in a later section of this report. It is a question which is not unrelated to another matter to which some consideration must be given, namely the possible provision for fire detection or fire prevention or both in Zone 3 of this aircraft.

The general course the fire took, I find on the evidence, was that it passed into the port wheel bay. Inspections of Viscount aircraft made subsequent to the disaster show that in the rear nacelle and wheel bay areas an accumulation of fuel in the form of oil is not uncommon as a result of long operation of Viscount aircraft. The

fibreglass ducting was in such a position that it would ignite under these conditions and the fire would be assisted by this accumulation of oil. There seems little question that the ducting did ignite and carry the fire into the port wheel bay.

There is evidence of an in-flight fire in cell 2 of fuel tank No. 2, which is adjacent to the port wheel bay. It does not appear that this fire was initiated in the fuel tank and there is no previous instance, so far as the Board is aware, where a fire has been initiated in this part of this particular type of aircraft during its 8 million flying hours spread over more than 400 aircraft.

The source of the fire in cell 2 of tank 2 would therefore seem to have been the fire which existed in flight in the port wheel bay. Fire in that area could ignite an oil contaminated electrical loom, which loom passes from the wheel bay in to the tank 2 cell 2 bay.

The fire, once it entered the wing, would be likely to breach the fuel cell and an intense fire, probably assisted by the air from the wing de-icing system, would then develop. The air flow pattern in cell 2 bay would be such that it would be likely to direct the fire to the main spar to the extent where the upper boom failed and portion of the port wing section broke off in flight.

It appears to me on the evidence before the Board that this is the sequence of events which led to the loss of the aircraft.

In giving attention to what may have been the initial cause of blower failure which led to the fire, the Investigation Branch have not been able to advance a firm view, but those who rely upon what has come to be referred to as the "Extractor Seal Shell Theory" contend that the evidence justifies a conclusion that the ball bearing of the driving rotor was incorrectly assembled at last overhaul.

As explained by Mr. Samuels in his final address, the theory rests upon the view that the ball bearing housing was not fully home in the gear end cover. The outer race was thus permitted to spin and thus wore the face of the extractor seal shell. It wore the shell first to the amount of the initial clearance between the rotors and the gear end cover, namely sixteen thousandths inch; at that stage, Mr. Samuels said, there would have been contact between the rotors and the end cover, so the next step would be this degree of wear produced end rub and an out-of-balance condition of the rotors leading to break-up. In the course of this break-up the remaining nineteen thousandths inch was worn from the face of the extractor seal shell. So, Mr. Samuels said, you have a total to account for being the depth of wear on the face of the extractor seal shell of thirty-five thousandths

inch. You have to account for that; the theory accounts for it by saying that sixteen thousandths of it was worn before contact took place between the rotors and the gear end cover and the remaining nineteen thousandths was worn in the course of rotor break-up.

Evidence was given in relation to this matter on behalf of the Investigation Branch by Mr. Broughton, Senior Airworthiness Engineer (Turbines), in the Department of Civil Aviation, and Mr. Whalley, Senior Engineer in the Air Safety Investigation Branch of the Department.

Mr. Broughton's attitude was that he was not able to put his finger on evidence that the initial cause of out-of-balance in the failed blower was a particular event. Mr. Whalley was of the same view. Mr. Broughton's attitude is expressed in an answer to a question put to him by Mr. Crockett. He said :

> "I cannot distinguish between the sixteen thousandths of an inch wear which could occur prior to contact between the rotor and the casing and the nineteen thousandths wear which must have occurred after contact if this wear was a primary cause of the break-up. To me, there is no difficulty in saying that the entire wear was caused during the rotor break-up. I cannot distinguish between the two although I have tried."

A contrary view was supported by Mr. Salter, Chief Engineer, Godfrey U.K., who expounded the theory to the Board. Among other things he said:

> "Looking at the rotor chamber I concluded that this failure did not initiate from a rotor rub on the tips of the rotor because, had that happened, I would have expected to see a much greater build-up of aluminium on the case.
>
> In other words I take it you mean material coming off the rotors and being imposed, superimposed, on the case itself? --- Deposited, yes.
>
> Is that what you mean? --- Yes, that is what I mean.
>
> If I may just expand that a little bit, would that lack of evidence of build-up in any way be conclusive if you don't know the pattern of break-up? --- No, but having seen quite a number of failures, I draw that conclusion from experience."

Later on he said:

> "Looking through these components I found, as others had found before me, wear on the extractor seal shell; this to me showed

the driving rotor had lost its axial location. This would be consistent with that rotor having rubbed on the gear end cover. Therefore from that I concluded as the ball bearing was still reasonably intact and not in a failed condition the location had been lost in the bearing assembly and looking further into it the wear which had taken place on the extractor seal shell was 32 to 35 thou. which meant this was more than the end clearance. I think other witnesses have said it is difficult to explain this, but the wear was there. This was the one physical thing one could measure and establish.

Also, looking further into it I found the nip on the outer track of the bearing, by again looking at the dimensions and measuring the dimensions, was correct, therefore the extractor seal shell was assembled correctly and yet there was wear on it. So from that I concluded either the bearing housing had not been fully pressed home and had been assembled with such a correct amount of shimming to be put in or that the bolts holding the extractor seal shell must have been loose."

His views were strongly supported by Mr. Syres, Manager of the Aircraft Division of Godfreys Australia. Mr. Madgwick, Senior Design Engineer, Fire Precaution with B.A.C., also lent support in the following evidence :

"I think you did say it is the only positive piece of evidence that you were able to detect, but I want to press you on this. Would you agree that, having regard to what you have seen in that connection, and the analysis you have been good enough to discuss with us, it is more probable than not that the cause of the initial rotor failure is to be found on the wear in the extractor seal shell? --- In my opinion, yes."

In the light of these conflicting views the Board, on the 30th June, 1967 indicated its desire that a critical examination of the following should be undertaken :

a. The present condition of the ball bearing, including the balls and races, and an explanation of the rotational marks and so-called hammer marks on the outside of the outer race, and the possible effect of heat in this area.

b. Examination of the associated bearing housing in relation to the bearing fits and side-wise nip of the outer race probably existing at the time of overhaul and until the time of the RMI accident 915 compressor operating hours later.

c. A critical examination of the wear and the wear pattern on the extractor seal shell and a probable reason for this happening.

d. The characteristics of Loctite over the temperature range experienced and its effectiveness both as an anti-fretting compound and a bearing securing cement in the present application.

The necessary tests were undertaken by the Aeronautical Research Laboratories and the Defence Standards Laboratories and thereafter Mr. Whalley prepared a report on the tests and gave further evidence in relation to the matter. Among the conclusions set out in his report was the following :

> "3. No positive evidence was found which would support or refute the proposition that the bearing housing or the bearing itself was not fully home at the time the unit was assembled."

In the course of his evidence he said :

> "I see nothing in this further evidence which takes it any further. It does not refute it; it does not support it."

At a later stage in his evidence he was asked the question which follows, and gave the following answer :

> "This next question I want to put to you is perhaps two questions in one, so I will pose it to you fairly slowly. In the light of the information which you gained from this recent examination and testing and the earlier examination made in the course of the accident investigation, what do you now believe to be the most likely sequence of failures in the blower, and what order of time would you estimate for each of the significant elements in this sequence? Would you like that question in two parts? First of all, could you tell us, if you have an opinion about this, the most likely sequence of failures in the blower? --- It appears there has been a rotor break-up of some magnitude, the magnitude I do not know, which was the initial event in the sequence of events that led to a complete cabin blower break-up."

And later he said :

> "The rotor break-up apparently was not associated with the quill shaft failure, the rotors had continued to rotate for some time after the rotor break-up."

In other words, with the additional evidence available as a result of the tests, Mr. Whalley was able to favour a conclusion that the initial cause of blower failure was rotor break-up.

Mr. Morrison, Chief Airworthiness Engineer, B.A.C., gave valuable evidence in relation to the same matter including a reference to contamination found in the ball bearing in the course of which the following appears in the transcript :

> "Do you find some difficulty in accepting that evidence as sufficient to sustain the hypothesis which Mr. Whalley seeks to base upon it? --- Yes, I do. When a theory or postulation is being made and it boils down to one or two facts as being paramount, then I think that these facts have to be very, very closely examined as to their validity as to their being the only source of that information.
>
> In this case we have two possible sources of the same material in the ball bearing. We have the rotor material and we have the metering unit material; so we have to look very hard at how this material could possibly have got into the ball bearing.
>
> With no reflection on the Department's examination of this machine and subsequent handling of it, there must be the possibility of contamination by metal particles in this ball bearing during the strip and subsequent to the strip."

At a later stage his evidence is as follows :

> "I think you have said this fairly clearly that in your view as an engineer with no interest in the matter of this aspect of it there were two theories being debated before the Board: one, the extractor seal shell theory, and the other one which has come to light now from Mr. Whalley, is that right? --- Yes, that is so.
>
> But in your opinion you cannot prefer one theory to the other, is that so? --- No, I think you have it slightly astray. The two theories regarding the extractor seal shell wear; one was that it was a long term wear, possibly extending since the machine was last overhauled and then speeding up at the last stage when the machine broke up, and the other was that it was fairly rapid wear, all confined at the end. Mr. Whalley's theory is in fact just supporting in another way, the rapid wear theory.
>
> Is it your view this Board, in its wisdom, should say that both of those theories involved too much speculation to be completely acceptable? --- If I were on the Board I think that would be my view, yes."

I do not think the evidence justifies the acceptance of the extractor seal shell theory, and I reject it. This involves the acceptance of the view that the ball bearing of the driving rotor was correctly fitted at the last overhaul of the blower. On the whole, I think that

the evidence justifies the acceptance of Mr. Whalley's final conclusion and I find that the initial cause of the disaster was a rotor break-up, the blower subsequently being driven by the quill shaft in an out-of-balance condition long enough for the metering unit to become separated by the resulting vibration. It is not possible on the evidence to determine what was the cause of the rotor break-up.

This conclusion is supported by the fact that Ansett-A.N.A. had overhauled these blowers for some years and the assembly procedure insofar as the bearing was concerned is straight forward. At the time of the last overhaul of the No. 2 blower on VH-RMI, Ansett-A.N.A. had done about 200 blower overhauls and it is reasonable to accept that the workshop concerned was familiar with the assembly procedure.

Evidence points also to the fact that Loctite cement was used in securing the bearing. One must also assume that at the time of the initial strip of the failed blower in the presence of D.C.A., Ansett-A.N.A. and Godfrey specialists, close attention would have been paid to all fastenings and loose retaining screws should have been readily apparent.

VENT PLUGS

Throughout the proceedings there has been a large body of evidence directed to the question of the positioning of what is called the vent plug in the cabin blower attached to the No. 2 accessory gear box.

There are four plugs inserted in the rear end cover of the blower, one of which has a hole in it, the others being solid plugs. The correct position of the plug with the hole in it, referred to as the vent plug, is in the bottom position as the blower is installed in Viscount 832 aircraft. This position of the vent plug enables any oil which may otherwise collect in the vent chamber to be released on to an oil drip tray. The transposition of this plug to the top position is likely to result in an accumulation of a small amount of oil in the vent chamber. It appears that the accumulation will amount to about 20 cc's to 24 cc's of oil.

The presence of this oil in the vent chamber appeared of greater significance in the early stages of the Inquiry than when all the evidence had been taken. No-one was prepared to say with any conviction that the accumulation of oil resulting from the transposition of the vent plug was responsible for the ignition of the fire which occurred in the sense that it was probably the original source of the fuel which ignited.

Furthermore, the evidence does not justify a conclusion that the fire which developed in the blower and travelled to the fibreglass ducting would not have so travelled without the assistance of any accumulation of oil in the vent chamber. This oil may have contributed in some degree to the intensity of the fire which developed but there seems little doubt that the accident would have occurred even if the vent plug had been properly located and there had been no accumulation of oil in the vent chamber.

Support for this view is provided by an incident in the British West Indies in 1964, to which further reference will be made hereafter, and also an incident in Canada in the same year in which fires seem to have originated in a blower and to propagate out of the blower without any aid of a reservoir of oil in the vent chamber, there being no suggestion in either of these instances that the vent plugs were transposed.

From the whole of the evidence in relation to this matter it is, I think, proper to conclude that the transposition of the vent plug was not a cause of the ultimate catastrophe. However, in view of the fact that for some considerable period vent plugs were transposed in the Ansett-A.N.A. overhaul workshop, it is necessary to consider why this departure from proper practice occurred.

Until early 1964 blowers were overhauled on behalf of Ansett-A.N.A. by Godfrey (Australia) at its establishment which is situated not very far from the workshops of Ansett-A.N.A.

It appears that in 1962 Ansett-A.N.A. gave consideration to the possibility of themselves overhauling the Godfrey blowers. By a letter dated 17th December, 1962 Godfrey Australia forwarded to Ansett-A.N.A. two copies of the Godfrey overhaul manual. This was described as a completely new issue replacing a previous overhaul manual and it was stated in the letter that the manual "has been prepared to meet A.T.A. Specification No. 100 details which will no doubt be familiar to you." Some justifiable criticisms were directed by Ansett-A.N.A. in the course of evidence against this manual and in fact it does not meet A.T.A. Specification No. 100.

That Specification is issued by the Air Transport Association of the United States of America to establish a standard for the presentation of information contained in Maintenance and Overhaul Manuals to which all manufacturers of aircraft, engines and components licenced for Regular Passenger Transport in the U.S.A. must comply.

The next relevant step was that on the 2nd May, 1963 Godfrey Australia forwarded to Ansett and other operators in Australia and the Far East what is described as a comprehensive wall chart depicting most current Marks of Type 15 cabin supercharger arrangements. It was numbered Mc 3533D and dated 24th April, 1963. The letter stated :

> "We have taken the various configurations from the overhaul manual and present them on one sheet, which we suggest you may hang in your servicing or maintenance Department."

Ansett-A.N.A. acknowledged Godfrey's letter in a letter dated 7th May, 1963 in which it suggested two small changes to the drawing, one being the addition of the following suggested wording (in large letters across the top of the drawing) "THIS DRAWING SHOWS THE ADDITIONS NECESSARY TO THE BASIC TYPE 15 BLOWER TO FORM THE DIFFERENT ASSEMBLIES FOR VARIOUS AIRCRAFT." The letter also indicated that Ansett-A.N.A. would appreciate receiving 24 copies of the completed chart in due course. The request for 24 copies was never complied with but on the 3rd April 1964 a letter from Godfrey Australia to Ansett-A. N. A. stated :

> "We are now delivering to you by safe-hand one transparent copy of the drawing from which we are sure that you can take off any number of copies you may require."

It was also noted in the letter that the amendment previously suggested by Ansett-A. N. A. had been embodied on the drawing.

In the meantime, on the 18th December, 1963 three copies of a number of drawings were forwarded to Ansett-A. N. A. by Godfrey Australia, together with a letter which stated, inter alia, that this course was taken "in response to the request of your Mr. Keith Park for drawings of Godfrey equipment in Viscount and Friendship aircraft."

There is evidence which I accept that Mr. Park had in December, 1963 spent a period of ten days or a fortnight at the workshop of Godfrey Australia and doubtless it was during this time that he made the request to which reference is made in the letter of 18th December, 1963.

Among the drawings of which copies were enclosed with the letter of the 18th December, 1963 was a drawing No. 139003, being issue 14 of a drawing entitled "Installation of supercharger Type 15 Mk. 9S2D". All the drawings referred to in the letter were stated to be "At latest issue".

The drawing referred to in the letter of the 2nd May, 1963 which has been referred to in the course of the Inquiry as the Mc. drawing, was not compiled by Godfrey U.K. but by its wholly owned subsidiary in Australia. It does not appear to have been circulated among workshop employees at the overhaul workshop of Ansett-A.N.A. either when it was originally received in May 1963 nor when the transparent copy was forwarded in April 1964. It appears probable however that Park, after attending at the workshop of Godfrey Australia in December 1963, brought back a copy of the Mc. drawing.

Mr. Davies, Component Overhaul Superintendent of Ansett-A.N.A., gave evidence as to the circumstances in which the practice was adopted in the Ansett-A.N.A. workshop to place the vent plug in the top position in the blower. He says the matter was raised with him by the foreman and sub-foreman in the overhaul workshop (namely Mr. Ladd and Mr. Park) when they were starting to put together the first overhaul. They had the drawings to which reference has already been made, including the Mc. drawing and also the overhaul manual of Godfrey U.K. Mr. Davies says that he took the manual and drawings home and studied them closely and resolved that the Mc. drawing was the latest in date and that it should be followed. This drawing wrongly showed the position of the vent plug in the top position, whereas drawing No. 139003 showed this plug in the bottom position. Having made this decision Mr. Davies directed his men to insert the plugs in the way in which they were shown on the Mc. drawing and that course appears to have been followed by Ansett-A.N.A. until December 1966. I accept the evidence of Davies in relation to this matter but am quite unable to comprehend why he did not seek a solution to the problem which faced him by consulting with Godfrey Australia. He had drawings before him which were not reconcilable and the whole problem could have been solved without any difficulty by consulting Godfrey Australia whose premises, as has already been indicated, are within the vicinity of the workshop of Ansett-A.N.A.

Godfreys cannot escape criticism for what occurred since they circulated not only the Mc. drawing but also illustrations in the overhaul manual which indicated the position of the plug in what in fact was the wrong position. The Mc. drawing was, as I have said, a product of Godfrey Australia, a wholly owned subsidiary of Godfrey U.K. Because it was issued by the Australian Company it is said that it was not in any event an approved drawing to which Ansett-A.N.A. should have referred for the purpose of overhauling these blowers. This aspect of the matter is discussed in some detail at a later stage of this report.

I think it has been established that the practice followed at the Ansett-A.N.A. workshop in relation to the vent plug was changed in about the middle of December, 1966. According to Mr. Ladd, after the blower was removed from VH-RMI and dismantled in the workshop, Mr. Ladd studied an amended overhaul manual very closely to see if there had been any deviation in any way from the instructions laid down in the manual. He did notice in the illustrated parts list of the manual that for this particular blower assembly the vent plug was placed in the lower position. This appeared to Mr. Ladd to be the only difference in their practice from that prescribed in the manual. He says that he communicated with Mr. Fred Phillingham, Foreman in charge of Hydraulic Section, T.A.A. Essendon, to find out if the information in the illustrated parts list was correct and in effect received information from Mr. Phillingham that the vent plug on the Viscount supercharger was not in the same position as the same plug in the F.27 supercharger, thus indicating that the position as shown in the illustrated parts list was correct. Mr. Phillingham has denied this conversation and the account given by Mr. Ladd was attacked by Mr. Crockett Q.C. Some justification for his attack is to be found not only in the denial by Mr. Phillingham but also by reason of the fact that this evidence was not given until after it had been established that all blowers overhauled by Ansett-A.N.A. had not in fact followed the Mc. drawing insofar as the vent plug was concerned. For reasons I indicate below I accept Mr. Ladd's evidence in this respect and also find that as a result of his study of the overhaul manual and his conversation with Mr. Phillingham he instructed Mr. Lewis that from then on the vent plug should be inserted in the lower position as indicated in the illustrated parts list in the manual.

It is a curious feature of this incident that Mr. Ladd did not indicate to Mr. Davies that he was changing his practice in this regard and that the only communication he had with anyone else in relation to the matter was to instruct Mr. Lewis orally that the practice was to be changed.

Despite the criticisms which may be directed against Mr. Ladd's evidence, I am led to accept it by three circumstances which seem to me to indicate that it is accurate.

First is evidence provided by Mr. Whalley in which he says that in a note he made on 17th February, 1967 he had written "Last December changed position of vent to standardize to Viscount position, that is adjacent to oil metering unit". The note referred to Ansett-A.N.A. aircraft although Mr. Whalley was unable to recall from whom he had received the information. Further support for Mr.

Ladd's account is provided by Mr. Broughton who recalled a conversation he had with Mr. Ladd in February 1967 in which he had said that Ansett had been putting the plugs in the opposite position, that is in the lower position, for some time and that Mr. Ladd had told him that he had confirmed from Mr. Phillingham that this was the correct position. He had said to Mr. Broughton that he had rung Mr. Phillingham and asked him three questions which allowed him (Ladd) to determine where the plugs went.

The third circumstance which supports the account is that with the exception of one blower which went into the overhaul shop on 13th November 1966 and was signed out from overhaul on 13th January 1967 by Mr. Park, all blowers overhauled since mid-December had the vent plug inserted in the lower position. The work on the exceptional case may well have been completed before the change was made.

APPROVED DRAWINGS

In the course of the Inquiry it has been necessary to give some consideration to the Air Navigation Regulations and Air Navigation Orders issued pursuant to those regulations relating to the modification, repair and overhaul of aircraft components and in particular with a view to determining what are approved drawings. The matter is by no means free of difficulty from a strictly legal point of view.

One commences the examination of this matter by referring first of all to S. 26 of the Air Navigation Act. It provides (inter alia) :

"26.-(1) The Governor-General may make regulations, not inconsistent with this Act -

(a) prescribing all matters which by this Act are required or permitted to be prescribed or which are necessary or convenient to be prescribed for carrying out or giving effect to this Act;

(2) Without limiting the generality of the preceding provisions of this section, the regulations that may be made under the powers conferred by those provisions include regulations for or in relation to -

(a) the registration, marking and airworthiness of aircraft;

(b) requiring persons performing specified functions in relation to the operation or maintenance of aircraft to be the holders of licences or certificates of specified kinds, and providing

for the grant, cancellation, suspension or variation of such licences and certificates;

(h) empowering the Director-General, or an officer thereunto authorised by the Director-General, to give or issue directions or instructions to all or any of the persons holding licences or certificates under this Act or the regulations, being directions or instructions with respect to matters affecting the safe navigation and operation, or the maintenance, of aircraft and providing for the manner in which such directions and instructions are to be notified; "

Pursuant to these provisions the Air Navigation Regulations have been enacted. Regulation 8 provides :

"8.-(1.) Wherever the Director-General is empowered or required under these Regulations to issue any direction or notification or to give any permission, approval or authority, he may, unless the contrary intention appears in the regulation conferring the power or function or imposing the obligation or duty, issue the direction or notification or give the permission, approval or authority in Air Navigation Orders or by writing under his hand.

(2.) Expressions used in Air Navigation Orders shall, unless the contrary intention appears, have the same meanings as in these Regulations. "

The words "approved" and "authorised" are defined in the definition section (S.5) as meaning "approved by the Director-General" and "authorised by the Director-General".

Two other Regulations are of significance. Regulation 30(2) provides :

"(2.) The Director-General may issue, renew or render valid a certificate of airworthiness in respect of an aircraft where -

(a) the applicant furnishes such documents or other evidence relating to the airworthiness of the aircraft as the Director-General requires; and

(b) the Director-General is satisfied that it is airworthy."

Regulation 32 is in the following terms :

"32.-(1.) A person shall not modify or repair an aircraft in respect of which there is a valid certificate of airworthiness, or modify or repair any aircraft component or item of equipment of that aircraft, unless he has been required to do so in pursuance of regulation 31 of these Regulations or unless he has obtained the prior approval of the Director-General.

"(2.) The Director-General may give approval for the repair or modification of an aircraft in respect of which there is a valid certificate of airworthiness, or of any aircraft component or item of equipment of that aircraft, where the owner or operator furnishes such evidence relating to the intended modification or repair and its effect on the airworthiness of the aircraft, as the Director-General requires.

(3.) Where an aircraft, or an aircraft component or item of equipment of the aircraft, has been modified, repaired, replaced, inspected or overhauled or has developed a major defect, the aircraft shall not be flown until an aircraft maintenance engineer licensed for the purpose or an approved inspector has certified that the aircraft is airworthy and safe for flight or that the aircraft is in a fit condition to be flown for the purpose of experiment or test, as the case may be.

(4.) A certification in pursuance of the last preceding sub-regulation shall not be issued unless the design, materials, components and workmanship comply with such drawings, specifications and instructions as the Director-General has approved or required."

Pursuant to regulation 8 certain Air Navigation Orders have been issued. They include one referred to as Section 100.4

Paragraph 1 relates to the applicability of the section and paragraph 1.1. provides :

"1.1 - This Section prescribes the requirements to be observed for -

(a) the manufacture of aircraft;

(b) the manufacture of materials and components intended for use in aircraft; and

(c) the modification, repair and overhaul of aircraft components intended for use in aircraft.

Note - Section 100.5 of the Air Navigation Orders specifies the requirements to be observed for modification and repair of an aircraft and of components when fitted to an aircraft."

Paragraph 4 relates to "Modification Repair and Overhaul of Aircraft Components". The paragraph is in the following terms :

"4 - MODIFICATION, REPAIR AND OVERHAUL OF AIRCRAFT COMPONENTS.

Note - Modification, repair and overhaul of aircraft components intended for use in aircraft are required to be performed by organisations holding a valid Certificate of Approval issued for the purpose in accordance with Section 104.0 of Air Navigation Orders or by persons or organisations otherwise approved for the purpose by the Director-General.

4.1 - The modification and repair of aircraft components shall be performed to approved design and procedures.

Note - Section 100.6 of Air Navigation Orders specifies the procedures for obtaining approval of design documents and also specifies data which may be considered as having been approved by the Director-General.

4.2 - Overhaul of aircraft components shall be performed in accordance with procedures approved for the purpose by the Director-General.

Note 1. - Unless otherwise notified by the Director-General or except where they conflict with Air Navigation Orders, the procedures specified for overhaul in the component manufacturer's current Maintenance, Overhaul and Repair Manuals, Service Bulletins and similar documents may be considered as having been approved by the Director-General.

Note 2. - Service Bulletins and similar documents promulgated by the manufacturer of an aircraft component are not mandatory unless specifically so notified by the Director-General.

Note 3. - Notification referred to in this paragraph will normally be by Air Navigation Order or in writing to the owner, operator, approved organisation and other persons concerned.

Note 4. - Parts Catalogues are not always accurate and cannot therefore be used to show the correct methods of assembly or installation unless they have previously been checked for accuracy against approved assembly drawings."

The problem arises in its most acute form in relation to the Mc. drawing. Was it a drawing which the Director-General had approved within the meaning of Regulation 32(4)? Was it an approved assembly drawing within the meaning of Note 4 to para. 4 of Section 100.4? It is difficult to give an affirmative answer to either of these questions unless the drawing can be properly brought within the phrase "the component manufacturer's current Maintenance Overhaul and

Repair Manuals Service Bulletins and similar documents". Even if one treats the drawing as a similar document it still seems to fail to qualify for inclusion in the phrase because it cannot, I think, satisfy the requirement that attracts the Director-General's approval, namely that it must be "the manufacturer's" and it must be "current". It seems to me that the drawing which satisfied these requirements was No. 139003 which was described as being "at latest issue" and was a Manufacturer's drawing in that it was the product of Godfrey U.K. who are the manufacturers, whereas the Mc. drawing was the product of Godfrey Australia. Ansett-A.N.A. may well be pardoned for not appreciating this latter distinction. Its error is one which Godfreys should take steps to avoid in future relations with their clients.

INHERENT SOUNDNESS OF BLOWER

The rejection of the extractor seal shell theory which if accepted would support a conclusion that faulty replacement during overhaul contributed to the disaster, renders it necessary to give some attention to the inherent qualities of the blower itself.

It appears that when the Viscount aircraft was being designed consideration was necessarily given to the means of providing the suitable type of air supply for a pressurised aircraft.

At that time a blower design had been developed for use in military aircraft and was currently being fitted to piston engines in civil aircraft.

Manufacture of the product had at the request of the appropriate United Kingdom government production authority been undertaken by Godfrey U.K. and by Rotol Ltd. The latter subsequently ceased manufacture and Godfrey U.K. became the sole supplier.

When early in the 1950s the Viscount with the Dart engine emerged as a civil transport the aircraft manufacturer selected a blower design identified as Type 15 after it had proved to be satisfactory throughout Dart engine testing and in test flying. Apart from the aircraft manufacturers approval it was a design approved by the Air Registration Board in the United Kingdom and subsequently accepted by other appropriate authorities.

Mr. Morrison explained in relation to the risk of fire that in the installation of high energy rotating machines in an aircraft his company applied two broad design principles, namely that the machine should contain the products of its own failure and that it should be so located and installed that its failure would not affect the continued ability of the aircraft to fly on safely.

He said that rotor break-up due to the ingestion of foreign material was a known source of failure but fire escaping from the blower was not regarded as a hazard. A further factor apparent from failures which had occurred during the development of the blower and its use in other aircraft was that the quill shaft severed and so protected the gear box and the aircraft from continued churning of the broken blower. There was no case in which fire had followed any failure and in fact there is no evidence that fire did follow any failure prior to the occurrence of two incidents in 1964 to which further reference will be made later in this report.

The absence of evidence of fire associated with blower failure is the more significant when regard is had to the number of blower failures. The evidence is that up to the end of 1966 there had been 611 blower failures reported to the aircraft manufacturer in eight million aircraft flying hours, or an average of one reported failure every 13,100 aircraft flying hours. Not all of these involved rotor break-up but failures due to that cause have been sufficiently numerous to reveal a danger of fire, if in fact that danger was present.

It is proper to conclude on the evidence that the selection of the Godfrey blower for installation in Viscount aircraft was proper and appropriate and that at the time of its selection and in subsequent years of operation, until at least 1964, there was no reason why those responsible should have foreseen an event such as the loss of VH-RMI. Modifications which have been adopted as a consequence of this accident are referred in detail hereafter. These have removed any doubts as to the acceptability of these components as installed in Viscount aircraft.

One other matter however calling for consideration in relation to the blower is the adoption of fibreglass ducting. The original design on prototype Viscount aircraft had a fabricated metal outlet duct. It was discarded as unsuitable because early in the test flying it cracked as the result of vibration and the pulsing of the air that was coming out of the blower. A polyester resin impregnated glass cloth in laminated form was substituted. Initially the resin incorporated so-called flame retardant additives but after some years experience it was established that these additives caused delamination of the duct and reduced its structural strength when exposed to high temperatures such as temperatures up to 180 degrees C to which the ducting was exposed.

Another element which contributed to the course which was taken with respect to the ducting was that because it was considered there was no risk of fire there was no need for it to be of fire proof material.

Between 1956 and 1960 in an attempt to standardise resin materials used in various parts of the aircraft, the resin mix with flame retardant additives was used but because ducts were failing due to delamination caused by the additive the manufacturer reverted to its earlier design standard. VH-RMI was delivered in 1959 with ducting containing the additive but this ducting was changed by the operator in 1966 to a duct of MK. 2 standard which did not contain the additive.

As will appear hereafter, one modification to the blower which has been adopted as a result of the VH-RMI disaster is the wirelocking of the nuts and studs retaining the metering unit. Without this modification the risk of fire spreading to the ducting was remote. The adoption of the modification makes the possibility still more remote and may justify the continued use of fibreglass ducting as heretofore but in my view the substitution of metal ducting as now required in Australia is a wise and prudent course.

CANADIAN AND BRITISH WEST INDIAN INCIDENTS

A letter dated 23rd June, 1964 was forwarded by Air Canada to the Service Manager of B.A.C. It is in the following terms :

"Mr. P.J. Stanbury,
Service Manager,
British A/C Corp. (Operating) Ltd.,
Weybridge Division,
Weybridge, Surrey, England.

Dear Phil :

Subject : Viscount - Supercharger Fire During Ground Run A/C 611

Attached is a copy of Report No. ORS 4493 which details the subject incident.

Throughout our operation, we have had numerous cases of end rub between rotors and end plate. This may have been the primary factor in this failure. We have, therefore, increased the rear end clearance from .024 to .026 driven rotor, .019 to .021 driving rotor.

Also the TCA flexible inlet duct has proved to be difficult to rid of supercharger debris after failures. Subsequent ingestion thus often has caused another failure. The inlet duct is, therefore, being replaced with the Vickers-Armstrongs metal duct installation. We believe that these two changes will prevent

recurrences, however, we have also installed fire sleeving on the TCA teflon supercharger oil lines. We are also looking at replacing the fibreglass outlet ducts with metal and are considering to do some experimentation on a reduced shear neck.

This is for your information.

Yours truly,

(K. F. Chapman)
Engineering Superintendent.

Attach.

cc - BAC Service Rep. (Canada) - Montreal."

By letter dated 26th June, 1964, B.A.C. replied as follows :

"SS/PAA/DB/1150 26th June, 1964

Air Canada,
P. O. Box 768,
WINNIPEG,
MANITOBA,
CANADA.

For the attention of Mr. K. F. Chapman,
Engineering Superintendent;

Dear Ken,

Viscount - Supercharger Fire

As Phil Stanbury is away I am writing to thank you for the copy of your report No. ORS 4493 giving details of the above incident. This will be circulated to the departments interested within our organisation and should they have any comments to make we will of course pass them on to you.

Yours sincerely,

(P. A. Arondel)
Service Department. "

The Report referred to in the letter from Air Canada was that of Overhaul Research Services, Winnipeg, a technical department of the airline. It related to an incident on May 10th, 1964 when A/C 611 returned from flight 279 after six minutes airborne due to smoke in the cabin. It was found that the No. 2 supercharger (77U57E) had failed and suffered severe rotor break-up. The break-up had evidently started with a rub of the rotors on the rear end cover. The rub may have started with contamination but there is a possibility of insufficient clearance at this location. The drive quill in this instance

had sheared to prevent further damage. The supercharger bearings and oil supply were normal. The flex inlet duct was checked at this time and found in good condition. Bits of metal from this rotor failure were found in the inlet duct and as far down the outlet ducts as the spill valve. The inlet duct was cleaned by removing the filter screen and pulling rags through and blowing through the duct. The outlet ducts were removed for cleaning.

It was at this time that supercharger 77U90E was installed on A/C 611 No. 2 position and was involved with a fire incident on ground run. Supercharger 77U90E had completed a half life of 3194 hours on A/C 643 No. 4 position. It was found normal on shop check and on rig test and was returned to service.

The conclusions of Overhaul Research Services in relation to this latter incident included the following :

"1. The fire in the No. 2 nacelle of A/C 611 appeared to originate within the cabin supercharger.

2. The overheat to cause the fire was the result of an extremely heavy supercharger rotor rub on the rear end cover.

3. Fire resulted when sufficient damage to the rear end cover allowed oil to enter the case from the rear scrolls. The rotors were sufficiently hot to sustain fire with a small supply of oil from the rear scrolls and bearings.

4. Heat and flames from within the supercharger had set the fibreglass ducts on fire. They were fanned by air from the broken rotors and produced extensive heat which accounted for the secondary heat damage to the adjacent units and structure and caused the bromide bottle to explode.

5. The fire was sustained by oil squirting out of the burned supercharger supply line and being drawn into the supercharger through the burned hole in the inlet duct.

6. The drive quill had eventually sheared but not in time to prevent extensive damage to the supercharger, with a resulting fire.

7. Damage to the supercharger in this instance was much more severe than is usually experienced before the quill shears.

8. The initial foul and break-up of the rotors was probably a result of metal particles being left in the inlet duct and being drawn into the rotor case on start up, or from some other source of contamination. Lack of oil supply is not considered a cause of failure as indications are the oil was running to

wash the contamination from the rear driven bearing to the forward bearing. An initial bearing failure is not indicated as the supercharger had just been test run and was found normal."

Among recommendations made by the research unit were some not irrelevant to certain of the problems posed by the loss of RMI. I refer in particular to recommendations 1, 2, 4, 5 and 7 which were as follows :

"1. The Maintenance Manual be revised to call for removal and thorough cleaning of the inlet ducts after a supercharger rotor failure - Actioned.

2. Tests be carried out with weaker supercharger drive quills which will fail sooner and afford a greater margin of safety - Being actioned.

4. Consideration be given to installing fire protection probes in the nacelle area with an automatic extinguishing system.

5. Consideration be given to converting to the latest configuration of super-charger ducts which features metal inlet ducts and a long metal outlet manifold that replace the short metal outlet manifold plus the first fibreglass duct. Eleven aircraft would have to be converted. - Metal inlet ducts are being installed in all aircraft.

7. Consideration be given to the use of steel engine control rods in this area or a means of protecting the present control rods in case of fire."

The course followed by B.A.C. upon receipt of the letter and report referred to above is summarised by Mr. S.J. Davies, Assistant Service Manager, B.A.C., in the following terms :

"The content of the Air Canada letter dated 23rd June, 1964, together with the detailed reports which contained the conclusions and recommendations, were discussed, as I have said, with all the appropriate departments at Weybridge. It was also my considered opinion when I saw it a short while after and it was concluded that, with the special circumstances surrounding this particular incident, no further action was required by B.A.C., and the thoughts which the operator had already or was about to institute."

No further action in fact was taken. When asked by me whether B.A.C. took the matter up with Godfrey U.K. Mr. Davies said :

"It was not taken up with Godfrey's, Your Honour, no, since this was considered insignificant. Although T.C.A. had said in their letter that they had had several cases of end rub, we could hardly

tie that up with the fact that it constituted a hazard in any possible way because the overhaul life of the blower as set out by Godfrey's is 2,500 hours and T.C.A. at that time must have been working to an overhaul period in excess of 6,000 hours. This did not suggest to us that this was likely to be a hazard.

In the light of the RMI disaster it appears unfortunate that the matter was not taken up with Godfrey U.K. and perhaps pursued further with Air Canada. It is fair to observe that the material was passed on to B.A.C. by Air Canada, not for the purpose of seeking advice, but "for your information".

Once the conclusion was reached, as it was, that special circumstances surrounded the particular incident, it ceased apparently in the opinion of B.A.C. to have any interest of use to other operators.

On 5th October, 1964 British West Indian Airways Ltd. forwarded to B.A.C. a letter in the following terms :

"Our ref. 1/393 5th October, 1964.

Messrs. British Aircraft Corp., (Operating) Ltd.,
Weybridge Division,
Brooklands Road,
Weybridge, Surrey,
ENGLAND.

Dear Sirs,

We are submitting the enclosed drawing, BWIA/158, which shows the repair scheme carried out on our Viscount 772 aircraft, VP-TBU, following a fire which broke out in the No. 4 engine nacelle caused by oil spillage from the compressor on to the heat shield.

Also included on this drawing is a repair carried out to a crack between Stn. 236.25 and 243.25 as shown in Figure 209 Chapter 7 of the Viscount Repair Manual. You will notice that the path was made larger and this was due to slight buckling in the area.

Would you please let us have your approval of this repair scheme at your earliest convenience.

Yours faithfully,

for BRITISH WEST INDIAN AIRWAYS LIMITED.

S. H. Best
Acting Chief Inspector."

To this letter B.A.C. replied on a date which does not appear on the copy in evidence before the Board, in the following terms :

"British West Indian Airways Ltd., SS/AEG/IMS/1889
Kent House, 1/393
Long Circular Road,
Maraval, Trinidad W.1.,
P.O. Box 604.

Attention of Mr. S.H. Best,
Acting Chief Inspector.

Dear Sirs,

Repair to Viscount VP-TBU

We wish to acknowledge and thank you for your letter dated 5th October, 1964, together with your drawing BWIA/158 requesting the approval of the repair recently carried out to the top skin panel of the above aircraft as a result of a slight fire in the No. 4 engine nacelle, and crack between station 236.25 and 243.25.

While the repair as shown would be satisfactory for a limited period, it is not considered adequate as a permanent repair, as it is felt the crack in the skin could very well propagate and to some extent run under the engine strut to wing attachment fitting, which of course could not be seen with the cover plate fitted.

Furthermore bearing in mind the condition of the area of skin which has been subjected to heat from the fire, and in this respect we would recommend as a permanent repair a part panel replacement be carried out.

We would refer to you the Repair Manual Chapter 7 figure 119 which shows a typical part panel replacement, and in your case the joint could be made midway of the access panel aperture, furthermore it will not be necessary to fit a butt strap at the joint at the outboard rib position station 257.75.

It is regretted we cannot accept your scheme as a permanent repair, and that you will understand our reasoning, but if we can be of further assistance to you in this matter please do not hesitate to contact us.

Yours faithfully,

for BRITISH AIRCRAFT CORPORATION
(OPERATING) LTD., WEYBRIDGE DIVISION

A. E. Green

for Service Manager

Copies Mr. W. Simpson,
Mr. Mills. "

The reference in the first paragraph to "a slight fire" seems scarcely justified by the letter from the operator to which it is a reply. The letter from the operator was disposed of by the Service Department as one merely seeking approval of a repair scheme as indeed it was, and the reply of the Service Department ended the matter as far as B.A.C. were at that time concerned.

It is not, I think, the function of this Board to pass judgement on the conduct of B.A.C. in relation to the matter. The incident does however suggest that a wider circulation of the letter with its reference to a fire in the No. 4 engine nacelle among B.A.C. officials, particularly those in the airworthiness department, might have alerted them to the seriousness of the incident and perhaps resulted in someone recalling the Canadian incident less than four months earlier, and have led to some closer investigation of each of these incidents. Perhaps a lesson to be learned is that the cause of a fire in an aircraft, whether on the ground or in the air, if not clearly ascertained is a matter for proper investigation and appropriate report.

It did not come to the knowledge of B.A.C. until 1967 that this incident had been brought to the attention of Godfrey Engineering Coy. Ltd. Canada in October 1964.

A letter dated 15th October, 1964 from Jet Turbine Service Inc. of Farmingdale N.Y. to Godfrey Canada reads as follows :

"Godfrey Engineering Co. Ltd.,
480 Montreal-Toronto Blvd., Lachino,
Montreal, Canada.

Gentlemen:

We recently received a letter of request from a Viscount operator to consider an improved method of locking nuts that secure oil metering unit to cabin supercharger type 15. Operator states failure of a supercharger and consequent fire was caused by metering unit completely backing off mounting flange.

Since any change of design must be from the manufacturer, we are therefore bringing this matter to your attention. Suggested methods to lock nuts are use of loctite, use of "Pal" nuts, or use of fibre lock nuts.

Very truly yours,

Paul Kahl,
Chief Inspector."

There is a not insignificant note written on the letter by one McKenzie who was in charge of the engineering side of Godfrey's business in Canada. "This seems to me to be an isolated case not warranting any action. Are not the bolts wire locked in any event?"

A reply to the letter is dated 10th November 1964 and is as follows :

"10th November, 1964.

Jet Turbine Service Inc.,
210 Adams Blvd.,
FARMINGDALE,
N.Y. 11735.

Attention Mr. P. Kahl
Chief Inspector.

Dear Sir,

With reference to your letter of October 15th 1964, we have evaluated your suggestion for changing the locknut arrangement on the studs securing the metering unit and bearing cover and do not consider this to be warranted.

In our long history with the Type 15 Supercharger there has been no previous incident of this nature, which we believe to be an isolated case.

Yours very truly,

GODFREY ENGINEERING CO. LTD.
Signed : D. M. Howard. "

This reply was forwarded by Godfrey Canada without any reference to Godfrey U.K.

Godfrey Canada is a wholly owned subsidiary of Godfrey U.K. The latter and its wholly owned subsidiary in Australia were represented at the Inquiry by Mr. Crockett Q.C. and Mr. Beach but no-one appeared on behalf of the Canadian company and no evidence was given by an official of that company, concerned in the incident. I therefore hesitate to criticise those responsible for what occurred.

It seems most unfortunate that this matter was not referred by the Canadian company to its parent Company in England. The letter from Jet Turbine Service expressly sought action from "the manufacturer". Unless the Godfrey group of companies are to be regarded as a single entity, which is not legally the position, then Godfrey U.K.

was manufacturer, Godfrey Canada was not. The statement by Godfrey Canada in its reply, namely "In our long history with the Type 15 supercharger there has been no previous incident of this nature" was apparently made without reference to or confirmation by the parent company.

I leave the matter with the comment that failure by the Canadian company to consult its parent company was to say the very least most unfortunate.

One can only speculate as to what consequences may have followed if B.A.C. had acquainted Godfrey U.K. with the material it had in relation to the Canadian incident and Godfrey Canada had consulted with its parent company in relation to the British West Indian incident.

FIRE DETECTION AND PREVENTION IN AUXILIARY GEAR BOX ZONE

At an early stage of the investigation consideration was given to the desirability of making provision for fire detection and protection in the auxiliary gear box area (zone 3) of Viscount aircraft. The matter is referred to in a circular issued by D.C.A. on 14th November 1966 in which the following appears :

"Fire Detection and Protection

Positive evidence was available that in addition to VH-RMI, at least one other fire had occurred in the auxiliary gear box zone (zones) of Viscount aircraft and that the pilot had no means of controlling such a fire other than by feathering the propeller and stopping the engine. The British Civil Airworthiness Requirements do not require fire detection and protection in such a zone but a reasonable interpretation of the United States Federal Aviation Regulations would result in this being fitted to United States certificated aeroplanes. In fact, it is now known that the Grumman Gulfstream and Fairchild F.27 have fire detection and protection in this area. It is also known that the United States did not make such a provision mandatory for their Part 10 type certifications of the Viscount or the Fokker F.27.

In view of the fact that fires have occurred and that the area is one where there are both ignition sources and inflammable fluid supplies, it was agreed that fire detection and protection should be introduced as a modification to Viscount aircraft and to Fokker F.27 aircraft. Such a modification is by no means an easy one

to design and accomplish, and will require full and proper design action by the respective manufacturers. For example, it will be necessary to determine the amount of extinguishant, the location of detectors and the location of spray rings. In addition, it will be necessary to determine whether or not the extinguishant currently provided for the areas forward of the firewall can be used to cover zone 3 as well.

An Air Navigation Order will be issued immediately requiring general modification to provide fire detection and protection in accordance with a system to be approved by the Department and in accordance with the time scale which will be based on the capability of the manufacturers to produce the design and the associated hardware. "

The matter is again referred to in a circular dated 30th December 1966 in the following terms :

"Fire Detection and Protection

It has been confirmed that the Grumman Gulfstream G159 has a fire detection and extinguishing system for the accessory gear box zone. However, the Fairchild F27 does not have fire detection and extinguishing in this area as previously reported.

An Air Navigation Order requiring general modification to provide fire detection and protection in the accessory zone of the Viscount and F27 aircraft has not yet been issued. The investigation of the exact needs in this matter is still in hand and until this is clarified no A.N.O. will be issued. It is proposed to meet with the airlines when all parties have initially studied the problem and together define the requirement. It is expected that the A.N.O. will be issued early in January, 1967."

In a circular dated 10th April 1967 the following appears :

"If a practical and reliable early failure warning device can be developed for the supercharger installation, it should be possible to avoid a requirement for general fire detection and extinguishing systems in accessory gear box compartments of Viscount aircraft, as envisaged in our earlier reports on this subject. The provision of such systems would involve considerable difficulty and expense and it would obviously be desirable to dispense with them if an adequate level of safety can be achieved by simpler means."

The matter is referred to in the report of Mr. Langford, Assistant Director-General, Airworthiness, D.C.A., in which the following appears :

"3.10 The only indication of a blower failure normally available in the cockpit of a Viscount aircraft is provided by a warning light actuated by closure of the appropriate duct non-return valve. Unfortunately, this is not a positive and exclusive indication since the non-return valves will also close as a result of simple duct failure and also, during normal operations, as the result of manual or automatic operation of the appropriate spill valves. It is considered that, in addition to the various modifications already discussed, it would be highly desirable for Viscount aircraft to be fitted with a system that could give a pilot early and unambiguous warning of a blower failure or overheat condition of a type that, if unchecked, might possibly lead to fire. This would enable the engine concerned to be closed down before a serious hazard developed.

"3.11 The long-term need for such a warning system has been discussed and agreed with Australian Viscount operators, who are already obtaining experimental data and experience with trial installations. In addition this matter is also receiving attention from B.A.C., Godfrey's and the Air Registration Board in Britain. However, there are still a number of technical difficulties to be overcome in the design, development and certification of a suitable system and the Department is not yet in a position to specify realistic requirements in an Air Navigation Order.

"3.12 Serious thought was naturally given to the possibility of requiring full fire protection treatment, including complete sealing and the installation of fire detection and extinguishing systems, for the accessory gear box compartments and wheel wells in Viscount aircraft. However these ideas have not been proceeded with. Modifications of this type might be considered desirable, in principle, but technical assessment of the problem shows that they would involve very considerable difficulty and that their cost might imperil the economic future of the aircraft. Further, the benefits achieved would probably only be marginal in view of the significant improvements in safety resulting from the other modifications that have already been required."

Mr. Langford in the course of his evidence said :

"In our judgement the value of fire detection and fire extinguishant would be so little as to make it completely unreasonable, an unreasonable step to take."

When it was suggested to him that the Department was not giving further consideration to the installation of a fire detection or an extinguishing system in the nacelle area, he said :

"On the evidence available at this stage we have made our judgement. Other evidence may come forward upon which of course we would have to re-evaluate our judgement."

He was supported in this view by both Mr. Madgwick and Mr. Morrison of B.A.C.

When questions were put to Mr. Madgwick concerning the necessity or the possibility of providing fire protection in the zone 3 area, he indicated in his opinion it was not required and that he would concur with D.C.A.'s current views on this question. He said : "My prime reason is I think that the corrective action that has been taken as a result of this Inquiry will prevent a re-occurrence". He said his company had not done any work in regard to the provision of a temperature switch attached to the compressor, and he further said that in his view without any corrective action being taken the probability of fire in this region was remote. Now that the corrective action has been taken in respect of providing more positive locking of the oil metering unit attachments, the risk must be even more remote than it was.

Mr. Morrison expressed similar views.

I think the views expressed by Mr. Langford and the other witnesses to which I have referred in relation to this matter are sound and should be accepted.

A suggestion made by Mr. Pearce was that, it if is feasible and practicable engineering-wise, each engine should have its own independent fire extinguishing system so that the contents of two bottles of extinguishant should be available for each engine. The Departmental view with regard to this matter was put by Mr. Langford when he was asked whether any consideration had been given by the Department to providing additional extinguishers to serve the engine area. He said it had not - "When I say no consideration has been given to it, this is a standard applicable right across the aircraft population. To require more extinguishers in this case we would have to be requiring them on all aircraft and I respectfully suggest history has shown this has not been necessary."

Mr. Madgwick said that the provision of additional fire extinguising bottles for zones 1 and 2 of each engine was totally unnecessary "because the tests that have been done in connection with zone 1 and zone 2 indicate that there is a very adequate quantity already provided far in excess of the ARB requirements." He also said: "The aircraft is fitted with a 2-shot system, which is the standard required by the certificating authorities", and that he was quite satisfied with that.

Mr. Morrison said he shared Mr. Madgwick's views on this matter.

I think the views so expressed are sound and that additional fire extinguishers are not required.

AIRWORTHINESS ACTION TAKEN AS RESULT OF ACCIDENT

Mr. Langford has provided the Inquiry with a report of action progressively taken as a result of the accident to avoid any repetition and the following paragraphs of this report are mainly extracts from Mr. Langford's account.

At a meeting between representatives of Ansett-A.N.A., T.A.A. and Departmental representatives held on Friday 28th October, 1966 it was decided in the light of the evidence of in-flight fire in the port wing of VH-RMI and of reported observations of oil contamination of nacelle and wheel well areas in other Viscount aircraft, that early action should be taken to inspect and, where necessary, clean up all such areas.

On Monday 31st October, 1966, a cable was received from the British Aircraft Corporation recommending that all oil line "banjo" type connections in Godfrey blower installations in Viscount aircraft be checked for tightness and security as soon as possible. Air Navigation Orders were consequently promulgated by teleprint on the same day requiring this to be done, and also calling for the previously agreed inspection and cleaning of nacelle and wheel well areas. These requirements, which carried the compliance statement "before commencement of operations on Wednesday 2nd November, 1966" were applied to Fokker Friendship F. 27 and Grumman Gulfstream G. 159 aircraft as well as to Viscount 700 and 810 series aircraft.

At a meeting on Wednesday 9th November, 1966 technical representatives of the Department, Ansett-A. N. A. and T. A. A. agreed that early action should be taken to reduce the strength of the blower quill shafts in Viscount 810 series aircraft, to provide positive locking of the nuts and studs attaching oil metering units to their blowers, and to replace the "banjo" type connections on the oil supply lines to the metering units, by stronger and more positive type standard pipe connections. It was agreed that the two latter modifications were to be applied to Viscount 700 series, F. 27 and G159 aircraft in addition to Viscount 810 series aircraft.

Confirmatory Air Navigation Orders making these provisions were promulgated by teleprint early on Tuesday 15th November, 1966. In the meantime, action to install weaker quill shafts and positive

locking of the oil metering units on Viscount 810 series aircraft had been proceeding and all affected aircraft were modified before 16th November, 1966, the specified compliance date. Locking of the oil metering units on Viscount 700 series, F.27 and G159 aircraft, was required to be completed not later than 30th November, 1966. Replacement of the oil supply line "banjo" fittings was a more difficult job and the compliance date was eventually negotiated with the operators as 31st March, 1967, to allow time for suitable modifications to be designed and the necessary new parts to be obtained.

Immediate advice of the Australian action was passed by cable to interested parties overseas and, at the same time, a circular letter and paper describing the action in greater detail was despatched to a wide range of addresses in Australia and overseas, including other airworthiness authorities and manufacturing companies.

On 21st November, 1966, further A.N.O.'s were issued by teleprint relevant to Viscount 700 series and F.27 aircraft requiring that the security of the nuts attaching cabin blower oil metering units be checked daily until the requirement for positive locking was complied with. This action resulted from the discovery that a blower removed for modification from a T.A.A. Viscount 700 series aircraft had some loose studs and nuts on the oil metering unit. Although this requirement was only effectively current for nine days, that is the period between its promulgation date and the date for compliance with the requirement for positive locking of nuts and studs on blower oil metering units, notification was also transmitted to various interested parties overseas through the Civil Aviation Liaison Officer, London and the Civil Air Attache, Washington.

On the 6th December 1966, A.N.O.'s required that on a trial basis the dimensions of certain blower drive quill shafts on Viscount 700 series and F.27 aircraft be reduced to a size known to have been released for flight test on another type of Dart-engined aircraft, namely the HS 748. Following several weeks of successful operation, this modification requirement was confirmed for all Viscount 700 series and F.27 cabin blower installations, the final compliance date being 31st January, 1967.

During the first week of February 1967 Air Navigation Orders were distributed relating to the following :

(1) Replacement of fibreglass blower outlet ducts by ducts of more fire-resistant construction;

(2) modifications to improve the general standard of cleanliness of accessory gear box compartments and wheel wells;

(3) introduction of engine fire extinguishers having provision of thermal pressure relief;

(4) introduction of fireproof engine control rods in potentially critical locations in nacelle and wheel well areas.

Compliance requirements were not written into the Orders at that stage, the airline being given a period of some weeks in which to complete designs for the necessary modifications and to evaluate the situation regarding supply of parts and incorporation of modification programmes into the pattern of maintenance operations.

Subsequently an additional modification was introduced to connect the Godfrey supercharger case vents to the existing nacelle drain systems and to inspect and modify where necessary the drip tray installation to ensure adequate drainage.

On the 16th February, 1967 Mr. Madgwick's discovery that a vent plug had been wrongly installed in an Ansett-A. N. A. Viscount 832 aircraft was reported to the Department. An urgent check was required to be carried out on all other blower installations in Australian Viscount aircraft and advice of this action was at the same time passed by cable to interested parties overseas. The inspection was completed on all affected aircraft within 48 hours.

The most important item covered in the modification programme, having regard to the conclusions ultimately reached by the investigation group was the positive locking of the nut and stud assemblies attaching the cabin blower oil metering units. Action was completed on all Australian Viscount 810 series aircraft by the 16th November, 1966 and on all Australian Viscount 700 series, Fokker F.27 and Grumman G159 aircraft by 30th November, 1966.

In addition to the matters referred to above, a number of other improvements to the installation are under consideration by the operators and by the Department. These include incorporation of a temperature switch in the casing of the cabin blower and consideration of the appropriate operational procedures which would follow upon indications of cabin blower overheat condition.

The view of B.A.C. apparently is that only one of these modifications is essential in the light of this accident and that is the wire-locking of the oil metering unit nuts and studs. It would seem that its view is that fire in this area can only occur as a result of the oil metering unit backing off and that once this is prevented by wire-locking other precautions become superfluous.

One's attitude in relation to this matter may be affected in some degree by the view one takes as to the course taken by the fire

in the Air Canada occurrence and in VH-RMI. So far as Air Canada is concerned, B.A.C. formed the judgement that the only reason for the internal ignition of the fibreglass ducting downstream of the blower was the existence of a non-standard inlet duct which provided flammable material which passed through the blower. As far as VH-RMI is concerned, the view propounded by certain witnesses, including Mr. Madgwick of B.A.C., was that the fire which started in the blower passed rearwards between the oil metering unit and the blower end cover and then externally to the fibreglass duct.

Mr. Madgwick's view was based on the major premise that the air flow would be from the rotor chamber out through the rear bearing compartment. Mr. Davies of Ansett-A.N.A. thought that the inward path was unlikely because he could not see sufficient air flow there to carry the fire. Mr. Broughton, on the other hand, favoured the view that the fire travelled internally. He provided the Board with a closely reasoned analysis of his approach and said that in his view it was almost an impossibility for the fire to have followed an external path.

Mr. Whalley was less emphatic on the matter and indeed found himself unable to resolve in his mind the actual path of the fire. Among his conclusions was conclusion 14 which reads: "The fire in the No. 2 cabin blower propagated to the port wheel bay. The path of propagation has not been conclusively established but the possibilities that the fire travelled through the blower outlet duct and then ignited the fibreglass duct or entered the nacelle area directly from the exposed bearing housing are both tenable."

Mr. Yeend, in his final conclusions, was unable to accept one view or the other. Among other things he said: "The fire entered the nacelle area either by erupting through the fibreglass section of the air conditioning duct or by passing between the oil metering unit and the blower rear end cover."

In view of the evidence, I think the attitude expounded by Mr. Whalley and Mr. Yeend is to be preferred to the more positive opinion advanced by Mr. Madgwick and Mr. Davies. Once this conclusion is reached one has less confidence in reaching a decision that the wire-locking of the oil metering unit nuts and studs is of itself sufficient precaution. Indeed, having regard to all the material placed before the Board in relation to this very important matter I think the Department of Civil Aviation have acted wisely in adopting the other requirements already referred to.

ALTERATIONS TO FLIGHT OPERATIONAL PROCEDURES

During investigations subsequent to the accident consultation between D.C.A. and the major domestic operators initially suggested three areas in which amendments to the crew operating drills were indicated. The specific drills involved related to pilot action required to be taken in the event of :-

(a) engine fire warning;

(b) airframe anti-icing overheat warning;

(c) air flow failure warning .

Engine Fire Warning - Attention was directed to the need to prevent the anti-icing airflow entering the wing ducting during engine fire warning. On November 14, 1966 the two major domestic operators agreed with D.C.A. to adopt amendments to operating drills which, firstly, strictly limited the use of thermal anti-icing to occasions when icing conditions were imminent or prevailing, and secondly, in the event of an engine fire warning, immediate OFF selection of anti-icing airflow was required. The desirability of allowing pilot discretion in the event of a fire warning during actual anti-icing operations was recognised and included in the amendment.

Airframe Anti-Icing Overheat Warning - Revised procedures to be followed upon the illumination of the airframe anti-icing overheat warning light were adopted in January 1967. One required the shut down of No. 2 or No. 3 engine in the event of the appropriate overheat light illuminating, with both switches in the OFF position. The other dealt with a possible situation arising out of an overheat condition occurring during actual anti-icing operations. This specified after switching OFF the system, the time limitation of one minute for overheat warning to cease; failing which, appropriate propeller feathering action was to be taken. If in either case a warning condition continued after propeller feathering, a descent to the nearest suitable aerodrome was prescribed. Both drills called attention to the possibility of fire in the engine accessory section.

Airflow Failure Warning - New emphasis was placed on the three airflow failure warning lights which had previously been regarded as not being of major significance.

Procedures for Viscount 810 aircraft made effective in January 1967 required the feathering of the propeller of an engine whose blower

gave airflow failure indication other than those indications normally expected below 12,000 feet altitude. The 700 series Viscount also received consideration, and suitable drills based on the same philosophy were devised, having regard to manual spill valve operation.

The operators were developing a blower rear end casing temperature probe with a flight deck light indication. At a meeting between D.C.A. and the operators early in June 1967, as progress had been achieved in the fitment of a blower overheat warning system to Viscount 810 aircraft, appropriate drills were introduced.

The Department further indicated that in future all spill valves would need to be selected to "Auto" in the Viscount 810 aircraft prior to take-off. This required changes in the procedure being used by Ansett-A.N.A. This operator was using an optional procedure whereby only one spill valve was selected to "Auto" prior to take-off and the other two spill valves were moved to "Auto" shortly after take-off. This operator is now selecting all spill valves to "Auto" prior to take-off and progressively incorporating the consequent modification to its Viscount 832 aircraft to locate the intercool valve position indicator and control in the cockpit.

Further operational and technical review of the amendments made to the operating drills showed that the requirement to close down the engine and feather the propeller following the illumination of an airflow failure warning light had led to a large number of propeller featherings.

In view of this trend D.C.A. formed a committee consisting of airworthiness and operational representatives of the airline and the Department to make a further overall review of Viscount operating drills in the light of the various modifications and changes in procedures which had been progressively introduced since the accident.

Recommendations of this committee which were adopted in August 1967 by the Department and the operators, amended the operating procedures to have regard for the information which a pilot would be able to derive from the cabin compressor overheat warning system. Basically, the introduction of this system permitted a reduction in the number of occasions requiring an engine to be feathered when an airflow failure warning light was illuminated.

I understand the Committee still has these matters under review.

MODIFICATIONS TO BLOWER BY ANSETT-A. N.A.

The evidence revealed that some modifications were made to the blowers during overhaul by Ansett-A.N.A. which may be criticised upon the basis that they were carried out without proper authorisation. There is no suggestion that they in any way affected safety. The modifications were :

1. An increase in the rotor rear end clearances.

Mr. H.W. Davies, as a result of his experience of blower failures handled in Ansett-A.N.A. overhaul workshop, formed the view in 1965 that such failures might be reduced in number without loss of efficiency by increasing the rotor rear end clearances. He obtained verbal approval for his suggestion from Mr. Bibo, the Technical Manager of Ansett-A.N.A. and informed Mr. Syres of Godfrey Australia of his idea. Mr. Bibo authorised a trial adoption of the alteration before the issue of an engineering release. After trial the practice was continued but no formal engineering release was in fact issued.

In the meantime, Godfrey's U.K. developed a similar idea and a modification proposal was circulated in February 1966 and an optional modification was issued in July 1966 but not received by Ansett-A.N.A. until May 1967.

The position therefore is that at the time of the disaster the modification made by Ansett-A.N.A. substantially accorded with that properly authorised by Godfrey U.K.'s modification although Ansett-A.N.A. had not at that time knowledge of that modification.

2. A groove or passage was cut on the inner face of the end cover of the metering unit.

This course was adopted by Mr.Davies shortly after Ansett-A.N.A. commenced the overhaul of blowers. Mr. Davies said the alteration was designed to give an improved flow of oil from the metering unit. He did not seek or obtain the approval of Mr. Bibo and Godfreys were not consulted. Mr. Salter of Godfreys, in the course of his evidence was of the opinion that the alteration was not harmful in any way but he regarded it as undesirable.

A proper engineering release for the alteration was signed on 22nd February, 1967.

3. The torque loading applied to the nuts attaching the metering unit to the cabin blower was decreased from 36 inch lb. to 30 inch lb.

The reason for the alteration was that 2BA studs were found to be stretched and the threads distorted through being overtightened. This again was an alteration made by Mr. Davies without any consultation with Mr. Bibo. There was no engineering release. Mr. Davies did not seek one treating the matter as one of normal workshop procedure. There is no suggestion that the studs were not adequately locked at the lower figure or that the alteration had any significance in relation to the accident.

4. The use of shims to axially position the rotors correctly.

This practice was commenced early in 1964 by Mr. Davies. Its adoption was not referred to Mr. Bibo and no engineering release was obtained until 26th April 1967. Mr. Davies considered the matter one of normal workshop procedure not requiring a release.

Mr. Davies thus caused modifications to be made on his own responsibility. This was quite unnecessary and indeed under the practice operating in the overhaul workshop at the time, he should have referred these for approval of the Technical Department of Ansett-A.N.A.

Evidence has been placed before the Board that Ansett-A.N.A. have now instituted a system whereby technical information requests go through the Planning Department who are responsible for processing these requests and ensuring that authorised engineering decisions are given.

VOICE RECORDER

Valuable information in relation to the accident would doubtless have been provided if a voice recorder had been installed in the aircraft on the day of the fatality, and survived the crash. Subsequent to the report of the Board of Inquiry appointed in 1960 to enquire into the loss of Fokker Friendship F. 27 aircraft VH-TFB instruments of this description were installed in about 1963 in regular public transport aircraft in Australia. This followed a recommendation of that Board of Inquiry.

The instrument is one which records cockpit conversation and also all in-bound and out-bound communications to and from the aircraft. The instruments installed in Australian aircraft are manufact-

ured in the United States of America and it seems that the installation of such instruments has only been required in the United States and Australia. The instrument chosen for use in Australia differed from the one used in the United States in that it provided a record of a conversation for a period of one hour, whereas the American model recorded the conversations for 30 minutes.

The performance of the recorders both here and in the United States has not been wholly satisfactory, and in view of the difficulties encountered steps were taken in 1966 to have the recorders returned to America for modification. It was unfortunately during the period that the recorders were absent from aircraft in Australia that the accident occurred.

The recorders have since been returned from the United States and are now installed in aircraft in Australia.

It is unnecessary to emphasise the valuable character of these instruments and it is to be hoped that the modified recorders now installed will prove satisfactory. If not the Board is strongly of the opinion that every effort should be made to obtain satisfactory recorders.

D.C.A. ACCIDENT INVESTIGATION REPORTS

The work of the D.C.A. Accident Investigation Group, particularly as documented in the two-volume published report provided the Board with an excellent starting point for its Inquiry and the officers concerned are to be commended for the manner in which the information was presented. From time to time, however, during examination of evidence it was felt that some aspects arose on which comment should be made.

A special factor in this accident was the importance of technical evidence, particularly following fairly early and positive indication of fire originating from a mechanical failure of the Godfrey blower driven by the No. 2 engine.

Defect analysis of this component and close examination of the evidence and propositions brought forward to explain the process of failure would have been assisted if a more precise strip examination record had been made on dis-assembly of the blower. Recollections of events by witnesses some months after their occurrence are often imprecise.

The Board suggests that, as a minimum in dis-assembly of major mechanical components, a log of strip operations be made out at the time, recording particularly the condition and breaking torque of fastenings. The recording of such details might have readily disposed of the question, for instance, as to whether or not the screws retaining the extractor seal shell were in fact properly tightened.

This procedure should supplement any photographic records made. In making this suggestion the Board is aware that the condition of mechanical assemblies after impact will often determine an ad hoc approach to the dis-assembly procedure to be followed but urges that the fullest possible written record be made on each occasion.

In respect of investigation notes and log records, including meetings and telephone discussions, precision is desirable in dating, and authorship should be clear. In formal reports and records submitted to the Board there was sometimes a lack of identity of the documents. Such documents should be clear as to their authorship and date to assist in examination of the evidence.

SUMMARY OF PRINCIPAL CONCLUSIONS

1. At approximately 1303 hours Eastern Standard Time on 22nd September 1966 Viscount 832 Type aircraft VH-RMI operated by Ansett Transport Industries (Operations) Pty. Ltd. (trading as Ansett-A.N.A.) experienced a structural failure in flight and struck the ground about $13\frac{1}{2}$ miles on a bearing of 260^{o} magnetic from Winton Aerodrome in the State of Queensland.

2. The aircraft was totally destroyed.

3. At the time of the accident the aircraft was engaged on a regular public transport service from Mt. Isa to Brisbane via Longreach. The service was authorised by an Airline Licence issued to the operator and the flight was designated as Flight 149.

4. The aircraft carried a crew of four and twenty passengers, all of whom were lost as a result of the accident.

5. At the time of the accident the aircraft was proceeding to make an emergency landing at Winton Aerodrome following an emergency descent en route.

6. The forecast weather conditions and the weather conditions actually existing at the time of the flight were not such as to suggest any unusual or hazardous circumstances and had no bearing on the accident.

7. The aircraft departed from Mt. Isa at 1208 hours Eastern Standard Time.

8. The aircraft was loaded within permissible limits and there is no evidence to suggest that anything relating to the load contributed to the accident.

9. After leaving Mt. Isa the aircraft climbed to its cruising height of approximately 17,500 feet and proceeded at that level with the automatic pilot engaged until about 1247 hours.

10. At about 1247 hours the automatic pilot was disengaged prematurely and this was followed shortly after by a descent described in a message from the aircraft as an emergency descent.

11. Messages from the aircraft show that the emergency was indicated by a fire warning being received in the flight compartment.

12. At 1257 hours the crew reported they had a visible fire in No. 2 engine and that they were tracking to Winton.

13. Appropriate action was taken to prepare the aircraft and passengers for an emergency landing.

14. The crew, both pilots and hostesses, were adequately and properly trained and competent to operate VH-RMI on the 22nd September, 1966.

15. Both pilots held appropriate licences and ratings pertinent to the flight and had met the required medical standards.

16. There is no evidence to suggest that on the day of the flight the pilots were not medically fit to undertake their respective duties.

17. The flight plan was correctly and properly prepared and the quantity of fuel carried was more than adequate for the flight.

18. There is no evidence that the flight crew was aware of any unserviceability of the aircraft or any of its components prior to take-off.

19. The evidence supports a conclusion that Captain Cooper's decision to divert to Winton rather than continue the flight to Longreach was an appropriate one and that he acted properly in following this course rather than electing to make a forced landing.

20. The crash of the aircraft followed the failure in an upward direction of the port wing between No. 1 and No. 2 engines at approximately 1302½ hours Eastern Standard Time when the aircraft was at a height of 3,500 feet to 4,000 feet above ground level.

21. The port wing failed as a result of a weakening of the main spar due to a fire in No. 2 cell of No. 2 fuel tank.

22. The fire originated in the No. 2 cabin blower and travelled through the rear of No. 2 engine nacelle and port wheel bay to the fuel tank.

23. The fire in No. 2 cabin blower was initiated as a result of a rotor break-up, the blower subsequently being driven in an out-of-balance condition by the quill shaft long enough for the metering unit to become separated from the rear end cover by the resulting vibration.

24. The metering unit continued to be driven after separation and lubricating oil continued to be supplied. The driven rotor lost its rear stub shaft location and caused metal-to-metal contact which generated a temperature sufficiently high to ignite the oil in that area.

25. It is not possible on the evidence to determine what was the cause of the rotor break-up.

26. The rotor break-up was not due to incorrect assembly of the extractor seal shell and the ball bearing and its housing at the last overhaul by Ansett-A.N.A..

OBSERVATIONS AND RECOMMENDATIONS

1. The evidence indicates the need for the continuous maintenance of the utmost accuracy in manuals issued by manufacturers of aircraft and components and in sketches and drawings included therein. It has been necessary unfortunately to take note of a number of inadequacies and inaccuracies in the overhaul manual issued by Godfrey U.K. I am satisfied however that disclosures in this Inquiry revealed to Godfrey U.K. the need for improvement in that regard and that steps will be taken by them to ensure accuracy in the future. When changes are made, whether in the text or the sketches and drawings, attention should be drawn explicitly to their purpose and they should be circulated among interested parties with appropriate despatch, having regard to their nature.

It is pertinent to add that adherence to these standards will be of little avail unless organisations using manufacturers manuals ensure that the manuals and revisions are made available to and are closely studied by those who are required to work in accordance therewith. They should first be scrutinized by persons competent to determine their significance and qualified to direct their appropriate

distribution. A check by those responsible for supervision to ensure that such procedures are in fact being maintained in their own organisation would be reassuring to the whole industry.

Reference has already been made to the specific requirement in the United States of America for compliance with a recognised standard for the preparation and amendment procedure for such manuals. The Board feels it timely that consideration be given to adopting such a standard for manufacturer's manuals for future types of regular public transport aircraft on the Australian register. It seems that A.T.A. Specification 100 is a suitable standard to adopt.

2. Where doubt is entertained by responsible representatives of an operator as to the accuracy of any drawing, whether it be an assembly or installation drawing or as to any method or procedure of overhaul or repair, it should be referred to the manufacturer for determination.

3. The safety and airworthiness of aircraft is dependent to a large degree on the maintenance of accurate technical operating records. During the course of the Inquiry it has been necessary to take note of discrepancies and inconsistencies in the records maintained by Ansett-A.N.A. in relation to overhaul, maintenance and inspection procedures. Some errors in technical records can be expected to be disclosed in such a penetrating Inquiry, but the numbers of discrepancies in this case exceeded normal expectancy. I am satisfied that, as a result of disclosures in evidence before the Board, Ansett-A.N.A. have already taken steps to improve the accuracy of their technical records and to provide proper surveillance of those concerned. I feel that a system of random checks might be adopted, including an occasional internal investigation based on an imaginary emergency involving an aircraft selected for this purpose.

4. The evidence in relation to the West Indian incident serves to emphasise the desirability of the utmost consultation between the subsidiaries or agents of manufacturers and their principals in relation to any unique or unusual incident which may be revealed. It is better that too much rather than too little information should be passed on in this way.

5. Particulars of modifications which vary a manufacturer's design of an aircraft component although made in accordance with airworthiness requirements should be notified to the manufacturers of that component.

6. The unusual, unexpected, unique incident or accident, whether the same appears to involve airworthiness or not, will at all times

repay careful scrutiny. This is particularly so where fire is involved. Any such accident or incident should be reported to the manufacturer of the aircraft with sufficient information to enable the manufacturer to assess its significance. Unless a cause of such an event is apparent to the manufacturer, then from whatever source its information is derived it should seek to determine such cause requesting such further information as may be necessary for that purpose. In the case of a vendor component the manufacturer of such component should be notified.

7. It seems desirable that rotors of the Godfrey blower should be balanced at each blower overhaul.

8. In rejecting the extractor seal shell theory as explaining the cause of rotor break-up and the subsequent failure of the cabin blower, the Board is conscious of the fact that no direct evidence points to any specific fault which could be accepted in this case as the primary cause.

While I am satisfied that the modifications already referred to will ensure that the risk of fire in future arising from such a blower failure is negligible, it is felt that further checks on the rotors at overhaul should continue for a period to ascertain, if possible, any indications of incipient cracking of the rotor casting.

The matter of metal fatigue in this part was discussed in evidence but the rotors from the failed blower of VH-RMI were so badly damaged that no metallurgical examination for fatigue indications was possible.

Rotor break-ups do occasionally occur in service and the Board feels that if any broken rotors become available in this way a special effort should be made to examine them closely for indications of fatigue failure.

I do not feel that these examinations should be continued indefinitely. Possibly for a period of about a year might be considered and if at the end of that time no positive failure indications are discovered in the rotor castings this would be additional assurance of their reliability in terms of aircraft safety.

9. It is a matter of the greatest concern that neither the Canadian or British West Indian occurrences of fires in cabin blowers were known in Australia until after the D.C.A. investigation into the loss of VH-RMI had commenced. Both fires caused considerable damage in the Zone 3 area and knowledge of the circumstances may have led to the introduction of modifications which would have precluded the VH-RMI accident.

Fire in an aircraft, whether in the air or on the ground, is an occurrence of the greatest potential danger and it is suggested that occurrences involving fire should at all times be the subject of investigation by appropriate airworthiness authorities and that their conclusions in relation thereto should be widely circulated. The matter appears to the Board to be of such significance as to call for action on the international level.

ACKNOWLEDGEMENTS

The Board has had the advantage of very valuable assistance from Counsel and other representatives of parties who appeared before it and wishes to place on record its keen appreciation of their meritorious contributions to the solution of the difficult problems involved. Our thanks are also due to Mr. G. P. Whitman, the Secretary of the Board, and to Mrs. R. Gill my Associate for the contribution they made to the efficient conduct of the proceedings.

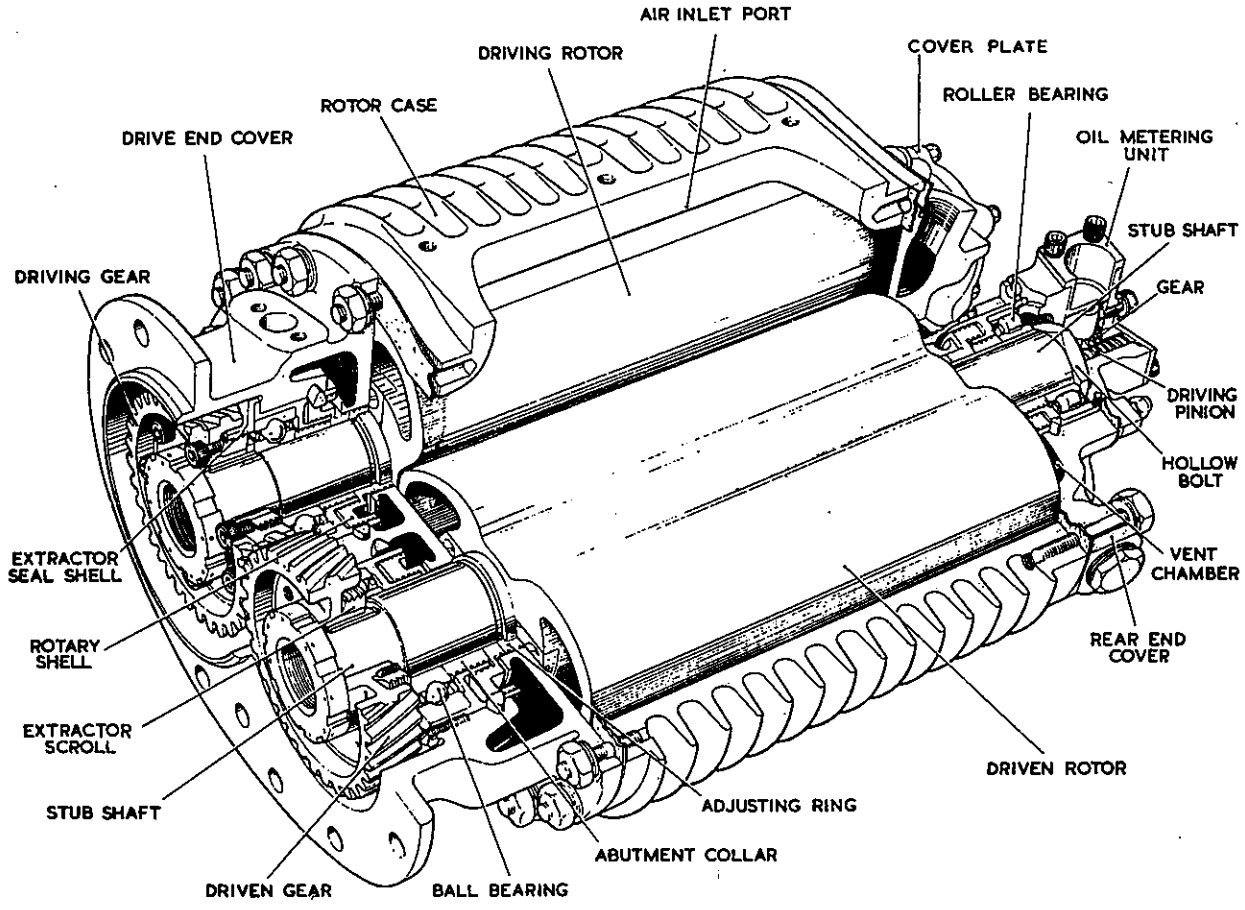
I wish to add my own most sincere thanks to the Assessors for their keen and patient attention to all aspects of the Inquiry and for the invaluable assistance they have at all times rendered to me, both in the course of the Inquiry and in the preparation of this report.

DATED this fourth day of October, 1967.

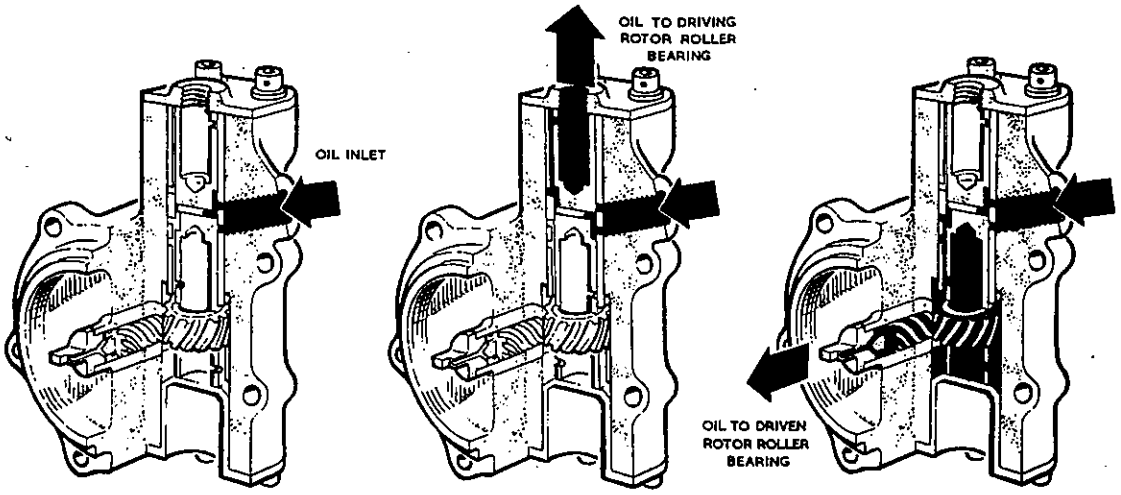
(Signed) J. A. SPICER
CHAIRMAN

We agree with the findings and recommendations of the Chairman.

Signed :	R. J. RITCHIE	ASSESSOR
	THOMAS W. AIR	ASSESSOR
	F. J. BALL	ASSESSOR
	C. S. GRIFFIN	ASSESSOR



Sectioned view of cabin compressor



Sectioned view of oil metering unit