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Civil Aircraft Airworthiness Data Recording Programme Special Events Relating to Airspeed Control and Handling (January 1968 to February 1969)

by

CAADRP Special Events Working Party

(Co-ordinated by G. E. King)

LONDON: HER MAJESTY'S STATIONERY OFFICE

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January 1970

CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAMME

SPECIAL EVENTS RELATING TO AIRSPEED CONTROL AND HANDLING (January 1968 to February 1969)

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SUMMARY

A small number of jet aircraft in normal airline service are fitted with recorders which produce continuous trace records of airworthiness data for 14 parameters. Throughout the recording period the records have been searched for unusual occurrences, and each one has been studied to determine its nature and, where possible, its cause.

This report describes a selection of events relating to airspeed control and handling which were found in records taken between January 1968 and February 1969.

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*Replaces R.A.E. Technical Report 69238 - A.R.C. 32354

CONTENTS

1 INTRODUCTION

The object of the Civil Aircraft Airworthiness Data Recording Programme is a systematic study of the normal operational flight of civil transports. A small number of aircraft in regular airline service are fitted with analogue paper trace recorders which collect data in the form shown in Fig.1. The whole programme is described fully elsewhere[1].

From time to time unusual or extreme events (special events) are noted and this report, being one of a series[2-9], contains a selection of such events relating to airspeed control and handling which occurred to pure jet transport aircraft in scheduled airline operations between January 1968 and February 1969. They are presented in the form of a reproduction* of the original record, together with a description of the event, any relevant supplementary information and comments which represent the opinion of a Working Party comprising members of R.A.E., A.R.B., Computer Instrumentation Data Centre Ltd., and the airlines concerned.

2 NOTE ON SELECTION OF SPECIAL EVENTS

After the photographic record has been developed, it is examined and annotated by the airline concerned. It is then scrutinized by a member of the Working Party for Special Events, and finally examined in detail at the Data Centre during routine analysis. There are thus three stages in which a Special Event may be detected.

It is not possible to lay down a hard and fast guide as to what is regarded as an unusual or extreme event, but the following is a summary of the type of thing which is looked for in the search:-

(a) Normal acceleration increments of about $\pm 1.0g$ or larger in turbulence and about $\pm 0.5g$ or larger for manoeuvres.

(b) Rapid and large changes of height or airspeed.

(c) Excessive application of a control.

(d) Infrequent operational events such as abandoned take offs, missed approaches, engine failures, engine out landings etc.

(e) Unusual oscillations of any of the traces.

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*Definition is necessarily lost in the reproduction of records and comments are based on the original records.

(f) Exceedences of operational limitations such as maximum operating speeds.

Despite the fact that each record is examined at least three times, it is unlikely that every unusual event will be detected; this is particularly true of certain of the operational events such as engine failure. Hence any frequencies derived from these data should be treated with caution.

3 SPECIAL EVENTS

3.1 General comments

Fig.1 shows a sample of normal flight to familiarise the reader with the recorded parameters. The events have been grouped according to flight phase.

3.2 Climb

Five events in this category are shown in Figs.2 to 6 with their respective descriptions (3.2.1. to 3.2.5).

3.3 Descent

Three events in this category are shown in Figs.7 to 9 with their respective descriptions (3.3.1 to 3.3.3).

3.4 Approach

Seven events in this category are shown in Figs.10 to 16 with their respective descriptions (3.4.1 to 3.4.7).

4 CONCLUDING REMARKS

The events described in this report can be divided into four groups:-

(i) Pitch oscillations.

(ii) High rates of descent.

(iii) Height control.

(iv) Airspeed control.

They cannot be described as hazardous situations because corrective action was taken soon enough to avert a possible accident. They do however, represent some of the extremes of behaviour experienced in many hours of normal flying. As such they illustrate the importance of close instrument monitoring, particularly on the approach (rate of descent) and during climb out after aircraft configuration changes (pitch attitude).

(i) The pitch oscillations in Figs.4, 5, 6, 8 and 16 were all initiated by an input such as flap raising or an overshoot, and the new pitch attitude was not accurately maintained. The pitch oscillation in Fig.15 is unusual and may have been caused by a faulty autothrottle.

(ii) The high rates of descent if Figs.10, 11 and 12 were generated after the aircraft were found to be too high on the approach. Although the rates were much higher than recommended and continued to below 500 ft, the recoveries were straightforward and well controlled. The high rate of descent in Fig.9 is emergency descent rate, but as no emergency was reported, the event is largely unexplained.

(iii) The height control events in Figs.2, 3 and 7 were caused by failing to anticipate local height keeping requirements in good time and two of the events involved manoeuvre loads of a magnitude which only occur roughly once in 3000 hours.

(iv) The low airspeed in Fig.13 was probably initiated by wind shear and the one in Fig.14 occurred during localiser/glide slope capture.

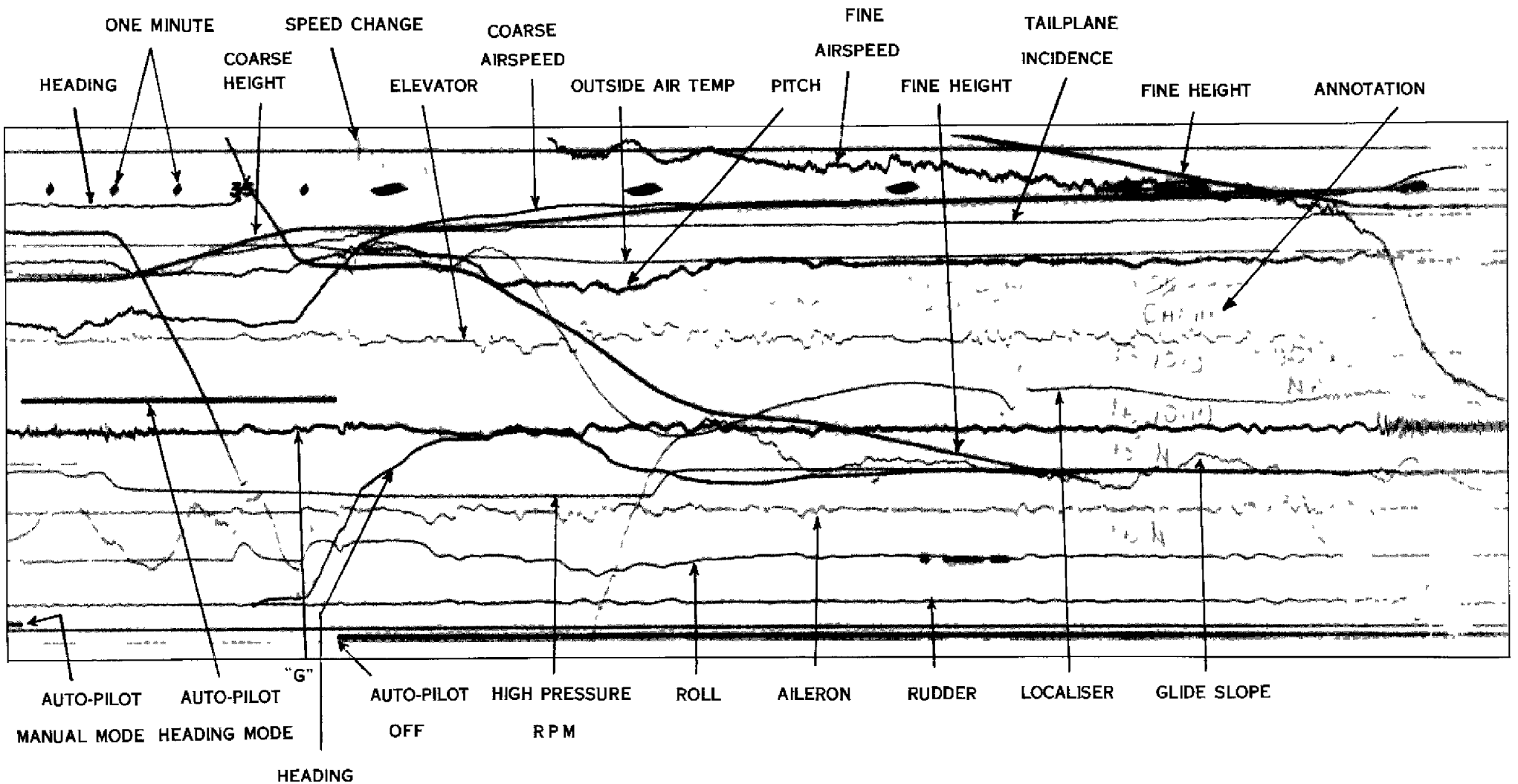

Fig.1. Sample record

3.2.1 Event in flight 20681

Sector: Montreal/Chicago - April 1968

Description

The aircraft climbed out from Montreal to 5500 ft and then descended in light to moderate turbulence with reduced power to 3200 ft before continuing the climb. Power and pitch changes at the resumption of the climb caused the airspeed to oscillate for one cycle between 280 kt and 320 kt before the autopilot was engaged. (See Fig.2.)

Supplementary information

The meteorological conditions for the area were a moderate to strong north westerly airflow (290^{o}/20-30 kt) which was very unstable up to 6000 ft with a stable isothermal layer between 6000 ft and 10000 ft. This was producing 3/8 cumulus with bases at 4000 ft but occasionally 3000 ft with snow showers. Moderate to severe turbulence was forecast.

Comments

The standard instrument departure from Montreal clears to 3500 ft. It appears that this level was flown through and returned to. Turbulence may have contributed to the untidy re-entry into the climb.

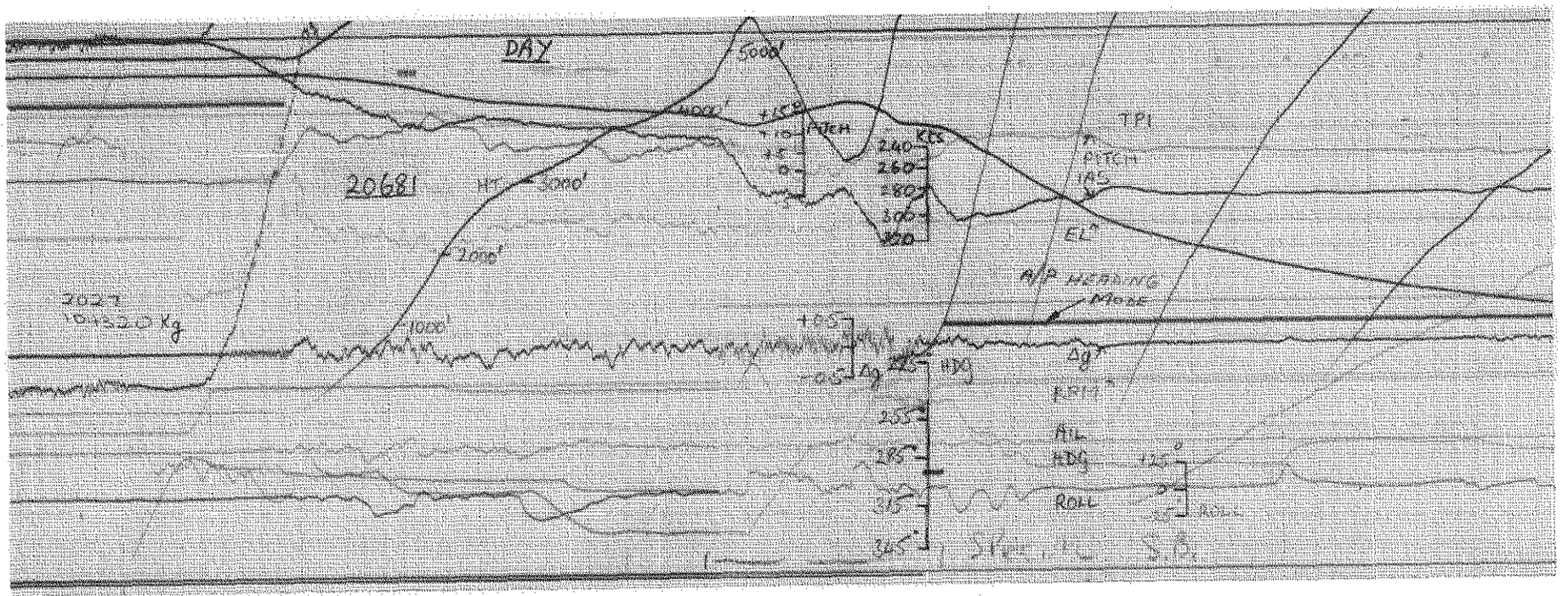

Fig.2. Event in flight 20681

3.2.2 Event in flight 42691

Sector: Birmingham/Glasgow - June 1968

Description

The climb out from Birmingham was interrupted at 2500 ft when the aircraft descended 200 ft. The climb was re-established by means of a +0.6g increment manoeuvre. (See Fig.3.)

Supplementary information

The weather at Birmingham was as follows:- 17.45 Z wind 200^{o}/14 kt, visibility 15 km slight rain, cloud 3/8 500 ft, 6/8 800 ft, 8/8 4000 ft, cold front progressing easterly.

Comment

The initial clearance out of Birmingham is usually to 2500 ft.

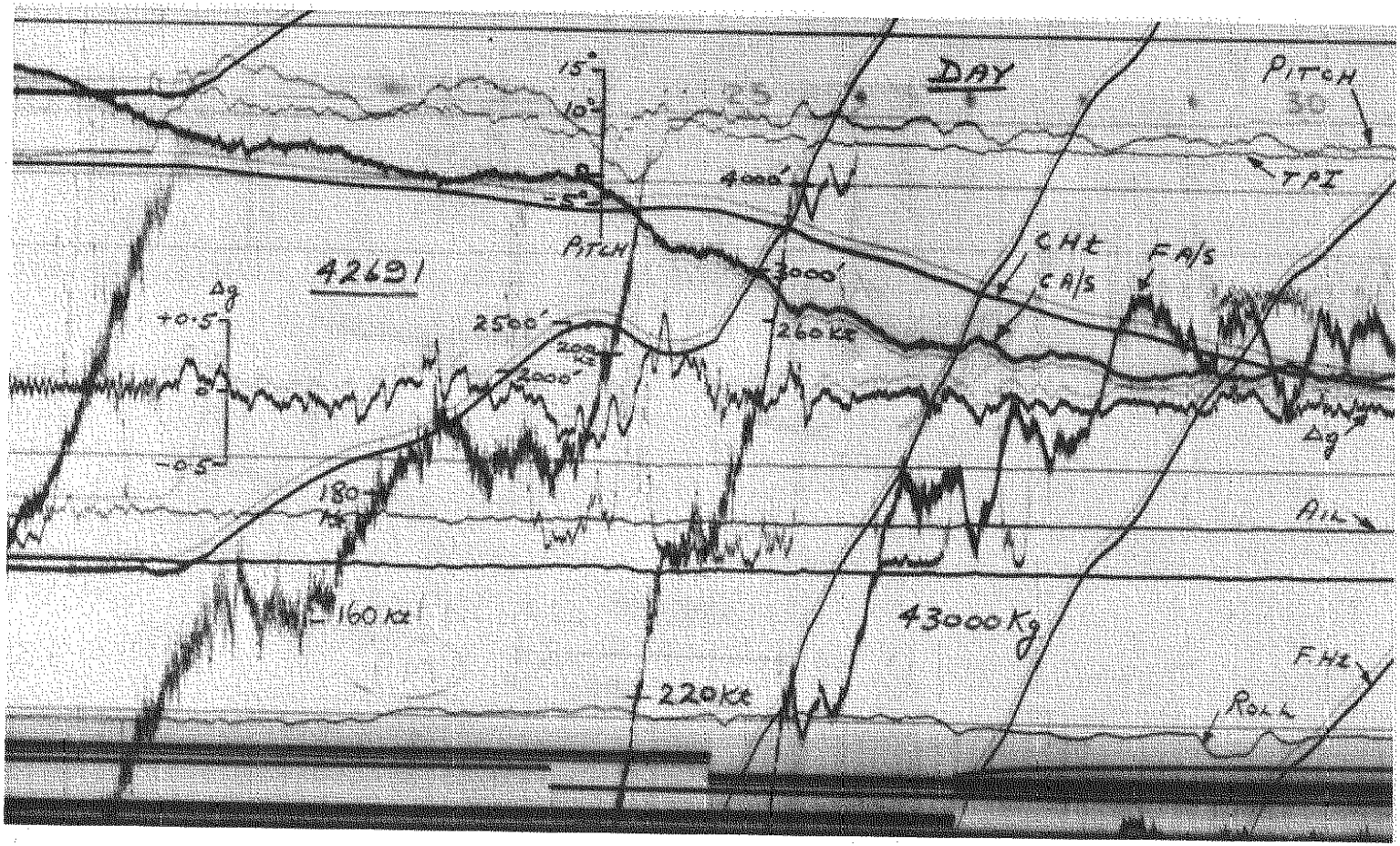

Fig.3. Event in flight 42691

3.2.3 Event in flight 12115

Sector: Boston/London - June 1968

Description

During the climb from 2500 ft to 10000 ft the pitch attitude oscillated between 4^{o} and 11^{o} nose up at 50 seconds period. This caused the airspeed to fluctuate over 20 kt and the rate of climb to vary between 3300 ft/min and zero. (See Fig.4.)

Comment

The oscillation started when the flaps were raised and continued during manual flight until No. 2 autopilot was engaged at about 10000 ft.

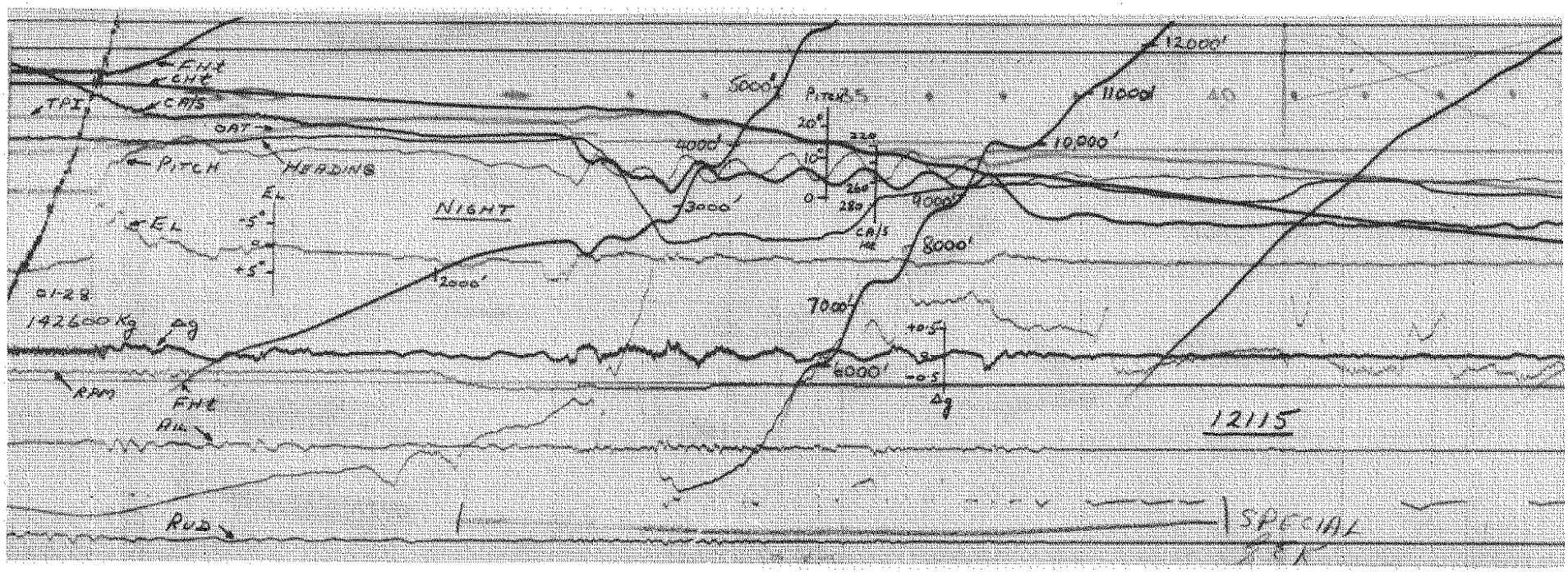

Fig.4. Event in flight 12115

3.2.4 Event in flight 12125

Sector: Boston/London - June 1968

Description

The flaps were raised during the climb at 3000 ft and the airspeed was allowed to build. This was checked by a pitch up manoeuvre which developed into a 50 second period oscillation in pitch, airspeed and rate of climb. (See Fig.5.)

Comment

The oscillation started when the flaps were raised and stopped when No. 1 autopilot was engaged.

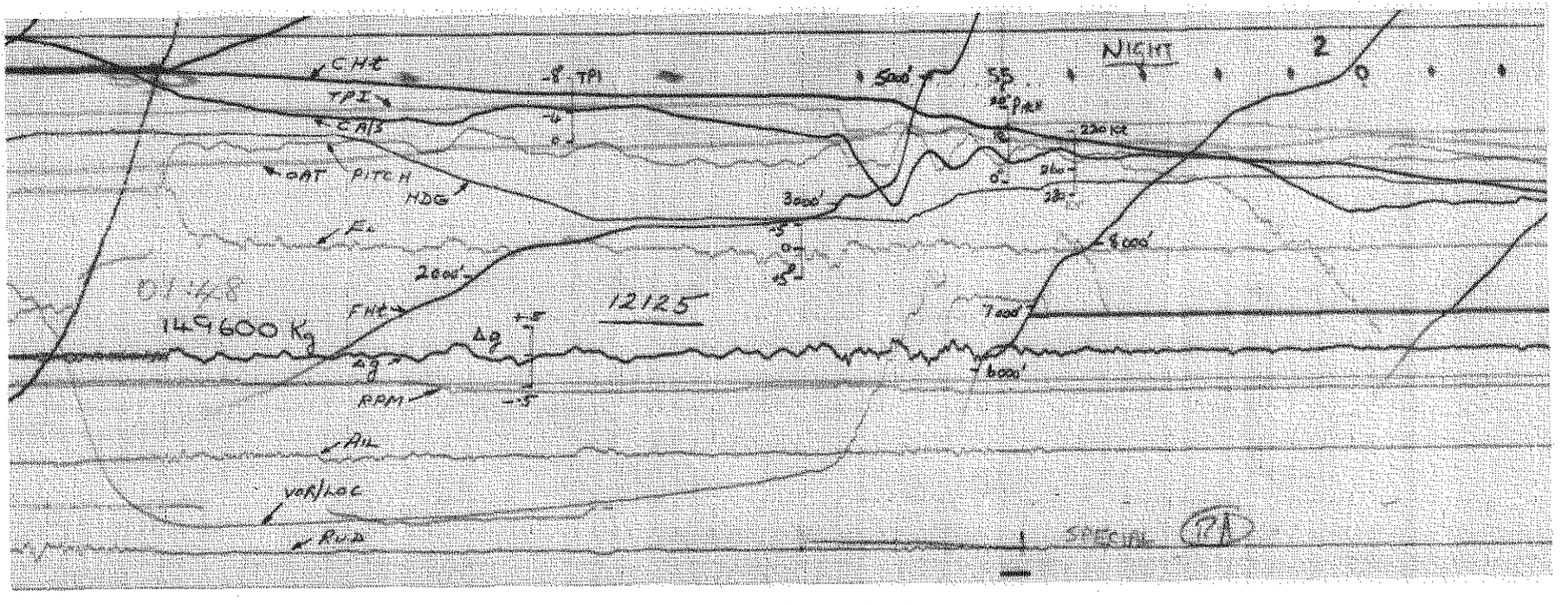

Fig.5. Event in flight 12125

3.2.5 Event in flight 12394

Sector: London/Rome - October 1968

Description

A 70 second period oscillation in pitch was present for most of the climb after the flaps were raised. The pitch attitude varied between 2° and 9° nose up thus producing airspeeds ranging between 280 kt and 300 kt and rates of climb ranging between 4300 ft/min and minus 200 ft/min. (See Fig.6.)

Comment

The longer period of this oscillation compared with those in sections 3.2.3 and 3.2.4 could be produced by a low all up weight at take off; 112000 kg against 143000 kg and 150000 kg. It is also of note that this oscillation was maintained by negligible elevator input.

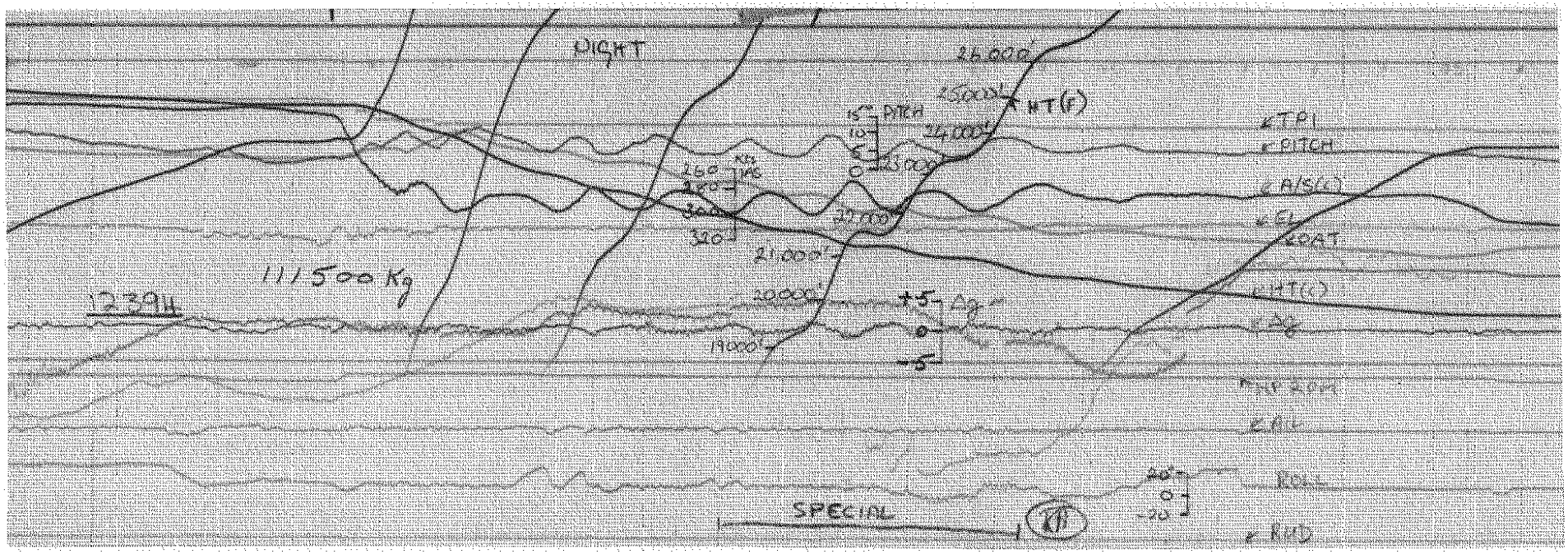

Fig.6. Event in flight 12394

3.3.1 Event in flight 20726

Sector: Caracas/Bogota - April 1968

Description

The descent into Bogota was checked by means of increased power and three manoeuvre acceleration increments of +0.4g, +0.6g and +0.5g which were initiated when 3800 ft above airfield level. The lowest height reached was 3500 ft. (See Fig.7.)

Supplementary information

The weather at Bogota was 220^{o}/03 kt wind, 20 km visibility, 2/8 alto cumulus at 9000 ft, a few fog patches.

Comment

The minimum height above airfield level in this approach area is 3650 ft and the manoeuvres were presumably to avoid descending below this level.

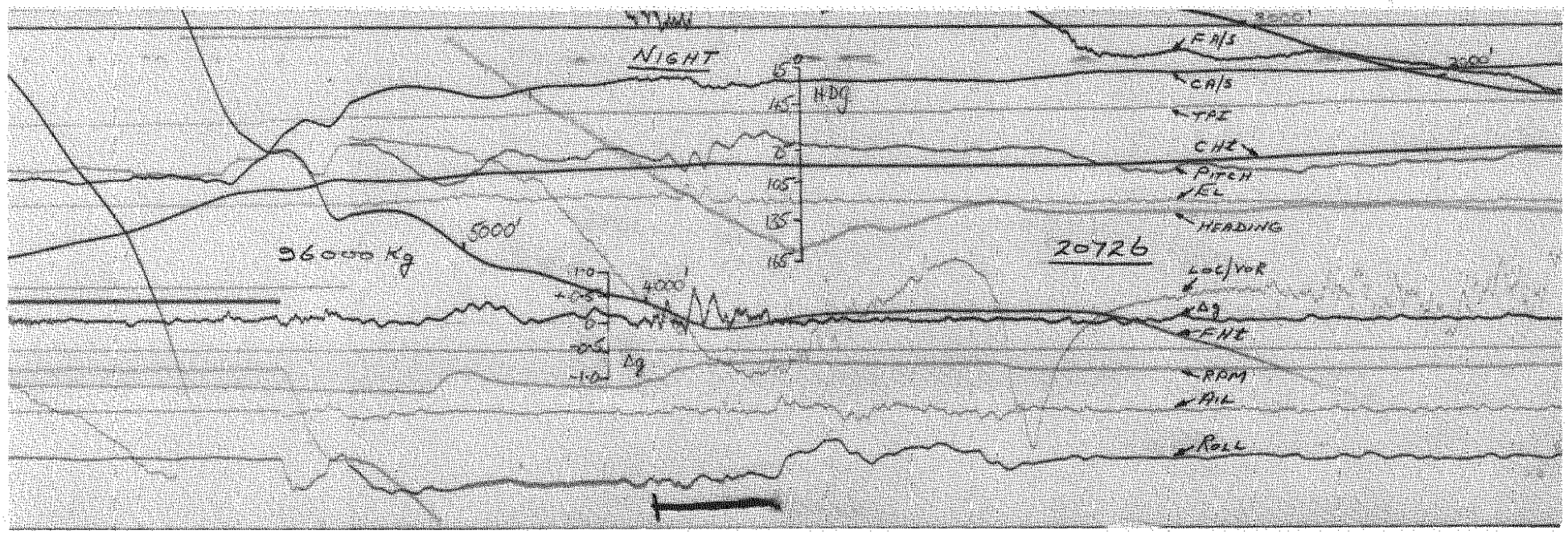

Fig.7. Event in flight 20726

3.3.2 Event in flight 20821

Sector: Trinidad/Trinidad - July 1968

Description

Because of congestion at Caracas, the descent was terminated at 6000 ft and the aircraft returned to Trinidad. The climb out for the return was oscillatory with the airspeed reaching 310 kt and dropping to 245 kt. (See Fig.8.)

Comment

The aircraft was not being flown on attitude as can be seen from the constantly changing pitch and roll angles.

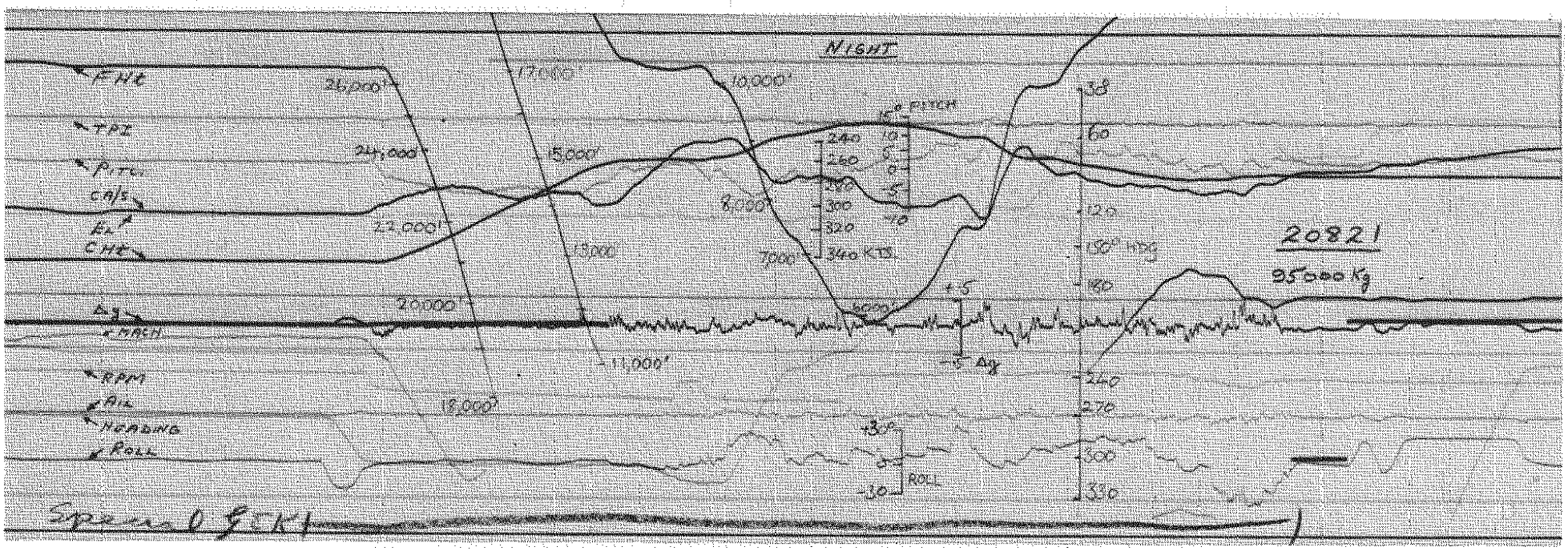

Fig.8. Event in flight 20821

3.3.3 Event in flight 53781

Sector: Zurich/London - December 1968

Description

The descent from 20000 ft was initiated, after the autopilot had been disconnected, by a -0.7g increment manoeuvre and 8900 ft/min rate of descent was maintained down to 9000 ft whereupon the autopilot was re-engaged. Four minutes later the autopilot was disconnected again and an oscillation in pitch at 3 seconds per cycle developed for four cycles. The aircraft then entered a turn where the maximum angle of bank was 50°. (See Fig.9.)

Comment

No information is available for this event, but as there is no entry in the aircraft log it was apparently not an emergency descent. The large bank angle was applied when the localiser signal went through zero.

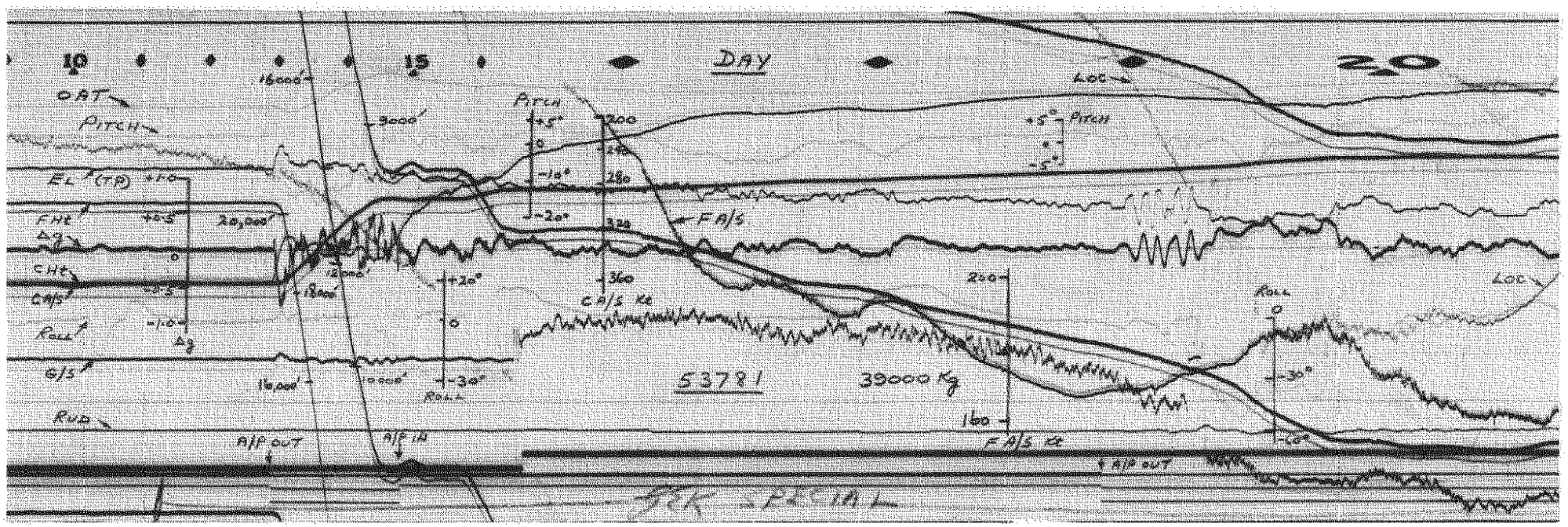

Fig.9. Event in flight 53781

3.4.1 Event in flight 12139

Sector: Zurich/London - June 1968

Description

During the approach into London, which was autopilot coupled, the rate of descent built up to 2000 ft/min at 1700 ft and continued at this rate for 37 seconds down to 500 ft. (See Fig.10.).

Supplementary information

The weather at London was as follows:-

0815 Z wind 360°/09 kt, visibility 5 km cloud 3/8 at 400 ft 8/8 at 600 ft

0845 Z wind 350°/10 kt, visibility 6 km cloud 2/2 at 400 ft 8/8 at 700 ft

The time of the event was 0829 Z.

Comment

The aircraft was 750 ft high at the outer marker and the high rate of descent was generated by the autopilot trying to capture the glide slope from above. The manual recovery was well controlled.

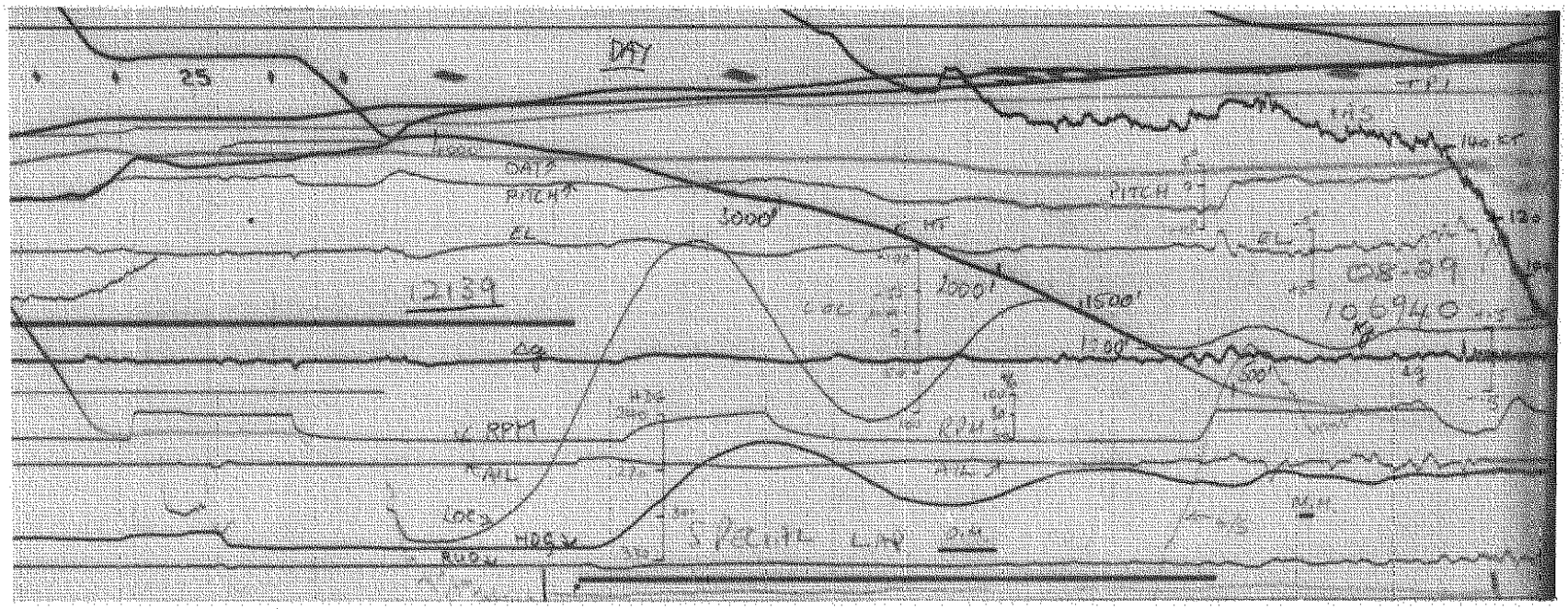

Fig.10. Event in flight 12139

3.4.2 *Event in flight 20899*

Sector: Dharan/Bahrain - August 1968

Description

During a manual approach into Bahrain, the rate of descent reached 1500 ft/min over a period of one minute. Power was applied at 600 ft and the rate of descent reduced progressively to touchdown. (See Fig.11.)

Supplementary information

The weather at Bahrain was as follows:-

wind 130°/3 kt, visibility 9 miles, no cloud.

Comment

This was a night approach over featureless terrain.

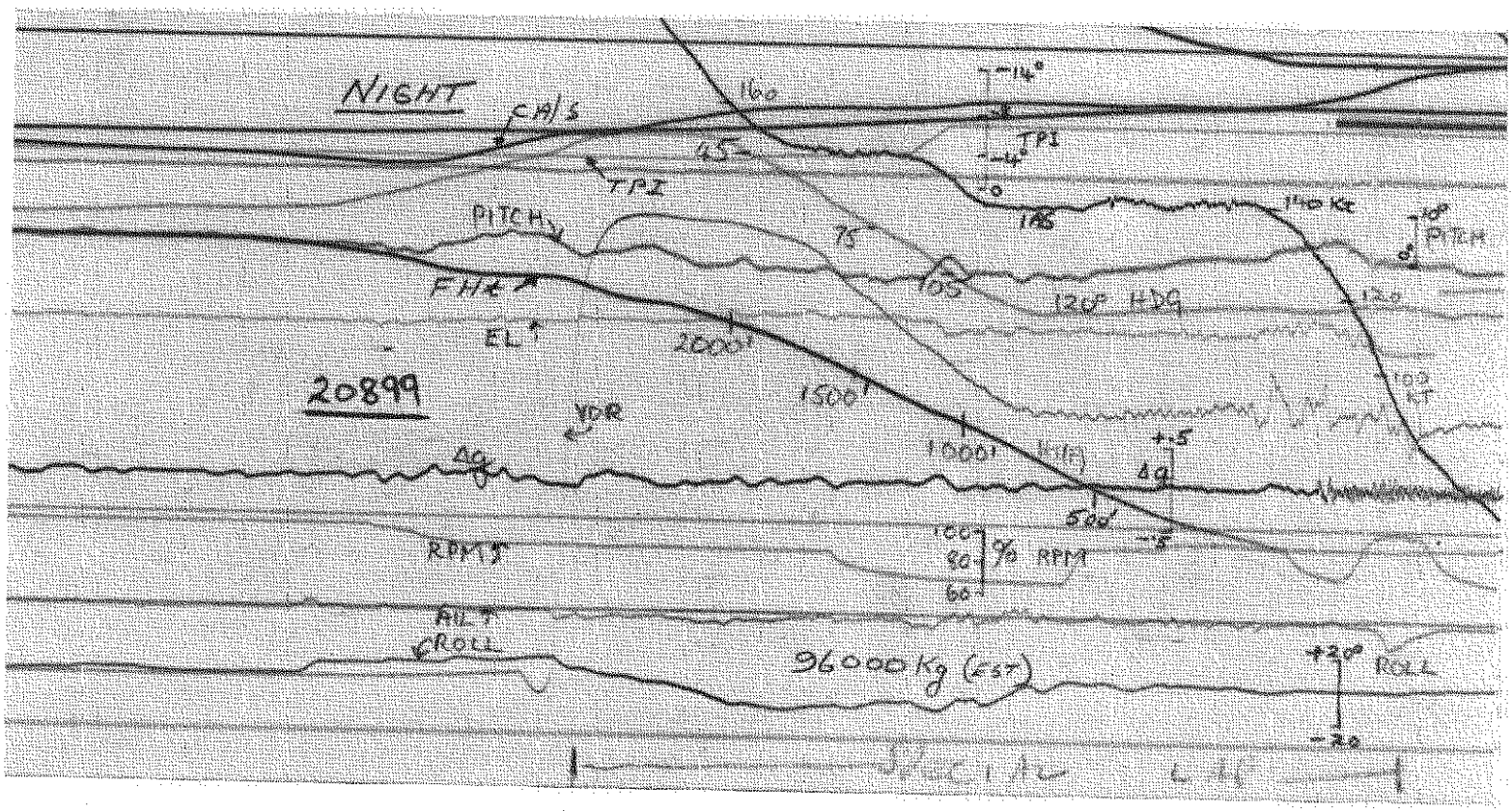

Fig.11. Event in flight 20899

3.4.3 Event in flight 53992

Sector: Manchester/Dusseldorf - February 1969

Description

At 1000 ft during the approach the rate of descent built up to 2300 ft/min and was maintained down to 350 ft above airfield level. (See Fig.12.)

Comment

The aircraft had flown through the glide slope beam with the autopilot engaged and was therefore above the correct approach path. The autopilot was disconnected at 2000 ft and the aircraft was flown manually thereafter.

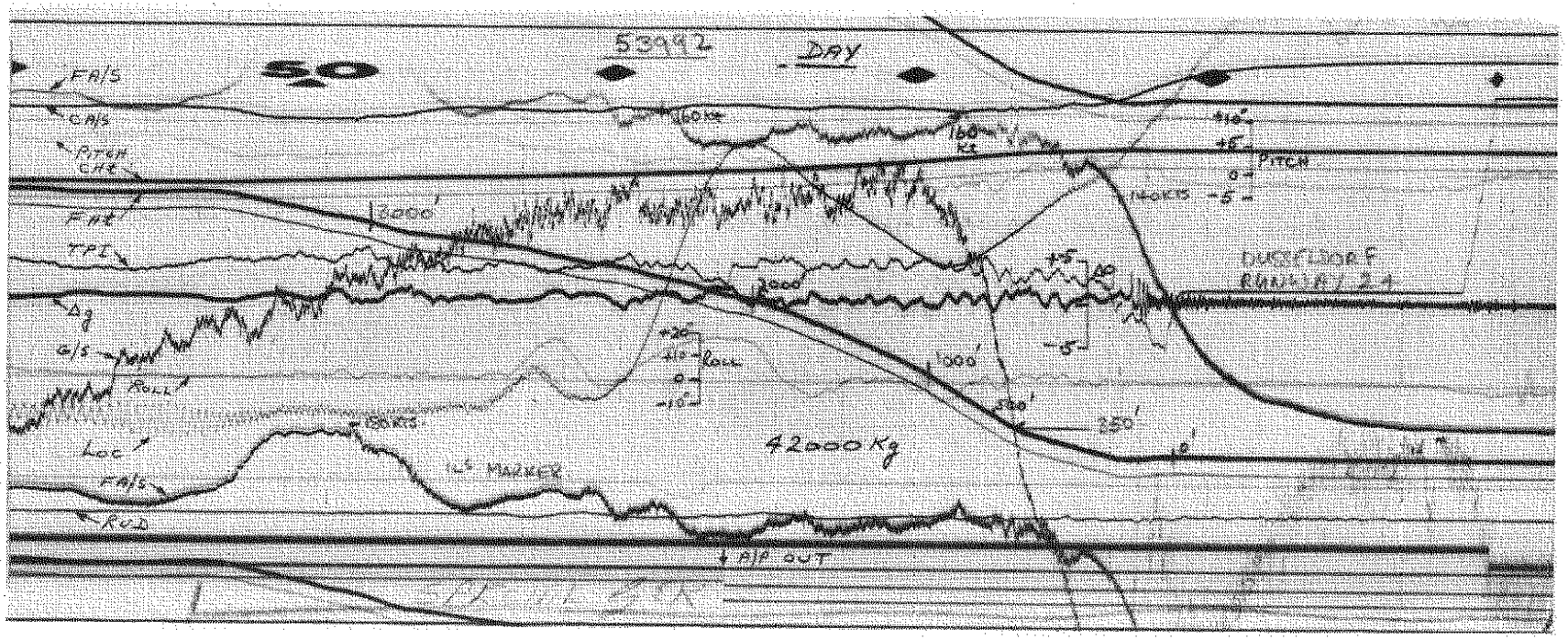

Fig.12. Event in flight 53992

3.4.4 Event in flight 20795

Sector: Kingston/Montego Bay - July 1968

Description

During the approach there were large variations in indicated airspeed. (See Fig.13.)

Supplementary information

The weather at Montego Bay was as follows:-

wind calm, visibility 10 nm, cloud 2/8 strato-cumulus at 2500 ft.

Comment

The Captain was monitoring a relatively inexperienced second pilot. However there is an almost instantaneous 10 kt increase in airspeed after the lowest value, which suggests that wind shear may have contributed significantly to the speed variations.

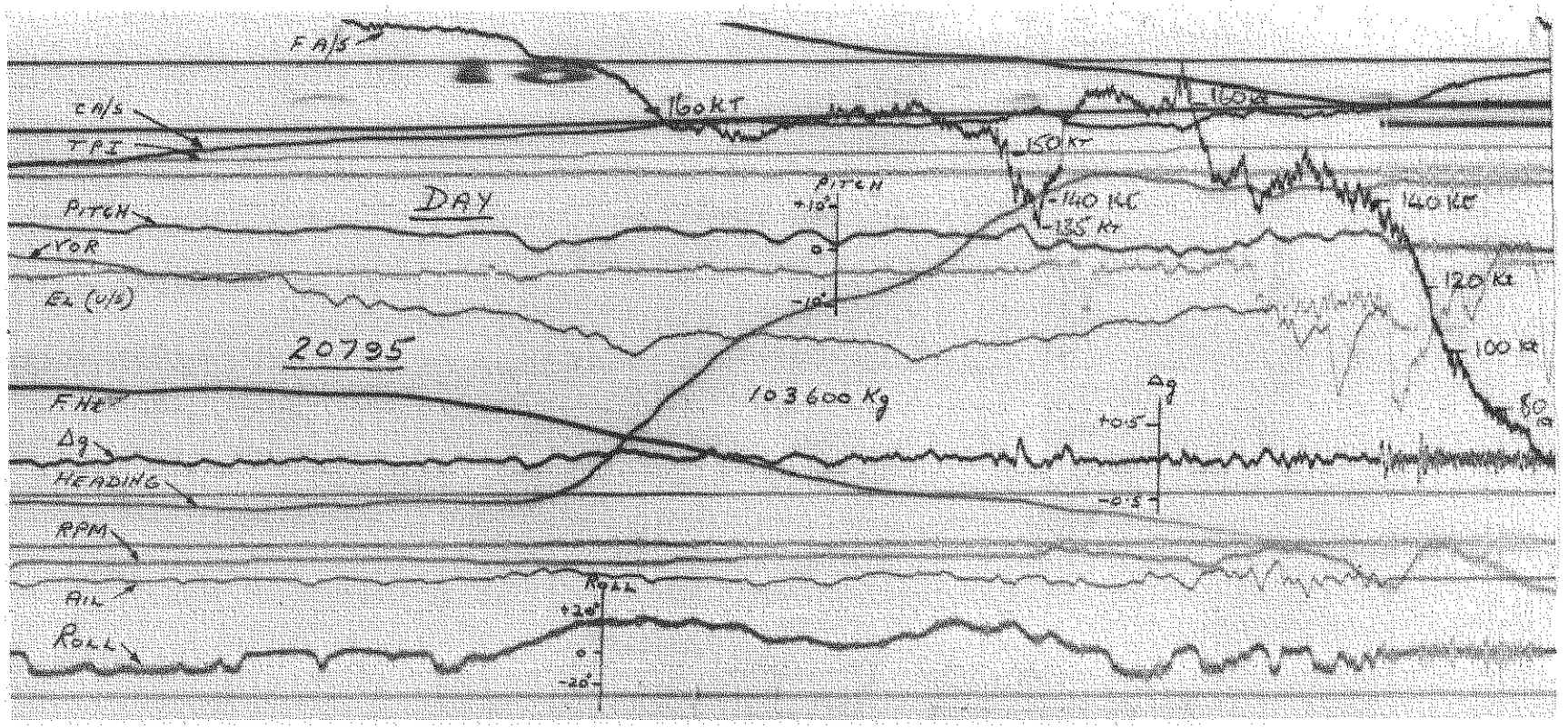

Fig.13. Event in flight 20795

3.4.5 Event in flight 53517

Sector: London/Paris (Orly) - October 1968

Description

During the approach at 2500 ft the airspeed fell to 135 kt (threshold speed 137 kt) and the runway centre-line was not attained until a half minute before touchdown. (See Fig.14.)

Supplementary information

The weather at Paris (Le Bourget) was as follows:-

wind 045°/5 kt, visibility 5 km, cloud 8/8 at 2500 ft. The aircraft landed on runway 07.

Comment

The lowest airspeed occurred during localiser/glide slope beam capture with the autopilot in. Approach to this runway calls for beam joining from above and the low airspeed may have been caused by the awkwardness of this manoeuvre.

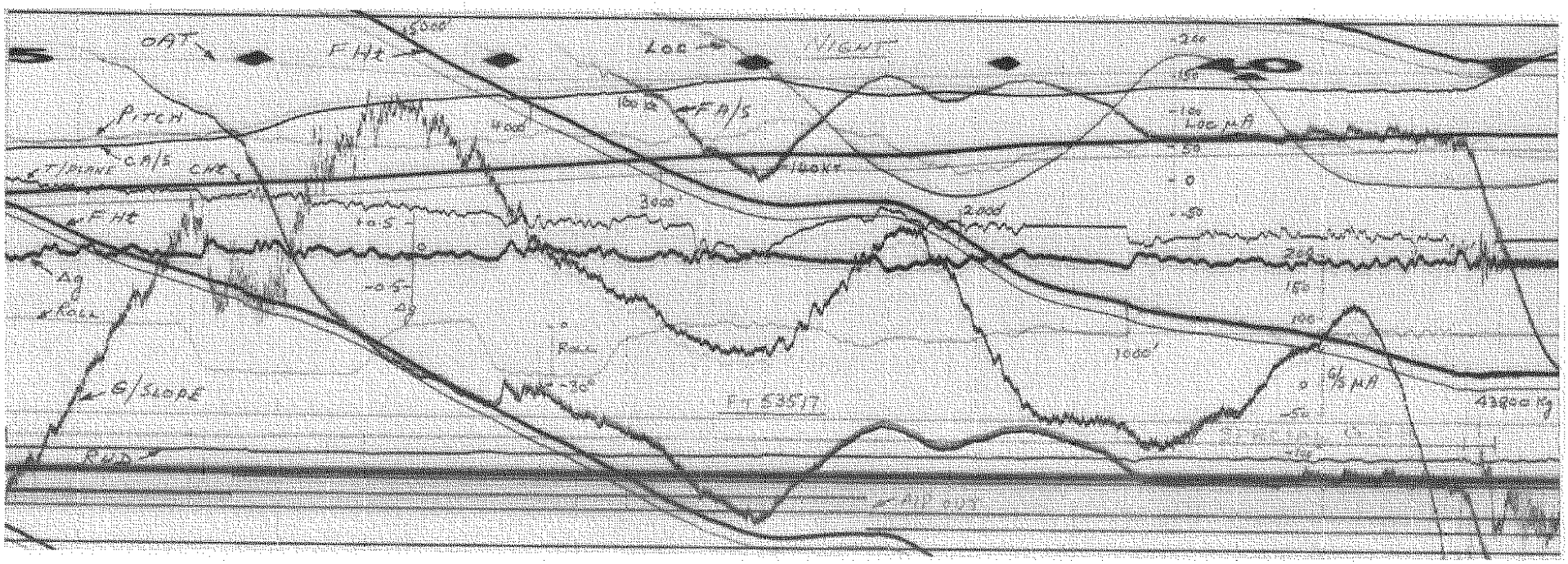

Fig.14. Event in flight 53517

3.4.6 Event in flight 53741

Sector: Cologne/London - December 1968

Description

A pitch oscillation at 15 seconds period was present during the whole of the approach which was flown manually. (See Fig.15.)

Comment

The oscillation may have been caused by a faulty autothrottle, but there is insufficient information to make a positive identification of the cause.

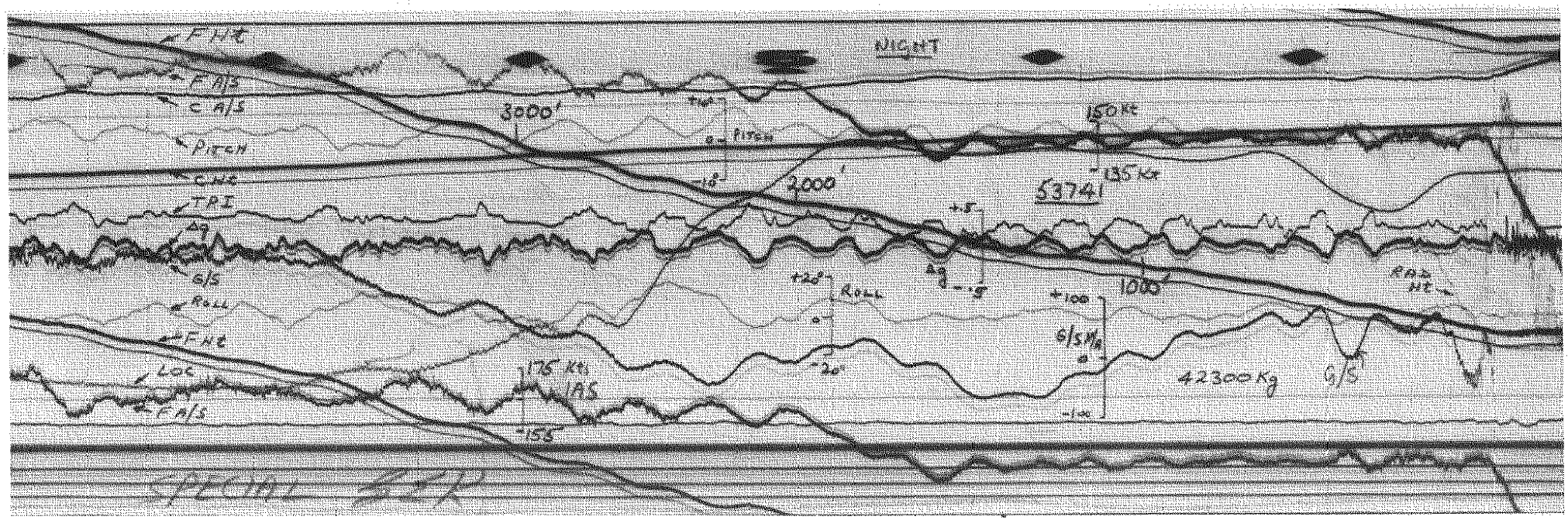

Fig.15. Event in flight 53741

3.4.7 Event in flight 21084

Sector: Gatwick/London - February 1969

Description

An overshoot was initiated at 500 ft and the subsequent climb was oscillatory with the pitch attitude varying between 1^{o} and 12^{o} nose up. (See Fig.16.)

Supplementary information

The weather at London was as follows:-

15.50 Z wind 200^{o}/18 kt, visibility 4 km rain, cloud 3/8 300 ft, 7/8 400 ft, overcast 5000 ft.

The Flight Manual states for an overshoot:-

Apply maximum continuous power and rotate the aircraft to 5^{o} nose up.

Select flaps to TO/20^{o} and as they retract progressively increase the nose up attitude to 8^{o}.

Retract the landing gear and maintain 8^{o} attitude to 180 kt ias.

Comment

The Flight Manual stresses the need for accurate control of attitude but in this case less attention appears to have been paid to the attitude indicator than to other instruments.

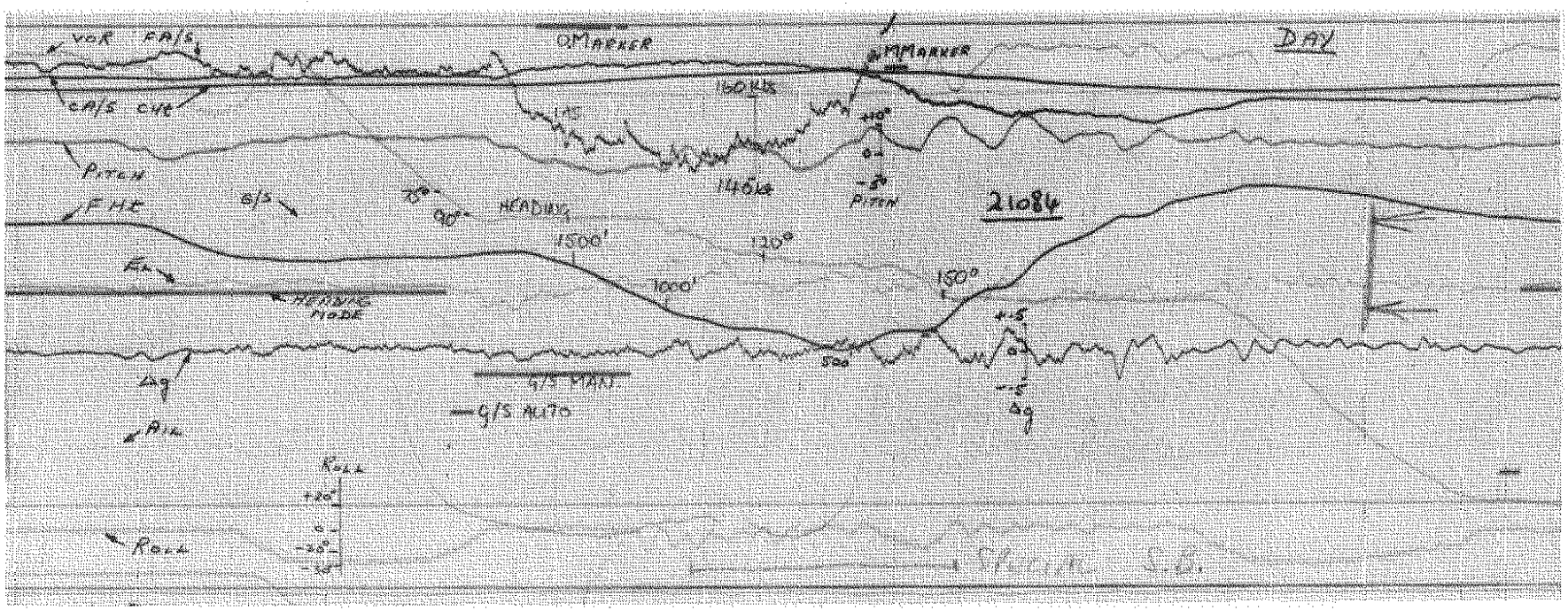

Fig.16. Event in flight 21084

REFERENCES

No.	Author(s)	Title, etc.
1	The CAADRP Technical Panel	The civil aircraft airworthiness data recording programme. R.A.E. Technical Report 64004, (A.R.C. 26490) (1964)
2	The CAADRP Special Events Working Party	Special events of an operational nature. (February 1964 to December 1964) R.A.E. Technical Report 65242, (A.R.C. 27823) (1965)
3	The CAADRP Special Events Working Party	Special events of meteorological origin. (November 1963 to December 1964) R.A.E. Technical Report 65243, (A.R.C. 27780) (1965)
4	The CAADRP Special Events Working Party (Co-ordinated by G. E. King)	Special events of meteorological origin. (January 1965 to December 1965) R.A.E. Technical Report 67071, (A.R.C. 29659) (1967)
5	The CAADRP Special Events Working Party (Co-ordinated by A. C. G. Seal, Air Registration Board)	Special events relating to autopilot induced control disturbances. (May 1963 to December 1965) R.A.E. Technical Report 67157 (1967)
6	The CAADRP Special Events Working Party (Co-ordinated by G. E. King)	Special events relating to airspeed control and handling. (February 1966 to December 1967) R.A.E. Technical Report 68195, (A.R.C. 31068) (1968)
7	Air Registration Board	Civil aircraft airworthiness data recording programme; 'Special events' - missed approaches. (February 1963 to July 1967) ARB Technical Note No.93

REFERENCES (Contd)

No.	Author(s)	Title, etc.
8	The CAADRP Special Events Working Party (Co-ordinated by A. W. Cardrick and K. D. Mephan)	Special events related to airspeed control practices. (February 1963 to February 1966) R.A.E. Technical Report 69113, (A.R.C. 31672) (1969)
9	The CAADRP Special Events Working Party (Co-ordinated by A. W. Cardrick and K. D. Mephan)	Special events relating to handling and control. (January 1963 to February 1966) R.A.E. Technical Report 69023, (A.R.C. 31460) (1969)

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629.13.053.3 :
629.13.075 :
629.13.074 :
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