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RESEARCH MEMORANDUM

for the

Air Materiel Command, U.S. Air Force

PRELIMINARY PERFORMANCE DATA ON GENERAL ELECTRIC INTEGRATED ELECTRONIC CONTROL OPERATING ON J47 RX1-3 TURBOJET ENGINE IN NACA ALTITUDE WIND TUNNEL

By Darnold Blivas and Burt L. Taylor, III

Lewis Flight Propulsion Laboratory
Cleveland, Ohio

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

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PRELIMINARY PERFORMANCE DATA ON GENERAL ELECTRIC INTEGRATED ELECTRONIC CONTROL OPERATING ON J47 RX1-3 TURBOJET ENGINE IN NACA ALTITUDE WIND TUNNEL

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SUMMARY

Performance data obtained with recording oscillographs are presented to show the transient response of the General Electric Integrated Electronic Control operating on the J47 RX1-3 turbojet engine over a range of altitudes from 10,000 to 45,000 feet and at ram pressure ratios of 1.03 and 1.4. These data represent the performance of the final control configuration developed after an investigation of the engine transient behavior in the NACA altitude wind tunnel. Oscillograph traces of controlled accelerations (throttle bursts), controlled decelerations (throttle chops), and controlled altitude starts are presented.

INTRODUCTION

An investigation of a General Electric Integrated Electronic Control on a J47 turbojet engine in the NACA altitude wind tunnel was undertaken at the NACA Lewis laboratory at the request of the Air Materiel Command to determine the following:

1. Steady-state and transient characteristics of the engine operating with and without reheat over a range of altitudes and flight speeds

2. Operation of the integrated electronic control

3. The nature of the fundamental revisions of the control configuration required to obtain optimum controlled response.

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Results of the preliminary operation of the controlled engine indicated that modifications of the control were essential in order to obtain satisfactory performance at altitude. An analysis was therefore conducted on the NACA electronic analog computor. The results of this analysis indicated changes that could be made to various control circuits to improve engine operation. The modifications that could be readily incorporated into the control were made and evaluated by determining the performance of the controlled engine.

The purpose of this report is to present data showing the operation of the control configuration with the incorporated modifications. These data were obtained on June 14-15, 1950 and are presented in the form of oscillograph records of the primary engine and control variables during transient conditions of operation. Data presented include controlled-altitude starts and responses of both engine and afterburner to burst and chops of the thrust-selector throttle.

APPARATUS

Engine type. - Gas turbine J47 RX1-3 with a variable area exhaust nozzle

Control. - General Electric Integrated Electronic Control Configuration Number 6-14-50

Engine mounting. - NACA altitude wind tunnel of 20-foot-diameter test section

Instruments. - The following table indicates the instruments used:

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	Transient instrumentation			Steady-state instrumentation
Measured quantity	Sensor	Recorder	Dynamic lag (equivalent time constant)	Instrument
Engine speed	Tachometer generator, direct current	Multiple-channel direct-inking oscillograph with associated amplifiers	0.04 sec	Tachometer generator, alternate current
Compressor discharge pressure	Aneroid-type pressure sensor		0.02 sec	Bourdon-type gage
Tail-pipe temperature	Unshielded loop thermocouple		0.25 sec at average sea-level mass flow	Thermocouple on Brown potentiometer
Thrust	Strain gage on main engine support		Less than 0.002 sec	---------------
Fuel-valve position and reheat fuel-valve position	Wire wound potentiometers		Less than 0.002 sec	Selsyns
Tail-pipe area	Wire wound potentiometer		Less than 0.002 sec	Selsyns

The transient responses of the primary engine variables as measured on the multiple-channel direct-inking oscillograph were calibrated by use of the steady-state instruments. The oscillograph chart was run at a speed of 2.5 units per second.

PROCEDURE

Windmilling starts. - With the engine windmilling at less than 2500 rpm the thrust-selector lever was advanced to the full dry position and the ignition switch was closed. Records were made of the automatically controlled start and acceleration to full dry thrust.

Bursts and Chops. - With the engine operating in a steady-state condition, the thrust-selector lever was manually advanced or cut back in a step-wise manner to produce a burst or chop. Runs were made with operation confined to either the dry or wet region, as well as runs involving operation in both regions. Records were made of these automatically controlled accelerations and decelerations.

RESULTS

The results of the engine and control transients are shown on oscillograph records as traces of fuel-valve position, thrust, compressor discharge pressure, tail-pipe area, engine speed, and tail-pipe temperature. During any transient in the reheat region, a trace of reheat fuel-valve position replaced that of compressor discharge pressure.

Initial and final operating levels of the variables, as well as simulated flight conditions, are indicated on the oscillograph records. On the speed traces in which initial and final conditions are identical or where oscillatory behavior was encountered, a scale factor (gain) for the traces are indicated.

During dry operation of the engine, the fuel-valve position is given in degrees. When operating in the reheat region, actual fuel flows are indicated on the fuel-valve-position and reheat-fuel-valve-position traces. Figure 1(a) is a calibration curve of fuel flow against fuel-valve position.

The operating level of tail-pipe area is indicated on the traces in volts. Figure 1(b) is a calibration curve of the exhaust-nozzle area against the indicator readings.

Absolute values of jet thrust have not been calculated, but the transient records provide an indication of the relative thrust at any time. In figure 2, the nominal schedule of thrust for any thrust-selector position in the dry region of operation is shown.

The controlled engine operation is shown graphically in figures 3 to 13, which are arranged according to Table I.

Lewis Flight Propulsion Laboratory,
National Advisory Committee for Aeronautics
Cleveland, Ohio, July 10, 1950.

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TABLE I - TABULATION OF TRANSIENT RESPONSE TRACES

Type of run	Figure number	Altitude (ft)	Nominal ram pressure ratio	Thrust-selector position (deg) Initial	Thrust-selector position (deg) Final
Automatically controlled start and acceleration to full dry thrust	3(a)	10,000	1.03	0	90
	3(b)	15,000	1.03	0	90
	3(c)	25,000	1.40	0	90
	3(d)	35,000	1.03	0	90
	3(e)	45,000	1.03	0	90
Automatically controlled acceleration from idle to full dry thrust	4(a)	10,000	1.03	10	90
	4(b)	15,000	1.03	10	90
	4(c)	25,000	1.03	10	90
	4(d)	25,000	1.40	10	90
	4(e)	35,000	1.03	10	90
	4(f)	45,000	1.03	10	90
Automatically controlled acceleration to full dry thrust with nozzle locked	5(a)	15,000	1.03	10	90
	5(b)	15,000	1.03	10	90
	5(c)	45,000	1.03	10	90
	5(d)	45,000	1.03	10	90
Automatically controlled acceleration from various throttle positions other than idle	6(a)	15,000	1.03	35	90
	6(b)	15,000	1.03	55	90
	6(c)	15,000	1.03	35	55
	6(d)	25,000	1.03	36	55
	6(e)	25,000	1.40	36	90
	6(f)	25,000	1.40	55	90
	6(g)	25,000	1.40	36	55
	6(h)	45,000	1.03	24	90
	6(i)	45,000	1.03	55	90
	6(j)	45,000	1.03	23	55
Automatically controlled accelerations from full dry thrust to full reheat	7(a)	25,000	1.03	90	110
	7(b)	25,000	1.40	90	110
	7(c)	45,000	1.03	90	110
Automatically controlled accelerations from full dry thrust to partial reheat	8(a)	15,000	1.03	90	---
	8(b)	25,000	1.03	90	---
	8(c)	25,000	1.40	90	---
Automatically controlled acceleration in the reheat region	9(a)	15,000	1.03	---	---
	9(b)	25,000	1.03	---	---
	9(c)	25,000	1.40	---	---
Automatically controlled acceleration from 6000 rpm to reheat	10	35,000	1.03	---	---
Automatically controlled deceleration from full reheat to full dry thrust	11(a)	15,000	1.03	110	90
	11(b)	25,000	1.03	110	90
	11(c)	25,000	1.40	110	90
	11(d)	45,000	1.03	110	90
Automatically controlled deceleration from full dry thrust to idle	12(a)	10,000	1.03	90	10
	12(b)	15,000	1.03	90	10
	12(c)	25,000	1.03	90	10
	12(d)	25,000	1.40	90	10
	12(e)	35,000	1.03	90	10
	12(f)	45,000	1.03	90	10
Automatically controlled deceleration from full dry thrust to thrust-selector position of zero	13(a)	10,000	1.03	90	0
	13(b)	15,000	1.03	90	0
	13(c)	25,000	1.40	90	0
	13(d)	35,000	1.03	90	0

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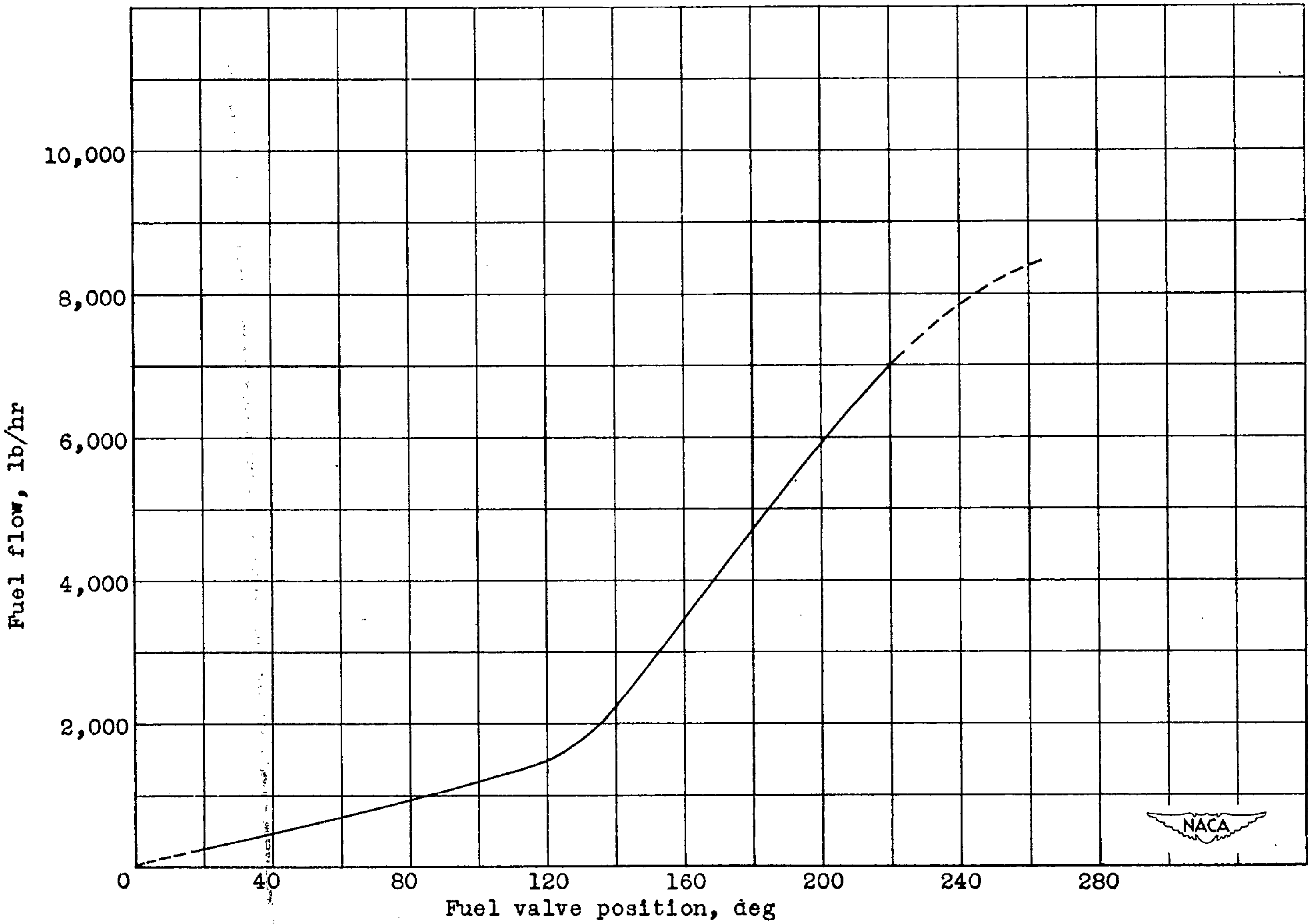

(a) Fuel valve position.

Figure 1. - Calibration curves for J47 RX1-3 turbojet engine.

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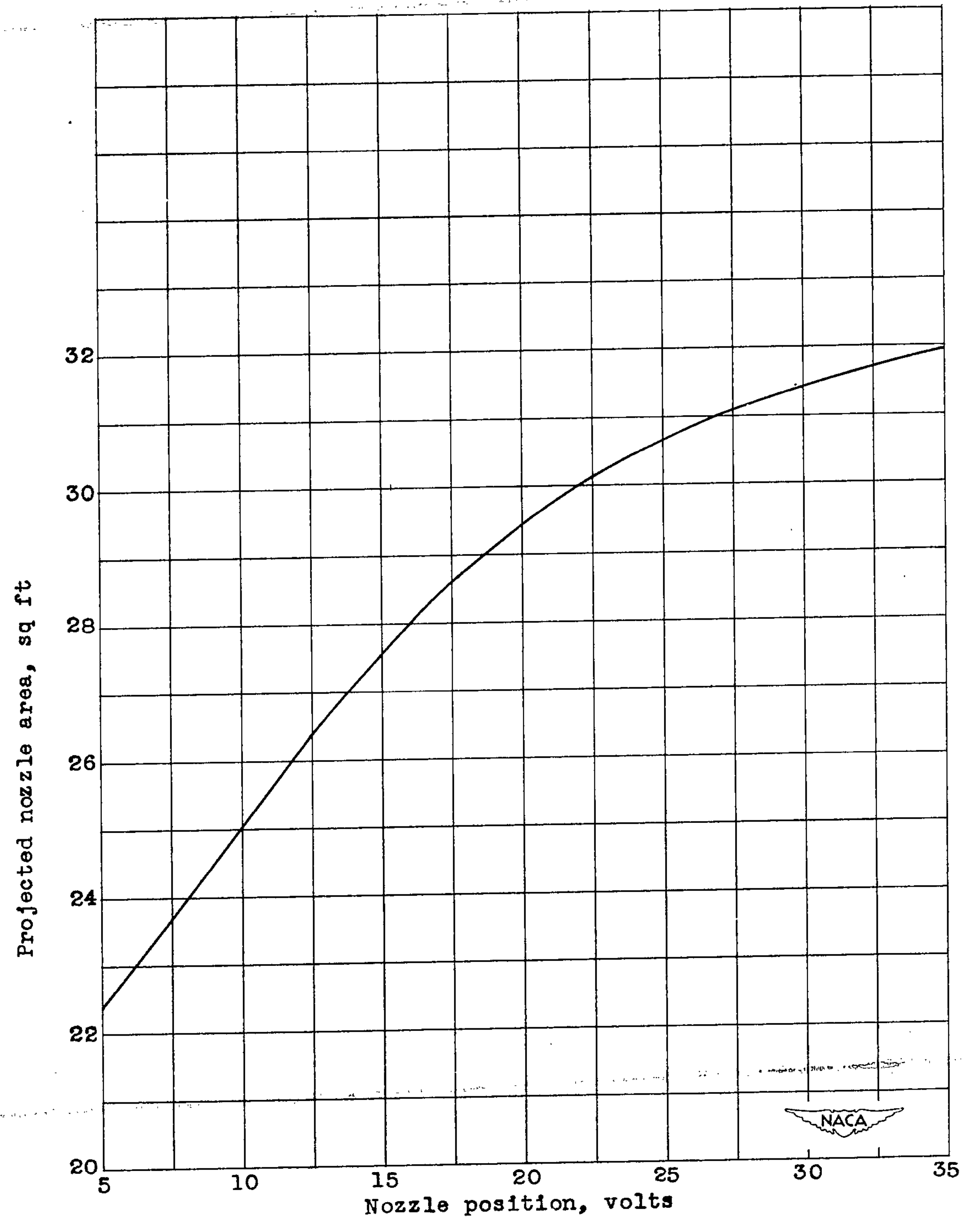

(b) Nozzle position indicator.

Figure 1. - Concluded. Calibration curves for J47 RX1-3 turbojet engine.

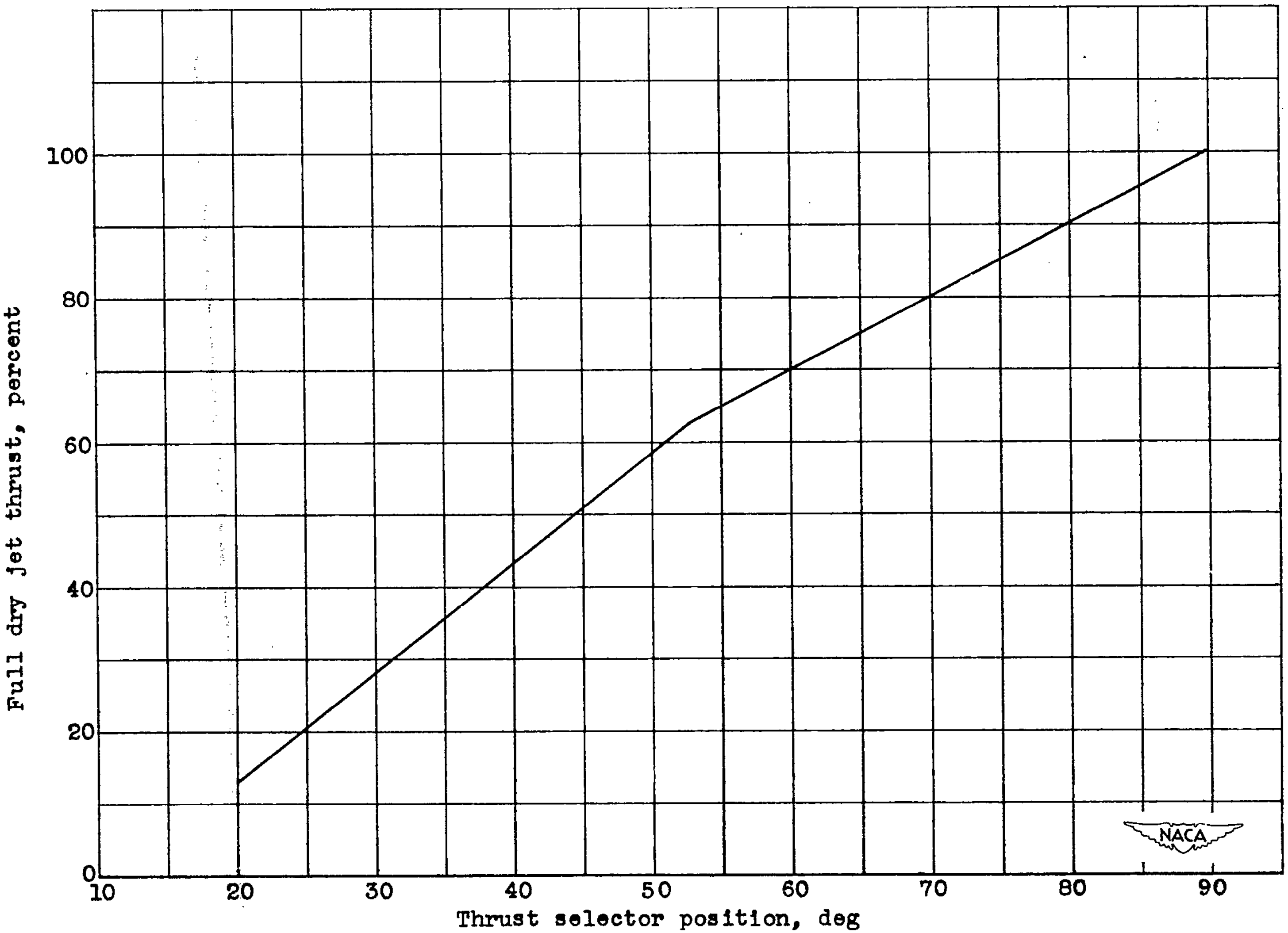

Figure 2. - Nominal schedule of jet thrust to thrust selector position for General Electric integrated electronic control on J47 RX1-3 turbojet engine.

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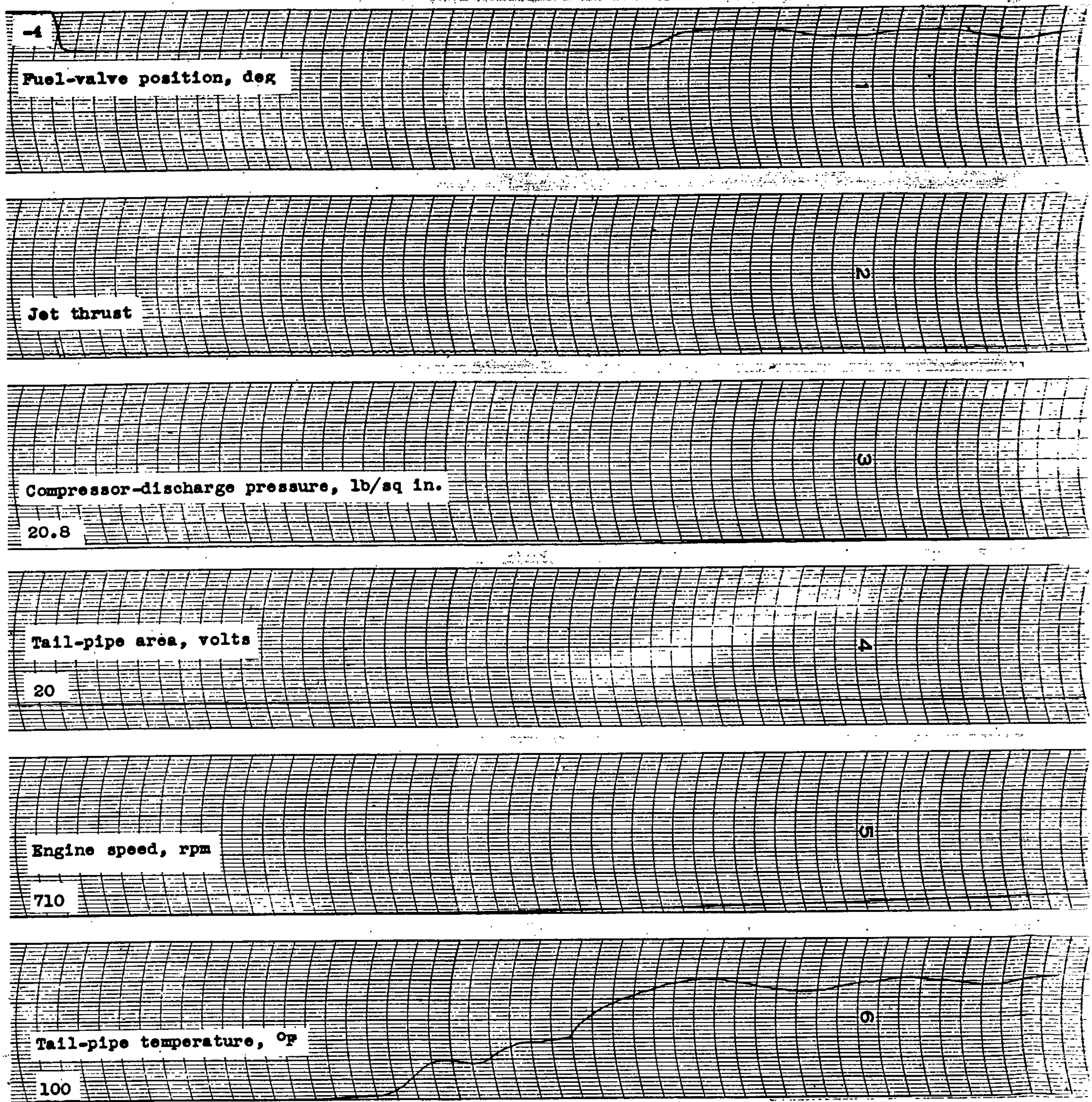
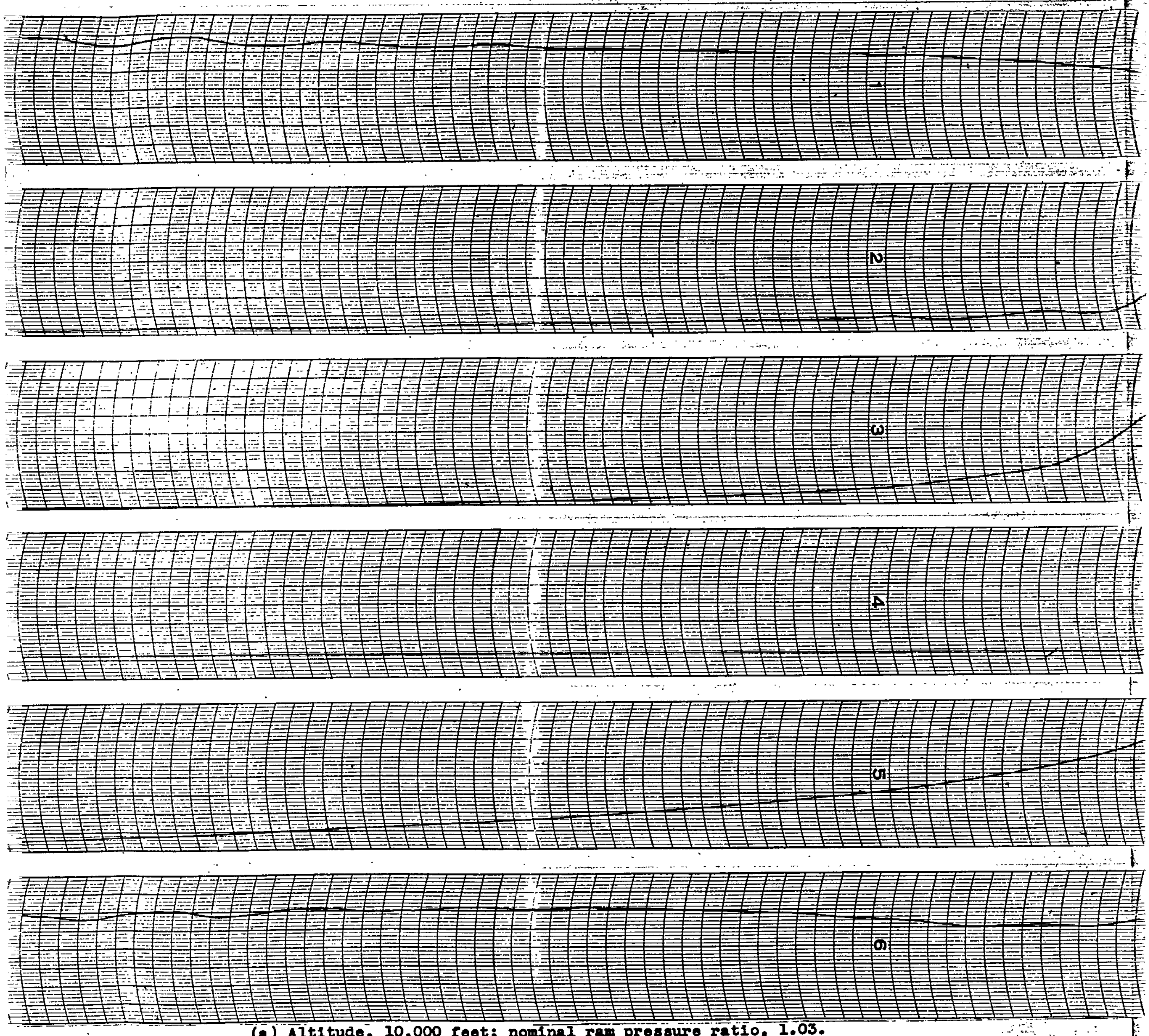
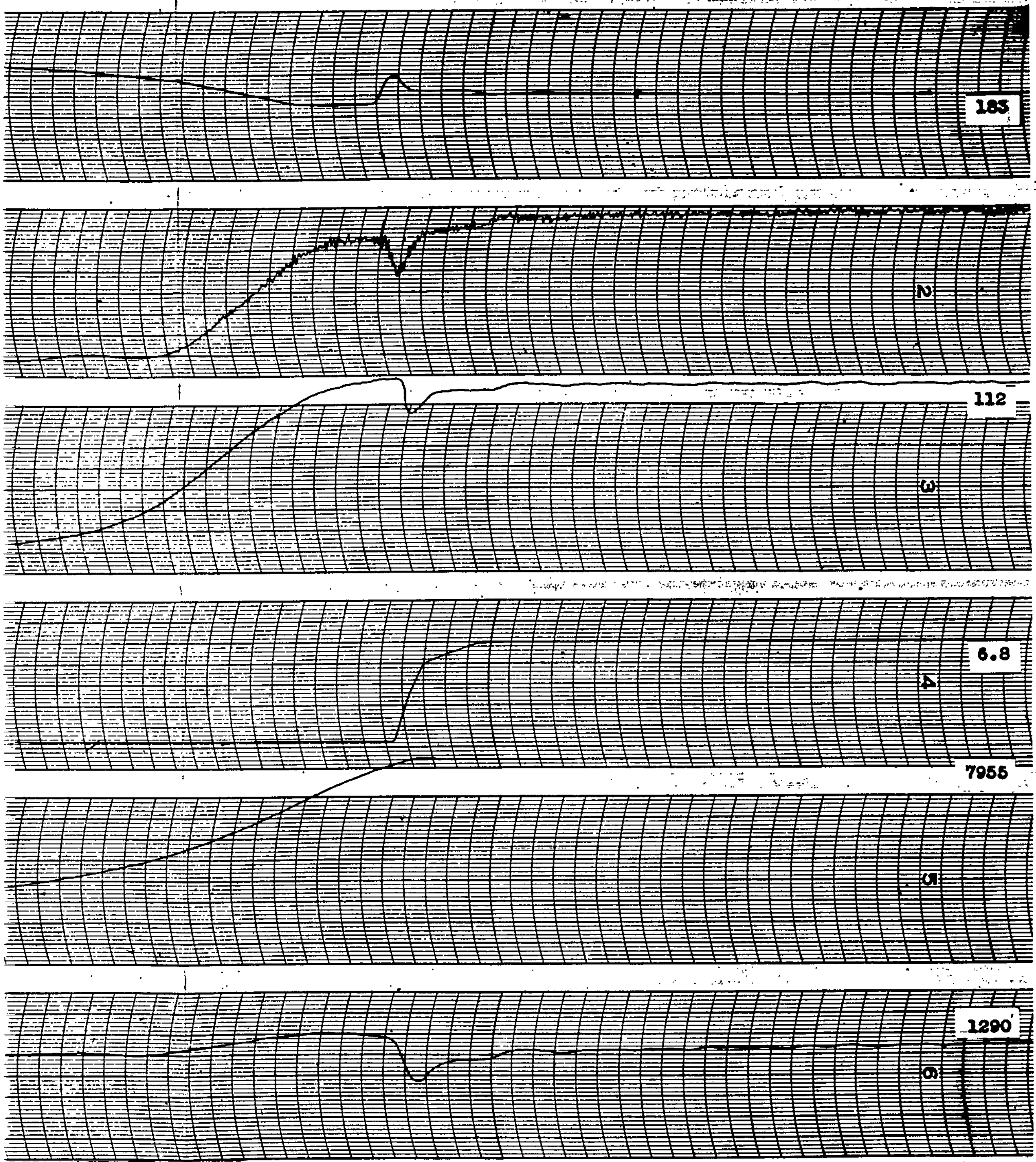


Figure 3. - Automatical



(a) Altitude, 10,000 feet; nominal ram pressure ratio, 1.03.

e 3. - Automatically controlled start and acceleration to full dry thrust. (Chart speed 2.5 divisions per second.)



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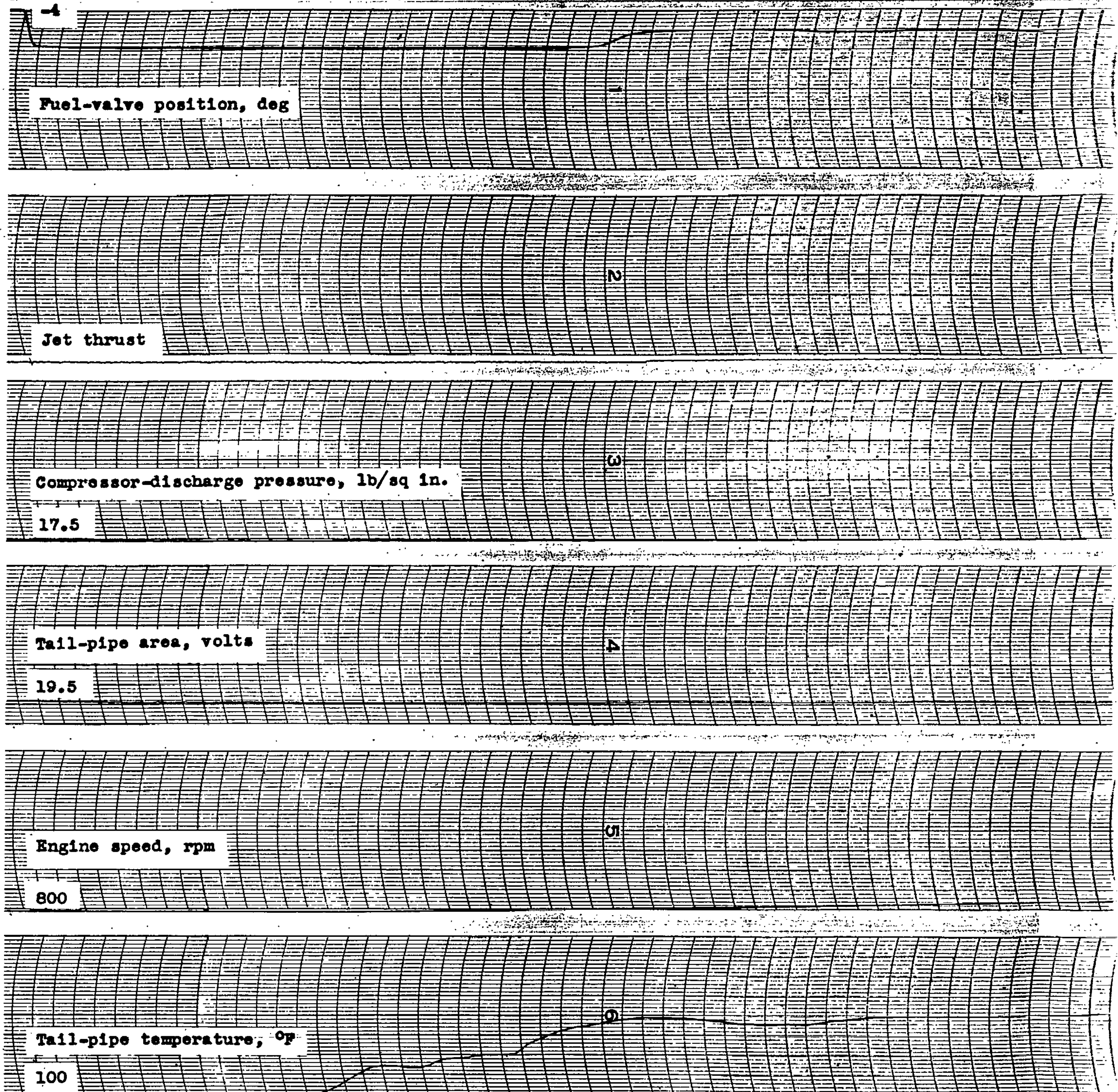

Figure 3. - Continued. Automatic

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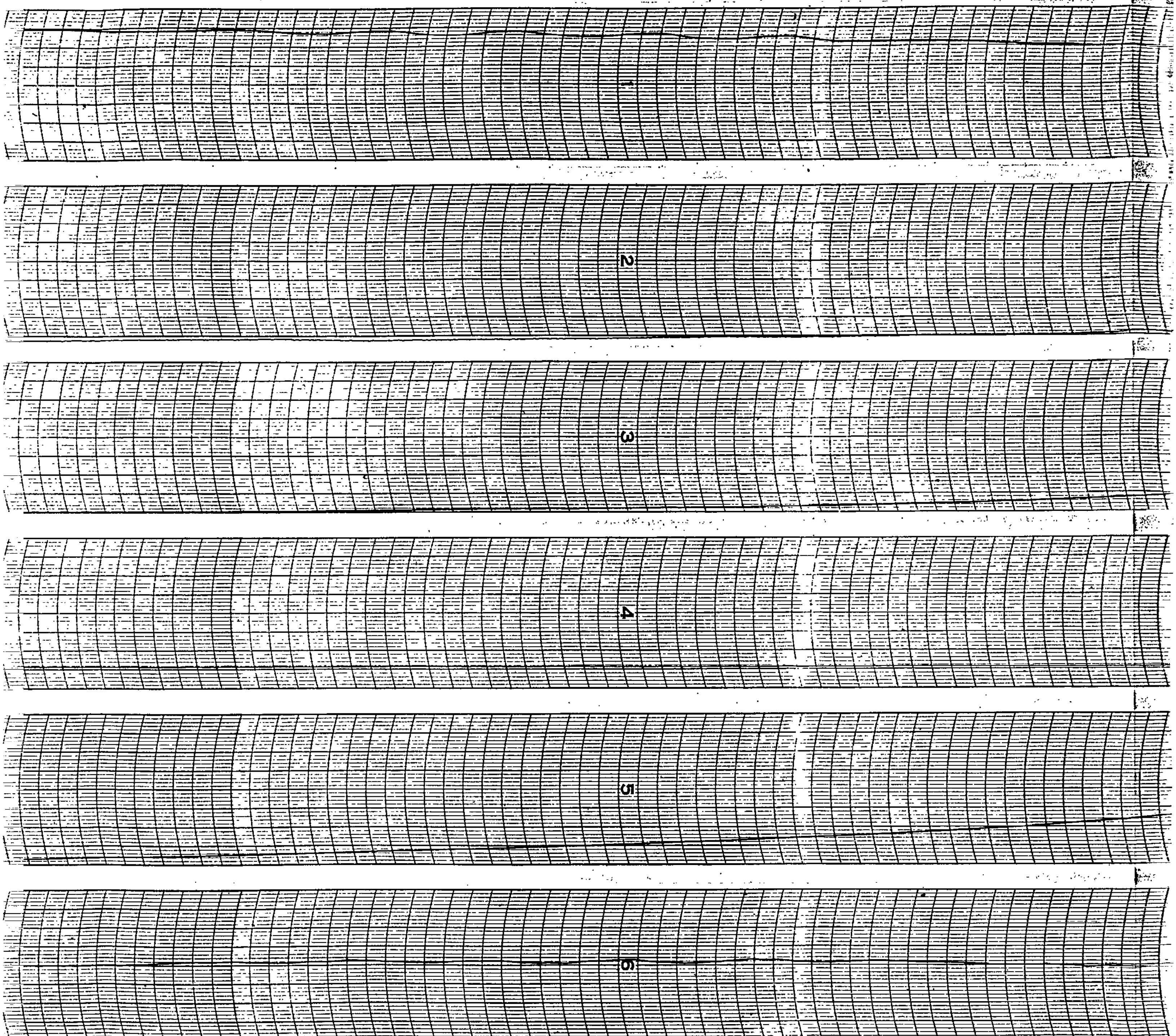
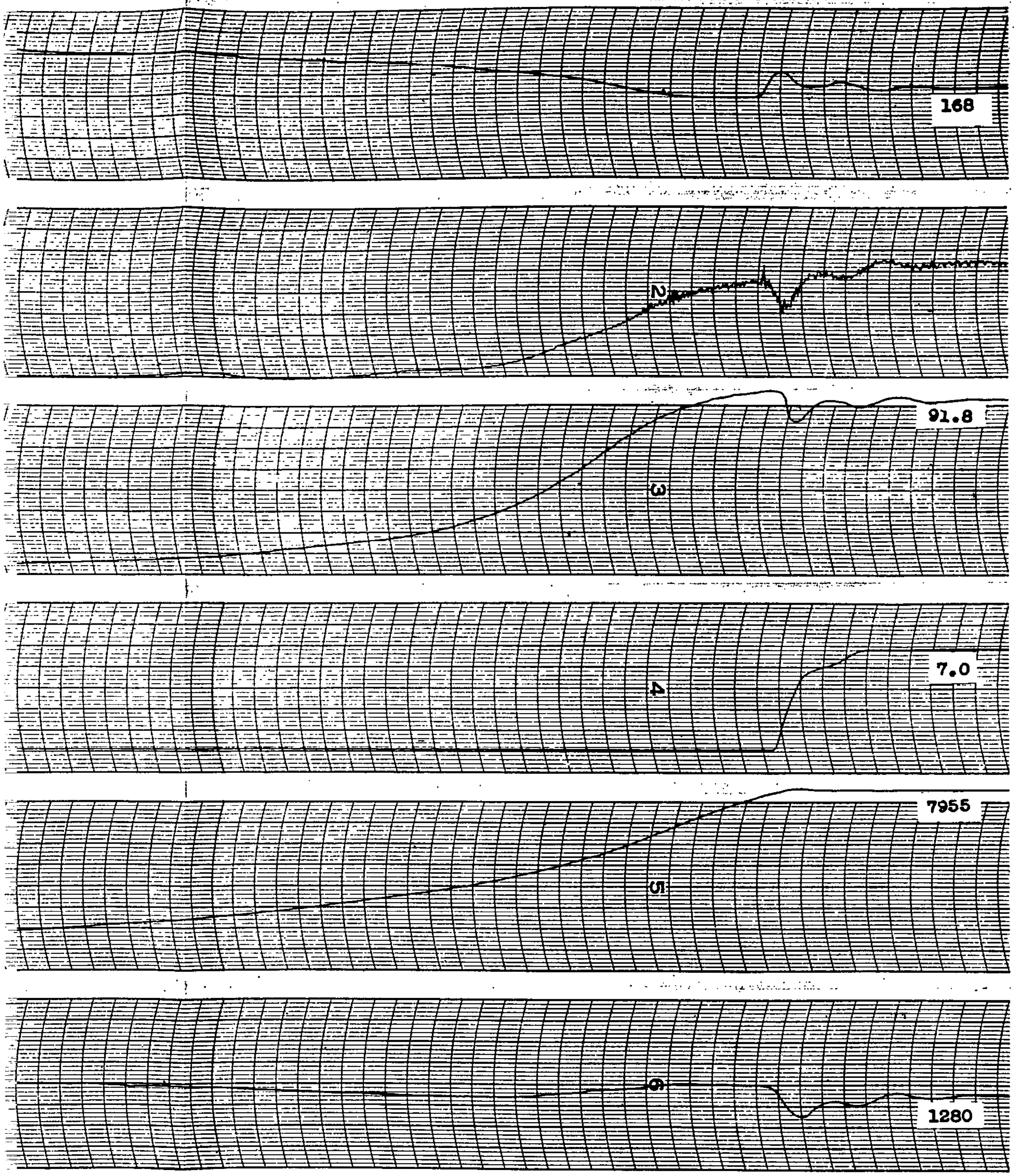


(b) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

tinued. Automatically controlled start and acceleration to full dry thrust. (Chart speed 2.5 divisions per second.)



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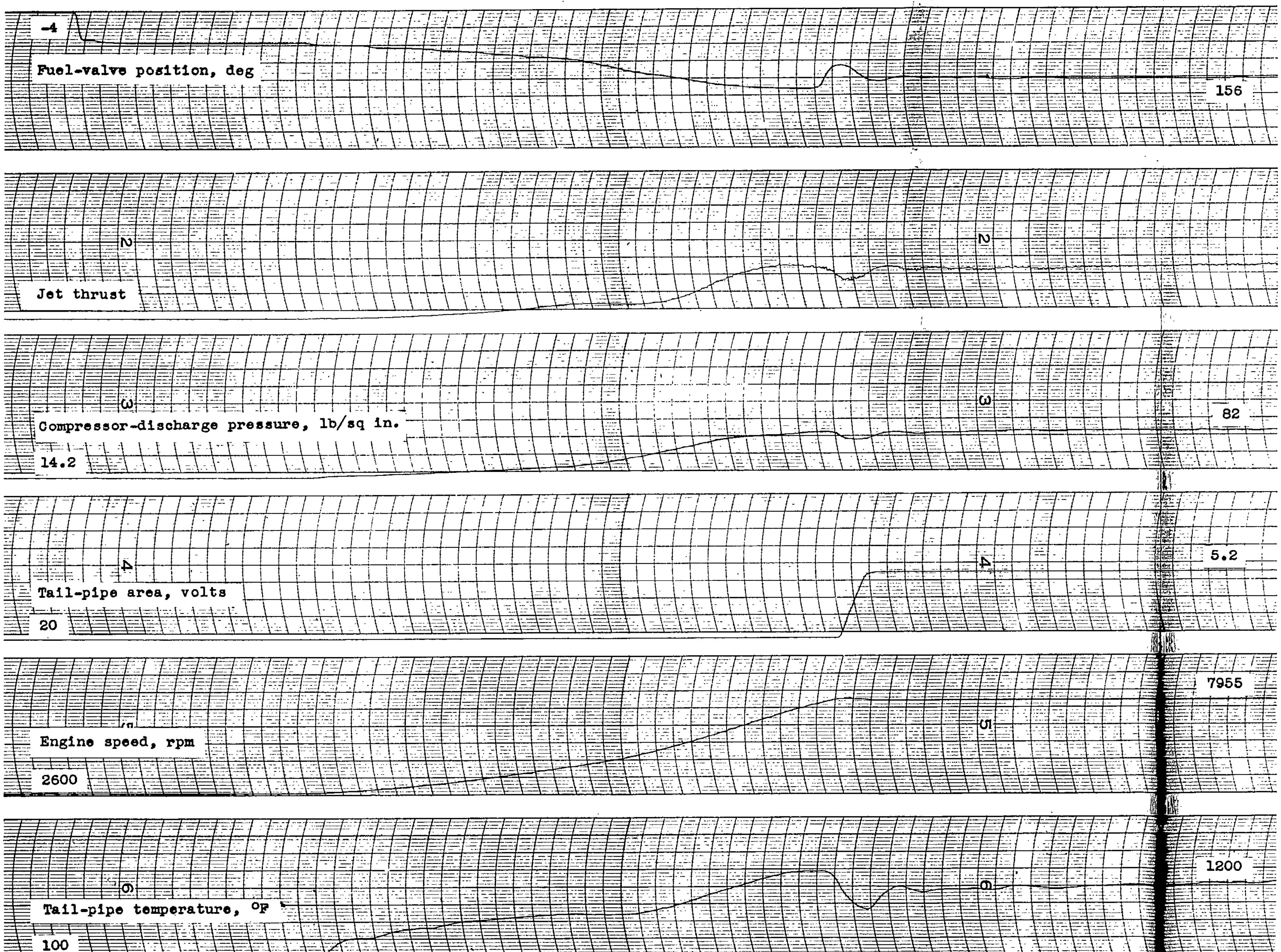

(c) Altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

Figure 3. - Continued. Automatically controlled start and acceleration to full dry thrust. (Chart speed 2.5 divisions per second.)

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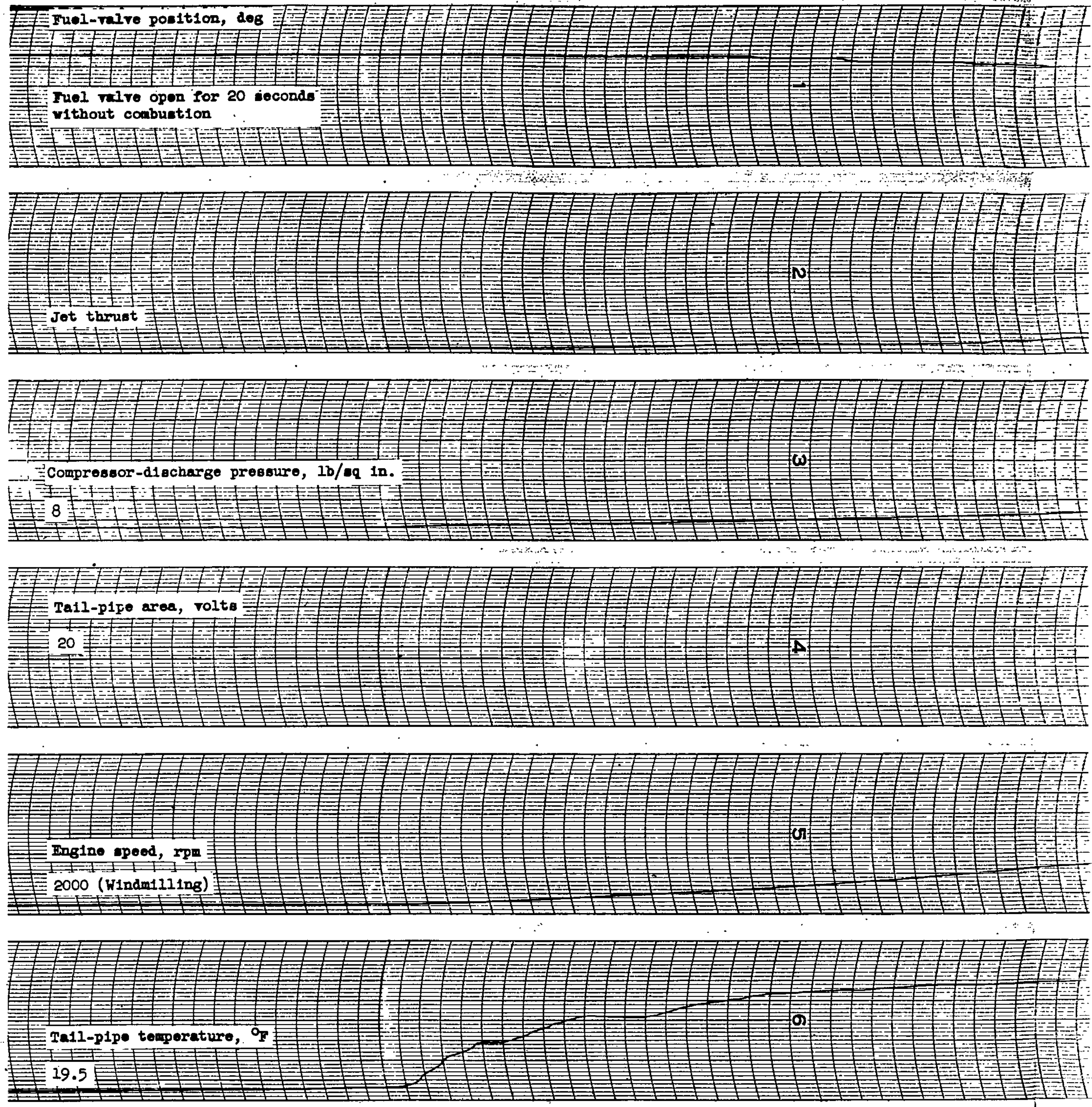

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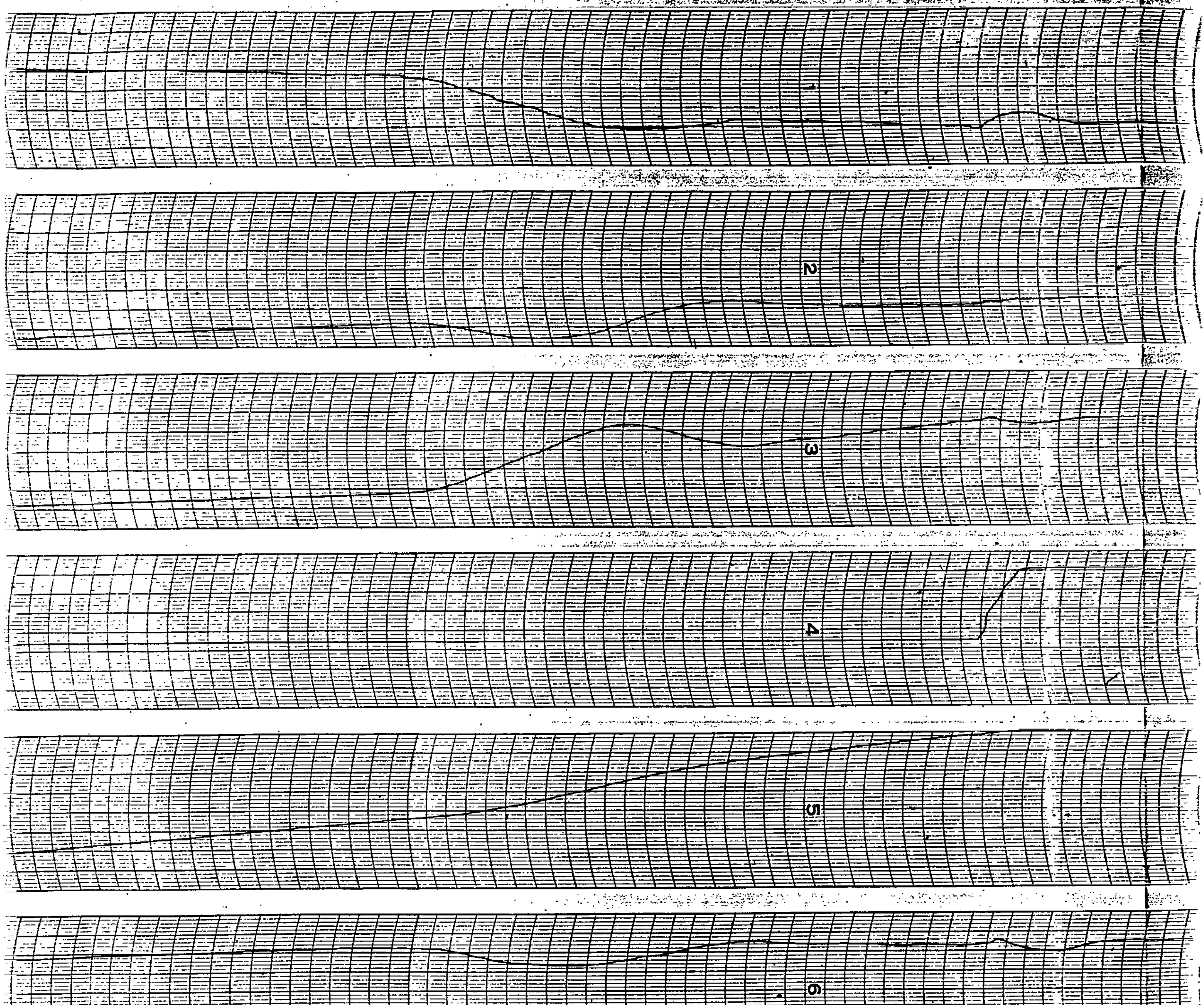
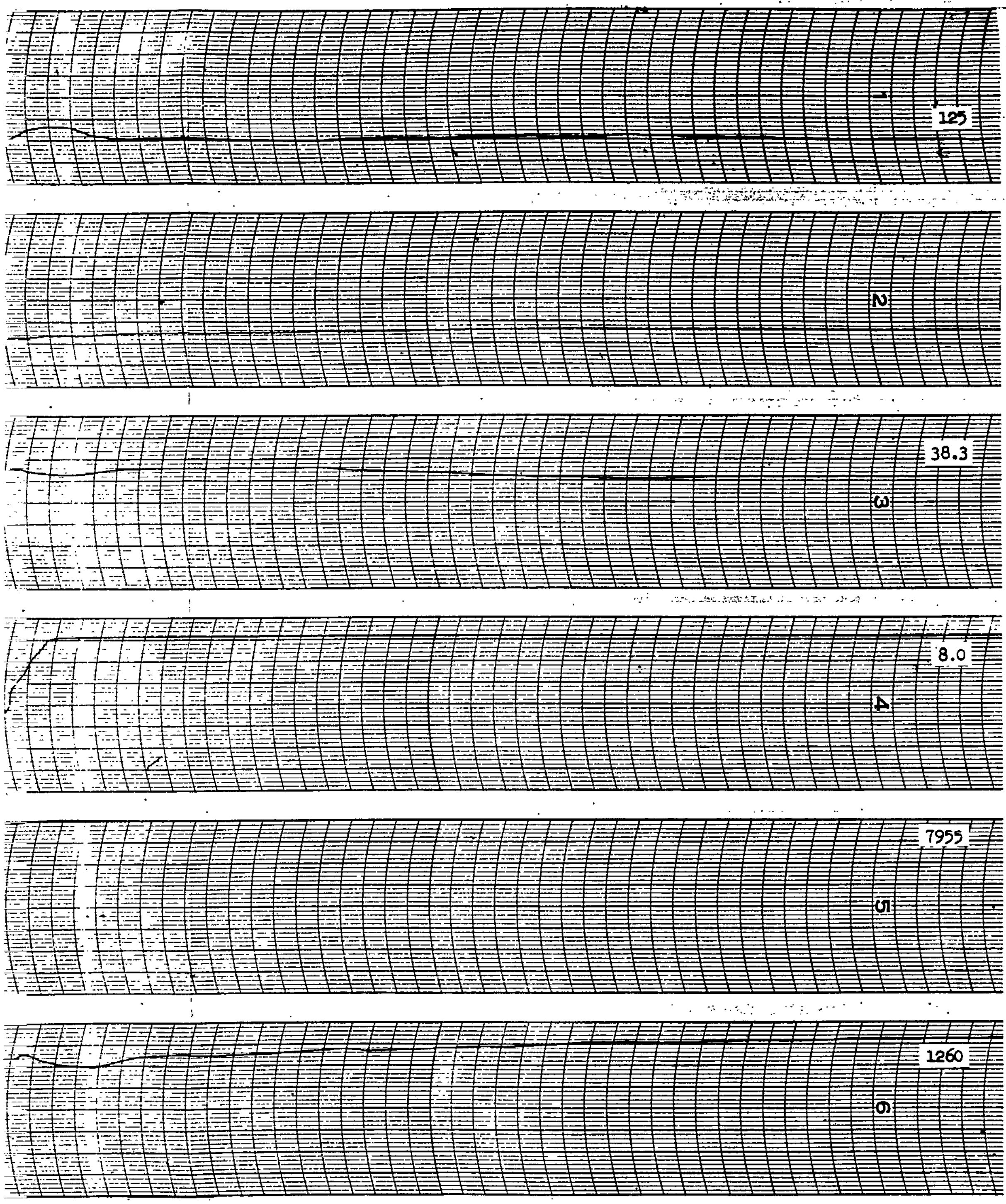


(d) Altitude, 35,000 feet; nominal ram pressure ratio, 1.03.

ued. Automatically controlled start and acceleration to full dry thrust. (Chart speed 2.5 divisions per second.)



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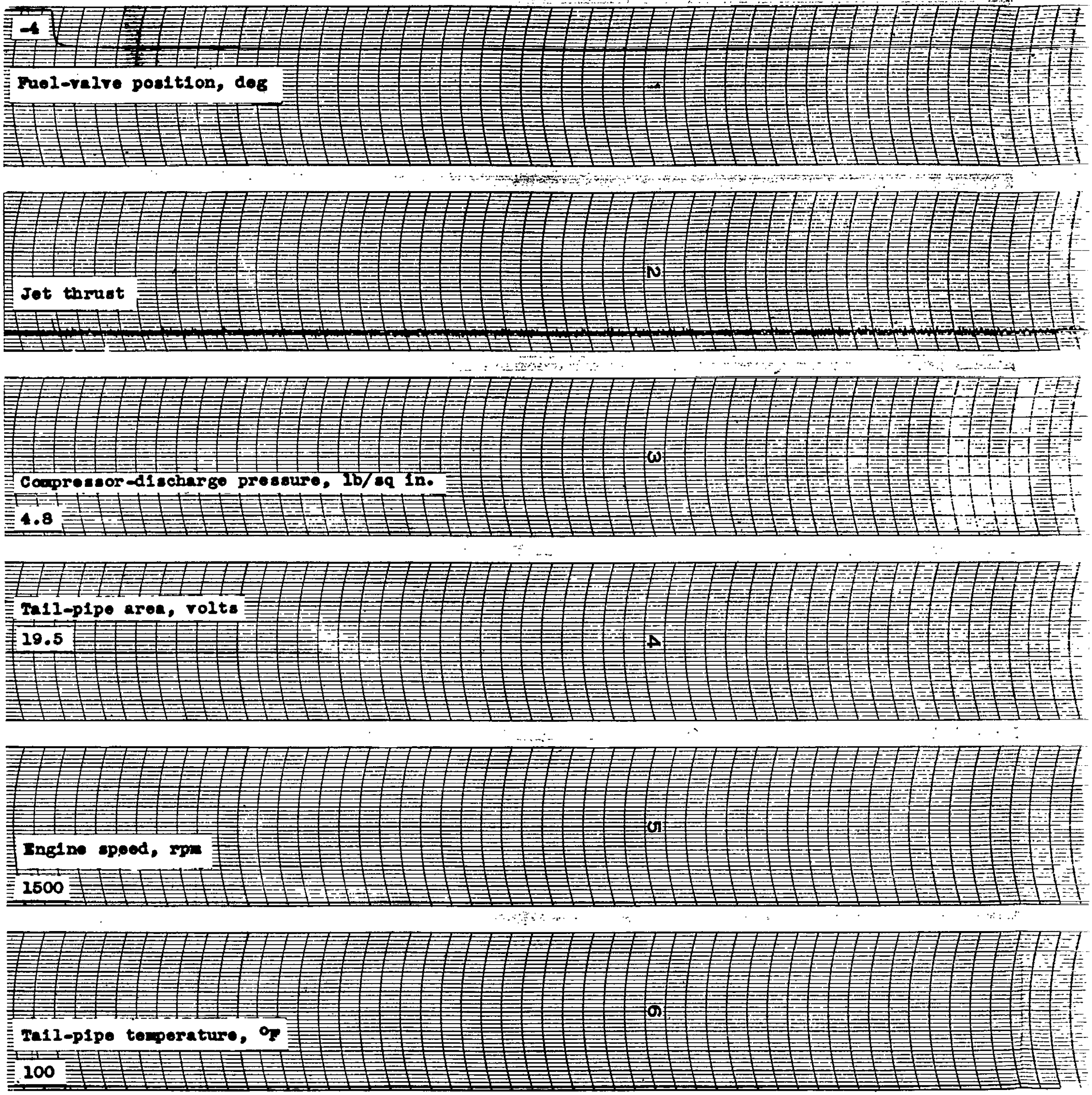

Figure 3. - Concluded. Automatic

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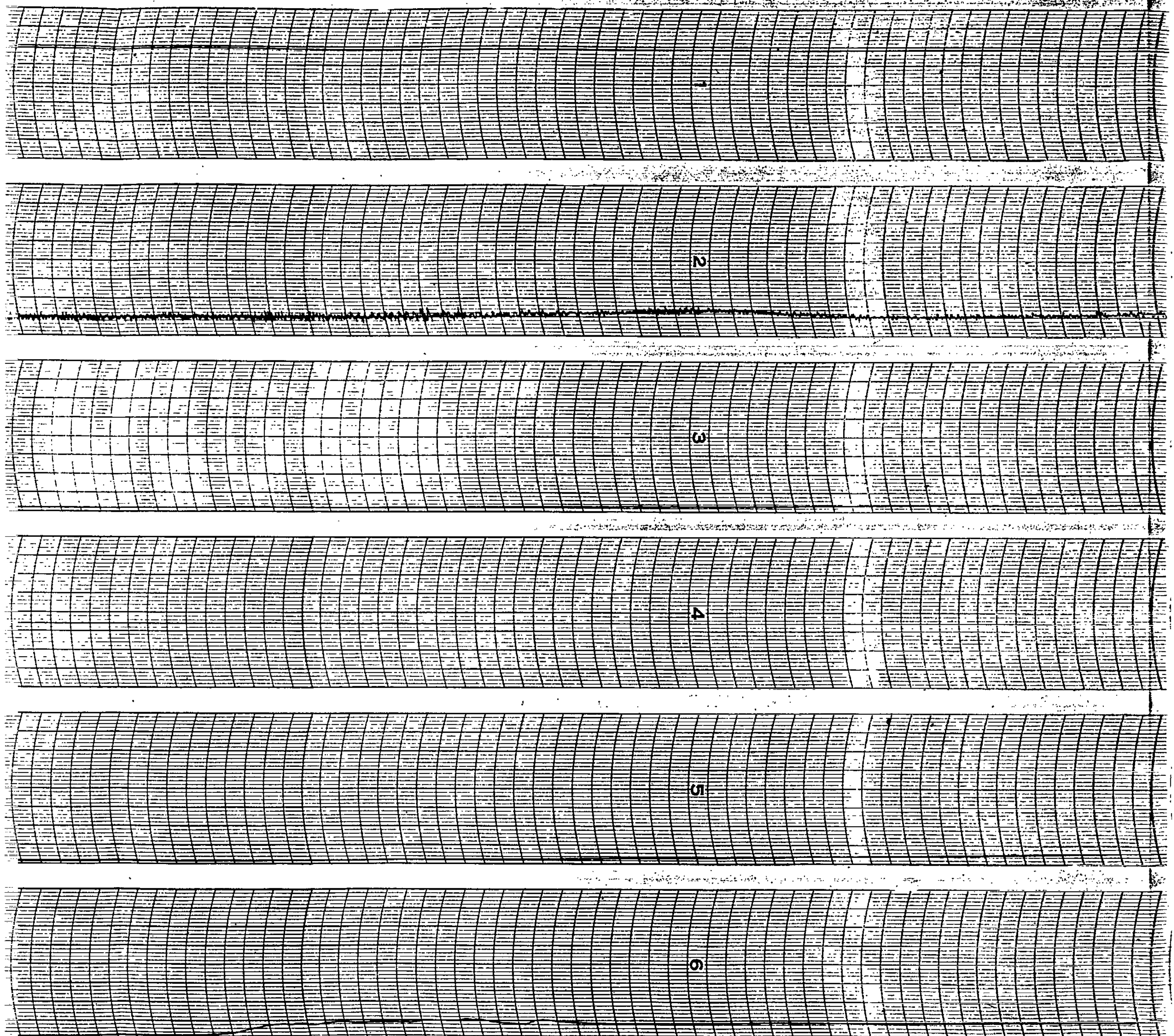
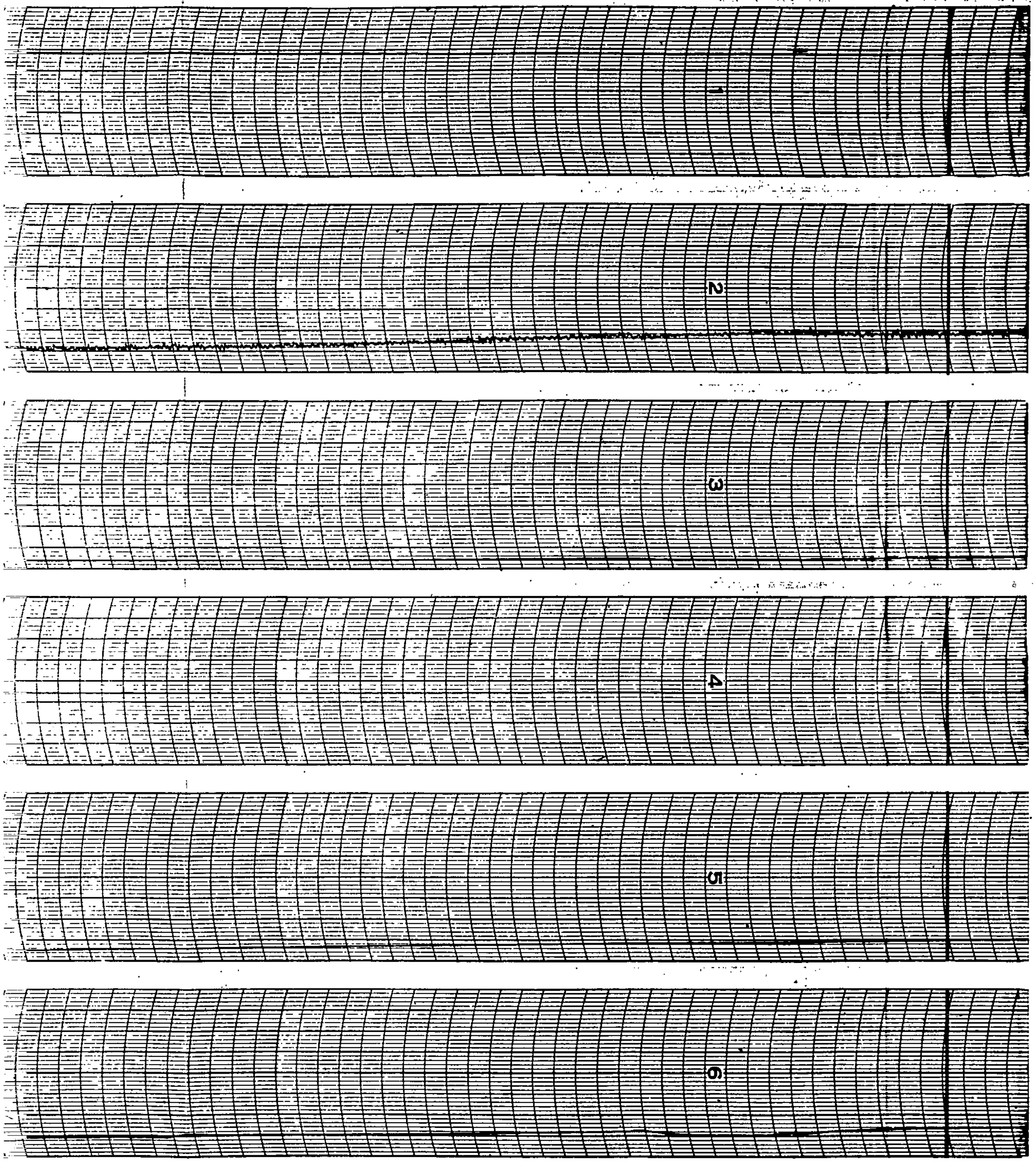


(e) Altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

:cluded. Automatically controlled start and acceleration to full dry thrust. (Chart speed 2.5 divisions per second.)



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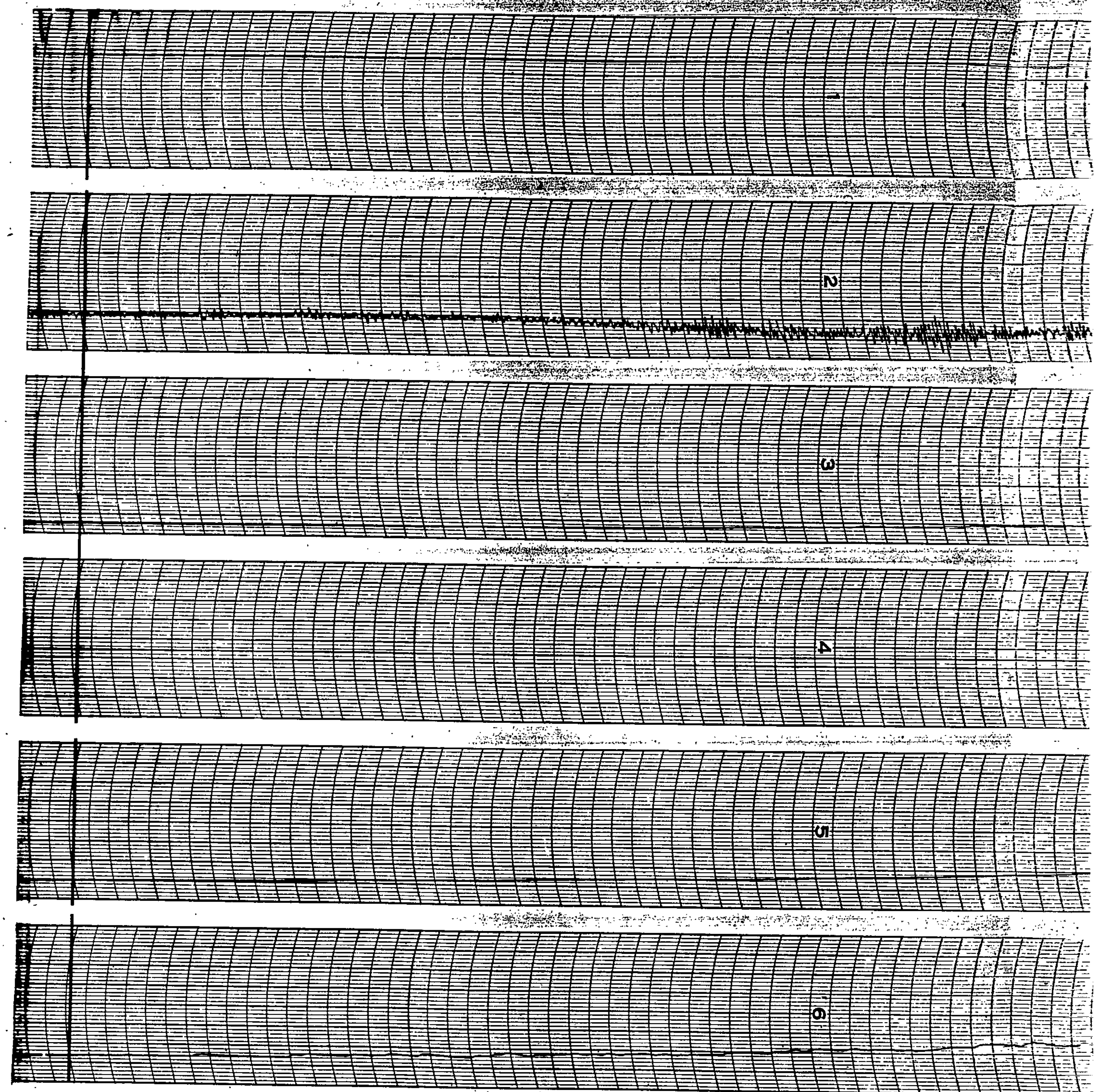

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Figure 3. - Concluded. Automatic

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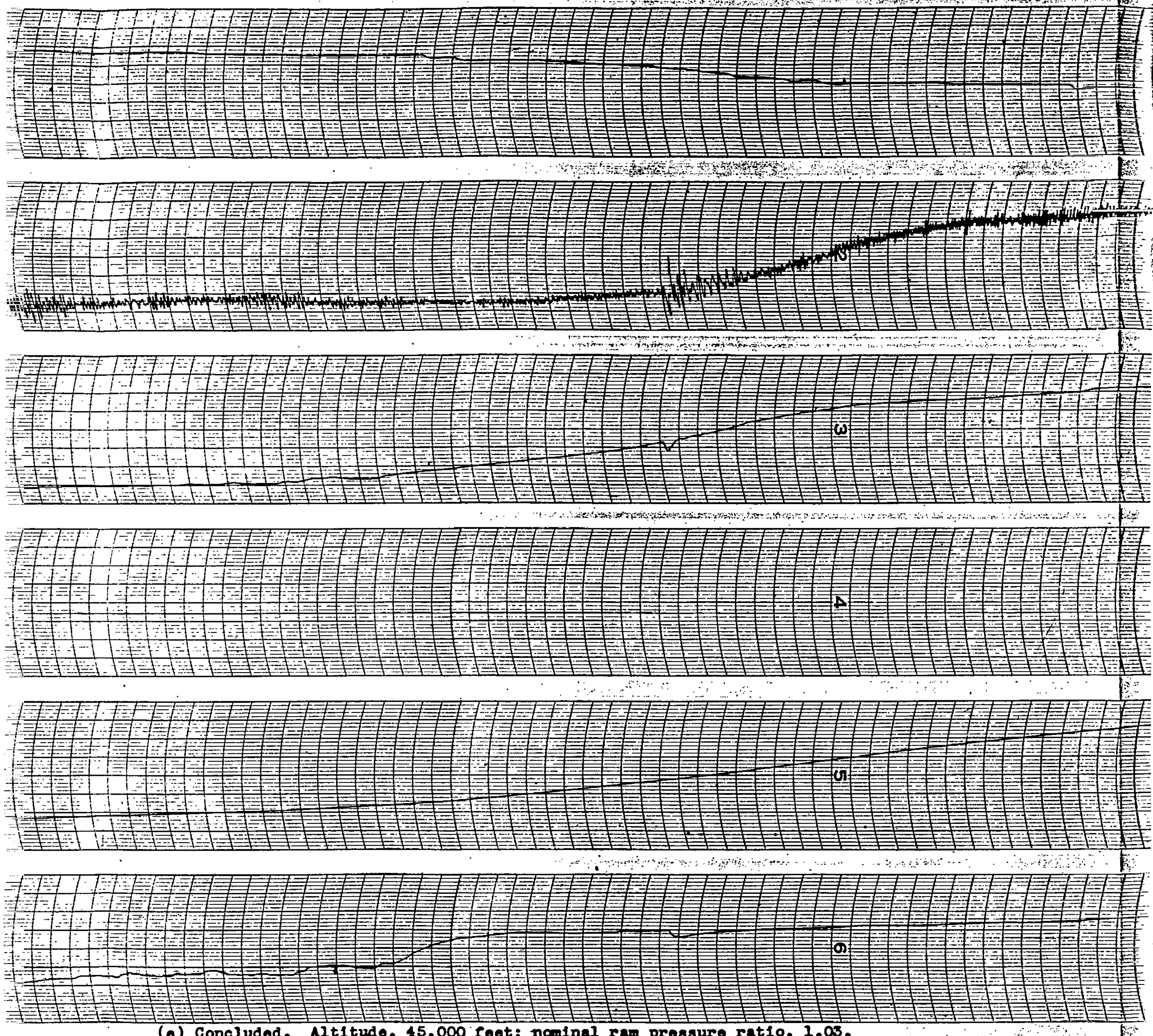

(e) Concluded. Altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

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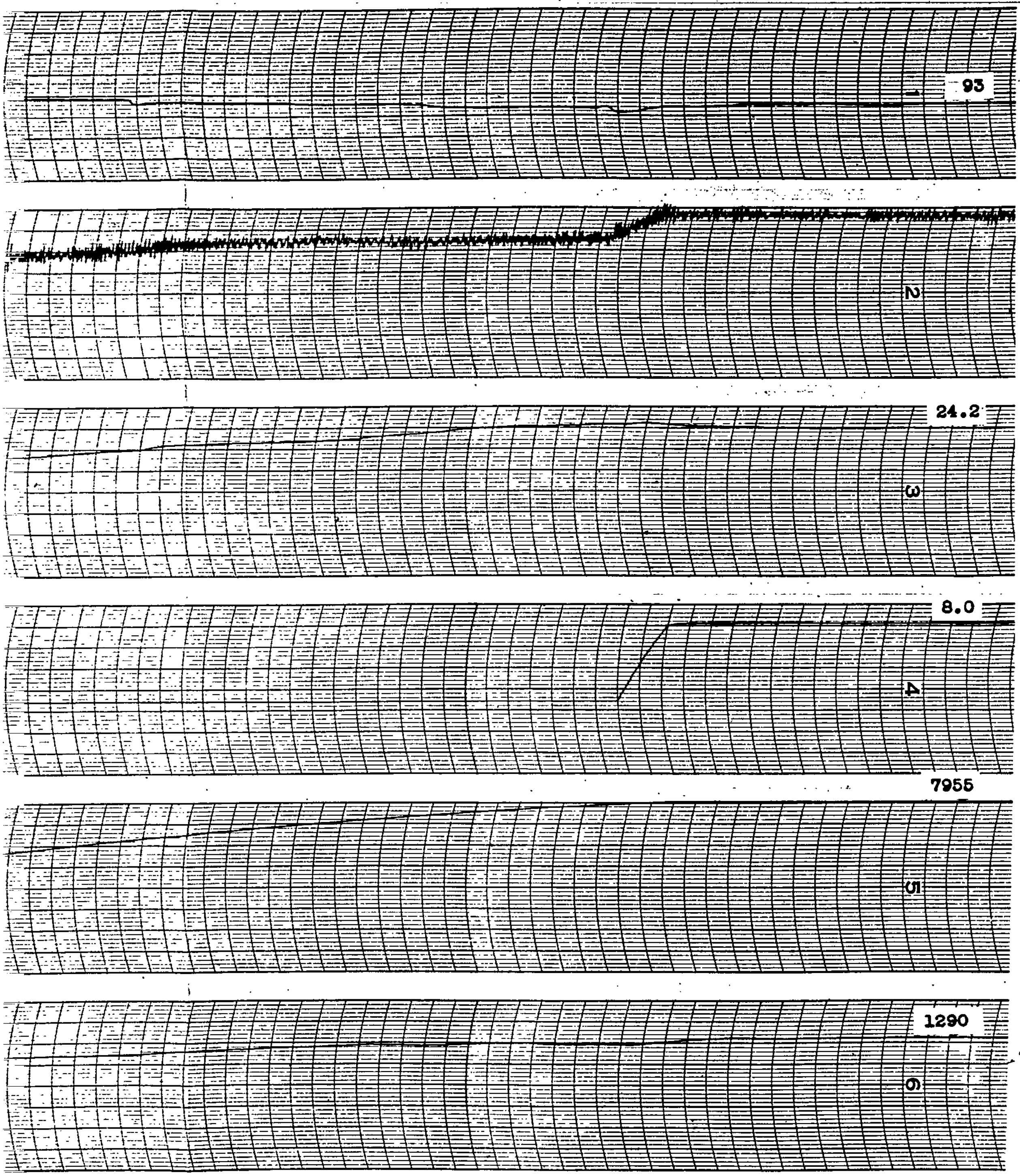

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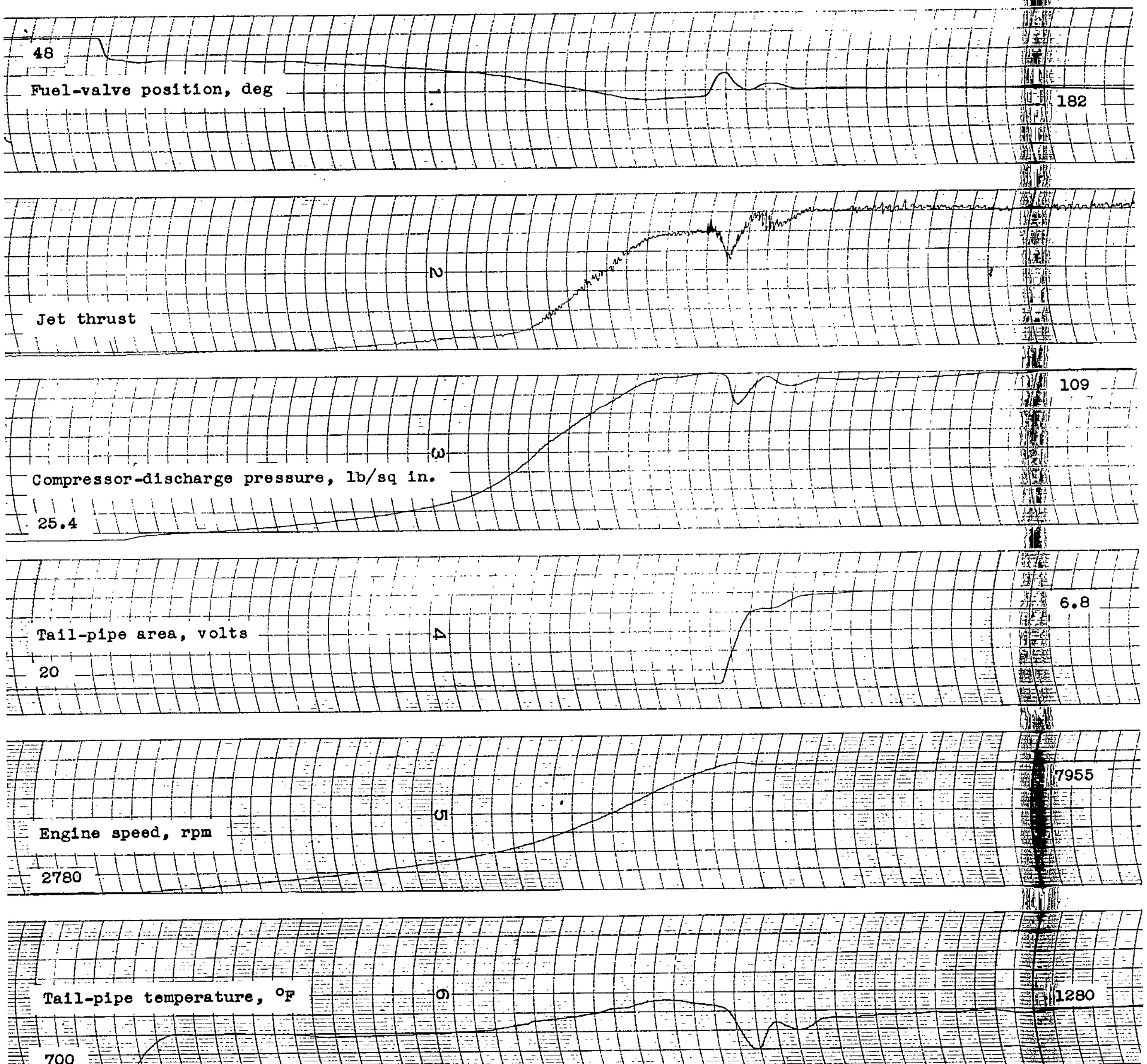

(a) Altitude, 10,000 feet; nominal ram pressure ratio, 1.03.

Figure 4. - Automatically controlled acceleration from idle speed to full dry thrust. (Chart speed 2.5 divisions per second.)

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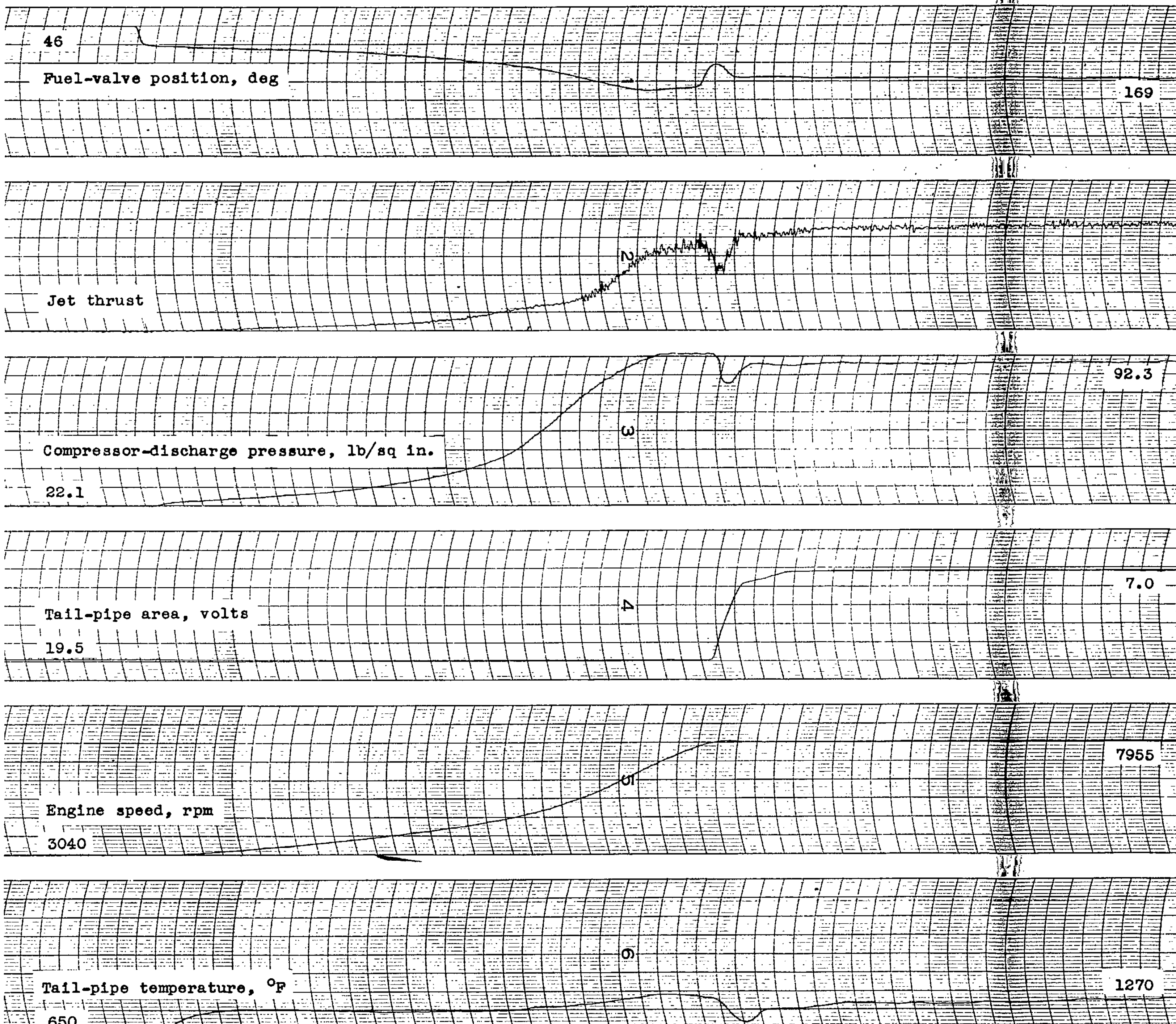

(b) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

Figure 4. - Continued. Automatically controlled acceleration from idle speed to full dry thrust. (Chart speed 2.5 divisions per second.)

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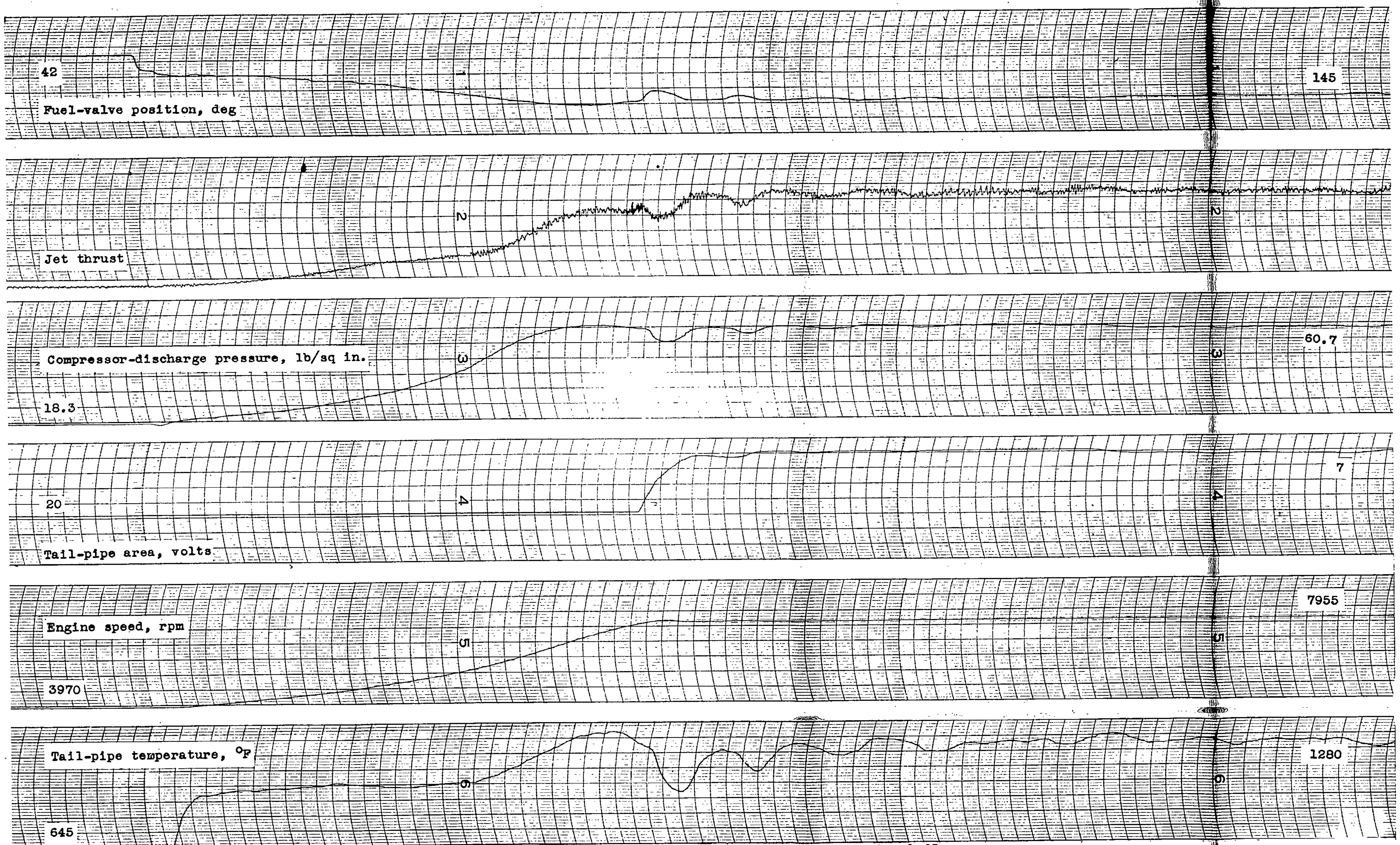

(c) Altitude, 25,000 feet; nominal ram pressure ratio, 1.03.

Figure 4. - Continued. Automatically controlled acceleration from idle speed to full dry thrust. (Chart speed 2.5 divisions per second.)

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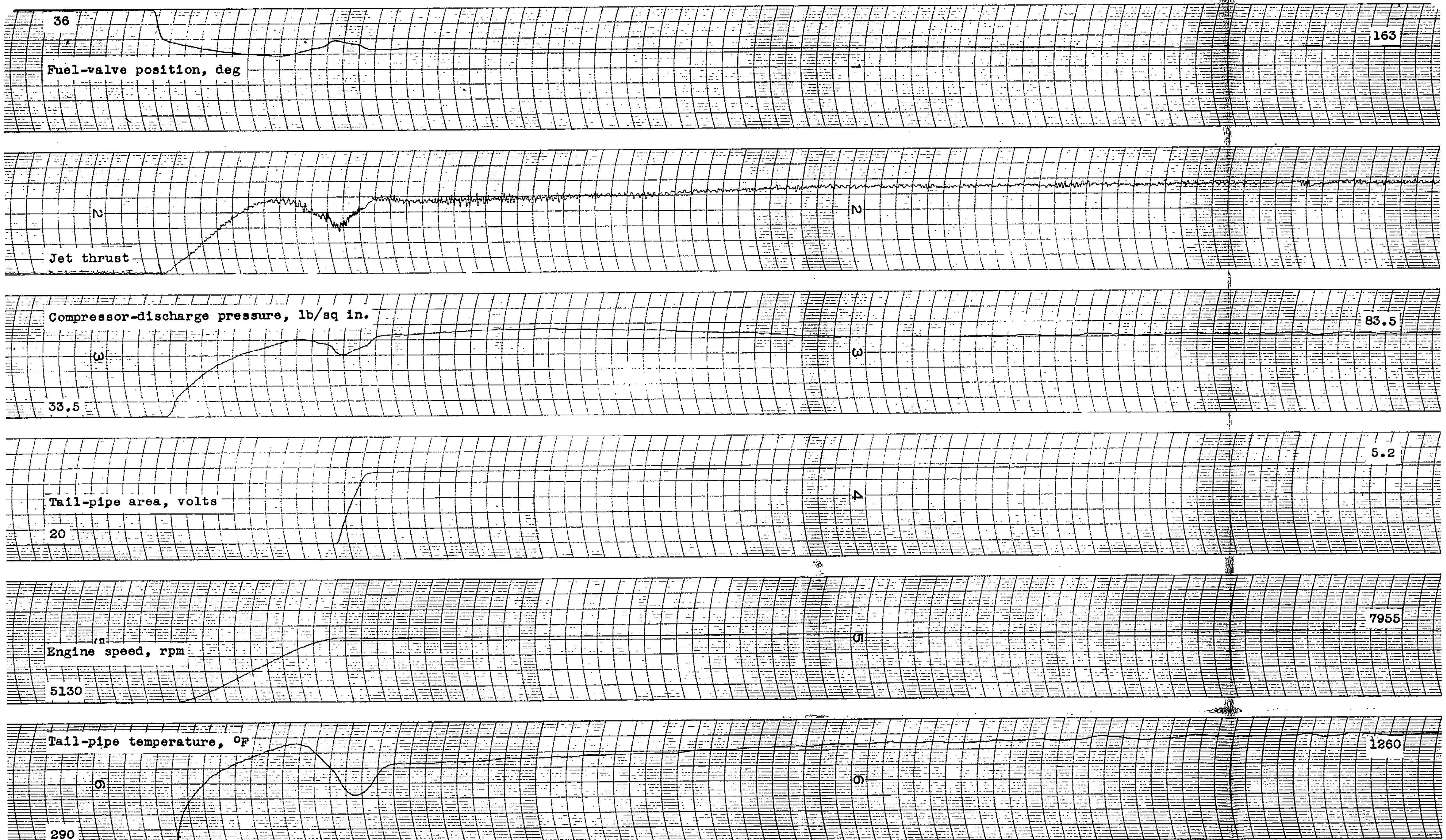

(d) Altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

Figure 4. - Continued. Automatically controlled acceleration from idle speed to full dry thrust. (Chart speed 2.5 divisions per second.)

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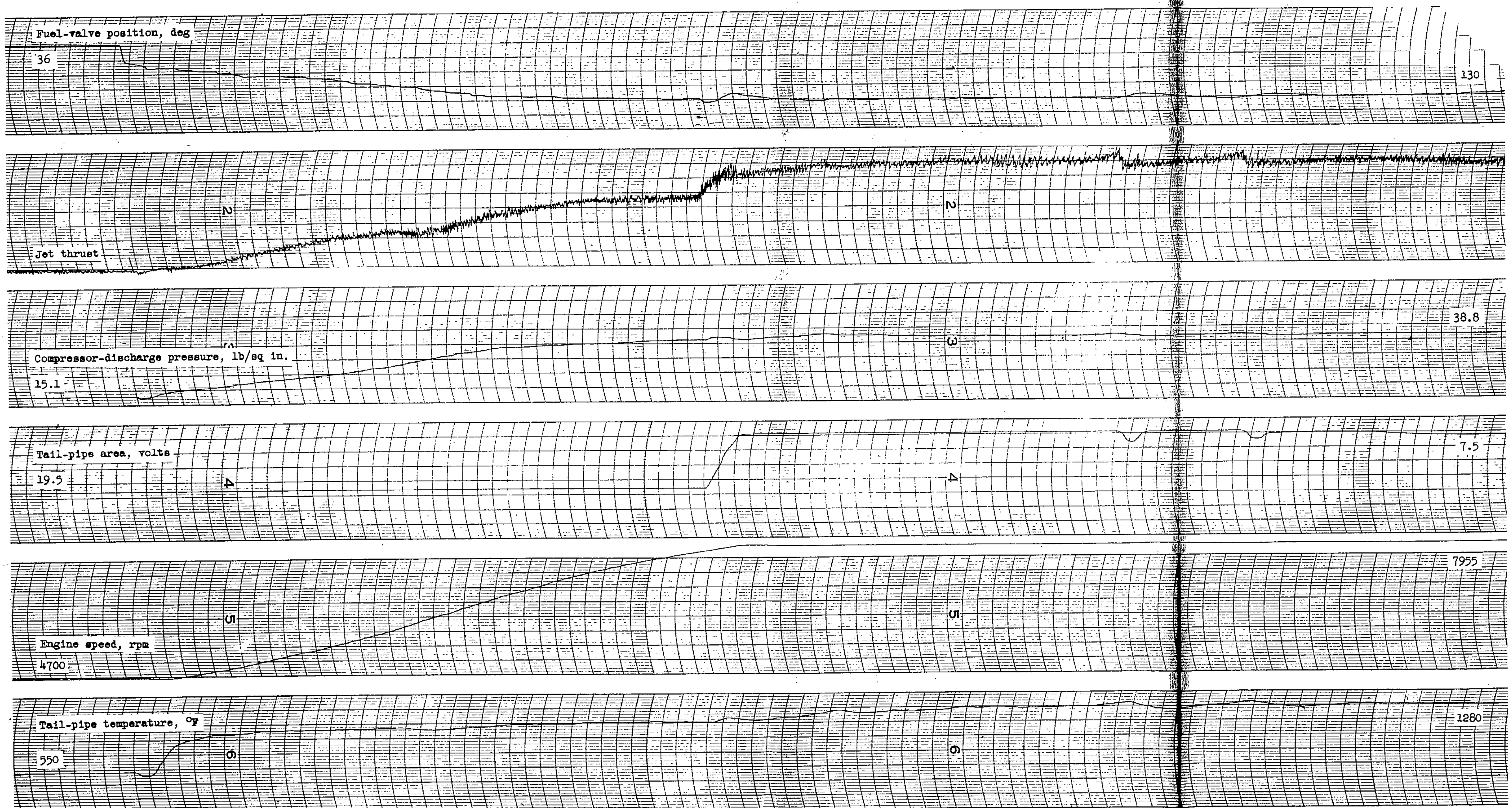

(e) Altitude, 35,000 feet; nominal ram pressure ratio, 1.03.

Figure 4. - Continued. Automatically controlled acceleration from idle speed to full dry thrust. (Chart speed 2.5 divisions per second.)

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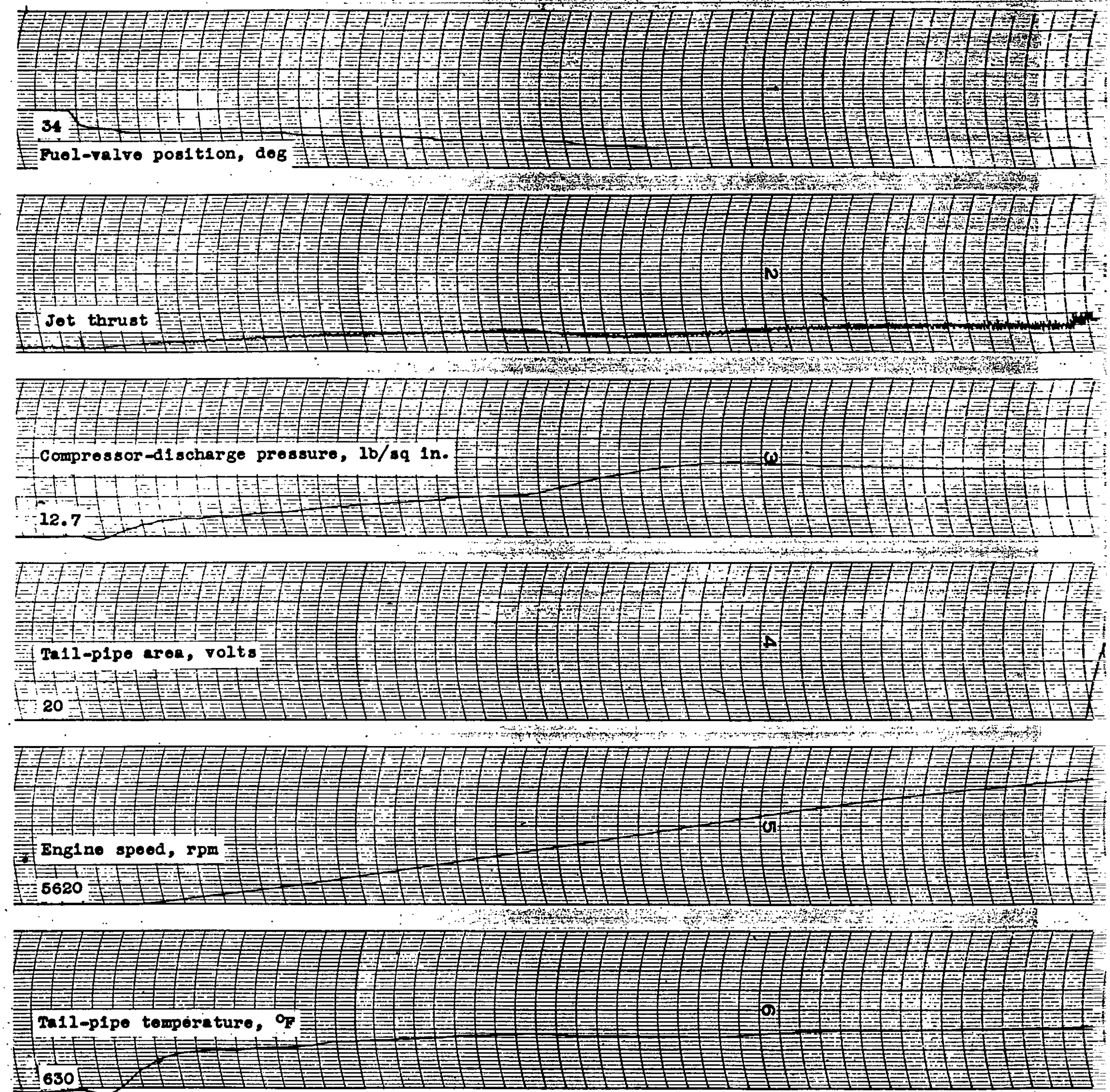

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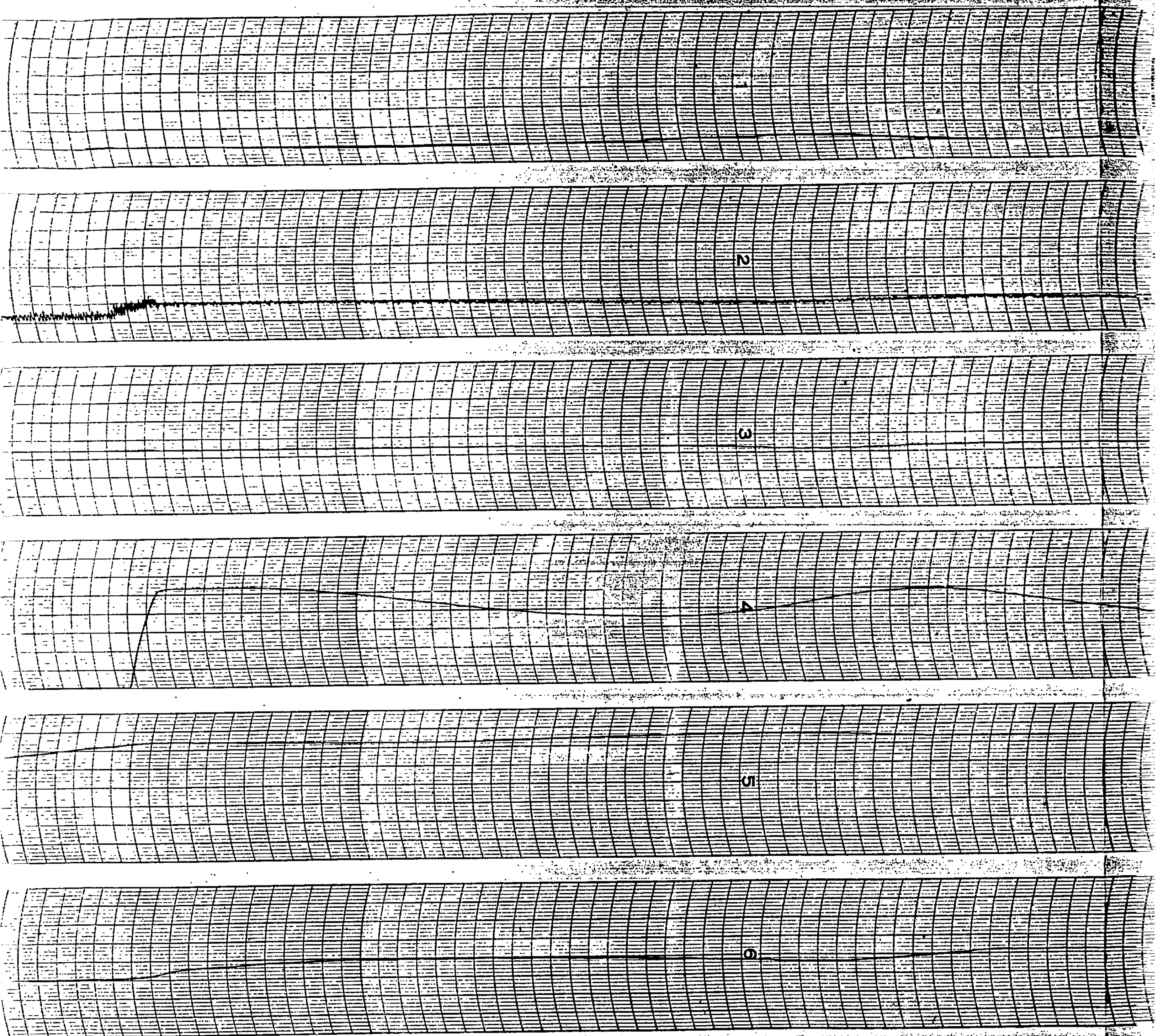
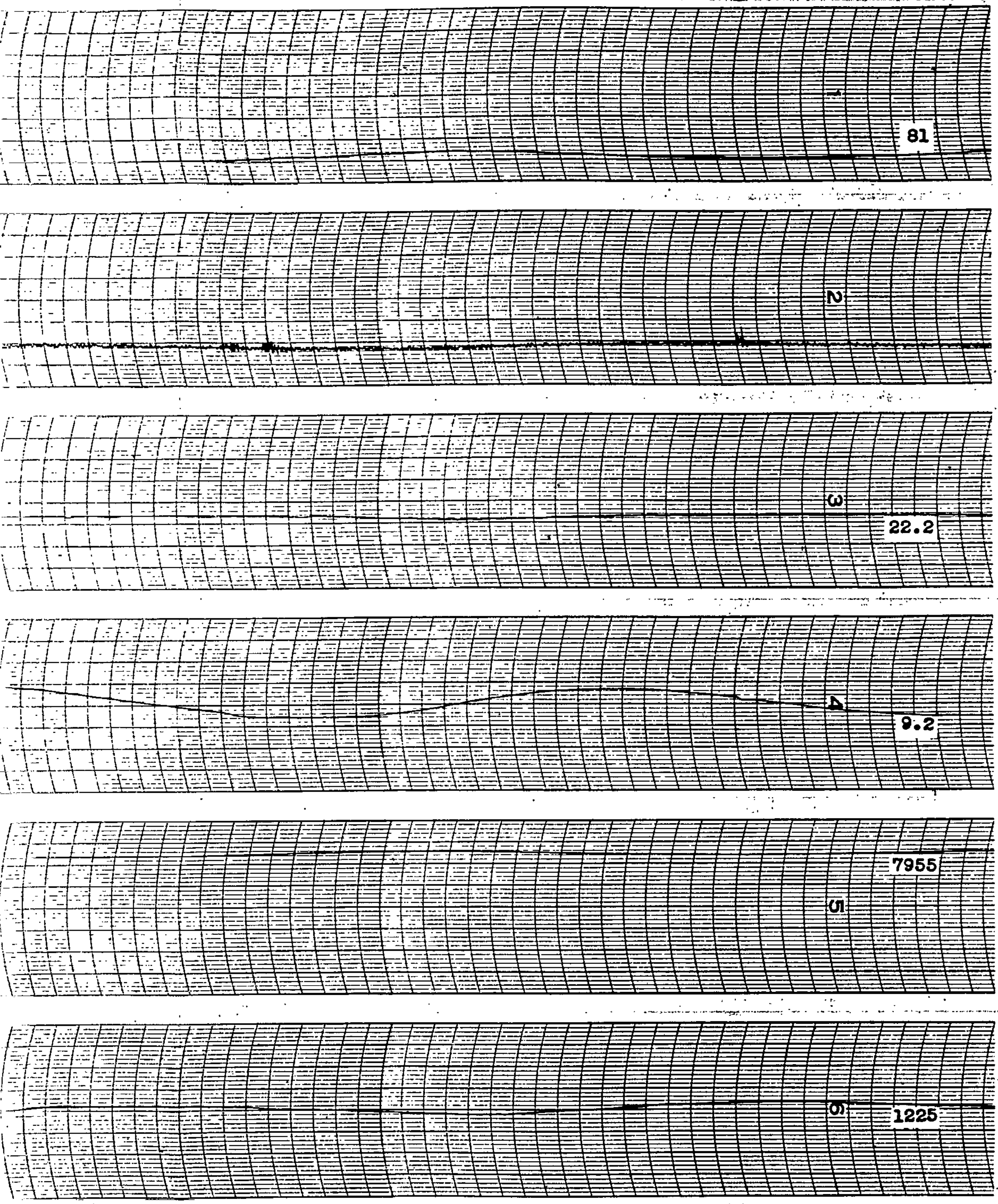


(f) Altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

. Automatically controlled acceleration from idle speed to full dry thrust. (Chart speed 2.5 divisions per second.)



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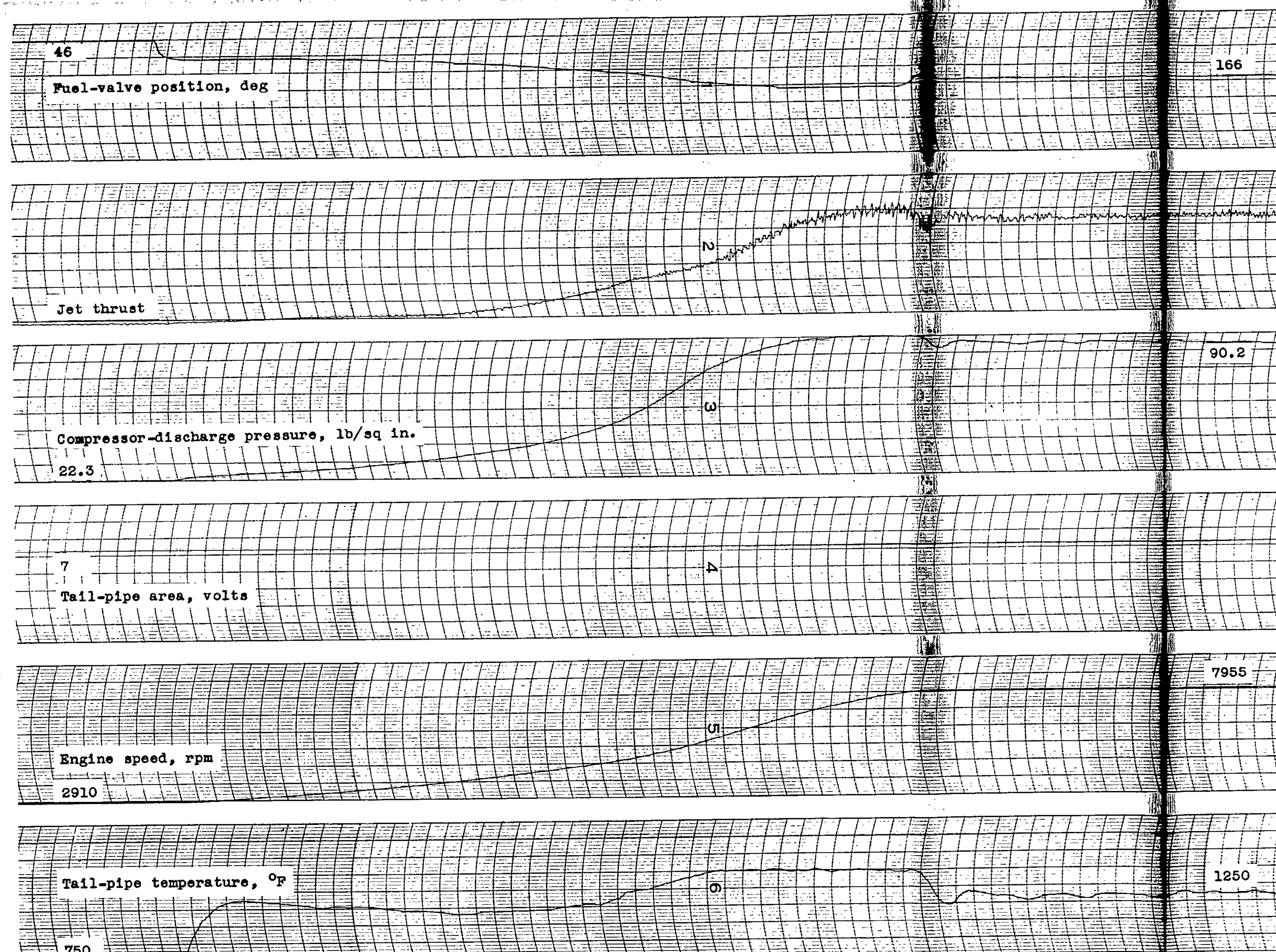

(a) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03; nozzle locked at 7 volts.

Figure 5. - Automatically controlled acceleration from idle speed to full dry thrust with nozzle locked. (Chart speed 2.5 divisions per second.)

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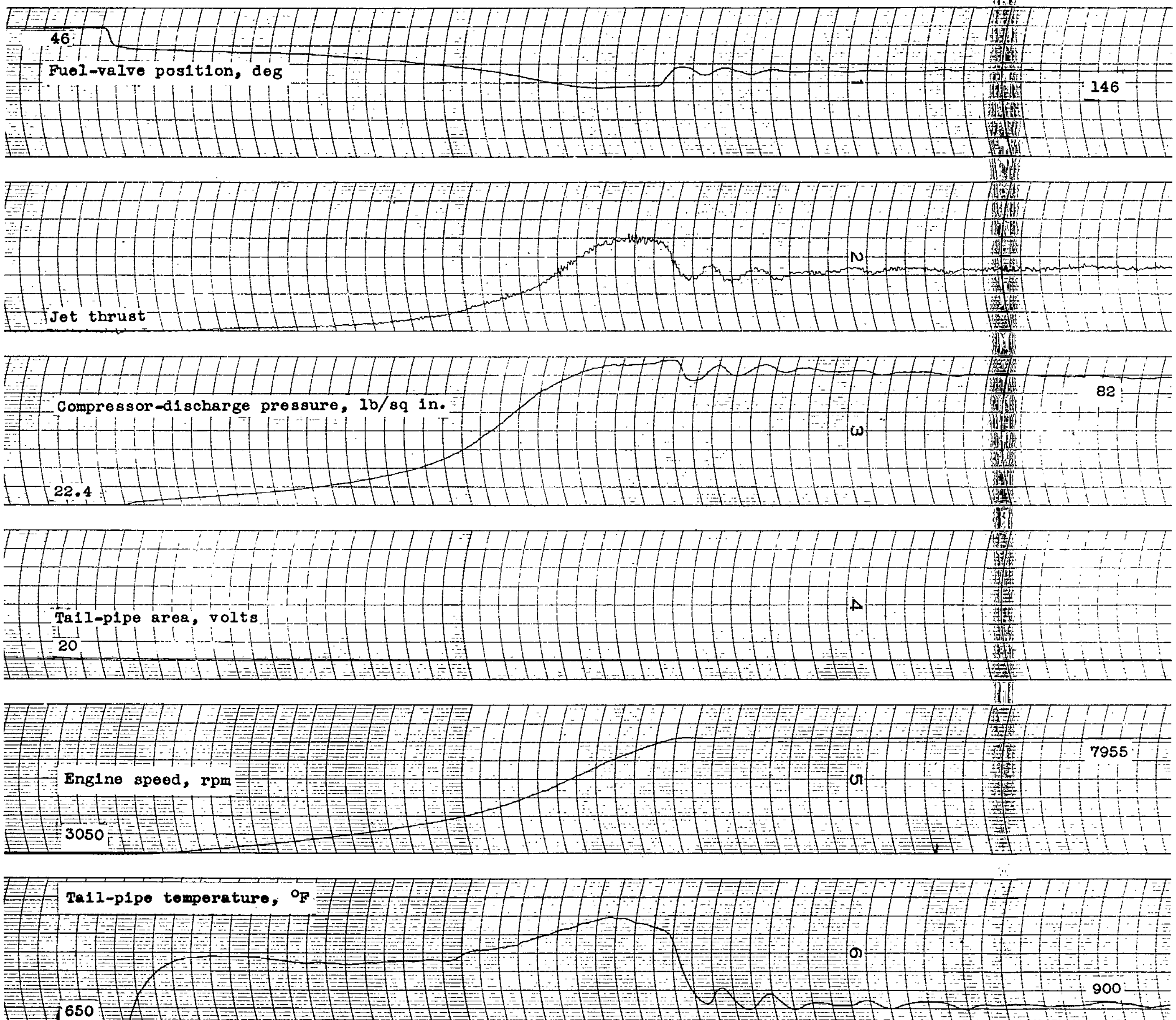

(b) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03; nozzle locked at 20 volts.

Figure 5. - Continued. Automatically controlled acceleration from idle speed to full dry thrust with nozzle locked. (Chart speed 2.5 divisions per second.)

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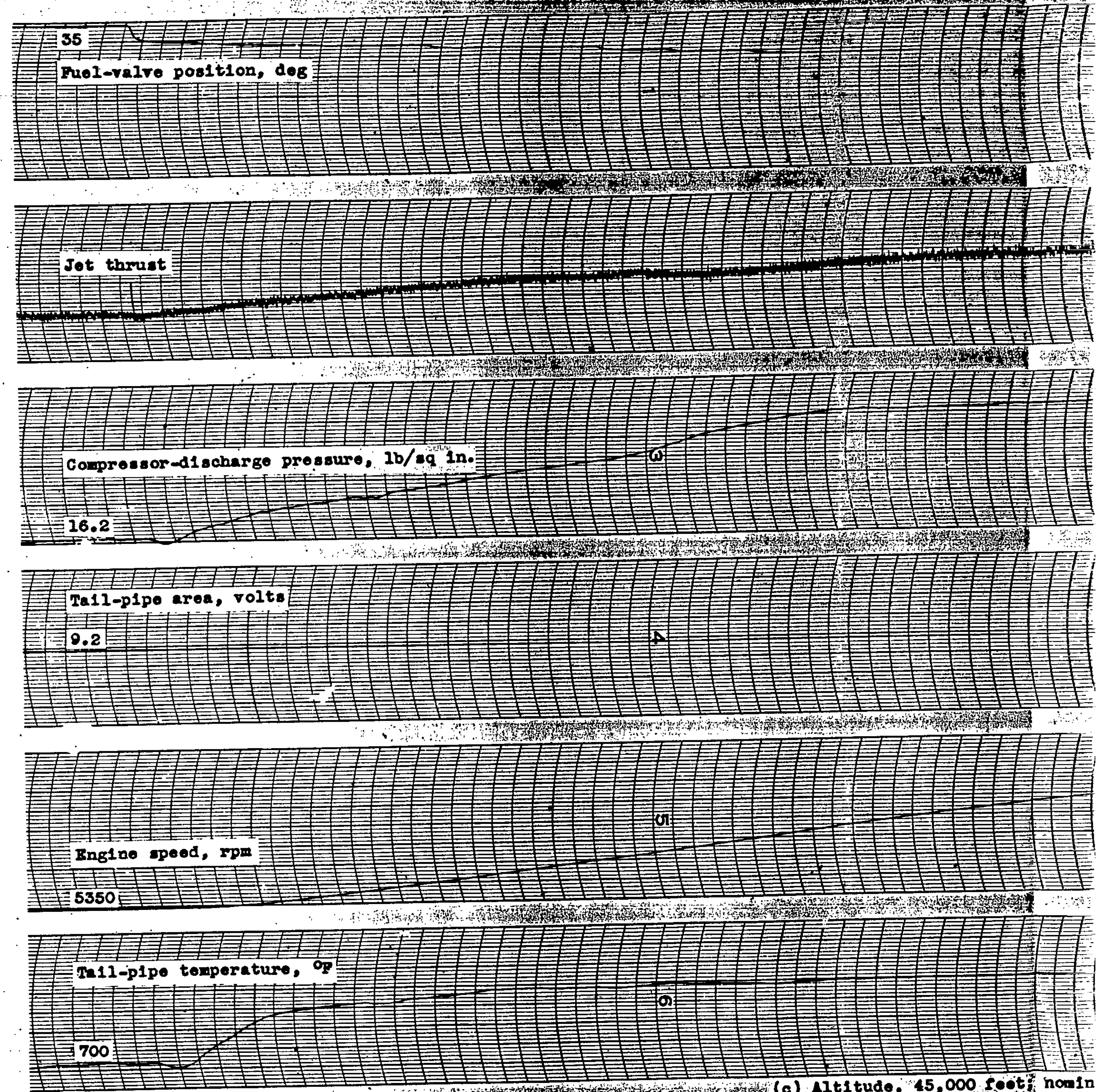

(c) Altitude, 45,000 feet; nomin

Figure 5. - Continued. Automatically controll
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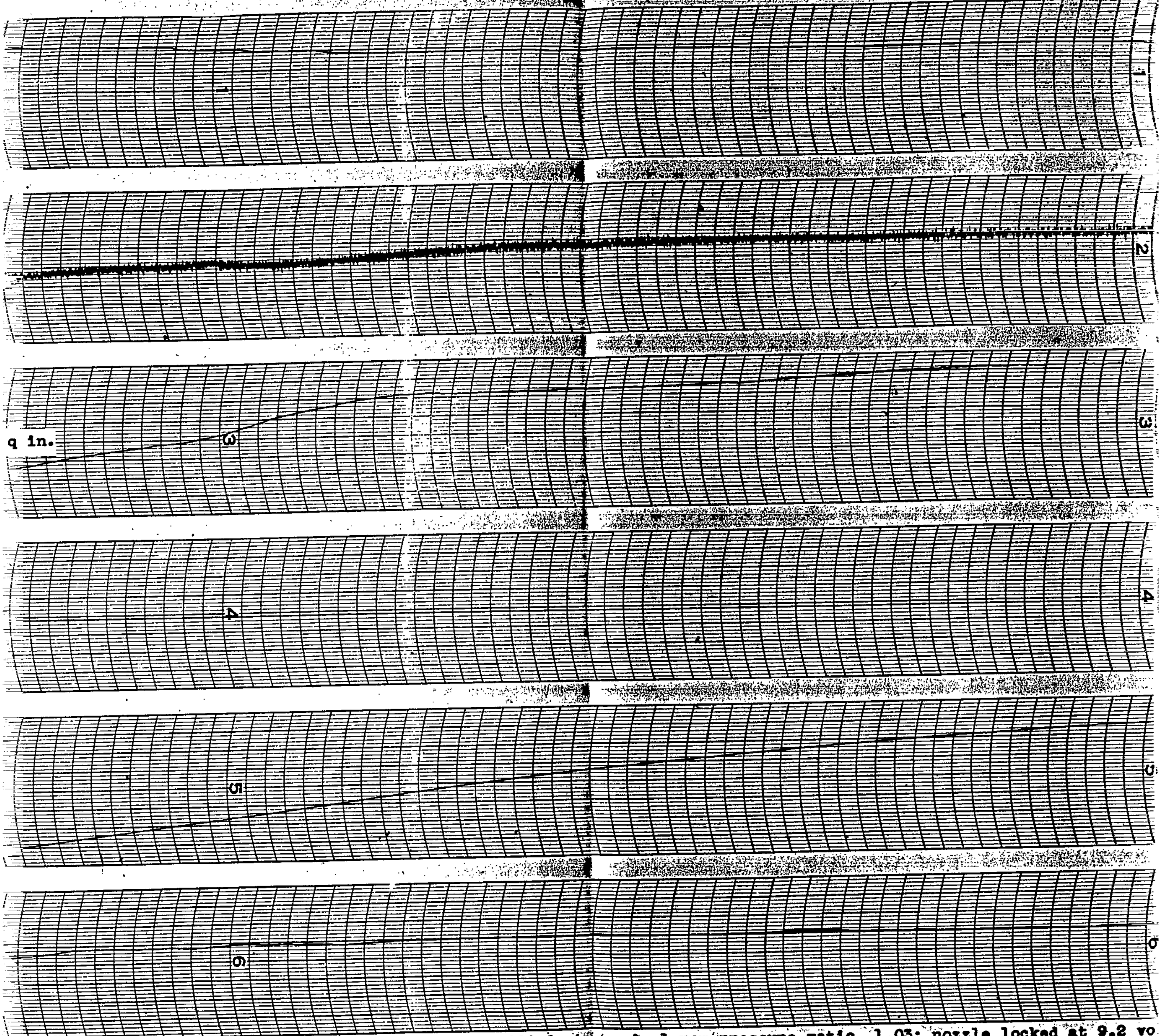

(c) Altitude, 45,000 feet; nominal ram pressure ratio, 1.03; nozzle locked at 9.2 vo

Figure 5. - Continued. Automatically controlled acceleration from idle speed to full dry thrust w
(Chart speed 2.5 divisions per second.)

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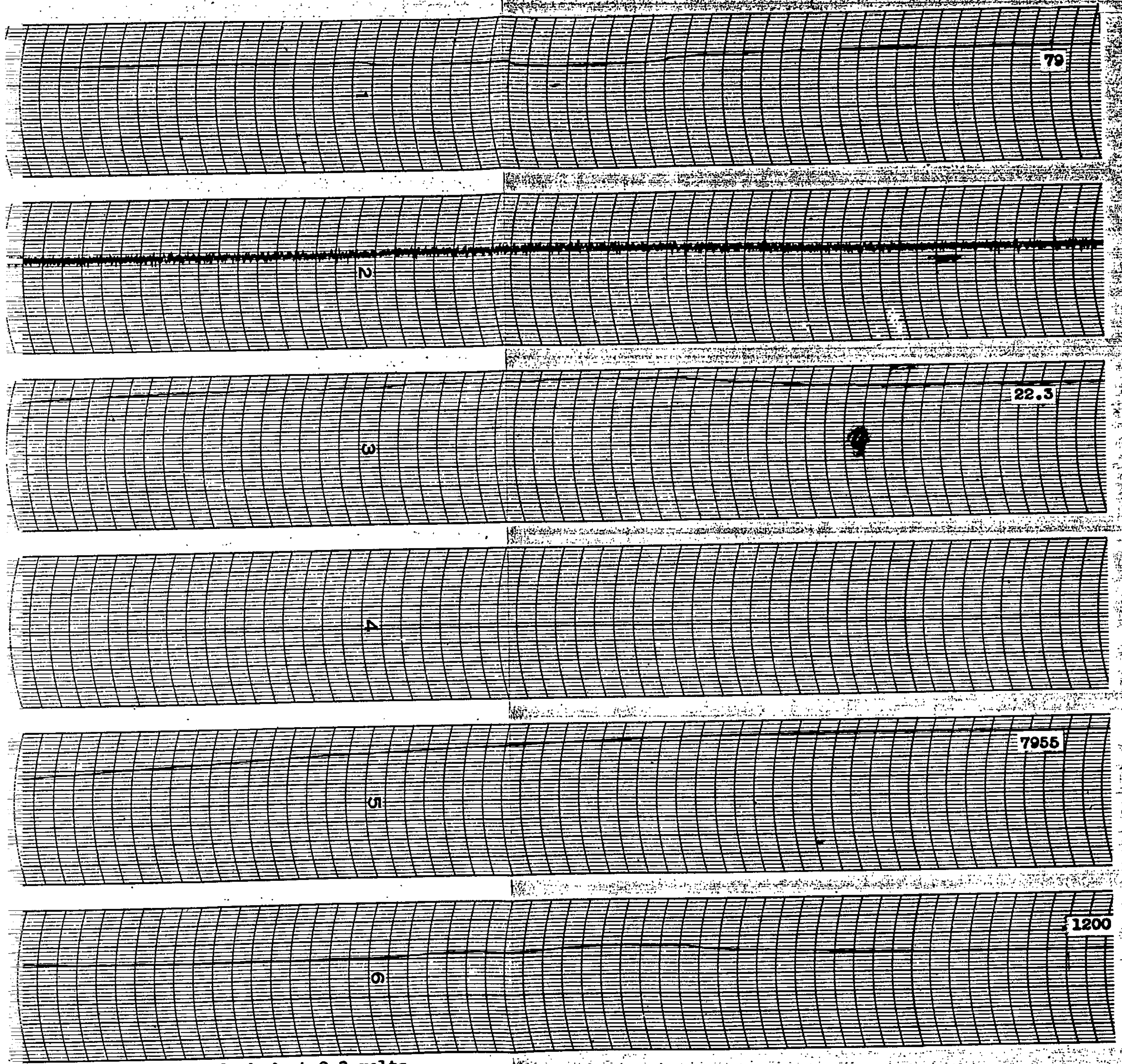

ratio, 1.03; nozzle locked at 9.2 volts.

from idle speed to full dry thrust with nozzle locked.

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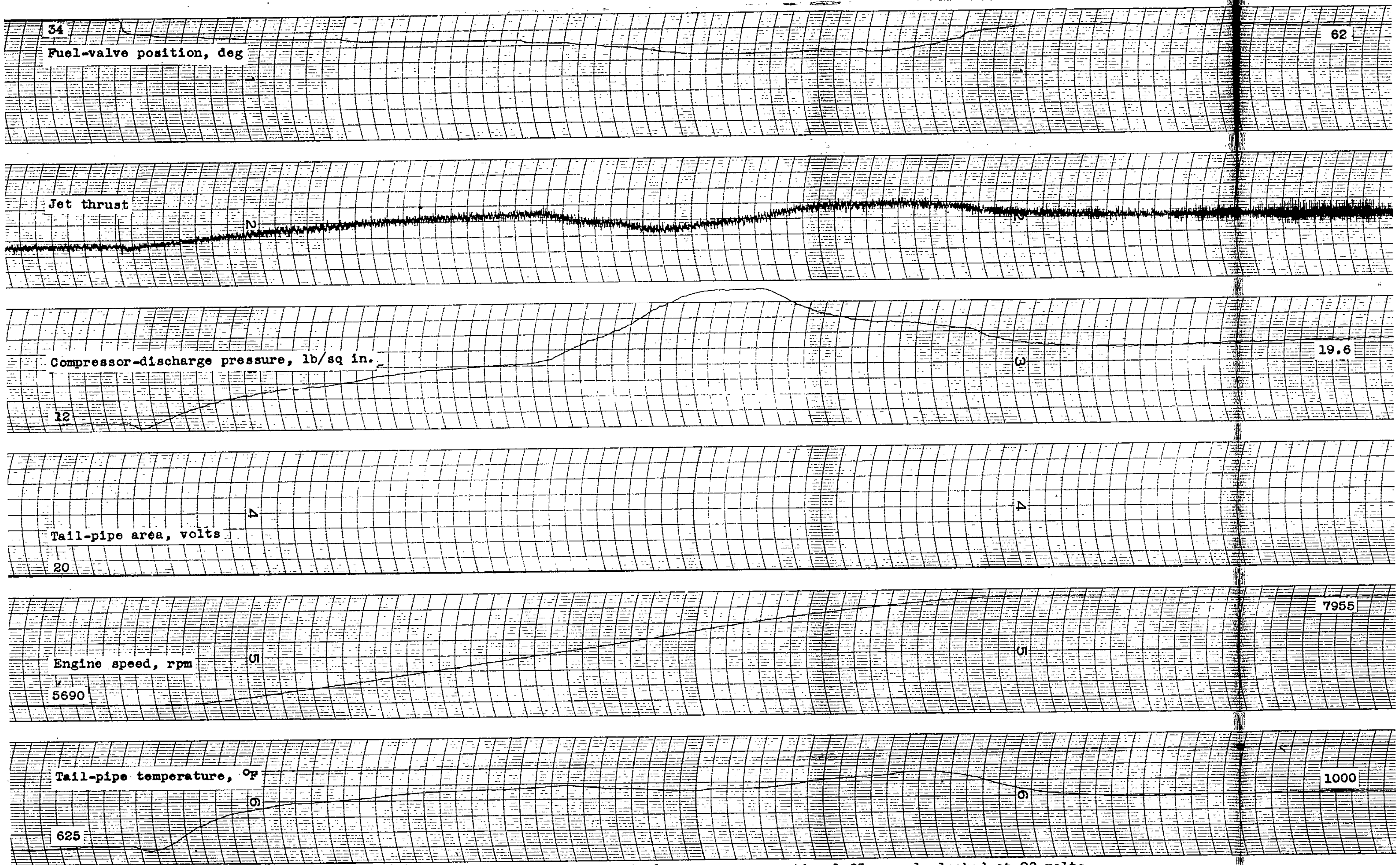

(d) Altitude, 45,000 feet; nominal ram pressure ratio, 1.03; nozzle locked at 20 volts.

Figure 5. - Concluded. Automatically controlled acceleration from idle speed to full dry thrust with nozzle locked. (Chart speed 2.5 divisions per second.)

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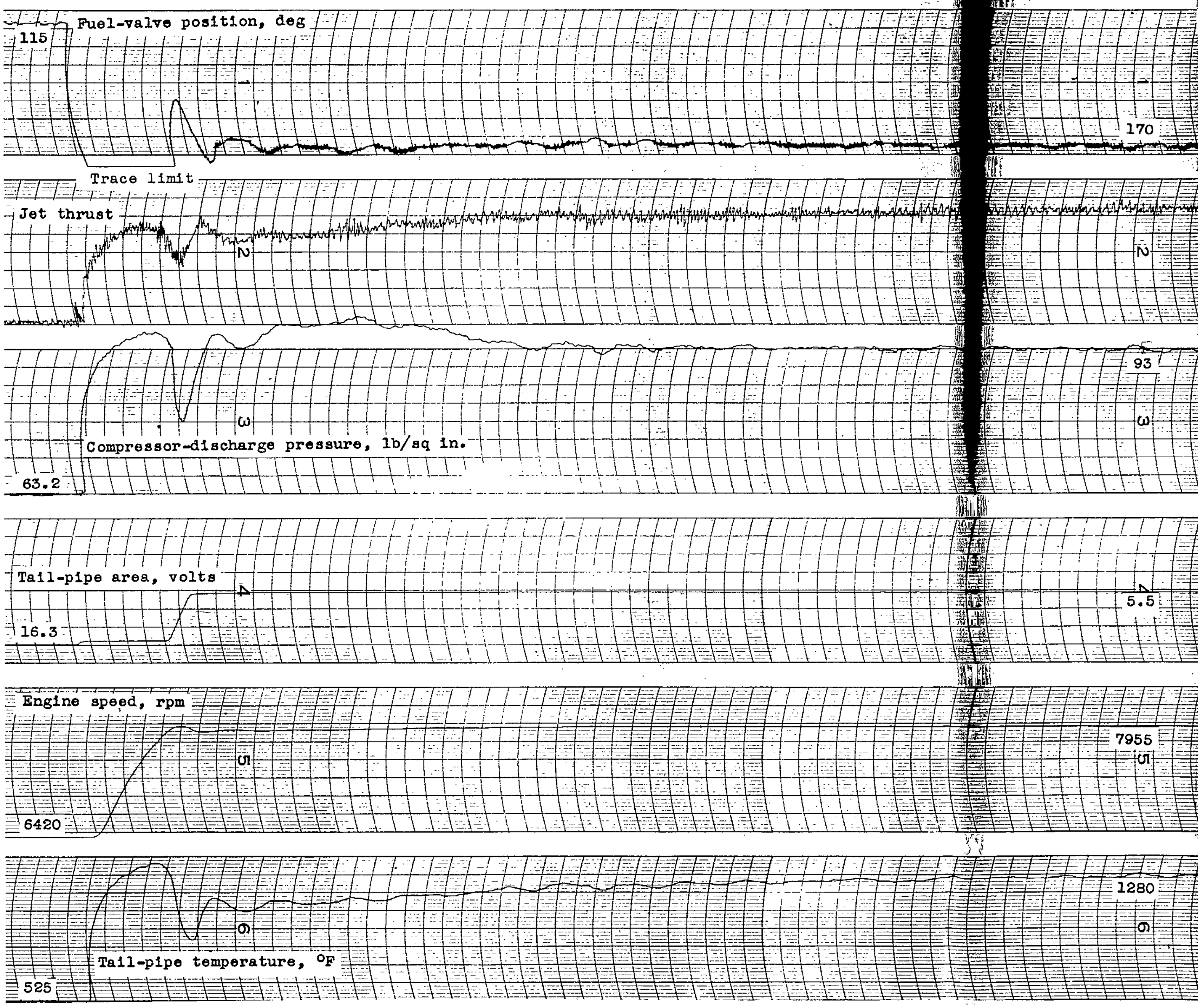

(a) Thrust selector variation, 35° to 90°; altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

Figure 6. - Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per second.)

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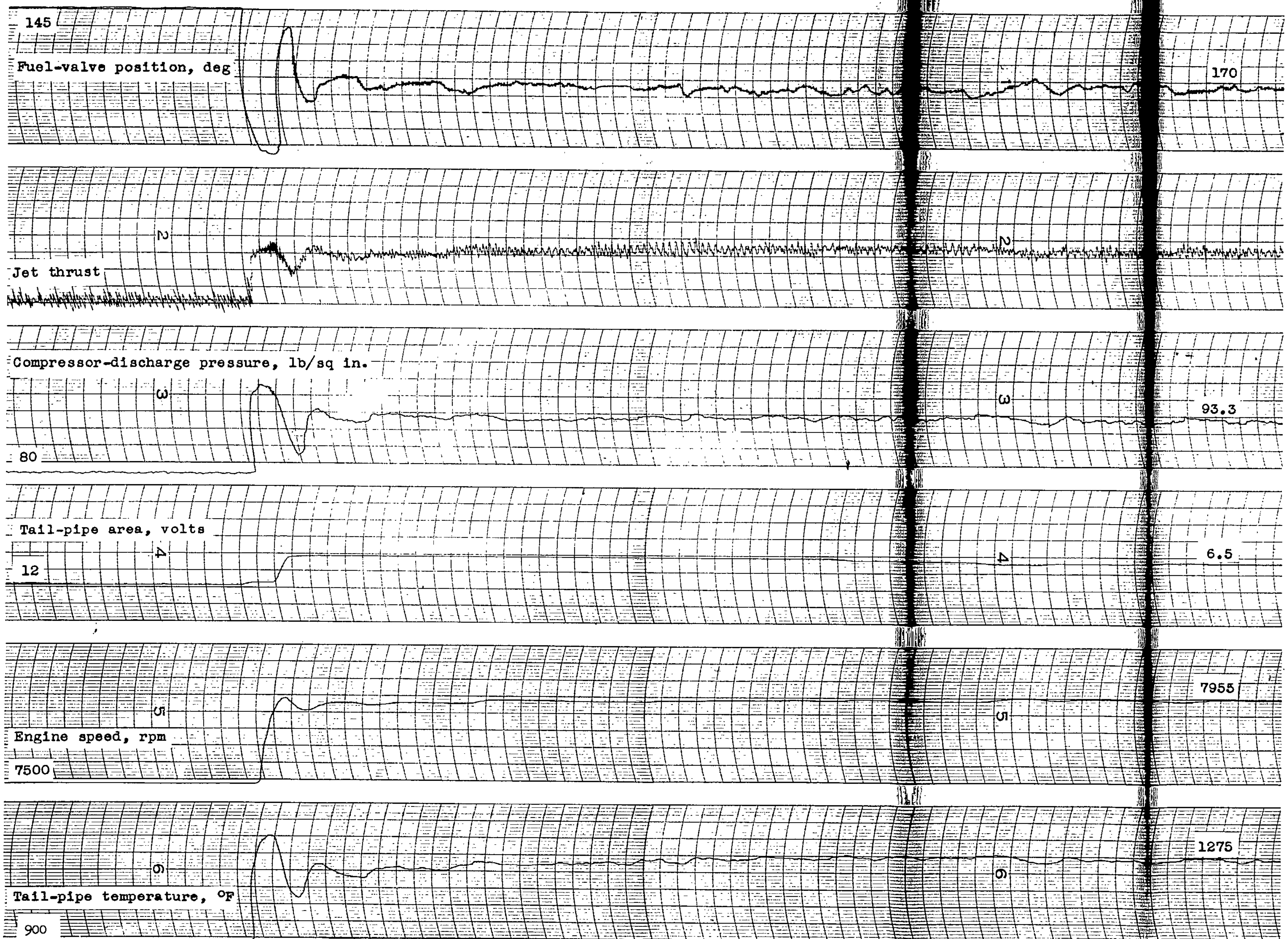

(b) Thrust selector variation, 55° to 90°; altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

Figure 6. - Continued. Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per second.)

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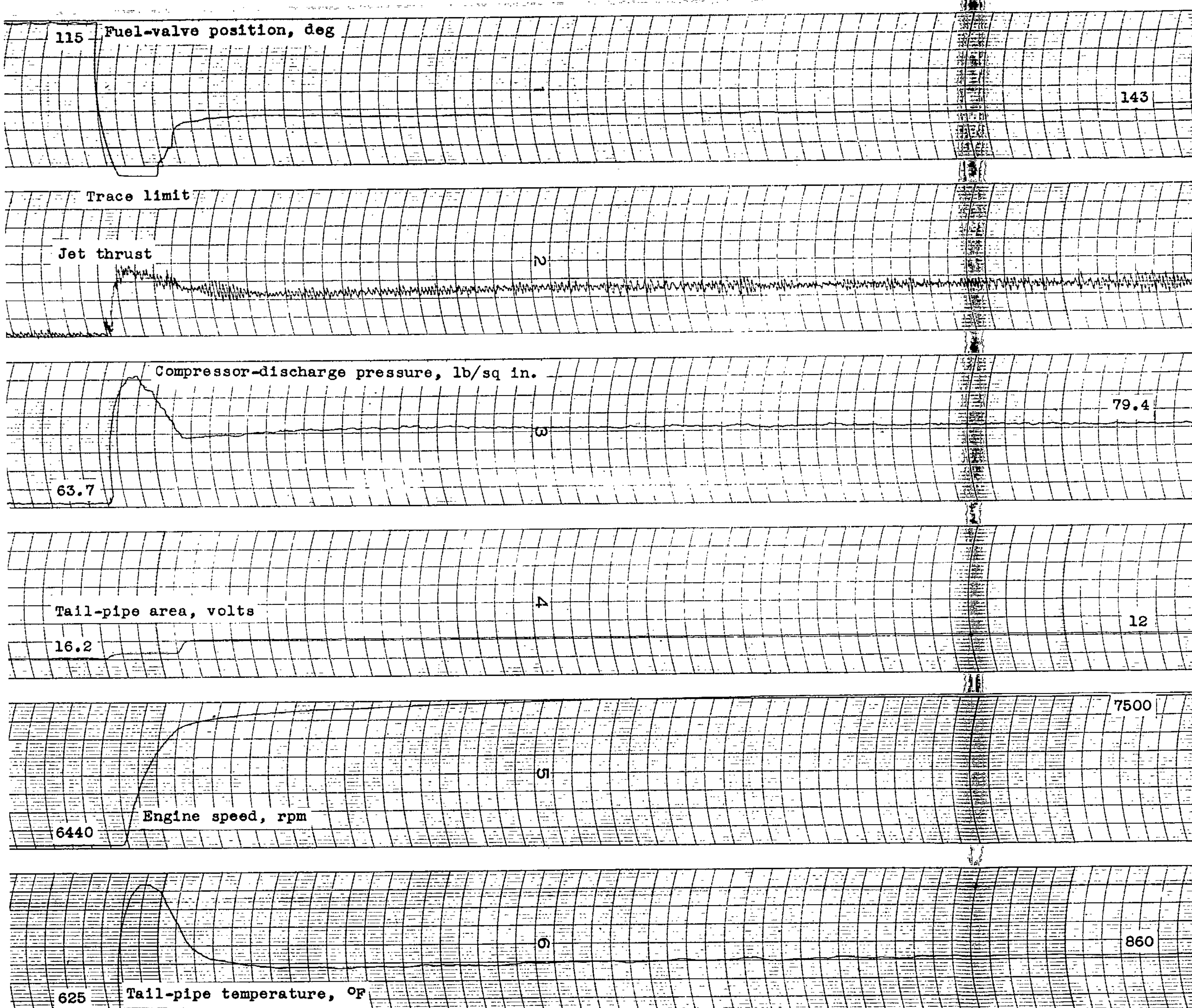

(c) Thrust selector variation, 35° to 55°; altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

Figure 6. - Continued. Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per second.)

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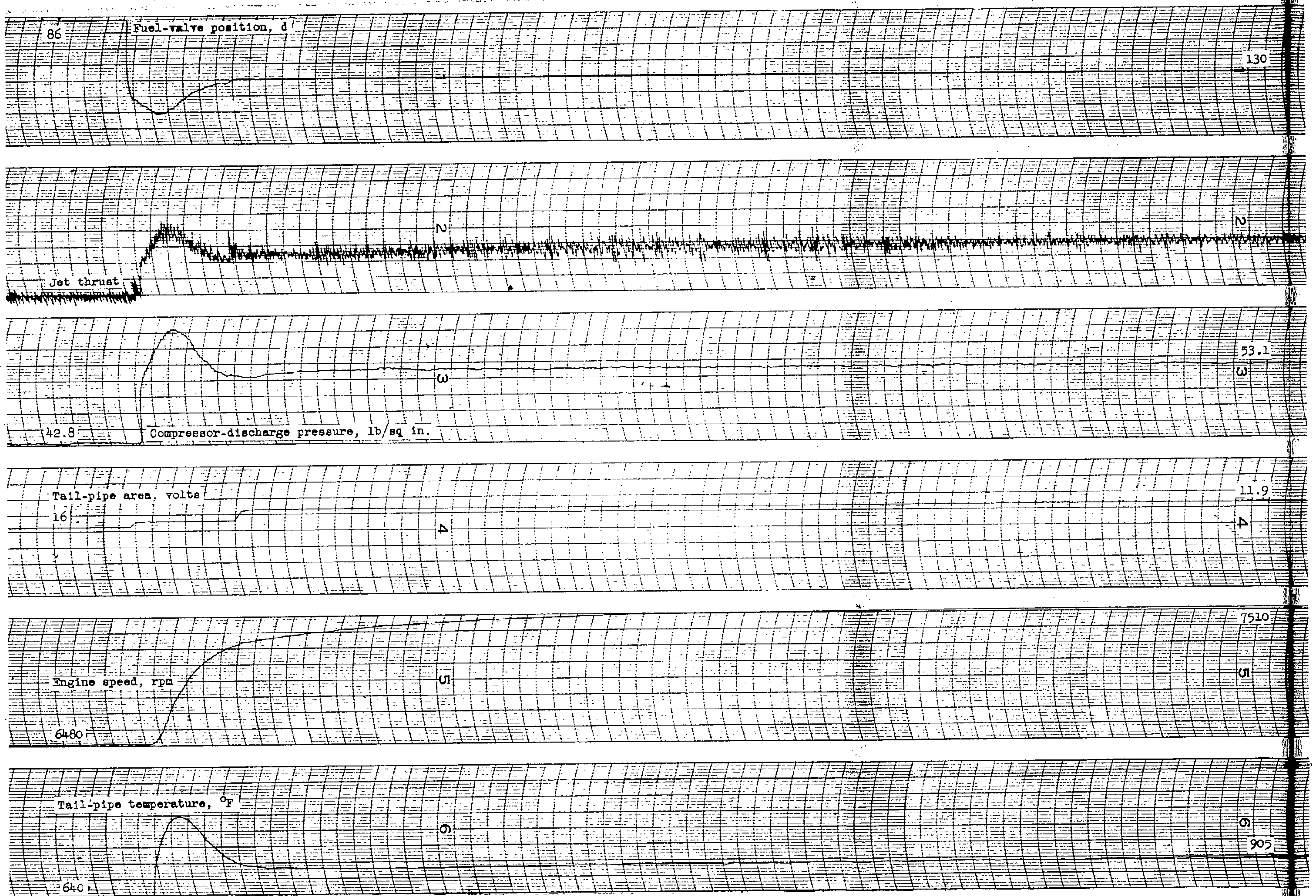

(d) Thrust selector variation, 36° to 55°; altitude, 25,000 feet; nominal ram pressure ratio, 1.03.

Figure 6. - Continued. Automatically controlled acceleration from various thrust selector positions other than idle.

(Chart speed 2.5 divisions per second.)

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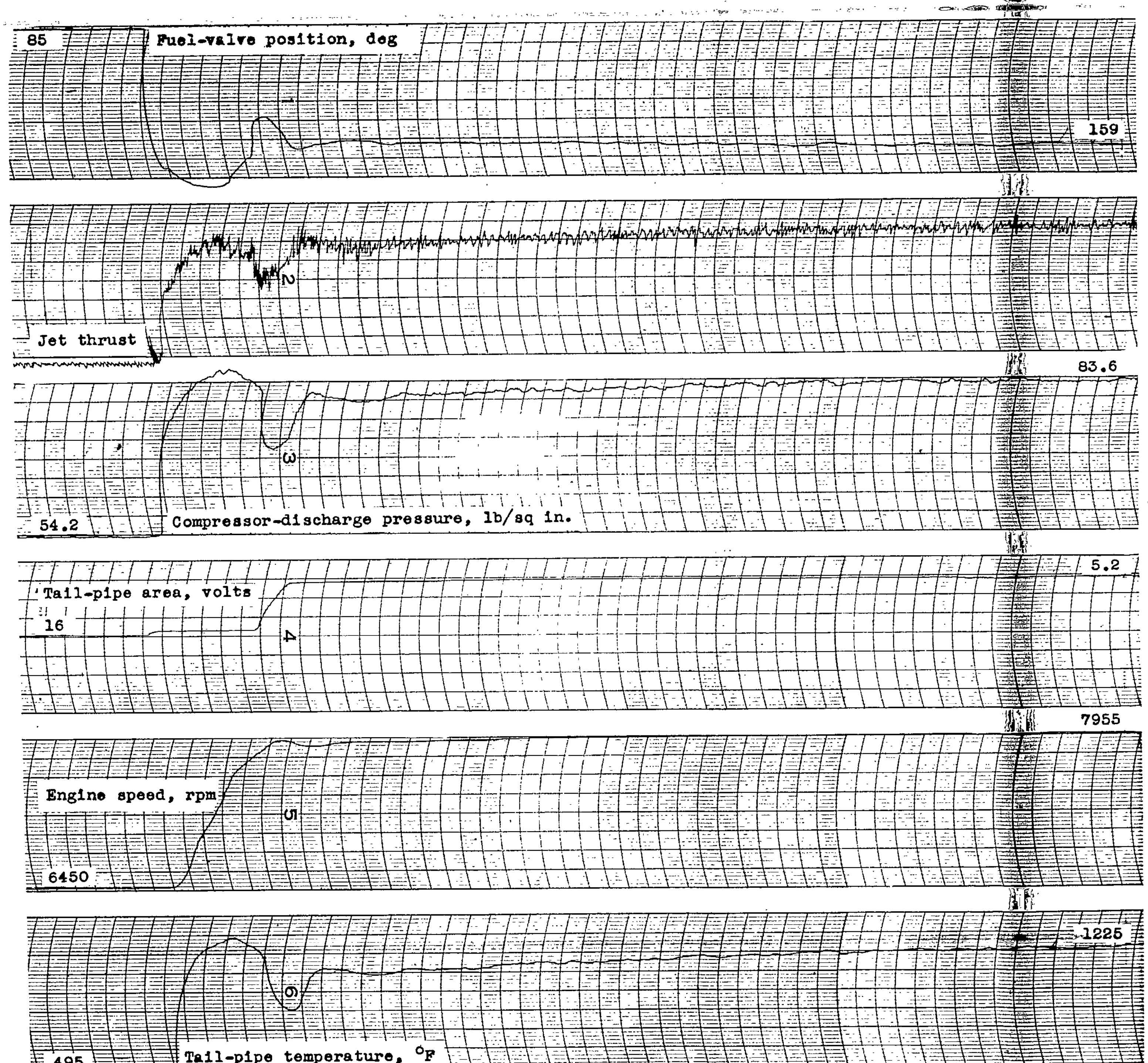

(e) Thrust selector variation, 36° to 90°; altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

Figure 6. - Continued. Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per second.)

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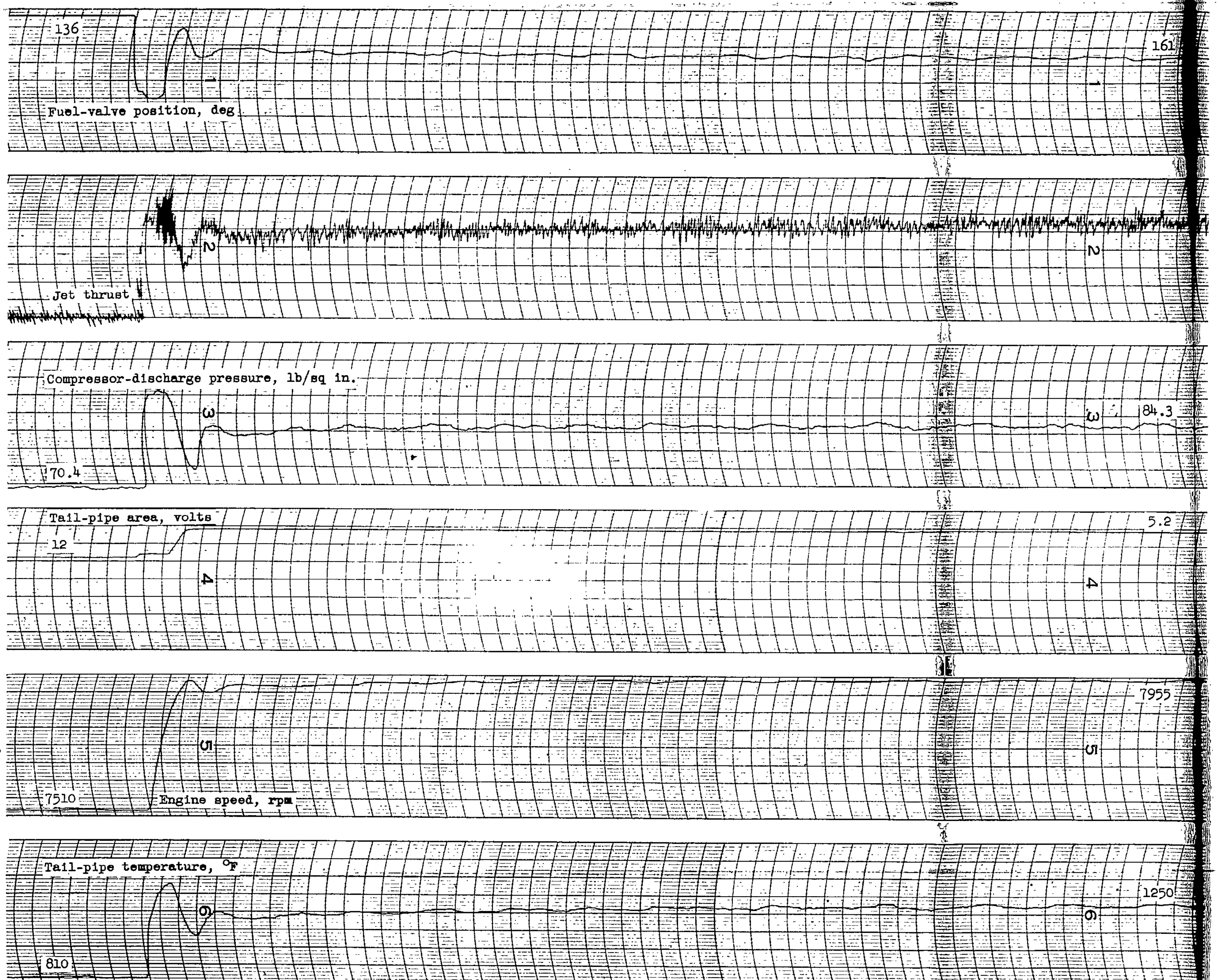

(f) Thrust selector variation, 55° to 90°; altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

Figure 6. - Continued. Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per second.)

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(g) Thrust selector variation, 36° to 55°; altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

Figure 6. - Continued. Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per second.)

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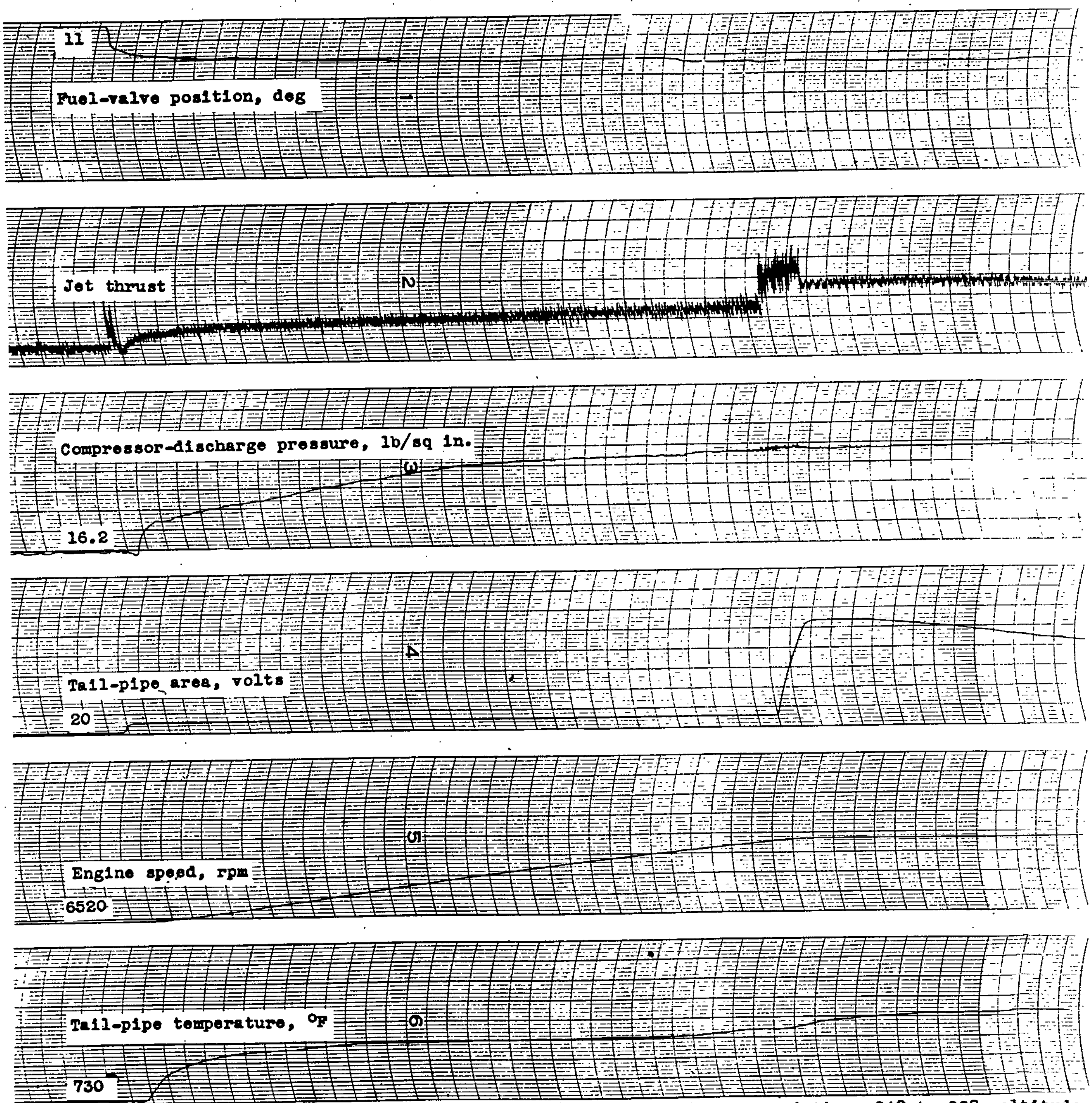
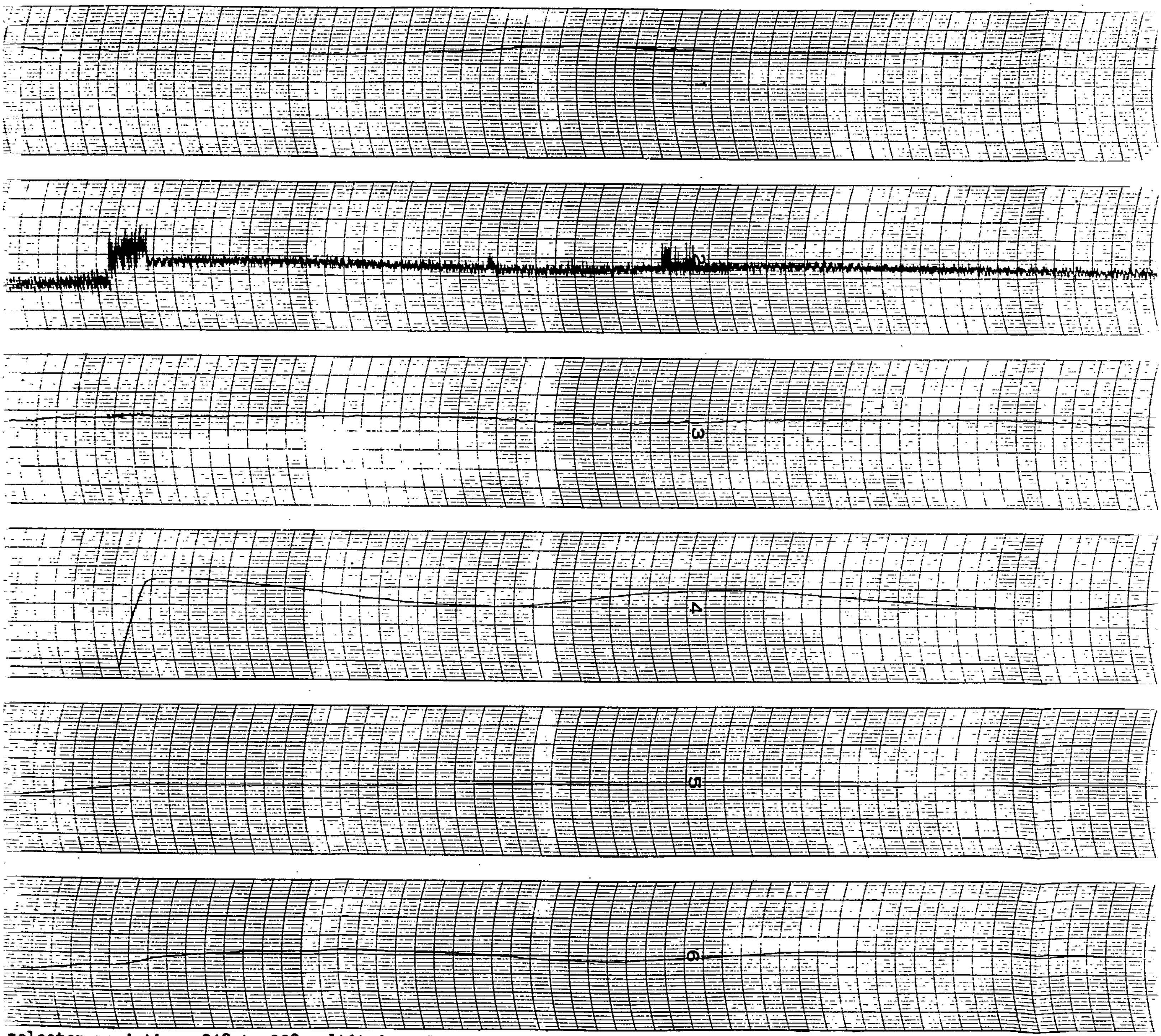


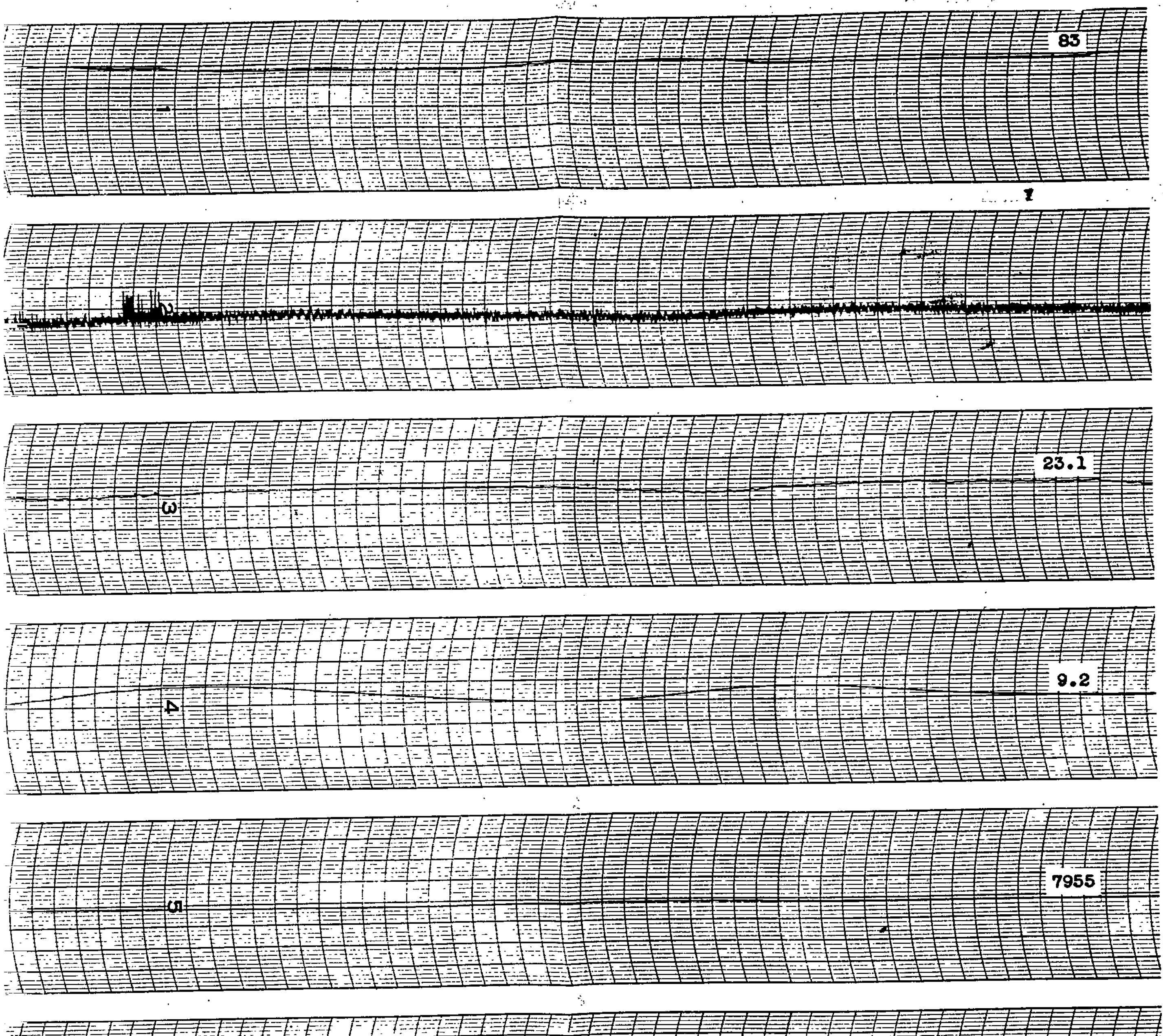
(h) Thrust selector variation, 24° to 90°; altitude,

Figure 6. - Continued. Automatically controlled acceleration from various



selector variation, 24° to 90°; altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

lly controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per se



nominal ram pressure ratio, 1.03.

r positions other than idle. (Chart speed 2.5 divisions per second.)

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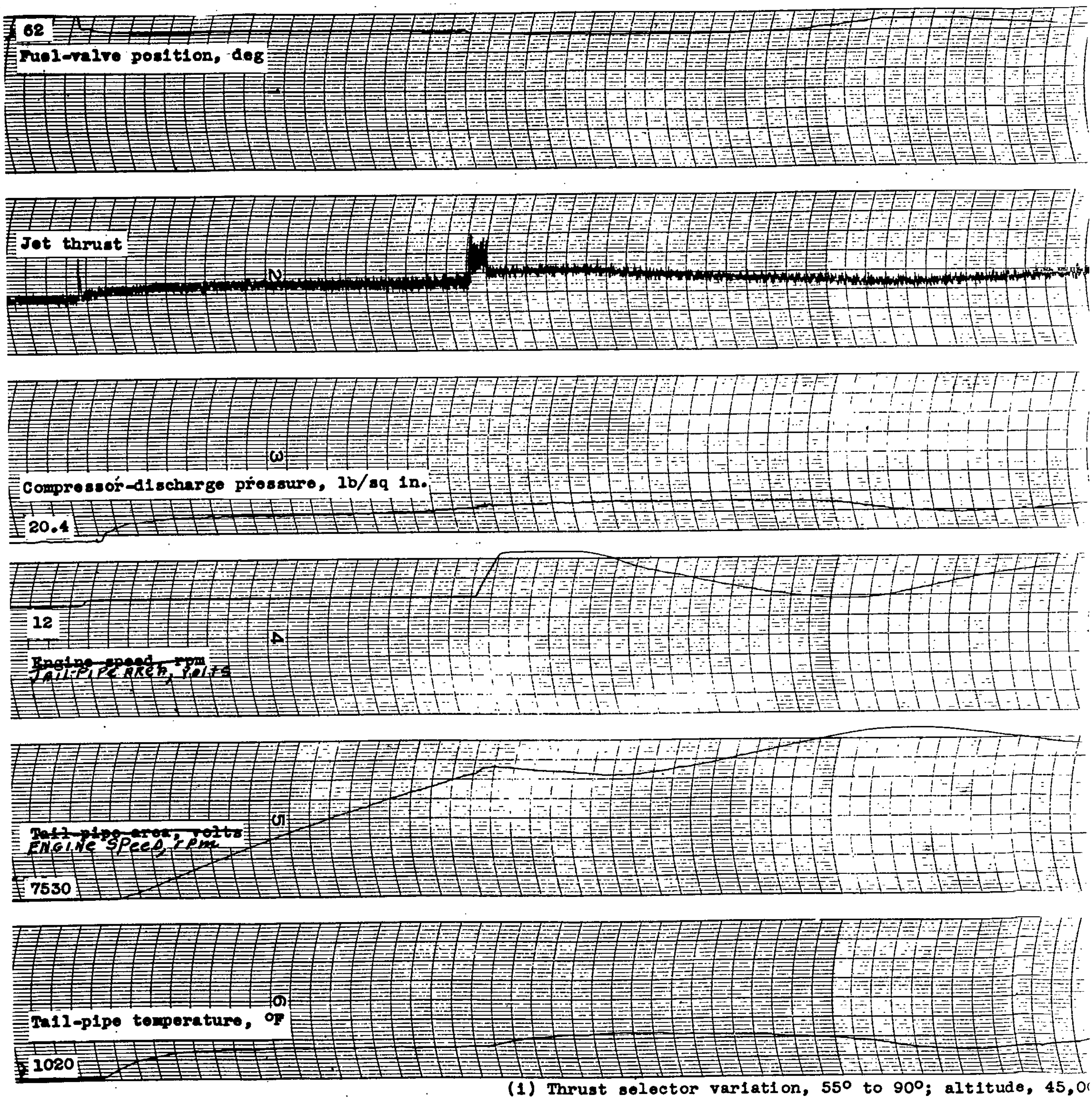

(i) Thrust selector variation, 55° to 90°; altitude, 45,0

Figure 6. - Continued. Automatically controlled acceleration from various thrus

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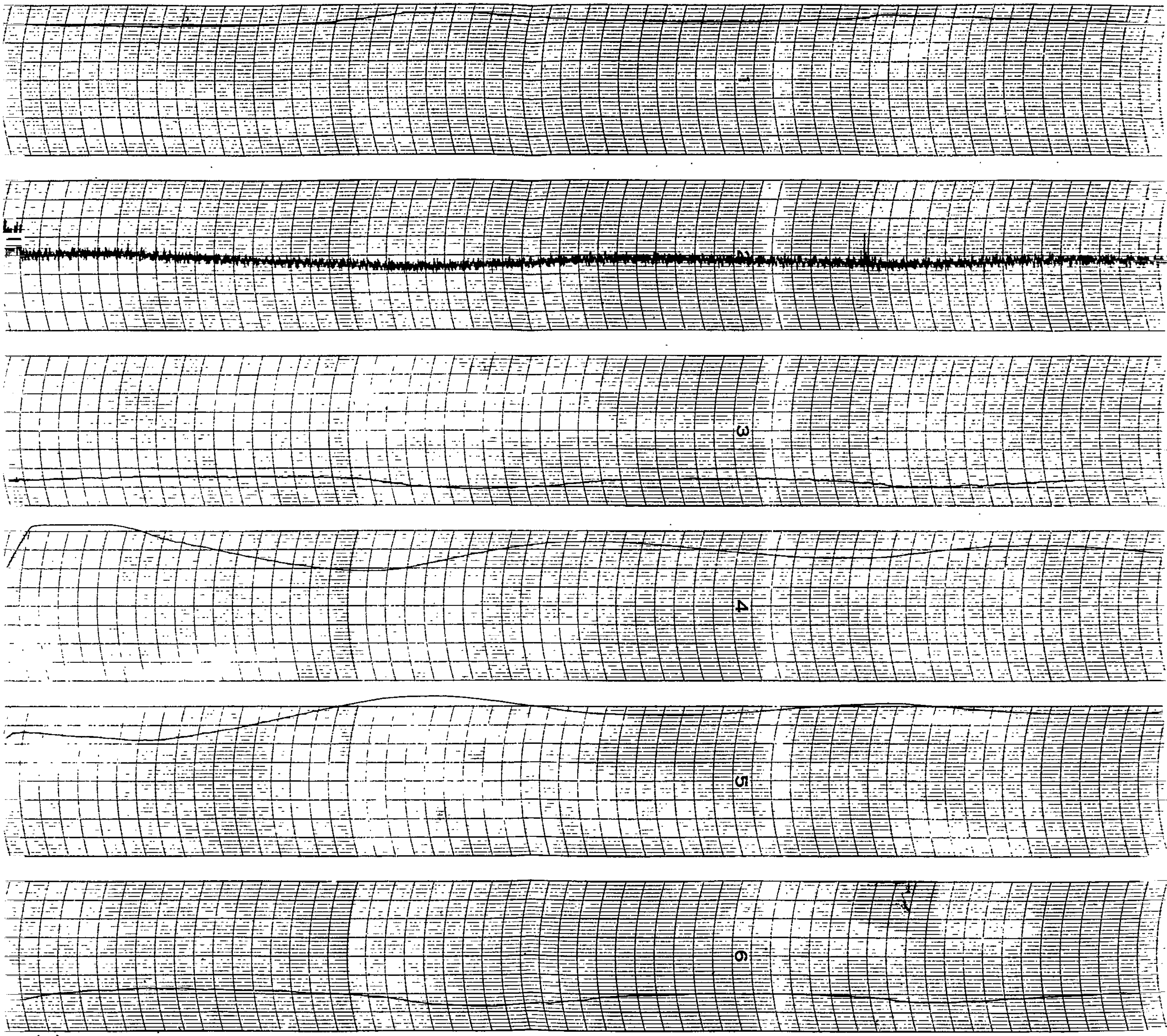

(i) Thrust selector variation, 55° to 90°; altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

i. Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 div

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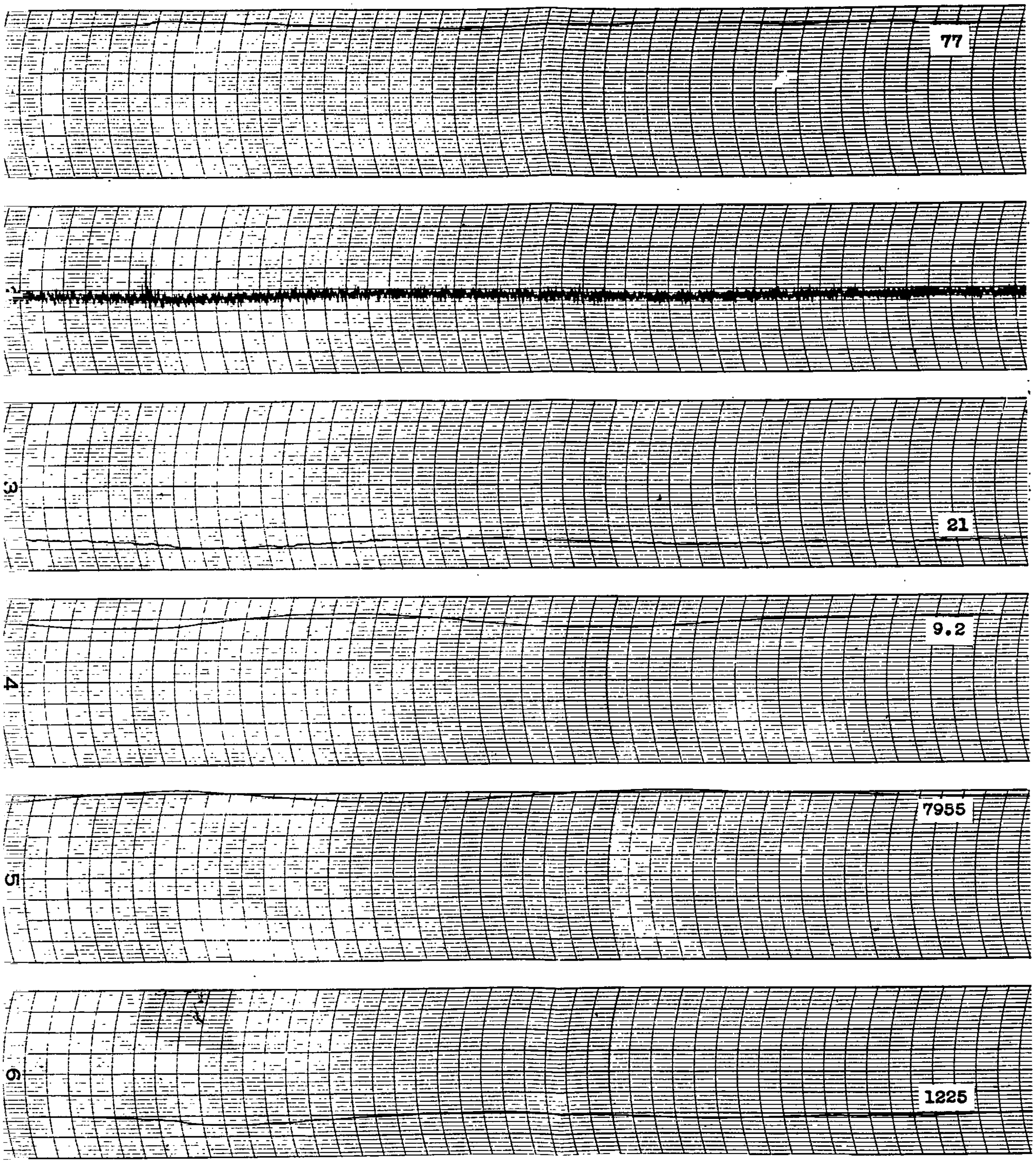

l ram pressure ratio, 1.03.

tions other than idle. (Chart speed 2.5 divisions per second.)

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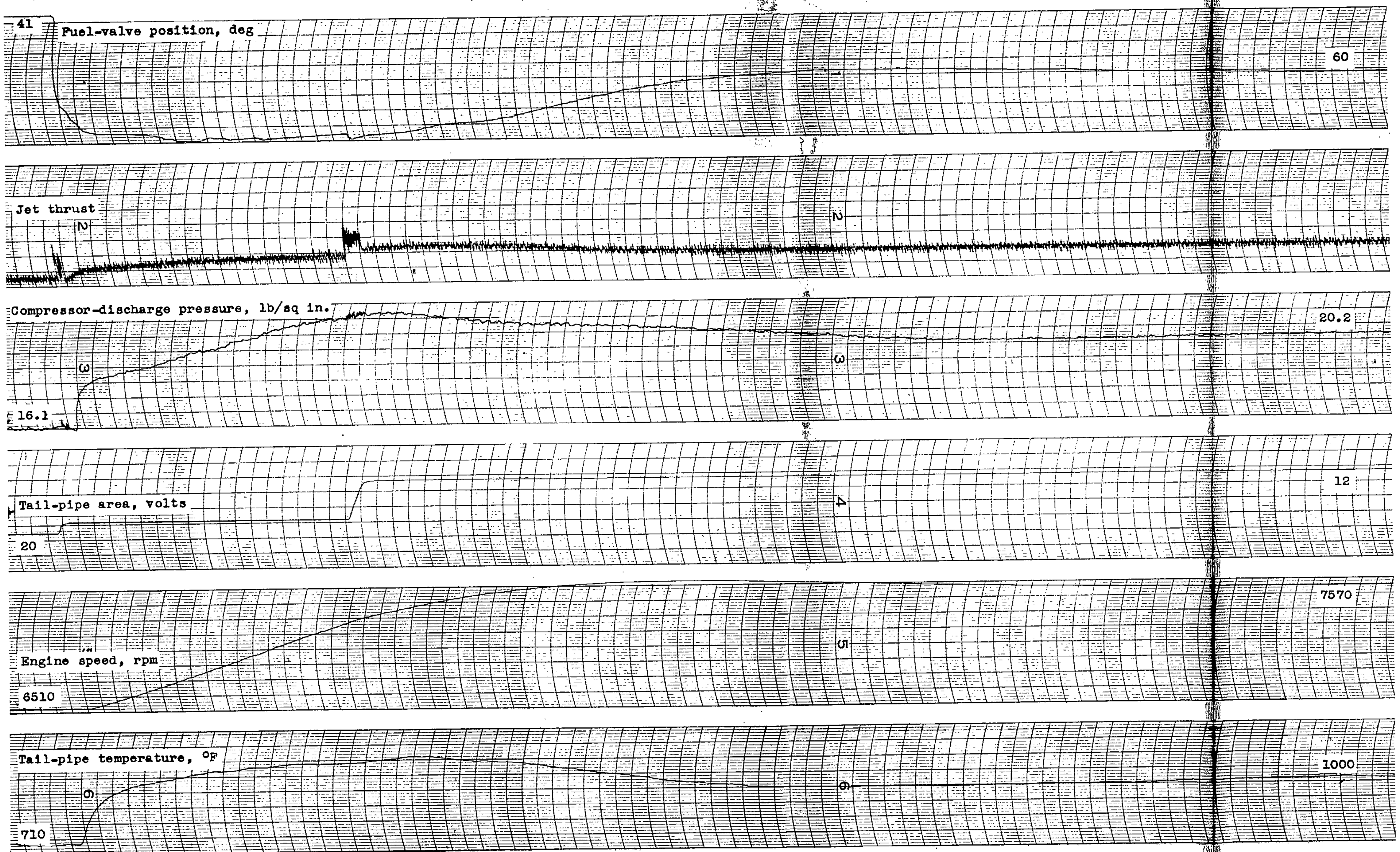

(j) Thrust selector variation, 23° to 55°; altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

Figure 6. - Concluded. Automatically controlled acceleration from various thrust selector positions other than idle. (Chart speed 2.5 divisions per second.)

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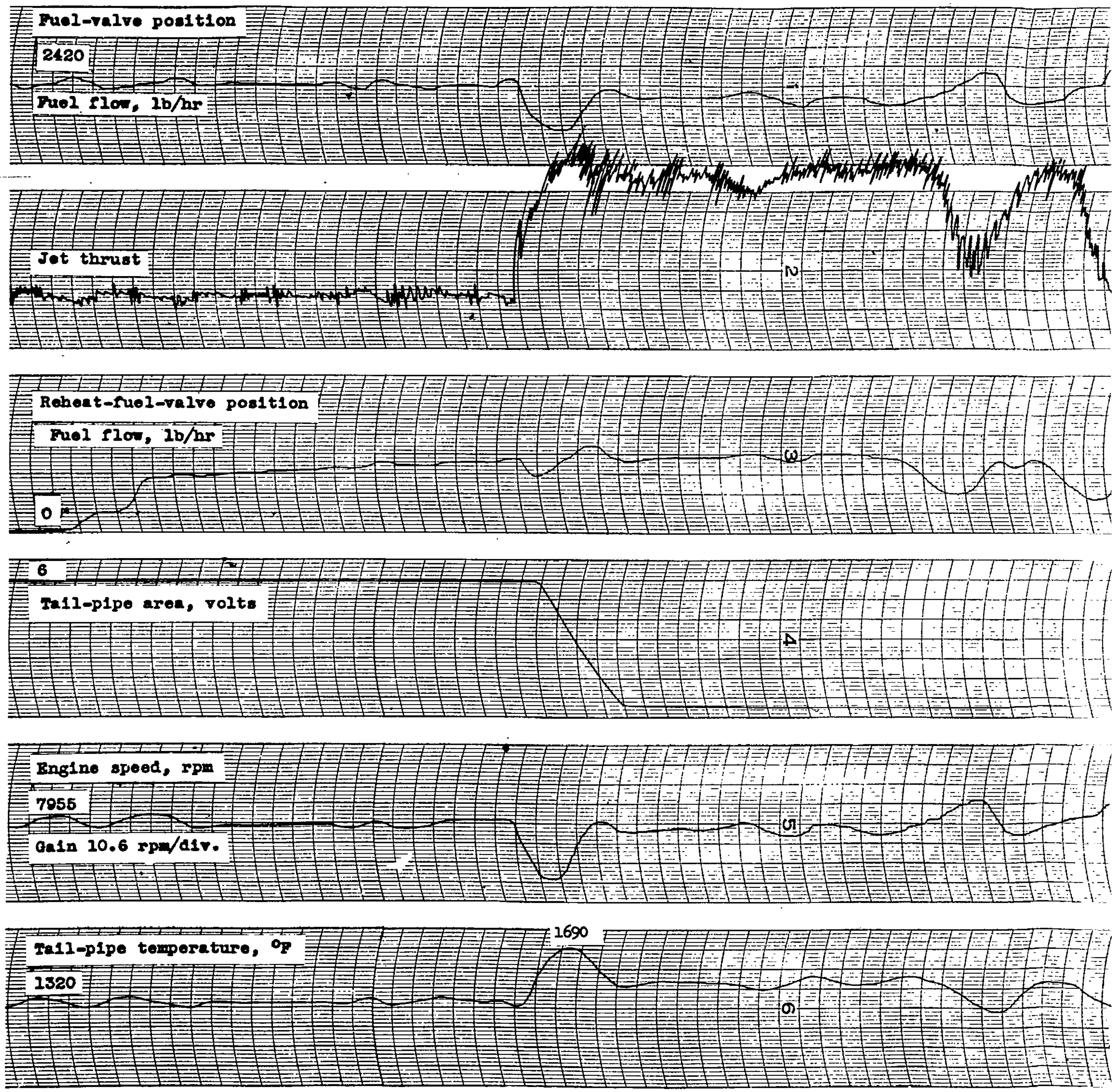
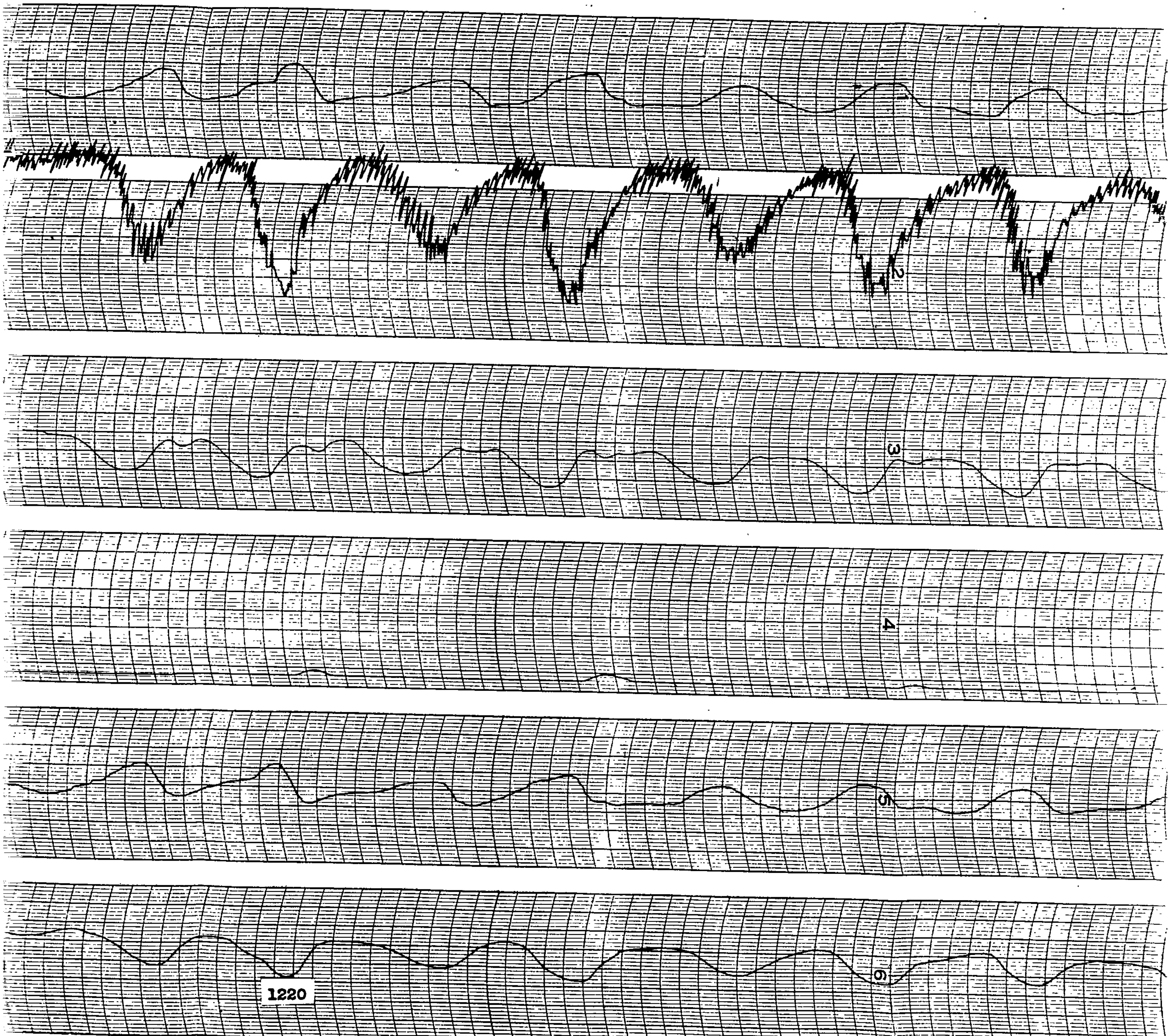


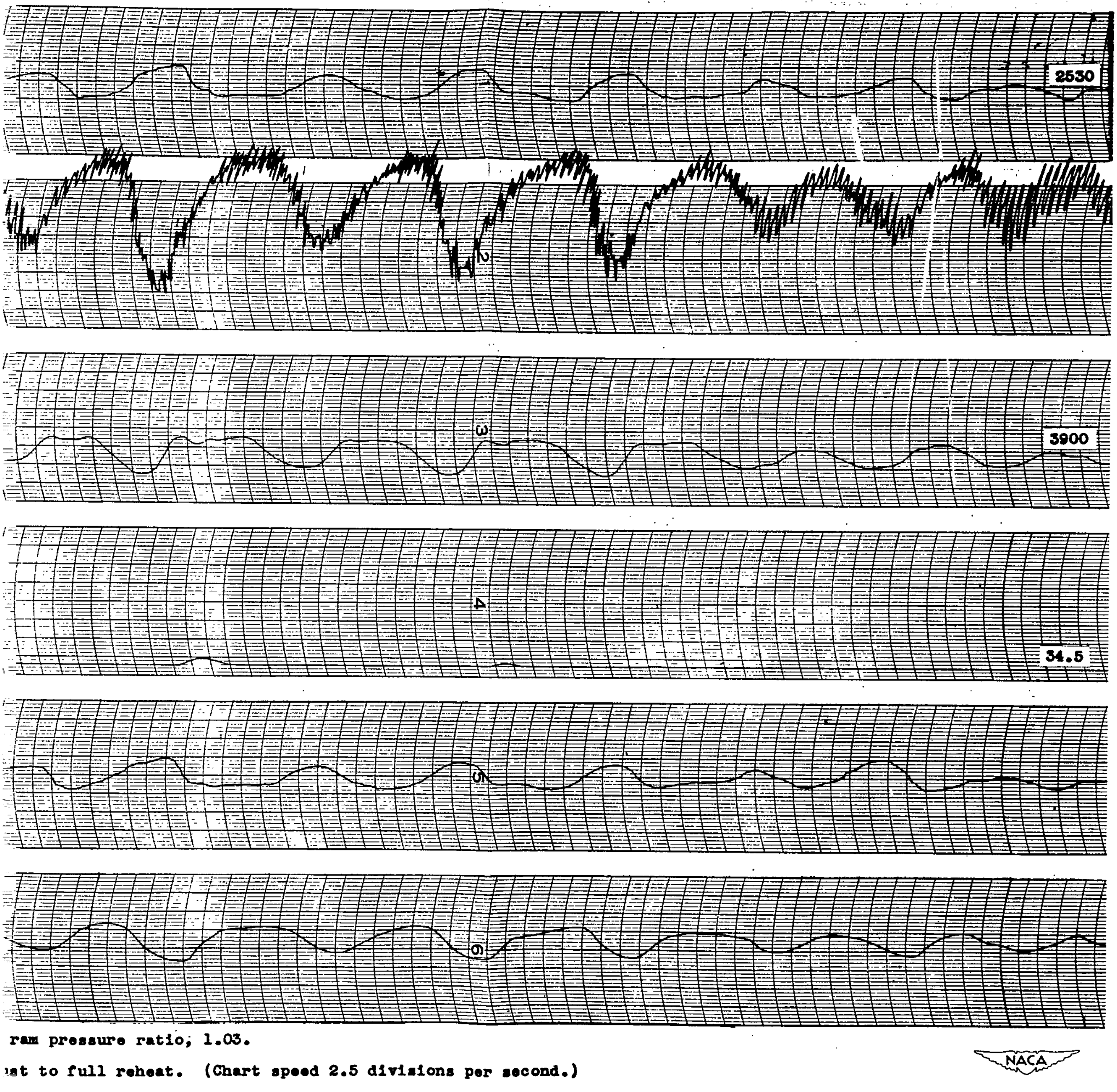
(a) Altitude, 25,000

Figure 7. - Automatically controlled acceleration fro



(a) Altitude, 25,000 feet; nominal ram pressure ratio, 1.03.

ontrolled acceleration from full dry thrust to full reheat. (Chart speed 2.5 divisions per second.)



ram pressure ratio, 1.03.

ist to full reheat. (Chart speed 2.5 divisions per second.)

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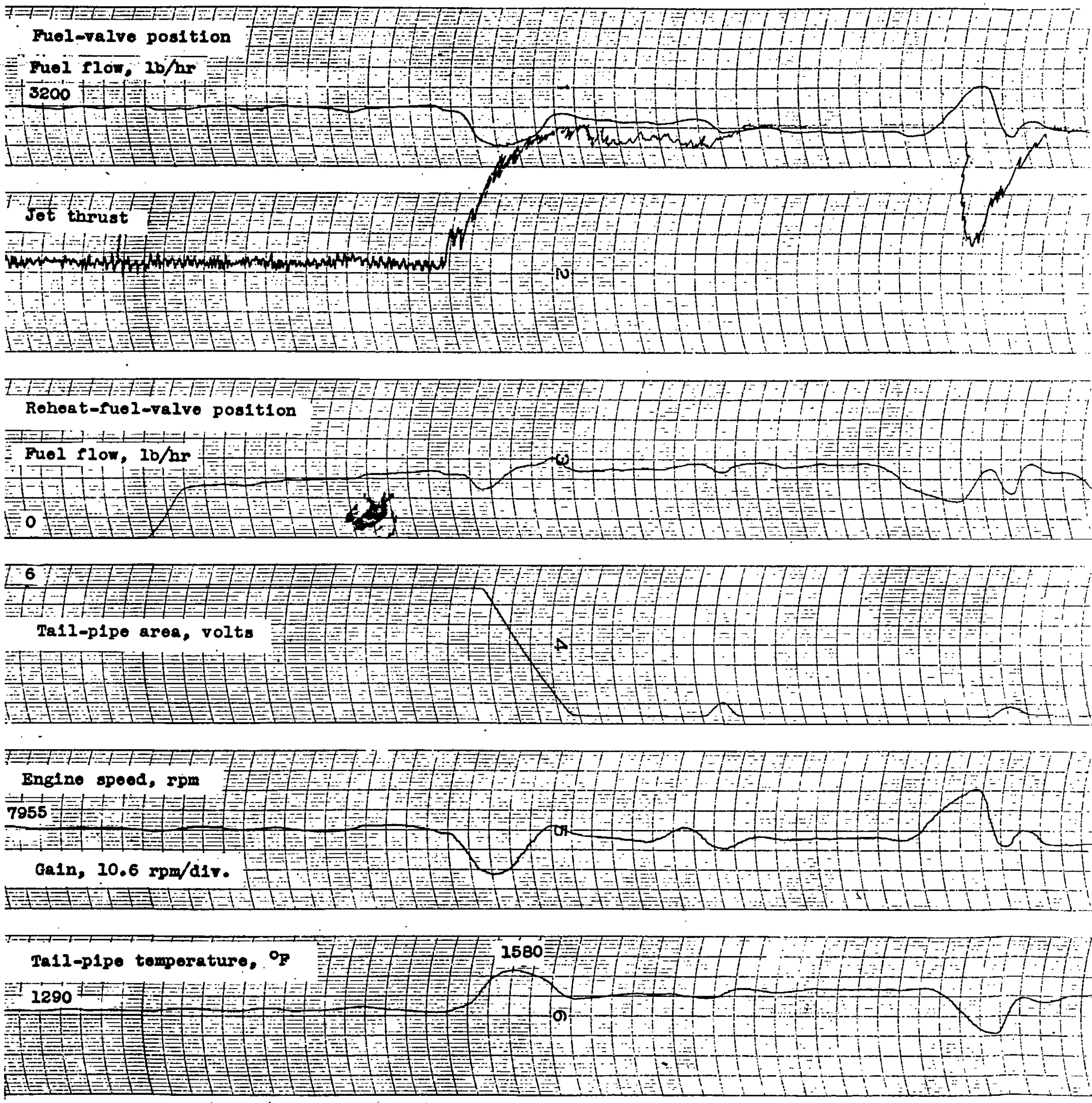
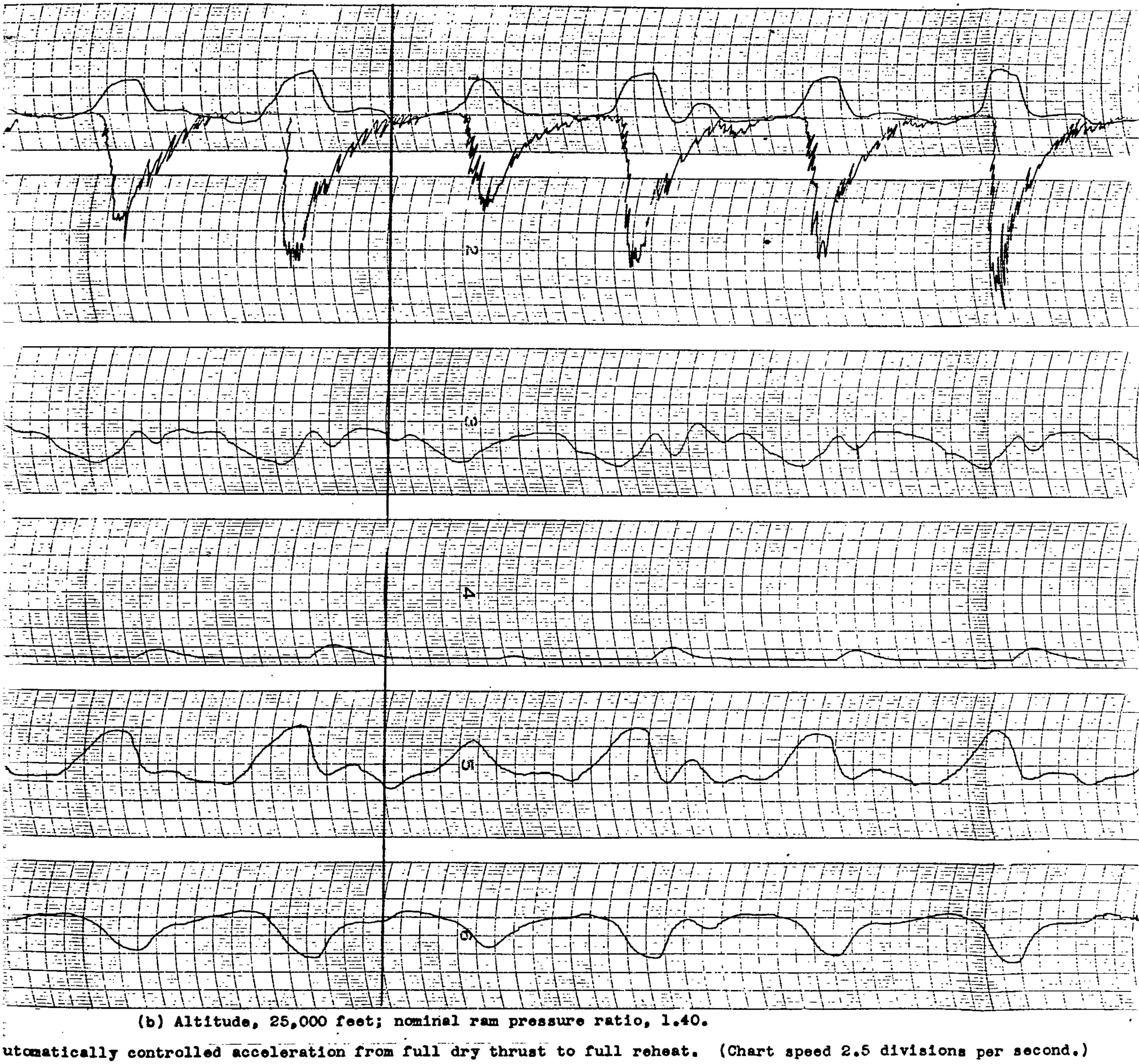
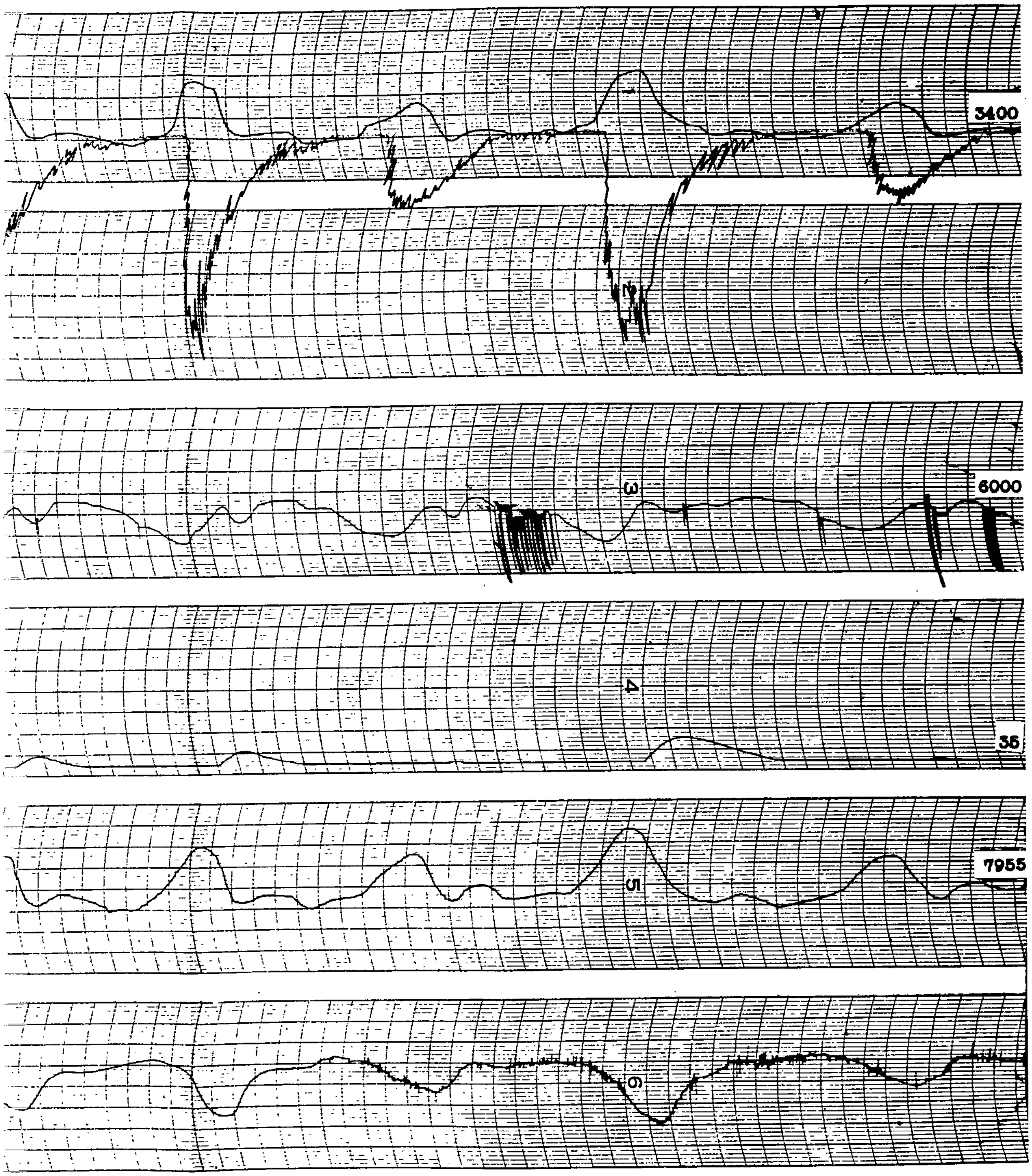


Figure 7. - Continued. Automat



(b) Altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

utomatically controlled acceleration from full dry thrust to full reheat. (Chart speed 2.5 divisions per second.)



.d 2.5 divisions per second.)

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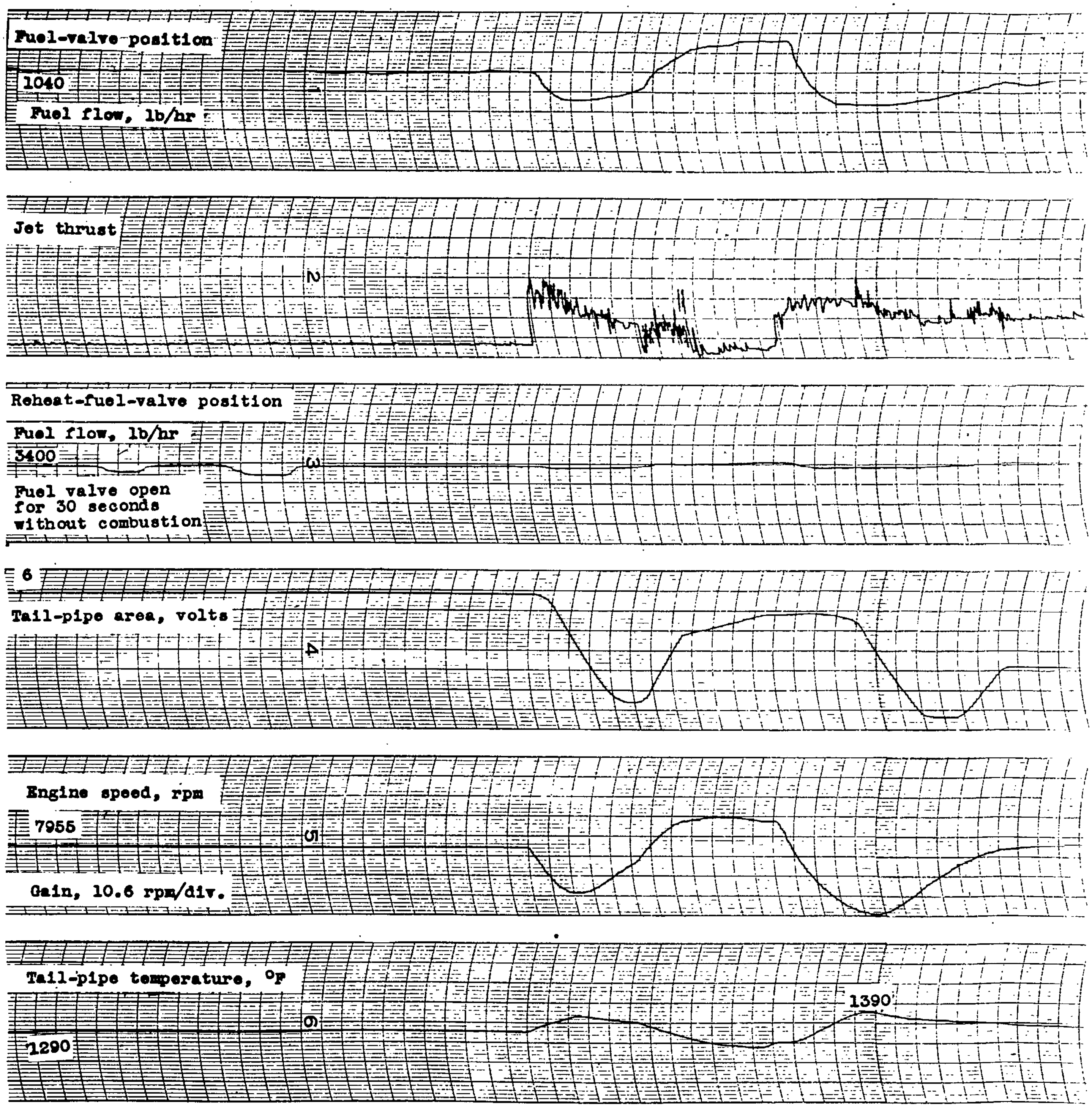
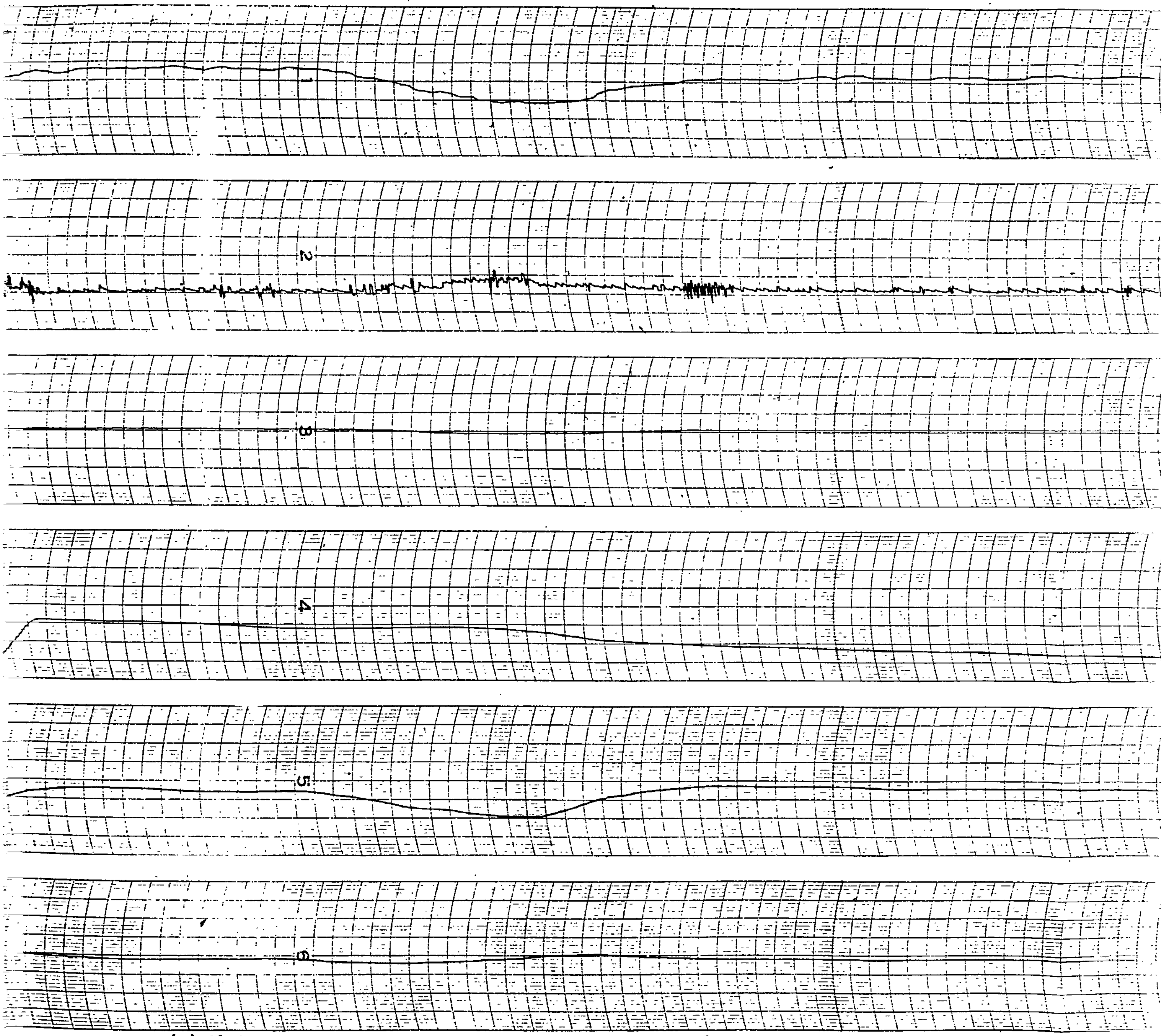
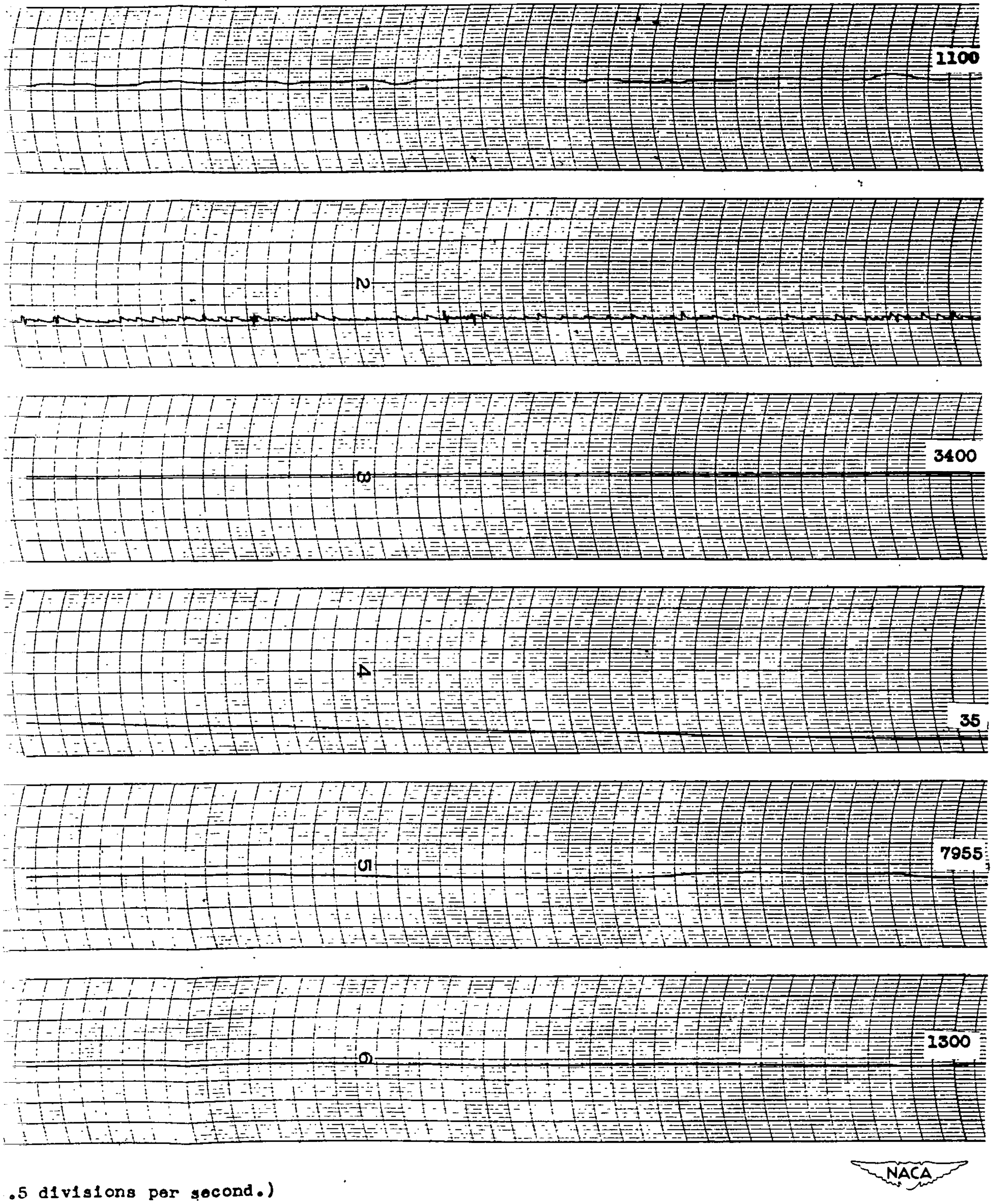


Figure 7. - Concluded. Automatic



(c) Altitude, 45,000 feet; nominal ram pressure ratio, 1.03

Automatically controlled acceleration from full dry thrust to full reheat. (Chart speed 2.5 divisions per second.)



.5 divisions per second.)

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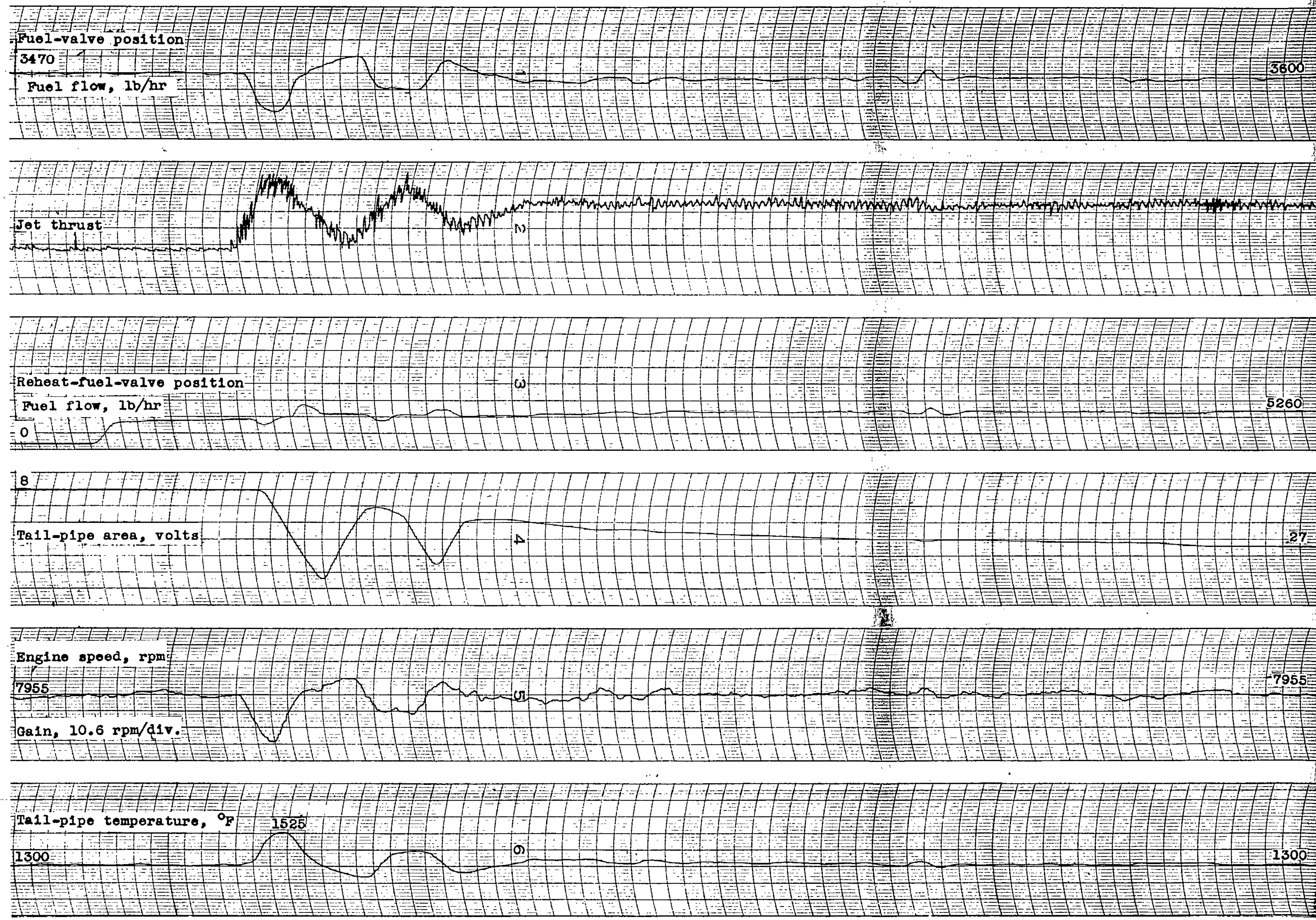

(a) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

Figure 8. - Automatically controlled acceleration from full dry thrust to partial reheat. (Chart speed 2.5 divisions per second.)

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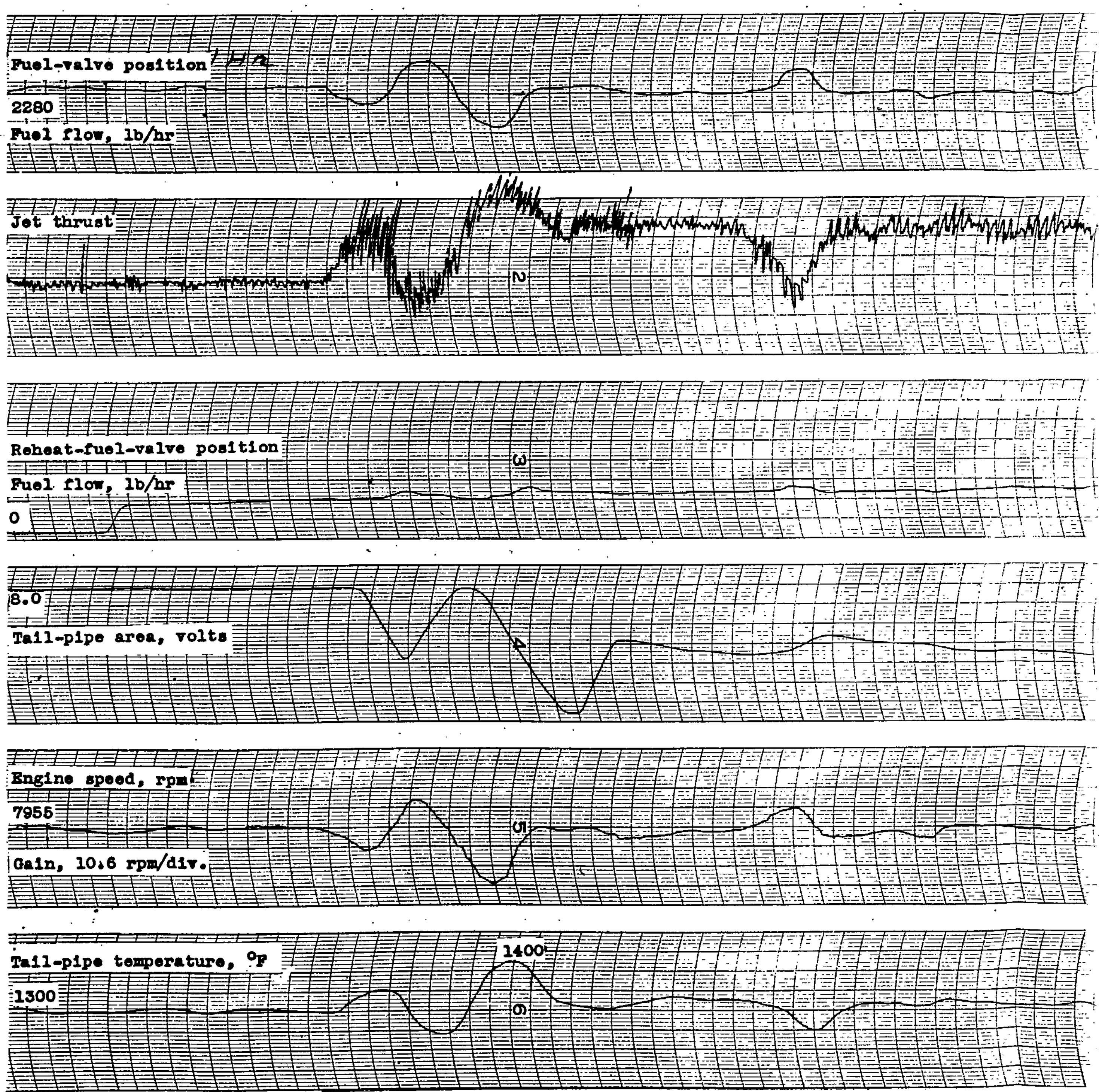
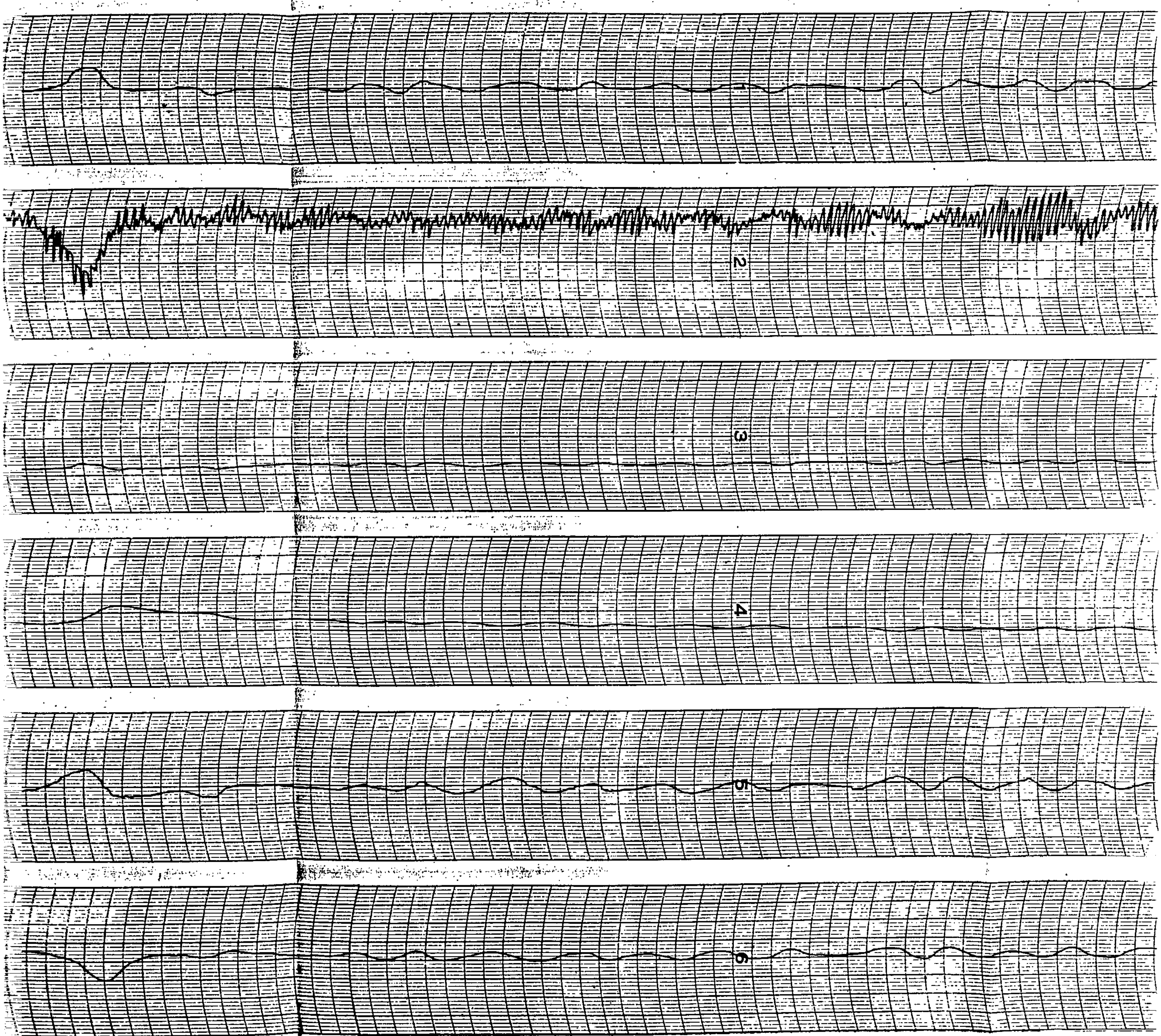


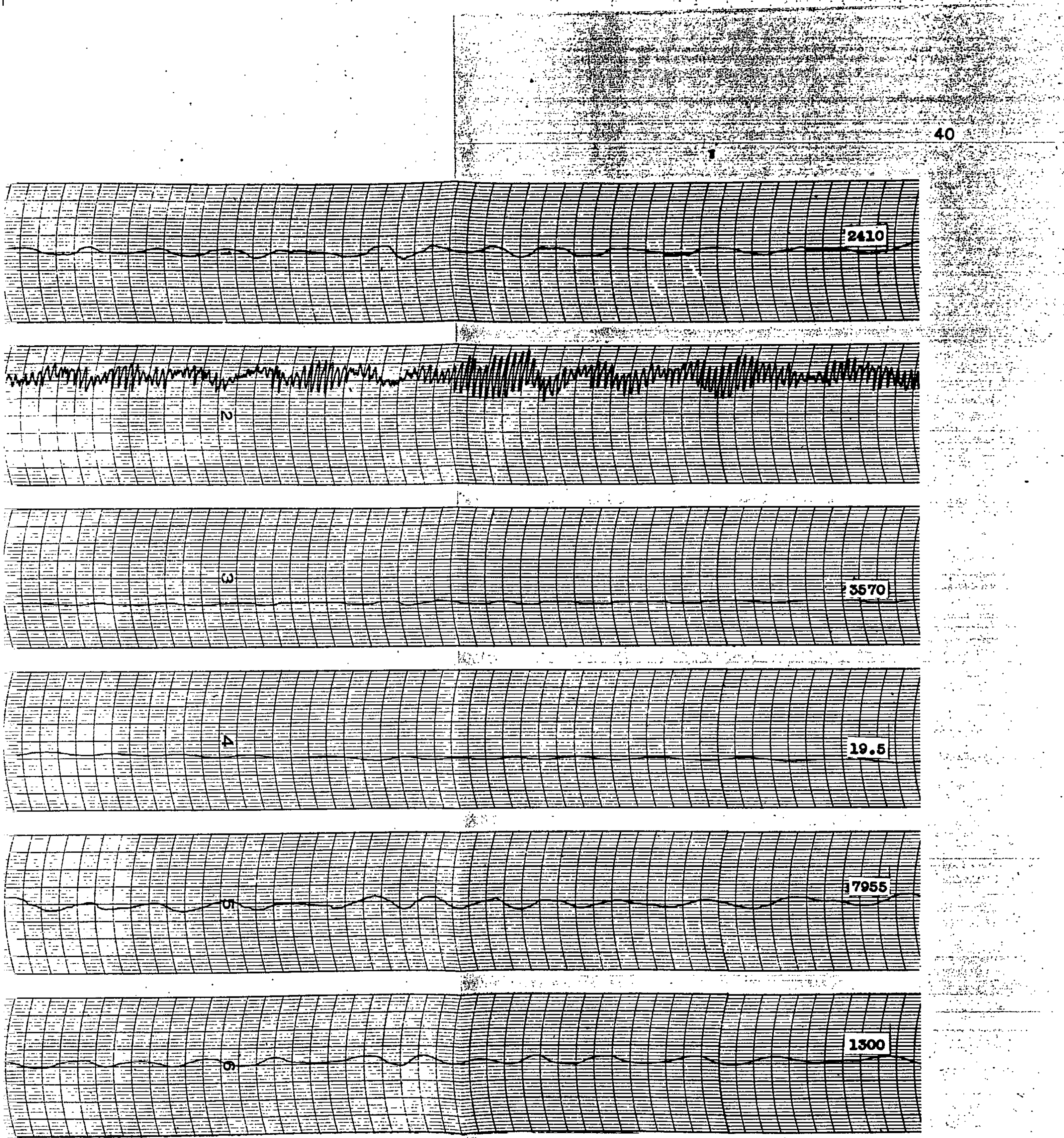
(b) Altitude, 25,000 fee

Figure 8. - Continued. Automatically controlled acceleration fro



(b) Altitude, 25,000 feet; nominal ram pressure ratio, 1.03.

omatically controlled acceleration from full dry thrust to partial reheat. (Chart speed 2.5 divisions per second.)



pressure ratio, 1.03.

ust to partial reheat. (Chart speed 2.5 divisions per second.)

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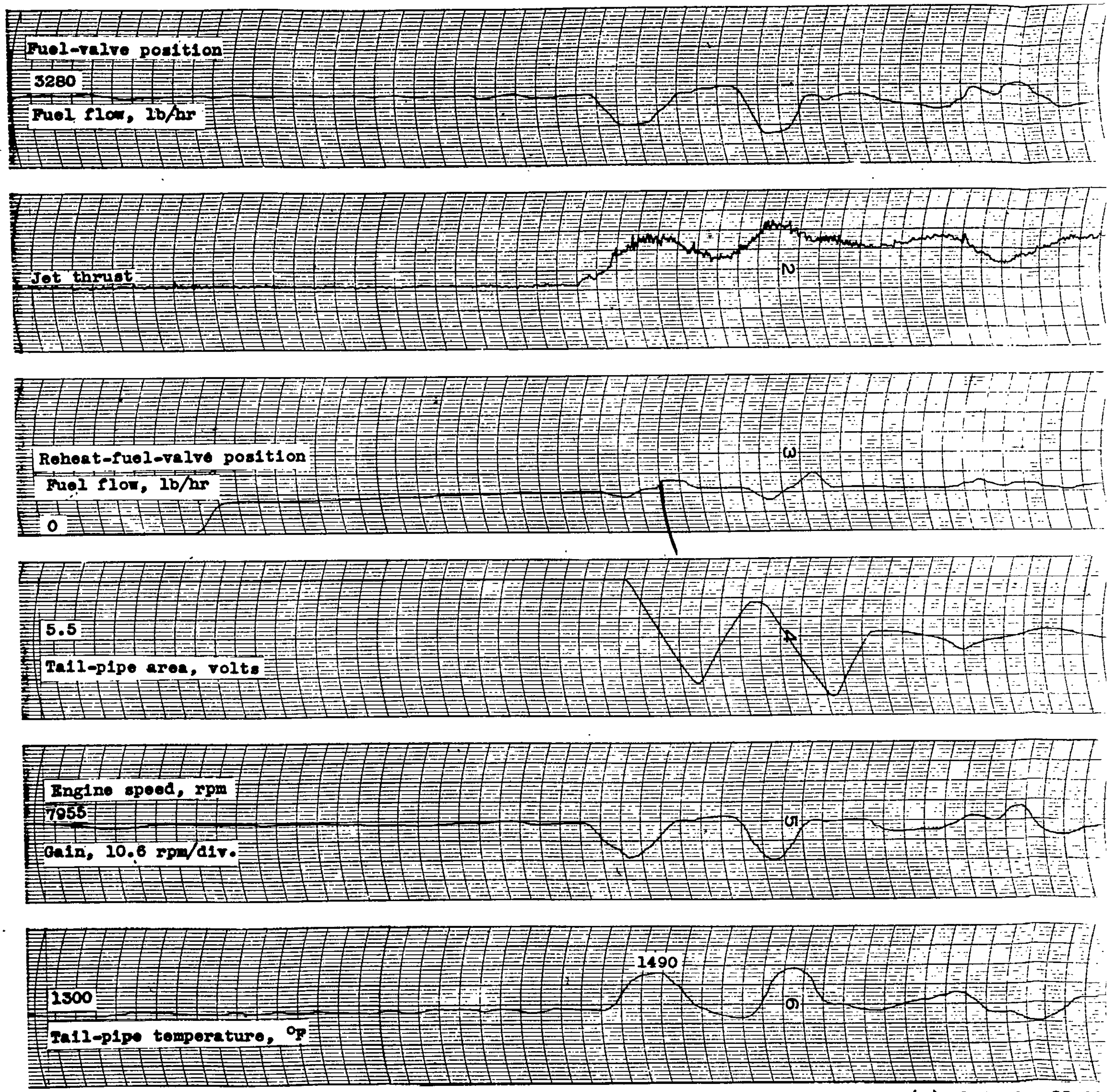

(c) Altitude, 25,00

Figure 8. - Concluded. Automatically controlled acceleratio

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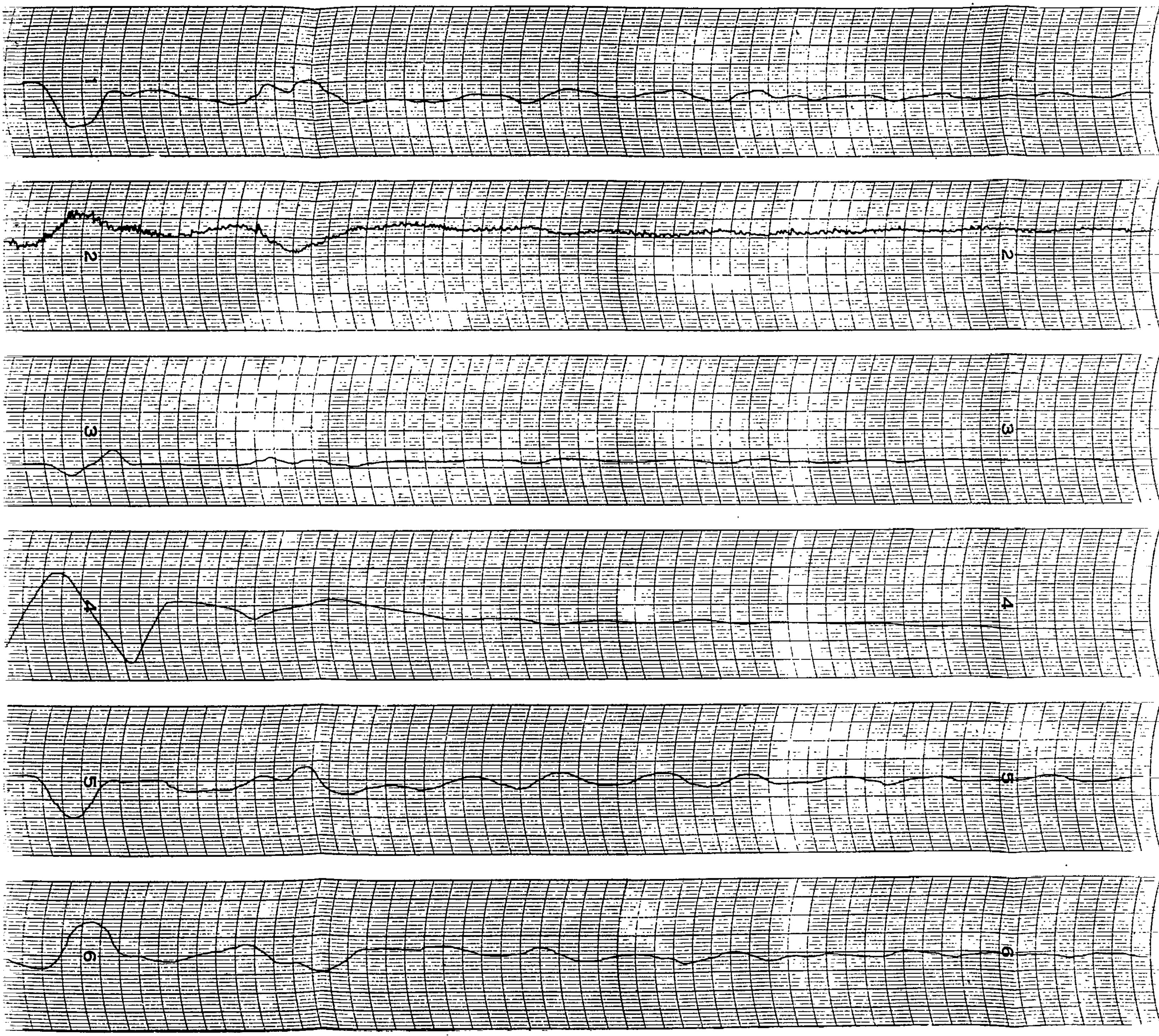
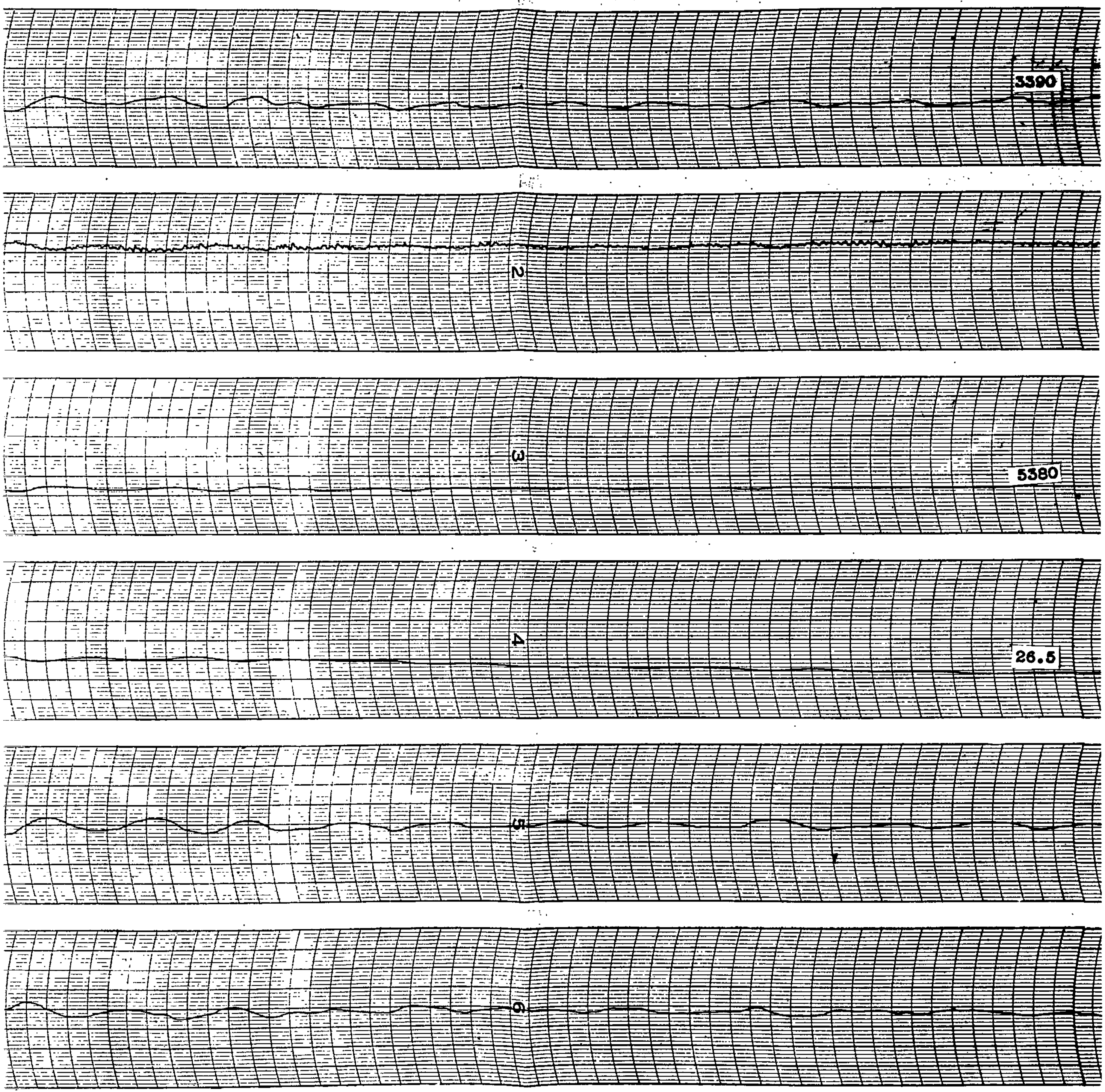


(c) Altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

. Automatically controlled acceleration from full dry thrust to partial reheat. (Chart speed 2.5 divisions per second



l ram pressure ratio, 1.40.

y thrust to partial reheat. (Chart speed 2.5 divisions per second.)

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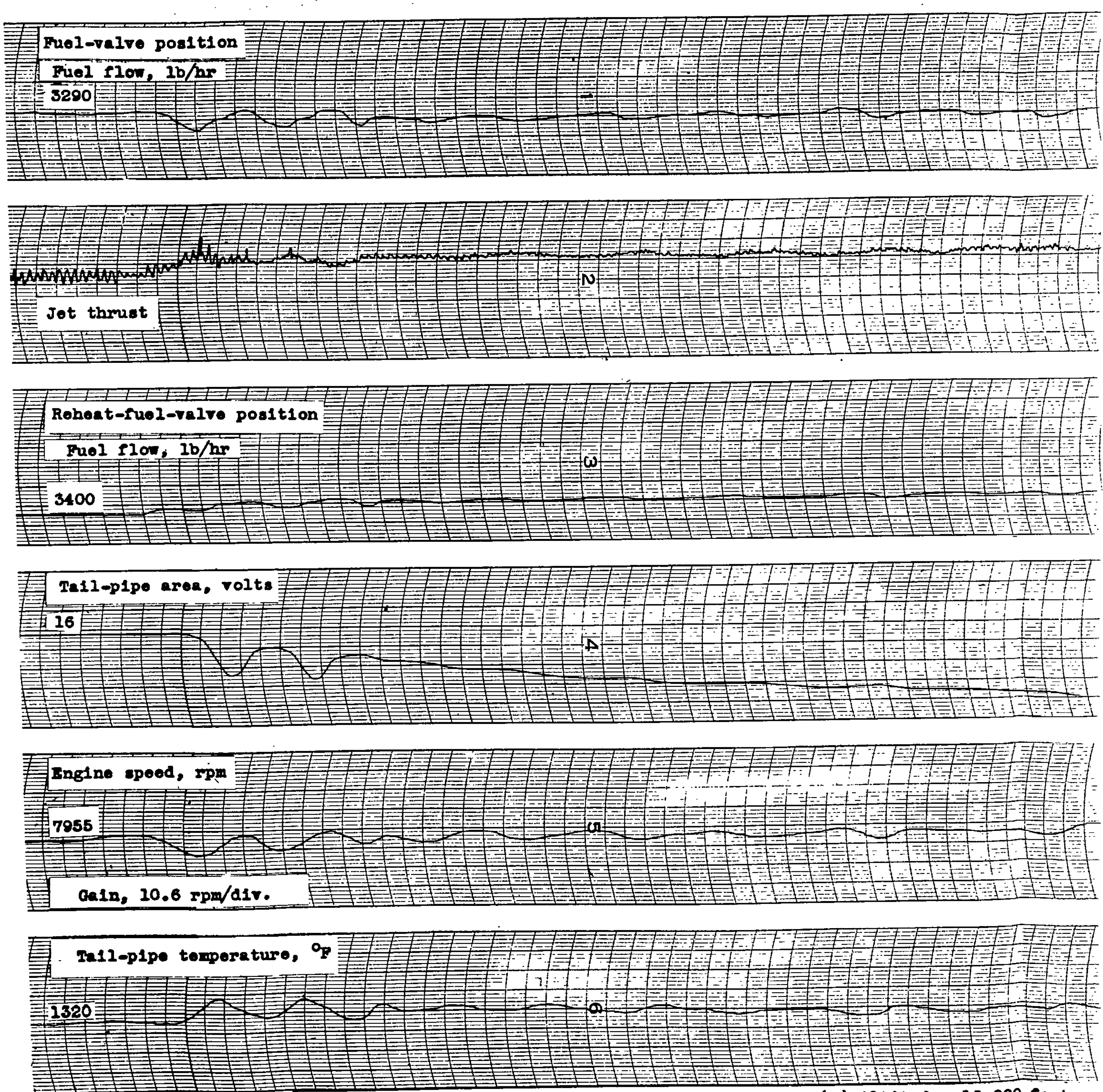

(a) Altitude, 15,000 feet; n

Figure 9. - Automatically controlled acceleration i

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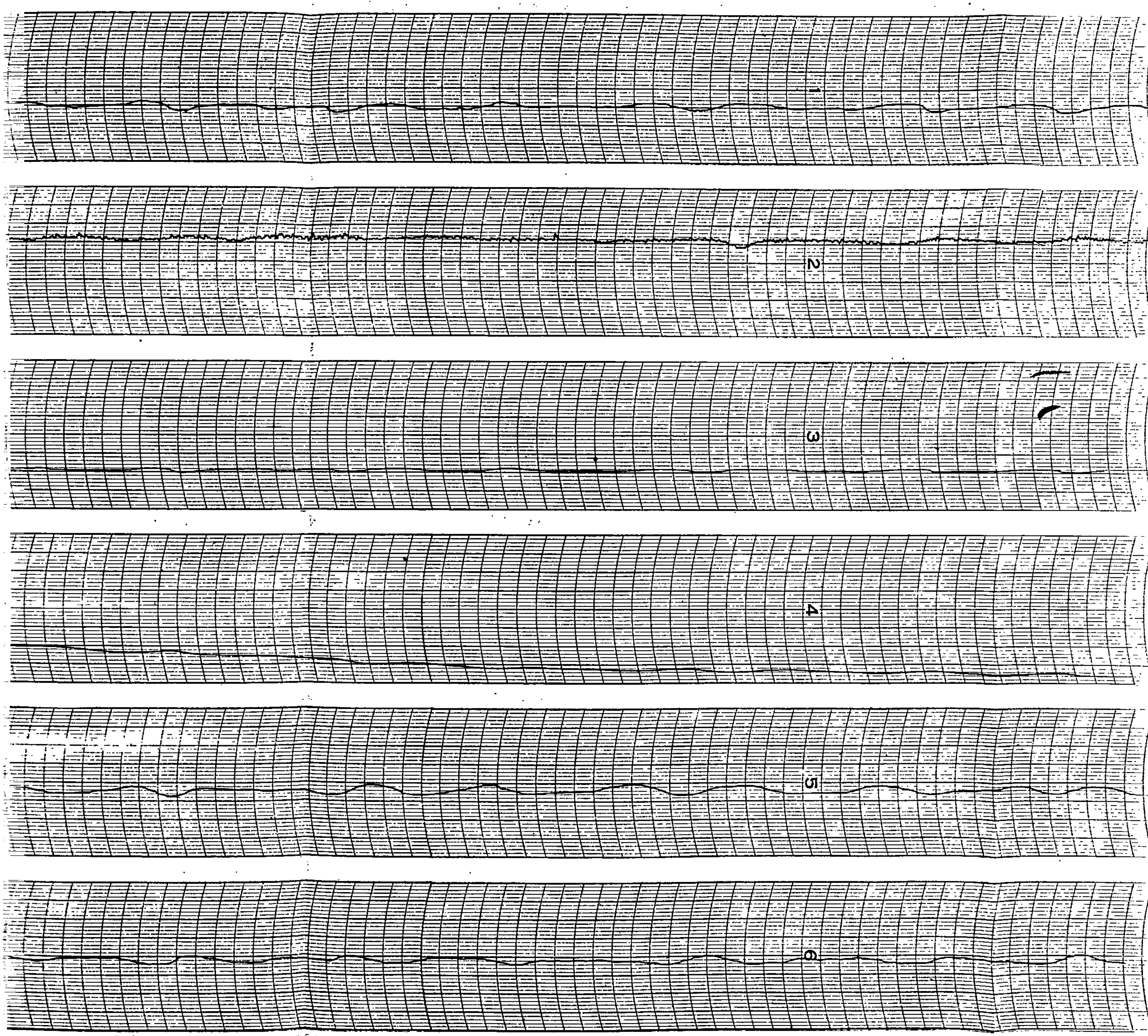
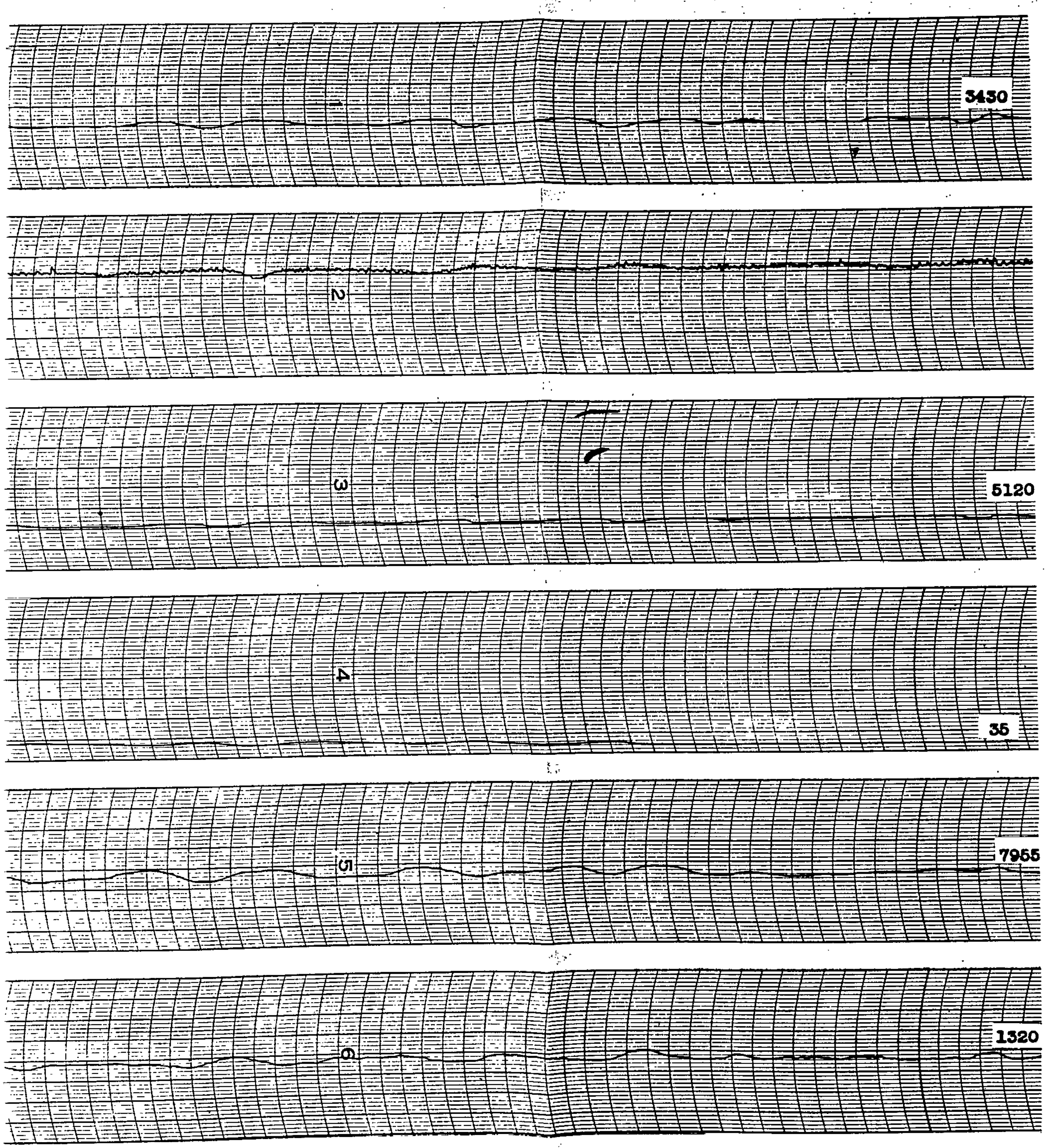


(a) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

Automatically controlled acceleration in reheat region. (Chart speed 2.5 divisions per second.)



ressure ratio, 1.03.

.on. (Chart speed 2.5 divisions per second.)

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(b) Altitude, 25,000 feet; nominal ram pressure ratio, 1.03.

Figure 9. - Continued. Automatically controlled acceleration in reheat region. (Chart speed 2.5 divisions per second.)

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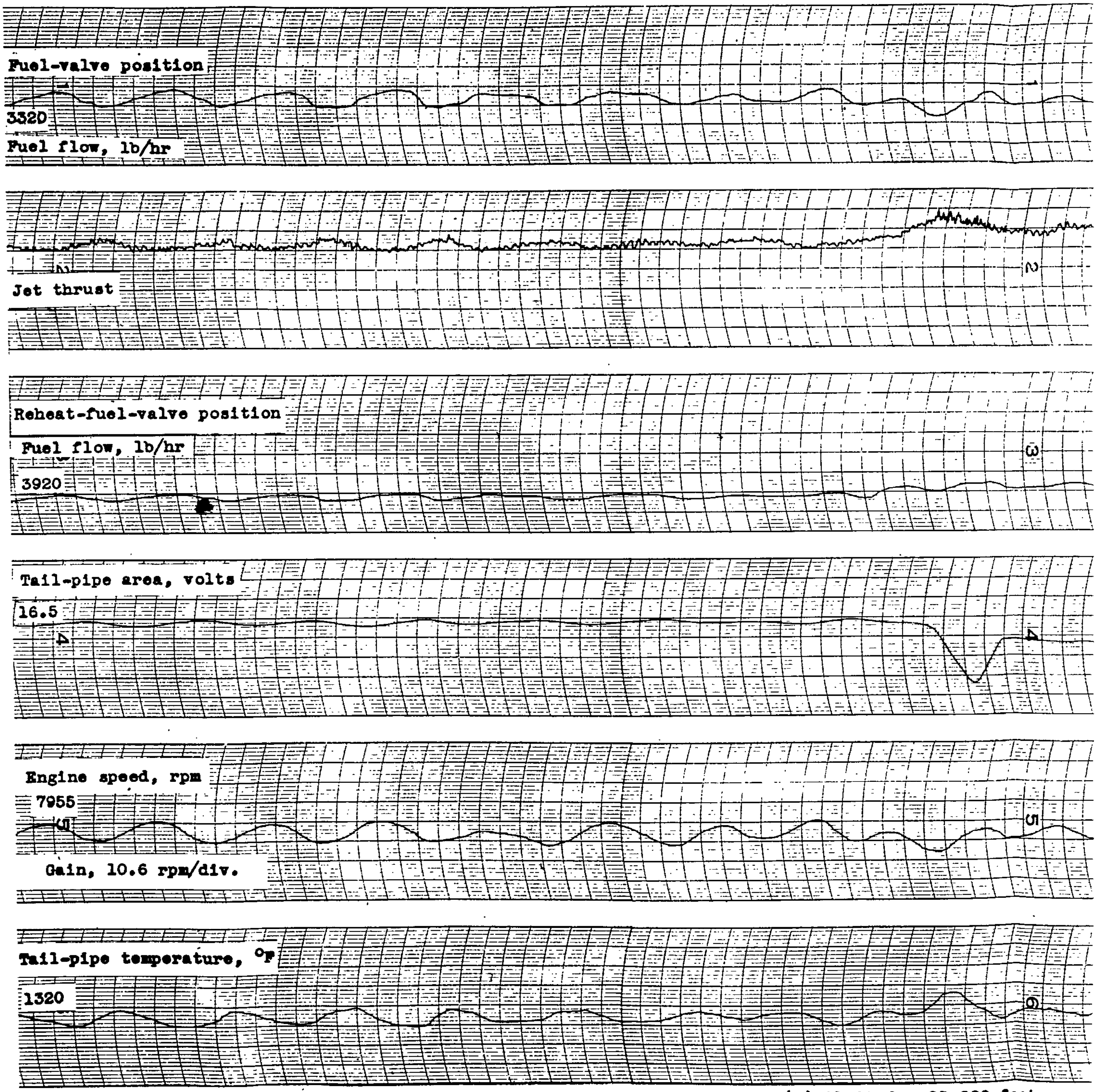
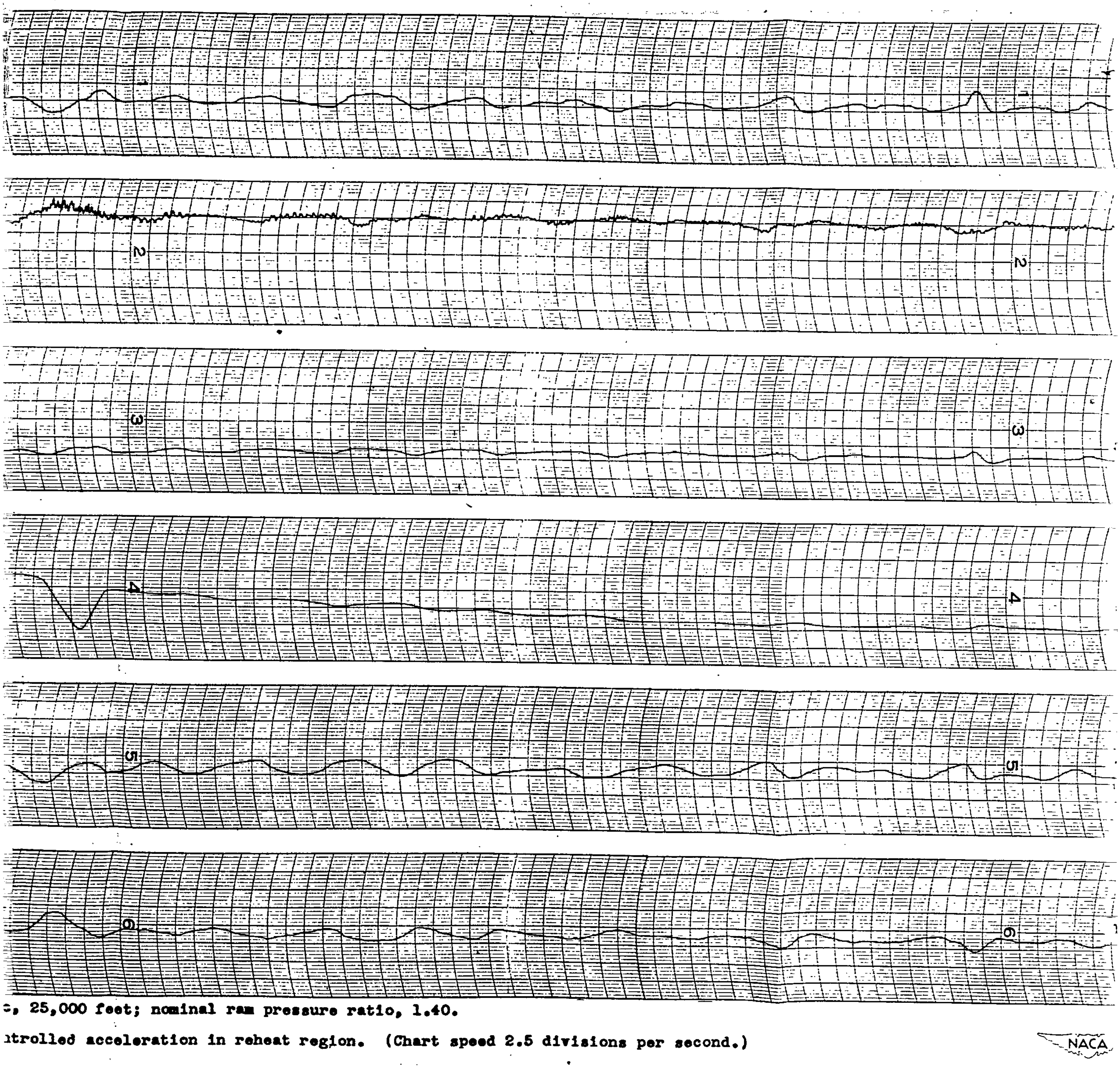


(c) Altitude, 25,000 feet; nom

Figure 9. - Concluded. Automatically controlled accelerati



c, 25,000 feet; nominal ram pressure ratio, 1.40.

ntrolled acceleration in reheat region. (Chart speed 2.5 divisions per second.)

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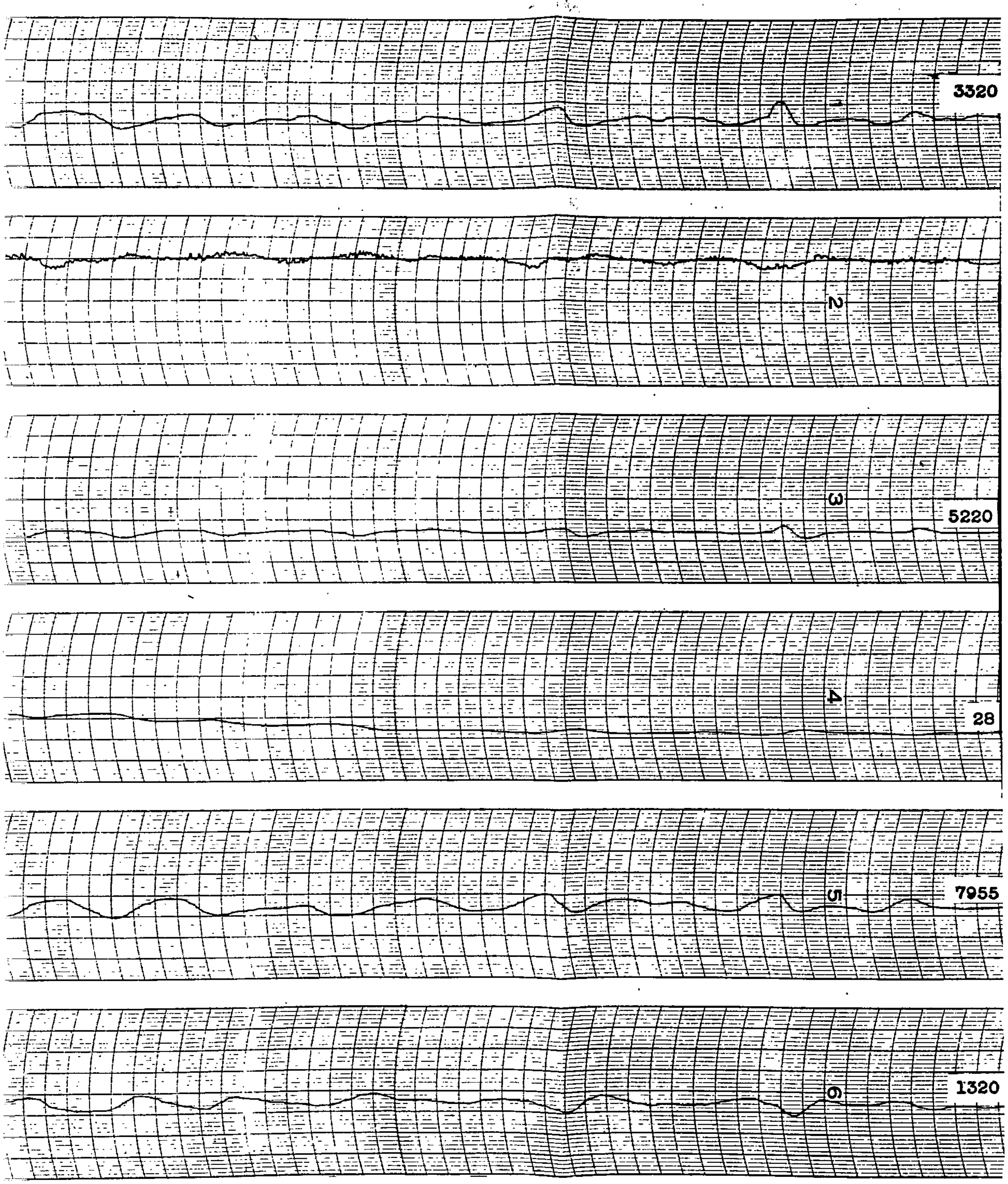


ure ratio, 1.40.

egion. (Chart speed 2.5 divisions per second.)

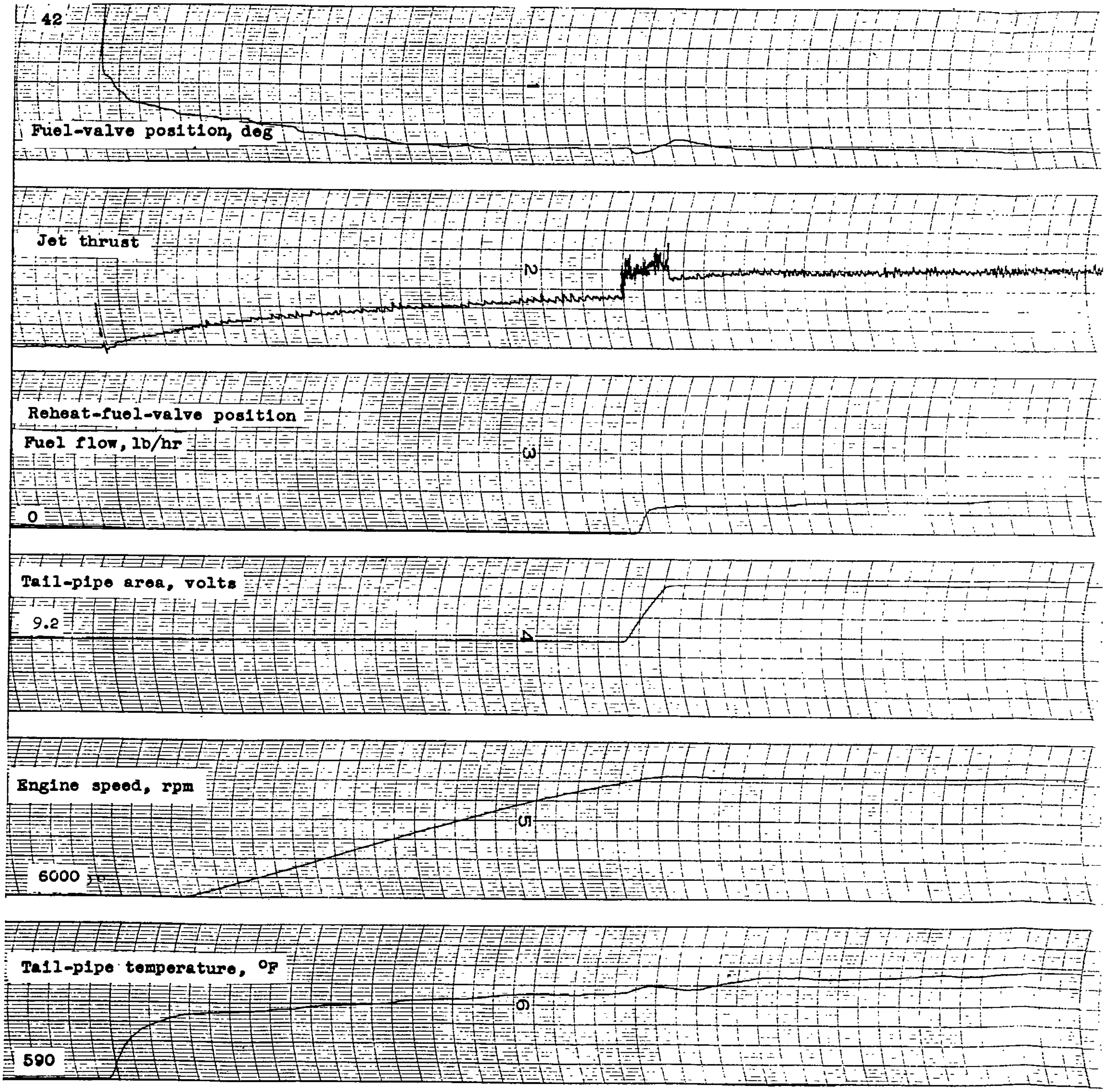
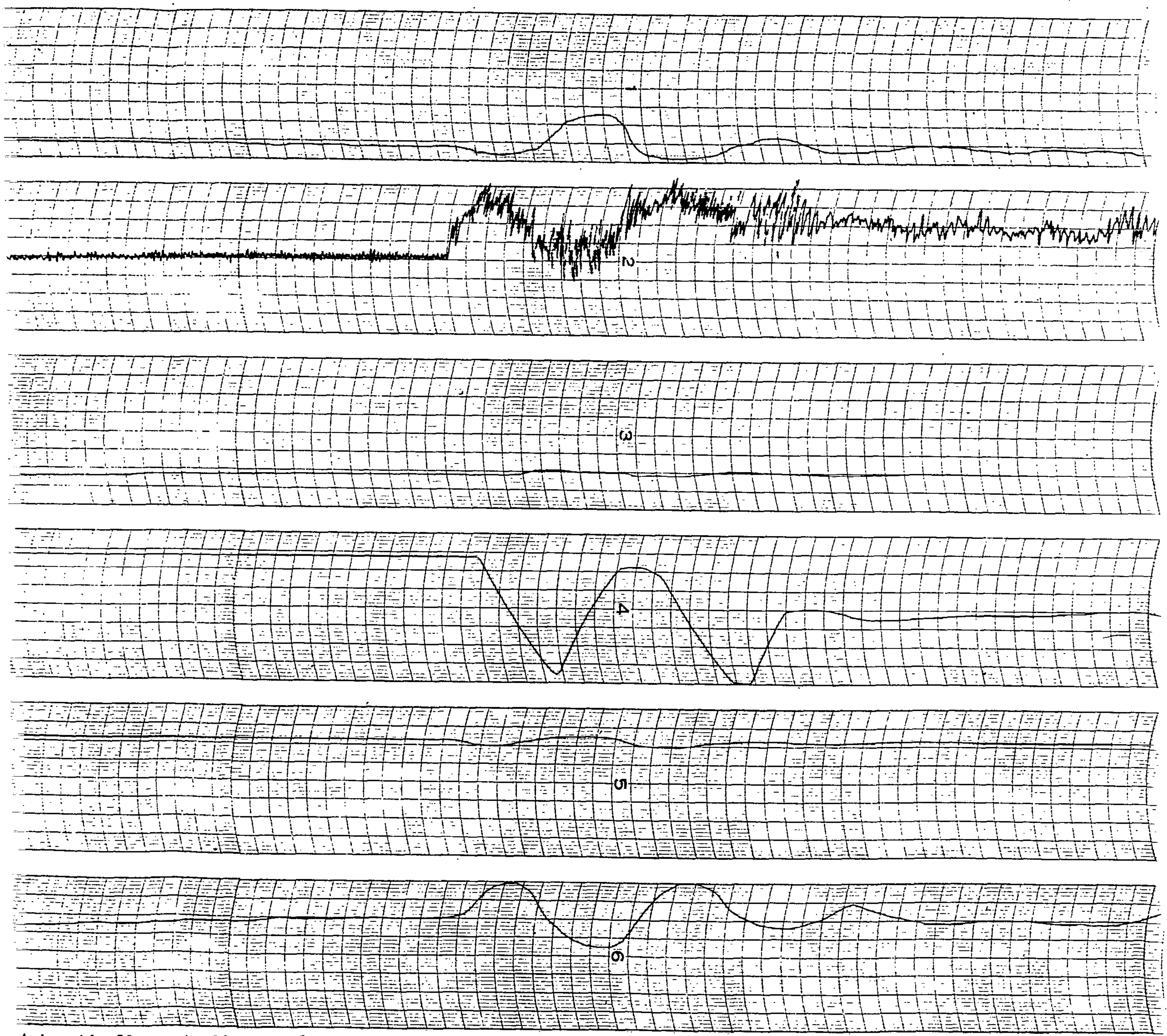
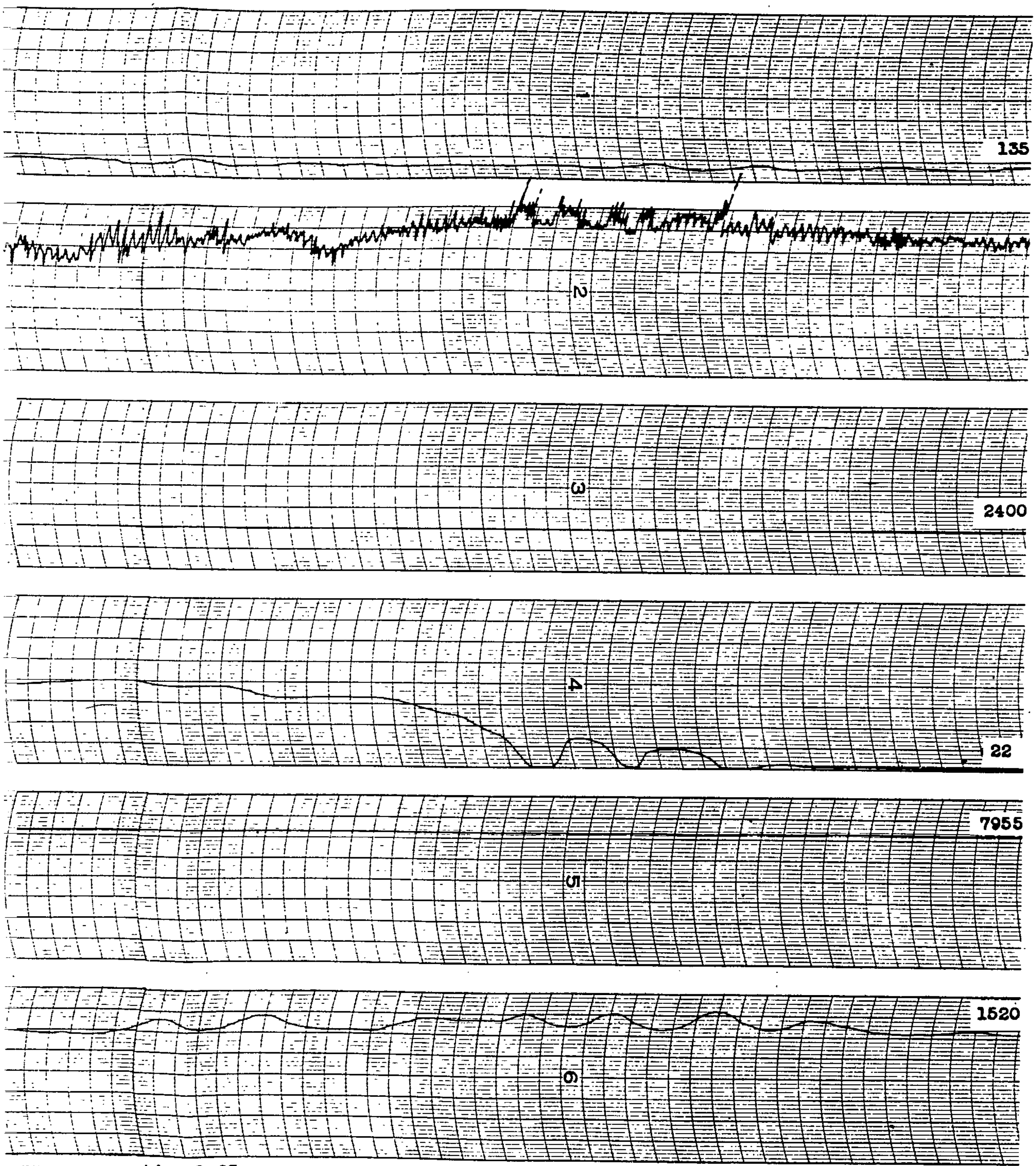


Figure 10. - Automatically controlled



Automatically controlled acceleration from 6000 rpm to reheat region. Altitude, 35,000 feet; nominal ram pressure rati
(Chart speed 2.5 divisions per second.)



pressure ratio, 1.03.

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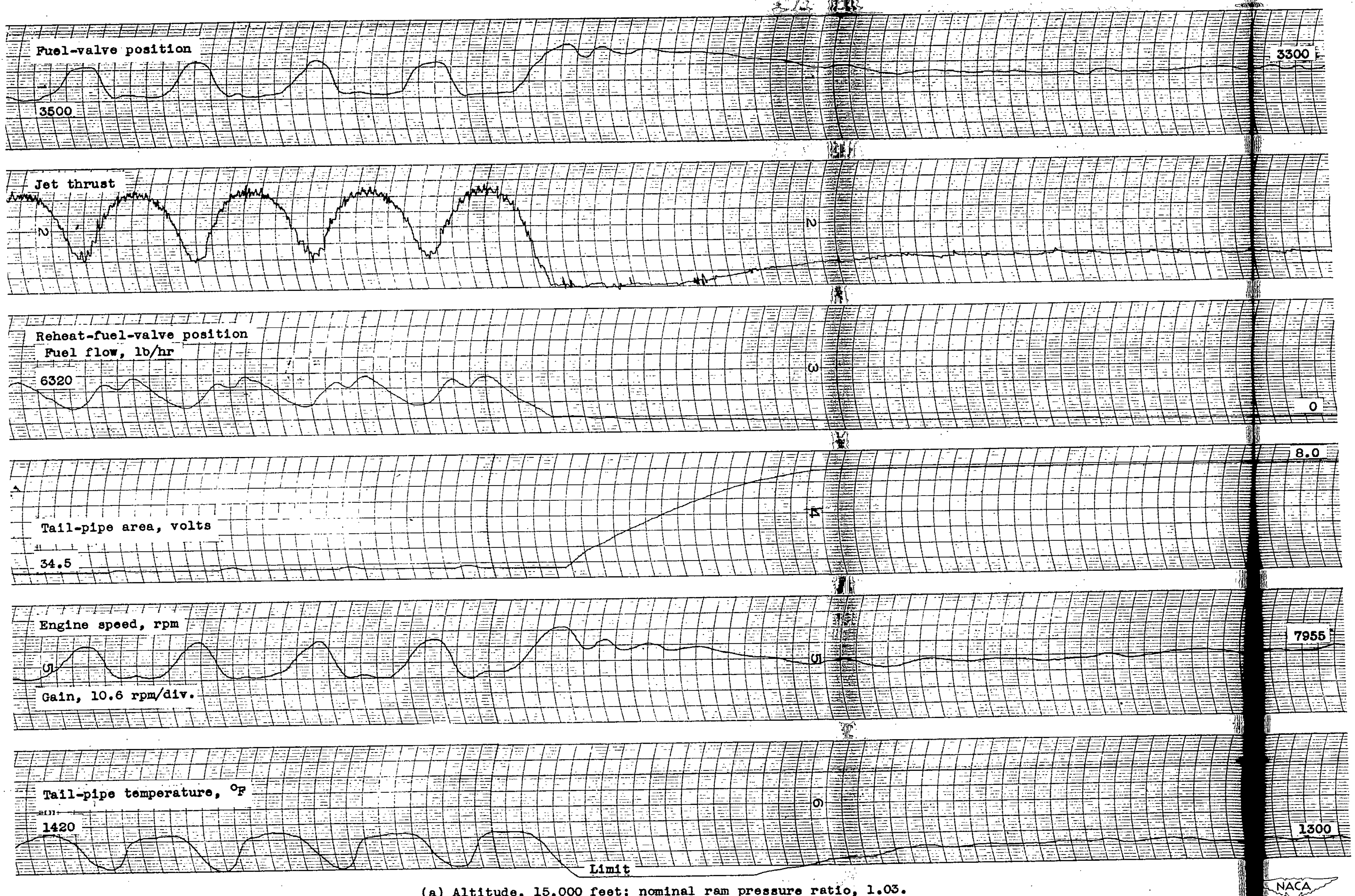
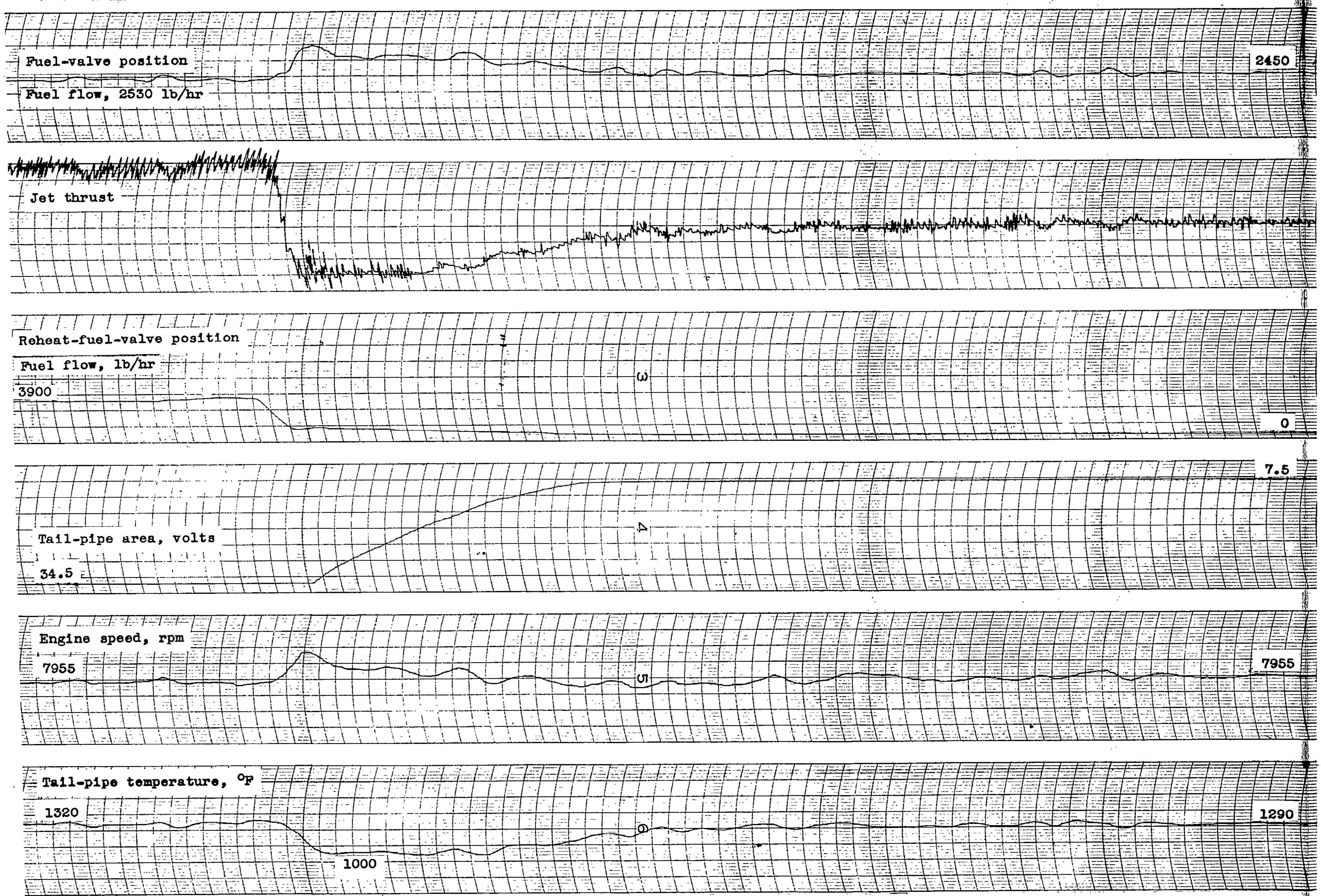


(a) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

Figure 11. - Automatically controlled deceleration from full reheat to full dry thrust. (Chart speed 2.5 divisions per second.)

1375



(b) Altitude, 25,000 feet; nominal ram pressure ratio, 1.03.

Figure 11. - Continued. Automatically controlled deceleration from full reheat to full dry thrust. (Chart speed 2.5 divisions per second.)

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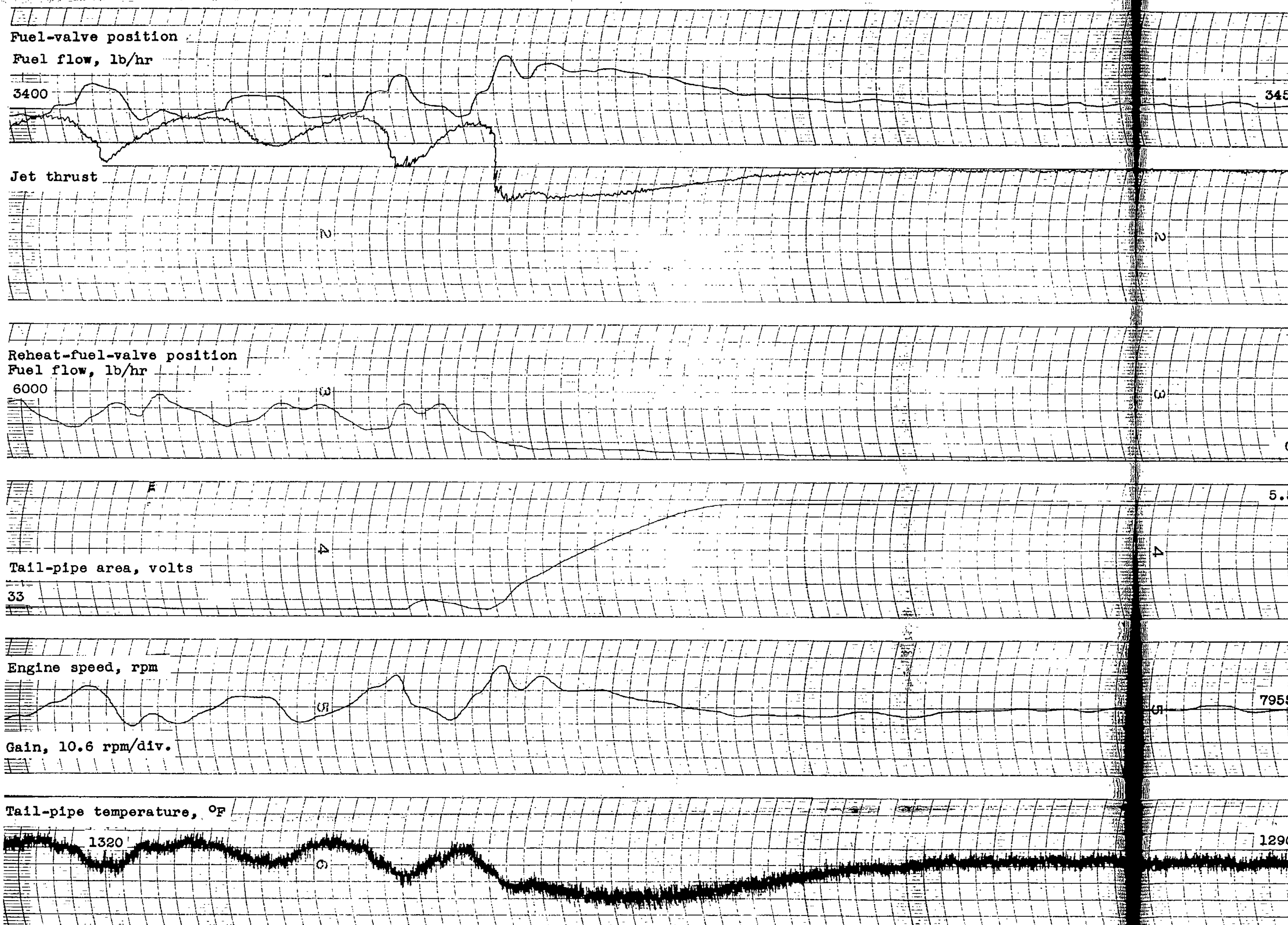

(c) Altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

Figure 11. - Continued. Automatically controlled deceleration from full reheat to full dry thrust. (Chart speed 2.5 divisions per second.)

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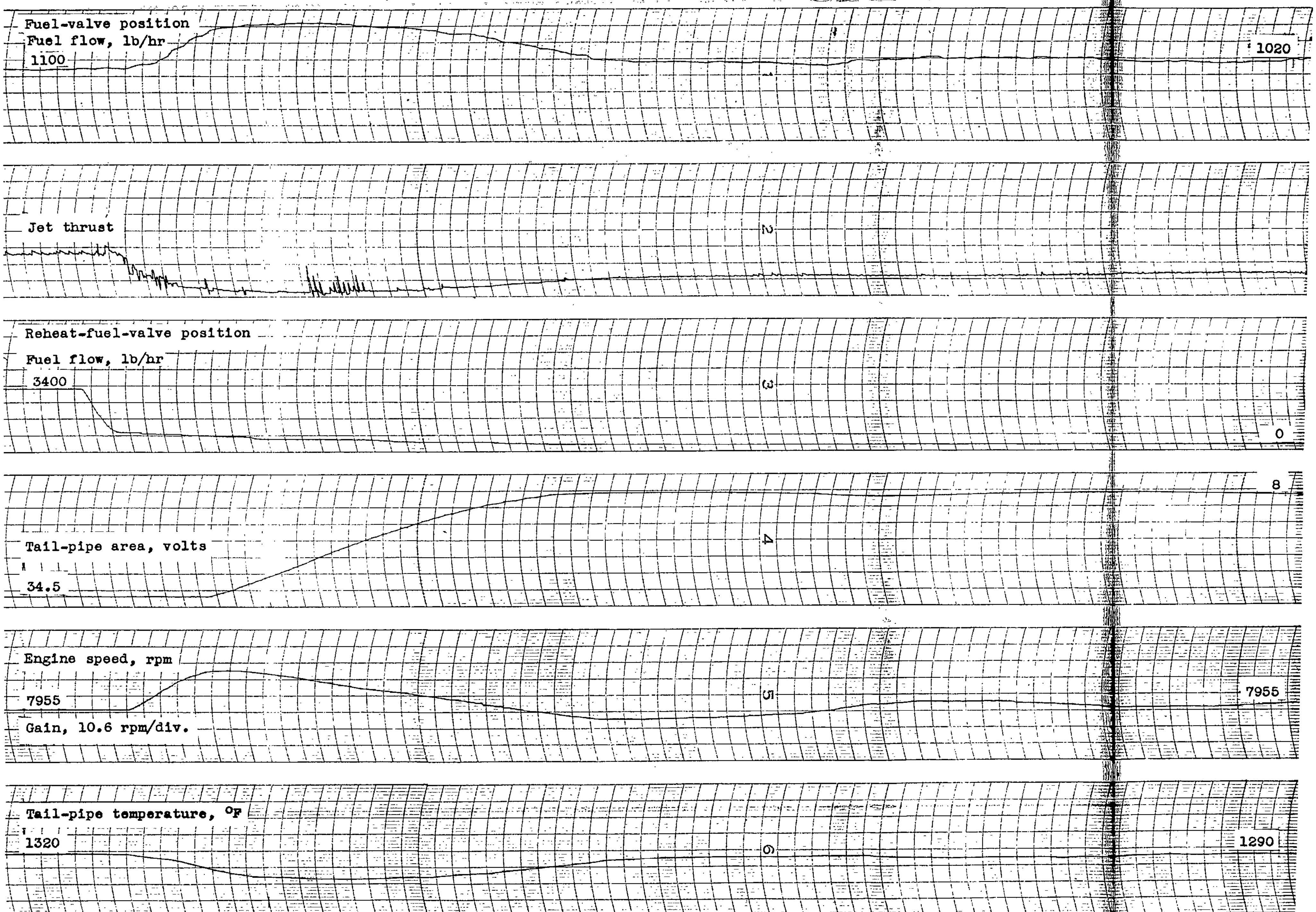

(d) Altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

Figure 11. - Concluded. Automatically controlled deceleration from full reheat to full dry thrust. (Chart speed 2.5 divisions per second.)

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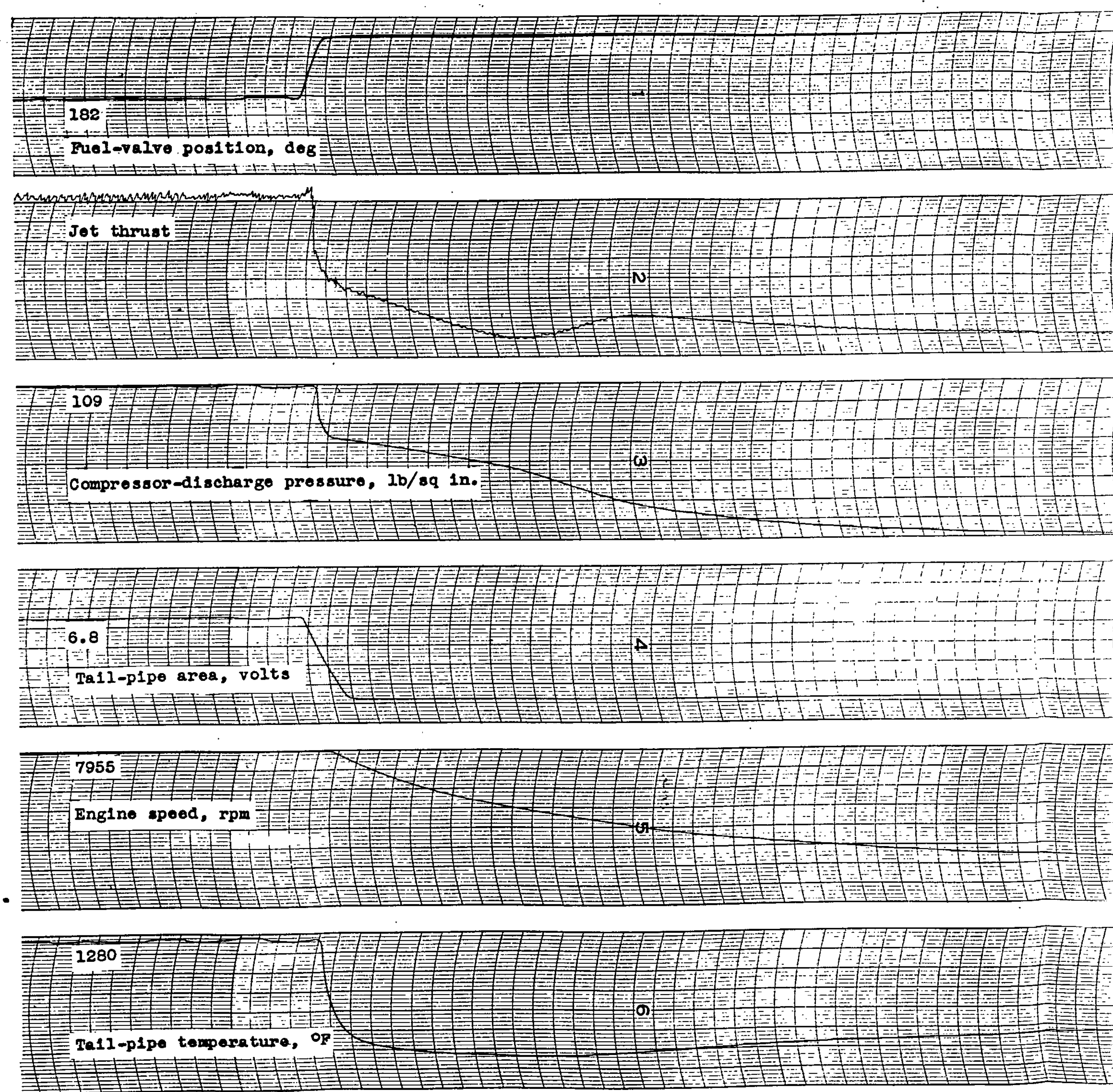
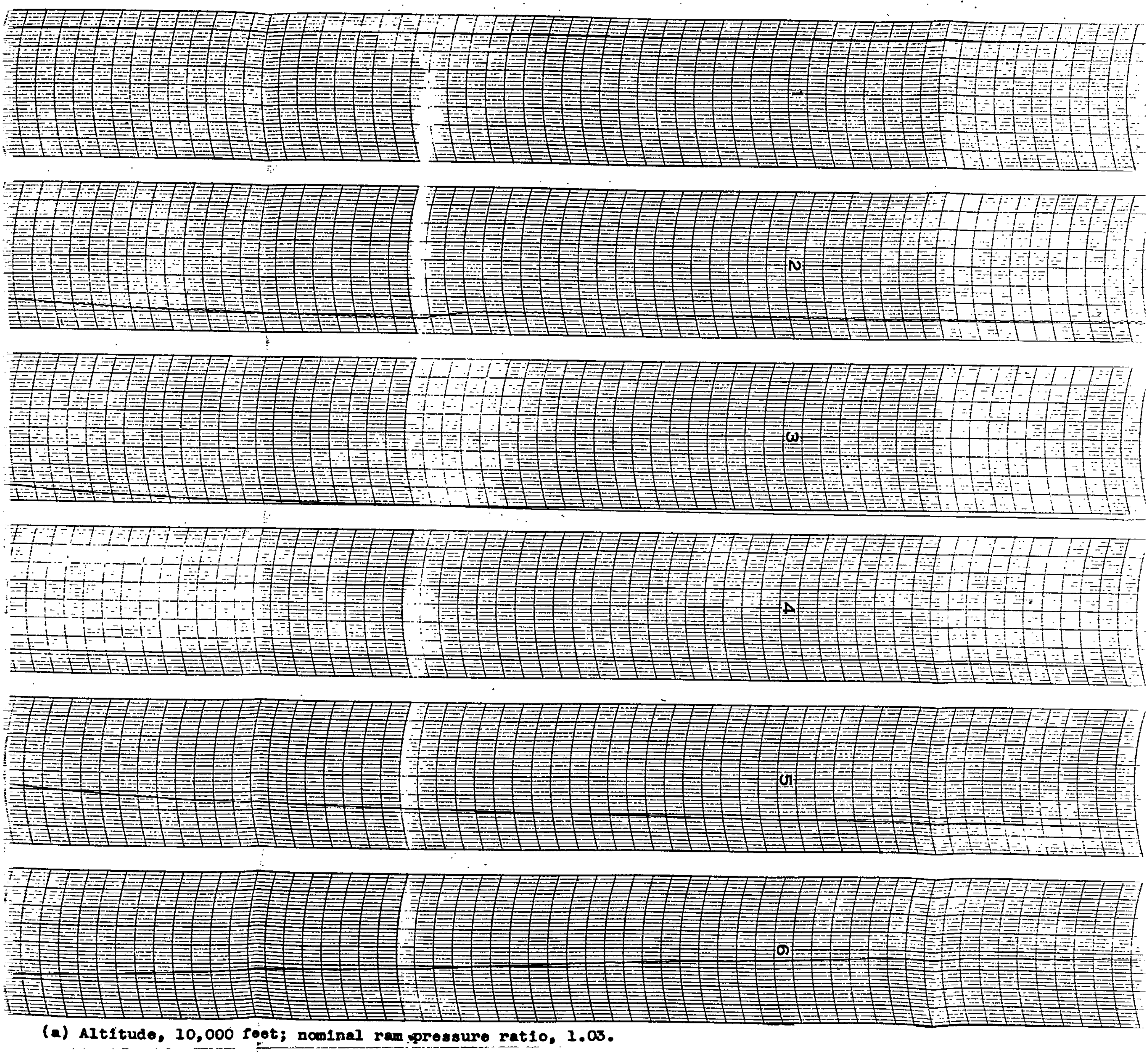


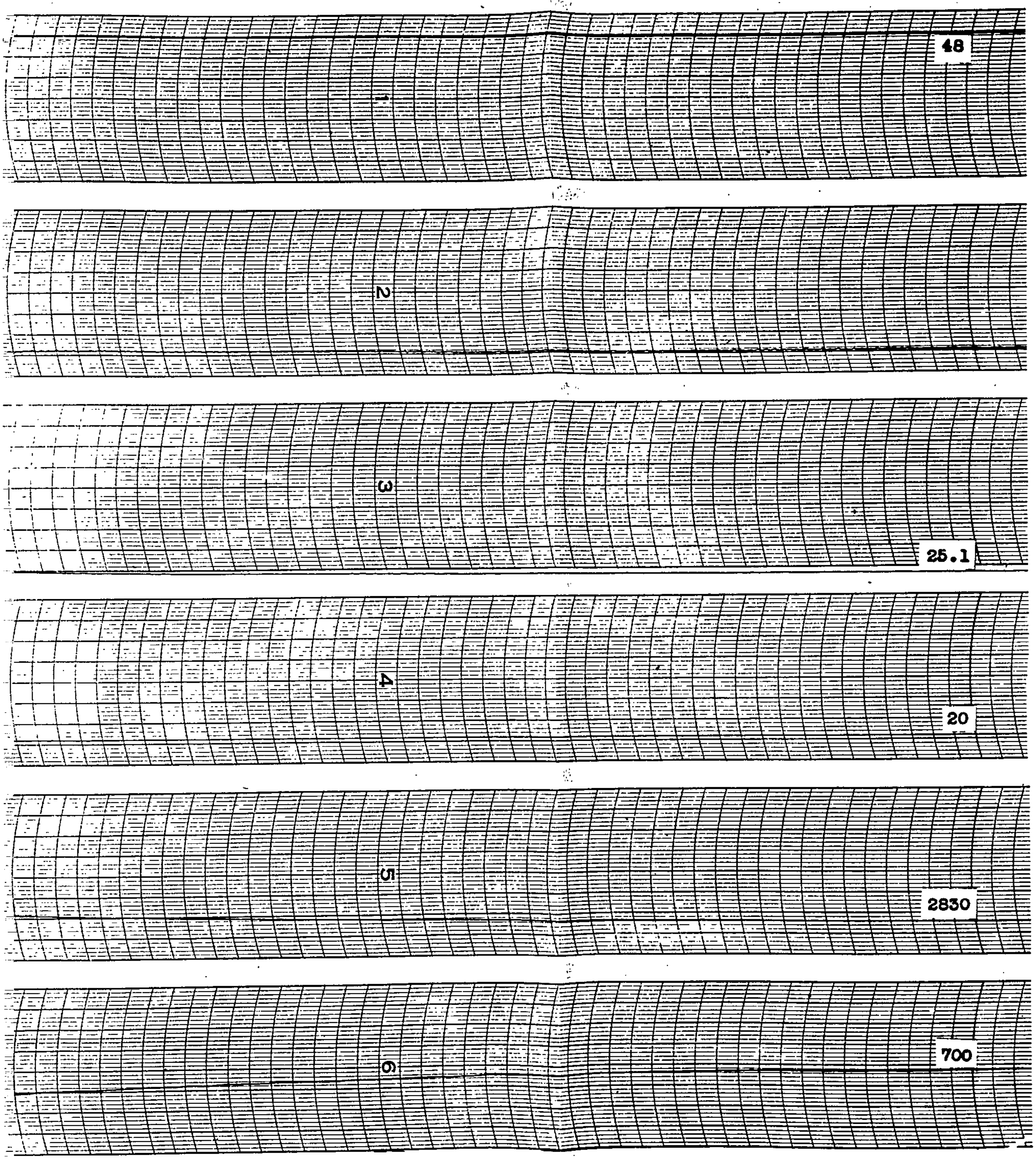
(a) Altitude, 10,000 feet; no

Figure 12. - Automatically controlled deceleration from full d



(a) Altitude, 10,000 feet; nominal ram pressure ratio, 1.03.

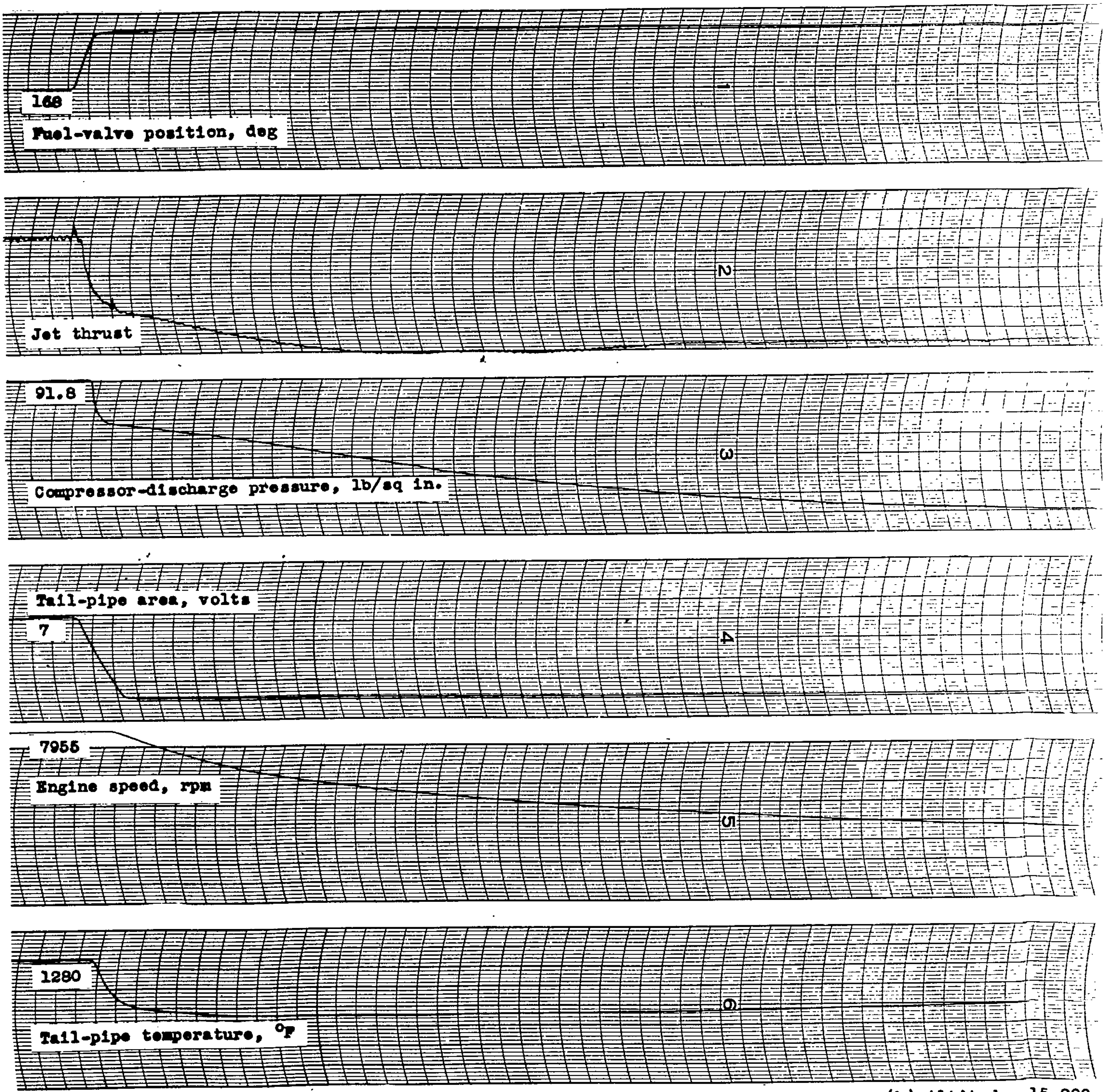
ıtrolled deceleration from full dry thrust to idle speed. (Chart speed 2.5 divisions per second.)



ssure ratio, 1.03.

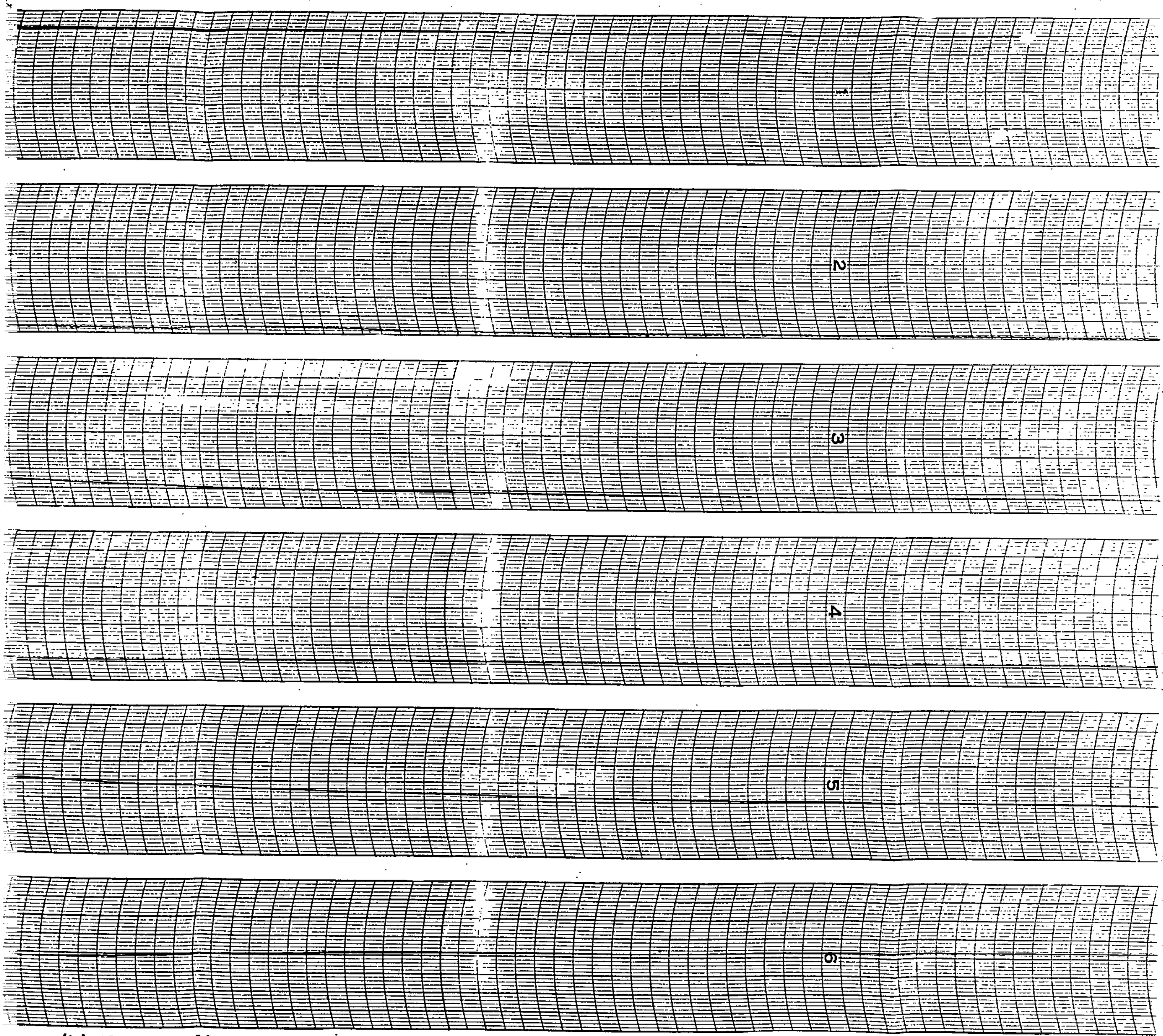
idle speed. (Chart speed 2.5 divisions per second.)

1375



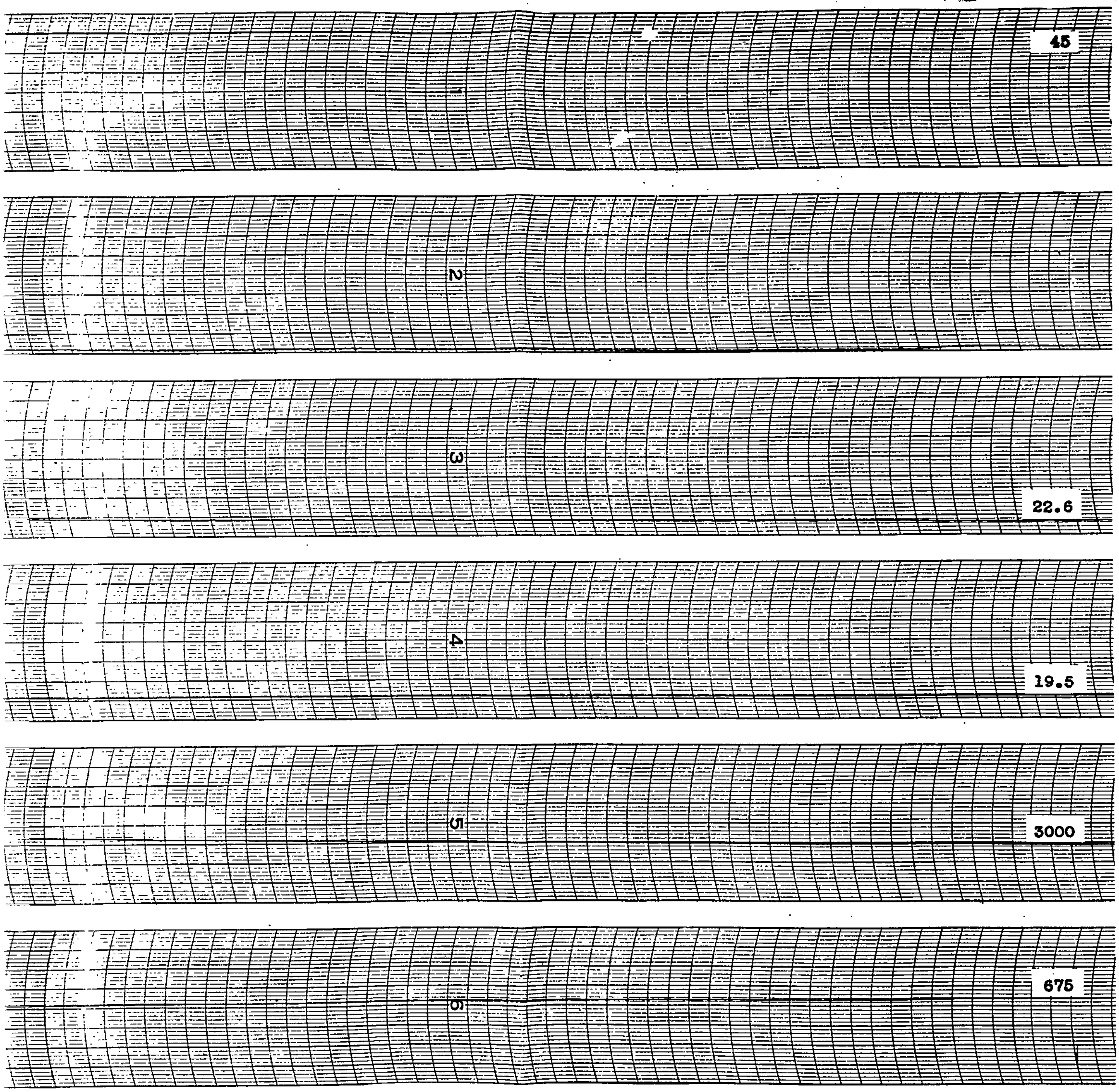
(b) Altitude, 15,000

Figure 12. - Continued. Automatically controlled decelerati



(b) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

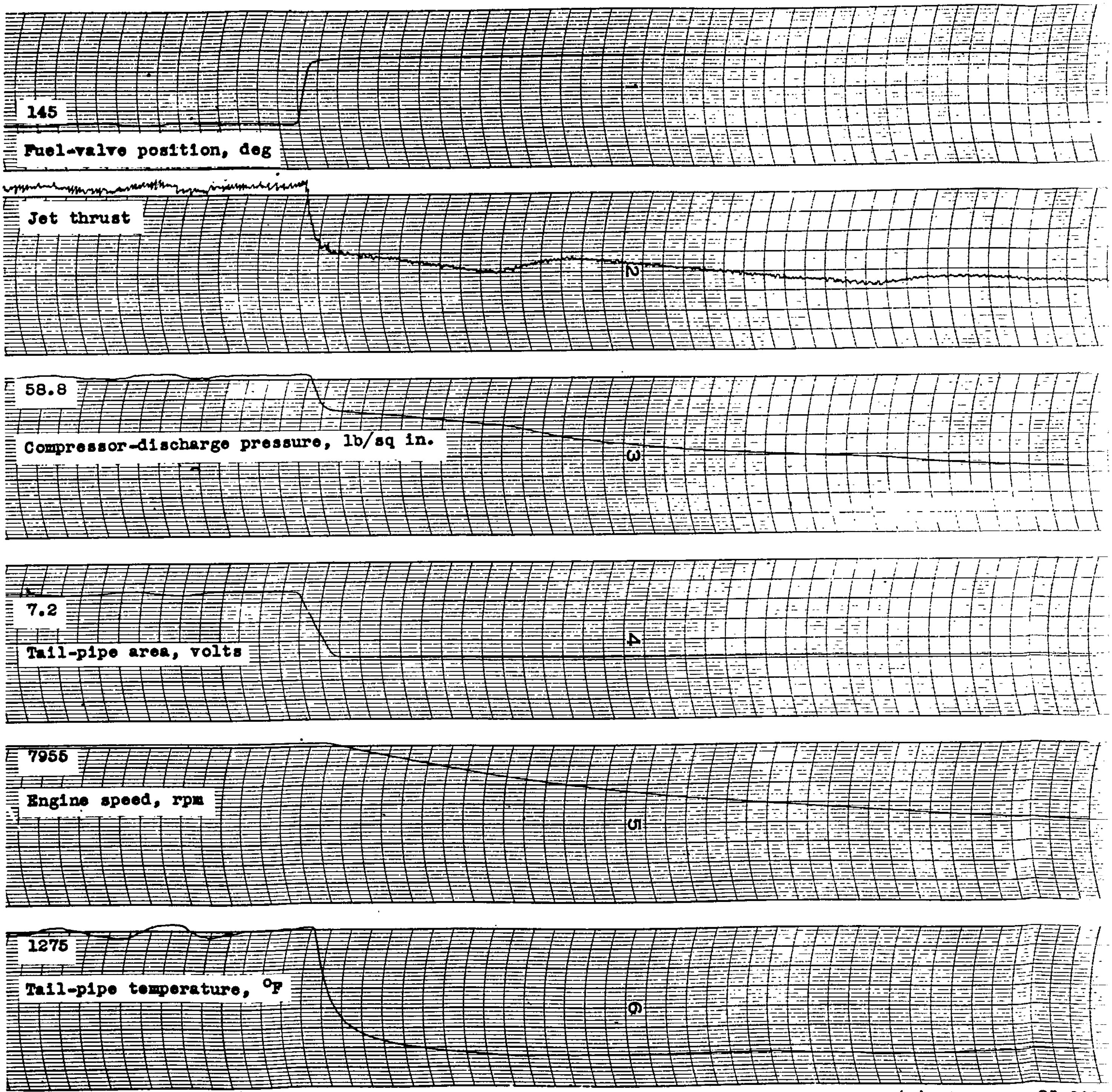
cally controlled deceleration from full dry thrust to idle speed. (Chart speed 2.5 divisions per second.)



ram pressure ratio, 1.03.

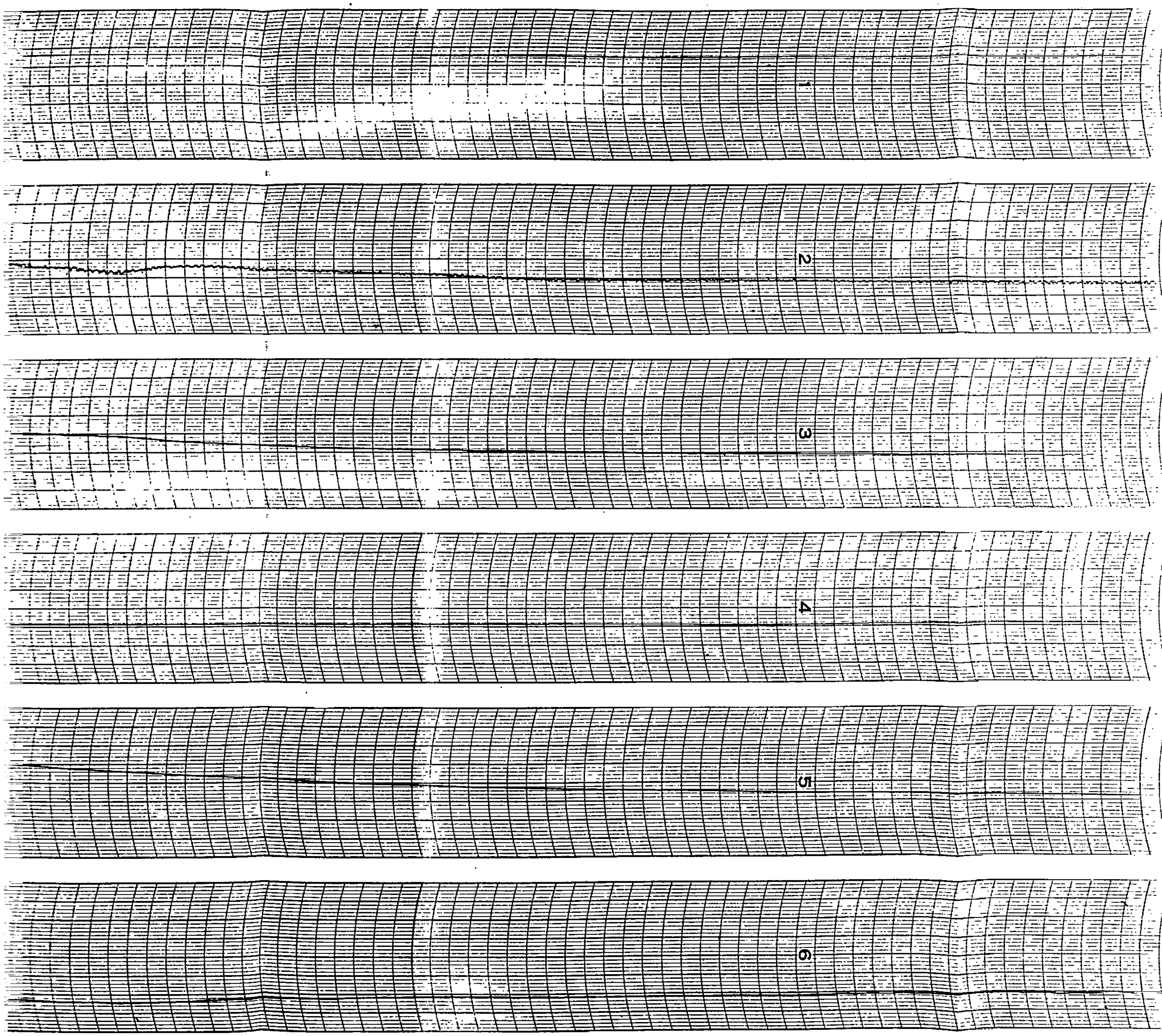
ry thrust to idle speed. (Chart speed 2.5 divisions per second.)

NACA



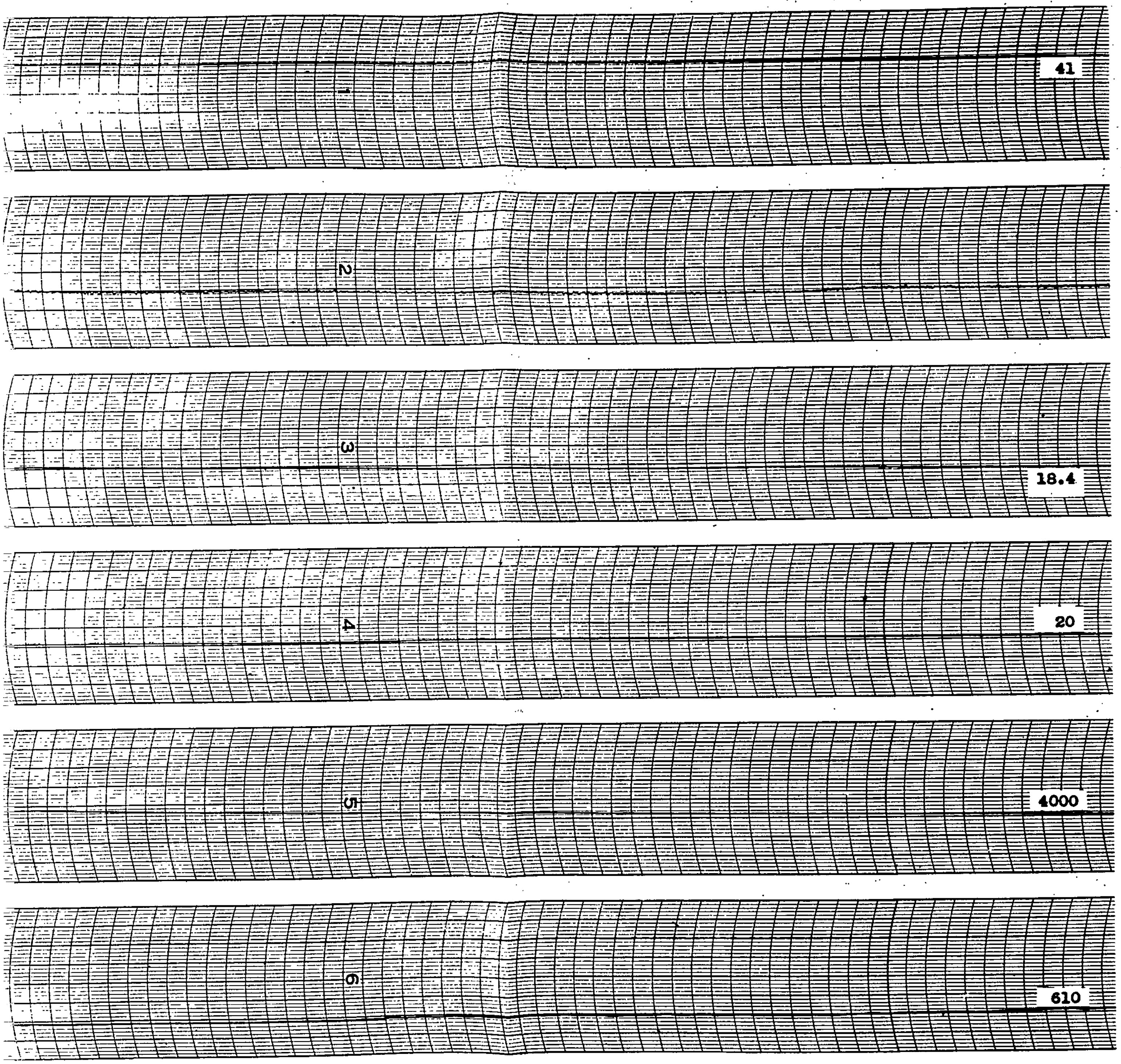
(c) Altitude, 25,000

Figure 12. - Continued. Automatically controlled decelerati



(c) Altitude, 25,000 feet; nominal ram pressure ratio, 1.03.

tomatically controlled deceleration from full dry thrust to idle speed. (Chart speed 2.5 divisions per second.)



ram pressure ratio, 1.03.

dry thrust to idle speed. (Chart speed 2.5 divisions per second.)

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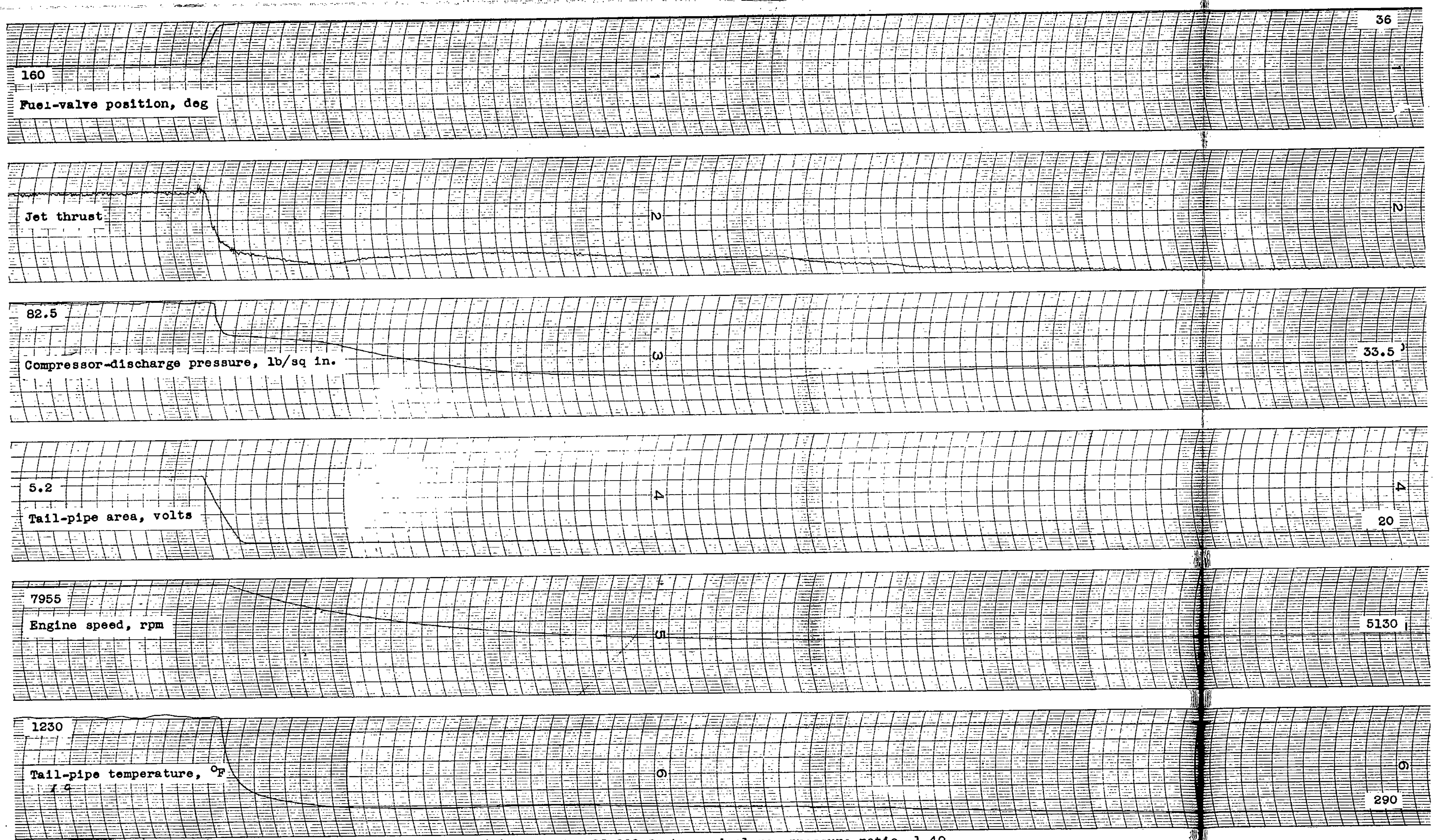

(d) Altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

Figure 12. - Continued. Automatically controlled deceleration from full dry thrust to idle speed. (Chart speed 2.5 divisions per second.)

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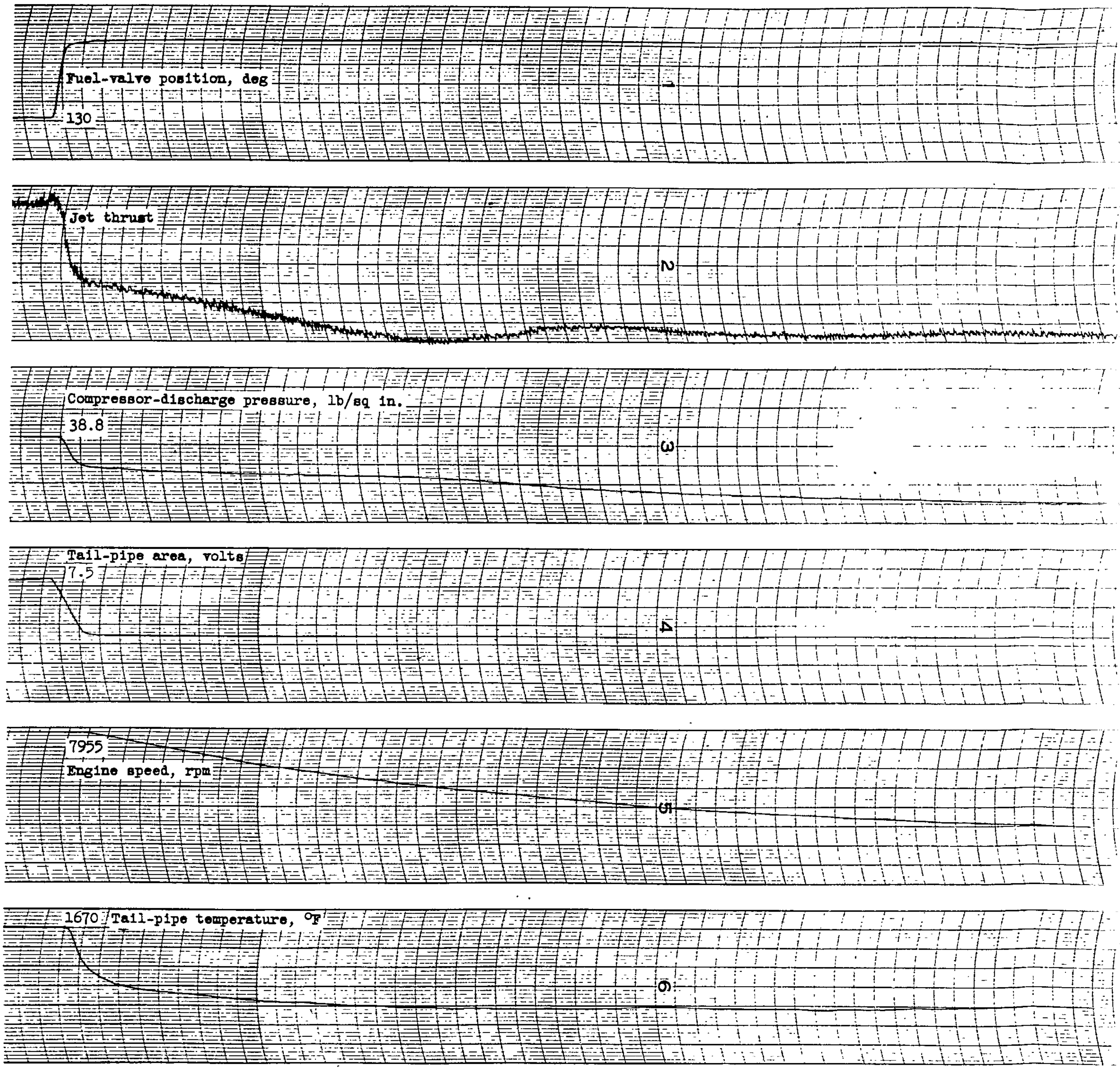

Figure 12. - Continued.

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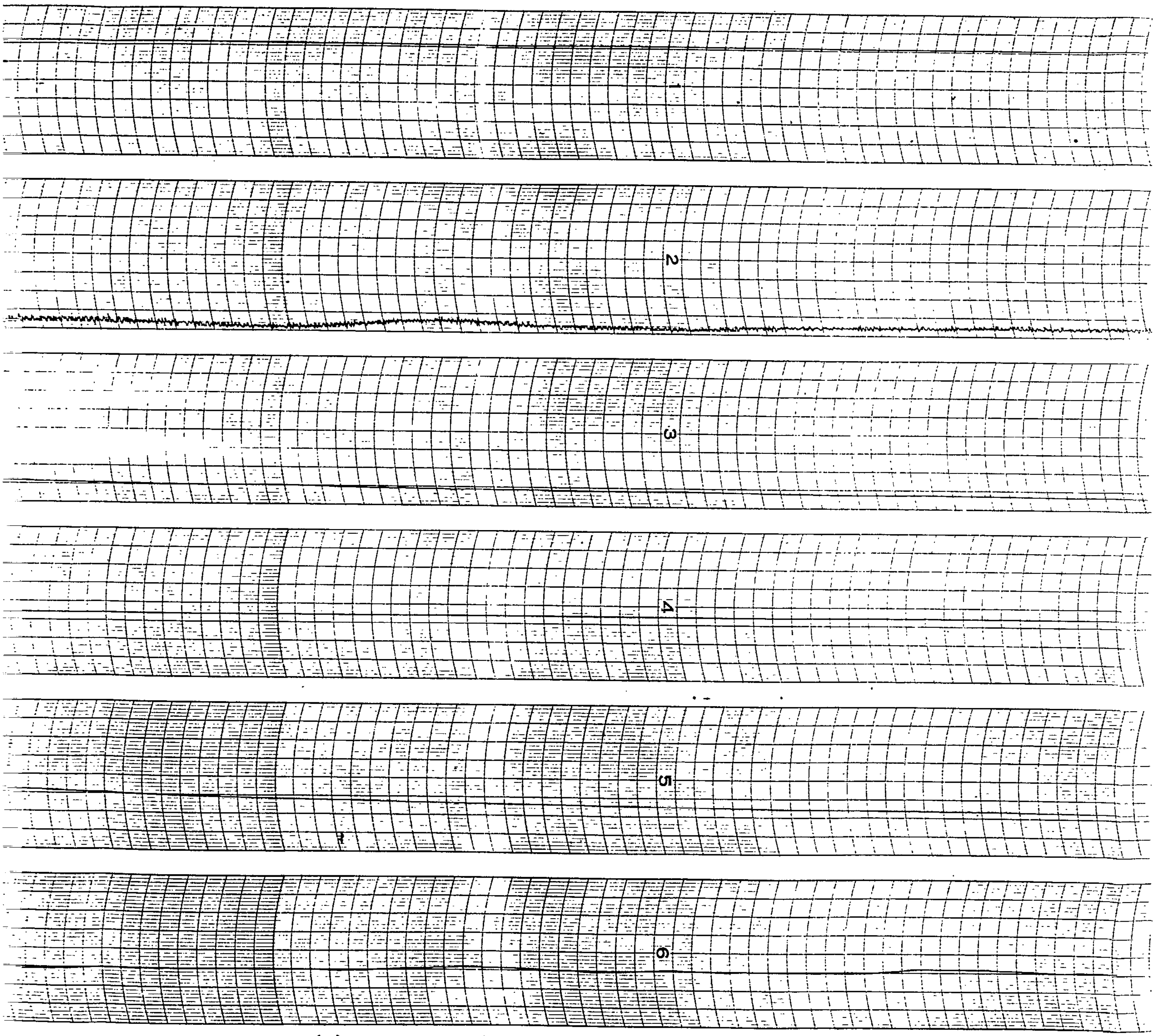
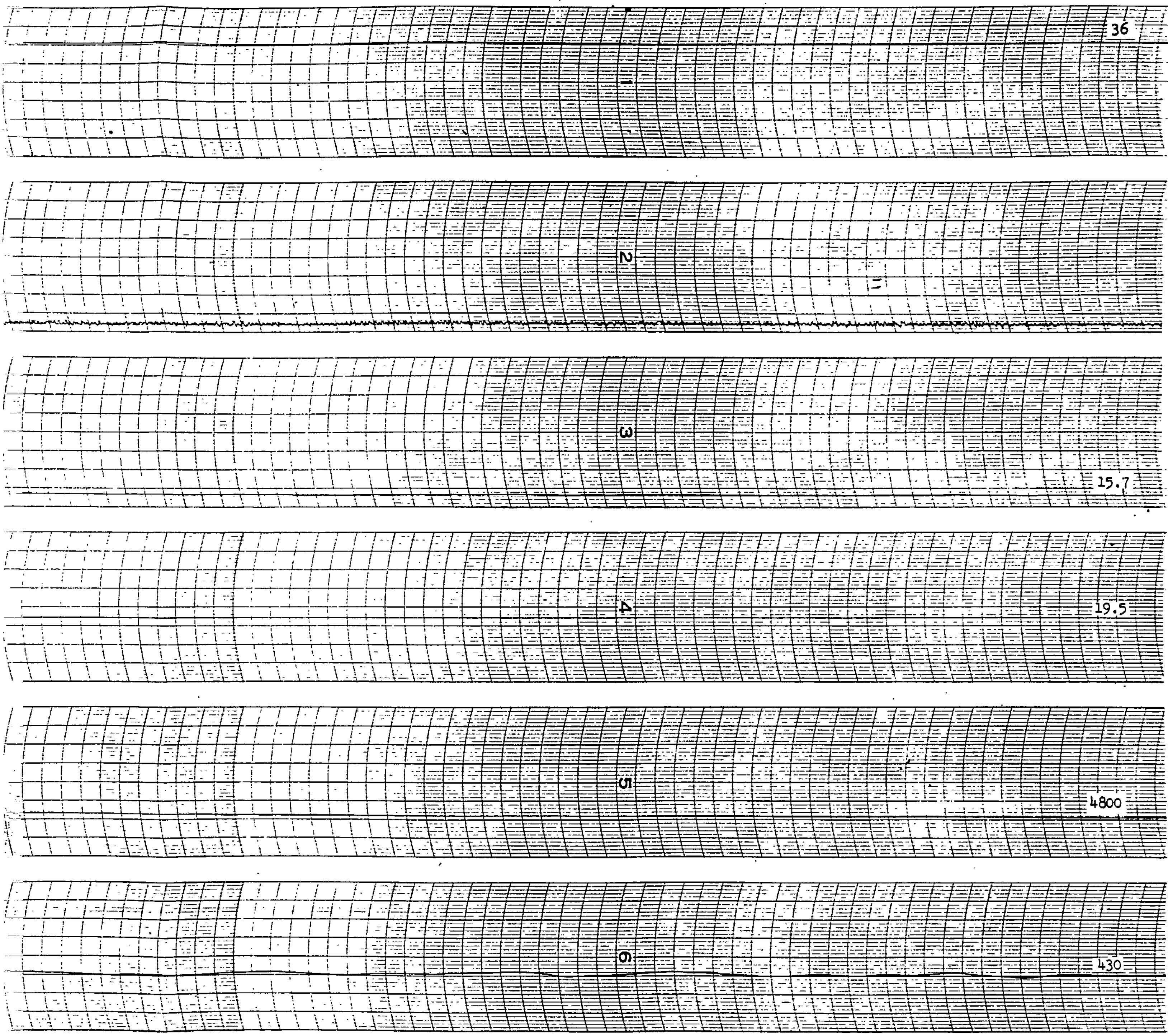


(e) Altitude, 35,000 feet; nominal ram pressure ratio, 1.03.

12. - Continued. Automatically controlled deceleration from full dry thrust to idle speed. (Chart speed 2.5 divisions



speed 2.5 divisions per second.)

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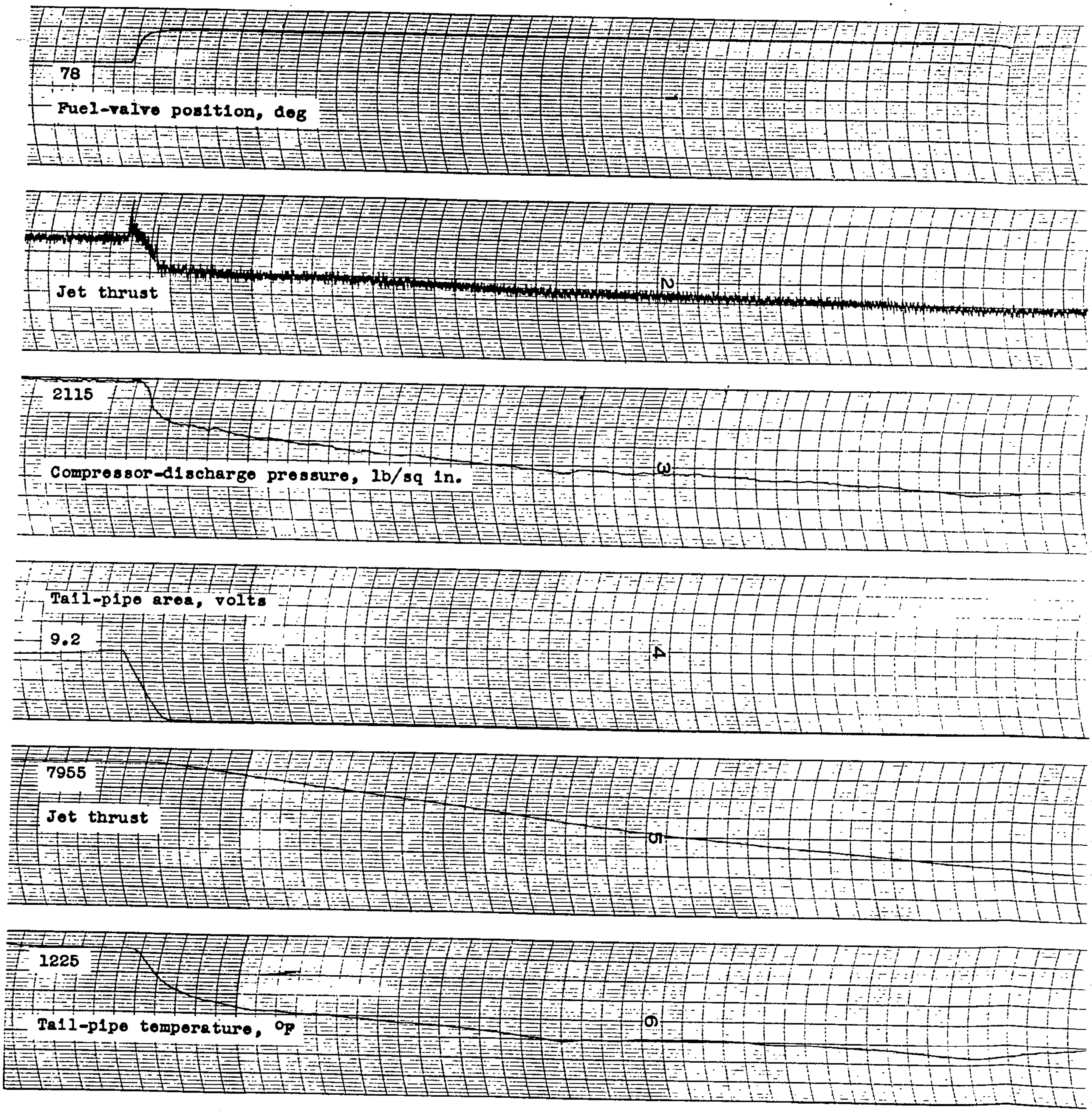

Figure 12. - Concluded. Automatically

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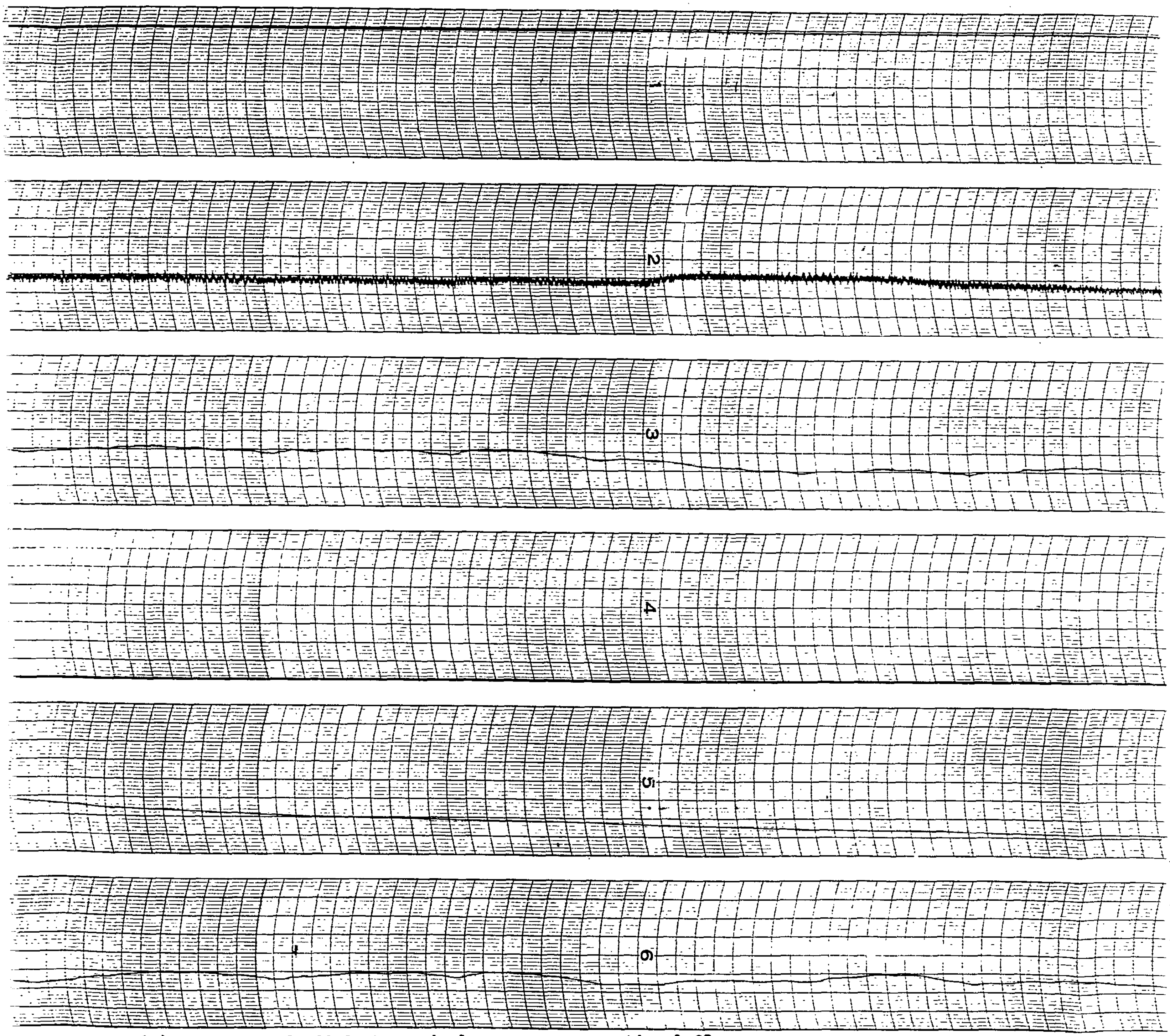
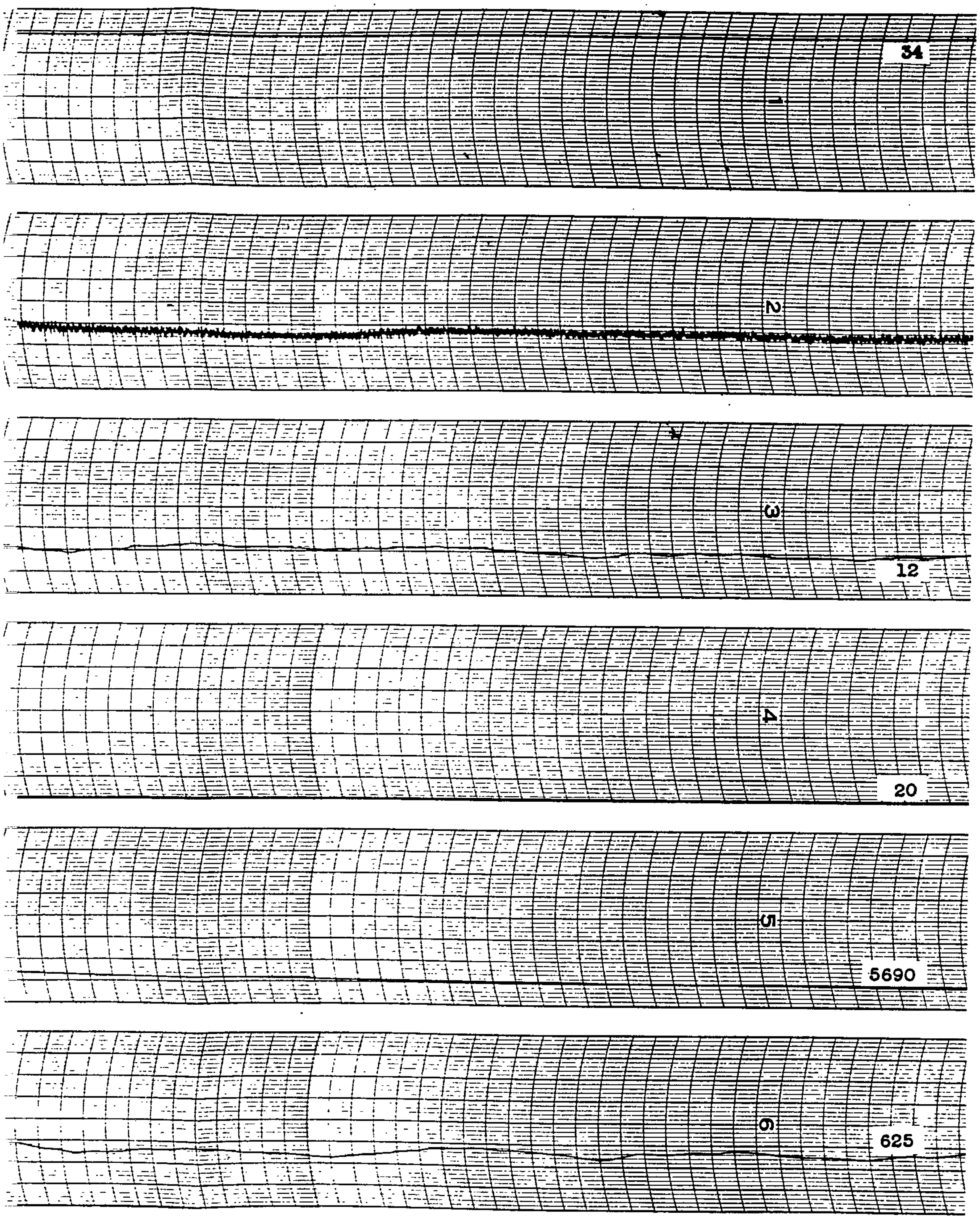


(f) Altitude, 45,000 feet; nominal ram pressure ratio, 1.03.

utomatically controlled deceleration from full dry thrust to idle speed. (Chart speed 2.5 divisions per second.)



visions per second.)

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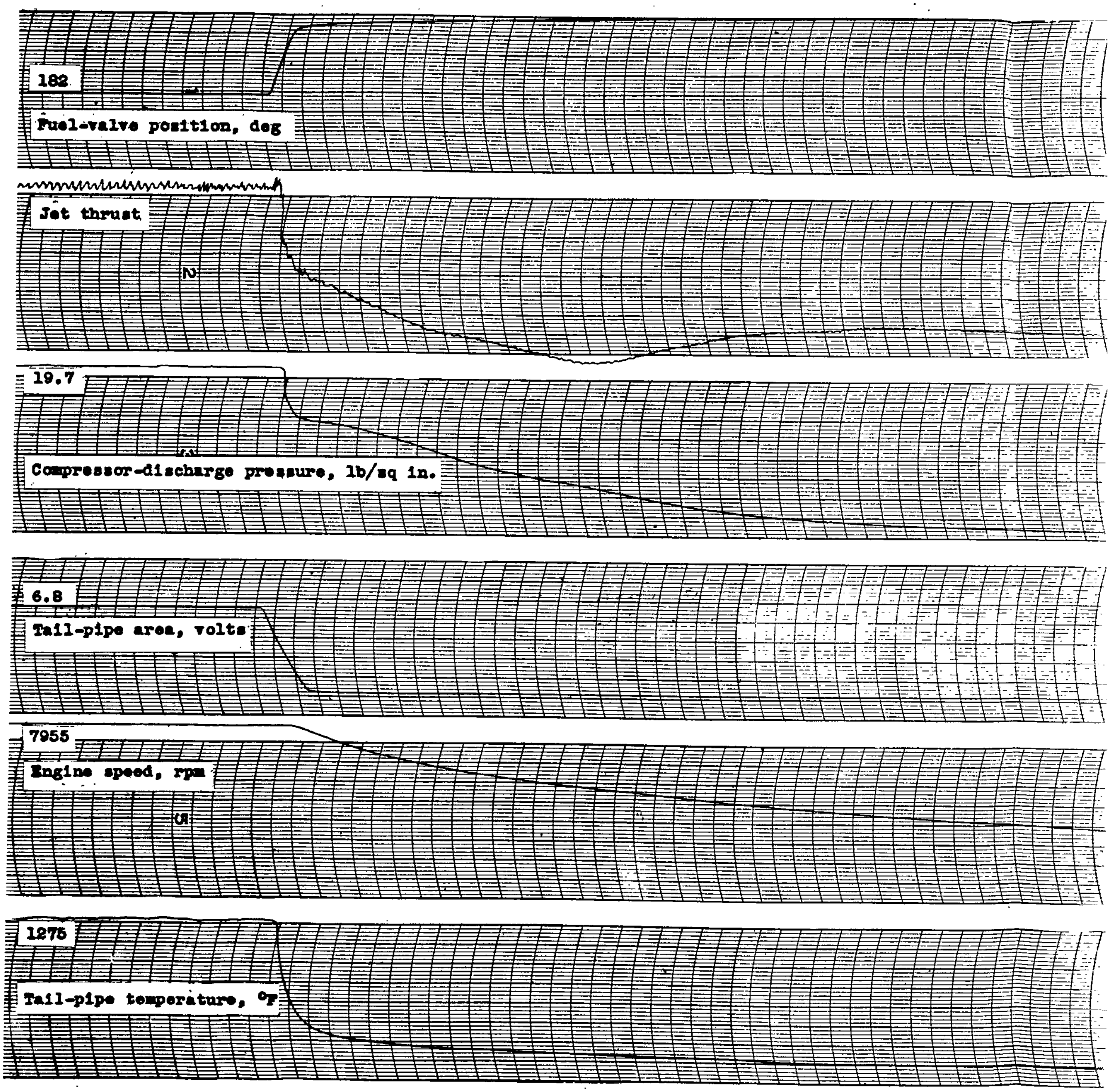
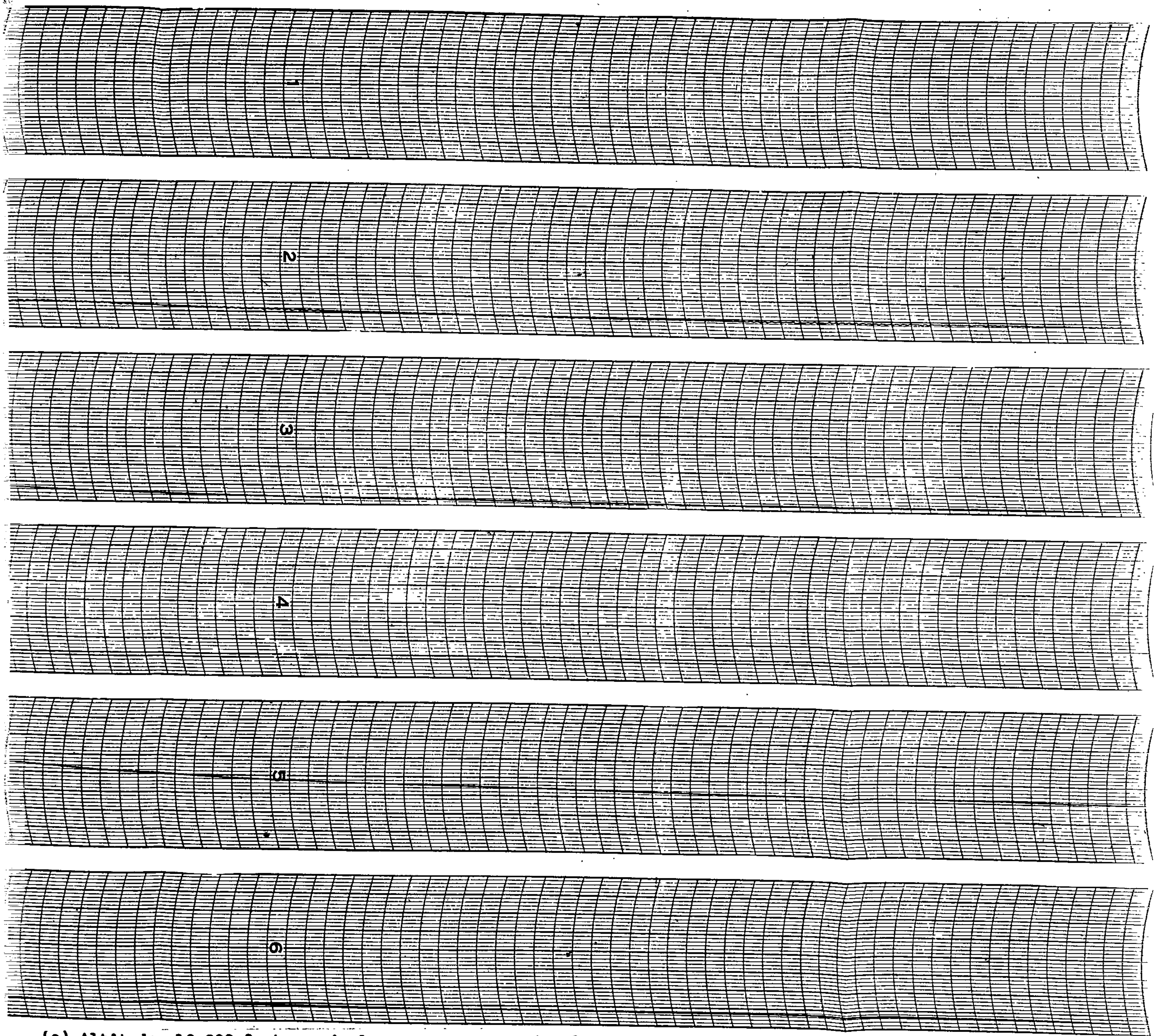


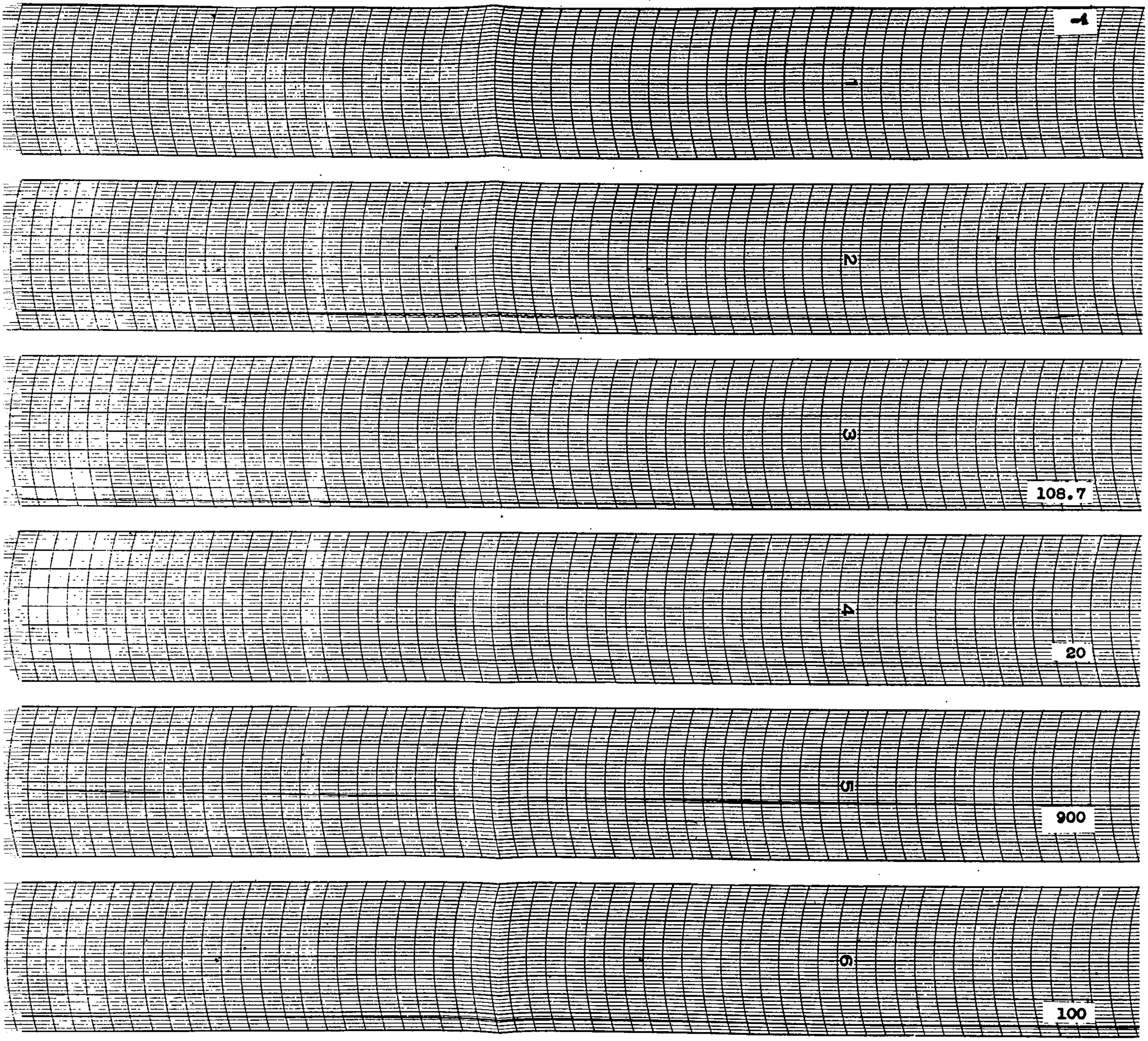
(a) Altitude, 10,000

Figure 13. - Automatically controlled deceleration from full dry



(a) Altitude, 10,000 feet; nominal ram pressure ratio, 1.03.

:celeration from full dry thrust to thrust selector position of 0°. (Chart speed 2.5 divisions per second.)



1 ram pressure ratio, 1.03.

hrust selector position of 0°. (Chart speed 2.5 divisions per second.)

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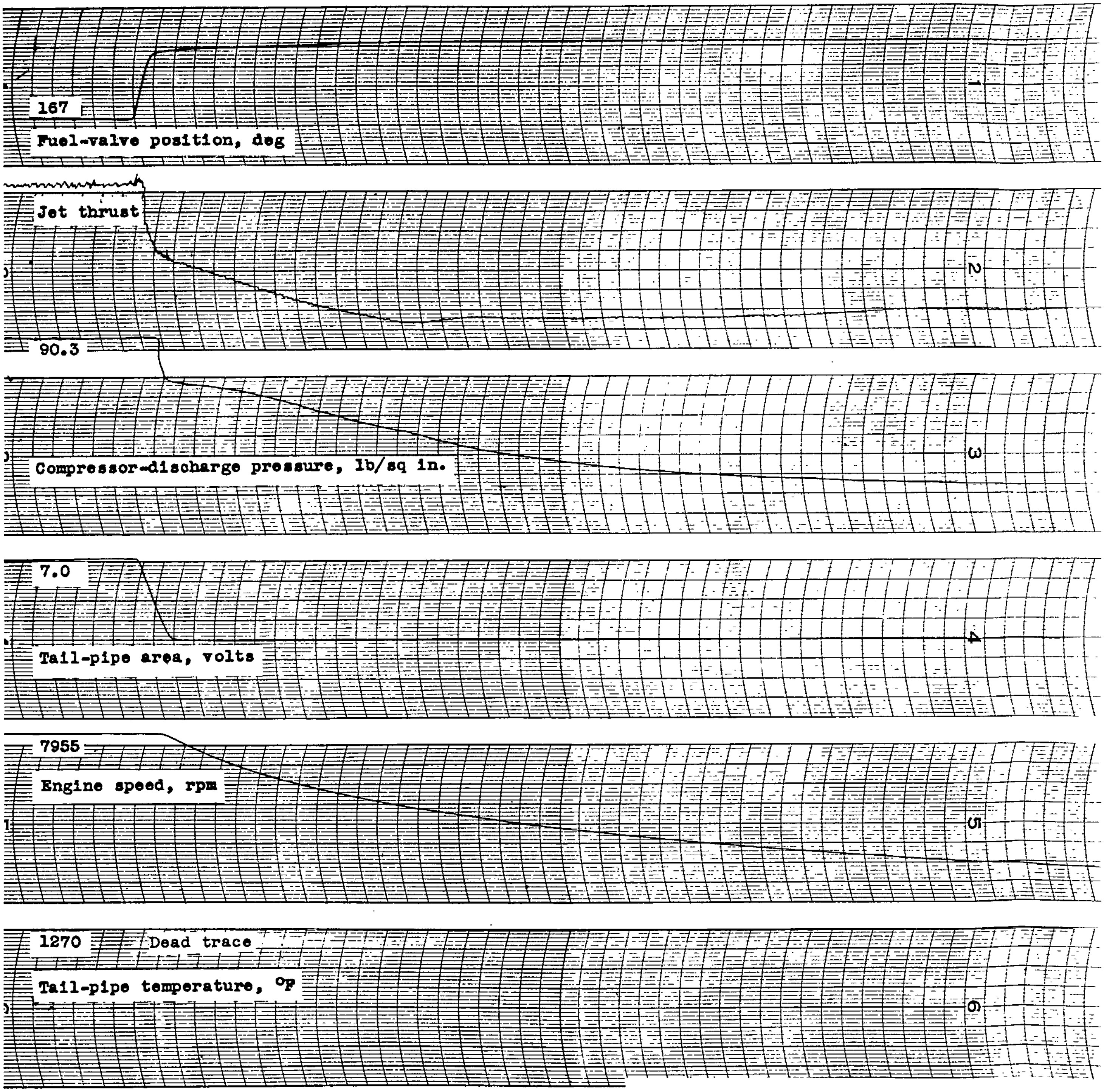
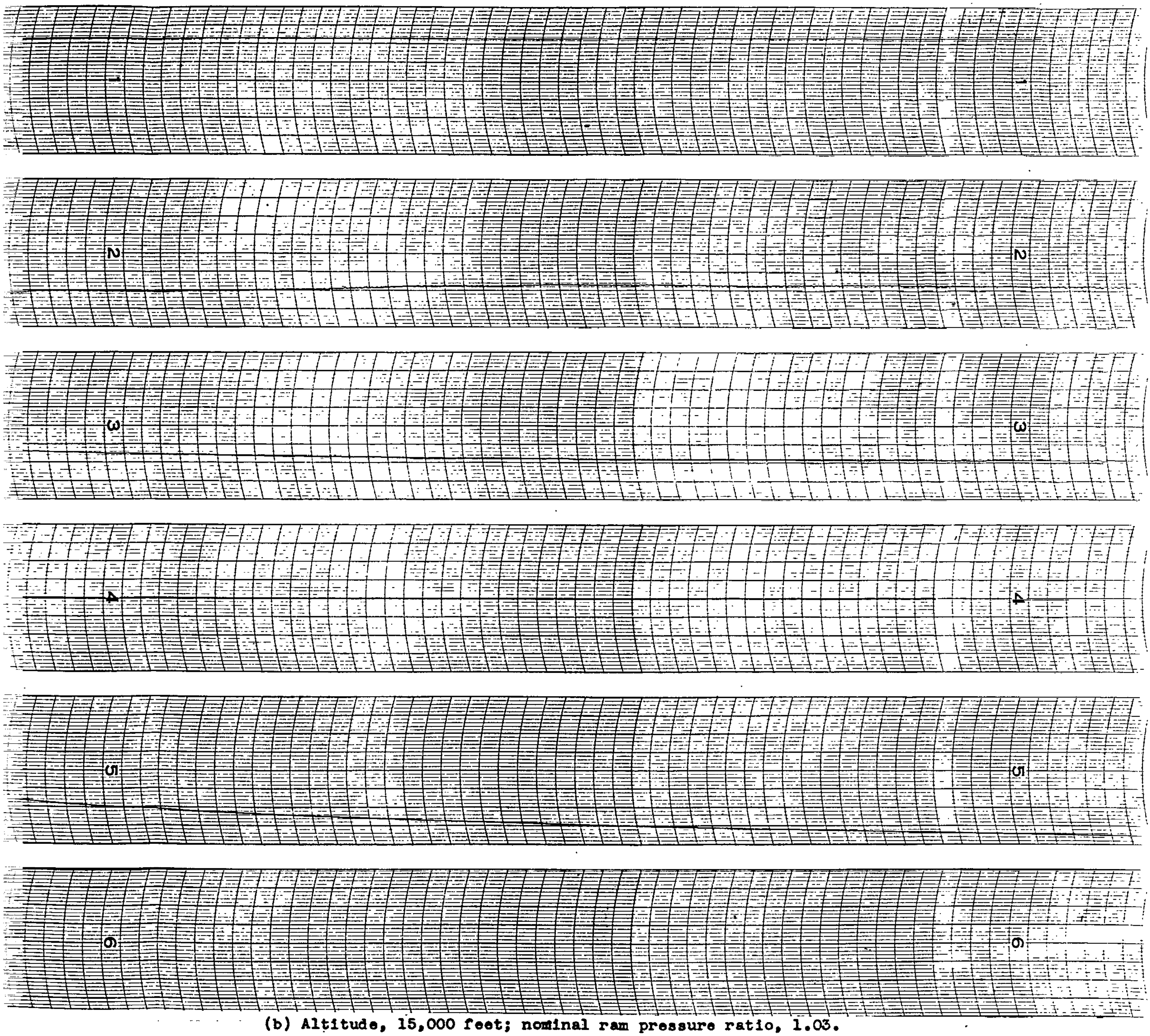
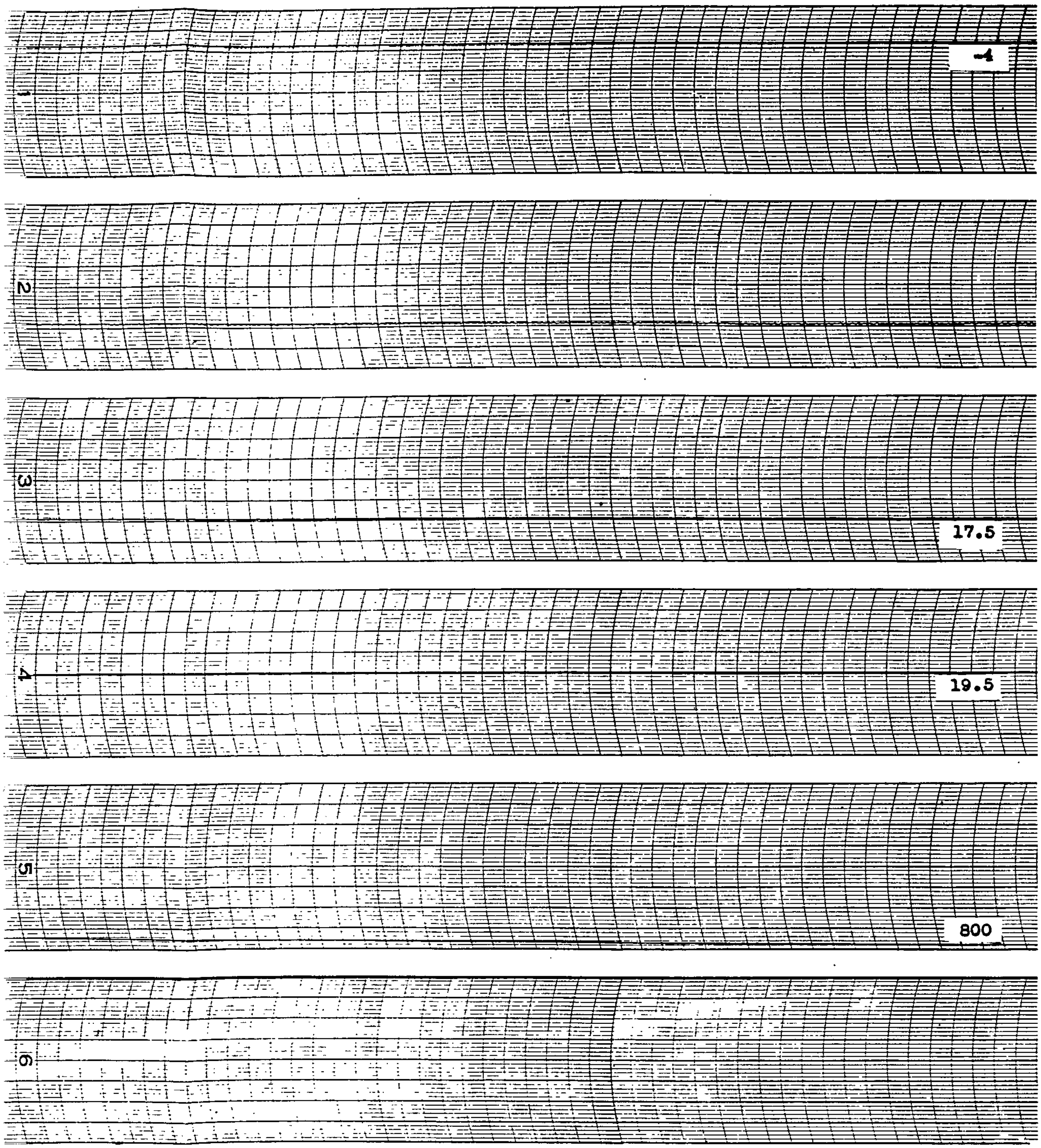


Figure 13. - Continued. Automatically control



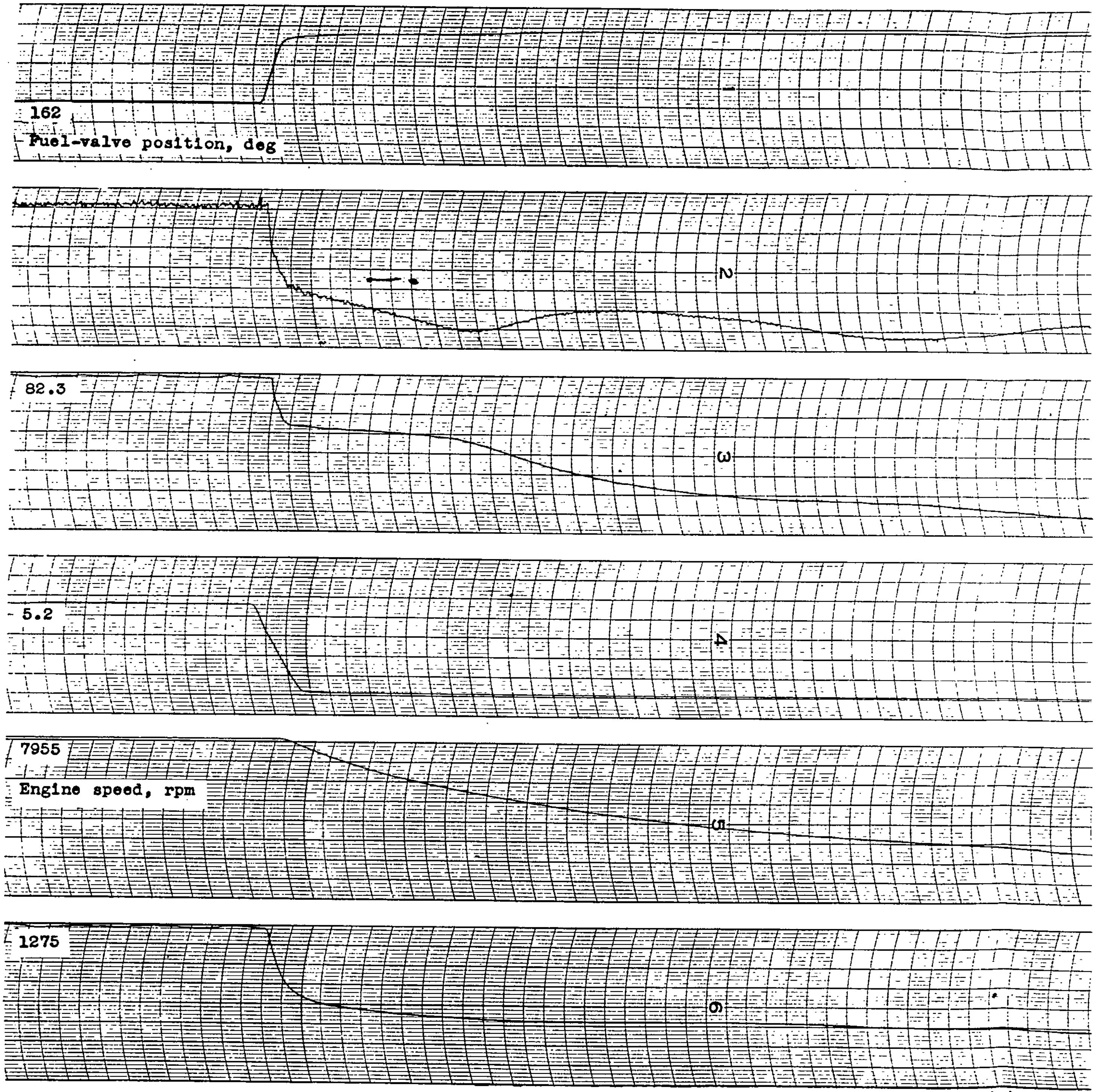
(b) Altitude, 15,000 feet; nominal ram pressure ratio, 1.03.

. Automatically controlled deceleration from full dry thrust to thrust selector position of 0°. (Chart speed 2.5 divi



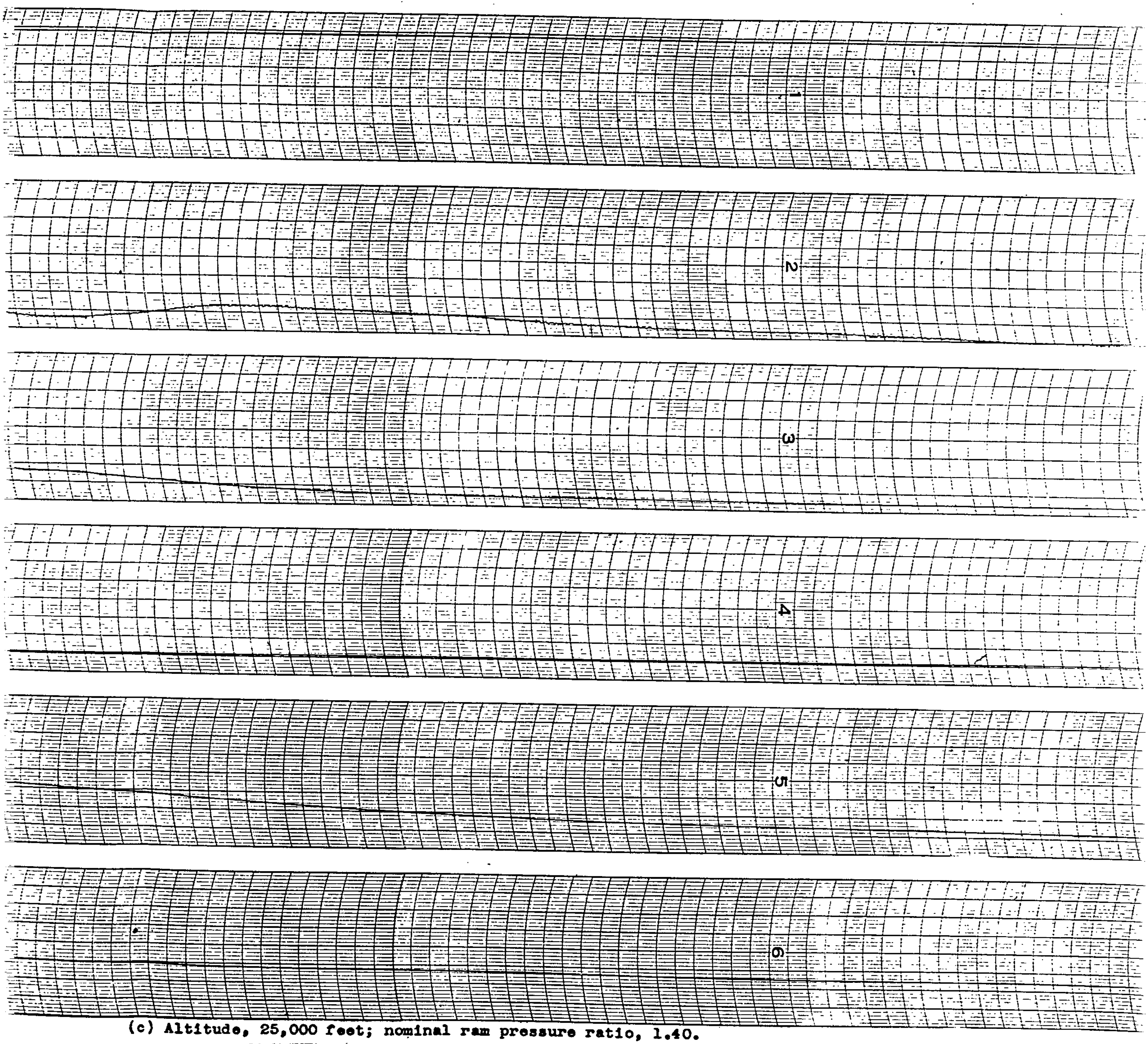
t speed 2.5 divisions per second.)

1375



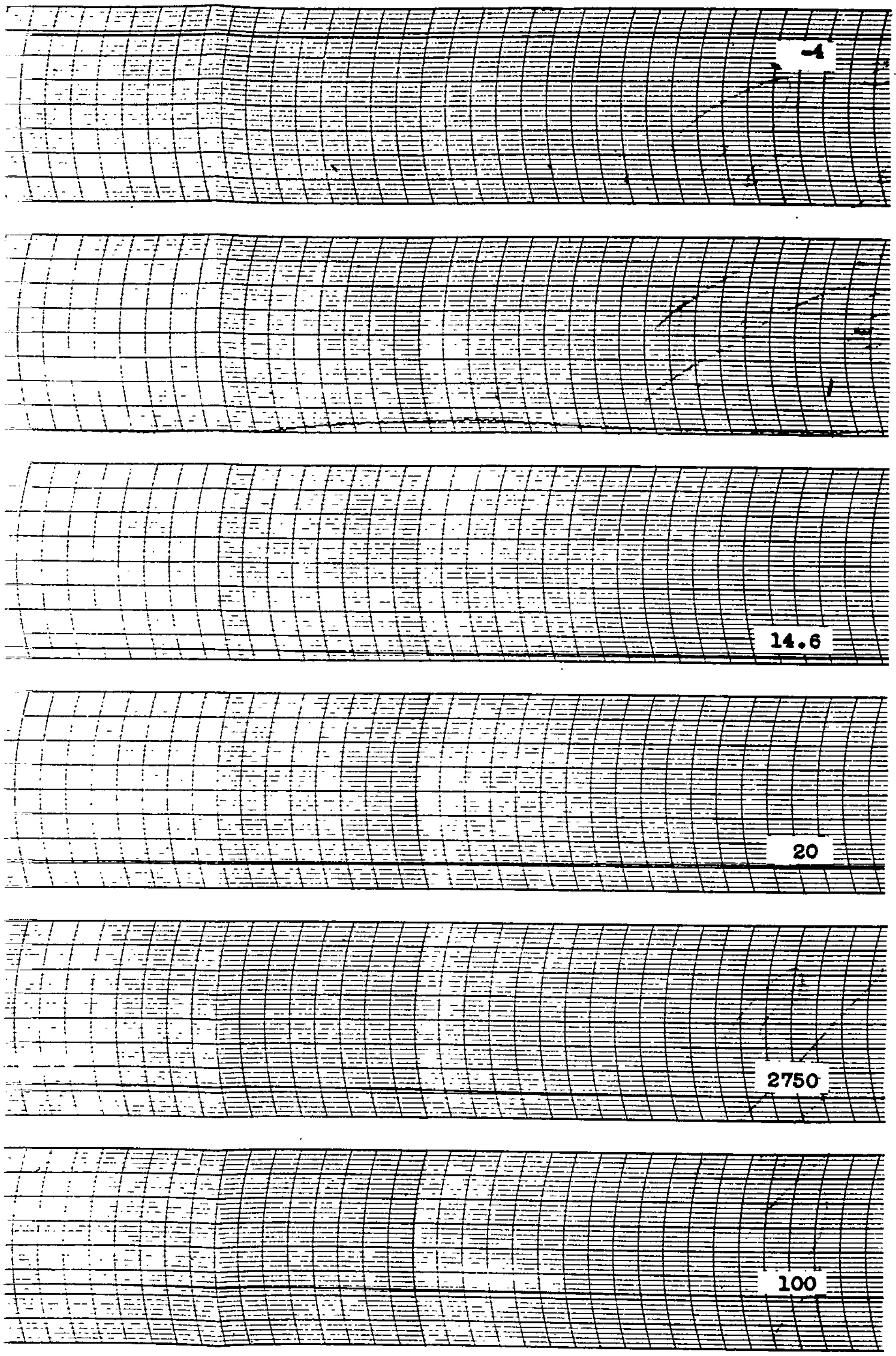
(c) Altituc

Figure 13. - Continued. Automatically controlled decelerat:

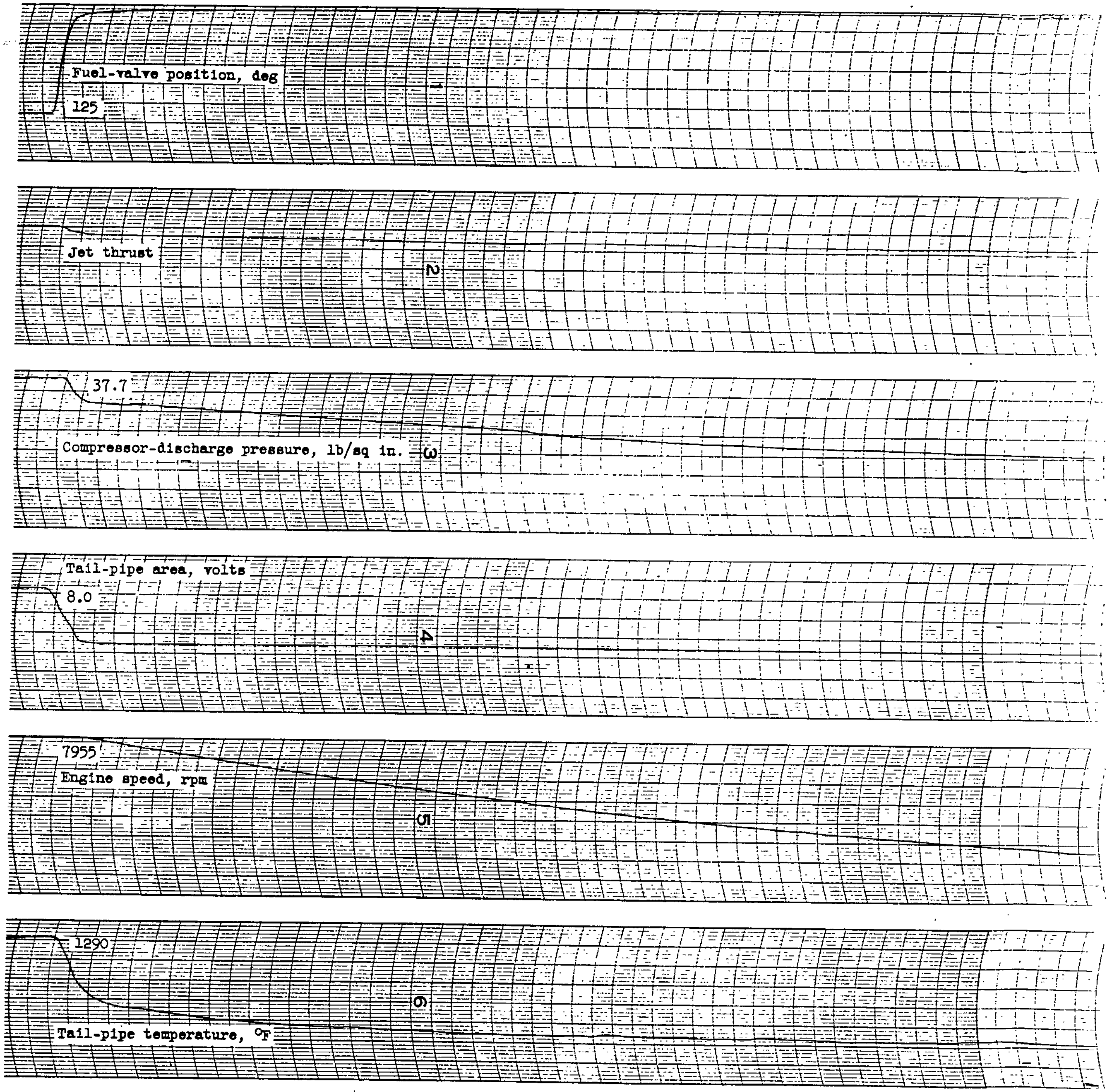


(c) Altitude, 25,000 feet; nominal ram pressure ratio, 1.40.

'y controlled deceleration from full dry thrust to thrust selector position of 0°. (Chart speed 2.5 divisions per secon



visions per second.)

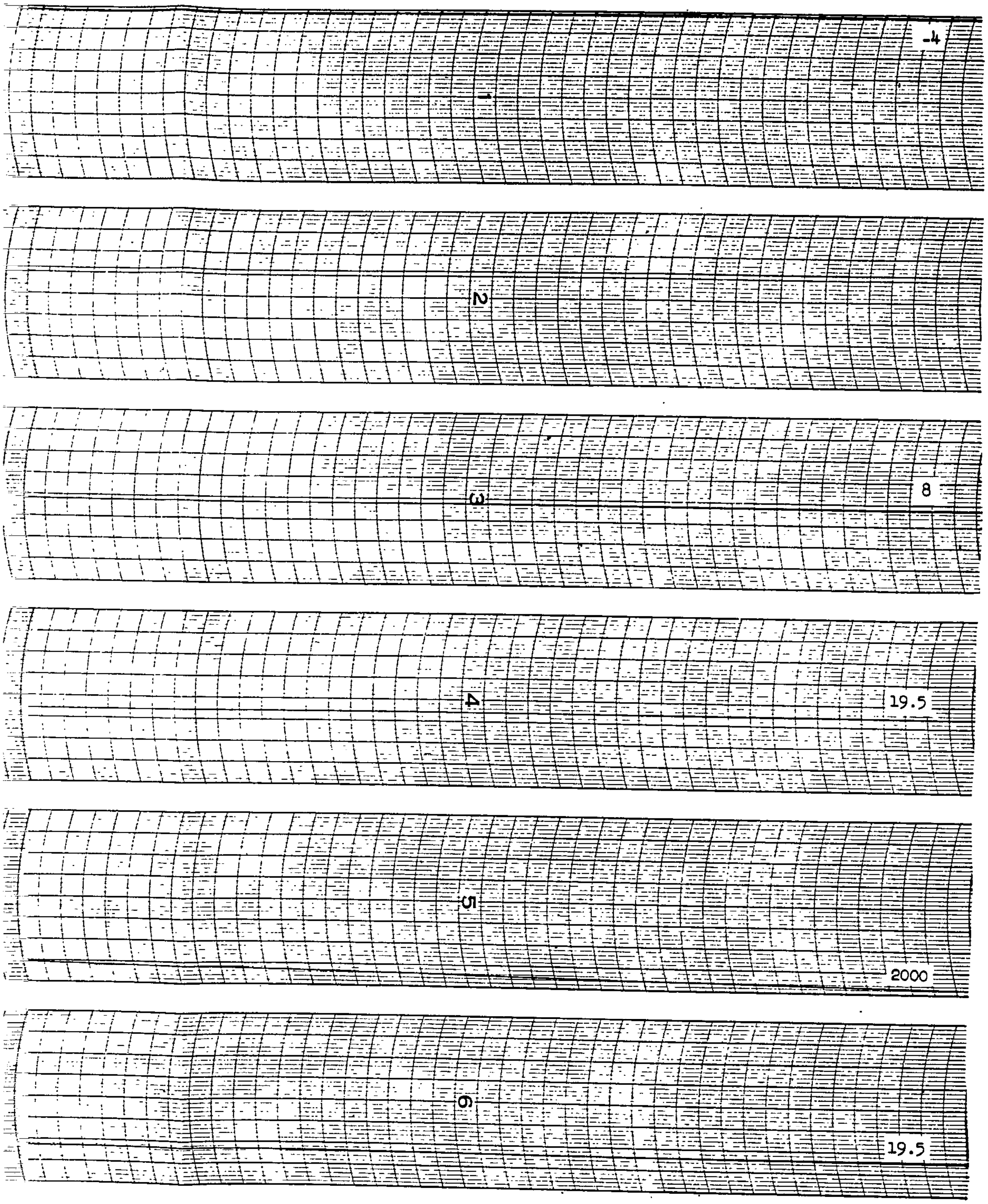


(d)

Figure 13. - Concluded. Automatically controlled de

(d) Altitude, 35,000 feet; nominal ram pressure ratio, 1.03.

y controlled deceleration from full dry thrust to thrust selector position of 0°. (Chart speed 2.5 divisions per secon



2.5 divisions per second.)