13E col. -4 down up
"Old Report"

SIA-42

UAG 15

UNIVERSITY OF ALASKA

GEOPHYSICAL INSTITUTE

ZENITH NIGHT SKY LIGHT MEASUREMENTS AT COLLEGE, ALASKA

John B. Wilcox, Fred F. Kohls, Harold Cronin

This work was supported in part by the CRPL, National Bureau of Standards. Order No. S-8097.

ZENITH NIGHT SKY LIGHT MEASUREMENTS AT COLLEGE, ALASKA[1]

John B. Wilcox, Fred F. Kohls, Harold Cronin[2]

Introduction

For purposes of studying the character of time fluxuations in arctic night sky brightness, we have erected a photoelectric monitory system at the Ballaine's Lake Field Station (latitude N64°52', longitude W147°49'). The unit was set in operation September 27, 1949, and dismounted June 6, 1950, when it became evident that further observations would be impossible due to lengthening days. Although no apparatus has been available by which the response curves of phototubes could be calibrated absolutely, a standard by which bright ness recordings of different phototubes can be reduced to approximate absolute values has been evolved. A limited investigation of a possible correlation between fluxuations in the intensity of upper atmospheric emissions and sporadic conditions in the ionosphere has been made.

Instrumentation

An RCA 1-P-21 photomultiplier tube, having a response similar to that of the human eye (Figure 1) has been utilized. The tube involves 9-stage amplification; in d.c. operation with -1000 applied to the cathode (or about 110 volts per stage), the current amplification is some 4×10^6. Figure 2 shows the tube circuit and assembly.

1. This work was supported in part by the CRPL, National Bureau of Standards. Order No. S-8097.

2. Geophysical Institute, University of Alaska, College, Alaska.

The tube was mounted in a heated box set atop a 20 foot tower. It was believed that an elevated installation would eliminate the effects of light in the nearby field station, and such proved to be the case. No change in phototube response was evident when these lights were eliminated. A 3 inch circular opening in the box admitted zenith sky light which was subsequently collimated by means of a 3 1/2 inch tube of 2 1/2 inch diameter. This opening was fitted with an ultraviolet transmitting filter (Filter 791, Corning Glass Works). The field of "view" of the phototube was about 14° in diameter. The box was oriented by means of an affixed target leveling glass and adjustable supports.

The phototube signal was led into a bridge and recorder circuit as shown in Figure 3. A Brown two-channel recorder was utilized and adjusted so that the sensitivity of the two channels was about ten-to-one, with the recording limits of the "sensitive" and "insensitive" scales standing at about 5 and 50 volts phototube signal respectively. This adjustment facilitated complete coverage in both the presence and absence of zenith polar aurorae.

A time clock activated the power supply each day at the time of earliest possible recording, i.e. the time during evening twilight when zenith sky brightness had fallen within the recorder limit. Simultaneously, the turning motor of a semicircular shutter designed to protect the phototube from direct sunlight was activated. Figure 4 shows the construction of this shutter mechanism. As shown, the shutter is in its daylight or closed position (covering the orifice), with microswitch A' closed. When the time clock activates the power supply, it also closes contacts A, thus activating the turning motor. Upon turning through about 180° and opening the orifice, the shutter closes microswitch B' and immediately thereafter releases microswitch

A', thus stopping the motor. At the end of the night's run, the time clock opens A (and deactivates the power supply) and closes B, so that the shutter turns again through 180°, closes A' and releases B', completing the cycle so that the orifice is again closed during the day.

Calibration of the bridge and recorder circuit was made simply by impressing known voltages across the input leads from the phototube. The recorder response was not quite linear with applied voltage. Originally, these calibrations were made almost daily, but their frequency was decreased when it became evident that they changed very little from week to week.

The Naval Research Laboratory visual photometer, Model 2, was used to provide a calibration of phototube signal vs. millimicrolamberts of illumination. During several twilight periods, the photometer was oriented vertical and points along the recorder twilight curve identified as to visual brightness. This provided a standard by which the response of different phototubes could be reduced to absolute brightness units. It is recognized that due to the differing spectra of twilight and night skies this standard is not completely accurate, but it afforded the best means available for comparison of phototube responses. The results of calibrations for the two phototubes used in this program are shown in Figures 5 and 6. Phototube No. 1 showed signs of fatigue; No. 2 did not. It is evident that the response of both tubes during the twilight period is closely linear in each case.

Investigation and Results

Traces from the recorder were divided at each midnight. The hourly means of brightness were first scaled according to the voltage calibration, then these mean values were multiplied by the factor

derived from Figure 5 or 6 in order to obtain brightness in μh. These values were recorded and forwarded to the National Bureau of Standards each month along with microfilm copies of the traces.

The ionospheric equipment at College produces a picture of the ionosphere every fifteen minutes. In order to investigate a possible correlation between night sky emissions and sporadic ionization in the E-region, we have scaled mean brightness values for fifteen minute intervals during which sporadic ionization was evident in the E-layer. The results are shown in Figures 7, where f_{E_s} represents the maximum radio frequency reflected from the E-layer (indicative, of course, of the degree of ionization there), and B represents the corresponding brightness. Moonlit periods were discounted in compiling this data due to the difficulty in segregating atmospheric emissions from the varying background of scattered moonlight. Frequent observations of atmospheric conditions were made on all but a few nights throughout the winter Until May 1.

It would appear from Figures 7 that although on many nights the curves follow each other strikingly, there is no consistent correlation between the two phenomena. Since the F-region was generally masked by sporadic E ionization, no investigation of possible changes in sporadic F conditions with night sky brightness has been feasible. Because of the slow sweep of the ionospheric equipment at this station, any conclusions drawn concerning possible correlations must be highly tentative. It is hoped that with the instllation of faster equipment, more conclusive surveys of this type can be undertaken.

June 30, 1950

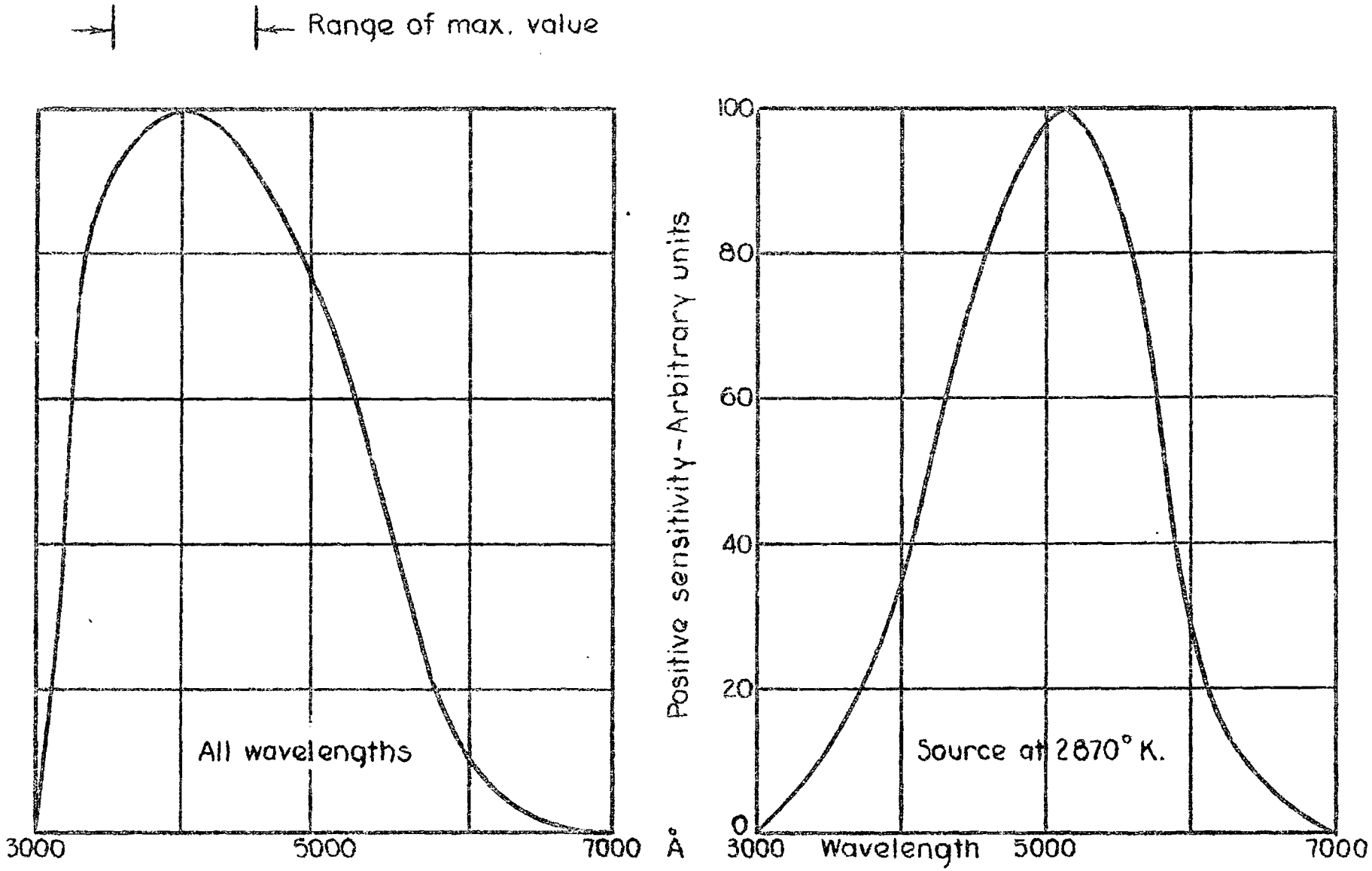
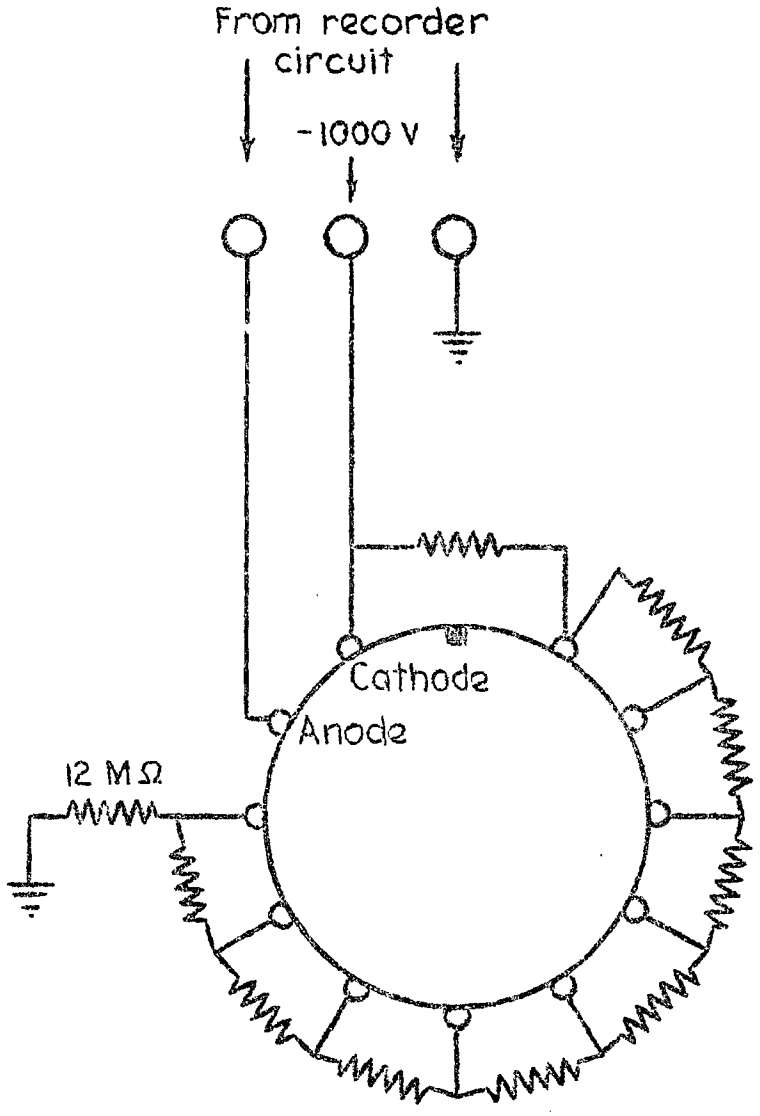


Fig. 1 - Spectral sensitivity characteristic of phototube having S-4 response.



All resistors 25,000 Ω unless designated

Fig. 2 - Photomultiplier

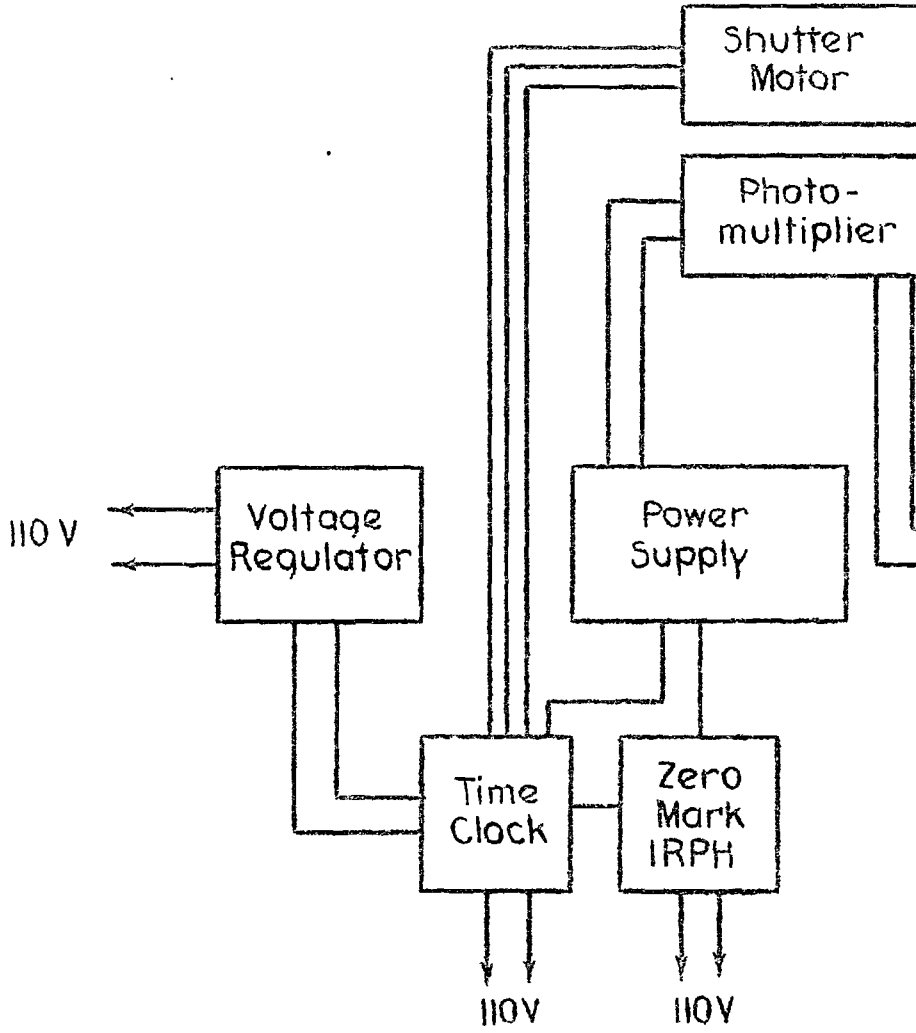
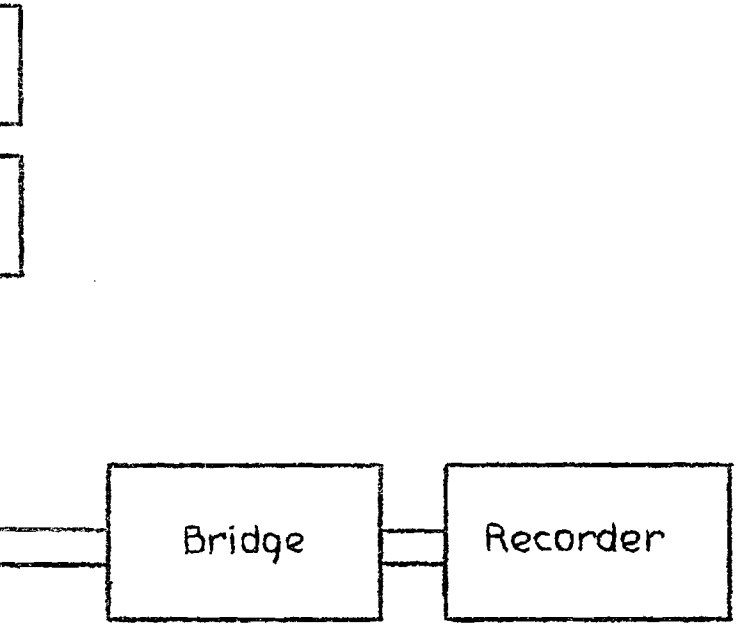

Shutter Motor
Photo-multiplier
110 V
Voltage Regulator
Power Supply
Time Clock
Zero Mark IRPH
110V
110V

Fig. 3


Bridge
Recorder

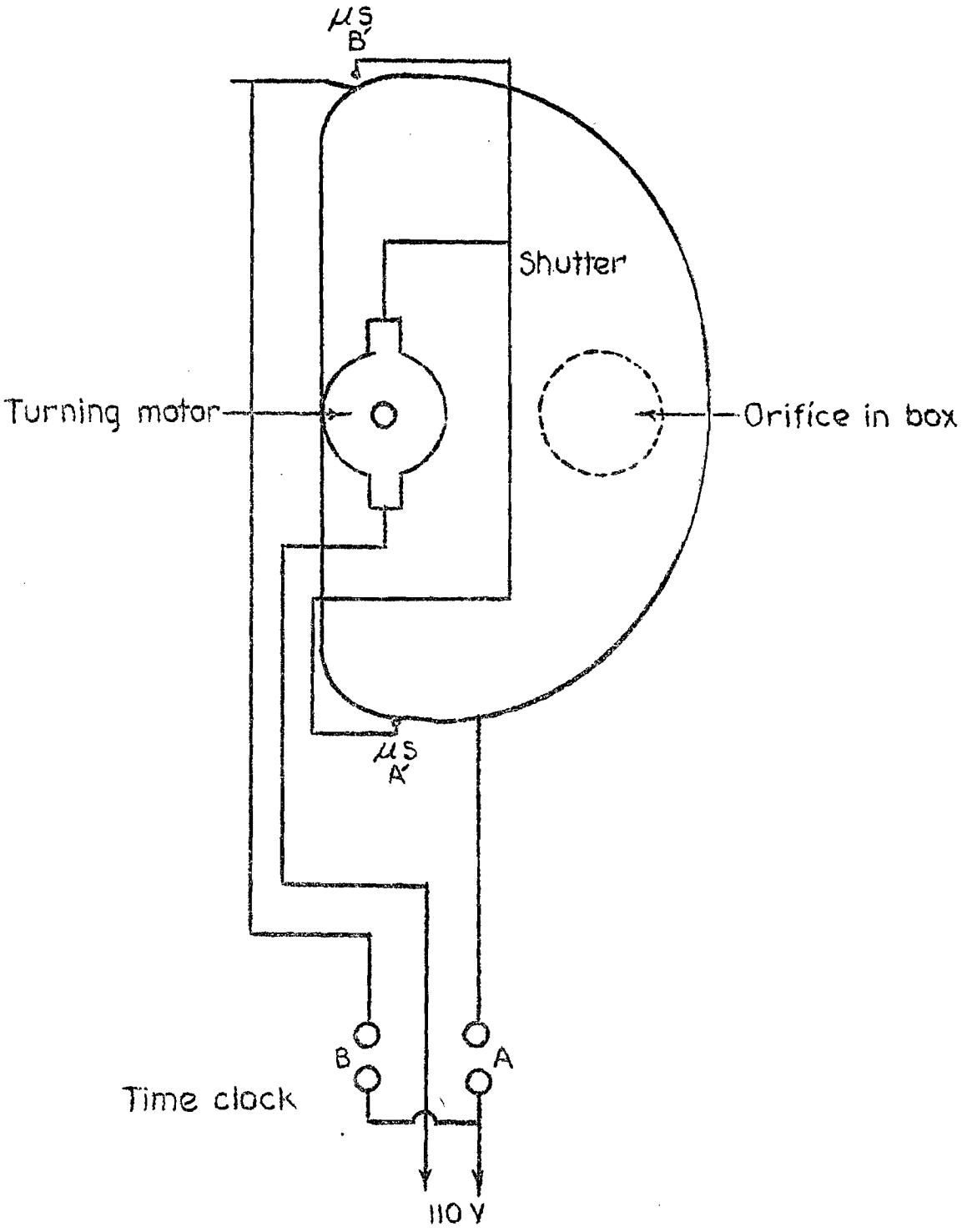

μS
B'
Shutter
Turning motor
Orifice in box
μS
A'
B
A
Time clock
110 V

Fig. 4

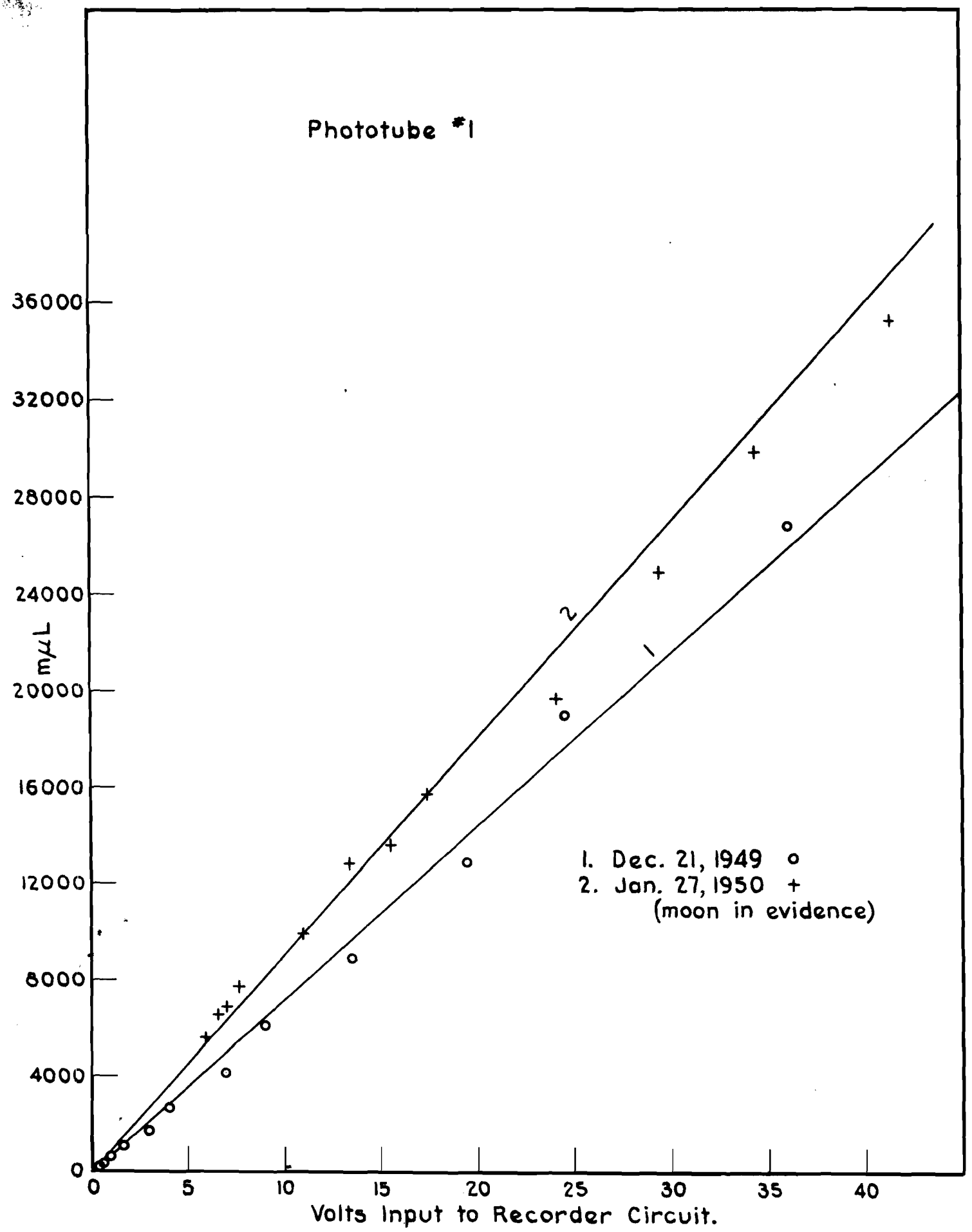

Phototube #1
36000
32000
28000
24000
20000
16000
12000
8000
4000
0
mμL
0
5
10
15
20
25
30
35
40
Volts Input to Recorder Circuit.
1. Dec. 21, 1949 o
2. Jan. 27, 1950 +
(moon in evidence)
1
2

Fig 5

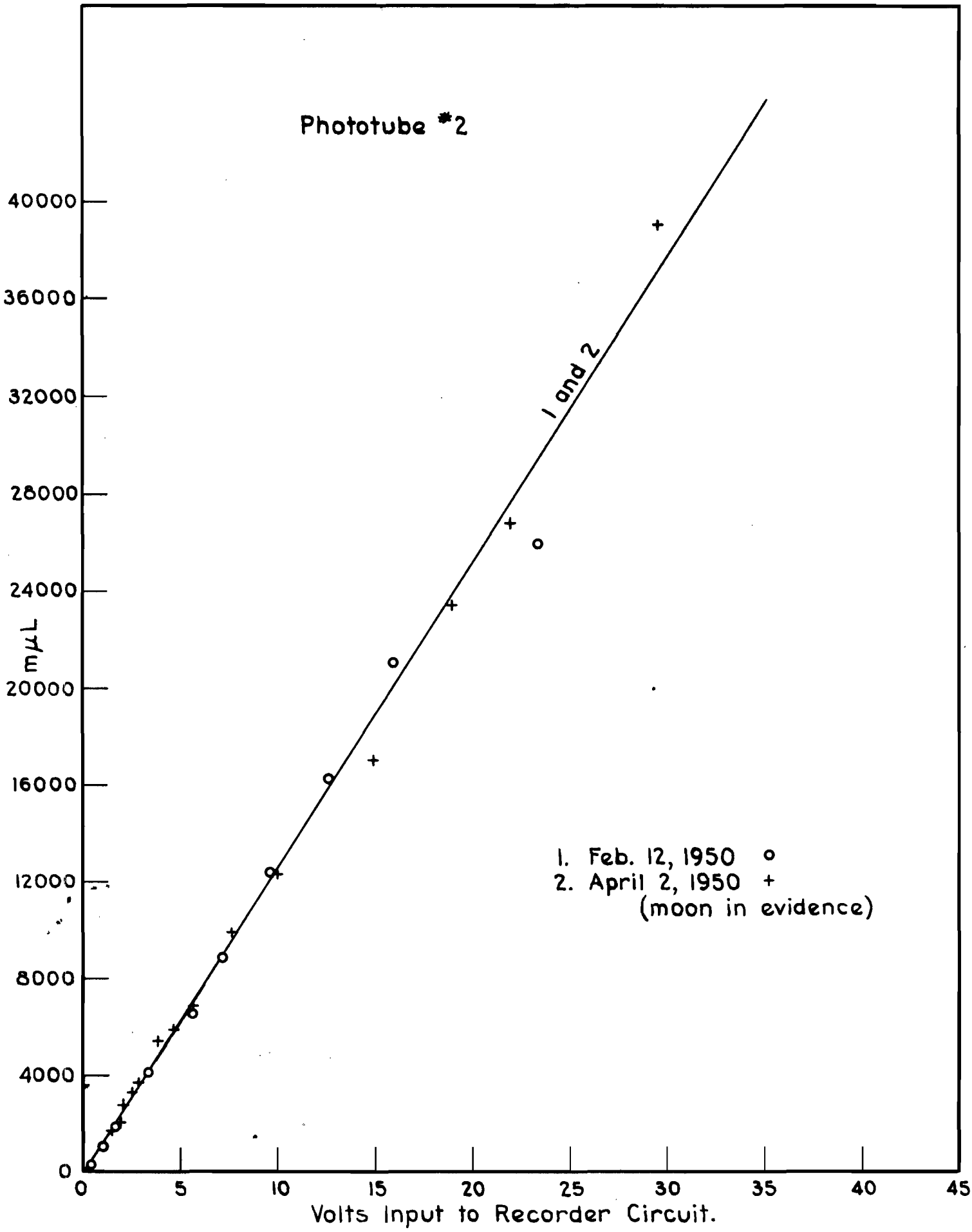

Phototube #2
1 and 2
40000
36000
32000
28000
24000
20000
16000
12000
8000
4000
0
mμL
0
5
10
15
20
25
30
35
40
45
Volts Input to Recorder Circuit.
1. Feb. 12, 1950 o
2. April 2, 1950 +
(moon in evidence)

Fig 6

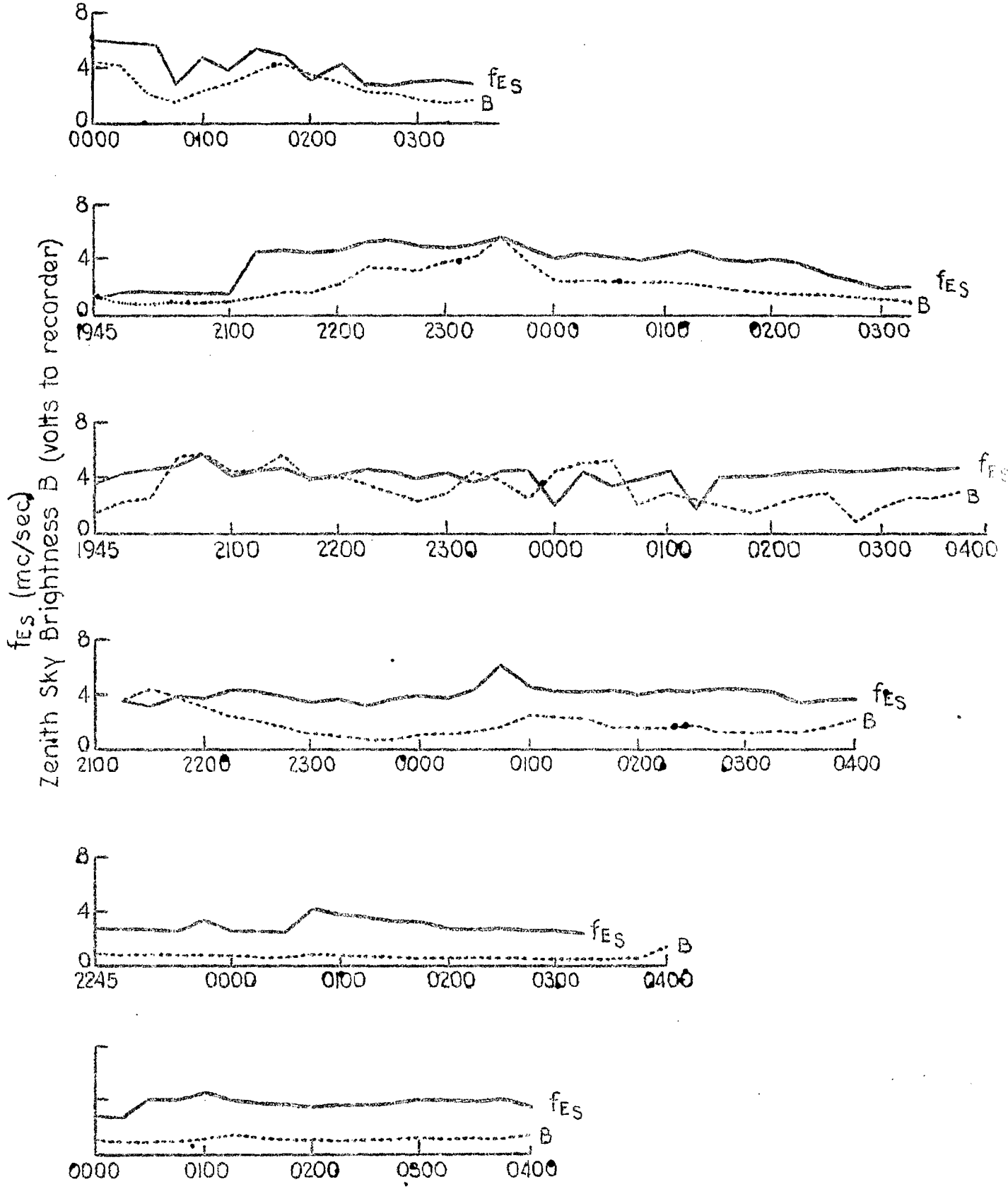
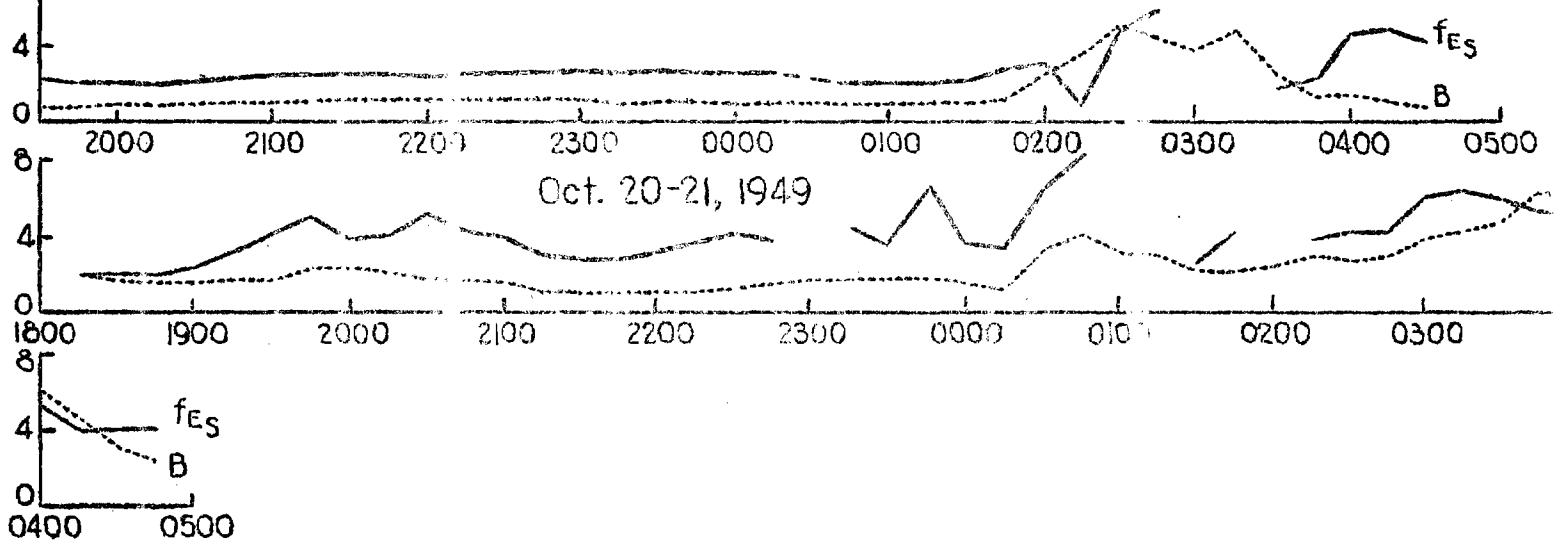

fES (mc/sec)
Zenith Sky Brightness B (volts to recorder)
8
4
0
fES
B
0000
0100
0200
0300
1945
2100
2200
2300
0400
2245

Fig. 7A


4
0
2000
2100
2200
2300
0000
0100
0200
0300
0400
0500
f_{ES}
B
8
4
0
Oct. 20-21, 1949
1800
1900
2000
2100
2200
2300
0000
0100
0200
0300
8
4
0
f_{ES}
B
0400
0500

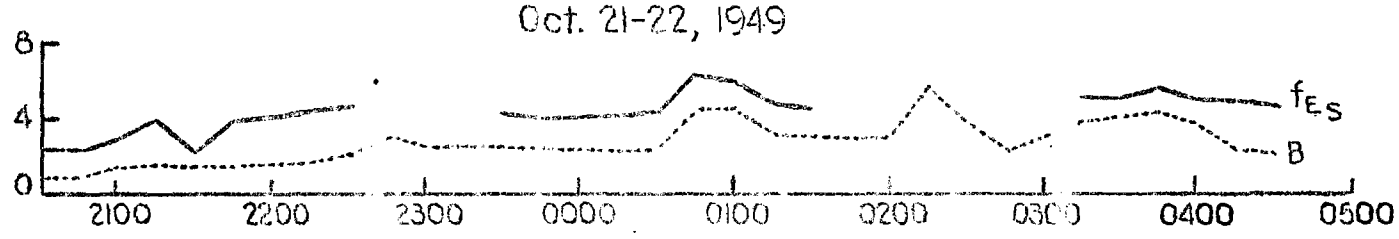
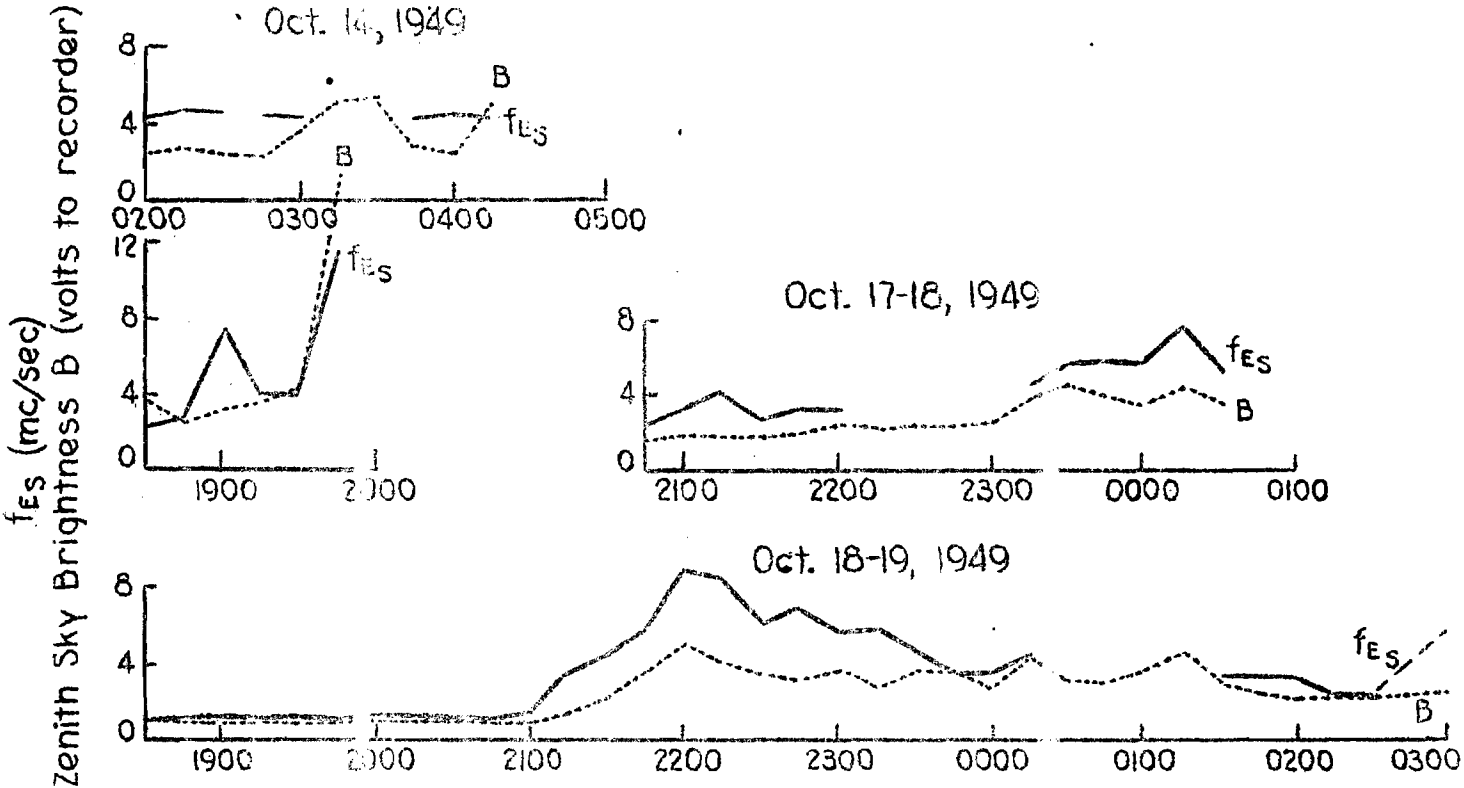

Oct. 21-22, 1949
8
4
0
2100
2200
2300
0000
0100
0200
0300
0400
0500
f_{ES}
B

Fig. 7B


Oct. 14, 1949
Oct. 17-18, 1949
Oct. 18-19, 1949
Oct. 19-20, 1949
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)
B
f_{ES}
0200
0300
0400
0500
1900
2000
2100
2200
2300
0000
0100
0200
0300

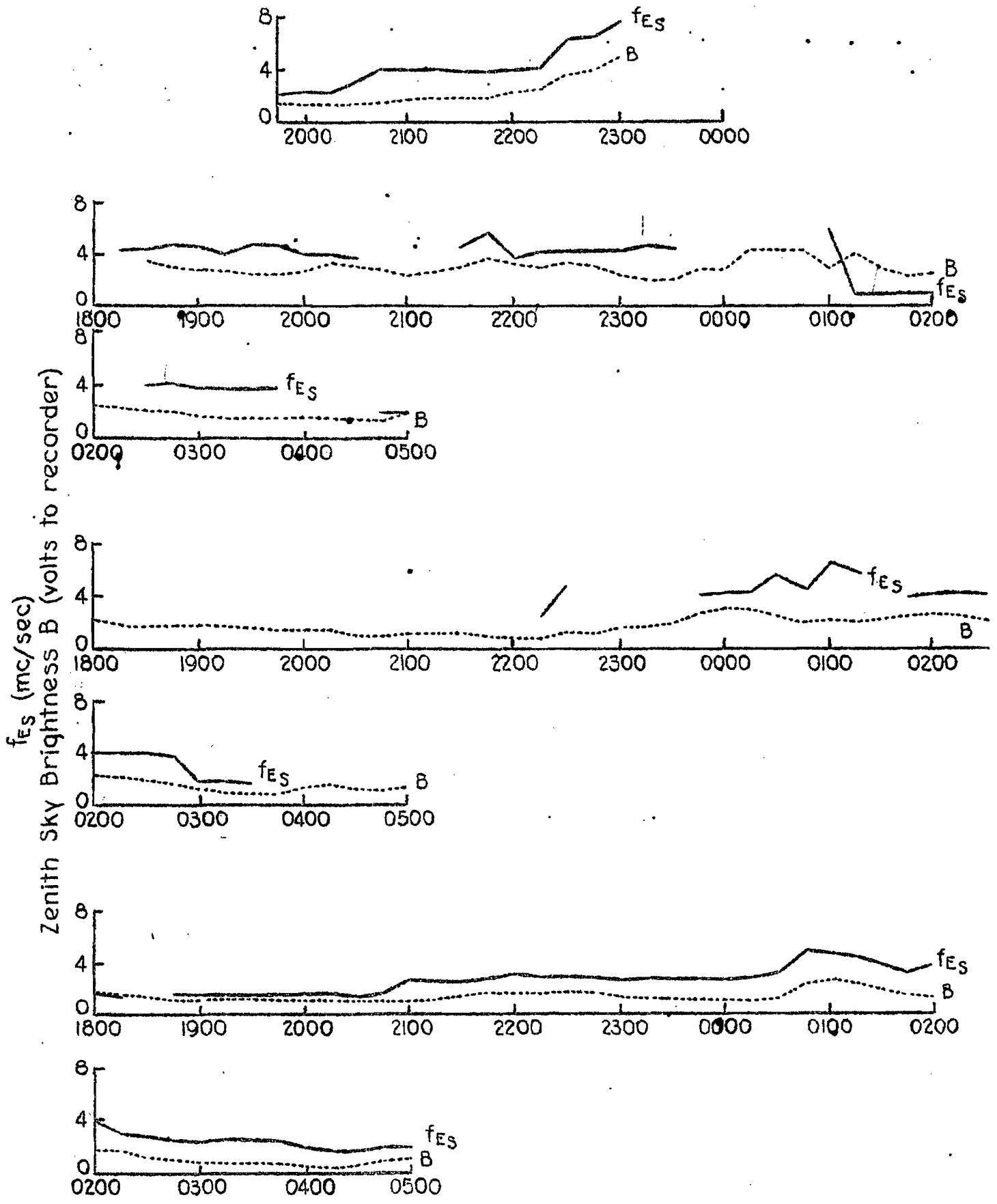

f_{ES} (mc/sec) Zenith Sky Brightness B (volts to recorder)
8
4
0
2000
2100
2200
2300
0000
f_{ES}
B
1800
1900
0100
0200
0300
0400
0500

Fig. 7C

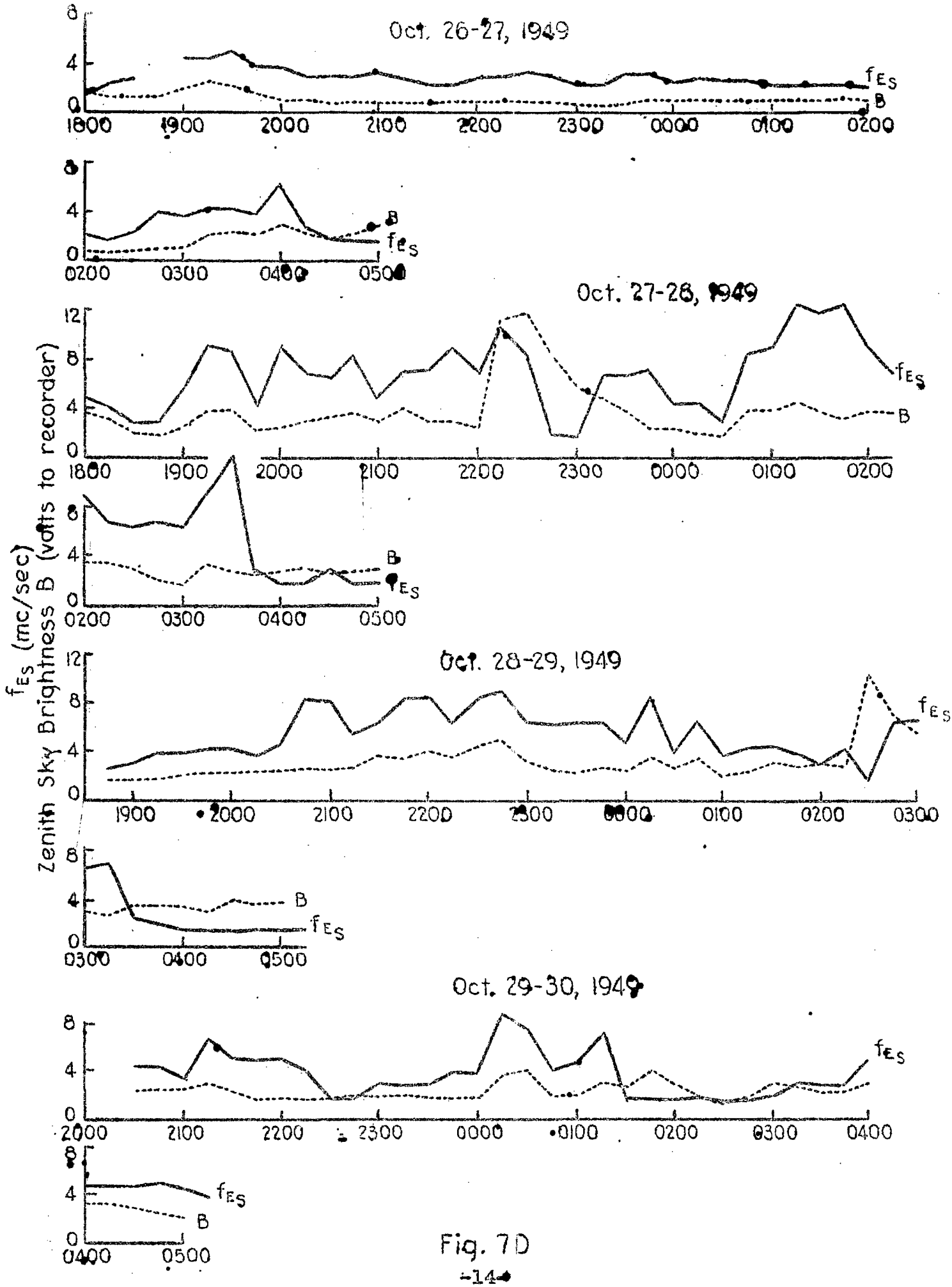

Oct. 26-27, 1949
Oct. 27-28, 1949
Oct. 28-29, 1949
Oct. 29-30, 1949
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)
f_{ES}
B
1800
1900
2000
2100
2200
2300
0000
0100
0200
0300
0400
0500

Fig. 7D

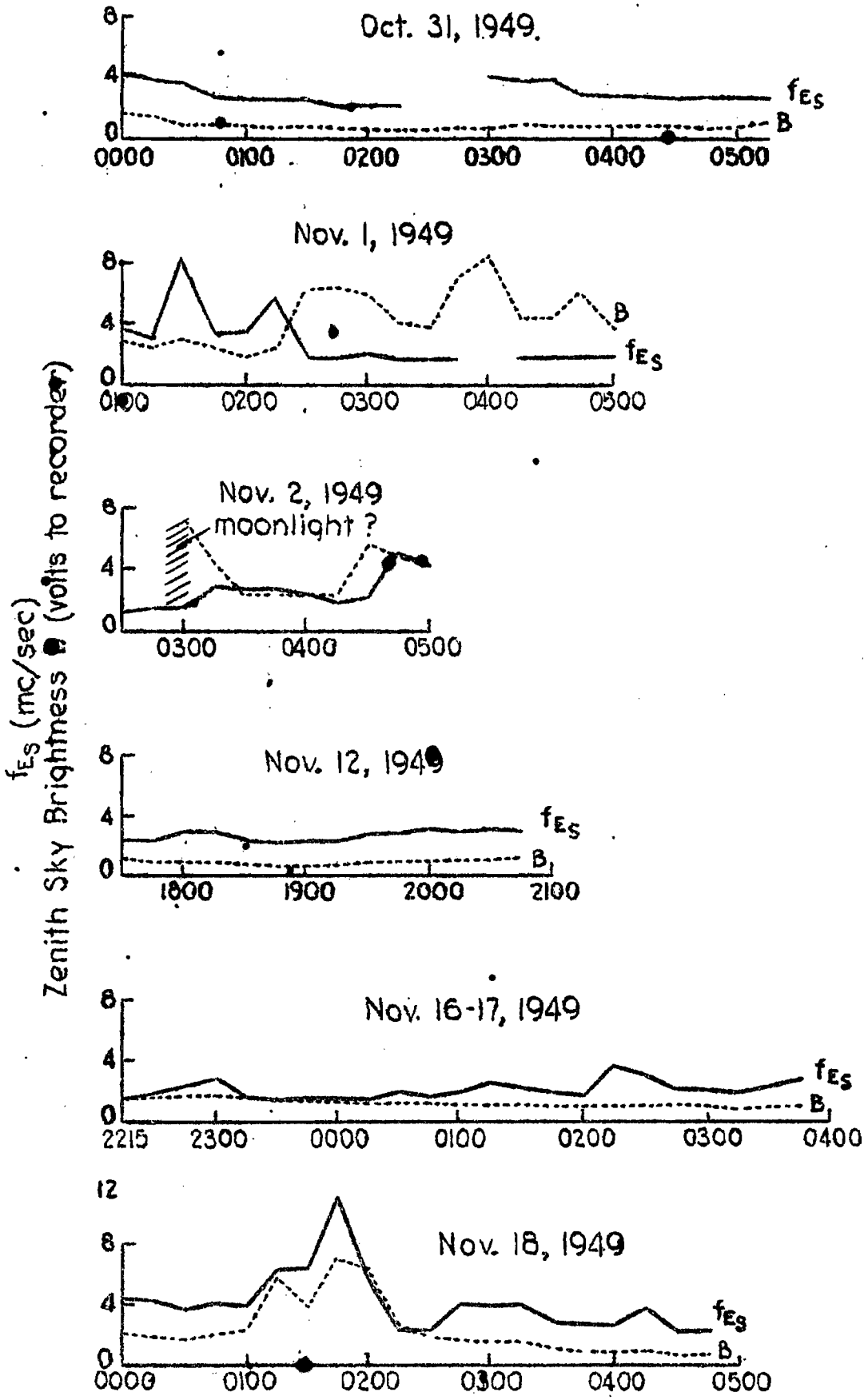

Oct. 31, 1949.
Nov. 1, 1949
Nov. 2, 1949
moonlight ?
Nov. 12, 1949
Nov. 16-17, 1949
Nov. 18, 1949
f_{ES}
B
f_{ES} (mc/sec)
Zenith Sky Brightness (volts to recorder)

Fig. 7E

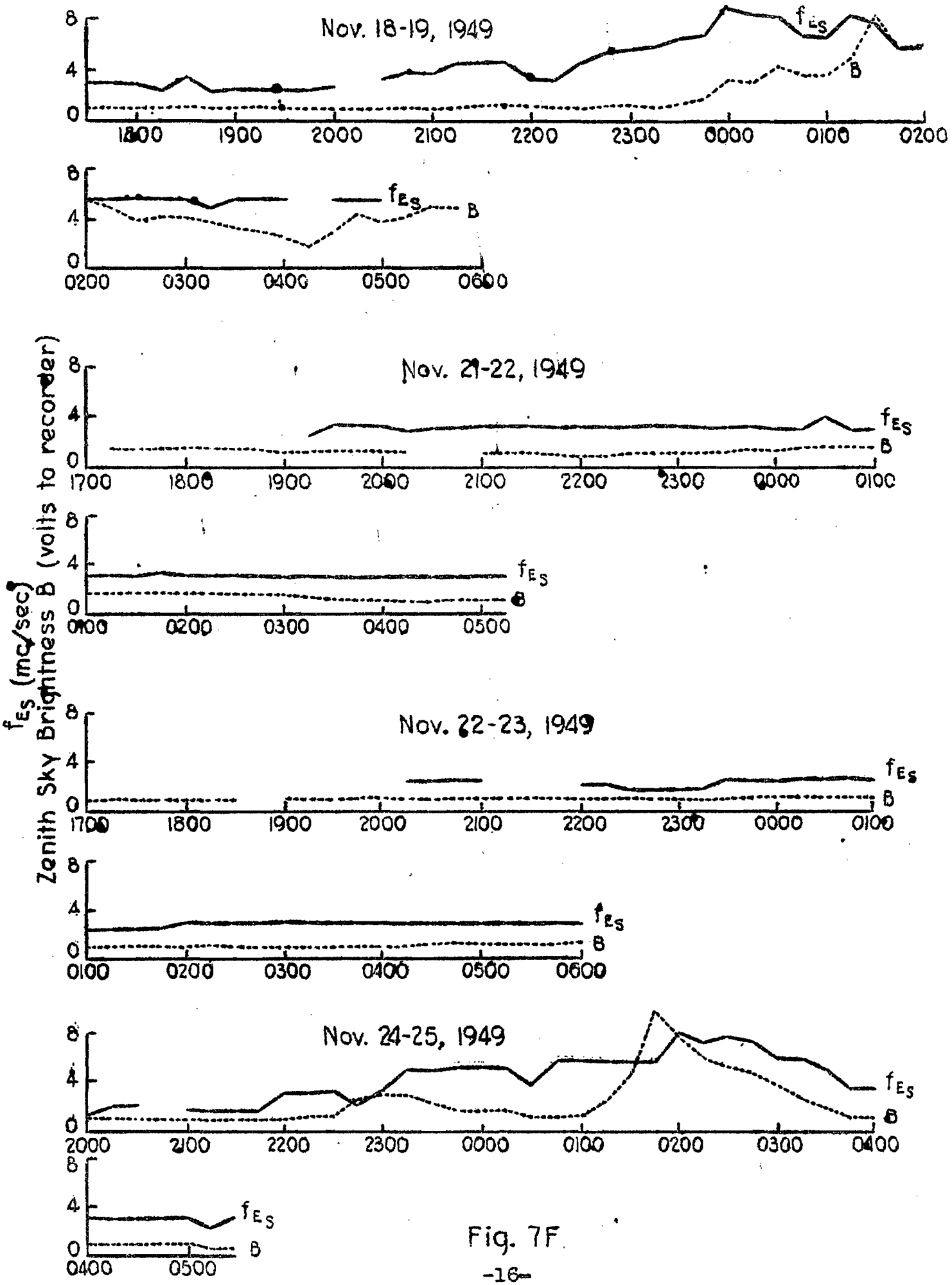

Nov. 18-19, 1949
Nov. 21-22, 1949
Nov. 22-23, 1949
Nov. 24-25, 1949
f_{ES}
B
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)

Fig. 7F

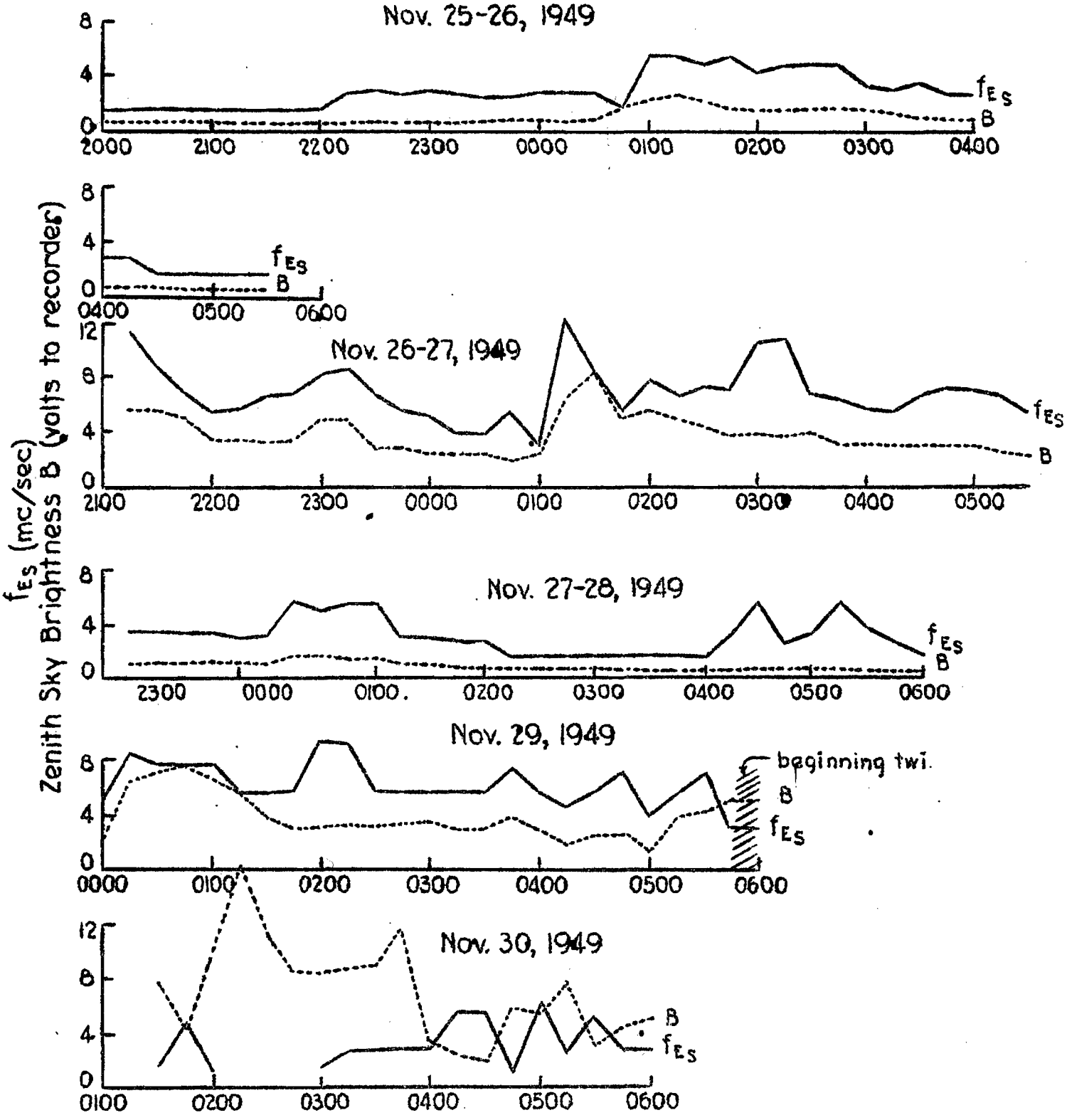

Nov. 25-26, 1949
Nov. 26-27, 1949
Nov. 27-28, 1949
Nov. 29, 1949
Nov. 30, 1949
beginning twi.
f_{ES}
B
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)

Fig. 7G

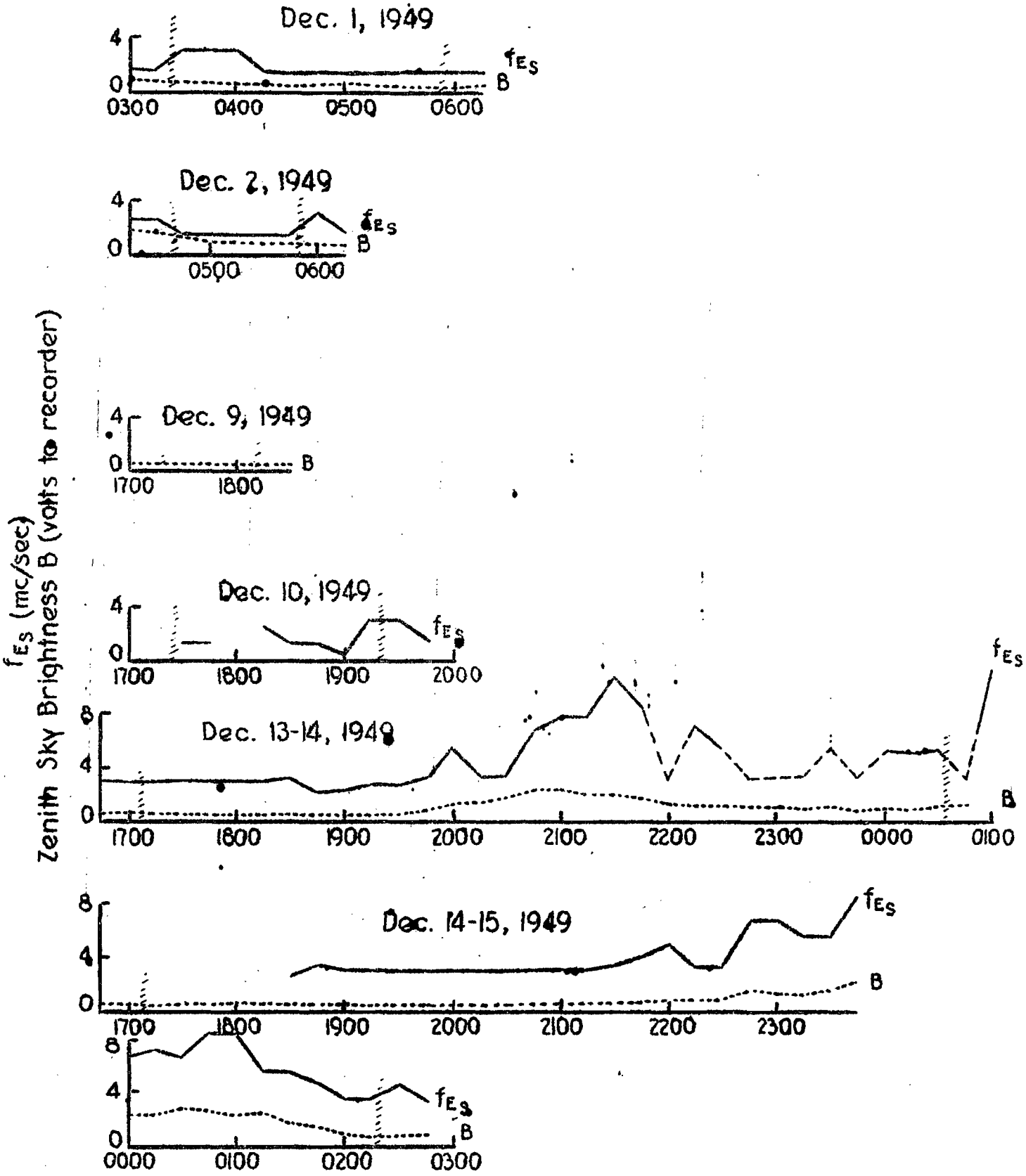

Dec. 1, 1949
4
0
f_{ES}
B
0300
0400
0500
0600
Dec. 2, 1949
4
0
f_{ES}
B
0500
0600
Dec. 9, 1949
4
0
B
1700
1800
Dec. 10, 1949
4
0
f_{ES}
1700
1800
1900
2000
Dec. 13-14, 1949
8
4
0
f_{ES}
B
1700
1800
1900
2000
2100
2200
2300
0000
0100
Dec. 14-15, 1949
8
4
0
f_{ES}
B
1700
1800
1900
2000
2100
2200
2300
8
4
0
f_{ES}
B
0000
0100
0200
0300
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)

Fig. 7H

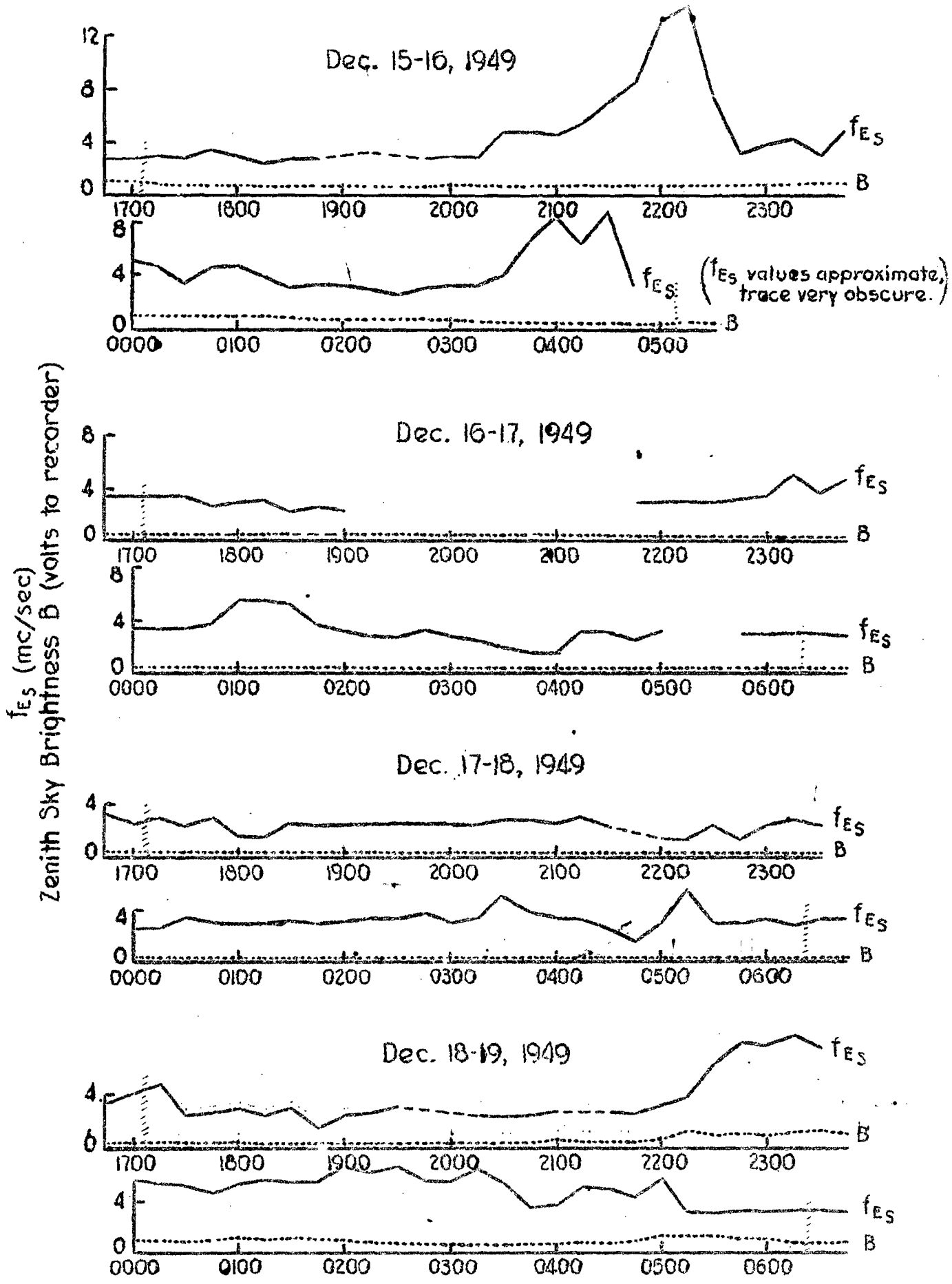

Dec. 15-16, 1949
Dec. 16-17, 1949
Dec. 17-18, 1949
Dec. 18-19, 1949
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)
f_{ES}
B
(f_{ES} values approximate, trace very obscure.)
1700
1800
1900
2000
2100
2200
2300
0000
0100
0200
0300
0400
0500
0600

Fig. 71

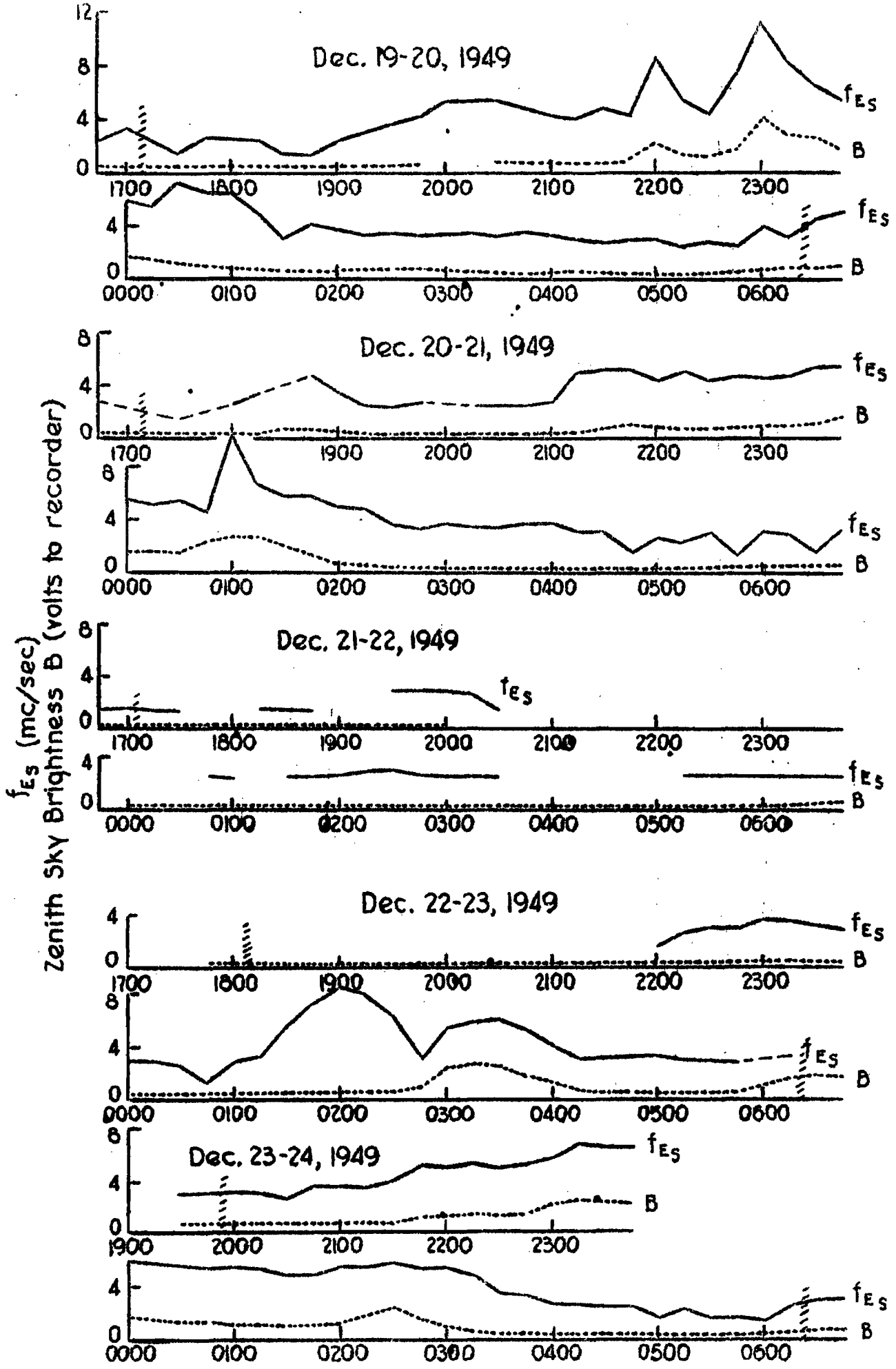

Dec. 19-20, 1949
Dec. 20-21, 1949
Dec. 21-22, 1949
Dec. 22-23, 1949
Dec. 23-24, 1949
f_{Es} (mc/sec)
Zenith Sky Brightness B (volts to recorder)
f_{Es}
B
1700
1800
1900
2000
2100
2200
2300
0000
0100
0200
0300
0400
0500
0600

Fig. 7J

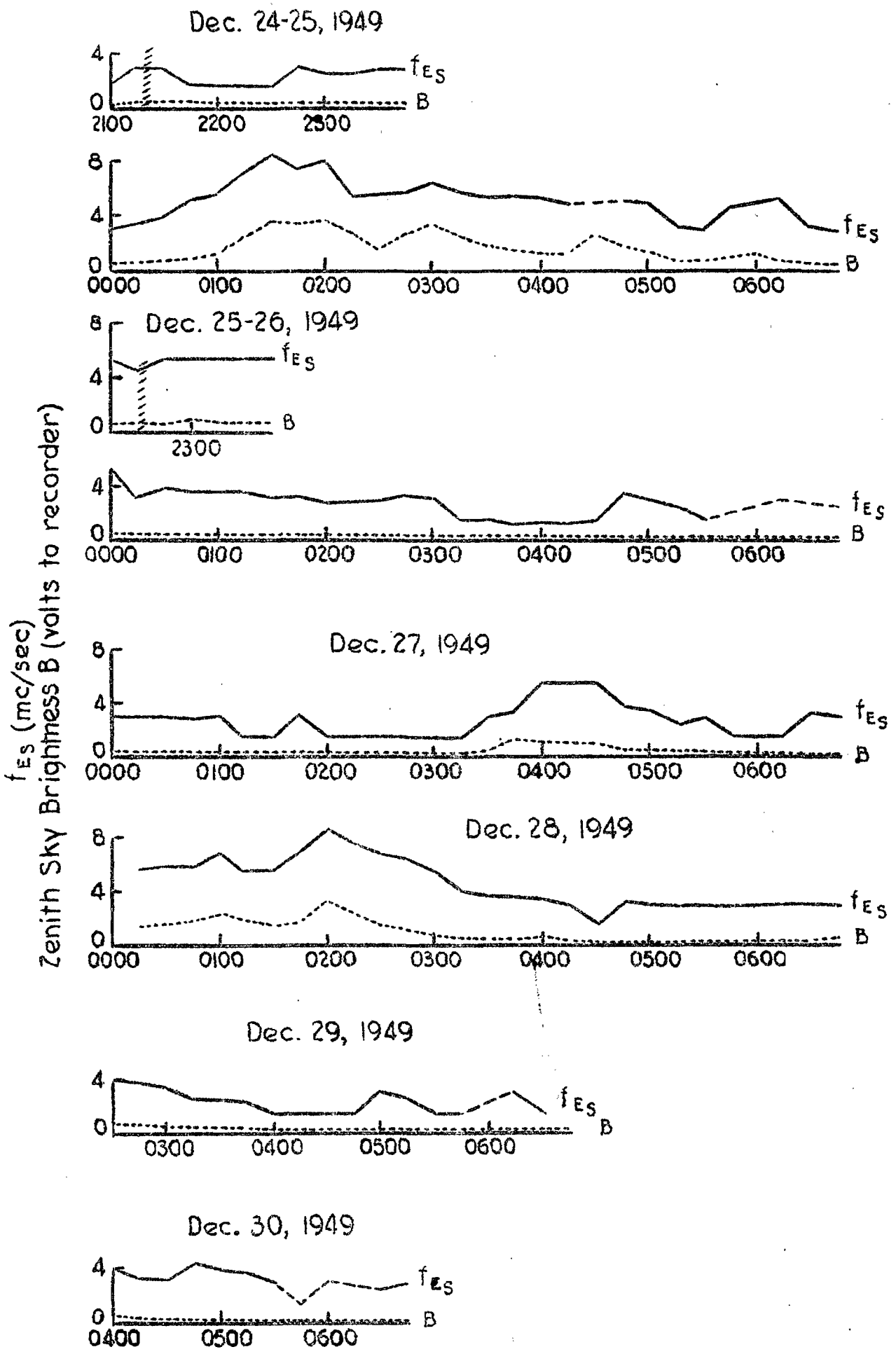

Dec. 24-25, 1949
Dec. 25-26, 1949
Dec. 27, 1949
Dec. 28, 1949
Dec. 29, 1949
Dec. 30, 1949
f_{ES}
B
2100
2200
2300
0000
0100
0200
0300
0400
0500
0600
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)

Fig. 7K

Jan. 1-6, 1950 (Moonlight)

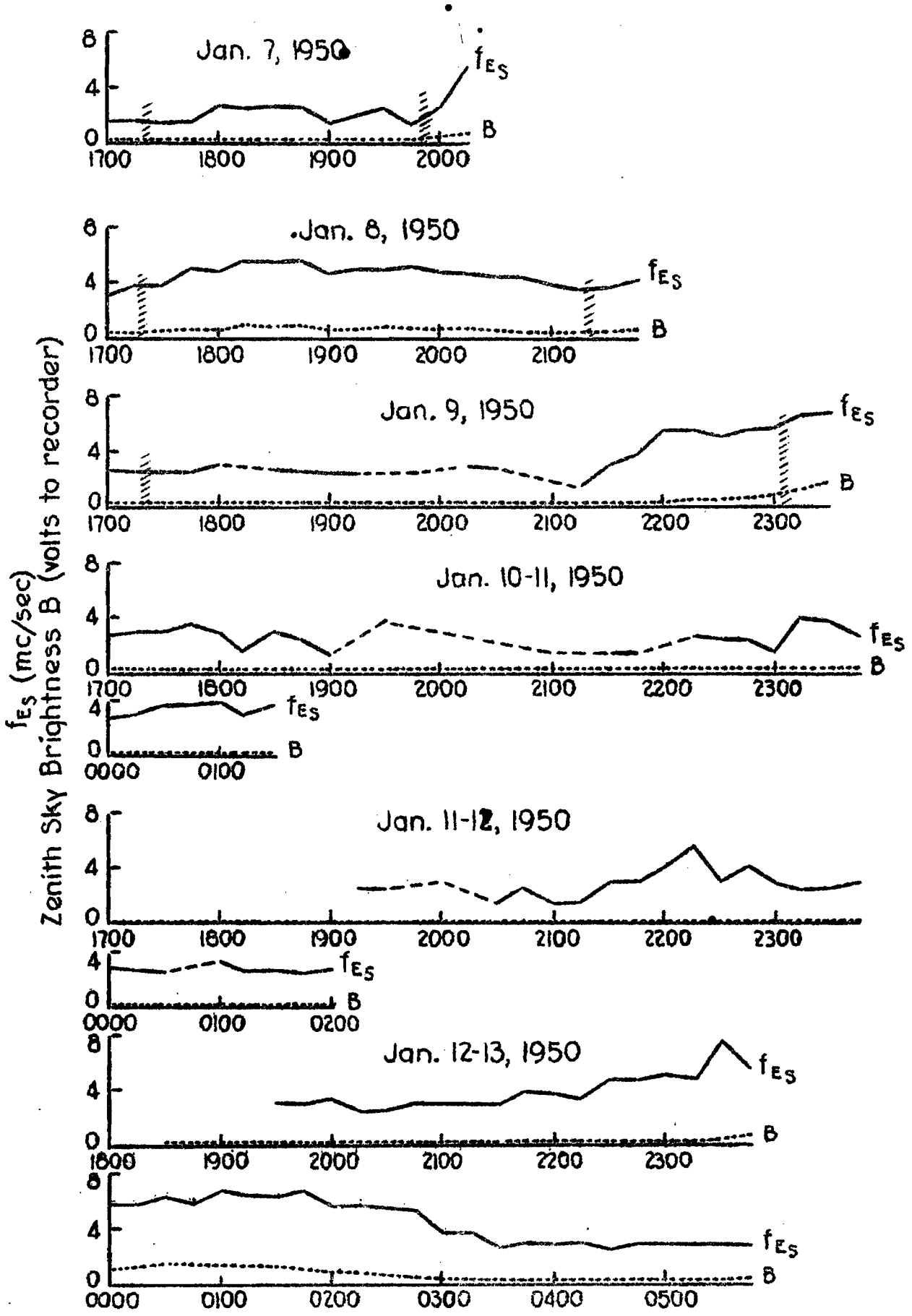


Fig. 7L

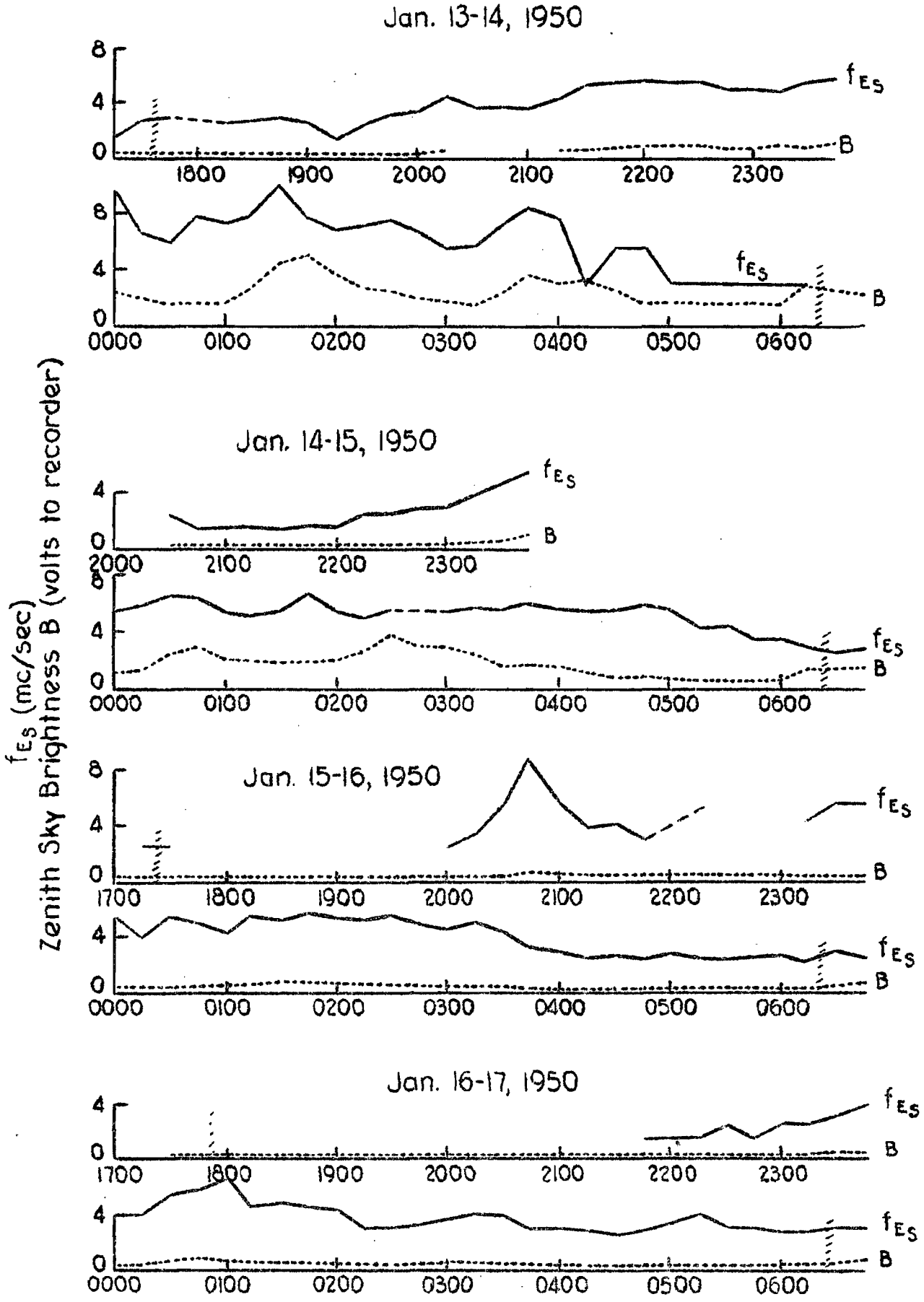

Jan. 13-14, 1950
Jan. 14-15, 1950
Jan. 15-16, 1950
Jan. 16-17, 1950
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)
f_{ES}
B
8
4
0
1700
1800
1900
2000
2100
2200
2300
0000
0100
0200
0300
0400
0500
0600

Fig. 7M

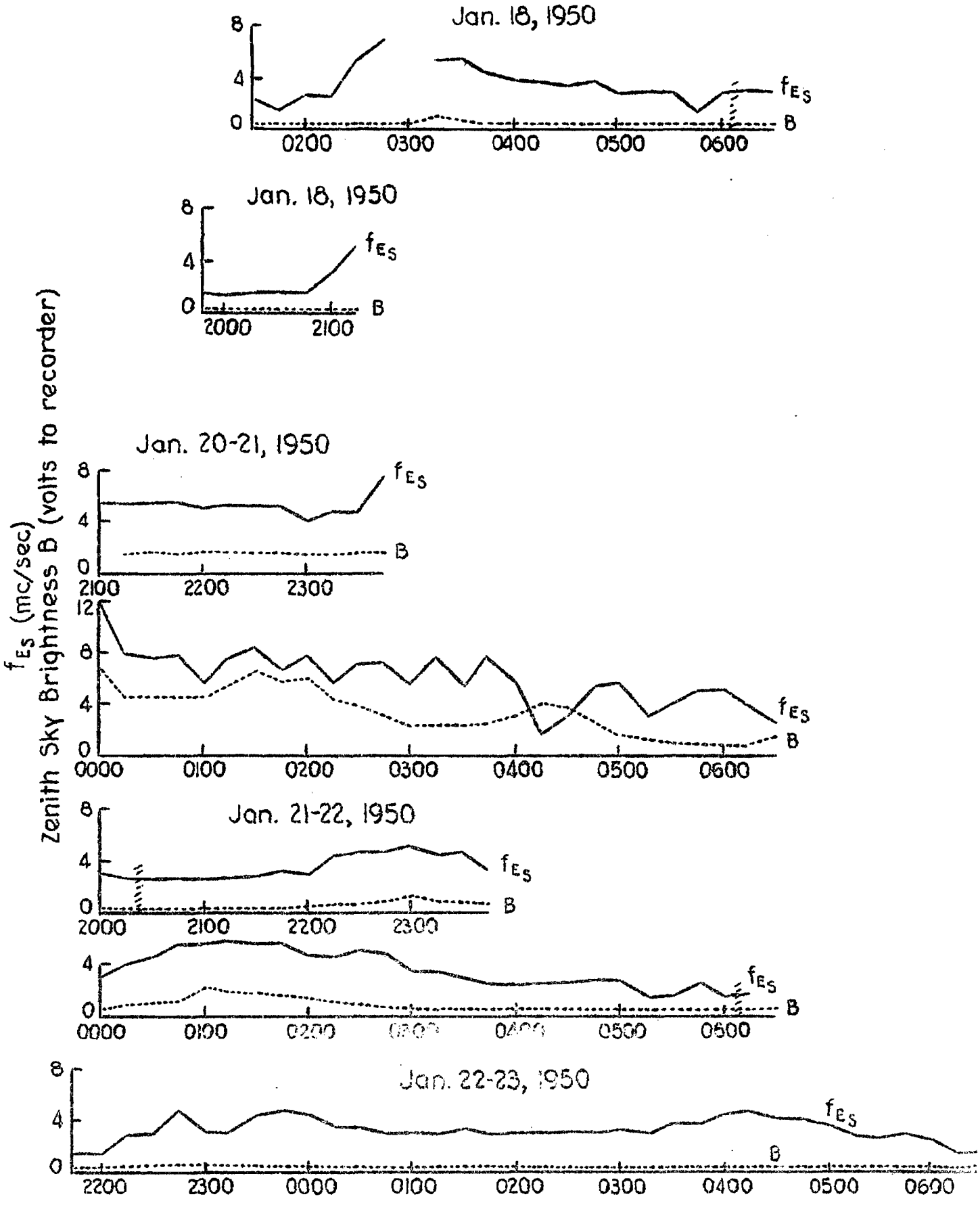

Jan. 18, 1950
8
4
0
f_{ES}
B
0200
0300
0400
0500
0600
Jan. 18, 1950
8
4
0
f_{ES}
B
2000
2100
Jan. 20-21, 1950
8
4
0
f_{ES}
B
2100
2200
2300
12
8
4
0
f_{ES}
B
0000
0100
0200
0300
0400
0500
0600
Jan. 21-22, 1950
8
4
0
f_{ES}
B
2000
2100
2200
2300
4
0
f_{ES}
B
0000
0100
0500
0600
Jan. 22-23, 1950
8
4
0
f_{ES}
B
2200
2300
0000
0100
0200
0300
0400
0500
0600
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)

Fig. 7N

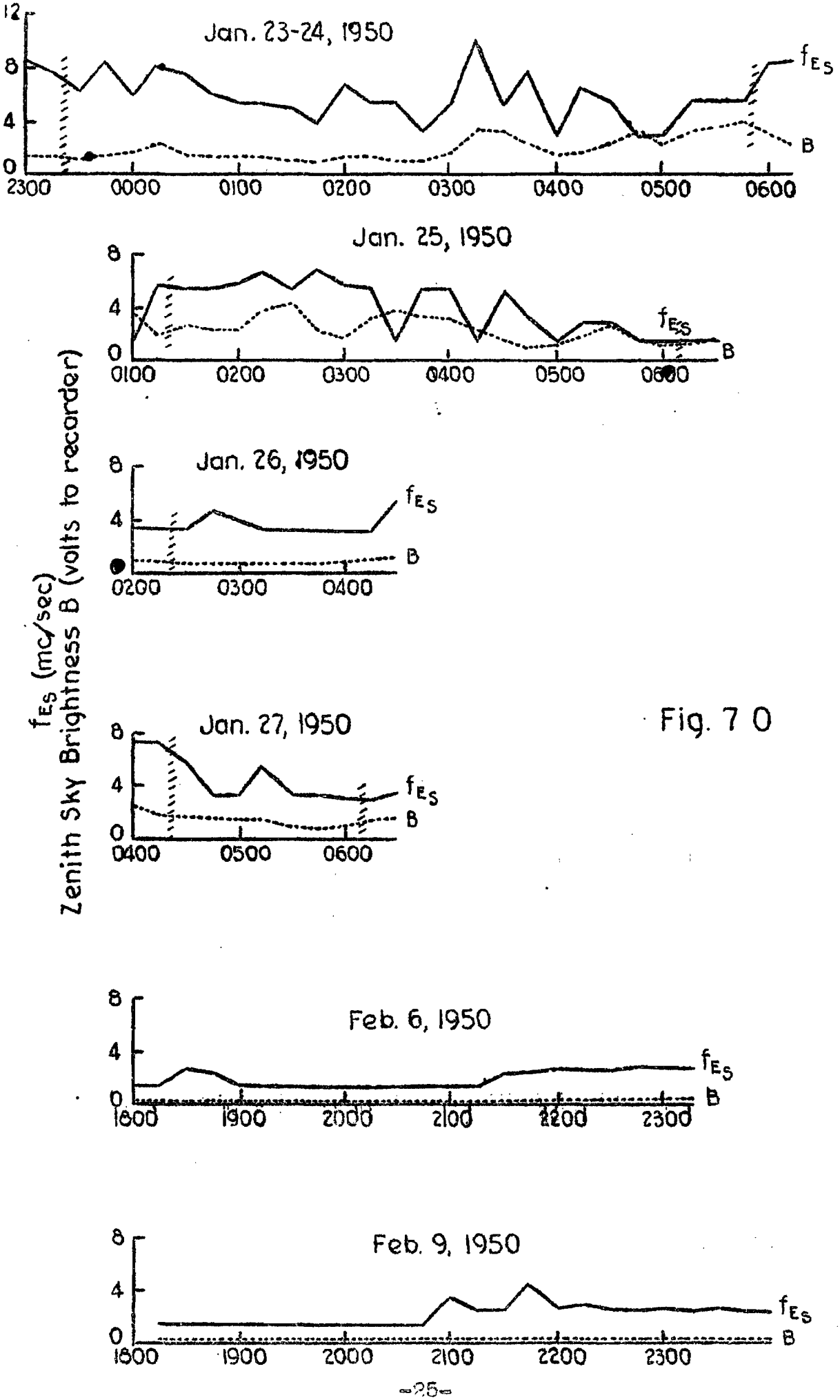

Jan. 23-24, 1950
Jan. 25, 1950
Jan. 26, 1950
Jan. 27, 1950
Feb. 6, 1950
Feb. 9, 1950
f_{ES}
B
Zenith Sky Brightness B (volts to recorder)
f_{ES} (mc/sec)

Fig. 7 0

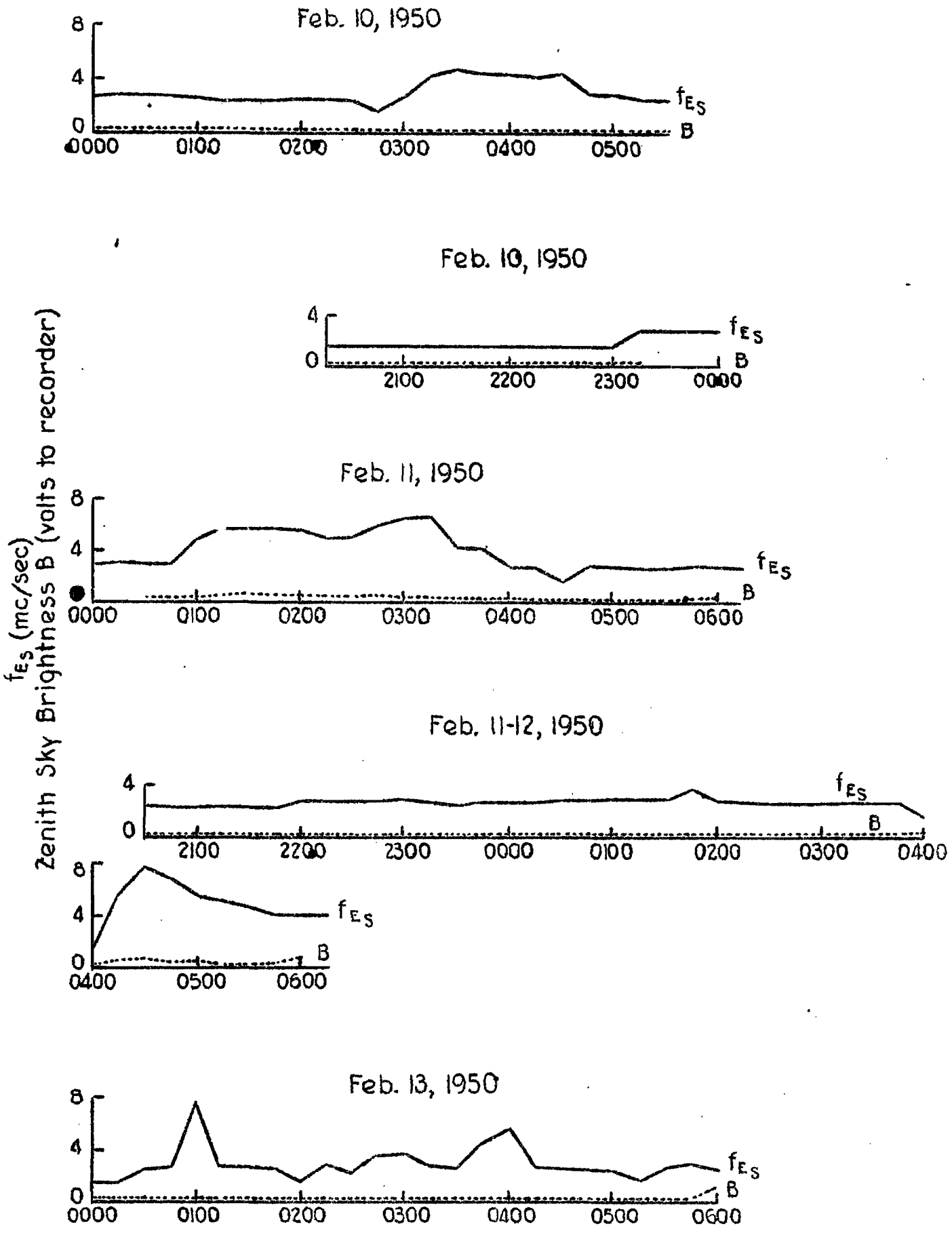

Feb. 10, 1950
8
4
0
f_{ES}
B
0000
0100
0200
0300
0400
0500
Feb. 10, 1950
4
0
f_{ES}
B
2100
2200
2300
0000
Feb. 11, 1950
8
4
0
f_{ES}
B
0000
0100
0200
0300
0400
0500
0600
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)
Feb. 11-12, 1950
4
0
f_{ES}
B
2100
2200
2300
0000
0100
0200
0300
0400
8
4
0
f_{ES}
B
0400
0500
0600
Feb. 13, 1950
8
4
0
f_{ES}
B
0000
0100
0200
0300
0400
0500
0600

Fig. 7 P

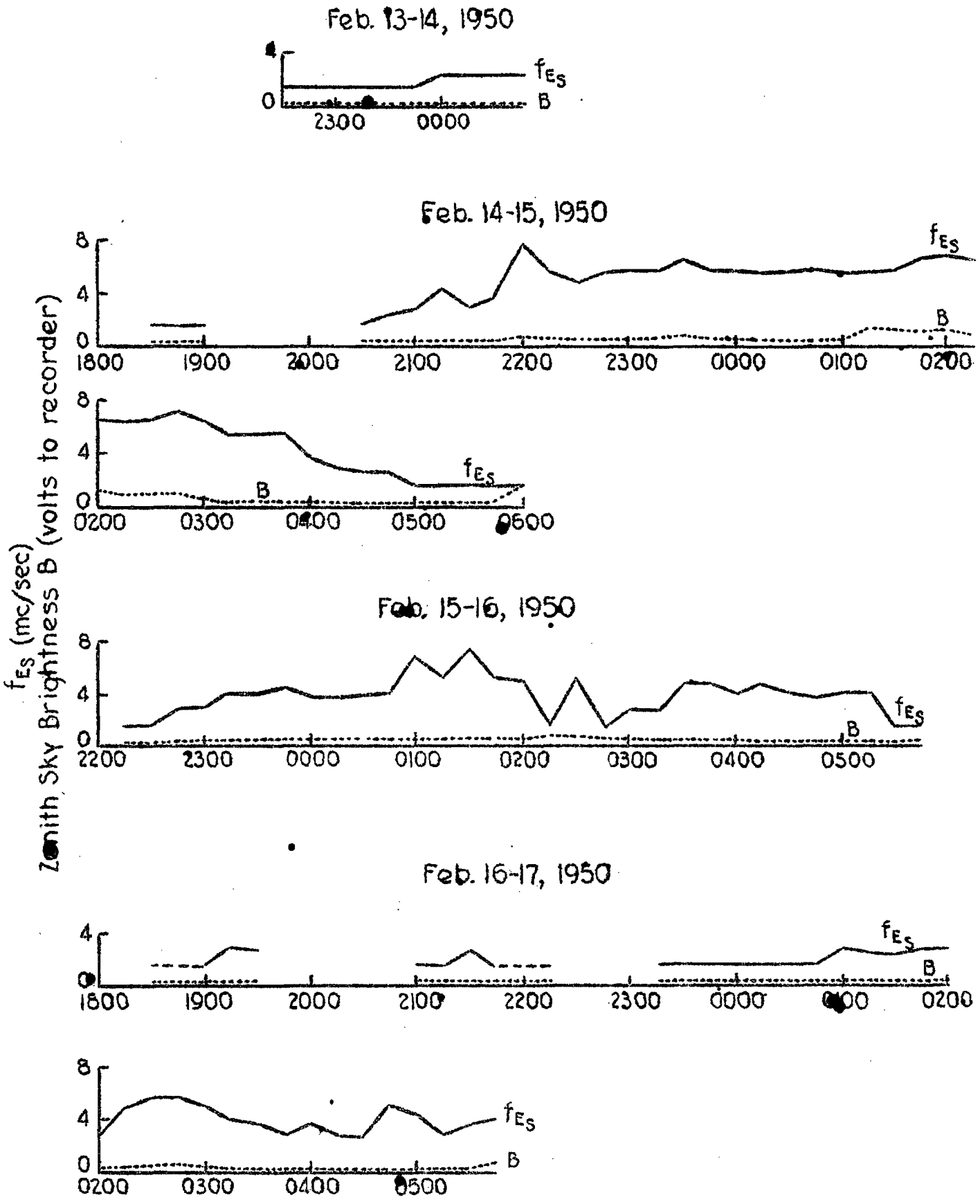

Feb. 13-14, 1950
4
0
f_{ES}
B
2300
0000
Feb. 14-15, 1950
8
4
0
f_{ES}
B
1800
1900
2000
2100
2200
2300
0000
0100
0200
0200
0300
0400
0500
0600
Feb. 15-16, 1950
2200
2300
0000
0100
0200
0300
0400
0500
Feb. 16-17, 1950
1800
1900
2000
2100
2200
2300
0000
0200
0300
0400
0500
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)

Fig. 7Q

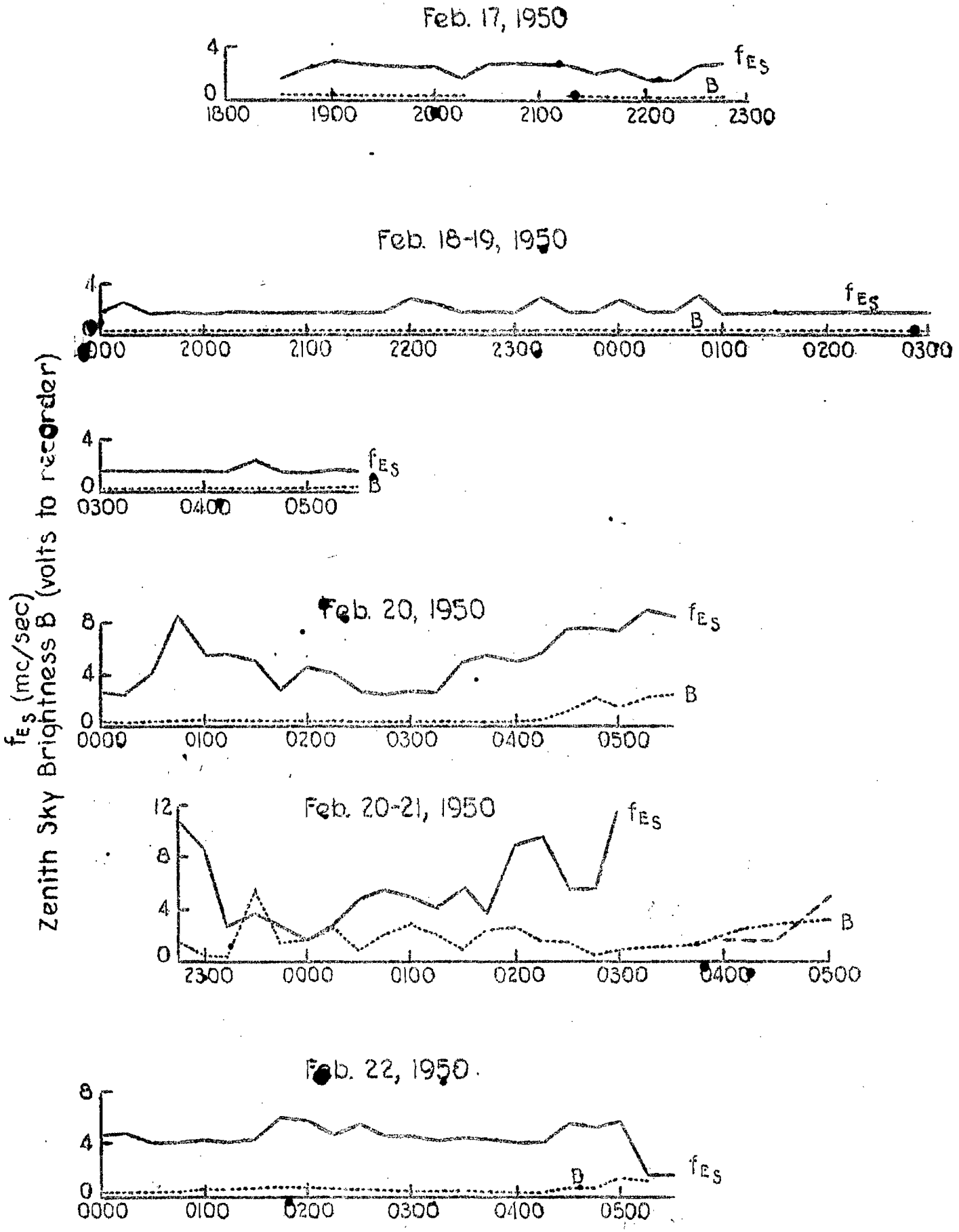

Feb. 17, 1950
Feb. 18-19, 1950
Feb. 20, 1950
Feb. 20-21, 1950
Feb. 22, 1950
f_{ES} (mc/sec)
Zenith Sky Brightness B (volts to recorder)
f_{ES}
B
1800
1900
2000
2100
2200
2300
0000
0100
0200
0300
0400
0500

Fig. 7R

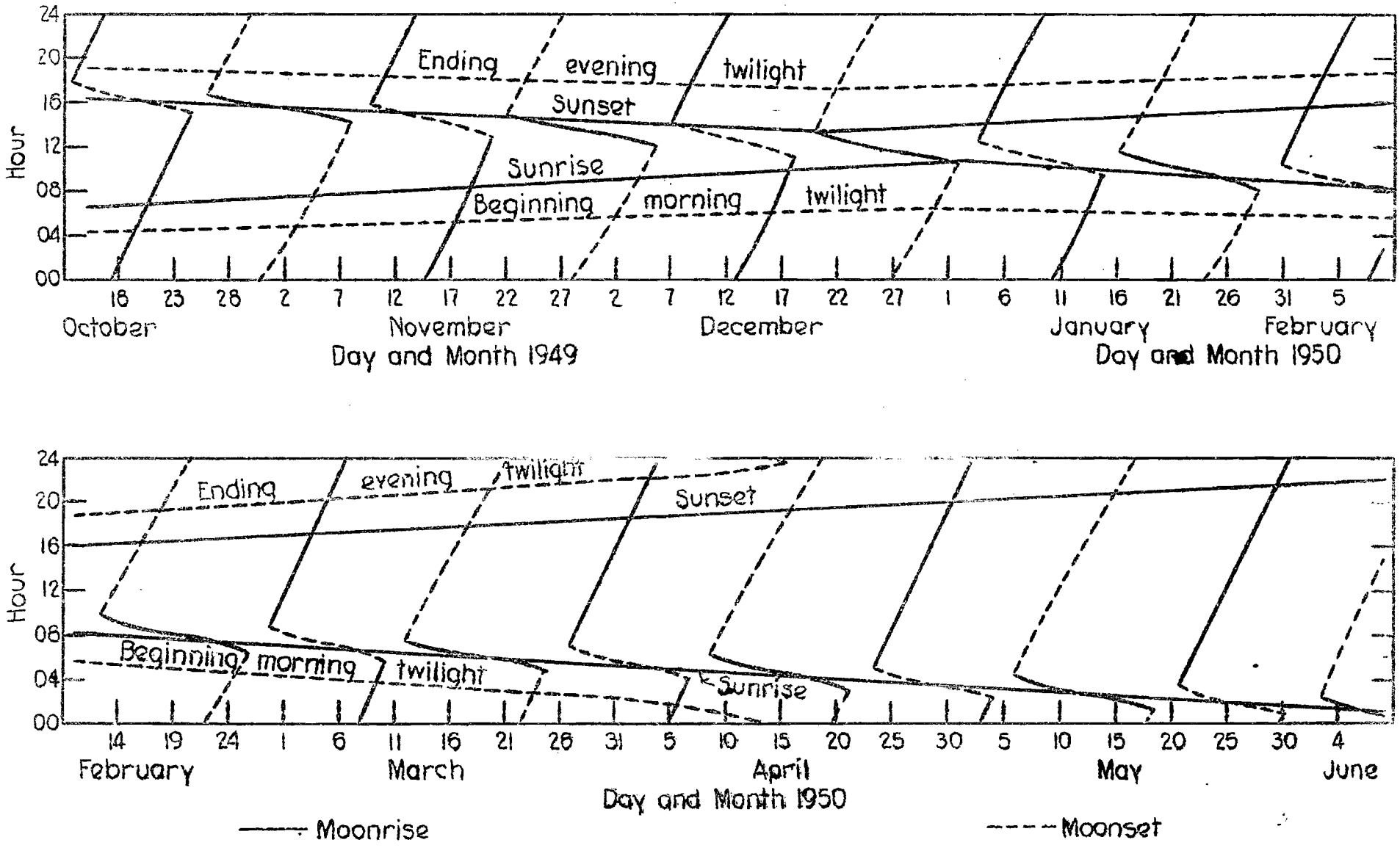


Fig. 8 – Moonlight, Moonset and Twilight at College, Alaska

Acknowledgement

Much of the work preliminary to this study was done by Mr. James E. Wilson. The appreciation of the authors is extended to Mr. Carl L. Noelcke for his valuable technical advice throughout the program.