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TRAJECTORIES OF EXPLORERS 33, 35, 41, 43 AND 47 MAY 1969-DECEMBER 1972

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GSFC — GODDARD SPACE FLIGHT CENTER —
GREENBELT, MARYLAND

72

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This document represents a continuation of a previous document (Behannon et al. 1970) and is presented with the intention that it will stimulate and facilitate correlative studies of data from various spacecraft. Figures 1-54 consist primarily of solar ecliptic plane projections of orbits of five different satellites although a limited number of XZ projections are shown to illustrate the large excursions of Explorer 33 away from the ecliptic plane. Nominal positions of the magnetopause and bow shock are included for reference.

The plots are intended only to represent the trajectory of the spacecraft and imply nothing about the operational status of the various experiments nor the availability of the data. Information on these latter points can be obtained from the National Space Science Data Center, (e.g. King, 1971). It should be pointed out, however, that Explorers 33 and 35 were very long lived spacecraft (> 2 yrs) and numerous experiments either ceased operation or exhibited a gradual deterioration during the extended lifetime.

On all plots the points indicating the locations of Explorers 33, 35 and 47 represent the spacecraft position

at the beginning of the day. For Explorers 41 and 43 the points represent the location and day of apogee. Specific comments on the various spacecraft are as follows.

Explorer 33 (alternate name AIMP-D) Launched July 1, 1966

The Explorer 33 GSFC magnetometer ceased operation after 119 weeks which is an interval ending before the period covered by this document. For completeness the trajectory is included through Feb 1970 when the trajectory was readily available to the authors.

Explorer 35 (alternate name AIMP-E) Launched July 19, 1967

The GSFC magnetic Field Experiment on Explorer 35 has been described in detail in a separate publication (Scearce et al., 1969) and more briefly by Ness et al. (1967). The spacecraft is in a lunar orbit (aposelene approximately 9400 km, periselene 2500 km) and consequently on the scale of the magnetosphere its orbit can be approximated by the orbit of the moon. The experiment has provided an extensive body of interplanetary, distant magnetosphere and lunar environment data and was still operating when data collection from the spacecraft was discontinued in June 1973.

The flipper on the Explorer 35 magnetometer failed on May 20, 1969 (week 96, day 139). The result of this failure was an inability to calibrate the zero level of the spin axis (Z) sensor. To process the data subsequent to week 96, the average zero level for weeks 1-95 was used for the Z sensor. It was concluded from the statistics of the calibration data in the X,Y and Z axes from the first 95 weeks that this long term average would be as accurate an estimate as that obtained by any other means. This estimate is considered conservatively to be accurate to within $\pm 0.5\gamma$ when used to calibrate data beyond week 95, if it can be validly assumed that the statistical characteristics of the Z sensor zero offset remained similar to those of weeks 1-95 throughout the useful instrument lifetime. The overall history of the X and Y sensor zero levels during almost five years supports this assumption.

Experimenters were warned by the project to be suspicious of their data beginning about May 31, 1971 (week 150) because of the onset of spacecraft performance problems. Magnetometer data subsequent to that date was still of good quality, but data availability became progressively more intermittent

with time and some increase in the scatter of detailed data points can be seen. The usefulness of the magnetic field data is questionable beyond week 248 (April 1972) due to the frequent gaps in the data and increasing difficulty in obtaining reliable calibration data. By May 1973 little processable data was being received from the spacecraft.

Magnetic field data tapes cover one week intervals and are numbered beginning with spacecraft launch. Table 1 lists the correspondence between week number, date and decimal day (decimal day is the day of the year, where Jan 1 is denoted day zero) to aid the reader in requesting data.

Explorer 41 (alternate names IMP-G, IMP-5) launched June 21, 1969

The GSFC magnetometer experiment on Explorer 41 was very similar to the experiment on Explorer 34 (IMP-4) (Mish, 1972). The Explorer 41 experiment provided high quality magnetic field data for 381 orbits until the spacecraft reentered the atmosphere on Dec 23, 1972. Data coverage was continuous except for orbits 262-269 when no tracking was provided and orbits 270-284 when coverage was restricted to intervals when the spacecraft was expected to be near the

plasma sheet. The experiment has been described by Fairfield and Ness (1972).

Figure 55 presents the XZ projections of four orbits spaced one year apart with apogee in the sunward direction in the noon meridian plane. Comparison of these orbits indicates the gradual changes that took place in the orbit in an inertial coordinate system. It should be pointed out that launch near the summer solstice with apogee in the sunward direction dictated that inbound orbits of Explorer 41 were at high geomagnetic latitude and provided good coverage of the polar cusp in the outer magnetosphere.

Explorer 43 (alternate names IMP-I [eye], IMP-6) launched March 13, 1971

The GSFC magnetometer experiment on Explorer 43 (Seek et al., 1973; Fairfield, 1973) continues to provide high quality magnetic field data at the time of this writing (Aug 1973) after more than two years operation. Data coverage has been continuous throughout this interval.

Figure 56 presents the XZ projections of two noon meridian plane orbits to illustrate the gradual changes taking place in an inertial coordinate system.

Explorer 47 (alternate names IMP-H, IMP-7) launched September 22, 1972

The GSFC magnetometer experiment on-board Explorer 47 (Scearce et al., 1973), which was turned on at 1411 UT on September 26, is one of 13 particle and field experiments on the s/c. Explorer 47 is the first part of a two s/c sub-series (IMP's H and J) planned so that at least one of the two s/c would be in interplanetary space at any given time to monitor the solar wind in the earth's vicinity and so that unique intercorrelative studies may be pursued. The H and J orbits are planned to be identical, aside from an 180^{o} phase difference of s/c position in longitude. IMP-J is scheduled for launch 25 October 1973.

The overall experiment differs from the previous magnetic field experiments in the IMP series in two major ways: (1) its increased sampling rate of 25 samples/sec and (2) the manner in which the data is compacted on-board the s/c through a technique of delta-modulation, enabling the higher sampling rate at a moderate telemetry bit-rate (180 BPS).

The experiment on-board Explorer 47 has experienced two serious misfortunes. On Dec. 28, 1972 the sensor flipper, useful for determining the spin axis zero level offset, ceased functioning. Then on April 4, 1973 a malfunction in the power supply rendered the experiment totally inoperative. Also the quality of the data, due to s/c antenna pattern problems, is partially degraded, especially during the first two months. Nevertheless, the experiment yielded over 6 months data, most of which are of good quality. Degradation of the data due to the flipper failure is less serious, because of reliable zero level determination based on statistical methods.

The orbit for Explorer 47 is nearly circular with a radius of $35 \pm 2\text{-}1/2\ R_E$; the first full orbit eccentricity was 0.0756. The inclination of the orbital plane with respect to the ecliptic plane was 32.6° on September 25, 1972 and 31.1° one year later.

In figures 51-54 inclusive the ecliptic plane projection of the orbit is shown as a dashed curve. Notice that dots are used to designate the first 13 days of any month, crosses for days 14 to 25 inclusive, and open circles for days 26

to the end of the month. Only odd days are labeled, except for December. During the highly elliptical initial transfer orbit shown in figure 51, no experiment had yet been turned on. For January through April 6, 1973 (after experiment failure) the s/c, of course, follows a similar near circular orbit with the azimuths shown in table 2.

TABLE 1
EXPLORER 35 CALENDAR

Week	Begin Date	Decimal Day	Week	Begin Date	Decimal Day
94	1969 May 1	120	125	Dec 4	337
95	8	127	126	11	344
96	15	134	127	18	351
97	22	141	128	25	358
98	29	148			
99	June 5	155	129	1970 Jan 1	0
100	12	162	130	8	7
101	19	169	131	15	14
102	26	176	132	22	21
			133	29	28
103	July 3	183			
104	10	190	134	Feb 5	35
105	17	197	135	12	42
106	25	204	136	19	49
107	31	211	137	26	56
108	Aug 7	218	138	Mar 5	63
109	14	225	139	12	70
110	21	232	140	19	77
111	28	239	141	26	84
112	Sept 4	246	142	Apr 2	91
113	11	253	143	9	98
114	18	260	144	16	105
115	25	267	145	23	112
			146	30	119
116	Oct 2	274			
117	9	281	147	May 7	126
118	16	288	148	14	133
119	23	295	149	21	140
120	30	302	150	28	147
121	Nov 6	309	151	Jun 4	154
122	13	316	152	11	161
123	20	323	153	18	168
124	27	330	154	25	175

Week	Begin Date	Decimal Day
155	1970 July 2	182
156	9	189
157	16	196
158	23	203
159	30	210
160	Aug 6	217
161	13	224
162	20	231
163	27	238
164	Sept 3	245
165	10	252
166	17	259
167	24	266
168	Oct 1	273
169	8	280
170	15	287
171	22	294
172	29	301
173	Nov 5	308
174	12	315
175	19	322
176	26	329
177	Dec 3	336
178	10	343
179	17	350
180	24	357
181	31	364
182	1971 Jan 7	6
183	14	13
184	21	20
185	28	27
186	Feb 4	34
187	11	41
188	18	48
189	25	55
190	Mar 4	62
191	11	69
192	18	76
193	25	83
194	Apr 1	90
195	8	97
196	15	104
197	22	111
198	29	118
199	May 6	125
200	13	132
201	20	139
202	27	146
203	June 3	153
204	10	160
205	17	167
206	24	174
207	July 1	181
208	8	188
209	15	195
210	22	202
211	29	209
212	Aug 5	216
213	12	223
214	19	230
215	26	237

Week	Begin Date	Decimal Day	Week	Begin Date	Decimal Day
216	1971 Sept 2	244	251	May 4	124
217	9	251	252	11	131
218	16	258	253	18	138
219	23	265	254	25	145
220	30	272			
			255	June 1	152
221	Oct 7	279	256	8	159
222	14	286	257	15	166
223	21	293	258	22	173
224	28	300	259	29	180
225	Nov 4	307	260	July 6	187
226	11	314	261	13	194
227	18	321	262	20	201
228	25	328	263	27	208
229	Dec 2	335	264	Aug 3	215
230	9	342	265	10	222
231	16	349	266	17	229
232	23	356	267	24	236
233	30	363	268	31	243
234	1972 Jan 6	5	269	Sept 7	250
235	13	12	270	14	257
236	20	19	271	21	264
237	27	26	272	28	271
238	Feb 3	33	273	Oct 5	278
239	10	40	274	12	285
240	17	47	275	19	292
241	24	54	276	26	299
242	Mar 2	61	277	Nov 2	306
243	9	68	278	9	313
244	16	75	279	16	320
245	23	82	280	23	327
246	30	89	281	30	334
247	Apr 6	96	282	Dec 7	341
248	13	103	283	14	348
249	20	110	284	21	355
250	27	117	285	28	362

TABLE 2.

EXPLORER 47 (IMP-7) LOCATIONS FOR 1973

Date (1973)	Time (UT)	Ø (Solar Ecliptic Azimuthal Angle)
Jan. 2	0200	270°
5	1300	0°
8	0500	90°
11	0730	180°
14	1930	270°
18	0030	0°
20	2230	90°
24	0000	180°
27	1300	270°
30	1300	0°
Feb. 2	1830	90°
5	1700	180°
9	0730	270°
12	0730	0°
15	1500	90°
18	0900	180°
22	0230	270°
25	0500	0°
28	0830	90°
Mar. 3	2230	180°
6	1930	270°
9	2100	0°
12	1900	90°
15	1100	180°
19	1030	270°
22	0900	0°
25	0230	90°
28	0200	180°
31	2300	270°
Apr. 3	1930	0°
6	1100	90°

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Seek, J.B., J.L. Scheifele, and N.F. Ness, GSFC Magnetic field experiment Explorer 43, to be published 1973.

FIGURES

Figure 1 - Solar ecliptic equatorial plane (XY) projections of Explorers 33 and 35, May 1969.

Figure 2 - Solar ecliptic meridian plane (XZ) projections of Explorer 33 and 35, May 1969.

Figures 3-20 - Explorers 33,35 and 41 (IMP-5) June 1969-Feb 1970. XY and XZ projections alternate.

Figures 21-32 - Solar ecliptic XY projections of Explorers 35 and 41 (IMP-5) March 1970-Feb 1971.

Figures 33-50 - Solar ecliptic XY projections of Explorers 35, 41 (IMP-5) and 43 (IMP-6) March 1971-Aug.1972.

Figures 51-54 - Solar ecliptic XY projections of Explorers 35, 41 (IMP-5), 43 (IMP-6) and 47 (IMP-7) Sept 72-Dec 72.

Figure 55 - Solar ecliptic XY and XZ projections of four Explorer 41 (IMP-5) orbits in the noon meridan plane spaced one year apart in time. The differences between the XZ projections indicate gradual changes in the orbit that are taking place in an inertial coordinate system.

Figure 56 - Solar ecliptic XY and XZ projections of two Explorer 43 (IMP-6) orbits in the noon meridan plane spaced one year apart in time. The differences between the orbits indicate the gradual changes in the orbit that are taking place in an inertial coordinate system.

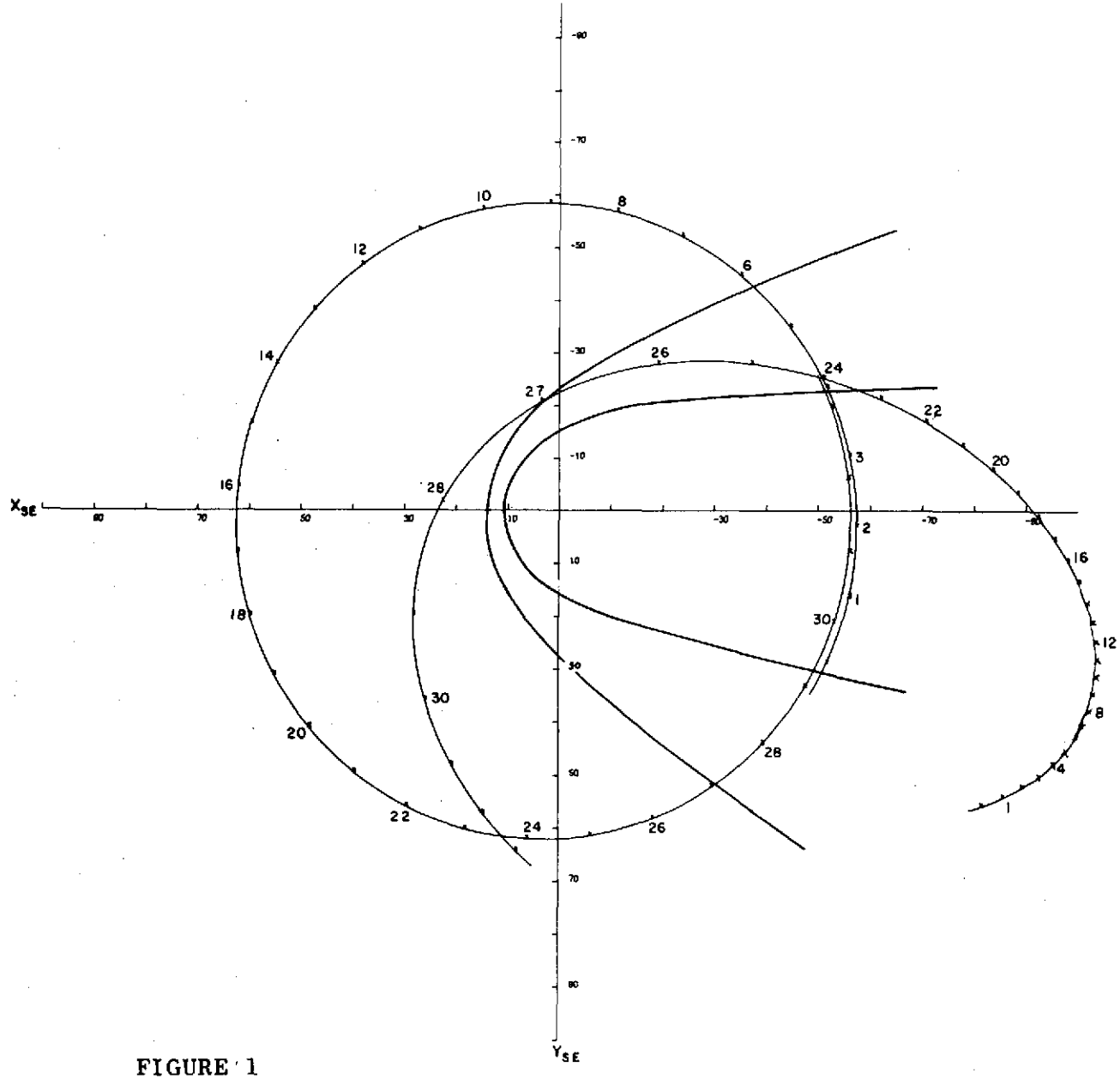

FIGURE 1

MAY 1969

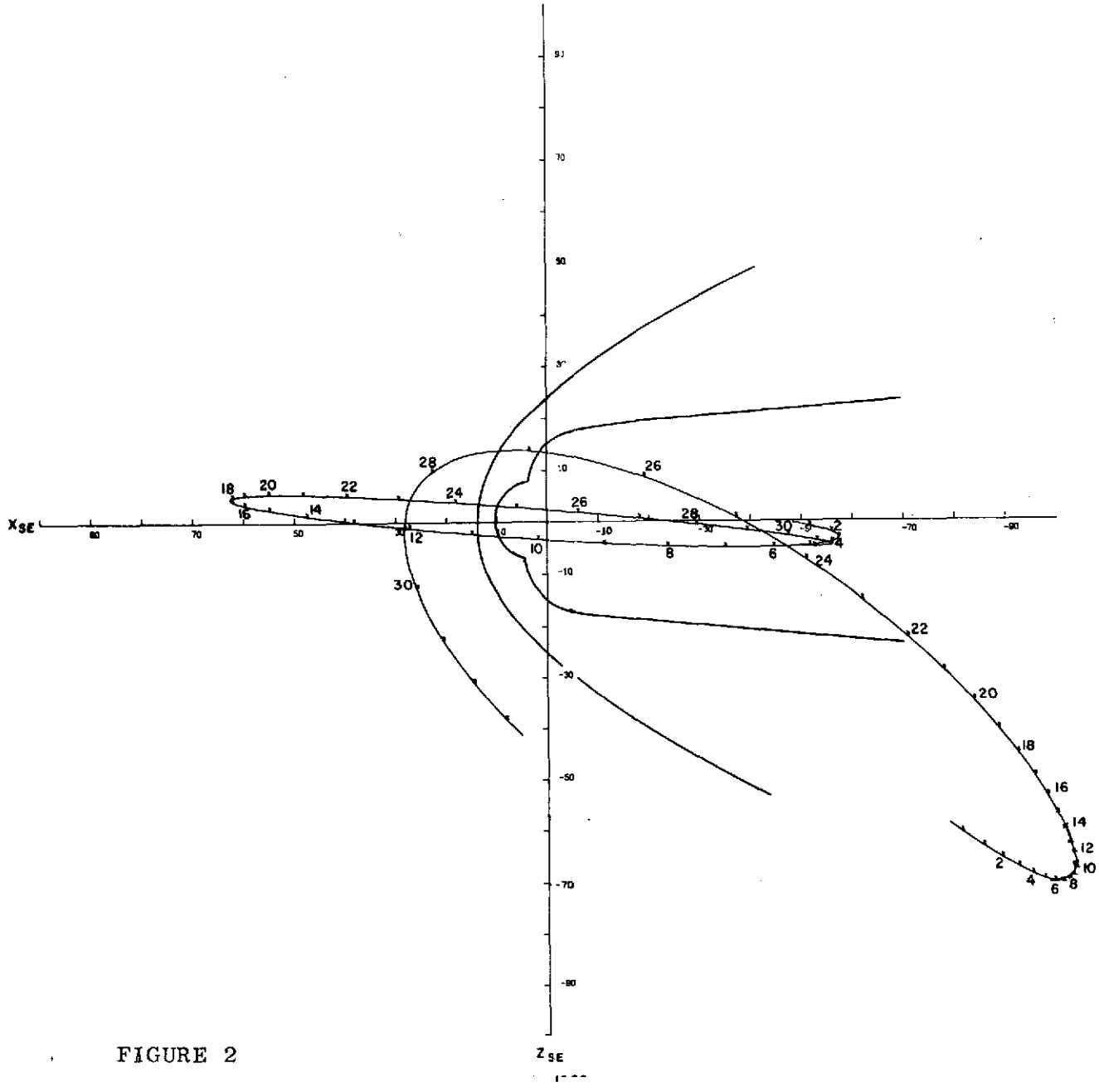

FIGURE 2

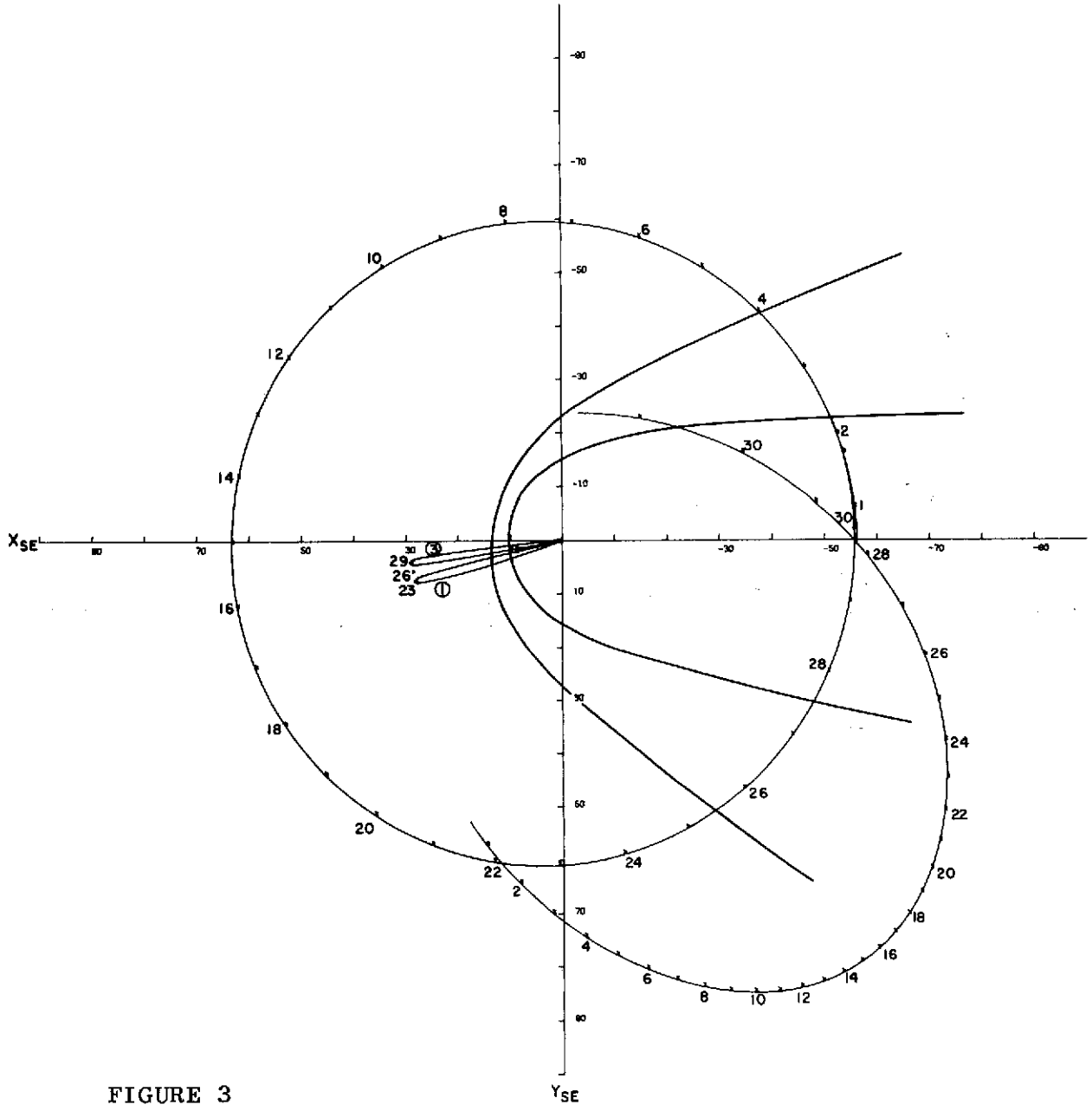

FIGURE 3

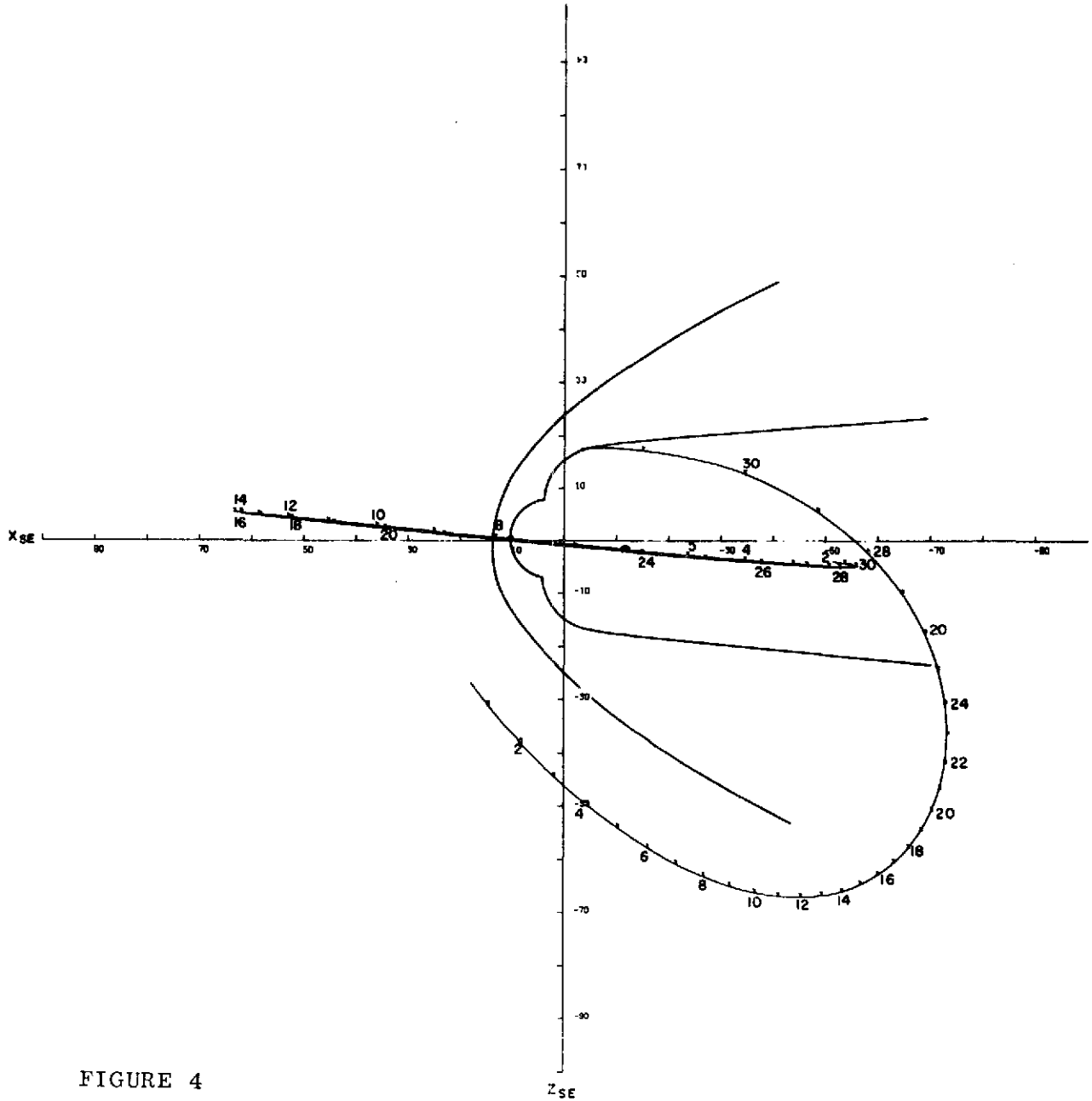

FIGURE 4

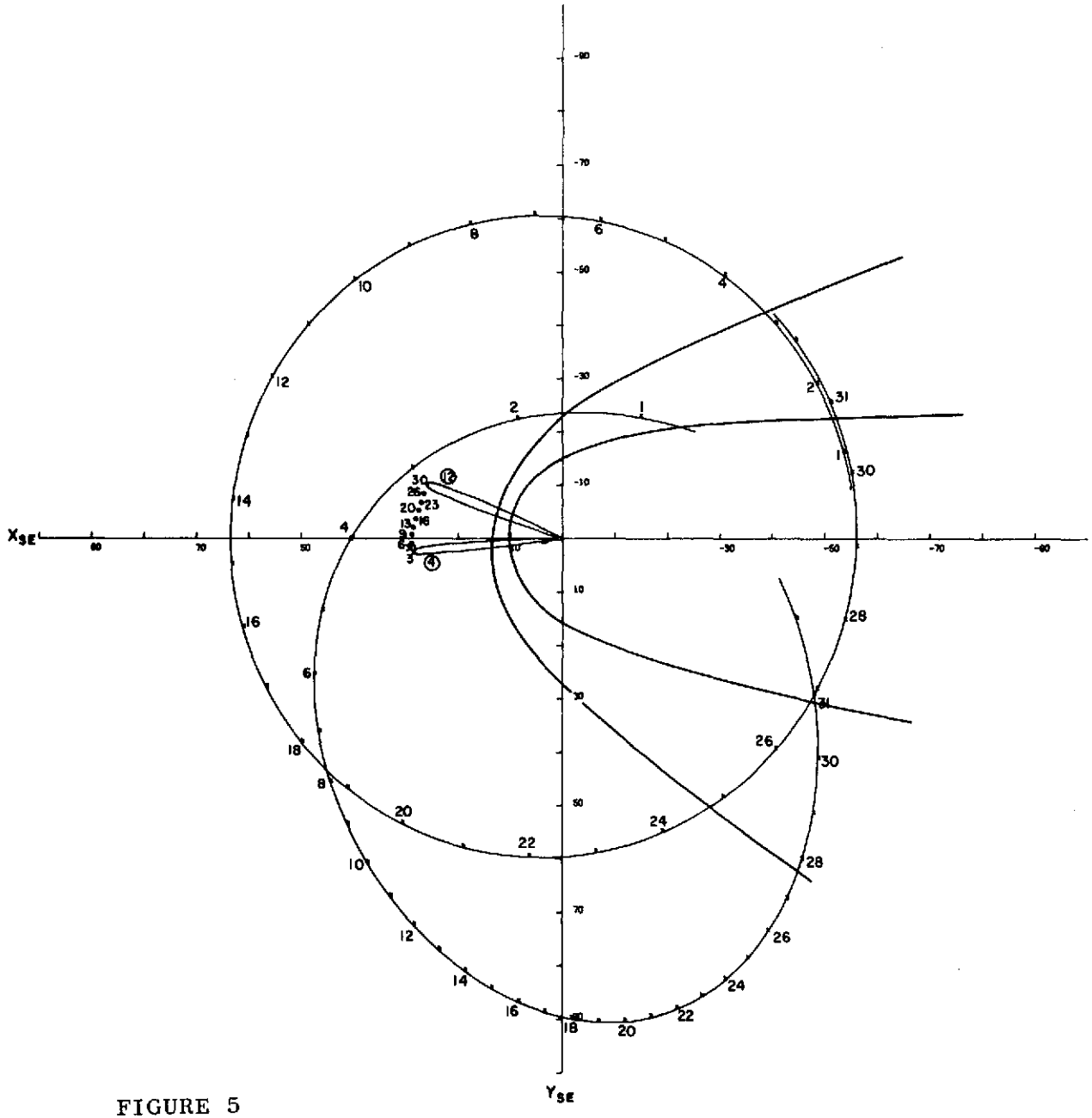

FIGURE 5

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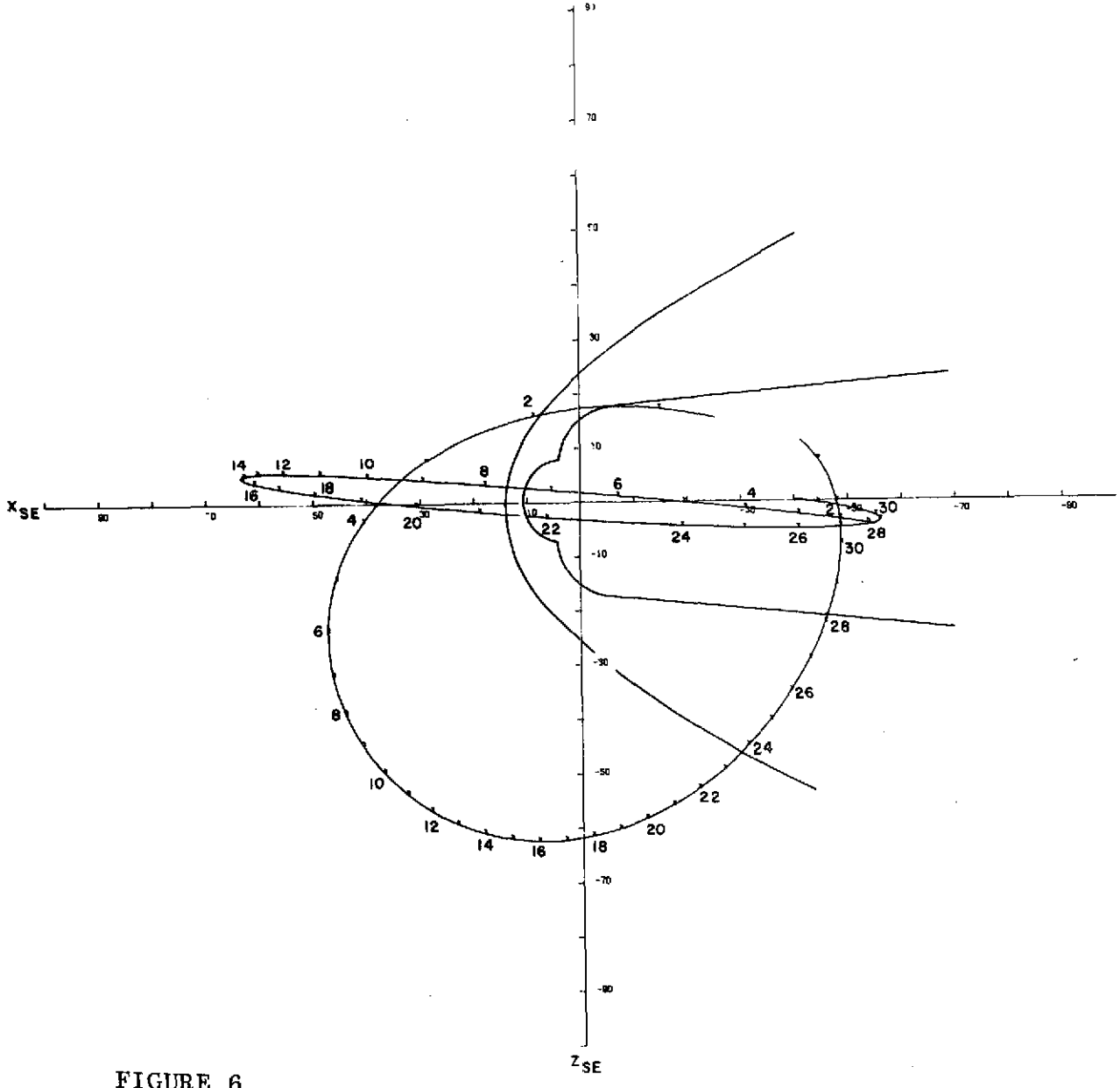

FIGURE 6

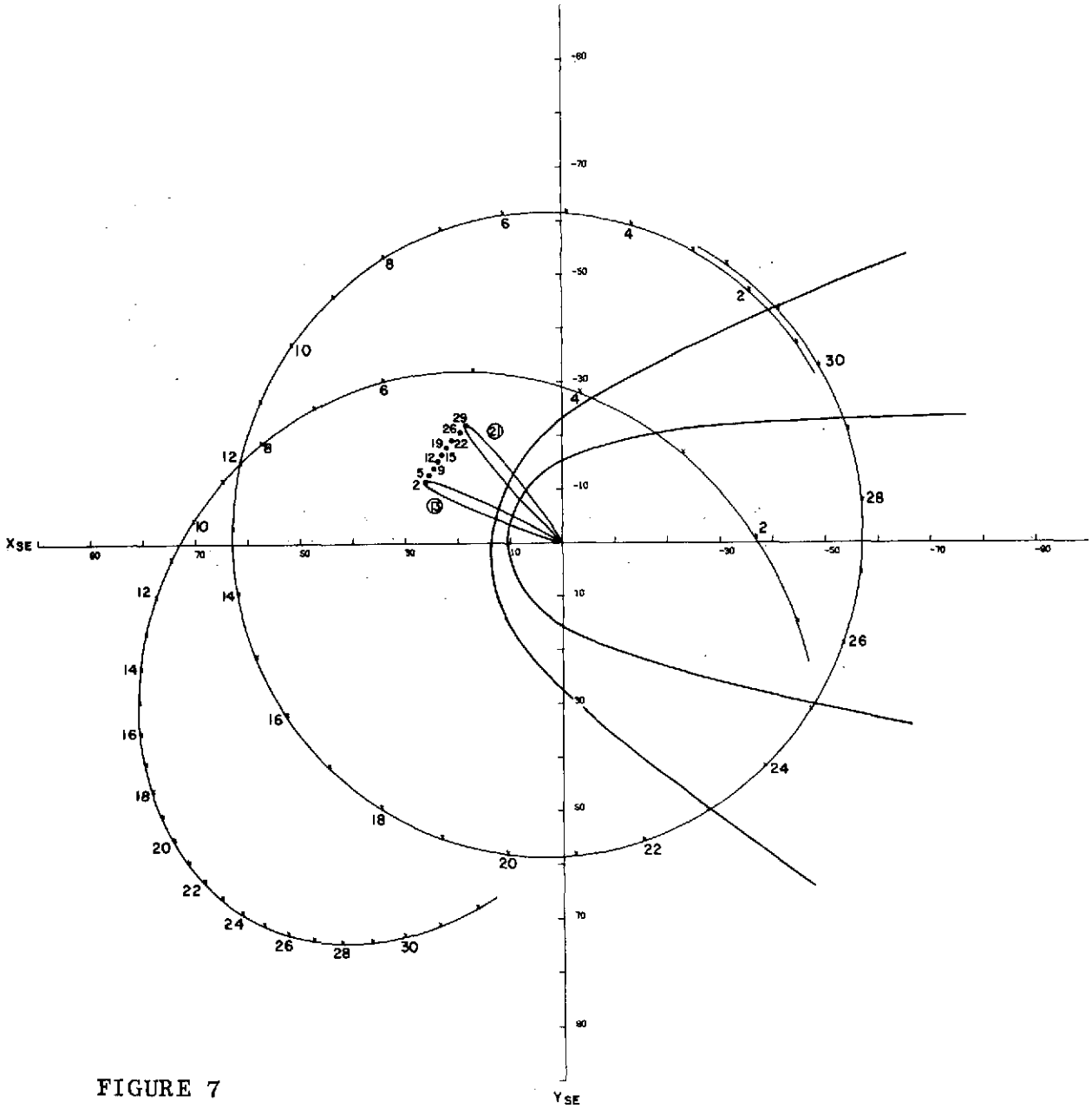

FIGURE 7

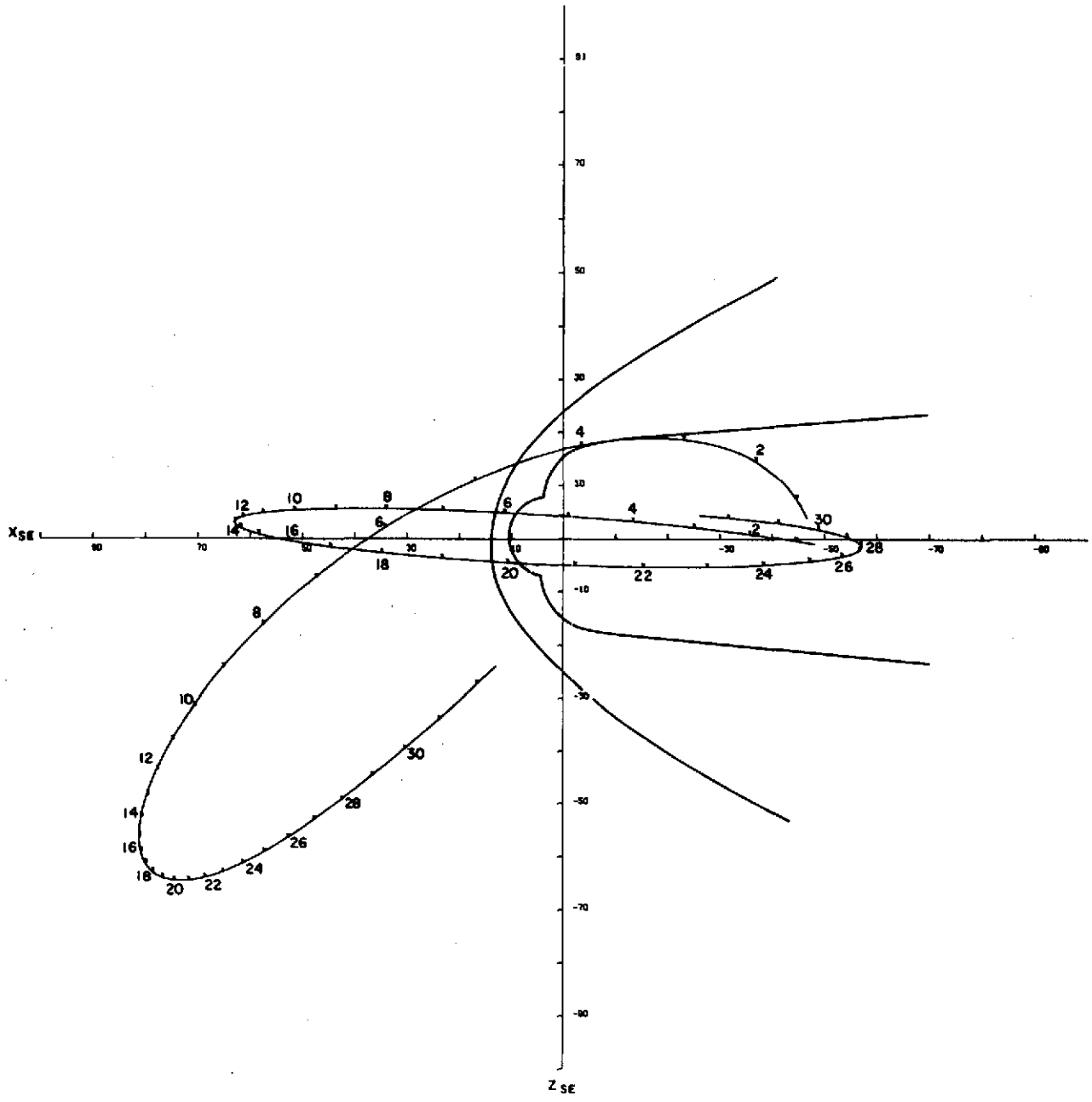

FIGURE 8

AUGUST 1969

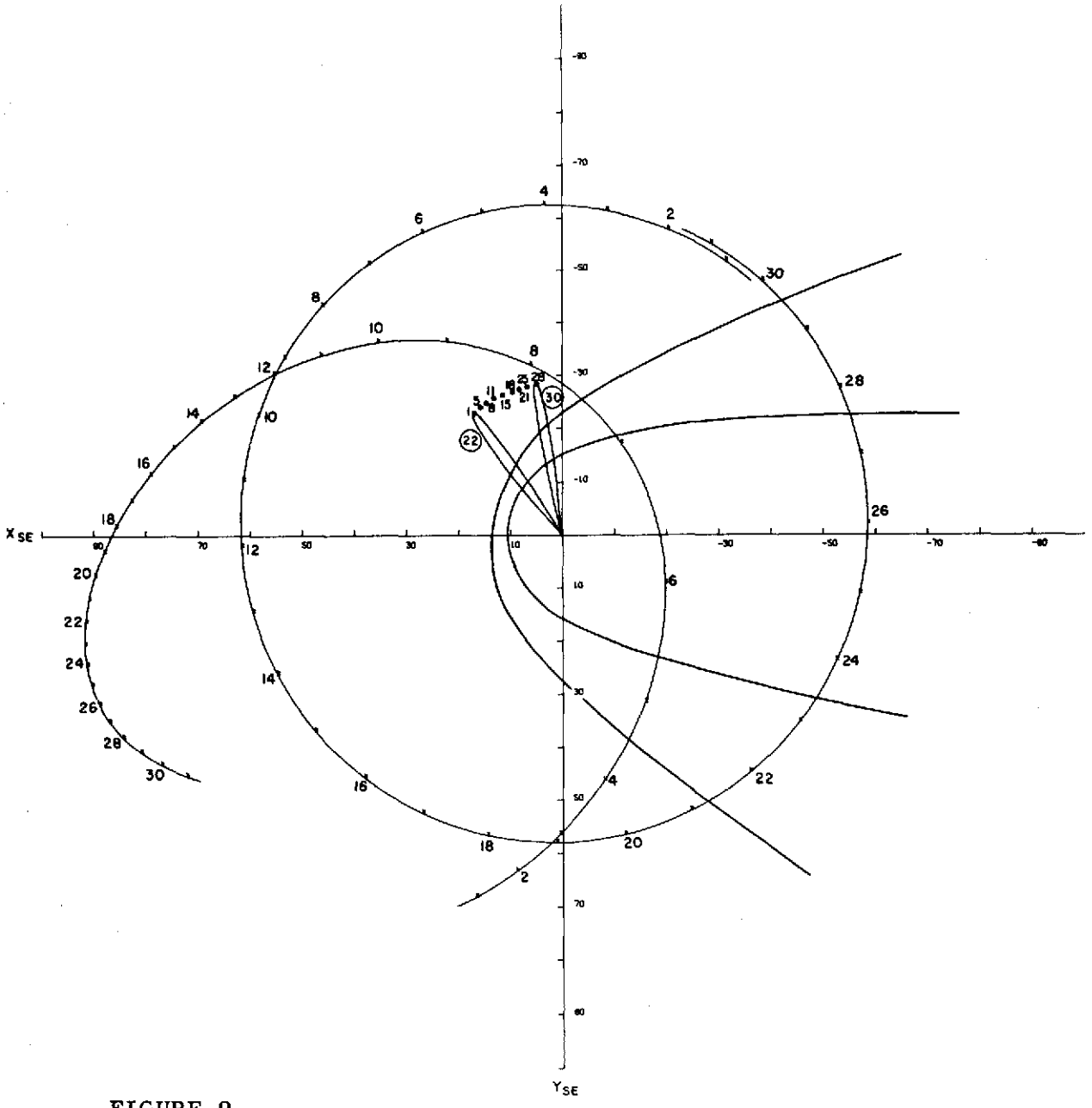

FIGURE 9

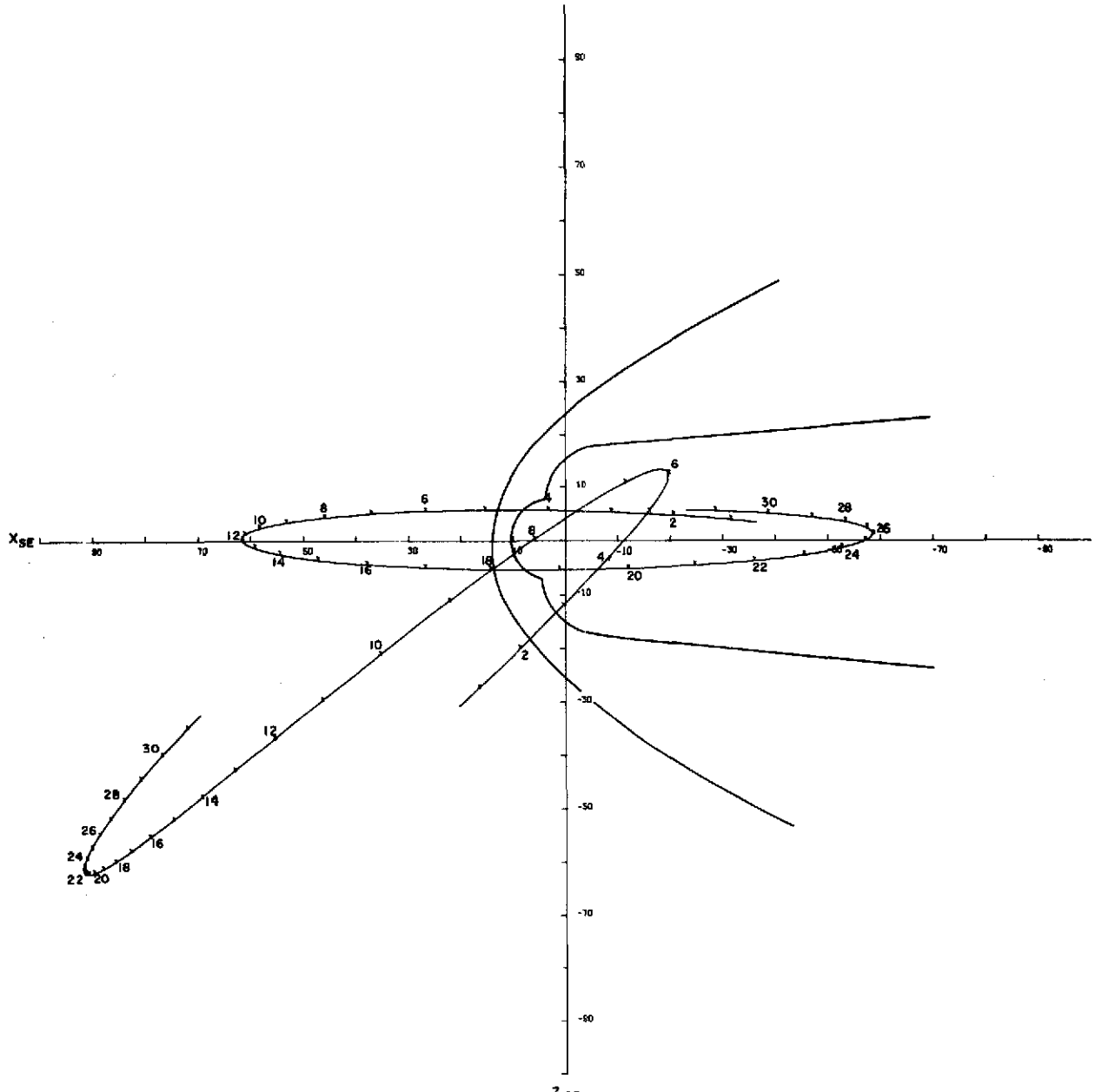

FIGURE 10

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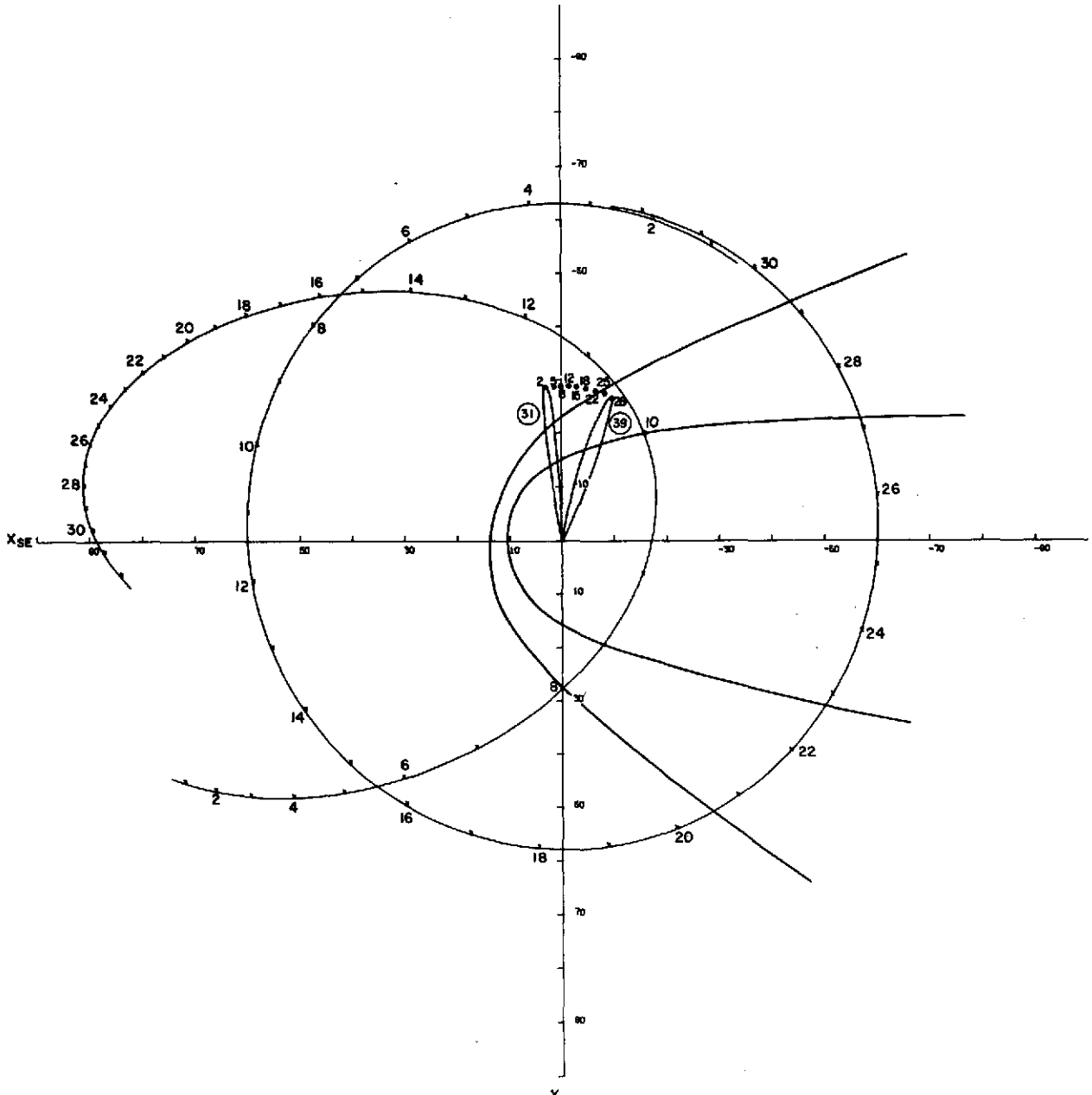
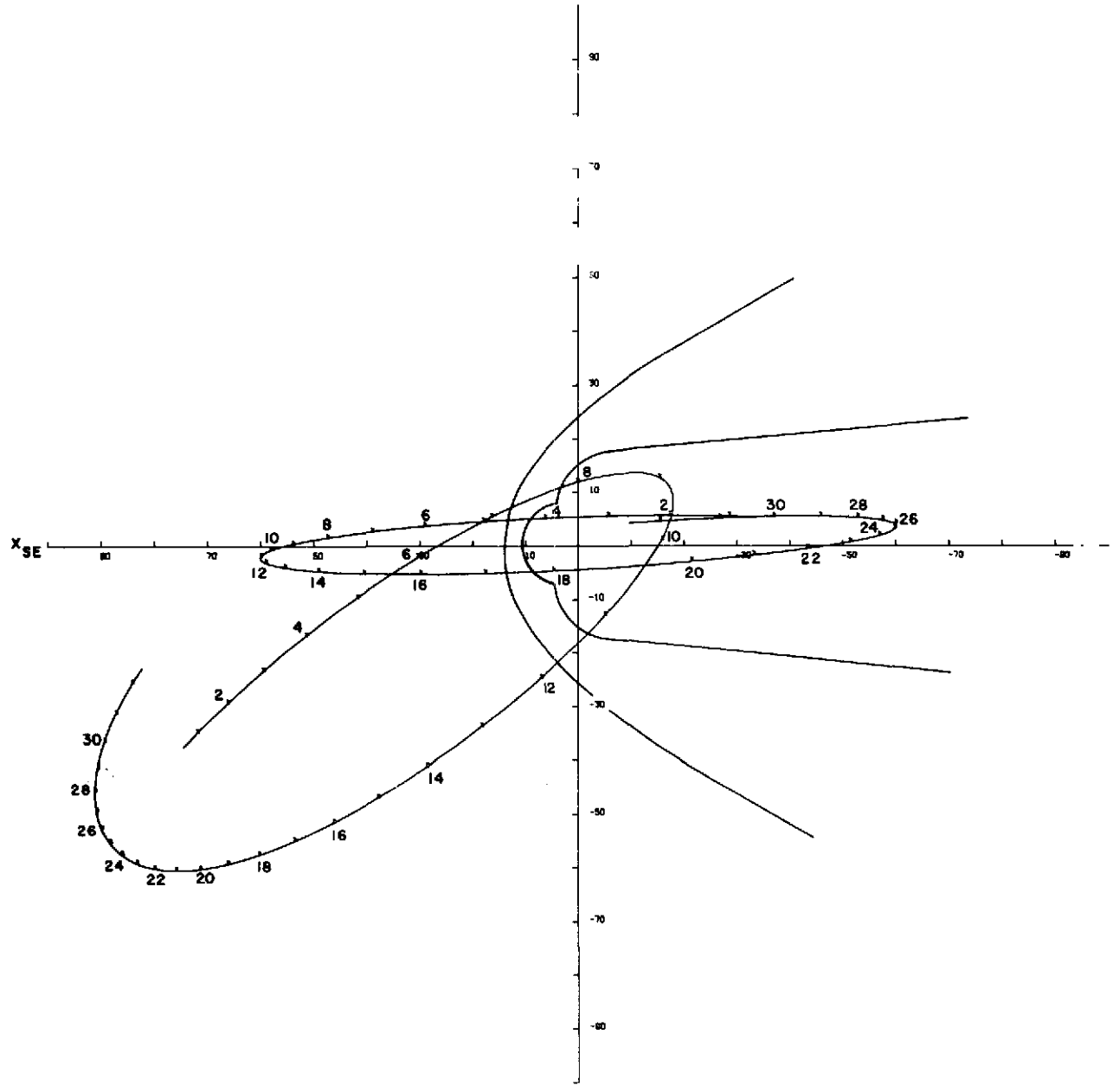


FIGURE 11

OCTOBER 1969



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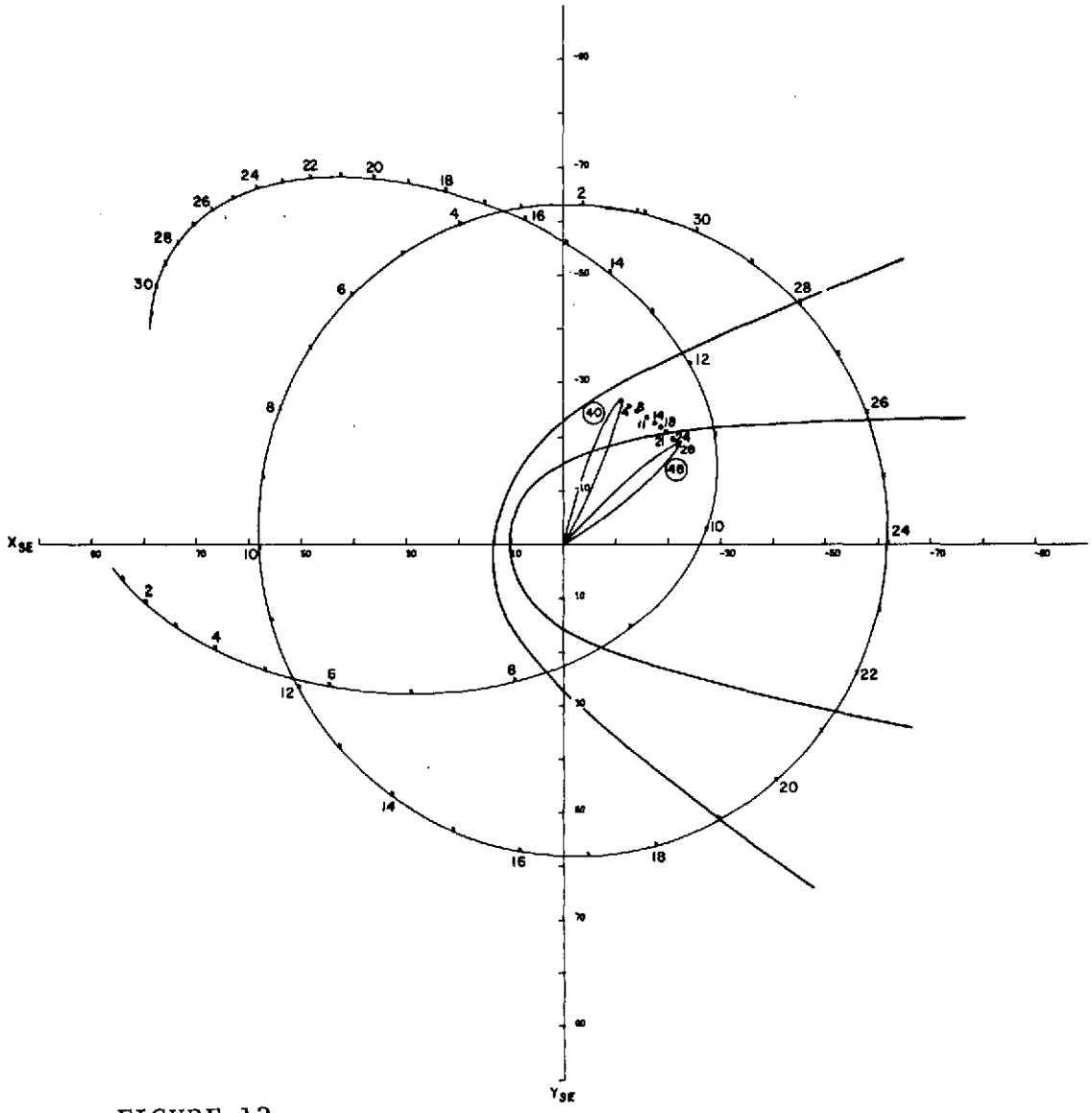

FIGURE 13

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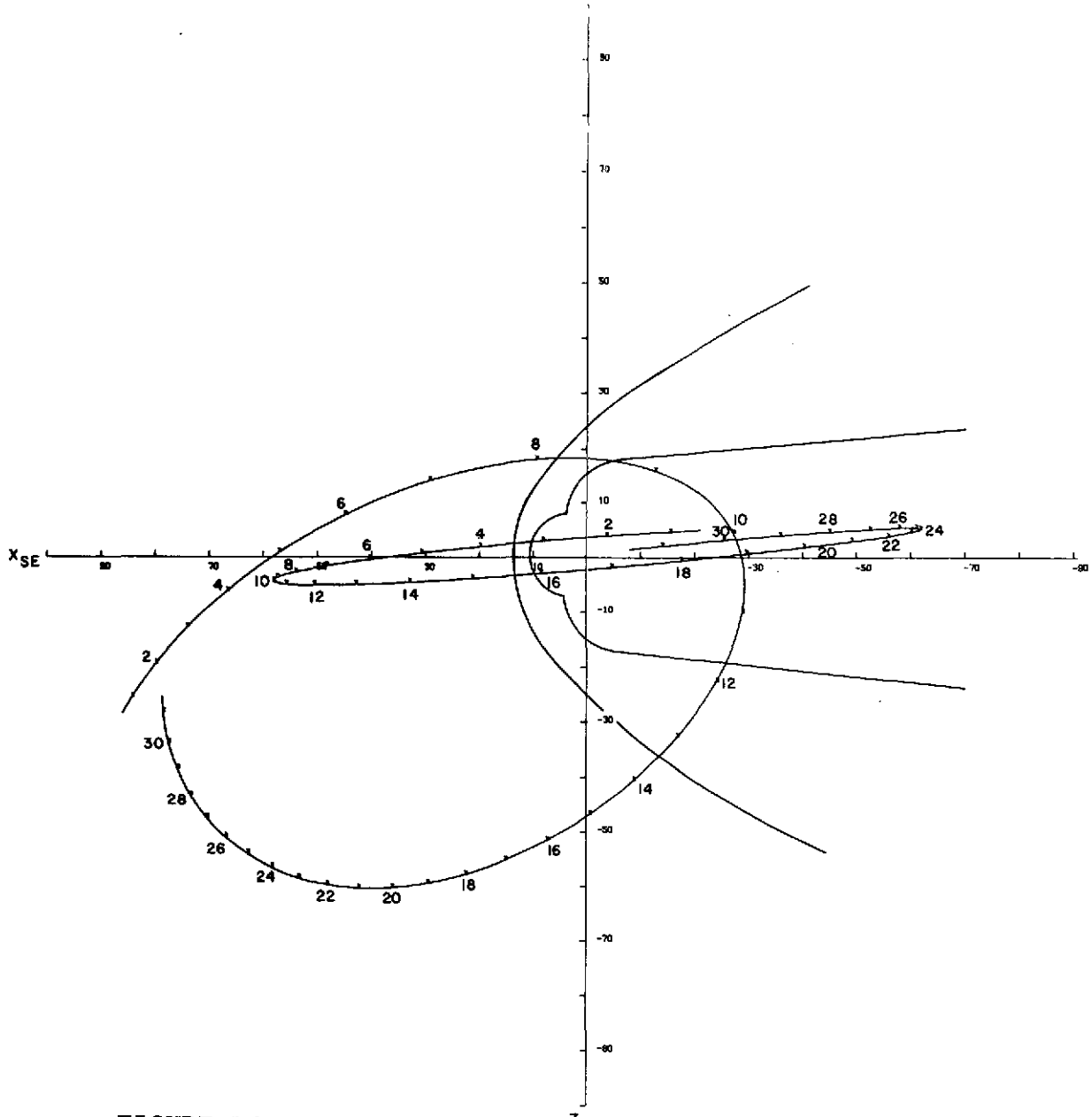

FIGURE 14

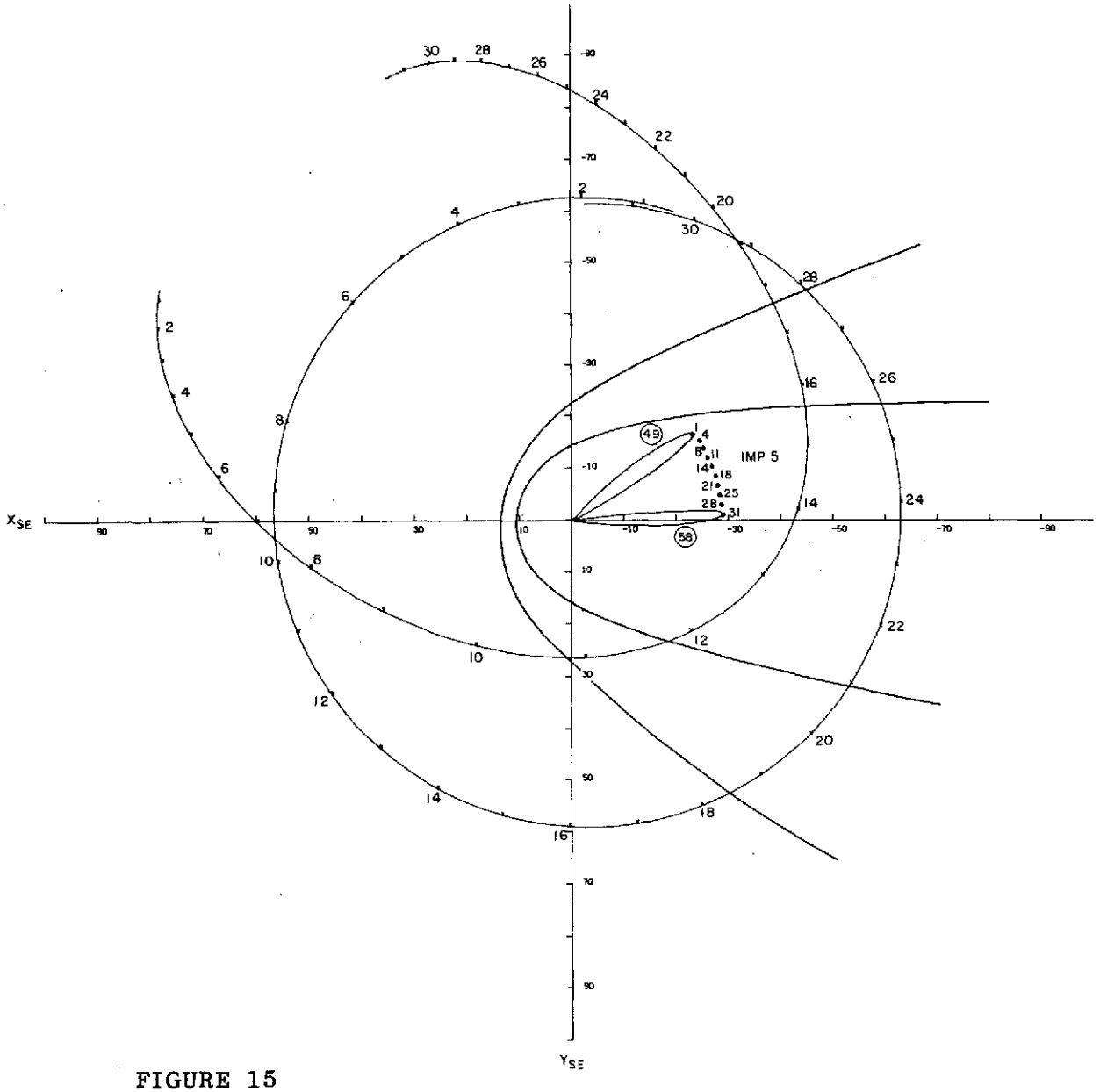

FIGURE 15

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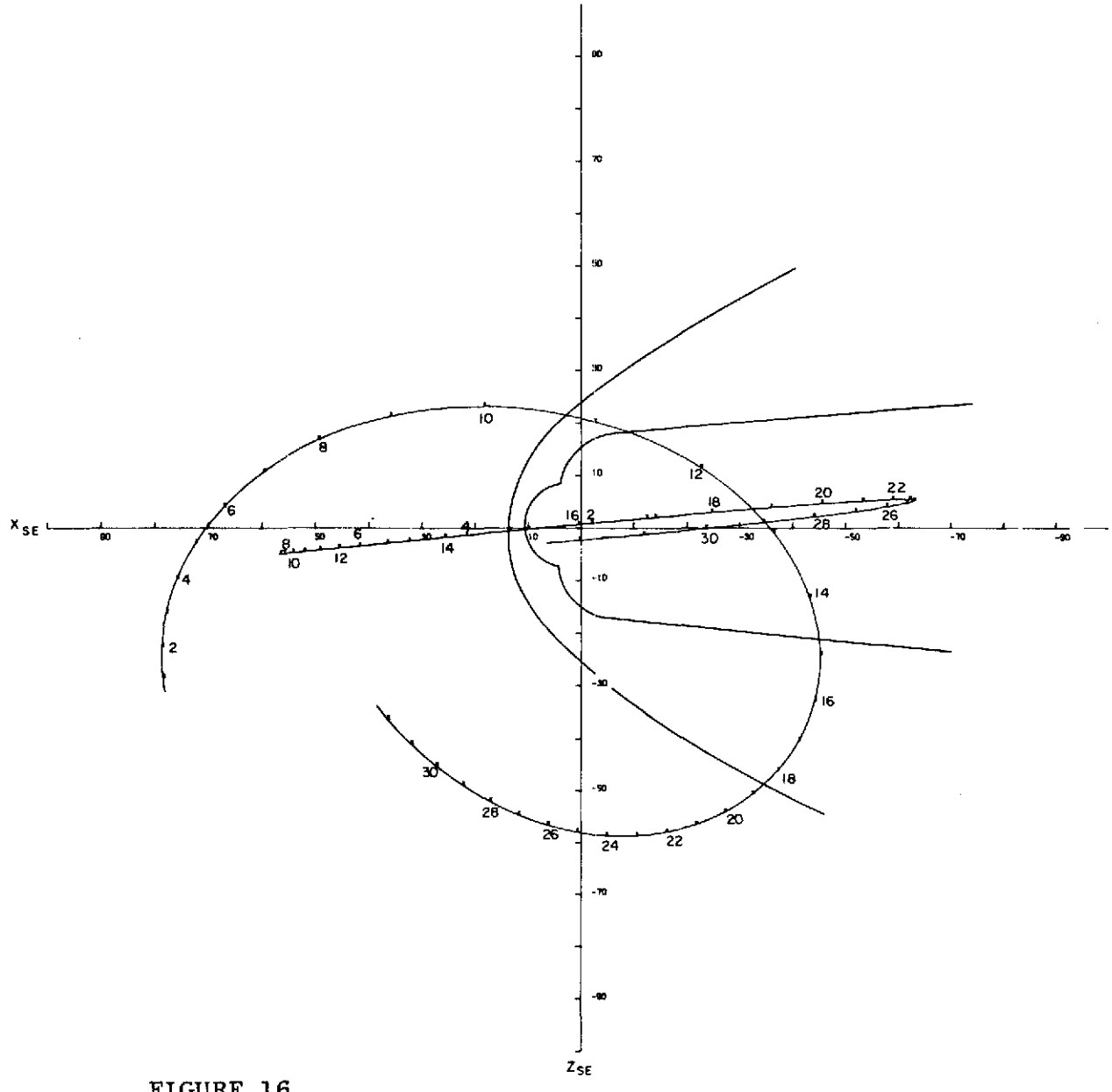

FIGURE 16

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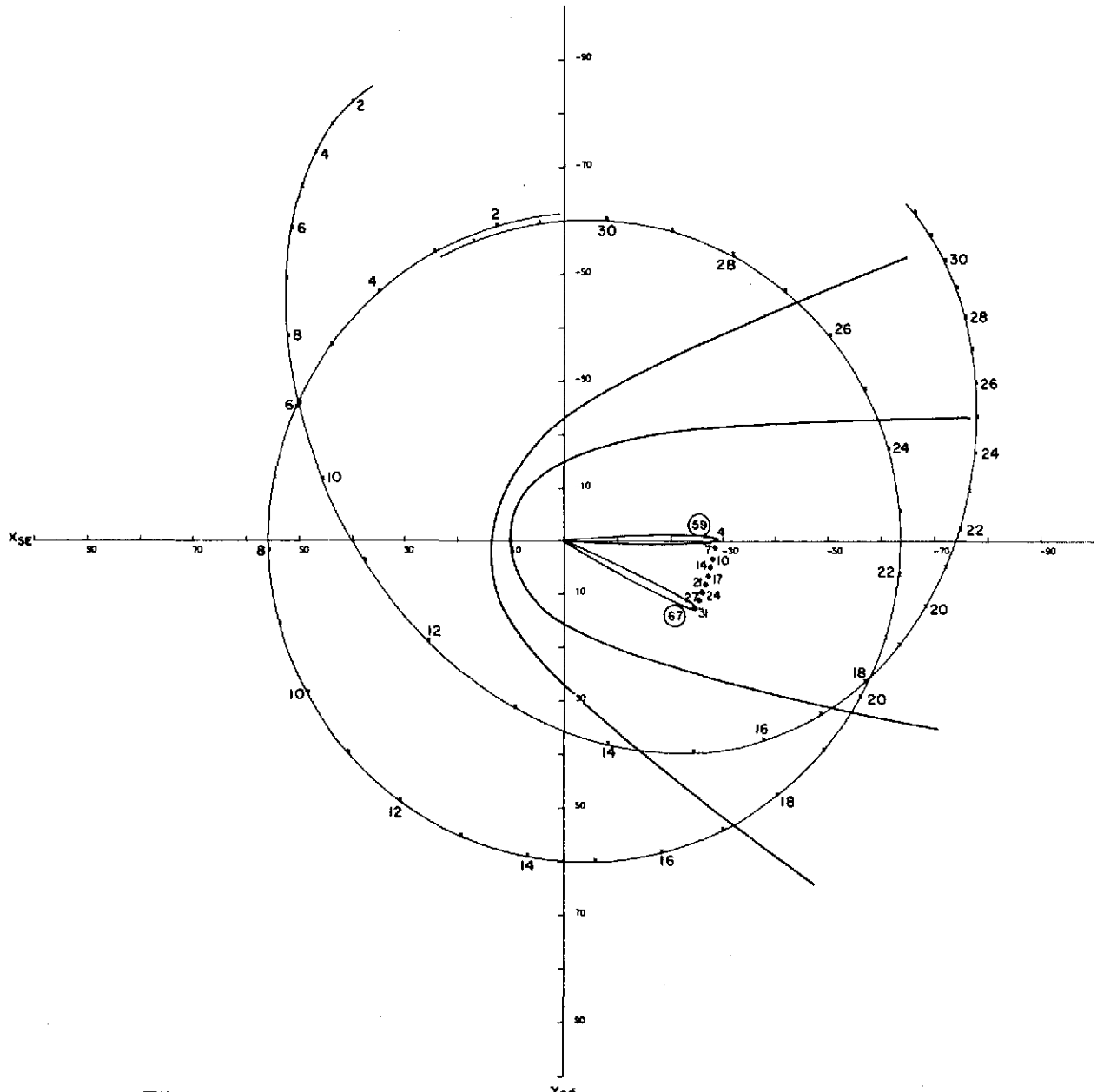

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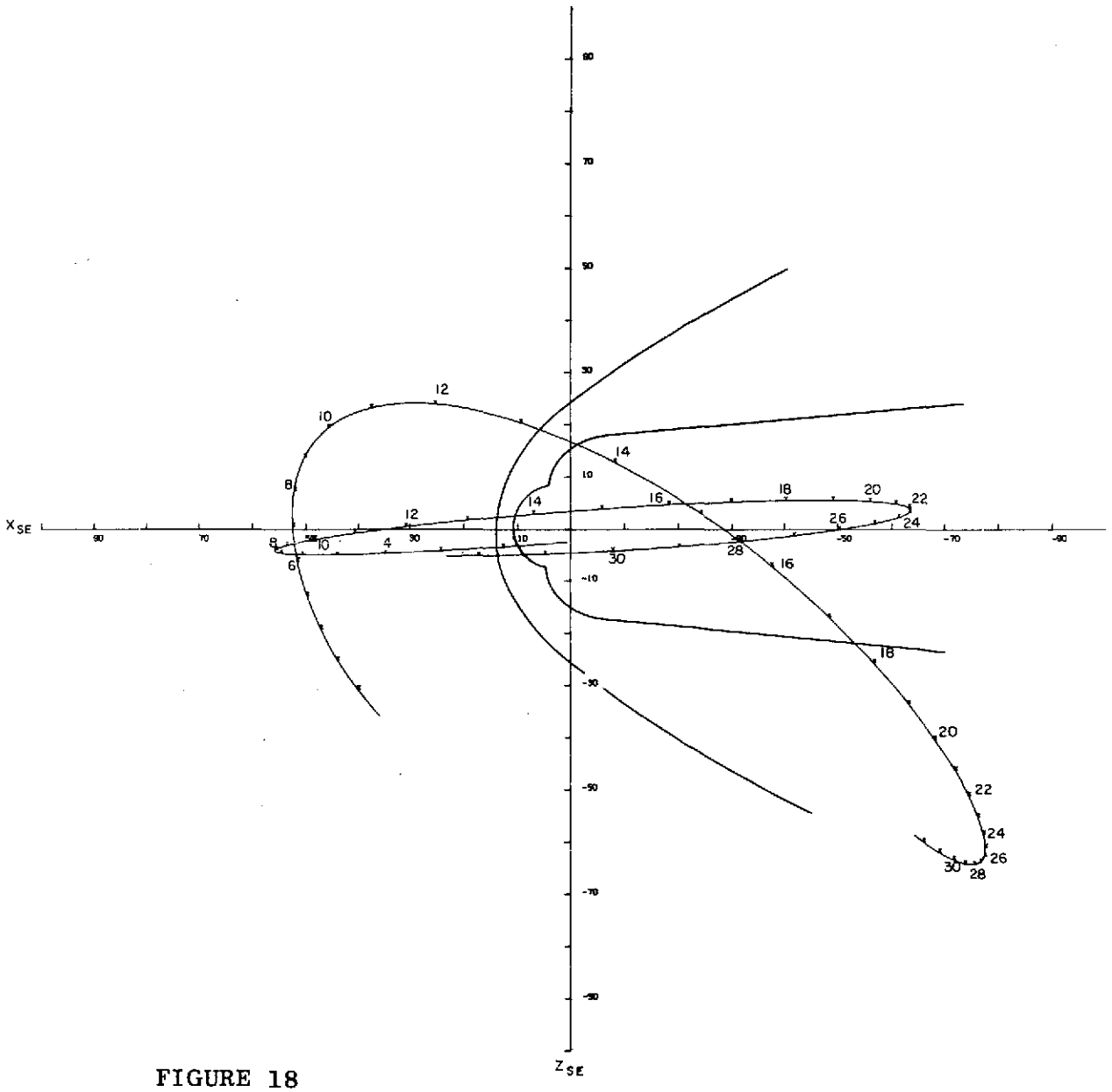

FIGURE 18

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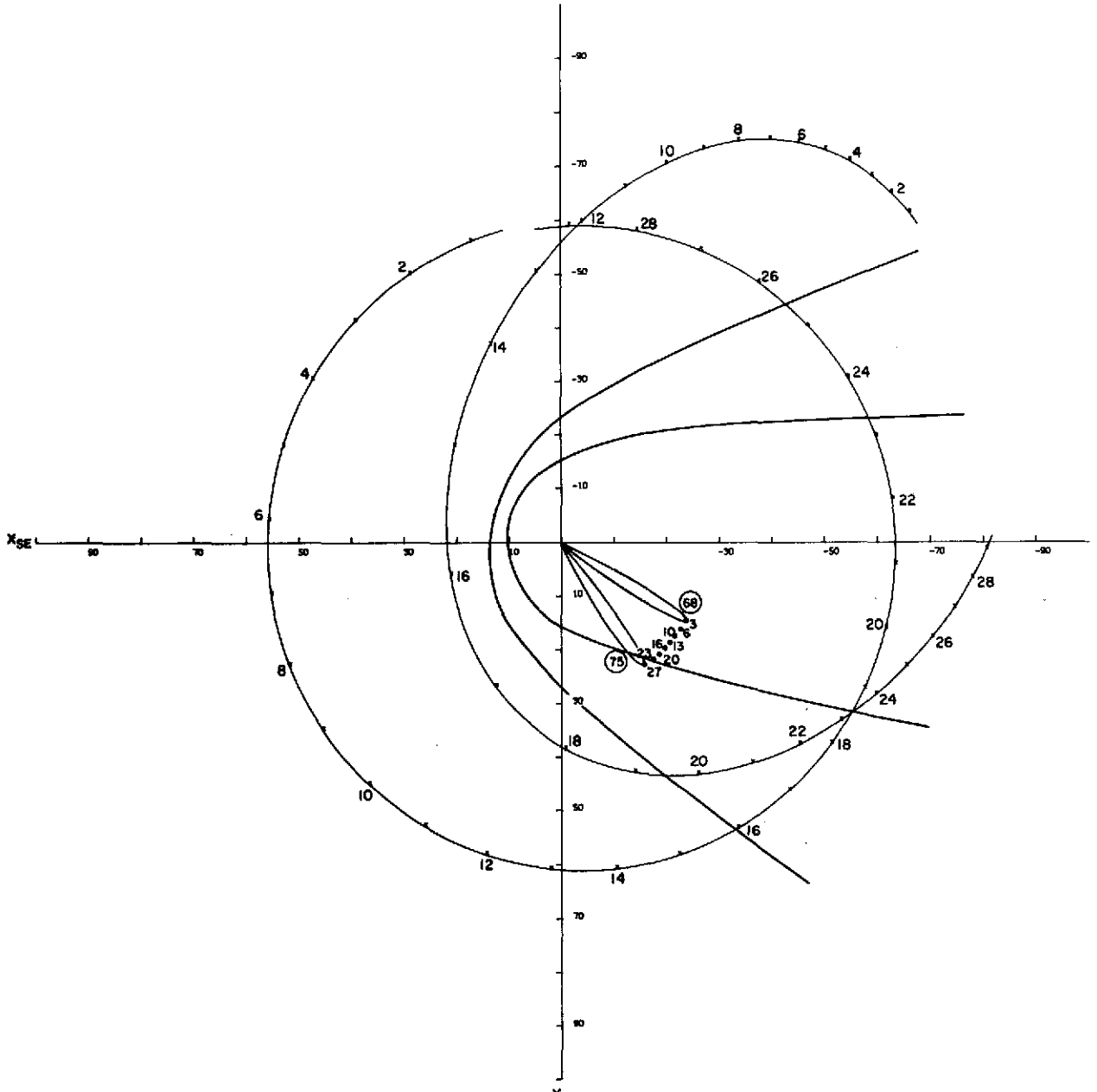

FIGURE 19

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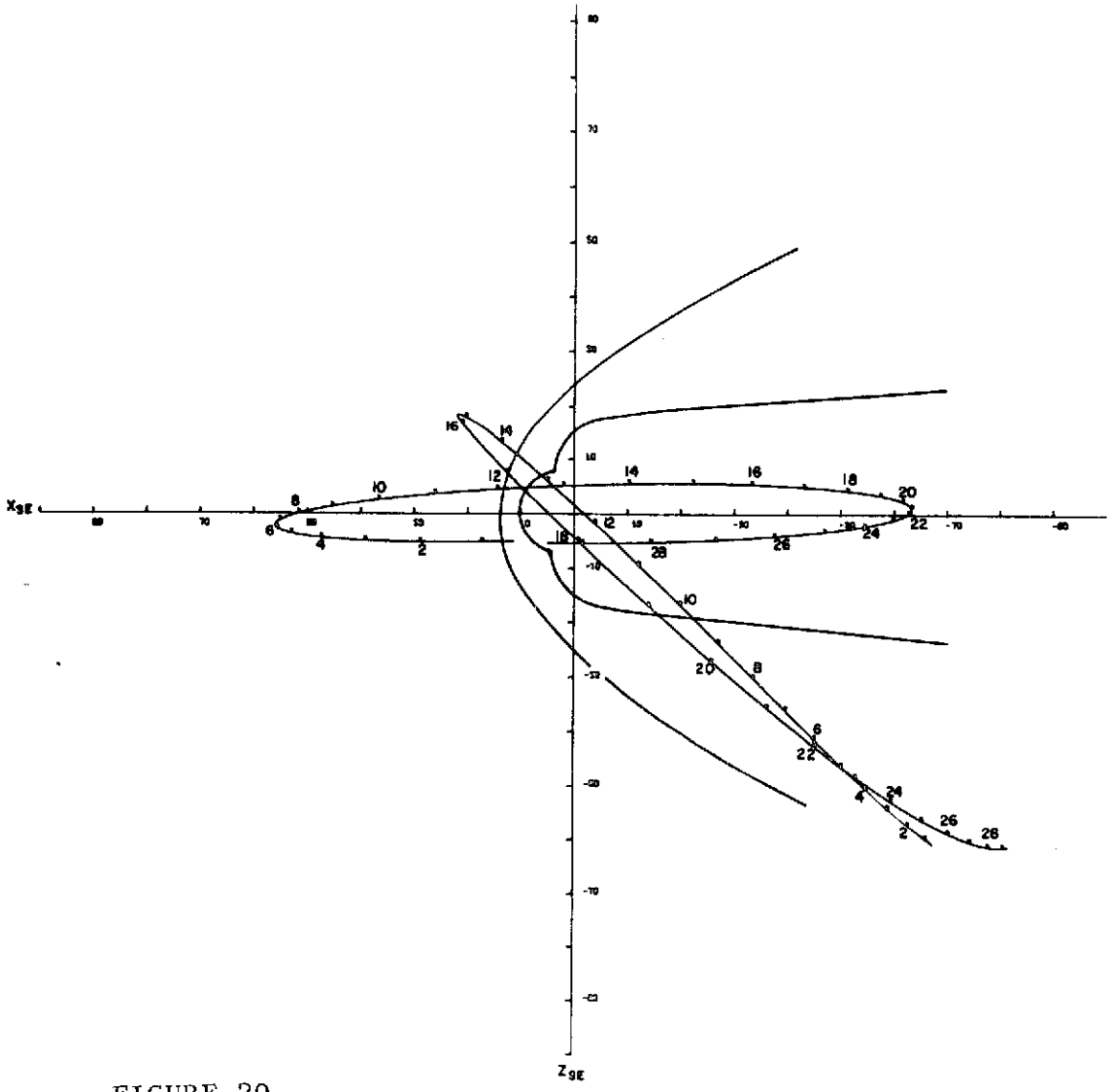

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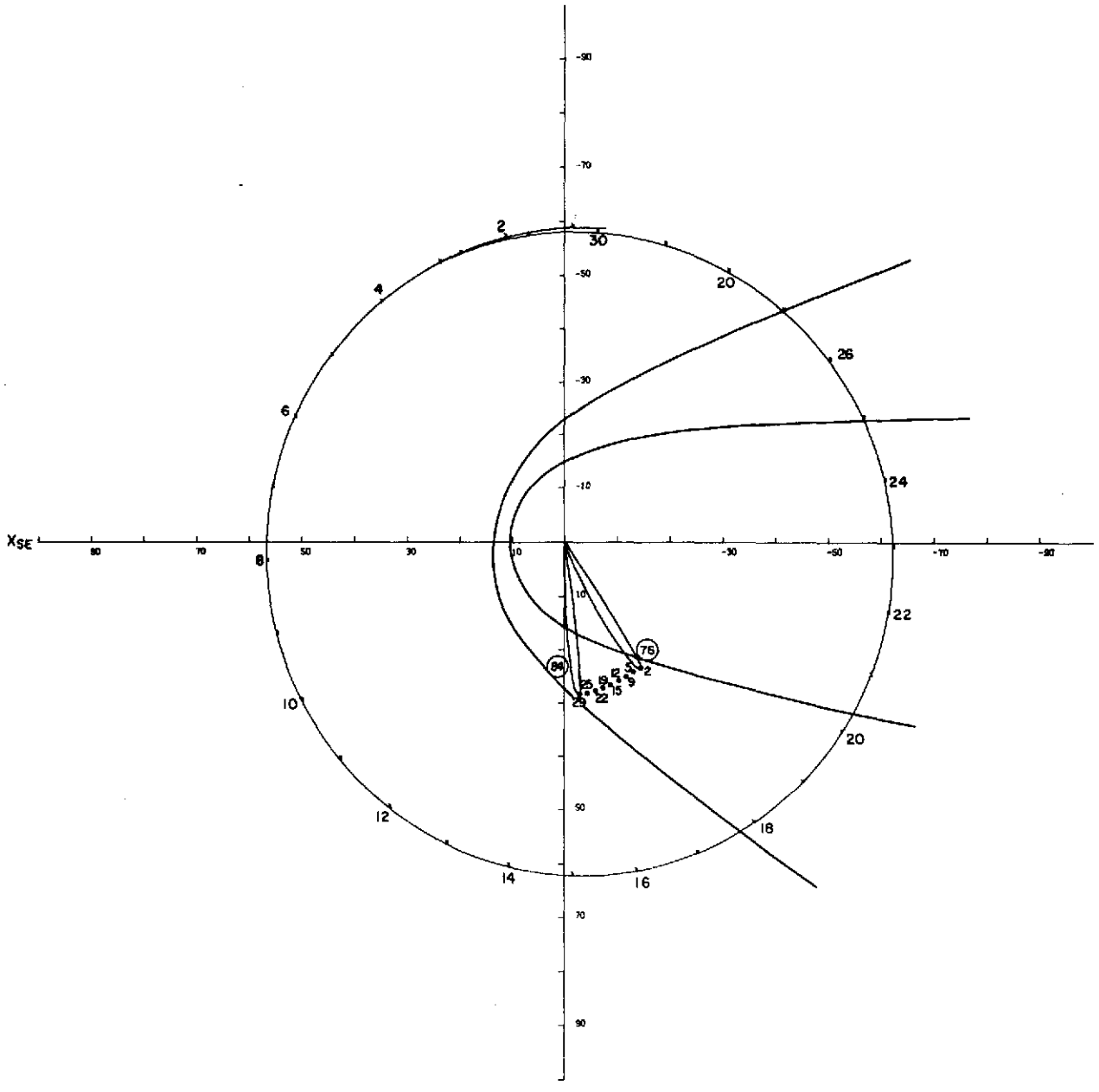

FIGURE 21

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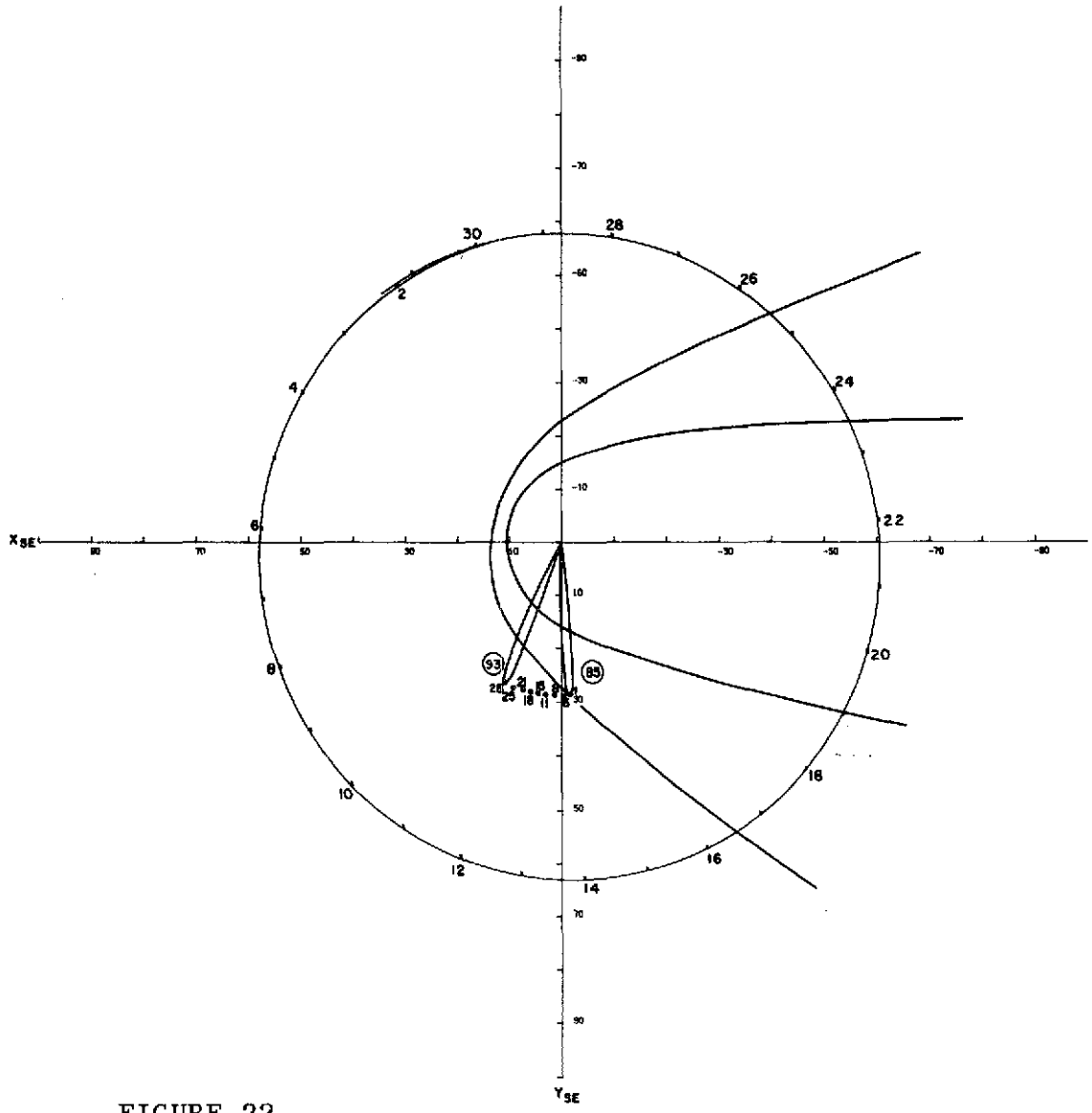
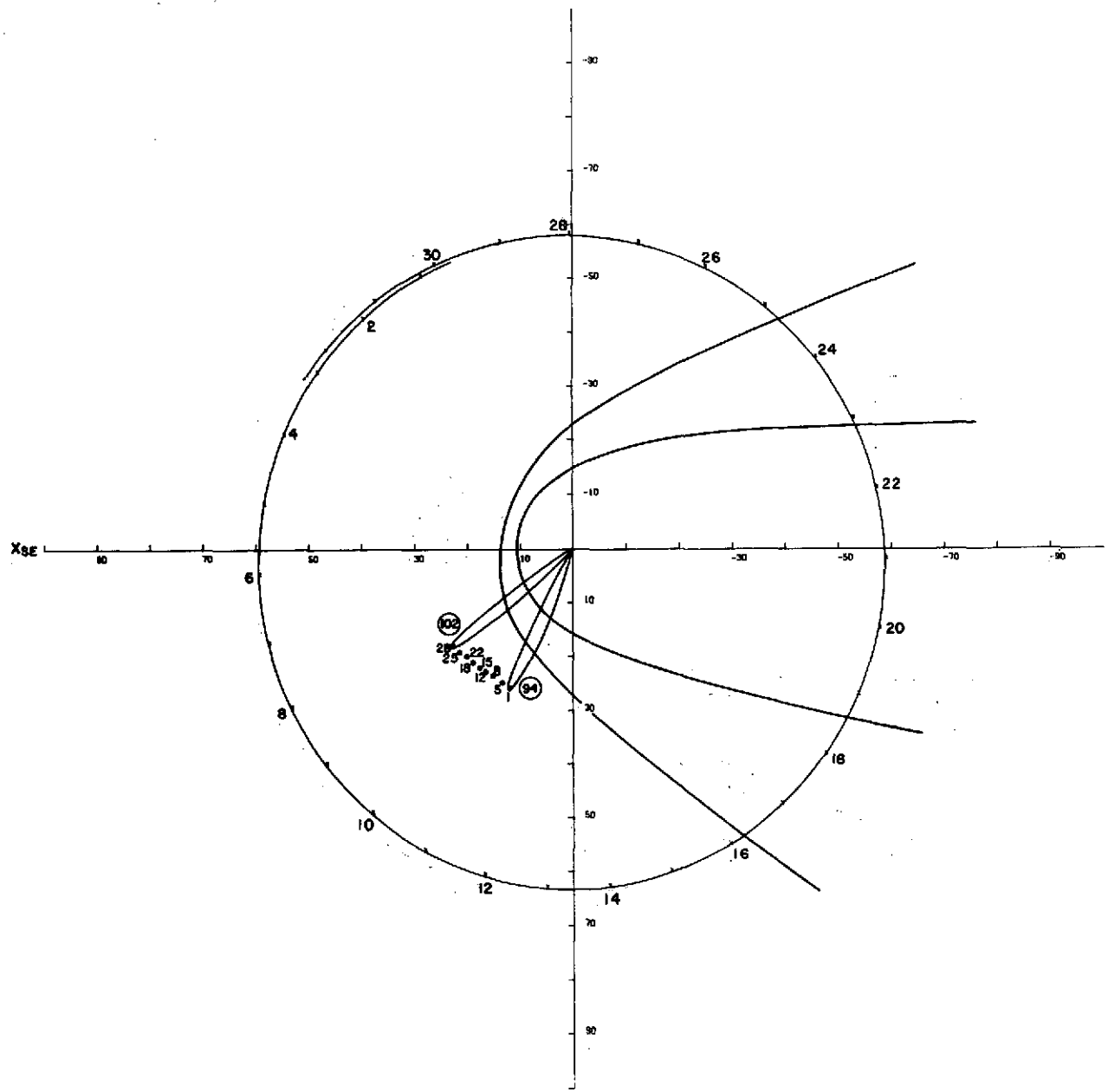


FIGURE 22



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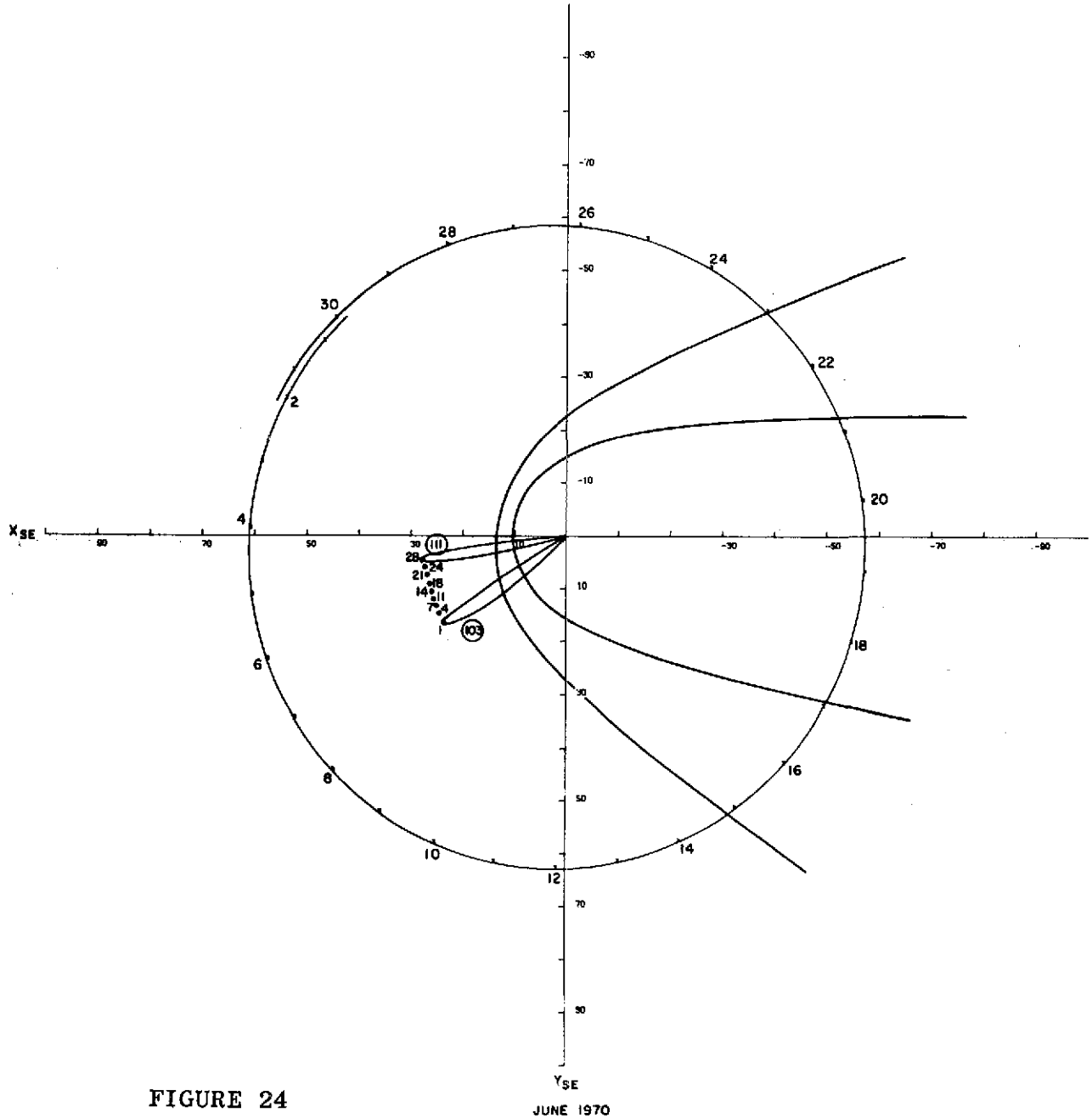
X_{SE}
Y_{SE}
JUNE 1970
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103
28
24
21
18
14
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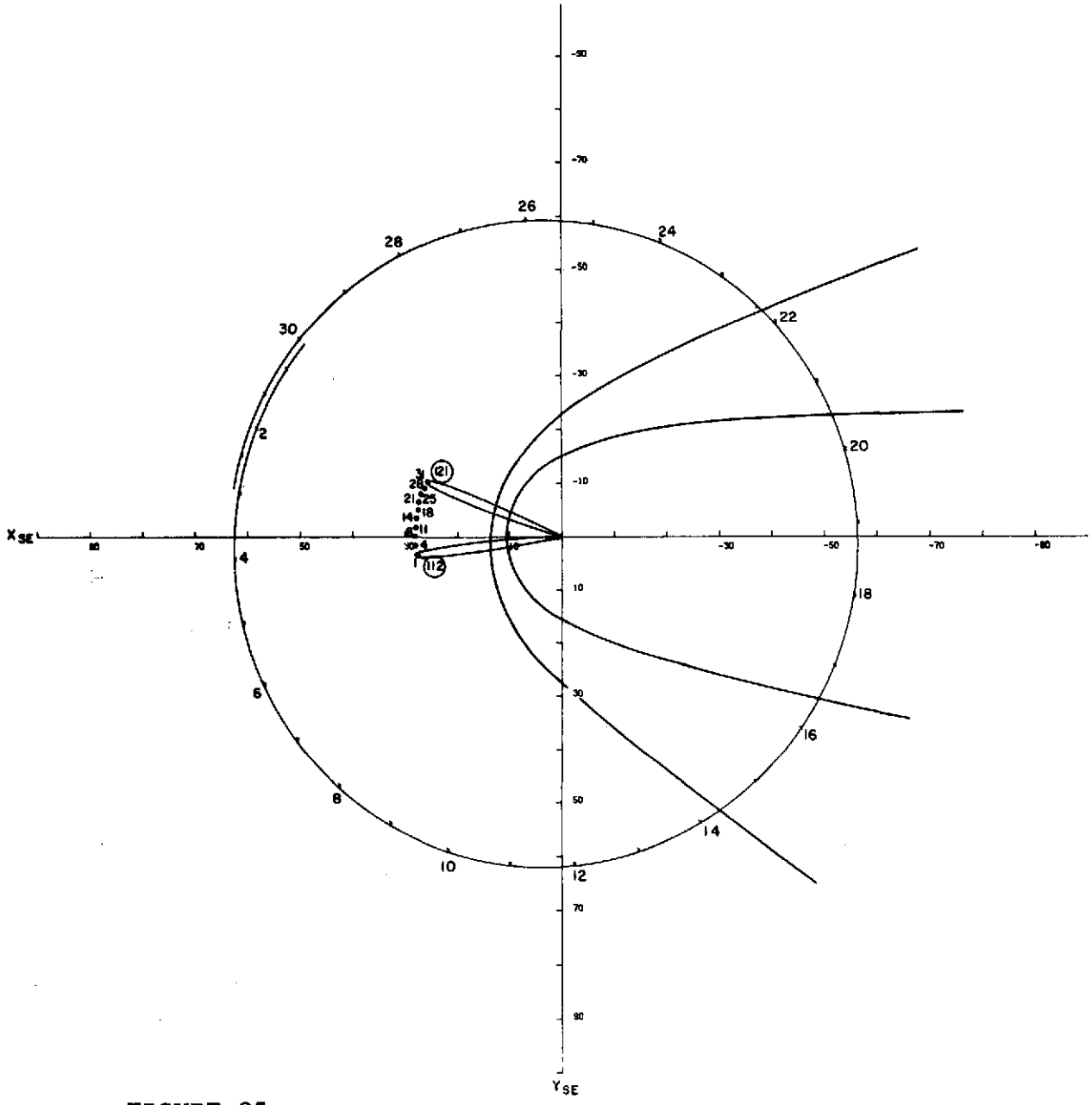
FIGURE 24



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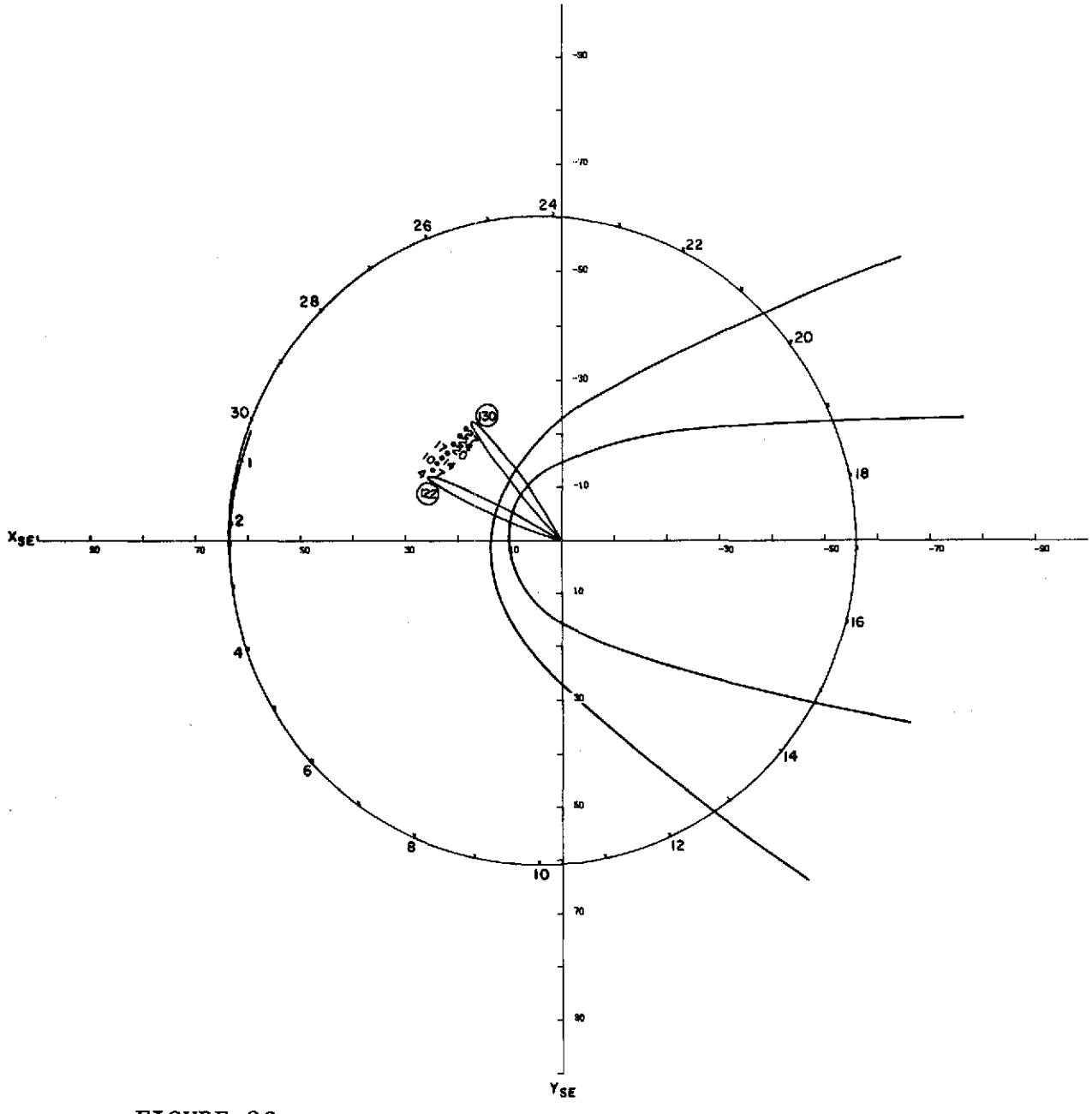


FIGURE 26

AUGUST 1970

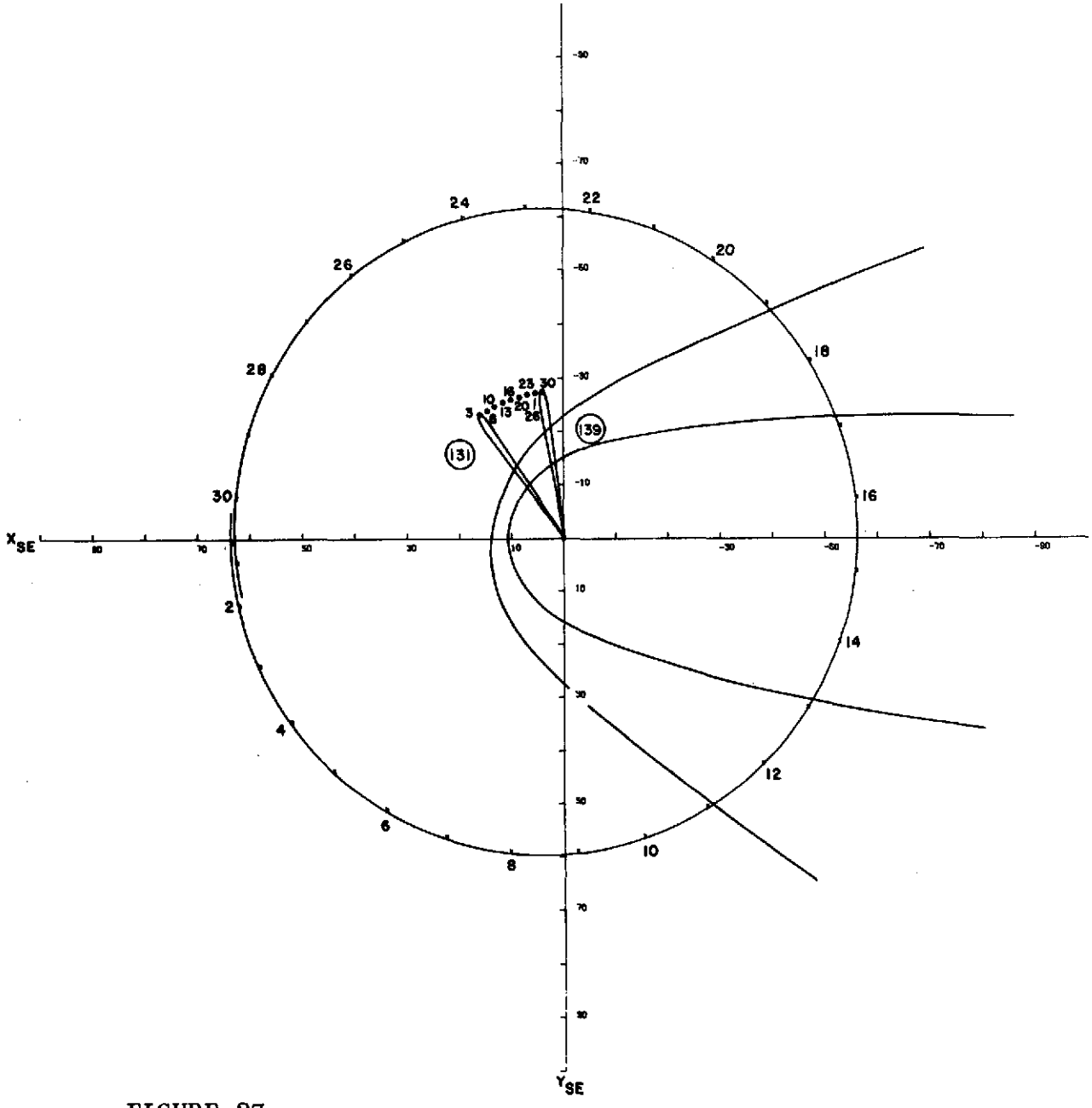


FIGURE 27

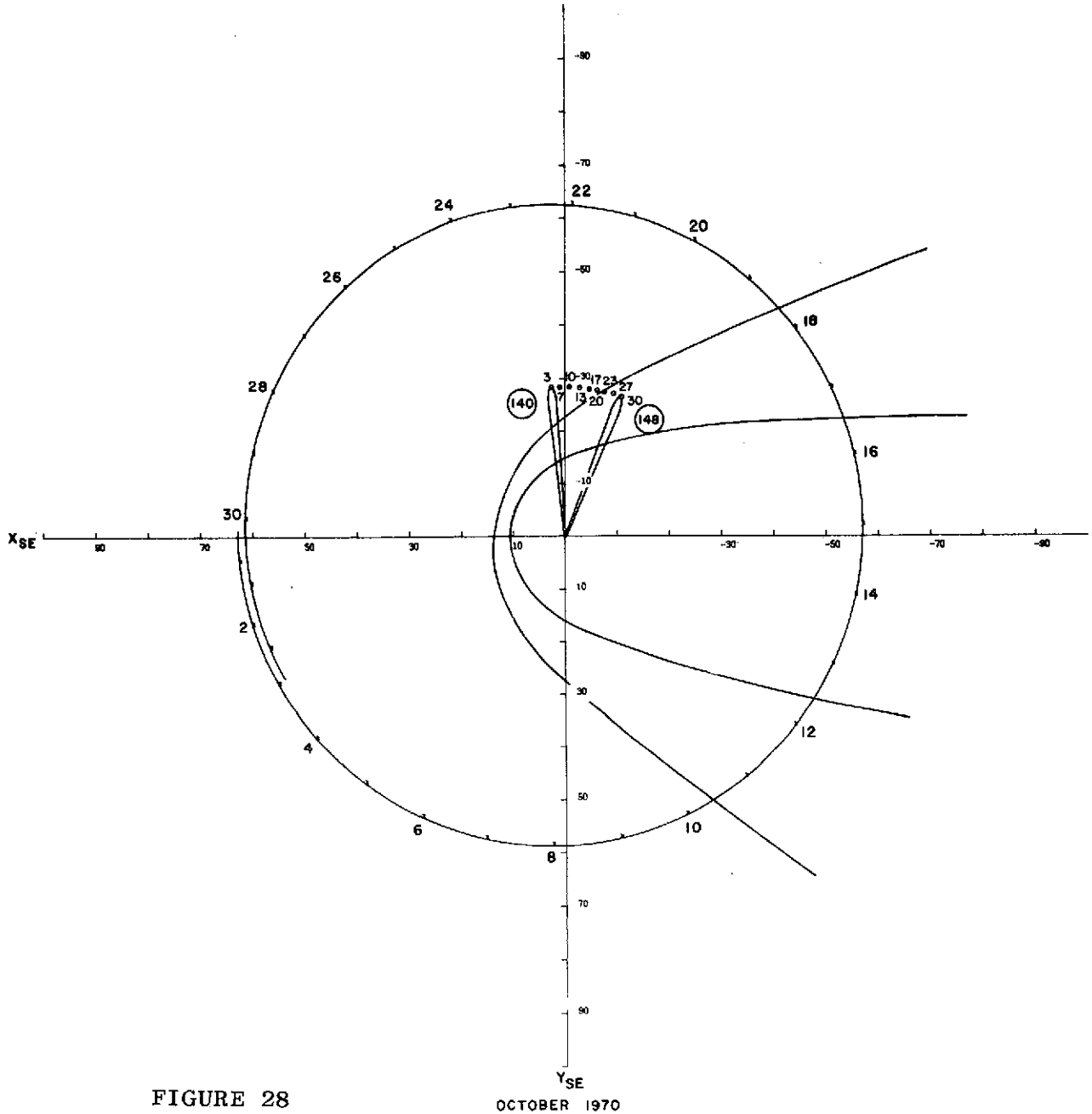


FIGURE 28

OCTOBER 1970

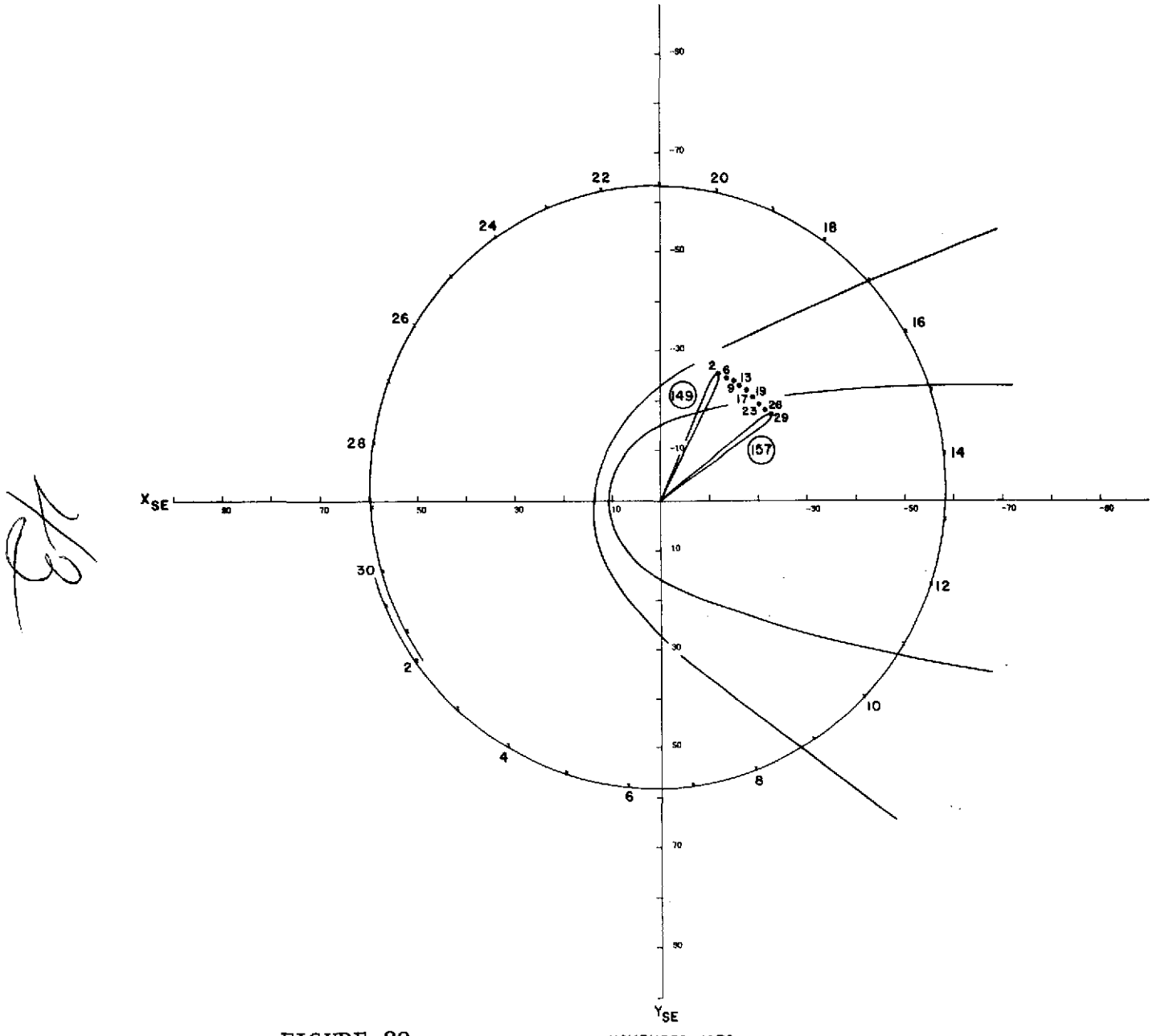


FIGURE 29 NOVEMBER 1970

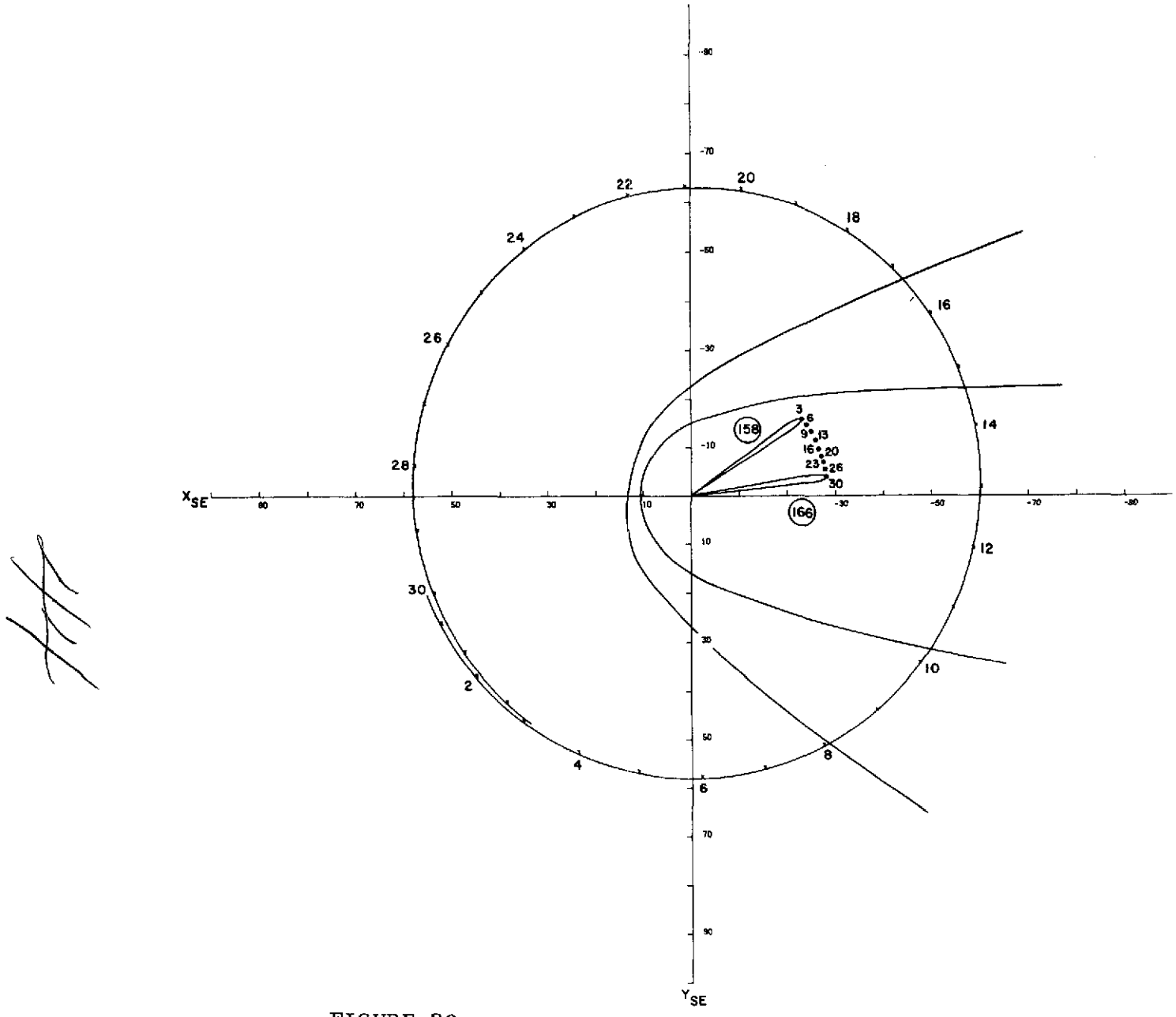


FIGURE 30

DECEMBER 1970

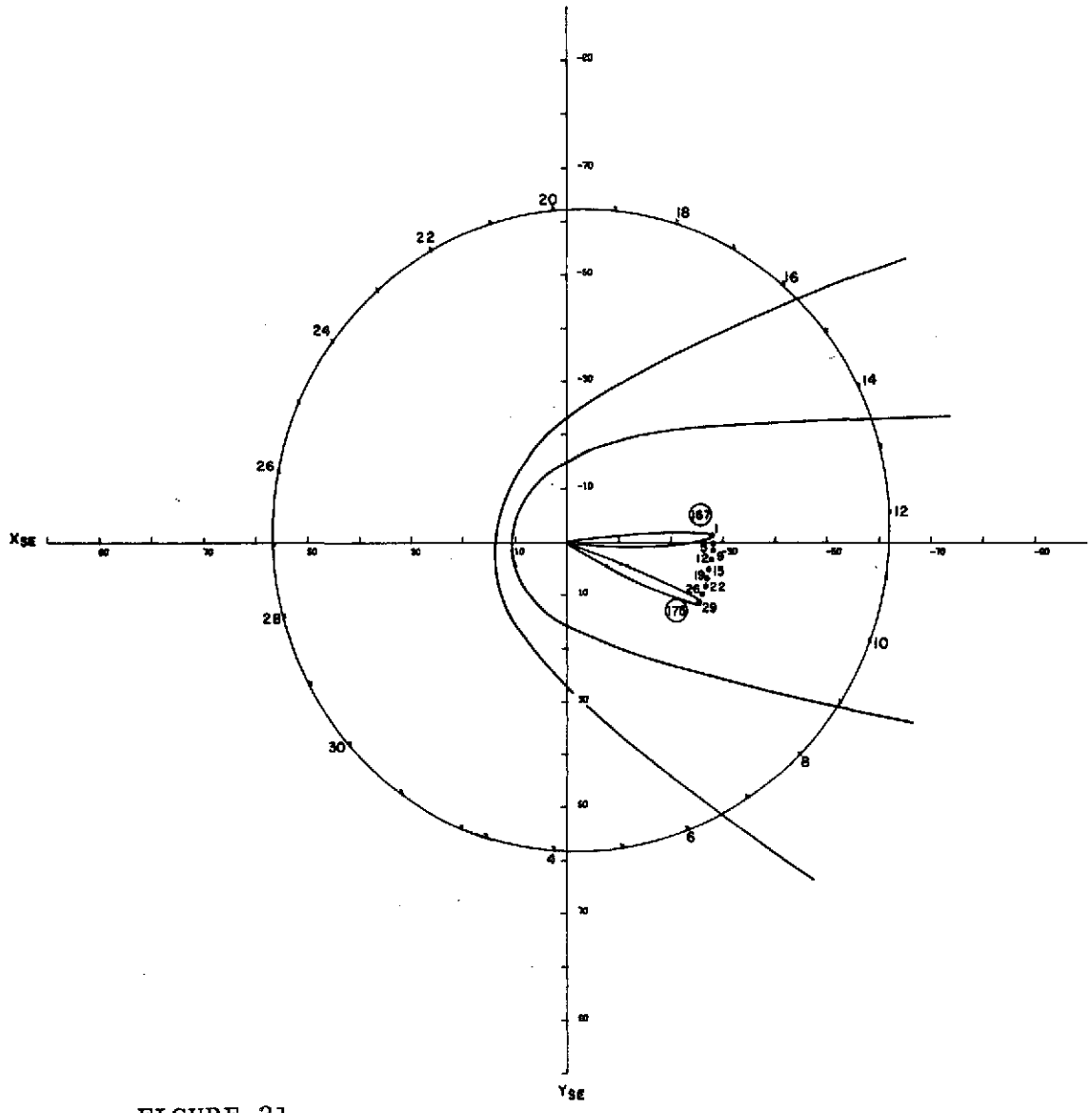

XSE
YSE
20
18
22
16
24
14
26
12
28
10
30
8
6
4
187
176
1
5
12
19
26
29
JANUARY 1971

FIGURE 31

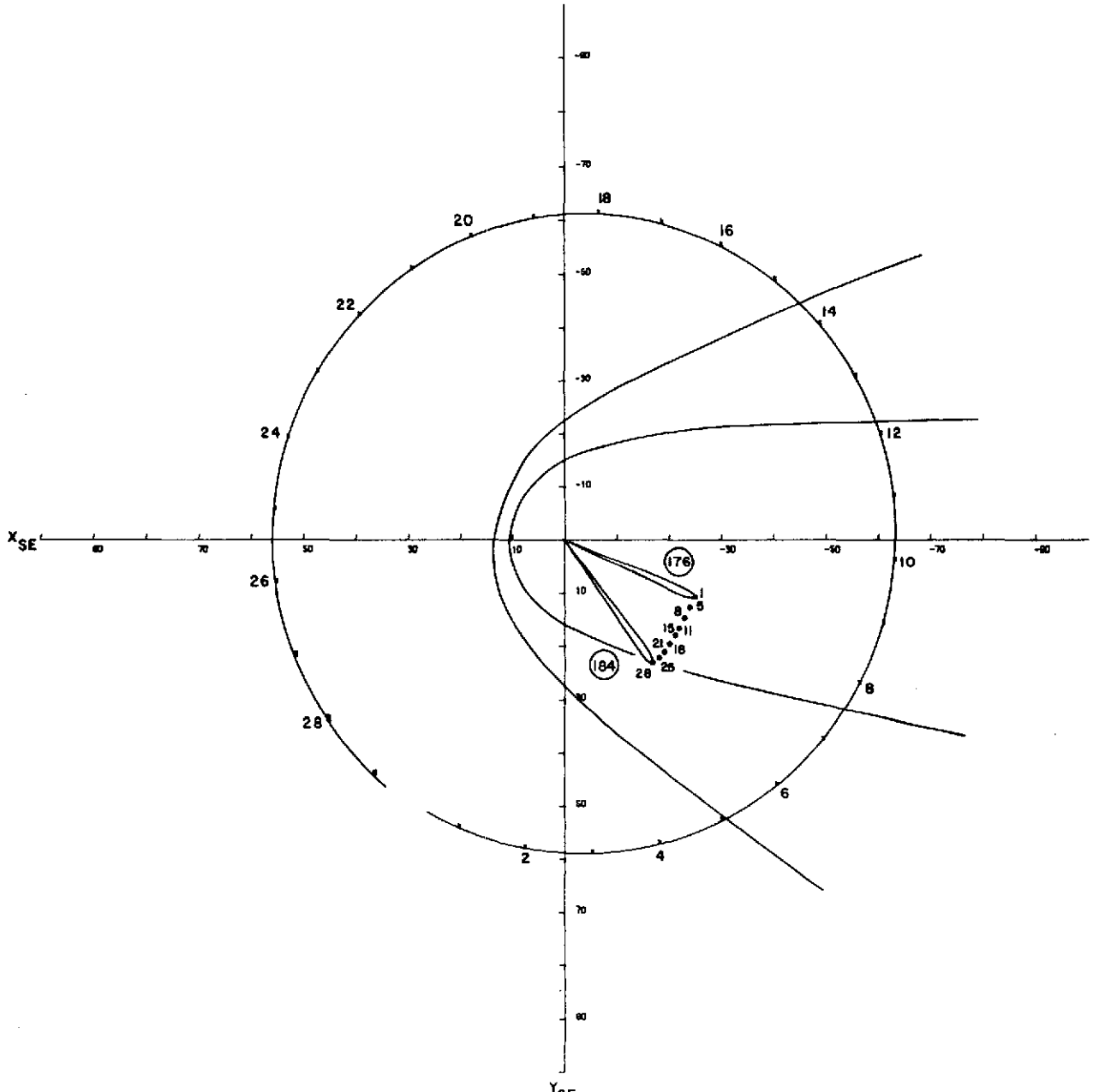


FIGURE 32

FEBRUARY 1971

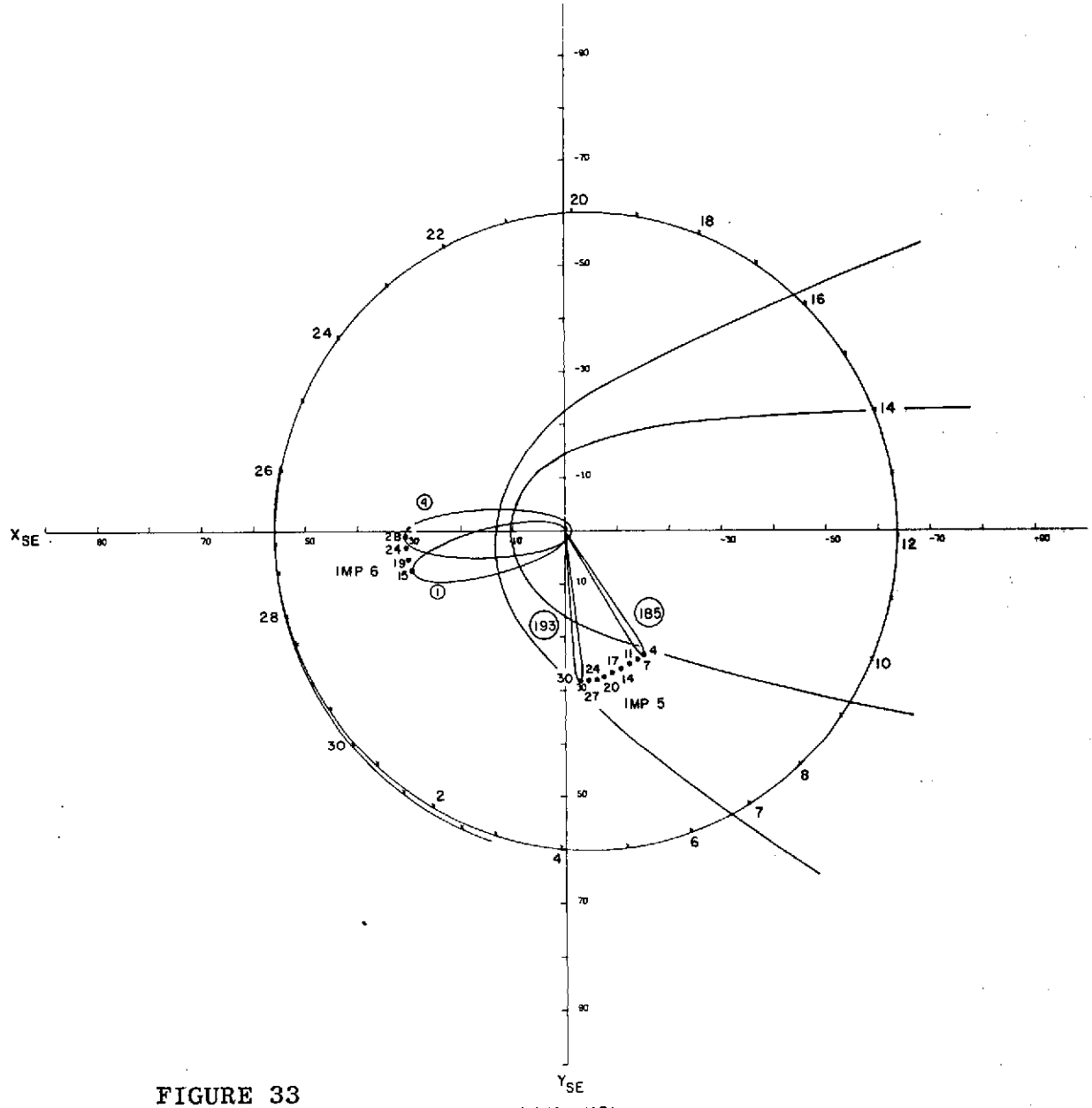


FIGURE 33

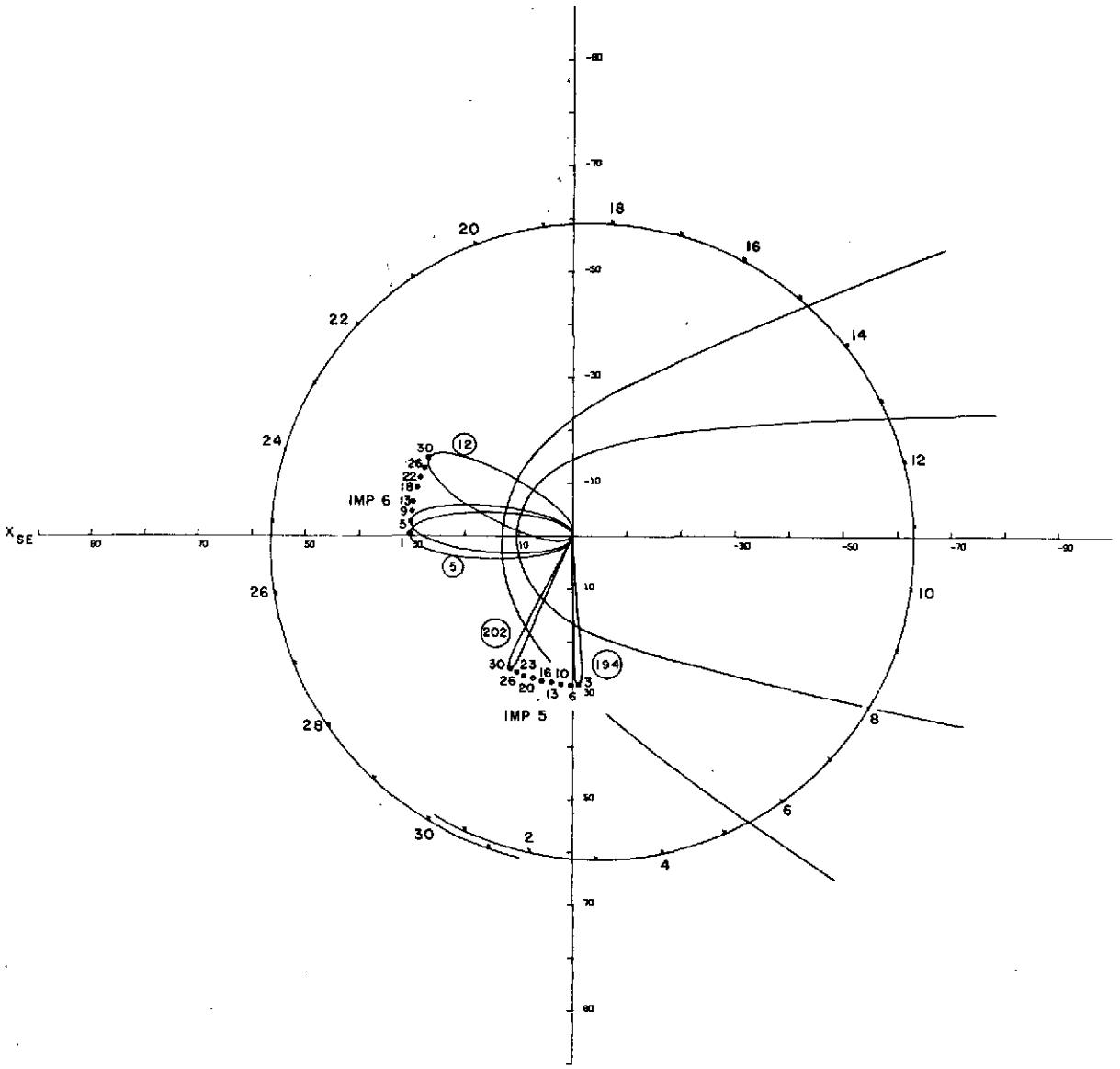


FIGURE 34

APRIL 1971

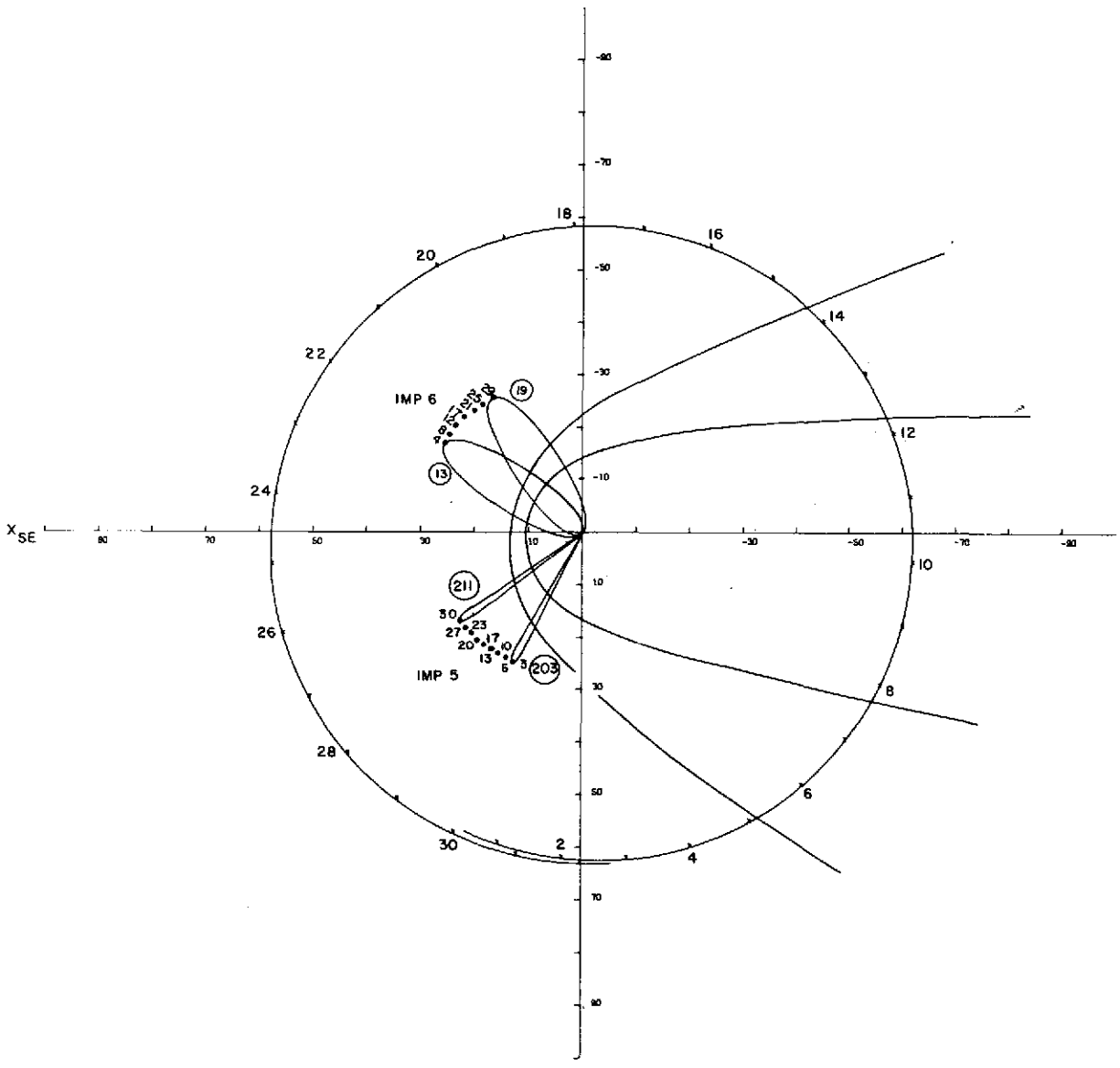


FIGURE 35

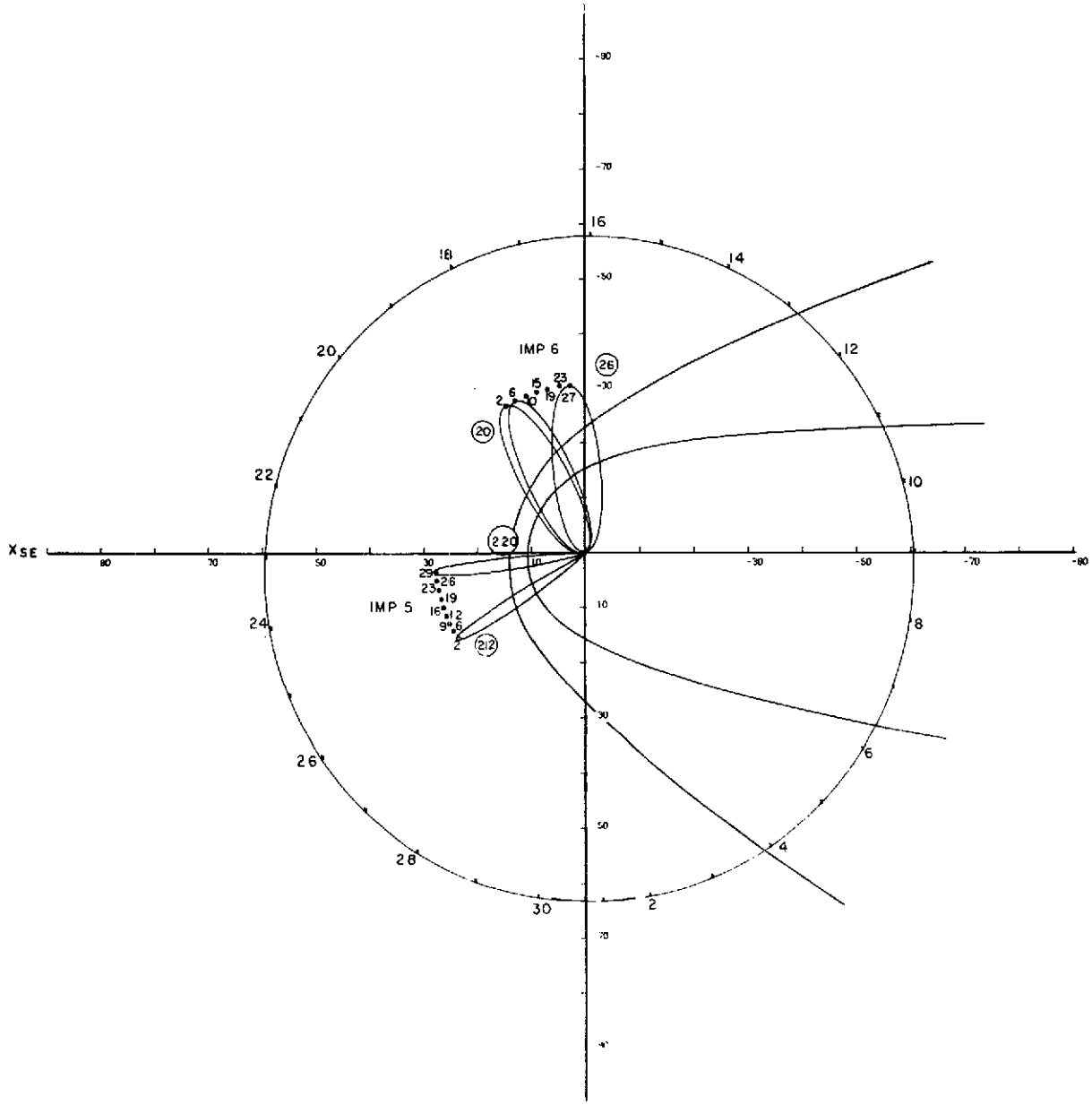


FIGURE 36

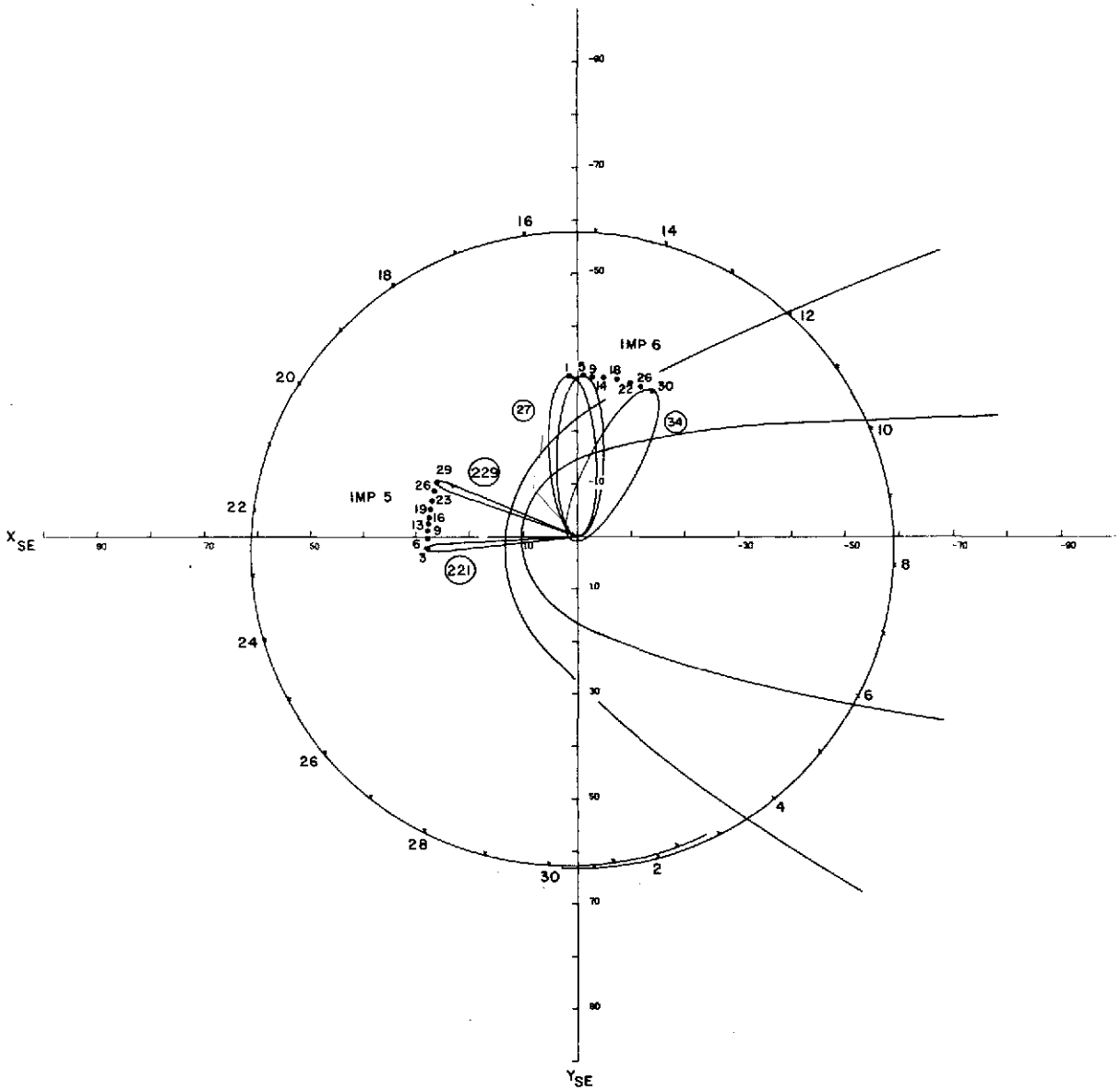


FIGURE 37

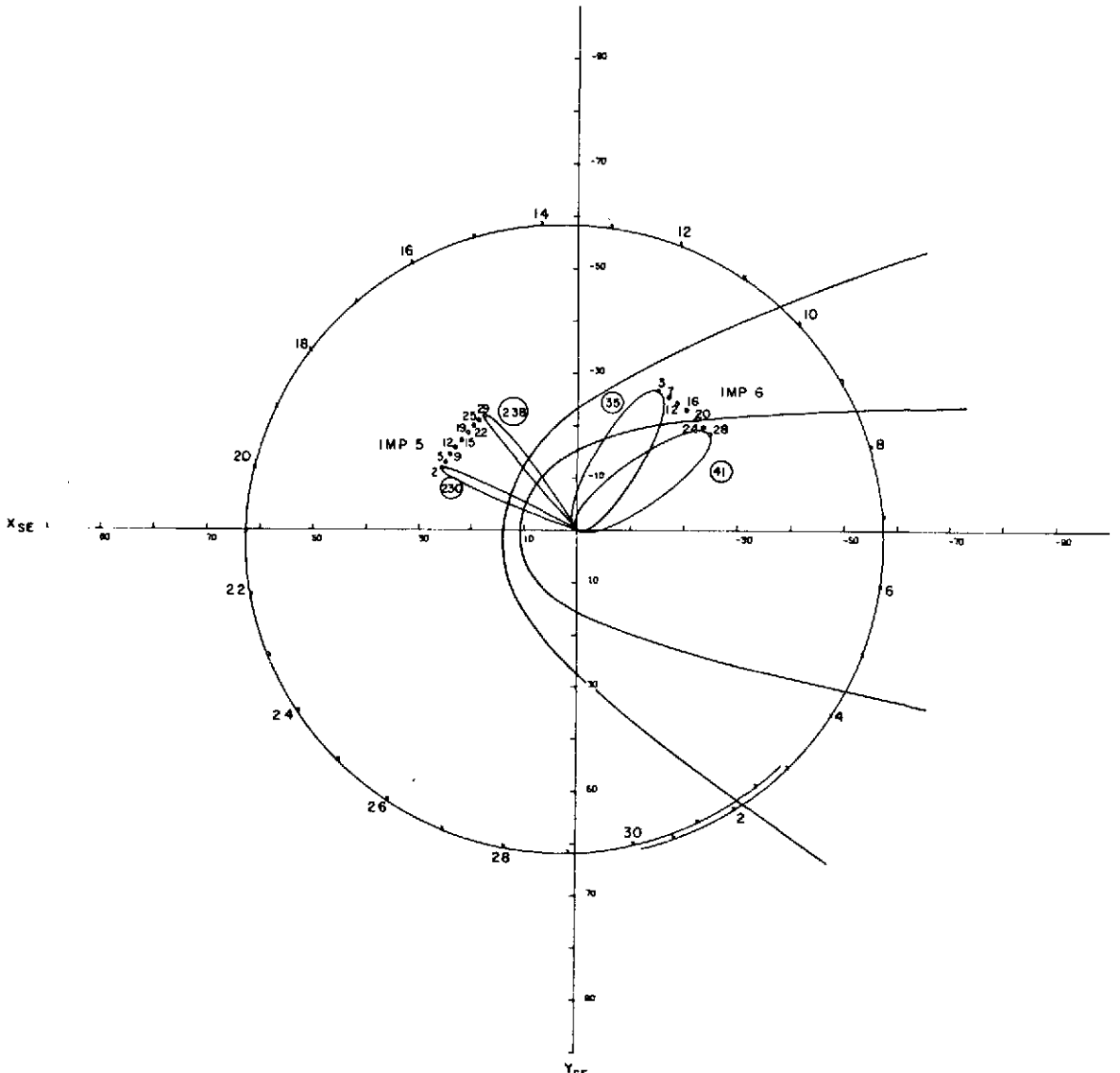


FIGURE 38

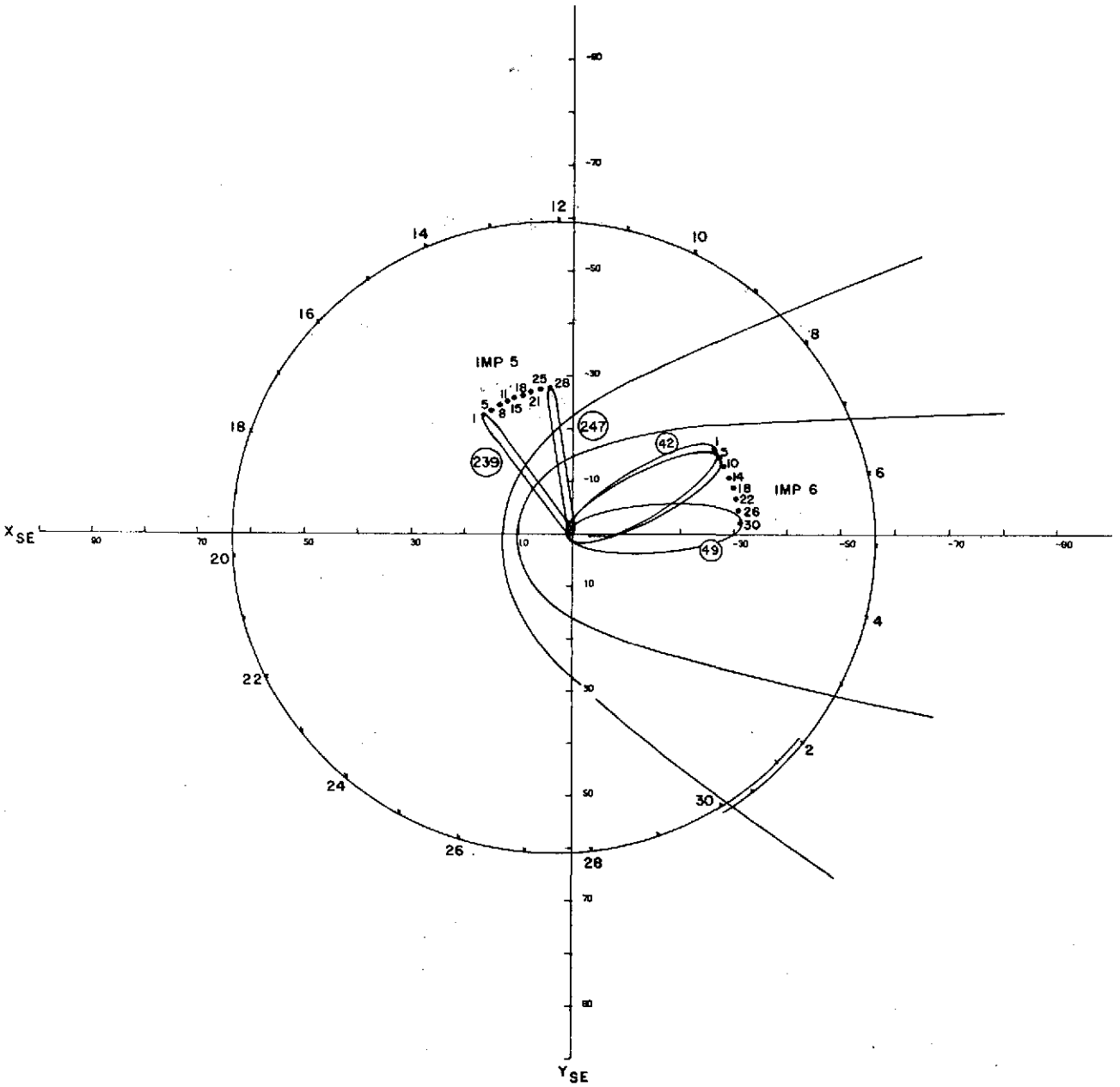


FIGURE 39

SEPTEMBER 1971

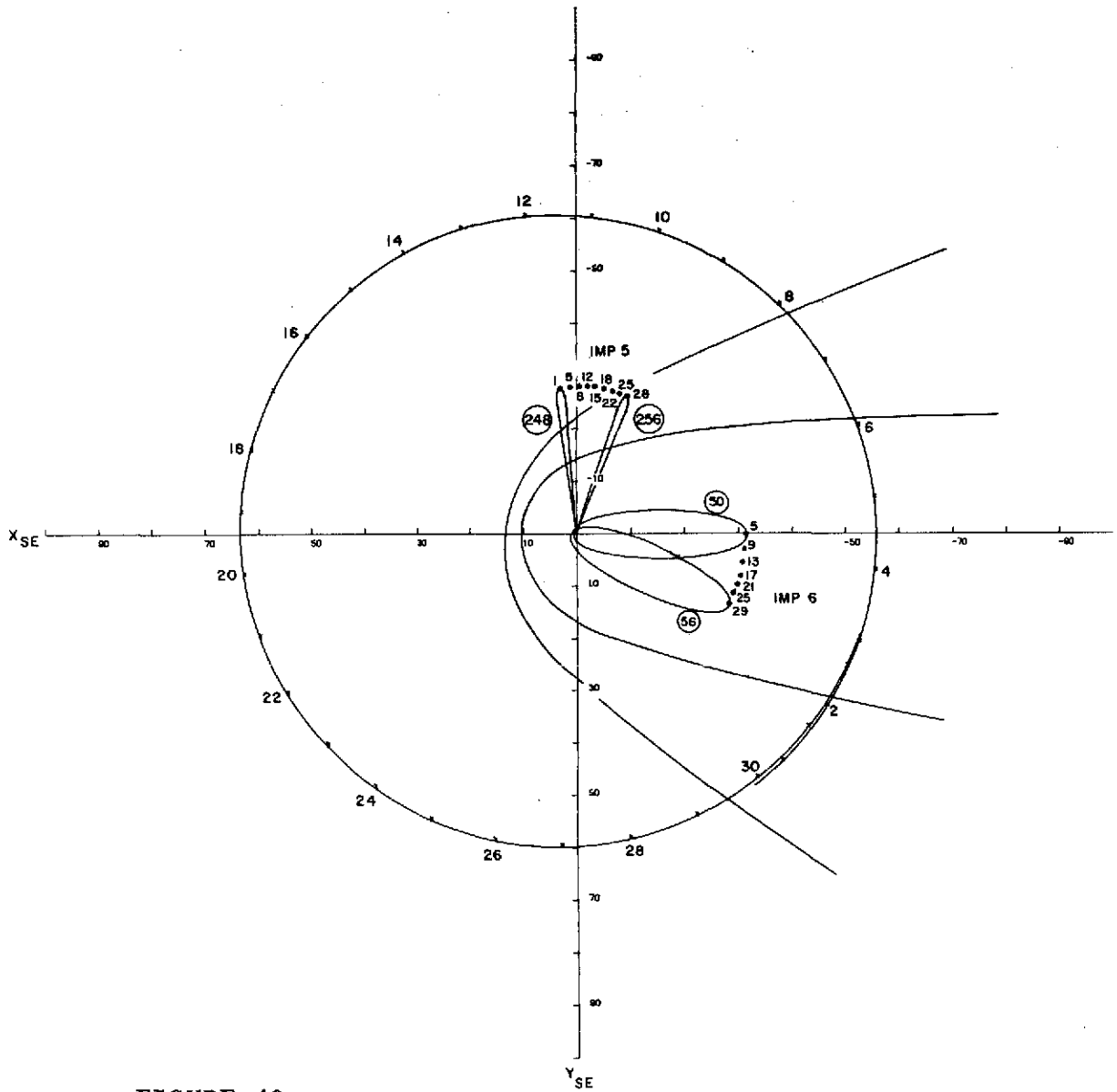


FIGURE 40

OCTOBER 1971

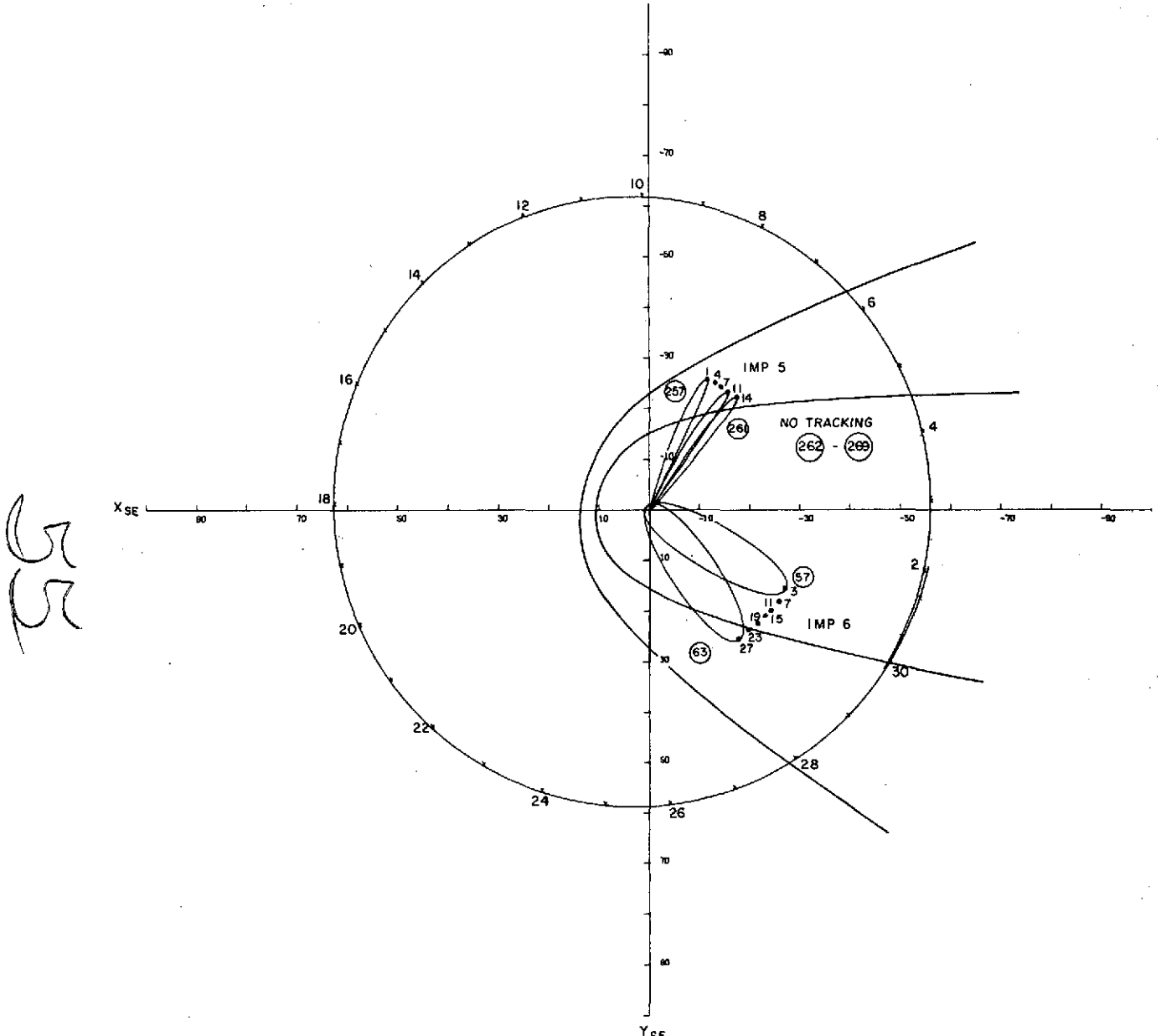


FIGURE 41

NOVEMBER 1971

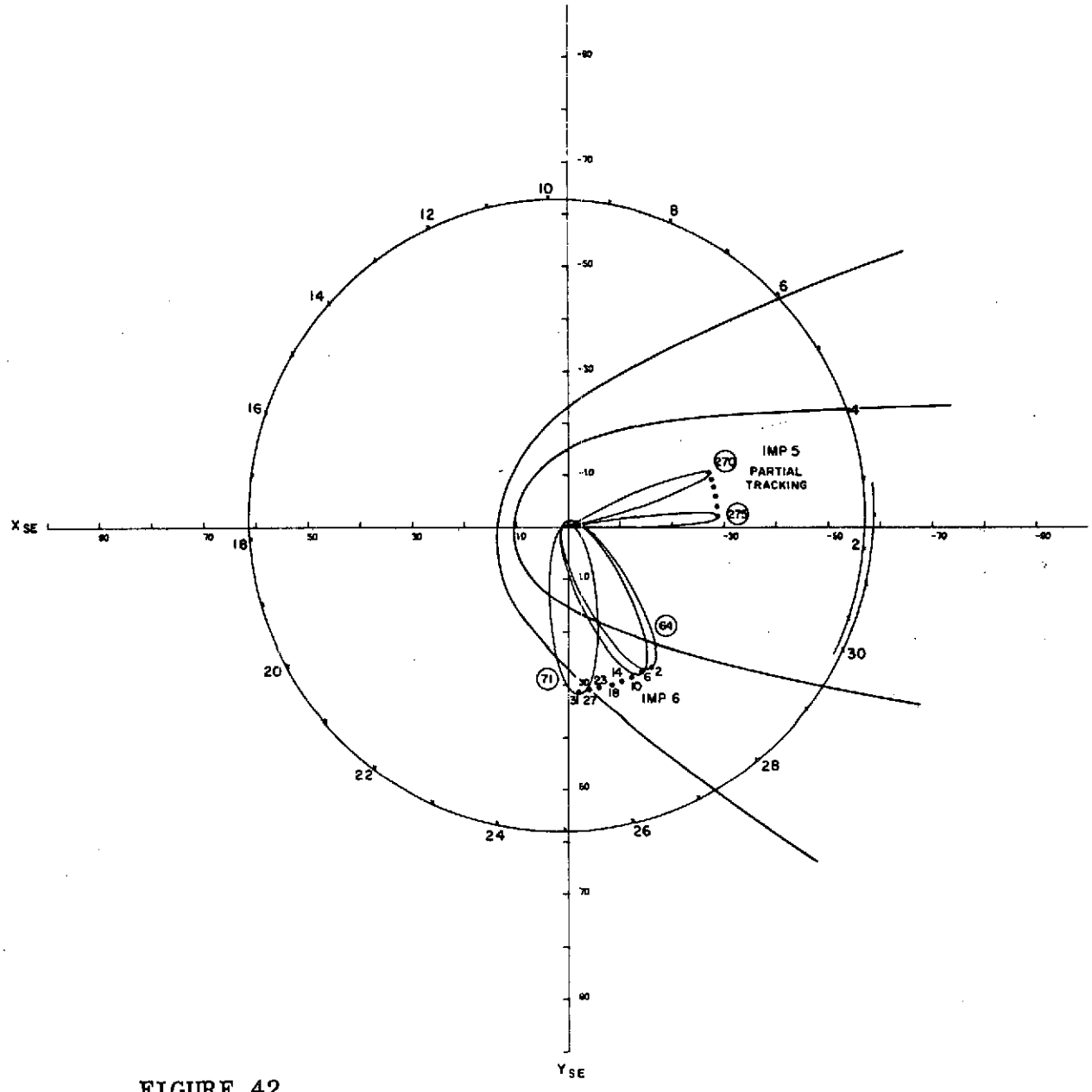


FIGURE 42

DECEMBER 1971

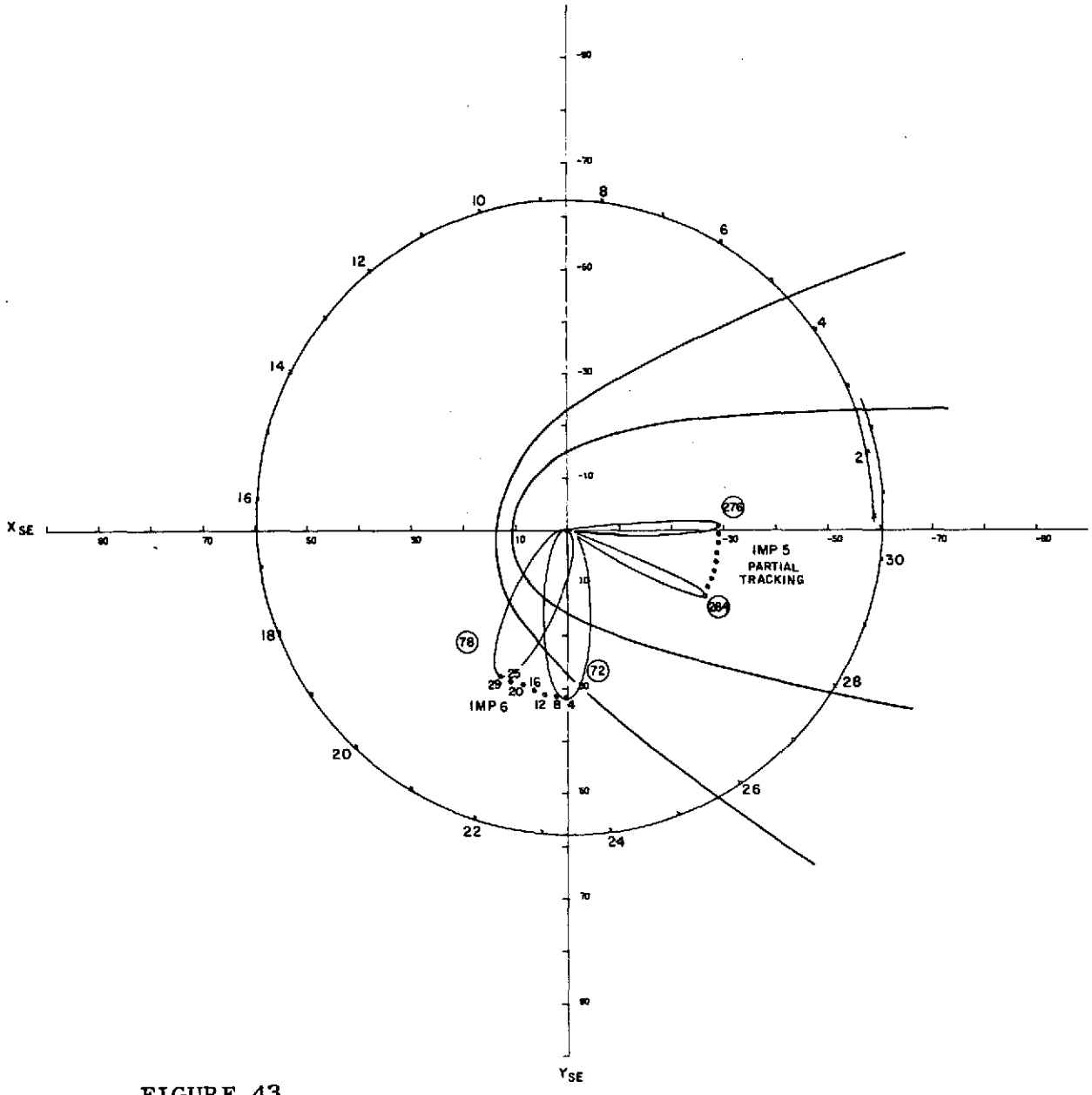

X SE
Y SE
IMP 5
PARTIAL
TRACKING
IMP 6
276
284
78
72
JANUARY 1972

FIGURE 43

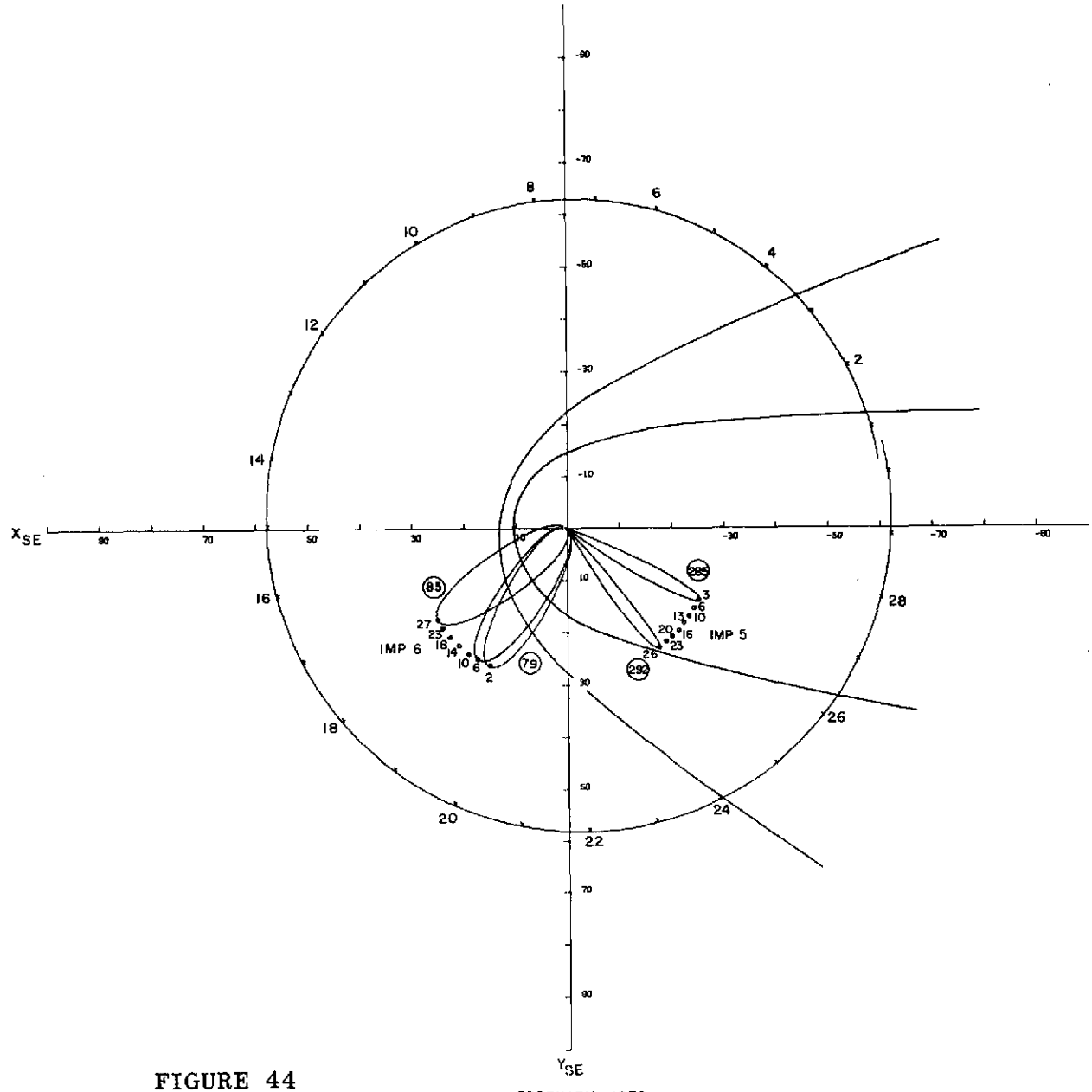


FIGURE 44

FEBRUARY 1972

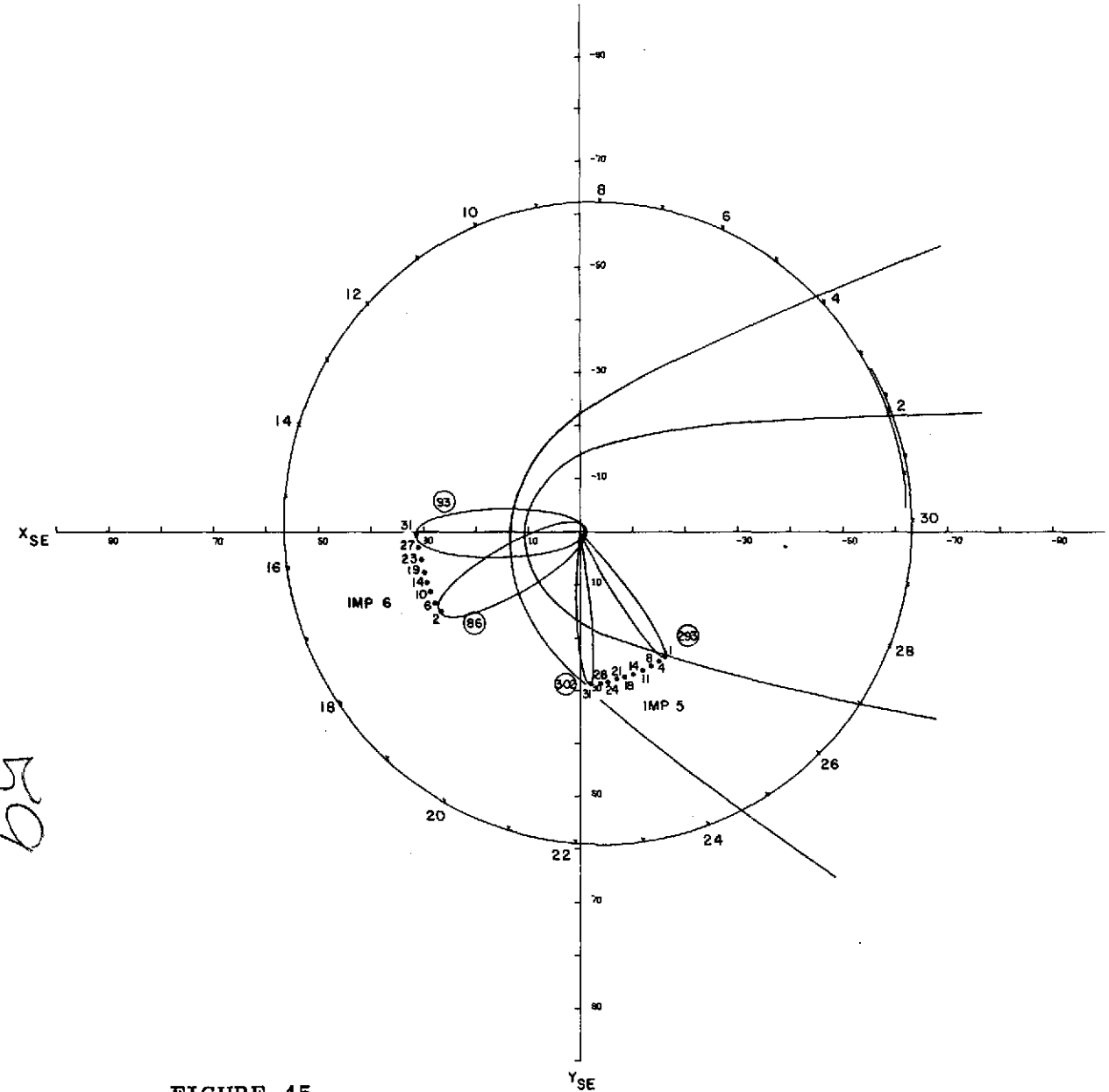


FIGURE 45

MARCH 1972

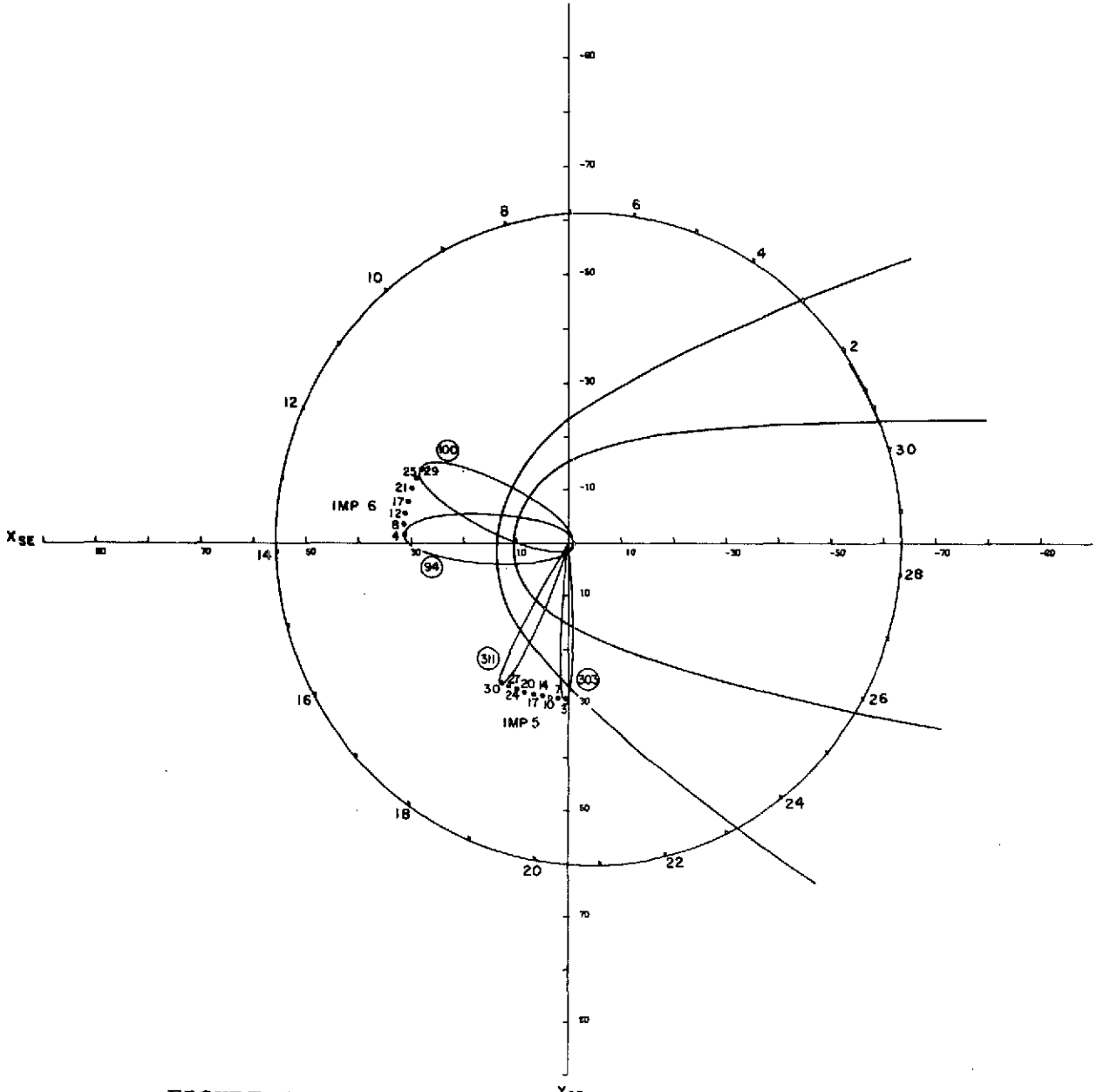


FIGURE 46

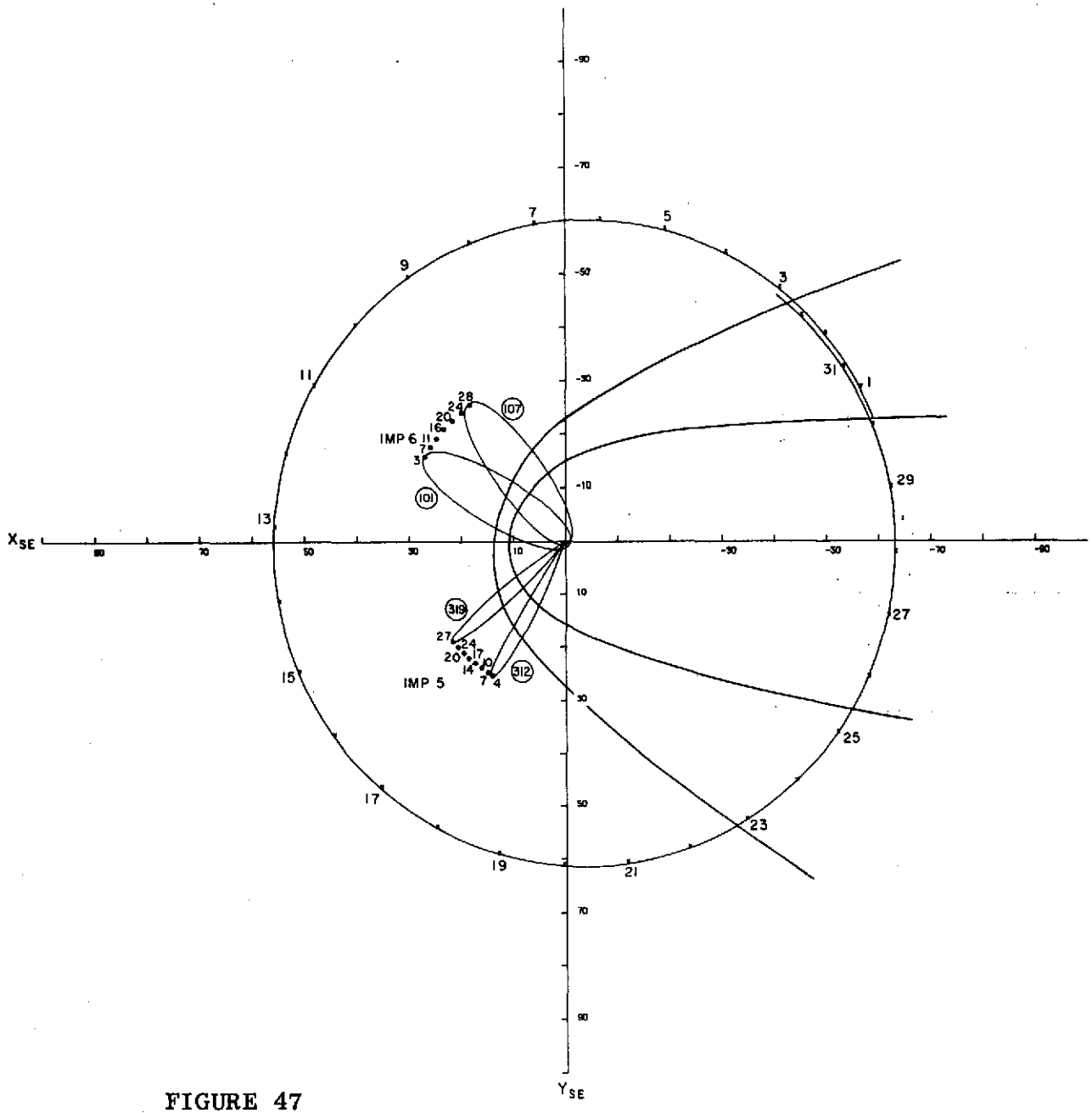


FIGURE 47

MAY 1972

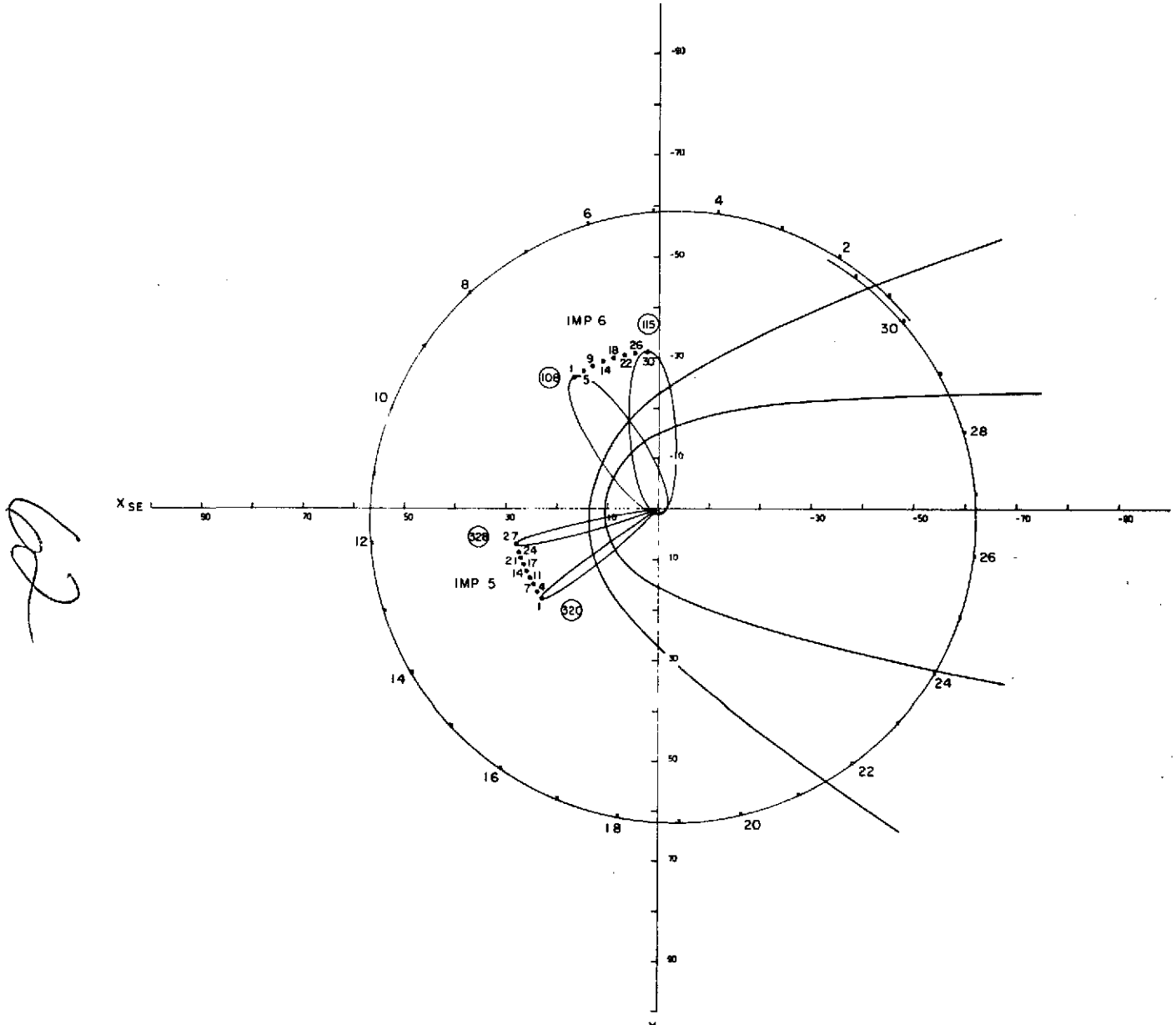


FIGURE 48

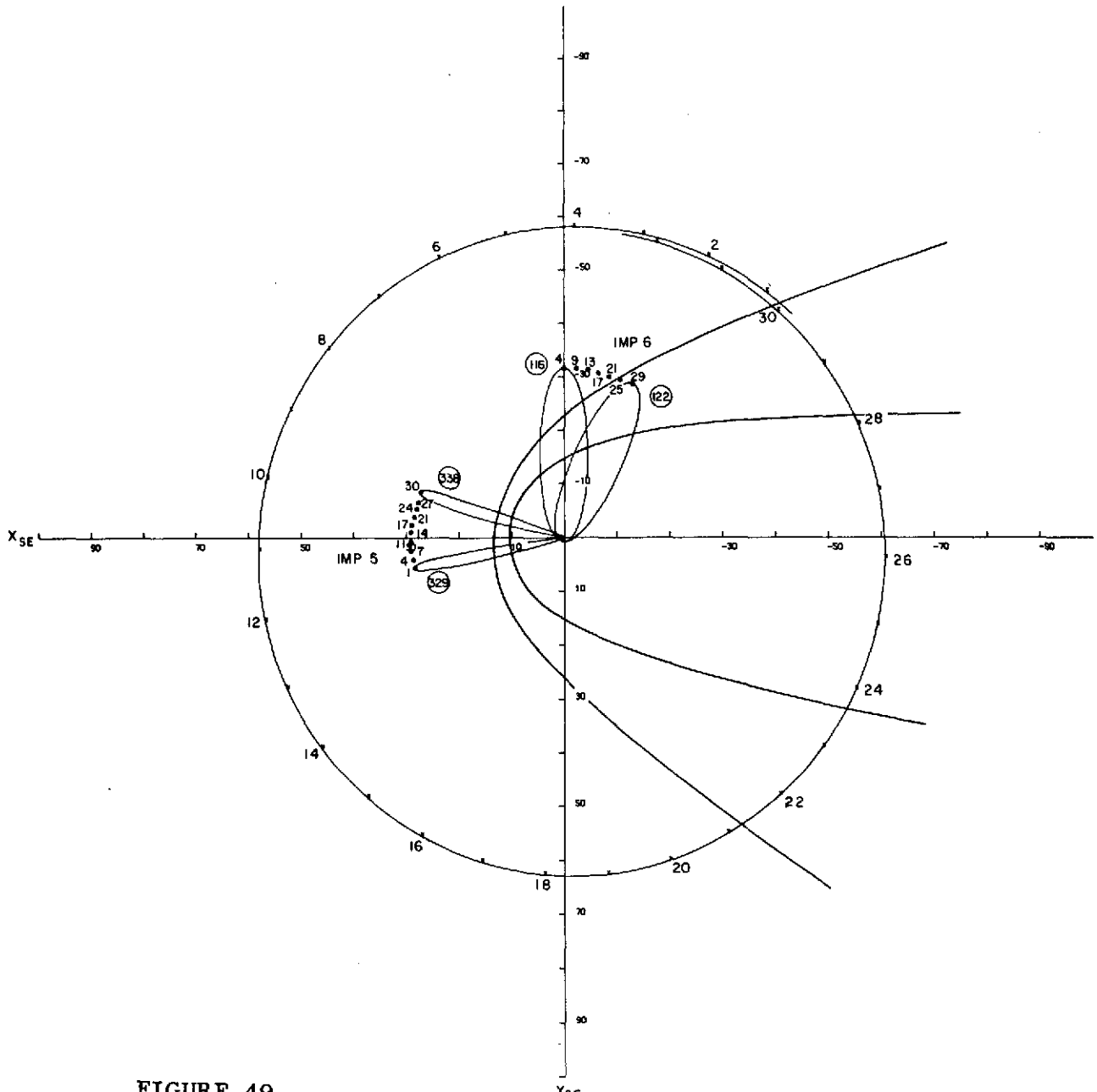


FIGURE 49

JULY 1972

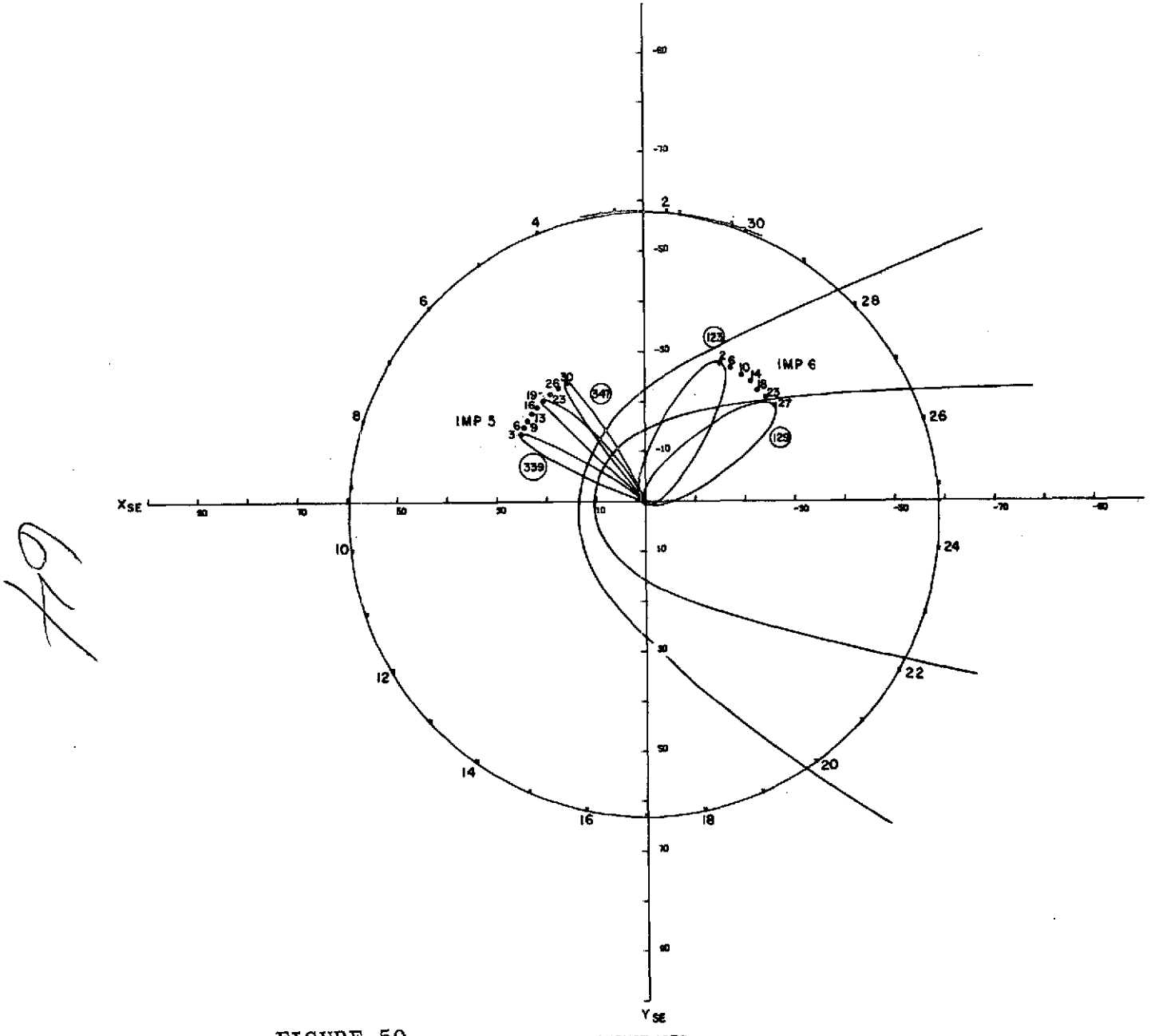


FIGURE 50

AUGUST 1972

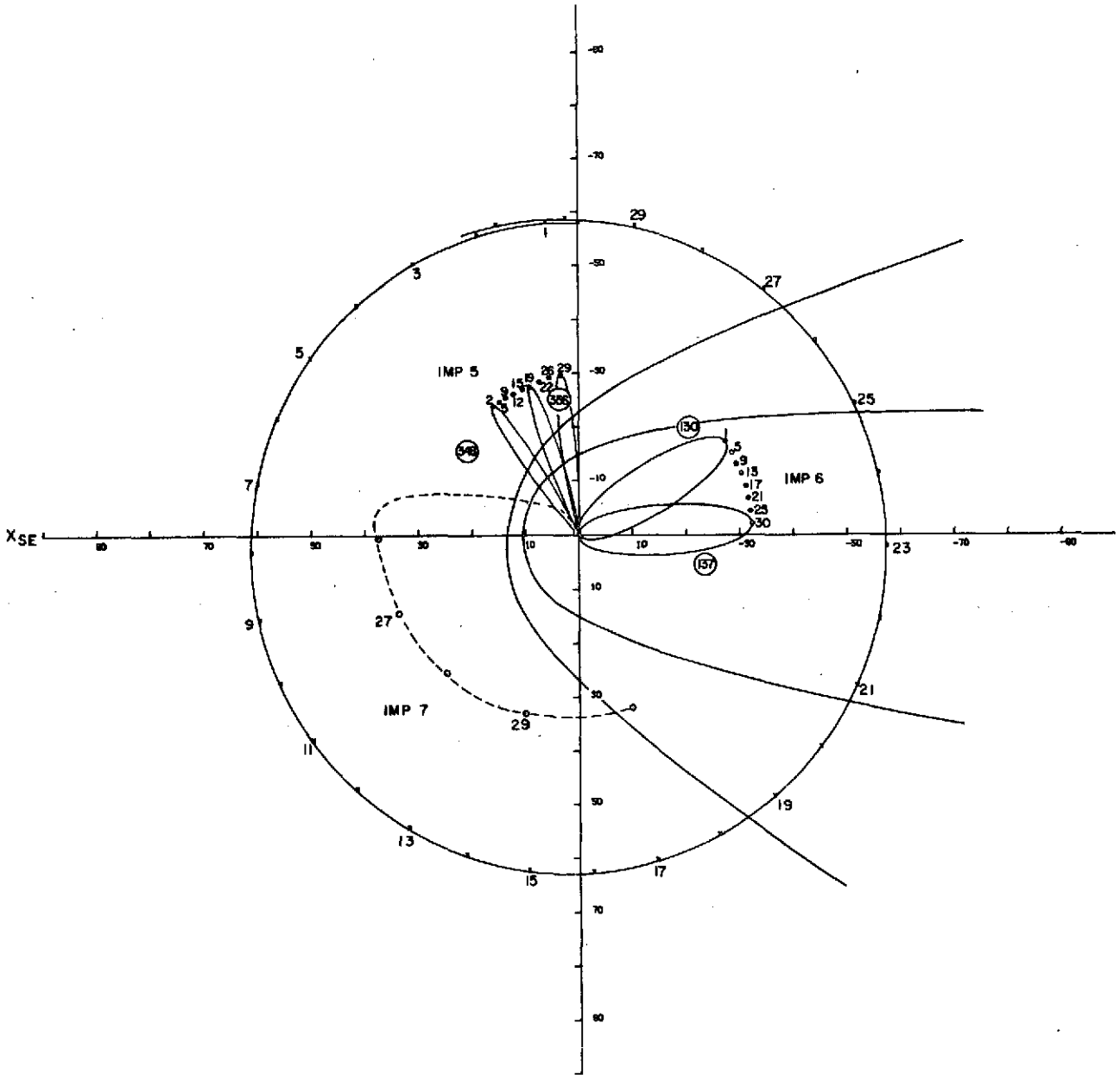


FIGURE 51

SEPTEMBER 1972

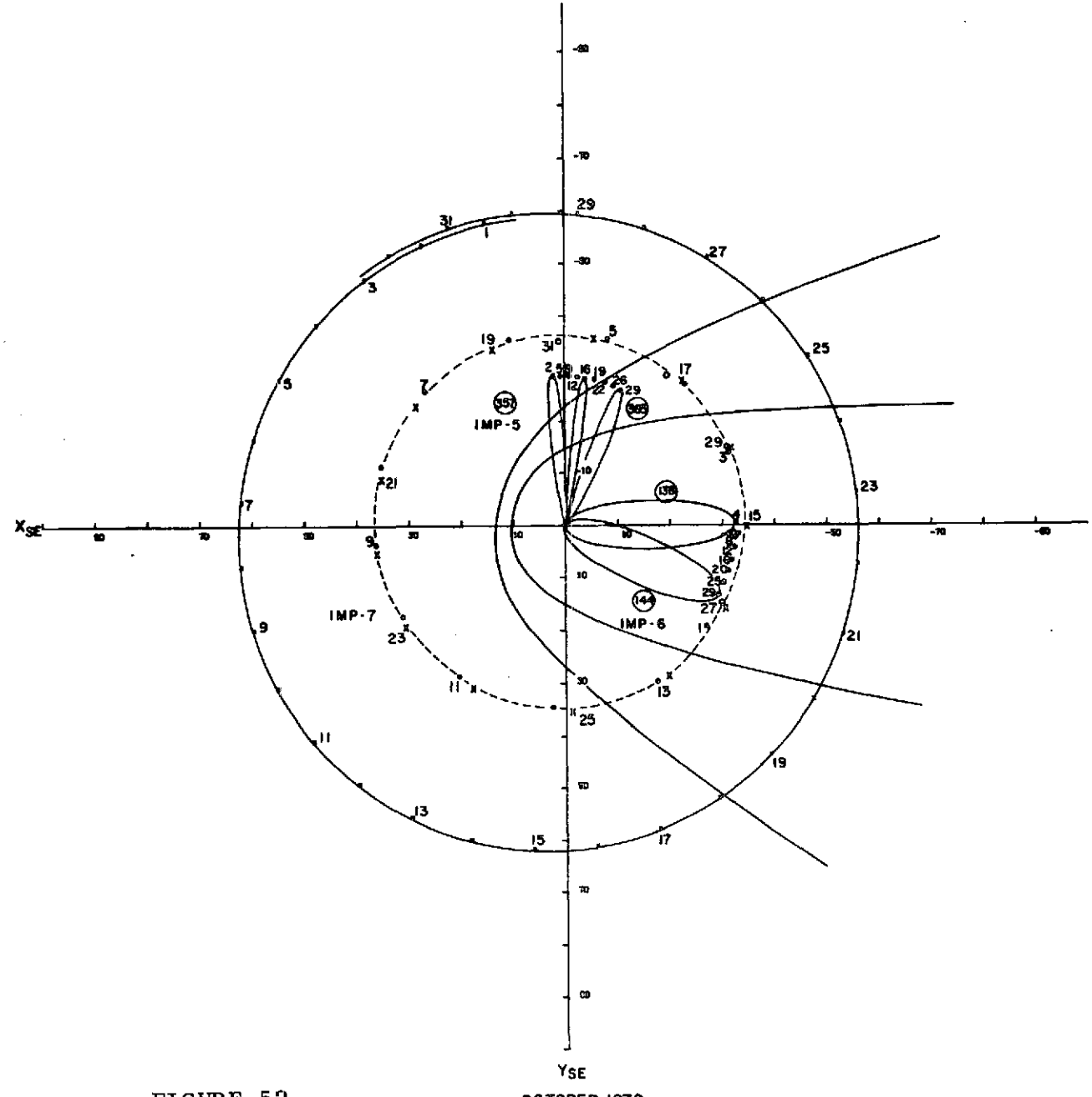


FIGURE 52 OCTOBER 1972

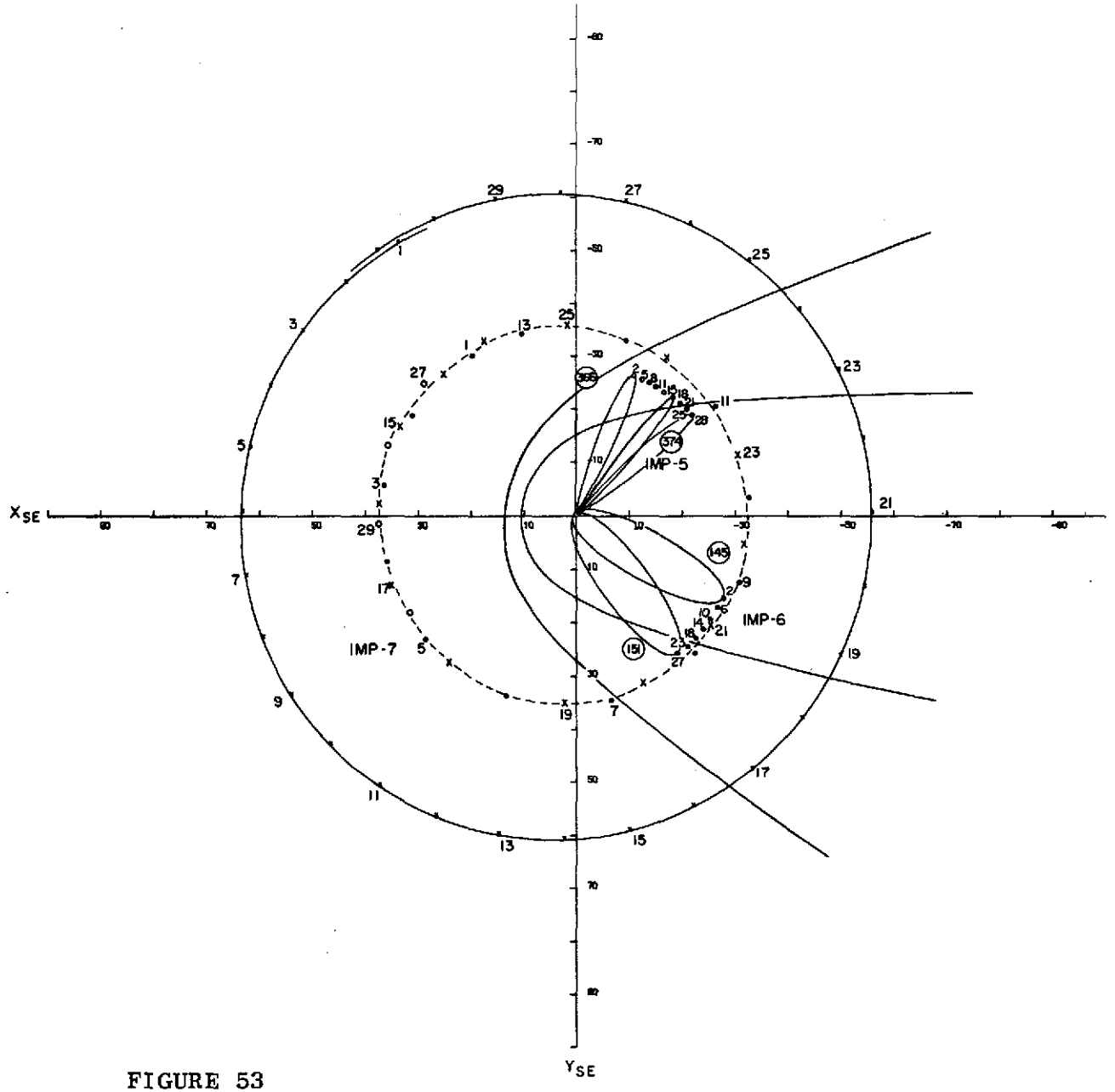


FIGURE 53

NOVEMBER 1972

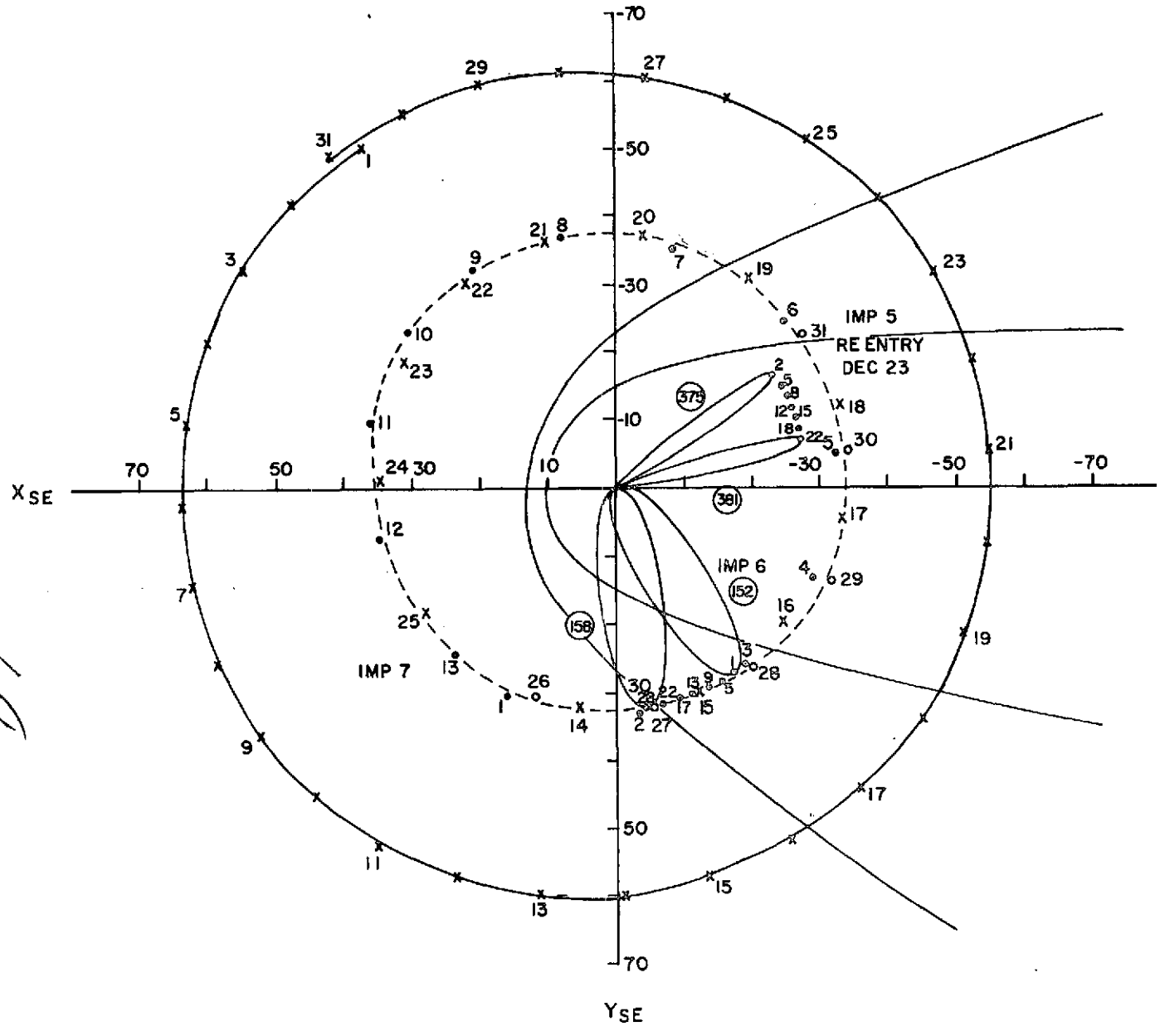


FIGURE 54

DECEMBER 1972

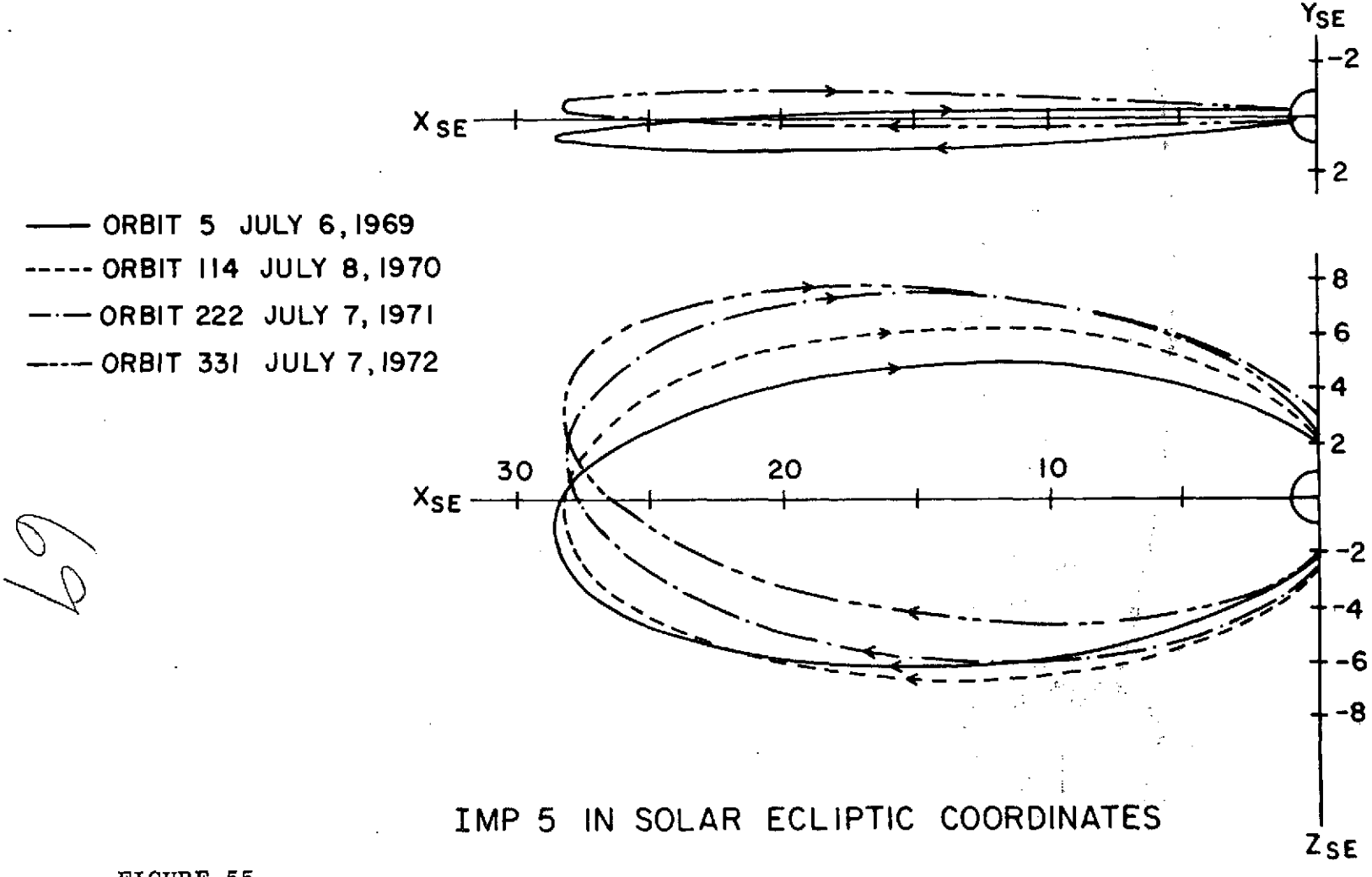
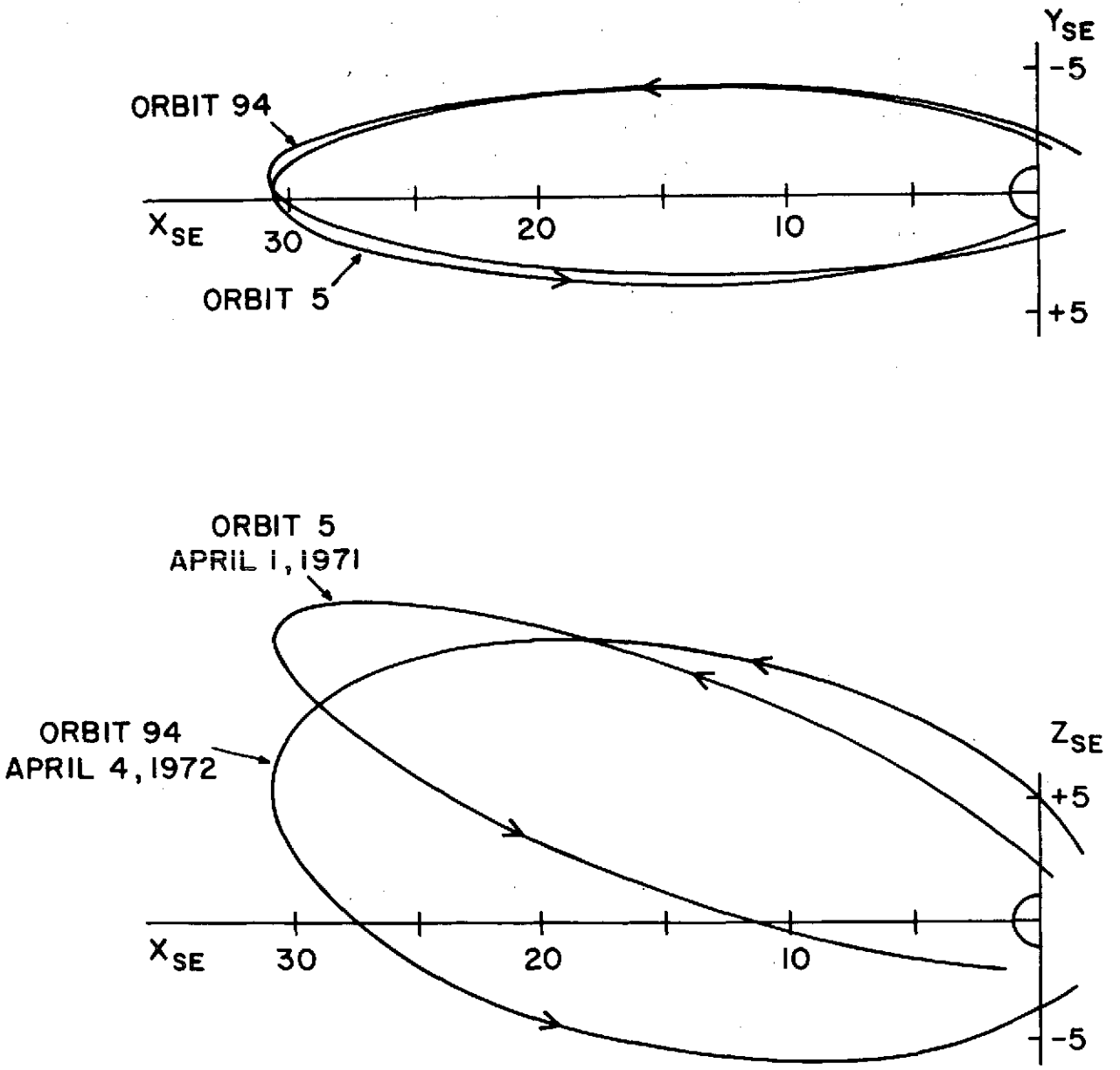

ORBIT 5 JULY 6, 1969
ORBIT 114 JULY 8, 1970
ORBIT 222 JULY 7, 1971
ORBIT 331 JULY 7, 1972
Y_{SE}
X_{SE}
Z_{SE}
-2
2
8
6
4
2
-2
-4
-6
-8
30
20
10
IMP 5 IN SOLAR ECLIPTIC COORDINATES

FIGURE 55



IMP 6 ORBIT IN SOLAR ECLIPTIC COORDINATES

FIGURE 56