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EVALUATION OF PROTOTYPE CA-2944 LOKC GONIOMETER LIMITERS

FOR LIMITED DISTRIBUTION

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EVALUATION OF PROTOTYPE CA-2944
10 KC GONIOMETER LIMITERS

Laboratory Tests

Two Type CA-1277 Hoffman monitors were used during these tests. One of the monitors was modified to operate on an external power supply. This modification consisted of substituting the internal a-c power supply with a well-filtered low-voltage d-c supply and a storage battery for the filament power.

Monitor Tests

1) AM Modulation Tests with Limiter-Filter Unit

A Type CA-1231 goniometer (Gon #2) was adjusted in accordance with standard practice and used as the signal source. The tone wheel signal (fed through a limiter-filter unit to eliminate all amplitude modulation) was fed to a special modulating amplifier in order to produce 30 cps (phase of the 30 cps signal was variable through 360°) amplitude modulation of zero or 7.5 per cent on the tone wheel signal. This signal was fed direct or through a limiter-filter unit to the test input terminals of either monitor.

Phase of 30 cps AM Mod.	Test Condition				Monitor Zero Phase Control Setting	
					Standard	Modified
	Modulation OFF,	limiter	OFF		-0.1	+0.2
0	" ON,	"	OFF		-1.5	-1.4
30	" ON,	"	OUT		+2.0	+2.2
	" OFF,	"	IN-Filter	OUT	+0.8	+0.8
	" OFF,	"	IN- "	IN	+0.4	+0.3
0	" ON,	"	IN- "	OUT	+1.1	+1.0
80	" ON,	"	IN- "	OUT	+0.8	+0.7
0	" ON,	"	IN- "	IN	+0.6	+0.6
80	" ON,	"	IN- "	IN	+0.7	+0.7

2) Tests Using Improved Limiting in Monitor

During these tests, additional limiters, tubes V116 and V117 in two Collins 51R-2 receivers, were used in the monitor circuitry to determine if this would eliminate the effects of AM modulation on the tone wheel signal. The signal was fed into No. 1 test input.

Phase of 30 cps AM Modulation	Test Condition	Zero Phase Control Setting
Normal Operation:		
	Modulation OFF	+0.1
0	" ON	+2.5
180	" ON	-2.5
Limiter connected between tubes V6B and V6A:		
	Modulation OFF	+0.4
0	" ON	+0.7
180	" ON	+0.1
One limiter connected between tubes V6B and V6A and a second limiter connected between the output of Z2 and input of V9B:		
	Modulation OFF	+0.5
0	" ON	+0.6
180	" ON	+0.4

3) 479S Mixed Signal Tests (Audio)

For these tests the tone wheel signal (with all amplitude modulation removed) was fed to a special modulating amplifier in order to produce 30 cps modulation at a depth of 7.5 per cent on the tone wheel signal, and this signal was then fed back to the 479S audio amplifier. The 479S audio generator output from the mix signal jack was fed to the #1 detector input. The zero phase condition was observed on an oscilloscope which was connected to the junction of C62 and R134 (phase comparison mixer circuit).

Phase of 30 cps AM Modulation	Test Condition	Var. Phase On 479S Gen.
External Collins Limiters Off:		
	Modulation OFF	179.9
0	" ON	180.0
180	" ON	179.8
479S power switched OFF then ON	Modulation ON	179.5
479S power switched OFF then ON	Modulation OFF	179.7
External Collins Limiters Connected as in the Third Condition of Test 2:		
	Modulation OFF	180.0
0	" ON	179.9
180	" ON	180.0
479S power switched OFF then ON	Modulation ON	179.9

4) AM Modulation from Goniometer Tone Wheels

The percentage AM modulation of the tone wheel output was measured using a wave analyzer and a vacuum tube voltmeter. The following are the results obtained:

Gon. No.	Direct	Through Limiter	Through Limiter and Filter
1	1.4 %	0.104 %	0.22 %
2	2.57	0.03	0.0055

5) Calibration of Monitors

Monitor #21 was modified to operate on an external hum-free power supply for the high voltage source and battery for filament power. Monitor #15 was operated as a standard monitor. Signal was fed through the 211 signal generator to the pick-up head.

Monitor #21 (See Figs. 1 and 2)

An inspection of these two figures indicates a general correlation between goniometers #1 and #2; also between the two limiter-filter units. The error spread under the test condition is as follows:

Gon. No.	Error Spread in Degrees Direct	Limiter in	Limiter & Filter in
1	+3.35-1.25 = 4.6	+3.45-1.75 = 5.20	+2.75-2.25 = 5.00
2	+3.0 -2.15 = 5.15	+3.0 -1.95 = 4.95	+2.4 -2.6 = 5.00

Monitor #15 (See Figs. 3 and 4)

Figs. 3 and 4 show a general correlation and indicate small differences between the tone wheels in Gon. 2 and the 479S audio generator. The total error spread under the test condition is as follows:

Tone Wheel	Error Spread in Degrees Direct	Limiter	Limiter & Filter
Gon. #2	+3.4-2.6 = 6.0	+3.4-2.9 = 6.3	+2.7-3.6 = 6.3
479S	+3.8-3.1 = 6.9	+3.5-3.1 = 6.6	+3.0-3.4 = 6.4

6) Receiver Calibration (See Figs. 5 through 11)

In this test the outputs of the tone wheels (9960 cps) were fed to the input of the 479S audio amplifier. The output of the amplifier modulated the Boonton Type 211 signal generator. The 30 cps alternator in the 479S was used as the variable phase signal. The effect of the limiter-filter units on receiver error is tabulated below.

Tone Wheel	Receiver	Error Spread in Degrees Direct	Limiter	Limiter & Filter
Gon. #2	ARC Type 15	+4.6-2.8 = 6.4	+5.3-2.9 = 8.2	+5.0-0.9 = 5.9
" #1	51R1 (Collins)	+0.1-0.7 = 0.8	+0.8-0.9 = 1.7	+0.8-0.4 = 1.2
" #2	51R1	+0.3-0.7 = 1.0	+0.6-0.5 = 1.1	+1.2-0.1 = 1.3
479S	51R1	+0.3-0.8 = 1.1	+0.7-1.0 = 1.7	+0.7-0.4 = 1.1
Gon. #1	51R2	0 -0.5 = 0.5	-0.2-0.7 = 0.5	-0.6-1.6 = 1.0
" #2	51R2	+0.3-0.3 = 0.6	0 -0.3 = 0.3	-0.4-0.7 = 0.3
479S	51R2	+0.5-0.7 = 1.2	+0.3-0.7 = 1.0	-0.2-1.2 = 1.0

Field Tests

The two limiters were mounted on Type CA-1231 goniometers which had been in service for an unknown period of time. Both goniometers were installed at a VOR station using a Type CA-655 modulation driver unit, a Type CA-663 carrier modulator unit, and a TUN transmitter. The new four-loop antenna array was used. The CA-1278 monitor field detector had been modified to use a vacuum tube detector; however, the CA-1277 monitor was unmodified. The same modulating and transmitting equipment was used with each goniometer. A standard Collins 51R-2 receiver and Collins 479S test equipment, located in the TDEC receiver laboratory, were used for these tests.

Tests were conducted as follows. The positions of the tone wheel yokes were adjusted to produce the same course at the receiver laboratory with either goniometer connected and their tone wheel outputs connected directly to the modulator driver. Tests were made with the filter in and out of the circuit. The antenna array was rotated in increments of 45° for 180° and a complete set of readings was taken in each position.

Monitor Calibration (Figs. 12 and 13)

For these tests the pick-up head was located at 0°. The antenna was rotated 180° and the monitor adjusted to read the azimuth. The error spread as tabulated below will include transmitter and antenna errors. (It should be mentioned that the antenna and counterpoise were replaced during the month of September.)

Gon. No.	Monitor No.	Error Spread in Degrees Direct	Limiter	Limiter & Filter
1	15	+1.8-1.3 = 3.1	+2.0-1.3 = 3.3	+1.6-1.7 = 3.3
2	15	+1.5-3.0 = 4.5	+1.7-2.7 = 4.4	+1.9-3.1 = 5.0
1	21	+2.0-1.0 = 3.0	+2.3-1.0 = 3.3	+1.6-1.0 = 2.6
2	21	+2.3-0.2 = 2.5	+2.4-0.4 = 2.8	+1.5-1.2 = 2.7

Station Calibration (Figs. 14 and 15)

Fig. 14 indicates the station calibration. The signal was received at the laboratory (approximately 10 miles distant) using a Collins 51R-2 receiver. The bearing between the laboratory and station was 119° FROM.

Fig. 15 shows the bearings received with a Collins 51R-2 receiver installed in a truck setting at 347° FROM and approximately 0.25 mile from the station. The antenna array was rotated 180° for these two tests. The tabulated data below will indicate transmitter and antenna errors:

Gon. No.	Receiver Location	Error Spread in Degrees Direct	Limiter	Limiter & Filter
1	Laboratory	+1.0-2.0 = 3.0	+1.1-2.2 = 3.3	+0.3-2.6 = 2.9
2	Laboratory	+0.5-2.4 = 2.9	+0.6-2.5 = 3.1	+1.2-3.2 = 4.4
1	Truck	0 -1.8 = 1.8	+0.4-1.6 = 2.0	-0.2-2.3 = 2.1
2	Truck	-1.1-3.9 = 2.8	-1.2-3.6 = 2.4	-0.6-2.6 = 2.0

The 10-kilocycle waveform was observed as it passed through the various transmitter modulation circuits. A slight increase in amplitude modulation was observed. With approximately one per cent amplitude modulation observed at the input to the modulator driver unit, about seven per cent appeared at the output of the carrier modulator. With the exception of this small amount of amplitude modulation, the 10-kilocycle waveform remained undistorted in the modulation circuits.

Comments

1) A comparison of the data taken in Test #1 with and without the limiter-filter unit indicates that the limiter alone would reduce the possible calibration error from approximately ±2.0° to approximately ±0.3° when the tone wheel signal was amplitude modulated at a depth of 7.5 per cent by a 30-cps signal. Use of the filter in conjunction with the limiter further reduces the calibration error from ±0.3° to ±0.1° error.

2) The adding of additional limiting circuitry in the variable calibrating channel (Test #2) reduced the calibration error from ±2.5° to ±0.3°. Increasing the limiting in the reference channel (Tests #2 and 3) further reduced this ±0.3° error to ±0.1° error in zero calibration.

3) With the exception of improving the monitor zero test condition, there appears to be no reduction in error of either the monitor station signals or receiver operation when the limiter-filter unit is placed in the output of the goniometer (see Tests #1 through #11.)

Conclusions

The limiter-filter unit Type CA-2944 is satisfactory only when used, with the filter in position, for calibrating the monitor on the test channel position. When used for station monitoring purposes, the limiter-filter does not improve the station operation.

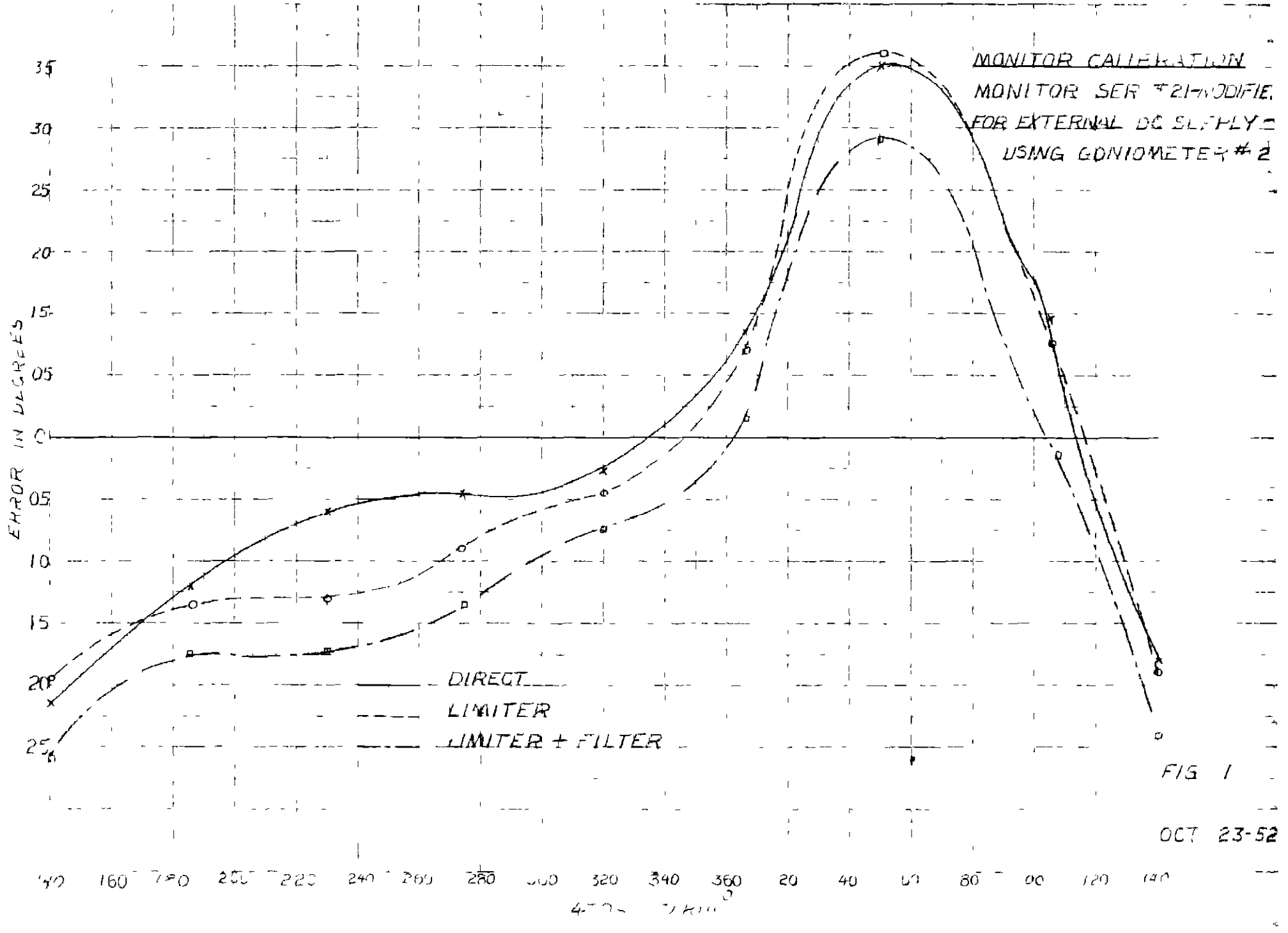


FIG 1

OCT 23-52

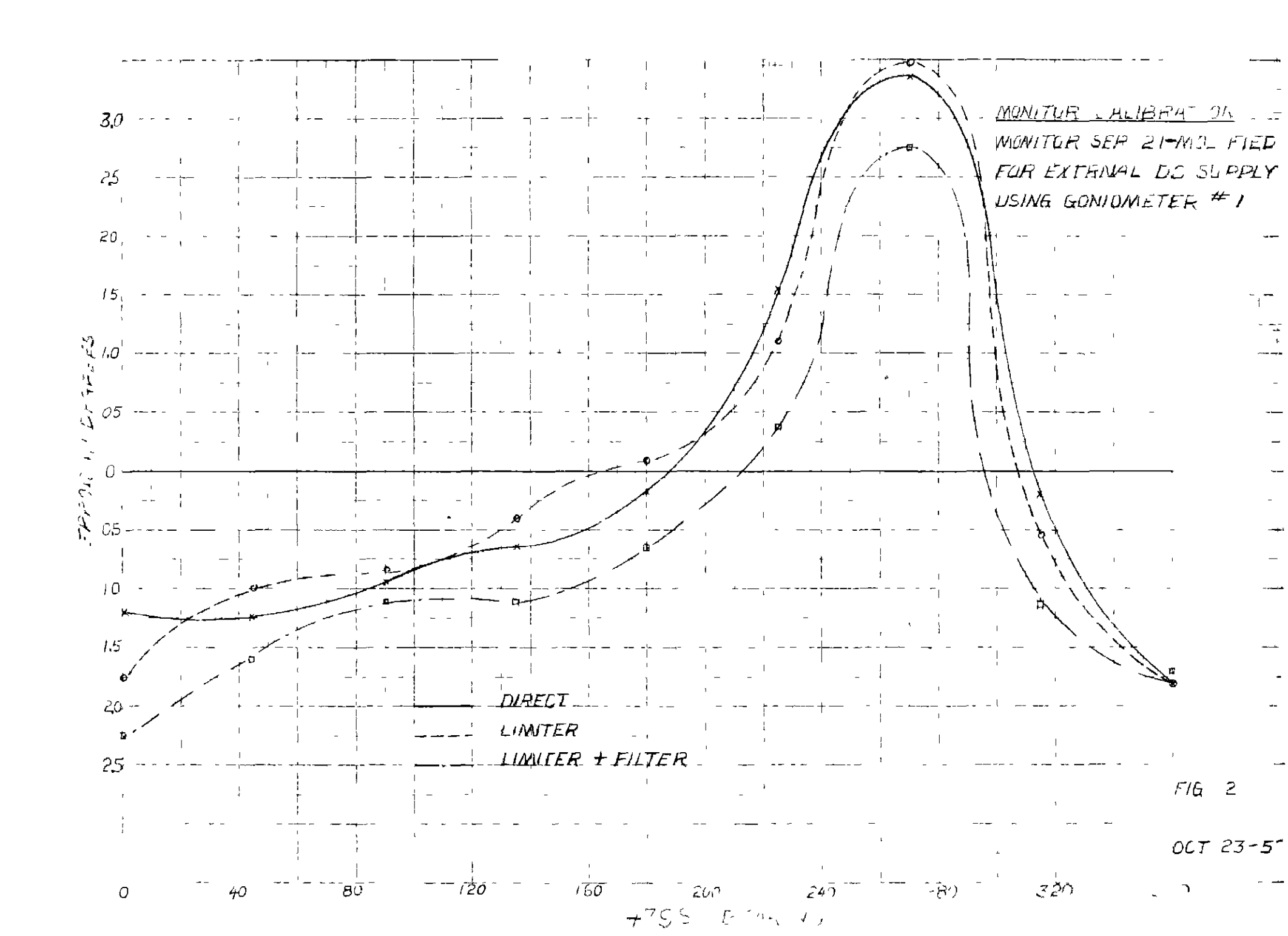

MONITOR CALIBRATION
MONITOR SER 21-MODIFIED
FOR EXTERNAL DC SUPPLY
USING GONIOMETER #1
DIRECT
LIMITER
LIMITER + FILTER
3.0
2.5
2.0
1.5
1.0
0.5
0
0.5
1.0
1.5
2.0
2.5
0
40
80
120
160
200
240
280
320

FIG 2

OCT 23-5

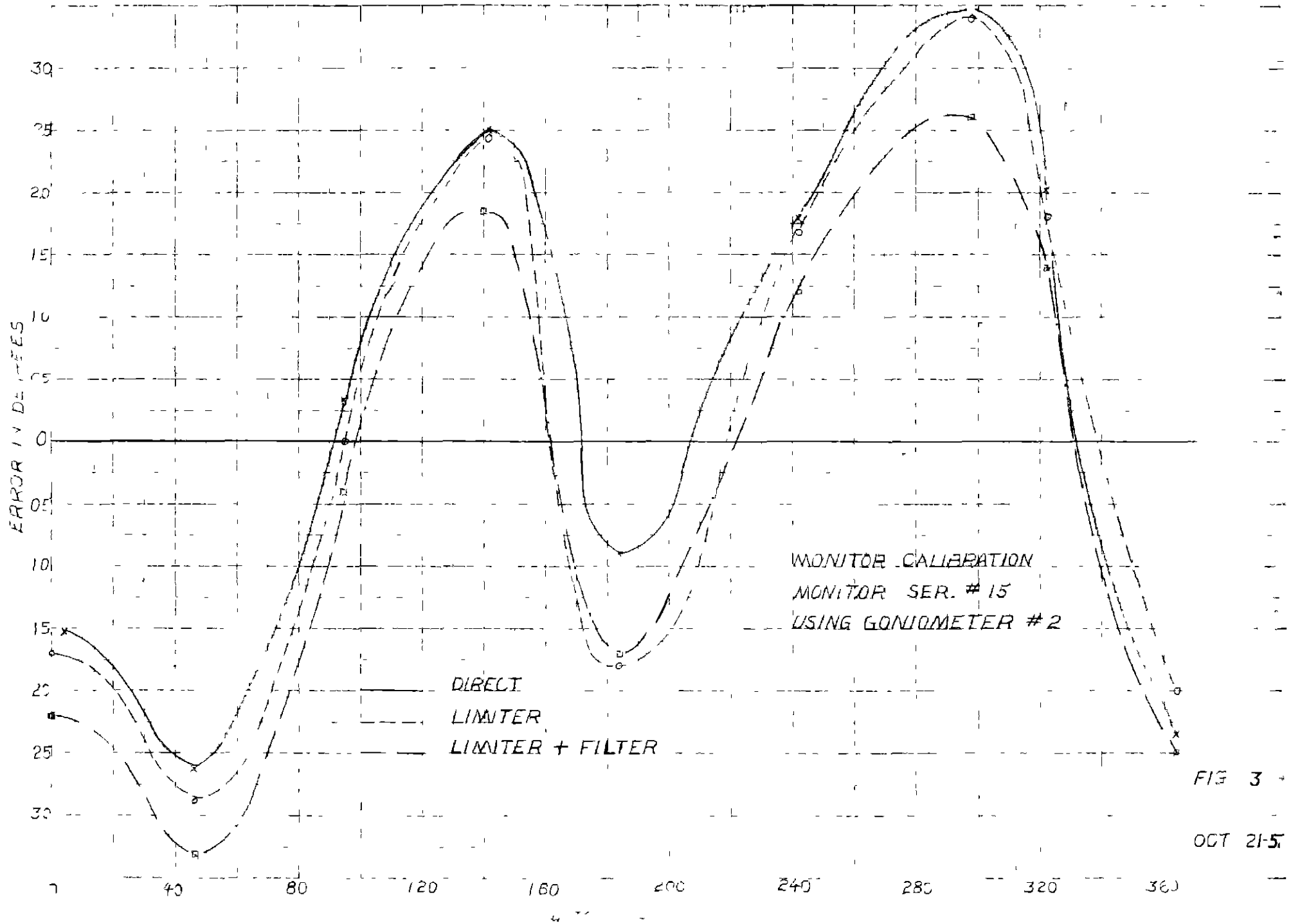

ERROR IN DEGREES
30
25
20
15
10
05
0
05
10
15
20
25
30
0
40
80
120
160
200
240
280
320
360
MONITOR CALIBRATION
MONITOR SER. # 15
USING GONIOMETER #2
DIRECT
LIMITER
LIMITER + FILTER

FIG 3

OCT 21-5

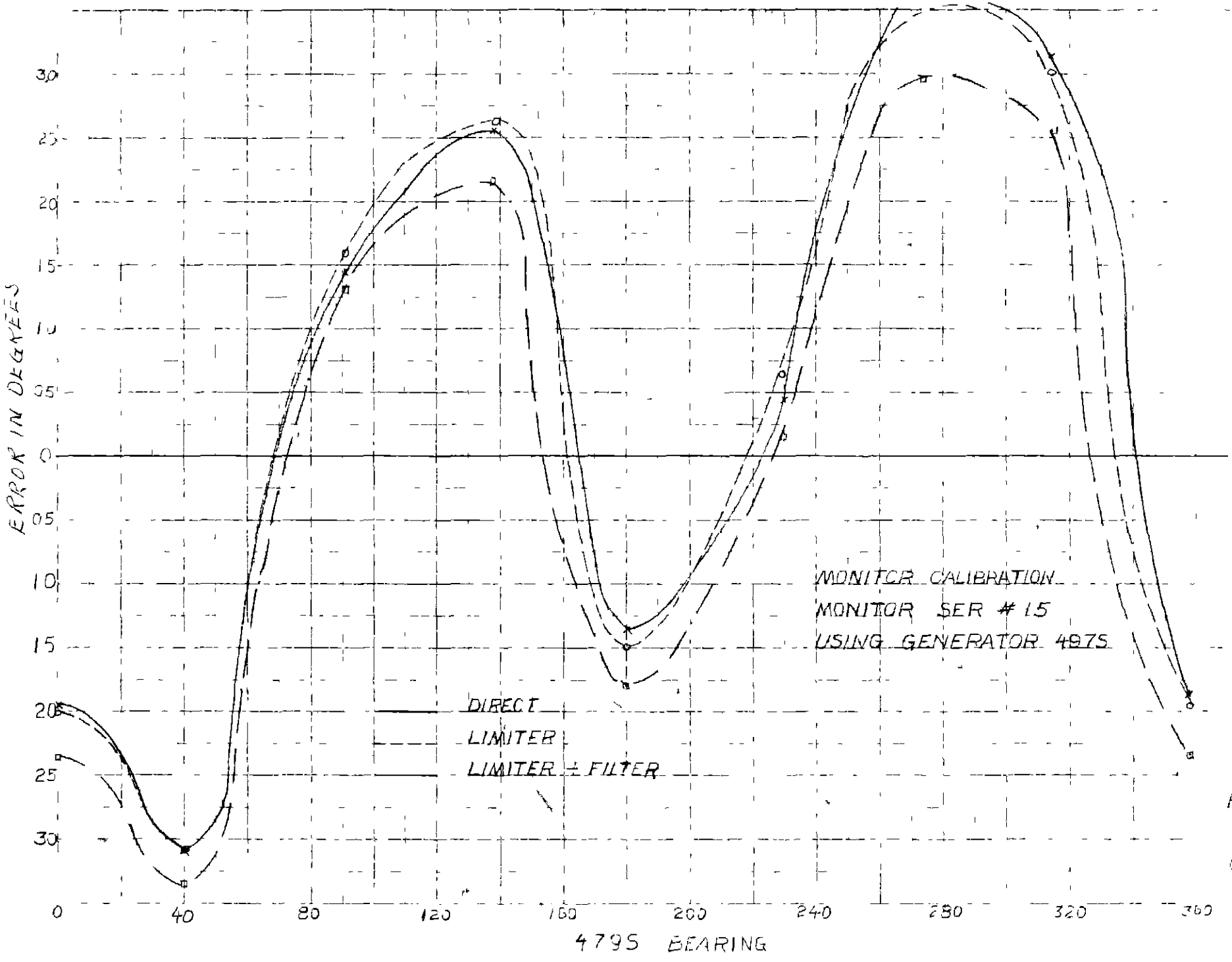

ERROR IN DEGREES
30
25
20
15
10
05
0
05
10
15
20
25
30
0
40
80
120
160
200
240
280
320
360
479S BEARING
DIRECT
LIMITER
LIMITER + FILTER
MONITOR CALIBRATION
MONITOR SER # 15
USING GENERATOR 497S

FIG 4

OCT, 21-5

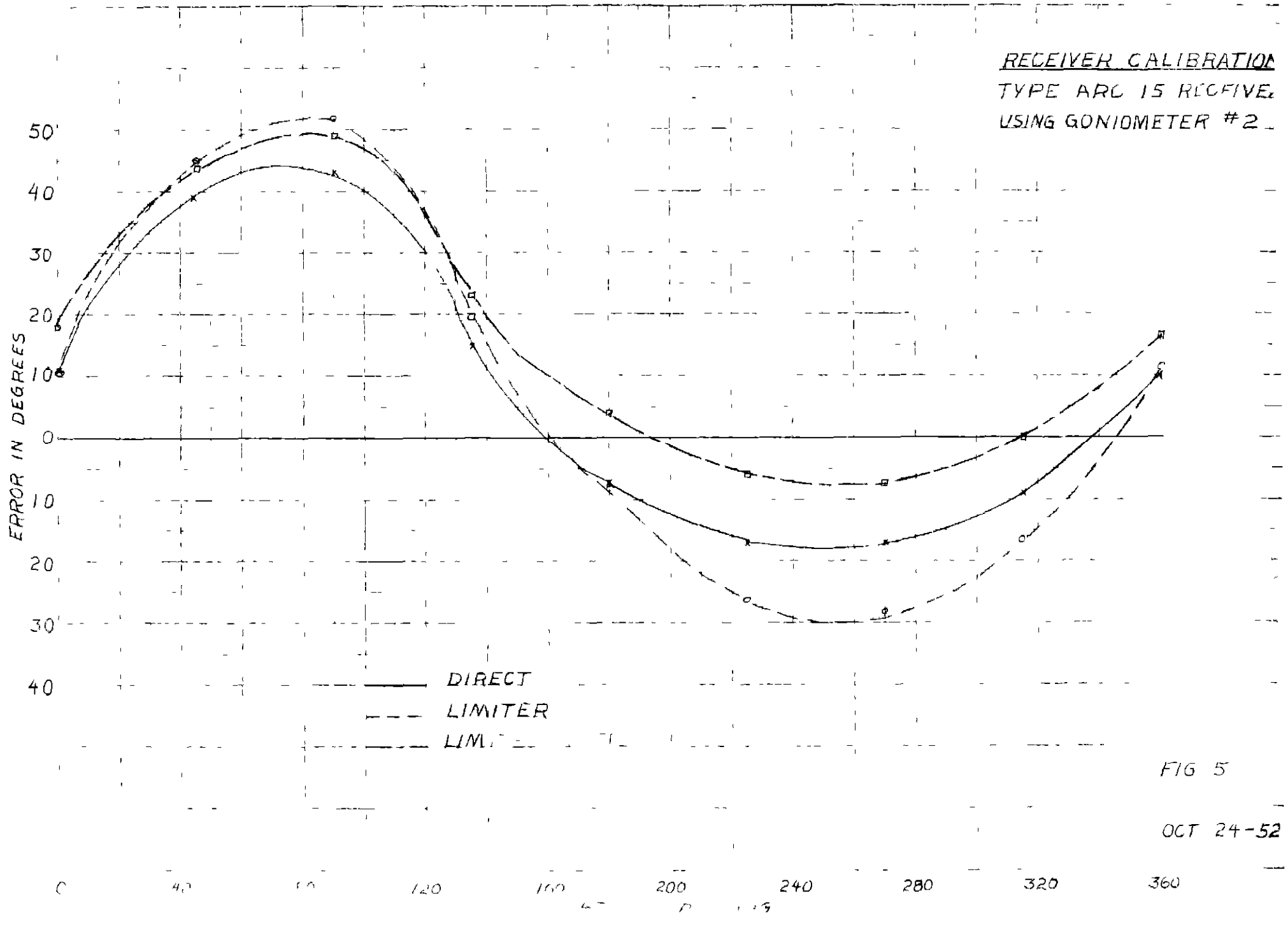


FIG 5

OCT 24-52

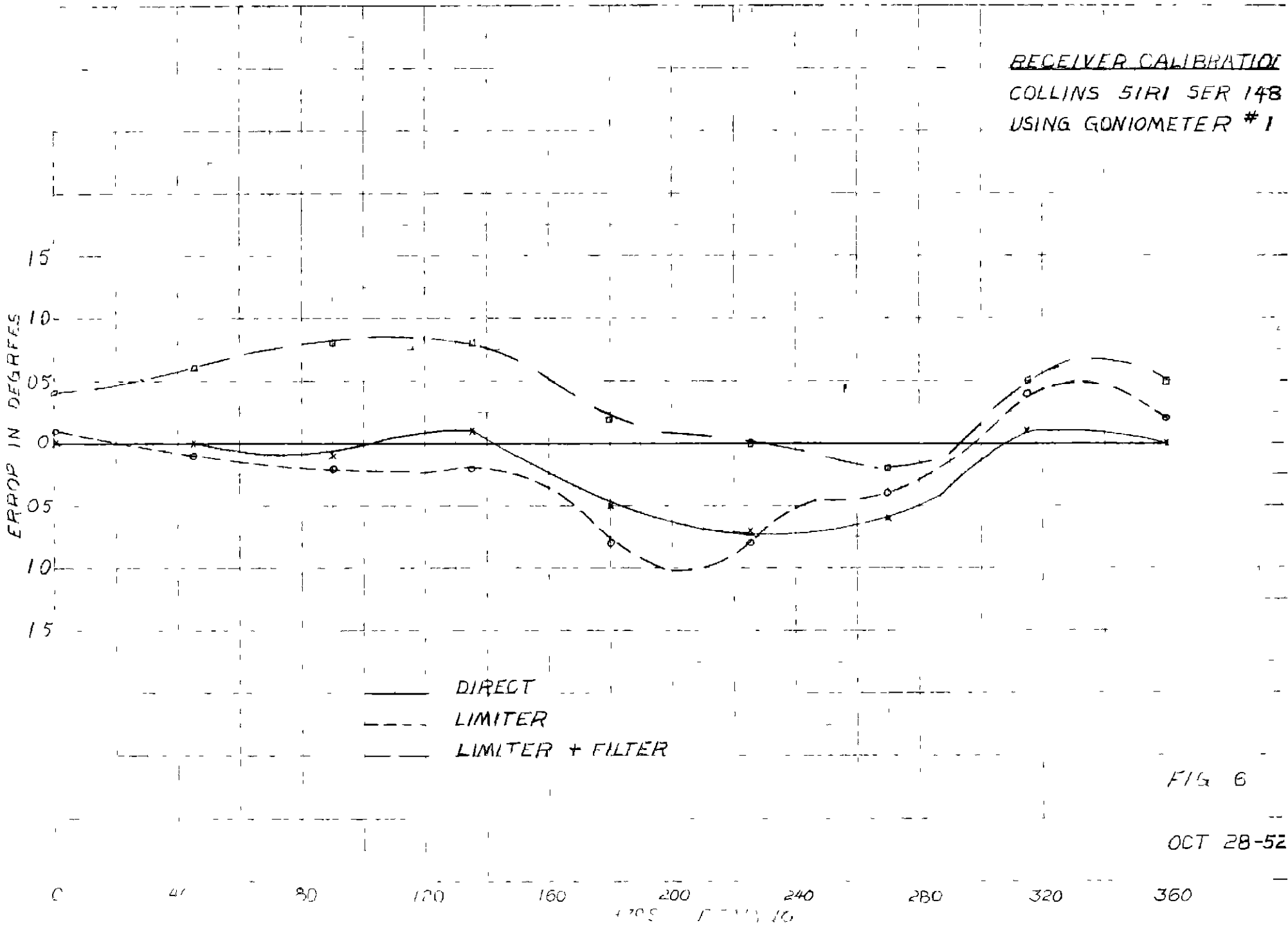


FIG 6

OCT 28-52

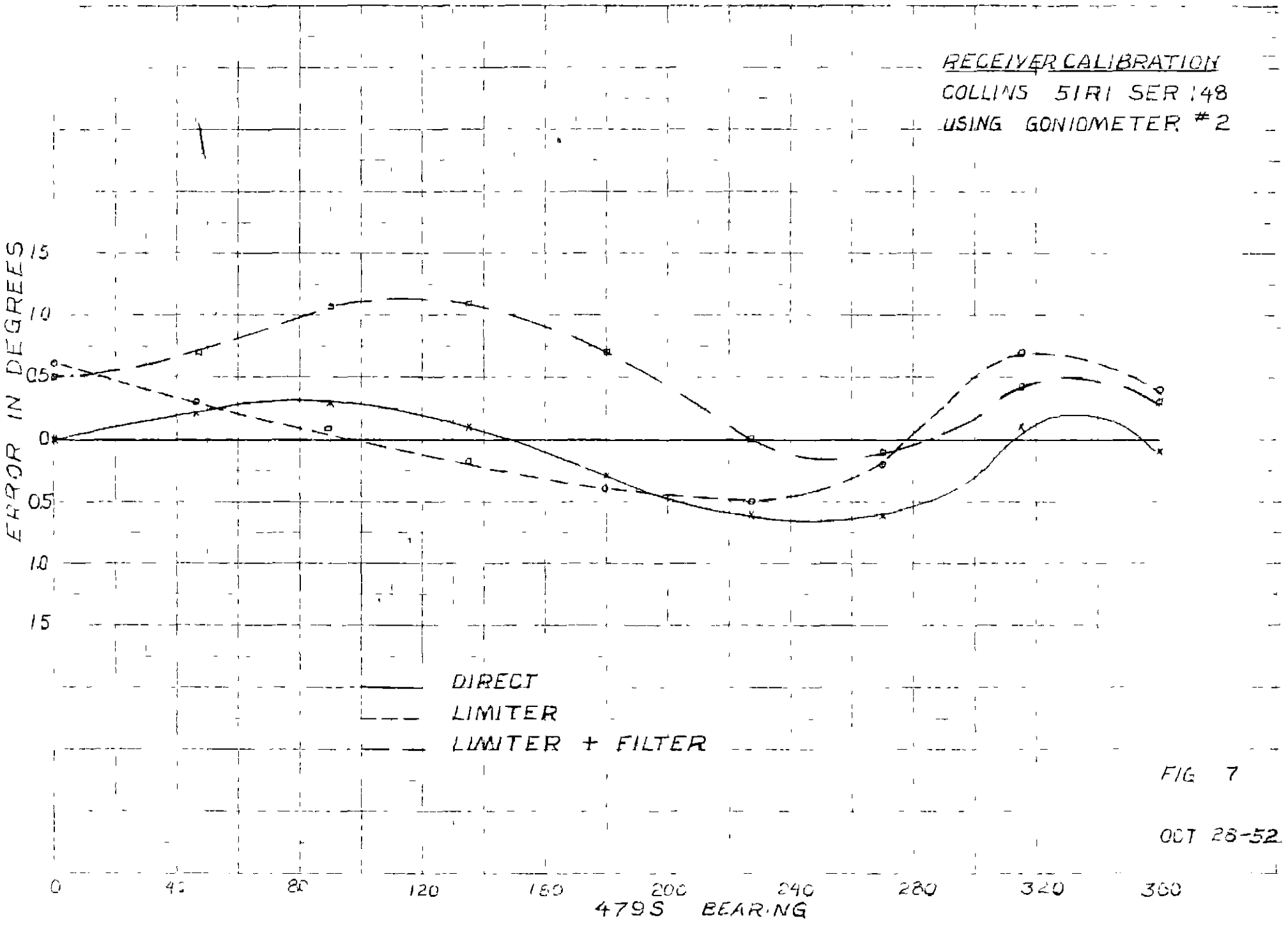


FIG 7

OCT 28-52

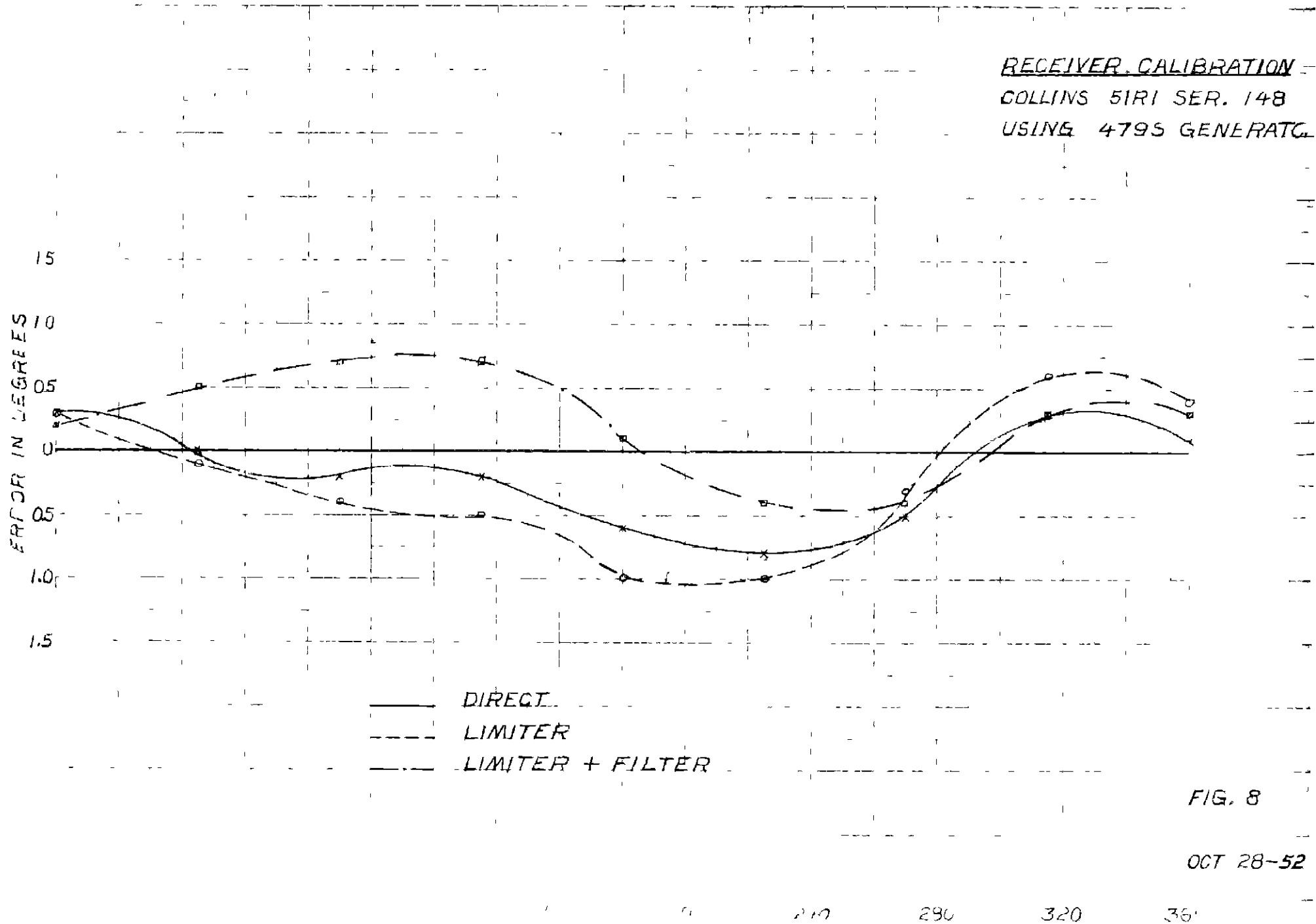


FIG. 8

OCT 28-52

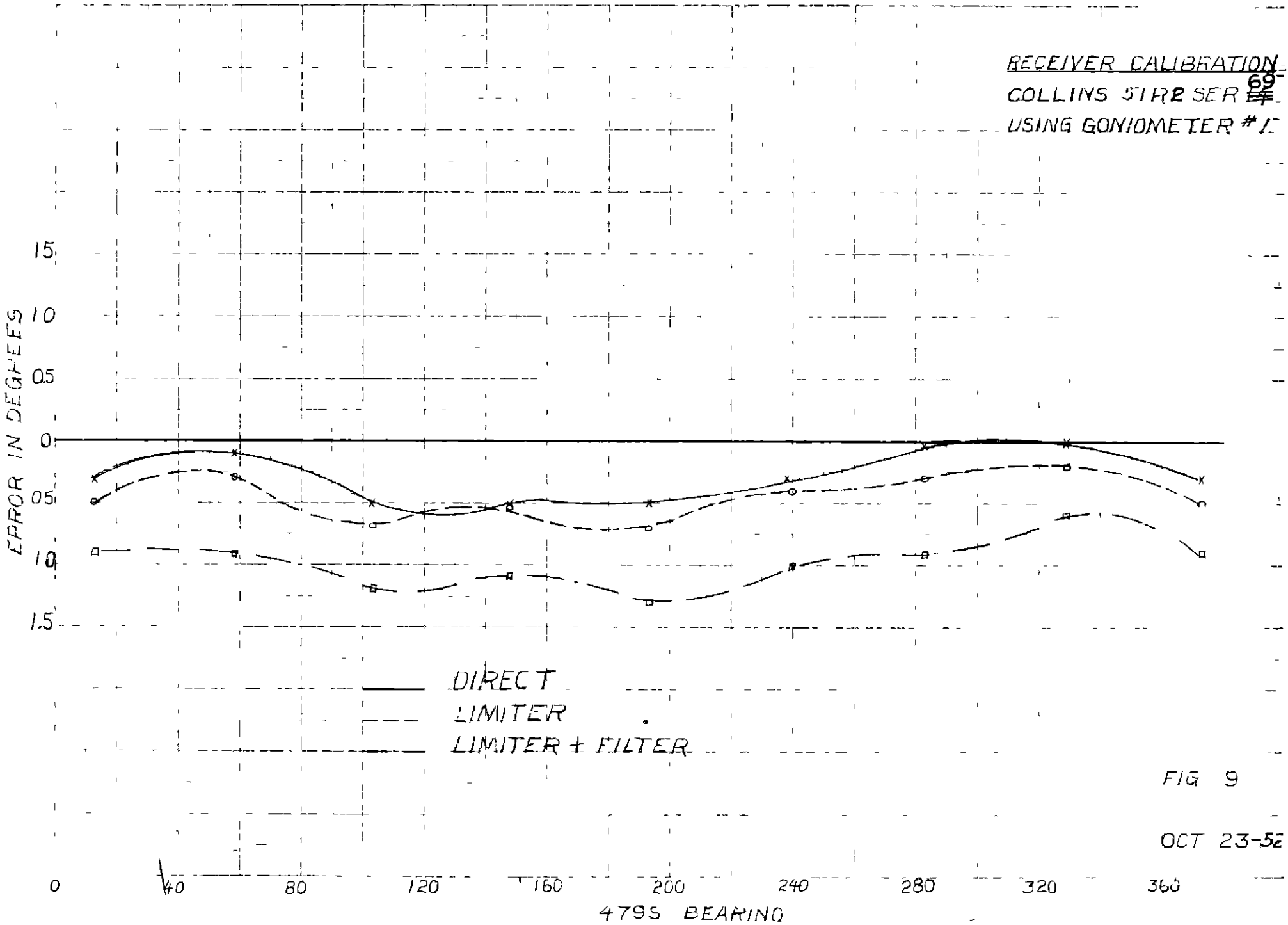


FIG 9

OCT 23-52

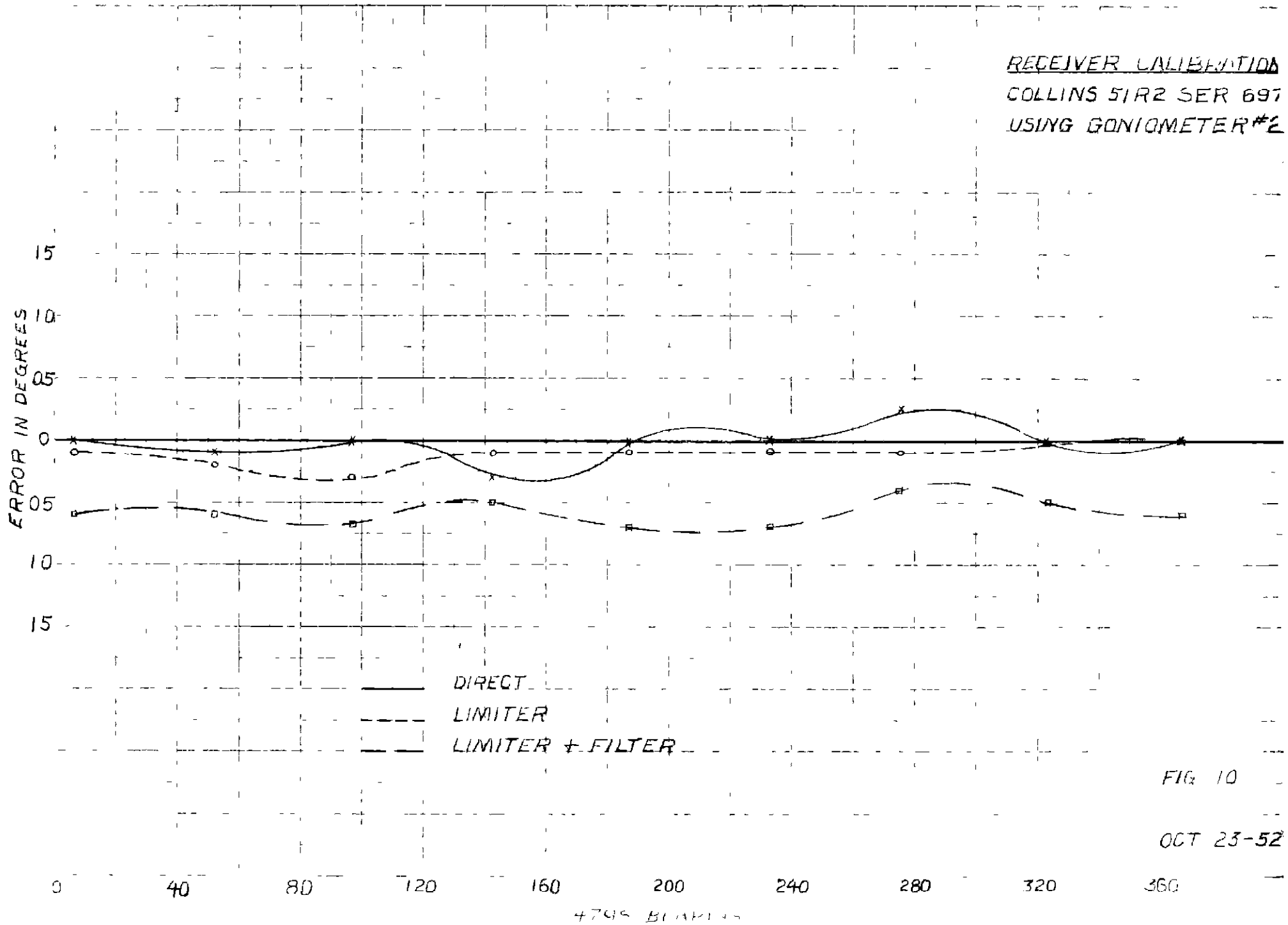


FIG 10

OCT 23-52

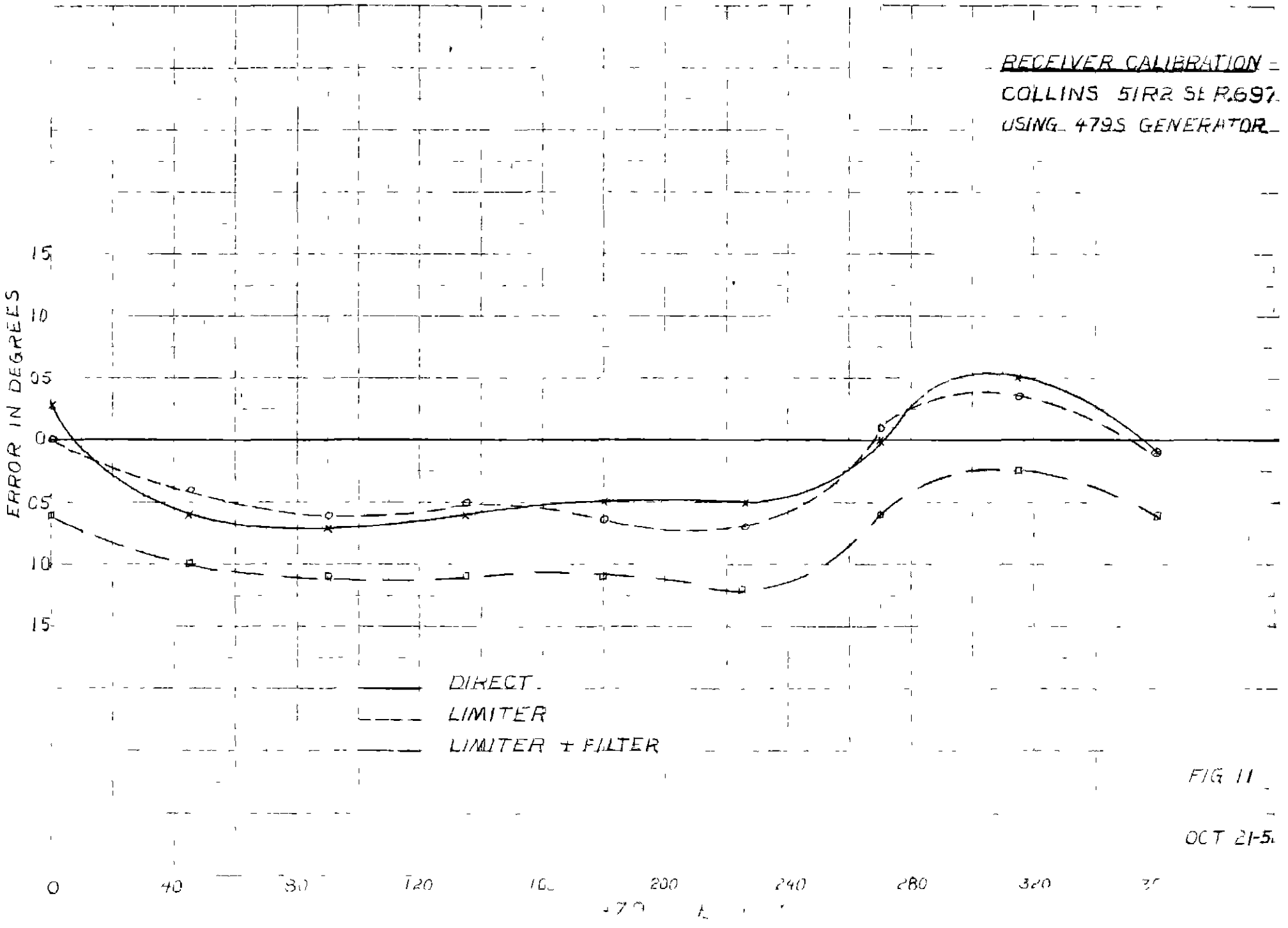
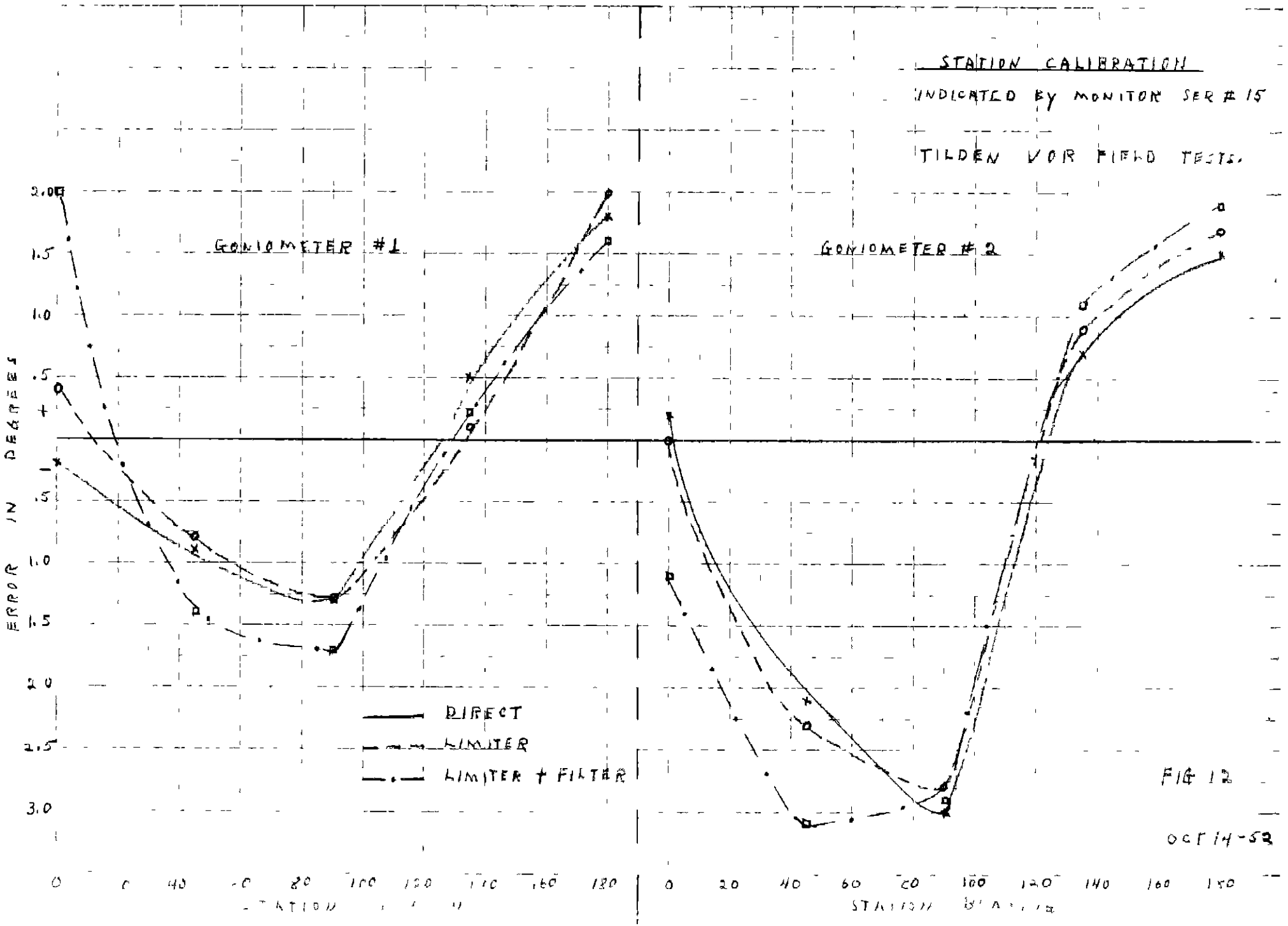


FIG 11

OCT 21-5


STATION CALIBRATION
INDICATED BY MONITOR SER # 15
TILDEN VOR FIELD TESTS
GONIOMETER #1
GONIOMETER # 2
ERROR IN DEGREES
2.0
1.5
1.0
.5
+
.5
1.0
1.5
2.0
2.5
3.0
DIRECT
LIMITER
LIMITER + FILTER
0 20 40 60 80 100 120 140 160 180
0 20 40 60 80 100 120 140 160 180
STATION
STATION
FIG 12
OCT 14-52

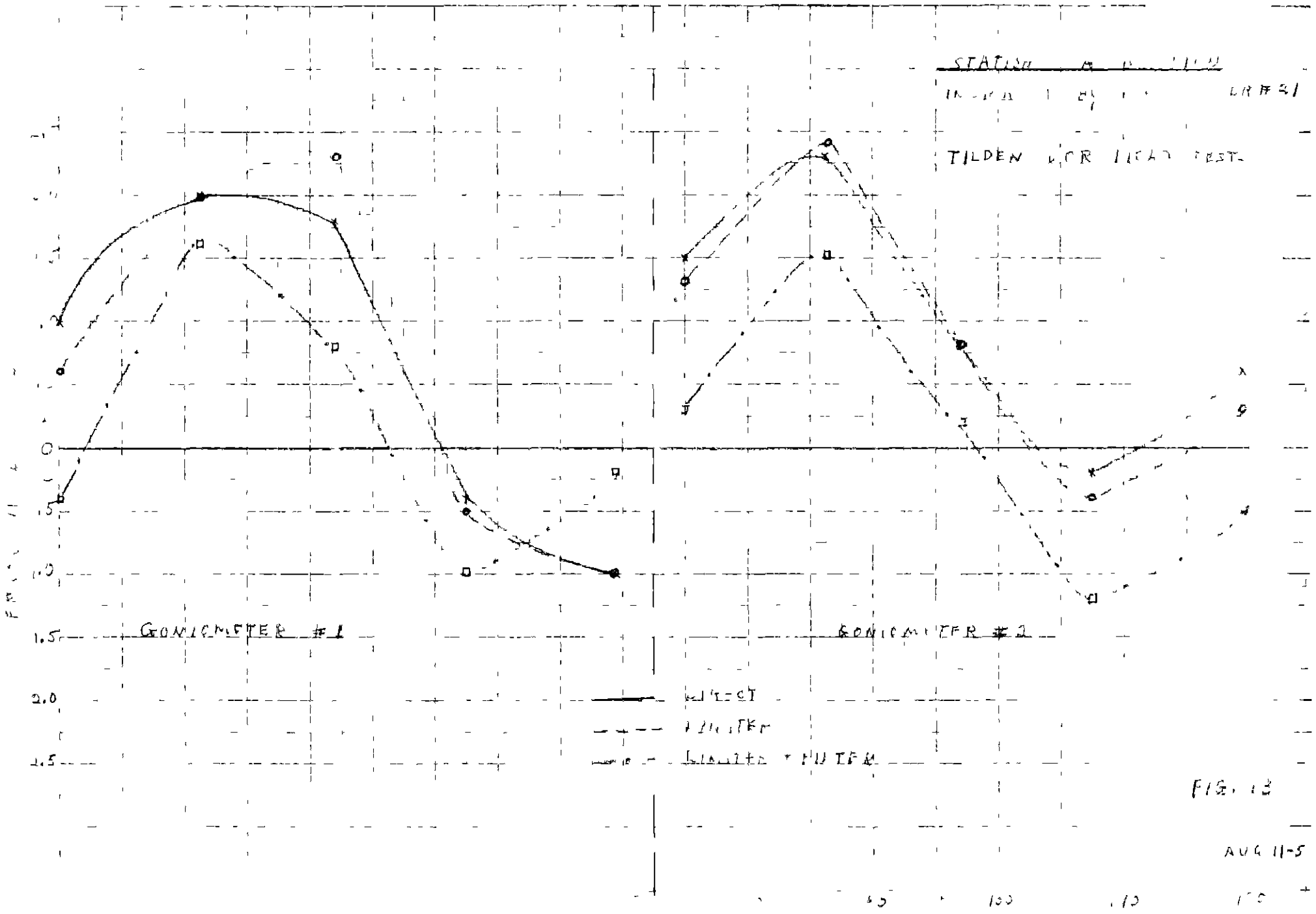
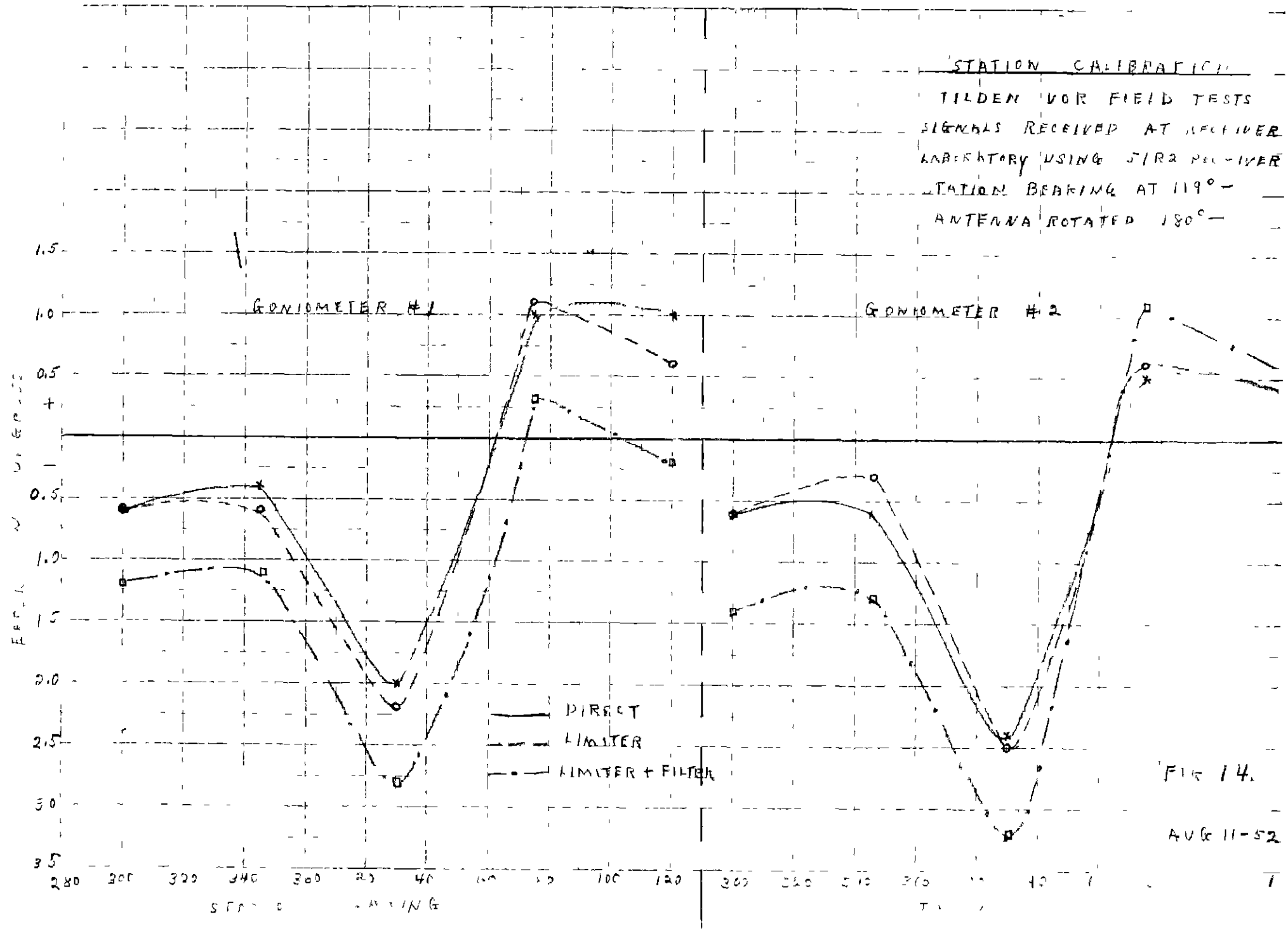


FIG. 12

AUG 11-5


STATION CALIBRATION
TILDEN VOR FIELD TESTS
SIGNALS RECEIVED AT RECEIVER
LABORATORY USING 51R2 RECEIVER
STATION BEARING AT 119° —
ANTENNA ROTATED 180° —
GONIOMETER #1
GONIOMETER #2
DIRECT
LIMITER
LIMITER + FILTER
FIG 14.
AUG 11-52
1.5
1.0
0.5
0.5
1.0
1.5
2.0
2.5
3.0
3.5
280
300
320
340
360
20
40
100
120
300
320
340
360
20
40

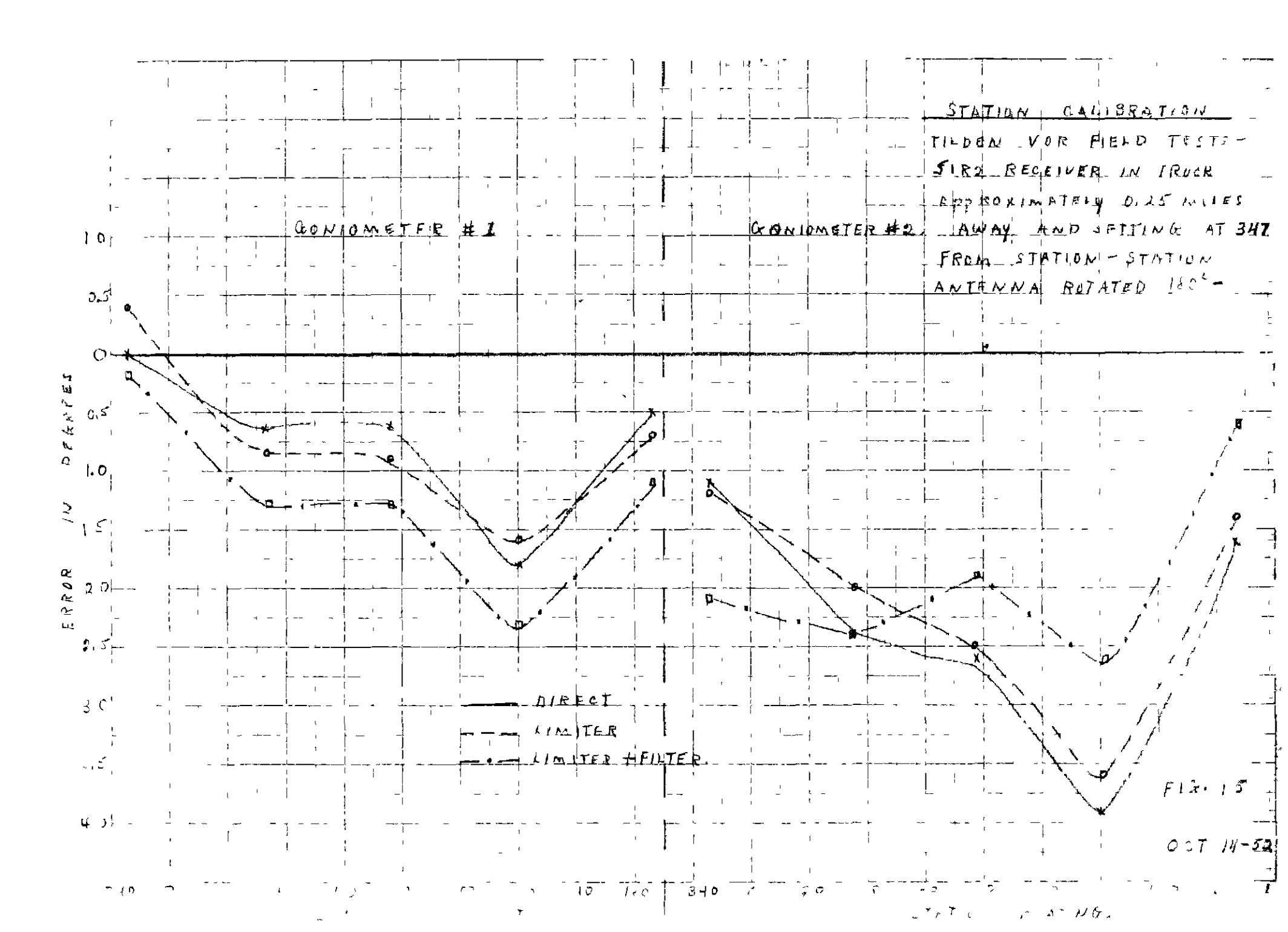


FIG. 15

OCT 14-52