MANCINO

11/21/56

RETMA* Measurements and Recommendations Regarding Occupied Bandwidth and Spurious Emissions of Television, Standard Broadcast and FM Broadcast Transmitters.

1. Television

1.1 Recommended Limits and Method of Testing Visual Transmitter.

(a) 50-100% Bandwidth Removed from the Center of the Band.
In this region, measurement of the attenuation characteristic is sufficient to assure suppression of sideband energy. The transmitter should be tested in accordance with the procedure described in Section 3.687, Paragraphs 3 and 4 of the FCC Rules. We recommend, however, that the attenuation requirements be those specified in Table 1 of this report.

(b) 100-150% Bandwidth Removed from the Center of the Band.

With the application of a composite color signal; i.e., saturated solid color or color bars, emissions shall not be greater than the limits specified in Table 1. Particular attention should be paid to measurement at frequencies removed from the Visual Carrier by multiples of the color subcarrier frequency. It is recommended that measurement be made by sampling the energy in the output transmission line.

(c) More Than 150% of the Bandwidth Removed from the Center of the Band.

Refer to Table 1 for suggested limits of emissions. The transmitter should be operated at reference black level since this test is for measurement of harmonic and spurious emissions. Emissions from the transmitter should be measured by sampling the energy in the output transmission line.

1.2 Recommended Limits and Method of Testing Aural Transmitter.

(a) 50-100% Bandwidth Removed from the Center of the Band.

In Table 1 a 40 db limit of emissions is recommended as measured with 85% modulation by a 15 KC sine wave test signal. Measurements can be made either off the air or by sampling the energy in the output transmission line.

Calculation of the aural sideband spectrum shows that sideband energy outside the television band is negligible. Accurate measurements, however, at the band edge are difficult because of the selectivity limitations of the test equipment.

* – RETMA – RADIO ELECTRONICS TELEVISION MANUFACTURERS' ASSOCIATION

11/21/56

(b) More than 100% of the Bandwidth Removed from the Center of the Band.

Refer to Table 1 for suggested limits. Tests should be conducted to determine harmonic and spurious output of the aural transmitter operating at normal power with no modulation. The technique of measuring should be the same as applied to measurement of spurious and harmonics from the visual transmitter.

1.3 Information to Support Recommendations.

(a) Fig. 1 is a composite curve showing the range of measurements obtained from tests conducted on five different transmitters modulated with various test signals including the RETMA test pattern and color slides. Two methods of testing were employed. One method was to set up the measuring equipment at various sites in the field with the transmitter operating into the antenna. With the Field Intensity Meter set for peak reading, the spectrum was measured out to 15 MC from the band edges. The sideband levels were then referenced to the Aural Carrier plus 3 db. The second method of testing was to sample the energy in the transmission line of the test transmitter operating into a dummy load. The sideband spectrum was measured out to 15 MC with the Field Intensity Meter set for peak reading. Sideband levels were referenced to the Visual Carrier measurement. Three different types of Field Intensity Meters were used in the above tests. They were the Measurements Corp. Model 58, RCA Type BW7A and Empire Devices Type NF105. It should be noted that, despite the fact that five different transmitters, two methods of measurement and several types of test signal were used, the spread of readings is only about 10 db. It was noticed that field measurements are affected by ambient noise, particularly beyond 3 MC from the band edge. A comparison of Fig. 1 with a previous survey, "An Experimental Determination of the Sideband Distribution in the RCA Color Television System," copy attached, shows a similarity of data.

(b) Attenuation Characteristic.

Fig. 2 provides a check on the emissions measurements shown in Fig. 1. This curve was obtained by adding a transmitter attenuation characteristic to a typical test pattern spectrum characteristic. There is very close correlation between Fig. 2 and Fig. 1. The attenuation characteristic was obtained by actual measurement in accordance with Section 3.687, Paragraph 4 of the FCC Rules.

(c) Aural Transmitter.

Fig. 3 shows measured and calculated data for the aural television transmitter. The procedure for measuring was to

modulate the transmitter 85% with a 15 KC signal and then to sample the energy in the output transmission line. The sampled energy was then heterodyned down to a lower frequency and measured with a narrow band receiver. The sideband level was compared to a measurement of the unmodulated carrier.

2. FM Broadcast

2.1 Recommended Limits.

Refer to Fig. 4 showing the calculated spectrum and the suggested limits for an FM transmitter modulated 85% by a 15 KC sine wave. In the sideband region, the suggested limit of emissions is 25 db from the band edge out to 240 KC. from the carrier. Beyond 240 KC the limit changes at the rate of .5 db per KC out to the frequency at which the formula 35 + 10 Log P applies. The apparent safety factor in the sideband region is desirable because of the inability of present day test equipment to measure low emission levels in the vicinity of the carrier. Actual sideband levels will be somewhat less than the calculated values.

As noted on Fig. 4, a limit of 35 + 10 Log P has been suggested for spurious and harmonics.

2.2 Measuring Techniques.

Measurement of the sideband spectrum will require a narrow band instrument. The best approach may be to heterodyne the sidebands down to a lower frequency. The technique of measuring harmonics and spurious will be the same as for television.

3. AM Standard Broadcast

3.1 Occupied Bandwidth (Sidebands).

(a) Limits.

Refer to Fig. 5 for suggested limits and test results. It is obvious that the AM sideband spectrum is not contained within 50 to 100% of the bandwidth removed from the center of the band. It is recommended that a limit of 25 db apply from the channel edge (10 KC) to 20 KC from the carrier. Beyond 20 KC, the emissions limit increases at the rate of .4 db per KC out to the frequency at which the formula 35 + 10 Log P applies.

(b) Test Results.

The data on Fig. 5 is a composite of tests on four transmitters, each modulated 85% with a 7500-cycle sine wave. Three of the transmitters were operated into a dummy load, the fourth into an antenna. In general, the levels measured

on the latter were somewhat lower than those measured on the other three. This is accounted for by the additional selectivity of the antenna circuitry. Receivers used in these measurements were the RCA Type WX2C and Stoddart NM20.

(c) Comments.

Attention is drawn to the fact that a 7500-cycle test signal at 85% modulation is not representative of AM program modulation. Reference is made to Fig. 6 showing the intensity levels for speech and music. It will be noted that the intensity is very low at 15 KC.

	FREQUENCY*	REQUIRED ATTENUATION DB	MODULATION
VISUAL	50 - 100%	10 Log $\frac{P}{100}$ 20 db Max.	Variable Frequency Sine Wave (200 KC. Reference)
	-3.58 MC	22+10 Log $\frac{P}{100}$ 42 db Max.	
	100 - 150%	30 + 10 Log P 60 db Max.	Solid Color or Color Bars
	150% and Up	30 + 10 Log P 80 db Max.	Operate transmitter at reference Black Level.
AURAL	50 - 100%	40 db.	15 KC Sine Wave
	100% and Up	35 + 10 Log P 85 db Max.	None

* Frequency is in % Bandwidth Removed from the Center of the Band.

P is Visual Peak Power in Watts.

Attenuation is in db Down From Visual Peak Except in the 50 - 100% Visual Region.

Table 1. Recommended Limits for Television.

11/21/56

11/21/56

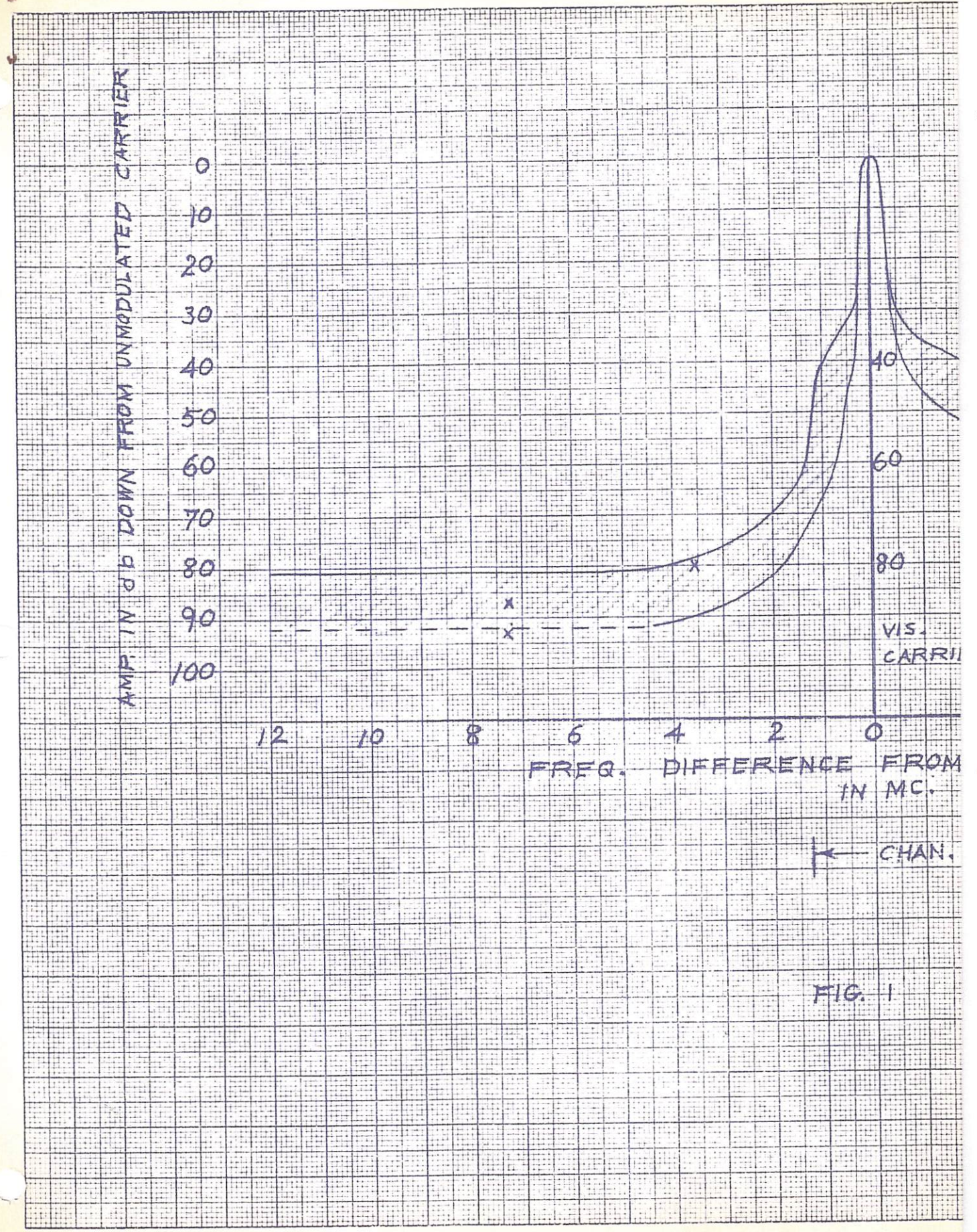
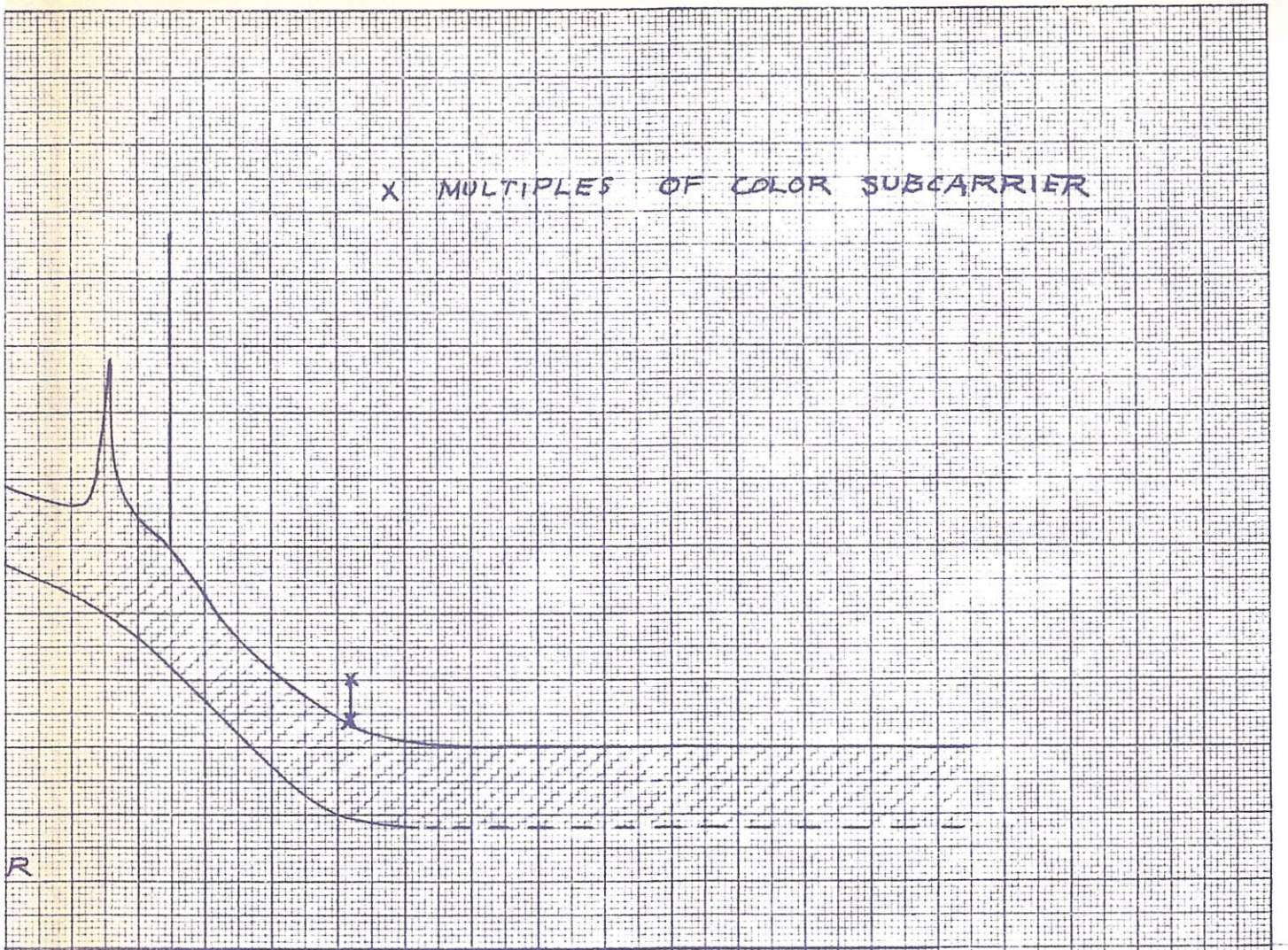

AMP. IN db DOWN FROM UNMODULATED CARRIER
0
10
20
30
40
50
60
70
80
90
100
12
10
8
6
4
2
0
40
60
80
VIS. CARRI
FREQ. DIFFERENCE FROM
IN MC.
CHAN.

FIG. 1

11/21/56



TELEVISION SIDEBAND DISTRIBUTION

FIG. 1

COMPOSITE CURVE SHOWING RANGE OF MEASUREMENTS OBTAINED FOR VARIOUS TYPICAL MONOCHROME AND COLOR TEST SIGNALS

J. F. Propst
11/13/56

11/21/56

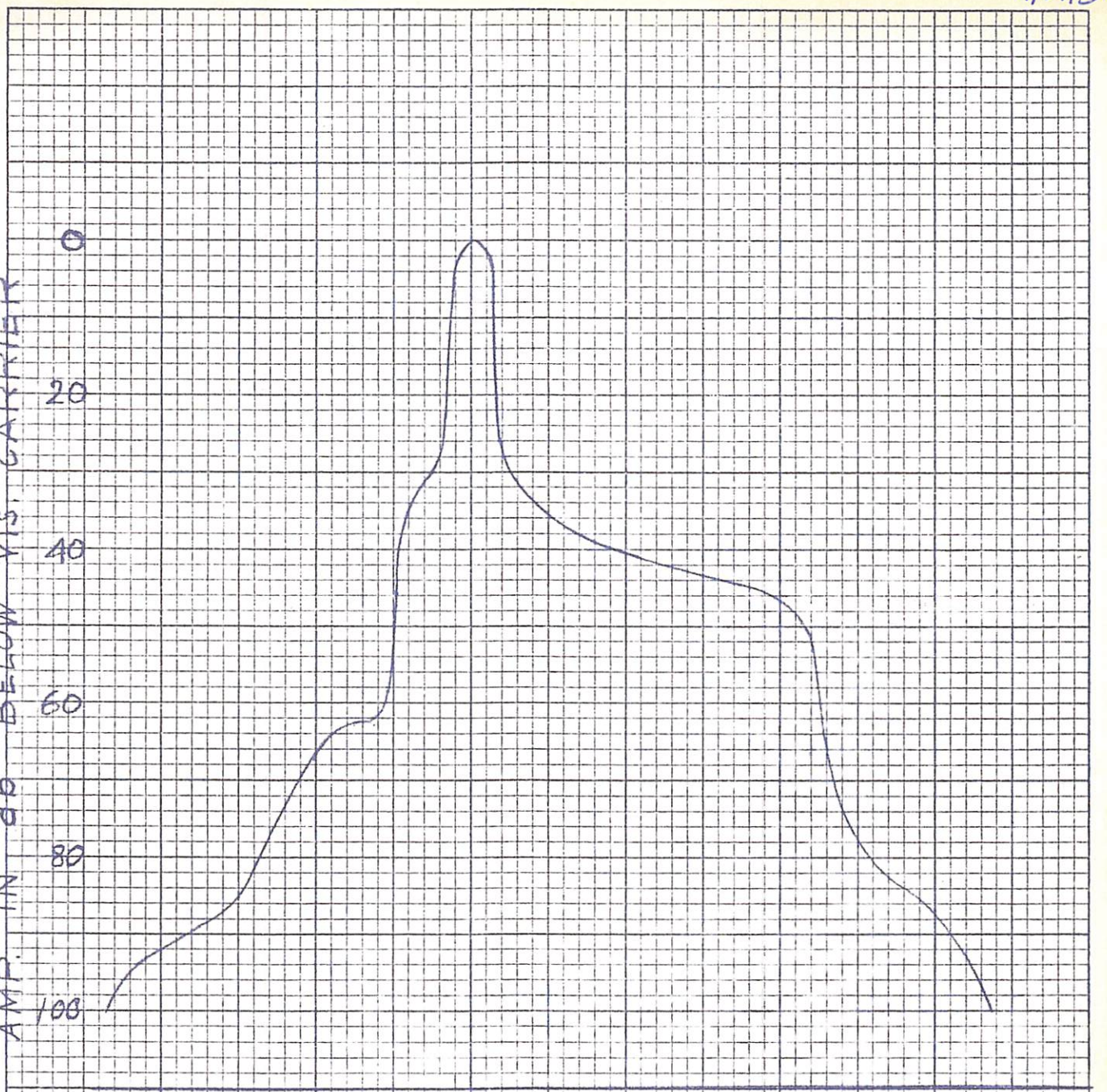


FIG 2 ADDITION OF "BUILT IN" ATTENUATION TO ATTENUATION INHERENT TO HIGHER ORDER SIDEBANDS OF PICTURE MODULATED CARRIER.

J. F. Brosse
11/5/56

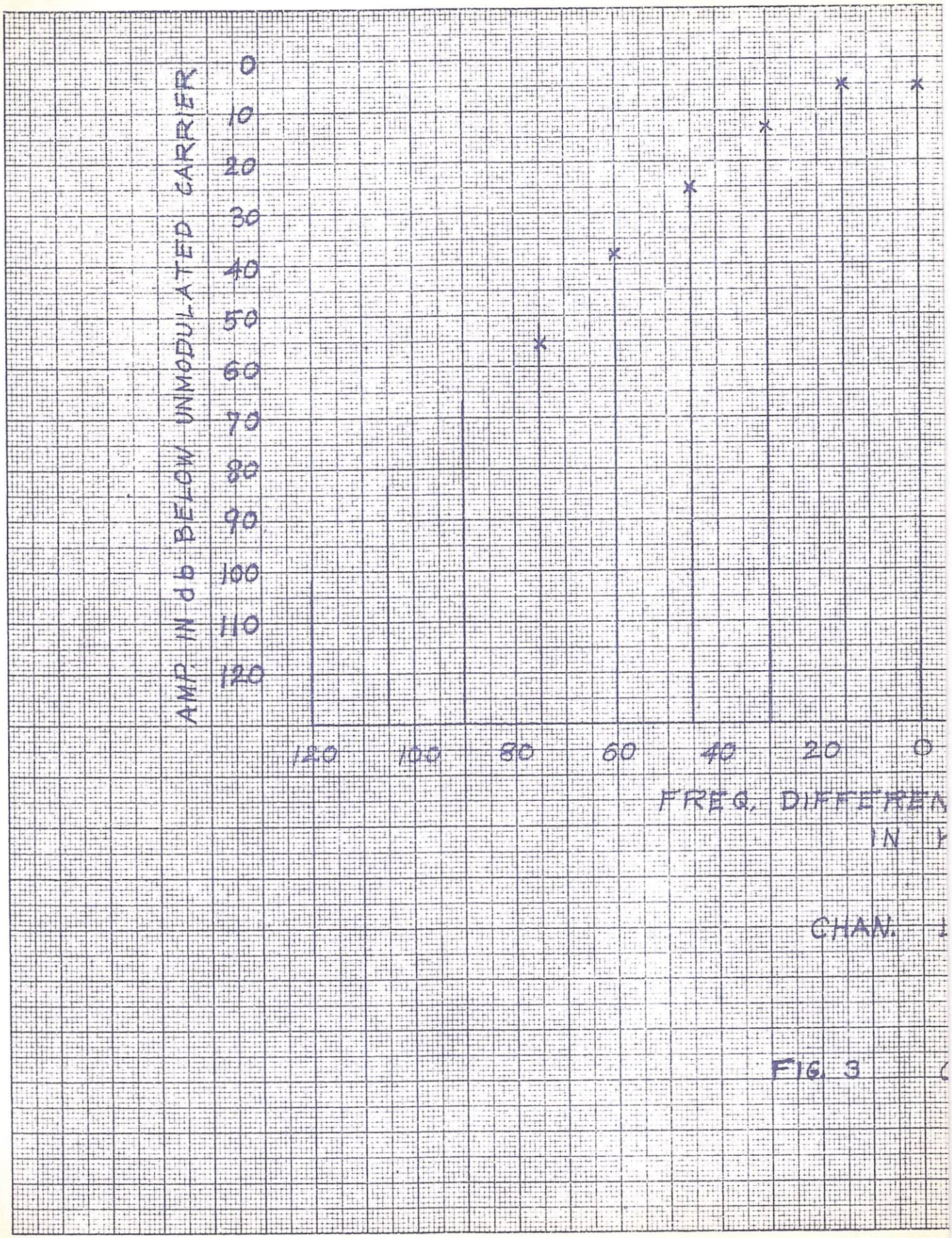

AMP. IN db BELOW UNMODULATED CARRIER
0
10
20
30
40
50
60
70
80
90
100
110
120
120
100
80
60
40
20
0
FREQ. DIFFERENCE
IN
CHAN.

FIG. 3

11/2/56

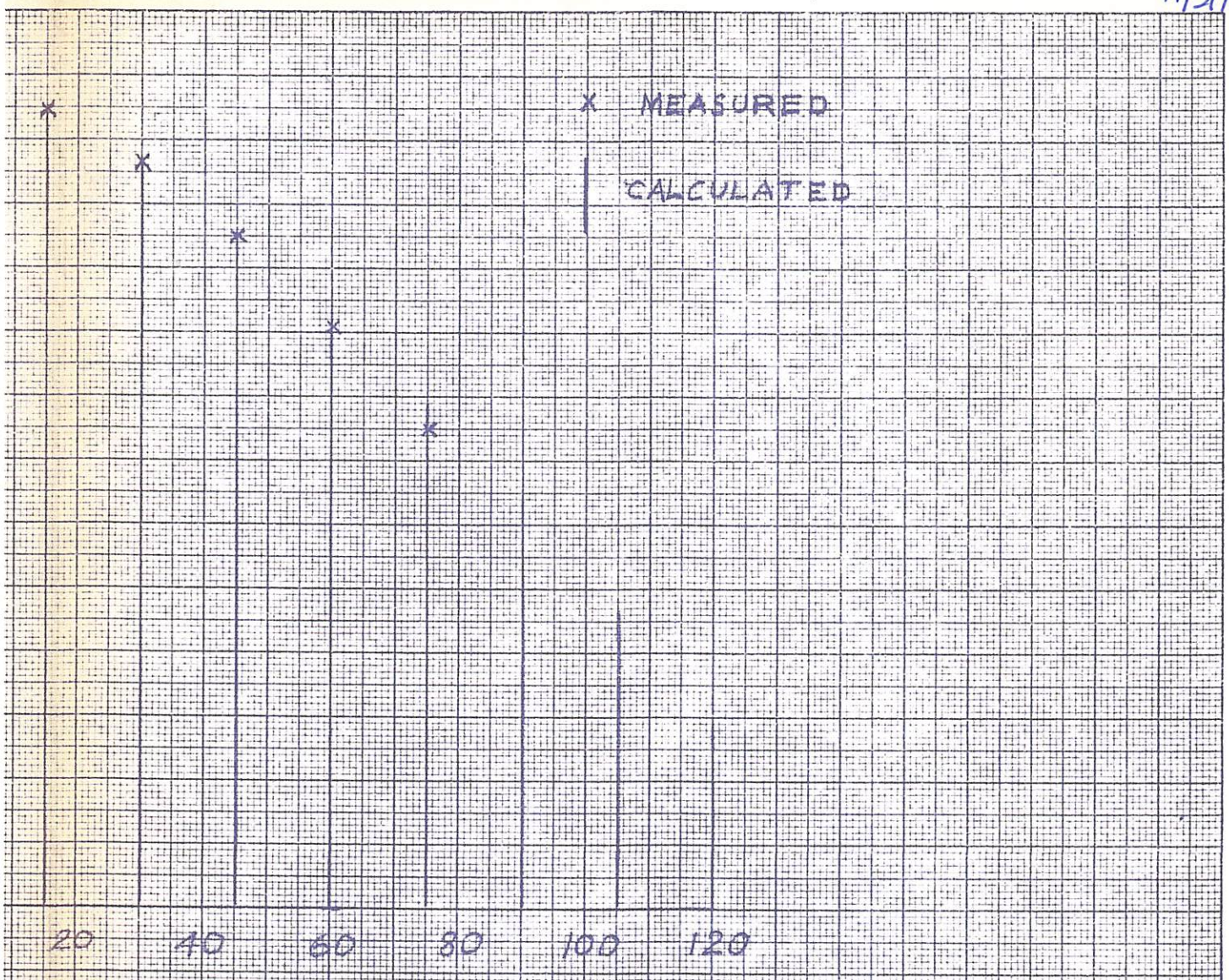


FIG. 3

LCULATED AND MEASURED SPECTRUM OF TV AURAL TRANS.
MODULATING FREQ. 15000 CPS
DEVIATION 21.25 KC.
MODULATION INDEX 1.42

J. F. Rieger
11/5/56

11/21/58

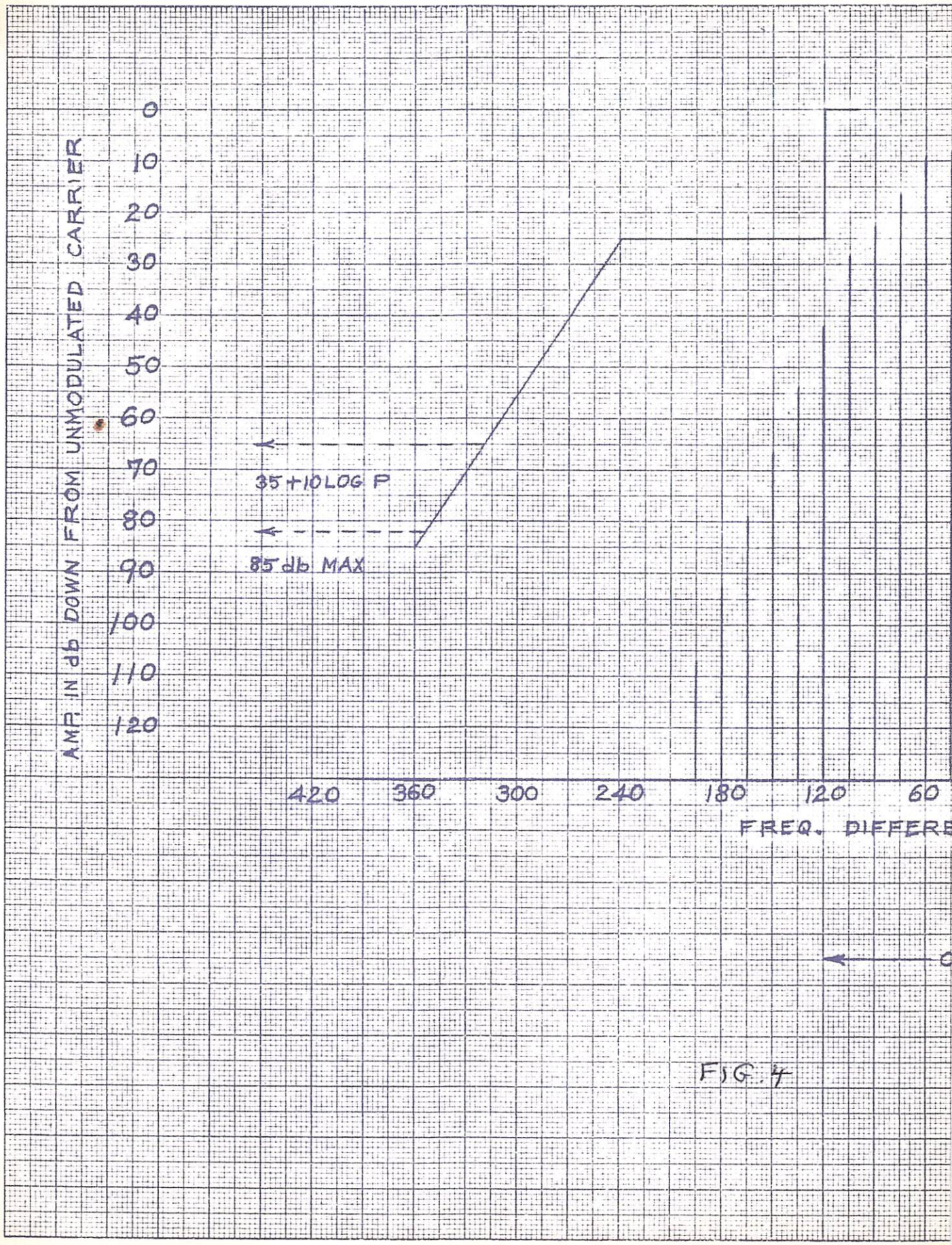

AMP. IN db DOWN FROM UNMODULATED CARRIER
0
10
20
30
40
50
60
70
80
90
100
110
120
35 + 10 LOG P
85 db MAX
420
360
300
240
180
120
60
FREQ. DIFFERE
C

FIG. 4

11/21/56

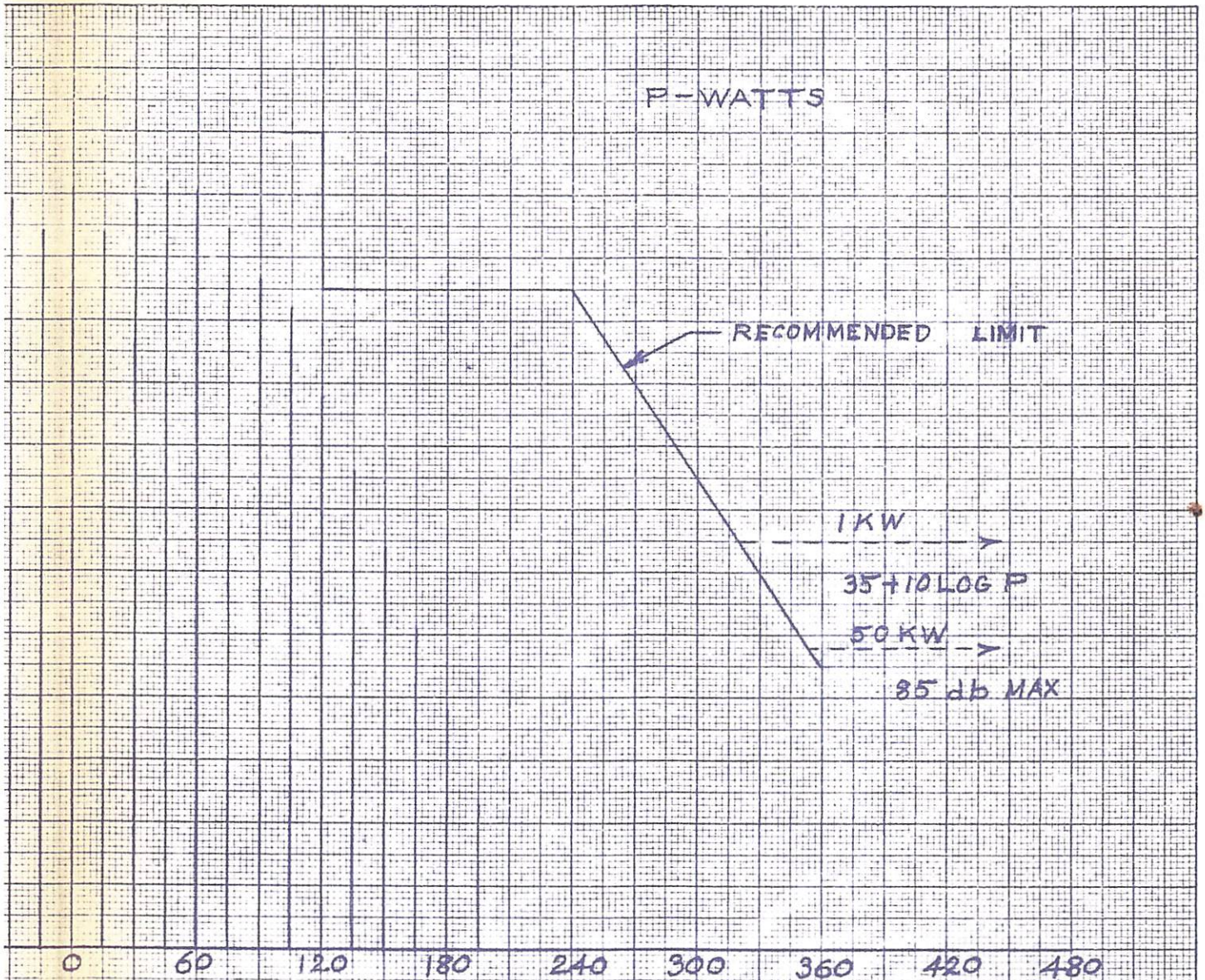
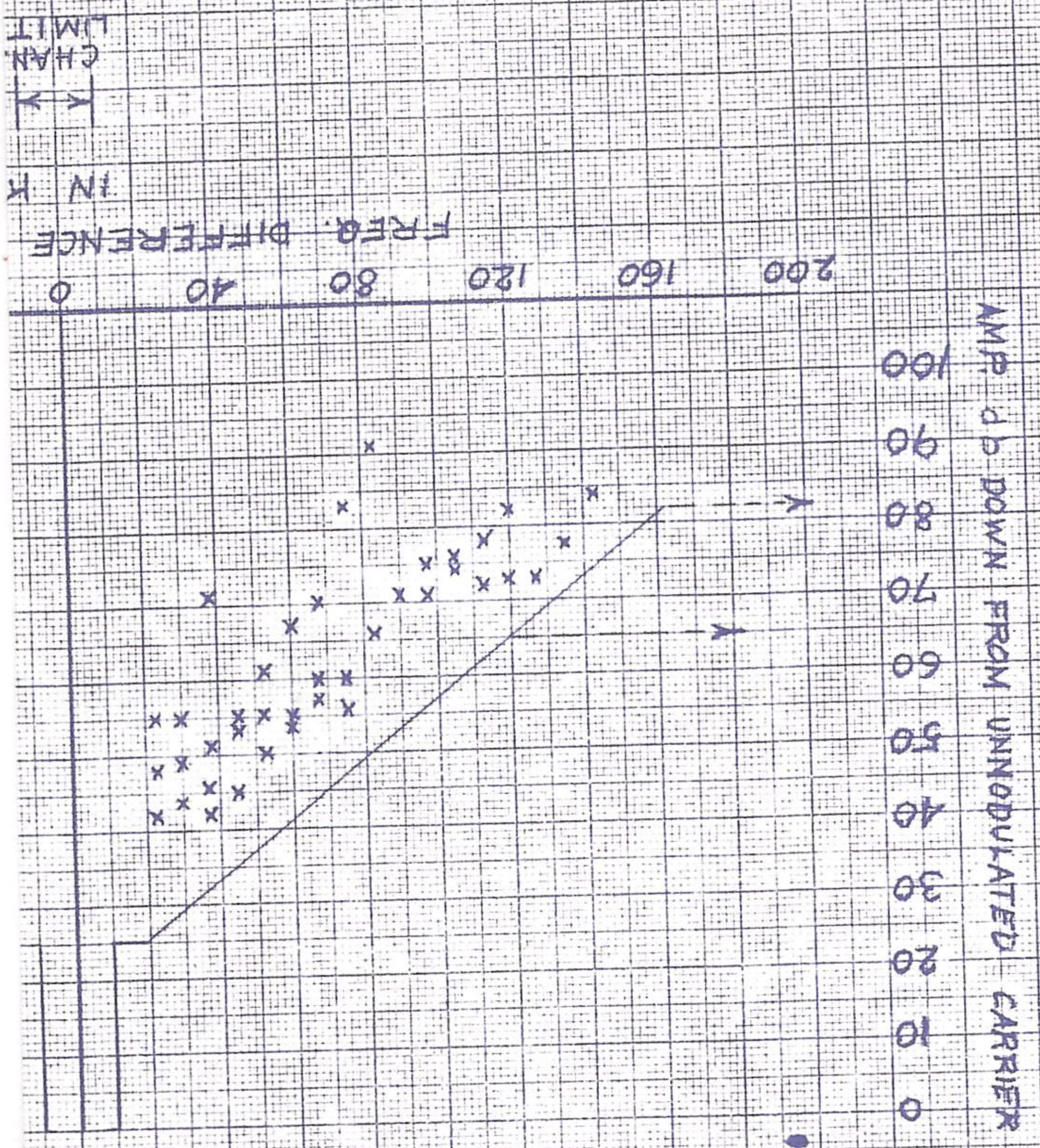


FIG. 4 CALCULATED SPECTRUM OF FM TRANSMITTER
MODULATING FREQ. 15000 CYCLES
DEVIATION 63.75 KC.
MODULATION INDEX 4.25

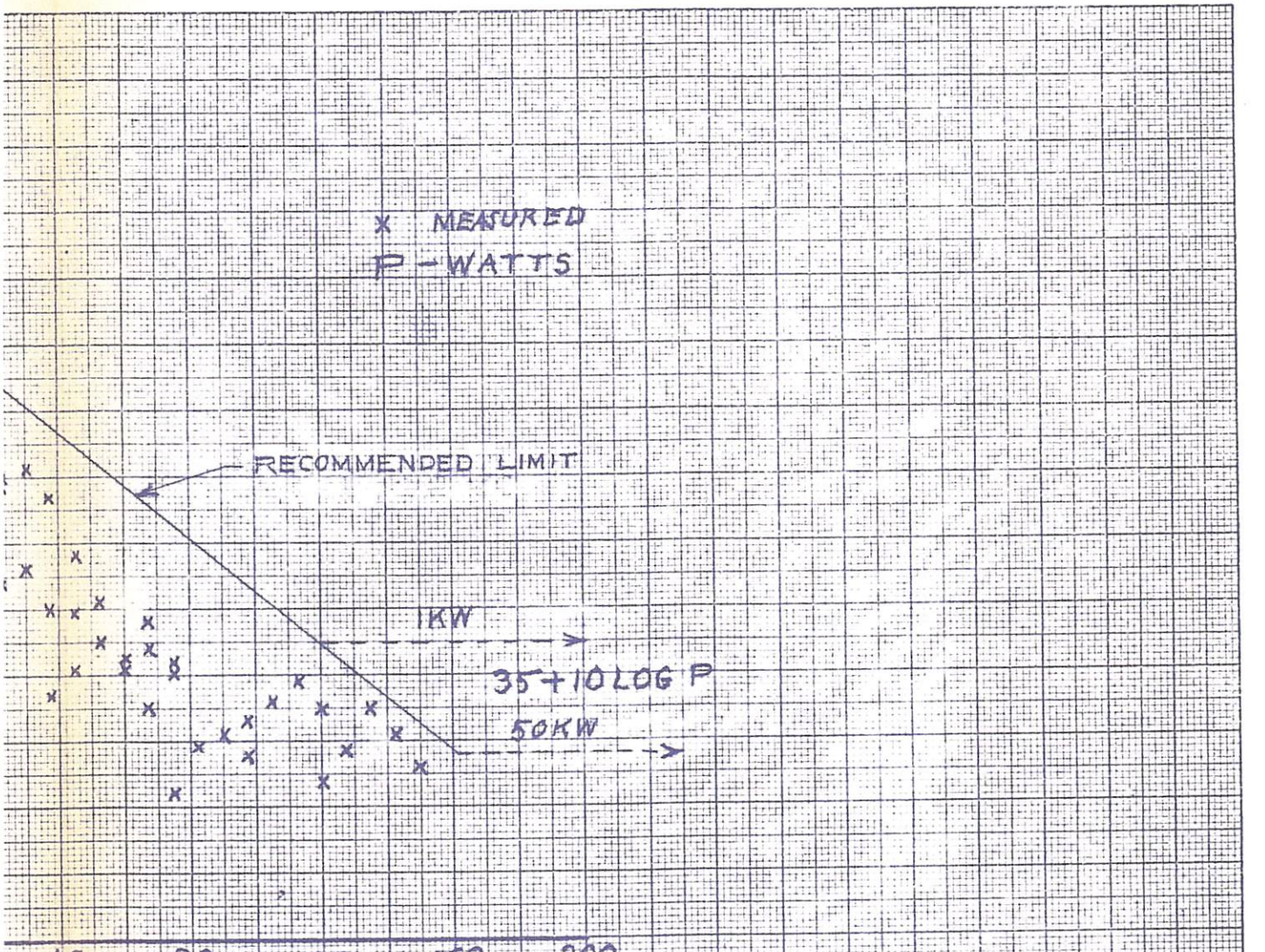
J. F. Rogers
11/21/56

FIG. 5


AMP. db DOWN FROM UNMODULATED CARRIER
0
10
20
30
40
50
60
70
80
90
100
FREQ. DIFFERENCE IN K
0
40
80
120
160
200
CHAN. LIMIT

11/12/56

11/21/56



AM SIDEBAND DISTRIBUTION AND LIMITS

MODULATING FREQ. 7500 CPS
85% MODULATION
4 TRANSMITTERS

FIG. 5

J. F. Briggs
11/7/56

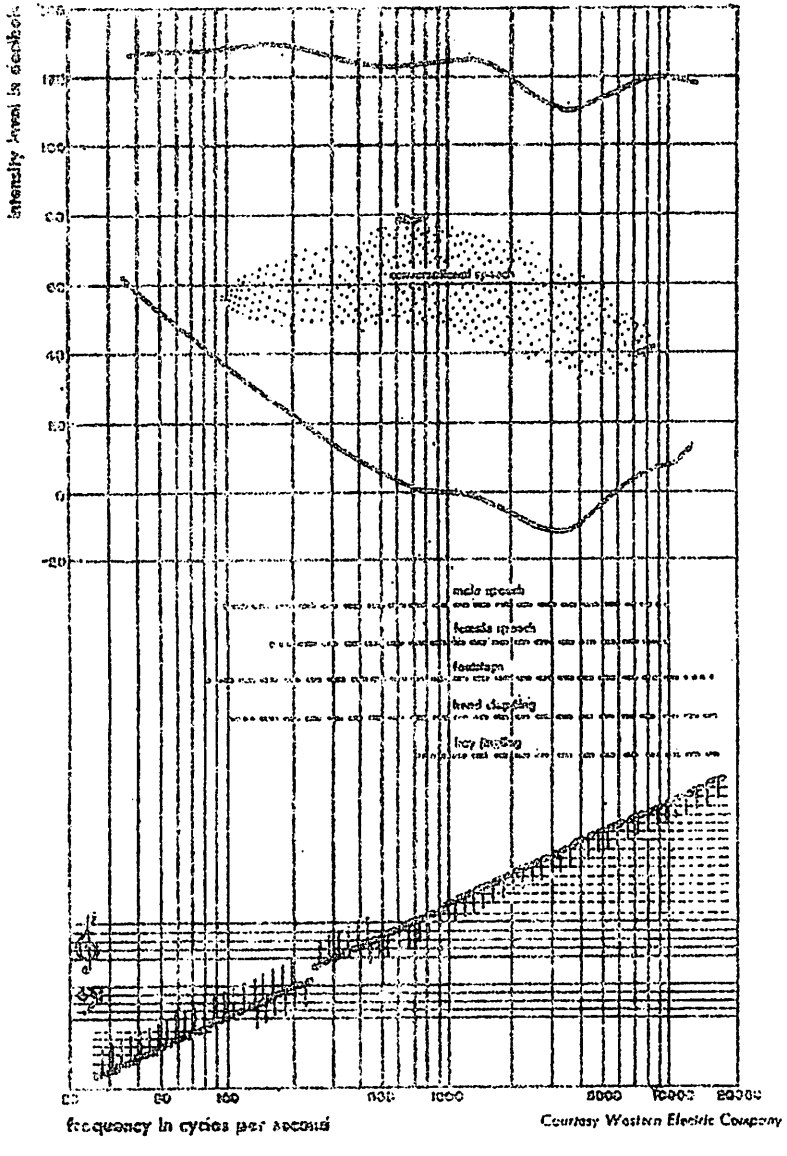


Fig. 10—Frequency ranges of male and female speech and other sounds. Intensity levels of conversational speech. Zero level equals 10^{-16} watt per square centimeter.

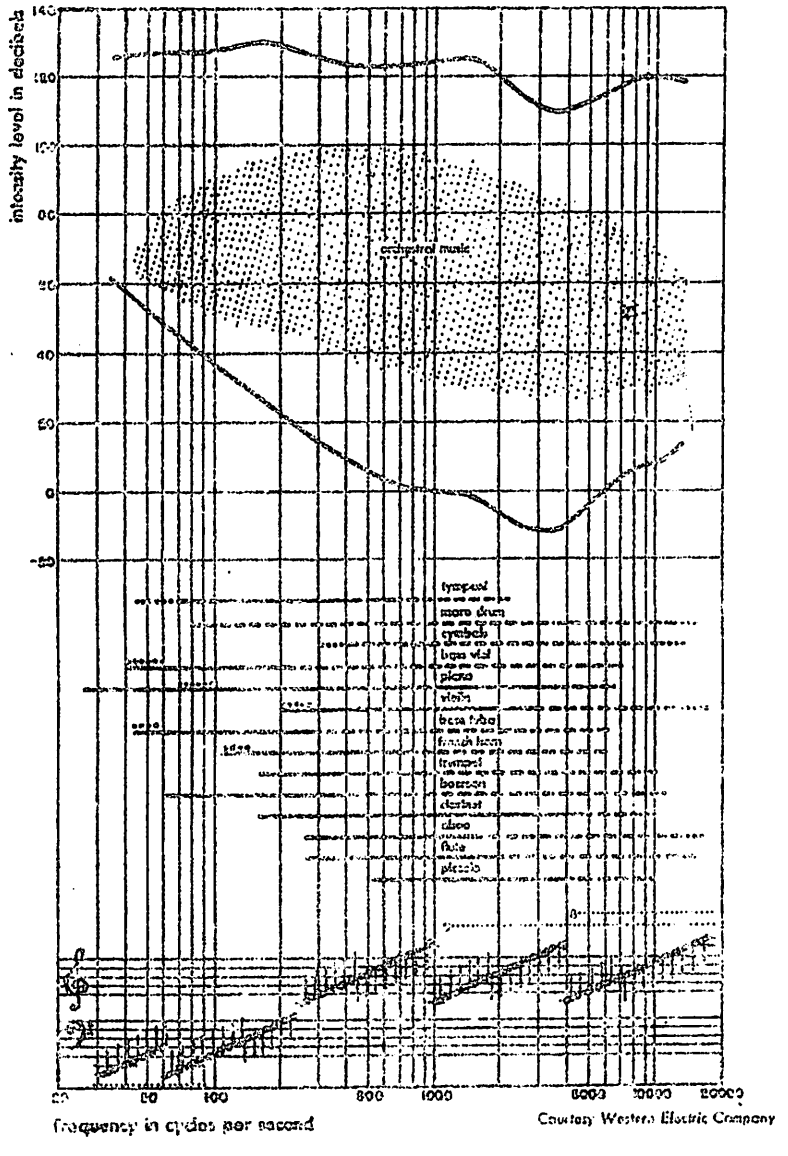


Fig. 9—Frequency ranges of musical instruments. Intensity levels of music. Zero level equals 10^{-16} watt per square centimeter.

Fig. 6

11/15/54