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 require-
ments 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 side-
band 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.

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(b) <u>More than 100% of the Bandwidth Removed from the Center
of the Band.</u>

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 modu-
lation. The technique of measuring should be the same as
applied to measurement of spurious and harmonics from the
visual transmitter.

1.3 <u>Information to Support Recommendations.</u>

(a) Fig. 1 is a composite curve showing the range of measure-
ments obtained from tests conducted on five different trans-
mitters 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. <u>They were the
Measurements Corp. Model 58, RCA Type BW7A and Empire Devices
Type NF105.</u> 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. <u>A comparison of Fig. 1 with a previous survey,</u>
"<u>An Experimental Determination of the Sideband Distribution
in the RCA Color Television System,</u>" copy attached, shows a
<u>similarity of data.</u>

(b) <u>Attenuation Characteristic.</u>

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, Para-
graph 4 of the FCC Rules.

(c) <u>Aural Transmitter.</u>

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 $35 \neq 10$ 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 $35 \neq 10$ 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 $35 \neq 10$ 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%	$10 \text{ Log } \frac{P}{100}$ 20 db Max.	Variable Frequency Sine Wave (200 KC. Reference)
	-3.58 MC	$22 + 10 \text{ Log } \frac{P}{100}$ 42 db Max.	
	100 - 150%	$30 + 10 \text{ Log } P$ 60 db Max.	Solid Color or Color Bars
	150% and Up	$30 + 10 \text{ Log } P$ 80 db Max.	Operate transmitter at reference Black Level.
AURAL	50 - 100%	40 db.	15 KC Sine Wave
	100% and Up	$35 + 10 \text{ Log } P$ 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.

AMP. IN db DOWN FROM UNMODULATED CARRIER

0
10
20
30
40
50
60
70
80
90
100

40
60
80

VIS.
CARRI

12   10   8   6   4   2   0

FREQ.   DIFFERENCE   FROM
IN MC.

CHAN.
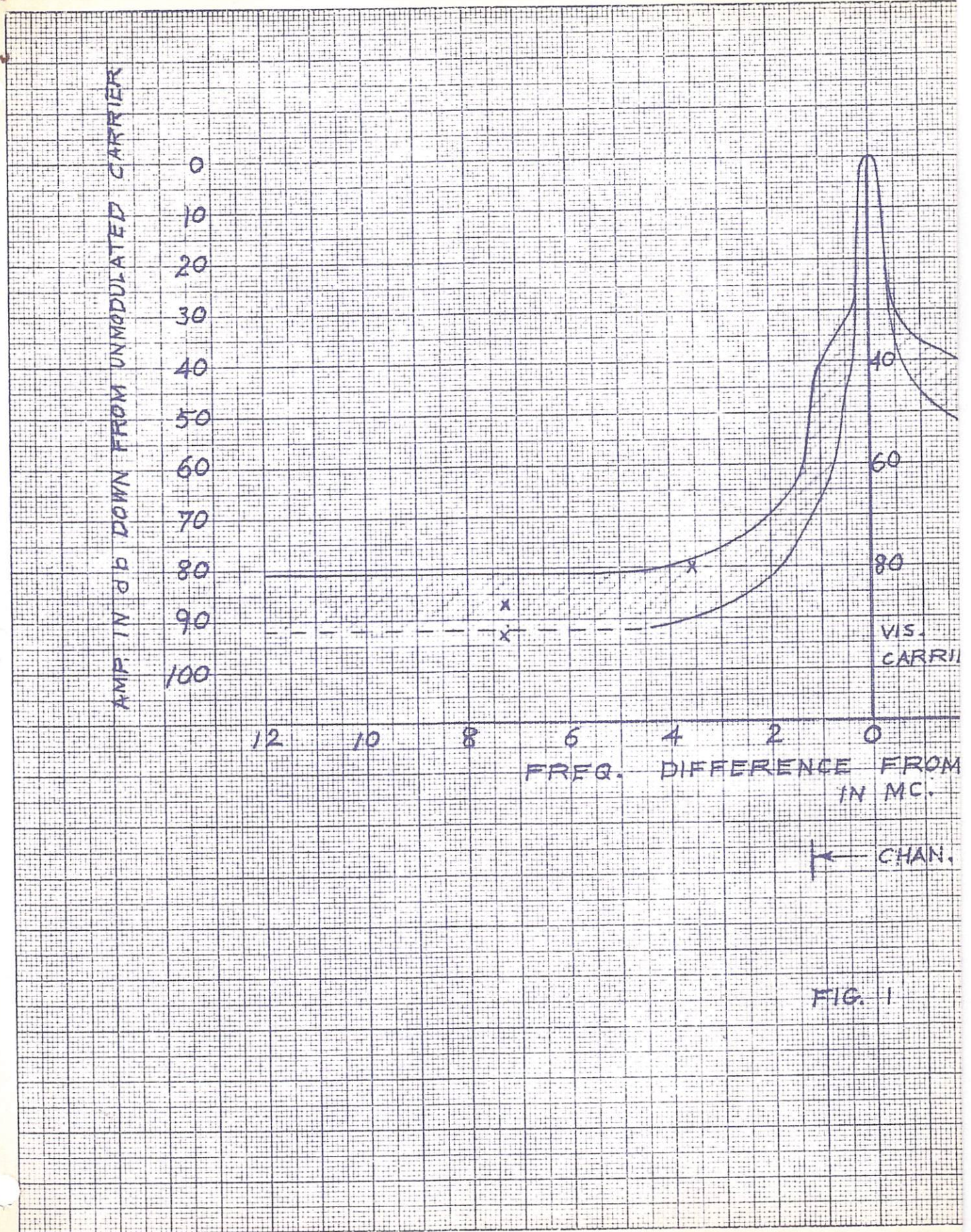
FIG. 1

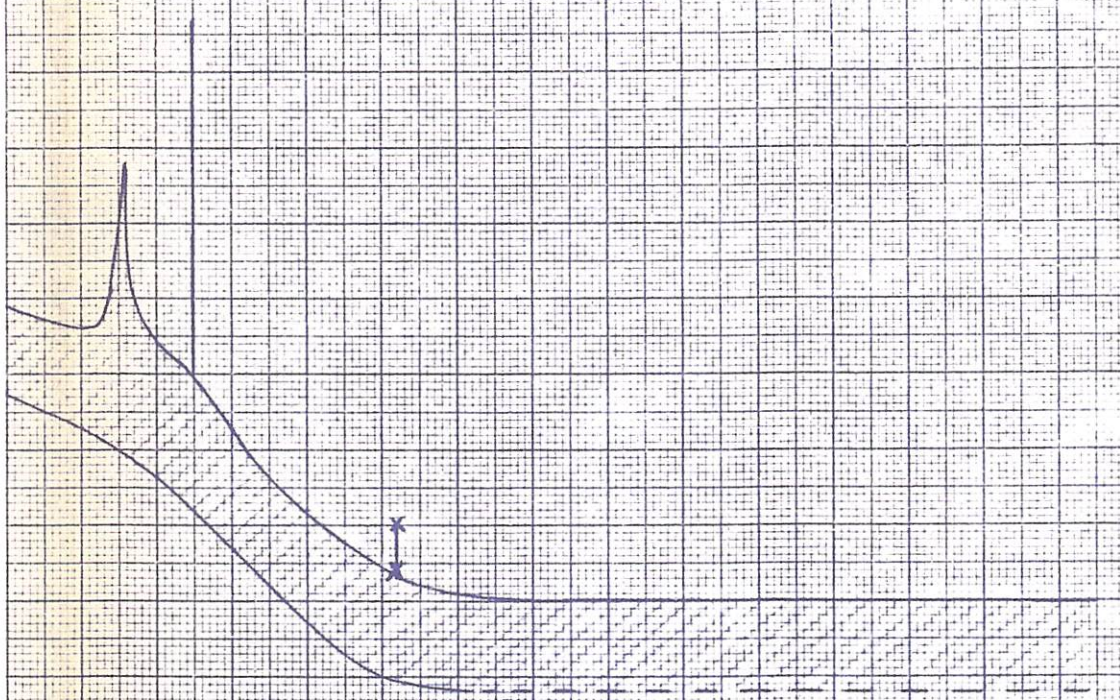X MULTIPLES OF COLOR SUBCARRIER

R

2   4   6   8   10   12   14   16

VIS. CARRIER

LIMITS ⟶

TELEVISION SIDEBAND DISTRIBUTION   FIG. 1
   COMPOSITE CURVE SHOWING RANGE OF
   MEASUREMENTS OBTAINED FOR VARIOUS
   TYPICAL MONOCHROME AND COLOR TEST SIGNALS

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AMP. IN db BELOW VIS. CARRIER

100 80 60 40 20 0

FREQ. DIFFERENCE FROM VIS. CARRIER IN MC.

4 2 0 2 4 6 8
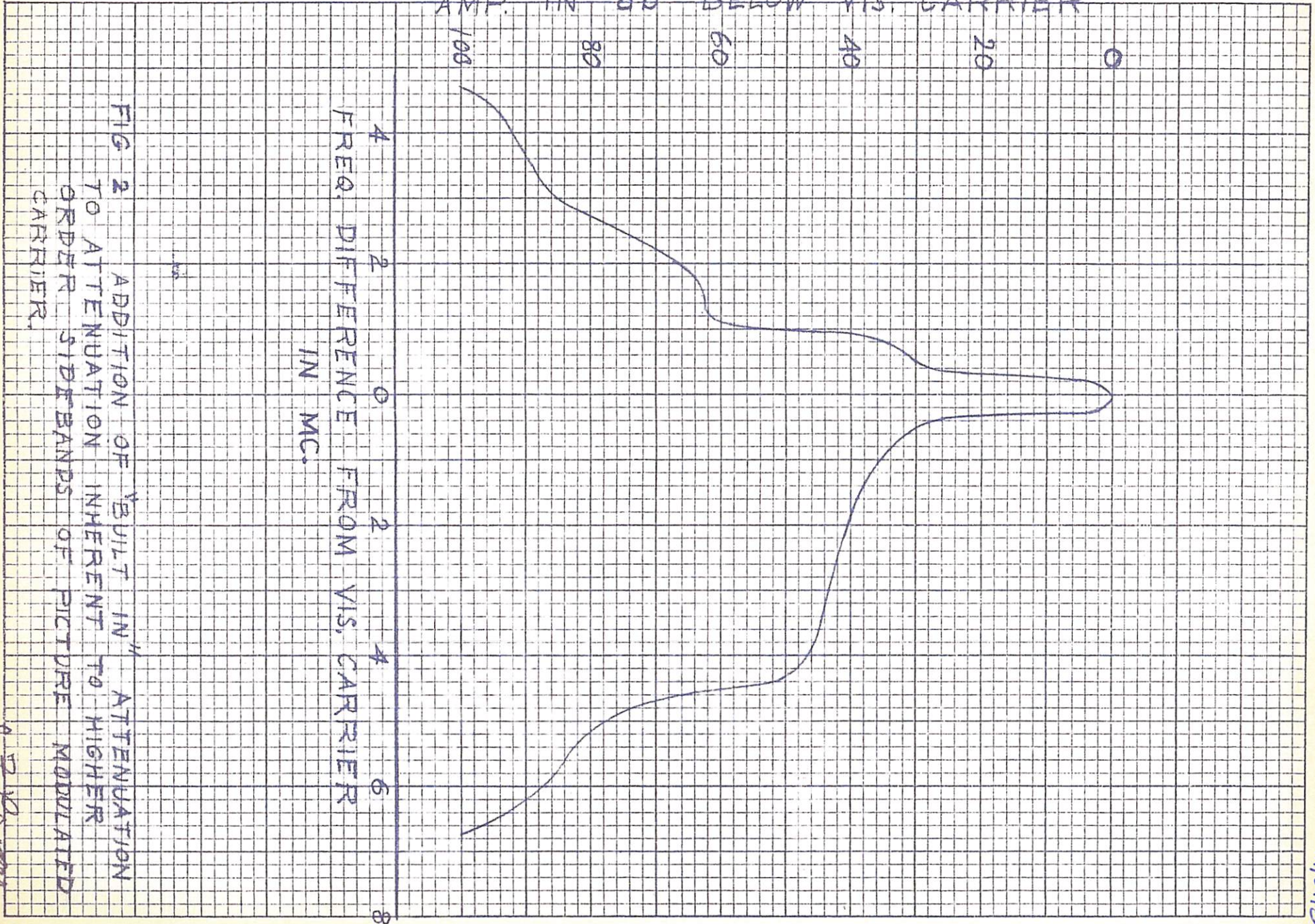
FIG 2 ADDITION OF "BUILT IN" ATTENUATION TO ATTENUATION INHERENT TO HIGHER ORDER SIDEBANDS OF PICTURE MODULATED CARRIER.

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. DIFFEREN
IN

CHAN.
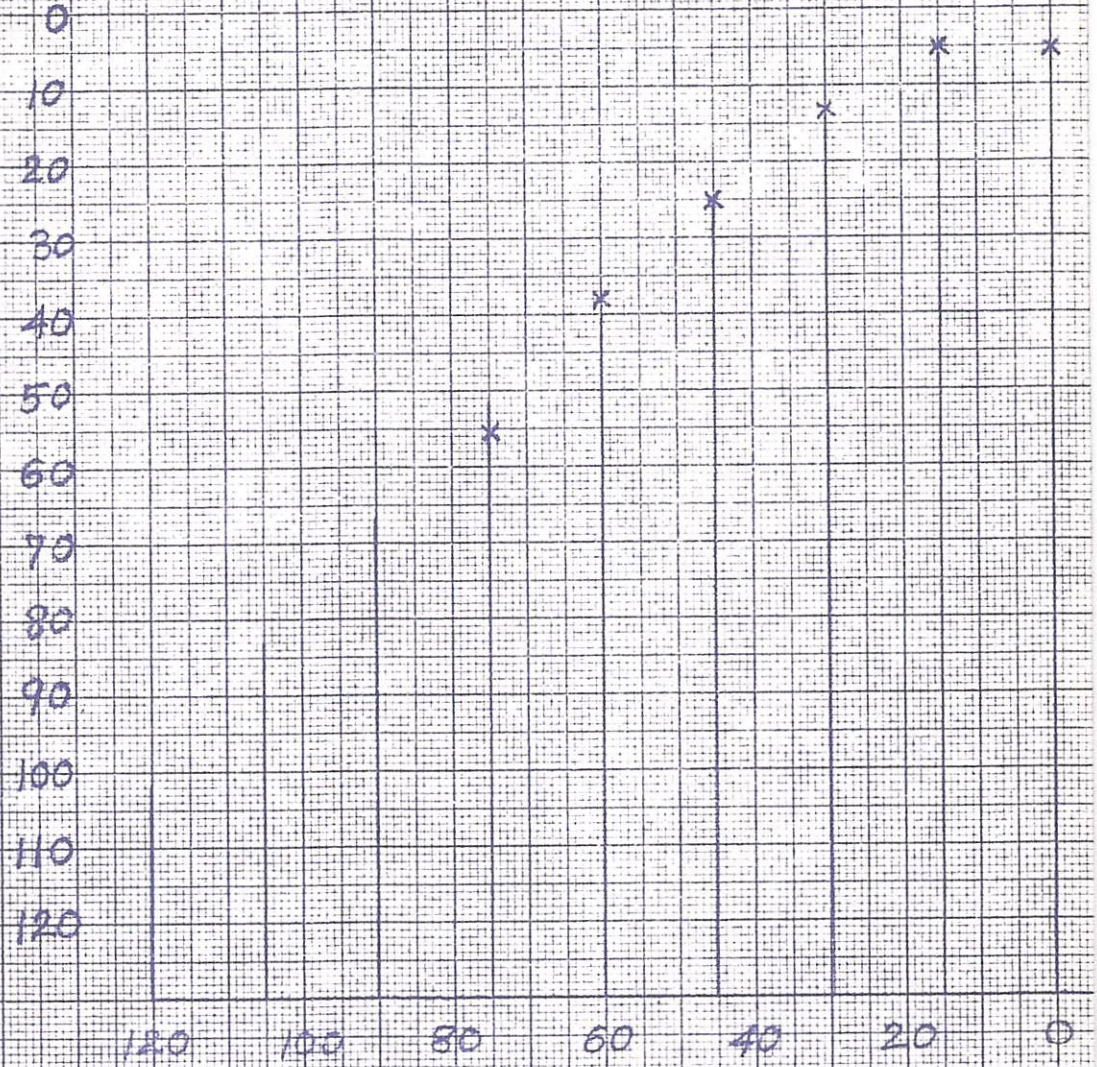
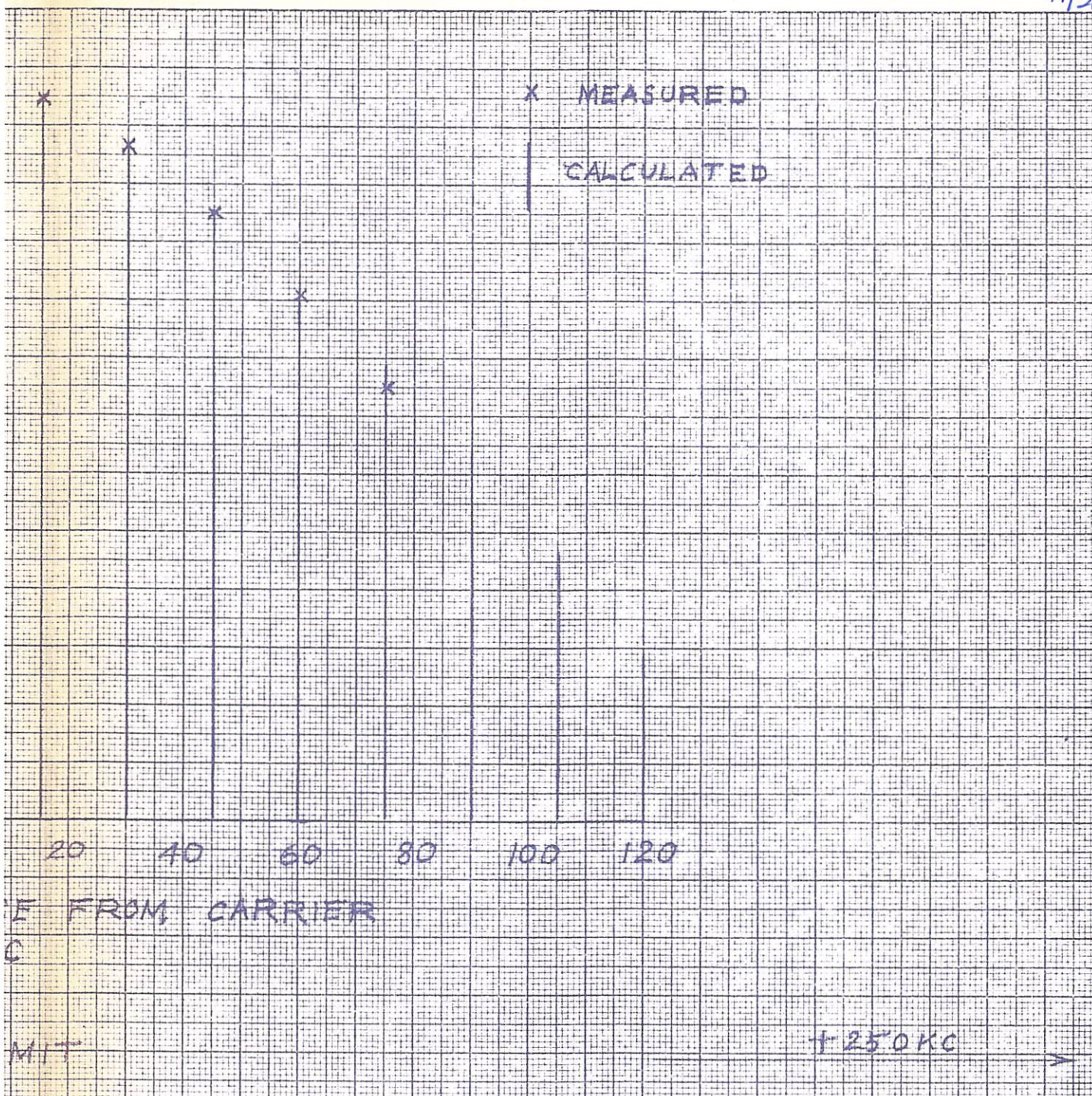FIG. 3

Calculated and Measured Spectrum of TV Aural Trans.
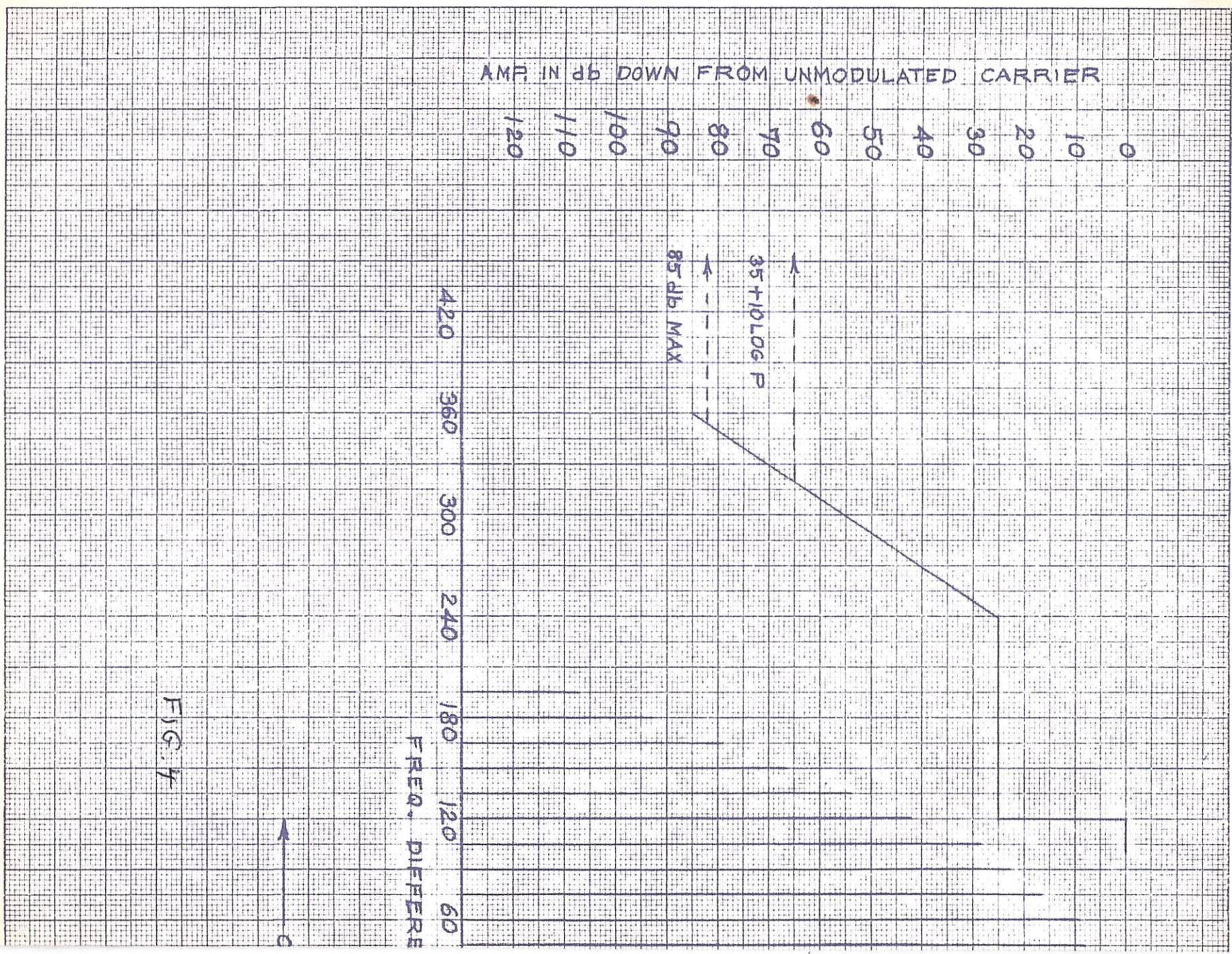Modulating Freq. 15000 CPS
Deviation 21.25 KC.
Modulation Index 1.42

Fig. 3

AMP in db DOWN FROM UNMODULATED CARRIER
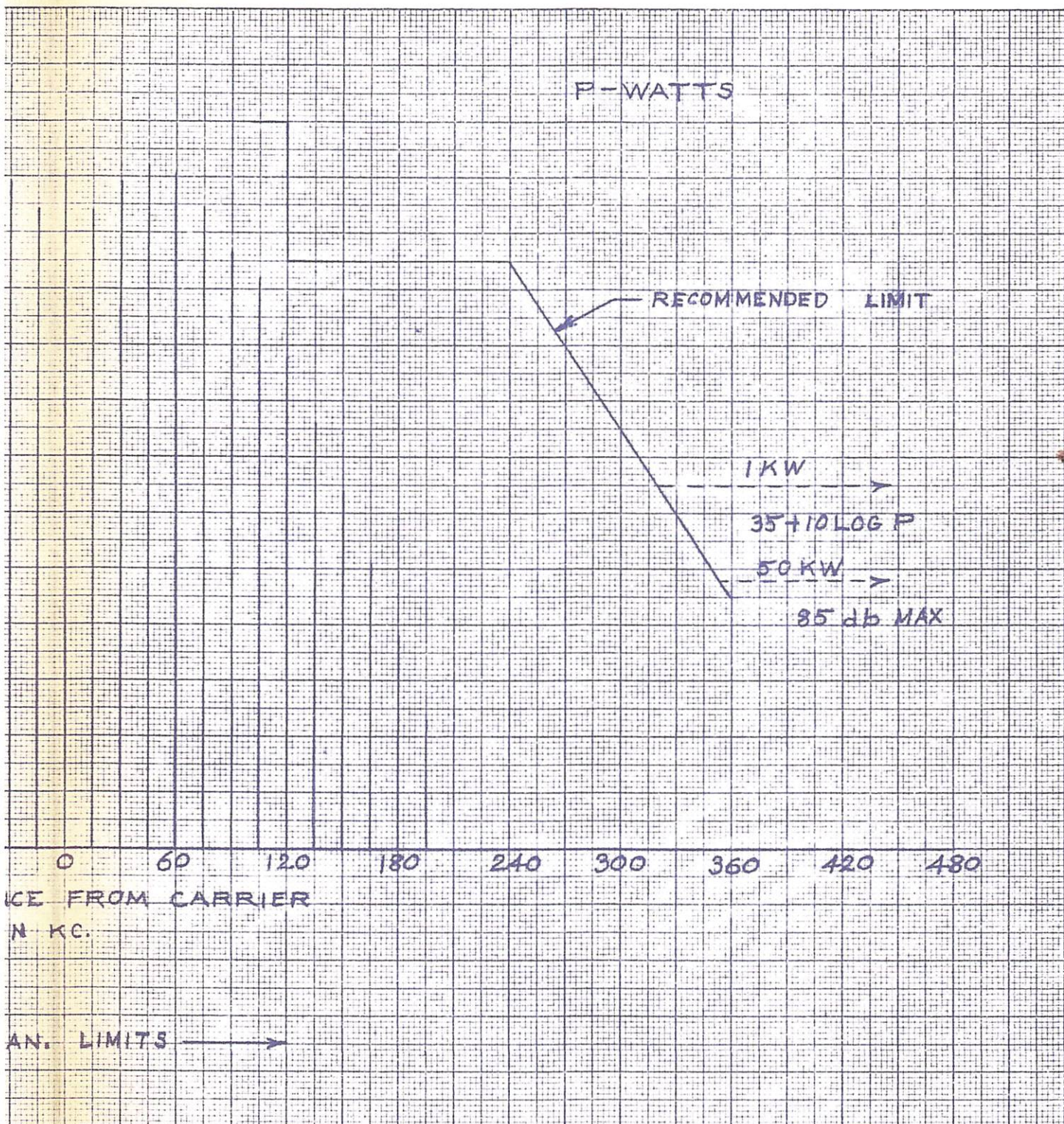
0
10
20
30
40
50
60
70
80
90
100
110
120

35 + 10 LOG P

85 db MAX

420   360   300   240   180   120   60   0

FREQ. DIFFERE

FIG. 4

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P—WATTS

RECOMMENDED LIMIT

1 KW

35 + 10 LOG P

50 KW

85 db MAX

0   60   120   180   240   300   360   420   480

CE FROM CARRIER

N KC.

AN. LIMITS

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

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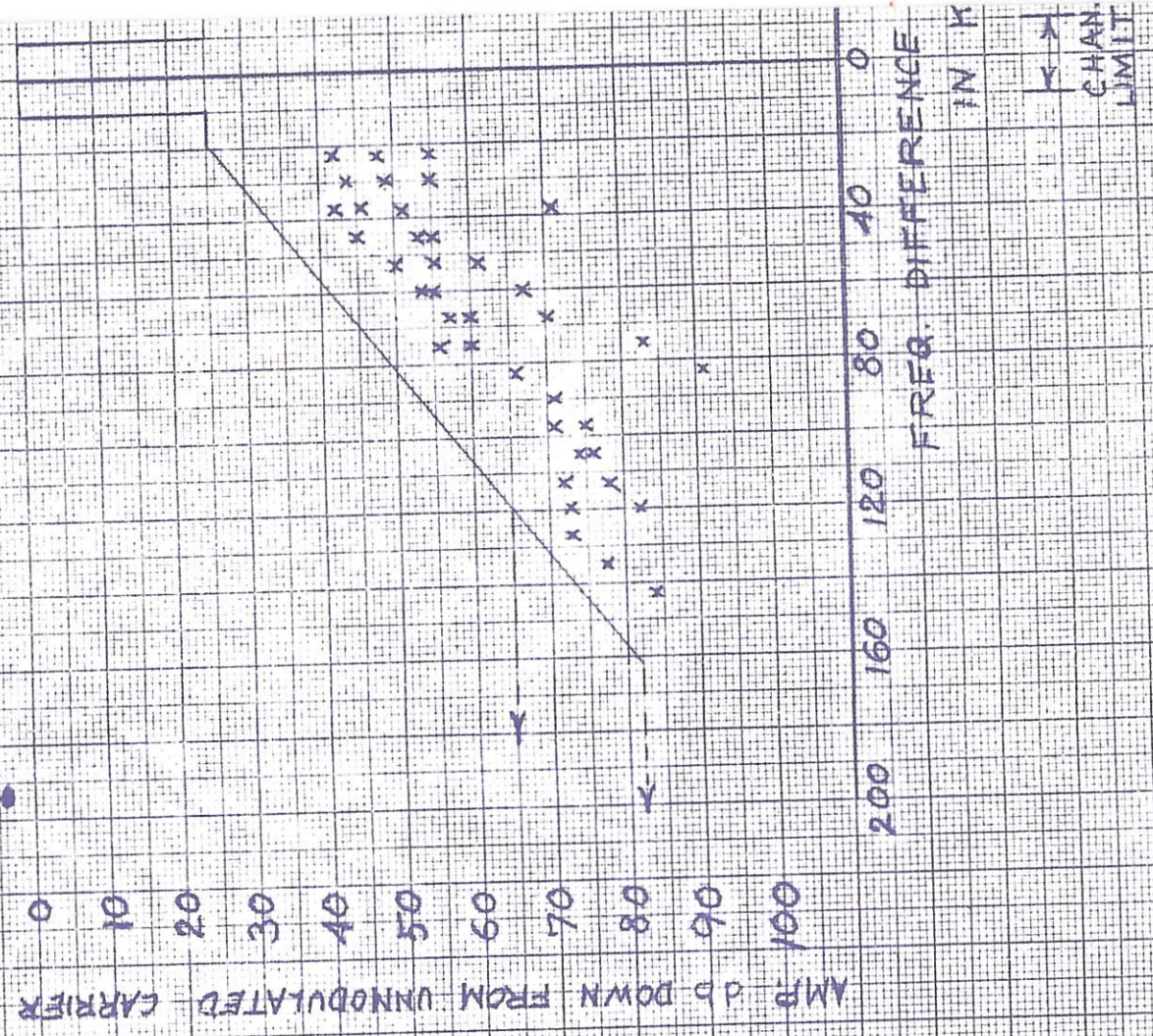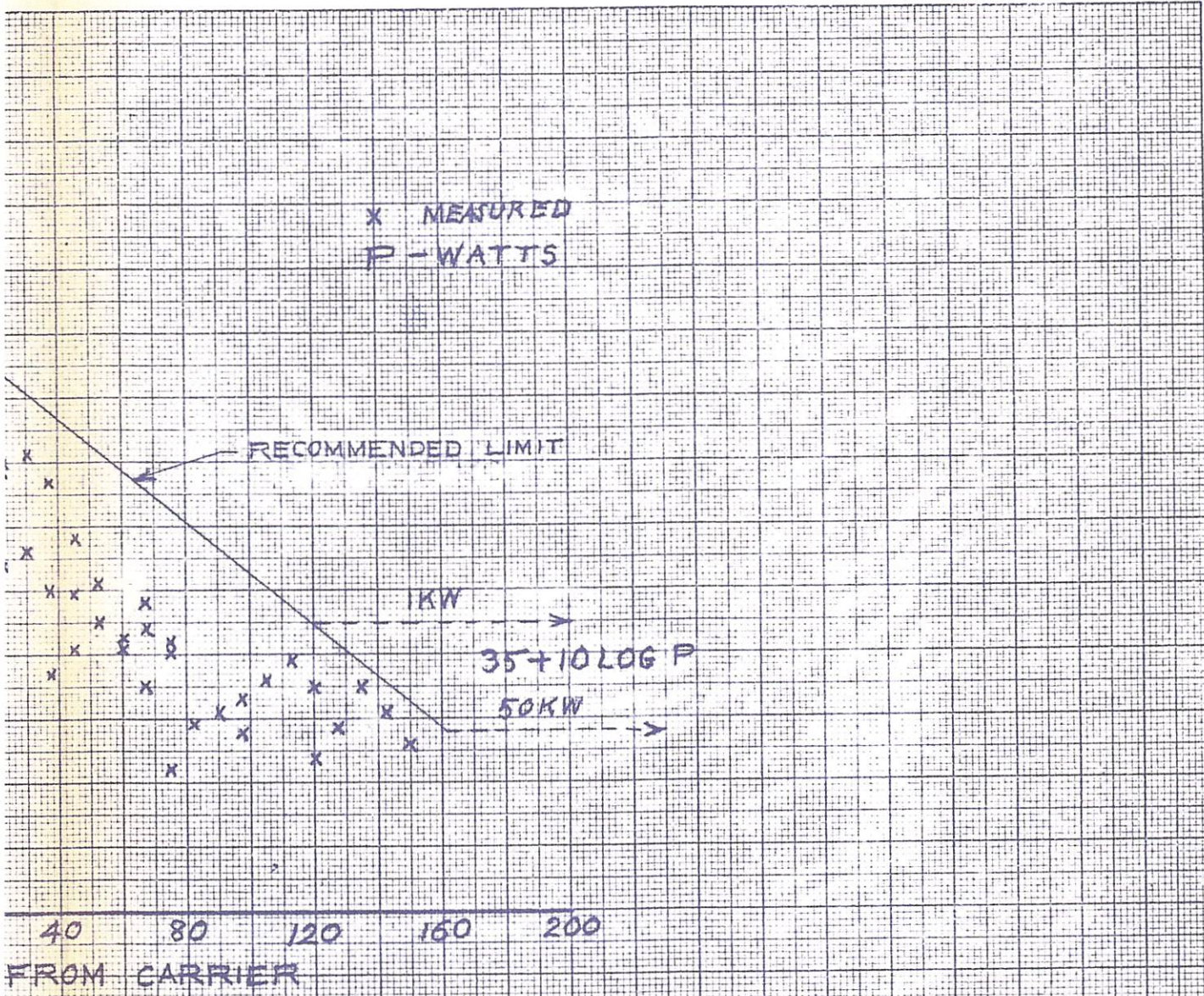
FIG. 5

x   MEASURED

P — WATTS

RECOMMENDED LIMIT

1KW →

35 + 10 LOG P

50KW --→

40   80   120   160   200

FROM CARRIER

A.M. SIDEBAND DISTRIBUTION AND LIMITS   FIG. 5

MODULATING FREQ. 7500 CPS
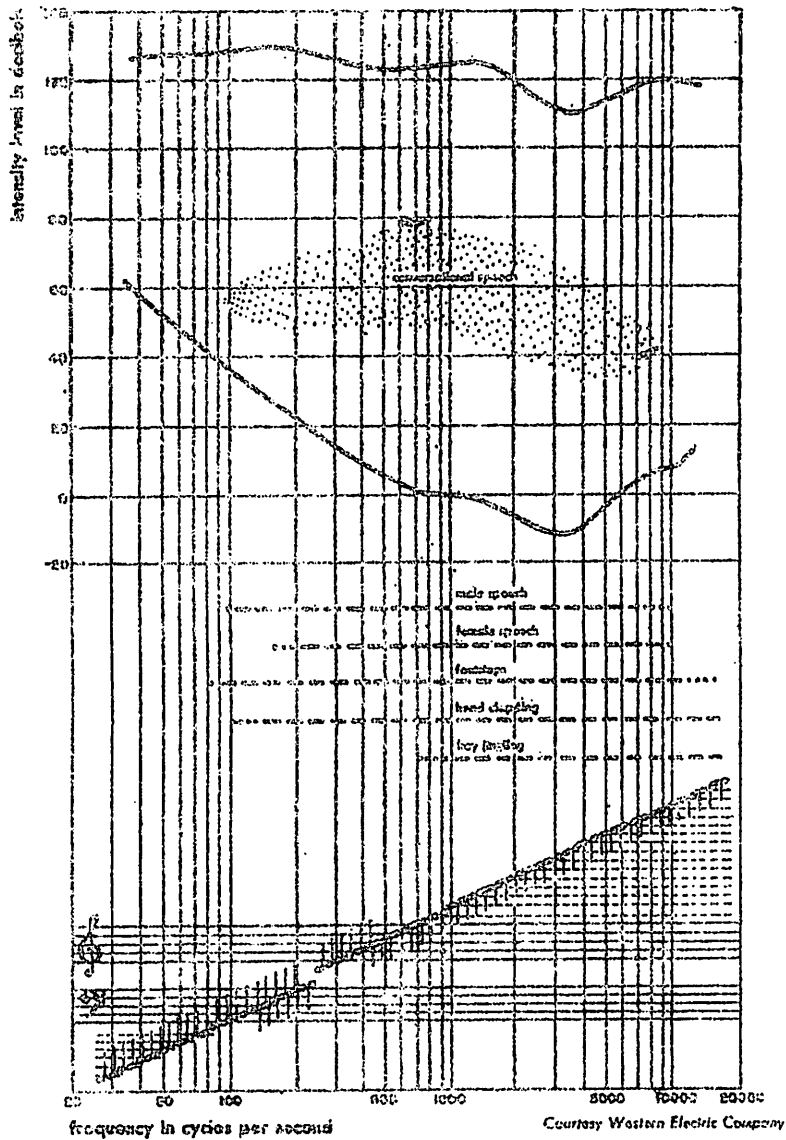85 % MODULATION
4 TRANSMITTERS

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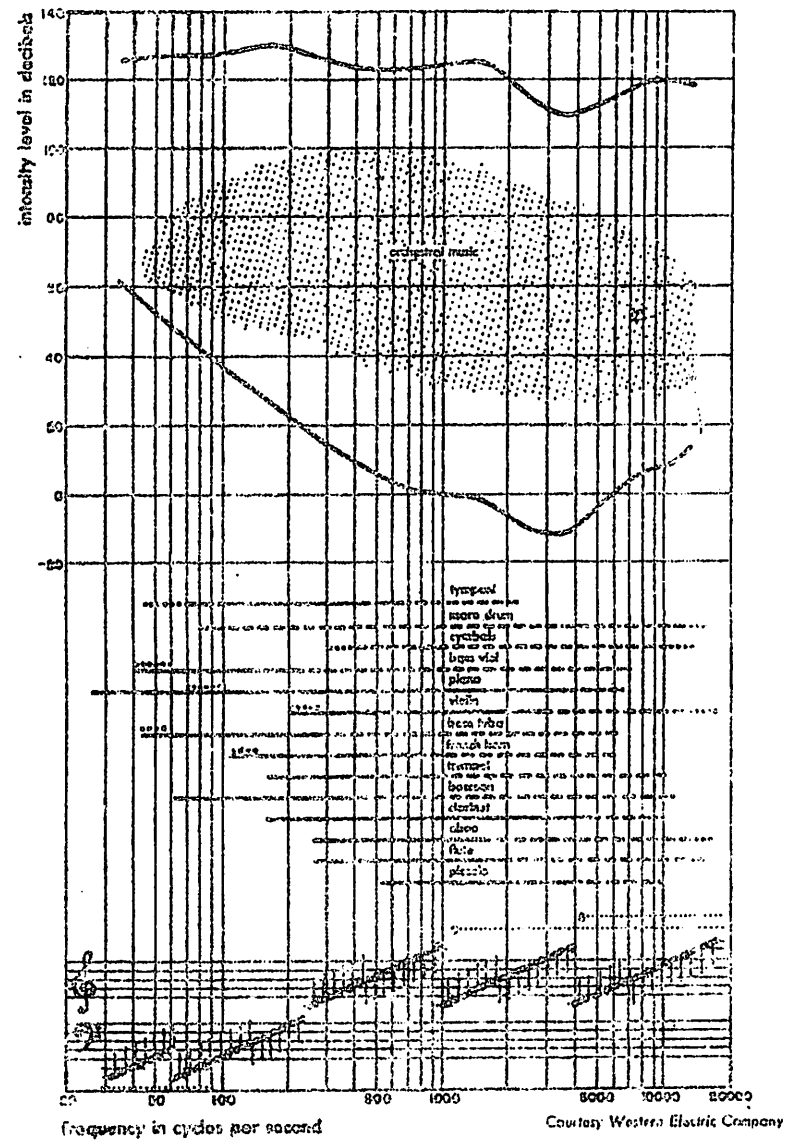
Fig. 9—Frequency ranges of musical instruments. Intensity levels of music. Zero level equals 10^{-16} watt per square centimeter.

Fig. 6